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## **Action Progress Report #1**

Reporting period: 1 Nov 2019 – 31 Dec 2020

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## 1. Introduction to EuroSea

Although the Ocean is a fundamental part of the global system providing a wealth of resources, there are fundamental gaps in ocean observing and forecasting systems, limiting our capacity in Europe to sustainably manage the ocean and its resources. Ocean observing is “big science” and cannot be solved by individual nations; it is necessary to ensure high-level integration for coordinated observations of the ocean that can be sustained in the long term. For Europe, EuroSea will point the way for the current and future cooperation between science and industry, politics and the public with the common goal of a sustainable blue economy and the responsible handling of the sensitive marine ecosystems. The project will make a significant contribution to not only generating, processing and linking information about our oceans, but also to make long-term and extensive use of this and the resulting knowledge in a wide variety of areas. As a link between sectors and disciplines, EuroSea faces a very big challenge.

The vision of EuroSea is to advance research and innovation towards a user-focused, truly interdisciplinary, and responsive European Ocean Observing and Forecasting System. – A system, that delivers the essential information needed for human wellbeing and safety, sustainable development and blue economy in a changing world.

In order to significantly improve European ocean observation and forecasting services, EuroSea is committed to working closely with developers and potential end-users of products and services. This co-design approach leads to the strengthening of a joint community which is needed for the design and the implementation of a functional system. The overall aim of EuroSea is not only to significantly improve the European ocean observing system which advances scientific knowledge about ocean climate, marine ecosystems, and their vulnerability to human impacts and demonstrates the importance of the ocean for an economically viable and healthy society by delivering ocean observations and forecasts but also to integrate this system as an important entity in the global context.

To achieve this overall goal, the following objectives have been set for EuroSea

1. Strengthening European ocean observing and forecasting as an integrated entity within a global context
2. Improving the design for an integrated European ocean observing and forecasting system for the European seas and the Atlantic, including the deep sea
3. Improving and enhancing the readiness and integration of ocean observing networks
4. Enabling FAIR data, supporting integration of ocean data into Copernicus Marine Service, EMODnet and SeaDataNet portfolios
5. Delivery of improved forecasts and new information synthesis products by better use of data in models
6. Development of novel services, demonstrating the value of the ocean observing system to users
7. Support of an integrated, sustainable and fit-for-purpose ocean observing system by engaging with a range of end-users and other stakeholders

The project consortium consists of 55 partners with expertise from various sectors (science, industry, ethics, economy, industry, education, politics, ...). Considering the size of the consortium and the broad range of tasks in the project, it is a great advantage that many of the partners have already worked together in different constellations and many of the tasks build on long-lasting and close collaborations and partnerships.

The project is divided into 10 work packages (WPs; Table 1, Figure 1), which in turn are subdivided into individual tasks. Roughly, these work packages can be classified into the following categories: Design & Coordination (WP2, WP3, WP4), Services & Innovations – EuroSea Demonstrators (WP5, WP6, WP7), and Governance & Legacy (WP1, WP8, WP9&10).

Table 1. List of EuroSea work packages

| WP # | WP title  |
|------|---|
| WP1  | Governance and Coordination of ocean observing and forecasting systems  |
| WP2  | Ocean Observing System Design   |
| WP3  | Network Integration and Improvement                                     |
| WP4  | Data integration, Assimilation, and Forecasting                         |
| WP5  | Coastal Resilience and Operational Services Demonstrator                |
| WP6  | Ocean Health Demonstrator   |
| WP7  | Ocean climate indicators demonstrator                                   |
| WP8  | Communication: Engagement, Dissemination, Exploitation, and Legacy      |
| WP9  | Project Coordination, Management and strategic ocean observing alliance |
| WP10 | Ethics requirements   |

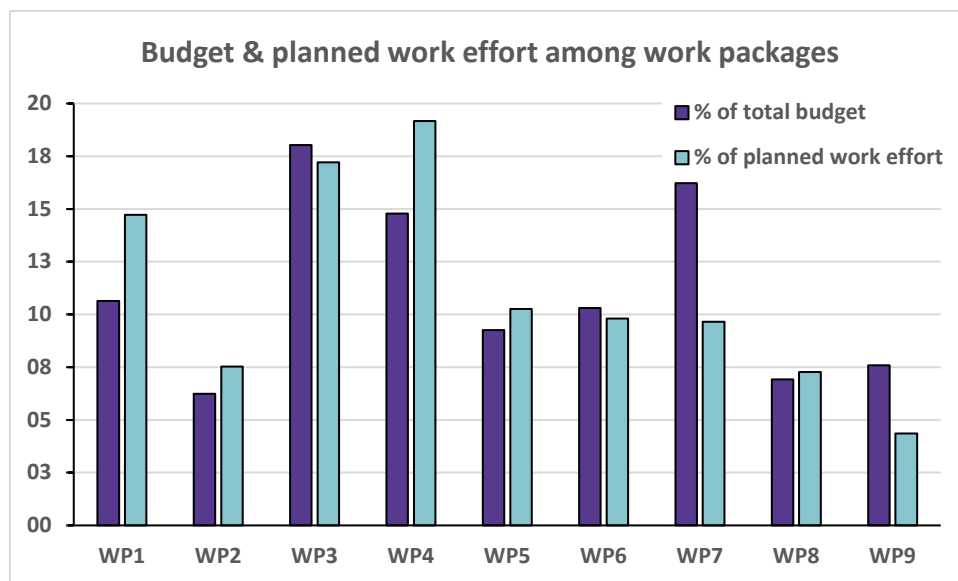


Figure 1. Distribution of budget and work effort (personnel months) among work packages. The total budget of the project is 12,600,000€. The overall planned work effort is 1188 project months. Difference in budget vs. work effort is related to investments.

## 2. Summary of progress

The First 14 months of EuroSea has been intense; activities in all work packages has spun-up and the first deliverables and milestones has been delivered. A summary of progress, overall and in the individual work packages, is provided in this section, whereas a more detailed account of progress per work-package and tasks toward the objectives and deliverables, is provided in the following chapter.

EuroSea benefited from a management support already a few months prior to the official start of the project, and could gather the consortium already by the end of month 1 of the project for the Kick-off-Meeting and the first General Assembly. EuroSea is, from the first moment, focusing on creating sustainable support structures and coordination for the observing and forecasting system of Europe, with a global perspective. This is a time of an increased ask from society for ocean information and services, and EuroSea is well positioned to play a leading role by a wide range of partners from intergovernmental organisations through universities and research institutes to commercial partners. EuroSea partners are working for creating structures and services with a lasting impact past the end of the project in about 3 years from now.

The year 2020 has been challenging for all of us because of the global COVID-19 pandemic, including for EuroSea. It has been impossible to hold in-person meetings, and field-work has been difficult to impossible. Although several meetings have been held virtually, several meetings and workshops where in-person attendance were deemed as particular important, have been postponed. This is in particular true for interaction and engagement with stakeholders, an important objective of EuroSea.

Without pointing to any particular success of EuroSea, all work packages have been able to work efficiently towards their objectives. The Steering Committee of EuroSea (i.e. the work-package leaders) have been meeting every month and been able to increase synergy and cooperation between the different tasks and work-package, and been able to mitigate potential issues at an early stage.

#### **WP1 - Governance and Coordination of ocean observing and forecasting systems.**

WP 1 has made steady progress to strengthen European leadership in Ocean Observing System coordination and foresight including strengthening the European Ocean Observing System (EOOS) and work towards the implementation of the Global Ocean Observing System (GOOS) 2030 Strategy. The successful establishment of EOOS Operations Committee has been an essential step towards this objective bringing together over 45 participants representing 23 European nations including GOOS National Focal Points (NFP), research infrastructure, EuroGOOS structures, and European earth observation agencies. This forum, together with the other EOOS governance structures, is a key to implementing EOOS and help GOOS implement its strategy in Europe.

Bringing together the leading global authorities in marine debris research to develop a marine debris Essential Ocean Variables (EOVs) was an important first step in developing a marine plastics observing system/capability. Work is well on track to begin towards an Integrated marine Debris Observing System (IMDOS) coordinating sustained observing of this EOVS, a human pressure EOVS for GOOS.

Work undertaken in mapping biological ocean observing networks and the extent of monitoring of the BioEco EOVS in Europe will help move towards a fully integrated global ocean observing system in Europe. To date, 135 biological marine monitoring networks in Europe have been identified and verified. The mapping of these networks will allow the understanding of the scale of coordination, variables measured, and other information to enable better integration.

Planning of workshops that allow engagement and knowledge exchange between EuroSea and the international ocean analysis and forecasting community under OceanPredict in close collaboration with other work packages is progressing. These workshops will support an integrated European Ocean Observing and Forecasting System and highlight European leadership in some of these areas. The production of best practices was identified by EuroSea as an essential legacy outcome of the project. To advance the development of best practices in the relevant work packages, engagement activities are being conducted,

and ideas will be created to support teams developing best practices. The analysis of the legal frameworks and mechanisms focused on supporting sustained ocean observing and fit for purpose ocean information is underway, with hard and soft law frameworks and mechanisms being analysed.

A timely public consultation on a European Commission (EC) Ocean Observation initiative will provide more impetus to advance and coordinate an integrated ocean observing system for Europe. EuroSea, under this WP, formulated a response to the EC's initiative for the joint planning of ocean observations and monitoring in Europe and will have input into the public consultation.

### WP2 - Ocean Observing System Design

In collaboration with WPs 4, 5, 6 and 7, WP2 is codeveloping a precise framework to increase the readiness level for the regular and sustained delivery on the Essential Ocean Variables (EOVs) and Essential Climate Variables (ECVs) which are needed to build the relevant climate and ocean indicators. To do so, WP2 has collected and rationalized relevant EOVs and ECVs for current indicators and set a strategy to co-develop and refine indicators with different stakeholders (task 2.1).

WP2 has also provided objective guidelines to improve existing elements and/or implement new components of the Atlantic and Mediterranean Sea Observing system (task 2.2). This is done based on Observing System Design Experiments that rely on physical and biogeochemical (BGC) models, or statistical techniques that realistically represent the space-time variability of the EOVs to be observed. Both methods optimally merge *in situ* and satellite observations.

Moreover, to improve the design of multi-platform experiments aimed to validate the future Surface Water and Ocean Topography (SWOT) satellite observations and to optimize the exploitation of such new high-resolution remote sensed data in general, WP2 has developed an approach to undertake a series of adapted Observing System Simulation Experiments (OSSEs). Such OSSEs are on very high-resolution models to simulate the observations and the ocean "truth" (deliverable D2.3). They will be used to evaluate different configurations of the *in situ* observing system. Several methods of reconstructions are being tested to reconstruct the simulated observations.

### WP3 - Network Integration and Improvement

WP3 oversees key aspects of integration of European observing technology for its optimal use in an EOOS and global initiatives such as GOOS. Two major categories of networks identified are included in the project: Observing networks, grouped around technology on platforms (mooring, tide gauges, glider, floats, ships, etc.), and thematic networks, grouped around a certain observing challenge (e.g. metagenomics, data, scientific issues). Improving internal coordination within the observing networks, and interaction with the observing component in the demonstration activities (WP5,6,7) are major objectives. Considering that a major mechanism within WP3 are the network specific workshops in which key experts are invited and thus effectively broadening the partnership, due to the COVID-19 pandemic, WP3 faced difficulties. More specifically, almost all scheduled workshops for the cooperation and integration of the individual networks have been postponed by a few months, adapting to the new conditions (teleconferencing). Two workshop-associated deliverables (D3.5 & D3.7) had to be postponed accordingly. The other two deliverables D3.1 & D3.2 have been delivered as scheduled.



#### WP4 - Data integration, Assimilation, and Forecasting

WP4 has strong links with the Copernicus Marine and Climate Services. This ensures that EuroSea research and development activities can be integrated in the Copernicus Marine and Climate Change Services, thus reaching TRL7 and 8 at the end of the project.

The first year has been devoted to the planning of the technical activities, the recruitment of personnel and the start of the different tasks. All tasks except task 4.4 (as from workplan) have started their work and are on track. Interfaces with WP2 and WP3, WP5, 6 and 7 have been partially defined. Recruitment of personnel has been slowed down by the COVID-19 crisis. There is delay of a few months for some tasks but this will not impact the completion of tasks in due time.

Tasks 4.1 and 4.2 have started assessing the impact of observations in Copernicus Marine Service models (Global, North East Atlantic, Med Sea) through Observing Systems Experiments in particular for gliders and deep Argo. A parallel work on advancing data assimilation techniques also started to better use observations in models (gliders, BGC Argo).

Task 4.3 has started to develop a regional ensemble forecasting system for the Mediterranean Sea. Uncertainties in the atmospheric forcing have been investigated. Wind ensembles will be used to generate members of an ensemble ocean forecasting system that efficiently captures the uncertainties in sea level and current forecasts.

Task 4.5 has contributed to the recent releases of the GLODAPv2.2020 and SOCATv2020 carbon data products.

Task 4.6 has used improved climate records of Ocean Heat Content (OHC), Sea Level (SL), Sea Surface Temperature (SST) to validate seasonal forecast of ocean. Initial verification indicates that dynamical seasonal forecasts of OHC and SL are more skilful than persistence, and also more skilful than equivalent forecast of SST.

#### WP5 - Coastal Resilience and Operational Services Demonstrator

WP5 provides a demonstration of improved end-to-end connection from a new generation of stakeholder co-designed observations to their wider integration and use in innovative software tools. The WP5 team has made extensive use of conferencing technologies to overcome the difficulties posed by the COVID-19 pandemic. Significant progress has been made in establishing the technical specifications of the multi-parameter measurement stations (with core sea level measuring capabilities). Instrumentation for testing sensor configurations and data transmission has been purchased and tested. We have established local organising groups at the port cities of Barcelona, Taranto, and Alexandria to optimise the planning of equipment installation and to mitigate against travel restrictions. Once all sites for installations have been selected then procurement of the full instrument packages will begin (starting in early 2021).

Progress towards an improved reconstruction and quantification of the various contributions to relative sea level in the Mediterranean Sea has been made by combining tide gauge observations with altimetry data and fingerprints of land-mass changes through a Bayesian spatiotemporal model. Coastally-retracked altimetry data has been generated using gridded altimetry datasets from the Copernicus Marine Environmental Monitoring Service (CMEMS), tide gauge and vertical land motion data have been obtained, and the Bayesian spatiotemporal model is under development. For the future sea level decision tool demonstrator, model runs for future coastal flooding scenarios at our case study site have been defined and are scheduled for

completion during 2020. Development of the conceptual interface and simplified impact assessment algorithms are both underway and stakeholder discussions are planned for January 2021. For the new coastal management product, Oceanographic Services at the service of Ports and Cities (OSPAC), detailed requirement documents have been developed, and the coding of the OSPAC interface has begun.

#### WP6 - Ocean Health Demonstrator

The role of WP6 in EuroSea is to highlight the importance of the ocean observing system in water resource management and ocean health through the development of products and services that detect, monitor and forecast anomalous and extreme events (e.g. marine heat waves, deoxygenation, eutrophication etc.) threatening marine ecosystems, resources, and related businesses. In WP6, downstream products are generated using a combination of the *in situ* data systems, earth observations, model analyses and forecasts, and biogeochemical and biological information, in many cases provided by our co-developers.

In this first reporting period, WP6 partners and co-developers agreed on requirements (EOVs) and approaches (*in situ* demos, design, models, methods, etc.) to be taken in the next period. A series of in-person and virtual meetings with stakeholders in Ireland and a dedicated online survey with Spanish aquaculture companies were conducted to define new EuroSea water quality assessments and forecasting products for aquaculture, fisheries, regulators and policy makers. Through this work, new high value datasets were identified. The WP6 team will gain access to recent and historical chemical, physical, and biological ocean data and use it to enhance and develop WP6 data products. The team will also help to ensure WP6 data is made available to the European data repositories. This will improve availability of both historical and recent data on variables such as temperature, pH, turbidity, and water currents, improving the modelling products.

In the context of connecting CMEMS and fisheries communities, anchovy, sardine and tuna were identified as species of interest. It was agreed that Copernicus products can give insight about environmental drivers on estimated recruitment time series. Selected EOVs are used in a GADGET model to provide forecasts and improve advice. Joint activities in the Baltic Sea by the Baltic Operational Oceanographic System (BOOS) and Helsinki Commission (HELCOM) focused on improving eutrophication status assessments are combining CMEMS products and *in situ* ship-based data from environmental monitoring. The operational delivery of monitoring data to CMEMS was initiated during this first year. Finally, EuroSea technical developers (XYLEM) designed a data buoy system solution to address the type of monitoring needed in SW Ireland and the Mediterranean Sea.

#### WP7 – Ocean Climate Indicators

The major progress of the WP7 climate demonstrator includes data product development and assessment for carbon stocktake in the North Atlantic and Mediterranean Sea (7.1), the definition of ocean indicators for seasonal forecasts, including stakeholder engagement (7.2), and the successful preparation of the mission components planned in 2021, including additional fund raising to assure the success of this project component (7.3).

#### WP8 - Communication: Engagement, Dissemination, Exploitation, and Legacy

WP8 delivers a critical support to the project and its demonstrators, assisting EuroSea in the delivery of viable and targeted outputs, displaying how EuroSea is improving the information provision to a range of users, and ensuring a legacy.

In the first 14 months of the project, WP8 engaged with the project partners to help them focus their stakeholder activities, delivered effective project visualisations and outreach tools (e.g. project website,

project video), and boosted visibility through a high-level stakeholder webinar and social media. Three documents were delivered and are available on the website: Responsible Research and Innovation Principles application for ocean observing (RRI info sheet), Communication Plan, and Updated Dissemination and Exploitation Plan. Work has been planned towards future engagement with the next generation of stakeholders. WP8 leader together with WP1 leader developed an impact monitoring protocol for EuroSea.

### WP9 - Project Coordination, Management and strategic ocean observing alliance

In November 2019, the project coordination unit (PCU) organized in collaboration with RBINS the EuroSea Kick-off Meeting (KoM) in Brussels where all 55 project partners were represented and which was a fantastic start in the first year of EuroSea. Briefly after the start of the project, mailing lists and a EuroSea cloud space were set up to facilitate and foster internal project communication. In monthly meetings with the Steering Committee, the project progress as well as challenges and opportunities were regularly discussed. In addition, the PCU provided support on cross-WP issues and activities and performed its role as a communication link to the EC. Among other things, two amendments were successfully requested.

In order to provide all project members with a regular overview of activities in the project and beyond across the landscape of ocean observing and forecasting, the PCU has decided to report personally to the consortium in short monthly newsletters. The first EuroSea News were issued in May 2020. In order to give all project partners the opportunity to exchange with the project manager in a personal and casual conversation, the EuroSea coffee corner was established from September 2020.

Communication and exchange with other projects and initiatives in the field of ocean observation and ocean research was advanced through participation in a wide variety of events.

## 3. Work package progress reports

Each work package contains one task (Tx.0) which is responsible for the coordination of the respective work package. This task is led by the WP leader and co-leader who organize dedicated WP meetings to exchange and share experiences and approaches and review the progress of all WP activities. For each work package report, we start with re-capping the objectives as articulated in the Grant Agreement (GA). We then report on delivery towards the objectives, which is followed by reports by task. There will inevitably be some overlap and repetition of content, but this way we can illustrate the progress across and along tasks of the work packages. We also report on progress towards deliverables and milestones as defined in the GA, and towards a set of “internal milestones” that are agreed on by the consortium but not articulated in the GA.

### 3.1. WP1 - Governance and Coordination of ocean observing and forecasting systems

Lead: IOC-UNESCO, CO-lead: EuroGOOS

| Objectives   |
|--|
| <ul style="list-style-type: none"> <li>Support observing system coordination and governance both on international (e.g. GOOS, JCOMM, GCOS, G7, OceanPredict, and GEO) and at European level in supporting EOOS/EuroGOOS implementation.</li> </ul> |
| <ul style="list-style-type: none"> <li>Deliver foresight into societal relevance, drivers and governance for ocean observation systems, new technologies and system sustainability.</li> </ul>   |

| Objectives  |
|---|
| <ul style="list-style-type: none"> <li>Strengthen the Ocean Observing system, with a focus on European needs, through extending the BioEco networks, monitoring of marine plastics, and supporting delivery for assessments, SDG indicators etc.</li> </ul> |
| <ul style="list-style-type: none"> <li>Development of key components of EOOS structure and implementation of the GOOS 2030 Strategy.</li> </ul>   |
| <ul style="list-style-type: none"> <li>Step change in availability and identification of Ocean Best Practices.</li> </ul>   |
| <ul style="list-style-type: none"> <li>Support ocean observing status monitoring and visualization.</li> </ul>  |

### 3.1.1. Summary of deliveries towards objectives

To support observing system coordination and governance both on international (e.g. GOOS, JCOMM, GCOS, G7, OceanPredict, and GEO) and at European level in supporting EOOS/EuroGOOS implementation.

(T1.1.1) Close collaboration with GOOS enable the establishment and running of the EOOS Operations Committee as part of its governance to represent the diversity of European ocean observing implementers in EOOS. Europe is a test case to establish a two-way dialogue with nations through the GOOS National Focal Points (NFP), and this process served to enhance the number of nations engaging with GOOS and EOOS through the national Focal Points. GOOS and EOOS are reaching out to nations that had yet to nominate a GOOS NFP, successfully getting a number of new nominations. (T1.1.2) Mapping of BioEco sustained monitoring in Europe is a first step towards enhancing European component of an integrated BioEco observing system. (T1.1.3) The development of a new EOVS on marine debris is well underway with several expert meetings undertaken and priorities and next steps identified. (T1.1.5) Workshops are under development with OceanPredict to establish connections with the modelling community. Preparation meetings within EuroSea to identify the scope, participation and timeframe for the workshops are ongoing. Exchanges with OceanPredict groups are underway to identify topics and timeframes.

Deliver foresight into societal relevance, drivers and governance for ocean observation systems, new technologies and system sustainability.

(T1.3.1) Broad consultation with EuroSea partners and other stakeholders was undertaken for input to the first deliverable “Foresight in Ocean Observing” (D1.1). This report identified over 120 initiatives, strategies and roadmaps that contribute to foresight in ocean observation internationally, at European scale, and regionally at the sea basin scale. (T1.3.3) Discussions are underway with agencies from the USA to organise a workshop on funding sustainability of ocean observing. In addition, we will be using the outcomes of the EOOS Technology Forum to inform activities for technology foresight activities (T1.3.2). (T1.4) Work of understanding the various legal frameworks around ocean observing will aid European governance structures for ocean observing in the broadest sense, e.g. encompassing data taken for fisheries or Marine Strategy Framework Directive (MSFD) monitoring.

Strengthen the Ocean Observing system, with a focus on European needs, through extending the BioEco networks, monitoring of marine plastics, and supporting delivery for assessments, SDG indicators etc.

(T1.1.2) Working on identifying the biological monitoring networks in Europe is underway, this activity also includes dialogue with other relevant communities such as Marine Biodiversity Observation Network (MBON), European Marine Board and EuroGOOS. (T1.1.3) A draft action plan to establish global coordination for an Integrated Marine Debris observing system has been delivered, and a working group established during the virtual OBP workshop in September 2020.

Development of key components of EOOS structure and implementation of the GOOS 2030 Strategy.

(T1.1.1) The EOOS Operations Committee KoM was conducted on the 24-25 November, bringing together over 45 participants representing 23 European nations as well as European Research Infrastructures, and EuroGOOS structures, European earth observation agencies, research vessel operators and network of marine stations. This forum will also help GOOS to implement its strategy in Europe representing the diversity of the ocean observing implementers at national, regional and pan-European levels. The EOOS Advisory Committee created to advise the Steering Group, bring together a broader stakeholder base. This Committee held two meetings over the first year of EuroSea. Both are essential for the implementation of EOOS.

Step change in availability and identification of Ocean Best Practices.

(T.1.1.4) Several presentations have been made to WP's within EuroSea to foster and promote the development of Ocean Best Practices. Close collaboration with T1.1.3 allowed the organisation of a Marine Debris working group (WG) during the OBP 2020 workshop, other WGs at the workshop worked on best practices in for example fisheries.

Support ocean observing status monitoring and visualization.

(T.1.2) A dashboard is under development by OceanOPS to facilitate the monitoring of the regional ocean observing system for different user types. A test case is being prepared for the Mediterranean Sea. (T1.1.2) Investigation about the potential creation of interactive maps for the bio-eco networks is underway. Links are being established with the Ocean Biodiversity Information System (OBIS).

### 3.1.2. Progress per task

#### Task 1.1: Observing and forecasting system coordination, national, regional, global

##### Subtask 1.1.1 EOOS GOOS Implementation

Task leader: EuroGOOS, Partners: IOC-UNESCO

The EOOS Advisory Committee held two meetings, one in November 2019 and another in September 2020. The meeting report will be submitted before the due date in 2021. The EOOS Operations Committee was initiated and had an inaugural meeting in November 2020. The membership of this committee is designed to capture representatives of sustained ocean observing across Europe and includes also the GOOS National Focal Points (most countries included and countries who had not nominated a national focal point assisted in doing so. Specific tasks included:

- A survey was prepared and sent to GOOS National Focal Points in Europe in October 2020 to collect information on ocean observing and marine monitoring activities and integration and funding sustainability in European countries – to gain a pan-European perspective and to share findings at the meeting. A report on the survey results will be finalised in January 2021;
- Success: Over 45 participants, across 23 European countries and observers from GOOS, DG MARE and EuroSea;
- Key outcomes and next steps are:
  - Facilitate creation of national ocean observing coordination structures that are multi-sectorial and multi-disciplinary;
  - Facilitate dialogue between neighbouring nations and between different communities (research, monitoring, industry) to improve information and knowledge exchange;
  - Map the ocean observing infrastructure networks and organisations;

- Develop plans for dialogue within and between nations to foster coordination and collaboration.
- A follow-up meeting is planned for March 2021, and we expect to include the results from mapping BioEco networks in task 1.1.2.

#### Subtask 1.1.2 Strengthen and extend BioEco monitoring networks throughout the European Seas

Task leader: IOC-UNESCO

The initial part of the task, mapping of European sustained BioEco observing activities, is almost complete. The GOOS BioEco Panel has identified and verified 135 programs, 84 monitoring programs as being currently active, and are following up on a further 51 potential monitoring programs. Specific tasks included:

- Identifying European monitoring programs that undertake national and/or regional monitoring of at least one biological EOVS;
- Verify which programs, out of the monitoring programs identified, are currently active;
- Create a database of active monitoring programs that will include information on country, administering organisation, monitoring program name, time-period, sampling frequency, use of standard operating procedures or best practices, EOVS monitored, funding source and URL.

#### Subtask 1.1.3 Developing capacity and coordination for a sustained ocean observations of marine plastic contaminants

Task leader: IO PAN

Several activities were undertaken by this task, including:

- Holding initial discussions with experts on marine litter monitoring about community needs and expectations at a technical workshop on “Marine Debris Indicators – What’s Next?” held in Brest, France, in December 2019 ([https://www.gstss.org/2019\\_Brest/](https://www.gstss.org/2019_Brest/)). Overall, the community supported EuroSea’s plans to establish global coordination of marine debris observations following the vision for an Integrated Marine Debris Observing System (IMDOS);
- A draft action plan to establish global coordination for IMDOS was prepared in early 2020. The plan was shared with members of GOOS structures and with several experts representing different working groups<sup>1</sup> and international organisations (European Space Agency, ESA);
- Convening a Marine Litter Working Group in September 2020, at the Ocean Best Practices IV Annual Workshop, in collaboration with IEE on task 1.1.4. The WG brought together 17 experts on different aspects of marine litter, from monitoring and data management to remote sensing, modelling and citizen science. These sessions delivered recommendations derived from broad consultations with marine litter experts from around the globe. The recommendations set priorities and next steps towards harmonising and standardising methods and approaches, in line with this task’s objectives. The Marine Litter WG will constitute the main body of experts who will develop the Marine Plastics Debris as a new EOVS of GOOS to set observing requirements complementing the existing set of indicators informing SDG target 14.1 on marine pollution.

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<sup>1</sup> Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), Working Group 40, MSFD Technical Group on Marine Litter, Scientific Committee on Oceanic Research Working Group 150 Floating Litter and its Oceanic Transport Analysis and Modelling (SCOR WG150 FLOTSAM)

#### Subtask 1.1.4 Ocean Best Practices

Task leader: IEEE, Partners: IOC-UNESCO, SOCIB

This task undertook several activities and delivered an internal milestone report. The activities include:

- Presentations on best practices provided to work packages WP5 and 6. This included discussion on what constitutes best practice and the benefits of documenting them and undertaking outreach activities to support their “widespread” adoption. Discussions considered the evolution of the Ocean Best Practices System and the value of having a readily accessible repository guided by the FAIR principles;
- Presentation on best practices at a WP3 meeting followed by successful discussions where work package leads provided advocacy for best practice creation and documentation;
- A Best Practice workshop held virtually in September. The workshop included best practices, technology and applications. It had eleven working groups of which four were in applications areas. Marine Litter/Plastics was one of the working groups, co-led by the EuroSea WP1 team of Artur Palacz. This was a collaboration between two of the WP1 tasks.

#### Subtask 1.1.5 Strengthening links to the leading edge of global forecast and prediction

Task leader: MetOffice

Two workshops are planned during the project, to allow engagement and knowledge exchange between EuroSea and the international ocean analysis and forecasting community under OceanPredict. Activities for this task included:

- Two preparation meetings within EuroSea to identify the scope, participation and timeframe for the planned workshops;
- Several exchanges with OceanPredict groups to identify opportunities for WS organisation (topics, timeframe, etc.);
- Due to COVID-19 workshops are planned to be organised no earlier than spring 2022, ideally as face-to-face events:
  - First workshop mostly focused on R&D exchange;
  - Second workshop should be a larger event to help the international agenda, providing opportunity to show EuroSea results in an international context.

#### Task 1.2: Observing system status monitoring

Task leader: IOC-UNESCO

OceanOPS have developed the first version of a “stakeholder focus” monitoring dashboard based on OceanOPS existing monitoring tools. It aims to support any stakeholders in monitoring their vision of the ocean observing system whether is GOOS National Focal Points, ROOSes Chairs or OCG Network Chairs. A first version will be open for feedback to the working group in early 2021. The dashboard will integrate a reporting capacity that will help stakeholders in their communications. Specific activities include:

- Meeting with stakeholders to present the purpose of the dashboard;
- Collect and synthesize requests from the stakeholders;
- Set up a working group;
- Specify the functionalities of the dashboard to IT team;
- Develop the Dashboard;

- Tests and adjust the dashboard.

### Task 1.3: Foresight

Task leader: EMB, Partners: EuroGOOS, IOC-UNESCO, GEOMAR

#### Subtask 1.3.1 Identifying existing initiatives in foresight in ocean observation, emerging strategies and roadmaps

Task leader: EMB

More than 120 initiatives, strategies and roadmaps that contribute to foresight in ocean observation internationally, at European scale, and regionally at the sea basin scale were identified and briefly analysed. This included consultation with EuroSea partners and other stakeholders to gather input. The findings were gathered in D1.1 “Report on policies in foresight in Ocean Observations”, submitted in time before July 31st 2020, and now available at EuroSea website. Current discussions include the further dissemination of the report.

#### Subtask 1.3.2 Foresight workshop 1: Ocean technology, platforms and Artificial Intelligence

No work has been performed on this task yet.

#### Subtask 1.3.3 Foresight workshop 2: Sustainability of the Ocean Observation system

Task leader: EMB, Partners: IOC-UNESCO

The following activities have been undertaken for this task:

- Contact was made with Emily Twigg and Susan Roberts, from the US National Academies of Science, the custodians of the Ocean Studies Board;
- A meeting was organised in August 2020 to learn the process of selecting experts and organising a foresight workshop on Sustaining Ocean Observations, taking place in September 2020;
- Similar processes were identified, and the outcomes of the workshop will be studied to inform the organisation of this future workshop on sustainability;
- Continues work on identifying experts, guidance, questions or angles to inform the organisation of the workshop.

### Task 1.4: Legal aspects of ocean governance and impact on the observing system

Task leader: GEOMAR, Partners: EMB

The following activities have been undertaken by this task:

- Analysis of hard and soft law frameworks and mechanisms to enable adequate adaptation of ocean observing system design at a regional and global level;
- Preparation of a report on the outcomes of the 2020 IOC Experts Workshop on ocean observations in areas under national jurisdiction;
- Formulation of responses to the EC’s initiative for the joint planning of ocean observations and monitoring in Europe.



### 3.1.3. Cooperation and interaction with other EuroSea work packages

| Co-operator                       | WP1 activity   |
|-----------------------------------|--|
| <b>WP8</b>                        | <ul style="list-style-type: none"> <li>• Participation in stakeholder training webinars and stakeholder engagement strategy development (T1.1.1, T1.1.3)</li> <li>• Assistance with “Impact Analysis” among WPs (T1.1.1)</li> <li>• Collaboration to improve dissemination of D1.1 (T1.3.1)</li> </ul> |
| <b>WP3, WP5, WP6</b>              | <ul style="list-style-type: none"> <li>• Presentation on best practices and support to create and submit best practices to the OBPS repository (T1.1.4)</li> </ul>   |
| <b>WP2, WP4</b>                   | <ul style="list-style-type: none"> <li>• Co-design of two OceanPredict workshops (T1.1.5)</li> </ul>   |
| <b>Partners among several WPs</b> | <ul style="list-style-type: none"> <li>• Receiving input to and review of the draft of D1.1 (T1.3.1)</li> <li>• Collaborative work with regard to EC’s initiative for the joint planning of ocean observations and monitoring in Europe (T1.4)</li> </ul>  |

### 3.1.4. Cooperation and interaction with other projects and initiatives

| Co-operator  | WP1 activity   |
|--|--|
| <b>MBON, EuroGOOS, EOOS</b>  | <ul style="list-style-type: none"> <li>• Discussion about integrate biological observing networks in existing ocean observing activities (one of the concept notes for EOOS implementation plan) (T1.1.1, T1.1.2)</li> </ul>   |
| <b>OBIS</b>  | <ul style="list-style-type: none"> <li>• Discussions about hosting biological network data (T1.1.2)</li> </ul>   |
| <b>PEGASUS project</b>   | <ul style="list-style-type: none"> <li>• Receipt of list of active monitoring networks and data aggregators in Europe (T1.1.2)</li> </ul>  |
| <b>GESAMP WG 40, MSFD Task Group on Marine Litter, experts from UN Environment, GEO Blue Planet, ESA, NASA, members of research institutions in France, USA and Japan among others, and NGOs</b> | <ul style="list-style-type: none"> <li>• Activities leading to harmonisation of monitoring methods and general enhanced coordination - contribution to the GOOS Implementation Plan and 2030 Strategy</li> </ul>   |
| <b>OceanPredict</b>  | <ul style="list-style-type: none"> <li>• Engagement to plan two workshops to promote knowledge exchange between EuroSea and the international ocean analysis and forecasting community under OceanPredict. This has been done in close collaboration with other work packages (see above). (T1.1.5)</li> </ul> |

| Co-operator   | WP1 activity   |
|---|--|
| <b>GOOS, GOOS National Focal Points, EOOS Steering Group, JERICO and European Research Infrastructures, earth observation agencies, DG MARE</b> | <ul style="list-style-type: none"> <li>Engagement as part of the establishment of the EOOS Operations Committee and the activities that the committee will undertake</li> <li>DG MARE has been invited as observer to both the EOOS Advisory Committee and Operations Committee to communicate about their public consultation (T1.1.1)</li> </ul> |
| <b>IOC Ocean Best Practices System</b>  | <ul style="list-style-type: none"> <li>Contribution of EuroSea best practices to OBPS repository (T1.1.4)</li> </ul>   |
| <b>Mediterranean GOOS National Focal Points, EuroGOOS ROOS, network chairs</b>  | <ul style="list-style-type: none"> <li>Team building to develop “stakeholder focus” monitoring dashboard based on existing OceanOPS monitoring tools (T1.2)</li> </ul>   |
| <b>EU WISE Marine, EMODnet, Frontiers in Marine Science, GOOS, JERICO-RI, MONGOOS, H2020 COLUMBUS and ODYSSEA projects, HELCOM</b>              | <ul style="list-style-type: none"> <li>Contact and receipt of input to D1.1 (T1.3.1)</li> </ul>  |
| <b>Custodians of the Ocean Studies Board (US National Academy of Sciences)</b>  | <ul style="list-style-type: none"> <li>Established contact for input and advice on how to organise future Foresight workshops (T1.3.3)</li> </ul>  |

### 3.1.5. Achieved main results

| Deliverables         |  |   |
|----------------------|--|---|
| <a href="#">D1.1</a> | Report on policies in foresight in OO  | ✓ |
| D1.2                 | Map of BioEco Observing networks/capability<br>Delayed due to later recruitment caused by COVID-19 and unforeseen tasks in order to improve the final result, new submission date: Feb. 2021 | ✗ |
| Milestones           |  |   |

|                            |  |   |
|----------------------------|--|---|
| MS5                        | Mapping plan for marine plastic contaminants           | ✓ |
| <b>Internal Milestones</b> |  |   |
| iMS10                      | EuroSea pilot application workshop – on Best Practices | ✓ |

### 3.2. WP2 - Ocean Observing System Design

Lead: CSIC, CO-lead: ENS

| <b>Objectives</b> |   |
|-------------------|---|
| •                 | Apply the systems design processes of the Framework for Ocean Observing (FOO) on the EuroSea observing system in support of connected and integrated European Ocean Observing systems for the broader Atlantic Ocean and Mediterranean Sea.   |
| •                 | Define the high-level requirements of EuroSea based on the societal benefits, providing a direct link to societal challenges related to the larger Atlantic and Mediterranean basins and the European Blue Growth strategy. These requirements will be translated into strategic recommendations about sustained monitoring of EOVs and linked with LR7 and LR8 societal relevant indicators. |
| •                 | Identify the requirements in existing observing networks in support of specific demonstrators (WP5,6,7).  |
| •                 | Deliver guidance to improve existing elements and/or implement new ocean observing components to EuroSea using various techniques, including OSSEs and data assimilation to optimally merge in-situ and satellite observations with models to provide accurate estimates for indicators.  |

#### 3.2.1. Summary of deliveries towards objectives

The overall objective of WP2 is to apply the systems design processes of the Framework for Ocean Observing (FOO) on the EuroSea observing system in support of connected and integrated European Ocean Observing systems for the broader Atlantic Ocean and Mediterranean Sea. It builds on the H2020 AtlantOS achievements and takes on its legacy to further develop them within the Galway and Belém agreements objectives. WP2 specific objectives are:

- To define the high-level requirements of EuroSea based on the societal benefits, providing a direct link to societal challenges related to the larger Atlantic and Mediterranean basins and the European Blue Growth strategy. These requirements will be translated into strategic recommendations about sustained monitoring of EOVs and linked with LR7 and LR8 societal relevant indicators.
- To identify the requirements in existing observing networks in support of specific demonstrators (WP5,6,7) and different operational services (subseasonal and seasonal climate and extremes predictions, ocean weekly forecasts and CS3 and CMEMS Copernicus services)
- To deliver guidance to improve existing elements and/or implement new ocean observing components to EuroSea using various techniques, including OSSEs and data assimilation to optimally merge *in situ* and satellite observations with models to provide accurate estimates for indicators.

The work undertaken in WP2 is in direct support of the EuroSea demonstrator activities (WP5, 6, 7), the observing network integration and improvement (WP3), data integration, and assimilation and forecasts

(WP4). The work focuses on verifying the EOVs and indicators, analysing the gaps of existing systems and possible upgrades [task 2.1] as well as carrying out system design studies [task 2.2] and [task 2.3].

Task 2.1 has the objective of developing Indicators for observing system networks (WP3), demonstrators (WP5-7) and verification of forecasts (WP4). To do so we have organized fit-for-purpose meetings and workshops to start to collect already defined indicators as well as the needs of WPs stakeholders with regards of their requirements in terms of indicators in order to assess the largest possible set of EOVs and their mapping against the expressed requirements. This large consultation and various interactions have led to a first list of indicators classified against their maturity. Successively we have worked in refining the most complete list and specification of EOVs linked with the defined (even if not yet mature) indicators. This has been delivered as a report materializing MS6. We are now further refining the specifications of indicators towards delivering the next milestone (MS10 expected Month 24 providing agreed requirements for indicators).

Task 2.2 has the goal to deliver objective guidelines to improve existing elements and/or implement new components of the Atlantic and Mediterranean Sea Observing system. The general approach is based on Observing System Design Experiments that rely on physical and BGC models, or statistical techniques that realistically represent the space-time variability of the EOVs to be observed, both methods optimally merge *in situ* and satellite observations. The "Design of the OSSEs with global ocean monitoring systems" was discussed and the associated MS1 report delivered.

Task 2.3 has the objective to improve the design of multi-platform experiments aimed to validate the Surface Water and Ocean Topography (SWOT) satellite observations with the goal to optimize the utility of these observing platforms. Observing System Simulation Experiments (OSSEs) are conducted to evaluate different configurations of the *in situ* observing system, including rosette and underway CTD, shipborne ADCP, velocities from surface drifters, and Argo vertical profiles, together with conventional satellite nadir altimetry. Simulations from high-resolution models are here used to simulate the observations and the ocean "truth" to represent fine-scale sea level and surface ocean velocities. Several methods of reconstructions are being tested to reconstruct the simulated observations. The capacity of the reconstructed fields to represent the sea level and surface current variability of the nature run models at the scales and with the expected accuracy of the future SWOT satellite mission will be then evaluated considering different configurations of *in situ* observations.

### 3.2.2. Progress per task

#### Task 2.1: Developing Indicators for observing system networks/Demonstrators

Task leader: ENS, Partners: CSIC

This task has started with the verification of the EOVs required to inform the major societal drivers of sustained ocean observing. We have linked Atlantic, Mediterranean and Baltic Sea's already developed indicators as well as indicators for climate (WP7), ocean health (WP6), coastal resilience and operational services (WP5), and for verification of forecasts (WP4) in co-development with stakeholders to collect, map and analyse the appropriate EOVs (MS6) that later (in the coming months) will translate into strategic recommendations about sustained monitoring strategies of the EOVs. This approach follows the FOO and will be used to define the critical requirements for EuroSea. In particular, in developing the mapping of EOVs we expressed societal requirements as the space-time resolution and accuracy required for sustained observations of the physical, BGC, and biological EOVs defined by GOOS. These recommendations, including

a strategy for the observing networks to monitor these EOVs, will be drafted from present knowledge in the coming months.

The list of the selected EOVs/ECVs as well as the stakeholder requirements and the initial set of indicators have been mapped for each of the demonstrator WPs and WP4 (MS6). The mapping consists, for each indicator and in agreement with the stakeholder requirements, of specifying the geographical domain, spatial (horizontal and vertical) and temporal resolution for each variable as well as the frequency and time span of interest. This set of information provides a general framework that will be further rationalized in the design and definition of co-developed indicators.

As a result of the discussions that took place within the first reporting period, the possible indicators of interest for stakeholders and end users within each WPs have been classified in three groups depending on the status of their definition according to the stakeholders and end-user requirements: Stage 1 (mature indices, already used in some applications, and further refined within EuroSea), Stage 2 (Intermediate stage of maturity, highly relevant for Europe under definition) and Stage 3 (Ideas for additional or more advanced indices to be co-developed with stakeholders; need to be explored during the project).

#### Task 2.2: Observing System Design Experiments with global ocean monitoring systems

Task leader: MOI, Partners: MOI, CLS, ENS

In order to guide the design of a fit-for-purpose *in situ* observing network for ocean monitoring and forecasting systems operated in CMEMS, different experimental approaches are planned. First, OSSEs are undertaken to test different design currently discussed for the physical component of Argo. For BGC observations, an analysis has been done to identify specific regions that need to have improved observation coverage. This analysis is based on the real time BGC monitoring system based on the PISCES<sup>2</sup> BGC numerical model.

##### Design for *in situ* Biogeochemical observations

The goal of this task is to identify the regions where BGC-Argo floats observations should be enhanced with respect to the global CMEMS BGC forecast system uncertainties. A comparison between global CMEMS BGC forecast system and BGC-Argo floats was conducted.

For different variables, we identified two types of regions where BGC-Argo floats observations should be enhanced: 1) regions where the actual density of BGC-Argo floats is not sufficient and 2) regions where the model error is the highest. An example is given for the variable oxygen in Figure 2.

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<sup>2</sup> Aumont, O., Éthé, C., Tagliabue, A., Bopp, L., & Gehlen, M. (2015). PISCES-v2: an ocean biogeochemical model for carbon and ecosystem studies. *Geoscientific Model Development Discussions*, 8(2).

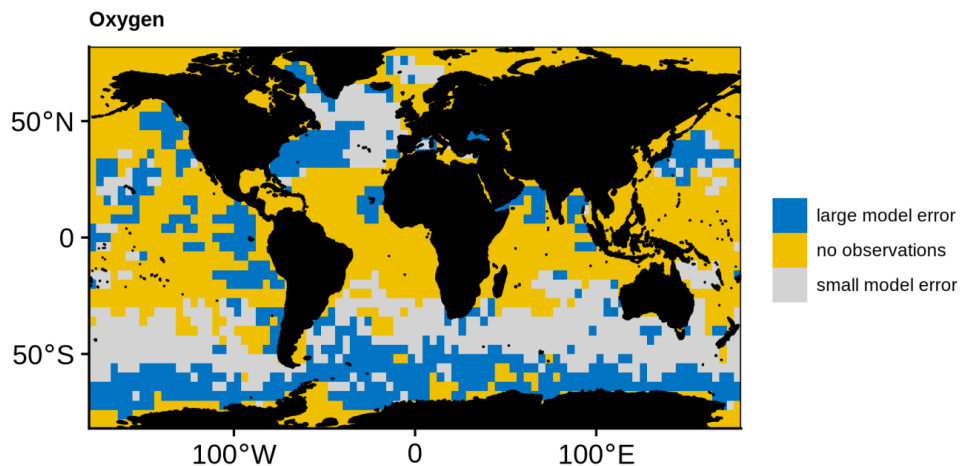


Figure 2. Regions where BGC-Argo floats observations should be enhanced. Yellow: Areas where there are less than 1 BGC-Argo profile of oxygen per bins of 4° by 4°. Blue: regions where the RMS differences between the model and the observations are the highest. Grey: regions where the RMS differences between the model and the observations are the lowest.

The yellow regions correspond to areas where there are less than 1 BGC-Argo profile of oxygen per bins of 4° by 4°. The second type of region (in blue) corresponds to areas where the Root Mean Square (RMS) difference between the model and the observations are the highest.

#### Design for *in situ* physical observations

As part of task 2.2, partners have defined the design of the *in situ* physical observations that they will focus on, i.e., the Lagrangian Argo floats and tropical moorings. CLS and MOI have worked together to determine a list of different scenarios that will be assessed based on observing system simulation experiments. It has been decided that MOI will simulate the “pseudo-observations” for both MOI and CLS. A detailed description of the work on the design and a work plan for the next period is available in the Milestone MS1 “Design of the OSSEs with global ocean monitoring systems” that was due on May 31st 2020 and is available at <https://eurosea.eu/milestones/>.

#### Task 2.3: Observing System Simulation Experiments: impact of multi-platform observations for the validation of satellite observations

Task leader: CSIC, Partner: CLS, IMT, OceanNext, SOCIB

In task 2.3 all partners have contributed to the design of the OSSEs aimed to optimize the multi-platform sampling strategies to validate SWOT. A detailed description of the design and a work plan for the next period is available in the Deliverable 2.1 “Design of the Observing System Simulation Experiments with multi-platform *in situ* data and impact on fine-scale structures” that was due on 31 October 2020 and is available at <https://eurosea.eu/deliverables/>. A map of the selected regions for the planned OSSEs can be found in Figure 3. The design of the OSSEs was presented to the international research community in the AGU Fall meeting on 17 December 2020.

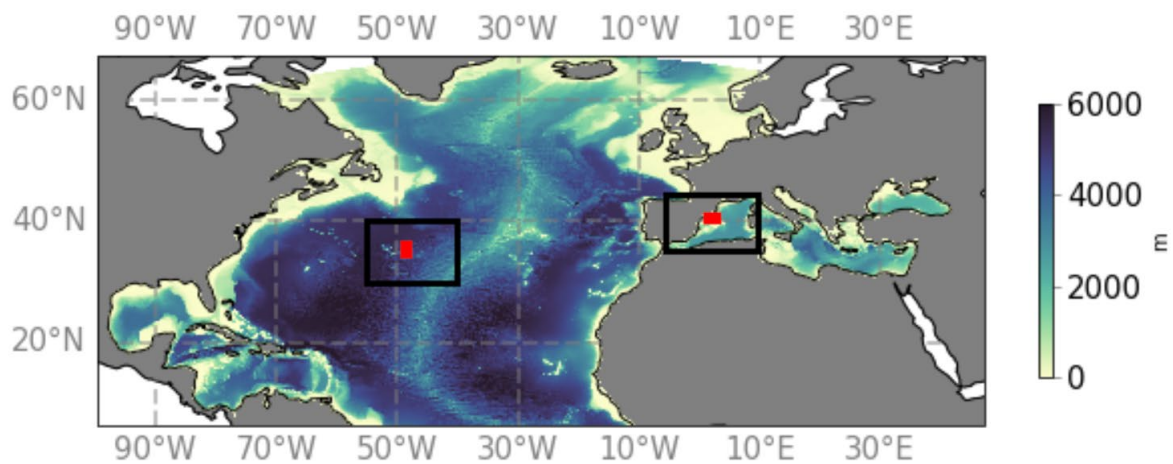


Figure 3. Map of the selected regions for the planned OSSEs in task WP2.3 (see Deliverable D2.1 at <https://eurosea.eu/deliverables/> for more details).

### 3.2.3. Cooperation and interaction with other EuroSea work packages

| Co-operator             | WP2 activities  |
|-------------------------|---|
| WP3, WP4, WP5, WP6, WP7 | <ul style="list-style-type: none"> <li>Joint meetings in July, September and October to discuss and define the EOVs and ECVs that meet the needs for defining future indicators relative to seamless forecasts (WP4), coastal resilience and operational services (WP5), ocean health (WP6), and climate (WP7)</li> <li>Co-development of EOVs and indicators (T2.1)</li> </ul> |
| WP8                     | <ul style="list-style-type: none"> <li>Collaboration to expand stakeholder engagement in the co-development of fit-for-purpose indicators (T2.1)</li> </ul>   |
| WP3                     | <ul style="list-style-type: none"> <li>Collaborative work with the deep and BGC Argo teams (T2.2 and T3.1)</li> </ul>   |
| WP7                     | <ul style="list-style-type: none"> <li>Discussions to define relevant assessment metrics for the observing network design experiments</li> </ul>  |
| WP4                     | <ul style="list-style-type: none"> <li>Direct link to T4.4 - simulated observations will be used in T2.3 to test methods to be implemented in T4.4</li> </ul>   |
| WP4, WP6, WP7           | <ul style="list-style-type: none"> <li>Partnership in the EuroSea Marine Heat Wave task team to discuss methodology and agree on a common approach.</li> </ul>  |

### 3.2.4. Cooperation and interaction with other projects and initiatives

| Co-operator  | WP2 activities  |
|--|---|
| HELCOM, CMEMS, C3S, ECMWF, GOOS, GCOS, NOAA, CLIVAR, WMO | <ul style="list-style-type: none"> <li>Close interaction in terms of current and future testing of indicators developed in EuroSea</li> </ul> |

### 3.2.5. Achieved main results

| Deliverables         |   |   |
|----------------------|---|---|
| <a href="#">D2.1</a> | Design of the OSSEs with multi-platform in situ data and impact on fine-scale structures    | ✓ |
| Milestones           |   |   |
| MS1                  | Design of the OSSEs with global ocean monitoring systems                                    | ✓ |
| MS6                  | Definition of EOVs in connection with demonstrators and Forecasts                           | ✓ |
| Internal Milestones  |   |   |
| iMS4                 | First Technical meeting of WP2 to define OSSEs to be implemented within T2.2                | ✓ |
| iMS6                 | First Technical meeting of WP2 to assess status of EOVs definition for EuroSea applications | ✓ |
| iMS7                 | First Technical meeting of WP2 to define OSSEs to be implemented within T2.3                | ✓ |
| iMS11                | Technical Workshop on Indicators definition for EuroSea applications                        | ✓ |
| iMS12                | Technical meeting on OSSE diagnostics to be implemented within T2.2                         | ✓ |

### 3.3. WP3 - Network Integration and Improvement

Lead: HCMR, CO-lead: GEOMAR

| Objectives   |
|--|
| <ul style="list-style-type: none"> <li>Oversee key aspects of integration of European observing technology for its optimal use in an EOOOS and global initiatives (e.g. GOOS) and, in parallel, addressing national interests. The integration has two dimensions: observing networks, grouped around technology or platforms (mooring, tide gauges, glider, floats, ships, etc.), and thematic networks, grouped around a certain observing challenge (e.g. metagenomics, data, scientific issues).</li> </ul>  |
| <ul style="list-style-type: none"> <li>Ensure that most observing networks reach TRL7, defined as:               <ul style="list-style-type: none"> <li>Network coordinates a community of Best Practice around a specific technology</li> <li>Network specification and governance structure is articulated (e.g. Terms of Reference)</li> <li>Network data policy is defined and comply with FAIR principles (findable, accessible, interoperable, re-usable)</li> <li>Long term (&gt;10 years) sustained observing needs are defined</li> <li>Networks are open to all operators of the respective observing technology</li> <li>Best Practices for each network, addressing the EOVS specification sheets, are documented and deposited at <a href="http://oceanbestpractices.org">oceanbestpractices.org</a></li> </ul> </li> </ul> |
| <ul style="list-style-type: none"> <li>Improve internal coordination within the observing networks, guided by scientific/engineering expertise and supported by a technical coordinator</li> </ul>   |
| <ul style="list-style-type: none"> <li>Interact with the observing component in the EuroSea Demonstration activities (WP5,6,7)</li> </ul>  |
| <ul style="list-style-type: none"> <li>Proof Best Practice documentation</li> </ul>  |
| <ul style="list-style-type: none"> <li>Enable a dialogue between observing requirements and the underlying scientific approach and the technology framework that is coordinated by the observing networks</li> </ul>   |
| <ul style="list-style-type: none"> <li>Ensure data delivery according to standards including communication pathways between platform operators, observing networks and data centers.</li> </ul>  |



### 3.3.1. Summary of deliveries towards objectives

A major part of the work during the reporting period has been the initial assessment of the EuroSea observational and thematic networks coordination. This is described in detail in deliverable D3.2 (Observing Networks initial Assessment) which is available at the project website. This deliverable serves to present the initial situation, in terms of coordination, of the observational and thematic networks in EuroSea represented in the work package. The networks include the networks represented in EuroGOOS and additional ones. The study is based on a comprehensive questionnaire that was answered by all WP3 tasks. In addition, information from the Global Observing Networks of GOOS was considered.

Towards the objective of ensuring data delivery according to standards a Data Management Plan (DMP) has been produced (deliverable D3.1), which sets the framework for the handling of data produced in the framework of EuroSea project.

Defining and adopting best practices within the network is of absolute importance but it is equally important to document best practices in order to facilitate communication and dissemination. A common virtual workshop with WP1 on Best Practices took place in July 2020 during which each network presented the state of play in terms of best practices and the future steps. The workshop gave the opportunity to exchange information and discuss commonalities and differences. Moreover, gaps and priorities were identified.

### 3.3.2. Progress per task

#### Task 3.1: Argo

Task leader: Euro-Argo Eric, Partners: Ifremer, SU

In task 3.1 progress has been achieved on 2 of the 4 main activities identified in the Grant Agreement (GA) for the development of the DEEP and BGC Argo components. As all Deep-Argo float types reveal a fresh salinity bias at high pressure, an ad-hoc working group involving Eurosea partners worked on a recommendation to correct this pressure dependent salinity bias and proposed a correction procedure to be implemented both in real-time and delayed mode. This procedure will be discussed at the next ADMT meeting for endorsement and implementation within the Argo data stream. Such adjustment will facilitate the use of the DEEP-Argo data by CMEMS and scientific users. In collaboration with the H2020 Euro-Argo-RISE project improvement of the processing of the BGC data processing procedures are discussed and will be presented to the Argo data Management meeting in November 2020. The EuroSea partners in particular contributed to the global ocean oxygen atlas international initiative that aims at developing an O<sub>2</sub> atlas from observations acquired not only from ships but also autonomous platforms such as BGC-Argo and gliders. To enhance the Euro-Argo Eric and international BGC, an OceanOps BGC-Argo project office position has been secured for an initial two-year term. It will be hosted at SU (LOV-IMEV, Villefranche sur Mer) during the first semester of 2021. BGC-Argo website has been improved with respect to statistical tools for publication. The project officer will strengthen the communication part and interaction with other components of the observing system. A new global map data visualization tool developed by SU will be released in January 2021. The Euro-Argo fleet monitoring tool was updated (<https://fleetmonitoring.euro-argo.eu/dashboard>) and presented to Argo International. Finally, the discussion started both at European and International level to organize a DEEP and a BGC workshop in 2021. The decision about having it as a virtual event has not yet been made.

### Task 3.2: Underwater Gliders

Task leader: CNRS, Partners: WMO

The EuroGOOS Glider Task Team (GTT) has recently renewed its Terms of References and Carlos Barrera (PLOCAN, Spain) and Pierre Testor (CNRS, France), both involved in EuroSea, have been nominated respectively as chair and co-chair of the Task Team for a period of three years (2021-2023). A call for membership has been sent out to the European glider community in early November 2020. The GTT intends to mobilize a robust cooperation between European Glider teams and other stakeholders to promote scientific collaboration and to share information/resources. The aim is to reinforce the European glider community and make in particular progress on (meta)data management, best practices, numerical model assessments and capacity-building.

In Task 3.2 the Glider task team has made progress on glider best practices by mobilizing the global and European community to work on a glider best practice community publication. The focus has been put on delayed mode quality control (DMQC) practices. This has been done on various ocean essential variables (OEV) including temperature, salinity, oxygen, chlorophyll concentrations, organic matter and ocean currents. To further boost these activities an online workshop is in preparation for March 2021. The aim of the workshop is to bring the global and European expert glider community together to make progress on the production, convergence and adaptation of OceanGliders best practices. Since October 2019, the OceanGliders working group on gliders data format harmonization, led by Dan Hayes (Cyprus University) have organized 5 online meetings to achieve the harmonization of the OceanGliders format across the OceanGliders community. Indeed, without international coordination on data management since the popularization of the use of gliders for ocean observing, glider groups around the world have developed their own data format. Despite the similarities, EU, US, and Australia produced a non-fully interoperable glider data format. Thanks to EuroSea funding for glider coordination, the international OceanGliders working group, led and supported by members of the EuroSea project (University of Cyprus, OceanOPS, BODC, SOCIB) will provide the OceanGliders steering team with the Terms of Reference of the future OceanGliders format that will become the unique format for the OceanGliders program.

### Task 3.3: Vessels

Task leader: NIVA, Partners: WMO

Task 3.3 (Vessels) coordination activities have taken place via the EuroGOOS FerryBox Task Team and the JCOMMOPS discussion with GOOS Observations Coordination Group and International Research Ship Operators executives. The FerryBox task team has updated the list of FerryBox routes in European seas and the variables that are regularly measured by those FerryBoxes. Progress has been made related to the development of harmonized metadata formats and related vocabularies/reference tables for the Ship Observation Team.

The team also took part in a common virtual workshop with WP1 on best practices, and work has begun to align with the EuroSea community. There was also involvement in a stakeholder workshop to both identify potential stakeholders and to assess the relevance of EuroSea and task 3.3 for the stakeholders. Finally, work between task 3.3. partners (FerryBox Task Team and JCOMMOPS) began on developing a web-based dashboard to include task 3.3 observing platforms, amongst others.

### Task 3.4: Eulerian Observations

Task leader: SU, Partners: EMSO-Eric, WMO

Task 3.4 (Eulerian Observations) A pH-CTDO2 sensor from Seabird (SeaPHOX) was bought in Sept 2020 in order to be installed at the DYFAMED site in November 2021 (deliverable D3.6). The delivery of the pH sensor should take place in LOV (Sorbonne Univ.) at the end of 2020. However, the supplier of essential parts to SEAPHOX is experiencing manufacturing delays. A new shipping date is expected soon. Discussions with the EMSO Data & Science Services groups have led to harmonisation of the metadata catalogue and the following of QC and format protocols from OceanSites (D3.11 and D3.12). In this context, all EMSO sites have been updated on the OceanOPS web site catalogue (M.Kreiger).

### Task 3.5: European Sea Level Network

Task leader: EPPE, Partners: NOC, CNRS, MI

Activities of the European Sea Level Network have been focused on improving harmonization between data portals and programs dealing with tide gauge data, and strengthen the connection with the global sea level network GLOSS. Activities in EuroSea and in the EuroGOOS Tide Gauge task team were presented by the chair (EuroSea beneficiary EPPE) at the GLOSS Data Portals meeting held at the IOC-UNESCO headquarters in Paris (March 2020). The planned European inventory of tide gauge metadata, to be developed by the MI (Ireland), was offered as a contribution to GLOSS needs and requirements in the region. The meeting raised the need for collaboration on common metadata standards and vocabulary definition, between existing GLOSS data portals and CMEMS In Situ TAC or EMODnet. This was the main topic of the last EuroGOOS Tide Gauge task team meeting, held virtually on 1 and 2 July 2020: Representatives of all these programs were invited to present their products, metadata management and quality control/processing strategy. As a result of this meeting, three small technical subgroups were established for progressing in:

- Review of site/station definition
- New unique ID definition and assignment
- Agreement on minimum metadata and common vocabularies

This will be accomplished through cooperation with OceanOPS and WMO initiatives: OceanOPS have been given delegated authority by WMO to assign unique identifiers for the global network and the WMO Oscar system may provide minimum metadata requirements and standards they will publish for all OceanOPS networks (including GLOSS). GLOSS and EuroGOOS Tide Gauge Task Team input have been required to contribute to these initiatives. EuroSea partners and external partners are involved in these initiatives.

SONEL<sup>3</sup> (CNRS) has developed an automatic code to compare the contents for the main Tide Gauge data portals in terms of gaps and duplicates. Preliminary results were presented during the last meeting in July, showing interesting issues and the importance of this exercise and cooperation.

NOC has reviewed the current land movement information on the Permanent Service for Mean Sea Level (PSMSL website<sup>4</sup>) to see what needs updating, and have begun identifying new versions of datasets. With respect to the GNSS-IR<sup>5</sup> technology, up to 245 sites have been identified where this technique could be valuable for sea level measurements, after adequate data processing. The design of the GNSS-IR data portal has also been started along with output formats and code to gather metadata required for each site. Finally, a successful proof-of-concept demonstration of GNSS-IR working in near real time is available.

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<sup>3</sup> French Network of Tide Gauges (<https://www.sonel.org/>) that also serves as the Data Assembly Center for GLOSS

<sup>4</sup> <https://www.psmsl.org/>

<sup>5</sup> technique that uses data from geodetic-quality Global Navigation Satellite System (GNSS) instruments for sensing the near-field environment

The first workshop of the EuroSea Tide Gauge Workshop will take place on 12-14 January 2021. The announcement was launched in October and it has been published on EuroGOOS and GLOSS websites. It will bring together the global tide gauge community to share experiences and promote discussion to overcome challenges across different geographical regions, while ensuring effective coordination and communication with GLOSS.

### Task 3.6: HF Radar

Task leader: AZTI, Partners: CNR, SOCIB, EPPE

In Task T3.6, significant efforts contributed in improving the communication and a joint work plan within the HF Radar Task Team. The #1 EuroGOOS HFR TT newsletter has been launched in June 2020. Trimestral online progress meetings are organized. Eurosea will then actively contribute in the establishment of a governance structure (work in progress) and on disseminating Best Practices for ensuring a centralized and standardized data delivery through the EU HFR Node. Finally, progress on developing an historical data processing tool has been performed. It will allow a common approach for advanced quality controls of historical data within the EU community. Connections with the Global network also started and will be reinforced in the coming phases.

### Task 3.7: Autonomous Surface Vehicles

Task leader: PLOCAN, Partners: UBREMEN, UPORTO, NOC

The priority of task 3.7 is the development of the Autonomous Surface Vehicles (ASV) network thus, some coordination efforts on observing networks has been done during this period, in the way to identify and engage potential key members from public and private sector, which will be responsible for the network structure and roadmap definition, among other tasks envisaged. This work will be conducted during the 1<sup>st</sup> ASV workshop, to be held in May 2021. In parallel, a great and successful interaction with the observing component-demonstration activities in WP7 has been conducted through the ATL2MED mission, lasting for 10 months and sailing 15.000 Nm connecting the Atlantic Ocean and Med Sea.

### Task 3.8: Augmented Observatories

Task leader: SZN, Partner: AWI

Within task 3.8, SZN and AWI, together with the external collaborator EMBRC-ERIC delivered a public consultation on “European Regional Genomic Observatories: operationalizing omics & eDNA in regional ocean observation” which aim was to solicit international feedback on marine omics observatories, their networks and to shape international standards to the needs of marine omics observatories. The objectives of the event were to:

- Co-create a joint briefing on the key activities related to networks of omically augmented observatories and initiatives at the European level
- Develop pathways to align activities through a Programme Action under the [UN Decade of Ocean Science for Sustainable Development](#) (UNDOS)
- Plan future collaboration towards a sustained network of observatories and developing the UNDOS proposal

The event took place on Monday 16<sup>th</sup> and Tuesday 17<sup>th</sup> of November 2020, where four sessions were held. In total, 27 individuals, mainly from Europe, attended with an average of 26 participants per session. Participants were both from within and outside of the EuroSea consortium.

During the two days, participants discussed the challenges and potential solutions to establish standardised approaches for marine omics observatories within the current context. This was articulated around four themes: 1) Funding and management models, 2) Sampling, 3) Data management and 4) Science and society. One of the main outcomes was the decision to set up a working group to develop a roadmap for European network of observatories and to include omics as a key component of oceanographic activities. This will help to coordinate efforts at European level while building on existing structures and initiatives as well as ensure alignment with international initiatives and platforms.

The consultation remained open until 25<sup>th</sup> of November and the organisers met at the beginning of December to discuss and compile all contributions with a view to prepare a briefing document which will be sent to participants and EuroSea members. This will summarise the discussions but also provide more details on the concrete actions to be taken. There will also be a follow-up workshop which will be hosted by AWI within the next 2 years.

Some open questions that will need to be addressed in going forward include:

- Overall: How to coordinate efforts and ensure that the right stakeholders are involved?
- For funding: How to make resources (infrastructures, standards, observatories, etc.) sustainable?
- For sampling: How to define a baseline for standards which also allow for contextualisation to local requirements?
- For data: Clearly identified need to consider data resources and aspects from the start of the process.
- For science & society: how to get citizens involved and engaged?

### Task 3.9: Integrating science

Task leader: SOCIB, Partners: CSIC, AZTI

Task 3.9 “Integrating science” aims to develop a strategic long-term vision of ocean integration in order to reach a higher Technology Readiness Level (TRL) of the Integrated Ocean Observing System in Europe. It will review existing examples of integration in different fields and the need in oceanography to advance along these lines. It will be working to propose and establish recommendations to advance towards a new approach to ocean sciences, more really integrated and valued in terms of scientific evaluation and societal impact. The objective is to design ocean integration and establish a path for this integration, and show with examples the relevance and power of real ocean integration. Task 3.9 is divided in two sub-tasks:

#### Subtask 3.9.1 Develop a Strategic European Vision of Ocean Integration

Concerning T3.9.1, a literature review has been undertaken to identify the different aspects of integration in ocean observation that should be developed to reach a fully Integrated Ocean Observing System in Europe. Public and private organizations have been identified as key players. We have also reviewed the obstacles to effectively implement ocean integration as well as the benefits that it would bring. A draft report is being prepared with the key concepts and background in order to adequately orient the forthcoming tasks.

#### Subtask 3.9.2 Show specific examples of Ocean Integration

During the first months, given the COVID-19 situation and the difficulties in having meetings to share the ocean integration concepts behind T3.9.1 with European key players and organizations, we have started to

advance on T3.9.2 and worked on a specific example of ocean integration applied to operational Search and Rescue (SAR) applications. The integration consists in combining High-Frequency Radar data with surface drifters and numerical models, using a user-friendly statistical tool to provide SAR operators an integrated information dashboard on the most useful model prediction. A paper has been submitted for publication (see dissemination section below).

### Task 3.10: Interface with In Situ data integrators

Task leader: IFREMER, Partners: ETT, OGS

The goal of task 3.10 is to connect the WP3 networks with the existing *in situ* data integrators that are CMEMS, EMODnet-Physics and Chemistry. To facilitate this integration a Data Management Plan (deliverable D3.1) has been issued by the EuroSea partners. The harmonisation of the work flow between the observing networks and the integrators through interoperable interfaces is based on existing international standards following up on the recommendations issued within the AtlantOS project. The EuroSea task 3.10 partners participated in the EuroGOOS Tide Gage task team (task 3.5) meeting in July 2020 that led to the identification of actions that will facilitate tide gauge integration in CMEMS and EmodNet-Physics. Discussions with the Saildrone community (task 3.7) led to the definition of a data flow between the Saildrone data system and CMEMS and a first integration of Saildrone data in the CMEMS products and in EMODnet-physics have been achieved. The integration of historical HF-Radars (task 3.6) facilitates the update of the CMEMS historical product and the data flow. Integration of European Eulerian data managed by EMSO-ERIC as well as carbon data managed by ICOS-ERIC will be facilitated thanks to the activity carried on within the ENVRI-FAIR H2020 project.

### 3.3.3. Cooperation and interaction with other EuroSea work packages

| Co-operator | WP3 activities   |
|-------------|--|
| <b>WP1</b>  | <ul style="list-style-type: none"> <li>• Organisation of workshop on Ocean Best Practices on 3 July 2020</li> </ul>                      |
| <b>WP5</b>  | <ul style="list-style-type: none"> <li>• Participation in development of new low cost and maintenance free tide gauges (T3.5)</li> </ul> |
| <b>WP7</b>  | <ul style="list-style-type: none"> <li>• Interaction on best practices to glider oxygen measurements (T3.2)</li> </ul>                   |
| <b>WP8</b>  | <ul style="list-style-type: none"> <li>• Participation in Stakeholder Engagement Strategy development webinars</li> </ul>                |

### 3.3.4. Cooperation and interaction with other projects and initiatives

| Co-operator   | WP3 activities   |
|---|--|
| <b>EuroGOOS</b>   | <ul style="list-style-type: none"> <li>• Joint coordination efforts</li> <li>• Close exchange with renewed EuroGOOS Glider Task Team</li> </ul>  |
| <b>Euro-Argo RISE &amp; Euro-Argo ERIC Management Board</b> | <ul style="list-style-type: none"> <li>• Collaboration</li> <li>• Partnership elaboration of DEEP and BGC Argo workshops to include various initiatives and complement them with new communities.</li> </ul> |
| <b>CMEMS In Situ TAC, EMODnet, GLOSS</b>                    | <ul style="list-style-type: none"> <li>• link between different programs to ensure higher harmonization of sea level data products to final users</li> </ul>   |

| Co-operator  | WP3 activities  |
|--|---|
| Jerico-S3  | <ul style="list-style-type: none"> <li>Close communication/link in terms of tide gauges integrated with other coastal platforms (Jerico and EuroSea have some common project partners in this field) (T3.5)</li> </ul>  |
| JERICO-S3, CMEMS-INSTAC, EMODnet Physics initiatives | <ul style="list-style-type: none"> <li>Interaction to increase data efficiency for product development</li> </ul>   |
| Mission Atlantic, TechOceanS, AARC                   | <ul style="list-style-type: none"> <li>Interaction through the ATL2MED sailing mission (T3.7)</li> </ul>  |
| AutoShipProject                                      | <ul style="list-style-type: none"> <li>Establishment of connection with the Autonomous Maritime Navigation sector (T3.7)</li> </ul>   |
| SASEMAR, UK Maritime, SeaMachines, UTEK              | <ul style="list-style-type: none"> <li>Establishing contacts with national agencies and industry sector on Autonomous Vessels</li> </ul>  |
| ENVRI-FAIR   | <ul style="list-style-type: none"> <li>Receipt of guidance and training for the better implementation of FAIR principles in the European Research Infrastructure data system allowing for a more fluent data flow to the CMEMS and EMODNET integrators</li> </ul> |

### 3.3.5. Achieved main results

| Deliverables        |  |   |
|---------------------|--|---|
| D3.1                | Data Management Plan (DMP)   | ✓ |
| D3.2                | Observing Networks initial Assessment  | ✓ |
| D3.3                | New tide gauge data flow strategy<br>Postponed to March 2021 as it relates directly to the Tide Gauge workshop (iMS17) | ✗ |
| Internal Milestones |  |   |
| iMS13               | Omics Augmentation 1st Workshop  | ✓ |
| iMS14               | Gliders workshop on “best practices”<br>To be conducted as face-to-face meeting in 2021                                | ✗ |
| iMS15               | FerryBox workshop<br>To be conducted as face-to-face meeting in 2021   | ✗ |
| iMS16               | Eulerian 1stWorkshop<br>To be conducted as face-to-face meeting in 2021  | ✗ |
| iMS17               | Tide Gauge 1stWorkshop<br>To be conducted as face-to-face meeting in 2021  | ✗ |
| iMS18               | HF Radar 1st workshop<br>To be conducted as face-to-face meeting in 2021   | ✗ |
| iMS19               | ASV 1st workshop<br>To be conducted as face-to-face meeting in 2021  | ✗ |
| Others              |  |   |
|                     | Successful ATL2MED mission   | ✓ |

### 3.4. WP4 - Data integration, Assimilation, and Forecasting

Lead: MOI, CO-lead: UNIBO

| Objectives   |
|--|
| <ul style="list-style-type: none"> <li>Ensure that new or consolidated <i>in situ</i> observation data sets from the different networks (WP3) and from the WP5, 6, 7 demonstrator activities are integrated in the European modelling and forecasting systems at different space and time scales, from the Copernicus Marine Service global to the regional North East Atlantic and Mediterranean Sea systems</li> </ul> |
| <ul style="list-style-type: none"> <li>Implement ensemble forecasting at regional level to extract Extreme Forecast Indices (EFI) to connect with WP5 and WP6</li> </ul>   |
| <ul style="list-style-type: none"> <li>Assess the skill of ocean variables from the Copernicus Climate Change seasonal forecasting systems using observable ECVs to develop and provide user-relevant indicators in WP2 and WP7</li> </ul>   |
| <ul style="list-style-type: none"> <li>Integrate all new products, observational and model data, in the Copernicus Marine Environment Monitoring Service and the Copernicus Climate Change System (C3S) thus reaching TRL7 and 8</li> </ul>  |

#### 3.4.1. Summary of deliveries towards objectives

WP4 will improve the integration of *in situ* observation data sets from the different WP3 networks and from the WP5, 6, 7 demonstrator activities in the Copernicus Marine Service modelling and forecasting systems (tasks 4.1 and 4.2). New ensemble forecasting capabilities will be developed and tested at regional level (task 4.3). *In situ* observations will also be used to improve satellite Cal/Val activities (task 4.4) and produce new carbon synthesis products (task 4.5). Finally, the skill of ocean variables from the Copernicus Climate Change seasonal forecasting systems will be assessed from observations (task 4.6). All tasks except task 4.4 (as from workplan) have started their work and are on track as detailed in the next sections.

#### 3.4.2. Progress per task

##### Task 4.1: Assimilation in the global and North East Atlantic (IBI) Copernicus Marine modelling system and analysis/forecast quality assessment

Task leader: MOI, Partners: EPPE

MOI teams have worked on the assimilation procedures used in the Mercator Ocean/CMEMS global data assimilation system, especially in the deep ocean. This goes through (i) their characterization in terms of error, space/time covariance, assimilation correction and (ii) disentangling the contribution of the *in situ* with regards to satellites ocean observation (e.g. assimilation correction, error on temperature/salinity/sea surface height). This work is mostly based the comparison of deep Argo observations from the pilot arrays and the GLORYS12 global 1/12° reanalysis (Figure 4), but also based on OSSEs carried out during the AtlantOS project. MOI is also currently hiring a postdoctoral researcher to work on the assimilation of tropical moorings in the Mercator Ocean global data assimilation system. She should start at the beginning of 2021.



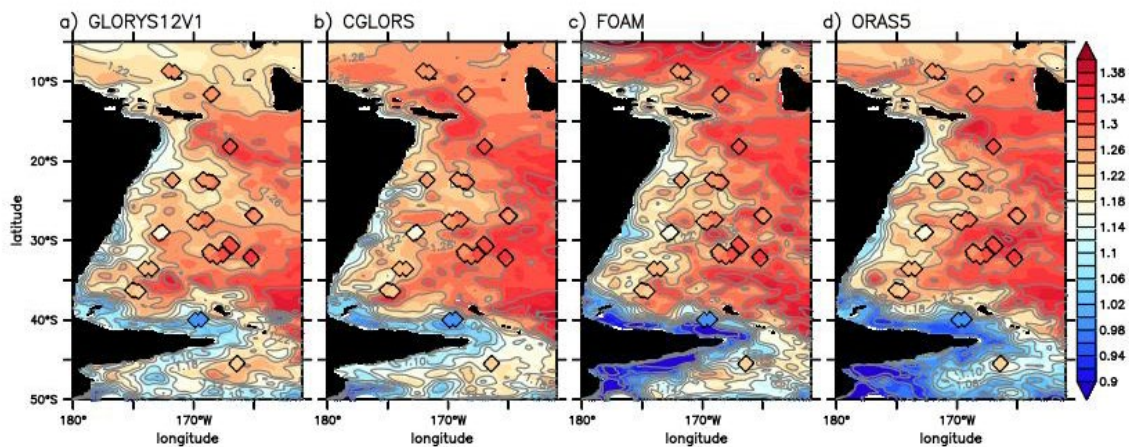


Figure 4. 3500-m potential temperature in June 2019 from (maps) the monthly Global Reanalysis Ensemble Product and (square) the deep Argo pilot array in the southwest Pacific. Only qualified data have been considered (adjusted).

The activities on the regional IBI system (EPPE) will start in 2021. Impact assessment of physical observing systems specific to regional/shelf areas will be conducted with a focus on gliders, Argo profilers and tide gauges.

Today, the regional system operated in CMEMS does not use optimally the high frequency content of data on the shelf. There will be first an analysis of the present Iberian Biscay Irish (IBI) system capacity to represent and control specific high frequency/smaller scale processes captured by the different *in situ* observation networks on the shelf. Improvement of the data assimilation scheme will be defined to better control the specific shelf dynamic and then tested in the very high resolution IBI system at 1/36°.

Presently the CMEMS BGC system assimilates only satellite observations. The developments towards the assimilation of BGC profiles are ongoing. A global data set of BGC-Argo profiles complemented with “pseudo” BGC-Argo profiles derived from CANYON-B neural network has been constituted. We have defined key BGC-Argo-based metrics of ocean health and biogeochemical functioning. We use these metrics for the validation of CMEMS BGC models. The parameter optimization of the BGC model PISCES using BGC-Argo observations will start in 2021. The assessment of the most convenient ensemble perturbations strategy for the assimilation of BGC-Argo floats in the global CMEMS BGC system will also start in 2021.

## Task 4.2: Assimilation in the Mediterranean Sea Copernicus Marine modelling system and analysis/forecast quality assessment

Task leader: CMCC, Partners: OGS, SOCIB

In task 4.2, CMCC, SOCIB and OGS aim to assess the impact of the available glider and Argo floats in the Mediterranean Sea on the MED-MFC PHY (CMEMS/CMCC), WMOP (SOCIB) and MED-MFC BIO (CMEMS/OGS) analysis/forecasting systems, respectively. The temperature and salinity profiles obtained from Argo floats are already ingested in MED-MFC PHY and WMOP systems, therefore, both systems will be improved to assimilate high-resolution glider temperature and salinity profiles. The systems will be configured to assimilate the same set of observations in order to evaluate their impacts using different numerical models and data assimilation schemes. The development of the techniques to assimilate the BGC-Argo observations is an emerging research topic in the ocean biogeochemistry community. Taking advantage from the chlorophyll BGC-Argo assimilation developed in MASSIMILI CMEMS SE project, OGS will assess the impact of

additional variables from BGC-Argo float (i.e., nitrate and oxygen) and will develop the assimilation of BGC-glider observations in the MED-MFC-BIO system.

In the first 14 months of the project, the team is focused on investigating the available products in various data repositories (e.g. CMEMS). Recent advancements in the assimilation of the glider observations are revisited. The relevant sub-sampling methods are overviewed to tackle the issue of correlated observations resulting from the high-resolution of the profiles measured by gliders. Moreover, a discussion on assimilating whether the up-cast or down-cast profiles has been carried out.

An impact assessment of the assimilation of the glider temperature and salinity profiles has been initiated in the WMOP system. Figure 5 (top panel) shows a sample glider trajectory and simultaneously gathered CTD profiles in a cruise to calibrate/evaluate the gliders. In the bottom panel, the comparison of the innovations and residuals are compared in each observation location to assess the potential improvement brought by the assimilation of the glider observations for salinity (left) and temperature (right). The mean of the innovations in salinity is 0.014 with a standard deviation of 0.21 while of the residuals is 0.004 with a standard deviation of 0.049. This means that the model state is closer to the observations after the assimilation with a much lower variance. This is an indication that the assimilation pushes the system in the right direction i.e. towards the observations. The same interpretation can be done for the temperature too.

Efforts for further assessment are ongoing. Similar experiments will be conducted using the MED-MFC PHY system. An intercomparison will be performed with the WMOP system.

The activities on the assimilation of the BGC Argo and glider observations are just starting at OGS.

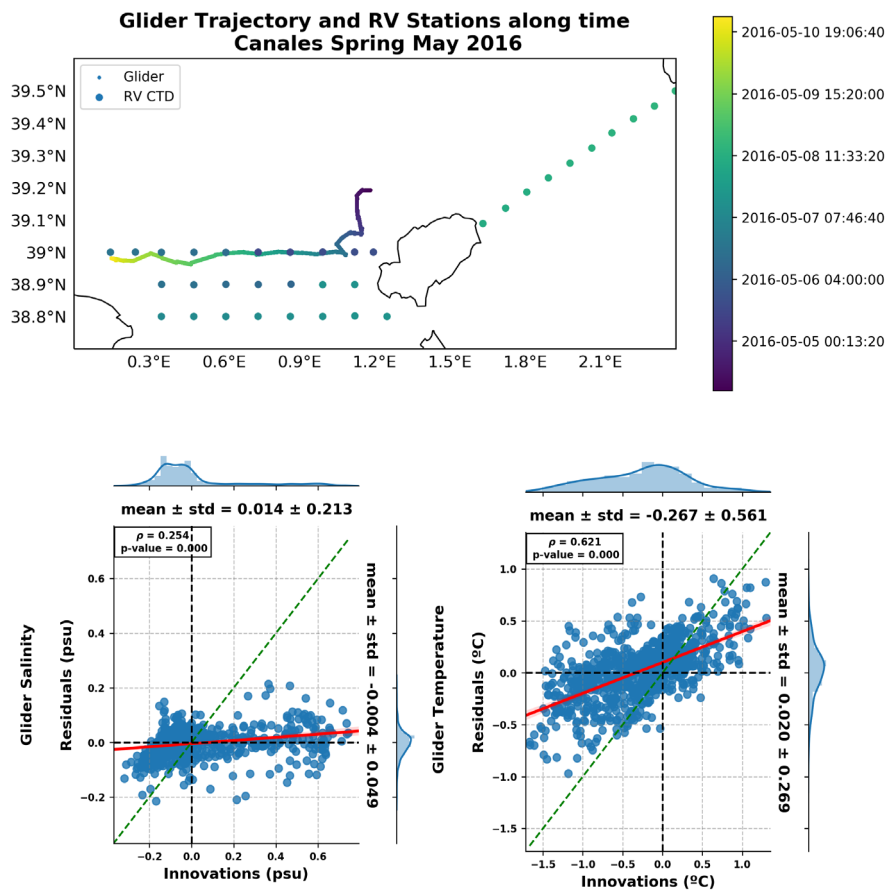


Figure 5. Top: A sample trajectory of a glider in the western Mediterranean Sea overlaid by the CTD sampling locations used for validation. Bottom: Comparison of the innovation and the residual for the salinity (left) and temperature (right).

### Task 4.3: Model development and validation for improved forecasting

Task leader: UNIBO, Partners: SOCIB, CMCC

In task 4.3 UNIBO, CMCC and SOCIB will develop new foundations for the 10 days lead ensemble forecasting in the Mediterranean Sea. Given the uncertainties stemming out of the initial conditions' errors, atmospheric forcing errors and numerical model errors ensemble forecasting is necessary to reach impact-based forecasting in the Mediterranean Sea. Starting with the work of Pinaridi et al. (2011)<sup>6</sup> and Lima et al. (2019)<sup>7</sup> a new methodology is being developed to find appropriate perturbations for the generation of the ensemble members. The new methodology starts from the recent understanding of the probability distribution function (PDF) for wind components and amplitudes. Wind uncertainties is understood to be the major source of uncertainties in the Mediterranean Sea, a land-locked marginal Sea where ECMWF winds reach only the resolution of 6-7 km which is clearly not sufficient to get the correct strength and direction of winds in several subregions of the Mediterranean Sea.

<sup>6</sup> Pinaridi N, Bonazzi A, Dobricic S, Milliff RF, Wikle CK, Berliner LM, 2011. Ocean ensemble forecasting. Part II: Mediterranean Forecast System response, Q. J. R. Meteorol. Soc, 137, 879-893, doi:10.1002/qj.816

<sup>7</sup> Lima, L. N., Pezzi, L. P., Penny, S. G., & Tanajura, C. A. S. (2019). An investigation of ocean model uncertainties through ensemble forecast experiments in the Southwest Atlantic Ocean. Journal of Geophysical Research: Oceans, 124, 432-452. <https://doi.org/10.1029/2018JC013919>

An initial study of the PDF has been carried out for 9 years of ECMWF analysis winds which confirms that a Weibull PDF fits both the wind components and the amplitudes. The Weibull PDF can be written as:

$$(1) \quad \text{pdf}(x; k, \lambda) = \frac{k}{\lambda} \left(\frac{x}{\lambda}\right)^{k-1} \exp\left(-\left(\frac{x}{\lambda}\right)^k\right)$$

where  $x$  is the wind amplitude,  $k$  is the shape parameter and  $\lambda$  the scale parameter.

In Figure 6, we show the distribution of wind amplitude for a point in the Sicily Strait from the 9 years data and its fit with the Weibull pdf (1). The horizontal variability of one of the Weibull parameters of the PDF is shown. As expected the shape parameter of the distribution varies spatially. Calculations are now being checked. The idea will be to extract from each point the value of amplitude from each point PDF and add to the wind as a perturbation and analyse the spread of the ensemble for a 10-day forecast run. At the same time, we are preparing to run several ensemble experiments with 1-day time lagged initial conditions and analyse the spread.

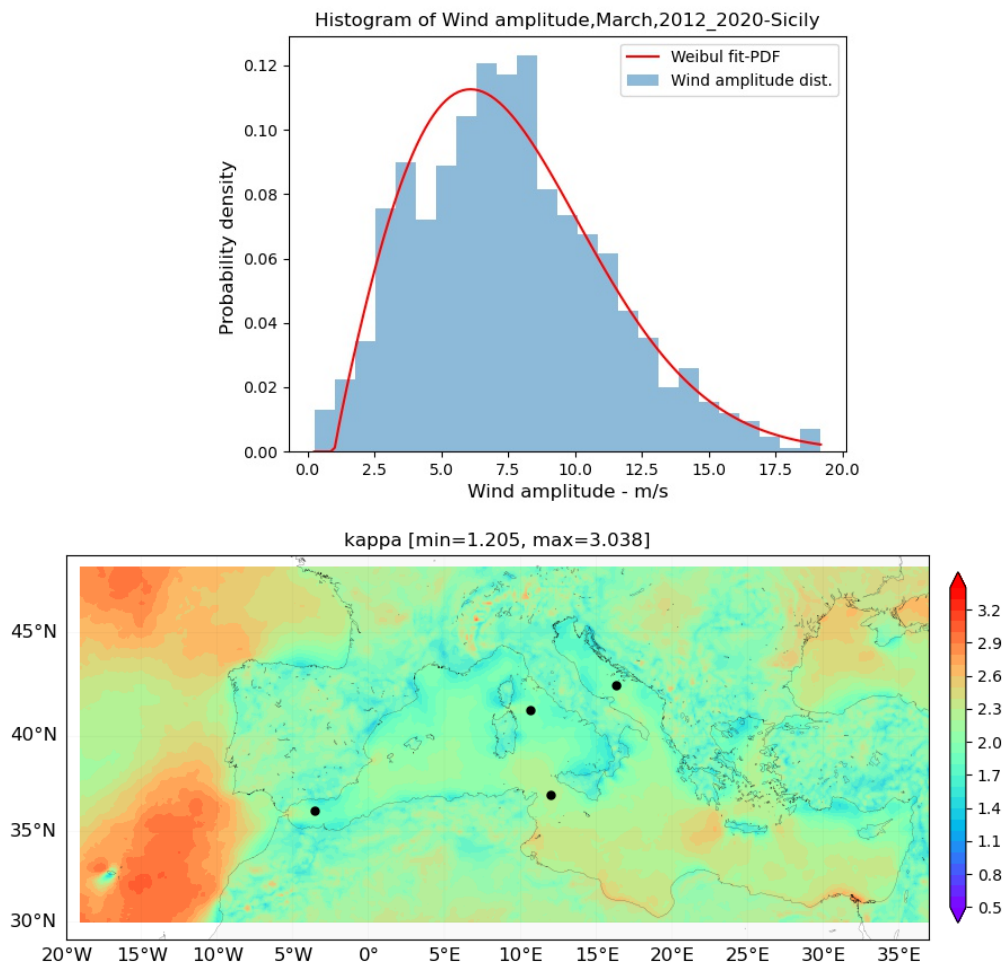


Figure 6. Top: The Weibull pdf distribution for a point in the Sicily Strait and for the 9 years of ECMWF data. Bottom: the horizontal values of the shape parameter  $k$  in (1).

#### Task 4.4: Improving the use of in-situ observations for the long-term validation of satellite observations

Task leader: CLS, Partners: AZTI, ACRI, CSIC

Although the task has not yet started (starts at PM20), we have participated in the two WP4 technical meetings. These meetings allowed us to collect user needs and to start preparing MS12, the “Work plan on the use of *in situ* for satellite validation” due at PM24.

#### Task 4.5: Synthesis product development based on ship-based in situ biogeochemical data

Task leader: UIB, Partners: GEOMAR

Task 4.5 was divided in 4 subtasks:

1. Develop quality control procedures for data from certain platforms e.g. ship-based time series stations
2. Plan and perform a workshop with PIs from international ship-based and open-ocean BGC time-series sites on data routines
3. Integration of those quality-controlled data with the Global Ocean Data Analysis Project (GLODAP)
4. Operationalize European Surface Ocean CO<sub>2</sub> Atlas (SOCAT) and GLODAP quality control efforts and test the implementation of the quality control routines for ship-based time-series

Within the first year of the project partners focused on the subtasks 1, 2 and 4. Subtask 3 will be implemented when finalized. Below we have details for the work performed in the respective subtasks.

##### Subtask 4.5.1 Develop quality control procedures for data from certain platforms e.g. ship-based time series stations

Partner GEOMAR collected and obtained permission of in total 12 time-series stations with ship-borne data (e.g. HOT, BATS, KNOT). Selection criteria have been 1) availability of carbon-relevant measurements, 2) high enough frequency of sampling periods, 3) length of time-series program (e.g. oldest samples dating back to 1988) and ideally 4) presence of “deep” data. Matlab routines have been written which transform the individual original datasets to a common and consistent format (based on the WOCE standards). Further, following routines and tools have been developed and proposed to enable the application of a consistent QC (precision) to make the data intercomparable (see example in Figure 7):

- Outlier detection based on statistical/empirical tests (e.g. z-test) and comparisons to CANYON-B
- Detrending of multi-annual variability
- Crossover-based calculation of the interconsistency of each time-series station
- Crossover-based comparisons to GLODAP (on hold due to too few comparing cruises)

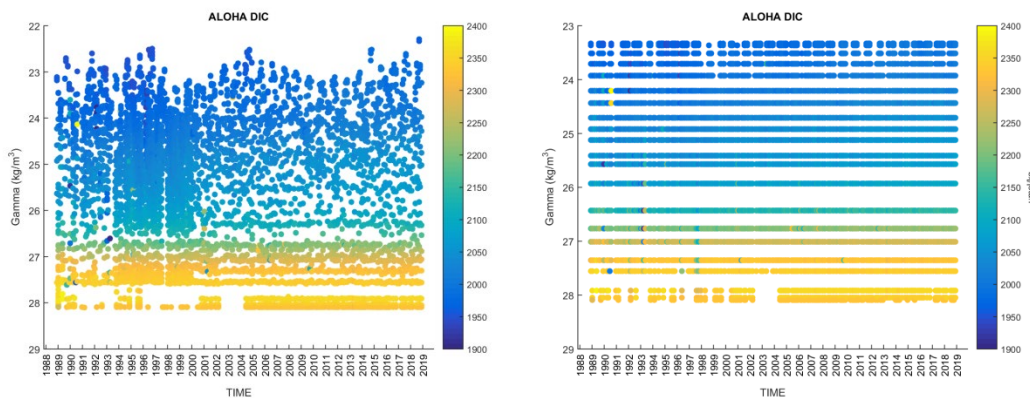


Figure 7. Example for Gamma techniques for QC procedures

## Subtask 4.5.2 Plan and perform a workshop with PIs from international ship-based and open-ocean BGC time-series sites on data routines

Details on subtask 2.) To keep the individual time-series PI's involved and obtain consensus on the actual mission and further gain feedback on the routines, Partner GEOMAR performed a workshop on 23-25.11.2020. Participants from all contributing sites supplied material. With the exception of the Japanese time-series sites (time zone conflicts) and DYFAMED (meeting conflicts) all contributing PIs have joined in personally. In the end, all time-series sites agreed to be on-board for a first pilot product and committed to first immediate steps which have to be undertaken. These include the formation of 4 working groups:

- “Concept” group led by GEOMAR: Overseeing the process and writing a concept document about the envisioned time-series product including 1) an articulated mission statement, 2) clearly outlined benefits for the TS-sites and TS-community, 3) an elaborated workflow 4) and timeline (Figure 8) briefly outlined contributions from the other three working groups.
- QC-Group: Working on 1) further developing and improving the proposed QC-routines learning from the most experienced sites (e.g. BATS and HOT). Eventually resulting in community agreed QC-methodology following Best-Practices (outlier flagging and interconsistency checks). 2) Applying the routines to data from the participating sites.
- Data-Policy Group: Working on 1) making the data compatible to the Environmental Research Division Data Access Program (ERDDAP), further 2) outlining/implementing the back-end workflow with regard to data archiving at the data centers and the subsequent gathering of the data for the product itself and 3) developing data policy guidelines, including citation and data user tracking.
- Metadata Group: Further developing metadata templates (starting from what has been already collected so far) and filling those with information from the individual sites. These need to also include fine details, e.g. pH dye impurities or metadata from different groups for the same site. Possibly, a first try will be undertaken to assign uncertainty values to different sites based on the collected information.

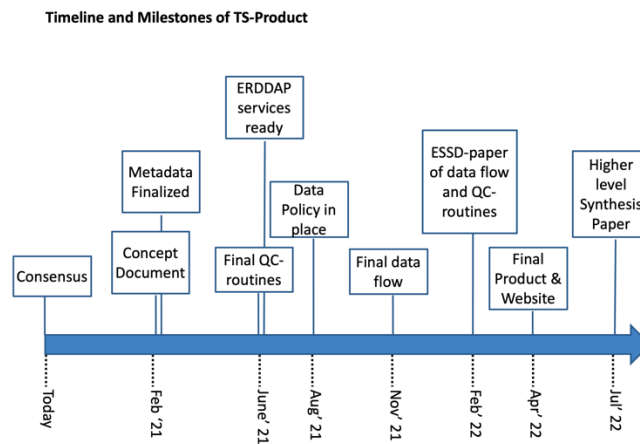


Figure 8. Timeline and milestones of a TS data product as agreed at the workshop held 23.-25.11.2020

#### Subtask 4.5.4 Operationalize European SOCAT and GLODAP quality control efforts and test the implementation of the quality control routines for ship-based time-series

GLODAPv2.2020 has been finalized in June 2020, with the two major updates being the addition of 106 new cruises and the inclusion of fCO<sub>2</sub> data. We helped with the collection of new and updated data, performed the 1<sup>st</sup> and 2<sup>nd</sup> QC of the new cruises, discussed the results at the reference group meeting, merged the data for the final product, generated updated statistics for the accompanying paper (<https://essd.copernicus.org/preprints/essd-2020-165/>, in press) and provided the data to CMEMS in-Situ TAC.

SOCATv2020 was released in June 2020. UiB assisted in uploading, assembling and coordination of SOCATv2020. Ongoing discussions with US colleagues about the automation of metadata entries and interoperability of these were discussed in November 2020. SOCAT will follow and be aligned with SDG 14.3 metadata reporting.

#### Task 4.6: Quality assessment of ocean variables from the C3S seasonal forecasts

Task leader: ECMWF, Partners: CMCC

Task 4.6 has performed the first extensive and global validation of sea level anomaly (SLA) and ocean heat content (0-300m, OHC) in seasonal forecasting systems. Re-forecasts from 1993 to the present day have been compared to long-term (~30 years) and high-resolution products: satellite-derived surface variables from ESA CCI, and the CMEMS Global Ocean Reanalysis Ensemble Product (GREP). Both variables have been assessed with a range of skill scores, and over a range of forecast periods (SLA was validated in SEAS5 at ECMWF, while OHC was validated in SPS3 at CMCC). With this global scope, task 4.6 has begun to show where (and when) SLA and OHC forecast skill is high and therefore where to focus for potential applications (Figure 9). Work to explore regions of interest to EuroSea has allowed us to perform specific validation analysis, relevant to future work on predicting Ocean Monitoring Indices. For example, the skill of OHC in the Mediterranean Sea is high, and so work has already begun with external stakeholders to find applications for this in the aquaculture sector.

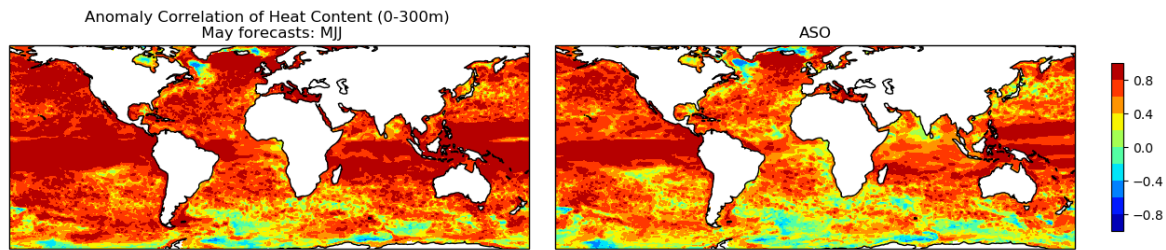


Figure 9. Anomaly Correlation Coefficient of heat content predictions. May start-date predictions of May-June-July (left) and August-September-October (right). Values close to 1 indicate agreement with validation dataset. Values above 0.4 are typically deemed to show acceptable forecast skill. Here, skill scores remain high across large swaths of the ocean; a promising result for OHC predictability in many regions of interest to climate variables.

### 3.4.3. Cooperation and interaction with other EuroSea work packages

| Co-operator   | WP4 activities  |
|---------------|---|
| WP2           | <ul style="list-style-type: none"> <li>Direct link to T2.3 - simulated observations will be used in T2.3 to test methods to be implemented in T4.4</li> </ul>   |
| WP3           | <ul style="list-style-type: none"> <li>Joint impact assessment of WP3 networks on CMEMS system (T4.1, T4.2)</li> </ul>  |
| WP7           | <ul style="list-style-type: none"> <li>Close communication and exchange about the common goal of improving seasonal forecasting systems for user-relevant applications, as well as by the co-involvement of CMCC and ECMWF: new validation efforts in task 4.6 have identified the capabilities of the forecast systems, while discussions with external stakeholders in task 7.2 have determined how to best communicate and display the validation work (T4.6)</li> </ul> |
| WP8           | <ul style="list-style-type: none"> <li>Participation in the "Stakeholder engagement strategy development" webinars</li> </ul>   |
| WP2, WP6, WP7 | <ul style="list-style-type: none"> <li>Partnership in the EuroSea Marine Heat Wave task team to discuss methodology and agree on a common approach.</li> </ul>  |

### 3.4.4. Cooperation and interaction with other projects and initiatives

| Co-operator                                      | WP4 activities  |
|--|---|
| CMEMS  | <ul style="list-style-type: none"> <li>Sharing of deep Argo and glider assimilation results with the large data assimilation community of CMEMS (T4.1, T4.2)</li> <li>Recommendation of selected verification datasets for sea level and ocean heat content for the verification of ocean variables now publicly available in Sub-seasonal to Seasonal data bases (S2S)<sup>8</sup> (T4.6)</li> </ul> |
| Argo steering team, OSE-Val Team of OceanPredict | <ul style="list-style-type: none"> <li>Sharing of deep Argo and glider assimilation results (T4.1, T4.2)</li> </ul>   |
| C3S  | <ul style="list-style-type: none"> <li>Continuous dialogue about T4.6 activities which are of high relevance for the C3S plans to deliver seasonal forecasts of ocean variables in the near future</li> </ul>   |

<sup>8</sup> <https://apps.ecmwf.int/datasets/data/s2s/levtype=o2d/type=cf/>



| Co-operator          | WP4 activities   |
|----------------------|--|
| WCRP <sup>9</sup> () | <ul style="list-style-type: none"> <li>The verification datasets for sea level and ocean heat content selected by EuroSea task 4.6 have been recommended for the verification of ocean variables now publicly available in Sub-seasonal to Seasonal (S2S) data base, in support for the activities for the WCRP S2S activities.</li> </ul> |

### 3.4.5. Achieved main results

| Milestones          |   |   |
|---------------------|---|---|
| MS7                 | Pilot global indices of SST/ SLA/OHC calculated | ✓ |
| Internal Milestones |   |   |
| iMS8                | Technical meeting                               | ✓ |

## 3.5. WP5 - Coastal Resilience and Operational Services Demonstrator

Lead: NOC, CO-lead: EPPE

| Objectives   |
|--|
| <ul style="list-style-type: none"> <li>To demonstrate the end-to-end connection from observations - including a new generation of multi-parametric monitoring station - to their wider availability and use by a wide variety of stakeholders by combining and incorporating existing CMEMS and satellite products into novel decision-making tools for policy and planning</li> </ul>   |
| <ul style="list-style-type: none"> <li>To develop new coastal management products including the downscaling of ocean analyses and forecasts for port and adjacent cities' operations aiming to:               <ul style="list-style-type: none"> <li>Provide an end-to-end demonstrator for climate quality sea level measurement to sea level services with a focus on the Mediterranean, but linked with Africa</li> <li>Development and demonstration of integrated observations and models supplying oceanographic services for ports and cities.</li> </ul> </li> </ul> |

### 3.5.1. Summary of deliveries towards objectives

Progress towards all WP objectives is on schedule. Our first deliverable, D5.1, is the prototype sea level planning and scenario visualization tool, which is due in April 2021. The good progress achieved under task 5.1.3 (conceptual interface and impact assessment algorithms, along with full definition of the coastal inundation model runs) will ensure the timely delivery of D5.1. Progress towards D5.2, D5.3, D5.4, and D5.5 is positive due to the developments of the OSPAC interface and the designs of local model configurations for each port.

### 3.5.2. Progress per task

#### Task 5.1

##### Subtask 5.1.1 Low cost and maintenance free tide gauges

Task leader: NOC, Partner: EPPE

Task 5.1.1 will deliver a new standard of low-cost and largely maintenance-free tide-gauge system, powered by renewable energy, to monitor both land motion and sea level, using novel techniques. The development of new, self-levelling, renewable energy powered tide gauges would address some of the concerns of low

<sup>9</sup> World Climate Research Programme

data volumes from the African and Aegean areas. There is potential to advance these technological solutions via the GLOSS community as a global standard. The new gauges under design will employ solar powered technology, free telecommunications systems and surface-mounted sea level radar sensors to eliminate costly underwater maintenance. They will meet the specifications of the GLOSS in order to guarantee scientific quality measurements. In addition, high-frequency samples can be transmitted every 6 minutes for tsunami monitoring purposes.

The novel instrumentation packages will be installed in three locations where we have stakeholder co-development: Barcelona, Taranto and Alexandria. To ensure the task makes progress during the COVID-19 pandemic and its associated restrictions, we have created local organising teams for each of the target locations. Contact has been made with Port of Barcelona and discussions continue in order to determine a suitable location for the tide gauge and GNSS installations. On the basis of local knowledge, a decision for installation location will be made in early 2021. For the Port of Taranto (Italy) the dialogue has begun to determine a suitable location. We are awaiting more information in this respect, so a meeting can be convened. We are currently using Google Earth to see if suitable installation locations can be pinpointed. For Alexandria (Egypt) we have submitted formal permissions with local collaborators and we are waiting for feedback.

Progress has been made defining the technical specification which is as follows: Dual radar sensors at each port (models will be peculiar to each port, since the port authorities require different functionality) with primary communications via Amazon web server 4G connection (latency ~1min) and secondary communications via EUMetsat's Meteosat (latency ~15 min). Co-located GNSS receivers (Trimble NetR9) at a minimum elevation of 6m above the sea surface, enabled for interferometric reflectometry (i.e. to measure sea level, significant wave height and land motion), with primary communications via 4G to NOC FTP site for processing and transmission to OSPAC (latency ~30 min). We are currently procuring instrumentation for assembly and testing in-house, to provide test data streams to enable parallel development of/integration into the OSPAC software tool (task 5.2).

Once all sites for installations have been selected, and the bespoke instrumentation agreed with local teams, then full procurement will begin. This will start with the GNSS equipment as this is universal for all sites. The Barcelona installation is nearly at the point where sign-off on the equipment is ready. Testing of the messaging system for data retrieval is still ongoing and other systems, which will be used as a fall-back method, are still being investigated. The service level agreement for using AWS messaging will be checked to ensure that it is resilient enough.

#### Subtask 5.1.2 Optimization of combined tide gauge data and satellite altimetry

Task leader: NOC

The objective of task 5.1.2 is the optimisation of combined tide gauge data and satellite altimetry. Sea-level changes in the Mediterranean Sea show large spatial variation and can deviate significantly both from the global average sea-level rise and from changes in the nearby Atlantic. Characterizing such spatial structure is crucial to improved coastal planning for climate change adaptation, but this is complicated by the sparseness of the observational record in time and space. Our main source of information on long-term sea-level changes comes from tide gauge records, but those are spatially sparse, often temporally inhomogeneous, and only located on the coast. In the case of the Mediterranean, nearly all tide gauges are situated in the northern coasts with almost no stations along the African coasts. Satellite altimetry provides a much better spatial coverage but only since 1992. To address the limitations due to data sparseness in the Mediterranean region,

this task will combine, in a statistically rigorous way, the tide-gauge observations with satellite altimetry data to yield reconstructed sea-level fields with the same spatial coverage as the altimetry data and spanning the same period as the tide-gauge record.

In designing the reconstruction strategy, it is important to recognize that while tide-gauges measure sea level relative to the land on which they reside (what is termed relative sea level), satellite altimetry measures geocentric sea level. This means that the sea level observed by tide gauges is affected by changes both in sea surface height (SSH) and in the underlying solid Earth (i.e., vertical land movements - VLMs) and so it is not directly comparable to the altimetry measurements. Therefore, combining tide-gauge data with altimetry observations requires a physically consistent framework that explicitly models the contributions from SSH and VLM. However, existing reconstructions of Mediterranean Sea level have typically made the assumption that tide gauge and altimetry observations are equivalent, except for VLMs associated with glacial isostatic adjustment (GIA).

In this task, we aim to take a step forward and reconstruct and quantify the various contributions to relative sea level in the Mediterranean Sea by combining tide gauge observations with altimetry data and fingerprints of land-mass changes through a Bayesian spatiotemporal model. The results will be compared with those based on the method of reduced space optimal interpolation, which has been used in previous sea-level reconstructions. We will use two different altimetry products. The first one is a multi-mission gridded dataset based on conventional retracking methods. Typically, conventionally retracked data are not reliable close to the coast where tide gauges are located, which poses a challenge when combining such data with tide gauge observations. Therefore, we will use a second altimetry dataset derived using a dedicated coastal re-tracking algorithm called ALES which has been developed at the National Oceanography Centre.

Significant progress for task 5.1.2 has been made as follows:

- The multi-mission gridded altimetry dataset has been downloaded from CMEMS (<https://marine.copernicus.eu/>) and the coastally-retracked altimetry data has been generated.
- The monthly tide gauge observations have been obtained from the Permanent Service for Mean Sea Level (<https://www.psmsl.org/>).
- The fingerprints of land-mass changes have been obtained from Frederikse et al. (2020)<sup>10</sup>.
- The development of the Bayesian spatiotemporal model has already started and substantially progress has been made in this regard.

### Subtask 5.1.3 Data-driven modelling and visualization for sea level guidance

Task leader: ARUP, Partner: UCAM

The aim of task 5.1.3 is to improve decision making in the coastal zone under uncertainty; the uncertainty is present in the range of possible future sea Level Rise projections. Decision makers in cities and other locations on the coast need to make informed decisions on risk and resilience in relation to coastal flood risk, now and into the future. The risk assessment process is complex, and it is difficult to bring through all the climate science and sea level rise projections to the decision making, and presently, decisions are made without real understanding of the uncertainty.

<sup>10</sup> <https://zenodo.org/record/3862995#.X9JiPdij7SUK>

The task has identified a case study location, the city of Hull, on the River Humber, on the east coast of the UK. Hull has significant risks from tidal flooding as shown in Figure 10. This task is split into 2 elements:

## Climate science and Physical Modelling of the Impacts

This element, led by University of Cambridge, has taken detailed sea level rise projection data, available around the UK as calculated by UKCP18. As projections get further from the present, the uncertainty around the prediction increases (Figure 10). Typically flood risk assessment for future scenarios are based on 50<sup>th</sup> percentile of a sea level rise projection, which ignores this sea level rise uncertainty.

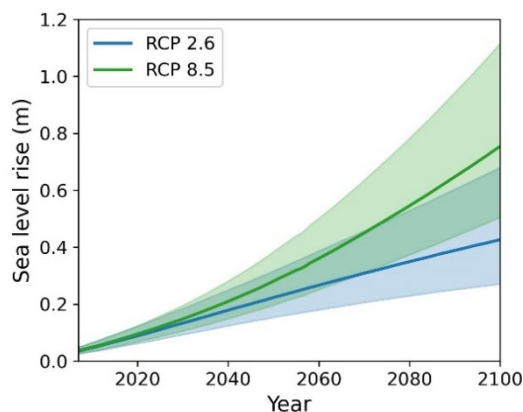


Figure 10. Sea level rise projections for the River Humber for a low (RCP2.6) and high emission scenario (RCP 8.5), showing 5th, 50th and 95th percentiles

To incorporate this sea level rise projection uncertainty into coastal flood risk assessment, UCAM are setting up a modelling framework that allows the uncertainty to be propagated through to the calculation of risk. To calculate the flood hazard, reduced complexity models are used to allow a large number of scenarios to be run and all potential pathways of flooding to be considered. Model input data is derived from already existing sources including wave data from (joint probability analysis), extreme water level and future sea level rise projections. The input hydrodynamics are used to calculate overtopping discharge at representative transects on the coastal defences of the Humber using the EurOtop<sup>11</sup> empirical equations. The overtopping discharge time-series is then used to drive a LISFLOOD-FP<sup>12</sup> flood spreading model. The models are run for the full range of potential conditions at the site, under current and future sea level rise.

## Risk Model and Visual Interface

Arup and CADA consulting are leading this element, which follows the UCAM modelling. In preparation for receiving the UCAM modelling, the following has been undertaken to date:

- Development of a conceptual interface to promote discussion with stakeholders
- Development of simplified impact assessment algorithms to combine probabilistic flooding, uncertain sea level rise and impact (cost) with integration to calculate the annual risk
- Development dummy flood and impact data to test the algorithms and interface
- Setting up meetings with stakeholders in New Year to test the principles and seek feedback for improvements on the communication

<sup>11</sup> EurOtop (2016) Manual on wave overtopping of sea defences and related structures. An overtopping manual largely based on European research, but for worldwide application. Van der Meer, J.W., Allsop, N.W.H., Bruce, T., De Rouck, J., Kortenhaus, A., Pullen, T., Schüttrumpf, H., Troch, P. and Zanuttigh, B., [www.overtopping-manual.com](http://www.overtopping-manual.com).

<sup>12</sup> Bates, P.D. and De Roo, A.P.J., (2000). A simple raster-based model for floodplain inundation. *Journal of Hydrology*, 236, 54-77.

The key challenge is in communicating the uncertainty to a range of stakeholders; we might end up with multiple visualisations depending on their background and need.

## Task 5.2

The major goal of task 5.2 is a new coastal management product: The Oceanographic Services at the service of Ports and Cities (OSPAC) demonstrator integrates observations and downscaled ocean model forecasts, in order to supply operational oceanographic services for the port cities of Barcelona, Taranto, and Alexandria. This demonstrator will create an integrated set of tools and measuring instruments that will provide an operational service to the city and the adjacent port in order to minimize risks and improve environmental management. The task will work directly with Barcelona, Taranto and Alexandria. The products and services will provide several socio-economic impacts and benefits, such allowing the control of water quality inside the port, providing a tool for management of the beaches to the town, and a tool to manage accidents such as oil spill. The following problems, amongst others, will be mitigated by the demonstrator: 1) water quality: coastal water quality depends on the activities of neighbouring cities, ports and beaches, as well as in coastal circulation; 2) navigation safety in the environment of cities and ports; 3) beach safety, e.g. rip current forecasts and sea state monitoring and forecasting.

All subtasks of task 5.2:

### Subtask 5.2.1 Model downscaling

Task leader: UPC, Partners: CMCC

### Subtask 5.2.2 Instrumentation deployment at test sites

Task leader: NOC, Partners: EPPE, CMCC

### Subtask 5.2.3 OSPAC software development

Task leader: Nologin, Partners: EPPE, CMCC

### Subtask 5.2.4 Demonstration of the tools at two European sites

Task leader: EPPE, Partners: NOC, CMCC, Nologin

### Subtask 5.2.5 Demonstration of the tools at a non-European site

Task leader: EPPE, Partners: NOC, CMCC, Nologin

are closely linked. Their progress is therefore described coherently:

High-resolution operational forecast systems for wave, sea level, sea surface temperature, and circulation will be developed at all test sites. In all cases, and for all variables, the output resolution will be in the order of meters. The open boundary conditions for the forecast systems will be provided by the CMEMS systems. Atmospheric forcing will come from national Met-offices. Results of the models will be made available every day in an open access system, so further third-party applications could be developed in the future. The models will be validated with already existing instrumentation at the test sites, and with the instruments deployed to be deployed in task 5.2.2. The systems will run on daily basis at Puertos del Estado and CMCC facilities, and the results will be exploited by the OSPAC software system (task 5.2.3). This task connects to the data integration for multi-hazards forecasting in WP4. Model development has already been started at Barcelona and Taranto sites.

The novel multi-parametric equipment developed in task 5.1.1 will be implemented at the test sites. Final configuration will depend on site requirements. For example, at Barcelona, meteorological, visibility sensors

and lightning detectors (to support safety during flammable liquid operations) will be implemented. All the real time data will be integrated in the OSPAC software and used for multiple purposes, e.g. real time alerts, model validation, monitoring of conditions for operations.

The advances in the deployment of the station vary from site to site:

- At Barcelona a working group has been established and is meeting regularly to proceed to the installation. Different locations are being suggested.
- At Taranto, initial conversation with the Port are being established
- At Egypt, the permits to install the instrumentation are under evaluation.

The new OSPAC software, to be used by Port and City authorities, will have the following capabilities: 1) real time alert based on the monitoring stations deployed at task 5.2.2; 2) provide a forecast of the sea-conditions at the Port and the city in the following days, and link it with an alert system based on SMS and e-mail; 3) forecast of rip currents at the city beach. The operational prediction of these currents, including shore parallel (alongshore) and shore perpendicular components (undertow and rips), will be carried out through a hybrid system (bulk formulations plus numerical models) for at least two city beaches; 4) flushing times forecast for each port and its docks: The methodology applied will be based on the numerical release of a Eulerian conservative tracer; 5) floating debris (including plastics) forecast tool for city and Port. Results from 5.2.1 will be used by a Lagrangian transport model in order to estimate the trajectories of debris. The simulated debris dispersion and advection patterns will be used by the port and the city to discuss impacts and recovery policy; 5) Flood and erosion risk forecast at the city beach, coastal flooding.

Detailed requirement documents have been developed, and the coding of the OSPAC interface has already started.

### 3.5.3. Cooperation and interaction with other EuroSea work packages

| Co-operator | WP5 activities   |
|-------------|--|
| WP8         | <ul style="list-style-type: none"> <li>• Participation in “Stakeholder engagement strategy development” webinars</li> <li>• Interaction in terms of stakeholder mapping and impact assessment</li> </ul> |

### 3.5.4. Cooperation and interaction with other projects and initiatives

None as yet.

### 3.5.5. Achieved main results

None as yet.

## 3.6. WP6 - Ocean Health Demonstrator

Lead: MI, CO-lead: CSIC

| Objectives  |
|---|
| <ul style="list-style-type: none"> <li>• Develop a shared understanding of water management among end-users in Aquaculture, Fisheries, Tourism, Environmental Agencies and Scientists by working together to co-create products that help to identify and foresee “Extreme Marine Events” threatening marine ecosystems, resources, and related businesses, and supporting adaptive management decisions</li> </ul> |

- |  |
|--|
| <ul style="list-style-type: none"> <li>• Demonstrate the value of ocean observing and forecasting of “Extreme Marine Events” at local to regional scales by developing downstream products and services to assess marine ecosystem health, and provide an early warning system to support sustainable Blue Growth industries and food security needs.</li> </ul> |
| <ul style="list-style-type: none"> <li>• Provide a new perspective for environmental managers and policy makers focused on maintaining healthy marine ecosystems in harmony with human activities supporting stronger local and regional governance by using EuroSea decision support tools to assess ocean health</li> </ul>                                    |
| <ul style="list-style-type: none"> <li>• Support the sustainable development of ocean observing and forecasting systems to monitor ocean health by stimulating international ocean observing initiatives</li> </ul>  |
| <ul style="list-style-type: none"> <li>• Create new market and management opportunities for the private sector by co-creating new ocean products for aquaculture and fisheries</li> </ul>  |

### 3.6.1. Summary of deliveries towards objectives

In this first reporting period, WP6 has progressed toward its objectives with one WP6 led milestone (MS3) submitted. EuroSea co-developers (task 6.1) have agreed on the demonstration requirements (EOVs), the data buoy system design (task 6.4) and the planned approach/methodologies in the next period.

In the context of connecting CMEMS and fisheries communities (task 6.2), in February 2020 there was a meeting in Lisbon between WP6 and scientists from the ICES Working Group on Anchovy and Sardine (WGHANSA), including a team from the Division of Modelling and Management of Fisheries Resources of the Portuguese Institute for Sea and Atmosphere (IPMA) and from Spanish Oceanographic Institute (IEO), where anchovy and sardine were identified as species of interest. It was agreed that Copernicus products can give insight about environmental drivers on estimated recruitment time series and then environmental influence can be used into a Globally applicable Area-Disaggregated General Ecosystem Toolbox (GADGET)<sup>13</sup> model to provide forecasts and improve advice. Then the priority is to implement or improve the already developed GADGET models for these areas.

WP6 (task 6.3) is helping to coordinate the activities that are carried out in the Baltic Sea through a joint initiative between BOOS and HELCOM. Two products are under development: regular assessment of eutrophication status and regular reports on abnormal or extreme events (e.g., salt water inflows). Both CMEMS products and *in situ* data from environmental monitoring are incorporated. Operational delivery of monitoring data to CMEMS is initiated during this first year.

Finally, technical developers (XYLEM) (task 6.4) designed a data buoy system solution to address the type of monitoring needed in SW Ireland and Mediterranean Sea.

WP6 decision support tools are co-developed with our technical developers (XYLEM), colleagues in aquaculture (MOWI; CTAQUA), fisheries (ICES WGHANSA), tourism (public through HELCOM), commissions/governments/environmental agencies (Helsinki Commission, Irish Department of Housing, Local Government and Heritage through the National Parks and Wildlife Service; Ireland’s Seafood Development Agency, BIM; Environmental Protection Agency, Ireland; Division of Modelling and Management of Fisheries Resources at IPMA, Portugal) and EuroSea partners (WP6: MI, CSIC, XYLEM, DMI, TalTech, SOCIB, IOC-UNESCO and other WPs).

<sup>13</sup> Begley J., Howell, D. (2004). An overview of Gadget, the Globally applicable Area-Disaggregated General Ecosystem Toolbox. ICES CM documents. <http://hdl.handle.net/11250/100625>

### 3.6.2. Progress per task

#### Task 6.1: Extreme Marine Events” Ocean Observing & Forecasting

Task leader: MI, Partners: CSIC, SOCIB, IOC-UNESCO

For T6.1 progress was made to understand our end-user requirements (Table 2). One to one meetings, workshops and follow-up on-line meetings with relevant stakeholders, and on-line surveys organised by the task partners to gather requirements.

In particular, the following meetings were considered important steps in the dialogue with our co-developers:

[First Irish EuroSea Co-Developer Workshop WP6 “Ocean Health Demonstrator”, 04-Nov-2019.](#)

Hosted by the Marine Institute with attendance by EuroSea co-developers National Parks and Wildlife Service (NPWS), MOWI Ireland, Bord Iascaigh Mhara (BIM) and the Irish Environmental Protection Agency (EPA).

At the workshop requirements (EOVs), focus area, and approach were agreed. Several different types of models available to the project that cover Irish waters were investigated and the types of downstream services currently available were presented to the co-developers. A round table discussion followed where each co-developer identified their requirements and the conversation then honed in on the type of ocean health indicators that would be helpful, e.g., marine heat waves, deoxygenation events, acidification that could be focused on during the EuroSea project. EuroSea project co-developers said that their expectations of the EuroSea project are low. The main reason for this, is based on past experience of other projects that were not as successful as expected. This is the first time this group has worked together on a project.

[WP6 meeting with CTAQUA, 04-Feb-2020.](#)

During this meeting, held at the CTAQUA facilities (Puerto Santa Maria, Spain), researchers from EuroSea described the overall objective of EuroSea project and explained what is expected in task 6.4. This introduction was necessary since these co-developers were unable to attend the EuroSea kick off. The main need of the Spanish stakeholders relates to damage generated by storms, of particular importance due to the trauma experienced by the aquaculture sector after the passage of the storm Gloria in winter 2019. The group analysed the possibilities of providing alerts to industry in future so they can prepare and put mitigation measures in place to prevent devastating infrastructural damage generated by the mechanical stress caused by extreme storm events. Other components (e.g., marine heat waves, deoxygenation events) are not discarded but postponed due to the present situation. It was decided to create an easy to understand questionnaire for the aquaculture sector to respond to in more detail to further identify their requirements. The results of this questionnaire indicate that the respondents are interested in getting alerts about extreme wave events, extreme events of current intensity and extreme events of water quality (oxygen, turbidity, pH, etc.). They are interested in data near the coast (between 25-50 meters depth) and a wave forecasting warning system for at least two days in advance of an event.

[Advance on an end-user-oriented tool for the exploration and visualization of extreme events and associated EOVs from ocean observing and forecasting systems in the Western Mediterranean.](#)

We have worked on the enhancement of a web-based tool for oceanographic data exploration and visualization described in Heslop *et al.* (2019)<sup>14</sup>. The new “Mediterranean Surface Exploration Tool” (MSET) has improved usability, visualization, and allows characterization of extreme events and exploration of

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<sup>14</sup> Heslop, E., Tintoré, J., Rotllan, P., Álvarez-Berastegui, D., Fontera, B., Mourre, B., Gómez-Pujol, L., March, D., Casas, B., Nolan, G., & Durand, D. (2019). SOCIB integrated multi-platform ocean observing and forecasting: from ocean data to sector-focused delivery of products and services. *Journal of Operational Oceanography*, 12(sup2), S67–S79. <https://doi.org/10.1080/1755876X.2019.1582129>.



various Essential Ocean Variables ([EOVs](#)) providing information on the sea surface of the Western Mediterranean Sea - temperature, salinity, sea level, chlorophyll-a, oceanic fronts and currents-. The information is obtained from the [SOCIB](#) Western Mediterranean Operational system ([WMOP](#)) and from satellite data provided by Copernicus Marine Service ([CMEMS](#)). Features can be explored as layers or as time series at specific points defined by the user when double-clicking the layer on display. Advances on this tool can be checked at: <http://apps.socib.es/oceanography-exploration/>.

The first deliverable from this task is due at project month 24. The work is on the way and there are no delays to report.

Table 2. EuroSea Ocean Health Service Requirements. The table summarises the needs of the service co-developers to support their environmental assessments. The table also provides an overview of data the co-developers will share with the EuroSea consortium.

| Subject   | Co-developer   | Co-developer requirements   | Co-Developer Datasets available to EuroSea  |  |   |   |                         | Suggested study area | Suggested Model to Use in EuroSea |
|---|--|---|---|--|---|---|-------------------------|----------------------|-----------------------------------|
|   |  |   | Physical  | Chemical   | Biological  | Others  | Resolution              |                      |                                   |
| Environmental Assessment of Natura 2000 sites         | National Parks and Wildlife Services NPWS                    | <u>Identification and forecast of:</u> <ul style="list-style-type: none"> <li>Marine Heat Waves</li> <li>Deoxygenation events</li> </ul> <u>Monitoring and forecast of:</u> <ul style="list-style-type: none"> <li>Water Quality variables</li> </ul> |   |  | <ul style="list-style-type: none"> <li>EUNIS habitat maps (e.g. <i>Zostera</i> communities; maerl communities)</li> </ul> | <ul style="list-style-type: none"> <li>Natura 2000 site maps</li> </ul>   | Report every 6 years    | SW Ireland           | SW Ireland model                  |
| Assessment of Fish farms, Fish health & Water quality | MOWI Ireland   | <u>Identification and forecast of:</u> <ul style="list-style-type: none"> <li>Marine Heat Waves</li> <li>Deoxygenation events</li> </ul> <u>Monitoring and forecast of:</u> <ul style="list-style-type: none"> <li>Water Quality variables</li> </ul> | <ul style="list-style-type: none"> <li>Water temperature</li> <li>Salinity</li> </ul>             | <ul style="list-style-type: none"> <li>Dissolved Oxygen</li> <li>Nitrate</li> <li>Nitrite</li> <li>Ammonia</li> <li>Phosphate</li> <li>Dissolved Inorganic Nitrogen</li> </ul> |   | Total Ammonia Nitrogen  | Monthly                 | SW Ireland           | SW Ireland model                  |
| Potential transport pathways of pathogens             | Ireland's Seafood Development Agency Bord Iascaigh Mhara BIM | <u>Evaluation of ocean currents:</u> <ul style="list-style-type: none"> <li>Model particle tracking</li> </ul> <u>Monitoring and forecast of:</u> <ul style="list-style-type: none"> <li>Water Quality variables</li> </ul>                           | <ul style="list-style-type: none"> <li>Water current speed and direction</li> </ul>               |  |   |   | Ad hoc deployments      | SW Ireland           | SW Ireland model                  |
| Environmental Assessments of Water Quality            | Environmental Protection Agency EPA                          | <u>Identification and forecast of:</u> <ul style="list-style-type: none"> <li>Marine Heat Waves</li> <li>Deoxygenation events</li> </ul> <u>Monitoring and forecast of:</u> <ul style="list-style-type: none"> <li>Water Quality variables</li> </ul> | <ul style="list-style-type: none"> <li>Water temperature</li> <li>Salinity</li> <li>pH</li> </ul> | <ul style="list-style-type: none"> <li>Total oxidised nitrogen</li> <li>Ammonia</li> <li>Phosphate</li> <li>Silica</li> <li>Dissolved Inorganic Nitrogen</li> </ul>            | <ul style="list-style-type: none"> <li>Phytoplankton Chlorophyll</li> </ul>   | National WFD monitoring programme. Sites and waterbodies can be viewed <a href="#">here</a> :<br>Parameters include: <ul style="list-style-type: none"> <li>Bottom depth</li> <li>Depth</li> <li>Secchi depth</li> <li>Dissolved Oxygen Saturation</li> <li>Dissolved Oxygen</li> <li>Biochemical oxygen demand</li> <li>Chlorophyll</li> <li>Suspended solids</li> </ul> | Monthly (growth season) | SW Ireland           | SW Ireland model                  |

### Task 6.2: Connecting CMEMS and fishery communities to increase uptake, and inform development of products for fishery management

Task leader: CSIC, Partners: MI

Meeting with Codevelopers WP6 meeting with member of the ICES WGHANSA (17-Feb-2020)

A meeting was held with a team from the Division of Modelling and Management of Fisheries Resources of the IPMA. Anchovies and sardines were identified as the fish taxa of interest. It was agreed that Copernicus products can give insight about environmental drivers on estimated recruitment time series and then environmental influence can be used into a GADGET model to provide forecasts and improve advice. Then the priority is to implement or improve the already developed GADGET models for these areas.

### Task 6.3: Multipurpose integration of BOOS & HELCOM observing networks

Task leader: DMI, Partners: TalTech

HELCOM State and Conservation meeting 12-2020 (11/14-May-2020)

The aim is to develop and make two products available: regular assessment of eutrophication status and regular reports on abnormal or extreme events (e.g., salt water inflows). Both CMEMS products and *in situ* data from environmental monitoring are incorporated. Operational delivery of monitoring data to CMEMS is initiated. Near real time (NRT) delivery agreed from Sweden, Denmark, Estonia and Finland, potentially also Germany and Poland.

Feedback on the potential products was requested from the HELCOM working group (HELCOM S&C 12-2020 on 11-14 May 2020). COVID-19 related restrictions did impact the observations – some monitoring cruises were postponed, while the autonomous observations continued, except for FerryBoxes that were stopped for two months (since ferries were stopped).

Multi-variate scheme for assimilating SST and T/S profiles is now under-development at DMI by using a Parallel Data Assimilation Framework (PDAF) for NEMO4-ERGOM model. The PDAF-NEMO-ERGOM will be further tested and used to produce interim reanalysis products which will be used for the eutrophication assessment.

### Task 6.4: System Operation

Task leader: Xylem, Partners: CSIC, MI

Eurosea T6.4 kick off with Stakeholders (Jan/March/May-2020)

The planned May 2020 site visit to SW Ireland was disrupted due to the COVID-19 crisis. Following a number of online meetings with our co-developers, MOWI Ireland, we have assessed all information related to the Irish site and the data buoy system solution design has been addressed for the type of monitoring needed (Figure 11). We are in discussions with our Mediterranean colleagues to design a system similar to Ireland for the Mediterranean Sea site. We are also looking for a solution to help with the early warning of extreme events such as that experienced during storm Gloria 2020 when massive structural damage to aquaculture sites occurred. The end of design phase is now completed with an expected delivery at the end of 2022. Work to date is ahead of schedule, as most of the work above was planned to at the end of year 2.

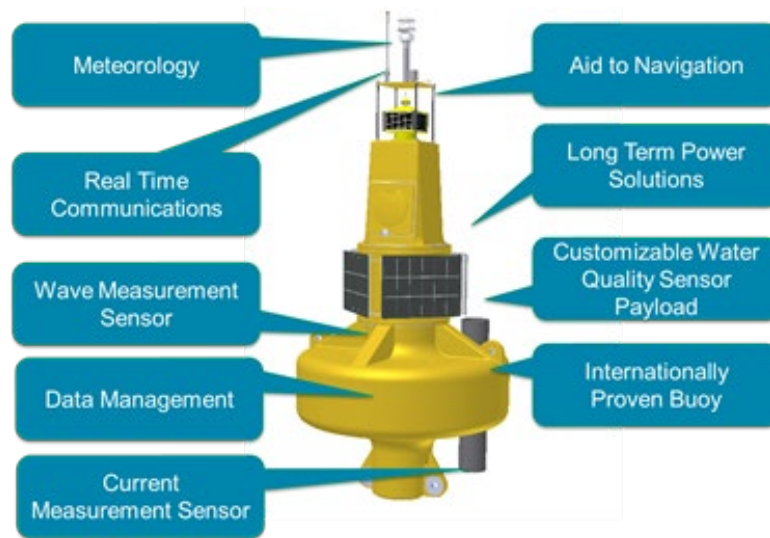


Figure 11. Xylem environmental buoy for real-time current, wave and water quality measurements.

### 3.6.3. Cooperation and interaction with other EuroSea work packages

| Co-operator   | WP6 activities   |
|---------------|--|
| WP2           | <ul style="list-style-type: none"> <li>Providing requirements of EOVs and platforms for sustaining indicators for WPs 4-7</li> </ul>   |
| WP2, WP4, WP7 | <ul style="list-style-type: none"> <li>Partnership in the EuroSea Marine Heat Wave task team to discuss methodology and agree on a common approach.</li> </ul>   |
| WP4           | <ul style="list-style-type: none"> <li>Relay of information about requirements of WP6-stakeholders (IPMA, Portugal and IEO, Spain) regarding CMEMS existing and/or new products with potential added value identified by WGHANSA; receipt of advice by WP4</li> </ul>                      |
| WP8           | <ul style="list-style-type: none"> <li>Participation in “Stakeholder engagement strategy development” webinars</li> <li>Providing the material for a website news story on “Predicting the extreme: How ocean observing helps industry prepare for extreme marine events” (MS3)</li> </ul> |

### 3.6.4. Cooperation and interaction with other projects and initiatives

| Co-operator | WP6 activities   |
|-------------|--|
| CMEMS       | <ul style="list-style-type: none"> <li>Data receipt for T6.1, T6.2 and T6.3 product development</li> </ul>   |
| Blue-Cloud  | <ul style="list-style-type: none"> <li>Contact to seek synergies between the two projects</li> <li>Attendance of webinars developed and hosted by Blue-cloud                             <ul style="list-style-type: none"> <li>Aquaculture Monitor – focused on an aquaculture atlas [25 September, 2020]</li> <li>Fish-a matter of scales – focused on expanding the FAO tuna atlas using Global Record of Stocks and Fisheries (GRSF) [14 October, 2020]</li> </ul> </li> </ul> |
| CoCliME     | <ul style="list-style-type: none"> <li>Gain access to a 30 hindcast downscaled model (1 Km res) off SW Ireland</li> </ul>  |

### 3.6.5. Achieved main results

| Milestones |   |   |
|------------|---|---|
| MS3        | Specification of user-needs and expectations Documented | ✓ |

### 3.7. WP7 – Ocean Climate Indicators

Lead: MOI, CO-lead: IO PAN

| Objectives   |
|--|
| <ul style="list-style-type: none"> <li>• Generate a feedback loop between EuroSea, climate and ocean services, the economy sector, and decision makers by co-examining ocean climate indicators, assessing their uncertainties and quantifying their economic value</li> </ul> |
| <ul style="list-style-type: none"> <li>• Provide user-relevant products for ocean climate monitoring and deliver ocean forecasting indicators in support of improved ecosystem management, risk management and blue growth</li> </ul>  |
| <ul style="list-style-type: none"> <li>• Carry out AtlantOS (H2020)<sup>15</sup> recommendations for observing system strategies, and demonstrate the improvements through ocean climate indicator developments with decreased uncertainty</li> </ul>                          |

#### 3.7.1. Summary of deliveries towards objectives

Task 7.1. aims to evaluate the economic value of the variable ocean carbon sink of European relevant deep convections regions. The analysis will be based on operational carbon assessments using a combined observing and modelling approach. The assessment of existing air-sea CO<sub>2</sub> and interior ocean carbon storage data products, methodological approaches and the data flows was key work during the first phase of the project. Regional high-resolution model simulations of partners are used to test different observational network strategies in the Mediterranean Sea and Labrador Sea.

With task 7.2, WP7 has successfully reached its first milestone (M7) with the essential advancement on the definition of indicators for the forecasting tool. Profound collaboration with WP2 has established the baseline while identifying Essential Ocean Variables (EOVs) critically needed within EuroSea. These EOVs have then been linked to ocean indicators classified for different types of sectors and stakeholders, and are particularly addressed for topics crossing WP activities within EuroSea (WP5, WP6).

In task 7.3, the majority of activities will take place in 2021, mainly conducting a multi-platform demonstration mission in the tropical Atlantic to enhance the quality of estimates of air-sea CO<sub>2</sub> fluxes in the region. So far, preparations for the different mission components are underway (extension of Brazilian PIRATA array by a CO<sub>2</sub> sensor, deployment of BGC Argo floats and a multi-month's mission between Cabo Verde and Brazil with autonomous surface vehicles, ASV). Equipment has been purchased and already partly delivered; additional funding secured for an ASV mission following withdrawal of external partner. In parallel, work is ongoing on physical oceanography indicators in the Tropical Atlantic, and a reconstruction of the surface ocean pCO<sub>2</sub> time series using PIRATA 8N/38W mooring data.

#### 3.7.2. Progress per task

##### Task 7.1: Carbon audit of the European relevant deep convection regions

In task 7.1 multiple existing observational based datasets (i.e. JenaCarboScope) / model outputs (i.e. CMEMS) for air-sea CO<sub>2</sub> fluxes and ocean interior CO<sub>2</sub> storage have been assessed. Coverage of high-quality carbon datasets (GLODAPv2, SOCAT) and associated data flows has been assessed. Additionally, a first assessment of observational and methodological uncertainties related to existing air-sea CO<sub>2</sub> flux estimates / products was performed. To give feedback/interact on CMEMS CO<sub>2</sub> flux and storage reanalysis and forecast products, a contact with Mercator Ocean has been established

<sup>15</sup> <https://www.atlantos-h2020.eu/>

The observational network in the Mediterranean Sea including surface underway observations (i.e. MOOSE), point measurements and glider deployments are assessed for carbon auditing and important actors have been connected. Regional high-resolution BGC model simulations are analysed to suggest improvements in the Mediterranean and Labrador Sea observing network.

Furthermore, a method to use information on the country social cost of carbon is developed. An estimated damage impact of climate change and the calculated monetary values cannot directly be translated into monetary transfers/trading values. Task 7.1 will rather inform on the implicit carbon wealth transfers between regions. The existing inclusive wealth accounts (i.e. <https://seea.un.org/content/inclusive-wealth-report-2018-measuring-progress-toward-sustainability>), use a different estimate for the social cost of carbon and do not account for the fact that countries are differently affected by climate change, resulting in differences in the country social cost of carbon.

### Task 7.2: Demonstrate societal benefit of physical Ocean Monitoring and Forecasting Systems: Design of user driven products

There had been considerable progress towards the critical objective to the definition of ocean indicators for seasonal forecasts through the finalization of MS7, which has been reached in Q4 2020. An overview is provided in Table 3. The MS7 definition of ocean indicators for seasonal forecasts include:

- ECVS used for verification: SST, SL (from ESA-CCI, delivered by C3S) and OHC from CMEMS GLORAN (Reported to WP2 during a teleconf on October 6)
- Indicators classified by maturity stage:
  - STAGE 1: Defined indices already used by applications. A subset of them (not all of them) will be used to define pilots: defined for different basins (Atlantic, Pacific, Indian and latitudinal bands), and applied to SST, SLA and OHC: The sectorial applications are the following:
    - Seasonal Forecasts. (SF)
    - Climate Variability and Change: changes in circulation, heat absorption, sea level change. (CVC)
    - Coastal Sea Level Change (CSL)
    - Marine Health: Large scale conditioner for Marine heat waves (MH)
    - Marine Productivity: Upwelling regions (MP)
  - STAGE 2: Intermediate stage of maturity but highly relevant for Europe: MEDITERRANEAN basin. For CVC, MP, MH. This indicator has an intermediate stage of maturity.
  - STAGE 3: Ideas for additional or more advanced indices, co-developed with stakeholders that will need to be explored during the project:
    - Upwelling areas (Fisheries, climate variability):
      - the Canary Upwelling region is from 11N to 31N and 6W-30W.
      - the Benguela Current System (BenCS, 15°S-35°S, from coast to 5E)
      - the Humboldt Current System or Peru Current System (HCS, 5° S-40°S, from coast to 85W)
      - the California Current System (CalCS, 22°N-45°N, from coast to 135W)
    - Coastal Sea Level change: To be elaborated

Moreover, there is considerable progress in data exchange specifications (which format, provide verification ECV in the same format, etc.), and discussions are under the way for software exchange.

Table 3. Overview on Essential Ocean Variables and their use for ocean indicator developments for different sectors / stakeholders as part of task 7.2.

| Observable EOVS*   | Sectors, indicators and user examples |                          |                           |   |  |                           |                                    |                                       |
|--------------------|---------------------------------------|--------------------------|---------------------------|---|--|---------------------------|------------------------------------|---------------------------------------|
|                    | Technologies for maritime safety      | Energy from the sea      | Aquaculture & fishery     | Maritime tourism and sport activities         | Transport and harbour services   | Marine digital services   | Maritime spatial planning and ICZM | Marine Protected areas                |
| SSH, currents      | OC, SLA                               | OC                       | OC                        |   | OC, SLA  | OC, SLA                   |                                    |                                       |
| T (Z)              |                                       |                          | HC, HW, HC-AC             |   |  | HC, HW, HC-AC             | HC, HW, HC-AC                      | HC, HW, HC-AC                         |
| SST                | TC, ETC, ENSO                         |                          | HW                        |   | TC, ETC  | TC, ETC                   | ETC                                | HW                                    |
| Potential EU users | Italian Navy, Portuguese Navy         | Ocean Energy Association | ISPRA, Azores' Government | Italian Sailing Federation, tourist operators | Port of Civitavecchia (IT), Port of Barcelona, Croatian maritime cluster, EMSA | Sea-Conditions web portal | Regione Emilia-Romagna (IT)        | Torr Guaceto (IT), Azores' Government |

\* EOVS SSH, currents indicators: Ocean Circulation (OC); Sea Level Anomaly (SLA); European Climate (Gulf Stream, Subpolar Gyre) (EC)  
 EOVS Temperature (Z): Heat Content (HC); Heat Waves (HW); + and – Heat Content Abrupt Changes (HC-AC); Heat Uptake (HU)  
 EOVS SST indicators: Surface Warming (SW), Heat Waves (HW); ENSO; Tropical Cyclones (TC), Extra Tropical Cyclones (ETC)

### Task 7.3: Quality enhancement of tropical carbon fluxes through network optimization of the Tropical Atlantic Observing System

Task 7.3 – the so called “tropical Atlantic demonstrator” – will develop indicators for carbon flux at the air-sea interface and for ocean acidification based on an improved Atlantic observing system. These carbon-based indicators are of high political relevance, and are identified as a key parameter under the UN SDG framework (SDG 14), under the EC MSFD framework and for the Intergovernmental Panel on Climate Change (IPCC). Demonstrating improved quality of carbon measurements even at a regional scale would benefit the implementation of the SDG 14.3.1 indicator for ocean acidification (IOC-UNESCO). An improved network design would also benefit stakeholders such as local fishing industries by providing access to near real-time environmental data. Major advancements include:

- Clarification of technical details for CO<sub>2</sub> sensor integration on PIRATA-BR platform
- Procurement of 5 BGC Argo floats (delivered) and auxiliary sensors (shipped) and a CARIOCA CO<sub>2</sub> sensor (not yet delivered)
- Preparation of PIRATA-BR emergency recovery cruise; unfortunately, the cruise had to be cancelled due to technical vessel issues and loss of mooring spare parts (destroyed during fire); the northern part of the network is now not operational for 2 years
- Liaison with stakeholders from race sailing community for joint collection of pCO<sub>2</sub> data (Vendée Globe 2020 and The Ocean Race 2022)
- Successful fund-raising (220.000 €) for Sairdrone ASV mission to mitigate negative COVID-19 impact on the private industry (Sairdrone sponsors)
- Technical integration of a VeGas pCO<sub>2</sub> system (incl. reference gas) on a small surface buoy to be deployed in summer 2021 at the Cape Verde Ocean Observatory

### 3.7.3. Cooperation and interaction with other EuroSea work packages

| Co-operator   | WP7 activities  |
|---------------|---|
| WP2, WP4, WP6 | <ul style="list-style-type: none"> <li>Partnership in the EuroSea Marine Heat Wave task team to discuss methodology and agree on a common approach.</li> </ul>  |
| WP3           | <ul style="list-style-type: none"> <li>Interaction on OceanGliders Best Practices</li> </ul>  |
| WP1, WP3      | <ul style="list-style-type: none"> <li>Best practice publication on delayed mode quality control (DMQC) for glider observations (in progress)</li> </ul>  |
| WP6           | <ul style="list-style-type: none"> <li>Topical exchange:               <ul style="list-style-type: none"> <li>Marine heat waves in the Atlantic</li> </ul> </li> </ul>  |
| WP4           | <ul style="list-style-type: none"> <li>Discussion about real-time data streaming of ASV mission in 2021</li> </ul>  |
| ISPRA         | <ul style="list-style-type: none"> <li>Marine seasonal forecasting for aquaculture, collaboration with WP2; is also partner of WP8 (T7.2)</li> </ul>  |
| DAL           | <ul style="list-style-type: none"> <li>Collaboration on carbon uptake in the Labrador Sea Region as part of “Ocean Frontiers Institution” activities (Douglas Wallace, Katja Fennel). The collaboration pays particular attention to improve understanding the seasonal cycle of carbon and the impact of mesoscale features on the carbon balance of the Labrador Sea. (Task 7.1)</li> </ul> |

### 3.7.4. Cooperation and interaction with other projects and initiatives

| Co-operator   | WP7 activities   |
|---|--|
| CMEMS   | <ul style="list-style-type: none"> <li>Engagement in discussions, particularly in the light of future use within the Copernicus Marine Service Ocean Monitoring Indicator framework<sup>16</sup></li> </ul>                                |
| Obs. Villefrance <sup>17</sup>                          | <ul style="list-style-type: none"> <li>Exploration of the potential of innovative neural network approaches for improved carbon auditing in the Mediterranean Sea (T7.1)</li> </ul>  |
| MIO <sup>18</sup>                                       | <ul style="list-style-type: none"> <li>Collaborative assessment of biogeochemical glider and Argo measurements in the Mediterranean Sea to understand their potential to carbon auditing (T7.1)</li> </ul>                                 |
| Laboratoire d'Aérodologie                               | <ul style="list-style-type: none"> <li>Collaboration in analysis of regional high-resolution BGC model simulations to make suggestions for an improved observation network for the Mediterranean Sea for carbon auditing (T7.1)</li> </ul> |
| PIRATA  | <ul style="list-style-type: none"> <li>Collaboration with Brazilian EuroSea partners (T7.3)</li> </ul>   |
| Race sailing community                                  | <ul style="list-style-type: none"> <li>Sharing of data from tropical Atlantic from Nov20/Jan21 provided by Boris Herrmann – Team Malizia (T7.3)</li> </ul>   |
| Capo Carbonara and Torre Guaceto Marine Protected Areas | <ul style="list-style-type: none"> <li>Marine Protected Areas (T7.2)</li> </ul>  |

### 3.7.5. Achieved main results

| Milestones |  |   |
|------------|--|---|
| MS7        | Pilot global indices of SST/SLA/OHC calculated | ✓ |

<sup>16</sup> <https://marine.copernicus.eu/science-learning/ocean-monitoring-indicators/>

<sup>17</sup> Observatoire Océanologique de Villefranche-sur-Mer, <http://oov.obs-vlfr.fr/>

<sup>18</sup> Mediterranean Institute of Oceanography, <https://www.mio.osupytheas.fr/en>



| Others |  |   |
|--------|--|---|
|        | Subpolar North Atlantic cruise                                     | ✓ |
|        | Analysis of approaches to conduct the carbon uptake variability    | ✓ |
|        | Strategy development for Exclusive Economic Zone (EEZ) assessments | ✓ |
|        | Secured co-funding for Sairdrone mission                           | ✓ |

### 3.8. WP8 - Communication: Engagement, Dissemination, Exploitation, and Legacy

Lead: EuroGOOS, CO-lead: GEOMAR

| Objectives   |
|--|
| <ul style="list-style-type: none"> <li>Deliver professional communications, stakeholder engagement and business exploitation support to the project and its demonstrators</li> </ul>   |
| <ul style="list-style-type: none"> <li>Enhance collaborative, inclusive, and strategic stakeholder dialogue that moves beyond stakeholder consultation towards co-design</li> </ul>  |
| <ul style="list-style-type: none"> <li>Enable exploitation of the project's results and products in business sector, sustainable strategic partnerships and governance, as well as strategic foresight</li> </ul>  |
| <ul style="list-style-type: none"> <li>Provide tangible support and guidelines on intellectual property rights and business development along the Responsible Research and Innovation principles and best practice in knowledge and technology transfer</li> </ul> |
| <ul style="list-style-type: none"> <li>Support capacity building to empower strategic partnerships, support business development and communicate achievements effectively</li> </ul>   |
| <ul style="list-style-type: none"> <li>Ensure the project's legacy is sustained with consolidated contributions to short, medium and long-term project's goals</li> </ul>  |

#### 3.8.1. Summary of deliveries towards objectives

WP8 is a cross-cutting activity in the project, connecting with the other WPs and supporting the interface with the outside stakeholders. In addition, this WP is bound by its nature to be responsive, adaptable, and effective. The first 14 months have demonstrated that the WP8-team has successfully achieved its objectives and went beyond those – despite of the challenges presented by the lock-down and crisis caused by the COVID-19 pandemic.

Key outputs and impacts of WP8 in the reporting period are below. Those include not only tasks as per the GA but also additional tasks the WP took on as a response to the project's needs:

##### Branding & outreach

The EuroSea branding was developed before the KoM in November 2019 where especially the logo received a lot of positive feedback. The initial project [website](#) was launched during the KoM and was improved with visualisations made by a professional visual recorder during the KoM and a new structure in June 2020. For the dissemination activities during conferences and workshops, two banners and business cards were designed. For the outreach to a wide community, also outside of ocean observing, the EuroSea Twitter account was launched during the KoM and the EuroSea [youtube channel](#) was opened in September 2020. The project vision and objectives were re-formulated for a more impactful messaging, while keeping the content, as agreed on during the KoM. The EuroSea [project video](#) was published in October 2020 and used to promote the EuroSea 1<sup>st</sup> Anniversary Webinar.

## Responsible Research and Innovation (RRI) in ocean observations

To outline the importance of RRI for ocean observing and forecasting a RRI [factsheet](#) was published giving also a set of reference documents useful in this context.

## Communication plan

The Communication Plan (D8.1) presents a set of big EuroSea messages which reflect the project's ambitions at a high level for engagement with stakeholders, as well as a set of tools and plans for impactful outreach during the project lifetime. It was submitted to the EC in April 2020 and is also publicly [available](#).

## Updated dissemination and exploitation plan

The dissemination and exploitation plan (D8.2) were updated in October 2020. The plan reflects the evolution of the project's plans due to the pandemic. It is also publicly [available](#).

## Stakeholder engagement trainings

WP8 (including the EuroSea exploitation manager) organized for the consortium a virtual workshop, split in four webinars, which have been running during September 2020 and March 2021. To aid the partners with the related assignments, WP8 assisted the partners with analysing stakeholders of each WP and their needs.

## Project presentation slides and EuroSea 1<sup>st</sup> Anniversary

Two professional PowerPoint presentations were designed by a contracted media designer: The short presentation gives a succinct overview about the project whereas the long presentation illustrates the work package objectives and tasks in more detail. The slides feature the infographics developed by the visual recorder during the EuroSea KoM. A pdf-version of the short presentation is available on the EuroSea [website](#).

The longer more detailed presentation was used during the EuroSea 1<sup>st</sup> Anniversary Webinar. During the webinar, held on 20 November 2020, the WP leads or co-leads, respectively, presented their WP to the audience. The project presentation led by the coordinator was supplemented by a panel discussion with representatives of key EuroSea stakeholders on the project's legacy. 157 people attended the live-webinar. The recording of the full webinar is available on the EuroSea [website](#) and the EuroSea [youtube channel](#).

## Impact monitoring protocol

A protocol dedicated to the impact monitoring of the project was developed by leaders of WP8 and WP1 between January and November 2020. The protocol reflects the ambitions and specific objectives of the project laid out in the proposal's impact section, the requirements laid out in the call, and the needs outlined in the Tsukuba Communique. This will be the first known protocol for measuring impact in an EU ocean observing & forecasting project.

## Exploitation plan

The first advanced draft of the Exploitation plan was developed by the EuroSea exploitation manager who resides in WP8. (please see task 8.3 below)

## Horizon Results Booster platform

WP8 co-leaders and exploitation manager (who is residing within WP8) supported by the project coordinator are setting up a cluster of projects to interact with stakeholders on the results of various activities around ocean observations and the value chain through the Horizon Results Booster (HRB), which is a new service offered by the EC. EuroSea successfully applied for the HRB "[Portfolio Dissemination and Exploitation Strategy](#)", which is divided in 3 modules:

- Module A: Identifying and creating the portfolio of R&I project results
- Module B: Helping projects from the portfolio to design and execute a portfolio dissemination plan
- Module C: Assisting projects to improve their existing exploitation strategy

Module A and B are implemented by the company Trust-IT, Module C is implemented by the company LC Innoconsult International. Once the cluster of projects is established, joint activities for outreach and exploitation of results will be considered (Module A and B). Module C focuses only on the key exploitable results of the EuroSea project.

### 3.8.2. Progress per task

#### Task 8.1: Engagement

Task leader: EuroGOOS, GEOMAR, Partners: SciencEthics, MI, RBINS, ISPRA, SOCIB

To build capacities for a joint stakeholder engagement strategy development, a series of internal training on stakeholder engagement has been organized. The webinar series is led by the external expert Elisabeth Crudgington (BrightGreenLearning) who has tailored this virtual workshop in collaboration with WP8. In total, 49 people registered for the webinars, representing all 10 WPs. The first two of four webinars took place in September and November 2020 addressing stakeholder identification and analysis and the definition of distinct stakeholder engagement goals for key stakeholders among all WPs. In additional meetings with the WP8 team, methods and tools learnt during the webinars were applied to EuroSea specific stakeholders. Overall, these cross-work package meetings have been instrumental in strengthening communication between work packages and reinforcing the sharing of experiences, ideas, but also concerns. The following two webinars will be conducted in January and March 2021.

#### Task 8.2: Dissemination

Task leader: SOCIB, RBINS, Partners: EuroGOOS, GEOMAR

Main activities planned were to deliver professional outreach activities to profile the EuroSea project to policymakers, industry, and science users, as well as the general public through media dissemination. The EuroSea Communication Plan (D8.1) was designed and implemented. It presents a set of big EuroSea messages which reflect the project's ambitions at a high level for engagement with stakeholders, as well as a set of tools and plans for impactful outreach. The deliverable D8.1 was submitted to the EC in April 2020.

The EuroSea website was launched during the KoM and represents one key instrument in the EuroSea outreach activities: It does not only provide information about the projective objectives and tasks of all work packages, but also shares news and deliverables provided by all EuroSea partners.

Another important communication instrument is the EuroSea Twitter account which was also launched during the EuroSea KoM. With a total of 381 tweets, the account already has over 500 followers (as of 20 December 2020). Both, website and Twitter account are maintained by WP8.

Besides professional branding and the design of EuroSea business cards, a roll-up and project presentations to foster the project's visual identity, the EuroSea public awareness video was created. With subtitles in 11 EuroSea languages, it features on the [homepage](#) and the EuroSea [YouTube channel](#). It has been submitted as milestone MS4 in October 2020.

### Task 8.3: Exploitation

Task leader: MI, Partners: ISPRA, SciencEthics

As noted above, a draft exploitation strategy for EuroSea has been developed as a living document. The current draft has identified the different commercially exploitable and other results of EuroSea. It has also identified some of the barriers and risks for exploitation and describes the measures being taken to ensure that the results meet the real needs of users by involving them in the project. This document will continue to be updated until the submission of the deliverable in October 2021.

Exploitation task partners are availing of services provided through the Horizon Results Platform (Module C) to assist with the development of the EuroSea exploitation strategy. The focus of this service is on the commercially exploited results of EuroSea and one Key Exploitable Result (KER) from each of the demonstration work packages has been chosen for the booster services. These are the Oceanographic Services for Ports and Cities (OSPAC) software on port and city real-time alert to provide forecast of sea conditions (WP5), a solution for marine sensors to measure and forecast oxygen, heat and pH related Extreme Marine Events onsite for aquaculture (W6) and user-driven calibrated seasonal forecast ocean indicators (WP7). These three KERs have been elaborated on with WP8 partners and the demonstration work package partners responsible for the delivery of the product or service. This has involved completing a characterisation table for each KER which has included a brief description of the KER, the problem it addresses, unique selling point and target market. The Horizon Results Booster services also includes the organisation of an Exploitation Strategy Seminar which will involve a workshop to further develop and fine tune the characterisation table. The main output of this will be a report that will be integrated into the EuroSea exploitation strategy deliverable.

### Task 8.4: Sustaining legacy

Task leader: SciencEthics, Partners: ISPRA, SOCIB, RBINS, MI, EuroGOOS, GEOMAR

EuroSea's legacy is defined as the output and adoption of the results by the various stakeholders at the end of the project and beyond. In the first year, the most relevant stakeholder categories were defined as follows: Industrial partners, networks / platforms / service providers, research institutes / organizations / projects, European Union, intergovernmental organizations, and national and local authorities. EuroSea partners will develop different approaches to discuss their results with these stakeholders for EuroSea communication and dissemination purposes. A first successful event, the EuroSea 1st Anniversary Webinar (see above), brought together 157 people from various organizations. This event will be repeated in the coming years to create a community of "potential end-users".

#### 3.8.3. Cooperation and interaction with other EuroSea work packages

| Co-operator | WP8 activities   |
|-------------|--|
| All WPs     | <ul style="list-style-type: none"> <li>Support in stakeholder identification and analysis</li> <li>Dissemination of WP deliverables</li> <li>Co-design and dissemination of WP news articles with task and WP leaders</li> </ul> |
| WP9         | <ul style="list-style-type: none"> <li>Coordination of communication strategies</li> </ul>   |
| GDB         | <ul style="list-style-type: none"> <li>Development of connections with the stakeholders of the next generation in the ocean observing value chain</li> </ul>   |

### 3.8.4. Cooperation and interaction with other projects and initiatives

| Co-operator  | WP8 activities  |
|--|---|
| HRB PG   | <ul style="list-style-type: none"> <li>Engagement in PG portfolio development</li> </ul>  |
| EC, GOOS, EOOS, MOI, ENVRI, World Ocean Council, Port of Barcelona | <ul style="list-style-type: none"> <li>Preparatory meetings with stakeholder representatives for the EuroSea 1<sup>st</sup> Anniversary Webinar panel discussion</li> </ul> |
| GOOS, EuroGOOS   | <ul style="list-style-type: none"> <li>Strengthen institutional links between EuroSea and these organizations and foster the development of EOOS</li> </ul>                 |

### 3.8.5. Achieved main results

| Deliverables         |   |   |
|----------------------|---|---|
| <a href="#">D8.1</a> | Communication Plan  | ✓ |
| <a href="#">D8.2</a> | Updated Dissemination and Exploitation Plan                               | ✓ |
| Milestones           |   |   |
| MS3                  | Specification of user-needs and expectations Documented                   | ✓ |
| MS4                  | Public awareness video  | ✓ |
| Internal Milestones  |   |   |
| iMS1                 | EuroSea website   | ✓ |
| iMS2                 | EuroSea Twitter account   | ✓ |
| iMS3                 | Intranet  | ✓ |
| iMS5                 | Infographic on actionable links in the project (international governance) | ✓ |

## 3.9. WP9 - Project Coordination, Management and strategic ocean observing alliance

Lead: GEOMAR

| Objectives  |
|---|
| <ul style="list-style-type: none"> <li>Provide top level management of the project to ensure aims of the project are efficiently and effectively met, on time and with the resources budgeted and that knowledge and innovation are properly managed</li> </ul> |
| <ul style="list-style-type: none"> <li>Provide effective reporting and communication within the project, between partners and stakeholders and between the consortium and the EC</li> </ul>   |
| <ul style="list-style-type: none"> <li>Provide support for and activities aimed at project internal integration</li> </ul>  |
| <ul style="list-style-type: none"> <li>Provide connections and interfaces with other projects funded under this topic</li> </ul>  |

### 3.9.1. Summary of deliveries towards objectives

The Project Coordination Unit (PCU) provided administrative, financial and legal support to all EuroSea partners and was responsible for the overall scientific and administrative management of the project. Regular meetings with the Steering Committee supported a constant exchange between the different work packages; this ensured regular information about progress, innovations and possible problems in the individual work

areas of the project. Furthermore, the PCU ensured effective and transparent communication within the project and between the consortium and the EC.

### 3.9.2. Progress per task

#### Task 9.1: Project coordination and management

Task leader: GEOMAR

During the first 14 months of EuroSea, the Project Coordination Unit (PCU) at GEOMAR has been very active and completed a wide range of tasks and activities associated with starting up and running the project.

Thanks to a grant from the German Helmholtz organisation (of which GEOMAR is a member) geared at supporting Helmholtz centres that coordinate international programs, we were able to have a project manager in place already 1.5 months before the project officially started (co-financing). This was very beneficial for mainly two items: Working on the consortium agreement between all (55) partners, and to organize the KoM at early stages of the project. As of 1 November 2019, the project officially started.

WP9 organized the KoM on the premises of the Royal Belgian Institute of Natural Sciences in Brussels (a EuroSea partner), together with our local partners, on 27-29 November 2019. The early management support and timely KoM allowed for a good start of the project (Figure 12).



Figure 12. Group picture of the members that attended the EuroSea Kick-off-Meeting in November 2019.

The PCU has set up infrastructure for exchange of information within the project and for a central location for project documents by a secured cloud space. This is a space for exchanging documents within WPs, but also to find useful, internal, information about the project which all EuroSea members can access.

WP9 is a central point of project internal communication and coordination, and as such we are maintaining a number of project internal mailing lists at different levels of granularity. WP9 is also maintaining a calendar to support the consortium with information on relevant meetings and events. In order to further strengthen the internal communication in a regular way, and to address recent, and upcoming, activities within and outside of the project, we are issuing monthly newsletters – the EuroSea News (see example in Figure 13). These are sent by email to the members of EuroSea and to ISTAB and ISC members, and are thus for project internal use.



Figure 13. Part of the first EuroSea Newsletter issued in May of 2020. The Newsletters are sent to EuroSea members on a monthly basis.

WP9 is organizing, and participating in, regular Steering Committee (SC) meetings. The EuroSea SC comprises of the WP leaders and co-leaders. The SC meetings are held once a month, and are an important item for the PCU and coordinator to manage progress of the project, manage issues and create synergy and foster cooperation between work packages. On several occasions we invited guests to our SC meetings to discuss specific topics. For instance, are the chairs of the Innovation and Stakeholder Committee (ISC) and the Gender and Diversity Board (GDB) regular guests. The minutes from the SC meetings are available to all EuroSea members via the EuroSea cloud system. So far, two meetings of the Executive Board (EB), comprised of the coordinator and 6 members of the Steering Committee have been convened.

WP9 is also managing the interaction with the International Scientific and Technical Advisory Board (ISTAB) and is supporting the activities of the Innovation and Stakeholder Committee (ISC). The ISC is led by the EuroSea Exploitation Manager (Kieran Reilly, Marine Institute) in WP8. However, WP9 is supporting the logistic and travel of the ISC. Several members of the ISC attended the KoM.

The day-to-day work of WP9 includes communication to the project and policy officers at the commission. During this first year we have requested, and got granted, 2 amendments to the Grant Agreement and communicated about delayed deliverables, almost exclusively due to the COVID-19 pandemic.

## Task 9.2: Interfaces to other projects under this topic

Task leader: GEOMAR, Partners: HCMR, IFREMER

During the first year WP9 have interacted with the “sister-project” Blue-Cloud that is funded under the same call. We have agreed on, and started to work on, cooperation on particular issues in WP3 and WP6, that is related to two of Blue-Cloud’s demonstrator activities: Fish, a matter of scales, and plankton genomics. We are also in close contact on a strategic level, with participation on the Blue-Cloud’s External Stakeholders Expert Board. Blue-Cloud was also represented during the EuroSea KoM.

EuroSea has also applied for, and was granted, the Horizon Results Booster (see also WP8 progress above). We have now initiated a cluster group within module A and B consisting of 9 EU funded projects with focus on ocean science and touchpoints on ocean observing and forecasting (Table 4). This cluster includes, among others, the newly started project Nautilus that was also funded under the BG7 call, focusing on technology for ocean observing. In a first virtual meeting on 14 December 2020 with almost all projects represented, a first exchange about common objectives, stakeholders and overarching goals took place.

Table 4. Horizon Results Booster project group led by EuroSea

| Project acronym         | Project name  |
|-------------------------|---|
| <b>AtlantECO</b>        | Atlantic Ecosystems Assessment, Forecasting & Sustainability  |
| <b>Blue-Cloud</b>       | Piloting innovative services for Marine Research & the Blue Economy   |
| <b>Eurofleets+</b>      | An alliance of European marine research infrastructure to meet the evolving needs of the research and industrial communities  |
| <b>iAtlantic</b>        | Integrated Assessment of Atlantic Marine Ecosystems in Space and Time   |
| <b>EU-Atlas</b>         | A trans-Atlantic assessment and deep-water ecosystem based spatial management plan for Europe   |
| <b>Jerico-S3</b>        | Joint European Research Infrastructure of Coastal Observatories: Science, Service, Sustainability - JERICO-S3   |
| <b>Nautilus</b>         | Nautical Integrated Hybrid Energy System for Long-haul Cruise Ships   |
| <b>Mission Atlantic</b> | Towards the Sustainable Development of the Atlantic Ocean: Mapping and Assessing the present and future status of Atlantic marine ecosystems under the influence of climate change and exploitation |
| <b>ODYSSEA</b>          | Operating a network of integrated observatory systems in the Mediterranean Sea  |

### 3.9.3. Cooperation and interaction with other EuroSea work packages

| Co-operators   | WP9 activities  |
|----------------|---|
| <b>All WPs</b> | <ul style="list-style-type: none"> <li>• Day-to-day communication</li> <li>• Organization of SC meetings</li> <li>• Informal interaction during the weekly virtual EuroSea coffee corner</li> <li>• Maintenance of project mailing lists and project cloud space</li> </ul> |

### 3.9.4. Cooperation and interaction with other projects and initiatives

| Co-operators                 | WP9 activities   |
|------------------------------|--|
| <b>HRB cluster (Table 4)</b> | <ul style="list-style-type: none"> <li>• Exchange about common objectives, stakeholders and overarching goals</li> </ul> |
| <b>AANChOR</b>               | <ul style="list-style-type: none"> <li>• Exchange about common objectives, stakeholders and overarching goals</li> </ul> |



### 3.9.5. Achieved main results

| Deliverables |   |   |
|--------------|---|---|
| D9.1         | Action Progress Report #1                     | ✓ |
| Others       |   |   |
|              | Adoption for the EuroSea consortium agreement | ✓ |
|              | Implementation of the ISTAB                   | ✓ |

## 3.10. WP10 – Ethics Requirements

Lead: GEOMAR

| Objectives |   |
|------------|---|
| •          | Ensure compliance with the 'ethics requirements' set out in this work package |

### 3.10.1. Summary of deliveries towards objectives

This work package sets out the 'ethics requirements' that the project must comply with. It focuses primarily on ensuring fair benefit-sharing arrangements with stakeholders from low- and middle-income countries (Egypt and possibly other African countries). The WP leader is supported and advised by the WP5 partners as well as the partner SciencEthics, who either work directly with stakeholders in Africa or advise the EC on similar issues and thus have the necessary experience and expertise.

### 3.10.2. Achieved main results

| Deliverables |                         |   |
|--------------|-------------------------|---|
| D10.1        | NEC – Requirement No. 1 | ✓ |

## 4. Management Structure

The organizational and governance structure (Figure 14) of EuroSea is designed to meet the needs of a large-scale international project. Low structural complexity combined with clearly defined responsibilities enable an optimal flow of information within and across work packages, and between participants, advisors, invited stakeholders and the EC.

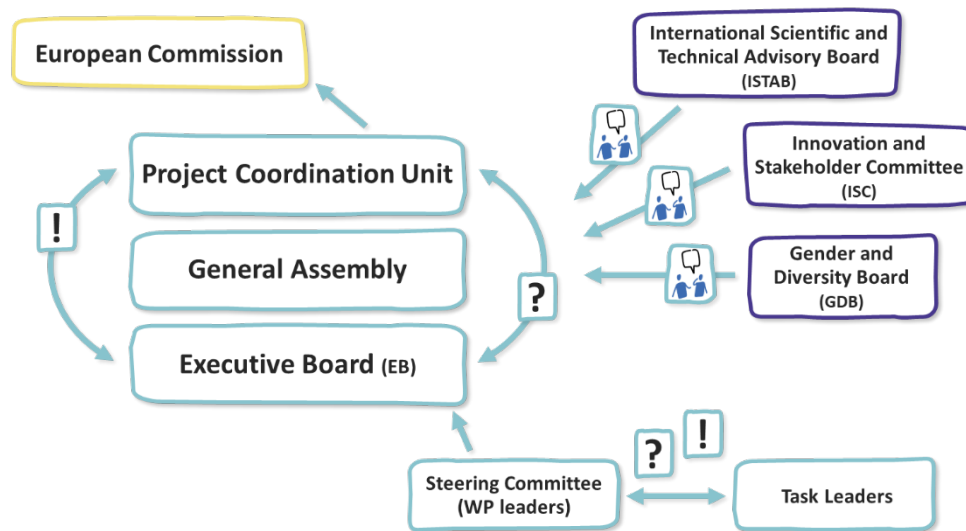


Figure 14. EuroSea governance structure.

The coordinator (Dr. Toste Tanhua, GEOMAR), is responsible for the overall coordination of the project and chairs the General Assembly, Executive Board, and Steering Committee Meetings. The Scientific and Technical Manager (Dr. Nicole Köstner, GEOMAR), responsible for the day-to-day implementation of the project, supports him. The coordinator and the Scientific and Technical Manager will liaise with the EC on behalf of the consortium, with the Coordinator as the primary contact point.

Responsibilities in EuroSea are assigned to four different bodies with different roles:

#### Decision-making bodies

The **General Assembly (GA)** is the ultimate decision-making body of the consortium. The GA will be called to validate key decisions or orientations for the action as a whole introduced by the Executive Board (EB). The GA is comprised of one representative of each consortium participant and is chaired by the Coordinator. Over the lifetime of EuroSea, there will be four formal GA meetings, which will be combined with the annual project meetings. The first GA meeting was conducted during the KoM, the second GA meeting will take place during the virtual 2<sup>nd</sup> Annual Meeting in January 2021.

#### Executive bodies

The **Executive Board (EB)** is the supervisory body for the execution of the action, and will monitor and analyse the actions progress and propose actions/decisions to the GA if required for the implementation of the work plan and in accordance to the Grant and Consortium Agreements. The EB is comprised of the Coordinator and 6 members of the Steering Committee (SC) that were appointed during the project's kick-off meeting: Ananda Pascual, Caroline Cusack, Emma Heslop, Glenn Nolan, Kevin Horsburgh, and Pierre-Yves Le Traon.

#### Advisory Bodies

The **Steering Committee (SC)** is comprised of the project coordination, the work package leaders (see Table 7 below) and co-leaders, and the chair of the Gender and Diversity board (GDB). The SC makes propositions to the EB on the project's work plan, innovation issues or any matter related to the success of the project. With the exception of the holiday season, the face-to-face or virtual SC meetings were held at monthly intervals.

The **Gender and Diversity Board (GDB)** raises gender, early career, and other diversity awareness within the consortium. The GDB is chaired by Michele Barbier (expert for responsible research and innovation) and comprises 5 additional members that were appointed during the project’s kick-off meeting: Dina Eparkhina, Kieran Reilly, Raffaella Casotti, René Garello, Sheila Heymans. The GDB met monthly to discuss the actions to be developed within Eurosea to raise awareness of gender and diversity issues among scientists. Two surveys have been designed, one institutional and one individual, to collect specific facts related to diversity and gender within marine communities. Of the 37 institutions contacted, only 11 responded to the institutional questionnaire. The analysis of these questionnaires will be used to design the discussion at the round tables at the Eurosea Annual Meeting (January 2021). These round tables are defined around three themes: Gender & Science, Diversity & Career and Culture & Science to identify problems and collect ideas of potential actions to be developed with Eurosea. A seminar on the history of women in oceanography will open these discussions. The GDB is supported by the Scientific and Technical Manager.

The **Innovation and Stakeholder Committee (ISC)** has been established to monitor the project’s innovation and exploitation activities to ensure that the potential of EuroSea activities is maximised and to ensure that the EuroSea development partners are focused on the market exploitation of their results. The group is chaired by the EuroSea exploitation manager Kieran Reilly, and is comprised of one representative per demonstration work package, at least one external stakeholder per demonstration activity, and a number of other key external stakeholders (Table 5).

Table 5. List of ISC members

| Name                                 | Affiliation                            |
|--------------------------------------|--|
| Kevin Horsburgh                      | NOC, WP5 co-lead                       |
| Javier Ruiz                          | CSIC, WP6 co-lead                      |
| Karina von Schuckmann                | MOI, WP7 co-lead                       |
| Kieran Reilly                        | Exploitation manager                   |
| Catherine McManus                    | MOWI, External stakeholder WP6         |
| Thorsten Kiefer and Sandra Ketelhake | JPI Oceans                             |
| Francisco Armando Arias Isaza        | POGO representative                    |
| Inger Grave                          | Xylem-Aanderaa (WP6)                   |
| Michele Barbier                      | Science Ethics, SME with EuroSea (WP8) |
| Karianne Kojen Andersen              | GCE Ocean technologies                 |
| Christine Valentin                   | World Ocean Council                    |
| Bjarte Fageraas                      | Octio Environmental                    |

The main role of the ISC group is to provide feedback to the exploitation manager on the exploitation strategy at key stages of the project. The first virtual meeting of the ISC was held on 27 April 2020. The topics discussed included the EuroSea draft exploitation strategy, establishing closer links between exploitation manager and demonstration WPs and interaction with stakeholders. A key outcome from the first meeting was the recommendation for the exploitation manager to increase dialogue with WP leaders to ensure the development of a successful exploitation strategy.

The **International Scientific and Technical Advisory Board (ISTAB)** will ensure scientific and technical evaluation of the action. The ISTAB is comprised of selected leading international experts and end users of EuroSea products that were invited by the Coordinator subsequent to prior online-suggestions by the consortium (Table 6). ISTAB members are not directly involved in project tasks but will review the project and advise the Coordinator and EB on overall strategy, especially at key milestone stages. They will meet

annually with the EB, or more frequently if needed. They will advise on the appropriateness of the project planning to deliver key objectives, emerging issues that may need to be reflected in a project change, connection to stakeholders, and promotion of project outcomes at European and international and level. The status of the ISTAB is restricted to advisory only; any suggested change to the project must be agreed by the consortium and approved by the EC.

Table 6. List of ISTAB members

| Name           | Affiliation   |
|----------------|---|
| Clair Jolly    | OECD, UK  |
| Susan Wjiffels | WHOI, USA   |
| Zdenke Willis  | Veraison Consulting, USA                                      |
| Peer Fietzek   | Kongsberg Maritime, Germany                                   |
| Tony Lee       | JPL/NASA, member OOPC, USA                                    |
| Colm Jordan    | Marine Institute, vice chair ICES Advisory Committee, Ireland |

The ISTAB met (virtually) once during the first year of EuroSea for an update of the project, and to agree on the working modalities. The ISTAB was also invited to the 1<sup>st</sup> Anniversary Webinar in November 2020, and receives the monthly EuroSea News to stay informed about the project on a regular basis. The first meeting between ISTAB and EB is scheduled for 8 January 2021.

#### Management bodies

The **Project Coordination Unit (PCU)** located at GEOMAR is responsible for the management of EuroSea. The PCU team includes the Coordinator, the Scientific and Technical Manager and the Financial Manager (Anja Wenzel). The PCU is supported in the daily project management by the **work package leaders and co-leaders** who play a key role in the scientific management at the work package level, to ensure that the planned work at WP level is carried out according to plan. They are also responsible for the timely achievement of deliverables and milestones and build the direct link to the EuroSea project coordination, ensuring that the decisions taken at executive level are implemented at WP level. They also coordinate cooperation and exchanges with the partners across the EuroSea working fields. Each work package has several tasks which are led by the **task leaders**, they are in charge of the progress of the task and if required interaction with related task leaders / work package leaders.

There were two changes in the co-leaders of the work packages in the first year of the project: In WP1, Inga Lips took over from Glenn Nolan for the partner EuroGOOS in May; in WP6, Gabriel Navarro took over from Javier Ruiz for the partner CSIC in August.

Table 7. WP leaders and co-leaders

| WP | Lead                 |             | Co-lead                |             |
|----|----------------------|-------------|------------------------|-------------|
|    | Name                 | Affiliation | Name                   | Affiliation |
| 1  | Emma Heslop          | IOC-UNESCO  | Inga Lips              | EuroGOOS    |
| 2  | Ananda Pascual       | CSIC        | Sabrina Speich         | ENS         |
| 3  | George Petihakis     | HCMR        | Johannes Karstensen    | GEOMAR      |
| 4  | Pierre-Yves Le Traon | MOI         | Nadia Pinardi          | UNIBO       |
| 5  | Kevin Horsburgh      | NOC         | Enrique Alvarez-Fanjul | EPPE        |
| 6  | Caroline Cusack      | MI          | Gabriel Navarro        | CSIC        |

| WP | Lead                  |             | Co-lead           |             |
|----|-----------------------|-------------|-------------------|-------------|
|    | Name                  | Affiliation | Name              | Affiliation |
| 7  | Karina von Schuckmann | MOI         | Maciej Telszewski | IO PAN      |
| 8  | Dina Eparkhina        | EuroGOOS    | Nicole Köstner    | GEOMAR      |
| 9  | Toste Tanhua          | GEOMAR      |                   |             |

## 5. Dissemination

### Scientific publications

- Muñiz Piniella, Á. & Heymans, J.J. (2020) Report on initiatives, strategies and roadmaps that contribute to foresight in ocean observation. EU EuroSea project. DOI: 10.5281/zenodo.3956082 (WP1)
- Révelard, A., Reyes, E., Mourre, B., Hernández Carrasco, I., Rubio, A., Lorente, P., De Lera Fernández, C., Mader, J., Álvarez Fanjul, E., and J. Tintoré (2020). Sensitivity of Skill Score metric to validate Lagrangian simulations in coastal areas: recommendations for Search and Rescue applications. *Frontiers in Marine Science*, section Ocean Observation. (submitted) (WP3)
- Olsen, A., Lange, N., Key, R. M., Tanhua, T., Bittig, H. C., Kozyr, A., Álvarez, M., Azetsu-Scott, K., Becker, S., Brown, P. J., Carter, B. R., Cotrim da Cunha, L., Feely, R. A., van Heuven, S., Hoppema, M., Ishii, M., Jeansson, E., Jutterström, S., Landa, C. S., Lauvset, S. K., Michaelis, P., Murata, A., Pérez, F. F., Pfeil, B., Schirnack, C., Steinfeldt, R., Suzuki, T., Tilbrook, B., Velo, A., Wanninkhof, R., and Woosley, R. J.: GLODAPv2.2020 – the second update of GLODAPv2, *Earth Syst. Sci. Data*. 2020. pp. 1-41. (accepted) (WP4)
- Fu, Y., F. Li, J. Karstensen und C. Wang (2020): A stable Atlantic Meridional Overturning Circulation in a changing North Atlantic Ocean since the 1990s. *Science Advances*, 6, <https://doi.org/10.1126/sciadv.abc7836>. (WP7)

### Presentations

- SHAREMED First Capitalization Workshop, December 14-15, 2020, EuroSea presentation (WP9)
- [Sea-Tech Week](#), virtual meeting, 17 November 2020, oral presentation: “The role of images and instrumentation” in the session on coastal observation across Europe. (WP6)
- AGU Fall meeting on December 17th 2020, oral presentation: “Optimizing multi-platform sampling strategies to anticipate SWOT validation.” Speaker: Bàrbara Barceló-Llull; contributors: Ananda Pascual, Sabrina Speich, Eugenio Cutolo, Ronan Fablet, Florent Gasparin, Stéphanie Guinehut, Jaime Hernández-Lasheras, Stephanie Leroux, Alexandre Mignot, Baptiste Mourre, Sandrine Mulet, Elisabeth Rémy, and Nathalie Verbrugge (WP2)
- HELCOM STATE & CONSERVATION 12-2020, 11-14 May 2020 – EuroSea project and WP & Task 6.3 activities were presented. Potential products were discussed and feedback from contracting parties requested. (WP6)
- Ocean Science Meeting in San Diego, February 2020, EuroSea promotion (WP9)
- AORA / AANChOR workshop in Brussels, February 5, 2020, EuroSea presentation (WP9)

#### Other dissemination and communication activities

- EuroSea Anniversary Webinar, presentation of EuroSea to a larger group of stakeholders demonstrating the progress during the first year, and laying out the plans for the next years of the project; the recording is available on the [EuroSea website](#) and the EuroSea [youtube channel](#)
- News article about the KoM of the EOOS OC in EuroGOOS, EOOS and EuroSea websites. Social media communication (Twitter) was used during the meeting. (WP1)
- Marine Litter WG was convened as part of the Evolving and Sustaining Ocean Best Practices IV workshop which was held in September 2020. Recordings of most sessions are available on YouTube: <https://www.youtube.com/playlist?list=PLkuDz7rC6Mb9p-xlXqmJ8iKfVoazla5Tr> (WP1)
- Evolving and Sustaining Ocean Best Practices IV workshop was held in September 2020. (see iMS10) (WP1)
- Launch of Deliverable 1.1: News articles at EuroSea, European Marine Board and Periscope websites. Tweets from EuroSea and EMB accounts. (WP1)
- Dissemination activities around ATL2MED mission: (1) SOCIB social media (Twitter); (2) MONGOOS GA on 27.11.2020; (3) SASEMAR; (4) Mission Atlantic KoM; (5) EuroGOOS Integration WS; (6) MARINETECH (Lisbon); (7) Summer School LSTS; (8) ICOS Science Conference; (9) AUV 2020; (10) JEH; (11) ESTOC 25 Years Symposium; (12) X Glider School (2019); (13) PLOCAN website; (13) Saildrone website - Several news and press releases for this period. (WP3)
- HELCOM STATE & CONSERVATION 13-2020, 5-9 October 2020. Attendance. (WP6)
- BOOS Annual meeting, 4-6 November 2020 – NRT delivery of research vessel based CTD profiles the BOOS data stream was discussed and agreed. It is a necessary step to provide products for the HELCOM needs. (WP6)
- [Marine data to support aquaculture](#) 20-21 October, 2020 organised by The European Aquaculture Technology and Innovation Platform (EATIP), EMODnet and the Copernicus Marine Service together with DG MARE and DG DEFIS – Participation in discussions on the concept of co-developing an open access “one-stop-shop” facility or platform to support European aquaculture. (WP6)
- [News article “Predicting the extreme”](#) – news article focused on how the ocean observing system can help industry prepare for extreme marine events published at the EuroSea Webpage (WP6 & WP8)
- [EuroSea Promotional video](#), August 2020 (WP6, WP8, WP9)
- [Responsible Research and Innovation in Ocean Observing and Forecasting - Factsheet](#) (WP8)

All public EuroSea deliverables are available on the [EuroSea website](#).

## 6. List of partners

Table 8. List of EuroSea beneficiaries

| Acronym    | Name of Organisation   | Link  |
|------------|--|---|
| GEOMAR     | GEOMAR HELMHOLTZ-ZENTRUM FÜR OZEANFORSCHUNG KIEL                 | <a href="https://www.geomar.de/en/">https://www.geomar.de/en/</a>               |
| EuroGOOS   | EUROGOOS   | <a href="http://www.eurogoos.eu">www.eurogoos.eu</a>                            |
| IOC/UNESCO | UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANISATION | <a href="http://www.ioc-unesco.org">www.ioc-unesco.org</a>                      |
| MOI        | MERCATOR OCEAN INTERNATIONAL                                     | <a href="https://www.mercator-ocean.fr">https://www.mercator-ocean.fr</a>       |
| UNIBO      | ALMA MATER STUDIORUM – UNIVERSITÀ DI BOLOGNA                     | <a href="https://www.unibo.it/en/homepage">https://www.unibo.it/en/homepage</a> |

| Acronym        | Name of Organisation   | Link  |
|----------------|--|---|
| MI             | MARINE INSTITUTE   | <a href="https://www.marine.ie/Home/home">https://www.marine.ie/Home/home</a>                                     |
| CSIC           | AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS  | <a href="http://www.csic.es/home">http://www.csic.es/home</a>   |
| ENS            | ECOLE NORMALE SUPERIEURE   | <a href="https://www.ens.fr/en">https://www.ens.fr/en</a>   |
| CLS            | COLLECTE LOCALISATION SATELLITES SA  | <a href="https://www.cls.fr/">https://www.cls.fr/</a>   |
| OGS            | ISTITUTO NAZIONALE DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE   | <a href="http://www.inogs.it">www.inogs.it</a>  |
| CMCC           | FONDAZIONE CENTRO EURO-MEDITERRANEO SUI CAMBIAMENTI CLIMATICI  | <a href="http://www.cmcc.it">www.cmcc.it</a>  |
| UiB            | UNIVERSITETET I BERGERN  | <a href="http://www.uib.no">www.uib.no</a>  |
| SU             | SORBONNE UNIVERSITE  | <a href="http://www.sorbonne-universite.fr">http://www.sorbonne-universite.fr</a>                                 |
| SOCIB          | CONSORCIO PARA EL DISEÑO, CONSTRUCCION, EQUIPAMIENTO Y EXPLOTACION DEL SISTEMA DE OBSERVACION COSTERO DE LAS ILLES BALEARS | <a href="http://www.socib.eu/">http://www.socib.eu/</a>   |
| ECMWF          | EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS   | <a href="https://www.ecmwf.int">https://www.ecmwf.int</a>   |
| IO PAN         | INSTYTUT OCEANOLOGII POLSKIEJ AKADEMII NAUK  | <a href="http://www.iopan.gda.pl/">http://www.iopan.gda.pl/</a>   |
| IfW            | INSTITUT FÜR WELTWIRTSCHAFT  | <a href="https://www.ifw-kiel.de/">https://www.ifw-kiel.de/</a>   |
| Euro-Argo ERIC | EURO-ARGO ERIC   | <a href="https://www.euro-argo.eu/">https://www.euro-argo.eu/</a>   |
| CNRS           | CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE   | <a href="https://www.cnrs.fr">https://www.cnrs.fr</a>   |
| IFREMER        | INSTITUT FRANCAIS DE RECHERCHE POUR L'EXPLOITATION DE LA MER   | <a href="https://www.ifremer.fr/en">https://www.ifremer.fr/en</a>   |
| RBINS          | INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE   | <a href="http://www.naturalsciences.be">www.naturalsciences.be</a>  |
| SCIENCETHICS   | INSTITUT DE SCIENCE ET ETHIQUE   | <a href="http://www.sciencethics.org">http://www.sciencethics.org</a>   |
| ISPRA          | ISTITUTO SUPERIORE PER LA PROTEZIONE E LA RICERCA AMBIENTALE   | <a href="http://www.isprambiente.gov.it/en?set_language=en">http://www.isprambiente.gov.it/en?set_language=en</a> |
| IEEE           | IEEE FRANCE SECTION  | <a href="https://www.ieee-france.org/">https://www.ieee-france.org/</a>   |
| EMB            | EUROPEAN MARINE BOARD IVZW   | <a href="http://www.marineboard.eu">www.marineboard.eu</a>  |
| IMT            | INSTITUT MINES-TÉLÉCOM   | <a href="https://www.imt.fr/en/">https://www.imt.fr/en/</a>   |
| OceanNext      | OCEANNEXT  | <a href="https://www.ocean-next.fr">https://www.ocean-next.fr</a>   |
| AZTI           | FUNDACIÓN AZTI - AZTI FUNDAZIOA  | <a href="http://www.azti.es">www.azti.es</a>  |
| EPPE           | PUERTOS DEL ESTADO   | <a href="http://www.puertos.es">www.puertos.es</a>  |
| ACRI           | ACRI-ST SAS  | <a href="https://www.acri-st.fr/">https://www.acri-st.fr/</a>   |
| ARUP           | OVE ARUP & PARTNERS INTERNATIONAL LIMITED  | <a href="https://www.arup.com">https://www.arup.com</a>   |
| HCMR           | HELLENIC CENTRE FOR MARINE RESEARCH  | <a href="https://www.hcmr.gr/en/">https://www.hcmr.gr/en/</a>   |
| NIVA           | NORSK INSTITUT FOR VANNFORSKNING   | <a href="https://www.niva.no/en/">https://www.niva.no/en/</a>   |
| Met Office     | MET OFFICE   | <a href="https://www.metoffice.gov.uk">https://www.metoffice.gov.uk</a>   |
| EMSO ERIC      | EUROPEAN MULTIDISCIPLINARY SEAFLOOR AND WATER COLUMN OBSERVATORY - EUROPEAN RESEARCH INFRASTRUCTURE CONSORTIUM             | <a href="http://emso.eu">http://emso.eu</a>   |
| PLOCAN         | CONSORCIO PARA EL DISEÑO, CONSTRUCCIÓN, EQUIPAMIENTO Y EXPLOTACIÓN DE LA PLATAFORMA OCEANICA DE CANARIAS                   | <a href="http://www.plocan.eu">www.plocan.eu</a>  |
| UBREMEN        | UNIVERSITAET BREMEN  | <a href="https://www.marum.de/en/index.html">https://www.marum.de/en/index.html</a>                               |
| UPTO           | UNIVERSIDADE DO PORTO  | <a href="https://lsts.fe.up.pt">https://lsts.fe.up.pt</a>   |
| SZN            | STAZIONE ZOOLOGICA ANTON DORHN   | <a href="http://www.szn.it/index.php/en/">http://www.szn.it/index.php/en/</a>                                     |

| Acronym | Name of Organisation  | Link  |
|---------|---|---|
| AWI     | ALFRED-WEGENER-INSTITUT, HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG | <a href="http://www.awi.de">www.awi.de</a>  |
| ETT     | ETT SPA   | <a href="https://www.ettsolutions.com">https://www.ettsolutions.com</a>           |
| Nologin | NOLOGIN CONSULTING, S.L.  | <a href="https://www.nologin.es">https://www.nologin.es</a>                       |
| UPC     | UNIVERSITAT POLITECNICA DE CATALUNYA                                      | <a href="https://lim.upc.edu">https://lim.upc.edu</a>                             |
| DMI     | DANMARKS METEOROLOGISKE INSTITUT  | <a href="http://www.dmi.dk">http://www.dmi.dk</a>                                 |
| TalTech | TALLINNA TEHNIKAULIKOOL   | <a href="http://www.ttu.ee/">http://www.ttu.ee/</a>                               |
| CNR     | CONSIGLIO NAZIONALE DELLE RICERCHE  | <a href="http://www.ismar.cnr.it">http://www.ismar.cnr.it</a>                     |
| IRD     | INSTITUT DE RECHERCHE POUR LE DÉVELOPPEMENT                               | <a href="http://www.ird.fr">www.ird.fr</a>  |
| UCAM    | THE CHANCELLOR MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE        | <a href="https://www.cam.ac.uk">https://www.cam.ac.uk</a>                         |
| XYLEM   | XYLEM AANDERAA DATA INSTRUMENTS AS  | <a href="https://www.xylem.com/">https://www.xylem.com/</a>                       |
| WMO     | ORGANISATION METEOROLOGIQUE MONDIALE                                      | <a href="http://www.wmo.int">www.wmo.int</a>                                      |
| UERJ    | UNIVERSIDADE DO ESTADO DO RIO DE JANEIRO                                  | <a href="http://www.uerj.br">www.uerj.br</a>                                      |
| UFPE    | UNIVERSIDADE FEDERAL DE PERNAMBUCO  | <a href="https://www.ufpe.br">https://www.ufpe.br</a>                             |
| MUN     | MEMORIAL UNIVERSITY OF NEWFOUNDLAND                                       | <a href="http://www.mun.ca">www.mun.ca</a>  |
| DAL     | DALHOUSIE UNIVERSITY  | <a href="https://www.dal.ca/diff/cerc.html">https://www.dal.ca/diff/cerc.html</a> |
| NOC     | NATIONAL OCEANOGRAPHY CENTRE  | <a href="https://noc.ac.uk">https://noc.ac.uk</a>                                 |

## 7. Abbreviations

| Abbreviation | Description   |
|--------------|---|
| BGC          | biogeochemical  |
| BOOS         | Baltic Operational Oceanographic System   |
| C3S          | Copernicus Climate Change Services  |
| CMEMS        | Copernicus Marine Environmental Monitoring Service  |
| DMQC         | Delayed Mode Quality Control  |
| EB           | Executive Board   |
| EC           | European Commission   |
| ECV          | Essential Climate Variable  |
| EEZ          | Exclusive Economic Zone   |
| EOOS         | European Ocean Observing System   |
| EOV          | Essential Ocean Variable  |
| ERDDAP       | Environmental Research Division Data Access Program   |
| ESA          | European Space Agency   |
| FOO          | Framework for Ocean Observing   |
| GA           | Grant Agreement / General Assembly  |
| GADGET       | Globally applicable Area-Disaggregated General Ecosystem Toolbox                                      |
| GESAMP WG40  | Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, Working Group 40 |
| GLODAP       | Global Ocean Data Analysis Project  |
| GLOSS        | Global Sea Level Observing System   |
| GNSS         | Global Navigation Satellite System  |
| GOOS         | Global Ocean Observing System   |



| Abbreviation    | Description   |
|-----------------|---|
| GREP            | CMEMS Global ocean Reanalysis Ensemble Product  |
| GTT             | EuroGOOS Glider Task Team   |
| HELCOM          | Helsinki Commission   |
| HRB             | Horizon Results Booster   |
| IBI             | Iberian Biscay Irish  |
| ICES            | International Council for the Exploration of the Sea  |
| IMDOS           | Integrated Marine Debris Observing System   |
| IMS             | internal milestone  |
| IPCC            | Intergovernmental Panel on Climate Change   |
| IPMA            | Portuguese Institute for Sea and Atmosphere   |
| ISC             | Innovation and Stakeholder Committee  |
| ISTAB           | International Scientific and Technical Advisory Board   |
| KER             | Key Exploitable Result  |
| KoM             | Kick-off Meeting  |
| MBON            | Marine Biodiversity Observation Network   |
| MS              | milestone   |
| MSET            | Mediterranean Surface Exploration Tool  |
| MSFD            | Marine Strategy Framework Directive   |
| NFP             | National Focal Point  |
| NRT             | Near real time  |
| OBIS            | Ocean Biodiversity Information System   |
| OBP             | Ocean Best Practices  |
| OEV             | ocean essential variable  |
| OHC             | Ocean Heat Content  |
| OSPAC           | Oceanographic Services at the service of Ports and Cities   |
| OSSE            | Observing System Simulation Experiment  |
| PCU             | Project coordination unit   |
| PDAF            | Parallel Data Assimilation Framework  |
| PDF             | probability distribution function   |
| PG              | Project group   |
| PSMSL           | Permanent Service for Mean Sea Level  |
| QC              | quality control   |
| R&D             | research and development  |
| RMS             | Root Mean Square  |
| RRI             | Responsible Research and Innovation   |
| S2S             | Sub-seasonal to Seasonal (S2S) data bases   |
| SAR             | Search and Rescue   |
| SCOR<br>FLOTSAM | Scientific Committee on Oceanic Research Working Group 150 Floating Litter and its Oceanic Transport Analysis and Modelling |
| SL              | Sea Level   |
| SOCAT           | Surface Ocean CO <sub>2</sub> Atlas   |
| SONEL           |   |
| SST             | Sea Surface Temperature   |
| SWOT            | Surface Water and Ocean Topography  |
| WG              | working group   |
| WGHANSA         | ICES Working Group on Anchovy and Sardine   |

| Abbreviation | Description                              |
|--------------|--|
| WMOP         | Western Mediterranean Operational system |
| WP           | work package                             |