

Project information	
Project full title	EuroSea: Improving and Integrating European Ocean Observing and Forecasting Systems for Sustainable use of the Oceans
Project acronym	EuroSea
Grant agreement number	862626
Project start date and duration	1 November 2019, 50 months
Project website	<a href="https://www.eurosea.eu">https://www.eurosea.eu</a>

Deliverable information	
Deliverable number	D3.9
Deliverable title	<b>Glider network, European coordination</b>
Description	Report on European glider network coordination (Best Practices, OceanGliders, metadata and data management)
Work Package number	WP3
Work Package title	Network Integration and Improvement
Lead beneficiary	CNRS
Lead authors	Pierre Testor, Soeren Thomsen
Contributors	Magali Krieger, Victor Turpin, Carlos Barrera, Johannes Karstensen, George Petihakis
Due date	31.10.2022
Submission date	13.12.2022
Comments	Due to Covid and travel restrictions, this work required much more preparatory and asynchronous work than initially anticipated. In addition, the work and preparation of the document was complicated by staff changes, which ultimately led to a late submission of 6 weeks.



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

## Table of contents

Executive summary.....	1
1. Introduction.....	2
2. The European and international context .....	4
3. OceanGliders GitHub Community: A new tool to foster global coordination in an effective, inclusive, open transparent and asynchronous way .....	8
4. Development, maintenance, endorsement, and enforcement of Best Practices for glider operations... 9	
4.1. Status of Best Practices prior to EuroSea and progress report .....	10
4.2. How does the glider network organize its Best Practice development and governance?.....	13
5. Cooperation with other EuroSea Work Packages and other projects.....	15
5.1. Collaboration with EuroSea WP1 and WP2.....	15
5.2. Collaboration with EuroSea WP3 other Tasks.....	15
5.3. Collaboration with EuroSea WP4 .....	16
5.4. Collaboration with GROOM II project and the EuroGOOS glider Task Team .....	16
6. Key workshops.....	17
6.1. OceanGliders Best Practices Workshop May 11-25, 2021 .....	17
6.2. European Glider Data Management Workshop, June 20-24 and July 5-8, 2022 .....	19
7. Community capacity development.....	21
7.1. GitHub training .....	21
7.2. Glider School.....	21
8. Communication activities .....	23
Conclusion .....	24
References.....	27

## Executive summary

This report describes the overall European glider network activities done during the EuroSea project that have contributed to its reinforcement. We report on coordination actions held in that context: (i) in terms of global coordination, (ii) for the setup of an OceanGliders GitHub community and the establishment of Best Practices and format, (iii) to establish connections with other EU projects and EuroSea work packages, (iv) on network capacity development and (v) on communication. The report gives an overview of the glider network's current situation, demonstrates the great achievements made by the glider network thanks to the EuroSea project and points out future priorities for further development of our network.

### Main successes:

1. Ensure the European leadership in the process of strengthening and consolidating the global OceanGliders coordination activity with a direct link to the GOOS and GCOS via the Observation Coordination Group (OCG)
2. Launch of OceanGliders GitHub Community as a central place to discuss and converge the local wisdom, practices, and documents into community agreed-on Best Practices and data formats based on, whenever possible, existing vocabularies. After its launch in September 2021, the online community has already attracted 131 members (28 June 2022).
3. Capacity development of the glider community. In total 7 GitHub training sessions have been carried out since September 2021 with +50 community members to learn how to use these tools for future asynchronous community work.
4. Initiate and lead the convergence process needed to receive a first set of European and globally agreed Best Practices for glider operations to record the EOVs for surface and subsurface Salinity and Temperature, Depth-Average Currents, Oxygen, nutrients (Nitrate) and phytoplankton (Chlorophyll-a).
5. Ensure the European leadership in the development and release of a globally agreed data and metadata format (OceanGliders Format 1.0). Led by European glider and data management communities, this international initiative will be conducted by the OceanGliders program of the Global Ocean Observing System (GOOS) to uniformize the glider data format globally. Constrained by vocabularies, aligned with international standards (cf, OceanOPS, ACDD) and interoperable with other formats (Argo, OceanSITES), the new OG1.0 format will have a great impact on the glider community. The unique glider format will accelerate data uptake through improved data sharing and data flow, but also in the monitoring of the program and the development of common tools. Despite delays due to difficulties in the harmonization of the multiple existing formats, OG1.0 will be released officially this year and become operational in 2023. This great achievement for the international community has been made possible thanks to multiple meetings among experts from the EU, USA, and Australia over the last 18 months.

Priorities for the next years: The overall priority is to ensure the sustainability of the network activities in scientific, technological, data management and international cooperation areas. To maintain such dynamism and continue to reinforce the glider network at the European level and beyond, we clearly rely on our ability to get funding from national and international projects on technical development and ocean science process

studies but more importantly on our institutions to recognize the need for sustained glider observations and our coordination activities.

## 1. Introduction

The ocean is an important component of the global earth system influencing the global/regional climate, weather, ecosystems, living resources and biodiversity. The ocean plays a major role in many human activities including coastal protection, tourism, search and rescue, defence and security, shipping, aquaculture and fisheries, offshore industry, deep mining, and marine renewable energy. Ocean observation practices enable us to better understand ocean functions and to meet the societal needs related to these activities. The Intergovernmental Oceanographic Commission (IOC of UNESCO) developed the Global Ocean Observing System (GOOS) more than two decades ago to coordinate the different national efforts in terms of sustained ocean observations throughout the world and to maximize the societal benefits of ocean observations. GOOS has three observation panels for the development of observing strategies for climate, biogeochemistry, and biology/ecosystems. Furthermore, the Observation Coordination group (OCG) of the World Meteorological Organization (WMO)/Intergovernmental Oceanographic Commission (IOC) Joint Commission on Oceanography and Marine Meteorology (JCOMM) is responsible for technical coordination of ongoing observations. GOOS also serves as the ocean component of the Global Climate Observing system (GCOS). It is implemented through GOOS Regional Alliances and supported by a wide range of bodies, such as the Committee on Earth Observing Satellites (CEOS), the Partnership for Observation of the Global Ocean (POGO) and the GEO Blue Planet initiative.

The OceanObs'99 conference stimulated the first design of GOOS and 10 years later, the OceanObs'09 conference assessed the progress made in implementing GOOS. At that time, an international consensus was reached on how GOOS should continue to evolve. Discussions around GOOS highlighted the tremendous potential value for physical, biogeochemical, and biological observations, particularly in the transition between the open ocean and the coastal environment, which is a key area for societal issues, and economical applications. This was especially considered in Europe since similar conclusions were supported by the "Blue Book", with the corresponding "Marine Strategy Framework Directive" (MSFD) publication in 2008 and later the "Marine Spatial Planning" (MSP) Directive. Therefore, the need for a multi-dimensional mapping of Member States' waters which includes activities developed in the framework of the Copernicus Marine Environment Monitoring System (CMEMS) was stressed. It also clearly stated the important role the glider technology (which emerged in the late 1980s but became available only a decade ago) could play in filling this gap when reaching a sufficient level of maturity. Gliders were considered in this global framework from the very beginning, especially for the transition between the open ocean and the coastal environment, which is a prime area for autonomous underwater glider observations (Davis et al., 2002). Developed between 1980 and 1990 (Lee and Rudnick, 2018), they arose from the vision that a network of small, intelligent, mobile, and cheap observing platforms could fill sampling gaps left by the other ocean observing platforms (Stommel, 1989). This idea was first discussed at OceanObs'99 (see Conference Statement 1) when the technology was immature and further developed at OceanObs'09, when the technology was still maturing but poised to make a substantial contribution to global ocean observing (Testor et al., 2010). It was agreed that gliders could fill important gaps left by other observing systems and thus greatly enhance GOOS if fully integrated into the system, and recommendations were made for the next decade.

These recommendations were followed and the international OceanGliders program was created in 2016 at the 7th EGO (Everyone's Gliding Observatories) meeting (National Oceanography Center, Southampton, UK) to gather the global glider community under one umbrella. The organizational structure of OceanGliders was outlined as such that international initiatives such as GOOS or GCOS could be addressed in dialogue and activities. OceanGliders' objectives include unifying and thus strengthening the glider community (users, scientists, engineers, operators, manufacturers) and facilitating the worldwide use of gliders to support the acquisition of trusted and interoperable data for sustained observing objectives for the benefit of society and science. The OceanGliders coordination network as representation and contact point for glider observations for GOOS was approved via OCG by the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) at their 5th Intergovernmental Session in October 2017. The dialogue works as such that the OceanGliders Steering Team reports to the GOOS OCG (Observations Coordination Group) as other associated networks do (e.g. Argo, OceanSITES, Data Buoy Cooperation Panel (DBCP), Global Ocean Ship-based Hydrographic Investigation Program(GO-SHIP), ...).

An initial structure and set of governance rules were agreed upon, as well as more detailed ways to maintain and develop the program. Because of their proven ability to fill gaps and needs in the existing observation system, gliders are on the cusp of a transition from isolated, regional use by a few expert teams, to widespread use around the globe by coordinated groups with a wider range of applications. The glider community has realized the many benefits of sharing expertise, Best Practices, data, and even infrastructure components among existing and new members. Providing a global program, in which new ideas can be discussed and coordinated for larger-scale adoption, is turning regional efforts into integrated global efforts. This fits perfectly into GOOS' mission to promote feasible, high impact observing programs. The progress of the glider community was then presented at the OceanObs'19 conference (Testor et al., 2019).

The idea for a glider community emerged in October 2005 in Europe at the first "EGO Workshop and Glider School" and since then, collaborations have further developed. EGO Workshops and Glider Schools have been organized on an annual basis, to present and discuss scientific and technological issues, and to train and engage new users from countries around the world. The formation of a user group and global coordination has improved glider operational reliability and data management and resulted in more efficient glider monitoring and ocean observing, at the same time enabling significant developments of the glider platform. This loose glider network in Europe was first supported by the EGO COST (Cooperation in Science and Technology) Action (2010-2014) and the 7<sup>th</sup> Framework Program (FP7) GROOM (Gliders for Research, Ocean Observation and Management) design study (2011-2014) of a European Research Infrastructure for managing gliders. This allowed much further progress also in collaboration with FP7 Joint European network of Research Infrastructures for Coastal Observation (JERICO). The EuroGOOS Gliders Task Team was then established in 2015 to sustain and support the European part of the global glider community and to contribute to GOOS in the framework of the European Ocean Observing System (EOOS). At that time this coordination activity was further supported by Horizon 2020 (H2020) AtlantOS (2015-2019) and it is worth saying that all these projects helped Europe to get leadership in the set-up of OceanGliders.

The Work Package 3 (WP3) of the EuroSea project, "Network Integration and Improvement", aims at increasing integration between ocean observing networks, improving their coordination, and supporting data quality control and dissemination. WP3 targets several ocean observing networks including underwater gliders. The aim of EuroSea WP3 Task 3.2 "Underwater Gliders" is to continue the above-mentioned coordination activities by improving glider coordination at the European level through EuroGOOS and its Glider Task Team. In turn, the active participation of European actors in OceanGliders but also a dialogue

with the EuroGOOS glider Task Team (TT) ensures the needed feedback between the global and the European operations.

This task has been supporting EOOS to develop a glider network that is in phase with the results of recent international programs (COST Action EGO; FP7 GROOM, H2020 AtlantOS), the EuroGOOS glider Task Team, and the G7 recommendations for gliders. The main objectives of this task are to improve glider coordination at the European level (providing a technical coordinator) through EuroGOOS and its Regional Ocean Observing Systems (ROOSes) in particular, and to link them to the global activities to make them fully integrated in GOOS.

A strong focus in this task has been put on the convergence of local, expert knowledge and practices into widespread, global, agreed, and trusted Best Practices for glider operations, data management and quality control. Effective coordination of global and European glider activities is challenging due to many reasons such as fragmentation or lack of sustained funding. During EuroSea, a global pandemic made the coordination effort even more challenging. Until 2020 a lot of coordination was happening through synchronous in-person meetings i.e., classical conferences or workshops. The COVID pandemic strongly impacted international travel from early 2020 until mid-2022 and thus a new way of organizing international collaborations was required. The pandemic forced us to improve the coordination approach of the glider network, making it less dependent on meetings, more inclusive and more sustainable but this required a significantly larger number of resources than expected, which were provided as in-kind contributions.

## 2. The European and international context

Since the early coordination efforts in 2006, strong monitoring of the European glider activity has been done, with contacts systematically made with new users to join the community. As a result, all 'glider' teams in Europe have been contacted and joined the EuroGOOS Gliders Task Team (GTT). They provide in-kind but small contributions to this task team whose aims are to:

- Support the coordination of the European glider activities.
- Assist in the standardization of glider operations, data, and applications.
- Ensure data availability for the Copernicus Marine Environment Monitoring Service (CMEMS), via the EuroGOOS regional data portals (ROOS) in particular.
- Generate and promote Best Practices in applications, technologies, data management, and scientific development.
- Jointly contribute to European projects.

The EuroGOOS GTT coordinates the European community contributions to the GOOS and is part of its governance, together with other similar groups like the US Underwater Glider Group/Integrated Ocean Observing System (UG2/IOOS) in the USA, OceanGliders Canada, and Integrate Marine Observing System/Australian National facilities for Ocean Gliders (IMOS/ANFOG) in Australia. It is an entity that gathers the European glider community mostly on operational oceanography aspects. The work of EuroSea Task 3.2 has consisted much in supporting this community with the project resources.

Since 2020, the community has been working again on the design of a European Research Infrastructure for operating gliders in the framework of the H2020 GROOM II (Gliders for Research, Ocean Observation and management: Infrastructure and Innovation) project. H2020 GROOM II aims at designing a European Research Infrastructure that integrates national infrastructures for Marine Autonomous Systems (MAS mainly including gliders but also autonomous surface vehicles) to provide access to platforms and services to the broadest range of scientific and industrial users, as well as other ocean observing Research Infrastructures (RIs). It maintains a unique centralized provision of cyber-infrastructure, data, and knowledge for the optimized use of MAS to study climate and marine environments and to support operational services and the blue economy. This is a follow-on for the FP7 GROOM that aims more at designing the infrastructure from a political point of view, while the first GROOM project allowed us to make strong progress on scientific and technological aspects. The Marine Research Infrastructure (MRI) landscape had also evolved much since then, and discussions are ongoing with the different stakeholders in the MRI landscape (EuroArgo, European Multidisciplinary Seafloor and water column Observatory (EMSO), Eurofleets, JERICO, SeaDataNet, ENVRI) to try to better design a glider infrastructure that would be fully integrated in this landscape. The role of EuroSea Task 3.2 has been successful in this context supporting the EuroGOOS GTT in coordination with GROOM II efforts, especially by helping to develop Best Practices and focus on the requirements for the future GROOM RI (Research Infrastructure) and by establishing the link with the broader community than only the H2020 GROOM II project partners. The work of EuroSea Task 3.2 has also fuelled and channelled global efforts in the framework of OceanGliders. Within the global coordination network OceanGliders, currently co-chaired by the EuroSea partner Centre National de la Recherche Scientifique (CNRS), operation areas and major scientific themes where glider observations play a prominent role have been identified and formalized via global Task Teams (TTs). Chaired by recognized specialists in their domains, the OceanGliders TTs are fully open to engaging broader communities and act as interfaces with other expert teams in OCG networks. It is expected that the mission based TTs will continuously and organically develop by aggregating the different initiatives about the following topics around the world. Six TTs are currently identified:

- Boundary Currents
- Storms
- Water Transformation
- Ocean Health
- Best Practices
- Data Management

The coordination work of EuroSea Task 3.2 allowed the international community to really move forward on the Best Practices aspects in this framework. The progress made at the global level with the set-up of an OceanGliders GitHub community must be considered an important legacy of the EuroSea project as well as having trained and enabled the global community to carry on the work. We have followed the approach and recommendations developed more broadly for ocean observation in Pearlman et al. (2019), by the Ocean Best Practices System (OBPS)<sup>1</sup>, which is an Intergovernmental Oceanographic Commission (IOC joint IODE/GOOS) Project and followed the work of the OCG on Standards and Best Practices across the global

---

<sup>1</sup> <https://ioc.unesco.org/media-and-publications/ocean-best-practices-system>

ocean observing networks. It recognises the need to define reproducible methods across activities from research to operations and to products, all along the ocean observing value chain (Figure 1), from survey design to post-mission processing and services in order to increase the societal benefits of GOOS and develop further requirements and subsequent evolutions of the system through:

- quality and consistency of observations
- efficiency (not reinventing the wheel)
- transparency through data traceability and reproducibility, as well as Findable, Accessible, Interoperable, and Reusable (FAIR) data
- historical data - improved recovery
- seamless linkages between design, data, models and applications
- supporting capacity development.

The OBPS has documented the characteristic of a Best Practice, and contrary to a practice or a methodology document, and where two aspects must be fulfilled (Pearlman et al. 2019): *“a Best Practice is a methodology that has (1) repeatedly produced superior results relative to other methodologies with the same objective; to be fully elevated to a best practice, a promising method will have been (2) adopted and employed by multiple organizations”*. Embedded in the definition of "Best Practices" are guidelines on how these must be achieved: on the one hand, it is expected that information on practices that already exist is compiled and aligned across numerous actors. This process is referred to by OBPS as "convergence". For the convergence process, access to the numerous documents/practices in the OBPS repository is useful and intended. The universal character that Best Practices have due to the way they are created should mean a wide use, and consequently the trust of numerous programs and groups. In this context, it is advantageous if programs and groups can "commit" to Best Practices that they support. In OBPS, this support or commitment is called "endorsement". OBPS exemplified a first endorsement process with GOOS (Hermes et al. 2020) but currently awaits other programmes and initiatives to follow.



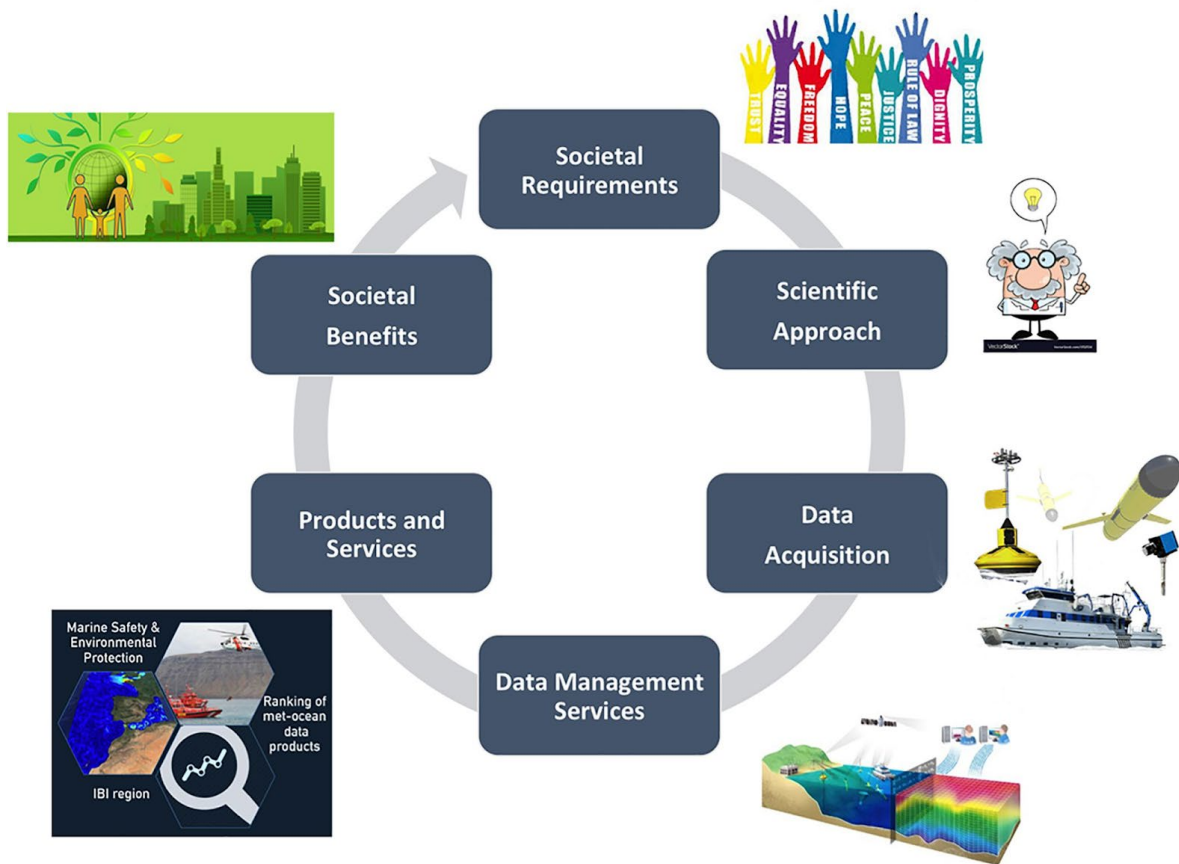


Figure 1. The ocean observing value chain (Pearlman et al., 2019).

As outlined in Hermes et al. (2020) for a “GOOS endorsement” the GOOS panels (Ocean Observation Panel for Climate (OOPC), International Ocean Carbon Coordination Project (IOCCP), GOOSBioEco) prove the alignment of a “for-endorsement proposed” Best Practices with a set of targets they defined for data streams, sensor handling, and operations about delivery of Essential Ocean Variables (EOVs)<sup>2</sup>. The obvious provider of “for GOOS endorsement proposed” Best Practices are the global ocean observation networks (e.g., OceanGliders, Argo, OceanSITES, etc.), coordinated under the umbrella of the OCG. Conversely, it makes sense for the OCG networks to issue an endorsement for the network-specific Best Practices - a process that hardly any networks have carried out so far.

However, given the various stakeholders and thus requirements internal groups but also European groups should consider the endorsement because expectations on the European level might differ and be more detailed and specific in a European context. In practical terms this could mean that the EuroGOOS Glider TT defines, in a dialogue with EuroGOOS, under what circumstances a Best Practices can be considered a comprehensive compendium of current knowledge that will allow addressing the EuroGOOS ocean observing requirements (e.g., documentation of data flow into the European data aggregators). This way the European glider operators will know which Best Practice to follow if they are interested in sampling and delivering data that is interoperable across EuroGOOS observational networks.

<sup>2</sup> [https://www.goosoocean.org/index.php?option=com\\_content&view=article&id=170&Itemid=114](https://www.goosoocean.org/index.php?option=com_content&view=article&id=170&Itemid=114)

### 3. OceanGliders GitHub Community: A new tool to foster global coordination in an effective, inclusive, open transparent and asynchronous way

The COVID situation forced us to move away from an email and in-person meeting culture towards a continuous, open, and asynchronous community working approach and, in a way, this helped us to move forward. Classical communication within the scientific community is still mainly based on meetings and email. When coordinating a global effort of several hundreds of community members this approach is limited. Long email threads are quickly difficult to follow and are not properly archived which makes it hard for future collaborators to join. Consequently, many discussions are repeated, and progress is limited. The same occurs often during in-person meetings if the knowledge is purely exchanged orally and not properly documented in an organized written way. During the OceanGliders Best Practice workshop in May 2021 which we organized, it was decided to launch a GitHub Community (Figure 2) to better manage the glider activities.

GitHub is a social media site that has been created to support the developers' communities using Git which is a versioning tool for software. GitHub allows one to record or rewind any change to one's code and to keep one's team in sync. It is open source and allows one to use it for free with unlimited public and private repositories. While it was first developed for developers, it can also be used to jointly write and version text documents with nice features in terms of edition. Official document releases can be made with a few clicks, which is very useful for constantly changing and evolving Best Practice documents. GitHub and its community tools like the ones used to raise issues, approval mechanisms and document governance allow a more effective, inclusive, fully open and transparent working mode. Anyone can join the discussions at any time, from any place. This is key because it allows people to engage in their time zone, schedule, and pace.

One key action of EuroSea Task 3.2 was to organize the community reviews of various OceanGliders Standard Operating Procedures (SOPs) that have been started thanks to the virtual Best Practices workshop we organized in May 2021, as well as others that emerged later on. This was a great success as all comments can be addressed in an open, transparent, and organized way. From its creation in September 2021 until June 2022 this online community has attracted 131 members and has 13 repositories ranging from Best Practices, data format description and glider data assimilation.

This community tool is envisioned to be of major help to the global OceanGliders community to develop its Best Practices all along their convergence, adoption and eventually even the endorsement processes. However, as a first step it needs to be defined which European initiative will find the trust of the European community of glider operators to be the authorized group for such an endorsement. It is also sustainable by the community since main editors can change. Also, it allows a smooth transition in case some people leave the efforts and new ones want to join. However, this first year of experience of GitHub showed that significant resources in terms of personnel were needed to animate the community and help new GitHub users to adopt this new tool. The hope is that after this initial phase the use of the platform is more easy and self-explaining and only little help and guidance is needed to operate the GitHub.

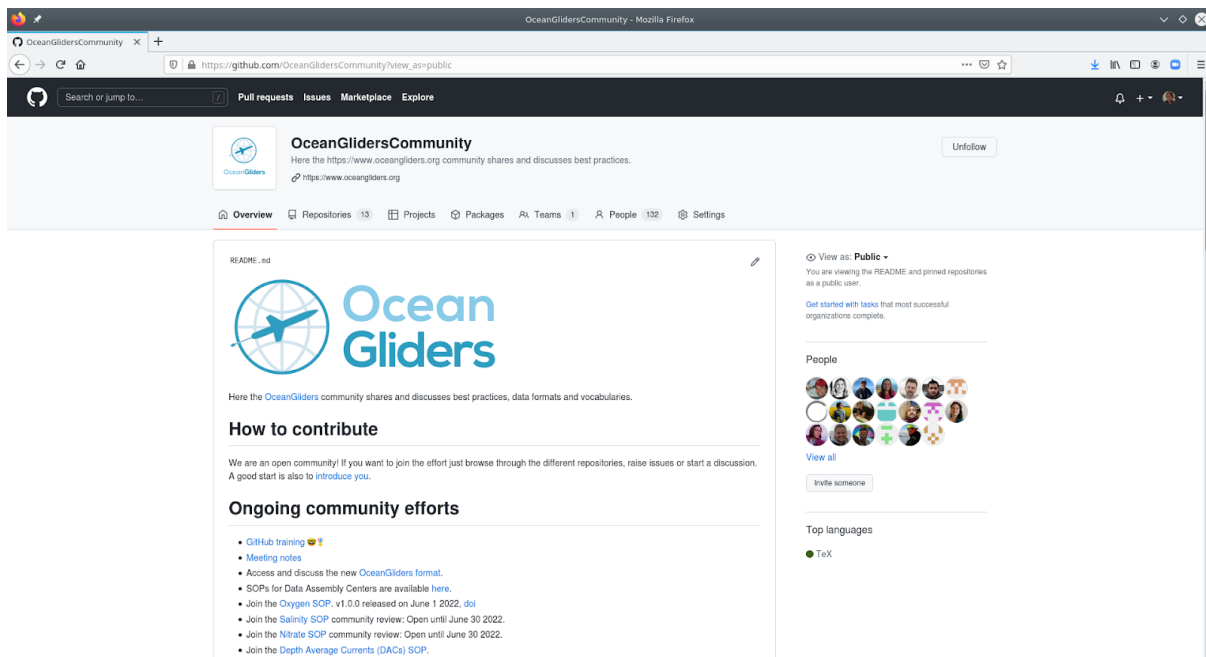


Figure 2. OceanGliders GitHub Community landing page

## 4. Development, maintenance, endorsement, and enforcement of Best Practices for glider operations

What is the difference between a Best Practice and a Standard Operating Procedure (SOP)? As outlined above “a Best Practice has two key characteristics: (1) repeatedly produced superior results relative to other methodologies with the same objective, and (2) adopted and employed by multiple organizations”. Best Practices improve the reproducibility of scientific research, as well as interoperability across disciplines and datasets by standardizing methods and data collection, which allows practice in one area to be transferred to another. Best Practices increase productivity, save duplication of effort, and help future-proof datasets (the methods of collection and processing can be identified). They provide transparency in data collection within the ocean science community, enhancing the usefulness, reproducibility, reusability, and interoperability of the data. Best Practices support the transfer of knowledge and capacity building and make the data usable by communities outside of the observing community.

According to Akyar (2015), a Standard Operating Procedure (SOP) is a process document that describes in detail the way that an operator should perform a given operation. SOPs involve the purpose of the operation, the equipment and materials required, how to perform the set-up and operations required for the process, how to perform the maintenance and shutdown operations carried out by the worker, a description of safety issues, troubleshooting, a list of spare parts and where to find them, illustrations, and checklists. The SOP is one of many process documents which is needed for consistent operation of a given process, with other documents involving process flow charts, material specifications, and so forth. So, a SOP is somewhat very similar to, and could be considered as, a Best Practice but SOP are generally more detailed and technical while Best Practices are more methodological.

#### 4.1. Status of Best Practices prior to EuroSea and progress report

Many documents have been produced about Best Practices starting about a decade ago. Among those noteworthy to mention are the work done in FP7 JERICO (Petihakis et al. 2012) and FP7 GROOM (Hannides et al 2014). Other groups, in the USA and Australia in particular, have developed similar initiatives which resulted in a variety and number of documents. During the 8th EGO/UG2 meeting organized in May 2019 (Rutgers University, USA), there was a strong consensus that the OceanGliders program could not develop without developing a better and strong framework for Best Practices. There is a need to focus on developing the information on the state-of-the-art glider 'Best Practices' in the OceanGliders context and to produce a document on glider 'Best Practices', written under the OceanGliders umbrella. It would need to be as exhaustive as possible, but at the same time provide a real synthesis of what would be the base of OceanGliders Best Practices. This would also provide the opportunity to highlight gaps where Best Practices need to be developed and would be very valuable for existing and developing glider groups alike. It would highlight the valuable work already done and facilitate the adoption of such glider 'Best Practices' worldwide, foster homogenization and standardization of glider observations, and ultimately help to extend the glider data user community.

This motivated the proposed work of EuroSea Task 3.2. At the beginning of EuroSea, no clear framework for glider Best Practices was in place and the collective knowledge has been scattered around the globe. Across the glider community, many 'Best Practices' have been developed by many teams around the world during the last decades and many documents have been already produced, however, they are scattered across the community, hidden in peer-reviewed papers, project reports, or institutional archives. They are in many different forms (i.e., standard operating procedures (SOPs), manuals, handbooks, guides, cookbooks, published scientific papers, training and educational material). Some have already been deposited in the Ocean Best Practices System<sup>3</sup>, with 151 results for a query on gliders as of April 27, 2021 (246 in November 2022). However, there is not yet any overview of these practices, nor a set of community agreed Best Practices. Many glider 'Best Practices' are just recommendations or adopted by one or two laboratories/institutes and not yet adopted by the wider OceanGliders community. Narrow scopes of practices (such as sea area/conditions, glider types, equipment base, etc), gaps and overlaps in the documents, their different levels of details, as well as some institutional constraints, hinder their adoption by wider communities and their evolution into standards.

There is a clear need to identify, document and share the key Best Practices adopted across the OceanGliders community, to identify gaps, consider convergence, and reach an international consensus on a set of OceanGliders community Best Practices across EOVs and the observation life cycle. This is a necessary step in the development and strengthening of the OceanGliders community. Parallel efforts of different teams on the same issues would be avoided for the benefit of everyone. Such a documented set of OceanGliders Best Practices could then be endorsed as the OceanGliders Best Practices.

During the OceanGliders Best Practice Workshop we organized in May 2021, the community worked intensively on various documents. Namely, we have started an overview paper "Towards OceanGliders Best Practices and Standards" and several standard operating procedures (SOPs) related to measured variables. The overview publication covers practices for glider operations from setting up a glider facility, deployment preparation, piloting, to data quality control and data delivery (Figure 3). The target readers here are PIs,

---

<sup>3</sup> <https://www.oceanbestpractices.org>

who need to have an overview of the requirements. On the other hand, the SOPs are targeting users and glider operators. The general characteristics of such documents we agreed upon and their status are presented below.

## Towards OceanGliders Best Practices and Standards - Community Paper

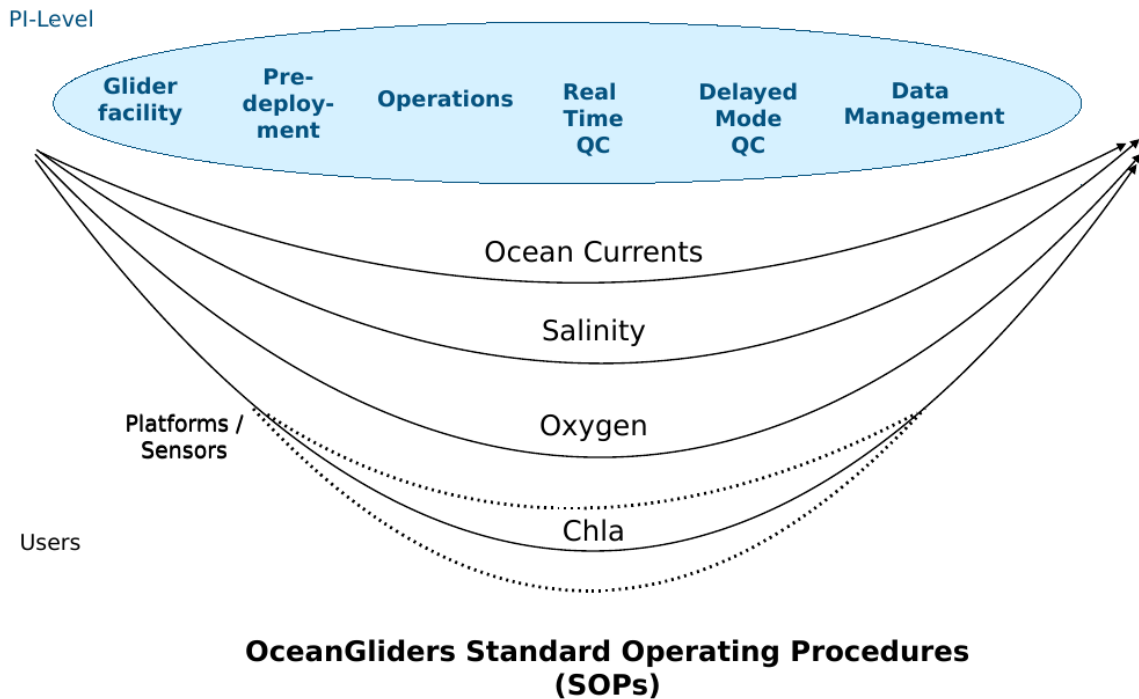


Figure 3. Schematics of OceanGliders Best Practices

### 1) Overview paper

The overview paper “Towards OceanGliders Best Practices and Standards” is supposed to:

1. be an expert and synthetic curated review of the existing range of ‘Best Practices’ on all aspects of the glider activities
2. be very general: focus on the methodologies and principles (not on details), try to avoid glider/sensor specifics
3. be as exhaustive as possible but concise
4. Recognize/cite all the work done, in a convergence process

The overview paper is well advanced thanks to the work of more than 100 contributors from all around the world. The authors will be P. Testor, S. Thomsen, E. Heslop, M. Palmer, leads of chapters (in chapter order), other authors (alphabetical order) and the table of content is the following:

Introduction (Co-lead: Pierre Testor, Soeren Thomsen, Emma Heslop, Matthew Palmer, draft 1500 words)

1. Setting up a glider facility (Co-lead: Jack Barth, Sandy Thomalla, Sebastiaan Swart, draft 7300 words)

2. / 3. Pre-deployment preparation / Operations (Co-lead: Josh Kohut, Álvaro Lorenzo Lopez, draft 7000 words)

4. Real Time Quality Control (Co-lead: Guilherme Pimenta Castelão, Mark Bushnell, draft 0 words)

5. Delayed Mode Quality Control (Co-lead: Soeren Thomsen, Pierre Testor, Emma Heslop, Matthew Palmer, draft 8700 words)

6. Data Processing and Management (Co-lead: Victor Turpin, Justin Buck, Emma Slater, draft 4800 words)

Conclusion (Co-lead: Pierre Testor, Soeren Thomsen, Emma Heslop, Matthew Palmer, draft 400 words)

There is a wonderful wealth of information with 29700 words on Best Practices (BP) in the draft document at this stage but there is still a long way to go, and we miss chapter 4 (even though impressive work has been done on that matter no document is ready yet for this section). Considering the constraint of 12000 words max (~27 pages) from the “Ocean Best Practices” Special Issue in Frontiers in Marine Science, we face a challenge but have some solutions: (i) hardcore rewording to reduce text length (but not trimming to a pointless list of citations...); (ii) split paper in Part I and Part II? (iii) create more SOPs to refer to and (iv) find a journal with fewer constraints on manuscript lengths. The submission of a final draft to the community is expected in mid-2023 for feedback before submission to a peer-reviewed journal (ideally Frontiers in Marine Science special issue on Ocean Observing Best Practices).

## 2) SOPs (variable-based: Oxygen, Nitrate, Ocean Currents, Salinity)

The SOPs are supposed to:

- provide all details required for users
- be living documents, ideally connected with code
- target submission to OceanBest Practices System (OBPS)

Several SOPs have been developed in parallel to the overview paper and their status is the following:

- Salinity: Community review finished, received GOOS endorsement (see section 3.2). Preparation of v1.0.0 to be released on OBPS
- Depth AverageCurrents: In preparation for community review
- Oxygen: Publication of v1.0.0 which is deposited on OBPS with doi<sup>4</sup> (López-García et al. 2022). Received GOOS endorsement
- Nitrate: Community review finished, Preparation of v1.0.0 to be released on OBPS
- Chlorophyll-a: Just initiated by the community. Writing started at the end of June 2022

---

<sup>4</sup> <http://dx.doi.org/10.25607/OBP-1756>

During the European Data Management workshop in June 2022, a new Chlorophyll-a SOP was initiated by the community. The SOP will be developed collectively on GitHub over the next months and follows the same procedure as the 4 other SOPs.

The SOPs are available on the OceanGliders GitHub repository:

- Oxygen SOP<sup>5</sup>
- Salinity SOP<sup>6</sup>
- Nitrate SOP<sup>7</sup>
- Depth-Average Currents SOP<sup>8</sup>
- Chlorophyll-a SOP<sup>9</sup>

#### 4.2. How does the glider network organize its Best Practice development and governance?

As described by Hermes (2020), the benefits of following recognised community Best Practices are numerous and fundamental to the sustained global ocean observing effort. The GOOS 2030 Strategy is to be a ‘truly global ocean observing system that delivers the essential information needed for our sustainable development, safety, wellbeing and prosperity’. The creation and use of ocean Best Practices play a fundamental role in achieving this, they are a vital underpinning to system resilience, interoperability, and the delivery of fit-for-purpose data to end users. The GOOS 2030 Strategic Objectives 4, 7 and 10 all rely on ocean Best Practices. GOOS communities have created Best Practices, but they may not be sufficiently broadly visible, and it may not be clear that they have been through a rigorous community process. The OBPS has been set up to facilitate the dissemination and archiving of Best Practices in an open and accessible manner. However, there are currently more than 1700 documents (November 2022) across all parts of ocean science available in the OBPS repository and only a few are Best Practices of global communities. There is a pressing need to help identify key GOOS/OCG community tested and adopted Best Practices. Through a close GOOS, OCG and OBPS collaboration, an endorsement process for GOOS community Best Practices linked to the OBPS, has been created and then adopted by both the GOOS Steering Committee and the OBPS Steering Group in October 2020. This provides an endorsement process within GOOS and filtering mechanism within the OBPS repository, fostering their discovery and access.

To ensure that the endorsement is consistent, reliable, and efficient several steps are identified for GOOS to endorse what is considered the community-adopted Best Practices, for recommendation to the broader community (e.g., for a particular EOV). To qualify as “GOOS endorsed” a best practice is expected to

- Have completed a rigorous community review process whereby comments are publicly invited, adjudicated and actioned by the author
- Originate from a network that is at least “pilot” in all the BioEco or OCG network attributes (when applicable, i.e., originating from a BioEco or OCG network)

---

<sup>5</sup> [https://oceangliderscommunity.github.io/Oxygen\\_SOP/](https://oceangliderscommunity.github.io/Oxygen_SOP/)

<sup>6</sup> [https://oceangliderscommunity.github.io/Salinity\\_SOP/](https://oceangliderscommunity.github.io/Salinity_SOP/)

<sup>7</sup> [https://oceangliderscommunity.github.io/Nitrate\\_SOP/](https://oceangliderscommunity.github.io/Nitrate_SOP/)

<sup>8</sup> [https://oceangliderscommunity.github.io/DepthAverageCurrents\\_SOP/](https://oceangliderscommunity.github.io/DepthAverageCurrents_SOP/)

<sup>9</sup> [https://github.com/OceanGlidersCommunity/Chla\\_SOP](https://github.com/OceanGlidersCommunity/Chla_SOP)

- Be approved by the leadership of the relevant network, expert team, or other community leaders
- Is fit for the purpose as defined and fully satisfies the definition of a Best Practice on the OBPS
- Has been recognised as such through the relevant GOOS body, e.g., GOOS BioEco panel, BioGeoChemical (BGC) panel, OOPC or OCG or Expert Team on Operational Ocean Forecast Systems (ETOOFS), after the approval of the relevant network leadership
- Is available and identifiable within the OBPS repository or will be submitted as soon as endorsement is received
- Is updated at relevant timeframes

To ensure that the Best Practices remain relevant, GOOS will keep a central record of when Best Practice has been endorsed, by which community and GOOS Component, and with the lead author's contact details. After 3-5 years a reminder will go out to the GOOS endorsing component and current active authors to check for updates.

We have been working on OceanGliders Best Practices aiming them to be endorsed by GOOS from the very beginning. The GOOS Essential Ocean Variable approach is followed, and this implies that each measured variable by OceanGliders has its own SOP, which is governed by the community of experts. At the moment 5 expert groups exist which follow the GOOS endorsement roadmap. At the moment, 3 SOPs have received the GOOS endorsement which implied a review process by the OceanGliders community that we organized. For these SOPs an endorsement certificate has been created and an acknowledgement has been added to the GitHub documents. The documents have then been linked to the OBPS along with the standard required metadata which includes a 'GOOS endorsed' label, enabling specific endorsed searches to be performed and an 'endorsed' filter applied.

Following the process of endorsement, it is strongly recommended that the creators consider publishing either the complete Best Practice or a notice about the endorsement (as a commentary) in *Frontiers in Marine Science*, Research Topic Best Practices in Ocean Observing, and link this to their Best Practice, which will have a DOI, in the repository. The OceanGliders SOPs have been published on OceanGliders GitHub and linked to OBPS. The final step is to publish notices in this special issue of *Frontiers in Marine Science* for each SOP. The documents are now at various stages of progress, the most advanced being the notice for the SOP on Oxygen. They are not yet submitted but we expect soon all notices on existing SOPs to be submitted.

The next step is to define which European group will set the definitions for an endorsement that is tailored to European needs, and which may be wider than the GOOS needs and thus differ from the GOOS endorsement criteria. For example, considering observing requirements set by European directives such as the MSFD or considering the specifics of European data flows. Defining and executing a European specific Best Practice endorsement could be done via the European-wide groups that define the umbrella for coordination and overview of European actors on EuroSea WP3 and which are the EuroGOOS task teams.



## 5. Cooperation with other EuroSea Work Packages and other projects

### 5.1. Collaboration with EuroSea WP1 and WP2

All Best Practices efforts have been coordinated and co-designed with WP1 Best Practices, namely Jay Pearlman and Pauline Simpson who also represent the steering group of the Ocean Best Practice System (SG-OBPS). With respect to the publishing of the documents, we had a dialogue with the OBPS coordinated Frontiers In Marine Sciences Research Topic (“Best Practices in Ocean Observing, Editor: J. Karstensen). In that respect, we collaborated with Task 1.1 “Observing and forecasting system coordination, national, regional, global” (task lead: EuroGOOS, partner: IOC-UNESCO) and more particularly with T 1.1.4 “Ocean Best Practices” (task lead: Institute of Electrical and Electronics Engineers (IEEE), partner: IOC/UNESCO, Sistema de Observación Costero y de Predicción (SOCIB)).

We have also worked on broader coordination activities at the European level and the international level. We organized the OceanGliders Steering Team meetings (December 2020, December 2021, June 2022)<sup>10</sup> and developed a call for nomination to renew the Steering Team in January 2022. We represented the European Glider community to the EOOS Operation Committee as EuroGOOS GTT Chairs and GROOM II coordination team, as well as during the 9th EuroGOOS International Conference (May 2021). We have contributed to Task 2.2 Observing System Design Experiments with global ocean monitoring systems (task lead: Mercator Ocean International (MOI), partner: Collecte Localisation Satellite (CLS), Ecole Normale Supérieure (ENS)) and represented the OceanGliders and EuroGOOS GTT communities at the UN Decade co-design workshop<sup>11</sup>.

### 5.2. Collaboration with EuroSea WP3 other Tasks

Collaboration with WP3 has been ongoing from the beginning of the project, with the WP leaders constantly aligning efforts throughout the different tasks. In particular, we have collaborated on a presentation at MetroSea 2022 entitled “Recommendations on data harmonization for ocean observation networks” (Obaton et al, 2022 proceeding in IEEE) and supported the collaborative WP3 publication by Adèle Révelard, which advocates for transformative scientific, cultural, organizational, and management changes. After analysing the barriers that currently prevent integration within the occidental ocean observing systems, the authors have suggested several approaches for breaking down the organisational silos and promoting better coordination and sharing (Révelard et al. 2022 - see EuroSea communication<sup>12</sup>).

We also developed our Best Practices collaboration with the help of BGC ARGO experts. Our work on Best Practices and in particular the writing of SOP by variable Oxygen and Chlorophyll-a SOPs has allowed us to really connect with these experts from the Argo community and convinced some that GitHub is a good approach to develop such a documentation. It is an argument to better support such efforts in the future since it clearly results in integration. Noteworthy, we could convince EuroArgo, who already used GitHub for software, to use it for the development of Best Practices.

---

<sup>10</sup> see <https://www.oceangliders.org/documents/> and [https://github.com/OceanGlidersCommunity/meeting\\_notes](https://github.com/OceanGlidersCommunity/meeting_notes)

<sup>11</sup> [https://goosocean.org/index.php?option=com\\_content&view=article&id=404:ocean-decade-co-design-workshop&catid=9&Itemid=411](https://goosocean.org/index.php?option=com_content&view=article&id=404:ocean-decade-co-design-workshop&catid=9&Itemid=411)

<sup>12</sup> <https://eurosea.eu/new/new-paper-calls-for-ocean-science-integration-and-optimized-multi-disciplinary-collaboration/>

### 5.3. Collaboration with EuroSea WP4

Collaboration has been established with Task 4.1 “Assimilation in the global and Northeast Atlantic (IBI) Copernicus Marine modelling system and analysis/forecast quality assessment” (task leader: MOI, partner: Spanish Public Port Authority (EPPE)) as well as Task 4.2 “Assimilation in the Mediterranean Sea Copernicus Marine modelling system and analysis/forecast quality assessment” (task leader: Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), partner: Istituto Nazionale di Oceanografia et di Geofisica Sperimentale (OGS), SOCIB) on the assessment of the impact of glider observations on the ocean analysis/forecast products.

A poster entitled “Leveraging the Multi-system Glider Data Assimilation Experiments Within EuroSea to the International Level”<sup>13</sup> was jointly produced and presented at the EuroSea/OceanPredict Workshop on Ocean Prediction and Observing (June 2022). This poster aimed at enhancing the cooperation between the ocean operational community and ocean observing community to (i) advocate for the sustainability of in situ observations, (ii) show the role and potential of glider data in improving the ocean estimates, (iii) discuss future needs and requirements from an operational perspective, (iv) gain a better understanding of the observation information content, data treatment and quality content, (v) disseminate results acquired during EuroSea and (vi) highlight the diversity of studies and the need for joint perspectives from each community to leverage disseminated efforts.

To enhance collaboration at the international level, we also presented this work at the UG2 Workshop Seattle '22 (USA, Seattle, September 2022) and as a demonstration of the community interest in that respect, we have been solicited to turn the poster into an oral presentation that triggered a lot of feedback and the possibility of the creation of a new Task Team in OceanGliders. This matter will be discussed at the next OceanGliders Steering Team meeting in December 2022.

Ocean data assimilation practices are not very well known by the ocean observing community and vice versa. This lack of shared knowledge between the two communities is limiting scientific cooperation and impedes the achievement of the full potential of glider's data assimilation. To try to overcome this situation for glider data, we have recently opened a dedicated repository on OceanGliders Github page<sup>14</sup>.

### 5.4. Collaboration with GROOM II project and the EuroGOOS glider Task Team

As already mentioned in sections 2 and 4.1, we have established particularly strong linkages between EuroGOOS GTT, GROOM II and EuroSea T3.2. This is not only because their coordination has been shared (EuroGOOS GTT chaired by Carlos Barrera, Pierre Testor and Victor Turpin; H2020 GROOM II coordinated by Laurent Mortier and Pierre Testor; EuroSea WP3 T3.2 led by Pierre Testor) but also because the alignment of efforts has been maintained by the organization of many video conferences during the project with the different stakeholders. The EuroSea project resources mainly helped both European and international communities to move forward in terms of integration and coordination, as well as to develop a solid basis for the development of Best Practices in an international context. These are all important aspects that would have to be handled by the future GROOM-RI that is being designed by H2020 GROOM II with respect to the integration of the European glider activity in the future EOOS.

---

<sup>13</sup> [https://oceanpredict.org/docs/Documents/Projects/EuroSea/WS1/Posters/1.9-poster\\_glider\\_V2.pdf](https://oceanpredict.org/docs/Documents/Projects/EuroSea/WS1/Posters/1.9-poster_glider_V2.pdf)

<sup>14</sup> [https://github.com/OceanGlidersCommunity/data\\_assimilation\\_practices](https://github.com/OceanGlidersCommunity/data_assimilation_practices)

## 6. Key workshops

Due to Covid all in-person meetings have been cancelled and transferred into virtual formats. Much effort was put into making the most out of this new format. i.e., we built on the Best Practices of virtual community experts as described in detail below. In general, we received very good feedback for the virtual format from our participants.

### 6.1. OceanGliders Best Practices Workshop May 11-25, 2021

The OceanGliders Best Practice virtual workshop was held between May 11<sup>th</sup> and 25<sup>th</sup>, 2021, was supported by H2020 EuroSea and GROOM II projects and was embedded into the global OceanGliders observing network. The aim of the workshop was to converge on practices around all glider activities such as preparation, deployment, data management, sensor calibration, and data processing to create a comprehensive set of Best Practices. This collective effort will ensure that the valuable data acquired by gliders around the globe will be inter-comparable with other data and accessible to all data users to better understand, predict and make sustainable use of our ocean. In total, more than 150 glider experts from around the globe participated in the workshop (Figure 4).

#### Workshop goals

- Reinforcing the OceanGliders.org community
- Preparing an overview document that outlines the needs and strategy “Towards OceanGliders Best Practices and Standards”
- Development of Standard Operating Procedures (SOPs) for the Essential Ocean Variables (EOV) measured by gliders

The workshop consisted of three plenaries spanning two weeks and many working group meetings in the interim. The different working groups that formed around SOPs (Salinity, Oxygen, Nitrate and Depth-Average Currents) made substantial progress in moving toward a consensus on methods for different sensor types, data management and operations. These working groups have continued their writing tasks and all aim to publish different documents (i.e., the Community Overview paper and multiple SOPs etc). All documents will be fed into the OPBS repository.

166 Registered [^](#)

List View Map View Skill Connections



Figure 4. Attendance at the OceanGliders Best Practices Workshop in May 2021

The meeting was set up following Best Practices on Virtual Meetings, developed by the virtual communication and e-learning communities over the past decade. Namely, we aimed to have a few short (1.5 h max.) sessions per day accommodating different time zones to support global participation, combined with asynchronous working sessions at our own pace in between. A couple of synchronous workshop sessions were primarily used for discussion and only very few introductory presentations were scheduled. Additionally, multiple networking modes were offered: (1) Ice-Breaker event, (2) random small breakout groups during the plenaries, and (3) networking rooms for personal one-to-one discussions. Many new research labs including technical personnel and students, which typically could not participate due to funding limitations, contributed to this inclusive low-carbon workshop.

The meeting allowed us to make substantial progress on the overview paper “Towards OceanGliders Best Practices and standards” and to develop four SOPs (Oxygen, Salinity, Nitrate, Depth-average currents) as well to make progress on data management with SOPs produced by different data centres. Furthermore, significant progress on the definition of the OceanGliders 1.0 format was achieved which is now agreed at the global level and is constrained by vocabularies, aligned with international standards (cf, Ocean in situ Observations Programmes Support (OceanOPS), Attribute Convention for Data Discovery (ACDD)). The format will be released at the end of 2022 and put into operation early 2023.

The progress made on data assembly centres SOP is available in the OceanGliders GitHub repository<sup>15</sup>. The manual on OceanGliders 1.0 format is available in the OceanGliders GitHub repository<sup>16</sup>. Meeting notes can also be found in the OceanGliders GitHub repository<sup>17</sup>.

## 6.2. European Glider Data Management Workshop, June 20-24 and July 5-8, 2022

This meeting was fully virtual and spread over two weeks with various sessions on European glider data harmonization, Best Practices on real-time data quality control and gathered between 25 and 50 persons during the sessions (Figure 5). The European Glider Data Management workshop was organized in collaboration between GROOM II, EuroSea and EuroGOOS<sup>18</sup>. It was decided to centralize all OceanGliders-related meeting notes on OceanGliders GitHub to increase community engagement.

The first week of the meeting aimed at discussing short-term data management issues. Where do we want to be, collectively in 2 to 3 years regarding data management? This first week of discussion was built around very technical questions like the harmonization of real-time quality control across EU glider teams, the use and benefit of common vocabularies and the need for tools to support data and metadata management. We also offered a training session on Github on the first day of the meeting. The SOPs (Salinity, Oxygen, Nitrates, Depth-Average Currents, Chlorophyll-a) developed during the previous year were also planned at the agenda for discussion, advertisement, improvement and confrontation with real cases. This first week was extremely dense with a high level of participation on these topics. It demonstrated the vitality of the European glider community, the interest in the data management topic and the continuous will to engage in a community approach for glider data management.

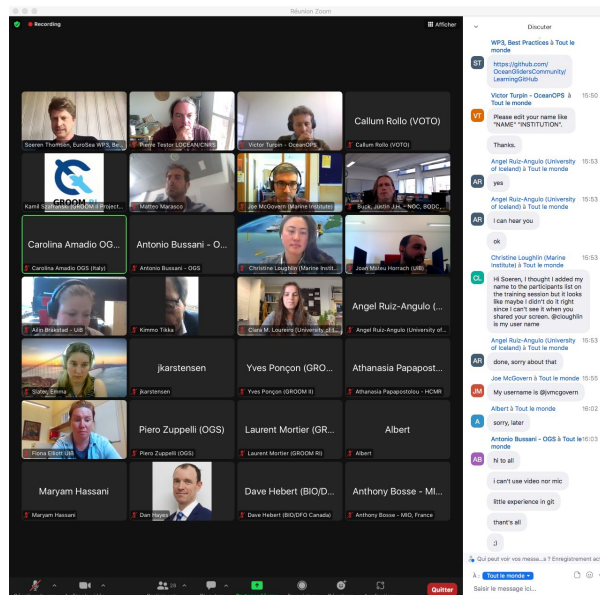


Figure 5. Attendance to the European Glider Data Management Workshop in June-July 2022

<sup>15</sup> [https://github.com/OceanGlidersCommunity/DataAssemblyCenter\\_SOP](https://github.com/OceanGlidersCommunity/DataAssemblyCenter_SOP)

<sup>16</sup> <https://github.com/OceanGlidersCommunity/OG-format-user-manual>

<sup>17</sup> [https://github.com/OceanGlidersCommunity/meeting\\_notes/blob/main/2021/2021\\_05\\_11-25\\_OG\\_BP\\_workshop.md](https://github.com/OceanGlidersCommunity/meeting_notes/blob/main/2021/2021_05_11-25_OG_BP_workshop.md)

<sup>18</sup> <https://www.groom-ri.eu/european-glider-data-management-workshop/>

The second week of the meeting aimed at discussing the longer-term data management issues. The larger community of glider data “stakeholders” was invited to join three sessions focusing on:

1. The data management architecture of DACs (Data Assembly Centers) and GDACs (Global Data Assembly Centers) in Europe and the role of NODCs (National Ocean data Centers) in this regard
2. The future needs in terms of data management regarding the increasing capacity of gliders to measure a new type of data (sound, images, samples, ...)
3. The GROOM RI data management roadmap

European Data aggregators (EMODNET, SeaDataNet and Copernicus Marine In Situ) joined the discussion and had the chance to provide their views on these strategic questions. They appreciated a lot to be associated with this brainstorming effort and their inputs were highly valuable to imagine the future of glider data management. The final session on the GROOM Research Infrastructure data management roadmap was a good opportunity to wrap up these two weeks of workshop and define an agenda to produce a glider data management roadmap for Europe considering integration and the development of a GROOM RI able to manage that in the future. The EuroGOOS GTT and the EuroGOOS Data Management Working Group will be key to implementing this open science roadmap at the European level, in line with global efforts.

#### **Key outcomes of the workshop:**

- OceanGliders GitHub activities must be maintained and increased and need sustainable coordination
- Define medium and long-term (2 and 5 years) data management roadmap for the GROOM RI
- Update the EU glider community on the status of data management in Europe
- Increase community engagement on SOPs
- Discuss highly technical questions related to real-time data management

This meeting can undoubtedly be considered very productive and very successful. We managed to organize 12 sessions with 30 to 60 attendees at each meeting with presentations from experts, discussions, workshops, and training. The virtual mode was interactive enough to collect feedback from a large community. We also engaged with people beyond the EU. Canadian, American, Lebanese, and Iranian also attended the meeting. From this experience, we are convinced that this kind of workshop was needed and expected to form the glider community in Europe. Thanks to the EuroSea project we managed to open a new way to get together efficiently around technical topics like SOPs and data management. This experience should be reproduced in the future, probably on a yearly basis.

Meeting notes and talks can be accessed in the OceanGliders GitHub repository<sup>19</sup>.

---

<sup>19</sup> [https://github.com/OceanGlidersCommunity/meeting\\_notes](https://github.com/OceanGlidersCommunity/meeting_notes)

## 7. Community capacity development

### 7.1. GitHub training

In total 7 virtual training sessions on “basic GitHub skills” have been organized with more than +50 participants from the global glider community, with a strong representation of the European community. The sessions can be seen online<sup>20</sup>.

Training the community in these new tools is key for the long-term success of glider data management as it allows more effective collaboration. Long-term sustained funding is required to moderate and coordinate the GitHub community, organize training sessions, and support the community.

### 7.2. Glider School

The Plataforma Oceánica de Canarias (PLOCAN) Glider School<sup>21</sup> should be understood as a basic hands-on training approach, which is the reason why it is sized to a group of only 15 students per edition (annual), selected from a process of curricular merit in compliance with the quality certification criteria under which the PLOCAN Glider School is conducted. The main objective of the PLOCAN Glider School is focused on providing students with an overview of state-of-the-art glider technologies, including their wide range of uses and applications from both scientific and engineering perspectives.

For its proper development, the PLOCAN Glider School provides a fleet of ocean vehicles from the Vehicles, Instruments and Underwater Machines (VIMAS) facility of PLOCAN, where the main commercial glider technologies are represented, in addition to own boats and facilities specifically designed, such technical and testing laboratories, piloting room, as well as direct, quick, and easy access to both confined and open waters for practising in a safe and useful manner.

The didactic contents taught at the PLOCAN Glider School are carefully selected and dimensioned aiming to keep the goal and purpose of the school, considering aspects such as the hands-on training component, the profile of the attendees, the number of technologies to be shown, and the duration of the training, among others. It is not the purpose of the school to overlap with specific training courses that each technology offers through the manufacturing company or official delegate. Beginner students and those without any prior glider experience are intended to benefit from the opportunity to approach these technologies in a basic and initial way, without diving too deeply into any of them, but rather making the most of the exceptional situation of being able to get a state-of-the-art overview of the main commercial technologies available for both profiling and surface gliders (ASV), by having them all in the school.

The five days of PLOCAN Glider School are divided into eight-hour slots, in which both theoretical and practical sessions in the laboratory, confined and open waters are combined. In these sessions, students have access to learn about Slocum (Teledyne Marine), Seaglider (iROBOT, Kongsberg, HII), Spray (Bluefin Robotics, MRV Systems), SeaExplorer (ALSEAMAR), Waveglider (Liquid Robotics), Sailbuoy (Christian Michelsen Research (CMR), Offshore Sensing), OCEANSCOUT (Hefring Engineering) and AutoNaut (Seiche-AutoNaut) technologies. Each of them includes several theoretical-practical sessions given by technical specialists belonging to the development companies themselves, in which they are shown from the concepts and basic principles of operation to mission planning and piloting interface, as well as scientific payload configurations,

---

<sup>20</sup> <https://github.com/OceanGlidersCommunity/LearningGitHub>

<sup>21</sup> [www.gliderschool.eu](http://www.gliderschool.eu)

data management, assembly and disassembly, maintenance, ballasting, etc. from a perspective of basic training for beginners.

Once the basic knowledge of each one of the gliders and ASV technologies mentioned has been duly acquired, the fifth day of school is fully dedicated to carrying out practices in confined and open waters. This implies deployment and recovery manoeuvres and piloting, which in some cases, is required to be carried out from a boat to which the students have access for a better and more realistic approach to this type of sea operations. Although the main leading role is provided by gliders or ASV platforms themselves, PLOCAN Glider School also includes specific contents referring to components of their subsystem that are of special relevance and interest to students, such as science payload and telemetry.

To better frame and reinforce the basic didactic contents specifically related to glider technologies themselves, each training day combines sessions where world-renowned skilled operators and users (Memorial University, MARUM, National Oceanography Centre, Rutgers University, Monterey Bay Aquarium research Institute (MBARI), Voice of the Ocean (VOTO)-University of Gothenburg etc.) share their experiences with the students and thus show the potential in terms of related applications of this type of autonomous ocean observation platform. Similar to this, lessons on the international coordinated management framework for the Global Glider Network strategy (EGO, OceanGliders, EuroGOOS Glider Task Team, etc.) are provided so that students can recognize the role that this kind of initiative plays in the Global Ocean Observation System (GOOS, OceanOPS) and can support and contribute by building capacity.

One of the main pillars and strengths of the PLOCAN Glider School undoubtedly lies in its professoriate, which includes both the best technical specialists worldwide of each glider technology that the school handle, as well as renowned operators and scientists with proven experience in operation and use of this type of autonomous ocean observing technologies.

The PLOCAN Glider School professoriate belongs to leading companies in this sector as well as to technological-based ocean-research institutions with an interest in the use and application of these cutting-edge technologies. In these ten years of PLOCAN Glider School, a total of 28 companies and 15 institutions have joined and supported the initiative. All the professoriate members have collaborated and contributed with their best possible commitment and dedication, always providing the best of their knowledge and expertise. Among all of them, a core group of teachers stands out for having kept their direct involvement and joined Glider School over the years, almost every edition, which is of special mention. Up to now, ten annual editions have been conducted since 2011. The last two editions (2021 and 2022) have been joined by a total of 31 students from around the world (Europe, Asia, America, and Africa), with academic and professional profiles mostly related to marine science, ocean technology and engineering,

The main motivation and interest of these students refers to accessing a first experience and training approach from a more practical than theoretical perspective to a large representative number of the main commercial glider technologies simultaneously, while being aware of the insufficient time to achieve a level of knowledge and skills as expert user or operator. The Glider School offers students to be able to identify, know and compare with certain detail and criteria the particularities and capacities of each technology that the school provides. In some way, it brings better knowledge and criteria when a procurement of this type of equipment, or a particular service request, becomes necessary in their institutions or companies to cover specific needs on ocean monitoring.



## 8. Communication activities

To draw the attention of the glider community to our coordination efforts and the new Best Practices, various communication channels have been used. Announcements of the OceanGliders Best Practices meeting in May 2021 and the European Glider data management meeting in June-July 2022 have been made on all communication channels we have, namely OceanGliders<sup>22</sup>, EGO<sup>23</sup>, OBPS<sup>24</sup>, EuroGOOS GTT<sup>25</sup>, EuroSea<sup>26</sup>, and GROOM II<sup>27</sup> websites news and mailing lists. Various news articles have been written to inform the community on the start/end of the community's review on the same channels. We also communicated our initiative through institutional websites like the one from NOC<sup>28</sup>. The information about these meetings was also relayed on other websites, like OceanConnectes<sup>29</sup> and ptprotecma<sup>30</sup>, and triggered some activity on Facebook and Twitter<sup>31</sup>. In addition, the presentation we made at the UG2 Seattle 2022 meeting was a reminder of the community effort on OceanGliders Best Practices and a suggestion to engage, as well as to present the progress made so far. And the same was done during the Glider Schools. The work on Oxygen SOP was also presented with a poster (Lopez-Garcia, 2022) at the Challenger conference 2022 (6-8 September) which marked the 150th anniversary of the Challenger expedition and celebrates the birth of international and interdisciplinary oceanography.

---

<sup>22</sup> [https://www.oceanglid.org/taskteams/best\\_practices/](https://www.oceanglid.org/taskteams/best_practices/)

<sup>23</sup> <https://www.ego-network.org/dokuwiki/doku.php?id=public:news:newsdata>

<sup>24</sup> <https://www.oceanbestpractices.org/2022/04/07/oceanglid-bests-practices-are-online/>

<sup>25</sup> <https://eurogoos.eu/news/>

<sup>26</sup> <https://eurosea.eu/new/oceanglid-bests-practices-workshop/>

<sup>27</sup> <https://www.groom-ri.eu/category/events/>

<sup>28</sup> <https://noc.ac.uk/news/glider-experts-share-knowledge-improve-global-ocean-health-data>

<sup>29</sup> <https://oceansconnectes.org/en/european-glider-data-management-workshop-2022/>

<sup>30</sup> <https://ptprotecma.es/evento/european-glider-data-management-workshop/>

<sup>31</sup> For example:

<https://www.facebook.com/eurogoos/>

[https://twitter.com/NAUTILOS\\_H2020/status/1456564949270949890](https://twitter.com/NAUTILOS_H2020/status/1456564949270949890)

<https://twitter.com/PolarGliders/status/1461333307224961036>

<https://twitter.com/ThomsenSoeren/status/1465617837427511299>

[https://twitter.com/Euro\\_Sea/status/1532323842185740288](https://twitter.com/Euro_Sea/status/1532323842185740288)

## Conclusion

Significant progress has been made on community building and data management, as well as on the development, convergence, endorsement, and adoption of glider Best Practices thanks to the work done in EuroSea WP3 Task 3.2.

We have ensured the European leadership in the process of strengthening and consolidating the global OceanGliders coordination activity community with a direct link to the GOOS and GCOS via OCG. We have organized the OceanGliders Steering Team meetings and established a renewal process for their members. With the inclusion of new members in the Steering team, the activity within this network is expected to be powered on and the contours of the OceanGliders Task Teams will certainly evolve soon. This will be at the agenda of the next OceanGliders Steering Team meeting that we will organize late November early December. Our suggestion is to have Scientific Task Teams (Boundary Currents, Storms, Water Transformation, Ocean Health) and Technical Task Teams (Best Practices, Data Management). It is expected that the former presenting the scientific framework will not evolve much in the near future while the latter would need to develop much more, with the possible inclusion of a new Task Team on Technological Assessment.

Connections with other EuroSea WPs and in particular WP1, 2 and 3 have been very beneficial to the glider community particularly in terms of coordination with other Ocean Observing communities, while connections with WP4 initiated an interesting collaboration between observers and modellers on glider data assimilation. The alignment of efforts with the EuroGOOS GTT and H2020 GROOM II has certainly produced more than the sum of the parts. The next important steps in terms of coordination of the glider community in Europe are to clarify the role of the different entities related to the European glider activity. Considering that there is the EuroGOOS GTT, OceanGliders/GOOS, EGO, national networks/infrastructures, and projects like H2020 EuroSea, H2020 GROOM II, EUMarineRobots and JERICO (who both offered Transnational Access to gliders), it is difficult for a new user to understand where to engage. The EuroGOOS GTT has been successful in engaging new teams, but the relations are at the moment probably too high-level and too thin for the needs of the community. They are mostly restricted to established PIs who are not necessarily involved in the basic day-to-day work and so, many users (students, Early Career Researchers, engineers/technicians) do not see that as an entry point. The establishment of national contact points in the GROOM II project has probably also reinforced the idea there is no entry point. Consequently, the EuroGOOS GTT will certainly try to open up to all possible users in the near future and provide this unique entry point in the European glider landscape, while the necessity to have national contact points remains clear for organizational reasons for the design of the GROOM RI.

The Covid pandemic was used to successfully reorganize the glider community coordination and the OceanGliders GitHub community quickly became an integral and central new place to share knowledge and govern documents. The adhesion of more than a hundred members to this platform has allowed us to move forward despite the travel restrictions. Thanks to GitHub training sessions given to about half of this group, the community has undergone a paradigmatic change in using these tools for asynchronous community work and the EuroSea WP3 T3.2 work has supported a very nice community effort with a lot of progress made so far.

We have also organized two important virtual workshops in May 2021 and June 2022 that allowed significant progress in line with our GitHub community efforts. The first one allowed us to initiate and lead the convergence process needed to arrive at a first set of European and globally agreed on OceanGliders Best Practices for glider operations to record the EOVs for surface and subsurface Salinity and Temperature, Depth-Average Currents, Oxygen, nutrients (Nitrate) and phytoplankton (Chlorophyll-a). It also helped us to gather a wealth of information for the overview paper “Towards OceanGliders Best Practices and Standards” which is delayed, but still on track. This is an important community effort on Best Practices convergence since it is an exhaustive review of existing documents on good practices. It also accompanies our community which has already and will continue to produce Best Practices in the shape of SOPs.

This first meeting also allowed us to lead the development and release of a globally agreed data and metadata format (OceanGliders Format 1.0 - OG1.0). Led by European glider and data manager communities and thanks to multiple meetings along the last 18 months and amongst experts from EU, USA, Canada and Australia. This new format will be released at the end of 2022 and will be operational in 2023. It will uniformize the glider data format globally. The new OG1.0 format is constrained by vocabularies, aligned with international standards (cf, OceanOPS, ACDD) and interoperable with other formats (Argo, OceanSITES) and great benefits are expected in terms of glider data sharing, uptake and utilization, as well as in terms of OceanGliders program monitoring and the development of common tools.

The second meeting allowed us 1) to better structure the glider data management in Europe and 2) to define a data management roadmap in the short and mid-terms. In addition to European NODCs, European Data aggregators (EMODNET, SeaDataNet and Copernicus Marine In Situ) joined the discussion and provided their views on these strategic questions. It was clearly stated that OceanGliders GitHub activities must be maintained, which needs sustainable coordination, and that we should continue to engage the community on SOPs and better update the EU glider community on the status of the data management in Europe with regular similar workshops.

There is a need to work on the development of Best Practices and Standard Operating Procedures (SOPs), to converge in methodologies and Best Practices, not only across all EOVs measured in OceanGliders sustained monitoring, but also across the observation lifecycle. There are a lot of topics to be addressed all along the value chain, from the scientific approach to the societal requirements (Figure 1) and, if a very significant work has been achieved, a huge amount of work needs to be done that will be largely, but only partly, described in the overview paper “Towards OceanGliders Best Practices and Standards”. Other Best Practices, for instance concerning products and services, will probably be better shared with other observing networks and we expect to interact more with them. There is also a need to identify gaps (i.e., it would be great to keep track of all mission failures (when, where, why, on what type of glider) from the different groups in a single document/database) and further community work will be necessary to fill these gaps. We will try to organize dedicated sessions at international community meetings to continue this work and will continue to encourage the submission of any methodological documents to the Ocean Best Practices System (OBPS) since submitted documents could be browsed with keywords and is a useful tool for Best Practice convergence. Establishing Best Practices and SOPs is a slow process relying on the goodwill of many people generally contributing outside their normal working hours. There are 3 key elements in this BP/SOP process: convergence, endorsement, and peer review/publication. We have developed the SOPs under the OceanGliders umbrella and made them as living documents. They can continuously evolve until a major new release with an update on the associated paper/notice published in *Frontiers in Marine Science* Special Issue on Best Practices in Ocean Observing by using the ‘comment’ functionality. This ensures rapid updates are

possible, convergence with a large consultation and a community endorsement. This process also aligns with the 'GOOS' endorsement and peer-reviewed publication as appropriate and will be followed for future Best Practices and SOPs.

The next important steps in terms of Best Practices are linked to the quantitative testing and comparison of different methodologies i.e., Quality Control Tests or post-processing efforts. This would be fostered by increasing interoperability of existing software packages and the development of new open-source ones. The release of the OceanGliders V1.0 format will help in that respect. The development of OceanGliders SOPs and software/code could go hand in hand to ensure everything is well aligned. Since GitHub primarily allows a software version control, the connection between the SOP documents and code is expected to become very natural at some point. It is easy to write, edit and assign editors. The benefit is multiple with easy access for new people, everyone can raise an issue at any time, but this can only work as an asynchronous community effort in the long term, and continuous support from the OceanGliders community is key.

Capacity-building efforts have also been carried out with the GitHub training events and the Glider Schools which primarily engage new glider users. There is a lot of pressure on attendance at these events and there are new teams in Europe acquiring new gliders. This is a good sign showing the community is still growing in Europe. There is certainly a need to organize more training sessions on a variety of topics and with different degrees of expertise (beginners/advanced users, scientific/technical) but this would require resources that the community does not have at the moment. The work carried out during the project in the establishment of SOPs and the OG1.0 format is expected to help a lot in that respect, reducing the dispersion of efforts and aligning the tutorials along the SOPs.

Finally, we do need to sustain the network activities in scientific, technological, data management and international cooperation areas. We clearly rely on our ability to get funding from national and international projects on technical development and ocean science but more importantly, on our institutions recognizing the need for sustained glider observations and our coordination activities. The GROOM RI would hopefully help the European glider community to sustain these network activities and to integrate, sustain and simplify their work. The GROOM RI is designed to be the central hub for European Marine Autonomous Systems (MAS) and gliders in particular and has the objectives to facilitate and harmonize access to MAS services, operate MAS, provide efficiency and economy of scale, be the leader in MAS technology development and ensure high-quality data production and good access to data. It is clear that our work in coordination and Best Practices is being fully considered in the design of this RI and, if it is established in the MRI landscape, it would hopefully provide sustained resources for that. We estimate 0.5 Full Time Equivalent (FTE) would be necessary to continue the coordination work at the European level in the long term, with a community which is still expanding. In addition, the continuation of the Best Practices efforts, another 0.5 FTE would be necessary after the EuroSea project to continue this as successfully as it started with the engagement of the community. A lot of work on Best Practices is necessary and considering the community in-kind resources that impose a relatively low pace on progress in that matter, this would really need to be a long-term commitment to effectively maintain existing Best Practices and produce all the new ones that we need.

## References

- Akyar, I., (2012) 'Standard Operating Procedures (What Are They Good For?)', in I. Akyar (ed.), Latest Research into Quality Control, IntechOpen, London. 10.5772/50439.
- Davis, R., Eriksen, C., and Jones, C. (2002) "Autonomous Buoyancy-driven underwater gliders," in *The Technology and Applications of Autonomous Underwater Vehicles*, ed G. Griffiths (London: Taylor and Francis), 37–58.
- Hannides A., Ruiz S., Merckelbach L., Alvarez A., Smeed D. D'Ortenzio F., Fer I., Krahmann G., Cauchy P., Tintore J., Palmer M., Beguery L., Heywood K., Kaiser J., Dumont E., Gerin R., (2014) GROOM. Best Practices for glider missions and sensor use: preparation, operation, calibration, intercalibration/comparison, and recovery D5.3
- Hermes, J. (ed.) (2020) GOOS Best Practices Endorsement Process. Version 1. Paris, France, Global Ocean Observing System, 7pp. DOI: <http://dx.doi.org/10.25607/OBP-926>
- Lee, C. M., and Rudnick, D. L. (2018) "Underwater gliders," in *Observing the Oceans in Real Time*, eds R. Venkatesan, A. Tandon, E. A. D'Asaro, and M. A. Atmanand (Cham: Springer), 123–139. doi: 10.1007/978-3-319-66493-4\_7
- López-García, P., Hull, T., Thomsen, S., Hahn, J., Queste, B.Y, et al (2022) OceanGliders Oxygen SOP, Version 1.0.0. OceanGliders, 55pp. DOI: <http://dx.doi.org/10.25607/OBP-1756>. (GitHub Repository, OceanGliders Oxygen SOP. Available: )
- Lopez-Garcia P. (2022) OceanGliders Oxygen SOP v1.0.0: A good example of open collaborative scientific work, The Challenger conference, 6-8 September 2022, London, UK.
- Obaton D., A. El Rahman Hassoun, B. Perez Gomez, A. Novellino, T. Carval, J. Mader, A. Giorgetti, S. Thomsen, S. Pouliquen, V. Turpin, L. Coppola (2022) Recommendations on data harmonization for ocean observation networks, IEEE INTERNATIONAL WORKSHOP ON METROLOGY FOR THE SEA, 3-5 October 2022, Milazzo-Messina, Italy
- Pearlman J, Bushnell M, Coppola L, Karstensen J, Buttigieg PL, Pearlman F, Simpson P, Barbier M, Muller-Karger FE, Munoz-Mas C, Pissierssens P, Chandler C, Hermes J, Heslop E, Jenkyns R, Achterberg EP, Bensi M, Bittig HC, Blandin J, Bosch J, Bourles B, Bozzano R, Buck JJH, Burger EF, Cano D, Cardin V, Llorens MC, Cianca A, Chen H, Cusack C, Delory E, Garelló R, Giovanetti G, Harscoat V, Hartman S, Heitsenrether R, Jirka S, Lara-Lopez A, Lantéri N, Leadbetter A, Manzella G, Maso J, McCurdy A, Moussat E, Ntoumas M, Pensieri S, Petihakis G, Pinardi N, Pouliquen S, Przeslawski R, Roden NP, Silke J, Tamburri MN, Tang H, Tanhua T, Telszewski M, Testor P, Thomas J, Waldmann C and Whoriskey F (2019) Evolving and Sustaining Ocean Best Practices and Standards for the Next Decade. *Front. Mar. Sci.* 6:277. doi:10.3389/fmars.2019.00277
- Petihakis G., Sorensen K.i, Hernandez C., Testor P., Ntoumas M., Petersen W., Mader J., Mortier L. (2012) JERICO. Report on Best Practices in conducting operations and maintaining. D 4.4. doi:10.13155/49741
- Révelard A, Tintoré J, Verron J, Bahrel P, Barth JA, Belbéoch M, Benveniste J, Bonnefond P, Chassignet EP, Cravatte S, Davidson F, deYoung B, Heupel M, Heslop E, Hörstmann C, Karstensen J, Le Traon PY, Marques M, McLean C, Medina R, Paluszkiwicz T, Pascual A, Pearlman J, Petihakis G, Pinardi N, Pouliquen S, Rayner

R, Shepherd I, Sprintall J, Tanhua T, Testor P, Seppälä J, Siddorn J, Thomsen S, Valdés L, Visbeck M, Waite AM, Werner F, Wilkin J and Williams B. (2022) Ocean Integration: The Needs and Challenges of Effective Coordination Within the Ocean Observing System. *Front. Mar. Sci.* 8:737671. doi:10.3389/fmars.2021.737671

Simpson, P., Pearlman, F., and Pearlman, J. (eds) (2018) "Evolving and Sustaining Ocean Best Practices Workshop, 15 – 17 November 2017," in *Proceedings of the Intergovernmental Oceanographic Commission*, (Paris: AtlantOS/ODIP/OORCN Ocean Best Practices Working Group), doi: 10.25607/OBP-3

Stommel, H. (1989) The slocum mission. *Oceanography* 22–25. doi: 10.5670/oceanog.1989.26

Testor P., B. de Young, D. Rudnick, S. Glenn, D. Hayes, C. M. Lee, C. Pattiaratchi, K. Hill, E. Heslop, V. Turpin, P. Alenius, C. Barrera, J. Barth, N. Beaird, G. Bécu, A. Bosse, F. Bourrin, A. Brearley, Y. Chao, S. Chen, J. Chiggiato, L. Coppola, R. Crout, J. Cummings, B. Curry, R. Curry, R. Davis, K. Desai, S. DiMarco, C. Edwards, S. Fielding, I. Fer, E. Frajka-Williams, H. Gildor, G. Goni, D. Gutierrez, P. Haugan, D. Hebert, J. Heiderich, S. Henson, K. Heywood, P. Hogan, L. Houpert, S. Huh, M. Inall, M. Ishii, S. Ito, S. Itoh, S. Jan, J. Kaiser, J. Karstensen, B. Kirkpatrick, J. Klymak, J. Kohut, G. Krahnemann, M. Krug, S. McClatchie, E. Mauri, A. Mehra, M. P. Meredith, T. Meunier, T. Miles, J. Morrel, L. Mortier, S. Nicholson, J. O'Callaghan, D. O'Conchubhair, P. Oke, E. Pallas Sanz, M. Palmer, J. Park, L. Perivoliotis, P.-M. Poulain, R. Perry, B. Queste, L. Rainville, E. Rehm, M. Roughan, N. Rome, T. Ross, S. Ruiz, G. Saba, A. Schaeffer, M. Schonau, K. Schroeder, Y. Shimizu, B. Sloyan, D. Smeed, D. Snowden, Y. Song, S. Swart, M. Tenreiro, A. Thompson, J. Tintore, R. Todd, C. Toro, H. Venables, T. Wagawa, S. Waterman, R. Watlington, D. Wilson (2019) *Oceangliders: A glider component of the integrated Global Ocean Observing System*, *Front. Mar. Sci.*, 6:422, doi:10.3389/fmars.2019.00422.

Testor P., Meyers G., Pattiaratchi C., Bachmayer R., Hayes D., Pouliquen S., Petit de la Villeon L., Carval T., Ganachaud A., Gourdeau L., Mortier L., Claustre H., Taillandier V., Lherminier P., Terre T., Visbeck M., Krahnemann G., Karstensen J., Alvarez A., Rixen M., Poulain P.M., Osterhus S., Tintore J., Ruiz S., Garau B., Smeed D., Griffiths G., Merckelbach L., Sherwin T., Schmid C., Barth J.A., Schofield O., Glenn S., Kohut J., Perry M.J., Eriksen C., Send U., Davis R., Rudnick D., Sherman J., Jones C., Webb D., Lee C., Owens B., Fratantoni D., (2010) *Gliders as a component of future observing systems*, in *Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society (Vol. 2)*, Venice, Italy, 21-25 September 2009, Hall J., Harrison D.E., and Stammer D., Eds., ESA Publication WPP-306, doi:10.5270/OceanObs09.cwp.89