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	https://www.eurosea.eu

Deliverable information	
Deliverable number	3.2
Deliverable title	**Observing Networks initial Assessment**
Description	Report on assessment of the EuroSea observational (and thematic) networks coordination
Work Package number	3
Work Package title	Network Integration and Improvement
Lead beneficiary	GEOMAR
Lead authors	Johannes Karstensen, George Petihakis, Vicente Fernandez
Contributors	Leaders of Tasks 3.1-3.7
Due date	31 October 2020
Submission date	30 October 2020
Resubmission date	7 December 2021 (Conclusions section and Glossary added)
Comments	All WP3 partners contributed to this deliverable by providing most informative input to the self-assessment questionnaire

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

https://doi.org/10.3289/eurosea_d3.2

Table of contents

Executive Summary

This Deliverable serves to present the initial situation, in terms of coordination, of the observation and thematic networks in EuroSea represented in work package 3 (WP3). The networks include the networks represented in EuroGOOS and additional ones. The study is based on a comprehensive questionnaire that was answered by all EuroSea WP3 tasks. In addition, information from the Global Observing Networks of GOOS was considered. An important basis for the questionnaire was the list of "Network Attributes, Commitment and Benefits - What it means to be an OCG (Observation System Coordination Group) network" of GOOS. This deliverable is linked to the deliverable D3.10 that will repeat the assessment at the end of the EuroSea project to assess the evolution of the coordination over the period of the EuroSea project.

The present study shows that the observation and thematic networks in EuroSea all have highly developed coordination mechanism elements, except for task 3.7 - ASV, which represents a new network to be established. Given the spectrum of coordination themes and envisioned targets significant heterogeneity across the networks is also evident. The coordination of ship-based observations is not fully represented in EuroSea (and thus in EuroGOOS) and ideally this task should have been divided into research vessels and commercial vessels (container ships, ferries) but as it stands currently is dominated by one technology only (Ferrybox). This reflects the situation in EuroGOOS. For the thematic networks it is interesting to note that the observatories that are operated in task 3.8 (Augmented observatories) are not represented in the observational networks (task 3.1-3.7).

The assessment presented in this deliverable has its focus on the status quo. It does not question or analyze the necessity for individuals, institutions and countries to be represented in a network - “Why should individuals, institutions or countries feel a need or a motivation to engage with the networks?”. It seems logical that networks are only founded, maintained and developed when individuals see an advantage in their involvement in a network – for themselves, their institution or a country. The "characteristics" of the apparent advantage of contributing to a network is likely of central importance. For example, if the advantage is only that there are no disadvantages (e.g. fines), a further development and improvement of the network is questionable. This important investigation of the motivation of individuals will be part of final assessment prepared in D3.10.

1. Introduction

One component of ocean observing systems are observational platforms, used to acquire data. Maybe two groups of observational platforms can be distinguished: 1) satellite and air-borne remote sensing which provide data from scanning the sea-surface/upper ocean, and 2) in-situ observations providing data from the ocean interior. A most efficient operation of observational devices from the two groups requires coordination with other components of ocean observing systems, first of all with data centers which make the observational data accessible for yet other parts of ocean observing systems such as data integrators e.g. assimilation and forecast systems for use in ocean product generation.

In EuroSea the focus of WP3 is on observational platforms that record in-situ ocean and eventually metocean[1] data. The platforms considered include vessels (commercial and research), autonomous floats, underwater gliders, fixed-point observatories, sea level stations, high frequency radar and autonomous surface vehicles. The operations of the in-situ ocean observational platforms are often controlled or impacted by heterogenic groups of actors comprising research institutes, governmental agencies and the private sector (e.g. ferry companies).

[1] Metocean data stands for data from close to or at the ocean atmosphere interface that is of relevance for both – atmospheric monitoring and ocean monitoring

Over the last few decades we have seen significant innovation in ocean observing capacity in respect to innovative sensors and observational platforms, and ocean observing now can include a wide spectrum of biogeochemical and biological sensors, and operations of autonomous platforms can last over long periods of time. These innovations have improved the data sampling component of ocean observing systems. Several of the sensors and platforms already at Technology Readiness Level (TRL[2]) 6, or higher.

The TRL scheme was adopted to be applicable to an ocean observing system view, and which goes beyond technological aspects, in the Framework for Ocean Observing (FOO; Lindstroem et al. 2012)[3] by means of Readiness levels (RLs). According to the FOO the RL scheme can be applied to (1) Requirement Processes, (2) Coordination of Observational Elements, and (3) Data Management and Information Processes in order to assess the status ("readiness") of the processes. Relevant in the context of this deliverable is the Framework Process 2 "Coordination of Observational Elements". This process is categorized in nine RL, grouped into 3 groups: Concept, Pilot, Mature and outlined in the following table:

Group	Readiness Level	Description
Concept	Level 1 "Idea"	System Formulation: • Sensors • Platforms • Candidate technologies • Innovative approaches
	Level 2 "Documentation"	Proof of Concept: • Technical capability • Feasibility testing • Documentation • Preliminary design
	Level 3 "Proof of concept"	Proof of Concept Validated: • Technical review • Concept of operations • Scalability (ocean basin)
Pilot	Level 4 "Trial"	Pilot project in an operational environment
	Level 5 "Verification"	Establish: • International commitments and governance • Define standardized components
	Level 6 "Operational"	Implementation Plans Developed: • Maintenance schedule • Servicing logistics
Mature	Level 7 "Fitness for purpose"	Fitness-for-Purpose of Observation: • Full-range of operational environments • Meet quality specifications • Peer review certified
	Level 8 "Mission qualified"	System "Mission Qualified:" • Regional implementation • Fully scalable • Available specifications and • documentation
	Level 9 "Sustained"	System in Place: • Globally • Sustained indefinitely • Periodic review

[2] Website: ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016_2017/annexes/h2020-wp1617-annex-g-trl_en.pdf

[3] Lindstrom, E., Gunn, J., Fischer, A., McCurdy, A. and Glover, L.K. (2012) A Framework for Ocean Observing. By the Task Team for an Integrated Framework for Sustained Ocean Observing. Paris France, UNESCO, 25pp. (IOC/INF-1284,) doi: 10.5270/OceanObs09-FOO

When it comes to a real RL assessment the FOO concept is only of strategic help and further refinements are needed. The EuroSea WP3 assessment used as a strawman for the assessment, a recent document from the GOOS Observing Coordination Group (OCG) group "Network Attributes, Commitment and Benefits - What it means to be an OCG network"[4] and created list of some high-level objectives to be directly or indirectly addressed in the assessment:

- Long term (>10 years) sustained observing needs are defined
- Network coordinates a community of Best Practice around a specific technology
- Best Practices for each network, addressing the Essential Ocean Variables (EOVs) specification sheets, are documented and deposited at oceanbestpractices.org
- Networks are open to all operators of the respective observing technology
- Improve internal coordination within the observational networks, guided by scientific/engineering expertise and supported by a technical coordinator
- Network data policy is defined and comply with FAIR principles (Findable, Accessible, Interoperable, Re-usable)
- Network specification and governance structure is articulated (e.g. Terms of Reference)

For the assessment this list was used to request information from the networks in WP3 (observation networks task 3.1 to task 3.7 and thematic networks task 3.8, 3.9).

2. Main Objective of this study

The primary objective of WP3 is to assess the current status of the coordination of observational networks and of (two) thematic networks (Figure 1). The assessment in this deliverable and its dissemination shall create a dialogue inside the networks as well as among the networks in order improve (if needed) the structures and their operations. The intention is that through these dialogues the networks are in an improved (if needed) state to better serve the observing requirements articulated as part of the European observing systems such as EOOS or EuroGOOS but also in global observing systems (e.g. GOOS). This activity will result in an improvement in the Readiness Level.

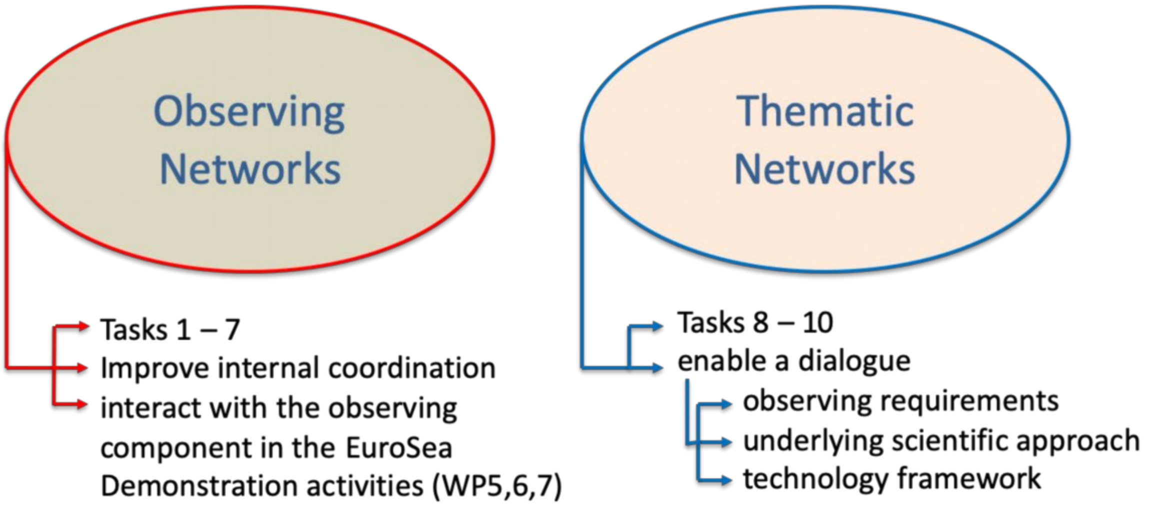

Figure 1: Schematic showing the two types of networks and associated tasks as represented in WP 3

[4] https://www.goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=24002

The WP3 observational networks are grouped around observing technology platforms such as profiling floats, underwater electric gliders, research and commercial vessels, fixed-point observatories, sea level gauges, HF radar observations and autonomous surface vehicles as an emerging observing technology. The thematic networks include augmented observatories (i.e. genomic-enabled multidisciplinary observatories), multiplatform sampling (undefined) and data management. In EuroSea instruments and platforms with high TRL are mostly used and pilot action (executed in the demonstration missions in WP5 to 7) are executed to show that new sampling schemes may provide improved observational products. The thematic networks aim on enabling a dialogue between observing requirements and the underlying scientific approach and the technology framework that is coordinated by the observational networks. Moreover, one thematic network shall ensure that the data delivery according to standards including communication pathways between platform operators, observational networks and data centers is realized.
This Deliverable will be in conjunction with the Observational Networks Final Assessment Deliverable (D3.18) the means to assess progress and provide future directions.

3. Assessment of the Networks

The assessment of the two networks types (Figure 1) was based on the following list of topics. Through a questionnaire, that was provided to the tasks of WP3, information was acquired. Moreover, information was added by considering information on the OCG observational networks from their respective websites (see also website links given in the table under subsections 3.1 and 3.2).

Observational networks (task 3.1- 3.7)

- Internal organization
  - Website
  - Institutions (incl. outside Europe)
  - Terms of Reference (ToR)
  - Governance structure established and documented
  - Self-assessment on representing of the respective European observing efforts via the network
  - Linkages to the global observational networks
- Network Internal Performance and Targets
  - Sensor/Instrument/Hardware Best Practices availability
  - Data Quality assurance (QA) strategies
  - Data Quality Control (QC) strategies
  - Exchange of metadata and data with European data centers
- Visibility of the network
  - Metadata (location, time period, instrument types used, data archives, principal investigator, ...) delivery to European or international data base
  - Best Practice Documentation accessibility
  - Key performance indicators (definition and monitoring)
  - Data availability on Global Telecommunication System (GTS)
  - Data policy
- Coverage and Facilities
  - Primary drivers for the network operations
  - Primary drivers for the observational activities

- Dialogue with “thematic networks”
- Future aspirations
  - Practices in developing future operations
  - Where do you see your network in 2030?
  - Major challenges and opportunities for the operation of future operations
- EuroSea Activities
  - Task objectives
  - Observational networks cross cutting activities
  - Workshops and Meetings
  - Common issues with other observational networks/tasks

Thematic networks (note, only two are represented in WP3 – task 3.8 & task 3.9)

- Internal Organization
  - Website
  - Institutions involved
  - Terms of Reference
  - Governance Structure
  - Embedding the operations into European observing initiatives
- Network internal performance, Targets
  - Number of science cases covered by the thematic network and respective documentation
  - Data Requirements document (incl. link to the relevant Best Practices/SOP)
  - Considering international standards (when possible)
- Visibility of the thematic network
  - Link to EuroSea observational networks (Task 3.1-3.7)
  - Link to international observational networks (Argo, GO-SHIP, GLOSS, …)
  - Link to international or even global thematic networks (if exists)
- Coverage and Facilities
  - Coverage of thematic network applications
  - Dialogue with “observational networks”
- Future aspirations
  - Practices in developing future operations
  - Major challenges and opportunities for future operations

3.1. Observational Networks

3.1.1. Internal Organization

Website

Network	Global Website 1	European Website 2	Metadata access Website 3
Argo	http://www.argo.net	https://www.euro-argo.eu/	https://www.oceanops.org/board?t=argo
Gliders	https://www.oceangliders.org	https://www.ego-network.org	http://www.oceanops.org/board?t=oceangliders
Vessels	https://www.go-ship.org/	http://eurogoos.eu/ferrybox-task-team	http://www.oceanops.org/board?t=sot http://www.oceanops.org/board?t=go-ship
Eulerian	www.oceansites.org	http://eurogoos.eu/emso-task-team/	https://tinyurl.com/yy9v56mu http://www.oceanops.org/board?t=dbcp
Sea Level	http://eurogoos.eu/tide-gauge-task-team	https://www.gloss-sealevel.org/	http://www.oceanops.org/board?t=gloss
HF-Radar	http://global-hfradar.org/	http://eurogoos.eu/high-frequency-radar-task-team/	http://global-hfradar.org/
ASV (Autonomous Surface Vehicles)	http://www.oceanops.org/dbcp/overview/evaluation_usv.html		Via DBCP - Data Buoy Cooperation Panel https://tinyurl.com/y635eptm

Six out of seven have a website and 3 of them they have more than one. Only one network (the ASV) does not have a website at the moment but this is expected in the framework of the project.

Institutions involved (incl. outside EuroSea)

Network	European Partners
Argo	12 European countries more than 20 institutes (https://www.euro-argo.eu/About-us/Partners/Partners-list)
Gliders	21 European Institutions in the EUROGOOS Glider Task Team, (Gothenburg University, FMI, Tallinn University, Hereon, GEOMAR, Marine Institute, SAMS, UEA, NOC, MARS, LOCEAN, CNRS/DTINSU, PLOCAN, SOCIB, OGS, CNR, CMRE, HCMR, Cyprus University, IOLR, Universidad do Porto)
Vessels	12 European institutions in the Ferrybox part (NIVA, HZG, SMHI, HCMR, CEFAS, SYKE, MSI, IMR, IFREMER); e.g. the Cruise summary reports from the National Oceanographic data centers accessed via Seadatanet interface report that 31 Countries do operate research vessels.
Eulerian	GOOS OCG (OceanSITES, DBCP) 11 European countries (27 institutions); EMSO ERIC: 8 European countries (17 institutions), only 6 overlap

Network	European Partners
Sea Level	EuroSea: Puertos del Estado (Spain), UKRI-NOC (UK), MI (Ireland), CNRS-SONEL (France). Outside EuroSea, members of the Task Team: SHOM (France), SMHI (Sweden), UIB-IMEDEA (Spain), BSH (Germany), CNR-ISMAR (Italy), NHS (Norway), JRC-EC, VLIZ (Belgium), DTU (Denmark), DMI (Denmark), ISPRA (Italy), IZOR (Croatia), University of La Rochelle (France). *With contribution from all European tide gauge operators*.
HF-Radar	Global network: 43 countries; 23 European institutions (AZTI, ISMAR, SOCIB, PdE, NMI, Marine Scotland, HZG, Univ. Plymouth, UNICAEN, IFREMER, MIO, INTECMAR, SHOM, PLOCAN, HI, NIB, OOdM, EUSKALMET, OGS, CALYPSO, Univ. Palermo, HCMR, CNRS)
ASV	Currently forming; process lead by Uni. Bremen, Uni. Porto, PLOCAN and UKRI

The following table shows the participation per European country. The table is compiled from input to the survey and investigations from the GOOS networks that fall under the OCG umbrella and report metadata to www.OceanOPS.org.

Country	Argo	Underwater Gliders	Research (R) & Commercial Vessels (c)[5]	Sea Level	Eulerian (EMSO x)	HF-Radar[6]	ASV
Albania							
Belgium							
Bosnia							
Bulgaria							
Croatia						x	
Cyprus							
Denmark							
Estonia			c				
Faroer							
Finland			c			x	
France			R		x	x	
Germany			R, c			x	
Greece			R, c		x	x	
Iceland						x	
Ireland					x	x	
Italy					x	x	
Latvia							
Lithuania							
Malta						x	
Monaco							
Montenegro							
Netherlands						x	
Norway			c			x	

[5] Including the Information from the Cruise Summary Reports submitted to the countries National Oceanographic Data Centre (from https://csr.seadatanet.org/)
[6] Including the listing from http://global-hfradar.org

Country	Argo	Underwater Gliders	Research (R) & Commercial Vessels (c)[5]	Sea Level	Eulerian (EMSO x)	HF-Radar[6]	ASV
Poland							
Portugal					x	x	
Romania					x		
Russia							
Slovenia						x	
Spain					x	x	
Sweden			c			x	
Turkey							
Ukraine							
United Kingdom					x	x	
TOTAL	**12**	**13**	**31**	**27**	**11 (8)**	**31 (16)**	**9**

This table represents information from a mix of different sources.

Terms of Reference

Network	ToR	Document
Argo	Yes	https://www.euro-argo.eu/About-us/The-Research-Infrastructure/Statutes
Gliders	Yes	https://www.oceangliders.org/wpcontent/uploads/2018/06/OceanGliders-sttor.pdf
Vessels	Yes	FerryBox (not available online) SOT (https://tinyurl.com/yynlx5ac) GO-SHIP (https://www.go-ship.org/About.html)
Eulerian	Yes	EMSO (no reference provided) OceanSites (http://www.oceansites.org/documents/index.html)
Sea Level	Yes	http://eurogoos.eu/tide-gauge-task-team/. GLOSS (https://unesdoc.unesco.org/ark:/48223/pf0000217832)
HF-Radar	Yes	not available online
ASV	No	no

Terms of Reference (ToR) describe the scope and limitations for each network and are important documents. They define the purpose and structure of the network, the goals and the means towards achieving. Most of the ToRs are available either online or on request (HF Radar & Vessels).

Governance structure

Network	Governance	Document
Argo	Yes	https://www.euro-argo.eu/About-us/The-Research-Infrastructure/Statutes
Gliders	Yes	OceanGliders Steering Team (https://www.oceangliders.org/about-us/organization/) EuroGOOS Glider Task Team (http://eurogoos.eu/gliders-task-team/)
Vessels	Yes	FerryBox: Chair and co-chair Others – no information provided

Network	Governance	Document
Eulerian	Yes	Members organization for EUROGOOS (ROOS); EMSO (CMO, ExCom, AoM) http://emso.eu/organization/; OceanSites (http://www.oceansites.org/documents/index.html)
Sea Level	Yes	EuroGOOS Tide Gauge Task Team, with a Chair and a Vice-chair, committed to support (among other international programs) the implementation of the global sea level network (GLOSS) in the region, although not all the tide gauges operated in Europe do contribute or belong to the GLOSS Core network. GLOSS governance structure includes a GLOSS Technical Secretary at the Intergovernmental Oceanographic Commission (UNESCO), in Paris, and a chair.
HF-Radar	Yes	EuroGOOS Task Team. Nevertheless, the overall governance of the European HF Radar community will be reviewed (D3.4 M18) clarifying the role of each HF Radar operator and the endorsement of the EU HF Radar Node.
ASV	No	Work in progress under OceanGlider initiative and EuroGOOS Glider TT Global: DBCP

Six out of the seven networks have a governance structure while ASV is in the process of establishing mainly through EuroGOOS Task Team. Moreover, there is 1 ERIC with a legal structure, 1 Global (Gliders), 4 EuroGOOS Task Teams which basically are characterized by a Chair and a Vice-Chair.

Self-assessment on representing of the respective European observing efforts via the network

Network	Representation of EU efforts	Comment
Argo	High	Euro-Argo ERIC coordinate all the European contribution to the Argo international network
Gliders	Medium - High	By providing metadata ingestions into the OCEANOPS (now: OceanOPS) metadata base; RT and DM of several parameters that contribute to EOVs for European coastal and open seas. Representation in International OceanGliders inititives (Science teams, data teams)
Vessels	Medium	Coordinates European Ships of Opportunity activities, links to European and international research infrastructures and initiatives
Eulerian	Medium	Currently 8 sites are registered as EMSO ERIC regional ocean/coastal facilities and 5 of those have registered metadata to the global system (OceanSites). However, in the global system 13 European institutions registered > 50 sites as being currently in operation.
Sea Level	Medium - High	Delegates/representatives from the most relevant actors, for all European basins: main national network operators and sea level scientists involved, considering all different approaches/applications of tide gauge observations: experts from oceanography, geodesy, hydrographers, storm surge and tsunami warning, meteotsunamis and harbor users.

Network	Representation of EU efforts	Comment
HF-Radar	Medium - High	The observational network attempts to have all the European HF Radar operators involved
ASV	Low - Medium	EuroGOOS Task Team (gliders), Ocean Glider group at GOOS and JCOMOPPS level. No connection made to provisional global network (DBCP ASV action group)

Linkages to the global observational networks

Network	Links to Global Observing Efforts	Comment
Argo	Strong	It's the European contribution to Argo international
Gliders	Strong	OceanGliders is an associated program of the GOOS.
Vessels	Ferrybox: Medium Underway metocean: Strong Research cruises: medium	Ferrybox: Some links to SOT MetOcean: Embedded in SOT Research cruises: links to GO-SHIP
Eulerian	Medium	EUROGOOS exchange with EU research infrastructure initiatives EMSO, EURO-Argo, EMBRC, ICOS and international networks (OceanSITES, DBCP, OOI, ONC, IMOS)
Sea Level	Strong	With a clear vocation from start of contributing to an improved implementation of the GLOSS network in Europe, as reflected in the Terms of Reference. The EuroGOOS Tide Gauge Task Team activities are regularly presented at the GLOSS Group of Experts meetings since 2016. GLOSS representatives in Europe have been invited to participate in several actions and meetings. The chair of the task team has recently reported on recent activities at the last GLOSS data centers meeting.
HF-Radar	Strong	a) Reporting and contributing in the GEO HF Radar Network, b) Technical exchanges for establishing a European standard on data management based on existing Best Practices at Global level, c) European contribution in Best Practices on Operations based on existing material available at Global level, d) Organizing the ingestion of Global data through the EU HF Radar Node (Pilot with US data in 2020)
ASV	low	No connection made to provisional global network (DBCP ASV action group) Bi- or multilateral collaboration between institutions (MBARI, SAEON, UCSD, LAMMA, CEFAS, GEOMAR, PROOCEANO, Memorial University, GOOS-OceanGliders Group, IOOS, IMOS, Marine Robotics Consortium (EUMR), etc.

There is a significant EU contribution through the networks to global observing efforts such as, Argo, OceanGliders, OceanSites, GLOSS and GEO HF-Radar.

3.1.2. Observational Network Internal Performance and Targets

Sensor/Instrument/Hardware Best Practices availability

Network	BP	Comment
Argo	Yes	Argo has defined a set of EOV and endorsed sensors to measure them and defined a process to accept new sensors (http://www.argo.ucsd.edu/Argo_Framework.html)
Gliders	No	Work in progress. Available but fragmented. OceanGliders has a Best practice Task Team
Vessels	Yes	JERICO-RI Deliverable, unclear; GO-SHIP manuals
Eulerian	Yes	a) Some best practices are available for sensors and EOV (e.g. DOXY), b) FIXO3 legacy BP available on OBPS and published on Marine Frontiers (Pearlman et al., 2019), c) EMSO ERIC BP on DO and Underwater Intervention to be released in Feb 2020 and made available on OBPS.
Sea Level	Yes	The ones defined for and by the GLOSS (Global Sea Level Observational System) global network, GLOSS manuals, oceanbestpractices.org: IOC Manuals and Guides No.14, Volumes I,II,III,IV,V (IOC, 1985,1994, 2002, 2006, 2016)
HF-Radar	Yes	JERICO-NEXT Deliverable "D2.4: Report on Best Practice in the implementation and use of new systems in JERICO-RI. Part 1: HF-radar systems" "Best practices on High Frequency Radar deployment and operation for ocean current measurement" C.Mantovani et al., 2020 Accepted in Frontiers Best Practices in Ocean Observing.
ASV	Yes	Ocean Best Practice Portal IODE

Six out of Seven networks have established some Best Practices or SOPs. For the Gliders it is among the highest priorities. Moreover, XXXX are in the OceanBestPractice repository.

Data Quality assurance (QA) established

Network	QA	Comment
Argo	Yes	Metadata are quality controlled (Format checker at GDAC) and checked regularly against OceanOPS data base both RT and DM Quality assessment procedure are defined (http://www.argodatamgt.org/Documentation)
Gliders	Yes	QA on delayed mode QC data
Vessels	Yes	via CMEMS-INSTAC
Eulerian	Yes	For water column EMSO follows OceanSites QA and QC (GDAC CORIOLIS): PAP, DYFAMED, E1-M3A. International Metadata (OCEANOPS) lags regular update
Sea Level	Yes	The ones defined for the GLOSS global network at different GLOSS manuals, and adopted by the different GLOSS data centers. Available in oceanbespractices.com. Other sea level data portals may have, or not, their own QA standards, that ideally should converge to those defined for GLOSS
HF-Radar	Yes	Included in Mantovani et al. (2020; 10.3389/fmars.2020.00210)
ASV	No	work on it during the project - QARTOD

Six out of seven networks have Data Quality Assurance

Data Quality Control (QC) strategy

Network	QC	Comment
Argo	Yes	All document related to QC in Near Real Time and in Delayed mode are described in the QC manuals (http://www.argodatamgt.org/Documentation)
Gliders	Yes	OceanGliders v1.0 data format dissemination includes RT QC for temperature, oxygen, salinity
Vessels	Yes	via CMEMS-INSTAC
Eulerian	Yes	OceanSites has some QC procedures for T, S and currents. EMSO is following the same procedures with GDAC and plan to go further by integrating BGC variables like oxygen, pCO2, pH (link to ICOS and Argo cookbooks)
Sea Level	Yes	GLOSS QC recommendations have been progressively updated according to changes in data requirements and data flow of sea level data in recent years, and included in deliverables of different European projects (e.g: MyOcean, AtlantOS...) and in the EuroGOOS DATAMEQ document on QC. Today, a new upgraded GLOSS QC manual is being drafted by members of the EuroGOOS TGTT, Permanent Service for Mean Sea Level, NOAA and the Hawaii Sea Level Center experts, among others, to compile existing approaches now available, not only in Europe, but also in the global community.
HF-Radar	Yes	JERICO-NEXT Deliverable “D5.14: Recommendation Report 2 on improved common procedures for HF RADAR QC analysis, including recommended common metadata and data model for HF radar current data for HF radar data implementation in European marine data infrastructures” + Best Practices included in above references
ASV	No	work on it during the project - QARTOD

Six out of seven networks have Data Quality Assurance and work is ongoing in updating them (SeaLevel). Some are project deliverables and an update mechanism must be thought.

Are you considering international data format standards?

Network	Int. Stand	Comment
Argo	Yes	All data are available through GDAC in NetCDF format CF compliant, used SeaDataNet Vocabularies for variable names, institution code and is setting up a Vocab to manage all the Argo reference tables (link ENVRI-FAIR project)
Gliders	Yes	OceanGliders standards (close to Argo and OceanSites)
Vessels	No	
Eulerian	Yes	EMSO ERIC: OGS/SWE - OceanSites specifications (report). OceanOPS delivers metadata through WMO/WIGOS compliant format
Sea Level	Yes	Contribution to their definition and improvement in collaboration with GLOSS experts, e.g: Netcdf format CF compliant is already used in Europe (CMEMS) and is being adopted as well by GLOSS data centers.
HF-Radar	Yes	existing international standards have been considered for establishing the European ones. Regular communication with GEO HF RADAR Network is taking place.
ASV	Yes	ISO and OGC, among other possibilities.

Six out of seven networks today explicitly considering international standards.

Exchange of metadata and data with European data centers

Network	SeaDataNet	CMEMS	Emodnet	Comment
Argo	Yes	Yes	Yes	All data are available through GDAC in Netcdf format CF compliant, used SeaDataNet Vocabularies for variable names, institution code and is setting up a Vocab to manage all the Argo reference tables (link ENVRI-FAIR project)
Gliders		Yes		through glider GDAC Coriolis
Vessels	No	Yes	Yes	
Eulerian	Yes	Yes	Yes	SEANOE and CORIOLIS (OceanSites and EMSO GDAC) exchange with SeaDataNet & EMODnet
Sea Level	No	unclear	unclear	data exchange is ad hoc and on a country-by-country basis, with no formal reciprocal agreement. GLOSS data centres do not submit data to SeaDataNet on behalf of other countries.
HF-Radar	Yes	Yes	Yes	the standards are including all the Seadatanet requirements and the EU HF Radar Node will feed the SeaDataNet archive system.
ASV	No	No	Yes	ISO and OGC, among other possibilities.

Mixed picture towards the three main data aggregators although considering operationality all networks exchange metadata with CMEMS.

3.1.3. Visibility of the observational network operations

Metadata availability

Network	Intl. Data Base	Comment
Argo	Yes	All European data available at Argo GDAC (Ifremer/France) and operated by the French NODC (National Oceanographic Data Center). Data also available through CMEMS in situ products, SeaDataNet , EMODnet and World Ocean DataBase (WOD) and GEOSS on international level.
Gliders	Yes	part of the OceanGliders data format
Vessels	GO-SHIP, CSR	Research cruises are reported to National Oceanographic data centers via the CSRs
Eulerian	Yes	GDAC and DAC
Sea Level	Yes	EuroGOOS Tide Gauge Task Team is in fact working actively now, one of the actions in EuroSea, in improving access to metadata in the region, and to make it available to GLOSS and CMEMS data portals.
HF-Radar	Yes	through the EU HF Radar Node, these metadata will be available both in EU marine data infrastructure and Global Network
ASV	na	Network to be defined

Best Practice Documentation accessibility

Network	OBP	Comment
Argo	Yes	There is an Argo community Section in OBPS repository
Gliders	No	In process
Vessels	Yes	GO-SHIP manuals (research vessels), RV-SOP developing incl. IRSO
Eulerian	Yes	Several in OBPS repository
Sea Level	Yes	GLOSS Manuals are already included in the in OBPS repository
HF-Radar	No	Ongoing, through JERICO-RI outputs & Peer Review Paper just submitted
ASV	No	Priority

The majority of the networks (4 out of 7) haven't made their Best Practices available through the OBP repository but all mention this as a priority.

Network Key Performance Indicators (KPIs)

Network	KPIs	Comment
Argo	Yes	Argo Network is monitored carefully through OceanOPS which generates indicators on network implementation and data processing The Euro-Argo ERIC generate additional KPI to monitors the European contribution to Argo and publish them in the Euro-Argo Annual report.
Gliders	No	Under definition
Vessels	Ferrybox: No	
	MetOcean: No	
	Research Vessels: Yes	For GO-SHIP and via Seadatacloud
Eulerian	No	In progress…Some are defined at OceanOPS and in EMSO but not yet for all networks. Implementation Targets needed first
Sea Level	No	Not yet
HF-Radar	No	Some Indicators are defined through the ingestion of EU HF Radar Node outputs into INSTAC Global Production Unit. More KPIs will be developed on JERICO-S3
ASV	No	Not yet

In terms of KPIs besides the two ERICs (EuroArgo and EMSO) none of the other networks have.

Data availability on Global Telecommunication System (GTS)

Network	NRT to GTS	Comment
Argo	Yes	All data are transmitted within less than 12 hours from acquisition.
Gliders	Yes	
Vessels	All: No	
Eulerian	Partly	For some nodes (e.g. ANTARES, PAP)

Network	NRT to GTS	Comment
Sea Level	Partly	In Europe only SHOM tide gauge network and some stations from UK network are today transmitting to GTS. The reason: in the past this was facilitated via the meteorological agencies, not always easy in some countries, and also due to the lack of personnel and funds to upgrade to GTS properly. Today this is one goal for the whole tide gauge network, especially after requirements defined by the new Tsunami Warning Systems implemented in the region.
HF-Radar	No	The organization of the data management is recent. Discussions are on going.
ASV	No	No because we haven't had any access to WMO, that is going to be changed to web services like WIS 2.0. Then, what we expect is to release data but not though GTS

Data policy

Network	Comment
Argo	Open and free data policy
Gliders	Open and free data policy
Vessels	
Eulerian	For most of the sites the data are free and in open access through GDACs (legacy of FIXO3 for data policy)
Sea Level	Open and free data policy, as for the GLOSS global network: IOC Oceanographic Data Exchange Policy: https://www.iode.org/index.php?option=com_content&view=article&id=51&Itemid=95). However, there are still some countries in the region that do not share tide gauge data yet (especially North of Africa stations, important in the Mediterranean Sea)
HF-Radar	Open and free data policy
ASV	no

Most networks operate under an open and free data policy having fully adopted operational characteristics.

3.1.4. Coverage and Facilities for observational networks

Primary drivers for the observational activities

Network	Drivers for Operational Activities
Argo	a) near-real time data for ocean and atmospheric services, b) high quality data for climate research, c) measure biogeochemical parameters to address oceanic uptake of carbon, acidification and deoxygenation
Gliders	Science
Vessels	Research and development
Eulerian	EMSO Science service groups: climate change, geohazard, operational oceanography, MSFD etc.

Network	Drivers for Operational Activities
Sea Level	a) National services for tides, storm surge and tsunami monitoring, b) Harbour authorities (navigation), c) Geodetic services and national datum definitions, d) Science
HF-Radar	a) Science, b) Capacity for model assessment and data assimilation, c) Search and Rescue, d) Response to pollution events (Oil spills…)
ASV	a) Science projects b) Monitoring /weather service data

Given the research framework that is around many of the observational efforts one can see that science is a major driver for the observational activities for all networks.

Drivers for observational plans

Network	Drivers for observational plans
Argo	a) Component of GOOS OCG (or integrated long-term Ocean observation, b) GODAE/OceanPredict: a. operational service b. enhance knowledge on ocean circulation c. climate research d. enhanced knowledge on ocean health and carbon cycle for ecosystem modelling
Gliders	a) science projects, b) long term observation, c) monitoring
Vessels	a) Science projects, b) monitoring, c) in situ validation for remote sensing
Eulerian	a) Science b) services (operational models & collectivities)
Sea Level	a) Monitoring b) services
HF-Radar	a) Operational services, b) Science and model assessment and improvement
ASV	a) Technology, b) science c) monitoring services

Science and Operational services are strong drivers

Dialogue with “Thematic networks”

Network	Dialogue Exchange	Comment
Argo	Yes	a) Link with GOOS as one of the networks of JCOMM, b) Link with IOCCP for the development of BGC-Argo, c) Link with GCOS.
Gliders	No	Through individual partners only. Need for better coordination

Network	Dialogue Exchange	Comment
Vessels	Yes	ICOS Ocean Thematic Centre
Eulerian	Yes	a) EMSO is involved in acidification issues by providing pH, pCO2 data through fixed observatories (surface and deep waters) – e.g. ICOS b) EMSO has started some dialogue with Augmented Observatories (e.g. genomic sampling in Northwest MedSea) - EMBRC
Sea Level	No	Not formally yet, but individual experts are integrated in the task team. Not a particular reason for that, this is something we could improve in the future (e.g. the hydrographic offices in our case)
HF-Radar	No	Only isolated connection, no connection at network level implemented yet, because the first steps has been focused on internal organization (relatively new network: 2014)
ASV	No	We don't have yet an observational network. We are working to setup the network. In the meantime, however, there is already specific activity/applications with ASV technologies trying to cover needs for all these science aspects and more (i.e. ICOS for CO2 measurements, EMSO for cross-calibration, MARCET for Marine Mammal monitoring, FRONTEX – Border surveillance, etc.)

3.1.5. Future Aspirations of observational networks

Practices in developing future operations

Network	Future Plans Process
Argo	a) Extend to create a fully global, top-to-bottom, dynamically complete, and multidisciplinary Argo program, b) Extend the Euro-Argo contribution to maintain ¼ of the new Argo Design
Gliders	Organically around the OceanGliders Themes (Task Teams) and through the EuroGOOS Glider Task Team
Vessels	Current plans are to expand to provide better regional coverage of European seas (Mediterranean and Arctic) and further develop use/validation of biogeochemical and biological sensors.
Eulerian	a) Implement more biological sensors (imagery, genomics), b) Develop integration with others infrastructures (EURO-ARGO, ICOS, EMBRC)
Sea Level	Aligned with GLOSS plans, and based on new needs derived from the increasing demand of tide gauge data today, required for diverse services and challenges as mean sea level rise and monitoring of extreme events. To fulfil this, the network is continuously being upgraded
HF-Radar	a) Integrating National plans, b) Establishing Requirements driven plans at Regional levels, c) Contributing in integrated approaches for developing the coastal network
ASV	Setup a task team in order to identify activities to be covered according the needs by different end-users and stake

Where do you see the network in 2030?

Network	The network in 2030
Argo	2500 T&S floats 1200 Deep float (4000/6000), 1000 BGC, good coverage of European marginals seas including high latitude (partially ice-covered areas) and moving closer to the coast
Gliders	Sustained and significant EU contribution to the 100 glider endurance lines foreseen by OceanGliders in 2030 (see OceanObs'19 CWP)
Vessels	Need to be defined
Eulerian	Depends on EuroGOOS and EU visions, members involvement; European players not involved in EuroGOOS drafted a vision as "*A truly global network for Eulerian Time series stations that is fully embedded in the Global Ocean Observation System and provide interoperable data considering latest scientific understanding*"
Sea Level	The tide gauge network is already well consolidated and a key element of the ocean observing system for coastal sea level observations, and this will be so for sure in the future.
HF-Radar	As a key component of the coastal ocean observing systems (like Met radars in Met networks)
ASV	A consolidated network at EU level, fully operational providing services according to needs, and with strong international links (IOOS-US, Canada, IMOS-Australia, South Africa, South America, etc.). Network acting as POC for current uses and potential future ones of this technology as strong component of Digital Ocean strategy

Answers are a mix from a "device centred vision" (target is to have x devices in the water by 2030) to vision that target the success of coordination.

Major challenges and opportunities for the operation of future operations

Network	Challenges and Opportunities
Argo	a) The new design is cost 3 times the original one, b) Challenges in term of technology/sensors for deep measurements, c) Challenges in term of QC for BGC measurements and coastal observations
Gliders	a) Major challenges: integration in the EU MRI landscape; system consolidation and sustainability (persons, infrastructures, vehicles), b) Major opportunities: integration with the other observational networks; biological EOVs; regional/coastal operational oceanography; services for public policies, market and innovation
Vessels	a) All partners are busy with funding issues and project commitments at home institutes b) we have to inspire more cooperation and involvement from partners to be able to push progress and innovation

Network	Challenges and Opportunities
Eulerian	a) Challenges: sensors and technology for deep water observation, cost maintenance for cabled observatories, integration of biological sensors (e.g. eDNA), harmonization of best practices and establishment of label; b) Opportunities: better integration with ERIC and global networks, metadata distribution. c) International: Creating and evolving a coordination framework that keeps to be attractive for the contributors without centralized funding
Sea Level	a) Increasing requirements on data sampling and precision, and access to real time data, requires adapting the management of data and the tools for quality control and quality assessment (this has already started). b) The network has evolved over the years and we foresee as well new improvements and technologies for coastal sea level measurements and data flow, including IOT and machine learning techniques. c) Adaptation of existing stations to these improvements may be a difficult challenge in most countries. d) Finally, as mean sea level rise continues to be a problem, the use of this data in platforms integrating models and altimetry data for helping in the decision-making process will be essential and will require adaptation of tide gauge operations.
HF-Radar	a) Integration with water column monitoring from fixed platforms, b) Integration with Satellite products, c) Ingestion into modelling capacities, d) Integration with BGC &Biological monitoring
ASV	Identify and provide true support services to end-users in regards common long-term goals at both scientific and technology level (CHALLENGE) + Gliderport and endurance-line network implemented at EU level (OPPORTUNITY)

For the networks, more challenges exist than opportunities. This is expected as in order to be able to see opportunities, appropriate mechanisms inbuilt the network structure are necessary. Foresight exercises, efficient connections with other global networks and with the decision centres are all required.

3.1.6. Observational networks in EuroSea

Objectives of the Task

Network	Objectives within EuroSea
Argo	To coordinate the development of the Argo extensions, deep - below 2000m (DEEP) and biogeochemical (BGC), in liaison with the Euro-Argo-Rise (Technology) and the ENVRI-FAIR (data interoperability) projects, and in close link with the Argo international network. Interoperability with other observations that acquire similar observations within the EOOS framework will also receive attention (with applications in WP7): a) consolidate, with Euro-Argo Eric Management Board, DEEP and BGC operations strategy (Atlantic, MedSea) considering input from CMEMS, EMODnet and the EuroSea demonstrator projects most critical weaknesses (applications and budget);

Network	Objectives within EuroSea
	b) develop Best Practices for DEEP & BGC Argo operations and data management via workshops and WP7 feedback, and upload to OceanBestPractices.org; c) support interested countries to engage with Argo in the Atlantic and Mediterranean Sea in partnership with Euro-Argo; d) enhancement of the Euro-Argo Eric and international BGC, website/newsletters to highlight Euro-Argo ERIC progress in EuroSea.
Gliders	a) Contribution to OceanGliders and EuroGOOS Glider Task Team activities, b) Best practices publications in peer-review journal and on IODE repository, c) Elaboration of EU long term glider plans for EOOS, d) Support to EuroSea demo activities.
Vessels	To improve SOOP & RV coordination in Europe by: a) encouraging countries so far not involved to the EuroGOOS FB Task Team to join; b) linking regional/global efforts (ICOS ERIC, SOCAT, SOT); c) re-evaluate/finalize Best Practices (in dialogue with SOT); 4) formulate Terms of Reference for the network; d) provide cost assessments for operations, data management according to FAIR, and evaluation for game-changing technologies (autonomous sampling systems, nutrient analyzer/sensors, towed device technology).
Eulerian	a) Upgrade pH sensor on EMSO-DYFAMED node (WP6 and WP7), b) Harmonize Best Practices OceanSites, DBCP, & EMSO, c) Progress on metadata catalogue for Eulerian observatories with OceanOPS
Sea Level	a) Establishment of an integrated European Tide Gauge Network as part of EOOS, b) Improve connection of the European and global community (GLOSS), by means of the following actions/activities: • Improve metadata inventory of stations based on current user requirements (e.g. OceanOPS, CMEMS, Tsunami Warning Systems) • Analyze gaps/duplicity in data portals providing tide gauge data and design a new strategy for data flow for tide gauge data storage, quality control and distribution • Assess/compile an on-line portal in PSMSL (Permanent Service for Mean Sea Level) of uplift/subsidence land data, including new Multipath Reflectometry of land-based Global Navigation Satellite Systems (GNSS-MR) technology. • Organization of two workshops involving the global community
HF-Radar	a) Enhance use of HF radar surface current data and added value products, b) Push the availability of FAIR HF radar data and implement Best Practices of HF radar operations and maintenance, c) Define a governance structure that ensures long-term sustainability, d) Guide the development of the network with a prioritization performed at Sea-basin scale.
ASV	a) ASV-Network definition and roadmap addressed to cover current and future user's needs, including access to infrastructures, community roadmap monitoring, promoting knowledge exchange, enhancement and partnership worldwide with the establishment of an ASV User Group; b) improvements on Standard Operating Procedures (SOP) for derived BP implementation on operational protocols, data management, knowledge

Network	Objectives within EuroSea
	transfer, risk assessment, legislation, etc. in order to properly improve the ASV technology, contributing to the EOOS implementation plan; c) Perform 2x workshops aiming at ASV technology - challenges, opportunities and user engagement, and ASV technology - Best-practices implementation. All to support the EuroSea demonstrator activities, in particular WP7 that will provide important feedback on ASV usage.

Observational networks cross cutting activities

Network	Cross cutting actions
Argo	a) Cross cutting with GOSHIP, and EMSO for Deep measurement, b) Cross-cutting with GOSHIP, ICOS, EMSO, Gliders, Ferrybox and JERICO for BGC measurement, c) Cross-cutting with EuroFleets for operation at sea
Gliders	Best practices on EOV basis and design of EOOS
Vessels	Sensor data QC/QA and data handling.
Eulerian	EMSO ERIC, OceanSITES, ICOS, EURO-ARGO (BGC variables)
Sea Level	Most of the actions are focused on specific needs of the tide gauges network, except perhaps the approach followed for the new metadata inventory. Possible collaboration during workshops
HF-Radar	Contribution to the multi-platform approach of Task 3.9 Integrating science
ASV	Sharing facilities and infrastructures, payload, cross-calibration, multiplatform experiments, technical support, data formats, some operation procedures, training, legislation, end-user and applications

Data management and data flow (Task 3.9) as well as Interoperable data (Best Practices and standards/reference material).

What workshops/meetings are scheduled (subject, dates)

Network	Workshops	Month
Argo	1. One international DEEP-Argo workshop in collaboration with Argo International, 2. One international BGC-Argo workshop in collaboration with Argo International, For both workshops, aims are: a) engaging with more countries around Atlantic and Med Sea, b) Develop cross-cutting links with other platforms listed in the previous point	M18 M24
Gliders	1. Best practices, likely to be postponed by a couple of months. 2. Second WS will be organized in line with progress made	2020 2021
Vessels	FerryBox Task Team workshop addressing EuroSea objectives	November 2020
Eulerian	1. Best Practices 2. Metadata	M12 M36
Sea Level	1. Europe-GLOSS collaboration, review of data flow between data portals and requirements on metadata	January 2021

	2. New automatic QC algorithms and products from tide gauge data. Other meetings will be held between partners, date to be defined.	November 2022
HF-Radar	1. Inviting all the European operators and key Global actors. Support for EUROGOOS Task Team (review of the status of the implementation of Best Practices; Review of priorities driven by ROOSs requirements; Joint Research and Operational Services) 2. Jointly organized with other observational networks. Main Objective: INTEGRATION	M9 M36
ASV	1. WS (not defined) 2. WS (not defined)	Fall 2020 Fall 2022

Common issues with other observational networks (task)

Network	Common Issues
Argo	a) QA/QC procedure, b) Deployment and float recovery, c) Design of multiplatform network, d) Harmonization of data services to users
Gliders	Inclusion in European/national roadmaps
Vessels	See answer to cross cutting actions.
Eulerian	a) QC and QA of BGC data; Metadata information and traceability/quality (OCEANOPS); databases interoperability; traceability of dataset provided by EMSO RF (DOI is not enough), b) Maintain expertise and staff in regional facilities for long term observing system (depend on country and institutes policies)
Sea Level	a) Documentation on Best Practices b) Requirement of metadata inventory/update tools
HF-Radar	To share methodologies and establishing integrated approach for defining priorities in the future development of the observing system at Regional level
ASV	Routine operation, subsystem failure, TRL, sensor drift, identification of synergies, partnership to improve operational efficiency, data formats, legislation, end-user engagement and new applications for marine-maritime sectors beyond science.

This is indicative of possible areas for cooperation especially in the framework of common workshops.

3.1.7. Summary Table

OBSERVING NETWORKS	Argo	Gliders	Vessels	Eulerian	Sea Level	HF-Radar	ASV
Website	yes	yes	yes	yes	yes	yes	no
No. of Institutions involved	20	21	9	>25	16	24	4
Terms of reference	yes	yes	yes	yes	yes	yes	no
Governance Structure	yes	yes	yes	yes	yes	yes	no
Representation of EU efforts	High	Medium-High	Medium	High	Medium-High	Medium-High	Low-Medium
Links to Global Observing efforts	Strong	Strong	Medium	Strong	Strong	Strong	Medium
Sensor/Instrument/Hardware Best Practices	yes	no	yes	yes	yes	yes	yes
Data Quality assurance (QA)	yes	yes	yes	yes	yes	yes	no
Data Quality Control (QC)	yes	yes	yes	yes	yes	yes	no
International standards	yes	yes	no	yes	yes	yes	yes
Exchange of metadata and data with data aggregators							
SeaDataNet	yes	???	no	yes	no	yes	no
CMEMS	yes	yes	yes	yes	???	yes	no
Emodnet	yes	???	yes	yes	???	yes	yes
Metadata fed to EU or Intl data base	yes	yes	???	yes	yes	yes	???
Best Practices available at IODE/UNESCO	yes	no	no	yes	yes	no	no
Key Performance Indicators defined	yes	no	no	no	no	no	no
Data to GTS	yes	no	no	partly	partly	no	no
Data Policy	Open	Open	???	Open	Open	Open	???
Drivers for observational activities	Sci, Serv	Sci	R&D	Sci, Serv	Sci, Serv	Sci, Serv	Sci, Serv
Drivers for observational plans	Sci, Serv	Sci, Mon	Sci, Mon	Sci, Serv	Sci, Mon	Sci, Serv	Sci, Serv, Tech
Dialogue/exchange with "thematic networks"	yes	no	yes	yes	no	no	no
Future plan process							
The network in 2030							
Challenges and Opportunities							
Objectives within EuroSea							
cross cutting actions with different observing networks							
workshops/meetings	M18, M24	2020 & 2021	Nov-20	M12, M36	2021 & 2022	M9, M36	Fall20 & Fall22
common issues with other observing networks							

3.2. Thematic Networks

3.2.1. Internal Organization

Website

Network	Website
Augmented Obs.	http://glomicon.org/
Interface with In Situ data integrators	http://eurogoos.eu/data-management-exchange-quality-working-group-data-meq/

Institutions (incl. outside EuroSea)

Network	Partners
Augmented Obs.	50 organizations are networked, as well as other networks and consortia
Interface with In Situ data integrators	EU integrators (CMEMS, SeaDataNet, EMODnet mainly Physics and Chemistry Emodnet), H2020 projects, EuroGOOS TT's

Terms of Reference - ToR (provide link)

Network	ToR	Document
Augmented Obs.	No	Under discussion: GLOMICON is a grassroots initiative, but will be formalizing under GEO BON as an Omic BON, which will require a ToR
Interface with In Situ data integrators	Yes	http://eurogoos.eu/data-management-exchange-quality-working-group-data-meq/

Governance structure (provide link)

Network	Governance	Document
Augmented Obs.	Yes	Coordination provided by AWI, UC Berkeley – governance is bottom-up
Interface with In Situ data integrators	Yes	EuroGOOS Task Team

Embedding the operations into European observing initiatives

Network	Representation of EU efforts	Comment
Augmented Obs.	Yes	Multiple established marine observatories (e.g. FRAM) have an omics component, EuroSea will upgrade this through the SZN
Interface with In Situ data integrators	Yes	EU integrators (CMEMS, SeaDataNet, EMODnet), H2020 projects, EuroGOOS TT's

Embedded in global observing thematic initiatives?

Network	Links to Global Observing Efforts	Comment
Augmented Obs.	Medium	Feeding in expertise and advice to the GOOS BioEco Panel EOVs, we will also attempt to federate under GEO BON (initial discussions already completed)
Interface with In Situ data integrators	Strong	Argo, OceanSITES, GOSUD, OceanGLIDERS, Drifter/DBCP

3.2.2. Network Internal Performance, Targets

Number of science cases covered by the thematic network and respective documentation

Network	Science Cases
Augmented Obs.	Each node pursues multiple scientific cases in its normal operation, there is (currently) no network-wide scientific mission, but this is being formulated pending improved coordination and interoperation of the nodes
Interface with In Situ data integrators	There is no network-wide documentation available

Data Requirements document (incl. link to the relevant Best Practices link)

Network	Data Requirements
Augmented Obs.	a) At the node level – projects in data exchangeability are underway for microbial biodiversity at the taxonomic level which will become a best practices recommendation b) Recommendations on metadata handling and standards compliance being drafted with the GSC c) Core data (i.e. sequence data) management at high readiness thanks to the field's use of INSDC norms d) Prototype exchanges and interfaces with OBIS and GBIF/ELIXIR/ENA
Interface with In Situ data integrators	a) Capitalizing on European initiative + existing standards b) Started first with physical parameters and extending to Biogeochemistry c) Provided as recommendations to the EuroGOOS communities and presented in EuroGOOS General Assembly d) For EuroSea integration starting point the AtlantOS WP7 deliverables also delivered to OBPS

Considering international standards (when possible)

Network	Intl. Standards	Comment
Augmented Obs.	Yes	Through coordination with the Genomic Standards Consortium and INSDC. We aim to significantly contribute to these and promote interoperability with other standards in the marine observatory space

Network	Intl. Standards	Comment
Interface with In Situ data integrators	Yes	a) Link with Research Data Alliance (link ODIP series of projects) including SeaDataNet Vocabularies and CF conventions, b) DMPA (Data Management Panel area) and (Observation Panel Area) JCOMM coordination activities

3.2.3. Visibility of the thematic network

Link to EuroSea observational networks (task 3.1-3.7)

Network	Links with EuroSea Obs. Networks	Comment
Augmented Obs.	Few	via observatories that have eDNA/omics capacities and also contribute to core oceanography
Interface with In Situ data integrators	Efficient	a) Well linked to the EuroSea observational networks that have set up or are setting up integrated services in Europe (Argo, Gliders, HF Radars, ICOS for Carbon) or are willing to enhance data interoperability in Europe (Sea Level, Ferrybox) or integrated at international level (OceanSites for Eulerian Observatories, Argo, Drifters/CBCP, Vessels underway data GOSUD). b) For vessels it's also done through SeaDataNet for research cruises c) Autonomous Surface Vehicles in link with SAILDRONES company

Link to international observational networks

Network	Links with Intl. Obs. Networks	Comment
Augmented Obs.	Efficient	a) Well linked to the GOOS, but more work is needed to transition data products from "conceptual" and/or unconsolidated to operational b) Some omics observers have existing links to GO SHIP and GEOTRACES which we hope to interface with
Interface with In Situ data integrators	Efficient	Argo, OceanSITES, GOSUD, OceanGLIDERS, Drifter/DBCP

Link to international or even global thematic networks (if exists)

Network	Links with Intl. & Global Thematic Networks	Comment
Augmented Obs.	Poor	thus, our objective to form an Omic BON under GEO BON for improved coordination of large- to small-scale projects
Interface with In Situ data integrators	Efficient	a) Contributing to Data Management cooperation and Operating GDACS for Argo, GOSUD, OceanSITES, b) Contributing to Data Management cooperation and setting GDACS for OceanGliders, Drifters

3.2.4. Coverage and Facilities

Coverage of thematic network applications

Network	Application coverage
Augmented Obs.	• The coverage in the EU is patchy at best, both temporally and spatially. The primary issue is a lack of standardized methodology and best practices and funding structures that are often difficult to link with long-term, observatory-grade monitoring • Even a set of local but interoperating observatories would have high impact on the status quo
Interface with In Situ data integrators	• DATAMEQ doesn't operate observing systems • Issues on data policy and unlocking access to existing data • critical areas: Arctic, Eastern Mediterranean and South Med, Black Sea • Easier for physical than BGC Essential Ocean Variables

Thematic network dialogue/exchange with "observational networks"

Network	Dialogue / Exchange	Comment
Augmented Obs.	Yes	several nodes in the network are embedded within observational networks, offering a biological dimension. However, these are poorly coordinated, preventing truly global impact.
Interface with In Situ data integrators	Yes	they are involved in the DATAMEQ working group

3.2.5. Future Aspirations

Practices in developing future operations

Network	Future Plans Process
Augmented Obs.	Through the GLOMICON coordination (now merged with the Genomic Observatories Network) via mailing lists and focus groups (multipliers, leadership) – coalition of willing participants
Interface with In Situ data integrators	EUROSEA should rely on existing data management infrastructures and enhance them for a sustain set of services after the end of EuroSea

Major challenges and opportunities for future operations

Network	Challenges and Opportunities
Augmented Obs.	Transitioning from a network of primarily academic institute motivated by “impact” and journal articles, to a fully-fledged observatory community – the reward structures must be realigned. The opportunity now is to leverage the high global interest in eDNA/omic observing (diverting the risk of siloed activity) and the GOOS BioEco Panel’s link to the Decade
Interface with In Situ data integrators	Challenges are more political than technical: • Need big push from stakeholders to support open data policy • Importance a dedicated sufficient funds for data management attached to observation network set up and maintenance • New services based on big data and Cloud systems should be user driven and not IT driven

3.2.6. Summary table

THEMATIC NETWORKS	Augmented Obs.	Interface with In Situ data integrators
Website	yes	yes
No. of Institutions involved	50	unclear
Terms of reference	no	Yes
Governance Structure	yes	Yes
Representation of EU efforts	yes	Yes
Links to Global Observing efforts	Medium	Strong
Science Cases	Multiple	Unclear
Data Requirements		
International standards	yes	yes
Links with EuroSea Obs. Networks	few	efficient
Links with Intl. Obs. Networks	efficient	efficient
Links with Intl. & Global Thematic Networks	poor	efficient

<u>THEMATIC NETWORKS</u>	Augmented Obs.	Interface with In Situ data integrators
Application coverage		
dialogue/exchange with "observational networks"	yes	yes
Future Plans Process		
Challenges and Opportunities		

4. Conclusions

Here an initial mapping of observational and thematic networks for ocean and marine observations presented in EuroSea is presented. The assessment illustrates the wide variability among the networks in terms of maturity and progress in the various attributes examined. This heterogeneity in maturity (according to the predefined attributes) does not come as a surprise considering the significant differences in the life-time of the networks. However, it can be said that almost all of them have highly developed coordination mechanism elements, with the exception of the Autonomous Surface Vehicles (Task 3.7) which is assessing the need for establishing a network for an emerging technology.

As illustrated in the summary table above there is generally a wide participation from the European research institutions which together with the governance schemes in place, ensures validity of actions and can promote the sustainability of the networks. However, a discrepancy between global and European networks participants indicate work is still needed to improve the inclusiveness up to an as complete as possible level. Most networks have pathways defined towards transparent Data Quality Assurance and also procedures for Quality Control addressing common standards. Likewise, all networks acknowledge and work on respective practices to ensure data distribution to all major aggregators in Europe under an open data policy and making use of standardized metadata schemes. In many cases strong connections have been established between European networks, mainly represented by EuroGOOS task teams, and the outside Europe / international groups most prominently the respective GOOS Observing Coordination Group Networks. Heterogeneity exists particularly for "vessel" which maybe was to general in the definition in EuroSea and thus only partly a match between European, namely the EuroGOOS FerryBox Task Team, and the OCG networks exists, namely the ship observation team (SOT) in GOOS.

Networks are very aware of the fact that all future development and progress will require proper documentation of all practices and techniques and via SOP and ideally community created and accepted Best Practice. Also, the definition of Key Performance Indicators for the network operations, contributions, and data availability (incl. real-time via Global Telecommunication System when feasible).

Regarding the Thematic Network "Augmented Observatories" it's attributes, such as participation, governance, links with international efforts and standards, are at a quite high level. Not surprisingly, due to the relatively short time-life of the network other areas which need significant improvement, in particular linking closer to the observational networks. This long-term existence and maturity on the other hand is clearly depicted in the interface with the in-situ data integrators.

5. Annex Glossary

- ASV: Autonomous Surface Vehicles
- CF: Climate & Forecast netCDF format
- CMEMS: Copernicus Marine Service (https://marine.copernicus.eu/)
- CMEMS-INSTAC: Copernicus Marine Service In Situ Thematic Centre
- CSR: cruise summary report
- DBCP: Data Buoy Cooperation Panel (https://www.ocean-ops.org/DBCP/)
- DM: Delayed mode
- eDNA: environmental DNA (genetics)
- EMBRC: European Marine Biological Resource Centre
- EMSO: European Multidisciplinary Seafloor and water column Observatory (https://emso.eu/)
- ENVRI: Environmental Research Infrastructures EOOS: European Ocean Observing System (https://www.eoos-ocean.eu/)
- EOV: Essential Ocean Variables (https://www.goosocean.org/index.php?option=com_content&view=article&id=14&Itemid=114)
- ERIC: European Research Infrastructure Consortium
- EuroGOOS: European GOOS Regional Alliance (https://eurogoos.eu/about-eurogoos/)
- FAIR: Findable, Accessible, Interoperable, Re-usable
- FOO: Framework for Ocean Observing (https://www.goosocean.org/index.php?option=com_content&view=article&id=18&Itemid=118)
- GDAC: Global Data Assembly Center (https://www.iode.org/index.php?option=com_content&view=article&id=372:iode-global-data-assembly-centres-gdacs&catid=10&Itemid=100088)
- GEO: Group on Earth Observations (https://earthobservations.org/index.php)
- GLOSS: Global Sea Level Observing System
- GO-SHIP: The Global Ocean Ship-Based Hydrographic Investigations Programme
- GOOS: Global Ocean Observing System (https://www.goosocean.org/)
- GTS: Global Telecommunication System (https://public.wmo.int/en/programmes/global-telecommunication-system)
- HF-Radar: High frequency radar
- ICOS: Integrated Carbon Observation System (https://www.icos-cp.eu/)
- IMOS: Integrated Marine Observing System (https://imos.org.au/)
- IOCCP: International Ocean Carbon Coordination Project
- IODE: International Oceanographic Data and Information Exchange (https://www.iode.org/)
- IOT: Internet of Things
- IRSO: International Research Ship Operators
- ISO: International Standards OrganizationOBPS: Ocean Best Practices System (https://www.oceanbestpractices.org/)
- OceanOPS: Observing Platform Support Centre (https://www.ocean-ops.org/board)
- OCG Observations Coordination group (https://www.goosocean.org/index.php?option=com_oe&task=viewGroupRecord&groupID=103)
- OGC: Open Geospatial Consortium
- ONC: Ocean Networks Canada (https://www.oceannetworks.ca/)

- OOI: Ocean Observatories Initiative (https://oceanobservatories.org/)
- QA: Data Quality assurance
- QARTOD: Quality Assurance/Quality Control of Real-Time Oceanographic Data
- QC: Data Quality Control
- PSMSL: Permanent Service for Mean Sea Level
- RL: readiness level
- RT: real-timeSOOP: Ships of Opportunity Program (https://community.wmo.int/ship-opportunity-programme)
- SOP: Standard Operating Procedures
- SOT: Ship Observations Team
- ToR: Terms of Reference
- TRL: technology readiness level
- WIGOS: WMO integrated global observing system
- WMO: World Meteorological OrganizationWOD: World Ocean DataBase (https://www.ncei.noaa.gov/products/world-ocean-database)
- WP: Work package