EMODnet Thematic Lot n°3 – Physics

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Start date of the project: 23/08/2021 - (24 months)

Centralisation Phase

Final Progress Report (2023)

Reporting Period: 23/08/2021 – 22/08/2023

Contents

Disclaimer

1.   Introduction

The European Marine Observation and Data Network (EMODnet) is a long-term marine initiative dedicated to facilitating the discovery and access to marine data and data products representing seven main themes: bathymetry, biology, chemistry, geology, human activities, physics, and seabed habitats. For each of these themes, EMODnet has created gateways to various data archives.
EMODnet Physics (www.emodnet-physics.eu) is one of the seven domain-specific projects. Through the effort undertaken during the preparatory action (MARE/2010/02), development (MARE/2012/10; EASME/EMFF/2016/006), operational (EASME/2019/OP/0003), and current phases (EASME/2020/OP/0006), EMODnet Physics has successfully designed, organized, and is now running operational services that provide ocean physics data and data products built with common standards, free of charge and without restrictions. The available parameters cover temperature, salinity, current profiles, sea level trends, wave height and period, wind speed and direction, water turbidity (light attenuation), underwater noise, river flow, and sea-ice coverage. In situ data recorded by fixed platforms (moorings, tide gauges, HF radars, etc.), moving platforms (ARGO, Lagrangian buoys, ferryboxes, etc.), and repeated observations (CTDs, etc.) are available. Data products include collections of in-situ data, reanalysis and trends of parameters, and space-time aggregated in situ data and model outputs. These marine data are made available in collaboration with organizations such as Copernicus Marine Service In Situ Thematic Assembly Center (INS TAC), SeaDataNet National Oceanographic Data Cemters, International Council for the Exploration of the Sea (ICES), thematic platform networks within OceanOPS, PANAGAEA, and more, all of which collaborate in the framework of a federation created by EMODnet Physics. EMODnet Physics data infrastructure was updated, improving the overall system performance, facilitating service maintenance and implementing the centralization of the service.

During previous designing and implementation phases, EMODnet Physics established a highly appreciated data management and discovery system that aligns with its stakeholders' requirements. Leveraging this legacy and collaborating with a wide network of international experts in the marine domain, the EMODnet Physics consortium (ETT, MARIS, Institut Français de Recherche pour l'Exploitation de la Mer - IFREMER, Sveriges Meteorologiska och Hydrologiska Institut - SMHI, and ICES) moved towards the centralization phase of the EMODnet program, which has now been fully achieved.

Nowadays, EMODnet Physics acts as a central hub for gathering oceanographic data for public dissemination, integrating data from key European oceanographic repositories and marine infrastructures, including EuroGOOS, Copernicus Marine Service INSTAC, SeaDataNet NODCs, ICES database, PANGAEA repository, the Permanent Service for Mean Sea Level - PSMSL, the Système d'Observation du Niveau des Eaux Littorales - SONEL - data assembly center for Global Sea Level, the

Global Sea Level Observing Service, and the European Multidisciplinary Seafloor and Water Column Observatory (EMSO). This integration aims to provide the most comprehensive catalog of in-situ ocean physics data and encourages the adoption of the Common Creative (CC-BY) license for data products.

EMODnet Physics updated its data infrastructure to improve system performance, facilitate service maintenance, and implement centralization and results are now integrated into the EMODnet Central Portal (www.emodnet.eu).

This report highlights milestones from this implementation phase:

- Tools for improving and updating machine-to-machine layers and interoperability according to common standards and directives have been updated.
- The acquisition of ocean physics parameters largely relies on an automated, federated network infrastructure linking data providers and marine data-aggregating infrastructures.
- New datasets and observing platforms have been ingested and made accessible. Operational platforms, such as ARGO, drifting buoys, moorings, tide gauges, river stations, deliver data regularly, with some collecting a single parameter and contributing to a single thematic collection, while others collect multiple parameters and contribute to multiple thematic collections. The Central Portal lists approximately 32,000 ARGO, 19,400 drifting buoys, 2,800 tagged sea mammals, 5,400 tide gauges, 970 river gauge stations, 270 unmanned vehicles (gliders, sailing drones, etc.), 440 vessels (including fishing vessels, ferrybox, and data from ocean race ships), and more than 3,000,000 CTD profiles under the Physics theme.
- New data flows from citizen science have been initiated and analyzed.
- EMODnet Physics continued its engagement with Regional Sea Conventions (RSC) and the European Union Technical Group on Underwater Noise (EU TG NOISE) on impulsive noise and continuous noise, addressing Descriptors 11.1 and 11.2 of the EU Marine Strategy Framework Directive (MSFD). EMODnet Physics provides two products related to underwater noise: a collection of impulsive noise events and an atlas of sites for continuous noise monitoring, unifying regional registries and making them available.
- EMODnet Physics supports international committees on data interoperability and the ocean data value chain, such as the OceanPrediction DCC - Ocean Forecasting Co-design Team and the Global Ocean Observing System (GOOS) Observations Coordination Group (OGC) group on low-cost technologies for ocean data collection.
- EMODnet Physics supports global communities, including the Southern Ocean Observing System (SOOS), and contributes to studies on climate change understanding and the Intergovernmental Panel on Climate Change (IPCC).

EMODnet Physics continues to organize thematic workshops to engage with new communities and expand the network of data providers and users. The team has participated in more than 100 events, including initiatives focused on cost-effective technologies and citizen science (e.g., European Marine Days, Ocean Data hours – The Ocean Race villages, etc.), which have proven to be valuable data providers, helping to fill marine data gaps and improve time and spatial resolution of coastal areas. The report also proposes future ideas and recommendations.

2. Update on the Tasks

Task 1. Maintain and improve a common method of access to data held in repositories

One primary aim of EMODnet Physics is to provide single access to in situ operational data as collected by fixed and moving in situ platforms. EMODnet Physics does not operate any platforms; instead, it serves as the final step in gathering oceanographic data for public dissemination. Data from key European oceanographic repositories and marine infrastructures (such as EuroGOOS, Copernicus Marine Service INSTAC, and SeaDataNet NODCs) are integrated with other available data sources, including the ICES database, PANGAEA repository, the Permanent Service for Mean Sea Level, the SONEL - GNSS data assembly center for Global Sea Level, the Global Sea Level Observing Service, and the European Multidisciplinary Seafloor and Water Column Observatory (EMSO). A comprehensive network has been developed during the years and it is involving about 400 between institutes and providers from all over Europe and beyond and more than a hundred thousand datasets have been linked and are accessible. While interacting and integrating these repositories, EMODnet Physics encourages the adoption of the CC-BY license for data products. The main types of In-Situ observing systems available in EMODnet Physics are:

- Drifting Argo Floats for the measurement of temperature and salinity profiles down to ~2000m and, by tracking them, mean subsurface currents.
- Research vessels which deliver complete suites of multidisciplinary parameters from the surface to the ocean floor (very sparse and intermittent spatial coverage and at very high cost of operations).
- XBTs (Expendable bathythermographs) by research vessels and ships of opportunity underway for the measurement of temperature and salinity profiles to ~450-750m depth.
- Fixed stations and Moorings capable of measuring different parameters continuously over long periods of time.
- Ferry-Box and other regional ship of opportunity measurement programs for surface transects which may include temperature, salinity, turbidity, chlorophyll, nutrient, oxygen, pH and algal types.
- The network of tide gauges, which provides long term reference and validation sea level data.
- Gliders, which complement floats and moorings and are able to perform transects of physical and biogeochemical parameters from the surface down to 1000m.
- Surface drifters are cheap and light-weight platforms that passively follow the horizontal flow at the surface via a drogue/sail.
- Surface autonomous vehicles, which collect sea-air interface parameters
- Sea mammals borne instruments for transects and profiles on temperature and salinity
- River stations for river outflow data (direct measurement or from river gauging data)
- High Frequency Radars which are land stations collecting sea surface current fields

The following tables summarize well the progresses.

Table 1. Platforms on EMODnet Physics (01/07/2020)

ARGO Floats	CTDs	Drifting Buoys	FerryBox and Ship	gliders	sea mammals	mini loggers	moorings	radar	river stations	tide gauges
5448	779444	14623	322	226	2141	182	4065	156	680	3504

Table 2. Platforms on EMODnet Physics (23/08/2021)

ARGO Floats	CTDs	Drifting Buoys	FerryBox and Ship	gliders	sea mammals	mini loggers	moorings	radar	river stations	tide gauges
8356	2371105	14879	332	226	2381	196	3483	157	877	3675

Table 3. Platforms on EMODnet Physics (01/08/2023) – now discoverable on the Central Portal

ARGO Floats	CTDs	Drifting Buoys	FerryBox and Ship	gliders	sea mammals	mini loggers	moorings	radar	river stations	tide gauges
13110	3061433	19400	440	276	2814	213	5006	164	971	5483

These repositories may employ different methodologies, data models, formats, data licenses, and interoperability tools. EMODnet Physics has developed and maintains tools to interoperate with these repositories and integrate these federated sources into thematic data collections. For each source, a special connection module may be required to process the source's metadata and data, making it ready for inclusion in EMODnet Physics collections and the Central Portal (see also Task 4).

Deliverable D2.9 describes this federation of sources.

The organization of a common method to access data in repositories also encompasses the promotion of common vocabularies and metadata, the adoption of common standards and procedures to ensure data interoperability, and the engagement of new communities and stakeholders to unlock data and address gaps in time and space.

Deliverable D1.31 outlines the minimum set of metadata and recommended vocabularies.

Making operational data available in Physics is particularly important for providing a single platform to view what, where, and how data is collected at sea. This also reduces duplication of effort among agencies, improves data quality, and lowers geographic information-related costs. This effort makes oceanographic data more accessible to the public and fosters key partnerships to increase data availability. However, new data sources may not always fully comply with applied standards (e.g., adoption of common Quality Check/Quality Flag - QC/QA procedures at the source, adoption of standardized metadata, etc.). The development of such procedures may not always align with the timelines of data providers, potentially conflicting with the momentum of engaging new providers.

To better manage the variety of data platforms, data sources, data model harmonization levels, and more, and to expand data coverage in both operational oceanography and research community infrastructures, bridging

the gap between Real-Time (RT), Near Real-Time (NRT), and archived data, and simplifying the data sharing process, the connection process to EMODnet has been divided into two distinct phases. The inclusion of the source "as is" (phase one) involves the utilization of machine-to-machine technologies, ranging from FTP file access to web APIs for real-time exchange, and the adoption of services like the Data Access Broker (DAB) or ERDDAP. Once a new operational data source is integrated into the data layer and a data collection is added to the ERDDAP data server, the next step is the inclusion of the source into a harmonized and validated data collection (phase two) for long-term stewardship. This step depends on data centers assessing the added value of the submitted data and the efforts required to process the data into common formats, if possible. Elaboration activities include review, validation, conversion to standard formats, and further integration into relevant European infrastructures, such as SeaDataNet, Copernicus Marine Service In Situ TAC, EU HFR NODE, GOSHIP database, ICES database, and others, depending on the theme, platform, and provider.

The transition from phase 1 to phase 2 requires further elaboration (e.g., adoption of common QC/QF at the source, adoption of standardized metadata, etc.). It may not always be possible, and the inclusion of operational near real-time data into harmonized collections may not yet meet the requirements for research-quality data stewardship. Therefore, phase 2 includes two sub-levels: the first level is reached when the operational data source is included in an operational data collection (e.g., the Copernicus Marine Service In Situ TAC, EU HFR NODE, etc.), and the second level (research quality) is achieved when the data is included in the SeaDataNet collection, along with the assignment of a Common Data Index (CDI) to the dataset.

The methodology has been defined within the Marine In situ Collaboration Technical Working Group (MIC TWG)[1], which was established between EMODnet Physics, EMODnet Ingestion and Chemistry, Copernicus Marine Service In Situ TAC, EuroGOOS office, EuroGOOS Task Teams, SeaDataNet/SeaDataCloud, and other relevant partners.

The promotion of this common basis also involves organizing workshops with data providers and emerging platform network communities (e.g., citizen science projects, data from smart sensors in fishing nets). These events aim to introduce and discuss the EMODnet scope, how providers can contribute, and the necessary metadata and data formats, along with long-term perspectives to support the evolution of EMODnet.

Task 2. Construct products from one or more data sources that provide users with information about the distribution and quality of parameters in time and space

EMODnet Physics offers a range of products, including in-situ data, reanalysis, trends, aggregations in space and/or time, and model outputs. In-situ data can be delivered either in near-real-time or with a delay, or after processing. EMODnet Physics data and products are accessible for search, visualization, and download in a manner that conceals the physical location of the data source from the user, although data provenance is always declared. This activity also involves generating several products and making optimal use of existing ones from the EMODnet Physics network (including SeaDataNet, Copernicus Marine Service, ICES, SONEL, etc.).

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[1] MIC WG is working on the further harmonization of standards, procedures and workflow for ingesting and sharing operational data

With the Central Portal (CP) operational, the flow from data source to products into the CP follows the following process:

1. Data "as is". These data are ingested and organized in the EMODnet Physics backend. The EMODnet Physics backend (erddap.emodnet-physics.eu, geoserver.emodnet-physics.eu) offers these data to central portal by means of standard M2M protocols (WMS, WFS). Download is possible via the Central Geoviewer that requests data packages to EMODnet Physics. EMODnet Physics forward these requests the data to original sources.

2. Data collections. In situ data is organized per theme (temperature, salinity …). Metadata is using harmonized and controlled vocabularies (see annex). This level also corresponds to Ingestion Level 1. These data are organized in the EMODnet Physics backend. The EMODnet Physics prod environment backend (prod-erddap.emodnet-physics.eu, prod-geoserver.emodnet-physics.eu) offers these data to central portal by means of standard M2M protocols (WMS, WFS). Download is possible via the Central Geoviewer that requests data packages to EMODnet Physics.

3. Research quality data. These datasets are fully validated by theme experts (e.g. SeaDataNet network of NODCs, PSMSL, Copernicus Marine Service Reanalysis, ICES, etc.). These data correspond to the Ingestion Level 2. These data are hosted into specialized DB. Download of these packages are possible via external links.

4. Products. Research quality data are used to make themes products - e.g. temperature, salinity climatology; sea level trend map, etc. These products may be gridded or not. These products are usually developed by EMODnet Physics partner projects/programs (e.g. Copernicus Marine, BlueCloud2026, GLODAP, ICES, etc.). These products are included into EMODnet Physics backend (prod-erddap.emodnet-physics.eu, prod-geoserver.emodnet-physics.eu) and cached into the EMODnet central ERDDAP (erddap.emodnet.eu/erddap/index.html).

As described, EMODnet Physics has successfully designed, organized, and is running operational services that provide ocean physics data and data products built with common standards, free of charge, and without restrictions. The available parameters cover temperature, salinity, and current profiles, sea level trends, wave height and period, wind speed and direction, water turbidity (light attenuation), underwater noise, river flow, and sea-ice coverage. Some of these parameters are also processed to create more complex and comprehensive products. Product management is organized into thematic teams (see WP1) whose expertise helps identify if a product is suitable for its intended purpose and how it can be utilized by a critical mass of beneficiaries. The following thematic products are available:

- ***Temperature and Salinity in the water column***

Temperature is a crucial component of the climate system and exhibits variability in the water column. Sea-surface temperature (SST) has a significant impact on energy, momentum, and gas exchanges between the ocean and atmosphere. Daily variations in SST can exceed 3°C and lead to changes of over 10 Wm-2 in the surface energy budget in the tropics and subtropics. Subsurface ocean temperature is a fundamental observation for understanding various ocean phenomena influencing climate, including ocean stratification, circulation, mixed layer dynamics, water mass properties, and coastal shelf-open ocean exchange. Profiling

subsurface temperature observation systems also contribute to in-situ validation of satellite observations of surface temperature. Changes in ocean temperature, for instance, can impact the growth rate of farmed fish, as well as the distribution and abundance of wild fish stocks and other economically and socially valuable marine species.

Salinity observations play a role in monitoring the global water cycle, ocean density, mass, and more. These in-situ data are essential inputs for many ocean models, for validating and calibrating remote sensing observations, and for understanding the ocean's role in the global climate system.

At a global scale, EMODnet collects in-situ data from the Joint WMO-IOC Commission for Oceanography and Marine Meteorology (JCOMM) networks (Argo, Data Buoy Cooperation Panel - DBCP, OceanSites, Global Ocean Surface Underway Data - GOSUD, OceanGliders, Global Ocean Ship-based Hydrographic Investigations Program - GOSHIP) and main international (US World Ocean Database - WOD, US National Data Buoy Center - NDBC, Integrated Marine Observing System - IMOS) and European (SeaDataNet, International Council for the Exploration of the Sea - ICES, Copernicus Marine Service INS TAC) aggregators. The most important source of profile data is the Argo network (about 4000 platforms cycling every 10 days) and its extensions to Deep Ocean and BioGeoChemical parameters. It is complemented by XBT lines (about 50 lines, half active in 2018) and sea mammals in high latitudes. In delayed mode, the GOSHIP CTD lines (60 lines planned) and other research cruise observations from US National Oceanographic Data Center - NODC and CLIVAR (Climate and Ocean - Variability, Predictability, and Change) and Carbon Hydrographic Data Office - CCHDO are included.

For time-series data, the most important source of observations is the Data Buoy cooperation Panel - DBCP network, operating more than 1400 drifters and 20 Arctic buoys, as well as more than 500 moorings providing both atmospheric and oceanographic data. It is complemented by the GOSUD and VOS network on voluntary observing ships, which provide both SST/SSS (sea surface salinity) and Surface Carbon data. The Argo network also provides time series of temperature and salinity at the surface and at drifting depths, along with derived velocity information.

EMODnet Physics provides in-situ observations from various catalogues, both European and international (including Marine Mammals Exploring the Oceans Pole to Pole - MEOP, Southern Ocean Observing System - SOOS, Deep Ocean Observing System - DOOS, etc.), linking different platforms with a wide range of spatial and temporal scales. The EMODnet Physics data collection includes moorings, which offer high temporal resolution at specific locations but have limited spatial resolution due to array density; gliders and tagged animals that provide higher spatial resolution depending on endurance and instrument characteristics; profiling floats (ARGO) that deliver temperature profiles typically from 0-2,000 meters; casts from ship-based Conductivity-Temperature-Depth (CTD) observations along research voyage tracks, providing temperature observations throughout the water column; Expendable probes (xBT) dropped from a network of volunteer commercial vessels along major shipping routes, observing temperature to several hundred meters depth on a roughly seasonal repeat schedule; and surface loads and ferrybox repeated transects, which offer high-resolution sea surface temperature datasets.

Using these in situ data, it is possible to analyze trends, create maps, and generate gridded data products. Examples include the CORA (Coriolis Ocean Dataset for Reanalysis), developed by IFREMER for the Copernicus

Marine Service and regularly updated (annually), and the SeaDataNet Regional Climatology products, developed by SeaDataNet partners using DIVA software and periodically updated
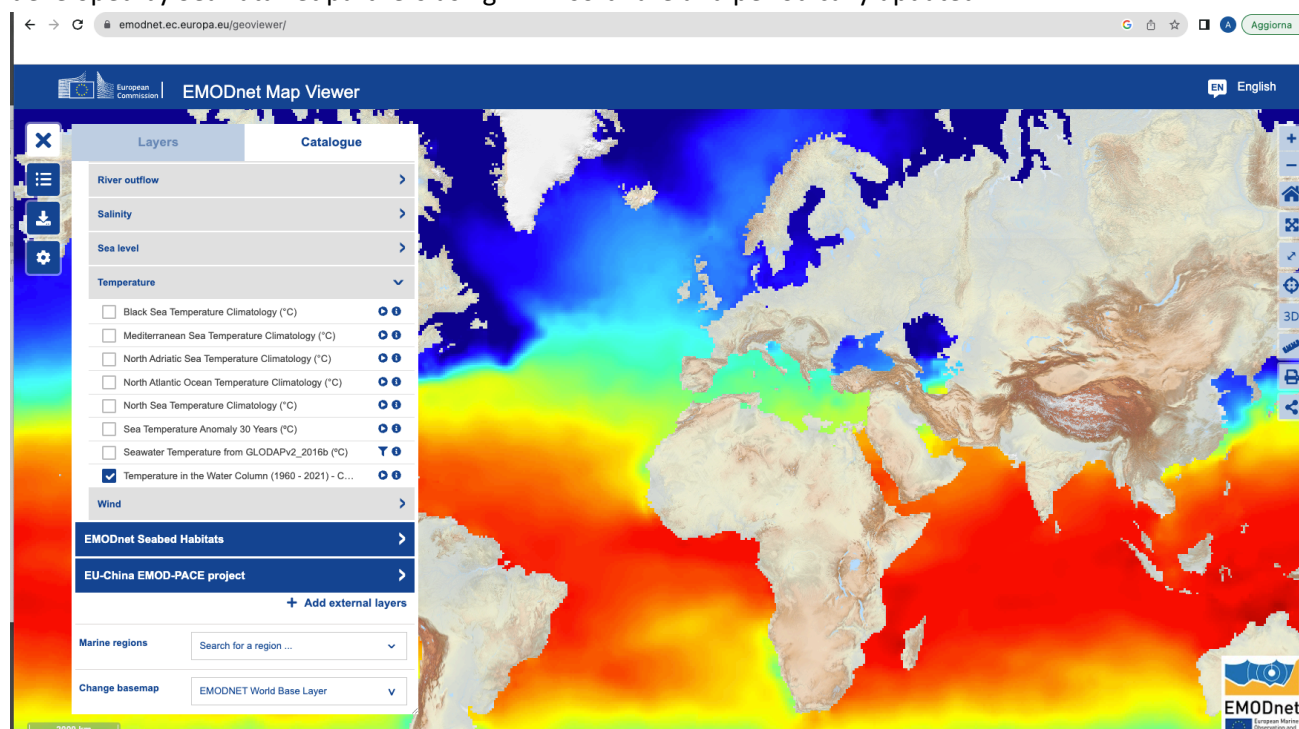
Figure 1. The Coriolis Ocean Dataset for Reanalysis under the Physics area

A near real time picture of the sea surface temperature and salinity is made available by a dedicated web interactive page
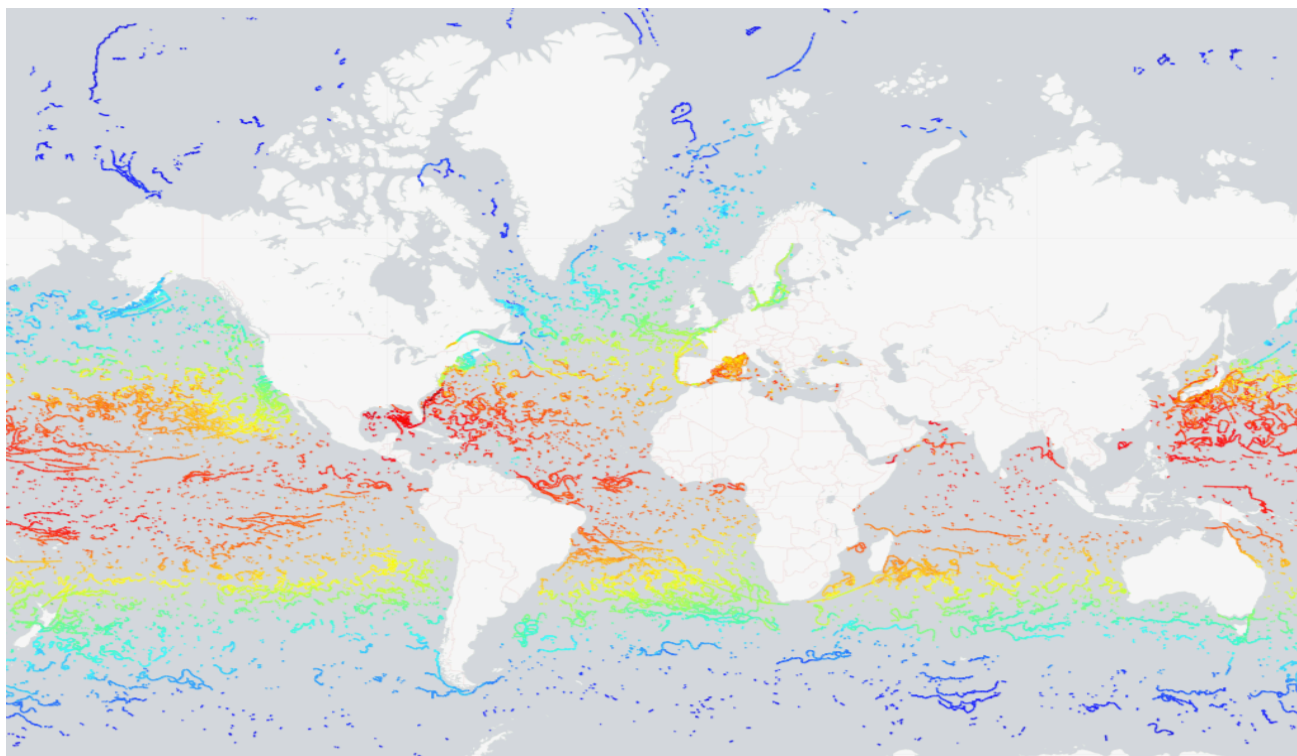
Figure 2. NRT temperature (integration time 60days) as collected by in situ stations
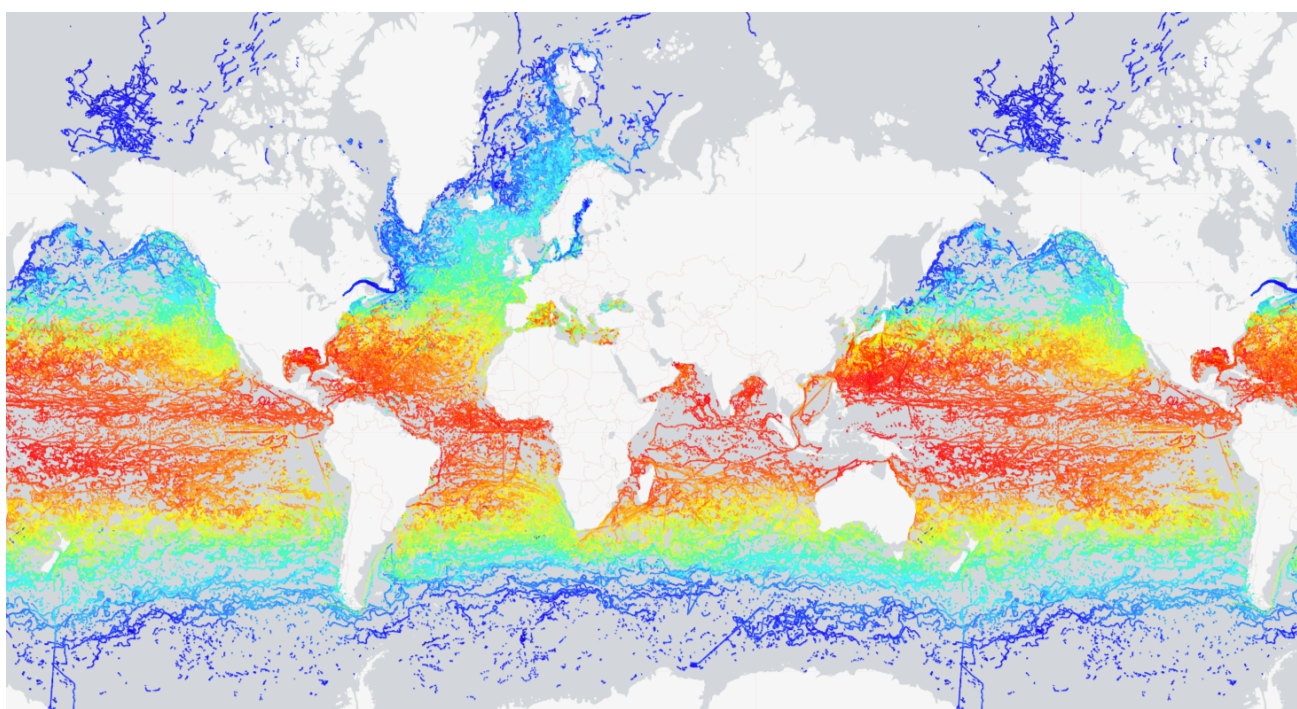
Figure 3. NRT temperature (integration time 12Months) as collected by in situ stations

EMODnet Physics also offers a Sea Surface Salinity (that integrates in situ data and Soil Moisture and Ocean Salinity – SMOS) product developed by the Barcelona Expert Center – CISC for EMODnet

- ***Sea Surface Currents***

The general circulation of the ocean surface plays a significant role in the transport of heat, salt, passive tracers, and ocean pollutants. Ocean currents, in conjunction with atmospheric currents, contribute to redistributing equatorial heat content towards the poles. There are two main types of sea currents: surface wind-driven currents and the thermohaline circulation. The existing surface current observing systems, such as moorings and Lagrangian drifters, capture a substantial portion of this range. EMODnet Physics combines these observations with land-based High-Frequency (HF) radar observations, which provide a high-resolution tool (albeit with limited spatial coverage) for improved understanding of surface currents, eddies, air-sea fluxes, and exchanges between coastal waters and the open ocean. The EMODnet Physics HFR catalogue, which includes approximately 150 antennas, combines the European HFR node observation capacity with global sources, making it one of the most comprehensive sources of HF Radar observations worldwide
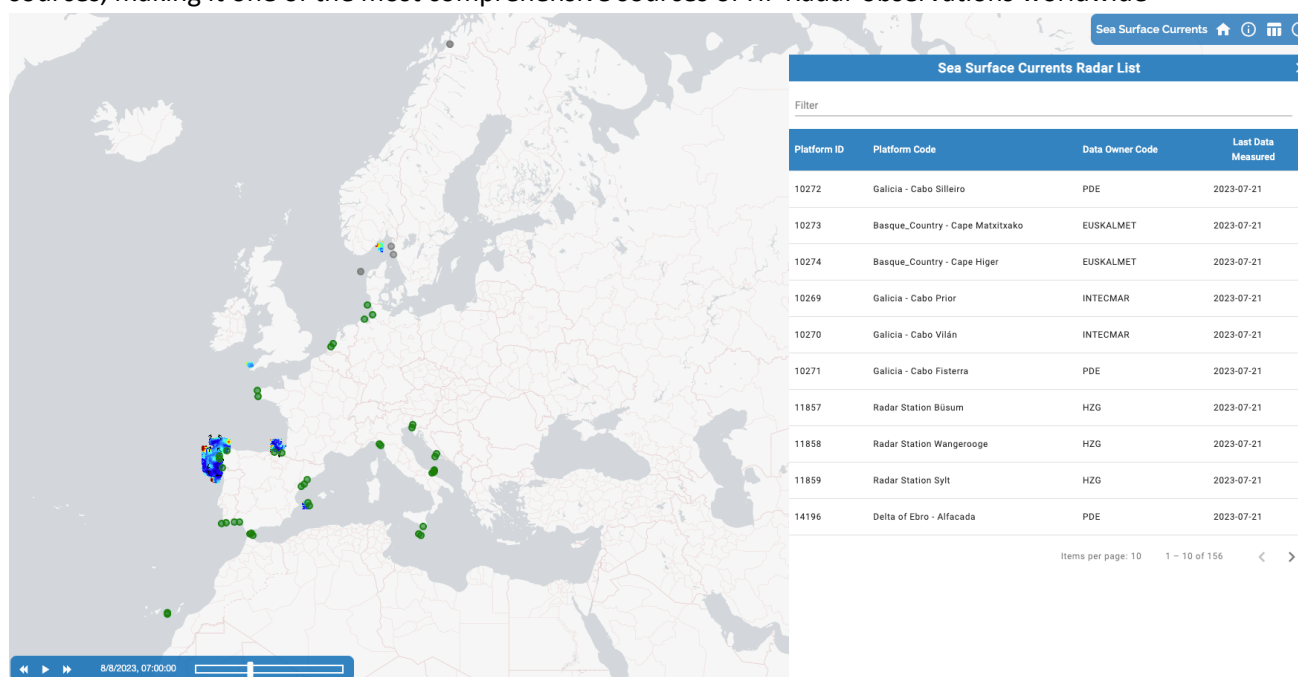
Figure 4. HFR and sea surface currents

- ***Sea Level***

Sea level is considered an Essential Ocean Variable by the Global Ocean Observing System (GOOS). Measurements of sea level along coasts have been conducted since the 19th century using tide gauges. Tide gauges remain a key method for observing trends in mean sea level, assessing extreme events, making tidal predictions, supporting geodetic applications, and facilitating harbor operations and navigation. Tide gauge measurements are increasingly important for new warning systems for tsunamis and storm surges, as coastal inundation and storm surges can lead to significant flood events and the destruction of property and infrastructure. Sea level is regarded as one of the most crucial Essential Climate Variables (ECVs), given that its projected evolution over the next few decades is predicted to pose challenges for millions of people, particularly those in vulnerable areas. Continuous monitoring of sea level trends is essential, and EMODnet Physics incorporates different data collections:

- European Tide Gauge Stations (EuroGOOS - Tide Gauge task team), which constitute a network of approximately 500 operational stations providing hourly data. These data undergo near-real-time quality control (NRTQC) to identify spikes.
- The UNESCO IOC Sea Level Monitoring Service, which comprises a network of over 1,250 operational tide gauges providing near-real-time data that contributes to international tsunami networks. These data are available "as is" and are not quality controlled or intended for research purposes.
- The Global Sea Level Observing Systems (GLOSS) core network, consisting of around 300 stations that form the foundation of the global in-situ sea level network. This network ensures even sampling of coastal sea level variation at various time scales.
- JRC-TAD tsunami array devices, a network of over 1,000 smart sensors that monitor real-time sea level status at a frequency of one minute, supporting tsunami warning services.
- The GLOOS Fast Delivery (FD) and Research Quality (RQD) tide gauge data, operated by the University of Hawaii Sea Level Centre (UHSLC). The database includes 574 stations. FD data are released within 1-2 months of data collection and undergo basic quality control focusing on large level shifts and obvious outliers. FD data is replaced by RQD data as it becomes available, usually 1-2 years after FD.
- The Permanent Service for Mean Sea Level (PSMSL) global sea level database, which provides long-term sea level change information from tide gauges and bottom pressure recorders. The database comprises over 2,350 stations and contains monthly and annual mean sea level values.

These in-situ data are processed by the Permanent Service for Mean Sea Level -PSMSL expert center, which provides relative sea level trend and sea level anomalies products. The relative sea level trends measured by tide gauges reflect local changes in water level plus local vertical land motion. However, these trends are not corrected for land movement. Tide gauge trends are relative to a fixed point on land and can be influenced by land movements caused by earthquakes or ground-water withdrawal. These in-situ trends are part of the EMODnet Physics products collection in the EMODnet GeoViewer.
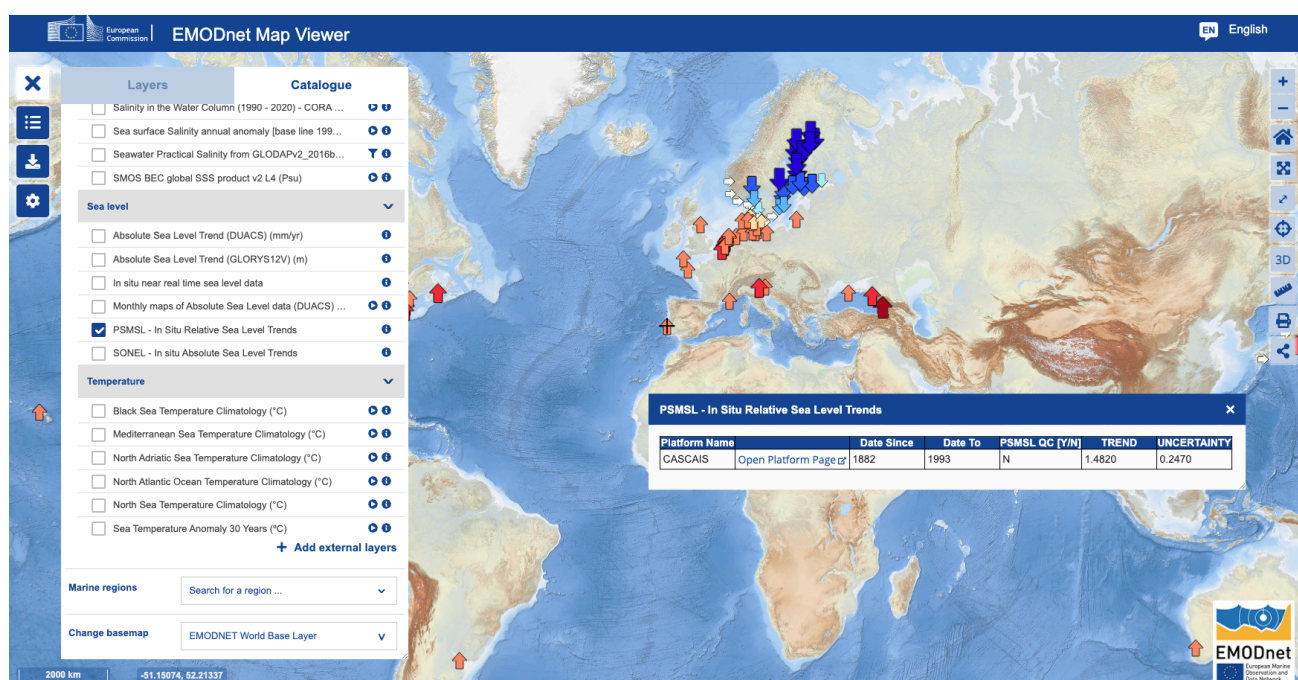
Figure 5. in situ sea level trends (PSMSL)

The absolute sea level is processed using geodetic data from in situ stations (Système d'Observation du Niveau des Eaux Littorales - SONEL). SONEL serves as the GNSS data assembly center for the Global Sea Level Observing System (GLOSS), developed under the auspices of the IOC/UNESCO. Based on the SONEL product, EMODnet Physics offers an absolute sea level trend product. EMODnet Physics also includes gridded and reanalysis products developed by CMCC for EMODnet Physics. The map is based on SSALTO/DUACS altimeter products produced and distributed by the Copernicus Marine Service. The satellite trends reflect changes in sea surface height, with most of the spatial variation resulting from the influence of winds blowing over the ocean

- ***Wave (height and period) - Sea State and Wind (speed and direction)***

Sea state refers to the characterization of waves and swells, including their height, wavelength, period, and directional wave energy flux. It is widely recognized that sea state significantly impacts marine safety, marine transport, and the potential for damage to structures. However, the availability of in-situ wave and wind observations remains limited. EMODnet Physics provides access to these data by integrating multiple data sources, such as the Data Buoy Cooperation Panel, OceanSITES, EuroGOOS regional observations in Europe, and more, into a single catalogue. Operational data are aggregated to provide a synoptic dynamic view of sea state conditions.

- ***River Runoff Data***

River runoffs exert a strong influence on their neighboring coastal areas in various ways, such as modifying water stratification, introducing significant fluctuations in circulation patterns, and modulating the impact of upwelling events. However, uncertainties arise due to the global decline of hydrometric networks, which affects the availability of river runoff data and information on water properties like temperature and salinity. Typically, climatology products of rivers are imposed at the land boundaries of coastal or regional ocean models, overlooking the inter-annual variability in flow and associated properties of rivers. This omission limits

our understanding of river dynamics and their impact on coastal areas. River flow fluctuations, from low to high levels, occur frequently and rapidly due to heavy rainfall, disrupting plant life and animal reproduction. These factors are crucial for coastal area management and improved forecasting systems.

EMODnet Physics serves as an in-situ hub for accessing operational river runoff data, offering over 600 stations. River runoff data can be accessed through the EMODnet GeoViewer and an advanced product that also includes river catchment information. The EMODnet Physics River runoff operational product is developed in collaboration with CoLabAtlantic+. The research-quality river data database is operated by the Global Runoff Data Center (GRDC). EMODnet Physics includes a subset of the GRDC, focusing on coastal areas and including only stations located near the river mouths.
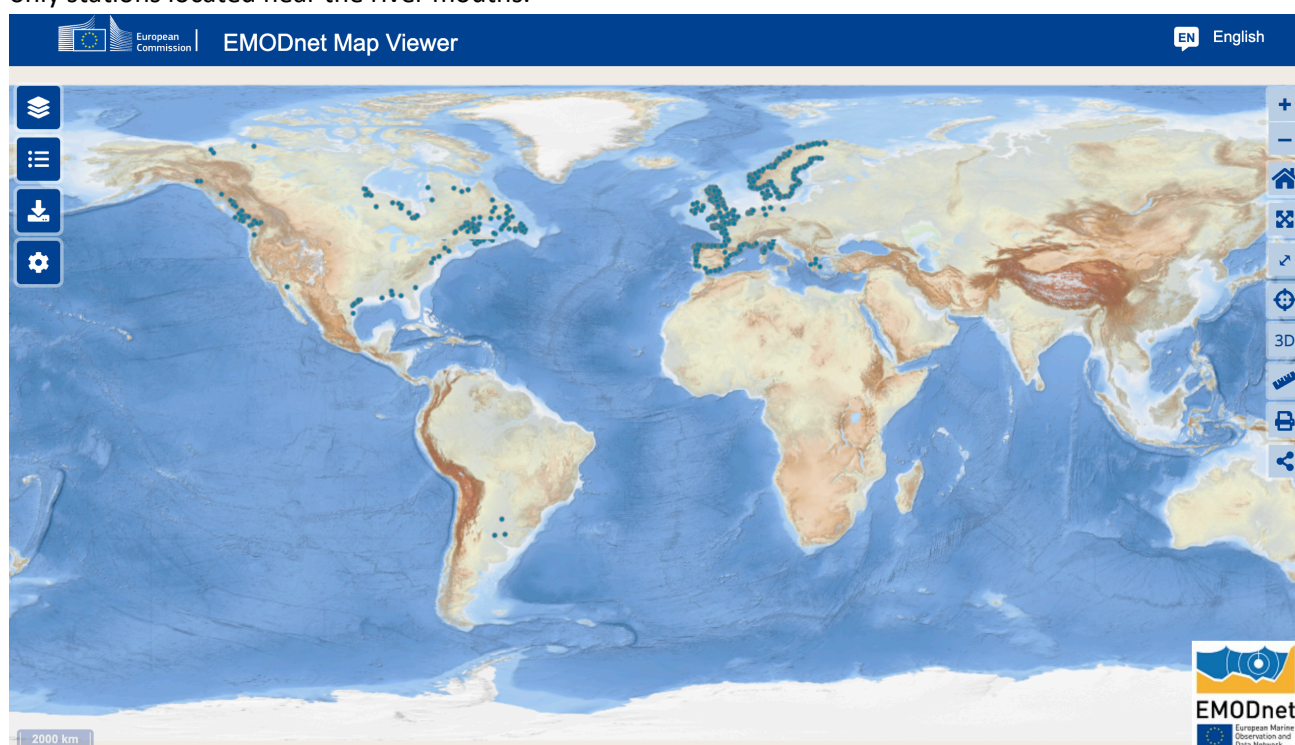
Figure 6. River outflow in situ data.

- ***Water Clarity (Light Attenuation)***

Light attenuation is a significant parameter for determining the photic zone, which refers to the zone with sufficient light for photosynthesis. It is essential for understanding total primary production and the distribution between pelagic and benthic primary production. In addition to working on in-situ data collection of water clarity data, including the availability of a database for parameters such as turbidity, EMODnet Physics offers a Total Suspended Matter (TSM) product. The TSM product represents the percentage of suspended particles (not dissolved) and is presented as a gridded product. It is based on the CoastColour L2W Concentrations Data, obtained from the OC4 algorithm for clear and moderately turbid waters, as well as the CoastColour v1 neural network. The L2W product is then remapped onto a regular grid while maintaining a full resolution of 300 meters. This allows for the generation of products covering European sea basins on a monthly average basis. The TSM product, developed by CNR – ISMAR for EMODnet Physics, covers the period from 2003 to 2012. It has started to be updated with recent data only on major rivers (Danube, Po, Rhone, Ebro,

Guadalquivir, Tejo, Douro, Garonne, Loise, Seine, Rhine, Elbe) mouth. The RROI (river regions of interest) are going to be fully released progressively in 2023.
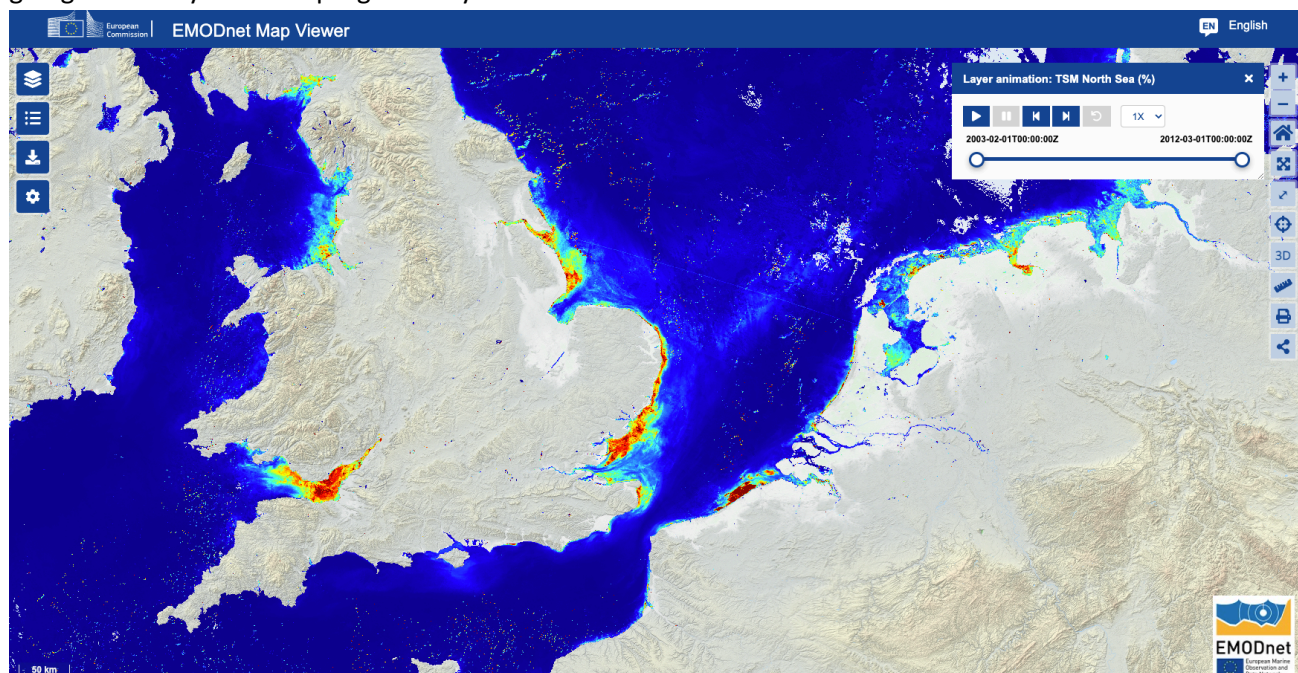
Figure 7. Optical properties – total suspended matter.

- ***Underwater Noise***

Underwater noise, which has adverse effects on the health of marine species and biological productivity, is gaining attention as a form of pollution. Maritime traffic serves as the main source of continuous noise, while impulsive noise sources include pile driving during construction, seismic exploration using airguns, explosions, and sonar systems. EMODnet Physics provides two products related to underwater noise: the collection of impulsive noise events and the atlas of sites for continuous noise monitoring. The impulsive noise events are compiled nationally from registers of licensed events, such as pile driving, controlled explosions from naval operations, and other activities that release energy. Most Member States provide these data to the Regional Sea Conventions, contributing to regional assessments of MSFD descriptor 11.1.1 (Low and mid-frequency impulsive noise). Regional registries, operated by ICES (HELCOM, OSPAR) and Centro Tecnologico Naval (Mediterranean Sea), are unified and made available through EMODnet Physics. These efforts aim to enhance understanding and assessment of underwater noise impacts in different regions.
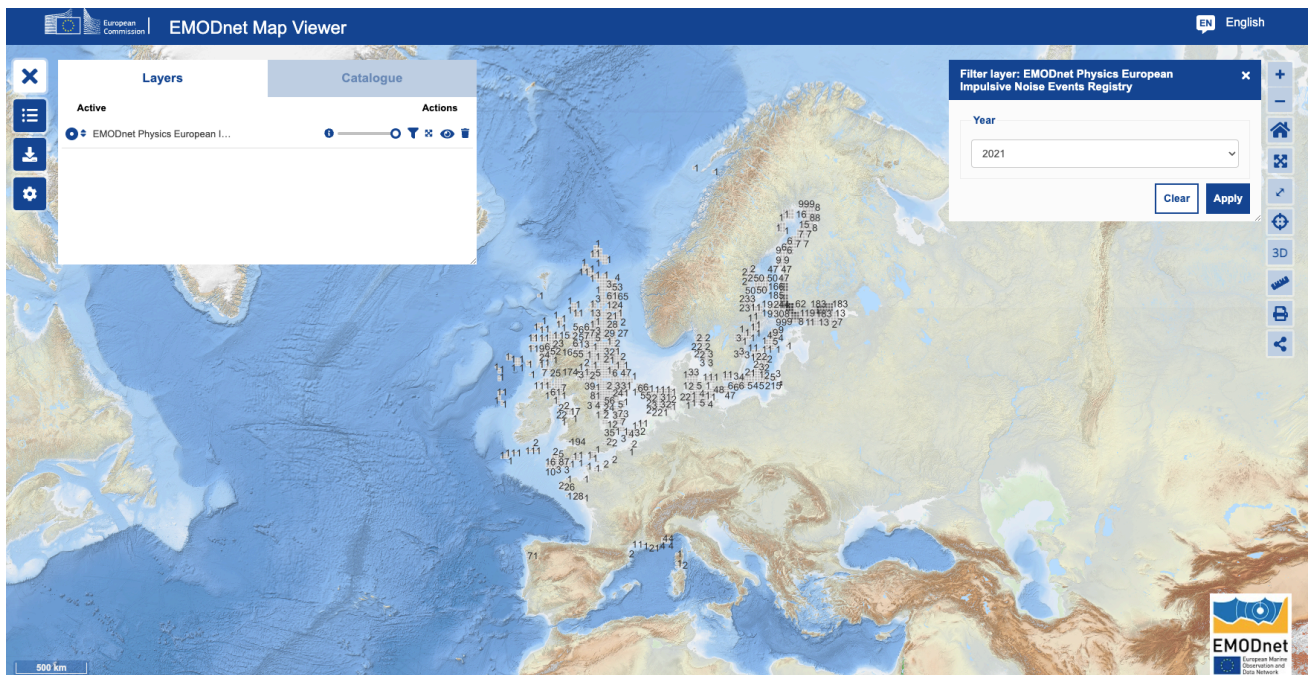
Figure 8. Impulsive noise events.

- ***Sea Ice data***

Sea ice extent and thickness are rapidly decreasing, particularly in the Arctic. This loss of sea ice can have long-lasting effects on the cold branch of the global thermohaline circulation. EMODnet Physics incorporates in-situ data collections from various sources, including the International Arctic Buoy Cooperation Program, the Woods Hole Ice-Tethered Profiler Program, and icebreakers and research vessels operating in the Arctic area (ARICE). Additionally, EMODnet Physics supports the Southern Ocean Observation System (SOOS) by providing the data backend infrastructure to host and make Southern Ocean data accessible.
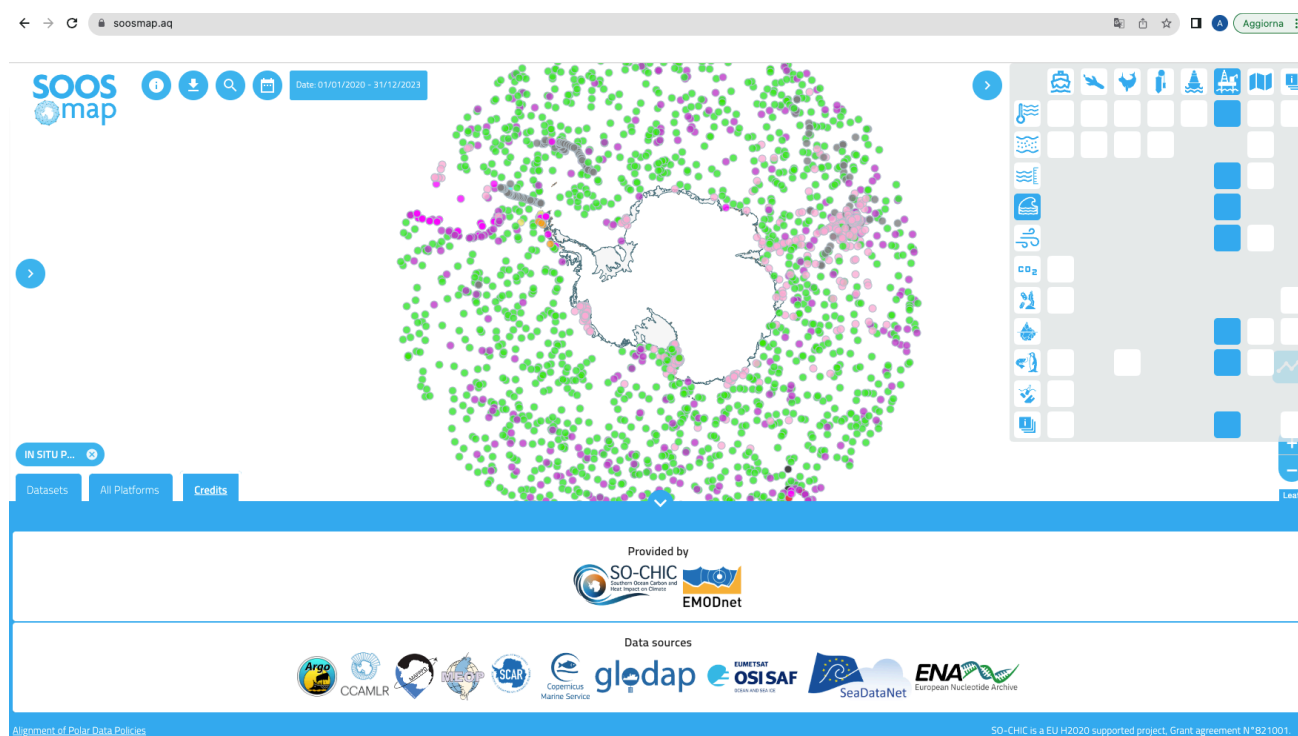
Figure 9. SOOSmap (www.soosmap.aq).

The positions of the platforms are superimposed on the sea ice extent[2] in both the Arctic and Antarctic Oceans.

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[2] Sea ice extent is derived from the SEAICE_GLO_SEAICE_L4_NRT_OBSERVATIONS_011_001 product, which was developed by SIW-METNO-OSLO-NO for the Copernicus Marine Service.

Task 3. Develop procedures for machine-to-machine connections to data and data products

EMODnet Physics continues to work on and optimize the FAIRness of its data flow and data management. The FAIR concept pertains to data and services that should be findable, accessible, interoperable, and reusable, for both machines and people, with a particular emphasis on machines. Technological advancements offer innovative opportunities for new forms of science, which is one of the driving forces behind the European Open Science Cloud (EOSC). It's worth noting that the EMODnet Physics coordinator was recently appointed as an EOSC-FAIR Champion (https://fair-impact.eu/eosc-fair-champions).

Table 4. FAIR Guiding Principles as defined in Wilkinson et al. (2016).

The FAIR Guiding Principles

To be Findable:
F1. (meta)data are assigned a globally unique and persistent identifier
F2. data are described with rich metadata (defined by R1 below)
F3. metadata clearly and explicitly include the identifier of the data it describes
F4. (meta)data are registered or indexed in a searchable resource

To be Accessible:
A1. (meta)data are retrievable by their identifier using a standardized communications protocol
A1.1 the protocol is open, free, and universally implementable
A1.2 the protocol allows for an authentication and authorization procedure, where necessary
A2. metadata is accessible, even when the data are no longer available

To be Interoperable:
I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
I2. (meta)data use vocabularies that follow FAIR principles
I3. (meta)data include qualified references to other (meta)data

To be Reusable:
R1. meta(data) are richly described with a plurality of accurate and relevant attributes
R1.1. (meta)data are released with a clear and accessible data usage license
R1.2. (meta)data are associated with detailed provenance
R1.3. (meta)data meet domain–relevant community standards

However, as previously mentioned (refer to Task 1), this requires well-described, accessible data that conforms to community standards. Machine-to-machine procedures consist of tools to establish connections from the source to EMODnet Physics and tools to implement interoperability from EMODnet Physics to third parties. A data source may provide data in various transport formats, different time granularities (hourly data, daily data, etc.), in real-time/near-real-time or delayed mode, using different data publishing services (FTP, OAI-PMH, webREST, etc.). EMODnet Physics operates services that facilitate the connection and linking to these various sources (also see Task 4).

As mentioned earlier, data product delivery modes range from real-time and near real-time to validated long-term time series. EMODnet Physics data infrastructure is logically divided into three layers: 1) Data layer, which includes all the machinery to collect and update in-situ data from sources, as well as new thematic products. 2) Application layer, which organizes data in a consistent manner to make it consumable. 3) Service layer, which exposes services to the Central Portal and users. Furthermore, to better support the Central Portal with

consumable and interoperable thematic data layers, the infrastructure includes both a staging and a production environment. The tools adopted for data services and cataloging are ERDDAP, GeoServer, ncWMS, and GeoNetwork.
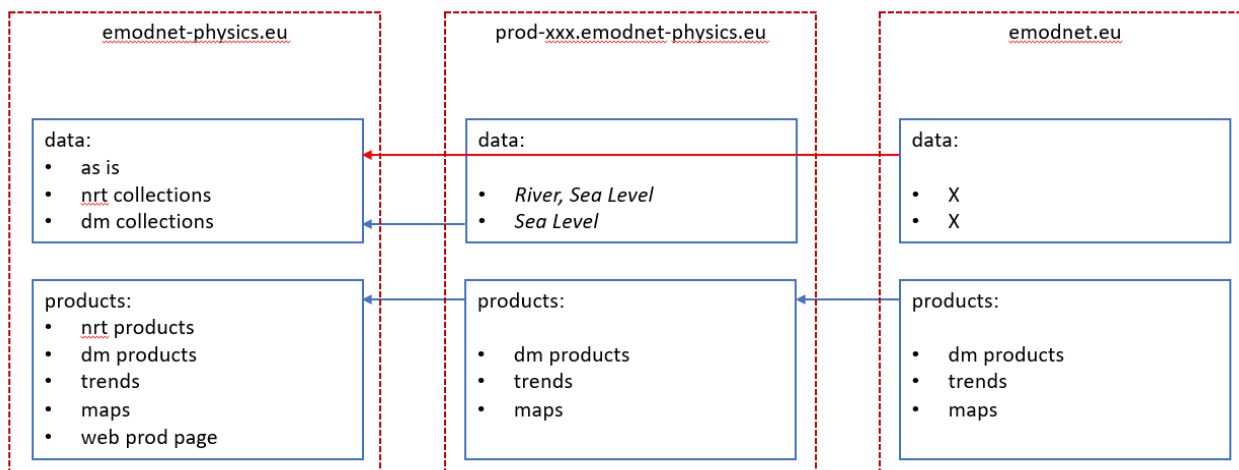
Figure 10. EMODnet Physics data and data product assembly and delivery to Central Portal pipeline

This task also involves collaboration with EMODnet Ingestion to support EMODnet Physics stakeholders with interoperability issues. Specifically, this involves organizing and providing software tools for implementing operational data exchange. One commonly used technology is ERDDAP. Originally initiated as a NOAA project, ERDDAP is now promoted and adapted by IOC and its programs GOOS and IODE, and it is used by an increasing community. EMODnet Physics is one of the trusted developers of ERDDAP technology. ERDDAP is an Apache-based data server that offers an easy and consistent way to download subsets of gridded and tabular scientific datasets in common file formats and generate graphs and maps. As part of Task 3, EMODnet Physics maintains and updates the ERDDAP Docker, which is available on the GitHub page (https://github.com/EMODnet-Physics). Another technology used is the Discovery Access Broker (DAB), developed by CNR and already in use in several project initiatives (ODIP, SeaDataCloud, EMOD-PACE, etc.). The Discovery and Access Broker (DAB) consists of coordinated software components responsible for geospatial resource brokering. Its aim is to enable interoperability among distributed and heterogeneous data sharing systems. The ultimate goal of DAB is to reduce entry barriers for both providers and consumers (clients) of System of Systems (SoS). EMODnet Physics and EMODnet Ingestion have developed pilot actions to assist operators in setting up standardized interfaces for managing and retrieving metadata and observations from heterogeneous sensor systems, ensuring that this data can be exchanged in real-time via ERDDAP.

The following table presents the downloadable volume, where some themes have seen significant increases, while others have been cleaned of duplicates (e.g., waves), and some have been refined to include only parameters that fall within the scope of Physics (e.g., Optical Properties now includes only platforms that collect turbidity or light attenuation).

Table 5. Downloadable volume

Parameters/Themes	Downloadable Volume 01/03/2019	Downloadable Volume 10/07/2020	Downloadable Volume 10/07/2023
Water Temperature	340187	825273	3067655
Water salinity	262176	745064	3065008
Currents	5388	6245	180772
Optical Properties	96215	97380	1830
Sea Level	3760	4320	5641
Atmospheric	11256	13056	11101
Water conductivity/ BioGeoChemical	181789	203581	96206
Waves	1363	1597	1158
Winds	1622	1775	1046
River	636	679	927
Underwater noise	3	3	5

Task 4. Contribute data, data products and content to a central portal that allows users to find, view and download data and data products

All the necessary actions and developments are undertaken to contribute data, products, and content to the central portal, enabling users to find, view, and download data and products. As previously mentioned in task 3, the current infrastructure includes both a staging and a production environment.

The first component of the data pipeline is the data layer within the staging environment. This layer is responsible for implementing the connection and harvesting of metadata and data from providers and data integrators. Sources may include FTP folders, websites, ERDDAP catalogues, web APIs, etc. This serves as the internal EMODnet Physics data access engine. EMODnet Physics verifies the availability of sufficient basic metadata and packages the data into datasets that can be consumed by the subsequent layers.

The following standards are applicable:

Table 6. applicable standards

Metadata field	Vocabulary exists	Link to vocabulary	Vocabulary governance
Platform id		https://www.ocean-ops.org/ https://vocab.ices.dk/?ref=1399 https://eurogoos.eu/download/eu-hfradar-inventory-2016/?wpdmdl=9972&refresh=642bf4a58042f1680602277 https://www.ego-network.org/dokuwiki/doku.php?id=public:glidersdeployments https://www.ferrybox.org/routes_data/routes/table_of_routes/index.php.en http://eutgn.marine.ie/geonetwork/srv/ita/catalog.search#/home	OCEANOPS/WMO ICES, EU HFR node EGO (glider) FB Tide Gauge
Owner/provider Institution	Yes	https://edmo.seadatanet.org/	SeaDataNet
qc_method	*	doi	
data_mode	Yes	NRT/DM/REP	EuroGOOS DATAMEQ
variable names	Yes	http://vocab.nerc.ac.uk/collection/P09/current/ http://vocab.nerc.ac.uk/collection/P02/current/ http://vocab.nerc.ac.uk/collection/P01/current/ http://vocab.nerc.ac.uk/collection/P07/current/ https://cfconventions.org /Data/cf-standard-names/79/build/cf-standard-name-table.html	BODC:NVS CF Standard Name Table v29
unit	yes	https://vocab.nerc.ac.uk/collection/P06/current/	BODC:NVS
Quality Flag Scheme	yes	http://www.oceansites.org/docs/oceansites_data_format_reference_manual.pdf https://vocab.seadatanet.org/v_bodc_vocab_v2/search.asp?lib=L20	OceanSites SeaDataNet
Time	yes	ISO8601	ISO
Datum	Yes	WGS84	ISO
Country	yes	ISO3166	ISO
Licence	Yes	https://creativecommons.org/	CC
INSPIRE	Yes	ISO 19115	ISO/INSPIRE

Table 7. applicable parameters vocabulary

Parameters

SDN:P09 MEDATALTAS parameter	long_name	unit	CF standard_name	additional attributes ('O'ptional or 'M'andatory)	SDN Param	SDN UoM
Coordinates						
TIME	Time	days since 1950-01-01T00:00:00Z	time	-	-	-
LATITUDE	Latitude of each location	degree_north	latitude	-	-	-
LONGITUDE	Longitude of each location	degree_east	longitude	-	-	-
DEPH	Depth	m	depth	-	SDN:P01::ADEPZZ01	SDN:P06::ULAA
PRES	Sea pressure	dbar	sea_water_pressure	-	SDN:P01::PRESPR01	SDN:P06::UPDB
Oceanographical						
TEMP	Sea temperature	degrees_C	sea_water_temperature	-	SDN:P01::TEMPPR01	SDN:P06::UPAA
PSAL	Practical salinity	0.001	sea_water_practical_salinity	-	SDN:P01::PSLTZZ01	SDN:P06::UUUU
CNDC	Electrical conductivity	S m-1	sea_water_electrical_conductivity	-	SDN:P01::CNDCZZ01	SDN:P06::UECA
DENS	Sea density (sigma-theta)	kg m-3	sea_water_sigma_theta	-	SDN:P01::SIGTEQ01	SDN:P06::UKMC
SVEL	Sound velocity	m s-1	speed_of_sound_in_sea_water	-	SDN:P01::SVELXXXX	SDN:P06::UVAA
BATH	Bathymetric depth	m	sea_floor_depth_below_sea_surface	-	SDN:P01:MBANZZZZ	SDN:P06::ULAA
HCSP	Horizontal current speed	m s-1	sea_water_speed	-	SDN:P01::LCSAZZ01	SDN:P06::UVAA
HCDT	Current to direction relative true north	degree	direction_of_sea_water_velocity	-	SDN:P01::LCDAZZ01	SDN:P06::UABB
EWCT	West-east current component	m s-1	eastward_sea_water_velocity	-	SDN:P01::LCEWZZ01	SDN:P06::UVAA
NSCT	South-north current component	m s-1	northward_sea_water_velocity	-	SDN:P01::LCNSZZ01	SDN:P06::UVAA
VCSP	Bottom-top current component	m s-1	upward_sea_water_velocity	-	SDN:P01::LRZAZZZZ	SDN:P06::UVAA
RDVA [2][3]	Radial sea water velocity away from instrument	m s-1	radial_sea_water_velocity_away_from_instrument	-	SDN:P01::LCSAWVRD	SDN:P06::UVAA
DRVA [2][3]	Direction of radial vector away from instrument	degree_true	direction_of_radial_vector_away_from_instrument	-	SDN:P01::LCDAWVRD	SDN:P06::UABB
Sea Level						

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SLEV	Water surface height above a specific datum	m	water_surface_height_above_reference_datum	time_sampling = n (M, in minutes) sea_level_datum = "chart datum", "geodetic datum", "…" (M) processing_method = "instantaneous values", "filtered values", "average", "…" (M) TGBM_name = "…" (O) TGBM_sea_level_datum = n (O) co_location_with_GNSS = "*Distance* (km)", "No", "Unknown" (O) TGBM_ellipsoidal_height_estimate = n (O) vertical_land_movement_estimate = "*trend (mm/year) - period*", "unknown" (O) GNSS_campaign = "Yes", "No" (O) comment="…" (O)	SDN:P01::ASLVZZ01	SDN:P06::ULAA
Waves						
VGHS [2]	Generic significant wave height (Hs)	m	sea_surface_wave_significant_height	type_of_analysis="unknown" (M)	SDN:P01::GTDHZZ01	SDN:P06::ULAA
VHM0	Spectral significant wave height (Hm0)	m	sea_surface_wave_significant_height	type_of_analysis="spectral analysis" (M)	SDN:P01::HMZEZZ01	SDN:P06::ULAA
VAVH	Average height highest 1/3 wave (H1/3)	m	sea_surface_wave_significant_height	type_of_analysis="zero crossing" (M)	SDN:P01::GAVHZZ01	SDN:P06::ULAA
VH110 [2]	Average height highest 1/10 wave (H1/10)	m	sea_surface_wave_mean_height_of_highest_tenth	type_of_analysis="zero crossing" (M)	SDN:P01::GTDTZZ01	SDN:P06::ULAA
VHZA [2]	Average zero crossing wave height (Hzm)	m	sea_surface_wave_mean_height	type_of_analysis="zero crossing" (M)	SDN:P01::HZAVZZ01	SDN:P06::ULAA
VEMH [2]	Estimated maximum wave height	m	sea_surface_wave_maximum_height	type_of_analysis="unknown" (M)	SDN:P01::GCMXVS01	SDN:P06::ULAA
VZMX	Maximum zero crossing wave height (Hmax)	m	sea_surface_wave_maximum_height	type_of_analysis="zero crossing" (M)	SDN:P01::GZMXZZ01	SDN:P06::ULAA
VCMX	Maximum crest trough wave height (Hc,max)	m	sea_surface_wave_maximum_height	type_of_analysis="crests" (M)	SDN:P01::GCMXZZ01	SDN:P06::ULAA
VMNL [2]	Depth of the deepest trough	m	sea_surface_wave_maximum_trough_depth	type_of_analysis="crests" (M)	SDN:P01:GMNLZZ01	SDN:P06::ULAA
VMXL	Height of the highest crest	m	sea_surface_wave_maximum_crest_height	type_of_analysis="crests" (M)	SDN:P01::GMXLZZ01	SDN:P06::ULAA

VEPK	Wave spectrum peak energy (Smax)	m2 s	sea_surface_wave_energy_at_variance_spectral_density_maximum	type_of_analysis="spectral analysis" (M)	SDN:P01::GEPKZZ01	SDN:P06::UMHZ
VTM10 [2]	Spectral moments (-1,0) wave period (Tm-10)	s	sea_surface_wave_mean_period_from_variance_spectral_density_inverse_frequency_moment	type_of_analysis="spectral analysis" (M)	SDN:P01::GTZAMIZZ	SDN:P06::UTBB
VTM02 [2]	Spectral moments (0,2) wave period (Tm02)	s	sea_surface_wave_mean_period_from_variance_spectral_density_second_frequency_moment	type_of_analysis="spectral analysis" (M)	SDN:P01::GTZAM2ZZ	SDN:P06::UTBB
VTZA	Average zero crossing wave period (Tz)	s	sea_surface_wave_mean_period	type_of_analysis="zero crossing" (M)	SDN:P01::GTZAZZ01	SDN:P06::UTBB
VGTA [2]	Generic average wave period	s	sea_surface_wave_mean_period	type_of_analysis="unknown" (M)	SDN:P01::GTAMZZ01	SDN:P06::UTBB
VTPK	Wave period at spectral peak / peak period (Tp)	s	sea_surface_wave_period_at_variance_spectral_density_maximum	type_of_analysis="spectral analysis" (M)	SDN:P01::GTPKZZ01	SDN:P06::UTBB
VAVT	Average period highest 1/3 wave (T1/3)	s	sea_surface_wave_significant_period	type_of_analysis="zero crossing" (M)	SDN:P01::GTZHZZ01	SDN:P06::UTBB
VT110 [2]	Average period highest 1/10 wave (T1/10)	s	sea_surface_wave_mean_period_of_highest_tenth	type_of_analysis="zero crossing" (M)	SDN:P01::GTZHTN01	SDN:P06::UTBB
VTMX [2]	Maximum wave period (Tmax)	s	sea_surface_wave_maximum_period	type_of_analysis="zero crossing" (M)	SDN:P01::GTZMZZ01	SDN:P06::UTBB
VTZM [2]	Period of the highest wave (Thmax)	s	sea_surface_wave_period_of_highest_wave	type_of_analysis="zero crossing" (M)	SDN:P01::GTHMXX01	SDN:P06::UTBB
VMDR	Mean wave direction from (Mdir)	degree	sea_surface_wave_from_direction	type_of_analysis="spectral analysis" (M)	SDN:P01::GMWDZZ01	SDN:P06::UABB
VDIR	Wave direction rel. true north	degree	sea_surface_wave_from_direction	type_of_analysis="unknown" (M)	SDN:P01::GWDRZZ01	SDN:P06::UABB
VPED	Wave principal direction at spectral peak	degree	sea_surface_wave_from_direction_at_variance_spectral_density_maximum	type_of_analysis="spectral analysis" (M)	SDN:P01::GPEDZZ01	SDN:P06::UABB
VST1 [2]	Maximum wave steepness	1	sea_surface_wave_maximum_steepness	-	SDN:P01::WVSTZZ01	SDN:P06::UUUU
VPSP	Wave directional spreading at spectral peak	degree	sea_surface_wave_directional_spread_at_variance_spectral_density_maximum	type_of_analysis="spectral analysis" (M)	SDN:P01::GSPRZZ01	SDN:P06::UAAA
VSPEC1D [2][4]	Wave scalar spectral density	m2 s	sea_surface_wave_variance_spectral_density	type_of_analysis="1st order spectral analysis" (M)	*TBD*	*TBD*
THETA1 [2][4]	Mean wave from direction	degree	sea_surface_wave_from_direction	type_of_analysis="1st order spectral analysis" (M)	*TBD*	*TBD*
STHETA1 [2][4]	Directional spread around THETA1	degree	sea_surface_wave_directional_spread	type_of_analysis="1st order spectral analysis" (M)	*TBD*	*TBD*
THETA2 [2][4]	Principal wave from direction	degree	sea_surface_wave_from_direction	type_of_analysis="2nd order spectral analysis" (M)	*TBD*	*TBD*

STHETA2 [2][4]	Directional spread around THETA2	degree	sea_surface_wave_directional_spread	type_of_analysis="2nd order spectral analysis" (M)	*TBD*	*TBD*
BGC						
DOXY	Dissolved oxygen	mmol m-3	mole_concentration_of_dissolved_molecular_oxygen_in_sea_water	last_calibration_date="YYYY-MM-DD" (O) calibration_method="…" (O) used_salinity=value or salinity="*varname*" (O) used_temperature=value or temperature="*varname*" (O) used_pressure=value or pressure="*varname*" (O) compensated="YES","NO" (O - default="YES")	SDN:P01::DOXYZZXX	SDN:P06::UPOX
DOX1	Dissolved oxygen	ml l-1	volume_fraction_of_oxygen_in_sea_water	last_calibration_date="YYYY-MM-DD" (O) calibration_method="…" (O) used_salinity=value or salinity="*varname*" (O) used_temperature=value or temperature="*varname*" (O) used_pressure=value or pressure="*varname*" (O) compensated="YES","NO" (O - default="YES")	SDN:P01::DOXYZZXX	SDN:P06::UMLL
DOX2	Dissolved oxygen	μmol kg-1	moles_of_oxygen_per_unit_mass_in_sea_water	last_calibration_date="YYYY-MM-DD" (O) calibration_method="…" (O) used_salinity=value or salinity="*varname*" (O) used_temperature=value or temperature="*varname*" (O) used_pressure=value or pressure="*varname*" (O) compensated="YES","NO" (O - default="YES")	SDN:P01::DOXMZZXX	SDN:P06::KGUM

OSAT	Oxygen saturation	%	fractional_saturation_of_oxygen_in_sea_water	last_calibration_date="YYYY-MM-DD" (O) calibration_method="…" (O) used_salinity=value or salinity="*varname*" (O) used_temperature=value or temperature="*varname*" (O) used_pressure=value or pressure="*varname*" (O) compensated="YES","NO" (O - default="YES")	SDN:P01::OXYSZZ01	SDN:P06::UPCT
PCO2	CO2 partial pressure	µatm	surface_partial_pressure_of_carbon_dioxide_in_sea_water	-	SDN:P01::PCO2XXXX	SDN:P06::UATM
FCO2	CO2 fugacity	µatm	fugacity_of_carbon_dioxide_in_sea_water	-	SDN:P01::FCO2XXXX	SDN:P06::UATM
CPHL	Chlorophyll-a	mg m-3	mass_concentration_of_chlorophyll_a_in_sea_water	last_calibration_date="YYYY-MM-DD" (O) calibration_method="…" (O) laboratory_technique="HPLC","spectrophotometry","fluorometry_analysis","…" (O) laboratory_method="…" (O)	SDN:P01::CPHLZZXX	SDN:P06::UMMC
CHLT	Total chlorophyll	mg m-3	mass_concentration_of_chlorophyll_in_sea_water	-	SDN:P01::CHLTVOLU	SDN:P06::UMMC
FLU2	Chlorophyll-a fluorescence	mg m-3	mass_concentration_of_chlorophyll_a_fluorescence_in_sea_water [1]	last_calibration_date="*YYYY-MM-DD*" (O) calibration_method="…" (O) proxy_method="…" (O) last_proxy_method_date="*YYYY-MM-DD*" (O)	SDN:P01::CPHLPM01	SDN:P06::UMMC
CDOM	Cdom	1e-9	concentration_of_colored_dissolved_organic_matter_in_sea_water_expressed_as_equivalent_mass_fraction_of_quinine_sulfate_dihydrate	-	SDN:P01::FLUOCDOM	SDN:P06::UUUU
TUR4	Turbidity	1	sea_water_turbidity	last_calibration_date="YYYY-MM-DD" (O) calibration_method="…" (O)	SDN:P01::TURBXXXX	SDN:P06::USTU
TSMP	Total suspended matter	g m-3	mass_concentration_of_suspended_matter_in_sea_water	-	SDN:P01::TSEDZZZZ	SDN:P06::UMGL
ALKY	Total alkalinity	mmol m-3	sea_water_alkalinity_expressed_as_mole_equivalent	-	SDN:P01::ALKYZZXX	SDN:P06::UPOX
ALKW	Total alkalinity	µmol kg-1	sea_water_alkalinity_per_unit_mass [1]	-	SDN:P01::MDMAP014	SDN:P06::KGUM

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PHPH	Ph	1	sea_water_ph_reported_on_total_scale	-	SDN:P01::PHXXZZXX	SDN:P06::UUPH
Meteorological						
WSPD	Horizontal wind speed	m s-1	wind_speed	-	SDN:P01::EWSBZZ01	SDN:P06::UVAA
WDIR	Wind from direction relative true north	degree	wind_from_direction	-	SDN:P01::EWDAZZ01	SDN:P06::UABB
GSPD	Gust wind speed	m s-1	wind_speed_of_gust	-	SDN:P01::EGTSZZ01	SDN:P06::UVAA
GDIR	Gust wind from direction relative true north	degree	wind_gust_from_direction	-	SDN:P01::EGTDZZ01	SDN:P06::UABB
WSPE	West-east wind component	m s-1	eastward_wind	-	SDN:P01::ESEWZZXX	SDN:P06::UVAA
WSPN	South-north wind component	m s-1	northward_wind	-	SDN:P01::ESNSZZXX	SDN:P06::UVAA
WBFO	Beaufort wind force	1	beaufort_wind_force	-	SDN:P01::WMOCWFBF	SDN:P06::UUUU
DRYT	Air temperature in dry bulb	degrees_C	air_temperature	-	SDN:P01::CTMPZZ01	SDN:P06::UPAA
WETT	Air temperature in wet bulb	degrees_C	wet_bulb_temperature	-	SDN:P01::CWETZZ01	SDN:P06::UPAA
DEWT	Dew point temperature	degrees_C	dew_point_temperature	-	SDN:P01::CDEWZZ01	SDN:P06::UPAA
RELH	Relative humidity	%	relative_humidity	-	SDN:P01::CRELZZ01	SDN:P06::UPCT
ATMS	Atmospheric pressure at sea level	hPa	air_pressure_at_sea_level	-	SDN:P01::CAPAZZ01	SDN:P06::UPBB
ATMP	Atmospheric pressure at altitude	hPa	air_pressure	-	SDN:P01::CAPHZZ01	SDN:P06::UPBB
ATPT	Atmospheric pressure hourly tendency	hPa h-1	tendency_of_air_pressure	-	SDN:P01::APRESSTN	SDN:P06::HPAH
RVFL	River flow rate	m3 s-1	water_volume_transport_into_sea_water_from_rivers	-	SDN:P01::RFDSCH01	SDN:P06::CMPS
PRRT	Hourly precipitation rate (liquid water equivalent)	mm h-1	lwe_precipitation_rate	-	SDN:P01::CPRRRG01	SDN:P06::MMPH

This dynamic vocabulary primarily pertains to parameters. It is continuously updated, and when a new term is required, the following workflow is applied:

How do I submit a request to the NERC Vocab Server?

1. If you know the collection that needs to be updated then create an issue ticket on GitHub.com/nvs-vocabs/{ID} where ID is the collection ID e.g. P06 or L22 or P01 (please indicate the project, network or activity this comes under)
2. If you are part of a community with a dedicated GitHub repo (e.g. EMODnetChemVocabs) then create a ticket in that repo so that the community can discuss the proposal
3. If you have been inducted to use the Vocab Editor or the Vocab Builder then use these direct routes
4. For anything else please email vocab.services@bodc.ac.uk
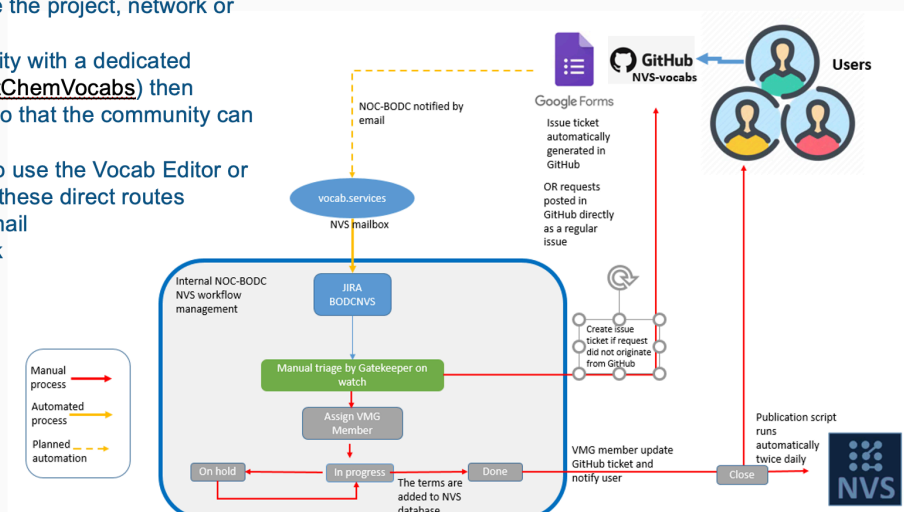
National Oceanography Centre | British Oceanographic Data Centre

noc.ac.uk | bodc.ac.uk

Figure 11. NVS new term submission procedure

Different sources are amalgamated into a single collection, which is then made accessible to the service and cataloguing layer. The service layer serves as the FAIR module, providing data and products to both internal consumers (Physics and Central Portal through the prod-env) and external consumers. This layer is responsible for operating data publishing services such as ERDDAP datasets and GeoServer Layers. Both the staging and production environments incorporate the EMODnet Physics service layer. The prod-env is responsible for organizing and publishing the official EMODnet Physics data products and implementing interoperability with the Central Portal system.

A comprehensive list of data collections and products can be found in deliverables D2.17 and D3.15.

Task 5. Contributing content to dedicated spaces in Central Portal

This task involves activities aimed at assisting the Central Portal team in promoting and facilitating the centralization phase and advancing the harmonization of the EMODnet single identity. These activities encompass organizing static content within the emodnet.ec central space, engaging stakeholders to present use cases (https://emodnet.ec.europa.eu/en/use-cases), and providing support for compiling the EMODnet annual reports (v.2022 has been just published[3] - June 2023)

Figure 12. https://emodnet.ec.europa.eu/en/physics

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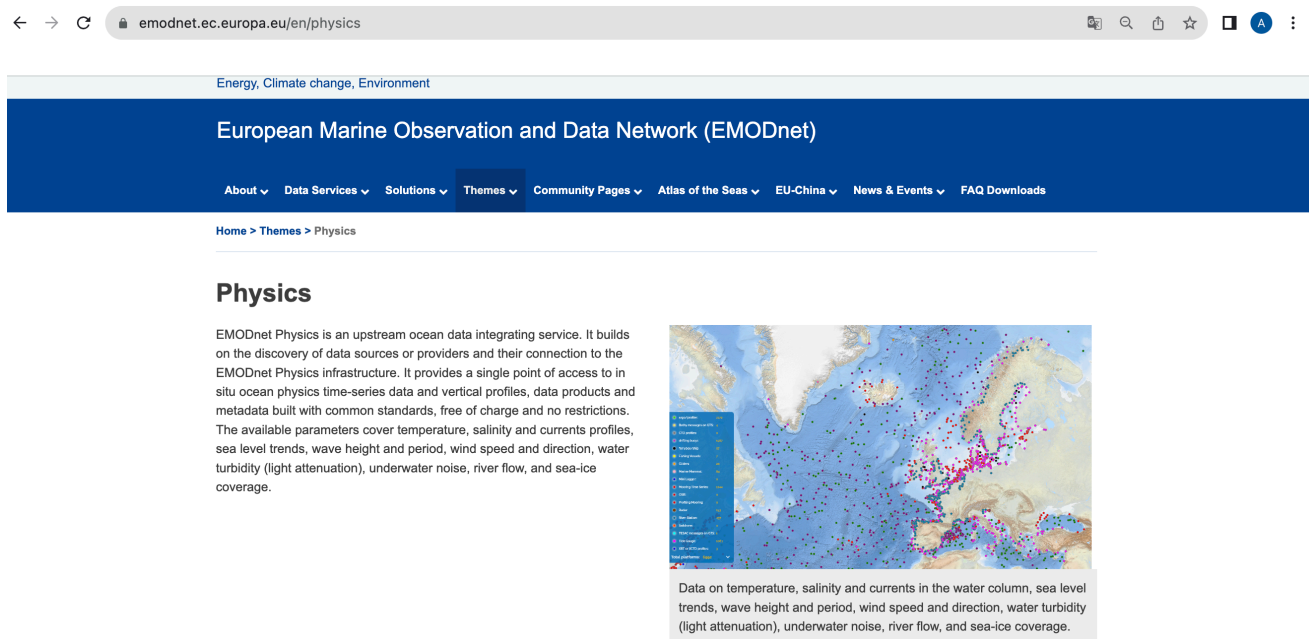
[3] https://emodnet.ec.europa.eu/sites/emodnet.ec.europa.eu/files/public/EMODnet_AnnualReport2022_June2023_FINAL.pdf
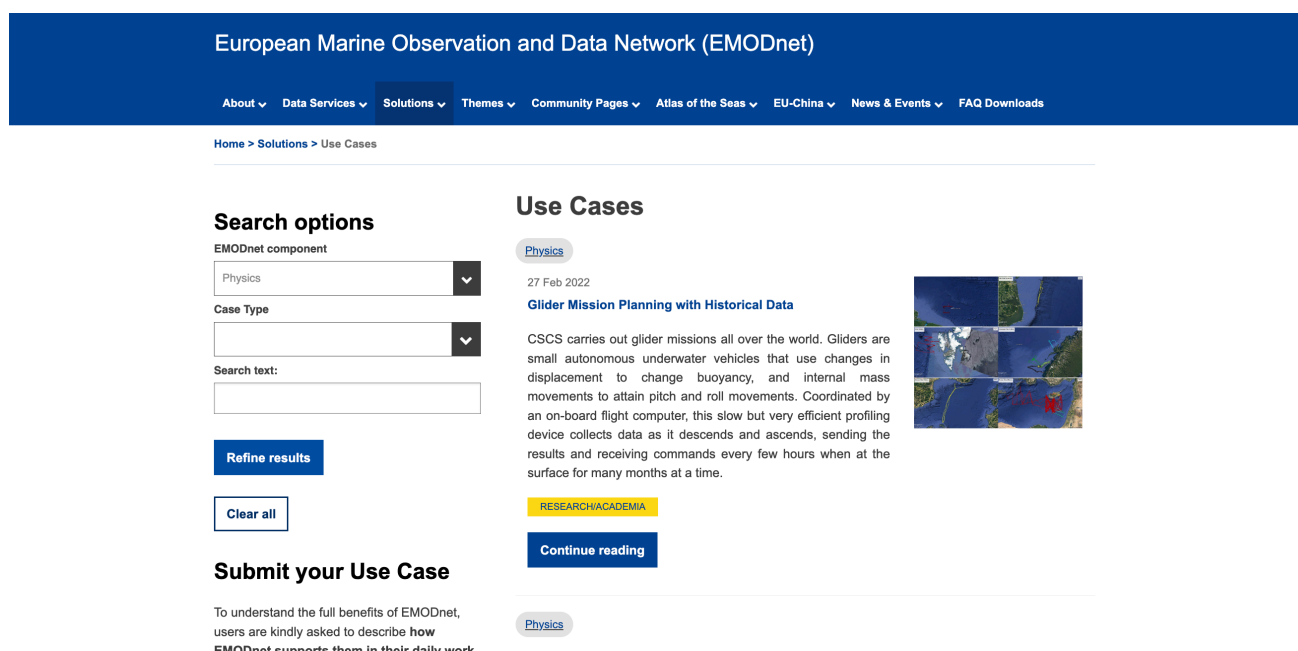
Figure 13. EMODnet Physics use cases[4]

This task also involves promotional and dissemination activities in joint events and meetings. EMODnet Physics is particularly active in this regard, having participated in more than 120 events. Notably, special mention goes to the "Ocean Data Hours" and "Ocean Data Week" events. These events were organized to engage new stakeholders, with a focus on citizen science initiatives and cost-effective technologies for ocean data collection.

The events took place in the Genova Pavilion at the Ocean Race Villages and featured roundtables, presentations, and pitches on the ocean data value chain. The Ocean Data Week event had more than 110 speakers, over 25 hours of live streaming, more than 300 attendees in person, and over 700 web views (the recordings are available online at ettsolutions.com/oceanrace). These events placed a central emphasis on EMODnet, FAIRness, interoperability, and open data. Notably, EMODnet Physics was invited to present at the event titled "Mission 'Restore our Ocean and Waters by 2030," organized by the EC, Comune di Genova, with the support of the LIFE4MEDECA and BlueMissionMed projects.

Task 6. Ensure the involvement of regional sea conventions

Regional Sea Conventions (RSC) are organizational structures that assist Member States (MS) in coordinating actions to address specific environmental pressures and ecosystems. Additionally, RSCs serve as advisory and stakeholder boards for guiding the implementation of the Marine Strategy Framework Directive (MSFD). EMODnet Physics has actively engaged with RSCs, with a specific focus on addressing underwater noise, which is one of the emerging areas of particular concern. This collaboration has occurred within the framework of the Technical Group TG NOISE and by supporting the advisory and stakeholder board[5] of regional MSFD

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[4] https://emodnet.ec.europa.eu/en/use-cases?field_portal_taxonomy_tid=28&body_value=

[5] Either the EMODnet Physics coordinator or ICES or both

projects (…). The MSFD is reaching the end of its second cycle (deadline for reporting by MS was end 2022). The third cycle will start in 2024, with first assessment of state, definition of GES and targets (Art. 8, 9, 10). Lately, TG NOISE published the guidance documents[6] for setting the thresholds framework:

- Setting EU Threshold Values for impulsive underwater sound - ISBN 978-92-68-03343-2
- Setting EU Threshold Values for continuous underwater sound - ISBN 978-92-68-03349-4

These documents will assist Member States in developing tools for managing and monitoring underwater noise. In this context, EMODnet Physics serves as the candidate European integration endpoint for accessing in-situ data required for assessments, such as underwater noise background recordings used to establish reference values. EMODnet Physics is fully prepared to connect and incorporate these new data products into its system.

Figure 14. picture from the opening session of SOOS Symposium 2023 - 14/8/2023 (Hobart, Australia)

Task 7. Contribute to the implementation of EU legislation and broader initiatives for open data

EMODnet partners have gained significant experience in organizing and processing data into validated and aggregated collections, which are valuable for stakeholders involved in the implementation of the Marine Strategy Framework Directive (MSFD). Particularly, EMODnet Physics is addressing a notable data gap (as shown in Figure 15 from the FP7 Perseus project) related to the availability of data for Indicator 7 (Alteration of hydrographical conditions) through river data and Indicator 11 (underwater noise).

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[6] EMODnet Physics team as co-authors
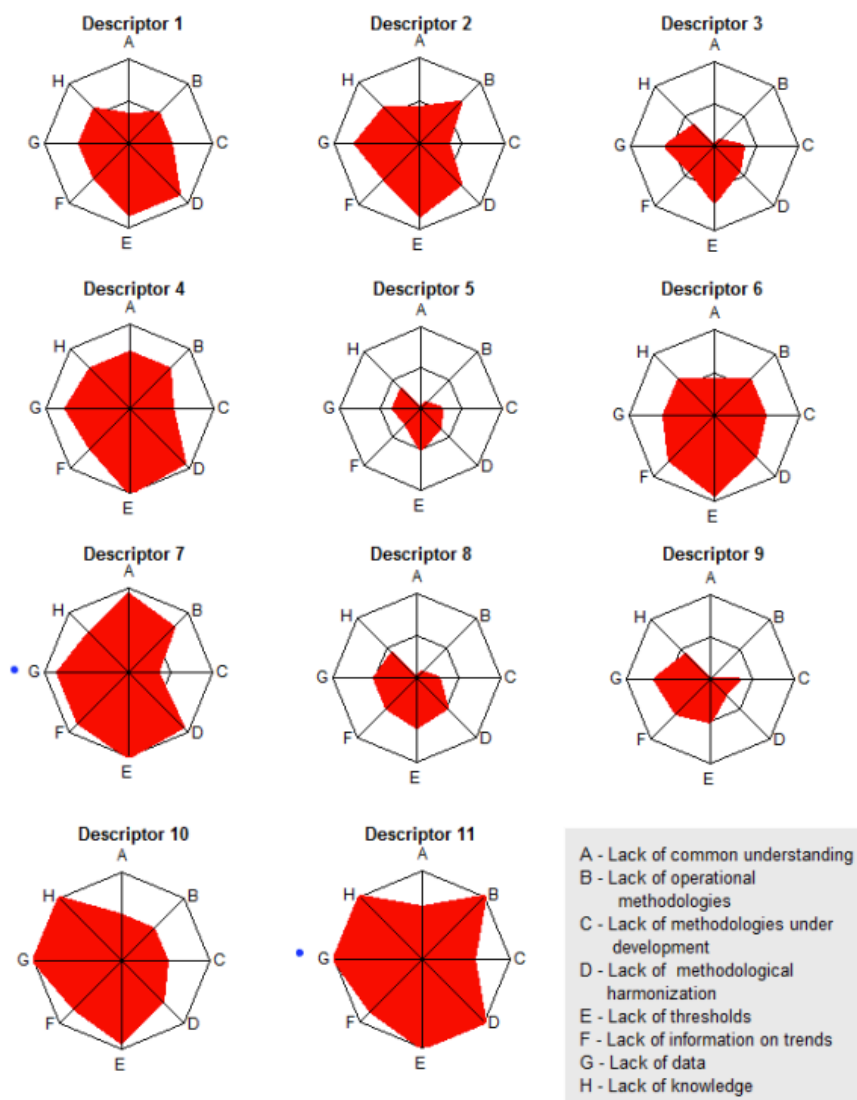
Figure 15. Gap analysis on MSFD from the Perseus project[7]

Moreover, as part of the EMODnet community, there is direct communication with GES assessment experts from DG Environment, EEA, and regional Sea Conventions (OSPAR, HELCOM, UNEP-MAP, and the Black Sea Commission). This communication occurs through regular participation in European Technical Groups (e.g., TG NOISE, …). The purpose of this activity is to engage with stakeholders, assist EU Member States in fulfilling reporting obligations (e.g., through involvement with TG-DATA, Member States Expert Group on Spatial Planning), maintain compatibility with European Open Data Portal, EOSC, Digital Earth, or other EU-wide initiatives. This activity also involves interacting with other relevant EU initiatives and parties, with a specific focus on disseminating data along coasts, aiming to establish seamless data provision between coastal land and sea. In this framework, EMODnet Physics contributes to a series of events, workshops, and documents (e.g., EuroSEA, European Marine Days, Copernicus Marine Service, EuroGOOS DataMEQ, etc.) on common

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[7] http://www.perseus-net.eu/assets/media/PDF/deliverables/2840.pdf

standards and open-data (see Table 14 for the full list of events), as well as the promotion for open data (CC-BY). As clearly stated during the SOOS Symposium 2023, without a clear understanding of the Southern Oceans, you cannot comprehend the behavior of the Global Oceans. Therefore, the collaboration and contribution of EMODnet Physics to the SOOS community are key enabling factors. SOOS has made significant contributions to IPCC and the latest COP26/27 reports. SOOS reports rely on data available on the SOOSmap, which is powered and maintained thanks to EMODnet Physics.

Task 8. Monitor quality/performance and deal with user feedback

Generally, the very first feedback and result is an increased level of collaboration among the different actors of data collection, validation, and integration. EMODnet, and in particular EMODnet Physics, has helped shift the cultural attitude from considering "my data" to "our data." This shift in mindset, combined with the adoption of tools (standards and tools) to facilitate and enable interoperability, has contributed to making FAIRness a tangible concept.

One of the most significant achievements is the strong and daily collaboration with the Copernicus Marine Service IN SITU Thematic Assembly Center. The extended team, recently named MIC (marine in situ collaboration), takes pride in the joint results. Serving as a unique backbone team, this collaboration facilitates interaction with all European and international actors, providing a unified voice for the benefit of the two major European marine-related programs, EMODnet and Copernicus Marine.

Moving towards more technical achievements, EMODnet Physics has made substantial contributions to refining the data management and dissemination pipeline. Being among the earliest adopters, integrators, and explorers of new technologies (such as HF radars, river data ERDDAP, Citizen Science data, and open data/tools access), the EMODnet Physics team has gained recognition and support from the community.

The ability to find, preview, download, and reuse data (both operational and research-based data) for scientific purposes and other applications has served a wide range of users from different sectors. The user statistics indicate that 60% of users are from academic institutions, 19% from businesses, 11% from government organizations, and 10% from NGOs (overall statistics until centralization). EMODnet Physics has consistently followed the philosophy of making data just two clicks away from the user. This approach remains the same with the EMODnet Physics thematic area under the Central Portal. EMODnet Physics hosts very large collections (e.g., sea level, surface currents, etc.), providing users with an easy, single platform to find the needed information. In the case of river runoff data, EMODnet Physics stands as the most important operational data provisioning platform (ETOOFS report 2022)[8], Making the system crucial for an increasing number of users, in chronological order, currents from HFR, wind, sea level, and river data are the products that we value the most. Likely, as they are the most requested, they are the ones that users value the most. In addition, the strong cooperation and involvement of the team in thematic groups (e.g., EuroGOOS Working Groups and Task Teams) help collect stakeholders' feedback, understand needs, assess the fit-for-scope of the system, and implement corrective actions to better match the stakeholders' expectations.

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[8] E Alvarez Fanjul et al 2022

EMODnet Physics also runs a service desk. Requests are collected centrally through the Central Portal, and a JIRA ticket is recorded and passed to the thematic team. Once the JIRA ticket reaches the EMODnet Physics team, it follows the already implemented workflow, which includes a first level of interaction (help desk level 1). HDL1 provides the most exhaustive feedback within 24 hours. In case HDL1 cannot address the user request, a second level of expertise, HDL2, is involved in the process with the aim of providing the user with feedback as soon as possible. HDL2 involves the full partner network of experts and EMODnet Physics contributors. GRDP is applied to the management of user requests. Task 8 also monitors the status (availability) of the services, and since the entry into force of the Central Portal, it focuses on performance (https://monitor.emodnet.eu/) and users' interactions (Europa Analytics) with the Physics contents in the Central Space.

Task 9.   Maintain the existing thematic web portal for a maximum of six months from the start of the projects

This task was fully achieved with the launch of the new Central Portal, early in 2023.

Table 8. Milestones and Deliverables - EASME/EMFF/2020/3.1.11/Lot4/SI2.83861

Status of the Milestones and Deliverables listed in the workplan				
Milestone/Deliverable	**WP**	**Date due**	**Status (Delivered/Delayed)**	**If Delayed: reason for delay and expected delivery date**
D1.1 Kick off Meeting	1	30/11/2021	8 November 2021	
D1.2 Annual assembly	1	30/11/2022	28-29 June 2023	(split session with core team during the Ocean Data Week at the Ocean Race Grand Finale)
D1.3 EMODnet SC	1	30/11/2021	8-10 September 2021	
D1.4 EMODnet TWG	1	30/11/2021	8-10 September 2021	
D1.5 EMODnet SC	1	31/05/2022	27-28 April 2022	
D1.6 EMODnet TWG	1	31/05/2022	26 April 2022	
D1.7 EMODnet SC	1	31/08/2022	18 July 2022	
D1.8 EMODnet TWG	1	31/08/2022	18 July 2022	
D1.9 EMODnet SC	1	30/11/2022	7-8 November 2022	
D1.10 EMODnet TWG	1	30/11/2022	21-22 September	
D1.11 EMODnet plenary event	1	31/12/2021	8-9 November 2021	The EMOdnet Physics KOM was organized in two session, the first one was closed to core partner (D1.1) the second was a plenary with invited speech about previous and recent developments of the EMODnet Physics networks and collaborators
D1.12 EMODnet plenary event	1	30/06/2022	12-13 April 2022	INS data ingestion WS. The event is involving EMODnet (Physics, Chemistry and Ingestion), CMEMS INSTAC and EurGOOS to discuss about joint actions for facilitating nrt operational data ingestion
D1.13 EMODnet plenary event	1	31/12/2022	4 October 2022. EMODnet Physics organized a special session during the MetroSEA2022 IEEE conference 21-24 November 2022. EMODnet Physics supported the organization of both the European HFR task team assembly and the MONGOOS annual workshop and assembly.	

D1.14 EMODnet plenary event	1	30/06/2023	the Ocean Data Week – The Ocean Race Grand Finale Genova 2023[9]	
D1.15 Quarterly report Q3.2021	1	15/10/2021	Delivered 15/10/2021	
D1.16 Quarterly report Q4.2021	1	15/01/2022	Delivered 15/01/2022	
D1.17 Quarterly report Q1.2022	1	15/04/2022	Delivered 15/04/2022	
D1.18 Quarterly report Q2.2022	1	15/07/2022	Delivered 15/07/2022	
D1.19 Quarterly report Q3.2022	1	15/10/2022	Delivered 15/09/2022	
D1.20 Quarterly report Q4.2022	1	15/01/2023	Delivered 15/1/2023	
D1.21 Quarterly report Q1.2023	1	15/04/2023	Delivered 15/4/2023	
D1.22 Quarterly report Q2.2023	1	15/07/2023	Delivered 15/7/2023	
D1.23 Annual progress report	1	23/08/2022	Delivered 23/8/2022	
D1.24 Final progress report	1	23/08/2023	Delivered 23/8/2023	This report
D1.25 Handover note	1	23/08/2023	Delivered 23/8/2023	See Annex
D1.26 EMODnet Physics note for Annual Report 2021	1	31/01/2022	Delivered (January 2022)	
D1.27 EMODnet Physics note for Annual Report 2022	1	31/01/2023	Delivered (March 2023)	
D1.28 EMODnet Ingestion general assembly 2021	1	30/11/2021	21-22 September 2021	
D1.29 EMODnet Ingestion general assembly 2022	1	30/11/2022	16-17 April 2022	
D1.30 Guideline on data ingestion procedures for new real time and near real time streams v.2022	1	31/08/2022	Delivered (August 2022)	
D1.31 Guideline on data ingestion procedures for new real time and near real time streams v.2023	1	23/08/2023	Delivered 23/8/2023	See Annex
D1.32 Use cases 2021	1	31/12/2021	CMCC delivered (Dec 2021) OGS delivered (Feb 2022)	

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[9] https://ettsolutions.com/oceanrace/

![EMODnet logo - European Marine Observation and Data Network]

D1.33 Use cases 2022	1	31/12/2022	CSCS delivered (Feb 2022) OceanGlider delivered (Feb2022)	
D1.34 Use cases 2023	1	23/08/2023		EMODnet Physics has been central in many presentations of the Ocean Data Week, many speakers awarded the support for setting up the ERDDAP, or for accessing the data or products. Yet to collect an official (new) use case in 2023
D1.35 Contribution to central space with background information and EMODnet Physics content	1	28/02/2022	In progress – tracked with JIRA	
D1.36 TGs - RSCs event attendance	1	31/12/2021	TG NOISE WS "towards EU thresholds for underwater noise", 13-14 Sept 2021	
D1.37 TGs - RSCs events sattendance	1	30/06/2022	TG NOISE WS: Towards EU threshold values for underwater noise (17/02/2022) 20th TG-NOISE – 22/03/2022	TG NOISE doc library[10]
D1.38 TGs - RSCs events attendance	1	31/12/2022	21st TG-NOISE – 24/05/2022	This event was attended by partners ICES and CTN.
D1.39 TGs - RSCs events attendance	1	30/06/2023	22nd TG-NOISE – 11/10/2022 23rd TG-NOISE – 21/02/2023	This event was attended by partners ICES and CTN.
D2.1. Data Inventory with gap analysis v.2021	2	31/12/2021	V.2021 attached to Q1.2022	EMODnet Physics_Inventory_v.2021.03
D2.2 Data Inventory with gap analysis v.2022	2	31/08/2022	V.2022 attached to Interim Report	
D2.3 Data Inventory with gap analysis v.2023	2	23/08/2023	Delivered 23/8/2023	See Annex
D2.4 EMODnet Physics Event/Workshop	2	31/12/2021	Delivered – (15/1/2022) - updates are described in the quarterly report Q4.2021 – Section 4	
D2.5 EMODnet Physics Event/Workshop	2	30/06/2022	Delivered – (15/4/2022) - updates are described in the quarterly report Q1.2022 – Section 4	

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[10] https://circabc.europa.eu/ui/group/326ae5ac-0419-4167-83ca-e3c210534a69/library/89b98517-6283-4d3a-abd0-3a716661b370?p=1

D2.6 EMODnet Physics Event/Workshop	2	31/12/2022	EMODnet team organized the special session on Data System Networking and Interoperability Technology and Methodology at the IEEE MetroSea 2022 (3-5 October 2022)	
D2.7 EMODnet Physics Event/Workshop	2	30/04/2023	Ocean Data Hours @ Ocean Race: 23/02/2023 - CapeTown 18/05/2023 – Newport (RI) 05/06/2023 – Aarhus 12/06/2023 – The Hague 26-30/06/2023 - Genova	
D2.8 Report on the maintenance and update of the EMODnet Physics smart connectors v.2022	2	31/08/2022	Delivered 23/08/2022	Annex to Interim Report I.2022
D2.9 Report on the maintenance and update of the EMODnet Physics smart connectors v.2023	2	23/08/2023	Delivered 23/8/2023	See Annex
D2.10 EMODnet Physics Handbook on data management	2	31/08/2022	Delivered 23/08/2022	Annex to Interim Report I.2022
D2.11 Support to develop common strategy and guideline for adoption cloud technologies	2	23/08/2023	Discussion is developed within the TWG in support of the digital twin of the ocean initiative	
D2.12 EMODnet Physics Metadata handbook and examples	2	31/08/2022	Delivered 23/08/2022	Annex to Interim Report I.2022
D2.13 Report on dissemination system interfaces update v.2022	2	31/08/2022	Delivered 23/08/2022	Annex to Interim Report I.2022
D2.14 Report on dissemination system interfaces update v.2023	2	23/08/2023	Delivered 23/8/2023	See Annex
D2.15 Updated list of EMODnet Physics products v.2021	2	31/12/2021	Delivered 15/1/2022	
D2.16 Updated list of EMODnet Physics products v.2022	2	31/08/2022	Delivered 23/08/2022	Annex to Interim Report I.2022
D2.17 Updated list of EMODnet Physics products v.2023	2	23/08/2023	Delivered 23/8/2023	See Annex
D2.18 SSS v.2020	2	28/02/2022	Released[11]	
D2.19 SSS v.2021	2	28/02/2023	Released[12]	

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[11] https://prod-erddap.emodnet-physics.eu/erddap/griddap/CISC-BEC-SSS.html

[12] https://prod-erddap.emodnet-physics.eu/erddap/info/MULTIOBS_GLO_PHY_SSS_L4_MY_015_015/index.html

D2.20 River Proxy V1.0	2	31/12/2021	Released[13]	
D2.21 River Proxy V2.0	2	31/08/2022	31/12/2022	Physics and Chemistry are working on a new river product (limited number of rivers) that includes both outflow, temperature and salinity. Release postponed to end of the year
D2.22 River Proxy V3.0	2	23/08/2023		
D2.23 INS RVFL DB v.1.0	2	31/08/2022	Released[14]	
D2.24 TSM v.2021	2	28/02/2023	Partially Released	At the time of writing the products includes some of the targeted RROI, the others are going to be progressively added
D2.25 SLEV INS DB	2	31/12/2021	Released[15]	
D2.26 SLEV REL TRENDS	2	31/08/2022	Released[16]	
D2.27 SLEV ABS TRENDS	2	31/08/2022	Released[17]	
D2.28 SLEV REL ANOM	2	31/08/2022	31/12/2022	SONEL, which is the provider for this product is developing a new workflow to facilitate harvesting from Physics. Only lately it was possible to start this action and should be possible to close and include the new product by end of the year
D2.29 SLEV ATL ABS TREND	2	31/08/2022	Released[18]	
D2.30 RFVL v.1	2	28/02/2023	Released	Fully operational, with continuous updates, directly towards the CP
D2.31 UWN ROI v.1.0	2	31/08/2022	Released[19]	
D2.32 WAVE INS DB+ NOWCAST v.2.0	2	28/02/2022	Delayed	The product is not covering whole Europe (hence it is not

[13] https://products.emodnet-physics.eu/EP_MAP_RVFL_001/

https://prod-erddap.emodnet-physics.eu/erddap/tabledap/ERD_EP_RVFL_NRT.html

[14] https://prod-erddap.emodnet-physics.eu/erddap/tabledap/ERD_EP_RVFL_NRT.html

[15] https://prod-erddap.emodnet-physics.eu/erddap/tabledap/ERD_EP_SLEV_NRT_60m.html

[16] http://prod-geoserver.emodnet-physics.eu/geoserver/EMODnet/wms?service=WMS&version=1.1.0&request=GetMap&layers=EMODnet%3AEP_PSMSL_SLEV_REL&bbox=-157.86700315733998%2C-36.843100736862%2C174.76900349538002%2C65.673401313468&width=768&height=330&srs=EPSG%3A4326&styles=&format=application/openlayers

[17] https://prod-erddap.emodnet-physics.eu/erddap/griddap/EMODNET_SEA_LEVEL_TREND.graph

[18] https://prod-erddap.emodnet-physics.eu/erddap/griddap/EMODNET_SEA_LEVEL_MONTHLY_MEAN_DESEASONALIZED.graph

[19] http://prod-geoserver.emodnet-physics.eu/geoserver/EMODnet/wms?service=WMS&version=1.1.0&request=GetMap&layers=EMODnet%3AEMODnet_Physics_-_Registry_of_continuous_noise_monitoring_sites&bbox=-3.536%2C36.93%2C30.6%2C68.91&width=768&height=719&srs=EPSG%3A4326&styles=&format=application/openlayers

				ready yet) – At the moment we are receiving data for Med Sea (UniGE – DICCA), Iberican Atlantic (CoLAB Atlantic), Irish Atlantic (Marine Institute), BlackSea (CMCC) and Baltic (DMI). The product is under final development.
D2.33 WIND INS DB+ NOWCAST v.2.0	2	28/02/2022	Released[20]	
D2.34 ICE SIC v.2.0	2	31/08/2022	Released[21]	
D2.35 TGs - RSCs event attendance	2	31/12/2021	19th TG NOISE: 26 October 2021	
D2.36 TGs - RSCs events sattendance	2	30/06/2022	20th TG NOISE: 22 March 2022	
D2.37 TGs - RSCs events attendance	2	31/12/2022	21st TG NOISE: 24 May 2022	
D2.38 TGs - RSCs events attendance	2	30/06/2023	22st TG NOISE: 10 October 2022 23rd TG-NOISE: 21 February 2023	The frequency of TG NOISE was increased to complete the deliverables for continuous noise threshold assessment.
D3.1 Report on the SOS.SWE connected stations v.2021	3	30/11/2021	Delivered 15/01/2022	Annex to Q4.2021
D3.2 Report on the SOS.SWE connected stations v.2022	3	31/08/2022	Delivered 23/08/2022	Annex to Interim Report I.2022
D3.3 Report on the SOS.SWE connected stations v.2023	3	23/08/2023	Delivered 23/8/2023	See Annex
D3.4 Handbook on procedure to set up SOS.SWE interoperability	3	23/08/2023	Delivered 23/8/2023	See Annex
D3.5 Report on new API v.2021	3	30/11/2021	Delivered	Annex to Q4.2021

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[20]http://prod-geoserver.emodnet-physics.eu/geoserver/EMODnet/wms?service=WMS&version=1.1.0&request=GetMap&layers=EMODnet%3ADAT_LatestDataParametersProduct&bbox=-180.0%2C-90.0%2C180.0%2C90.0&width=768&height=384&srs=EPSG%3A4326&styles=&format=application/openlayers

[21]Arctic Seas:

http://prod-geoserver.emodnet-physics.eu/geoserver/EMODnet/wms?service=WMS&version=1.1.0&request=GetMap&layers=EMODnet%3Aice_edge_nh_annual&bbox=-4632266.5%2C-2364732.5%2C4185461.75%2C3981740.25&width=768&height=552&srs=EPSG%3A3995&styles=&format=application/openlayers

Antarctic Seas:

http://prod-geoserver.emodnet-physics.eu/geoserver/EMODnet/wms?service=WMS&version=1.1.0&request=GetMap&layers=EMODnet%3Aice_edge_sh_annual&bbox=-2624331.25%2C-2947571.75%2C3415682.5%2C3649295.25&width=703&height=768&srs=EPSG%3A3031&styles=&format=application/openlayers

			15/01/2022	
D3.6 new APIs v.2022	3	31/08/2022	Delivered 23/08/2022	Annex to Interim Report I.2022
D3.7 new APIs v.2023	3	23/08/2023		
D3.8 handbook to use EMODnet Physics APIs v.2021	3	30/11/2021	Delivered 15/1/2022	Annex to Q4.2021
D3.9 handbook to use EMODnet Physics APIs v.2022	3	31/08/2022	Delivered 23/08/2022	Annex to Interim Report I.2022
D3.10 handbook to use EMODnet Physics APIs v.2023	3	23/08/2023	Delivered 23/8/2023	See Annex
D3.11 Phasing out of EMODnet Physics Landing page	3	28/02/2022	Completed the 23rd Jan 2023	
D3.12 Phasing out of EMODnet Physics mapviewer	3	30/11/2021	Completed 23rd Jan 2023	
D3.13 EMODnet Physics catalogue v.2021	3	30/11/2021	Delivered 15/1/2022	Annex to Q4.2021
D3.14 Maintenance and update of EMODnet Physics catalogue v.2022	3	31/08/2022	Delivered 23/08/2022	Annex to Interim Report I.2022
D3.15 Maintenance and update of EMODnet Physics catalogue v.2023	3	23/08/2023	Delivered 23/8/2023	See Annex
D3.16 Monitoring tools	3	28/02/2022	Given the centralization process the monitoring tools are going to be a combination of tools, some designed to let Physics and CP to interact and fix issues (e.g. JIRA), some to report on indicators (matomo) some to monitor M2M (the central team is updating the tools to monitor the new EMODnet Physics Environment). Whenever needed new tools will be discussed and deployed.	

3. Work Package updates

WP1 – Project management, monitoring and reporting

Covering Task(s): task 5, task 6, task 8

WP1 is organized into 9 sub-tasks and includes 39 deliverables. It is designed to manage and coordinate all project activities, ensuring timely delivery and high-quality results and products. This involves convening project meetings, delivering reports, participating in EMODnet Steering committee and EMODnet Technical Working group meetings, and attending other EMODnet-related events organized by the Contracting Authority and the EMODnet Secretariat. Task 5 involves contributing content to dedicated spaces in the Central Portal, which has been promptly delivered, and the EMODnet Physics team is prepared to transition to the central system. Management activities also involve ensuring the involvement of regional sea conventions (task 6). Regional Sea Conventions (RSC) are structures that support Member States (MS) in coordinating actions on certain pressures and ecosystems. RSCs also serve as advisory/stakeholder boards for the Marine Strategy groups responsible for implementing the Marine Strategy Framework Directive (MSFD). Partners ICES and CTN actively support RCS in implementing tools for EU legislation, such as the recent change in the ICES Impulsive Noise data reporting format[22] his has been agreed upon by HELCOM and is currently in the process of being agreed upon by OSPAR. CTN is also coordinating the QUITESEAS project, which is a legacy of the QUITEMED and QUITEMED2 projects. This initiative aims to develop community-based tools for implementing DL2 and DL4 (D11C1, D11C2 of the MFSD). In addition to offering access to data and products that are essential for RSC assessments, the EMODnet Physics team partners actively participated and contributed to TGNOISE in defining threshold values (TV) for impulsive and continuous noise, specifically DL2 and DL4, which have now been published:

- Setting EU Threshold Values for impulsive underwater sound - ISBN 978-92-68-03343-2
- Setting EU Threshold Values for continuous underwater sound - ISBN 978-92-68-03349-4

In this context, EMODnet (Physics) serves as the candidate European integrating endpoint for locating in-situ data needed for assessments, such as underwater noise background recordings for establishing reference values. Ensuring monitoring quality and performance and addressing user feedback (task 8) is an ongoing activity. This involves proactive participation in various international groups, advisory boards, and techno-scientific and educational events, including EuroGOOS Task Teams, Southern Ocean Observing System Data Management Steering Committee, Deep Ocean Observing System Data Management Working Group, SeaDataNet Technical Working Group, as well as projects like MyCoast and QuietSeas (see Table 14) to continue dedicating effort to consolidate and expand the gateways to national, regional, and thematic data repositories.

to better serve the increasing number of stakeholders and user communities, WP1 organized internal thematic working groups to provide more focused services for thematic communities. The active groups are River (ETT, OGS, CNR-ISMAR, SMHI), Sea Level (CMCC, NOC-BODC, VLIZ), Water Currents (AZTI, IFREMER), Temperature and salinity in the water column (IFREMER, CISC-BEC, ETT, MARIS), Underwater noise (ICES, CTN, ETT), Wave

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[22] https://www.ices.dk/data/Documents/NoiseRegistry/NoiseRegister.zip

and Wind (UNIGE-DICCA, ETT), and Water Clarity (CNR-ISMAR, MARIS). Although the ICE group was not activated, EMODnet Physics achieved two major milestones with (in-situ) ice data stakeholder communities – MoU with the H2020 ARICE[23] project and an even closer collaboration with SOOS (Southern Ocean Observing System) community, H2020 SOCHIC[24] project, European Polar Initiatives[25], HE OCEAN:ICE[26] project, and the Italian Arctic Data Center. Central to these interactions is the collaboration with EMODnet Ingestion. Importantly, WP1 also covers activities related to the Marine In-situ Collaboration Technical Working Group (MIC TWG) - see task 1.

WP2 – Data Access and Data Products

Covering Task(s): task 1, task 2, task 7

WP2 is organized in 5 sub tasks and 38 deliverables

P2 deals with the core data management activities in EMODnet Physics. WP2 runs the operational activities to maintain and update data collections. It also supports the identification of new potential sources. To engage and facilitate ingestion, EMODnet Physics (and Ingestion) provide guidance (Deliverable D1.31) and tools (e.g., ERDDAP Docker)[27] for preferred data and metadata formats. WP2 is dedicated to maintaining and improving a common method of accessing data held in repositories (task 1), as well as adding new data sources beyond European borders and creating products that offer users information about the distribution and quality of parameters in time and space (task 2). WP2 also contributes to the implementation of EU legislation and broader initiatives for open data (task 7), such as INSPIRE, MSFD, the European Open Data Portal, and Digital Earth.

WP2.1 Expanding data in time and space

A continuous action is to identify additional data sources that can contribute to the EMODnet Physics parameter portfolio, including sources like Argo, profiling floats, gliders, radar, CTD from ships, river flow, underwater noise, etc. This is done in collaboration with European programs and projects (such as Copernicus Marine Service INSTAC, SeaDataNet NODCs infrastructures, ICES, EMODnet Data Ingestion, etc.) and non-EU countries and initiatives. Once a source is identified, an ingestion workflow moves the data through two ingestion phases: making the data available "as is" on EMODnet Physics and including the data into a wider harmonized data collection.

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[23] https://arice-h2020.eu/

[24] http://www.sochic-h2020.eu/

[25] https://polar-data-forum.org/wp-content/uploads/2021/10/Book-Of-Abstracts_Final.pdf

[26] https://ocean-ice.eu

[27] https://github.com/EMODnet-Physics/docker-erddap-install

EMODnet
European Marine
Observation and
Data Network
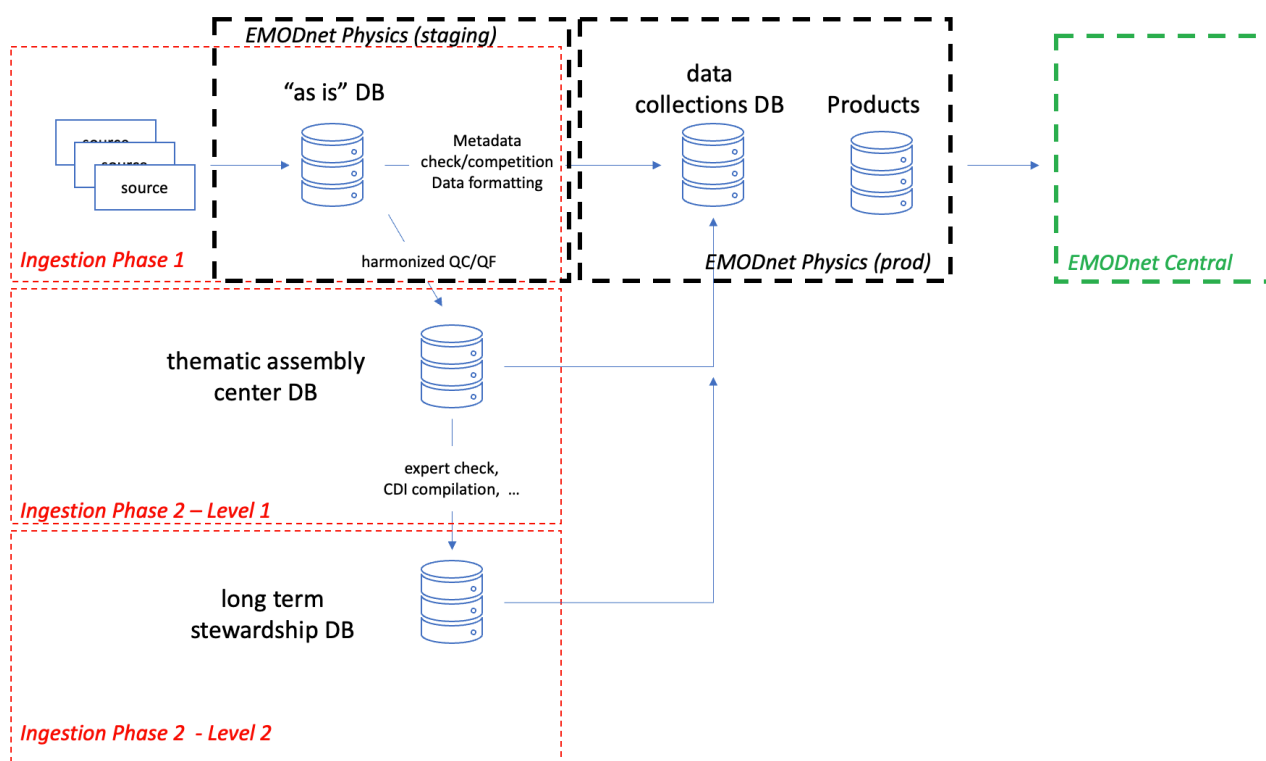
Figure 16. Simplified schema of the ingetion to central portal data workflow

The full process follows the following steps:

Source identification

Analysis of the dataset, data transport format, data access protocol

Mapping of the minimum set of metadata (time, datum, institute, platform type, parameters, units, etc.)

Ingestion "as is" in the EMODnet DB ‚Üí Data ingestion Phase 1 completed

Deeper analysis, QC/QF, processing, ‚Ä¶ by Thematic Assembly Center (e.g., INS TAC, NODCs, ICES, etc)

Integration into QC/QF catalogues/products

Ingestion "processed" in the EMODnet DB ‚Üí Data ingestion Phase 2 (level 1) completed,

Ingestion in long term stewardship DB ‚Üí Data ingestion Phase 2 (level 2) completed

To facilitate the action, EMODnet Physics developed services and open tools (e.g., the ERDDAP docker[28]), user-friendly interfaces for data and metadata uploading, documents on common data and metadata models (see also Deliverable D1.31)

WP2.2 Common methods for ocean data management

EMODnet Physics provides data on changes in sea-level, horizontal velocity of the water column, ice cover, inflow from rivers, salinity of the water column, underwater sound (noise), temperature of the water column, water clarity (light attenuation), wave height and period, and wind speed and direction. These data are collected by a wide variety of fixed and mobile platforms, which can deliver and make data available through various tools and services. EMODnet Physics, as an integrator and broadcaster of federated sources, organizes this data into collections with links to the original sources. Another goal of this activity is to continue collaborating with network platform operators to improve and harmonize standards and data flow schemes, establishing common nodes that can be linked to EMODnet Physics to make data available. An example of this specific action is the collaboration with the OceanGlider technical team and initiatives related to citizen science data[29]

WP2.3. information about the distribution of parameters in time and space

Metadata provides detailed information about the availability and geographical extent of marine data, including descriptions of individual data sets and measurements with key fields such as what, where, when, how, and who. Metadata for data produced within the Copernicus Marine Service INSTAC and SeaDataNet NODCs adhere to ISO 19115 and ISO 19139 requirements. OceanOPS also maintains information on relevant data requirements for observations in support of GOOS, GCOS, and the World Weather Watch of WMO. There is a collaborative effort among European Marine Data Infrastructures to support new stakeholders and improve metadata tracking and information management. Examples of this activity and its outcomes include the MIC TWG (as mentioned in previous sections) and the work by Obaton et al. in 2022 (EuroSea Deliverable D3.7).

WP2.4. Contribute to the implementation of EU legislation and broader initiatives for open data

The EMODnet community maintains open and direct communication with GES assessment experts from DG Environment, EEA, and regional Sea Conventions (OSPAR, HELCOM, UNEP-MAP, and the Black Sea Commission). This communication occurs through regular participation in European TGs, particularly in the TG NOISE. Following the adoption of EU threshold values for impulsive and continuous underwater noise in November 2022, the TG NOISE will shift its focus towards the concrete implementation of these EU threshold values and providing support for the MSFD 3rd cycle of implementation related to descriptor 11 on underwater noise.

This activity is designed to engage stakeholders, assist EU Member States in fulfilling their reporting obligations (e.g., through engagement with TG-DATA and the Member States Expert Group on Spatial Planning), ensure data and products comply with the INSPIRE Directive, and maintain compatibility with the European Open Data Portal, EOSC, Digital Earth, and other EU-wide initiatives. EMODnet Physics continues to update its products to support EU legislation and maintains collaborations with other relevant EU initiatives and organizations, with a particular focus on open data and interoperability (as also detailed in WP3).

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[29] https://maritime-day.ec.europa.eu/system/files/2022-05/european-maritime-day-programme-2022_en_2.pdf

WP2.5. Data Products

Central to the scope of EMODnet Physics is the production of products derived from one or more data sources, which provide users with information about the distribution and quality of parameters in time and space. EMODnet Physics offers a range of products, including collections of datasets, reanalysis, gridded products, and more. These products may vary in their continuity, with some being discontinuous (in situ) in time and space, while others are continuous (e.g., maps).

The organization of products is carried out by the product-working groups (as outlined in WP1). These groups may utilize key existing products, such as SeaDataNet climatologies, or develop specific products tailored for EMODnet Physics, such as the River DB. As described in earlier sections, these products are organized to ensure discoverability through the central portal. You can find a list of available products in EMODnet Physics in Deliverable D2.17.

WP3 – Catalogue, interoperability, service interfaces, and Central EMODnet

Covering Task(s): task 3, task 4, task 9

WP3 is organized in 4 sub tasks and 16 deliverables

WP3 focuses on working and optimizing the FAIRness of its data flow and data management. The FAIR concept emphasizes that data and services should be Findable, Accessible, Interoperable, and Re-usable, catering to both machines and humans. The work in WP3 involves several key tasks: Development of procedures for machine-to-machine connections to data and data products (task 3), Contribution of data products and content to a central portal, ensuring that users can easily find, view, and download data and data products (task 4), Maintenance of the previous system until the new Central Portal is ready for launch (task 9). These activities are essential to ensure that EMODnet Physics data and products adhere to FAIR principles and can be effectively utilized by a wide range of users and applications.

WP3.1 EMODnet Physics machine-to-machine (M2M) and interoperability features

Interoperability is a two-way concept: it involves data flow from sources to EMODnet Physics and from EMODnet Physics to users. Here are the key aspects of interoperability in both directions: 1) from Sources to EMODnet Physics: The primary goal is to facilitate the adoption of common tools and vocabulary among data sources. One example of this effort is the consolidation of a docker version of ERDDAP for the EMODnet community. This makes it easier for new providers and projects to share their data seamlessly. Notable organizations and projects, such as Voice Of The Ocean, Italian Arctic Data Center, CMCC, SMHI, and OGS, have already adopted this approach. 2) from EMODnet Physics to Users: This aspect focuses on organizing data collections and products in a way that aligns with standards such as INSPIRE, OGS, and other easily consumable services (e.g., ERDDAP/ncWMS). Additionally, it involves linking consolidated databases (e.g., PANGAEA) and presenting these collections to match the needs and preferences of EMODnet users and stakeholders.

Interoperability efforts in both directions are crucial for ensuring that data can flow smoothly and be effectively used by the EMODnet community and beyond (e.g. ARICE[30] H2020 project and e.g. Polarstern[31] data, or the iAtlantic[32] H2020 project, or SOOS[33] community).

Deliverables D2.9 and D2.14 provide a comprehensive list of the tools developed. Machine-to-machine (M2M) functionality goes hand in hand with the concept of FAIRness, which is actively promoted in educational and dissemination activities (e.g. summer schools[34], the "ocean data hours"[35]).

WP3.2 EMODnet Physics maintenance, update towards central integration and phasing out of current portal

As per the tender specifications and in coordination with the central portal team, EMODnet Physics maintained and updated both the front-end and back-end services to facilitate central integration. As described earlier, the system underwent regular maintenance and updates (Figure 10, Figure 16) to facilitate data flow and product integration under the Central Portal.

WP3.3 EMODnet Physics Catalogue

This task complements task 3.2 and ensures that metadata can be easily discovered by the central portal for cataloging and INSPIRE services. EMODnet Physics operates a GeoNetwork Instance with a user-friendly web interface for searching geospatial data, compliant with ISO19115/19119/19110 standards.
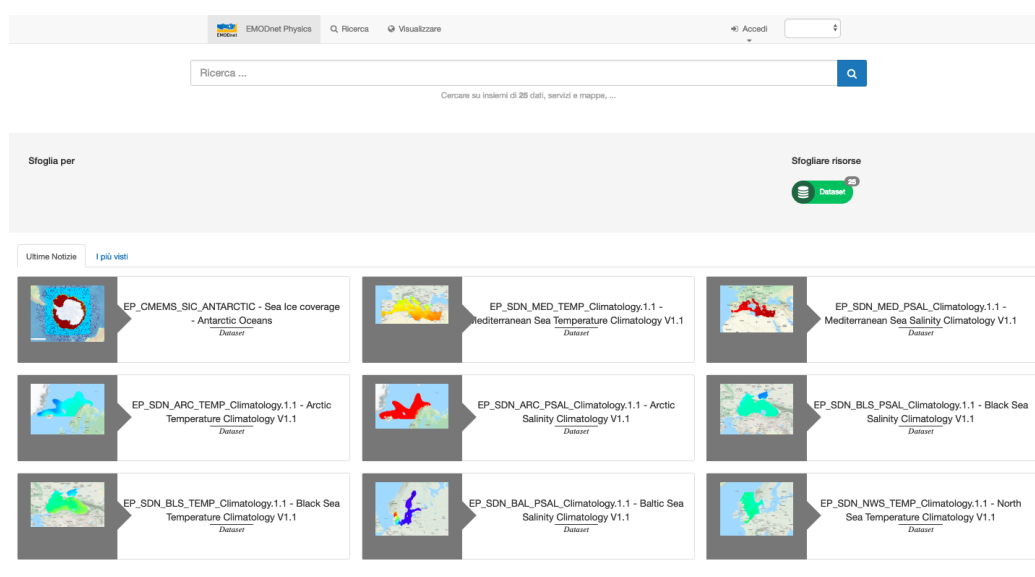
Figure 17. GeoNetwork catalogue for Physics

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[30] https://data.arice-h2020.eu/

[31] https://erddap.emodnet-physics.eu/erddap/search/index.html?page=1&itemsPerPage=1000&searchFor=polarstern

[32] https://www.iatlantic.eu/

[33] https://soosmap.aq

[34] https://www.mitportugal.org/activity/2022-marine-robotics-summer-school/program/

[35] https://www.ettsolutions.com/oceanrace

GeoNetwork is listing all the data-collections and products available in the EMODnet Physics domain. Deliverable D2.17 provides the full list of EMODnet Physics products.

WP3.4 Monitoring tools

EMODnet Physics monitoring involves operating the Help Desk and tracking system performance. The Help Desk service has been operational since the beginning of the contract, with support available from 9:00 to 17:00 CET/CEST, Monday to Friday. Initially, user queries were managed through a web form and emails, and each query received a unique help ticket number in the Help Desk database.

Upon the launch of the Central Portal, the Help Desk was centralized, and user queries are now organized using JIRA tickets. Users can create JIRA tickets when they contact the EMODnet Physics team directly, such as by emailing contacts@emodnet-physics.eu. The service has so far collected and solved 42 requests (@02/08/2023 – User feedback was collected through the HD user form until EMODnet Physics was centralized - Table 13). With the launch of the Central Portal in January 2023, this service is no longer in operation. HD requests are now collected centrally and managed through JIRA tickets. More general comments and feedback are described in task 8 and in the final comments.

Web page and service performance were monitored using Matomo (hosted @VLIZ – EMODnet Central portal) and GrayLog. These tools tracked visits, service usage, user behavior on pages, most visited pages, the volume of downloaded data, etc., and were instrumental for reporting (WP1) and for operating and maintenance purposes (WP2 and WP3). Currently, monitoring is performed centrally and includes OGC service performance monitoring (https://monitor.emodnet.eu/) and user interaction on the Central Portal (Europa Analytics), including shares on thematic areas and use cases.
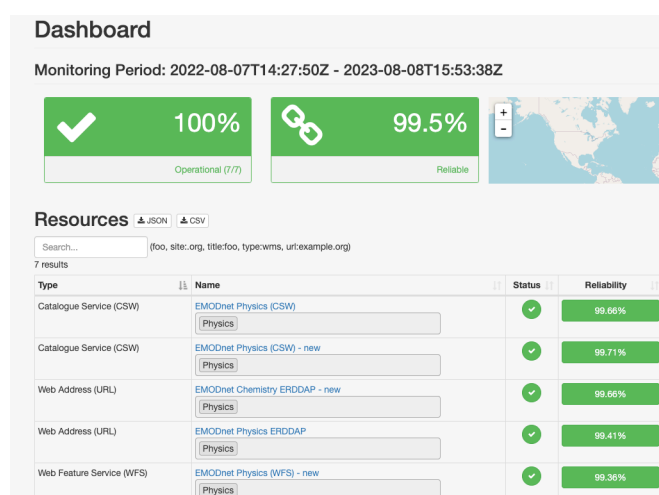
Figure 18. OGC monitor

With the introduction of the new monitoring services, thematic projects are no longer able to collect information on users' profiles or interests. Nevertheless, interactions in meetings, conferences, and other events where the team engages with stakeholders confirm the previous statistics. The majority of users (around 60%) come from the Research and Academia sector, followed by the private sector, making up

approximately 20%. Users from NGOs and the Government share the remaining 20% almost equally. The data are primarily used for Marine and Coastal applications, as well as Climate and Weather forecasting. Recent events, such as the Ocean Data Week, have shown that EMODnet Physics users extend beyond the EU.

4. Identified issues: status and actions taken

Table 9. Priority issues identified by CINEA/ DG MARE/ Secretariat

A. Priority issue(s) identified and communicated by CINEA/ DG MARE/ SECRETARIAT				
Priority issue	**Status** (Pending/Resolved)	**Action(s) taken / remaining actions planned**	**Date due**	**Date resolved**
service update to serve the ATLAS	In Progress	Working on it	ASAP	01/08/23 13:58
OGC service checker end point update	Done	Updated		01/08/23 13:52
Wind layer: data are not being fetched to display on the NRT plot	Done	Fixed		15/05/23 14:35
In situ near real time sea level data legend shows only platform initials	Done	Fixed		15/05/23 14:39
Update of the downloading features	Done	Fixed		23/05/23 17:43
update services - gethtml - to be compliant to EU requirements	Done	Updated		28/02/23 16:20
URLs redirects to Central Portal	Done	Redirected		25/01/23 15:51
Update the GetFeatureLayer	Done	Updated		28/02/23 11:12
Correct the WMS GetLegend Style	Done	Corrected		03/01/23 09:58
Review the TWG12 tools and features list.	Done	Reviewed		13/10/22 16:28
Review the Static content inner menu/sections list	Done	Reviewed		27/09/22 23:19
Update the EP_PLATFORMS_RVFL service layers for ATLAS	Done	Updated		27/02/23 16:49
Review/update the GeoNetwork catalogue to serve the Central Portal	Done	Reviewed		01/08/23 13:52
Support BB with service layer specs	Done	Done		17/06/22 11:36

Geoservice service update to serve the Central Portal testing system	Done	Updated		17/06/22 17:53
Missing data in a dataset exposed to the Central Portal test system	Done	Updated		21/04/23 14:08
Service update for EP_HFR_CFM_EUROPE layer to serve the ATLAS	obsolete	Updated		21/04/23 14:32
provide list of tags for setting up the Central catalogue	Done	Done		21/04/23 14:32
updating in situ platform layer filters	Done	Done		08/08/23 00:00
Update EMODnet Physics WMS service (GeoServer) to support GetLegendGraphic	Done	Done		03/04/23 16:42

Table 10. Priority issues identified by Physics group

A. Issues / challenges identified by the thematic assembly group itself				
Priority issue / challenge	Status (Pending/Resolved)	Action(s) taken / remaining actions planned	Date due	Date resolved
Update the platforms page with the same technology and responsiveness implement for the mapviewer	Done			31/03/2022
EMODnet Physics. In situ data Platforms" layer is not working on the Central portal- cql_filter problem	In Progress	CP team working on it		31/05/23 10:36
EMODnet Physics static content review/update on the CP	Done			07/08/23 15:56
OGC specifications for updating the EMODnet Physics products into the CP geoviewer	In Review	CP team working on it		31/07/23 14:38
Central Portal applies CQL_FILTER queries that are not correct	To Do	CP team working on it		18/07/23 17:31
EMODnet Physics static content updates	Done			24/08/22 16:59
EMODnet Physics static content updates	Done			24/08/22 16:59
EMODnet Physics static content updates	Done			27/04/22 19:11
WMS products' scale range updates	In Review	CP team working on it		31/07/23 17:33
OGC monitoring service - update of the endpoints to check	Done			31/05/23 10:46
Central portal - geoviewer - platform page popup size to be enlarged	Done			25/05/23 18:40
Central Portal - geoviewer - EPACE WMS service specs updates	Done			30/03/23 13:48
Central Porta - Geoviewer - Impulsive Noise product specifications update	Done			21/03/23 11:44
new user form specifications to be confirmed	Obsolete			24/02/23 16:31
Central Portal - geoviewer - review of the animation feature	To Do	CP team working on it		31/05/23 10:58
Central Porta - geoviewer - update of the EPACE - Sea Level Prod specs	Done			26/05/23 15:30
Central Protal - geoviewer - problem with the cql-filter	Done			16/05/23 10:33
Central Portal - geoviewer - discrepacy (between portal and back-end service) in the metadata on Impulsive Noise Registry	Done			17/03/23 16:01

5. Allocation of project resources

Table 11. Resource allocation

Information on the allocation of project resources	
Categories	Resource usage[36] (%)
Making data and metadata interoperable and available	23,5
Preparing data products	11,5
Preparing web-pages, viewing or search facilities	12,9
Managing user feedback	9
Project management	20,9
Outreach and communication activities	20,9
Others	1,4

Table 12. Resource allocation

Categories	Involved Tasks
Making data and metadata interoperable and available	1,3
Preparing data products	2
Preparing web-pages, viewing or search facilities	2,9
Managing user feedback	8
Project management	4,5,6,7
Outreach and communication activities	4,5,6,7
Others	9

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[36] Provide the workings of your calculations, *i.e*. percentage allocation of the total amount awarded.

6. User feedback

User feedback has been collected by the HD user form (until EMODnet Physics was centralized). Since January 2023 this service is not operated any longer. HD requests are collected centrally (forwarded to thematic teams and managed by JIRA tickets). The following table reports feedback/HD as collected until the entry in to service of the Central Portal. More recent tickets are in Table 7. More general comments and feedback is described under task 8 and in the final comments.

Table 13. User feedback

Overview of user feedback and/or requests received in this period							
Date	Organisation	Type of user feedback (e.g. technical, case study, etc.) and short description of the feedback received	Means of contact	Response time	Status of user query: resolved/pending	Measures taken to resolve the query	Status: if not (yet) resolved/pending, explain reason why and expected timeline
01/10/2021	Université du Littoral Côte d'Opale	request for help with data download	HD	0 days	Solved	Feedback by email.	
12/10/2021	CorPower Ocean	problem with dataset download	email	0 days	Solved	Feedback by email and server problem solved.	
12/10/2021	EnBW Energie Baden-Württemberg	request for help with data download	email	1 day	Solved	Feedback by email and server problem solved.	
14/10/2021	EuroGOOS	Arctic portal is down	email	0 days	Solved	Feedback by email.	
14/10/2021	Energinet	Problem with login	HD			Feedback by email.	
20/10/2021	Nautilus Energy	request for help with data download	email	1 day	Solved	Feedback by email.	
25/10/2021	Geoazur	issues with data download	HD	1 day	Solved	Feedback by email.	
26/10/2021	Norwegian University of Science and Technology	enquiry about wave data	HD	1 days	Solved	Feedback by email.	
09/11/2021	Deltares	login issue and data download enquiry	email	1 day	Solved	Feedback by email.	
10/11/2021	Bangor University	enquiry about tidal data	email	1 days	Solved	Feedback by email.	
22/11/2021	Institute of Geosciences Christian-Albrechts-Universität zu Kiel	data download enquiry	email	1 day	Solved	Feedback by email.	

26/11/2021	University of Genoa	wave data enquiry	email	1 day	Solved	Feedback by email.	
27/11/2021	Monitor My Ocean	Support to download data	HD	1 day	Solved	Feedback by email.	
18/12/2021	Private user	Support to download data	HD	1 day	Solved	Feedback by email.	
8/3/2022	CETMAR	Technical - change data source path	HD	1 day + in progress	Pending	Working on the mapping of the new source	
22/2/2022	Aktis Hydraulics	Support to download data	HD	1 days + 1 week	Solved	Feedback by email	
30/3/2022	TU Delft	Requesto for technical help	HD	1 days	Solved	Feedback by email.	
30/3/2022	XG - Xunta Galicia - Spain	Technical	HD	0 days	Solved	Feedback by email	
1/4/2022	Student	Support to download data	HD	1 days	Solved	Meeting to train	
4/4/2022	RPS	Metadata Access	HD	1 days	Solved	Feedback by email	
5/4/2022	RPS	Support to download data	HD	0 days	Solved	Feedback by email	
19/4/2022	University of Hull	Support to download data	HD	0 days	Solved	Feedback by email	
20/04/2022	Deltares	Technical problem on HR radar	HD	0 days	pending	Feedback by email	Individuated issue, fixing in progress
27/4/2022	VLIZ	Support to download data	HD	0 days	Solved	Feedback by email	
05/05/2022	CCMAR	Support to download data	HD	0 days	Solved	Feedback by email/ created API for data download	
10/5/2022	Helmholtz-Zentrum Hereon	Support for time series dowload	HD	0 days	Solved	Feedback by email	
13/5/2022	CENTEC	Suppory for platforms informstion	HD	3 days	Solved	Feedback by email	
20/5/2022	University of Manchester	Support to download data	HD	0 days	Solved	Feedback by email	
1/6/2022	University of South Florida	Support to download data	HD	1 day	solved	Feedback by email	
23/6/2022	COWI	Support to data visualization and download	HD	3 days	Solved	Feedback by email	
18/7/2022	Uni Oldenburg	Platform information	HD	1 days	resolved	Feedback by email	
2/8/2022	OGS	Web portal and related services	HD	0 days	resolved	Feedback by email	
2/8/2022	Leibniz Institute for Baltic Sea Research	Platform page isses	HD	0 days	resolved	Feedback by email	
18/07/22	Uni Oldenburg	Platform information	HD	1 days	resolved	Feedback by email	
02/08/22	OGS	Web portal and related services	HD	0 days	resolved	Feedback by email	

02/08/22	Leibniz Institute for Baltic Sea Research	Platform page isses	HD	0 days	resolved	Feedback by email	
12/08/22	ABPmer	Help for data dowload	HD	0 days	resolved	Feedback by email	
17/08/22	ULiège	Data dowload	HD	2 days	Resolved	Feedback by email	
25/10/22	x1wind	help on data integration	email	1 d	resolved	feedback by email	
27/10/22	VLIZ	help for data download	email	0 d	resolved	feedback by email	
22/11/22	University of hull	help for data download	email	0 d	pending		wrong email adress
06/12/22	MORE	specific data access	email	1d	resolved	feedback by email	

7.   Meetings/events held/attended & planned

Table 14. Meetings/events held/attended

A. Meetings/events Organized and attended					
Date	Location	Type event	Indicate if a ppt was given	Meeting attended (A) / organised (O)	Short description and main results (# participants, agreements made, etc.)
7-8/09/2021	On line	EMODnet SC	Yes	A	
20-24/09/2021	On line	Polar Data forum	Yes	A	https://polar-data-forum.org/ - PDF is a place where polar data holder get together and make more use of data. EMODnet Physics is supporting both the Antarctic (SOOS) and Arctic community and the team was involved in some of the tech brainstorming workshops.
21-22/09/2021	On line	EMODnet Ingestion Annual Meeting	Yes	A	
28/09/2021	On line	Physics – Central Portal KOM	No	A	Technical meeting to review and plan actions towards the centralization of the systems.
06/10/2021	Online	EMODnet Physics River team meeting	No	O	Periodic meeting with the expert team to review and plan internal actions
08/10/2021	Online	BluePlanet Forum	no	A	https://www.blueplaneteconomy.it/ - the event discussed about the Blue Economy and the tools and the service that can support it.
08/10/2021	Online	UniGe DISTAV collaborations WS	Yes	A	The workshop was to present on the collaboration between the DISTAV (Univerity of Genova) and key partners such ETT. EMODnet (Physics, Ingestion, Chemistry) were central in the presentation.
12/10/2021	On line	AtlantOS Ocean Hour - All-Atlantic Ocean Data Space	No	A	Workshop to discuss about standards and interoperability, how to best use data, collaborations. Etc.
19/10/2021	On line	NAUTILOS General Assembly	yes	A	Annual meeting of the H2020 NAUTILOS project
25/10/2021	On line	Glider School	Yes	A	Presentation about how EMODnet Physics and Ingestion deal and make available glider data (about 30 students)
26/10/2021	On line	Annual MONGOOS meeting	Yes	A	MONGOOS partners are key contributors to EMODnet Physics.

26/10/2021	Online	TG NOISE	no	A	Periodic TG NOISE technical meeting
26/10/2021	On line	EMODnet Central Portal	Yes	A	Technical meeting on migration to the new central portal
29/10/2021	On line	EMODnet Ingestion/SBM Offshore	no	A	It's a follow up meeting with SBM Offshore in order to identify possible sinergies to facilitate the ingestion of data collected at Offshore sites. The focus was on temperature, salinity and other basic physics data.
03/11/2021	On line	SOOS DMSC	Yes	A	SOOS map is powered by EMODnet Physics and with the presentation we updated the team on Centralization process, schedule and the planning to keep serving the SOOS community
8-9/11/2021	On line	EMODnet Physics 4 KOM	Yes	O	Annual meeting with Physics core and extended teams.
11/11/2021	online	VOTO Data	No	A	Technical meeting to interoperate with VOTO
16/11/2021	Online	EMODnet Chemistry	Yes	A	Presentation on the joint EMODnet Physics and Chemistry activities on River
18/11/2021	Online	New GESLA presentation	No	A	Presentation of the new GESLA – Sea Level Anomalies – product presentation. The product is of EMODnet Physics interest. The product can be included in the EMODnet Physics catalogue.
25/11/2021	On line	2nd EuroSea Anniversary Webinar	No	A	EMODnet is one of the main EuroSEA stakeholder.
29/11/2021	On line	EuroGOOS 2nd Integration Workshop	No	A	
30/11/2021	On line	SOOS DMSC	No	A	Periodic Data management SC meeting. We presented and reported on follow up actions since previous meeting.
13/12/2021	On line	EMODnet Chemistry full group KOM	yes	A	
17/01/2022	web	external	no	A	Arctic RCC, https://www.arctic-rcc.org/
24/01/2022	web	external	no	A	CMEMS INS TAC KOM - EMODnet Physics is attending the Advisory Board of CMEMS INSTAC
01/02/2022	web	internal	Yes, state of the art of EMODnet rivers service	A	EUROGOOS - Coastal Working Group
08/02/2022	web	external	no	A	Odyssey project launch
08/02/2022	web	external	no	A	Swedish ODF, Ocean Data Factory, workshop on data availability

08/02/2022	web	external	yes	A	Arctic ROOS GA - 8-9/02/2022
14/02/2022	Sopot, Poland + web	conference	yes	A	International Ocean Data Conference 2022 - The Data We Need for the Ocean We Want - https://oceandataconference.org/
17/02/2022	web	external	no	A	Intro TransEurope Marinas & EMODnet - to discuss about synergies between the two initiatives
17/02/2022	web	external	no	A	TG Noise thematic sessions "Towards EU threshold values for underwater noise"
24/02/2022	web	external	no	O	Meeting with Politecnico TO - MORELAB; ERG - to discuss about data availability, interoperability and use
01/03/2022	web	external	yes	A	SOOS DMSC - periodic meeting with the SOOS Data Management Steering Com. to discuss about interoperability and joint actions on data gaps
02/03/2022	web	external	yes	A	H2020 - ARICE project General Assembly - to brief up the Assembly about on going collaboration and future data interoperability goals
03/03/2022	web	internal	no	O	EMODnet HFR team meeting - reanalysis of data model and review of annual plan for involving other actors
03/03/2022	web	conference	yes	A	Ocean Science Meeting - EMODnet presented on its activities to engage industries and citizen scientists - https://www.aslo.org/osm2022/scientific-sessions/
04/03/2022	web	internal	no	A	EMODnet Central Portal technical team meeting with Physics
15/03/2022	web	external	yes	O	Meeting with Orsted on Offshore Wind and Ocean Data - EMODnet ingestion
22/03/2022	web	external	no	A	20th TGNOISE
24/03/2022	web	external	no	A	EuroSEA - Eulerian Observatories - meeting for Best Practice. EMODnet (Physics) is a key stakeholder in EuroSEA
24/03/2022	web	external	yes	A	EMODnet Physics presented on the "Marine Biology Live" to present on its actions on Citizens Science. MBL is a series of regular online talks organised by the Marine Biological Association.
25/03/2022	Copenhagen, Denmark	external	no	A	Meeting with Paralenz - to discuss on the physical data ingestion
28/03/2022	web	external	no	A	EuroGOOS - DATAMEQ - periodic meeting. EMODnet Phy is one of the member
30/03/2022	web	internal	yes	A	EMODnet Chemistry SC meeting - EMODnet Chemistry and Physics are jointly developing new river data products
05/04/2022	web	external	no	A	Best Practice in Aquaculture
08/04/2022	Sweden	external	yes	A	Swedish National Commettee for Ocean Decade
07/04/2022	web	internal	yes	A	DG MARE

12-13/04/2022	Genova, Italy		yes	O	Marine Insitu Collaboration - MIC TWG - to streamline data flow between main EU marine data operators and integrators
26/04/2022		internal	yes	A	EMODnet SC
28/04/2022		internal	yes	A	EMODnet TWG
09-10/05/2022	Malmo, Sweden	conference	no		Ocean Literacy - Ocean Decade Sweden - https://malmo.se/Welcome-to-Malmo/Sustainable-Malmo/One-Ocean---One-Planet-Ocean-Literacy-Action-2022.html.
9-13/05/2022	web + Cadiz, Spain	workshop	yes	A	EuroSEA workshops week + GA
19/05/2022	Ravenna, Italy	conference	no	A	European Marine Days - https://ec.europa.eu/maritimeaffairs/maritimeday/conference_en -
20/05/2022	Ravenna, Italy	conference	no	O	EU4Ocean @ EMD - https://european-maritime-day-2022.b2match.io/agenda?session=c2Vzc2lvbjoxMTI1OTA%3D&track_id=19933
24/05/2022	web	external	no	A	21th TGNOISE
26/05/2022	web	external	no	O	EMANEDS – European Marina Networks of Environmental Data Stations – to discuss about interoperability and data flow towards EMODnet
30/05/2022	Genova, Italy	meeting	yes	O	meeting with CIMA foundation (https://www.cimafoundation.org/) - to discuss about synergies
30/05/2022	web	internal	no	A	follow up on Centralization with CP team
16-17/6/2022	Athens, Greece	internal	yes	A	EMODnet Ingestion 3 - kick off meeting
16/06/2022	Genova, Italy	workshop	no	A	GESmartCity - Blue District - workshop to discuss about synergies between projects to support the municipality blue and smart projects - about 30 attenders
21/06/2022	web	external	no	O	EMANEDS – European Marina Networks of Environmental Data Stations – to discuss about interoperability and data flow towards EMODnet
21/06/2022	web	external	no	O	CCMALR - to discuss about interoperability
24/06/2022	web	internal	no	O	SONEL - follow up meeting on the integration of the new products and harmonization of data flow
01/07/2022	web	internal	no	A	follow up on Centralization with CP team
01/07/2022	web	internal	no	A	follow up on Centralization with CP team
05/07/2022	web	workshop	yes - EMODnet Physics status and activities for glider network	A	European Glider Data Management Workshop - https://www.groom-ri.eu/european-glider-data-management-workshop-agenda-2/ - https://docs.google.com/document/d/1hQSNbznH6sm5Eo1KjrkK1og1vQDOjRtwGa0xryANe54/edit#

04/08/2022	web	Conference	yes	A	*Open Science Conference* - SCAR OSC data session: Sharing science data FAIRly to support interdisciplinary research collaborations
18/08/2022	web	internal	no	A	Coordination with the CP team
08-09/09/2022	web	internal	Yes – Updates on EMODnet Phy	A	EMODnet Chemistry Steering Committee
14-15/09/2022	Rotterdam, Netherlands	workshop	Yes- Update on EMODnet projects	A	The NOOS annual meeting 2022
20-21/09/2022	web	workshop	Yes – Introduction to EMODnet Physics features under the CP	A	EMODnet-for-business two-day workshop on Offshore energy sector. The workshop was attended by more than 65 offshore renewable energy experts with representatives from diverse sectors including industry, research, policy and marine data services[1].
21-22/09/2022	Brussels, Belgium	Internal	Yes – updates on Physics	A	EMODnet Technical Working Group. Periodic meeting to check status on centralization, integration, data flow etc.
23-25/09/2022	Savona, Italy		Yes – examples of how to use and consume EMODnet Physics data for educational scope	A	WhyBio[2] is an annual event to build change from the bottom, in a sustainable and conscious way. It is a dissemination event to engage civil society towards a more sustainable attitude. It is attended by around of 15.000 visitors. ETT presented a VR experience to inform on climate change by using EMODnet Physics data and products
25/09/2022	Genova, Italy	Workshop	Yes – overview of EMODnet program, EMODnet Physics and Ingestion to enable new services and sustainable developments	A	Salone Nautico 2022 – International Boat Show – The sustainability comes from the sea: living experiences according to the One Health Approach Workshop. The theatre of the sea, at the hearth of the event, hosted the workshop to discuss about sustainability and oceans. The event was attended by more than 150 people on site. The event had a big hype on local newspapers and social channels[3]
28/09/2022	Brest, France	Meeting	No	A	Copernicus Marine Service INS TAC stakeholders meeting. EMODnet Physics is stakeholder for the Copernicus Marine Service INSTAC and the way round. The two projects work together to unlock more in situ data worldwide.
29/09/2022	Brest, France	Meeting	No	O	MIC working group meeting. Periodic meeting of the Marine In situ Collaboration team to review achievements and plan new actions to unlock and include more in situ data on EOVs for the benefit of EMODnet, Copernicus Marine Service, EuroGOOS and related initiatives.
29/09/2022	web	Workshop	Yes – updates on EMODnet and available features from the CP.	A	EuroGOOS FerryBox Annual Workshop[4]. Coordination with the FB TT is important for both Physics, Chemistry and Ingestion themes. The importance to work on a clear data licence (CC-BY) was largely discussed.
04/10/2022	Milazzo	workshop-special session	yes	O	MetroSea 2022. International IEEE event on Marine technologies and services. Event was attendend by about 100 people. EMODnet Physics organized the special session on data networking and interoperability. https://www.metrosea.org/special-session-1.

					https://www.metrosea.org/files/MetroSea2022_FinalProgram.pdf
05/10/2022	Genova	workshop	yes	A	GENOA SEA SUSTAINABLE CITY - EMODnet (program and focus on Physics, Chemistry, Ingestion) was presented and discussed during the event. https://www.genovabluedistrict.com/eventi/genoa-sea-sustainable-city/ Event was hybrid (about 50 in presence)
11/11/2022	Taranto	workshop	yes	A	GREENBLUEDAYS - A innovative forum on sustainable development in Southern Italy - EMODnet (program and focus on Physics, Chemistry, Ingestion) was presented and discussed during the session "new economy of the sea: compatibility and sustainability" - https://greenbluedays.it/tavola-rotonda-la-nuova-economia-del-mare-a-taranto-compatibilita-e-sostenibilita/ more than 300 attenders in presence during the event
11/10/2022	web	workshop	no	A	22nd meeting of the Technical Group on Underwater noise (TG Noise 22). To discuss and define recommendations for EU threshold values for impulsive and continuous underwater noise. TG NOISE members.
14/10/2022	web	meeting	no	A	DATAMEQ - EuroGOOS Data Management, Exchange, and Quality Working Group (DATAMEQ WG) helps improving harmonization and integration of European marine data. EMODnet is one core stakeholder for the community
17-18/10/2022	Venice	workshop	no	A	Knowledge Hub - Sea Level Rise Conference 2022 - https://knowledgehubsealevelrise.org/ - International Conference on Sea Level Rise. EMODnet representatives actively participated to panels discussion. Hybrid event with about 100 attenders in presence
20-21/10/2022	web	workshop	no	a	EMODnet-for-business two-day workshop on Offshore energy sector. Mediterranean and Black Sea stakeholders. https://webgate.ec.europa.eu/maritimeforum/en/node/7383
26/10/2022	FARO	meeting	yes	A	NAUTILOS - The flagship H2020 project will develop a new generation of cost-effective sensors and samplers and integrate observation technologies and platforms into large-scale demonstrations across European seas making a significant contribution towards the democratisation of marine environment monitoring. EMODnet is one key stakeholder for new data that the project is going to generate.
28/10/2022	web	meeting	no	O	MIC - sea level data - GLOSS
07/11/2022	web	meeting	yes	A	OCEANICE - assess the impacts of key Antarctic Ice Sheet and Southern Ocean processes on Planet Earth, via their influence on sea level rise, deep water formation, ocean circulation and climate. EMODnet is one the key stakholder. EMODnet program, Physics and Ingestion were presented
7-8/11/2022		meeting	yes	A	EMODnet SC periodic meeting of the EMODnet Steering Committee
08/11/2022	web	meeting	no	O	Internal meeting to check the bidirectional flow between SOOSmap data providers, EMODnet and SOOSmap

16/11/2022	web	summer school	yes	A	International ocean governance course - offered by the IOI and the University of Malta - about 30 students
21-22/11/2022	Florence	meeting	yes	O	HFR Task Team periodic meeting to review the general progress of the Task Team work plan, in order to progress in the joint roadmap. https://www.lamma.toscana.it/sites/default/files/doc/news/HFRadarTT_2022_annual%20meeting_agenda_draft.pdf
22-23/11/2022	Florence	workshop	no	AO	MONGOOS workshop - http://www.lamma.rete.toscana.it/news/dal-21-al-24-firenze-sara-la-capitale-delloceanografia-europea https://eurogoos.eu/current/mongoos-annual-meeting-workshop-on-the-importance-of-scales-and-uncertainties-in-ocean-transport-and-the-general-assembly/
24/11/2022	Florence	general assembly	yes	A	MONGOOS General Assembly. During the meeting updates about EMODnet program and centralization process were presented and discussed. http://www.lamma.rete.toscana.it/sites/default/files/doc/news/MonGOOS_General%20Assembly_Agenda_Florence22.pdf
24/11/2022	web	meeting	no	A	AIVP general assembly - AIVP is an NGO that has been bringing together urban and port stakeholders. Novellino joined as a partner and presented on EMODnet program and thematics
25/11/2022	web	meeting	no	A	EuroSEA - WP3 internal meeting to finalize deliverables on "network harmonization recommendations" where recommendations comes from internal and external stakeholders, hence EMODnet, SeaDataNet NODCs, and Copernicus Marine Service
14/12/2022	Rome	workshop	no	A	ONTM Genaral Assembly, ONTM is National Observatory for the Protection of the Sea, during the General assembly (about 50 attenders), EMODnet was indicated as a primary stakeholder for the observatory
10/01/2023	web	internal - tech meeting	no	A	Technical Innovation Board Meeting - NAUTILOS project. EMODnet is a primary NAUTILOS stakeholders and these meetings are good occasion to be synch on approach, methods, news, needs etc.
11/01/2023	web	workshop	no	A	OceanPrediction will be, first and foremost, a global, transversal, and cross-sectorial community built around ocean forecasting. Working in close collaboration with other Decade coordination bodies and actions, OceanPrediction DCC will promote the co-creation and development of ocean forecasting capacities worldwide. Serving the United Nations Decade of Ocean Science for Sustainable Development objectives, the centre will raise ocean literacy and public engagement, while inspiring standards, best-practices and tools to build an ocean science-to-service global framework centred on the principles of accessibility, interoperability and integration - https://oceanpredict.org/events/oceanprediction-un-decade-collaborative-centre-kick-off/#event-overview
13/01/2023	Alicante, Spain	workshop	yes - The role of data and data process for ocean and environment understanding and	A	OCEANRACE - Genova Pavillion and Italian Day. ETT was awarded to join the roadshow during the race legs to have a presentation covering ocean data management, processing, interoperability, etc. EMODnet, Copernicus Marine Service, EuroSEA, SO-CHIC, NAUTILOS and many

			sustainable exploitation		other European projects, as well as Italian projects are explained to the public
19/01/2023	Gothenburg, Sweden	workshop	no	A	Voice of the Ocean - ERDDAP lectures and workshops in Gothenburg. VOTO will present outcomes from the collaboration with EMODnet
20/01/2023	Gothenburg, Sweden	workshop	yes - Ocean data managment and EMODnet	A	SMHI - workshop to present on latest updates on ocean data management and EMODnet
23/01/2023	web	internal - meeting	no	A	EMODnet: achievements & way forward - an internal meeting to collect views on past achievements and perspectives for the years to come.
26/01/2023	web	workshop	no	A	EMODnet Sea-basin Checkpoints event
27/01/2023	Savona, Italy	meeting	yes	O	CIMA Foundation - new provider candidate - meeting to present on EMODnet
08/02/2023	web	internal - tech meeting	no	A	EuroGOOS Tide Gauge Task Team
13/02/2023 - 16/02/2023	pisa, Italy	internal - tech meeting	no	A	BlueCloud 2026 - KOM - EMODnet Physics is now contributing to the Blue-Cloud Data Discovery & Access service, a system that federates important European data management infrastructures to make it easier for users to find and retrieve multi-disciplinary datasets from various repositories. Its primary purpose is to simplify the discovery and access of data for users who need to access a wide range of datasets from different sources.
17/02/2023 - 18/02/2023	Bologna, Italy	internal - tech meeting	yes	O	CNR ISP - new provider candidate - meeting to present on EMODnet - discussion on cryosphere data
21/02/2023	Murica, Spain (web)	workshop	yes	A	MAR MENOR - Public workshop (on the 21st of February) to show their observational monitoring capabilities
23/02/2023	capetown, Sud Africa	workshop	yes	O	Ocean data hour - low cost tech and citizen science
24/02/2023	capetown, Sud Africa	workshop	yes	A	Presentation on ocean data management in Europe with an overview on the major European Marine data integrators
28/02/2023	Genova, Italy	seminar	yes	A	Accademia Marina Mercantile - ITS ... how to find and process ocean data
02/03/2023	web	workshop	no	A	Advancing EOOS - the foundation of European ocean knowledge - online launch event, the new EOOS Strategy and Roadmap for Implementation 2023-2027 will be presented and discussed by esteemed members of the European ocean community.
06/03/2023	web	internal - tech meeting	no	A	EMODnet Central Portal team meeting with Physics
09/03/2023 - 10/03/2023	Trieste, Italy	general assembly	yes	A	EMODnet Chemistry Assembly and stakeholder meetings - Presentation on River data management
13/03/2023	web	internal - tech meeting	no		SOOS DMSC
15/03/2023- 16/03/2023	Murica, Spain	workshop	yes	A	QuiteSEA - stakeholders workshop
20/03/2023- 21/03/2023	Paris, France	conference	no	A	IODE - II

EMODnet
European Marine
Observation and
Data Network

27/03/2023-28/03/2023	web	hackaton	no	A	EMODnet Hackaton
28/03/2023	web	internal - tech meeting	no	A	CMEMS INSTAC Stakeholder + MIC coordiantion
28/03/2023-29/03/2023	Amsterdam, the Netherlands	internal - tech meeting	yes - EMODnet Physics (Stations and products , ERDDAP, ERDDAP from Python)	A	BlueCloud 2026 - TSC meeting: technical developments for WP2-WP5 and technical tuning between WP2-WP5 - Vlab of interest: Vlab 1(Unlocking the potential for integration of Coastal Ocean Observations along Europe), Vlab2 (Coastal currents from observations), , new pipeline
30/03/2023	Gothenburg, Sweden	seminar	yes	A	Coastal Data Gap Challenge with Chalmers
30/03/2023	web	internal - tech meeting	yes	O	River runoff data management
31/03/2023	Genova, Italy	tv talk	no	A	The Ocean Race Genova The Grand Finale - Verso l'arrivo a Itajaì e la sostenibilità - During the talk we discussed about ocean data management in Europe and how EMODnet is dealing with data
13/4/2023	Las Palmas, Spain + web	workshop	yes	A	EUROSEA - Autonomous Surface Vehicles - EMODnet is a key stakeholder and was invited to present and discuss on metadata, ingestion and data flow
03-04/04/2023	web	technical working group	yes	A	EMODnet Technical working group
11-12/04/2023	Lanarca, Cyprus	meeting	yes	A	EMODnet Ingestion General Assembly
13/4/2023	web	workshop	yes	A	EuroSea - WP3 Platform Networks workshop - EMODnet is a key stakeholder and was invited to present and discuss on metadata, ingestion and data flow
20/04/2023	Itajai, Brasil	workshop	yes	O	Ocean Data Hours - ocean data management - The Ocean Race Village, Genova Pavillion
27/4/2023	web	workshop	yes	O	EMODnet River activites & BOOS
3/5/2023	web	meeting	yes	A	ArcticROOS - EMODnet is a key stakeholder and was invited to present and discuss on metadata, ingestion and data flow
04-05/05/2023	Madrid, Spain + web	workshop	no	A	Tide Gauge Workshop
09-11/05/2023	Oslo, Norway	meeting	yes	A	NAUTILOS General Assembly - EMODnet is a key stakeholder and was invited to present and discuss on metadata, ingestion and data flow
18/05/2023	Newport, Rhode Island, US	workshop	yes	O	Ocean Data Hours - low cost technology for ocean data monitoring - The Ocean Race Village, Genova Pavillion
23/05/2023	Brest, France	meeting	yes	A	EMODnet SC
24-25/05/2023	Brest, France	workshop	no	A	European Marine Days
26/05/2023	web	meeting	yes	O	MIC TWG - periodic meeting to discuss on metadata, QC/QF, ingestion and data flow, Ocean Best Practices, etc
2/6/2023	Cape Town, South Africa	workshop	yes	A	GOOS - Low cost technology Workshop
5/6/2023	Aarhus, Denmark	workshop	yes	O	Ocean Data Hours - talk to a scientist - The Ocean Race Village, Genova Pavillion

12/06/2023	The Hague, The Netherlands	workshop	yes	O		Ocean Data Day - talk to a scientist - The Ocean Race Village, Genova Pavillion
13-14/06/2023	Brussels, Belgium	meeting	yes	A		EFFECTIVE KOM - EMODnet is a key stakeholder and was invited to present and discuss on metadata, ingestion and data flow
15/06/2023	web	meeting	no	A		AIVP GA
19/06/2023	web	meeting	no	A		TG NOISE
26/06/2023	Genova, Italy	workshop	no	A		EyesOnPlastic
26/06/2023	Genova, Italy	workshop	yes	A		Mission Restore - EMODnet as source and destination for FAIRness in situ data
27-30/06/2023	Genova, Italy	workshop	yes	O		Ocean Data Week - The Ocean Race Village
SUM				**O**		**Total # of meetings organised = 28**
SUM				**A**		**Total # of meetings attended = 120**

Table 15. Meetings/events planned

A. Meetings/events planned in the future				
Date	Location	Type event (meeting, training (workshop), etc.)	Meeting to be attended (A) / organised (O)	Short description and main expected outcomes
August	Hobart, Australia	SOOSSymposium		
September	Paris, France	EuroSEA Annual Assembly		
September	Trieste, Italy	Science Festival		
September	web	EMODnet for Business WS		
September	Toulouse, France	Ocean Predict WG		
September	web	Copernicus Marine Service INSTAC stakeholder + MIC TWG		
October	Brussels, Belgium	TG NOISE meeting		
October	web	EMODnet TWG		
October	Paris, France	SO-CHIC + OCEANICE Annual Assembly		
October	Porto, Portugal	NAUTILOS General Assembly		
November	Genova, Italy	Science Festival		
November		BlueCloud 2026 General Assembly		
November	Venice, Italy	AIVP workshop		
November	Brussels, Belgium	EMODnet Jamboree + EMODnet SC		

8. Communication assets

Table 16. Communication products

	A. Communication products			
Date	Communication material	Short description (of the material, title, …) of the asset	Main results	Name of event at which material was disseminated (if applicable)
8/6/2022	https://www.linkedin.com/feed/update/ urn:li:activity:6940241693015216128/	Linkedin post	10 reactions[37]	
13/6/2022	https://www.linkedin.com/feed/update/ urn:li:activity:6942050665946886144/	Linkedin post	18 reactions	
16/6/2022	https://www.linkedin.com/feed/update/ urn:li:activity:6943110272244973569/	Linkedin post	13 reactions	
30/7/2022	https://www.linkedin.com/feed/update/ urn:li:activity:6958778221446230017/	Linkedin post	19 reactions	
30/09/22	https://www.linkedin.com/posts/outbe_fi%C3%B9-adventure-activity-6981182945566834688-uNaY	Linkedin post	12 reactions	
23/09/22	VR experience on climate change	About 2 minute 360*-3D video that informs on climate change and uses some EMODnet physics data and products		WhyBio. The experience received very good feedback on its potential as an educational - dissemination tool in (kid) schools
23/09/22	https://www.instagram.com/reel/CfzXppTIGzg/ ?utm_source=ig_web_copy_link	Instagram post		
11/03/22	https://www.instagram.com/reel/Ca9mritoTp3/ ?utm_source=ig_web_copy_link	Instagram post		
11/03/23	https://www.primocanale.it/sport/22865-the-ocean-race-genova-the-grand-finale-sostenibilita-storia-puntata-10.html	Web article + interview		
31/03/23	https://www.primocanale.it/sport/23927-the-ocean-race-genova-the-grand-finale-arrivo-itajai-sostenibilita-puntata-13.html	Web article + interview		
11/03/23	https://www.primocanale.it/sport/22865-the-ocean-race-genova-the-grand-finale-sostenibilita-storia-puntata-10.html	Web article + interview		
31/03/23	https://www.primocanale.it/sport/23927-the-ocean-race-genova-the-grand-finale-arrivo-itajai-sostenibilita-puntata-13.html	Web article + interview		

[37] In the first day of the post

	https://smart.comune.genova.it/comunicati-stampa-articoli/sostenibilit%C3%A0-cultura-promozione-turistica-il-pavilion-di-genova	Web article + interview	
	https://www.primocanale.it/sport/26816-sostenibilita-cultura-promozione-turistica-il-pavilion-di-genova-protagonista-anche-ad-aarhus-2.html	Web article + interview	
	https://www.primocanale.it/sport/25209-the-ocean-race-genova-the-grand-finale-genova-rotta-newport-puntata-17.html	Web article + interview	
	https://www.primocanale.it/sport/22865-the-ocean-race-genova-the-grand-finale-sostenibilita-storia-puntata-10.html	Web article + interview	
26/06/23	La verità viene dal mare – SecoloXIX	Newspaper	
22/06/23	All'Ocean Race le barche navigano contro il climate change – ilSole24ore	Newspaper	
29/06/23	https://www.corriere.it/tecnologia/23_giugno_29/ocean-race-progetto-scientifico-regata-dura-718381e4-561b-4a27-a814-c1785495dxlk.shtml	Newspaper	
4/1/2023	https://www.linkedin.com/feed/update/urn:li:activity:7016450166912106498	Repost	1201 reaction
9/1/2023	https://www.linkedin.com/feed/update/urn:li:activity:7018256293178011648	Post	1065 Reaction
10/1/2023	https://www.linkedin.com/feed/update/urn:li:activity:7018620570955120640	Post	1016 Reaction
11/1/2023	https://www.linkedin.com/feed/update/urn:li:activity:7018984404215607296	Post	1247 Reaction
12/1/2023	https://www.linkedin.com/feed/update/urn:li:activity:7019361438745931776	Post	1273 Reaction
13/1/2023	https://www.linkedin.com/feed/update/urn:li:activity:7019715649346121730	Post	1289 Reaction
19/1/2023	https://www.linkedin.com/feed/update/urn:li:activity:7021879132649078785	Repost	220 Reaction
23/2/2023	https://www.linkedin.com/feed/update/urn:li:activity:7034489516358787073	Post	906 Reaction
13/3/2023	https://www.linkedin.com/feed/update/urn:li:activity:7041086378830397440	Post	1901 Reaction
31/3/2023	https://www.linkedin.com/feed/update/urn:li:activity:7047599719178477568	Post	895 Reaction
6/4/2023	https://www.linkedin.com/feed/update/urn:li:activity:7049775712186109952	Post	591 Reaction
13/4/2023	https://www.linkedin.com/feed/update/urn:li:activity:7052302064441294849	Post	1583 Reaction
26/4/2023	https://www.linkedin.com/feed/update/urn:li:activity:7056958640687038465	Post	907 Reaction
26/4/2023	https://www.linkedin.com/feed/update/urn:li:activity:7057022629106360320	Post	365 Reaction
28/4/2023	https://www.linkedin.com/feed/update/urn:li:activity:7057674532433600512	Post	602 Reaction
4/5/2023	https://www.linkedin.com/feed/update/urn:li:activity:7059921911899635712	Post	342 Reaction
9/5/2023	https://www.linkedin.com/feed/update/urn:li:activity:7061718037514657792	Post	722 Reaction

16/5/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7064251827680100352	Post	705 Reaction	
18/5/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7064933118452899840	Repost	408 Reaction	
23/5/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7066712347901386752	Post	763 Reaction	
24/5/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7067120585151004672	Post	867 Reaction	
26/5/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7067766409560211456	Post	607 Reaction	
30/5/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7069223638675132416	Post	318 Reaction	
5/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7071497948097843200	Repost	279 Reaction	
8/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7072538838966910976	Post	465 Reaction	
12/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7074000404098785280	Repost	377 Reaction	
15/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7075132749325426689	Post	392 Reaction	
19/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7076551467700035585	Post	559 Reaction	
21/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7077227024406212609	Post	352 Reaction	
23/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7077941015323582465	Post	881 Reaction	
27/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7079372431127130112	Post	569 Reaction	
27/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7079382201791868928	Post	13 Reaction	
27/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7079438987399974912	Post	233 Reaction	
28/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7079738896586022912	Post	277 Reaction	
28/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7079751739125506048	Post	526 Reaction	
28/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7079793974596517888	Post	413 Reaction	
28/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7079798773920477184	Post	88 Reaction	
28/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7079858249436471297	Post	145 Reaction	
29/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7080101151752232961	Post	372 Reaction	
29/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7080156075538141184	Post	185 Reaction	
29/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7080174263994916865	Post	335 Reaction	
30/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7080463431606132736	Post	464 Reaction	

30/6/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7080524559463936000	Post	482 Reaction	
4/7/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7082026701823594497	Post	403 Reaction	
6/7/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7082622790205353984	Post	1326 Reaction	
11/7/2023	https://www.linkedin.com/feed/update/ urn:li:activity:7084511781183705089	Post	1009 Reaction	

Moreover, to facilitate access to EMODnet Physics material (presentations, recordings, etc.), lately, a Zenodo[38] community has been set up.

Table 17. Planned communication

B. Planned communication products			
Date	Communication material	Short description (of the material, title, …) and/or link to the asset	Main results expected

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[38] https://zenodo.org/communities/emodnetphysics/?page=1&size=20

Table 18. Publications

Date of publication	Type of publication	Full reference	ISBN	DOI	Is it open access? Yes/No
C. (Co-)Authored peer-reviewed publications in this project phase					
	e.g. paper; conference proceedings; book chapter; …				
2021	Paper	Martinez et al., In-situ real-time underwater noise dataflow: from OBSEA to EMODnet. Bollettino di Geofisica, Vol. 62-Supplement n.1, 2021	ISSN 0006-6729		Yes[39]
2021	Paper	Novellino et al., River data management for coastal oceanography. Bollettino di Geofisica, Vol. 62-Supplement n.1, 2021	ISSN 0006-6729		Yes
2021	Paper	Corgnati et al., The European HF Radar node: two years distributing standardized and quality-controlled data to the major European Marine Data Portals. Bollettino di Geofisica, Vol. 62-Supplement n.1, 2021	ISSN 0006-6729		yes
2021	Paper	Gorringe et al., Southern Ocean data: A community effort to build a data ecosystem. Bollettino di Geofisica, Vol. 62-Supplement n.1, 2021	ISSN 0006-6729		yes
2021	Paper	Novellino et al. EMODnet Physics from data to use cases. Bollettino di Geofisica, Vol. 62-Supplement n.1, 2021	ISSN 0006-6729		yes
2021	Paper	Thomas et al., How to stop re-inventing the wheel: a data management case study. Bollettino di Geofisica, Vol. 62-Supplement n.1, 2021	ISSN 0006-6729		yes
2021	Deliverable	Rubio et al., European High Frequency Radar network governance. EuroSea Deliverable 3.4		10.3289/eurosea_d3.4.	yes
2021	Deliverable	Poliquen et al., DMP data management plan. EuroSea Deliverable D3.1		10.3289/eurosea_d3.1.	yes
2021	Deliverable	Perez Gomez et al., New Tide Gauge Data Flow Strategy. EuroSea Deliverable D3.3		10.3289/eurosea_d3.3.	yes

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[39] https://imdis.seadatanet.org/content/download/151922/file/IMDIS2021_proceedings.pdf

2021	paper	Sotillo et al., River freshwater contribution in operational ocean models along the european atlantic façade: Impact of a new river discharge forcing data on the cmems ibi regional model solution. Journal of Marine Science and Engineering 9(4):401		10.3390/jmse9040401	yes
2021	paper	Delrosso et al., EMODnet preliminary highresolution temperature and salinity climatologies for the Northern Adriatic Sea. Advances in operational oceanography: expanding Europe's ocean observing and forecasting capacity. Proceedings of the 9th EuroGOOS International Conference. 3 – 5 May 2021, Online Event 2021, EuroGOOS. Brussels, Belgium. 574		10.13155/83160	yes
2021	Paper	Corgnati et al., THE EUROGOOS HIGH FREQUENCY RADAR TASK TEAM: A SUCCESS STORY OF COLLABORATION TO BE KEPT ALIVE AND MADE GROWING. Advances in operational oceanography: expanding Europe's ocean observing and forecasting capacity. Proceedings of the 9th EuroGOOS International Conference.		10.13155/83160	yes
2021	Paper	She et al., DEVELOP EUROGOOS MARINE CLIMATE SERVICE WITH A SEAMLESS EARTH SYSTEM APPROACH. dvances in operational oceanography: expanding Europe's ocean observing and forecasting capacity. Proceedings of the 9th EuroGOOS International Conference.		10.13155/83160	yes
2021	paper	Rubio et al., Building a reliable and standardized long-term data set of surface coastal ocean currents from the European HF Radars. Advances in operational oceanography: expanding Europe's ocean observing and forecasting capacity. Proceedings of the 9th EuroGOOS International Conference.		10.13155/83160	yes
2022	book	Manzella and Novellino, Oceanography: a recent scientific discipline with ancient origins. Ocean Science Data-Elsevier	ISBN: 978-0-12-823427-3	https://doi.org/10.1016/B978-0-12-823427-3.01001-X	no
2022	book chapter	Schaap et al., Data management infrastructures and their practices in Europe. Ocean Science Data, Elsevier.	ISBN: 978-0-12-823427-3	https://doi.org/10.1016/B978-0-12-823427-3.00007-4	no
2022	Paper	Campuzano et al., Framework for improving land boundary conditions in ocean regional products. Journal of Marine Science and Engineering 10(7)		10.3390/jmse10070852	yes

2022	Proceeding	Troupin et al., Gridding of high-frequency radar velocities using the Data-Interpolation Variational Analysis in n dimensions (DIVAnd), EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022, EGU22-2371, https://doi.org/10.5194/egusphere-egu22-2371, 2022.		doi.org/10.5194/egusphere-egu22-2371	yes
2022	Book Chapter	Mourre et al., Mediterranean observing and forecasting systems,E ditor(s): Katrin Schroeder, Jacopo Chiggiato, Oceanography of the Mediterranean Sea, Elsevier, 2023 (on line since 2022)	9780128236925	https://doi.org/10.1016/B978-0-12-823692-5.00001-7.	
2022	Report	Newman et al., Southern Ocean Observing System 5-Year Report (2016-2020)		https://zenodo.org/record/7444694#.Y6BUKezMJzQ	
2022	Workshop abstract	Solabarrieta et al., EuroGEO Workshop		https://www.sustuntech.eu/sustuntech-presents-at-the-eurogeo-workshop-in-athens/	
2023		Setting EU Threshold Values for impulsive underwater sound	978-92-68-03343-2		Y
2023		Setting EU Threshold Values for continuous underwater sound	978-92-68-03349-4		Y

Table 19. Publications

D. Other/non-peer reviewed types of publications (co-)authored in this project phase						
Date of publication	Type of publication	Full reference	ISBN	DOI		Is it open access? Yes/No
	e.g. paper; conference proceedings; book chapter; …					

A simple search in google scholar shows more than 900 documents between papers and projects deliverables using/citing EMODnet Physics. https://scholar.google.com/scholar?hl=it&as_sdt=0%2C5&q=EMODnet+Physics&as_ylo=2021

We also used the "Publish or Perish" web scraper tool[40] (on google scholar) to list papers using <EMODnet Physics> as a search keyword. The result lists 900 papers about or citing EMODnet Physics (full list in attach), a more refined search shows about 100 specific on EMODnet Physics.

> *For a compressive overview of publications referring to/making use of EMODnet data and/or data products, please consult Google Scholar.*

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[40] https://harzing.com/resources/publish-or-perish

9. Monitoring indicators

Table 20. Monitoring Indicators

Comments on the progress indicators in the indicators spreadsheet		
Progress indicator	**Means of collecting figures**	**Comment**
1. Current status and coverage of total available thematic data A) Volume and coverage of available data	Matomo/ server logs	EMODnet Physics input data is sparse, and for this indicator, we consider the "platform" as the "unit" for monitoring assessment. A platform is a logical system that hosts data, where data may be a single dataset (e.g., a profile in the case of CTD), a timeseries (e.g., a sea-level station), or a series of profiles (e.g., ARGO). For indicator 1.A, we report the percentage variation in the number of platforms for the given basin. It's worth noting that some platforms may move from one basin to another. Since we report figures based on the latest position, the percentages are significantly influenced by this movement. EMODnet Physics integrates data from several sources, which can result in duplicates in the system. Cleaning duplicates is an ongoing activity and also affects the percentage of available platforms (when a duplicate is identified, the two sources are linked to the same dataset to show full provenance). We use bounding box shapes for this indicator. Most of them are already compliant with new indications - EEA shapefiles. Atlantic now covers EEA Atlantic, and the South Atlantic is included in Other Seas. Caspian and Caribbean Seas have not been used yet, so platforms in these regions are counted under Other Seas. This also affects the variation in the sea areas. A single platform typically records multiple parameters, so the movement of a platform from one area to another affects more parameters. Looking at the global amount of available platforms-parameters, during the reporting period, we recorded a significant increase (about 200% more compared to 2021 and about 150% more compared to last year), largely associated with the ingestion of CTDs and bottle data (which increased the availability of temperature and salinity units by more than 250% compared to 2021 - the previous phase - and 200% compared to 2022 - interim report). The total volume is about half of the previous (final) report. This is because the files are now stored in netCDF v.4.0, which provides a higher compression factor, and many duplicates have been cleaned. Additionally, some sources are streaming towards physics (hence no buffering/caching is needed). For indicator 1.B, since the Central Portal is now up and running, EMODnet Physics cannot capture specific traffic on the map viewer. Therefore, we can only

		provide the overall volume of downloaded data. During this period, the service that connects EMODnet Physics to PANGAEA and ARICE was updated, linking a large amount of new CTDs
What is your opinion on the data coverage within EMODnet for your thematic?		EMODnet Physics is meeting expectations well. It continues to incorporate new data sources and develop sub-thematic products, further enhancing its coverage. While the current coverage is already good, the ongoing effort to add datasets in various dimensions and establish connections with new programs and initiatives, both within and beyond the European area, remains crucial and requires maximum commitment from the EMODnet Physics team and network
B) Usage of data since the start of the project phase		Indicator 1.B reports the amount of downloaded data from the map viewer. It's important to note that manual downloads were tracked until the central system came into effect. Therefore, the figures cover the period from August 2021 to December 2022. Examining the trends, it's evident that while manual downloads were a primary means of accessing EMODnet Physics data in the previous phase (2019-2021), users have increasingly been utilizing other features to access EMODnet Physics data during this period (2021-2023). Specifically, users are relying more on M2M tools and ERDDAP (as also indicated in Indicator 2). The EMODnet Physics map viewer serves as the entry point for users to explore data. Users access the map viewer, navigate to the relevant in situ platforms, review the data (timeseries, profiles), and, if needed, utilize scripts to obtain the data. This underscores the improved overall performance and usability of the machine-to-machine interfaces provided by EMODnet Physics.
2. Current status and coverage of total number of data products A) Volume and coverage of available data products		EMODnet Physics provides data products, which can be categorized as either data collections (e.g., PSMSL RLR) or products (e.g., gridded climatology). The current EMODnet Physics infrastructure consists of both a staging system (housing 'data as is,' 'harmonized data collections,' and 'gridded products') and a production environment used to populate the central system with gridded products and data collections. Since the Central Portal's introduction, this indicator should only consider products within the production environment. To ensure the figures remain comparable with the previous phase, we are reporting figures from the staging environment, resulting in a total of 383 data items (the complete list is provided in the 'Products20230630' sheet). All of these items are accessible and discoverable through the GeoNetwork catalogue. In the production environment and within the Central Portal (as indicated in the 'Prod-Prod' sheet), EMODnet Physics offers 34 products, with sea water temperature, sea salinity, and sea level

		being the most represented, each having 9, 10, and 8 products, respectively
B) Usage of data products since the start of the project phase	Logs	The figures related to the use of the EMODnet Physics map viewer are based on data from August 2021 to December 2022. Following the introduction of the Central Portal, EMODnet Physics can now primarily monitor direct interactions with the backend services (ERDDAP, GeoServer, GeoNetwork). Therefore, these figures may not encompass all actual interactions by EMODnet Physics users. Nonetheless, we observed a substantial overall increase in machine-to-machine interactions compared to the previous phase, aligning with the objectives outlined in the tender and project goals
3. Internal and external organisations supplying/approached to supply data and data products since start of the project phase		The EMODnet Physics team continuously promotes the program and services to facilitate new data flows into the EMODnet Infrastructure. This collaborative effort involves working closely with EMODnet Ingestion, EMODnet Physics partners' infrastructures (such as EuroGOOS, Copernicus Marine Service INS TAC, SeaDataNet, and ICES), with an emphasis on establishing operational data flows based on services for long-term sustainability and ease of maintenance. For products like gridded maps, deliveries are scheduled periodically. This workflow ensures a continuous data influx into the EMODnet Physics system, with a specific focus in this phase on adding or expanding data collections that may not be fully available elsewhere, such as river data. This proactive approach aligns with the needs and expectations of EMODnet Physics stakeholders, often involving EMODnet Physics reaching out to potential data providers. Events like the Ocean Data Hours and the Ocean Data Week have proven to be valuable opportunities for connecting with new stakeholders. Some of these, like data from the Ocean Race scientific program, are already integrated and visible in the system, while others are currently undergoing the ingestion process. Notably, many of the new data providers in this phase are related to river data.
4. Online 'Web' interfaces to access or view data		EMODnet Physics organizes data collections and product access through three primary components: ERDDAP, GeoServer, and GeoNetwork. GeoNetwork serves as the catalog and directs users to datasets in ERDDAP, GeoServer, or both. ERDDAP is responsible for managing time series data and certain gridded data using ncWMS. On the other hand, GeoServer hosts vector data, maps, and trajectories. To support and streamline the centralization process, EMODnet Physics maintains a development environment that is linked to data sources and handles tasks such as data checking, cleaning, and processing. Additionally, there is a production environment that hosts the highest-quality versions of

		datasets and products intended for presentation on the central portal
6. Statistics on information volunteered through download forms		This indicator presents data provided on a voluntary basis until the Central Portal entered into service. While it captures information from a limited number of Physics users (web traffic stats indicate a much larger user base), it offers valuable insights into user distribution. Approximately 60% of users are from academia, around 20% represent private businesses, and the remaining 20% are divided between NGOs and government sectors. Detailed information on the main use cases and application areas is extracted from the full database of registered users. The percentage of users from various countries and regions is also derived from the complete database. This indicator demonstrates that EMODnet Physics aligns well with marine and coastal applications, although it is also widely utilized for climate analysis and weather model forecasting, as evident from the list of publications referencing EMODnet Physics.
7. Published use cases		EMODnet Physics has collected a total of 23 use cases, with eight of them being published during this reporting period. Among these, the most viewed use case pertains to the Med Wave Model, which involved a private company. It is likely that this company is incorporating the use case into its communication and marketing activities. Interestingly, some of the recently published use cases, such as the one related to sea level products and the support provided for deploying ERDDAP, have garnered significant attention and interest. Additionally, the collaboration between EMODnet Physics and the Copernicus Marine Service has received the second-highest viewing score
9. Technical monitoring		The uptime of our services has been consistently excellent, maintaining a 100% uptime record. However, there have been occasional minor delays in the average response time or last response time. Some of these delays were attributed to memory-related issues, primarily with our Geoserver instance. These issues were promptly addressed through necessary updates. In July 2023, we encountered a new challenge related to GeoServer's memory management, which temporarily affected the availability of our WMS services and also impacted INSPIRE compliance during that period. Fortunately, the problem has since been resolved. This incident has prompted us to enhance our monitoring of GeoServer performance to prevent such occurrences in the future.
10. Visibility & Analytics for web pages		Before the launch of the EMODnet Central Portal, our Physics mapviewer was the most frequently used interface, showing a consistent upward trend in usage. The catalogue interface also experienced substantial consumption. However, following the introduction of the Central Portal, we observed a shift towards

		typical working hours usage patterns, characterized by peaks coinciding with events. It's worth noting that our system monitors the EMODnet Physics static page, which provides a general overview of our activities. Interestingly, the most visited page on our Physics website was the mapviewer. As a result, we recommend closely monitoring the Central Portal geoviewer, particularly focusing on thematic sessions.
11. Visibility & Analytics for web sections		The figures indicate that users directly accessed the mapviewer without visiting the landing page. Combining the statistics from indicators 9 and 10 reveals that the mapviewer was the most frequently accessed page (indicator 9), while the webportal section, which includes a link to the mapviewer (indicator 10), received relatively little traffic. This reinforces the notion that the mapviewer was the primary interface used by our users.
12. Average visit duration for web pages		Same comments as for sect.9 and 10
5.1) Daily number of page views of EMODnet Thematic entry page since the start of the contract		Since the Central Portal entered into service, we have observed a typical usage pattern of the portal during working hours, with peaks corresponding to events. Notably, the system is monitoring the EMODnet Physics static page, which provides a general overview of the activity. The most frequently visited Physics page is the map viewer; therefore, we recommend monitoring the Central Portal's geo-viewer, especially during thematic sessions
5.2) Total number of visitors, page views, unique page views and percentage of returning visitors, since the start of the contract		Physics generates significant interest, consistently ranking among the top-viewed themes. We have observed usage spikes during 'ocean data hours' events, with May being a particularly notable example. It would be more intriguing to analyze user interaction with the geo-viewer, where data is more dynamic compared to the static presentation page of Physics

The monitoring numbers reported as part of the progress monitoring of EMODnet performance are collected through Matomo and/or Europa Analytics, unless reported otherwise.

10. Recommendations for follow-up actions by the EU

EMODnet is a long-term program designed to address the fragmentation of marine data sources, making it easier to discover and access data and data products for various purposes. It aims to enhance data interoperability and accessibility, fostering utilization by industry, policymakers, and scientists. Thanks to its incremental approach, the program successfully achieved the European Commission's 2020 targets for marine knowledge accessibility and interoperability. As we move into a new operational phase, this imperative extends to all thematic projects, with a particular focus on EMODnet Physics. While the overarching goals remain consistent, EMODnet Physics must pivot toward increasing the productivity of those engaged in marine-related endeavors, promoting innovation in the blue economy sector, and reducing uncertainty in our understanding of marine behavior. This involves enhancing the accessibility and interoperability of marine data, encompassing regions beyond European seas. EMODnet Physics will continue to play a pivotal role in facilitating data and information sharing in alignment with the Marine Strategy Framework Directive[41], the Maritime Spatial Planning Directive[42], Marine Water Directive, European Green Deal, UN Decade of Ocean Science for Sustainable Development 2021-2030, etc. and fit-for-purpose catalogues and data-product collections should be organized.

EMODnet Physics is hosting large and comprehensive thematic data collections (e.g., Sea Level, Surface Currents from HFR, etc.), which are highly valued by EMODnet stakeholders. In the case of River Data, EMODnet Physics serves as the primary operational data provisioning platform (ETOOFS report 2022)[43], making the system crucial for an increasing number of users. Support and collaboration with SOOS are other key elements. A clear message from the SOOS Symposium 2023 is that a complete understanding of global effects requires considering the contributions of the Southern Oceans. In this context, SOOSmap plays a crucial role in showcasing available data and their locations. Without EMODnet Physics, this tool would either not be available or not perform as efficiently. The growing interest from a wider community and the need for continuous updates, both in terms of services and products, necessitate a new contract framework. Under this framework, the team does not need to bid for continuity every other year.

EMODnet Physics acts as a catalyst, bringing communities together to address and resolve various data issues, thereby increasing the amount of shared and available data. Any potential data-sharing challenges are discussed, and active solutions are proposed. This has been the case for HFR operators, glider operators, fishermen, and now EMODnet Physics is engaging with new and important communities: citizen science projects and cryosphere researchers. More specifically, EMODnet Physics is focused on enhancing the spatial resolution of its collections. Spatial resolution here refers to increasing the number of sources, closing gaps in coastal areas, and connecting with new providers involved in operational marine data programs. Importantly, other key European infrastructures such as Copernicus Marine Service-INSTAC, the SeaDataNet network of

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[41] http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm
[42] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0089&from=EN
[43] E Alvarez Fanjul et al 2022

NODCs, and European projects like EuroSEA, JERICO-S3, etc., also benefit from these efforts to unlock and coordinate data.

The priority should be given to parameters and communities that are unique in physics and not easily findable and accessible elsewhere. This list includes river data (to complement runoff data with other physical and meteorological data), ice data (from smart cameras), wind data, and cryosphere data at sea. To achieve this, it's crucial to continue developing collaborations and memoranda of understanding with key community players such as the Arctic Ice Breaker consortium, SIOS, EuroFleet, IMO, and WOD. Operational data from the BIOARGO program (including parameters like Alkalinity, pH, Dissolved Oxygen, and Chlorophyll) should also be included in Physics collections.

In parallel, it's important to develop and make available network platform products based on community requests. Other potential products could include monthly maps of surface currents, monthly maps displaying anomalies in Temperature, Salinity, and Sea Level, as well as 24-hour predictions for sea level/tide, wind, wave, and runoff data from in-situ platforms. Marine Forecasting Centers welcome this new data, as it helps improve thermohaline circulation models in coastal areas by providing better classification of land-marine boundary conditions, particularly focusing on salinity fields. It is recommended that the EU continues to support these activities and makes new, fit-for-purpose products available for coastal applications by integrating both in-situ and remote sensing data with model output products.

EMODnet Physics should continue to facilitate community data-sharing discussions and make additional sources of in-situ data available to EMODnet stakeholders and the Copernicus program. It is also recommended that EMODnet, in collaboration with Copernicus, work on data provenance and legacy information, providing details about the principal investigator, applied QC/QF procedures, links to other data sources for the same data, and more.

EMODnet Physics should also continue expanding its reach to new communities such as marinas, port associations, offshore wind energy associations, and emerging data sources like citizen science data.

According to statistics and user feedback, EMODnet Physics effectively meets the needs of users interested in both near-real-time data and long-term historical time series data. It is recommended to start working on incorporating in-situ forecast information to enhance the user experience. This is particularly relevant for certain parameters within the EMODnet Physics domain, such as sea level, wave data, currents, and wind data.

As mentioned earlier, it is advisable to focus on making more wind data available, including coastal marine data from citizen science initiatives, ocean literacy data (digitizing early data collections from research papers and reports), underwater noise data, in-situ ice data, HF Radar-derived wave height and direction data, and beach camera data. Another user request is for density maps of observations (e.g., days of recording per grid cell). Additionally, it's recommended to establish pipelines for more frequent releases of temperature and salinity climatology data, along with monthly maps of anomalies (beginning with temperature and salinity).

EMODnet Physics is also recommended to continue its efforts in improving and harmonizing metadata. EMODnet is founded upon international standards, such as SDN vocabularies, which are evolving entities. Therefore, some emphasis should be placed on developing simplified data models, including metadata schemas and minimum required metadata, as these are crucial for achieving EMODnet's objectives. Key references for metadata standards include ISO 19115 and 19139, the use of OceanSites netcdf data format and conventions, and SDN for parameters (P01-P02). Furthermore, encouraging a broader adoption of the Creative Commons framework, particularly CC-BY for data policy, is advisable. Additionally, promoting the use of unique identifiers like DOIs and ORCIDs to properly identify and acknowledge sources and provenance is important.

Registering the EMODnet service with the INSPIRE Geoportal and developing an EMODnet flagship framework where providers are considered INSPIRE compliant if their data are part of EMODnet would streamline the process, making it more efficient and reducing the burden on operators who would otherwise have to go through two separate processes.

Establishing a long-term contract framework, as opposed to holding tenders every other year, is essential. The current process can be bureaucratic and may raise concerns among stakeholders about the long-term sustainability of the program. This is especially important for ensuring timely delivery of data collections and products that are already within EMODnet's purview, while new data and services may be subject to additional calls.

Developing a structured framework for training materials and a help desk, similar to Copernicus Marine, is highly beneficial.

Given the increasing interest from a broader community in unique products such as river data, sea level information, wind data, etc., along with the need for continuous updates in terms of services and products, a new contract framework that eliminates the need for bidding every other year is crucial.

From a management perspective, the coordination team would benefit from simplifying the reporting documentation and indicators.

11. Annex: Other documentation attached

List of Attached documents

- D1.25 Handover note
- D1.31 Guideline on data ingestion procedures for new real time and near real time streams v.2023
- D2.9 Report on the maintenance and update of the EMODnet Physics smart connectors v.2023
- D2.11 Support to develop common strategy and guideline for adoption cloud technologies
- D2.14 Report on dissemination system interfaces update v.2023
- D2.17 Updated list of EMODnet Physics products v.2023
- D3.3 Report on the SOS.SWE connected stations v.2023
- D3.4 Handbook on procedure to set up SOS.SWE interoperability
- D3.7 new APIs v.2023
- D3.10 handbook to use EMODnet Physics APIs v.2023
- D3.15 Maintenance and update of EMODnet Physics catalogue v.2023

Connected NRT sources

- CMEMS INSTAC (in situ measurement from EuroGOOS and ROOSs institutes)
- European Oceanographic Data Centres
- GDAC (Coriolis)
- Global Sea Level Observing System (GLOSS)
- IOC Sea Level Station Monitoring (SLS)
- Permanent service for mean sea level (PSMSL)
- University of Hawaii Sea Level Centre (UHSLC) - GLOSS Fast-Delivery Centre
- Système d'Observation du Niveau des Eaux Littorales (SONEL)
- Deep Ocean Multi-Disciplinary Ocean Reference Stations (OceanSITES)
- ARGO profiling float data (including EuroARGO and BioARGO)
- Southern Oceans Observing System (SOOS)
- Global HF Radar Network
- Everyone's Gliding Observatories (EGO) and OceanGlider Network
- Voluntary Observing Ship (VOS), Ship of Opportunity Program (SOOP)
- Data Buoy Cooperation Panel (DBCP), Arctic Buoy Data (IAPB),
- Tropical Moored buoys: Pacific Ocean (TAO, TRITON), Atlantic Ocean (PIRATA), Indian Ocean (RAMA)
- European Multidisciplinary Seafloor and water column Observatory (EMSO)
- Global Ocean Surface Underway Data Pilot Project (GOSUD)
- US National Data Buoy Centre (NDBC), Integrated Ocean Observing System (IOOS), National Oceanic and Atmospheric Administration (NOAA)
- Australian Integrated Marine Observing System (IMOS)
- Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP)
- Berring Data Collective – Fishing vessels data
- JRC Tzunami Array Device

Other Sources

- NMDIS monthly sea level data
- International Council for the Exploration of the Sea (ICES)
- Marine Mammals Exploring the Oceans Pole to Pole (MEOP)
- PANGAEA - Data Publisher for Earth & Environmental Science
- Global Ocean Data Analysis Project (GLODAP)
- Surface Ocean CO_2 Atlas (SOCAT)
- Circular Arctic Expedition (ACE)
- Global Runoff Data Center (GRDC)
- SeaDataNet (Temperature Climatology and Salinity Climatology products)

Full list of publications

Table 21. List of Pblication from Google Scholar + Publish or Perish

Authors	Title	Year	Publisher
B Mourre, E Clementi, G Coppini, L Coppola…	Mediterranean observing and forecasting systems	2023	Elsevier
JA Álvarez-Gómez, P Herrero-Barbero…	Seismogenic potential and tsunami threat of the strike-slip Carboneras fault in the western Mediterranean from physics-based earthquake simulations	2023	nhess.copernicus.org
C Juretzek, A Müller, R Eigenmann, JF Borsani…	A Case Study-Based Analysis of Uncertainties on the Assessment of Impulsive Underwater Noise for the Marine Strategy Framework Directive	2023	mdpi.com
D Byrne, J Polton, E O'Dea, J Williams	Using the COAsT Python package to develop a standardised validation workflow for ocean physics models	2023	nora.nerc.ac.uk
D Christie, SP Neill, P Arnold	Characterising the wave energy resource of Lanzarote, Canary Islands	2023	Elsevier
S Hu, Q Liang, H Huang, C Yang	Construction of a digital twin system for the blended-wing-body underwater glider	2023	Elsevier
HJ van Heukelum, AC Steenbrink…	Preference-based service life design of floating wind structures	2023	research.tudelft.nl
G El Serafy, L Mészáros, V Fernandez…	EuroGOOS roadmap for operational coastal downstream services	2023	archimer.ifremer.fr
D Ruiz-García, JA Raga, D March…	Spatial distribution of the demersal chondrichthyan community from the western Mediterranean trawl bycatch	2023	frontiersin.org
FJ González, T Medialdea, H Schiellerup…	MINDeSEA: Exploring seabed mineral deposits in European seas, metallogeny and geological potential for strategic and critical raw materials	2023	lyellcollection.org
O Callery, A Grehan	Extending regional habitat classification systems to ocean basin scale using predicted species distributions as proxies	2023	frontiersin.org
L Baisi	Estimation and analysis of offshore renewable energy potential for Mediterranean Sea.	2023	webthesis.biblio.polito.it
G Coppini, E Clementi, G Cossarini, S Salon…	The Mediterranean forecasting system. Part I: evolution and performance	2023	egusphere.copernicus.org
C Ferrarin, F Pantillon, S Davolio…	Assessing the coastal hazard of Medicane Ianos through ensemble modelling	2023	nhess.copernicus.org
B Stechele, A Hughes, S Degraer…	Northern Europe's suitability for offshore European flat oyster (Ostrea edulis) habitat restoration: A mechanistic niche modelling approach	2023	Wiley Online Library
JC de Smit	Biophysical interactions in coastal habitats: And how they influence ecosystem stability thresholds and climate change sensitivity	2023	dspace.library.uu.nl
SG Demyshev, OA Dymova…	Variability of Available Potential Energy Density and Buoyancy Work in the Upper 300-m Layer of the Black Sea Based on the Simulation Results	2023	physical-oceanography.ru
A Toimil, M Álvarez-Cuesta, IJ Losada	Neglecting the effect of long-and short-term erosion can lead to spurious coastal flood risk projections and maladaptation	2023	Elsevier
G Radhakrishnan, X Han, BJ Leira, Z Gao, S Sævik	Calibration of high-fidelity hydrodynamic models utilizing on-site vessel response measurements	2023	Elsevier
R Sheldon	The Long Ascent, Volume 3: Genesis 1-11 in Science &Myth	2023	books.google.com
E Fakiris, X Dimas, V Giannakopoulos…	Improved predictive modelling of coralligenous formations in the Greek Seas incorporating large-scale, presence–absence, hydroacoustic data and …	2023	researchgate.net
F Ossing, S Attinger, T Jung, M Visbeck, S Brune…	Synthesis paper Digital Twins of Planet Earth: First Draft for the General Assembly	2023	oceanrep.geomar.de

M Simões-Marques, P Água, A Frias…	Metaverse and Digital Twins: Contributions, Opportunities and Challenges to a Sustainable Use of the Ocean	2023	researchgate.net
A Eladawy, T Nakamura, M Yoshikai	Multiscale hydrodynamics modeling reveals the temperature moderating role of the Northern Red Sea Islands	2023	Elsevier
S TOMBUL, E TÜKENMEZ, M OKSUZ…	Predicting the Trajectories of Drifting Objects in the Eastern Mediterranean Sea	2023	trjfas.org
L Alfonsi, C Cesaroni, M Hernandez-Pajares…	Ionospheric response to the 2020 Samos earthquake and tsunami	2023	researchsquare.com
F Raad, R Ebner, H Heida, P Meijer, J Lofi…	A song of volumes, surfaces and fluxes: The case study of the Central Mallorca Depression (Balearic Promontory) during the Messinian Salinity Crisis	2023	earthdoc.org
A Toimil Silva, M Álvarez Cuesta, I Losada Rodríguez	Neglecting the effect of long-and short-term erosion can lead to spurious coastal flood risk projections and maladaptation	2023	repositorio.unican.es
A Cucco, L Rindi, L Benedetti-Cecchi…	Assessing the risk of oil spill impacts and potential biodiversity loss for coastal marine environment at the turn of the COVID-19 pandemic event	2023	Elsevier
P Penna, F Domenichetti, A Belardinelli…	Dataset of Depth/Temperature profiles obtained in the period 2012–2020 using commercial fishing vessels of the AdriFOOS fleet in the Adriatic Sea (Mediterranean …	2023	essd.copernicus.org
V Reiskarts, K Savenkovs	Smarthub for supervising system for resource exploration and pollution control in deep-water and coastal areas based on ICT technologies	2023	emerald.com
R Maglietta, L Saccotelli, C Fanizza, V Telesca…	Environmental variables and machine learning models to predict cetacean abundance in the Central-eastern Mediterranean Sea	2023	nature.com
M Declerck, N Trifonova, J Hartley, BE Scott	Cumulative effects of offshore renewables: From pragmatic policies to holistic marine spatial planning tools	2023	Elsevier
SE Cravatte, A Pietri, F Colas…	Marine heatwaves (MHWS) are discrete warm-water anomalies events occurring in both open ocean and coastal areas. These phenomena have drawn researchers' …	2023	books.google.com
M Montanyès, B Weigel, M Lindegren	Community assembly processes and drivers shaping marine fish community structure in the North Sea	2023	Wiley Online Library
M Nenciu, V Niță, L Lazăr, A Spînu…	Fostering the Development of Western Black Sea Aquaculture: A Scientific Case Study for Finfish Cage Farming Allocated Zone Designation	2023	mdpi.com
N Pinardi, B van den Hurk, JA Jimenez, G Winter…	The Knowledge Hub on Sea Level Rise and the science-based European Seas assessment reporting	2023	meetingorganizer.copernicus.org
V Fanti, Ó Ferreira, V Kümmerer…	Improved estimates of extreme wave conditions in coastal areas from calibrated global reanalyses	2023	nature.com
JJ Dañobeitia, S Pouliquen, N Pade…	The role of the marine research infrastructures in the European marine observation landscape: present and future perspectives	2023	frontiersin.org
R O'Connell, R Furlong, M Guerrini…	Development and Application of a GIS for Identifying Areas for Ocean Energy Deployment in Irish and Western UK Waters	2023	mdpi.com
D Mata Flores, ED Mercerat, JP Ampuero…	Identification of two vibration regimes of underwater fibre optic cables by Distributed Acoustic Sensing	2023	academic.oup.com
E Conti, S Arrighi, N Bigliazzi, F Boschin…	Paleogeographic reconstruction of the Tuscan coastal area nearby Grotta dei Santi (Monte Argentario, Italy) during the Neandertal occupation	2023	researchgate.net
P Wang, NB Bernier	Adding sea ice effects to a global operational model (NEMO v3. 6) for forecasting total water level: approach and impact	2023	gmd.copernicus.org
VV Tone	Report on the Work of the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea at Its Twenty-Second Meeting, June 6–10 …	2023	brill.com

JC Muchowski, M Jakobsson, L Umlauf…	Observations of strong turbulence and mixing impacting water exchange between two basins in the Baltic Sea	2023	egusphere.copernicus.org
R Felix, J Hubbard, K Wilson, A Switzer	Sensitivity analysis of tsunami heights to shallow bathymetric resolution	2023	researchsquare.com
AI Mizyuk, OS Puzina, GK Korotaev	Features of Water Exchange through the Kerch Strait Based on the Results of Numerical Modeling of the Circulation with High Spatial Resolution	2023	researchgate.net
NMR Monteiro, TCA Oliveira	Mesh generation for underwater acoustic modeling with KRAKEN	2023	Elsevier
I Iglesias, M Lupiac, LR Vieira, SC Antunes…	Socio-economic factors affecting the distribution of marine litter: The Portuguese case study	2023	Elsevier
E Asciutto, F Maioli, C Manfredi, A Anibaldi, J Cimini…	Spatio-temporal patterns of whiting (Merlangius merlangus) in the Adriatic Sea under environmental forcing	2023	biorxiv.org
RT Melis, V Demurtas, M Mussi, P Emanuele Orrù…	The paleolandscape evolution of the southwestern coast of Sardinia (Italy) and its impact on Mesolithic settlements	2023	Taylor &Francis
P Elmore, B Calder, F Petry, G Masetti, R Yager	Aggregation Methods Using Bathymetry Sources of Differing Subjective Reliabilities for Navigation Mapping	2023	Taylor &Francis
O Dymova, N Markova	Numerical Estimation of the Black Sea Circulation near the Continental Slope Using SKIRON and ERA5 Atmospheric Forcing	2023	mdpi.com
M Lorenz, U Gräwe	Uncertainties and discrepancies in the representation of recent storm surges in a non-tidal semi-enclosed basin: a hind-cast ensemble for the Baltic Sea	2023	egusphere.copernicus.org
CV Makris, K Tolika, VN Baltikas, K Velikou…	The impact of climate change on the storm surges of the Mediterranean Sea: Coastal sea level responses to deep depression atmospheric systems	2023	Elsevier
V Vandelli, N Sarkar, AS Micallef, M Soldati…	Coastal inundation scenarios in the north-eastern sector of the Island of Gozo (Malta, Mediterranean Sea) as a response to sea level rise	2023	Taylor &Francis
J Kiesel, M Lorenz, M König, U Gräwe…	A new modelling framework for regional assessment of extreme sea levels and associated coastal flooding along the German Baltic Sea coast	2023	nhess.copernicus.org
S Karozis, IA Klampanos, A Sfetsos…	A deep learning approach for spatial error correction of numerical seasonal weather prediction simulation data	2023	Taylor &Francis
SA Morla, R Muñoz, J Tomás, EJ Belda	Factors driving dispersal and habitat use of loggerhead sea turtle post-hatchlings and its conservational implications	2023	researchsquare.com
M Kats, G Carvalho	Mapping essential fish habitats of herring (Clupea harengus) and mackerel (Scomber scombrus) in the North East Atlantic	2023	edepot.wur.nl
AC Ciappa	Oil trajectory analysis for oil spill surveillance by SAR in the Mediterranean Sea	2023	Elsevier
JS Heinonen	Abstracts of the 1st GeoDays, 14th–17th March 2023, Helsinki, Finland	2023	helda.helsinki.fi
L Mentaschi, M Vousdoukas, G Garcia-Sanchez…	A global unstructured, coupled, high-resolution hindcast of waves and storm surge	2023	arxiv.org
N Lange, T Tanhua, B Pfeil, HW Bange…	A status assessment of selected data synthesis products for ocean biogeochemistry	2023	frontiersin.org
N Bednarsek, B Guilloux, DM Canu, C Galdies…	Ocean Acidification as a Governance Challenge in the Mediterranean Sea: Impacts from Aquaculture and Fisheries	2023	library.oapen.org
F Foglini, V Grande	A Marine Spatial Data Infrastructure to manage multidisciplinary, inhomogeneous and fragmented geodata in a FAIR perspective... the Adriatic Sea …	2023	Elsevier
F Schlembach, F Ehlers, M Kleinherenbrink…	Benefits of fully focused SAR altimetry to coastal wave height estimates: A case study in the North Sea	2023	Elsevier
H Nagy, I Mamoutos, G Nolan, R Wilkes…	High-Resolution Model of Clew Bay—Model Set-Up and Validation Results	2023	mdpi.com

S Merlino, V Calabrò, C Giannelli, L Marini, M Pagliai…	The Smart Drifter Cluster: Monitoring Sea Currents and Marine Litter Transport Using Consumer IoT Technologies	2023	mdpi.com
E Miramontes, J Déverchère, C Pellegrini…	Mediterranean Sea evolution and present-day physiography	2023	Elsevier
N Fullin, E Duo, S Fabbri, M Francioni, M Ghirotti…	Quantitative Characterization of Coastal Cliff Retreat and Landslide Processes at Portonovo-Trave Cliffs (Conero, Ancona, Italy) Using Multi-Source Remote Sensing …	2023	preprints.org
M Irazoqui Apecechea, A Melet…	Towards a pan-European coastal flood awareness system: Skill of extreme sea-level forecasts from the Copernicus Marine Service	2023	frontiersin.org
J Karstens, J Preine, S Carey, KLC Bell…	Formation of undulating seafloor bedforms during the Minoan eruption and their implications for eruption dynamics and slope stability at Santorini	2023	Elsevier
R Bossis, V Regard, S Carretier	Initial shape reconstruction of a volcanic island as a tool for quantifying long-term coastal erosion: the case of Corvo Island (Azores)	2023	esurf.copernicus.org
P Favali, JJ Dañobeitia, BM Howe, H Ruhl	The discovery of the unknown planet: the ocean	2023	books.google.com
F Ribas, L Portos-Amill, A Falqués, J Arriaga, M Marcos…	Impact of mean sea-level rise on the long-term evolution of a mega-nourishment	2023	Springer
F Caeiro-Gonçalves, A Bio, I Iglesias, P Avilez-Valente	Sea Level Rise Effects on the Sedimentary Dynamics of the Douro Estuary Sandspit (Portugal). Water 2023, 15, 2841	2023	researchgate.net
I Santi, O Beluche, M Beraud, PL Buttigieg…	European marine omics biodiversity observation network: a strategic outline for the implementation of omics approaches in ocean observation	2023	frontiersin.org
GV Kozyrakis, K Spanoudaki, EA Varouchakis	Long-term wave energy potential estimation in the Aegean and Ionian seas using dynamic downscaling and wave modelling techniques.	2023	Elsevier
MI Apecechea, A Melet…	Towards a pan-European coastal flood awareness system: Skill of extreme sea-level forecasts from the Copernicus Marine Service	2023	search.proquest.com
N Trilla-Prieto	ORGANOPHOSPHATE ESTERS IN THE WATER COLUMN AND SURFACE MICROLAYER OF THE ATLANTIC OCEAN	2023	accedacris.ulpgc.es
F Maioli, B Weigel, E Chiarabelli, C Manfredi…	Influence of ecological traits on spatio-temporal dynamics of an elasmobranch community in a heavily exploited basin	2023	nature.com
HA Ruhl, BJ Bett, J Ingels, A Martin…	Integrating ocean observations across body-size classes to deliver benthic invertebrate abundance and distribution information	2023	Wiley Online Library
A Ulazia Manterola, A Sáenz Aguirre…	Performance variations of wave energy converters due to global long-term wave period change (1900–2010)	2023	addi.ehu.es
G Coro, L Sana, C Ferrà, P Bove…	Estimating hidden fishing activity hotspots from vessel transmitted data	2023	frontiersin.org
C Thomas, V Lieunard, B Oudon, O Bain…	Bio-inspired wave breakers to reduce swell erosion in the Bay of Biscay using Computational Fluid Dynamics	2023	Elsevier
F Paquet, I Thinon, O Dugué, B Tessier…	The Central English Channel troughs: major source-to-sink remnants or giant tidal scours?	2023	Elsevier
L Ursella, S Aronica, V Cardin, G Ciraolo…	Calibration and validation of high frequency coastal radar waves exploiting in-situ observations and modelled data in the south-west Sicily	2023	Taylor &Francis
K Silvestrova, S Myslenkov, O Puzina, A Mizyuk…	Water Structure in the Utrish Nature Reserve (Black Sea) during 2020–2021 According to Thermistor Chain Data	2023	mdpi.com
G Zodiatis, S Brenner, I Gertman, T Ozer…	Twenty years of in-situ monitoring in the south-eastern Mediterranean Levantine basin: Basic elements of the thermohaline structure and of the mesoscale …	2023	frontiersin.org
A Hildenbrand, H Zeyen, F Schmidt, S Bouley…	A giant volcanic island in an early Martian Ocean?	2023	Elsevier

A Argnani, N Alessandro Pino	The 1908 Messina Straits Earthquake: Cornerstones and the Need to Step Forward	2023	pubs.geoscienceworld.org
HL Close, PJ Barry, PSO McIlwaine…	Distolambrus maltzami (Miers, 1881)(Brachyura: Parthenopidae) with observed and modelled distribution in the North-east Atlantic	2023	cambridge.org
S Merlino, M Locritani, A Guarnieri, D Delrosso…	Marine litter tracking system: a case study with open-source technology and a citizen science-based approach	2023	mdpi.com
A Adell, B Almström, A Kroon, M Larson, CB Uvo…	Spatial and temporal wave climate variability along the south coast of Sweden during 1959–2021	2023	Elsevier
LQ Jiang, A Kozyr, JM Relph, EI Ronje, L Kamb…	The Ocean Carbon and Acidification Data System	2023	nature.com
J Sobrinho, H de Pablo, L Pinto, R Neves	Upscaling local domains in regional domains: An offline nudging approach	2023	Elsevier
L Bachmann, J Beermann, T Brey, HJ de Boer…	The role of systematics for understanding ecosystem functions: Proceedings of the Zoologica Scripta Symposium, Oslo, Norway, 25 August 2022	2023	Wiley Online Library
L Porz, W Zhang, C Schrum	Natural and anthropogenic influences on the development of mud depocenters in the southwestern Baltic Sea	2023	Elsevier
R Borgers, M Dirksen, IL Wijnant…	Mesoscale modelling of North Sea wind resources with COSMO-CLM: model evaluation and impact assessment of future wind farm characteristics on cluster-scale …	2023	wes.copernicus.org
S Velázquez-Medina, F Santana-Sarmiento	Evaluation method of marine spaces for the planning and exploitation of offshore wind farms in isolated territories. A two-island case study	2023	Elsevier
S Escobar, Q Bi, M Fettweis, S Wongsoredjo…	A dynamic 2DH flocculation model for coastal domains	2023	Springer
KP Graves, AEH Bridges, T Dabrowski, T Furey…	Oceanographic variability drives the distribution but not the density of the aggregation forming deep-sea sponge Pheronema carpenteri	2023	Elsevier
I Vrana, B Gašparović, S Geček…	Successful acclimation of marine diatoms Chaetoceros curvisetus/pseudocurvisetus to climate change	2023	Wiley Online Library
M Rowberry, J Klimeš, J Blahůt, J Balek…	A global database of giant landslides on volcanic islands	2023	Springer
VP Dimri, RP Srivastava, OP Pandey	Measuring Indian coastline using optimum scale: a case study	2023	Springer
PP Arlinghaus, C Schrum, I Kröncke…	Benthos as a key driver of morphological change in coastal regions	2023	egusphere.copernicus.org
P Scussolini, J Dullaart, S Muis, A Rovere…	Modeled storm surge changes in a warmer world: the Last Interglacial	2023	cp.copernicus.org
F Pereira, A Picado, H Pereira, JP Pinheiro…	Impact of Extreme Wind and Freshwater Runoff on the Salinity Patterns of a Mesotidal Coastal Lagoon	2023	mdpi.com
AM Addamo, A La Notte	Towards an ecosystem-based approach in marine ecosystem accounting	2023	publications.jrc.ec.europa.eu
A Konstantinou, T Scott, G Masselink, K Stokes…	Satellite-based shoreline detection along high-energy macrotidal coasts and influence of beach state	2023	Elsevier
M Cicala, F De Giosa, V Festa, SN Lisco…	The northern fault of the onshore-offshore Monte Giove relief in the southern Adriatic Sea, Italy: implications for tectonic reactivation in the Apulian Foreland	2023	gq.pgi.gov.pl
S Vranken, M Robuchon, S Dekeyzer…	AlgaeTraits: a trait database for (European) seaweeds	2023	mnhn.hal.science
A Picado, H Pereira, MC Sousa, JM Dias	Ria de Alvor Suitability for Aquaculture: Future Challenges	2023	mdpi.com
A Ulazia Manterola, J Sáenz Aguirre, A Sáenz Aguirre…	Paradigmatic case of long-term colocated wind–wave energy index trend in Canary Islands	2023	addi.ehu.es
G Coro, P Bove, K Kesner-Reyes	Global-scale parameters for ecological models	2023	nature.com
E Miettunen, L Tuomi, A Westerlund…	Transport dynamics in a complex coastal archipelago	2023	egusphere.copernicus.org

G Fernandez-Viejo, C Lopez-Fernandez…	Offshore seismicity clusters in the West iberian Margin illustrated by two decades of events	2023	egusphere.copernicus.org
B Kvamme, A Vasilev	Thermodynamic Feasibility of the Black Sea CH4 Hydrate Replacement by CO2 Hydrate	2023	mdpi.com
G Verri, I Barletta, N Pinardi, I Federico, J Alessandri…	Shelf slope, estuarine dynamics and river plumes in az* vertical coordinate, unstructured grid model	2023	Elsevier
E Torreblanca, R Real…	Spatial and temporal partitioning of the Western Mediterranean Sea by resident dolphin species	2023	ejournals.epublishing.ekt.gr
AJ Rosario Beltré…	Deterministic seismic hazard assessment of the area comprised between west Gulf of Cádiz and east Alboran Sea	2023	nhess.copernicus.org
P Carrera, U Tenreiro-López, V Trujillo-Gorbea…	Memoria Anual del Centro Oceanográfico de Vigo 2021	2023	digital.csic.es
B Biguino, ID Haigh, JM Dias, AC Brito	Climate change in estuarine systems: Patterns and gaps using a meta-analysis approach	2023	Elsevier
B Albouy, S Paquin, M Hinz, CD Wren…	The Last of Them: Investigating the Palaeogeography of the Last Neanderthals in Europe (Marine Isotopic Stage 3)	2023	Springer
K Salm, T Liblik, U Lips	Submesoscale variability in a mesoscale front captured by a glider mission in the Gulf of Finland, Baltic Sea	2023	frontiersin.org
P Mlakar, A Ricchi, S Carniel, D Bonaldo…	DELWAVE 1.0: Deep-learning surrogate model of surface wave climate in the Adriatic Basin	2023	egusphere.copernicus.org
A Pascual, B Mourre, P Balaguer, B Barceló-Llull…	Cruise Plan: Fine-Scale ocean currents from integrated multi-platform experiments and numerical simulations: contribution to the new SWOT satellite mission (FaSt …	2023	digital.csic.es
U Brönner, M Sonnewald, M Visbeck	Digital Twins of the Ocean can foster a sustainable blue economy in a protected marine environment	2023	ihr.iho.int
E Miramontes, C Pellegrini, D Casalbore…	Active geological processes in the Mediterranean Sea	2023	Elsevier
АА Богданов, АИ Мизюк…	Эволюция субмезомасштабных циклонов на периферии Батумского антициклона по данным численного моделирования	2023	mhiras.elpub.ru
F Paladini de Mendoza, K Schroeder…	Deep-Water Dynamics along the 2012–2020 Observations on the Continental Margin of the Southern Adriatic Sea (Mediterranean Sea)	2023	mdpi.com
F Estrada, G Ercilla, D Casas	Perills geològics submarins	2023	digital.csic.es
F Neri, T Romagnoli, S Accoroni, M Ubaldi…	Phytoplankton communities in a coastal and offshore stations of the northern Adriatic Sea approached by network analysis and different statistical descriptors	2023	Elsevier
FE i Llàcer, GE i Zárraga, DC i Layola	Perills geològics submarins	2023	raco.cat
K Kardakaris, DN Konispoliatis, TH Soukissian	Theoretical evaluation of the power efficiency of a moored hybrid floating platform for wind and wave energy production in the Greek seas	2023	aimspress.com
P Sanchez-Jerez, Y Raftoyannis, M Riihimäki	EU Bioeconomy Monitoring System indicator update	2023	rua.ua.es
B Kvamme, A Vasilev	Thermodynamic Feasibility of the Black Sea CH4 Hydrate Replacement by CO2 Hydrate. Energies 2023, 16, 1223	2023	researchgate.net
G La Manna, F Ronchetti, F Perretti…	Not only wide range shifts: Marine warming and heat waves influence spatial traits of a mediterranean common bottlenose dolphin population	2023	Elsevier
A Böhme, B Gerkensmeier, B Bratz…	Improvements to the detection and analysis of external surges in the North Sea	2023	nhess.copernicus.org
АИ Мизюк, ОС Пузина…	Особенности водообмена через Керченский пролив по результатам численного моделирования циркуляции с высоким пространственным …	2023	xn--c1agq7a.xn--p1ai

T Paramana, M Dassenakis, N Bassan, C Dallangelo…	Achieving coherence between the Marine Strategy Framework Directive and the Maritime Spatial Planning Directive	2023	Elsevier
C Gargiulo, R Battarra, C Guida…	A GIS-based tool for planning resilient climate cities	2023	Elsevier
HM Hassan, A Peresan, MN ElGabry…	Deterministic tsunamigenic earthquake hazard assessment for the northern coast of Egypt based on multi-scenario approach	2023	Springer
M Mostafavi, N Delpeche-Ellmann, A Ellmann…	Determination of Accurate Dynamic Topography for the Baltic Sea Using Satellite Altimetry and a Marine Geoid Model	2023	mdpi.com
R Roncella, B Ventura, A Vianello, E Boldrini…	Publishing Eurac Research data on the GEOSS Platform	2023	Taylor &Francis
LJ Clarke, RA Griffin, E Domoney, HCM Smith…	Low-impact rearing of a commercially valuable shellfish: sea-based container culture of European lobster Homarus gammarus in the United Kingdom	2023	int-res.com
IN Monioudi, AF Velegrakis…	Climate change-induced hazards on touristic island beaches: Cyprus, Eastern Mediterranean	2023	search.proquest.com
D Moraetis, V Mouslopoulou, A Pratikakis, J Begg…	The mechanism of REE-Y impregnation on active carbonate normal fault scarps	2023	Elsevier
M Bajo, C Ferrarin, G Umgiesser, A Bonometto…	Modelling the barotropic sea level in the Mediterranean Sea using data assimilation	2023	os.copernicus.org
O Hasan, N Smrkulj, S Miko, D Brunović, N Ilijanić…	Integrated Reconstruction of Late Quaternary Geomorphology and Sediment Dynamics of Prokljan Lake and Krka River Estuary, Croatia	2023	mdpi.com
P Alcorlo, S García-Tiscar, MR Vidal-Abarca…	Unravelling Complex Interaction among Coastal Management and Marine Biodiversity: A Case Study in Southern Spain	2023	mdpi.com
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