



European *In Situ* Marine Data Service Landscape

Marine knowledge underpins scientific research, EU environmental policy implementation, Blue economy operations, ocean management and conservation, and more. The foundation of marine knowledge is high-quality ocean observations, with observations falling into two distinct categories, those taken by satellites (remote sensing)¹ and those sampled through *in situ*² technology (direct measurements in the environment).

***In situ* measurements are not only key but mandatory to sustain state-of-the-art and fit for purpose ocean monitoring systems and a comprehensive knowledge base on the marine environment.** Many marine environmental parameters can only be taken by *in situ* technology. Thus, *in situ* ocean observations are essential to monitor the ocean interior at depth, to calibrate and validate satellite observations, and to provide information and knowledge for diverse users, spanning from research, to policy, to the blue economy, to society. *In situ* observing systems require human work and expertise, firstly to undertake high-quality sampling, and secondly for the quality control, processing and curation of the data post-collection, before it can be transformed into valuable information for enhancing marine knowledge.

The EU is strongly committed to the development of a coordinated system of global *in situ* ocean observations and has mature capabilities surrounding *in situ* ocean observations and marine monitoring. The **pan-European requirement for integrated and interoperable marine data, information, and knowledge** has given rise to **two cornerstone data services** of the European Commission (EC), serving as the backbone of marine knowledge: **EMODnet and the Copernicus Marine Service.**

The European Marine Observation and Data Network (EMODnet) is an EC operational marine data service, and a key marine knowledge initiative of EC DG MARE, with a core mandate for *in situ* marine data services, delivered at a multi-disciplinary pan-European scale. It provides Findable, Accessible, Reusable and Interoperable (FAIR) marine data and data products across seven broad marine environmental and human activities disciplines: physics, chemistry, biology, geology, bathymetry, seabed habitats, and human activities at sea. EMODnet is implemented by a network of more than 120 organisations and hundreds of experts in *in situ* marine data who work together to create pan-European data layers with metadata, aggregated from more than 600 marine data providers, infrastructures and services, to produce standardised, harmonized, and validated data and data products, according to international standards and made openly and freely available.

The Copernicus Marine Service, led by EC DG DEFIS and implemented by Mercator Ocean International, provides the European Union with a world-leading capacity for monitoring the ocean worldwide, through satellites, targeted *in situ* observations, and numerical models. *In situ*

¹ Satellites offer a global view of the surface of the ocean for a number of key parameters, which are essential for providing global coverage in near real-time, including for ocean forecasting and prediction.

² *In situ* ocean observations are collected by sensors and samplers placed in seawater, on/in the seafloor, the coastal zone and surrounding air.

observations, which play a key role in constraining global and regional ocean analysis and forecasting systems, are collected, quality-controlled and delivered by a dedicated service-unit called the Copernicus Marine *In Situ* Thematic Assembly Centre (*In Situ* TAC). The *In Situ* TAC is based on a distributed model of production, and developed in coherence with other components of the pan European data management landscape. Today more than 350 data-providers are contributing to a targeted core set of parameters (temperature, salinity, currents, sea level, waves, chlorophyll-a, oxygen, nutrients, and carbon) delivered in near-real time and in delayed mode, and directly useable for initialization, forcing, assimilation and validation of ocean numerical models.

Following a **high-level agreement between DG DEFIS and DG MARE** and the signature of Memorandum of Understanding (MoU) in 2016, **the two services have ensured a complementarity of their offers that are developed and evolve in close interaction and synergies**. The Copernicus Marine Service and EMODnet have jointly set up a Marine *In Situ* Coordination Inter-service Working Group in 2021 bringing in experts from EMODnet, Copernicus Marine Service and the EuroGOOS operational oceanography networks. The aim of the group is to further optimise data flows, coordination, and synergies of *in situ* marine data required by both services.

The **main area of collaboration for *in situ* data provision are the operational oceanographic platforms (e.g., from the Global Ocean Observing System (GOOS) and EuroGOOS) and research infrastructures**. EMODnet works with Copernicus Marine Service to publish such operational oceanographic data and to integrate these data into EMODnet's wider portfolio of *in situ* marine data that are derived from diverse sources including: research-driven time-series of data (e.g., from research cruises/campaigns), the private sector, civil society (e.g., non-governmental organisations and citizen science), and increasingly data collected by public authorities (e.g., for regulatory monitoring).

Several **interfaces have been set up to take advantage of synergies and to optimize and improve the two services**. Illustrating this point, a subset of EMODnet Physics - a core set of highly qualified parameters - is provided by the Copernicus Marine *In Situ* Thematic Assembly Centre. This remains a specific component of EMODnet Physics, with EMODnet coordinating other *in situ* physical marine, coastal and land-sea interface data (e.g., on rivers, wind, underwater noise and other parameters). On the other side, some EMODnet thematics provide *in situ* data to the Copernicus Marine Service, e.g., EMODnet Chemistry provides *in situ* biogeochemical data required for the validation of Copernicus Marine biogeochemical models. And in turn, some EMODnet thematics utilise Copernicus Marine Service outputs to further constrain and reduce uncertainty in EMODnet integrated data products e.g., the EMODnet Seabed Habitats EUSeaMap.

Over the coming years, **the Copernicus Marine Service and EMODnet will continue their collaboration to optimize data flows required by both services. They are also working together to provide the backbone data infrastructure and the core data streams into a common data lake underpinning the European Digital Twin Ocean (DTO).**

The two services (EMODnet and Copernicus Marine *In Situ* TAC) are data aggregator services. They depend on upstream global, pan European and coastal *in situ* observing networks (GOOS, EuroGOOS, European Marine Research Infrastructures), amongst others, and associated data assembly and processing infrastructures (National Oceanographic Data Centres, SeaDataNet). **These upstream observation infrastructures need to be consolidated and sustained at the European level as part of the EOOS (European Ocean Observing System) initiative³.**

³ See EuroSea Final Conference Declaration; EurOCEAN 2023 Vigo Declaration; EOOS 2023-2027 Strategy; EMODnet Call to Action 2023

Copernicus Marine and EMODnet EU marine data services: *In situ* marine data offer

The Copernicus Marine Service and its In-Situ Thematic Assembly Centre

- The Copernicus Marine Service led by EC DG-DEFIS provides the European Union with a world-leading capacity for monitoring the ocean worldwide through satellites, targeted *in situ observations* and models. *In Situ* observations, which play a key role in constraining global and regional ocean analysis and forecasting systems, are collected, quality-controlled and delivered by a dedicated service-unit called the In Situ Thematic Assembly Centre (In Situ TAC) to support the main service.
- The In Situ TAC is a distributed global and regional (European Seas) service integrating data from different sources (national, European and international networks).
- More than 350 data-providers contribute to a targeted core set of parameters delivered in near-real-time and in delayed mode, and directly useable for assimilation and validation of ocean numerical models. Data is also used to validate satellite products.
- The In Situ TAC provides thorough quality control and assurance based on internationally agreed standards and best practices.

European Marine Observation and Data Network, EMODnet

- EMODnet is the most comprehensive European *in situ* marine data service of the European Commission.
- The EMODnet EC marine data service is funded by DG MARE and implemented by network of more than 120 organisations working together to create pan-European Findable, Accessible, Reusable and Interoperable (FAIR) data layers and added value data products with metadata, all standardised, harmonized, and validated according to international standards and made openly and freely available.
- EMODnet provides the marine knowledge base for hundreds of marine data layers and data products across seven disciplines: physics, chemistry, biology, geology, bathymetry, seabed habitats, and human activities at sea (including National Maritime Spatial Plans).
- A layer of standardisation, harmonisation and integration is applied by EMODnet for its pan-European marine data layers and products, so these can be used for multiple purposes;



Both EC marine data services work together to optimize data flows, coordination and synergies of the *in situ* marine data parameters required by both services. This interoperability is also crucial as the Copernicus Marine Service and EMODnet form the backbone for the European Digital Twin Ocean. The products of both services are EU assets and are fully open to all.