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# THE IN SITU COMPONENT OF THE CMEMS – COPERNICUS MARINE ENVIRONMENT MONITORING SERVICE –

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## Abstract

The Copernicus Marine Environment Monitoring Service (CMEMS) measures, models and forecasts the state of the global oceans and European regional seas, providing more than 150 specific products comprising data from satellite images, ocean forecast models and ocean observations (measurements taken in the sea). The role of the CMEMS Thematic Assembly Centres (TACs) is to collect, process and quality control upstream satellite and in situ data required both to constrain and validate modelling and data assimilation systems and to directly serve downstream applications and services. Within CMEMS, the In Situ Thematic Assembly Centre (INSTAC) ensures that a steady supply of these in situ ocean measurements is made available to the other service components.

**Keywords:** In situ, Copernicus, Operational Oceanography

## 1. Introduction

### 1.1 In Situ component within CMEMS

The Copernicus Marine Service is based on a distributed model of service production, relying on the expertise of a wide network of participating European organisations involved in operational oceanography. The Service encompasses two kinds of production centres: 1. Monitoring and Forecasting Centres (MFCs), charged with maintaining numerical models of the ocean 2. Thematic Assembly Centres (TAC), which are tasked with the collection of ocean observations, both in situ (water column) and satellite observations. There are seven MFCs: six for regional seas and one for the global ocean. The six regional MFCs cover the areas defined as Regional Ocean Observing Systems (ROOS) areas under EuroGOOS, namely the Arctic Ocean, the Baltic Sea, the European North-West Shelf Seas, the Iberia-Biscay-Ireland Regional Seas, the Mediterranean Sea

and the Black Sea. To each MFC (regional and global) corresponds an in situ data production unit, and INSTAC itself acts as a centralised clearing house for the collection and integration of water column and surface data from this distributed network of in situ data centres.

### 1.2 Objectives of the In Situ component of CMEMS

The In Situ Thematic Assembly Centre, or INSTAC, is one of the components of the Copernicus Marine Service. Its role is to ensure that the Service has consistent and reliable access to a range of in situ data for the purpose of service production and validation. It aims at providing a global picture of the ocean state and variability by integrating thousands of local data from on-site sensors on board of a wide range of platforms operated by a few hundred of institutes. The In situ TAC deals with the collection of data from a wide range of networks and the development of homogenized quality control and validation procedures as well as high-level data products.

INSTAC has two main objectives:

1. To collect multi-source, multi-platform, heterogenous data, perform consistent quality control and distribute it in a common format (NetCDF) and in near-real-time (within 24 hours) to the CMEMS Marine Forecasting Centres (MFC), for assimilation into their numerical ocean models. Models need a constant supply of observation data in order to keep producing valuable forecasts, and assimilation is the process whereby new data is incorporated into the models.
2. To supply the MFCs and downstream users with re-processed 25-50-year products in delayed mode. In addition to the near-real-time products, these delayed-mode products are useful for model validation or assimilation in ocean reanalysis and climate studies.

## 2. INSTAC Operations

### 2.1 INSTAC organisation

16 institutes have joined their expertise to provide an in situ service compliant with CMEMS requirements. The INSTAC is coordinated by Ifremer in France. Each regional in situ data production centre has its own coordinator: 1. HCMR (Greece) for the Mediterranean Sea 2. IOBAS (Bulgaria) for the Black Sea 3. IMR (Norway) for the Arctic 4. SMHI (Sweden) for the Baltic Sea 5. BSH (Germany) for the North West Shelves region 6. Puerto del Estado (Spain) for the Iberia-Biscay-Ireland zone and Coriolis (France) for the global ocean. These leaders interact closely with national and international observing systems operators and data providers in close link with EuroGOOS and JCOMM (Joint Technical Commission for Oceanography and Marine Meteorology under WMO and IOC).

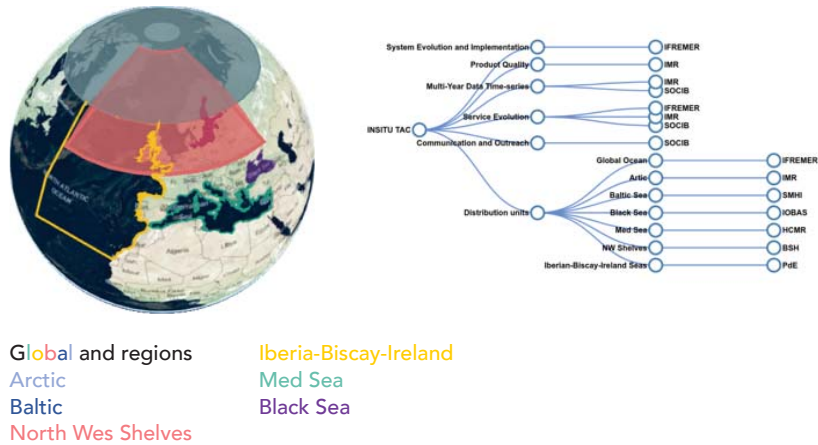


Fig. 1. The region breakdown within INSTAC and partners respective roles.

## 2.2 INSTAC operations

Within the broader community of operational oceanography, a wide range of national and international networks collect data of different kinds is necessary to fit the needs of a variety of users. The international Argo program is an emblematic example of such initiatives. CMEMS INSTAC collects data from many of these disparate data sources, carries out coherent quality control, and distributes data products in a consistent and homogenous manner. Homogeneity and standardisation are essential to ensure a coherent and efficient copernicus marine service. consistency with what is done at international level is also important. The focus of the CMEMS INS TAC is on parameters that are presently necessary for CMEMS MFCs namely temperature, salinity, sea level, currents, waves, chlorophyll-a/fluorescence, oxygen as well as nutrients (full list of parameters is available on <http://dx.doi.org/10.13155/40846>). Distributing a global and exhaustive ocean dataset means that INSTAC has to rely on the expertise of its regional coordinators, who are well-positioned to handle the specificities of their regional data collection systems, as well as identifying new data sources which may be interesting for Copernicus. Moreover it has to work closely with other European (EMODNET, SEADATANET, ICES) and international (GODAE, US/NCEI WOD) services and initiatives.

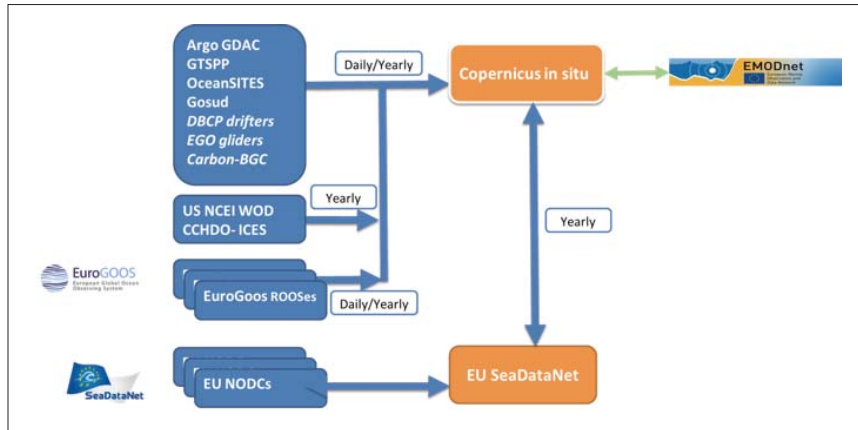


Fig. 2. INSTAC up-stream data flow for NRT and REP products and downstream link with EMNODNet-physics.

### 3. Products

#### 3.1 Product catalogue and documentation

Mercator-Ocean maintains a catalogue of CMEMS products. This includes the description of the prediction products elaborated by the Marine Forecasting Centres (MFCs) and the Ocean Observing Products elaborated by the Thematic Assembling Centres (TACs). Consequently, the in situ ocean observing products elaborated by INSTAC are described in this central catalogue: <http://marine.copernicus.eu/services-portfolio/access-to-products/> (Select “product with depth level”).

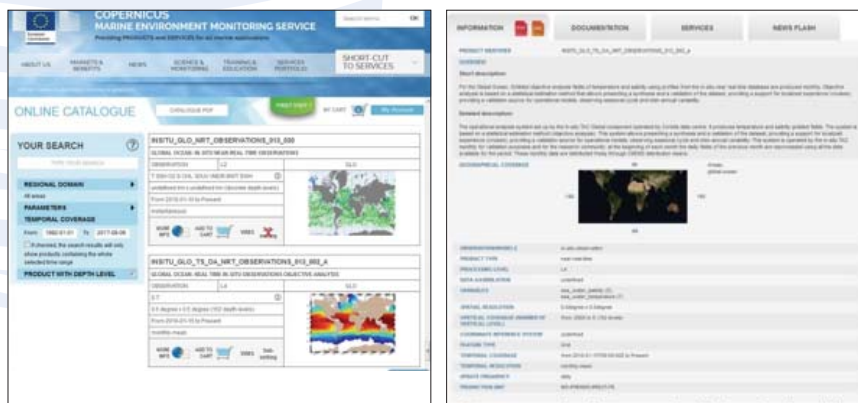


Fig. 3. CMEMS catalogue with focus on situ products.

The catalogue part dedicated to the in situ products is fed by the INSTAC product manager. A paper document also describes all the CMEMS products: <http://marine.copernicus.eu/wp-content/uploads/catalogue-cmems.pdf> . Each INSTAC product is documented with 2 types of documents: 1.PUMs: **Product User Manuals** 2.QUIDs: **Quality Information Documents**. PUMs describe the way to access the product while QUIDS describe the way the product has been elaborated and validated.

### 3.2 INSTAC products

INSTAC provides three types of products:

- NRT products (Near Real Time): In the in situ domain, near real-time data may have several meanings: 1.data that circulate from the originator to the data centre from a few hours to no later than 30 days after data collection (definition of the WMO –World Meteorological Organization) 2.data acquired by continuous, automatic and permanent observation networks 3.data that have been passed through an initial quality control check. Within INSTAC, NRT products are updated continuously and integrate observations, often acquired by automated platforms, received within a few hours or days from acquisition, that passed through automated Quality Control procedures. Their quality can be later enhanced by using more accurate quality checks and/or calibrations. The data may be then re-submitted as delayed mode data.
- REP products (REProcessed): These products are historical products , updated on a yearly basis from best quality data recovered either through SeaDataNet National Oceanographic Data Centres (NODC), or JCOMM networks Global Data Centres, or EuroGOOS ROOS providers, or international databases such USA/NCEI or ICES. Additional quality checks as well as regional consistency are performed with scientists and erroneous or suspicious observations are flagged. The most advanced REP product is the Global T&S product (INSITU\_GLO\_TS\_REP\_OBSERVATIONS\_013\_001\_b also called CORA) – see this EuroGOOS conference paper from T.Szekely and al.- and the surface current product (INSITU\_GLO\_UV\_L2\_REP\_OBSERVATIONS\_013\_044)
- From Global T&S REP product climate indicators such as Global Heat Content Indicator (GLOBAL\_REP\_PHY\_001\_021) can be processed. Such products are important for the Ocean State Reports issued annually by CMEMS.

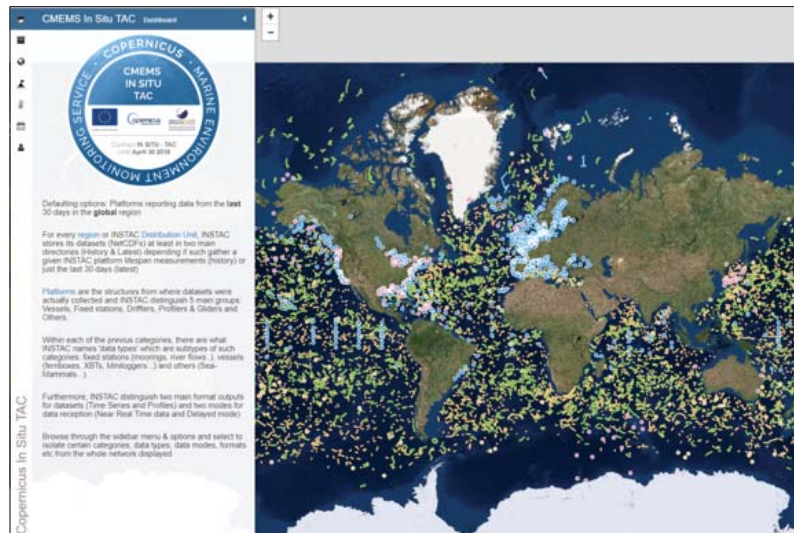


Fig. 4 Latest Month of data from INSITU\_GLO\_NRT\_OBSERVATIONS\_013\_030 product [www.marineinsitu.eu](http://www.marineinsitu.eu).

### 3.3 Service Evolution

INSTAC has steadily evolved in its successive versions, and there is a clear development roadmap towards the future: the initial version, **Version 1 (2015)**, was the heritage of *MyOcean suite of projects* with seven NRT products for temperature, salinity, current, sea level, oxygen, chlorophyll parameters and seven REP products for Temperature and Salinity covering 1990-2014. These REP products have been updated yearly and the latest year has been added to the time serie.

Since **Version 2 (2016)**, one surface current REP product designed for reanalysis purposes, integrates the best available version of in situ data for ocean surface currents for the period 1990-2016. The data are collected from the Surface Drifter Data Assembly Centre (SD-DAC at NOAA AOML) completed by European data provided by EUROGOOS regional systems and national systems by the regional INS TAC components. All surface drifter data have been processed to check for drogue loss.

Since **Version 3 (present)** the T&S REP product for the Global Ocean is a merged product between the V1 CMEMS product and ENACT4 product managed by UKMO. The coverage in time and space has been enhanced as well as the assessment method that took the best of each process to provide a product that both serve the research and the operational user needs. It covers 1950-2015.



For Version 4 (2018), seven WAVE REP products will aggregate long time series assessed in delayed mode from WAVE mooring operators covering the period 1990-2016. One BGC REP product for oxygen and chlorophyll parameters will aggregate long time series assessed in delayed mode by platform operators for the period 1990-2016. Whenever possible the consistency between the different platforms will be assessed by a scientist.

With Version 4, CMEMS will reach the end of phase 1 of the initiative. Mercator planned a phase 2 for the CMEMS. This should be officially launched through future calls for tender. They will be related on evolutions and improvements of the models and of the data services *inter alia*.

#### 4. Monitoring the service

Providing an operational or pre-operational service implies the necessity of an accurate monitoring of the service delivery. To reach this objective, INSTAC is developing KPIs (Key Performance Indicators). They allow to monitor the INSTAC activity in terms of data flowing.



Fig. 5. KPI monitoring page from CMEMS INSTAC WWW site.

## 5. Service Desk Management

As the INSTAC is run as a pre-operational system, a service desk has been set up. The service desk make the links: 1. Between the global CMEMS service desk (hosted by Mercator) 2. Between INSTAC external data providers and the INSTAC 3. Between the INSTAC and the final data users. The address of the INSTAC service desk is [cmems-service@ifremer.fr](mailto:cmems-service@ifremer.fr)

## 6. Conclusion

The IN SITU TAC of CMEMS provides a quite unique one stop shopping for ocean in-situ data for operational oceanography needs. As the area of operational oceanography is evolving quickly and continuously, the data management dedicated to in-situ near real time is continuously adapting its activity. The next steps will have to take into account new observation platforms such as tide gauges, HR radar, VM-ADCP... and new parameters (enhanced biogeochemical data management).

The consolidation and sustainability of the global and regional in situ observing systems remain a strong concern. There are critical sustainability gaps and major gaps for biogeochemical observations (e.g. carbon, oxygen, nutrients, Chl-a). New mechanisms need to be set up between the EU and member states to address them. Mercator Ocean as the EU delegated body for the Copernicus Marine Service is working with European Environment Agency, Euro-Argo ERIC and EuroGOOS in the framework of a future European Ocean Observing System (EOOS) to consolidate and improve global and regional in situ observing systems.

## Acknowledgements

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