
eosc | Blue-Cloud2026
Blue-Cloud
Virtual Labs &
Workbenches
in support of
Sustainable
Development
Goals

The Blue-Cloud thematic Virtual Labs (VLabs) and Workbenches are the main test beds for users to get the hang of the Blue-Cloud framework, exploiting the 10+ million datasets available via the Data Discovery and Access Service (DD&AS), as well as the easy access to the collaborative VLabs via D4Science and the EOSC federated login.
These collaborative workspaces hosted in the Blue-Cloud Virtual Research Environment (VRE) are serving more than 1,600 users in total spread across more than 25 countries.

Virtual Labs and applications at a glance

A total of 9 Vlabs were developed and deployed in both Blue-Cloud pilot and Blue-Cloud 2026 projects, making use of the analytical tools and generic services as provided through the VRE, and the data repositories, as made accessible via the DD&AS and through external data services. The Blue-Cloud VLabs are real-life demonstrators for web-based open science and are open and available for testing by different research communities. Each VLab comprises a series of applications for data processing, publishing of data results, and managing computation routines as well as services for collaboration, this way providing open science-friendly working environments for its users to analyse datasets and (re)generate research products:

- Aquaculture Monitor
- Carbon-Plankton Dynamics
- Coastal currents from observations
- Fish, a matter of scales
- Global Fisheries Atlas
- Integration of coastal ocean observations along Europe
- Marine Environmental Indicators
- Plankton Genomics
- Zoo & Phytoplankton EOV Products

Thematic marine services are included in the VLabs and make extensive use of the Blue-Cloud framework and its rich set of resources. These services illustrate the wide range of subjects that can be addressed using such resources, from genomics to wildlife as well as environmental data coming from multiple disciplines and repositories, and all together demonstrate Blue-Cloud 2026's potential in different fields of marine research, ranging from biodiversity to environmental science, as well as fisheries and aquaculture.

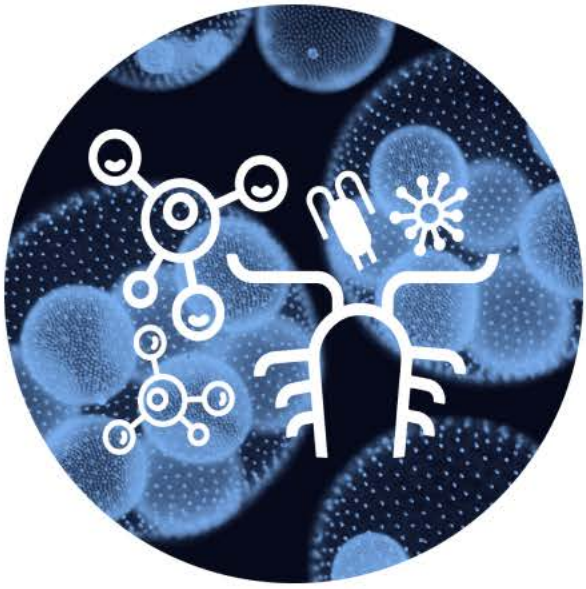
Workbenches in a nutshell

A number of intensive workbenches for selected Essential Ocean Variables (EOVs) in physics, chemi - stry and biology, are being developed and tested in Blue-Cloud 2026.
Ocean and data scientists can implement efficient workflows that allow them to harmonise, validate and qualify large and various in situ data sources, exploiting the blue analytical services available in the Blue-Cloud. These workbenches are highly relevant for analysing the state of the environment and numerical simulations of the planned Digital Twin of the Ocean (DTO), forecasting its evolution and possible impacts of measures, testing and optimising these workflows, related provenance management, and storage facilities:

- Ecosystem-level EOVs
- Eutrophication: chlorophyll, nutrients, oxygen
- Physics: temperature & salinity

Discover the many possibilities for Open Science in marine research with Blue-Cloud 2026

Virtual Labs



Carbon Plankton Dynamics

This Virtual Lab provides a service to analyse the relative contribution of the drivers in phytoplankton dynamics in the Belgium part of the North Sea and the northern Adriatic Sea.

Partners Involved

VLIZ OGS

Data Sources

EMODnet Biology/EurOBIS, EMODnet Chemistry, SOCAT, ICOS-Carbon portal.

Main Target Users

Blue-Cloud Hackathon and Training Academy participants, Blue-Cloud Task Forces, Researchers, Policy makers/EU initiatives.

UN SDGs addressed

Blue-Cloud Added Value

The collaborative and open science tools used in the Blue-Cloud VRE platform allow their re-use by other researchers, so it can be applied to fit their own research and/or to respond to other research questions, such as **"How do marine ecosystem respond to changing environmental conditions, such as ocean acidification and warming?"** or **"What is the role of biogenic reefs in carbon sequestration and its implications for climate change migration?"**

Steven Pint
VLIZ

Disruptions in phytoplankton communities will have a cascading effect throughout the food web, impacting both ecological and commercially significant fish species. In our model, we incorporate carbon data because phytoplankton plays a pivotal role in the ocean's carbon cycle, acting as carbon sinks through photosynthesis.

Learn More Here!

Global Fisheries Atlas

This Virtual Lab's mission is to help making fisheries data FAIR and, by doing so, to provide a more comprehensive view of global fisheries to support informed decision-making and management of fisheries resources.

Partners Involved

IRD Institut de Recherche pour le Développement FRANCE
FORTH
Food and Agriculture Organization of the United Nations

Data Sources

FIRMS (RFMOs), FishSource (Sustainable Fisheries Partnership), RAM, and FAO SDG14-4-1 Questionnaire.

Main Target Users

Fisheries management agencies, Marine Researchers, and the general public.

Services Introduction

The VLab offers a suite of tools and services to help users generate, browse and analyse (and interpret) data and knowledge. These tools include an integrated development environment (RStudio IDE), interactive maps and charts, as well as advanced data analysis and modeling capabilities. Some key datasets and code are made openly accessible (on Zenodo) to enable reproducible research.

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Spatial Data Infrastructure

The Spatial Data Infrastructure is a catalog for data discovery and a spatial database and server to access standardized metadata and data.

Triplestore

The Triplestore enables access over the contents of semantic web knowledge bases (i.e. GRSF knowledge base) using W3C standards (i.e. through a SPARQL endpoint).

Runtime Environment

The Runtime Environment is a tool to reproduce or customize the execution of R code in a shared RStudio

Atlas

The Atlas enables the viewers to display and explore information as map layers

Julien Barde
IRD

Our objective is to make fisheries data and code open for people to understand the status of the fish stocks worldwide. As a result, we raise awareness to manage resources more sustainably.

Learn More Here!

Coastal Currents from Observations

This Virtual Lab provides a service to generate integrate ocean surface current maps from direct and indirect current measurements derived from different sources, High Frequency (HF) radar.

Partners Involved

SOCIB Balearic Islands Coastal Observing and Forecasting System
LIÈGE université
cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

Data Sources

CMEMS, GEBCO, EMODnet Bathymetry, NOAA, Open Street Map, ECMWF.

Main Target Users

Scientifics aiming to better understand the surface circulation, Model users (forecasting and validation purposes), and Oceanography students.

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Blue-Cloud Added Value

The main output of this VLab is a service in the form of easily customizable Jupyter notebooks that allow users to generate surface currents maps for a user-chosen coastal region (when data is available and in particular the availability of HF radar data which extents depending on the configuration about 50 km – 200 km offshore). The user would also be able to make Lagrangian simulations based on these currents maps to visualize the movements of artificial drifters released at a user-chosen location (assuming suitable data coverage).

Abel Dechenne
ULiège

The code will be openly available as open-source. The DIVAnd method is coded in the Julia programming language. Its package manager helps the user to create its environment in a reproducible way effortlessly. We are also aiming to make this service intuitive and easily understandable for the user by using a JavaScript library leaflet-velocity which creates an interactive output for the user.

Learn More Here!

Integration of Coastal observations along Europe

This Virtual Lab implements an environment that is specifically designed to widely expand user's ability to access, integrate and exploit observations collected along the European coastal ocean areas, with particular focus to the observations provided by the partners of the Joint European Research Infrastructure for Coastal Observatories (JERICO-RI).

Partners Involved

hidrográfico marinha·portugal

SOCIB Balearic Islands Coastal Observing and Forecasting System

IEEE France Section

Data Sources

CMEMS, EMODnet Physics, Geology, Biology, Bathymetry and Human Activities, SOCIB Data Repository, IH, PdE, PLOCAN.

Main Target Users

Blue-Cloud Hackathon Participants, Blue-Cloud Task Forces (EU DTO), Marine Researchers, Blue Economy Actors, Crisis Managers, Policy Makers/ EU Initiatives, Citizen Scientists.

UN SDGs addressed

Services Introduction

ICOOE implements advanced processing and post-processing facilities, analytical tools and interactive state-of-the-art visualizations to provide unprecedented insight and build new knowledge on key scientific and societal questions about the coastal ocean environment of Europe, focusing three Thematic Services.

SERVICES

Transport and Connectivity

It focuses on "Transboundary Transport and Connectivity" along the European margins and explore the potential of integration of in-situ and remote observations and of numerical model results, to advance in the understanding of the transboundary processes along the European coastal ocean and mapping their potential impacts such as biological connectivity or the spread of contaminants.

Extreme Events

It addresses the "Extreme Events" that affect the European coasts, providing a number of tolls that enable to explore the available observations and to characterize the impacts of major storms on the coastal ocean environment and coastline.

Ocean Glider

The "Ocean Glider", aims to demonstrate the added value chain of repeated glider sections from data acquisition to advanced products and visualisations.

João Vitorino
Instituto Hidrográfico

We use the resources in Blue Cloud to fully exploit the integration of coastal ocean observations along Europe. The generated advanced exploration and visualization tools provided in the VLab will provide useful information to different stakeholders from the coastal environment.

Learn More Here!

Plankton Genomics

The aim of the plankton genomics demonstrator is to assess plankton functional distribution through a deep mining of biomolecular correlated with environmental data, through cutting edge machine learning.

Partners:

EMBL-EBI · SORBONNE UNIVERSITÉ · VLIZ

Data sources through Blue-Cloud:
EBI (MATOU version 1, MAGs), World Ocean Atlas.

Main target users:
Plankton researchers, ocean modellers, data product developers and Blue Data infrastructures, for their data products catalogues and as use cases.

Services introduction:
The Vlab offers two notebooks. One explores the clustering of a massive genomic dataset and its taxonomic and functional annotation. The other uses machine learning to relate those clusters to the environment (and their parameters such as longitude/latitude, temperature, pH) and extrapolate their potential distribution worldwide.

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Genomics Notebook
The genomics notebook provides an extensive network of protein clusters from the ocean microbiome based on DNA sequences collected by the Tara Oceans expedition. The clustering is based on similarity of sequences found in Metagenomes Assembled Genomes (MAGs). Sequences are taxonomically and functionally annotated but the building of clusters also highlights the large proportion of sequences that cannot be annotated (i.e. ½ of the sequences).

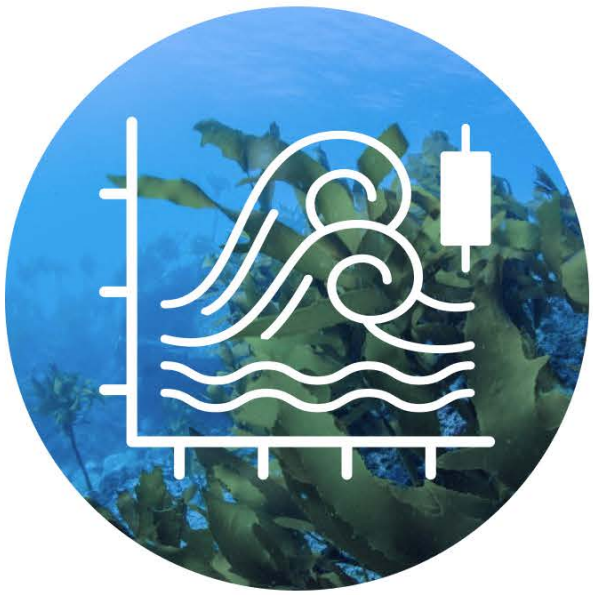
Habitat Modelling Notebook
The habitat modelling notebook queries the protein clusters for a list of functions/enzymes involved in certain biogeochemical processes. The relative abundance of the target clusters is related to environmental variables through Multivariate Boosted Regression Trees (MBRT) and the fitted model is used to predict the potential proportions of each over the world's ocean.

Modelling phyto & zooplankton interactions
Modelling phyto and zooplankton interactions enables users to calculate the relative contribution that limits the growth of phytoplankton by the drivers: nutrients, phosphates, silicates, light and zooplankton grazing.

Jean-Olivier Irisson
Sorbonne Université

Computing remotely is becoming more and more common and makes it easier to reach other users. It should also increasingly place computing power close to the data from big repositories and hence allow researchers to be much more efficient in exploring vast datasets.

Learn More Here!



Marine Environmental Indicators

The VLab aims to develop a web application that allows users to monitor and assess the environmental status of marine areas, by performing online spatio-temporal analysis with the implemented algorithms, for selected environmental variables.

Partners Involved

cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici
Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management
ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA
OGS

Data Sources

Copernicus Marine Service, Copernicus Climate SeaDataNet, World Ocean Database, EMODnet.

Main Target Users

Oceanographic and Environmental researchers, Governmental Environmental Agencies (like the italian ARPA), Marine Protected Areas managers, Municipalities, Port Authorities

UN SDGs addressed

Services Introduction

Started in the pilot phase of Blue-Cloud (2020-2022), Marine Environmental Indicators (MEI) VLab (Virtual Lab) **allows users to monitor and assess the environmental status of marine areas and support the decision-making process for the ocean management.** Multiple data sources are exploited in a unique data analysis service, which will allow the online computation of indicators. Functionalities developed in the pilot Blue-Cloud are going to be improved, including **new data sources** (physics, biogeochemistry, biology, chemical data) and **new algorithms**. The tool will calculate online metocean information and indicators on the environmental quality of the Mediterranean Sea and Global Ocean, using input from BDIs, also improving uncertainty evaluation.

Francesco Palermo
CMCC Foundation

We want to improve the user experience so the generation of the current marine environmental indicators and the new ones will be easier.

Learn More Here!

Aquaculture Monitor

Support to a workflow spanning Blue-Cloud and CLS infrastructures to produce maps based on Copernicus data. The VLab shows how Blue Cloud can integrate ISO-OGC products in a VLab.

Partners:

Data sources through Blue-Cloud:
The workflow uses Copernicus data services. It combines the output in a ISO/OGC compliant spatial data infrastructure that can be used to discover and access Blue-Cloud datasets.

Main target users:
Remote sensing data product developers and Blue Data product managers.

Services introduction:
The VLab offers two independent services; one for cage detection, the other for land-type classification. The first service is implemented as a Jupyter notebook in the Blue-Cloud infrastructure to analyse S1 data over an area of interest, while the second interoperates with a CLS proprietary service that applies AI to S2 images. The results are accessible through a Blue-Cloud VLab that provides a map viewer.

UN SDGs addressed

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Aquaculture Cage Detection

The Jupyter notebook for aquaculture cage detection generates GEOPACKAGES over an ROI using Copernicus Sentinel 1 images. The first step is a tiling service to prepare the data for analysis, while in the second step the cages are detected. The output is ingested the Spatial data infrastructure that supports the VLab and is managed through D4Science, and shown in the ISO/OGC compliant Map viewer in the Aquaculture VLab.

Aquaculture Ponds Detection

The VLab ingests AI based land-types classifications as GEOPACKAGES over an ROI that provided the base for a validation based on in-situ data. The Blue-Cloud approach showed the technical feasibility to interoperate with external proprietary software and bring the results in a collaborative environment. The results can be mashed up with other Blue-Cloud products.

Anton Ellenbroek
FAO of the UN

Accessing remote sensing data and methods in a collaborative working space enables to bridge the gap between geospatial data experts and local information managers that need spatial data products to better inform their management decisions. With Blue Clou we have proven that Copernicus derived products can be brought into a VRE, can be brought into context with other spatial data, and can provide cost-effective and standardised views over aquaculture areas.

Learn More Here!

Fish, a matter of scales

The objective is to deliver a scalable and robust open data portal for fisheries in EU waters and beyond, with a focus on the Global Tuna Atlas and the Global Record of Stocks and Fisheries (GRSF).

Partners:

Data sources through Blue-Cloud:
EMODnet bathymetry, EMODNET Biology.

Main target users:
Fisheries resource managers and fisheries research community, traceability experts and the general public.

Services introduction:
The VLab offers two independent services; the fisheries atlas (with Global Tuna Atlas as an example), and the Global record of Stocks and Fisheries that consist of a combination of a semantic knowledge base and data-flow, and a data integration service. Both services rely on ISO-OGC compliant data-flows and expose data in a catalogue and metadata-driven map viewer with R-Shiny components to expose data to the general public. Registered users can also access data using R, Jupyter notebooks, and dataminer.

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FIRMS Tuna Atlas
The FIRMS Tuna Atlas is one result of the Fisheries Atlas service. The service behind is a mature Spatial Data Infrastructure that is also used in Demonstrator 5. The service allows to harmonise and standardise fisheries data to become uniform global datasets. This requires a complex workflow that has to be validated with the data-providers in order to ensure high-quality datasets.

Global Record of Stocks and Fisheries
The Global Record of Stocks and Fisheries (GRSF) offers a Catalogue and a Map Viewer. The GRSF service enables a semantic workflow for data alignment and harmonisation, and attaches a stable UUID to validated records. The records can be enriched with ancillary information such as capture time series, model output, and assessment reports. This makes the GRSF the only global catalogue and particularly suited to traceability needs.

Marc Taconet
FAO of the UN

The Fisheries Atlas is an innovative product that presents authoritative and standardised public data on fisheries. It was made possible thanks to a strong and long-lasting partnership and a broad range of scientific and technical expertise. By facilitating access to high-quality and spatialised data, it provides the information needed to address critical issues such as traceability and sustainable fisheries management.

Learn More Here!

Zoo- & Phytoplankton Essential Ocean Variable products

This Virtual Lab provides a description of the current state of plankton communities and forecasts their evolution, representing valuable information for the modelling, assessment and management of the marine ecosystems.

Partners:

VLIZ LOV LIÈGE université

Data sources through Blue-Cloud:

EurOBIS, EMODnet Biology, LifeWatch, GEBCO, SeaDataNet, World Ocean Atlas, NOAA, Copernicus Marine Service, Argo GDAC, GlobColour.

Main target users:

Plankton researchers, ocean modellers, data product developers and Blue Data infrastructures, for their data products catalogues and as use cases.

Services introduction:

The Vlab offers three independent services that consist of the combination of different data types (biological, physical and environmental data) to then apply models that generate an output. These are offered in a working space where data and scripts are accessible and reusable.

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Zooplankton Essential Ocean Variable

Zooplankton EOV generates zooplankton gridded maps of six zooplankton species in the North East Atlantic.The workflow uses the DIVAnd software tool (Data Interpolating Variational Analysis in n dimensions) that allows to interpolate sparse in situ measurements onto a regular grid in an optimal way.

Phytoplankton Essential Ocean Variable

Phytoplankton EOV generates global open ocean 3D gridded products of (1) chlorophyll a concentration (Chla), which is a proxy of the total phytoplankton biomass, and (2) Phytoplankton Functional Types (PFT), as a proxy for phytoplankton diversity, based on temperature and salinity in situ data matched up with ocean color satellite products.

Modelling phyto & zooplankton interactions

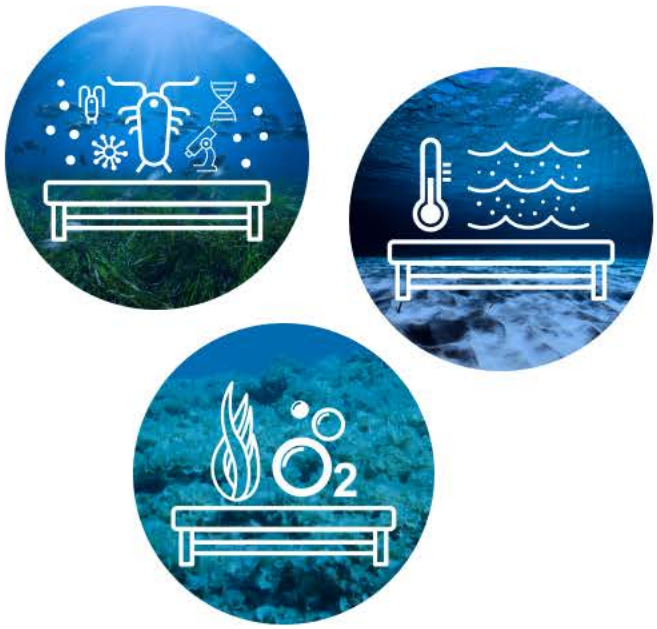
Modelling phyto and zooplankton interactions enables users to calculate the relative contribution that limits the growth of phytoplankton by the drivers: nutrients, phosphates, silicates, light and zooplankton grazing.

Patricia Cabrera
VLIZ

Accessing data and methods in a collaborative working space with high computing resources helps us assess plankton communities and make data-driven informed decisions. For example, the "Wildlife Tracker for Oceans" tool developed by one of the winning teams at the Blue-Cloud Hackathon uses data from this VLab to perform real-time assessment of Marine Protected Areas.

Learn More Here!

Workbenches



Workbenches for Essential Ocean Variables (EOVs)

A number of data-intensive **Workbenches for selected Essential Ocean Variables (EOVs)** are being developed and tested in Blue-Cloud 2026. Ocean and Data scientists will implement efficient workflows that allow them to harmonise, validate and qualify large and various in situ data sources, exploiting the blue analytical services available in the **Blue-Cloud Virtual Research Environment.**

The Workbenches

Ecosystem-level EOVs

The Ecosystem Workbench aims to improve the availability, quality, and interoperability of large collections of plankton observations and extrapolated biogeographies. This habitat modeling workflow will generate high-quality interpolated maps of these plankton entities, at the global scale and produce ecosystem-level EOVs.

Eutrophication: clorophyll, nutrients, oxygen

This Workbench will define and implement an efficient production workflow to merge multi-source datasets managed by Copernicus Marine Service, EMODnet Chemistry and the World Ocean Database, together with key EU RIs and build highly qualified EOV datasets for eutrophication variables: chlorophyll, nutrients, oxygen.

Physics: temperature & salinity

This Workbench will implement a cloud-based workflow to generate harmonised, validated and customisable EOV data collections for temperature and salinity, integrating datasets released from different EU and non-EU data infrastructures for the test region of the Mediterranean Sea.

Partners involved

Ecosystem-level EOVs

ETH zürich · SORBONNE UNIVERSITÉ · EMBL-EBI

Physics: temperature & salinity

ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA · hcmr · Ifremer · POKaPOK · OCEANSCOPE

Eurtrophication: chlorphyll, nutrients, oxygen

Ifremer · POKaPOK · OGS · SMHI

Learn More Here!

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