



# Blue-Cloud

Piloting innovative services for Marine Research & the Blue Economy

## A machine learning approach to derive plankton biomass and diversity products from the Global Ocean

IMDIS | 12 April 2021





Oceanographic and marine data management in the European landscape is progressing considerably during the last three decades. As such, providing discovery and access to multidisciplinary data sets is becoming more important.







EcoTaxa 2.5



**Blue-Cloud**  
Piloting innovative services for Marine Research & the Blue Economy



Copernicus  
Marine Service



**ENA**  
European Nucleotide Archive



EMODnet



EURO-BIOIMAGING

Large amounts of multidisciplinary marine data are available in an interoperable or harmonized way in leading European marine data. As new technologies become available, there is a challenge to adopt them to expand these data management services. In this context, the operators of these European marine data infrastructures have joined forces to explore and demonstrate the power of a Blue Cloud.



SeaDataNet



**ICOS** | Integrated  
Carbon  
Observation  
System



**urOBIS**  
European Ocean Biogeographic  
Information System



# 5 demonstrators to showcase the **Blue Cloud** Services and its potential in promoting the Blue economy



**Aquaculture  
Monitor**



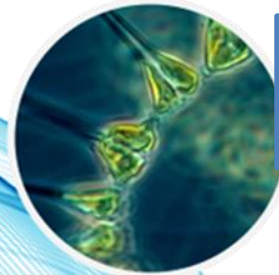
**Fish a matter  
of scales**



**Marine Environmental  
Indicators**



**Plankton  
Genomics**



**Zoo & Phytoplankton  
EOV products**



# Zoo & Phytoplankton EOV products



## Objective



Machine learning approach to derive zoo and phytoplankton biomass and diversity products

## Methodology

Data compilation & processing

Ground truth modelling using NRT data



Big data & Machine learning

## Tool

Catalogue

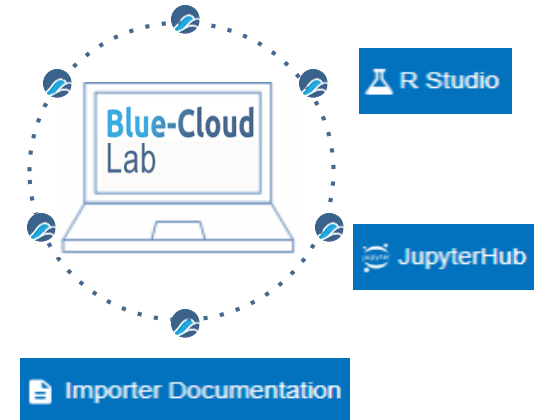
Software Importer

R Studio

Analytics Engine

JupyterHub

Importer Documentation





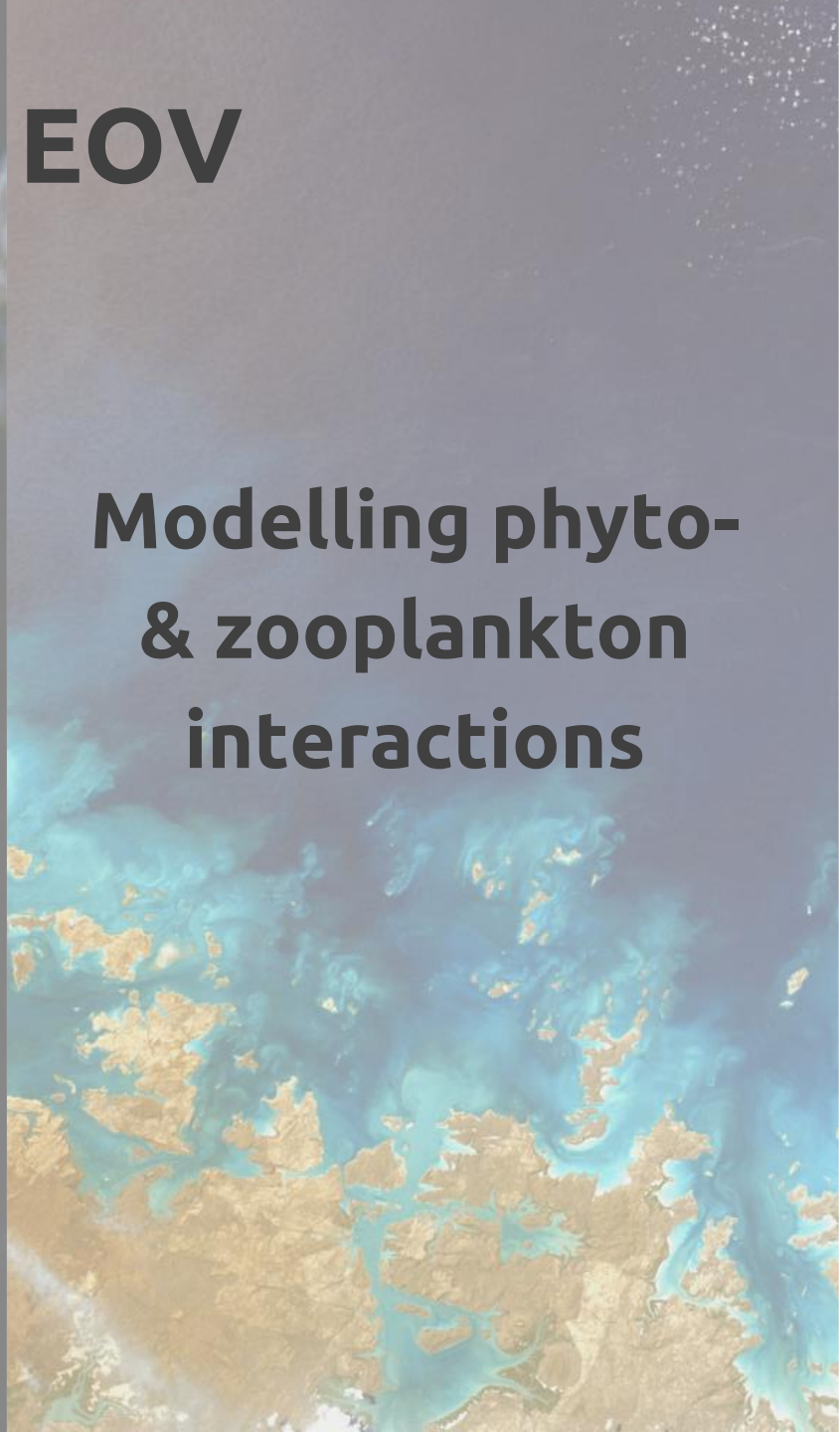


**Zoo & Phytoplankton EOV  
demonstrator**

**Phytoplankton  
EOV products**



**Zooplankton  
EOV products**





**Modelling phyto-  
& zooplankton  
interactions**

# Phytoplankton EOVS products

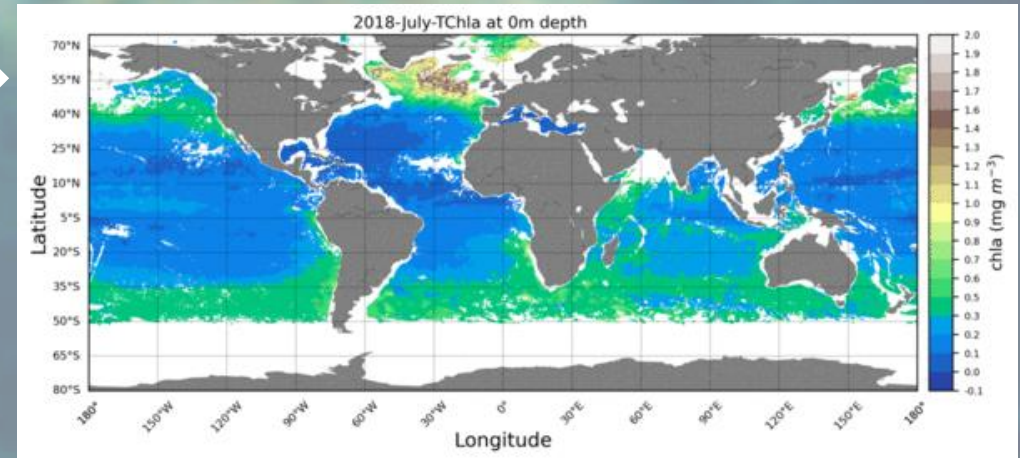
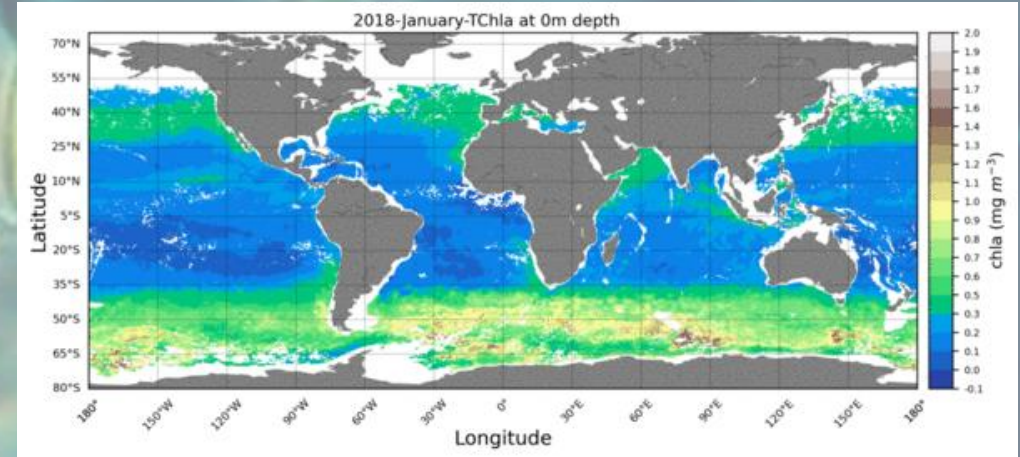
Deriving global ocean 3D Chlorophyll-a concentrations using machine learning techniques

## INPUT DATA

- BGC-Argo floats (Chla) 
- Satellite-derived reflectance's
- Satellite-derived Photosynthetically Available Radiation (PAR)
- Sea Level Anomaly
- T/S profiles 

NN model

Sauzède, et al. 2016










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# Zooplankton EOV products



Deriving gridded data products for zooplankton distribution using variational analysis & neural networks

## INPUT DATA

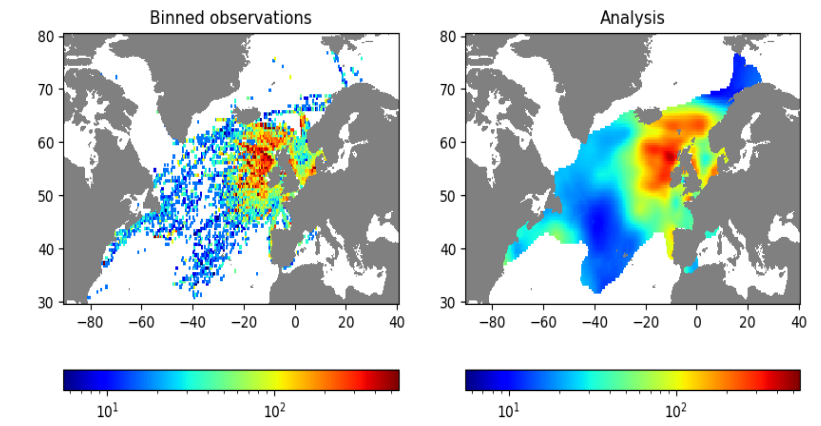
- Zooplankton abundances  EMODnet BIOLOGY Dive into data on Europe's marine life
- T/S climatologies  SeaDataNet
- Nutrients (World Ocean Atlas) 
- Distance from coast  NOAA
- Bathymetry 

NN model



## DIVAnd + Neural network

Acartia



<https://github.com/qher-ulg/DIVAnd.jl>







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# Modelling phyto- and zooplankton interactions

Understand the drivers that limit phytoplankton abundance and spatio-temporal changes based on the Nutrient, Phytoplankton, Zooplankton and Detritus (NPZD) model

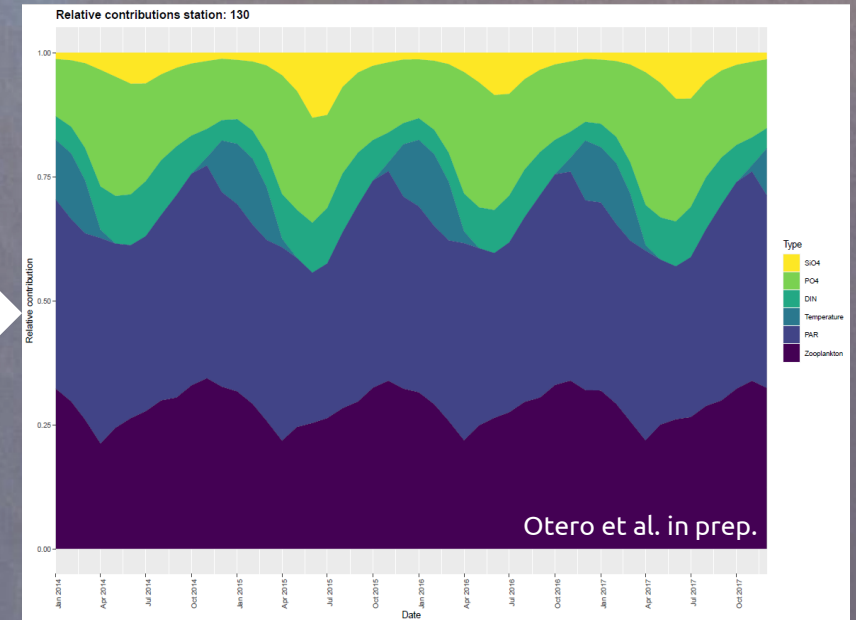
## INPUT DATA

- Zooplankton abundances
- Phytoplankton abundances
- Nutrient, temperature and light data



NPZD model

Everaert, et al. 2015





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# How to use the Demonstrator?



[https://blue-cloud.d4science.org/web/zoo-phytoplankton\\_eov](https://blue-cloud.d4science.org/web/zoo-phytoplankton_eov)

Home Sign In

**Zoo and Phytoplankton EOV Products Virtual Lab**

Developed by the **Flanders Marine Institute**, in collaboration with the **Faculty of Science and Engineering at Sorbonne University** and **GeoHydrodynamics and Environment Research at the University of Liège**.

Workspace > VRE Folders > Zoo-Phytoplankton\_EOV > Chla\_Product > Programs

Name	Owner
Models	Renosh Pannimpullath
Functions	Renosh Pannimpullath
CREATE_MONTHLY_FIELDS_Loop.ipynb	Renosh Pannimpullath
Output_spatial_plots.ipynb	Renosh Pannimpullath

Workspace > VRE Folders > Zoo-Phytoplankton\_EOV

Name	Owner
Formatting the Continuous Plankton Recorder dataset to DarwinCore E...	Patricia Cabrera
Chla_Product	Renosh Pannimpullath
DIVAndNN	Alexander Barth
test_VREFolder	Pasquale Pagano
<b>NPZD_Model</b>	Viviana Otero

BlueCloud Zooplankton Demonstrator

The aim of this notebook is to create a gridded dataset of the Continuous Plankton Recorder within the VRE context of BlueCloud

The first step is to install all dependencies (if necessary)

```
In [34]: using Pkg
try
  # check if DIVAndNN is already installed
  using DIVAndNN
catch
  # install all dependencies
  pkg"add https://github.com/gher-ulg/DIVAndNN.jl"
  pkg"add JSON PyCall PyPlot DIVAnd Glob DataStructures NCData"
end
```

Modelling phyto- and zoo-plantkon interactions

Viviana Otero  
2021-01-18

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Context

Marine phytoplankton primary production is the base of the marine food web and regulates functions in coastal ecosystems. Understanding how primary production changes through time and space is of key importance to better quantify the effects of human impact on the ocean.

With the methodology presented in this document, it is possible to analyse which factors drive the phytoplankton abundance and how these factors change in space and time. In this document, we are focused on the Belgian part of the North Sea, therefore the parametrization and visualizations shown here correspond to this particular area. For other areas, this document can be used as a guideline to adjust the relevant variables and data sources to obtain similar analyses.

Modelling approach

The ecosystem model for Nutrient, Phytoplankton and Zooplankton (NPZ) was used to simulate changes in plankton density from 2014 to 2017 (Soetaert and Herman, 2009). This model describes daily changes in phyto and zoo-plankton density based on abiotic parameters (Figure 1). The variables in the model are expressed in mmol N m<sup>-3</sup> for nutrient, phytoplankton and zooplankton densities. Daily changes in these variables are expressed in mmol N m<sup>-3</sup> d<sup>-1</sup>.

This model is useful to describe marine and freshwater systems. The state variables are nutrients, phytoplankton and zooplankton. In this document, we focused on a marine system, as in Everaert et al. (2015). Nutrients are defined as the total density of Dissolved Inorganic Nitrogen (DIN), Phosphate (PO4) and Silicate (SiO4). DIN is defined as the sum of NH<sub>4</sub>, NO<sub>3</sub> and NO<sub>2</sub>.



# Conclusions

- Plankton EOV products are available for users to explore the data, methodologies and technologies available in the Blue-Cloud VRE.
- The demonstrator will be updated in a next version to be released by 2022.
- The integration of different **EOV variables**, allows to see data-driven trend & to understand interactions in a **mechanistic way**.
- **Collaborative VRE** have a large potential to boost scientific productivity.





# Thank you



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To learn more about the demonstrator visit:  
<https://www.blue-cloud.org/demonstrators/zoo-and-phytoplankton-eov-products>

\*Pictures source: <https://www.blue-cloud.org/>