

ENHANCING PHYTOPLANKTON BIOMASS AND COMMUNITY STRUCTURE OBSERVATIONS FROM BGC-ARGO FLOATS USING MACHINE LEARNING

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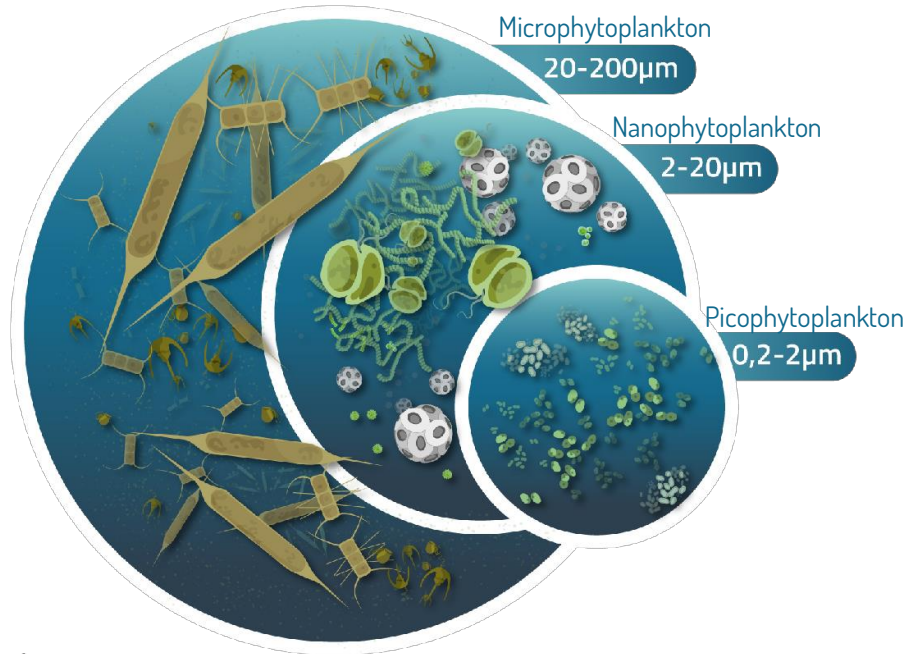


PHYTOPLANKTON: A KEY COMPONENT OF THE OCEAN

- Phytoplankton diversity affects marine ecosystems and biogeochemical functioning
- Phytoplankton community composition is a major driver of carbon fluxes (e.g. Cermeño et al. 2005; Finkel 2007; Henson et al. 2012)
- We need to monitor phytoplankton community composition on a wide range of spatial and temporal scales



HOW TO ESTIMATE PHYTOPLANKTON COMMUNITY COMPOSITION?

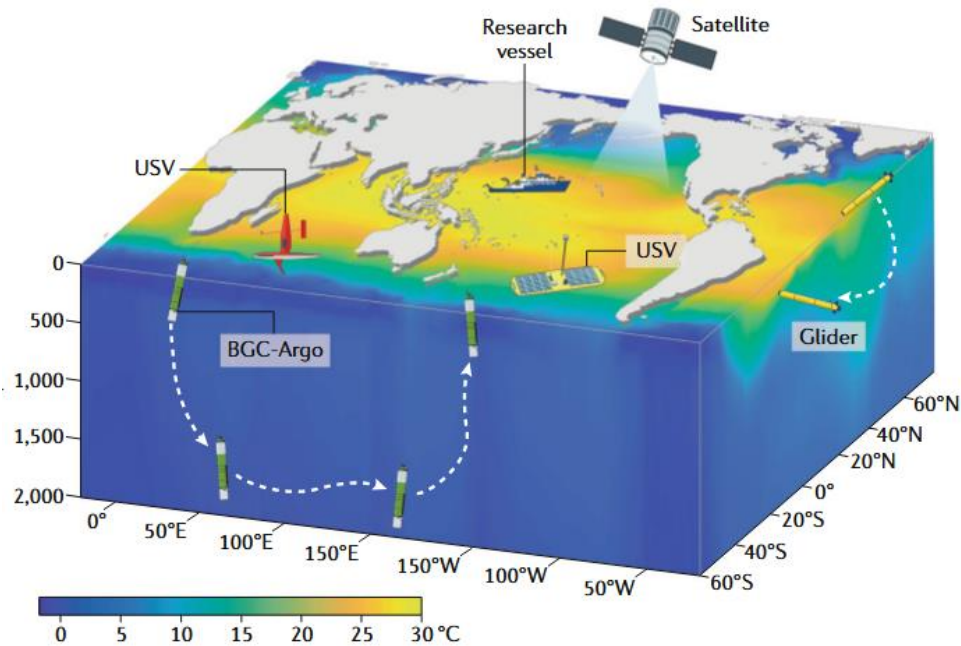


Phytoplankton diversity is characterized by a large size spectrum, different geometric shapes and pigment compositions

Accurate assessment of phytoplankton community composition can be made from water samples

But it drastically reduces spatial and temporal scales of observation

GLOBAL SCALE MEASUREMENTS



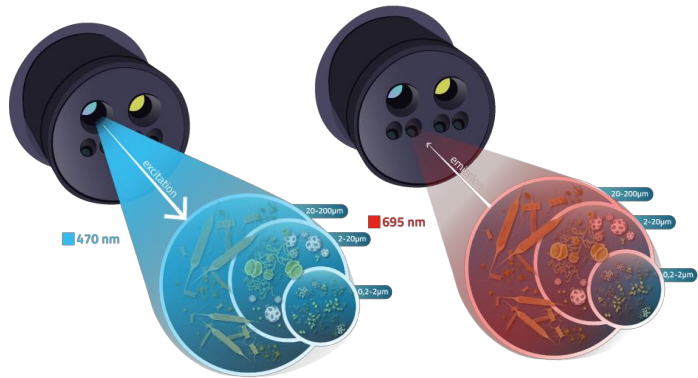
Oceanographic observations platforms (Chai et al., 2020)

Need for global scale data of phytoplankton biomass and community composition

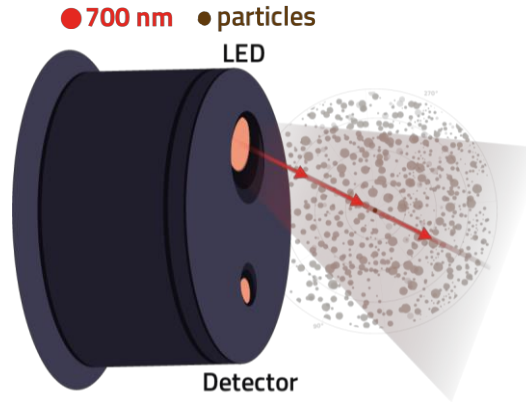
Satellite measurements allow global scale estimations (e.g. Bracher et al. 2017)

It does not provide vertical resolution

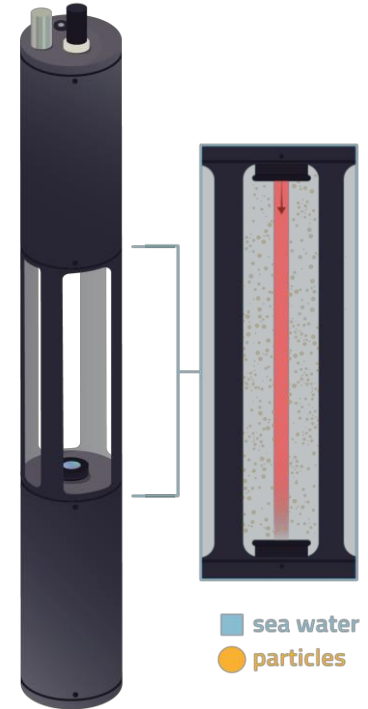
BGC ARGO FLOATS BIO-OPTICAL MEASUREMENTS



Chl_a fluorescence (FChl_a)

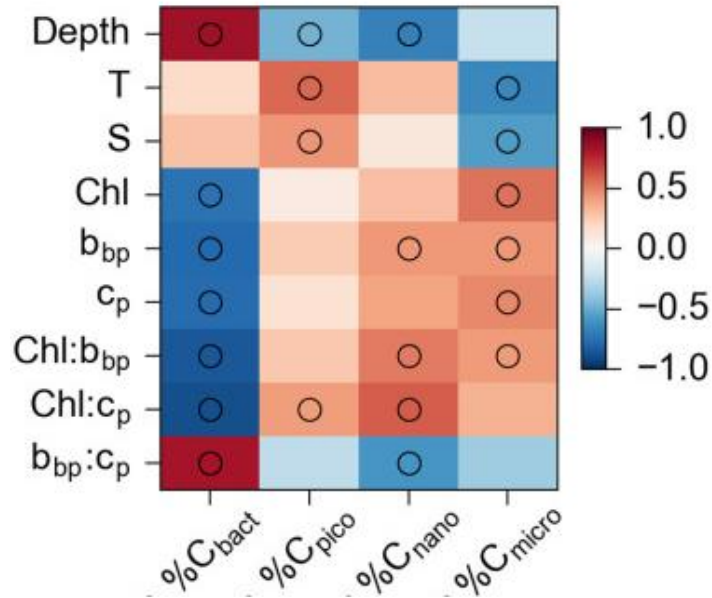


Particulate backscattering (b_{bp})



Particulate beam attenuation (c_p)

THE PLANKTON COMMUNITY STRUCTURE IS CORRELATED TO VARIABLES MEASURED BY BGC-ARGO FLOATS



Relationship between hydrographic and optical measurements and plankton community structure

Transfer function to predict the particulate organic carbon partition between four plankton groups from BGC-Argo measurements

Restricted to the Southern Ocean

Correlation coefficients between the relative contribution of four plankton groups to POC and optical and hydrographic measurements (from Rembauville et al. 2017)

OBJECTIVES

- Evaluate the performances of PLS on different dataset, reflecting contrasted plankton assemblages observed on the global scale
- Improve the use of transfer functions between BGC-Argo measurements and phytoplankton community structures to quantitative estimation of organic carbon concentration associated to plankton groups

PROTOCOLE

BGC-Argo-like optical sensor package

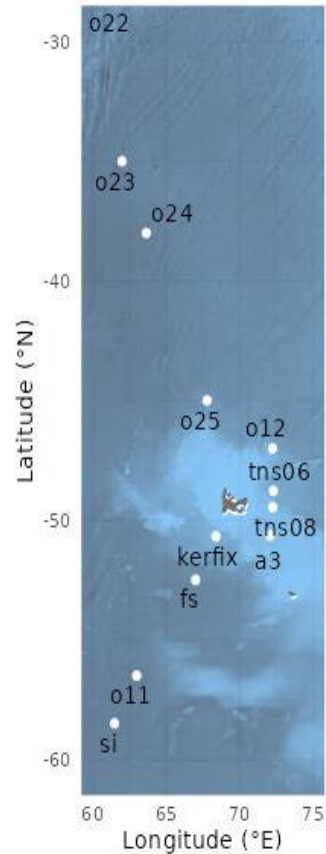
Phytoplankton community composition

- Flow cytometry (Pico- and Nano-phytoplankton)
- Microscopy (Microphytoplankton)
- POC filtration

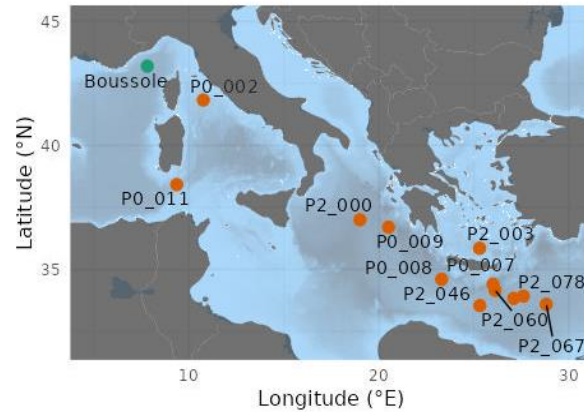
3 Depths, surface, DCM and sub-DCM



SOCLIM (SO)

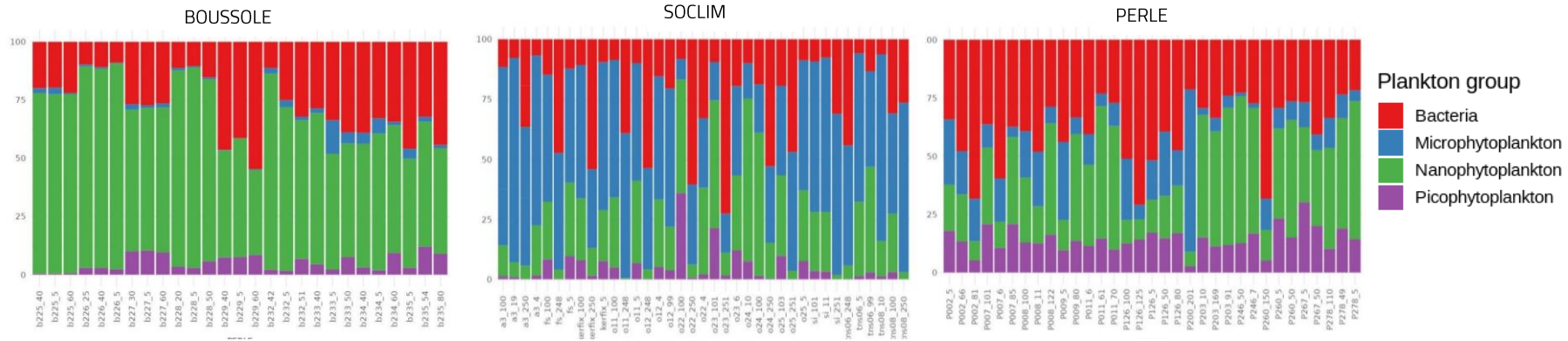


BOUSSOLE & PERLE (Med Sea)



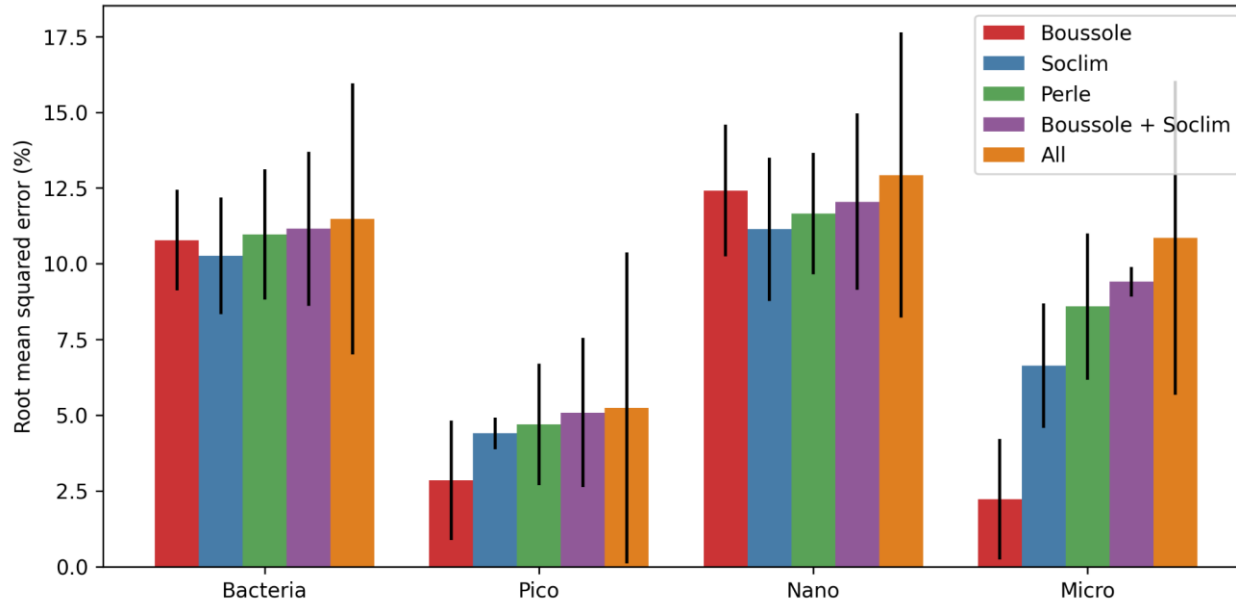
CONTRASTED PLANKTON ASSEMBLAGES FROM THREE DIFFERENT CRUISES

Evaluation of the PLS method performances for each plankton group and each dataset



Carbon contribution of four plankton groups in the different datasets

THE PLS METHOD PREDICTS PLANKTON ASSEMBLAGES IN DIFFERENT ENVIRONMENTS



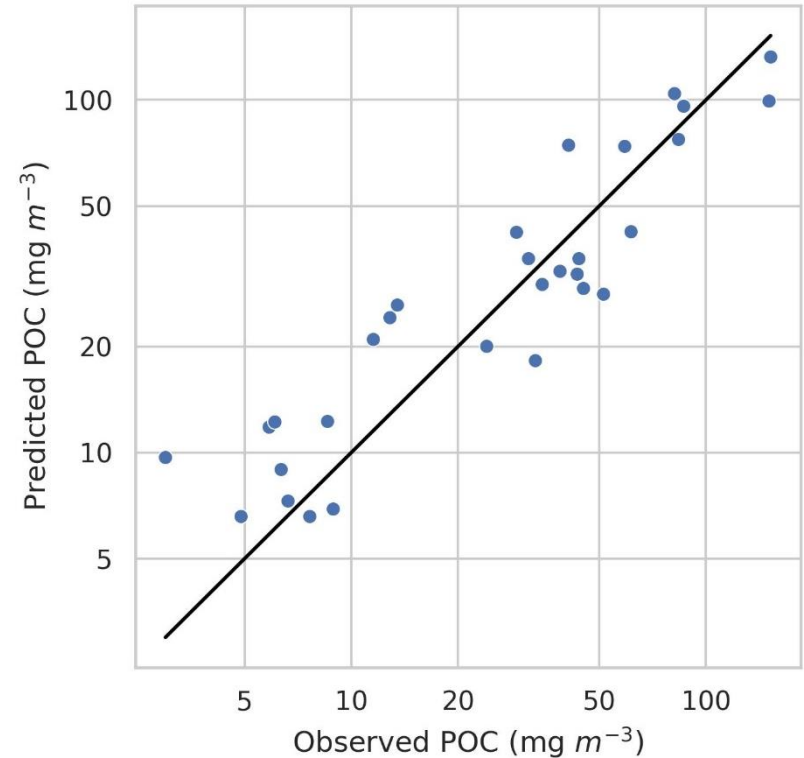
Root mean square error (in %) of the predicted contribution of each plankton group to POC for the different dataset cross-validations

PREDICTION OF POC CONCENTRATION

Use of standard BGC-Argo float variables (b_{bp} , FChla, T, S)

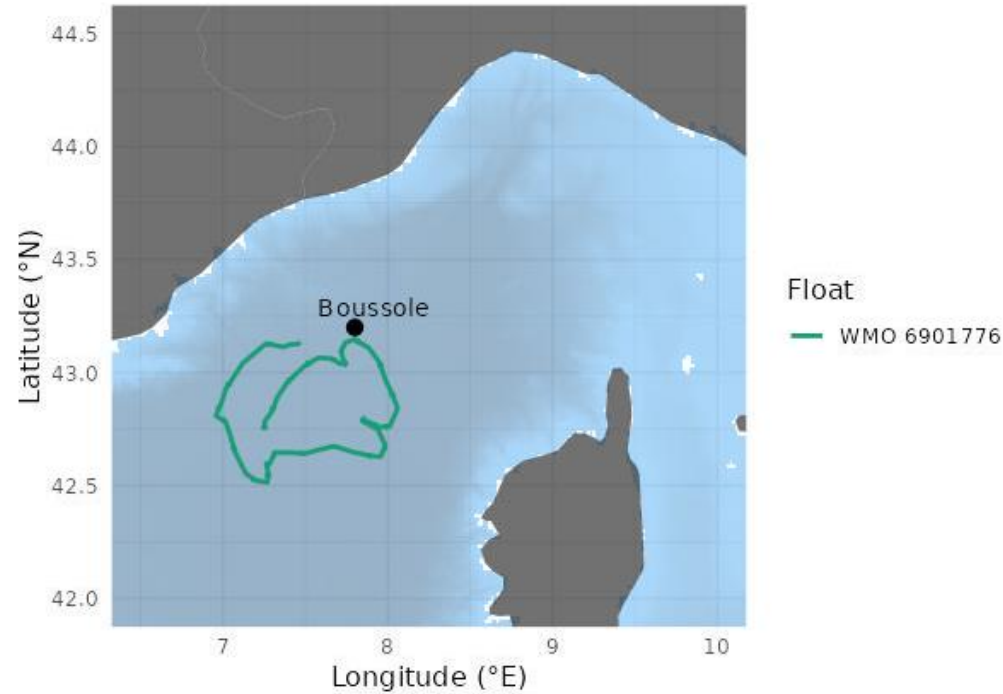
XGBoost regression

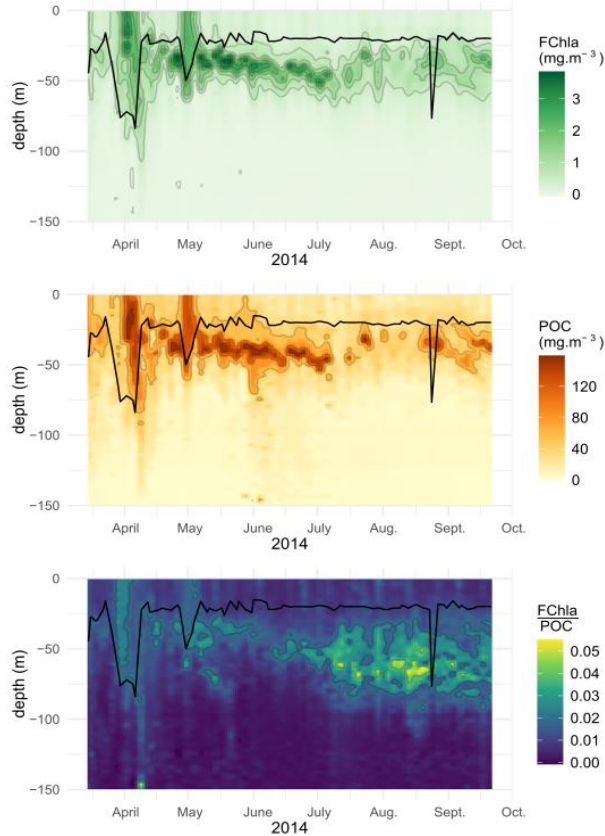
Cross validation -> MAPE of 34%



Comparison of predicted VS observed POC concentrations

CASE STUDY: PREDICTION OF POC AND PLANKTON ASSEMBLAGE FROM A BGC-ARGO FLOAT TIME SERIES





Prediction of POC, FChla, FChla/POC

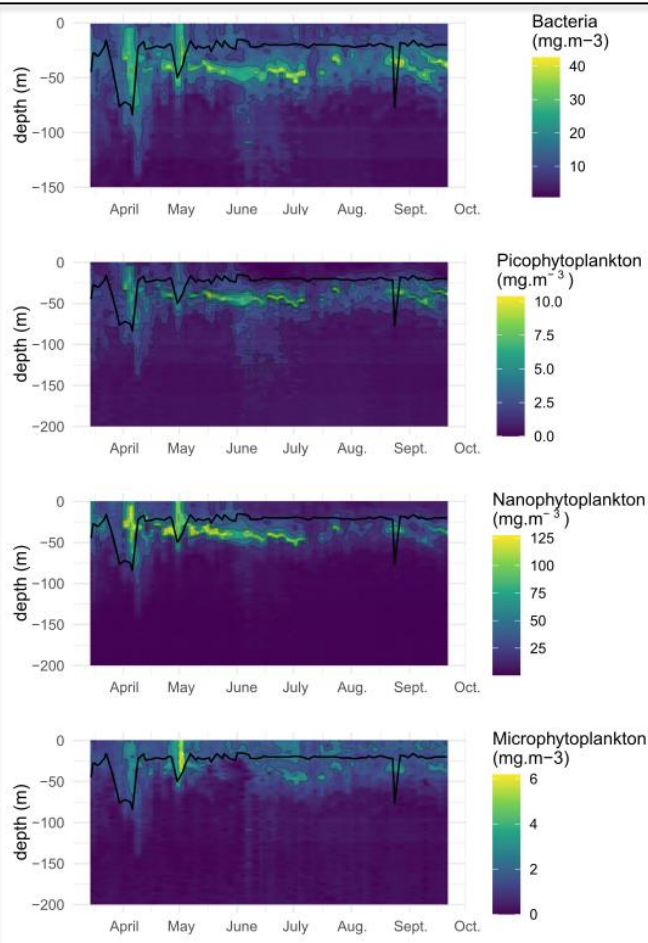
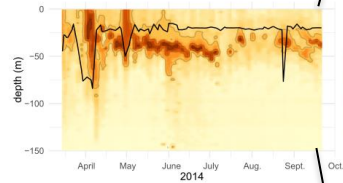
POC PREDICTION FROM BGC-ARGO FLOAT

The float timeseries is characterized by two mixing events inducing a biomass increase

The POC concentration is closely related to Chla concentration

The POC values are coherent with published observations (e.g. Bellacicco et al. 2019)

The ratio of FChla to POC follows a photoacclimation pattern with values consistent with published values (e.g. Graff et al. 2016)



PREDICTION OF PLANKTON ASSEMBLAGES

Nanophytoplankton are the main contributors to the POC concentration

Microphytoplankton increase during the spring bloom

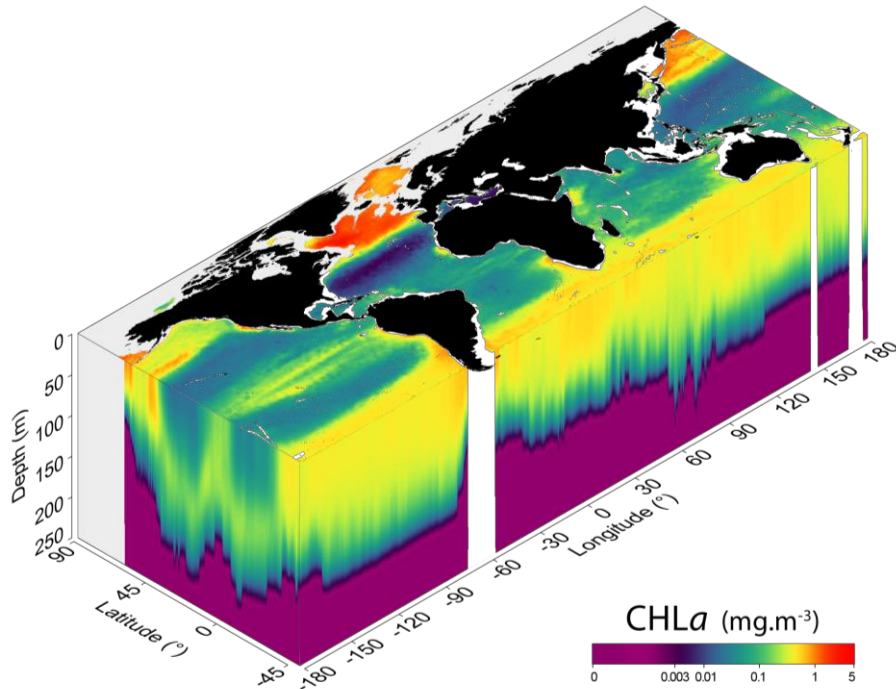
Picophytoplankton increase in summer

Prediction of the contribution of four plankton groups to POC

CONCLUSION

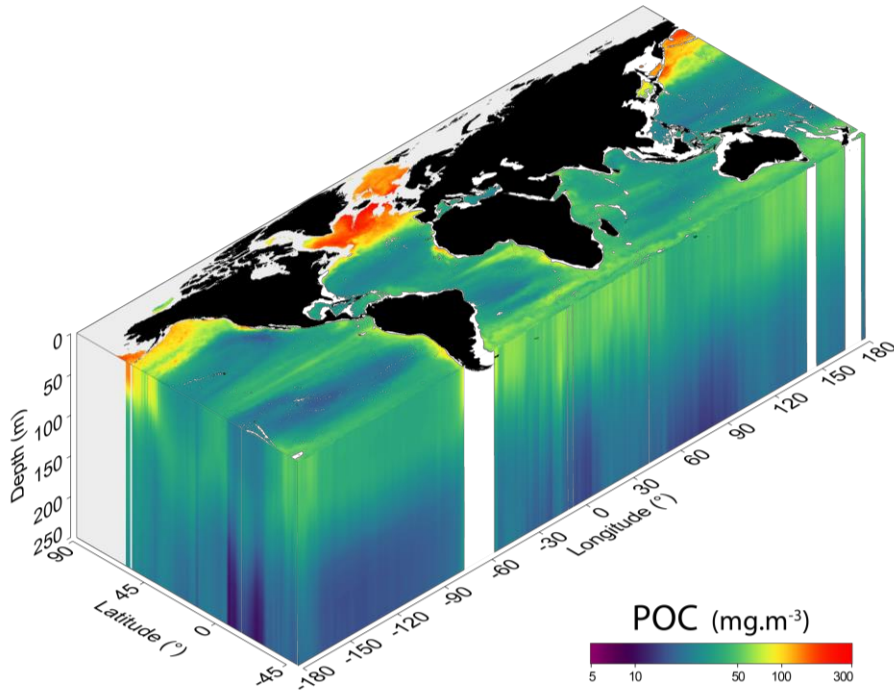
- The method published by Rembauville et al. (2017) can be extended to different oceanic provinces
- We propose a new method to derive POC concentration from BGC-Argo float standard variables (T/S, FChla, bbp)
- The combination of these two methods allows an estimation of the carbon stock associated to different plankton groups

COMBINATION OF BGC-ARGO FLOATS AND SATELLITES: 4D BIOGEOCHEMICAL DATA



These methods can be used in synergy with the various current and future means of observation of the phytoplankton community composition

COMBINATION OF BGC-ARGO FLOATS AND SATELLITES: 4D BIOGEOCHEMICAL DATA



These methods can be used in synergy with the various current and future means of observation of the phytoplankton community composition

This will allow phytoplankton community composition estimations on a wide range of spatial, vertical and temporal scales

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