PML Plymouth Marine Laboratory

# Phytoplankton community diversity and Ecosystem function from Sentinels (Phytodiverse ESA project)

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## PHYTODIVERSE AIM

To produce a workflow for phytoplankton **indicators** to inform **Convention on Biological Diversity (CBD) targets**. To do so, we will advance **algorithms to derive phytoplankton community diversity (inc. S2/S3 and PACE) and ecosystem function Essential Biodiversity Variables (EBV)** (Fig.1) and will demonstrate their utility to investigate the connection with climate driven processes (slow and extreme) in three Science Case studies (Fig. 2).

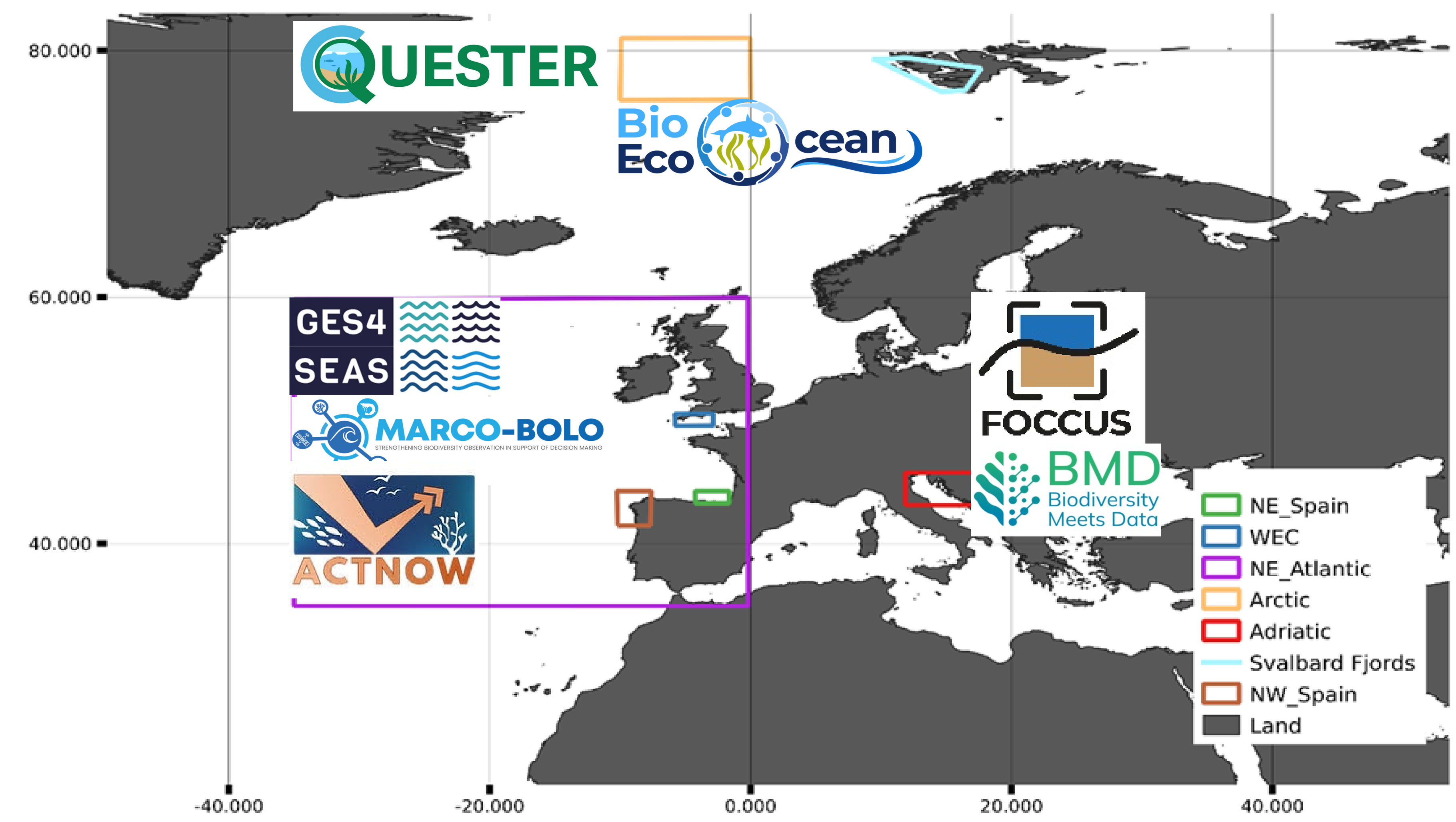


**Fig 2. Map for the areas of study in PHYTODIVERSE.** The three science cases are aligned with European Union (EU) funded projects (see logos in map). An important aspect of PHYTODIVERSE is to establish links with ongoing EC projects and find synergies between satellite data and in situ observations activities.

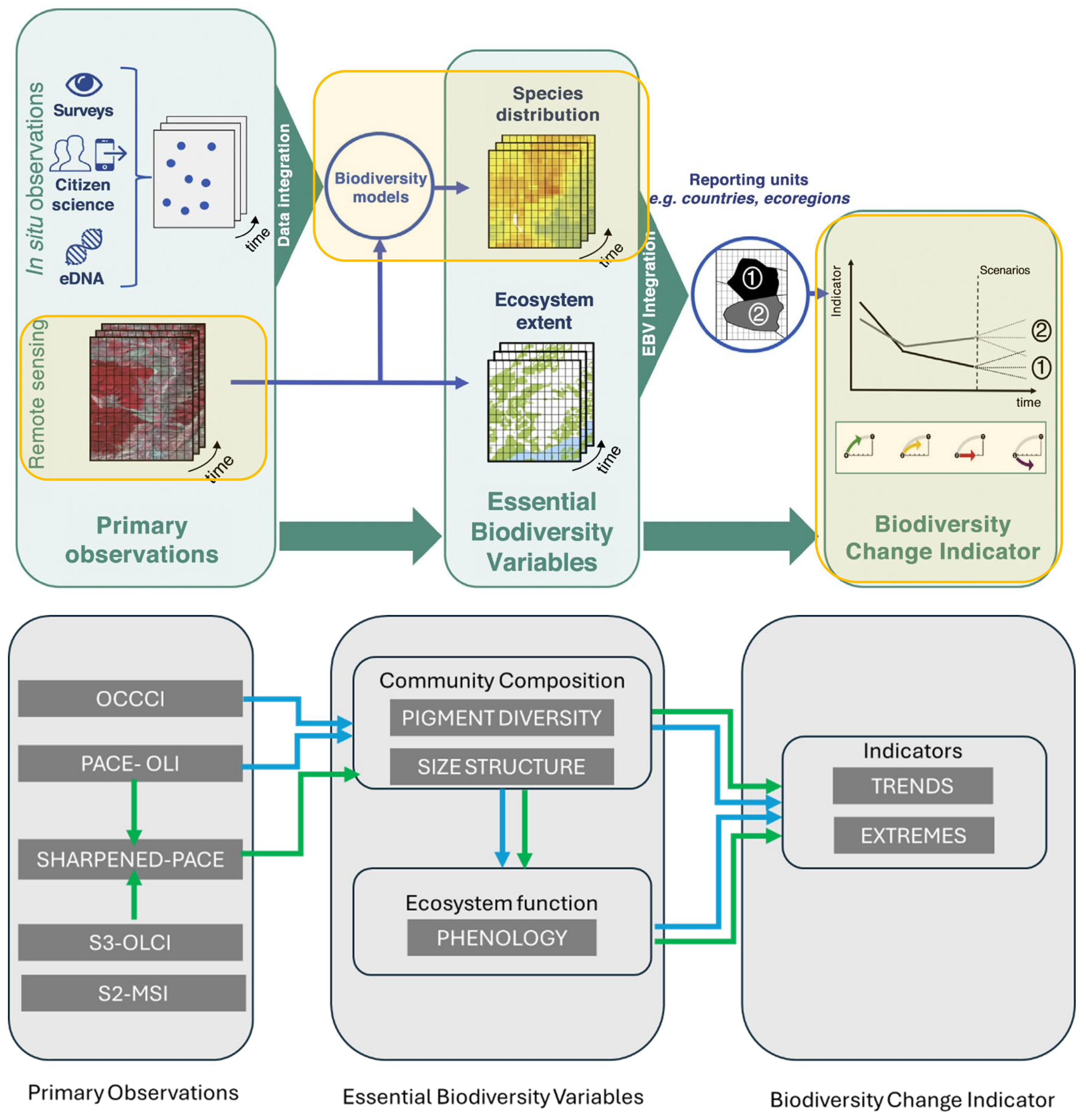


**Fig 1. The path to biological diversity indicators and the PHYTODIVERSE work plan.** Top figure shows a figure from Navarro et al. (2017) [1] highlighting the areas of work during the project. Bottom figure shows in detail the elements that will be used for each of the three Science cases and their connections: Blue lines are for the North Atlantic and the Arctic science cases. Green are for the Northern Adriatic science case.

## ALGORITHMS AND MODELS

New phytoplankton community diversity algorithms will be developed to take advantage of the hyperspectral capabilities in the NASA-PACE satellite and in preparation for the new ESA hyperspectral mission, CHIME (Fig. 3). Biological and hyperspectral bio-optical datasets will be compiled (Science Case sections below) for testing and validating algorithms (Fig. 4).

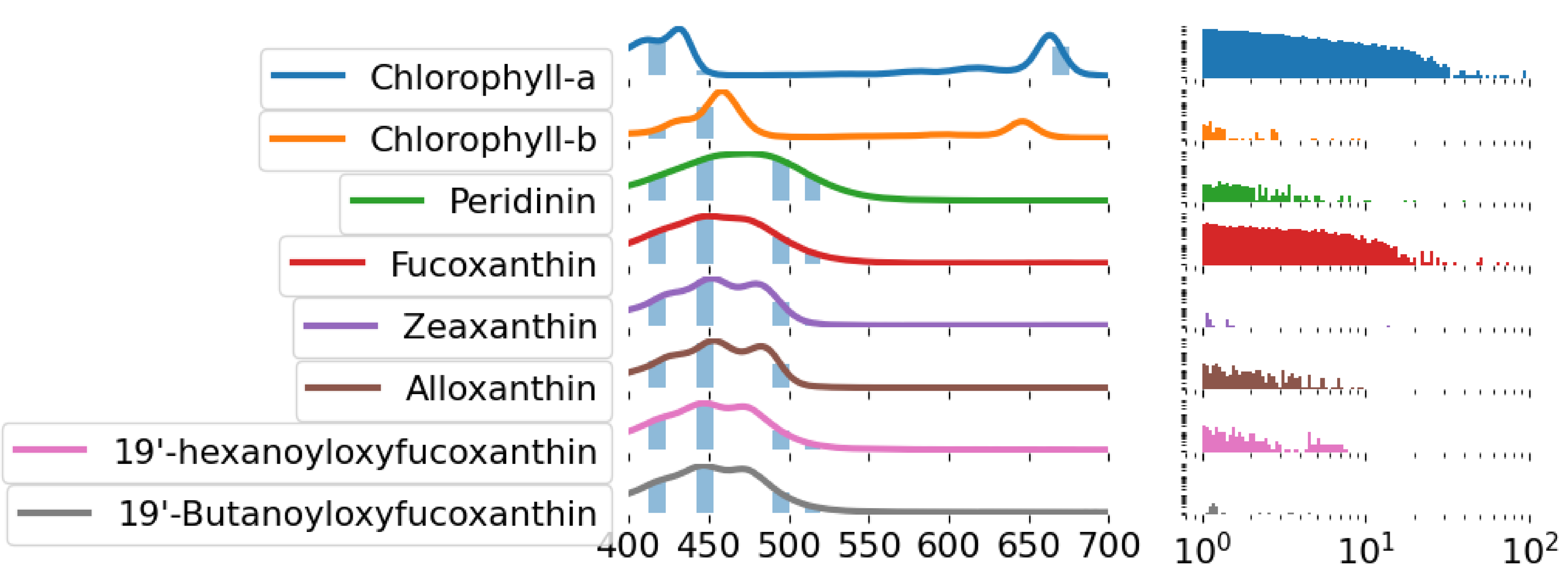


**Fig 3. Left) Absorption spectrum of pigments extracted from phytoplankton [2].** Blue bars illustrate the MERIS bands that OC-CCI uses as its reference [3,4]. **Right) Histogram of in-situ pigment concentrations** used for calibration [5].

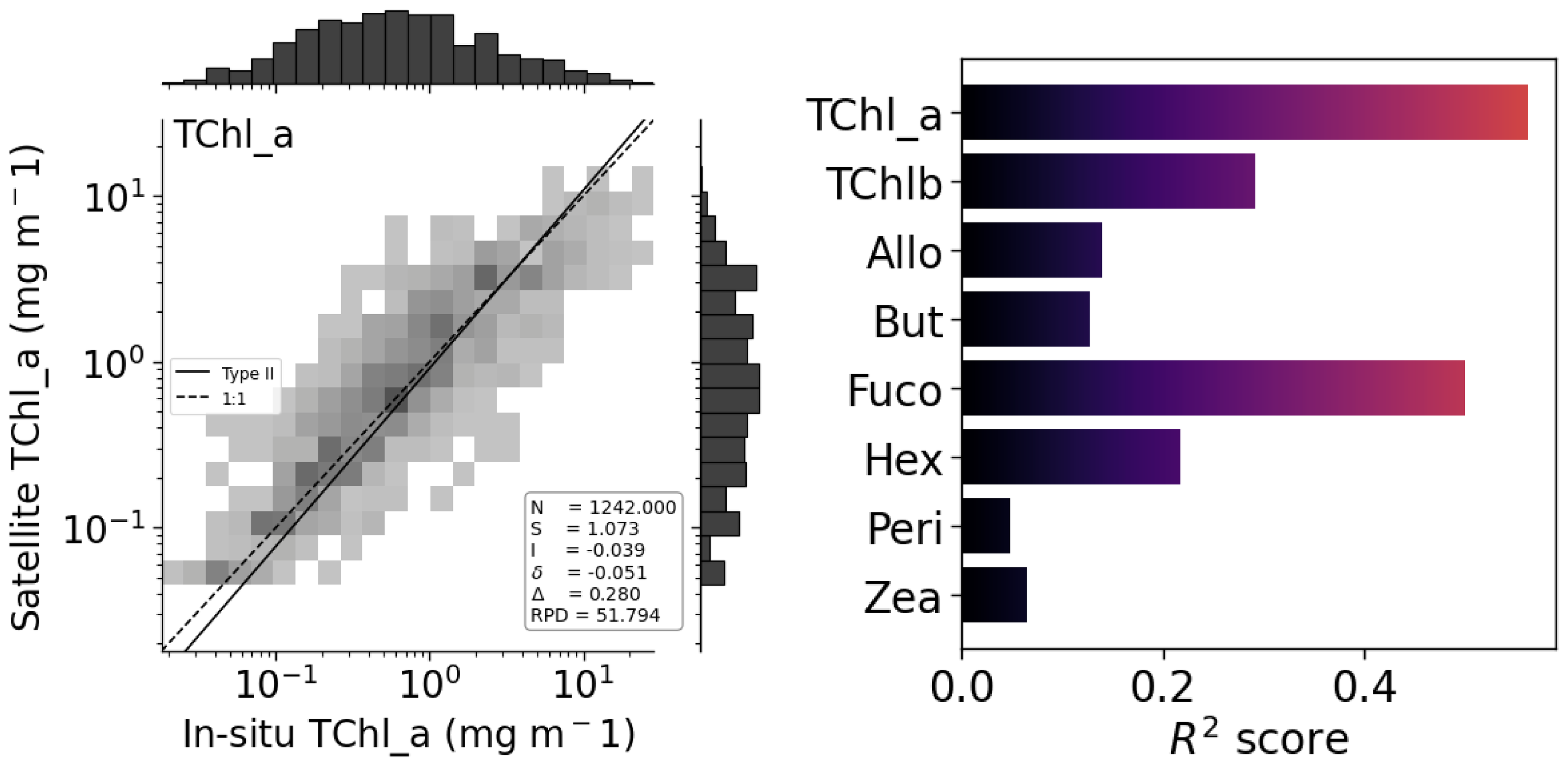


**Fig 4. Preliminary results on the retrieval of pigments using one of the algorithms that will be used during PHYTODIVERSE, a Machine Learning algorithm (Laurenson et al. in prep).** Left validation results of the algorithm on the retrieval of in-situ Chlorophyll-a (TChl_a in the figure) Dashed line shows 1 to 1 line, solid line shows type II regression where N is number of observations, S is the slope, I, the intercept, δ, bias, Δ, bias-corrected RMSE, RPD, relative percentage difference.. Right, R2 scores of model per pigment.

## SCIENCE CASES

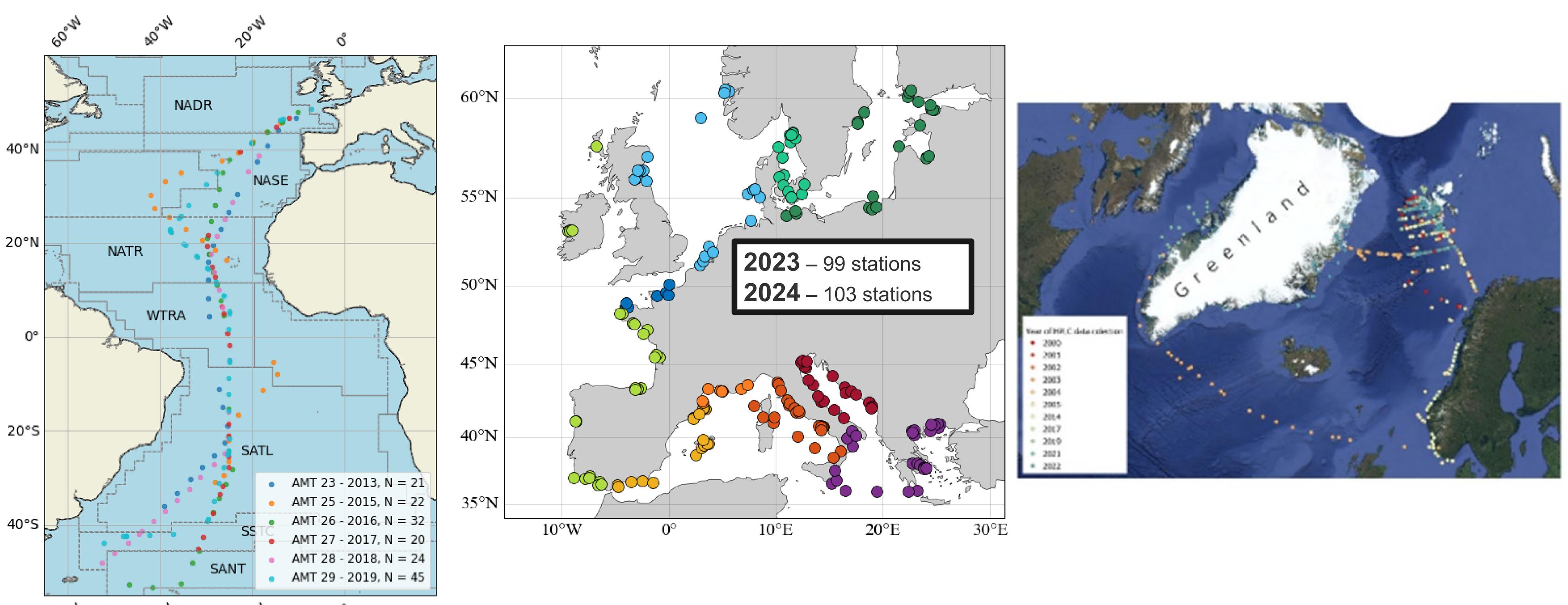


**Fig 5. Available pigment concentrations collocated with hyperspectral radiometry from the Atlantic Meridional Transect, TARA-TREC cruise as part of the HyperBOOST (ESA) project and Acrtic cruises from SEA-QUESTER and BioEcoOcean projects (EU).** .

## CONCLUSIONS: OPPORTUNITIES

- PHYTODIVERSE is collating a dataset of *in situ* optical and biological observations. In particular pigment concentration, taxonomical counts and size data for phytoplankton. **We welcome *in situ* data contributions from ongoing observation systems until end 2026.**
- PHYTODIVERSE is conducting an exercise to compare phytoplankton pigments algorithms, using hyperspectral data as inputs. **We welcome new algorithm providers to approach us to discuss participation in the exercise during 2026.**
- PHYTODIVERSE welcomes enquires for collaboration to apply novel hyperspectral algorithms **in new areas where there are historical observations of phytoplankton diversity to test and expand the *in situ* capabilities**.


**References**

1. Navarro et al. 2017. Remote Sensing of Environment. doi:10.1016/j.cosust.2018.02.005
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3. MERIS overview, https://earth.esa.int/eogateway/instruments/meris/description
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5. Sun, Xuerong, et al. Remote Sensing of Environment 285 (2023): 113415.



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