iFADO Final Meeting
Lisbon 31 may – 2 June

1st June 14h45: HPLC samples and Earth Observation in situ benchmarking

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Faculty of Sciences University of Lisbon

Novel EO derived products for Phytoplankton

- Microscope and HPLC pigment analysis of samples from Portuguese coast and North Atlantic

Ulisbon =FCUL

WP4

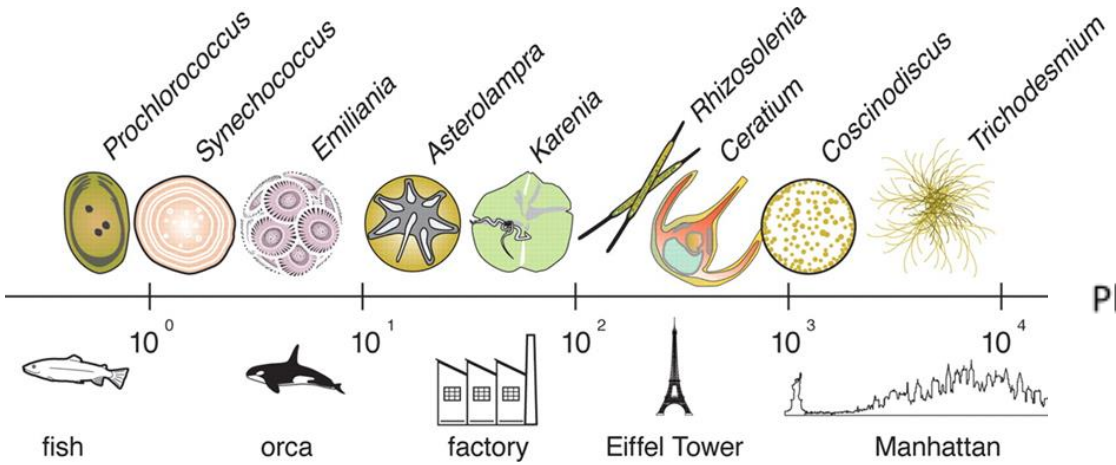
WP6

WP2

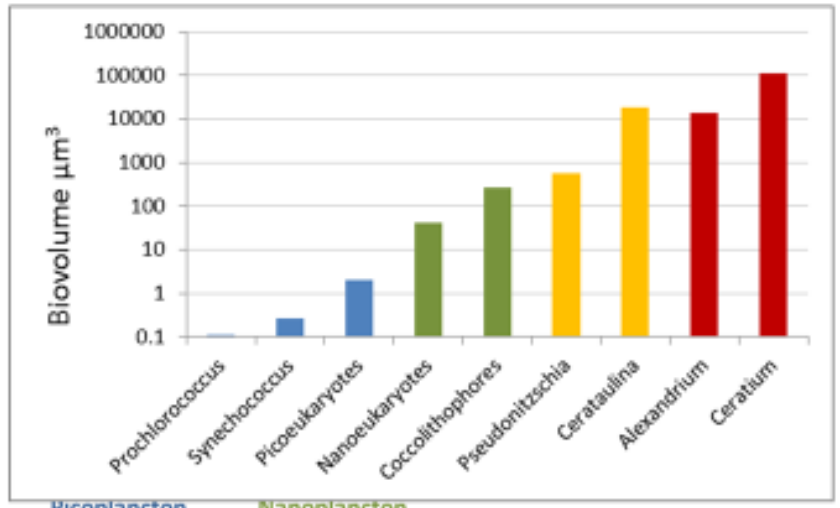
Action 4	6.4. Novel EO derived products for Phytoplankton
Start month	November 2017
End month	November 2021
Manager	PML
Participants	IST, PML, FCUL, IPMA, FRCT, NOVELTIS
Description (500 char.)	This action is linked to WP4, Action 5 to develop the detection of size classes relative abundance, algal blooms, contributing to the MSFD descriptors 1 and 5 on Biodiversity, Food Web and Eutrophication. In situ data from WP4 on identification and quantification of phytoplankton groups will be used to validate the algorithms for the Atlantic Area providing a transnational consistent product.
Outputs title	D6.4.1 – D6.4.8 - Phytoplankton size classes D6.4.9 Publication D6.4.10 Strategy and operations document.
Outputs description (250 char.)	EO-derived datasets together with in situ data (WP4) for the Atlantic area showing phytoplankton size class. Publication on results Strategy and operations document.

Outline

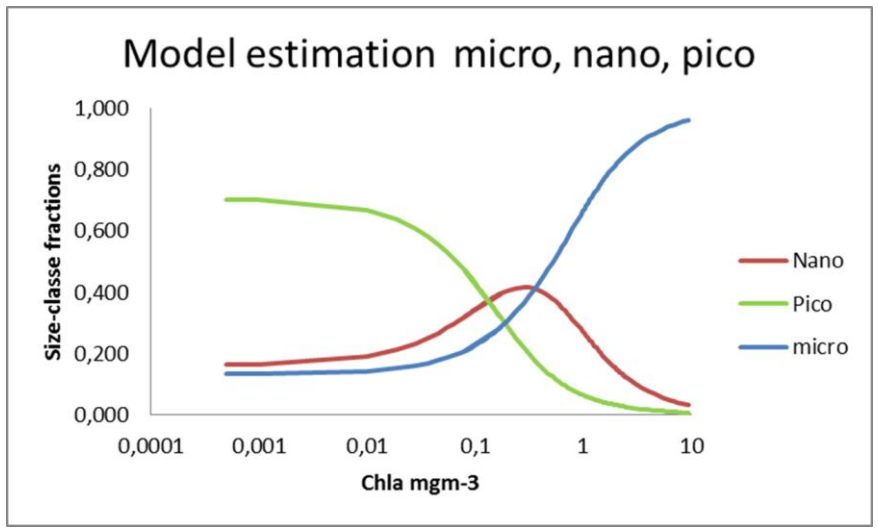
- Rationale of Action 4 WP6 – Diversity and Eutrophication
- Campaigns
- Chla and size classes across Atlantic provinces
- Study case of a Dinoflagellate bloom
- Chla and size classes – Iberia
- WP2 contributions to communication and ocean literacy



Phytoplankton Size-classes



PFTs: Phytoplankton Functional Types



Brewin et al 2010. Ecological Modelling

Picoplancton
Cyanobacteria
Picoeukaryotes

Nanoplancton
Coccolithophores
Nanoflagellates

Microplancton
Diatoms

Microplancton
Dinoflagellates

Pico-autotrophs

Calcifiers

Silicifiers

DMS producers (nanoflagellates, and ~ all groups)

Biogeochemical cycles

37

MSFD Descriptors 1 Diversity and 5 Eutrophication

but also D2 Exotic species, D4 Food webs, D7 Hidrographic conditions

- Diversity
  - ➢ Higher Diversity of Phytoplankton taxa
  - ➢ Higher Diversity of the different layers of the trophic chain (link with D4)

?

- Possible Alert to Alteration of hydrographic conditions, D7

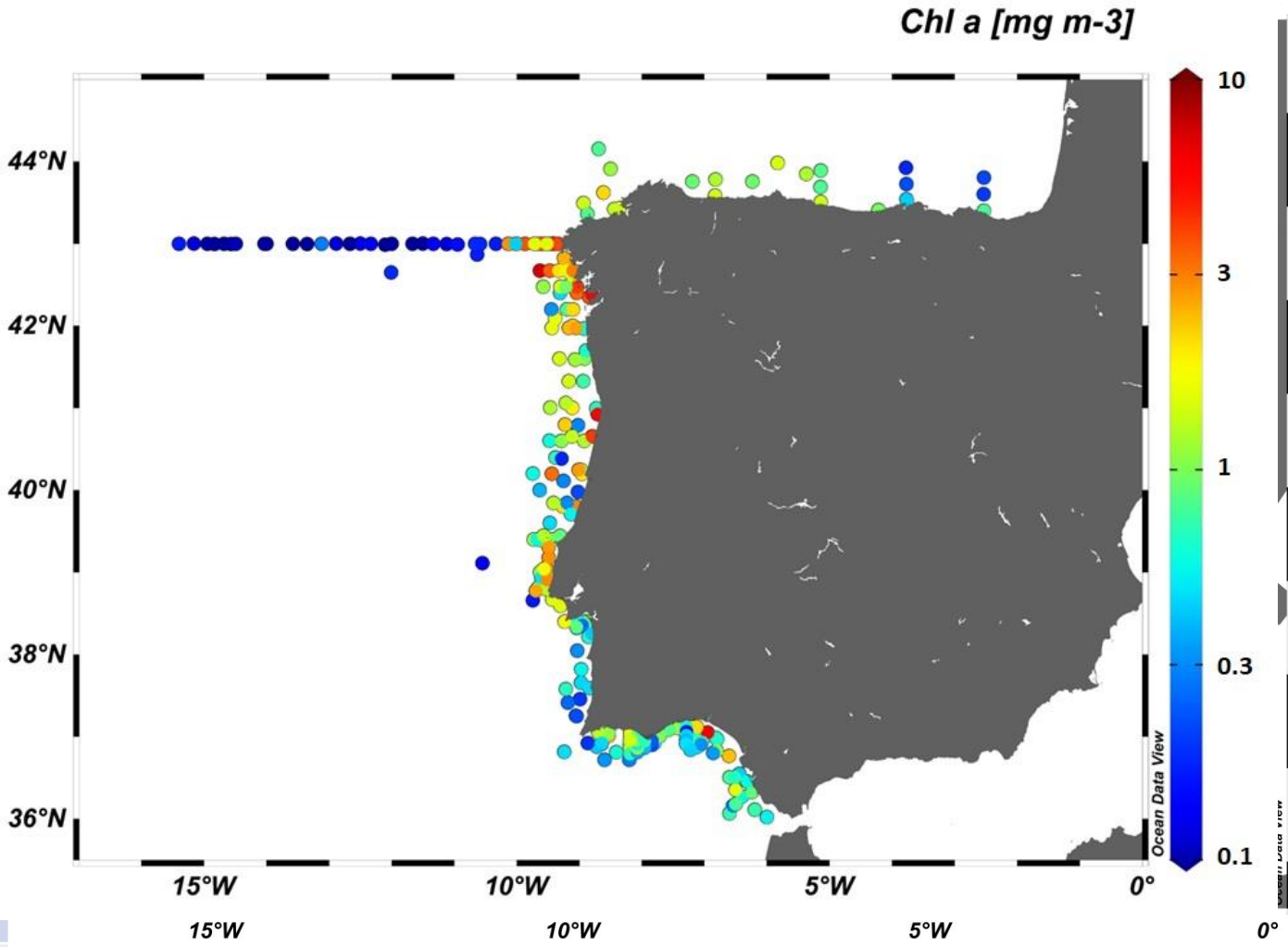
- Eutrophication

- may lead to extreme development of a single species
- Possible link to D2, exotic species – need to check

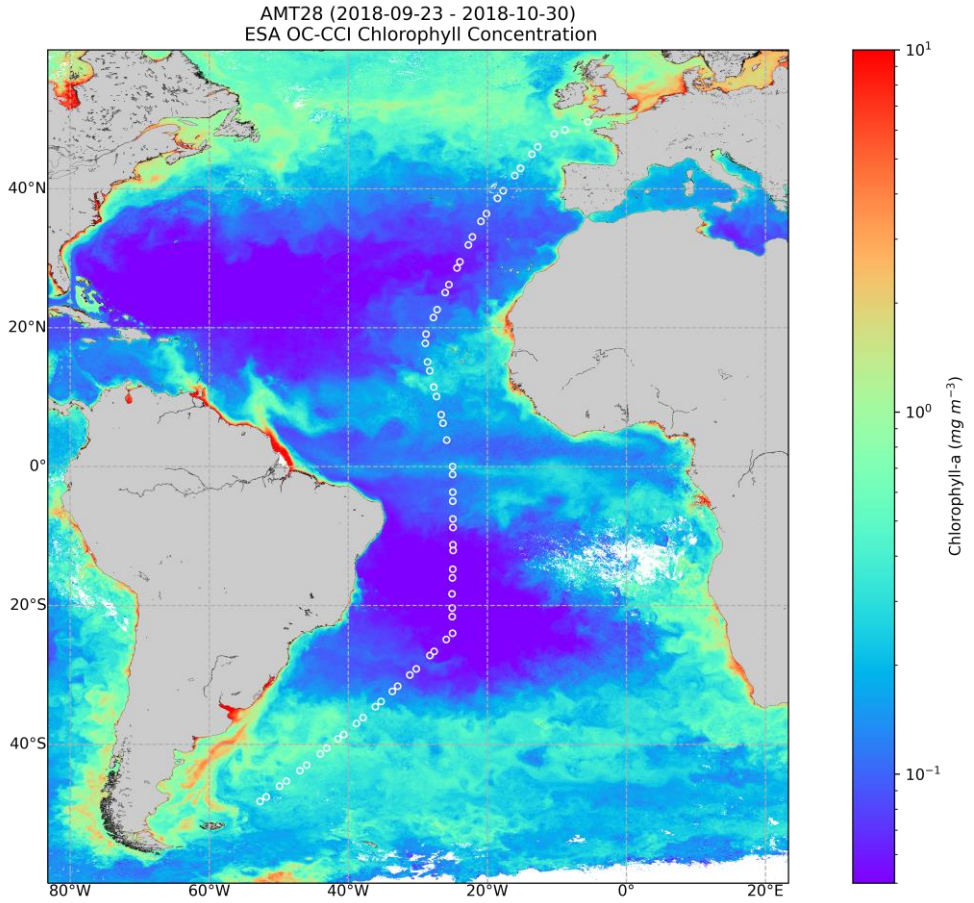
International Campaigns – Iberia and Celtic Sea

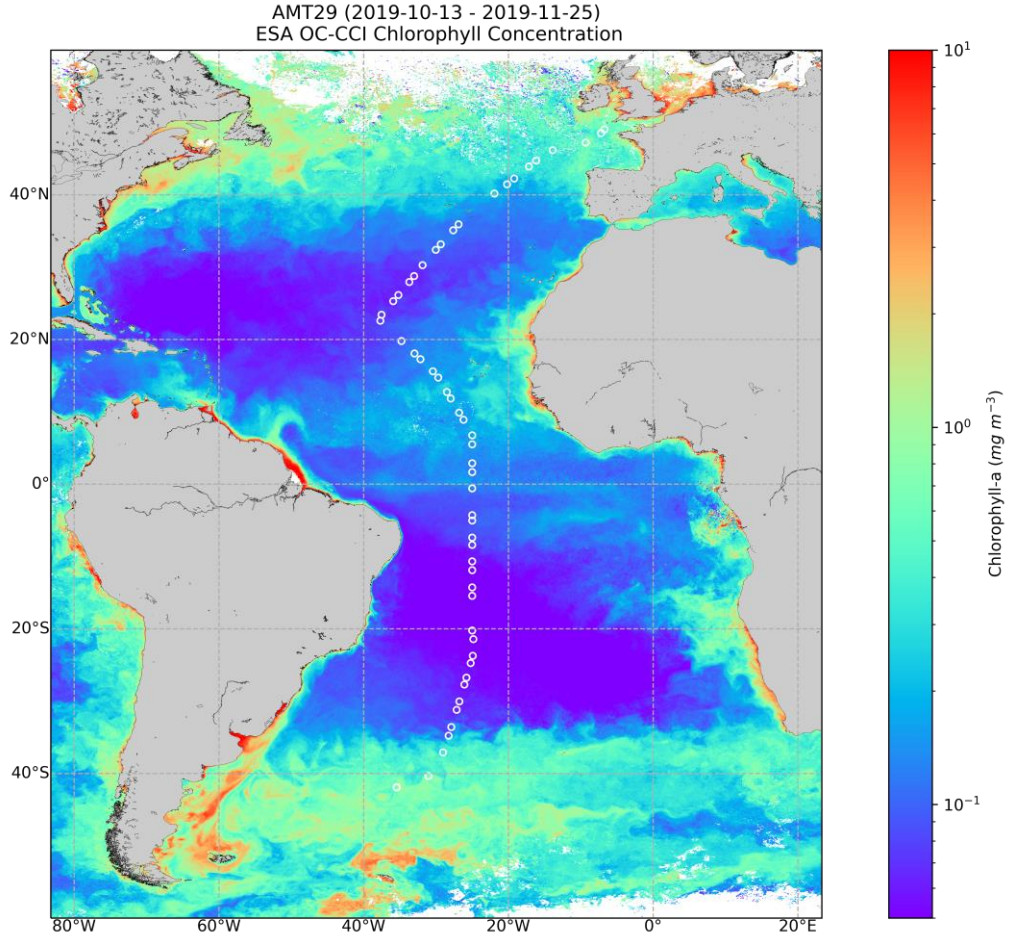
Partners:
UL, IPMA, CSIC, NOC

Cruises	Date	HPLC (nº)
DEPM2019	01/2019 to 02/2019	47
PELAGO2019	04/2019 to 05/2019	36
PELAGO2020	05/03/2020 to 09/03/2020	43
RADPROF2020	07/ 2020	59
RADPROF2021	08/ 2021	7
DEMP2022	03/2022 to 04/2022	15
PELAGO2022	01/03/2022 to 29/03/2022	22
RADIALES22	29/03/2022 to12/07/2022	8
PELACUS0322	27/04/2022 to 30/04/2022	60
PAP_SO	05/05/2022 to 14/05/2022	12
RADPROF0622	15/06/2022 to 22/06/2022	12
CARBO-ACID	08/ 2022	19
DEPM23	10/02/2023 to 21/02/2023	20
PELACUS23	02/03/2023 to 29/03/2023	22
	Total	382



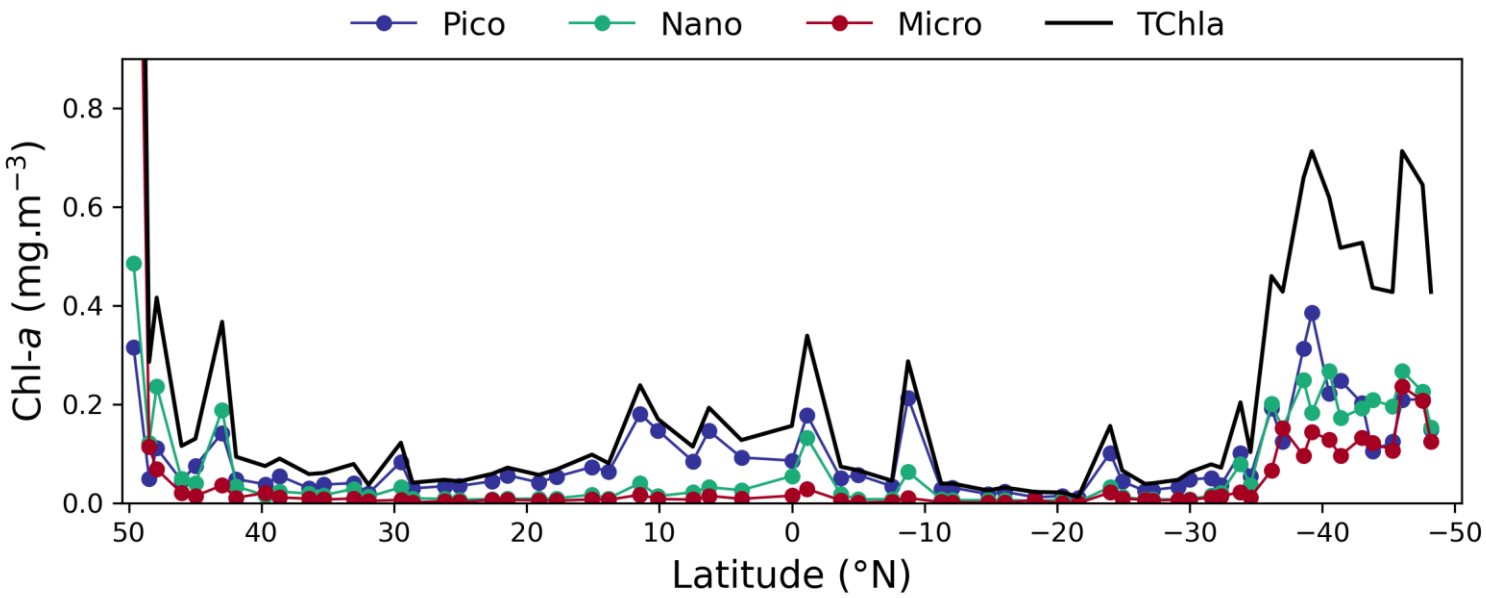
International Campaigns – Atlantic 50N to 50S AMT28 and AMT29



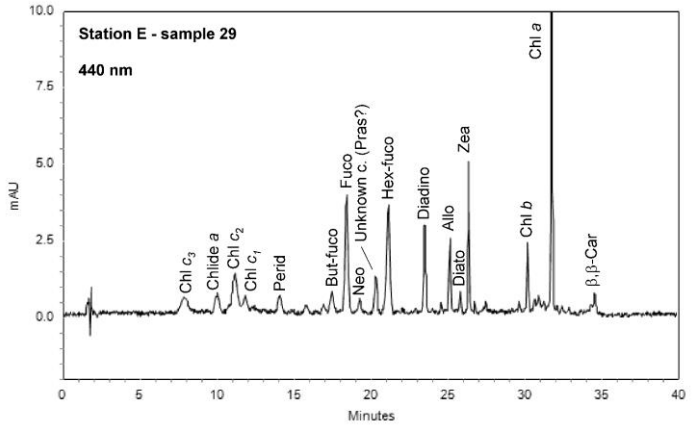


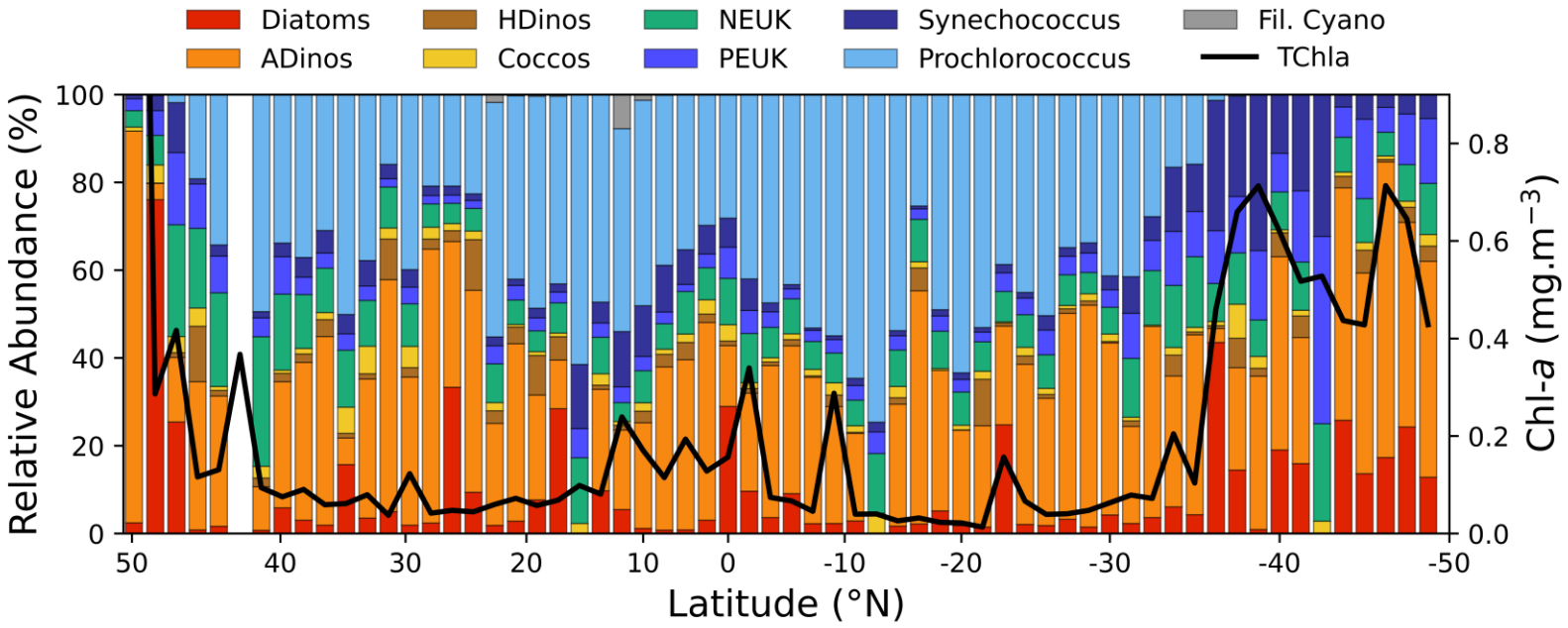
~200 samples for HPLC
~160 samples for microsopy

Size classes distribution across Atlantic provinces AMT28 and relative abundance of taxonomic classes – surface samples



HPLC measurment of pigment concentration



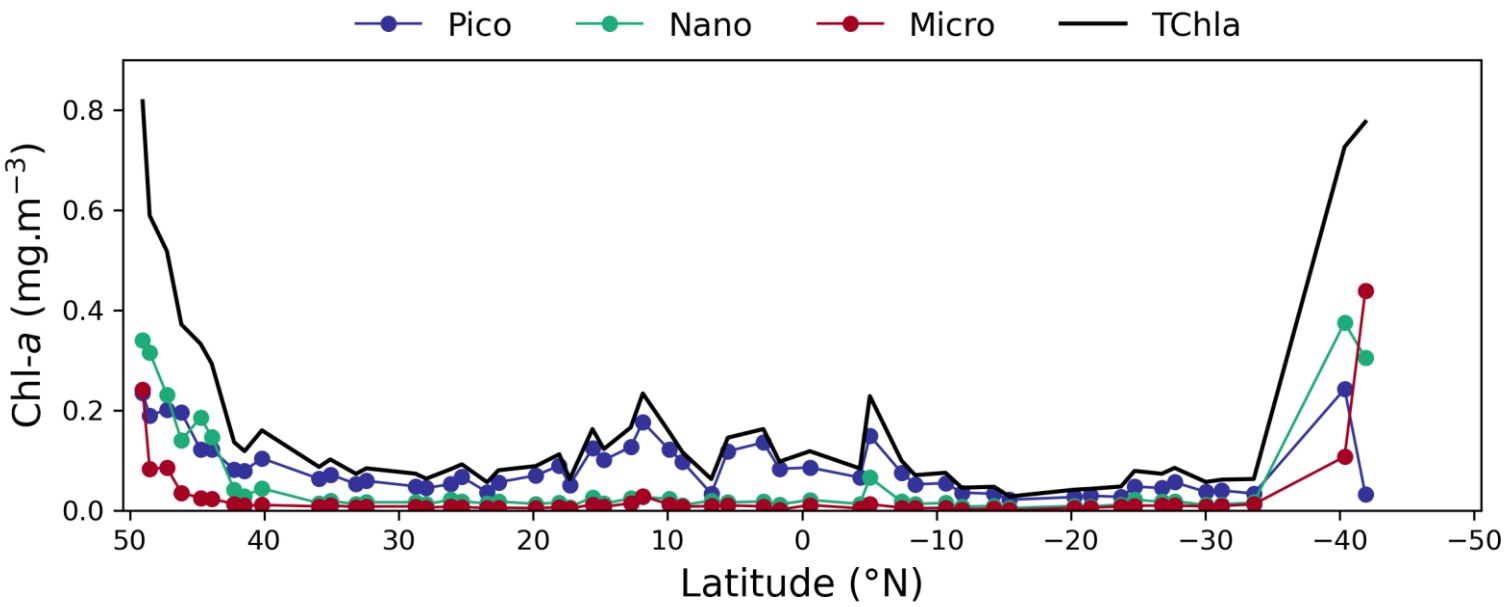


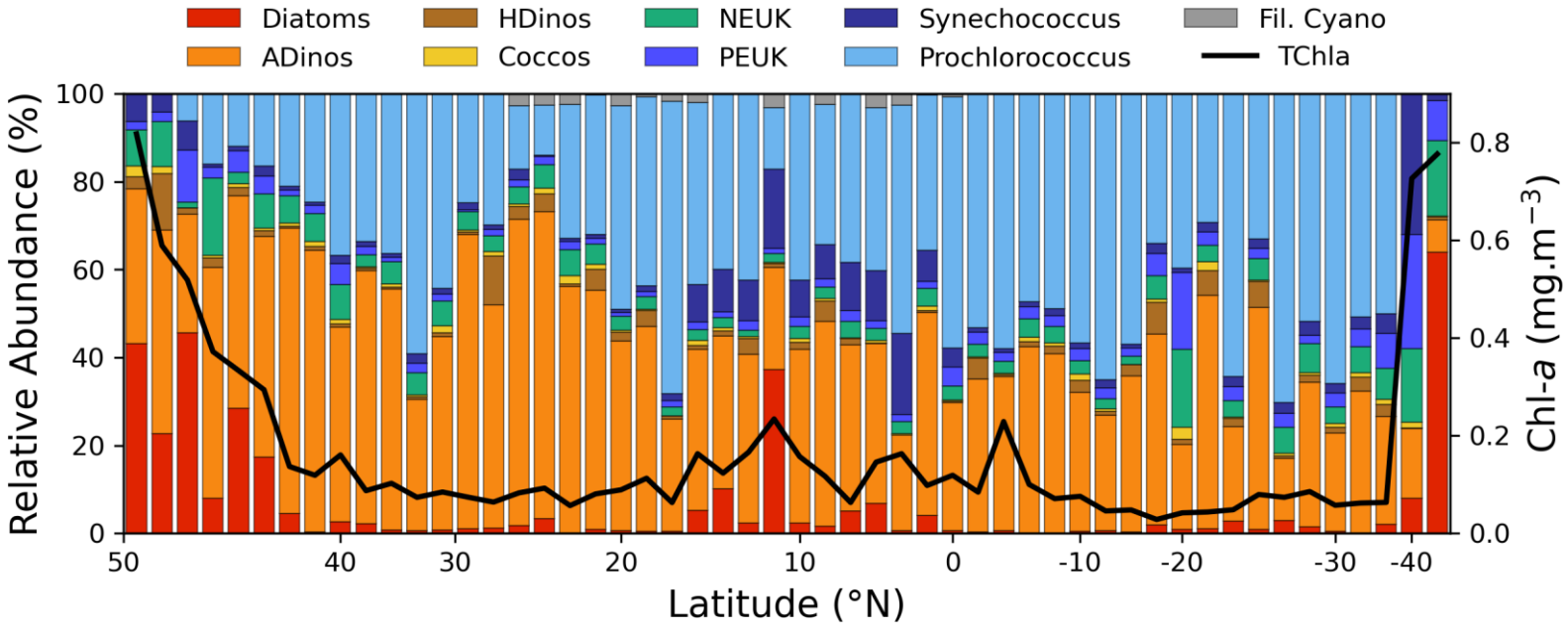
Cell abundance
Microscopy
And Flow
Cytometer
Estimates of cell
carbon

AMT29

Comparison of AMT
2015
2018
2019

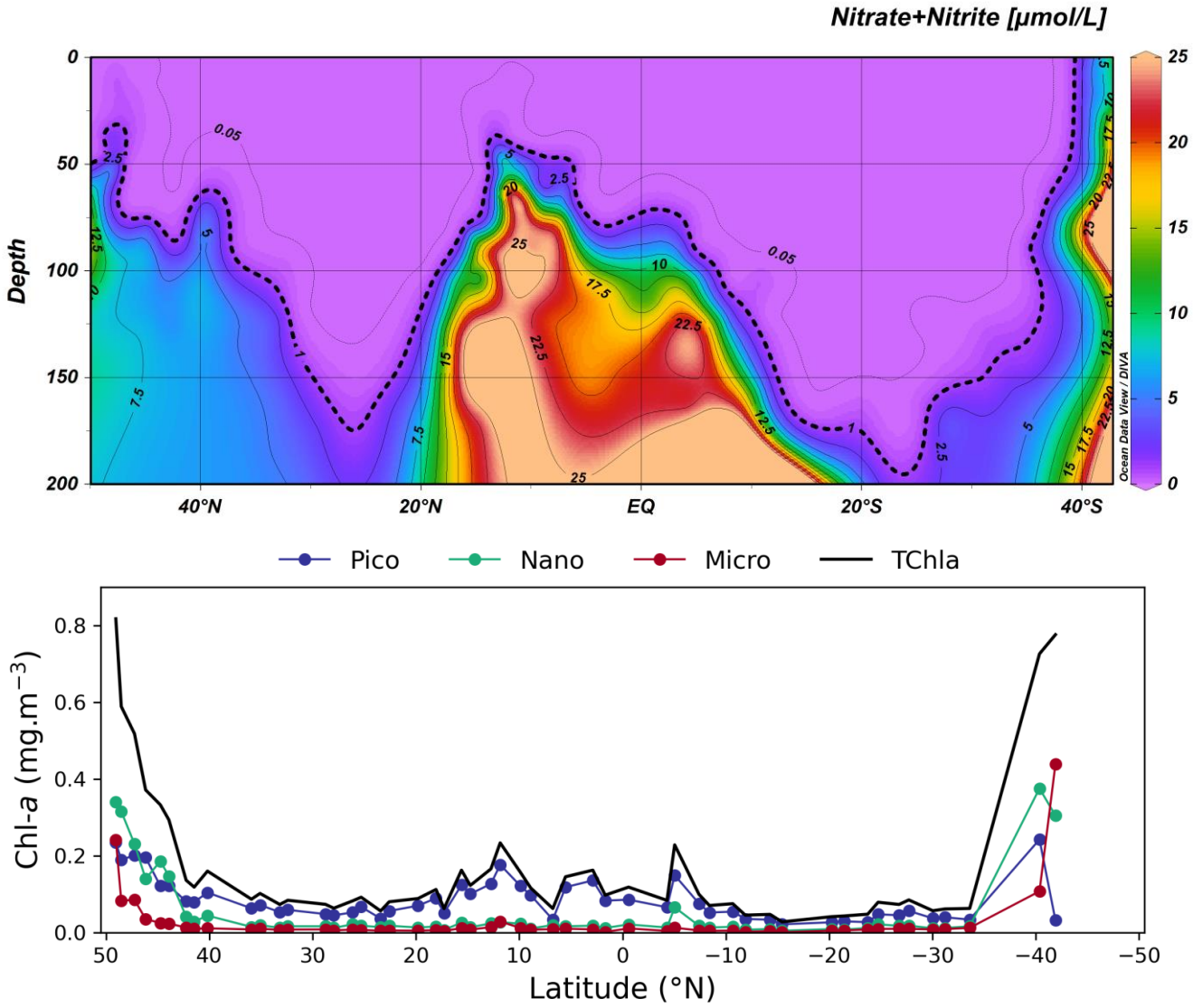
Increasing trend of Dinoflagellates
Increasing trend in Picoplankton
In South Atlantic





MSFD Descriptor 1 - Diversity

Nutrients and Size Classes

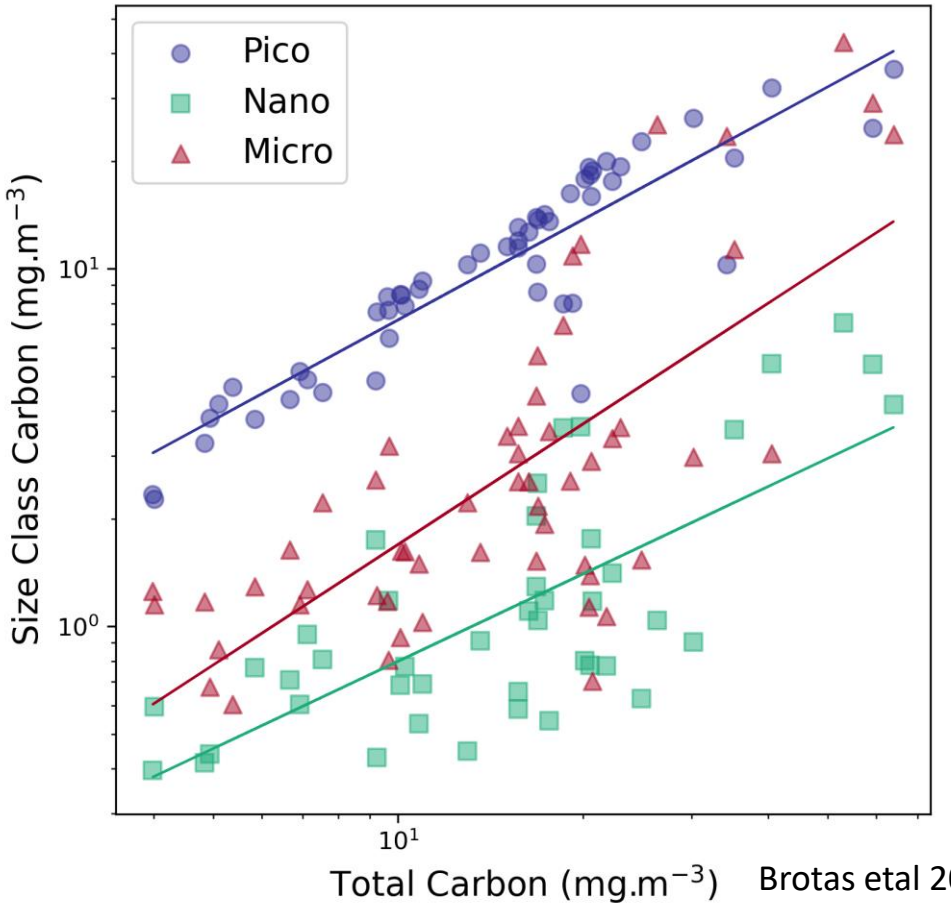


AMT29. Top: nitrates across the atlantic.

Bottom: Distribution of size classes across the Atlantic

Low nutrient latitudes – picoplankton dominates

Other groups very very low biomass



Brotas etal 2022

More nutrients, higher total biomass,

higher biomass of all size classes.

But dominance of microplankton, (because 1 cell of microplankton has “a lot more” of Chla and Carbon than a picoplankton cell

MSFD Descriptors 1 Diversity and 5 Eutrophication

but also D2 Exotic species, D4 Food webs, D7 Hidrographic conditions

- Diversity

  - Higher Diversity of Phytoplankton taxa
  - Higher Diversity of the different layers of the trophic chain (link with D4)

?

- Possible Alert to Alteration of hydrographic conditions, D7

- Eutrophication

- may lead to extreme development of a single species
- Possible link to D2, exotic species ? – need to check

Natural or anthropogenic?

MSFD Descriptor 5 - Eutrophication – Bloom of Dinoflagellate in the English Channel

Prorocentrum cordatum bloom

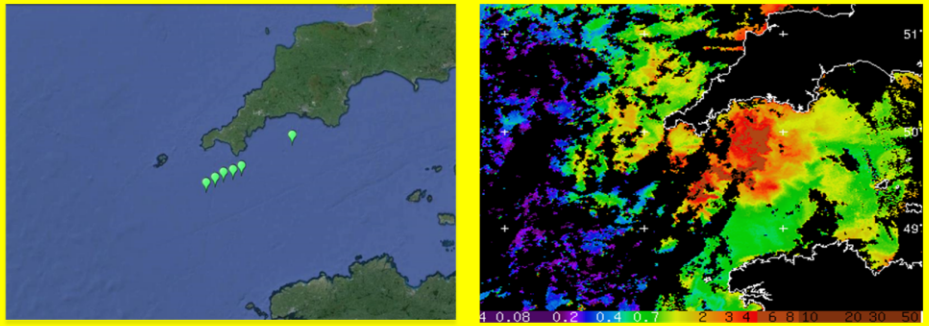


Figure 4 – Left: Stations for *Prorocentrum cordatum* bloom. Right: Chlorophyll a concentration in the area (MODIS image 17 Sept 2015, courtesy of NEODAAS)

Station	Date	Time (GMT)	Latitude	Longitude	Depth (m)
001_Test	18-09-2015	07:55	50º 02.000' N	04º 22.000' W	5
002_Bloom	18-09-2015	12:02	49º 45.000' N	5º 8,579' W	5
003_Bloom	18-09-2015	12:32	49º 42.900' N	5º 16.300' W	5
004_Bloom	18-09-2015	13:00	49º 41.580' N	5º 24.900' W	5
005_Bloom	18-09-2015	13:30	49º 38,640' N	5º 32,520' W	5
006_Bloom	18-09-2015	14:00	49º 35,700' N	5º 40.620' W	5

Table 1 – Geographic coordinates, time and depth of *Prorocentrum cordatum* bloom stations.

A strong bloom with water discoloration was observed in the English Channel at the start of the cruise. Cell counts, optical and radiometric measurements were performed in 6 Stations (Table 1). Microscope identification and cell counts showed a significant bloom of the small toxic dinoflagellate *Prorocentrum cordatum*.

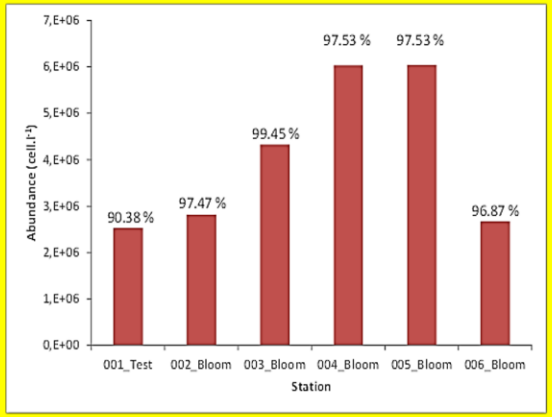


Figure 5 – *Prorocentrum cordatum* total cell number and percentage in relation to total cell counts. *P. cordatum* cell numbers attained $6x10^6$ cells L^{-1}, representing a dominance of almost 100% in the phytoplankton community.

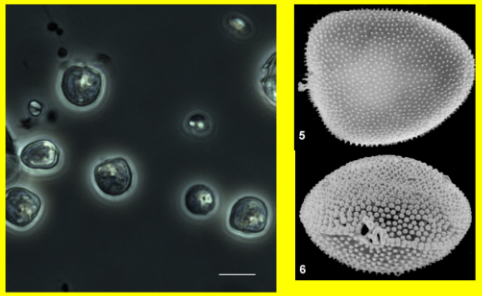


Figure 6 - Images of *Prorocentrum cordatum*. Left: phase contrast optical microscopy, scale bar 10 µm; Right: scanning microscopy from http://www.sms.si.edu/irlspec/Proroc_minimu.htm (top: lateral, view; bottom: apical view

The occurrence of this bloom, with contemporaneous satellite images, radiometric measurements and microscope observations constitutes an excellent set of data for remote sensing HAB detection improvements.

AMT25 – Chla 4.8 mg Chla m^{-3}

AMT28 – Chla 2.89 mg Chla m^{-3}

AMT29 – Not observed

Which are the dominant species? AMT25, 28, 29, North Atlantic

	NADR 56°N - 42°N	NAST 42°N - 30°N
AMT_1	NS	
AMT_3	NS	Athecate Dinoflagellates 4 ⊙
AMT_5	NS	
AMT_7	NS	
AMT_25	*Pseudo-nitzschia delicatissima* group 4 ♦ ● *Pseudo-nitzschia seriata* group 4 ♦ ● *Prorocentrum cordatum* 6 ⊙	
AMT_28	*Leptocylindrus minimus* 4 ■ ● Pennate group (10-30 µm) 4 ♦ ⊙ *Prorocentrum cordatum* 6 ⊙	
AMT_29	Athecate Dinoflagellates 4 ⊙	Athecate Dinoflagellates 4 ⊙

AMT30
March 2023
Samples arriving to Portugal
To be analysed.

Link with Descriptor 2 – exotic species

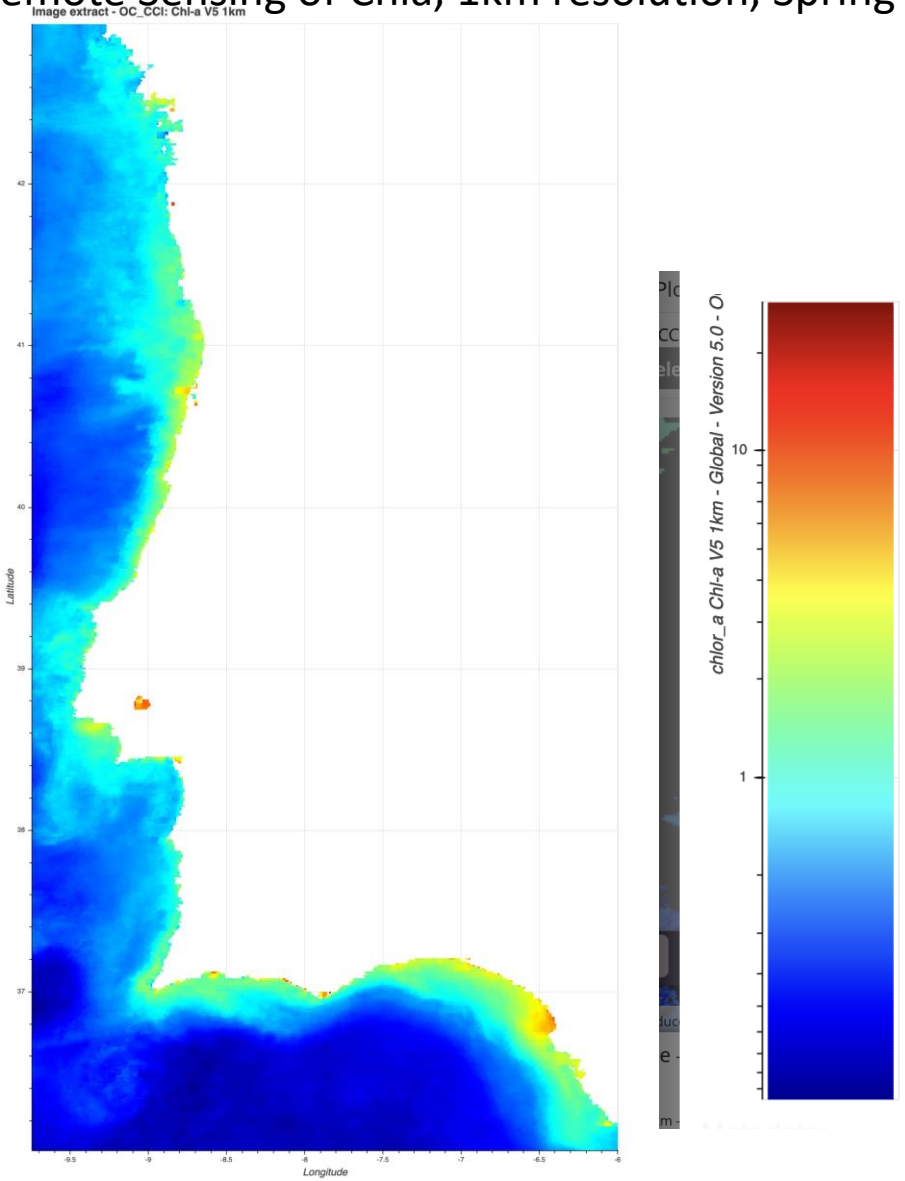
Northern sampling sations at AMT28, 50ºN

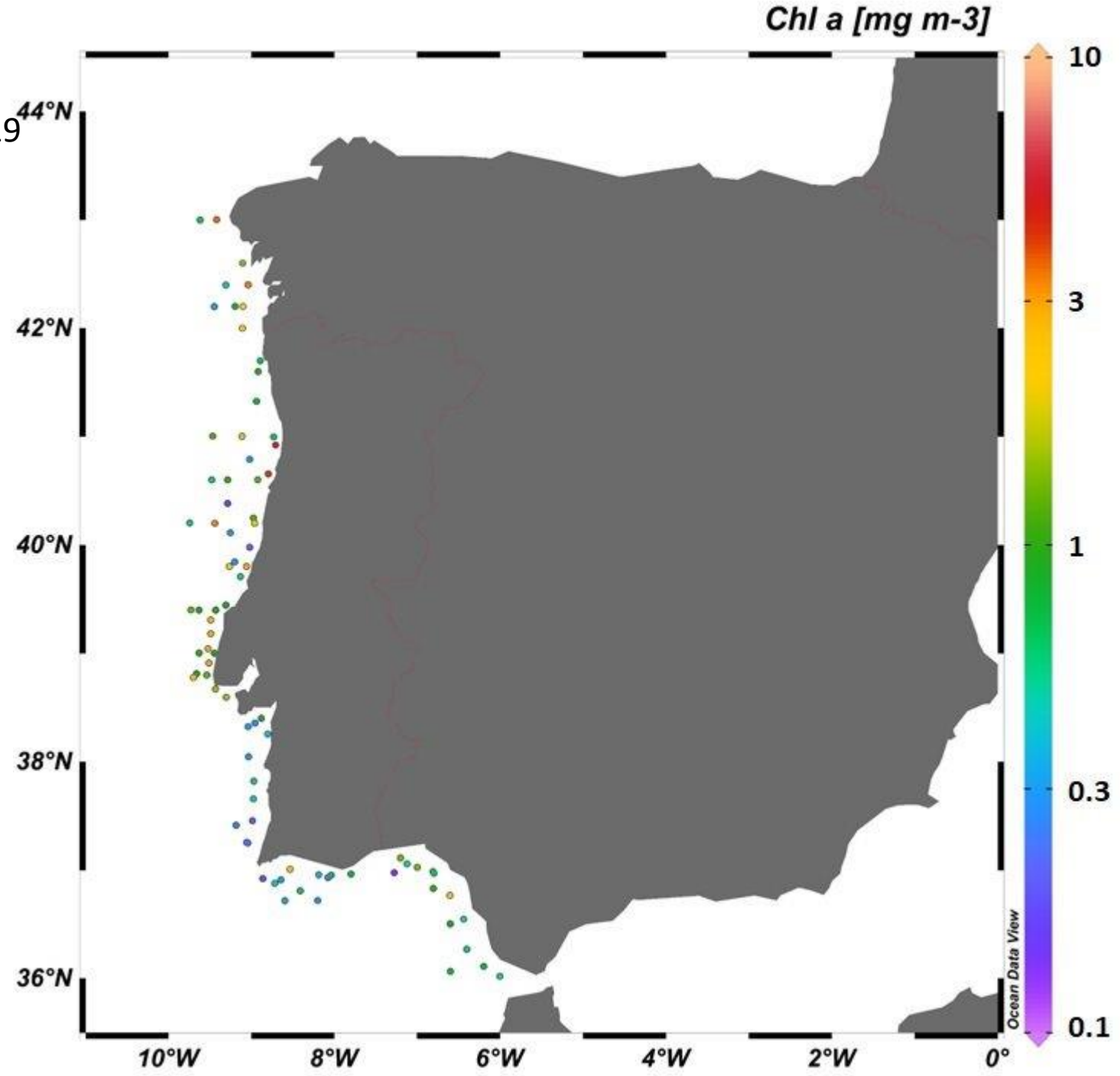
Dinoflagellate *Prorocentrum cordatum*, with 1.9 x10^6 cells L^{-1}, 95% of all phytoplankton carbon biomass

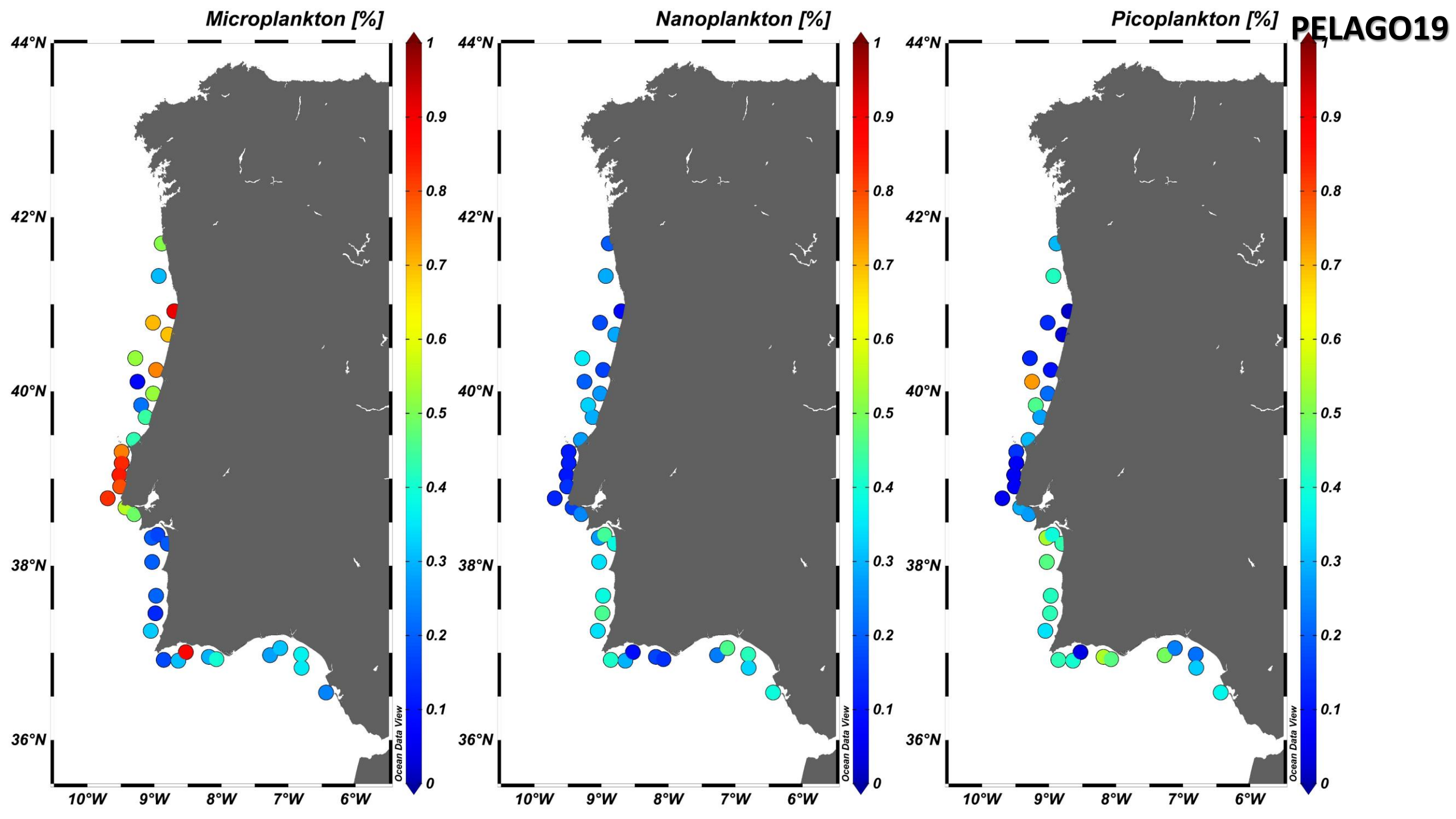
2019 - Iberia

Pelago -Pelacus

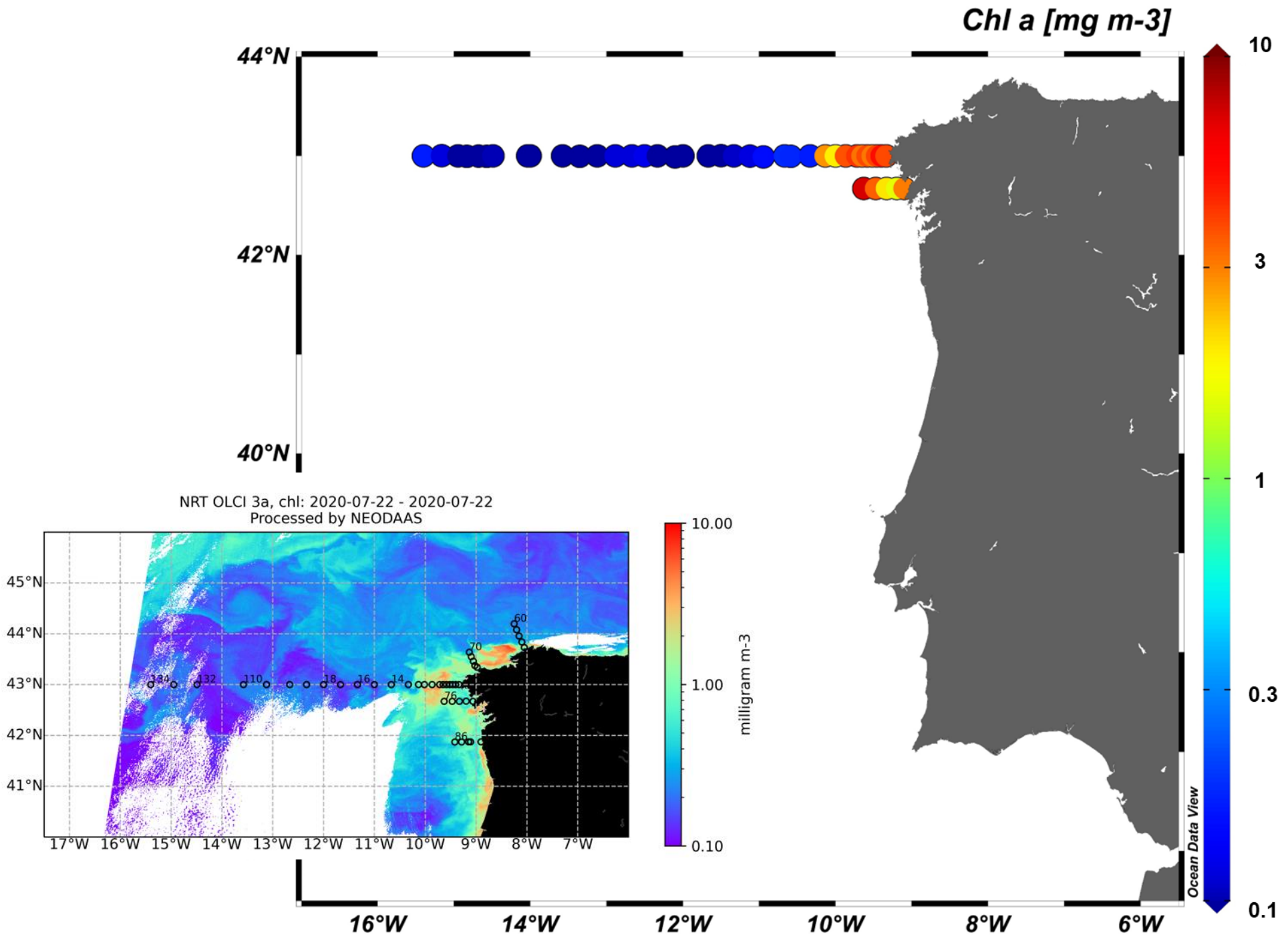
Remote Sensing of Chla, 1km resolution, Spring 2019

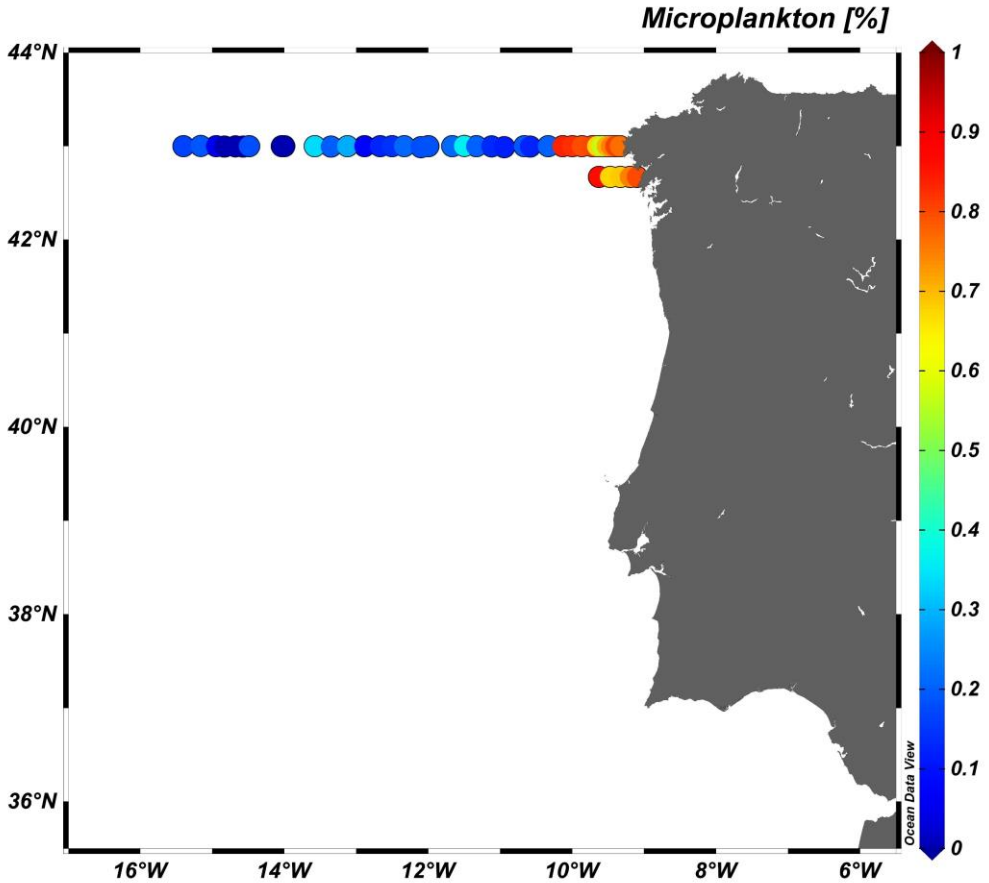


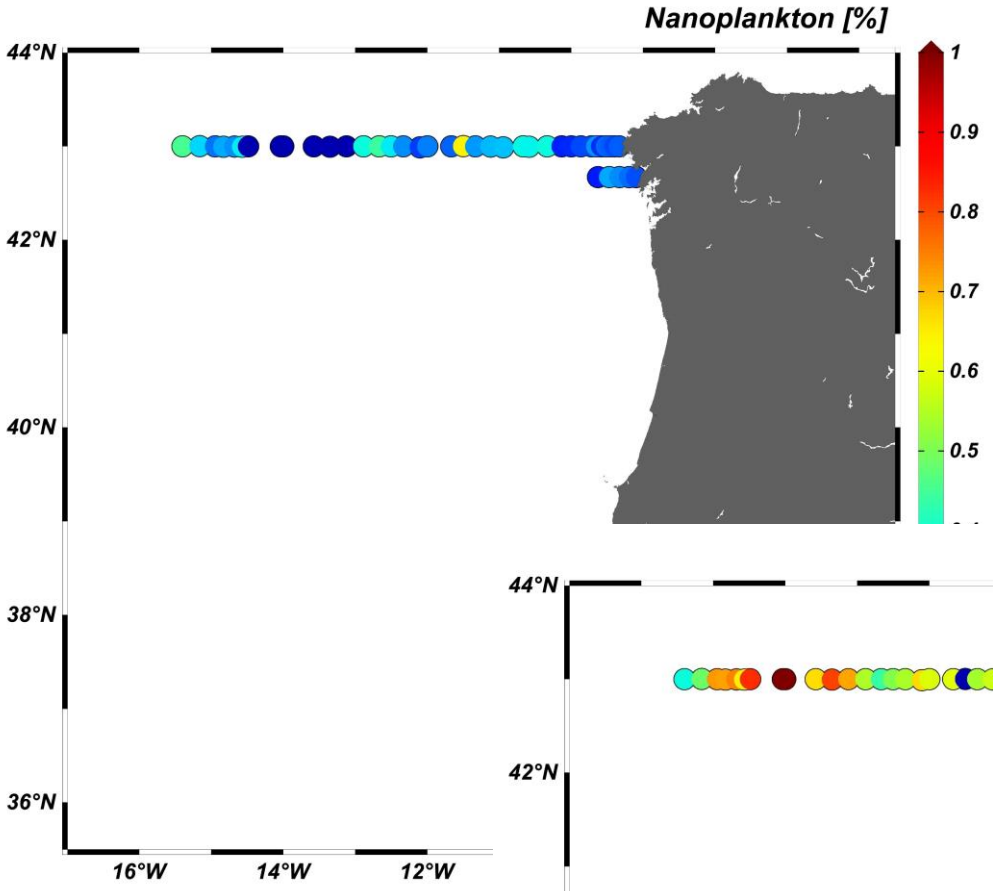



Microplankton [%]
Nanoplankton [%]
Picoplankton [%]
PELAGO19
44°N
42°N
40°N
38°N
36°N
10°W
9°W
8°W
7°W
6°W
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Ocean Data View

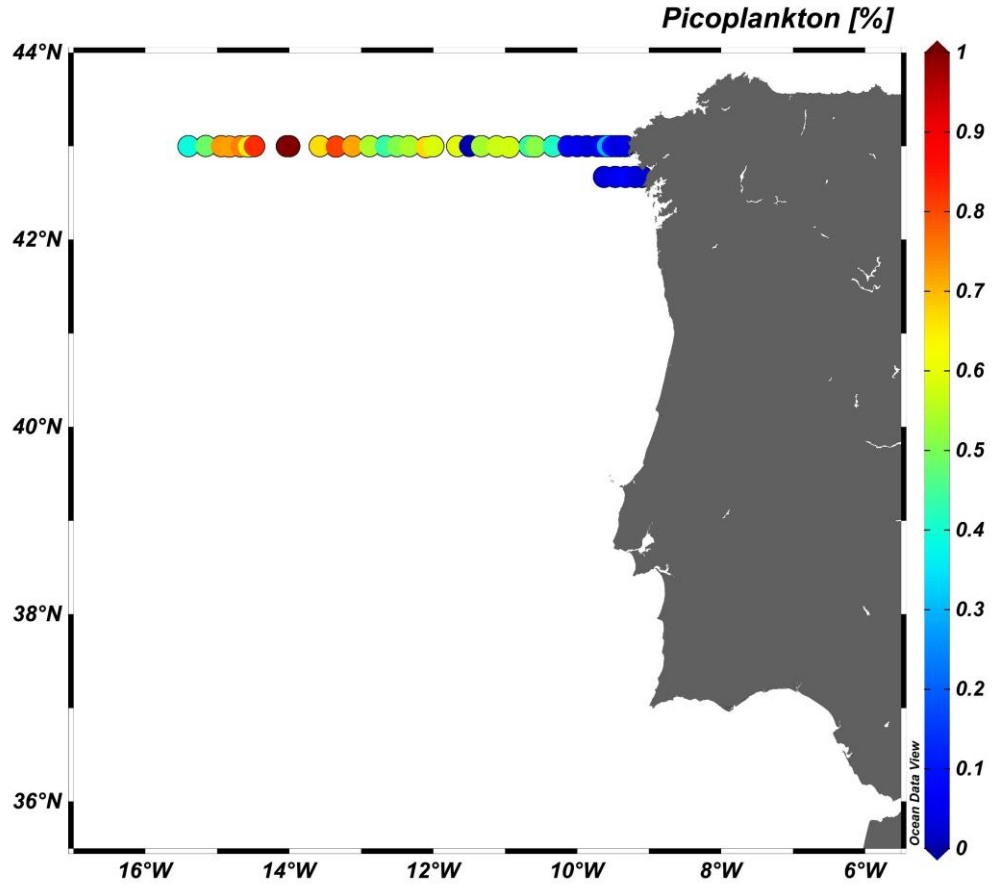
RADPROF20
surface







RADPROF20
surface
samples

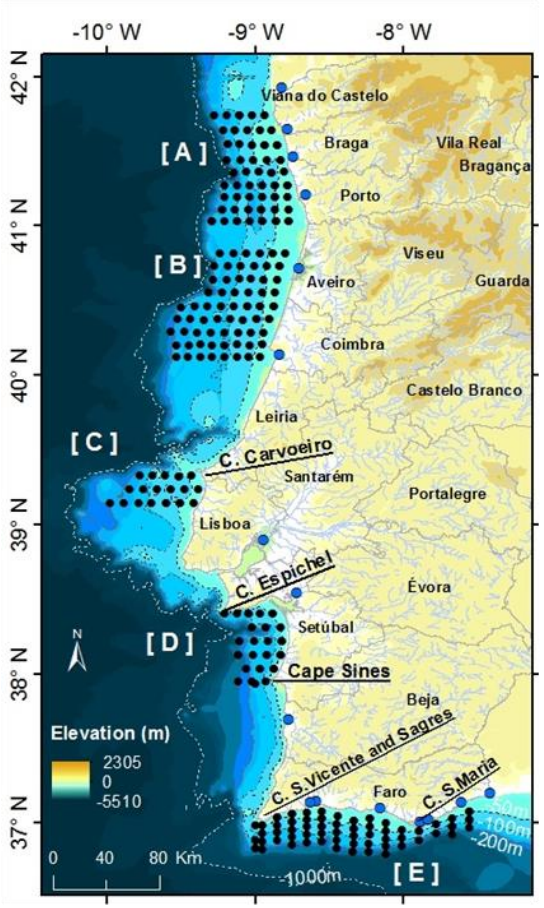


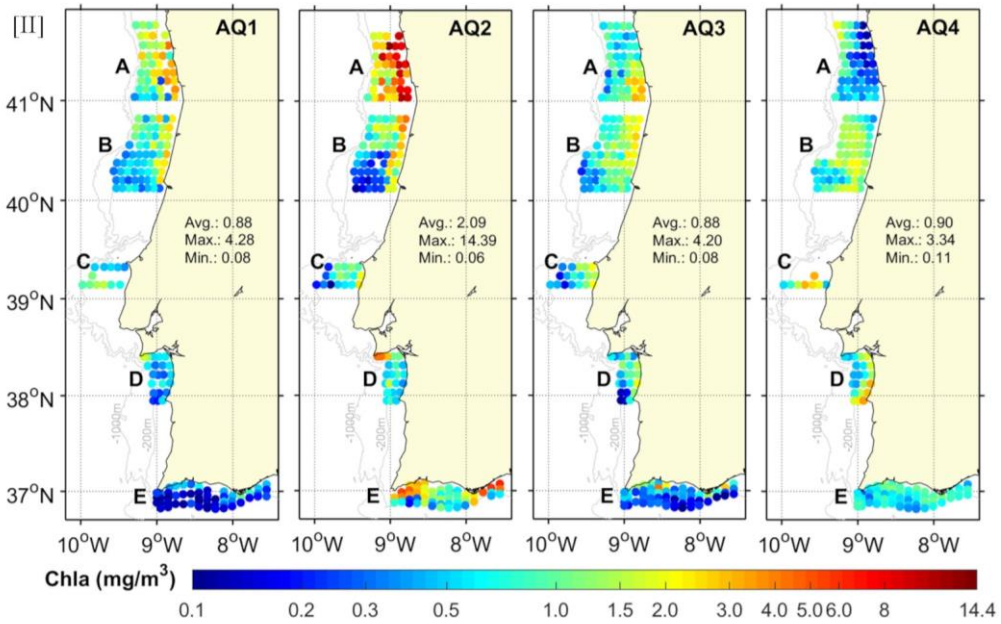
Tamara Rodriguez-Ramos et al

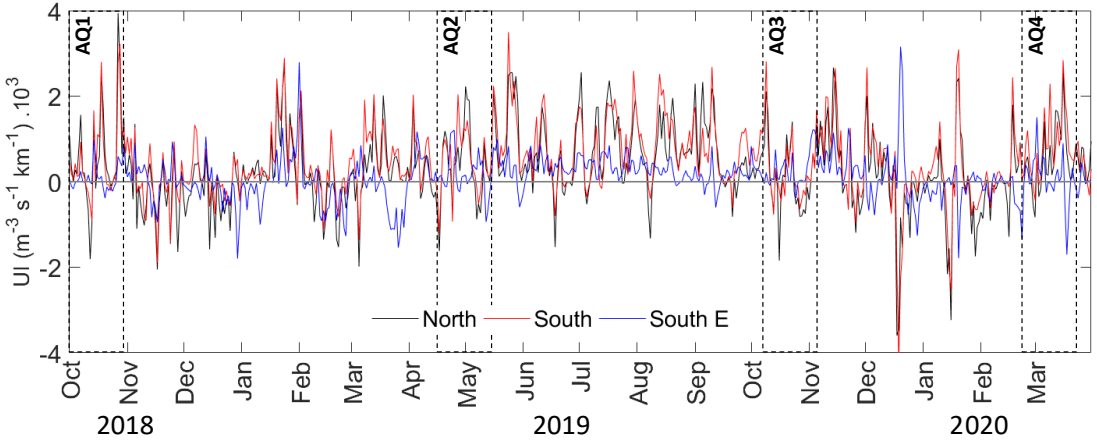
With Insituto Hidrográfico

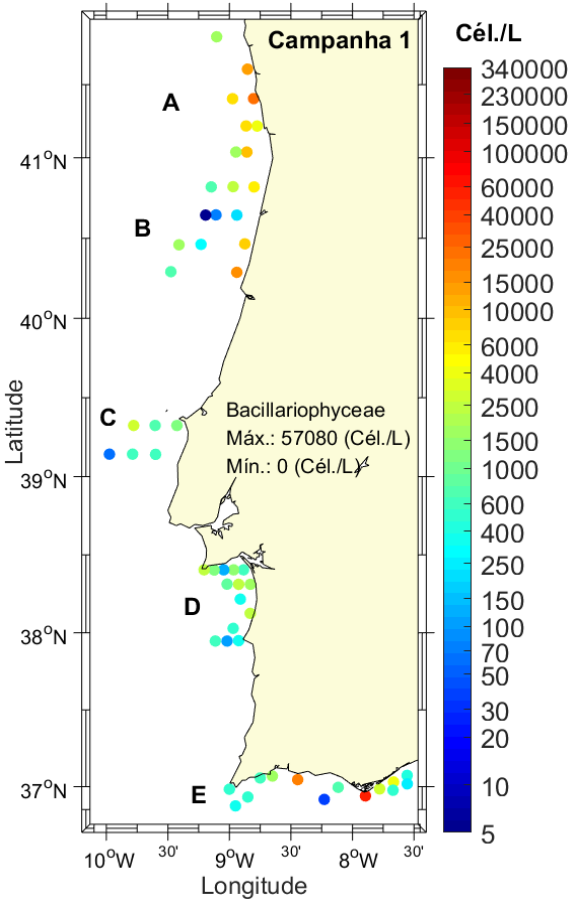
Response of phytoplankton to coastal upwelling: The importance of temporal and spatial scales

Luciane Favareto, et al, 2023, L&O









Recent papers and Other outputs 2022-2023

iFADO

Interreg Atlantic Area European Regional Development Fund

EUROPEAN UNION

MSFD monitoring of water quality off Spain and Portugal using in situ and satellite retrievals

Vanda Brotas, MªManuel Angélico, Steve Groom, Andreia Tracana, Pedro Nunes, Silvia Pardo, Paulo B. Oliveira

Ciências ULisboa · MARE · PML Plymouth Marine Laboratory · IPMA Instituto Português do Mar e da Atmosfera

- Brotas, Angélico, Groom, Tracana, Nunes, Pardo, Oliveira. Jornadas IH 2022
- Favareto, et al, 2023. L&O
- Brotas et al. 2022. Frontiers
- Brotas et al., 2023. submitted to Frontiers (special AMT issue)

LIMNOLOGY and OCEANOGRAPHY

ASLO

Limnol. Oceanogr. 9999, 2023, 1–12

doi: 10.1002/lno.12353

Response of phytoplankton to coastal upwelling: The importance of temporal and spatial scales

Luciane Favareto [1,2*] Vanda Brotas [1,2] Natalia Rudorff [3] Nuno Zacarias [4] Andreia Tracana [1,2] Luisa Lamas [4] Ângela Nascimento [1,2] Afonso Ferreira [1,2] Mara Gomes [1,2] Carlos Borges [4] Carla Palma [4] Ana C. Brito [1,2]

[1]MARE – Marine and Environmental Sciences Centre/ARNET - Aquatic Research Network, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal
[2]Departamento de Biologia Vegetal, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal
[3]Divisão de Satélites e Sistemas Ambientais, INPE–Instituto Nacional de Pesquisas Espaciais, Cachoeira Paulista, São Paulo, Brazil
[4]Instituto Hidrográfico, Lisbon, Portugal

Setting up an HPLC service.

- Ulisbon participated in 3 intercalibration exercises of HPLC Intercomparison on Phytoplankton Pigments (HIP-5, HIP-6 and HIP7)

Coordinated by JRC, Joint Research Center.

WP2 communication - literacy

https://ciencias.ulisboa.pt/pt/noticia/11-04-2023/o-mare-na-rota-do-atlantico

O MARE na rota do Atlântico

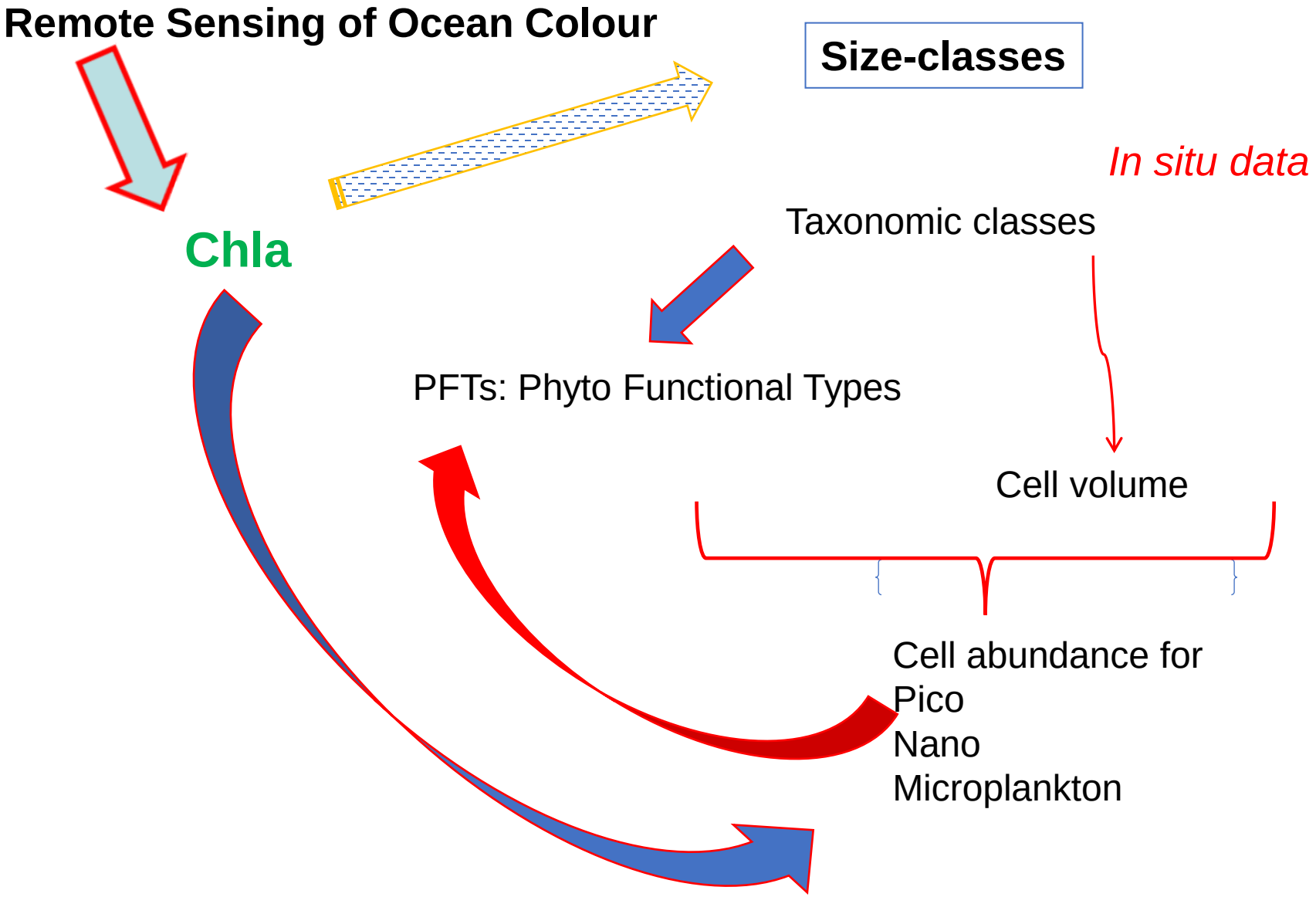
Share Tweet LinkedIn

11-04-2023

Afonso Ferreira, Federico Iena, Andreia Tracana, e Catarina Guerreiro estiveram embarcados em expedições oceanográficas

Fonte MARE Ciências ULisboa

THANK YOU


Remote Sensing of Ocean Colour
Size-classes
In situ data
Taxonomic classes
Chla
PFTs: Phyto Functional Types
Cell volume
Cell abundance for
Pico
Nano
Microplankton