Phytoplankton assemblage structure off southwestern Iberia:

Combining complementary approaches to assess variability and underlying drivers/predictors

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Why study phytoplankton off SW Iberia?

- Key primary producers, regulators of ecosystem functioning and services, and relevant indicators of environmental status
- Different species-specific functional traits and niche preferences lead to variable responses to environmental forcing
- Region characterized by high levels of mesoscale variability and vulnerability to climate change (Soares et al., 2023)

What are the current challenges?

Limited knowledge on phytoplankton structure off SW Iberia

Lack of understanding of environmental determinants shaping phytoplankton assemblage structure

RS-based algorithms for phytoplankton functional types mostly global, with poor quality for complex waters

Study objectives

1. Assess spatial-temporal variability patterns of phytoplankton assemblages off SW Iberia

2. Identify underlying environmental drivers and predictors

3. Evaluate the performance of satellite algorithms used to derive phytoplankton composition at a regional scale

Methods: field sampling

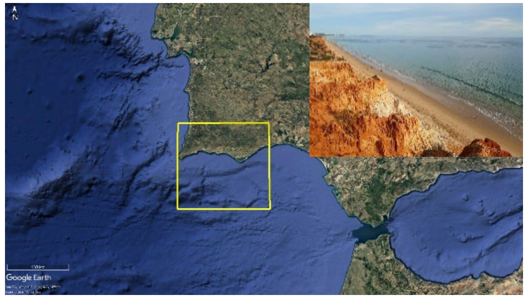
Regular sampling

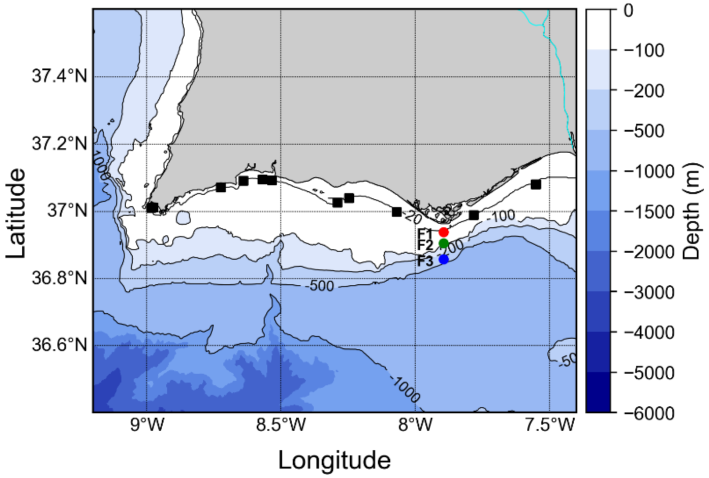
- 3 stations (**F1**, **F2** and **F3**)
- Coastal-offshore transect
- July 2012 – July 2014 (10 sampling dates)
- 3 depth levels: surface, 0.3*Secchi depth, 0.6*Secchi depth
- Sampling time synchronous with MODISA passage (±3h)

MarBIS oceanographic cruise

- 12 stations (black squares)
- Alongshore transect
- 20 June – 11 July 2013
- 3 depth levels

Satellite algorithm validation





Methods: variables, data sources and analysis

In situ | Remote sensing | Models

Physico-chemical: T, S, SDD, PAR, DO, NH_4^+, NO_3^-, NO_2^-, PO_4^{3-}, SiO_4^{4-}, SPM

Phytoplankton-related variables: Chl-a concentration, specific photosynthetic diagnostic pigments, abundance, biomass, community size structure and species composition

SST, PAR, Kd490, wind components and magnitude, Chl-a

NH_4^+, NO_3^-, PO_4^{3-}, SiO_4^{4-}, MLD, geostrophic velocity

Multivariate analysis (NMDS, PERMANOVA, CCA)

Methods: phytoplankton assemblage composition

- Contribution of size classes and functional types estimated from:
  - Abundance and biomass (epifluorescence and inverted microscopy)
  - Specific diagnostic pigment analysis (Hirata et al., 2011; Brewin et al., 2015 with weights tuned to the North Atlantic)
  - CHEMical TAXonomy analysis (CHEMTAX; Hayward et al., 2023)

- Comparison with satellite-based algorithms (3x3 matchup grid box; Xi et al., 2021), including the re-tuned three-component model by Brewin *et al.* (2010) with SST (Brewin et al., 2017), using type II linear regression

Methods: RS-derived phytoplankton composition

Daily data, 2012-2014

Copernicus Marine Service

PSCs & PFTs

North Atlantic Ocean Colour Plankton, Reflectance, Transparency and Optics MY L3 daily observations

Home > Marine Data Store > Product

OCEANCOLOUR_ATL_BGC_L3_MY_009_113 (L3, 1x1 km)

Global Ocean Colour (Copernicus-GlobColour), Bio-Geo-Chemical, L3 (daily) from Satellite Observations (1997-ongoing)

Home > Marine Data Store > Product

OCEANCOLOUR_GLO_BGC_L3_MY_009_103 (L3, 4x4 km)

PSCs

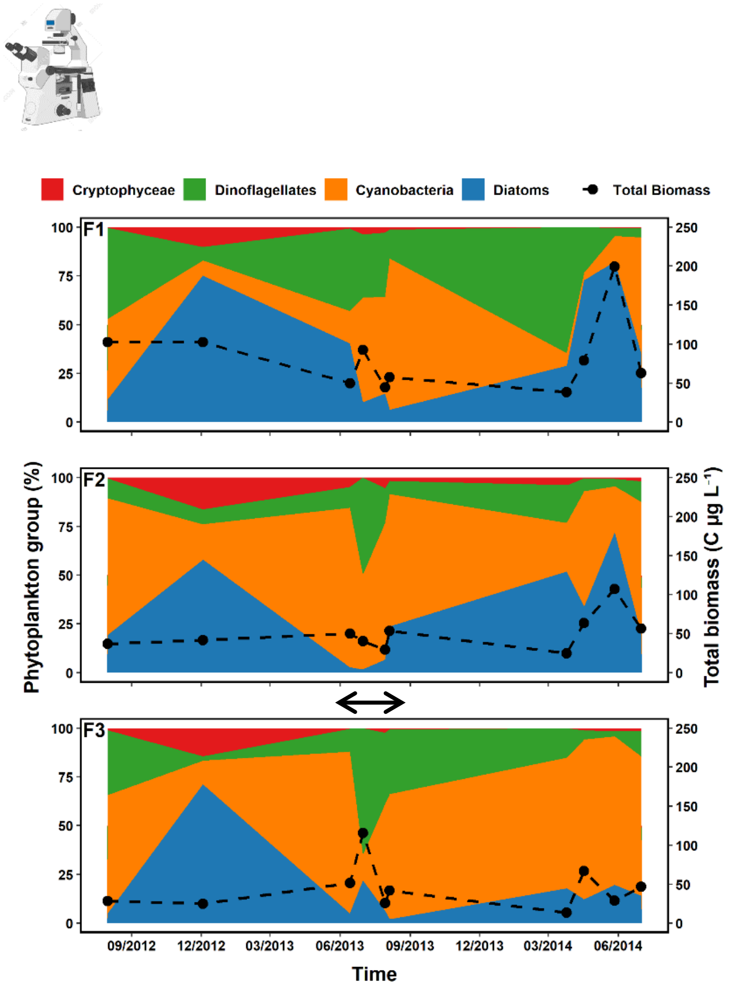
Global Ocean Colour Plankton and Reflectances MY L3 daily observations

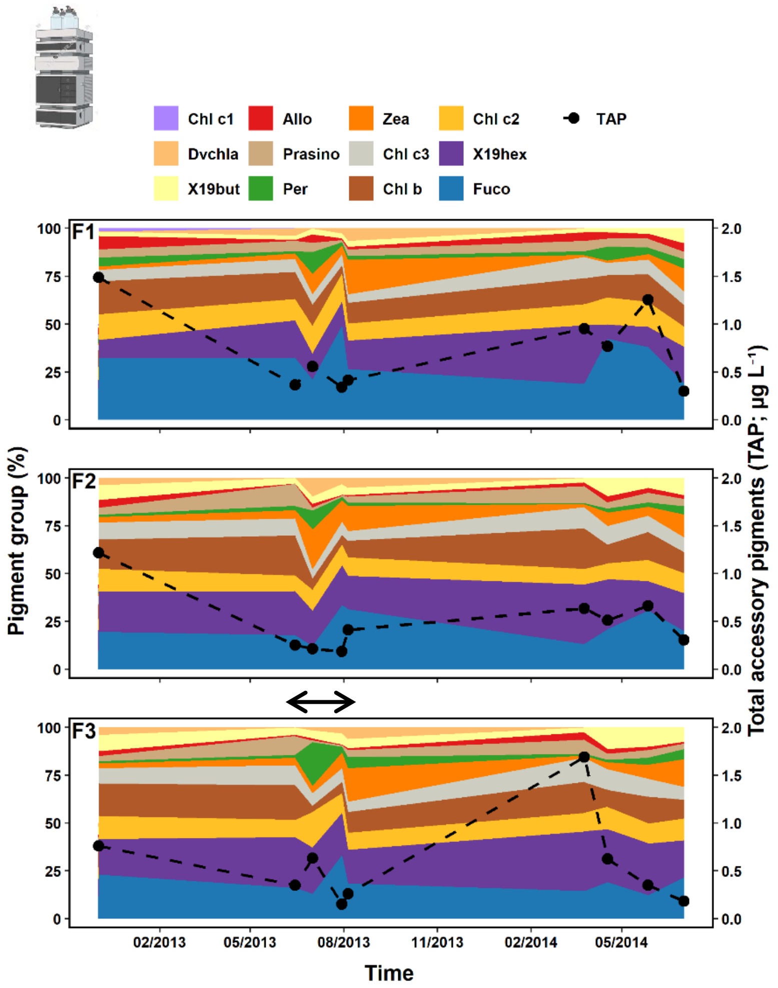
Home > Marine Data Store > Product

OCEANCOLOUR_GLO_BGC_L3_MY_009_107 (L3, 4x4 km)

Processing frameworks and providers
Spatial extent and resolution
Available variables

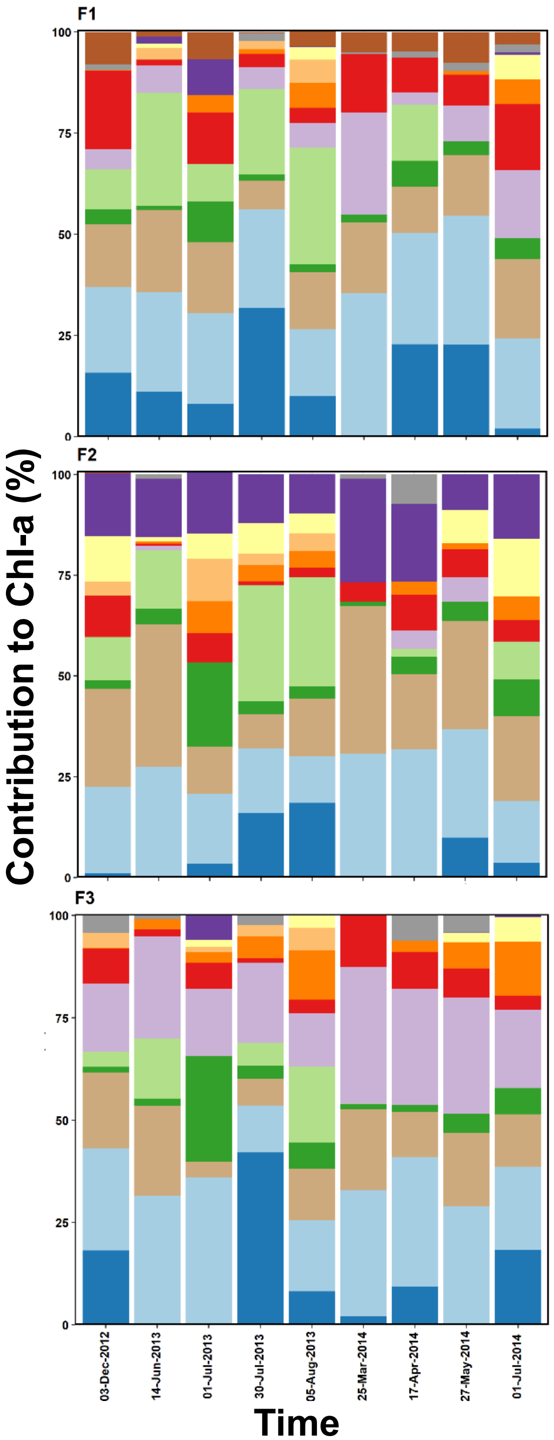
Phytoplankton assemblage structure and pigment signatures

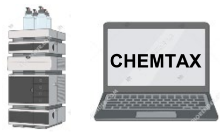




Chl: Chlorophyll, Dvchla: divinyl chlorophyll a; X19but: 19'-but-fucoxanthin; Allo: Alloxanthin; Prasino: Prasinoxanthin; Per: Peridinin; Zea: Zeaxanthin; X19hex: 19'-hex-fucoxanthin; Fuco: Fucoxanthin

Phytoplankton assemblage structure from pigment signatures





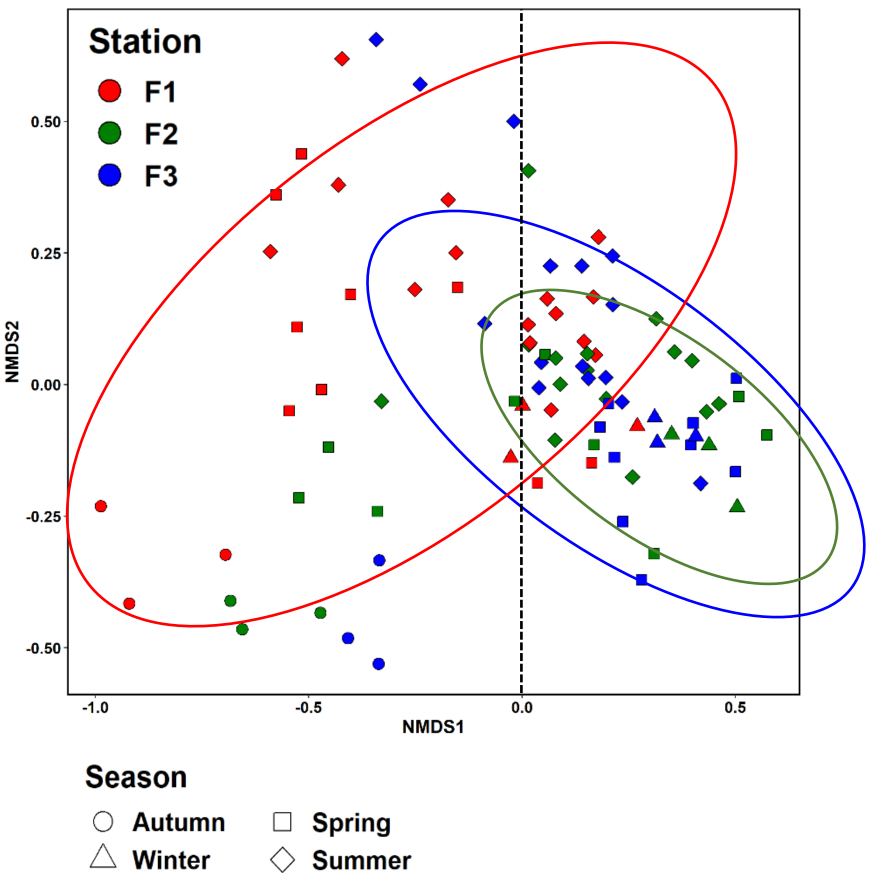
Phytoplankton classes

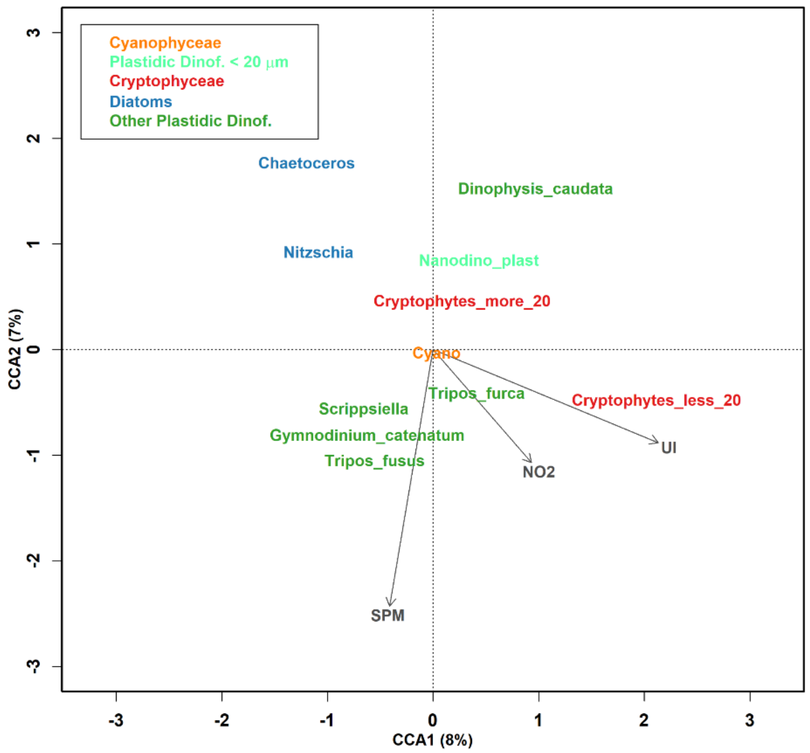
- (Other) Chlorophyta
- Chrysophyceae
- (Other) Haptophyta
- Pelagophyceae
- Prochlorococcus
- Synechococcus
- Cryptophyceae
- Prymnesiophyceae
- Dinoflagellates-2
- Dinoflagellates-1
- Prasinophytae
- Diatoms-2
- Diatoms-1

Group	r-coef	p-value	MAE	MSE	RMSE
Synechococcus	**0.80**	4.41E-07	**0.18**	**0.05**	**0.22**
Cryptophyceae	**0.83**	3.88E-07	**0.12**	**0.02**	**0.14**
Diatoms	0.74	7.73E-08	0.37	0.23	0.47
Dinoflagellates	0.56	2.03E-04	0.40	0.28	0.53

N = 25 - 39

Assemblage structure: variability and environmental predictors





Performance of RS-derived algorithms

Phytoplankton group (in situ pigments)	Satellite product	Performance metrics*		
		Bias	MAE	Overall Wins (%)
Pico	OCEANCOLOUR_ATL_BGC_L3_MY_009_113	1.29	1.67	27.27
	→ OCEANCOLOUR_GLO_BGC_L3_MY_009_103	1.20	**1.50**	**54.55**
	OCEANCOLOUR_GLO_BGC_L3_MY_009_107	**1.11**	1.73	18.18
	Abundance-based_model_with_SST	1.24	1.68	0
Nano	OCEANCOLOUR_ATL_BGC_L3_MY_009_113	0.66	1.84	18.18
	OCEANCOLOUR_GLO_BGC_L3_MY_009_103	0.61	1.87	18.18
	OCEANCOLOUR_GLO_BGC_L3_MY_009_107	1.49	1.80	27.27
	→ Abundance-based_model_with_SST	**1.39**	**1.75**	**36.36**
Micro	→ OCEANCOLOUR_ATL_BGC_L3_MY_009_113	0.60	**1.67**	**36.36**
	OCEANCOLOUR_GLO_BGC_L3_MY_009_103	0.57	1.88	9.09
	OCEANCOLOUR_GLO_BGC_L3_MY_009_107	**0.71**	1.74	18.18
	→ Abundance-based_model_with_SST	**0.70**	1.77	**36.36**
Prokaryotes	OCEANCOLOUR_ATL_BGC_L3_MY_009_113	1.80	1.90	33.33
	→ OCEANCOLOUR_GLO_BGC_L3_MY_009_103	**1.68**	**1.79**	**66.67**
	Abundance-based_model_with_SST	-	-	-
Diatoms	OCEANCOLOUR_ATL_BGC_L3_MY_009_113	**0.35**	2.88	9.09
	OCEANCOLOUR_GLO_BGC_L3_MY_009_103	**0.34**	2.98	18.18
	→ Abundance-based_model_with_SST	0.63	**1.91**	**72.73**
Dinoflagellates	OCEANCOLOUR_ATL_BGC_L3_MY_009_113	5.99	5.99	8.33
	OCEANCOLOUR_GLO_BGC_L3_MY_009_103	5.16	5.16	5.88
	→ Abundance-based_model_with_SST	**1.91**	**2.75**	**93.75**

Number of valid matchups = 12 – 27. The best statistical results are highlighted in **bold**.
*Selected according to Seegers *et al.* (2018).

Conclusions

- Diatoms and dinoflagellates dominated at coastal stations, while cyanobacteria surpassed dinoflagellates further offshore

- Winter-spring: diatom dominance; summer-autumn: cyanobacteria and dinoflagellate dominance

- UI, NO_2 and SPM were the best predictors of variability in the structure of the phytoplankton assemblage

- RS-based algorithms need further refinement and validation to be applied at regional scales

Next steps

- Estimate NO_3^- concentrations in the study area from *in situ*/satellite-retrieved water temperature, SiO_4^{4-}, and/or Chl-a concentrations using empirical regressions
- Apply multivariate analysis with model-derived NO_3^- concentrations
- Explore specific bloom events

Recommendations for conference organizers:

- Provide travel funding/scholarships for participants from developing countries
- Implement real-time feedback mechanisms (e.g., post-session surveys)
- Promote Q&A sessions/round tables after each session

Thank you!

Would you like to see the reference list?

Do you have any questions?

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