

Marine microbes over fronts

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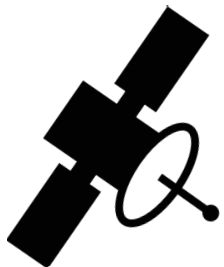


Gordon conference on Marine Microbes, Les Diablerets, Switzerland, 29 mai – 3 june 2022



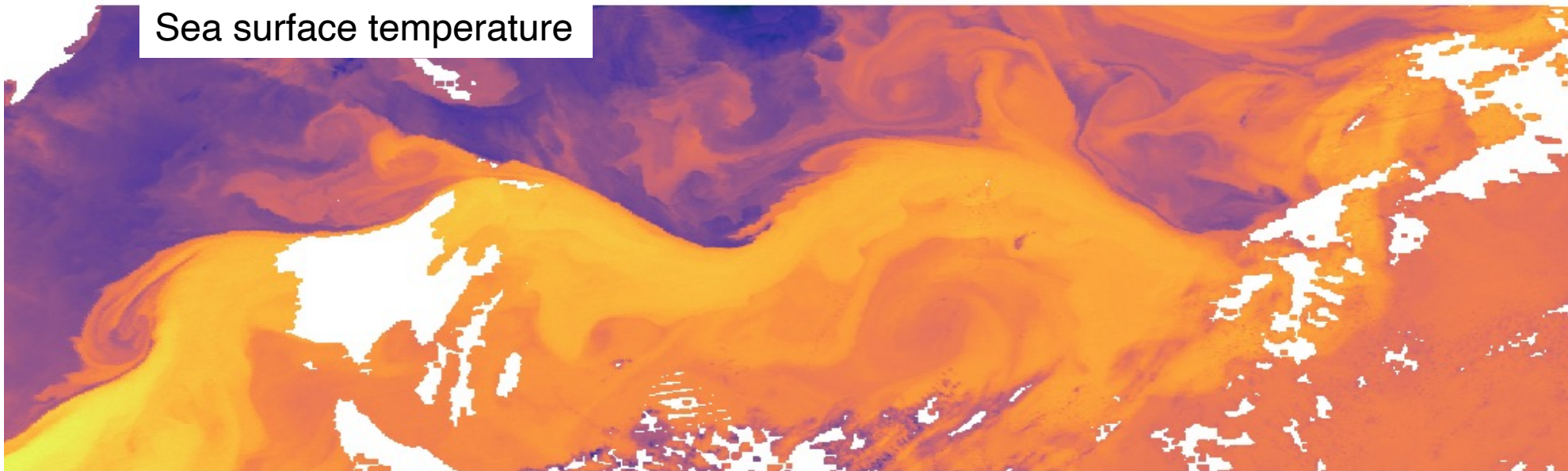
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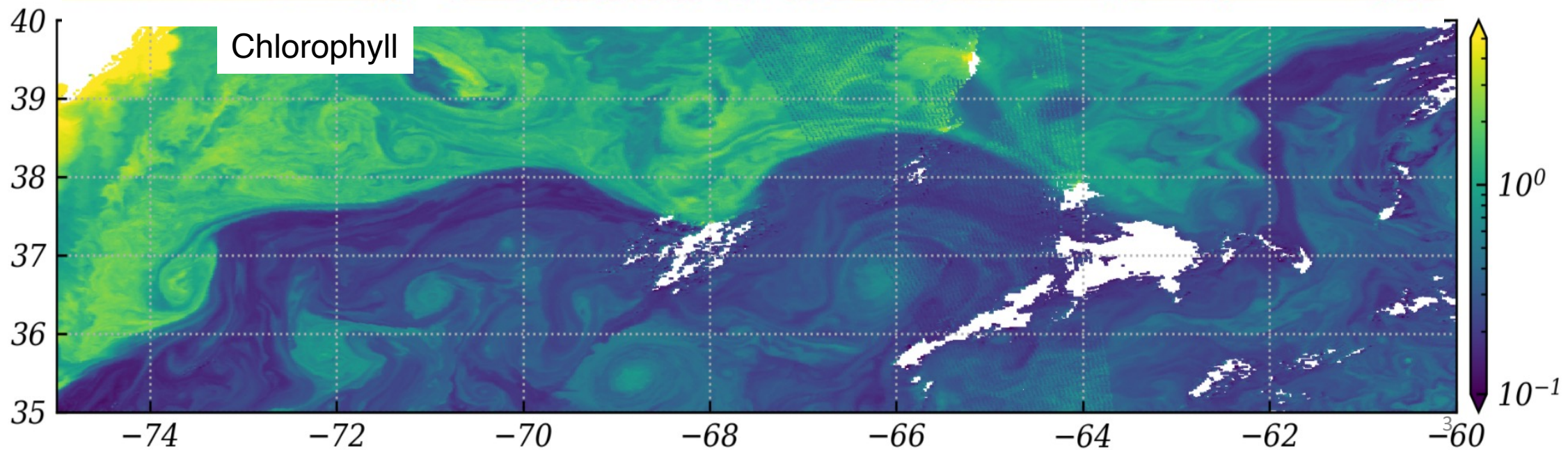


Gulf stream front

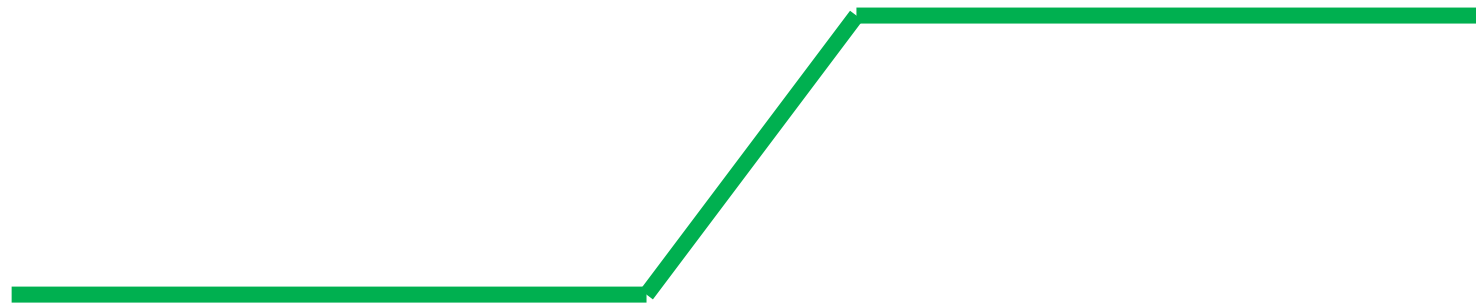
Sea surface temperature



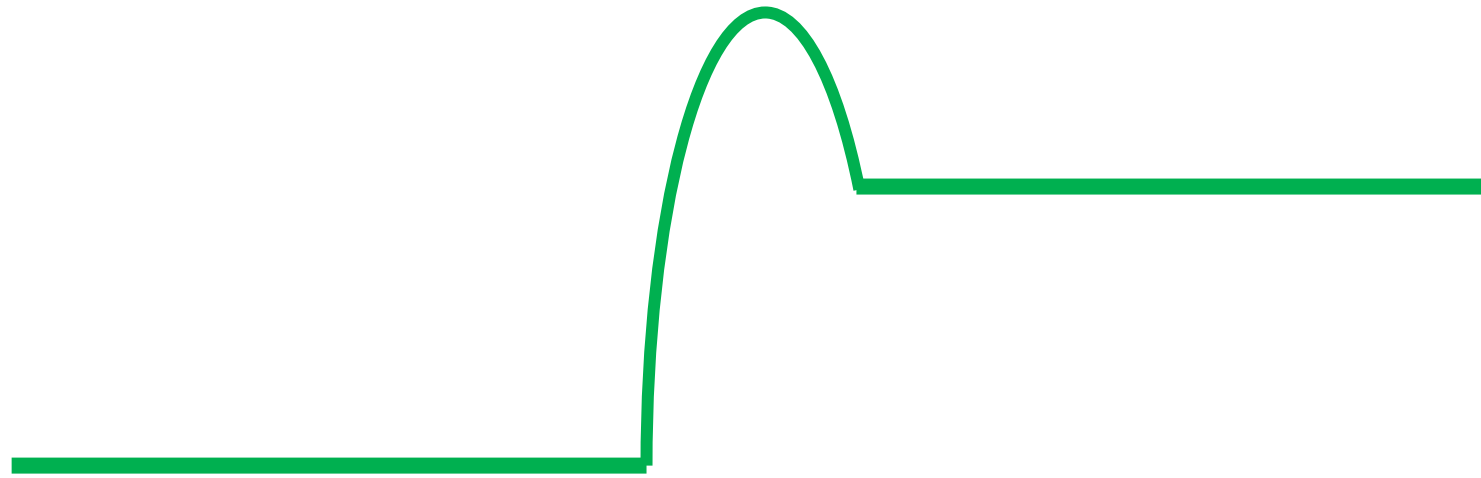
Chlorophyll

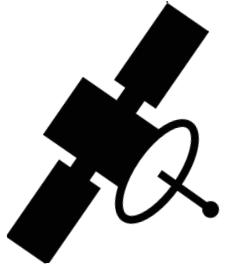


Transition front



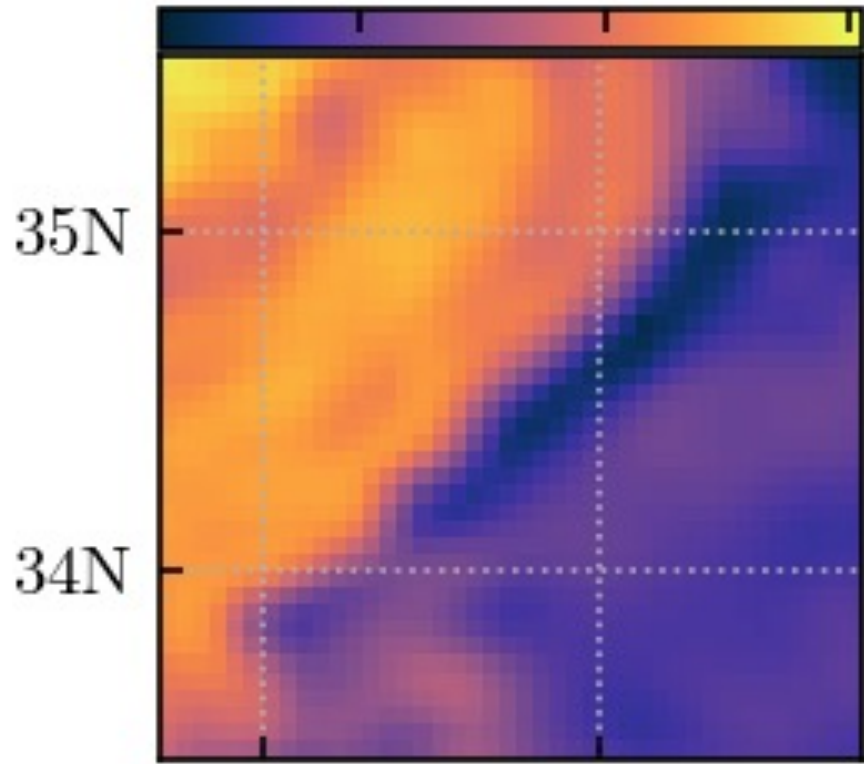
Peak front



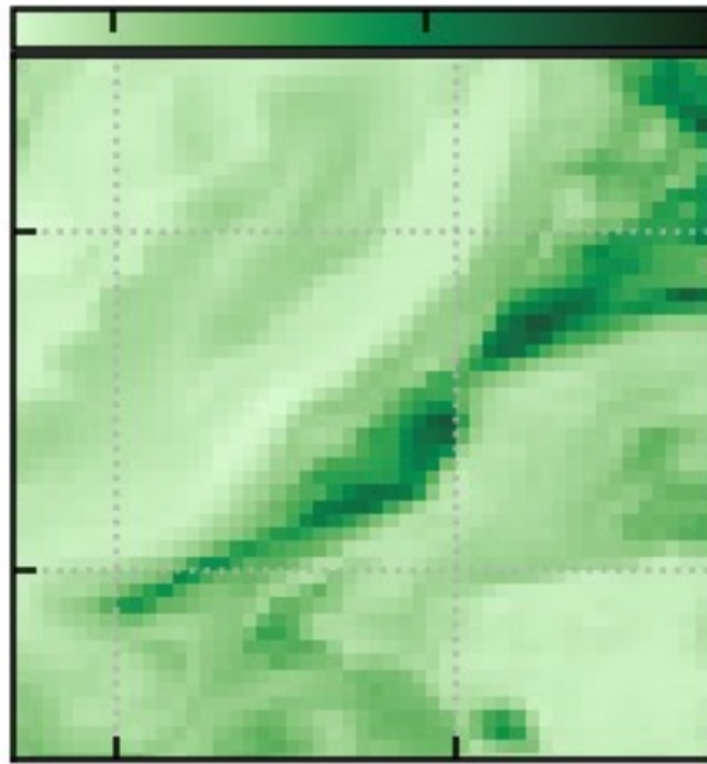


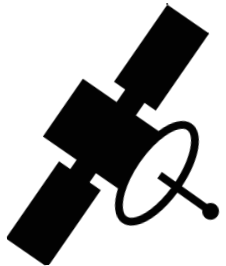
Peak front

SST [°C]
20 22 24



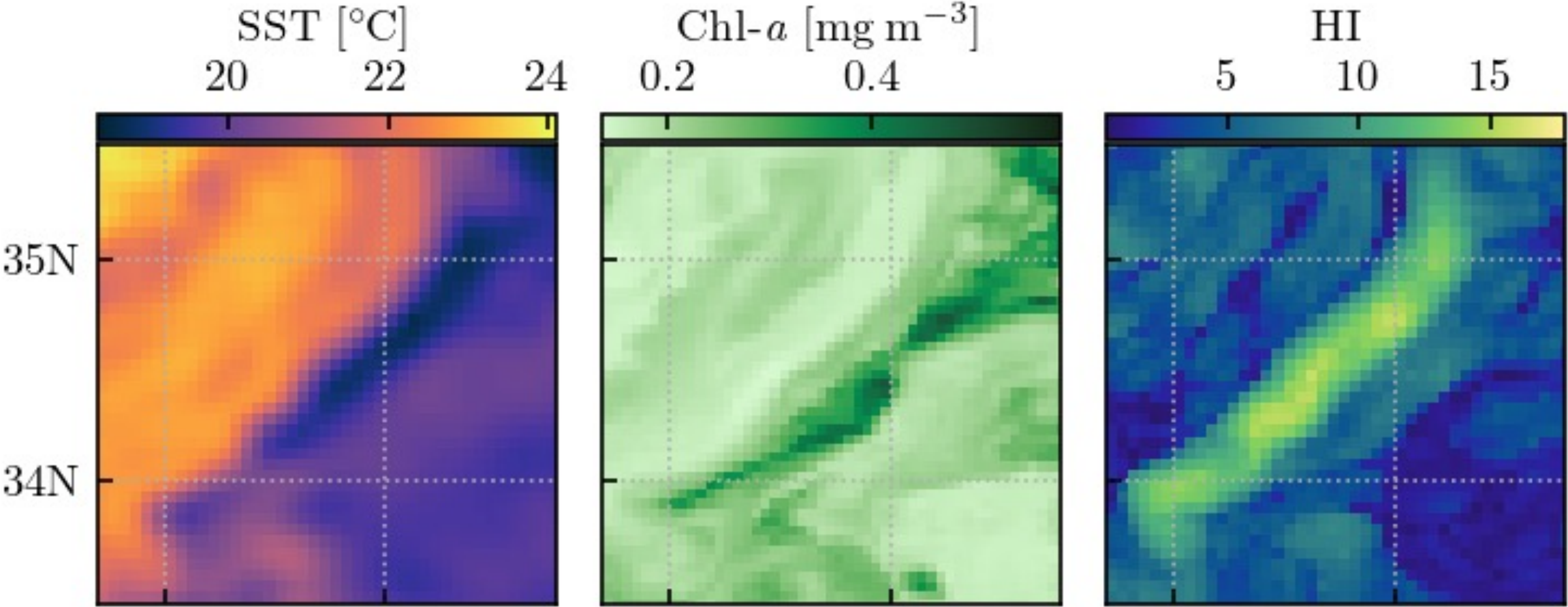
Chl-*a* [mg m⁻³]
0.2 0.4



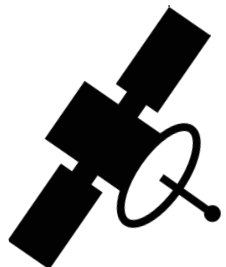


Peak front

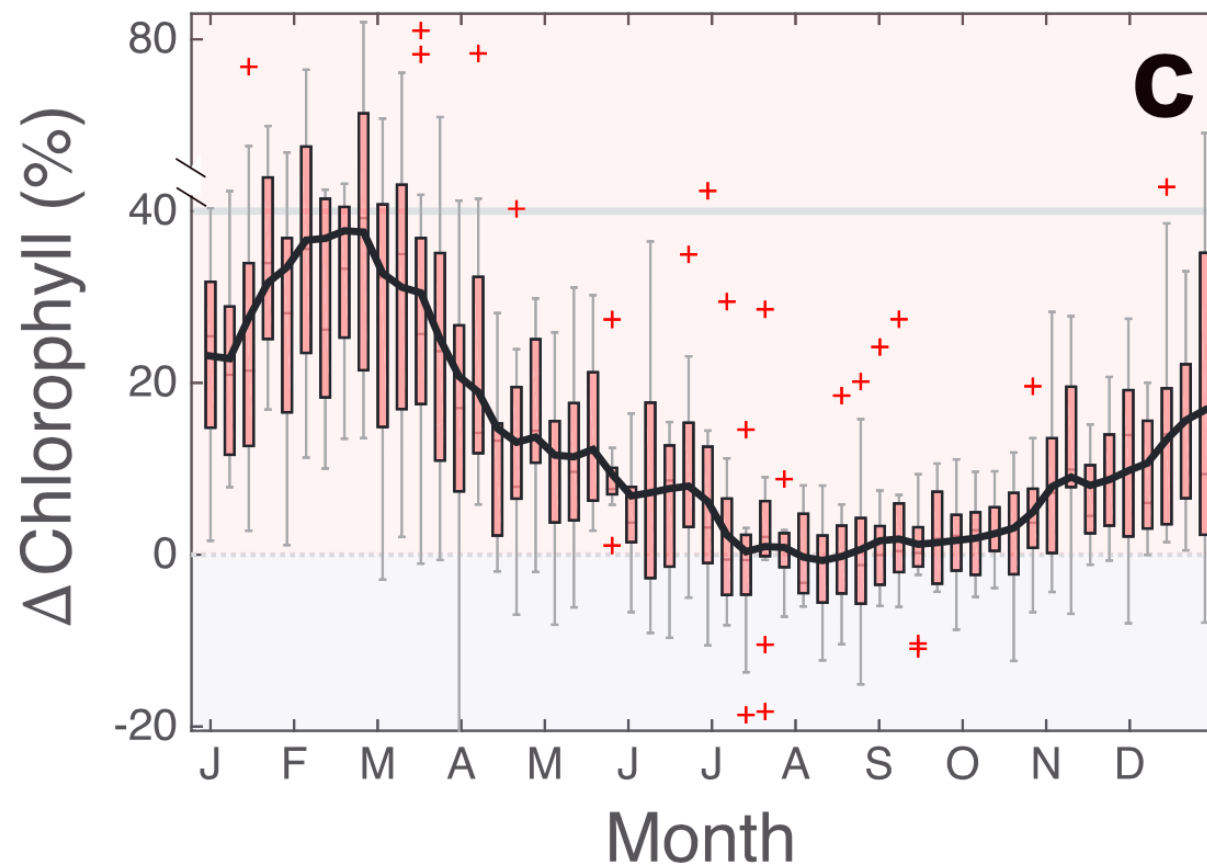
Heterogeneity index derived from SST



Liu and Levine, GRL, 2016

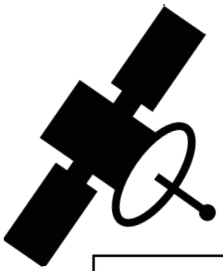


Enhanced phytoplankton biomass over SST fronts



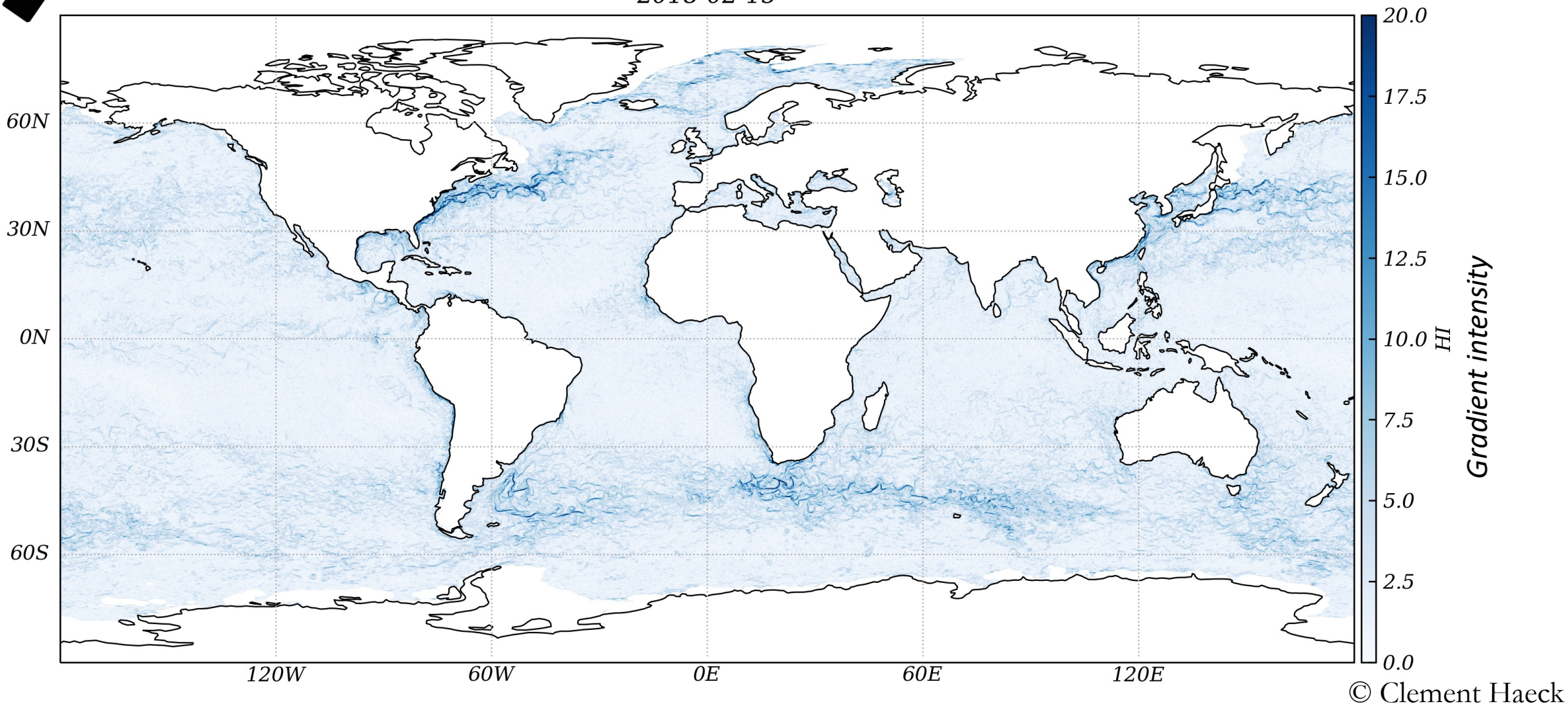
First quantitative estimate of the impact of fronts North Pacific subtropical gyre

Why do we even bother about fronts ?

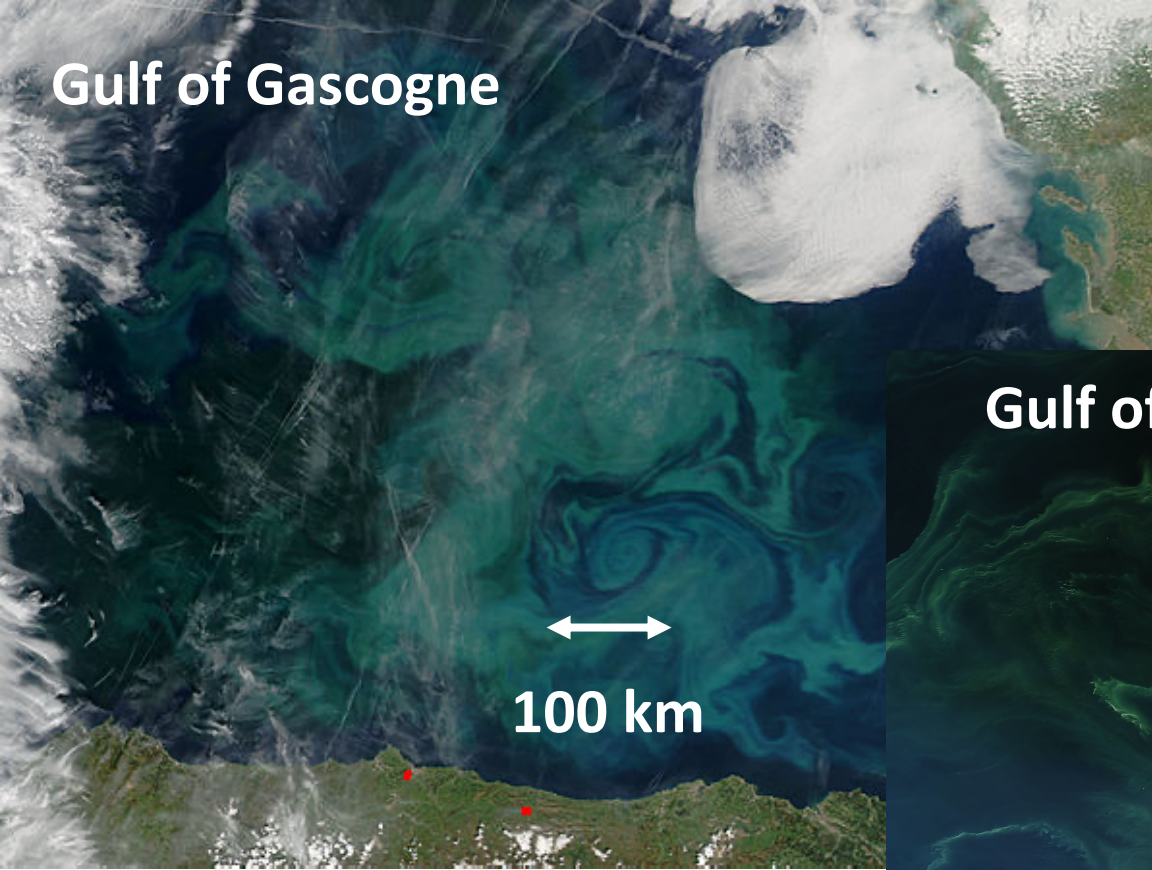


Sea-surface temperature fronts

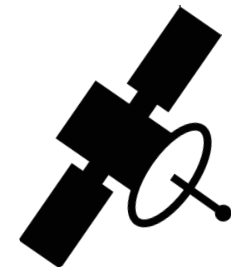
2018-02-15



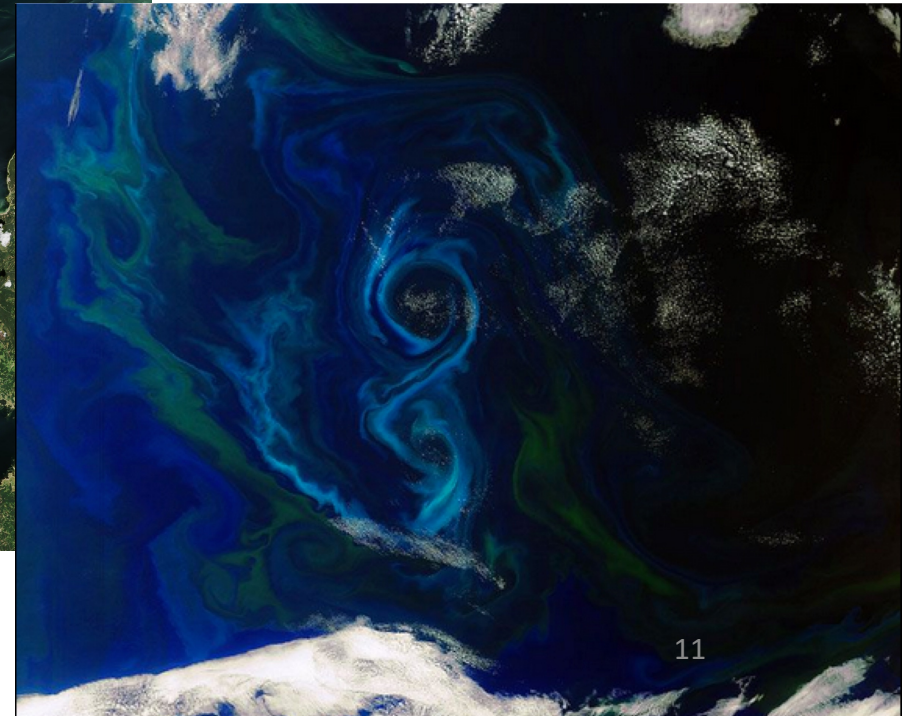
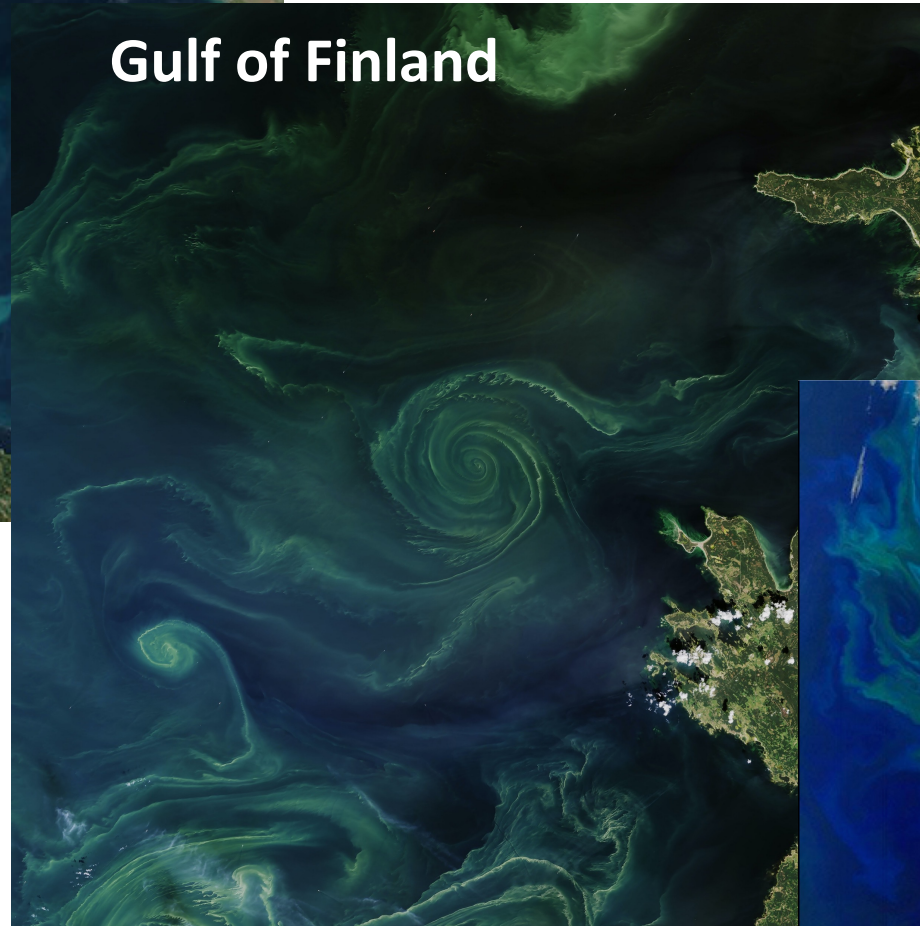
Gulf of Gascogne



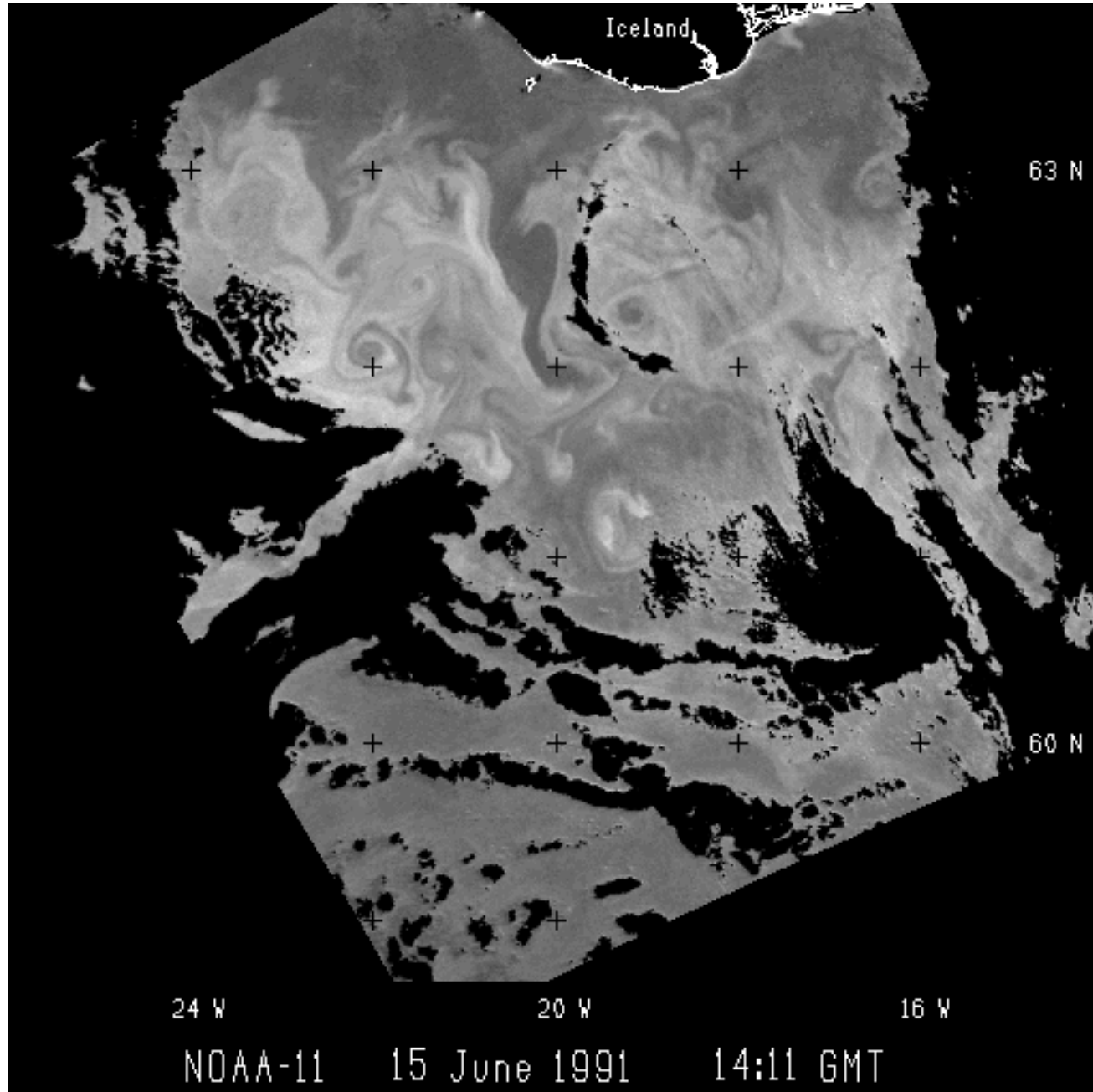
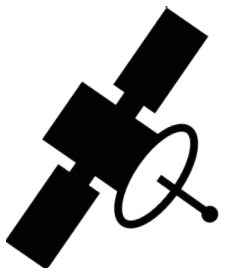
100 km



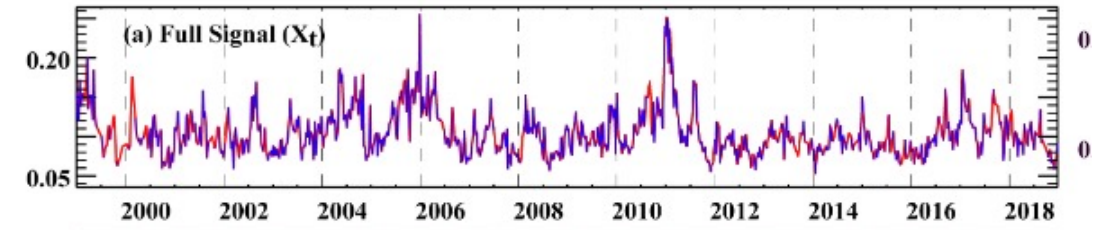
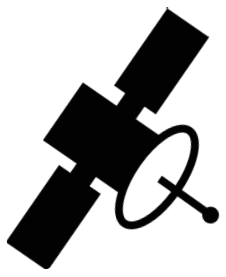
Gulf of Finland

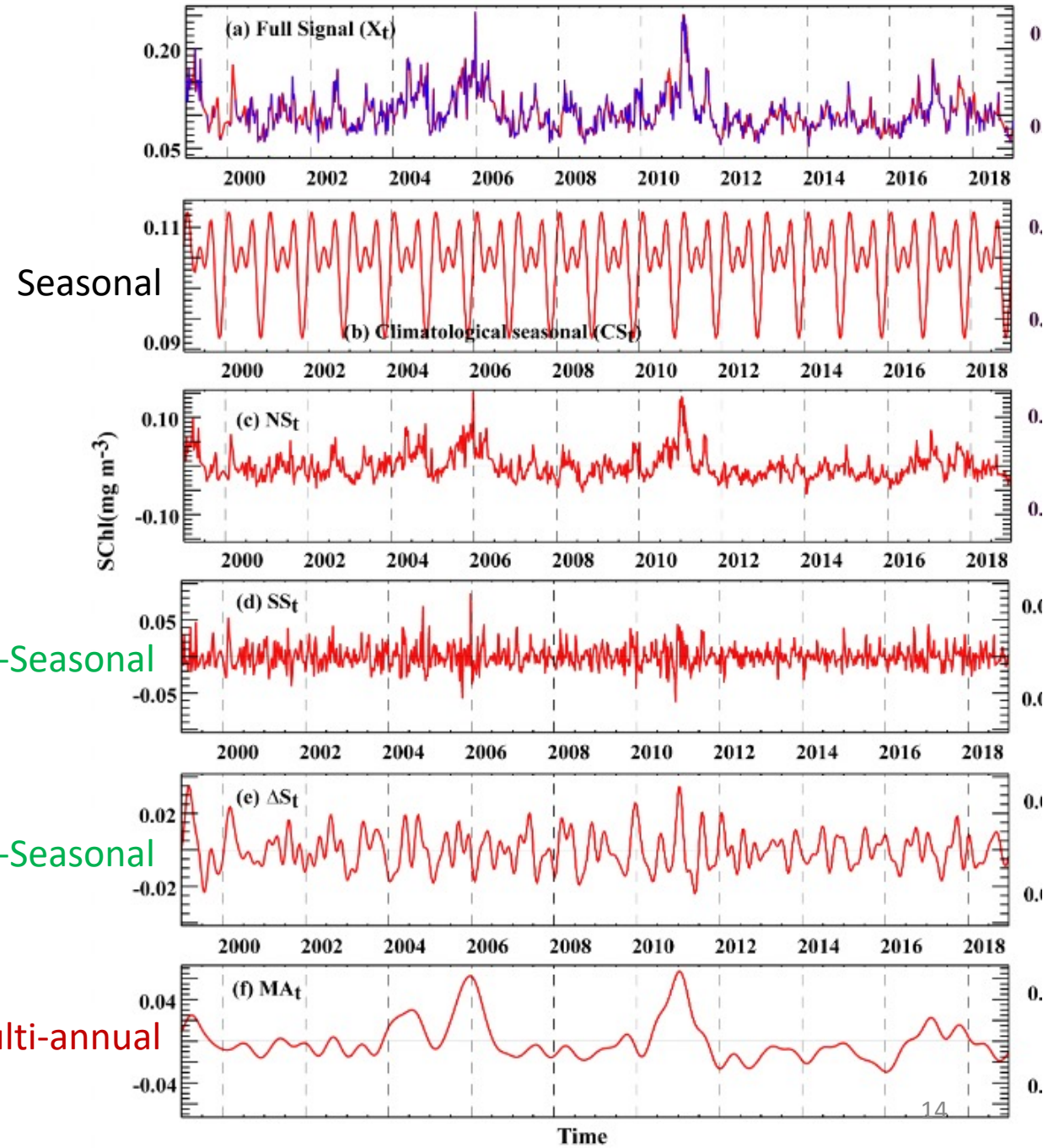
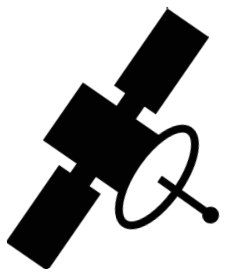


Evolution over 8 days



©Adrian Martin, NOC





Seasonal

Sub-Seasonal

Sub-Seasonal

Multi-annual

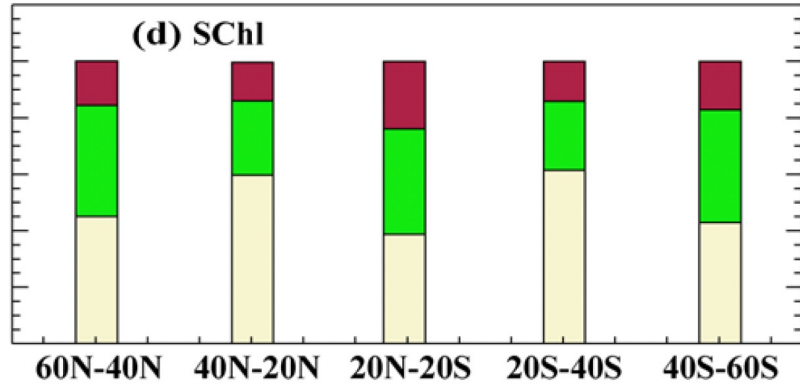


1/3 of Chl-a variance due to finescales

Multi-annual

Sub-Seasonal

Seasonal



Spatial scales

Sub-Seasonal

20-100 km

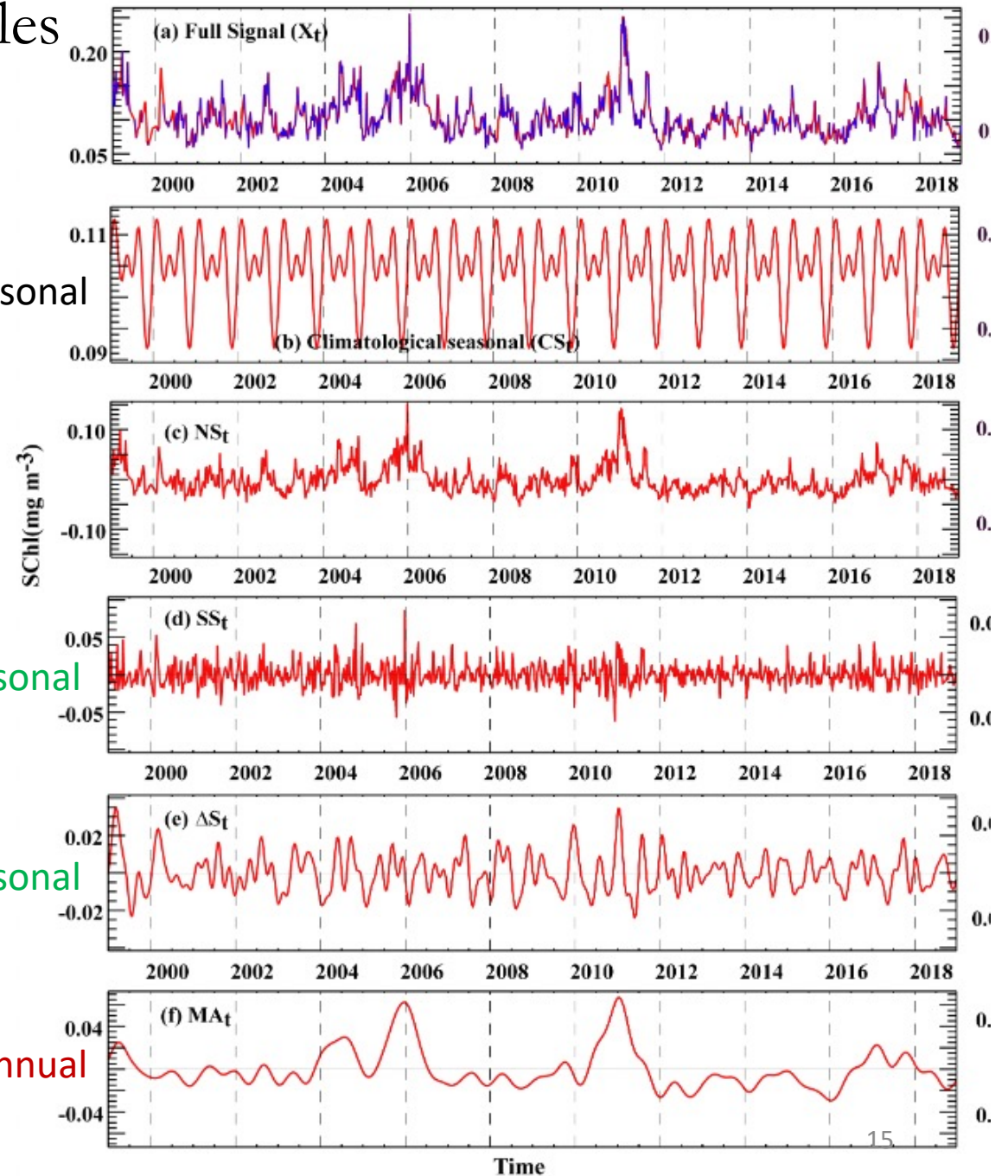
Seasonal

>> 100 km

Multi-annual

>> 100 km

Seasonal



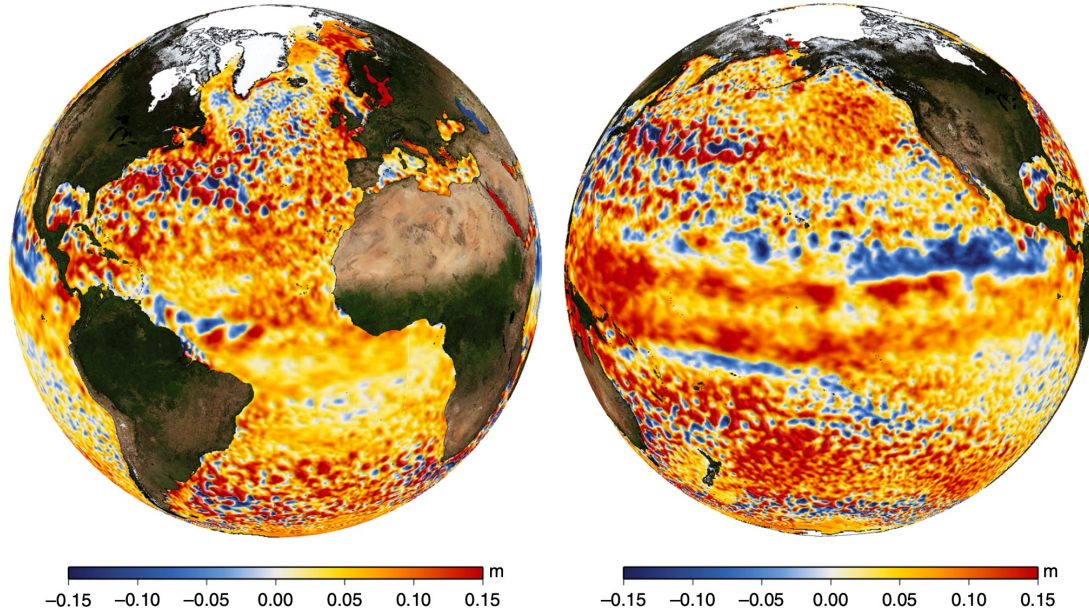
Sub-Seasonal

Sub-Seasonal

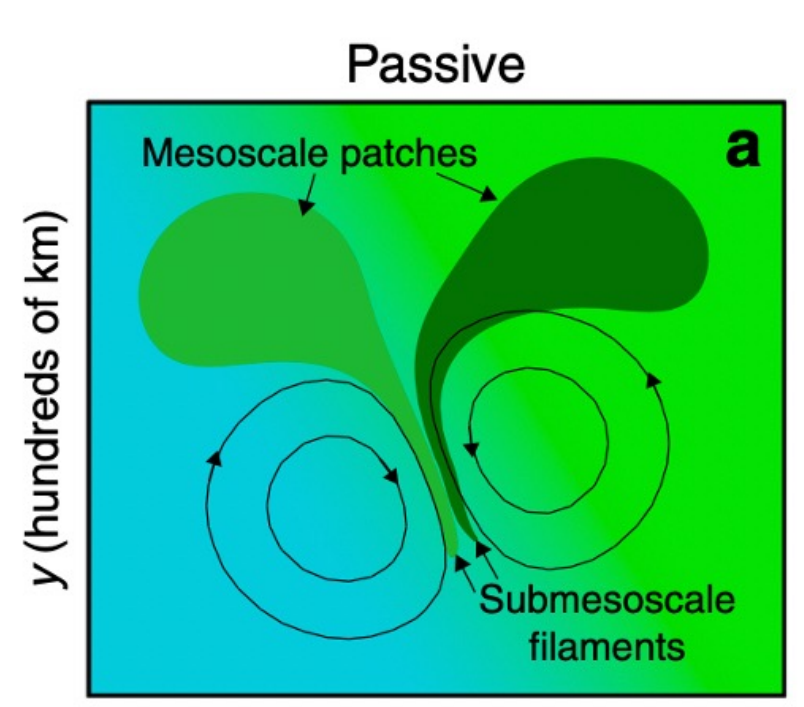
Multi-annual

Why is there a peak at the front ?

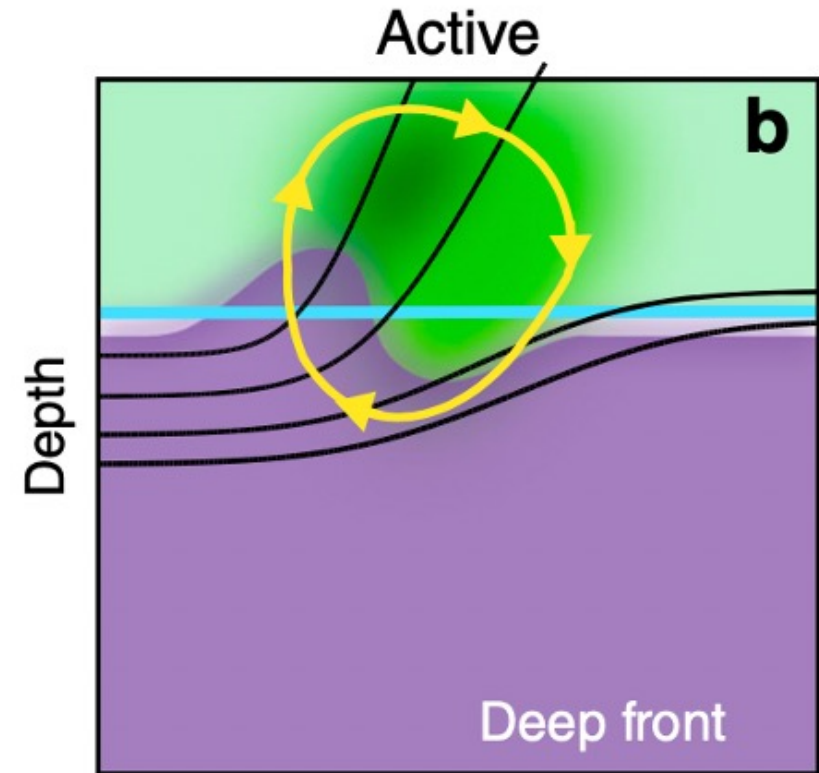
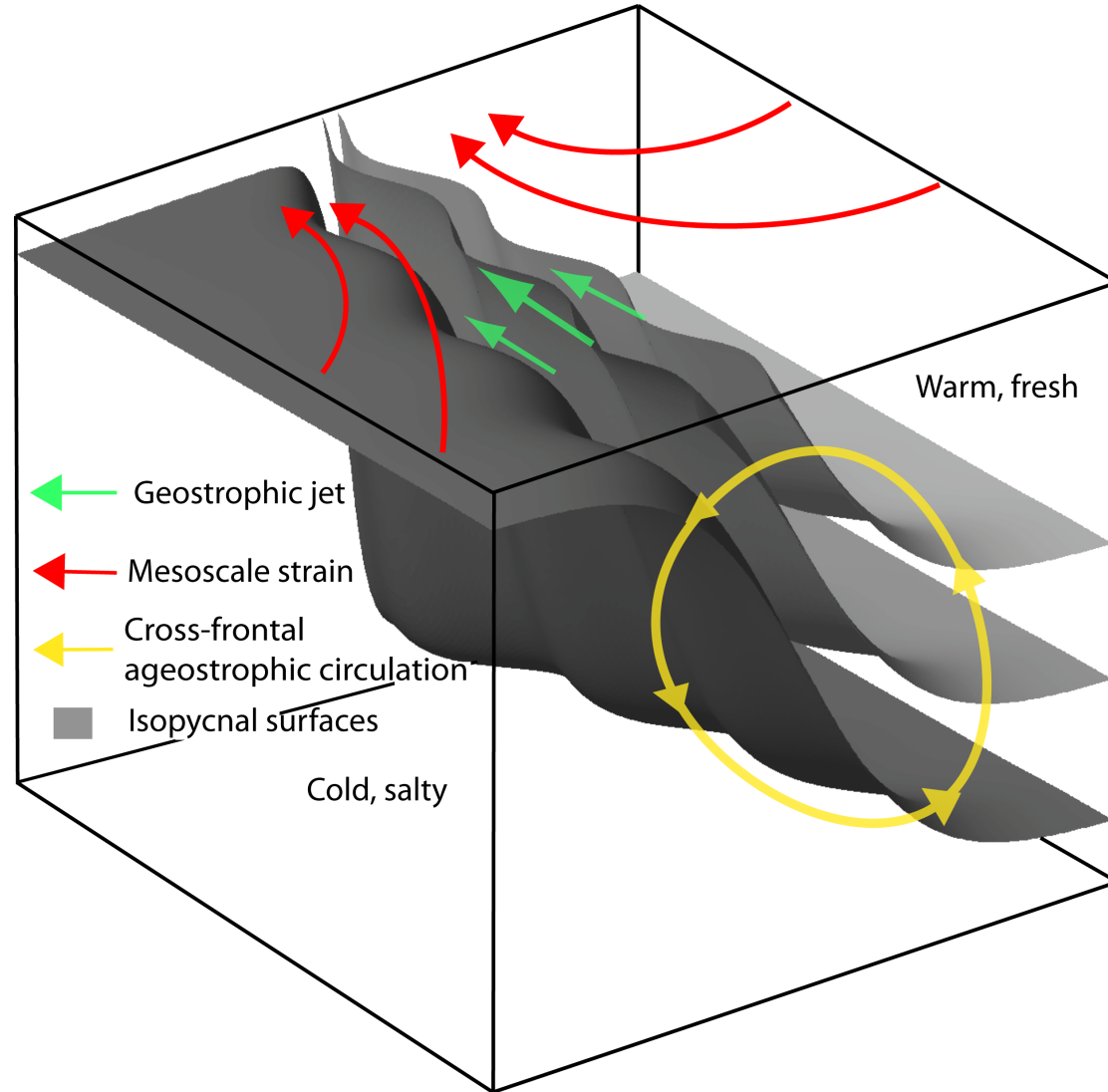
Stirring by ocean mesoscale eddies



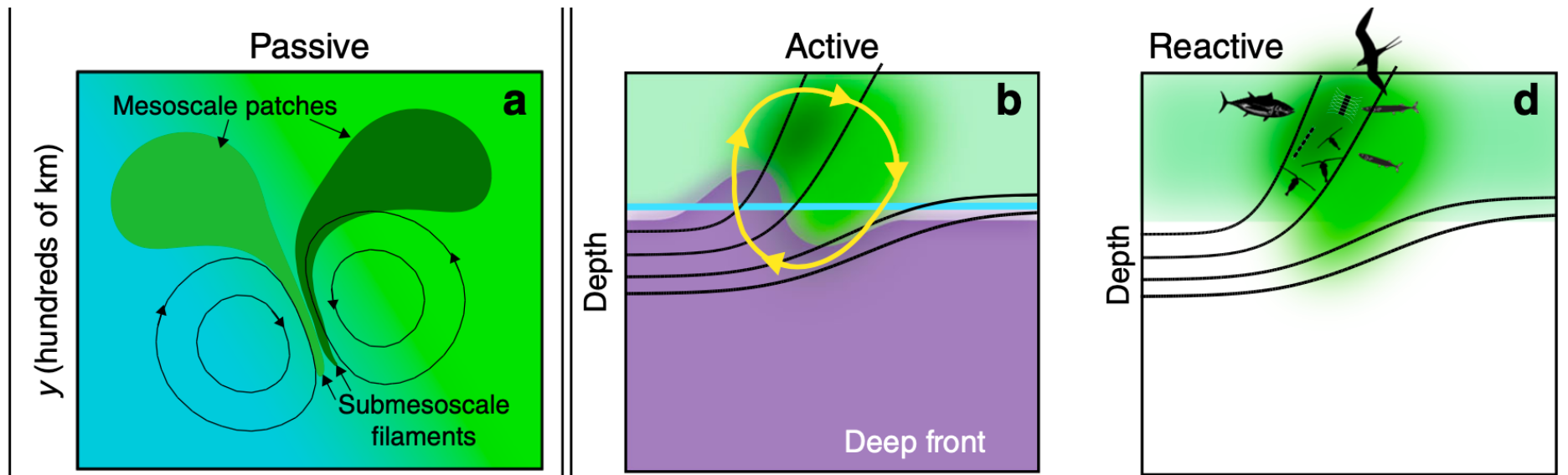
Sea-level Anomaly



Strong vertical circulation over fronts



Do these Passive and Active processes equality affect the microbial community or are there Winners and Losers ?



Challenge of resolution

Satellite data

In situ data

Numerical models

- Horizontal resolution
- Vertical resolution
- Time resolution
- Taxonomic resolution

✓

✓

✓

✓

✓

Satellite data

In situ data

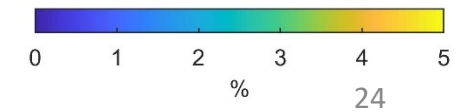
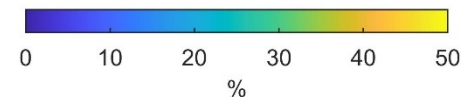
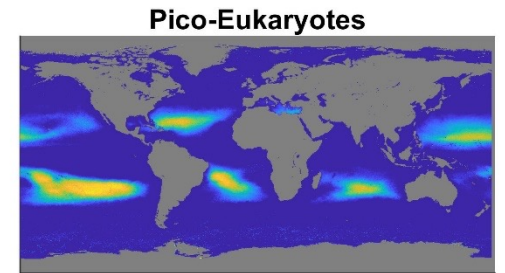
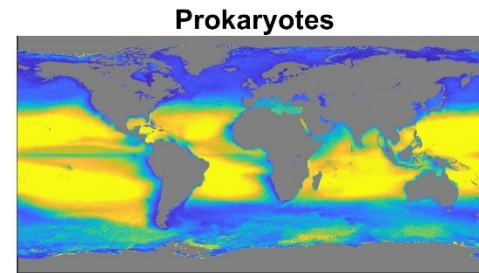
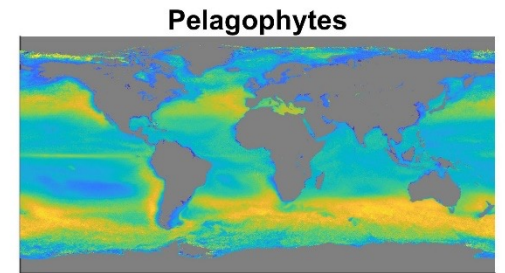
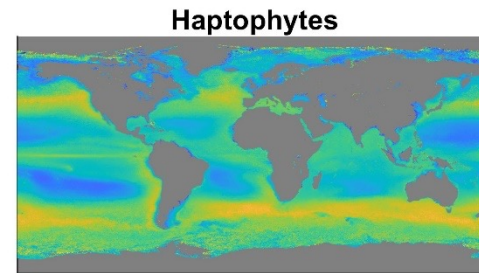
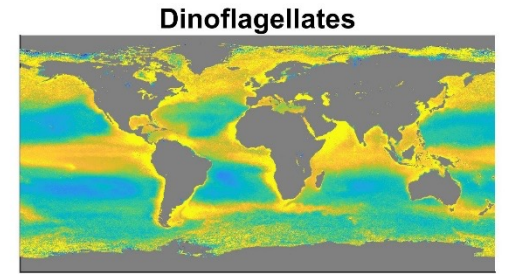
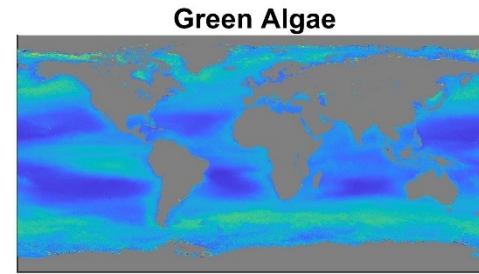
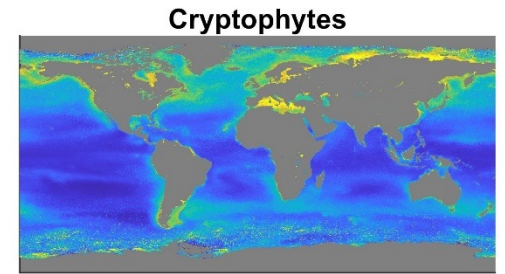
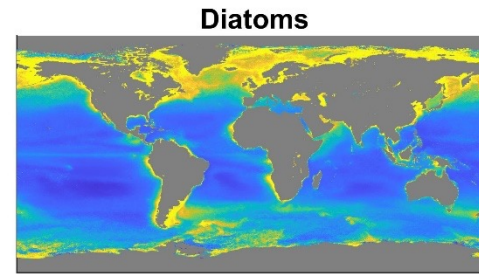
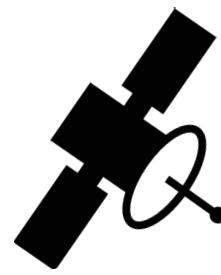
Numerical models

- Horizontal resolution
- Vertical resolution
- Time resolution
- Taxonomic resolution



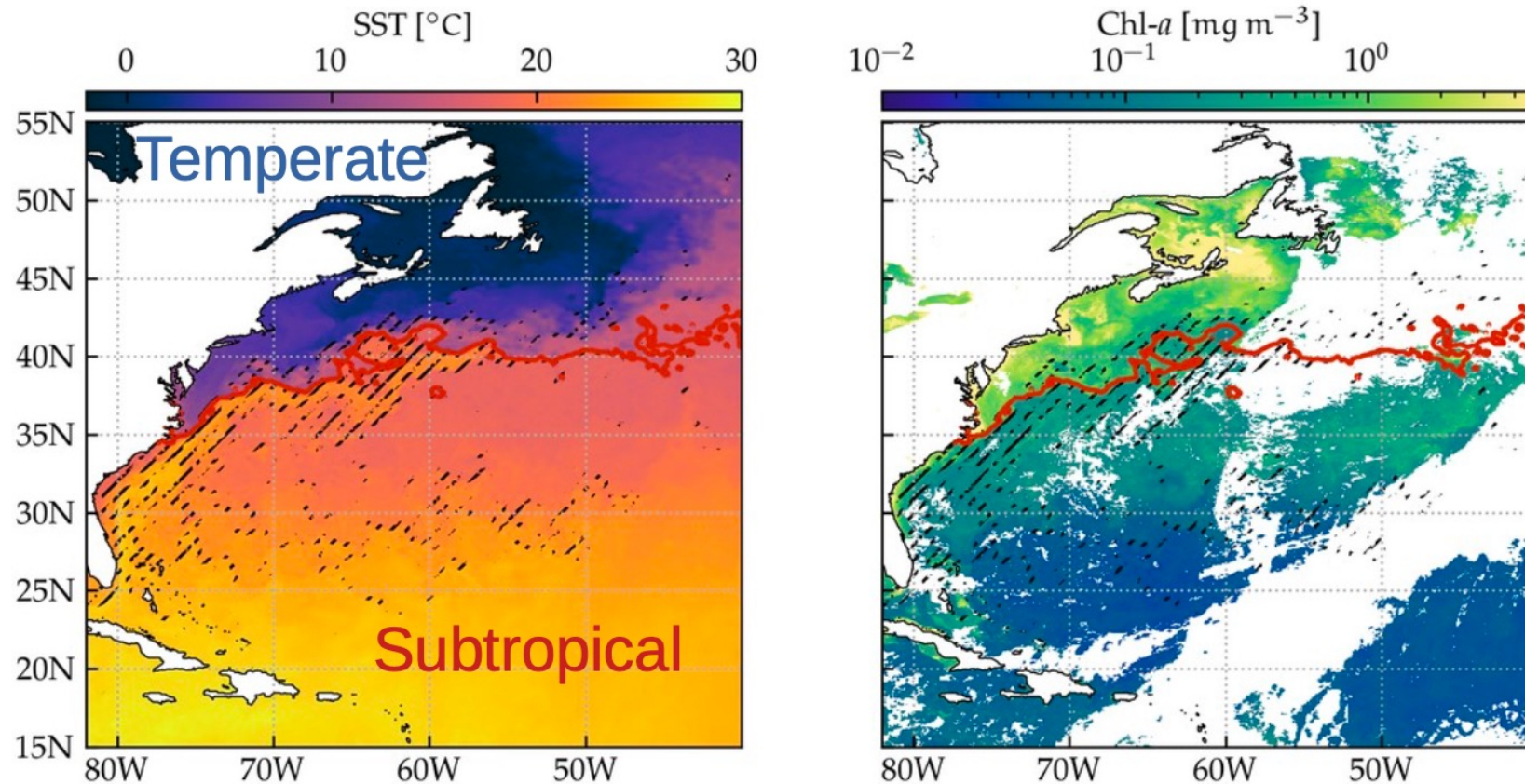
Increase the satellite taxonomic resolution

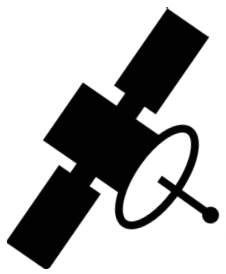
8 Phytoplankton functional groups





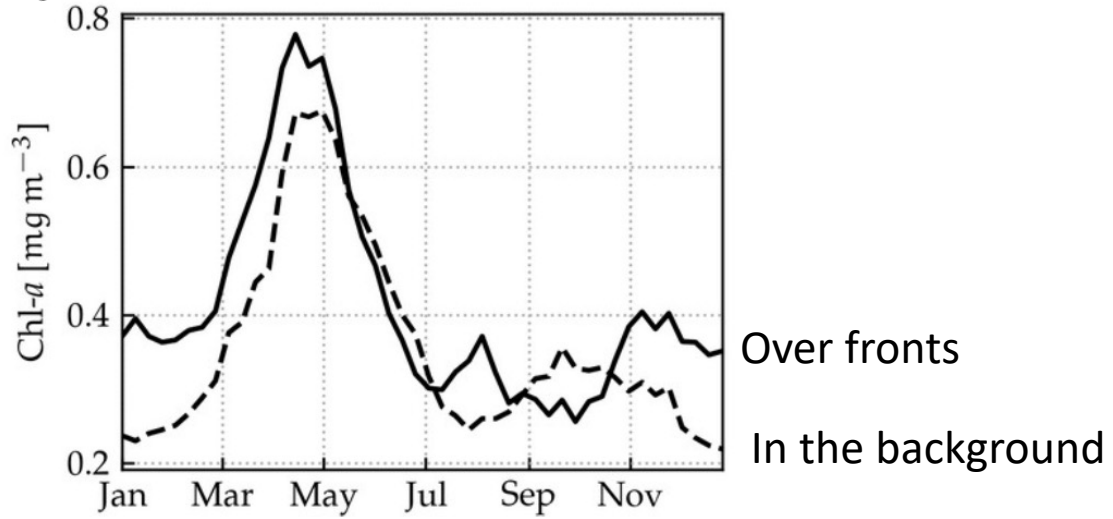
Responses of phytoplankton groups to fronts in the Gulf stream region



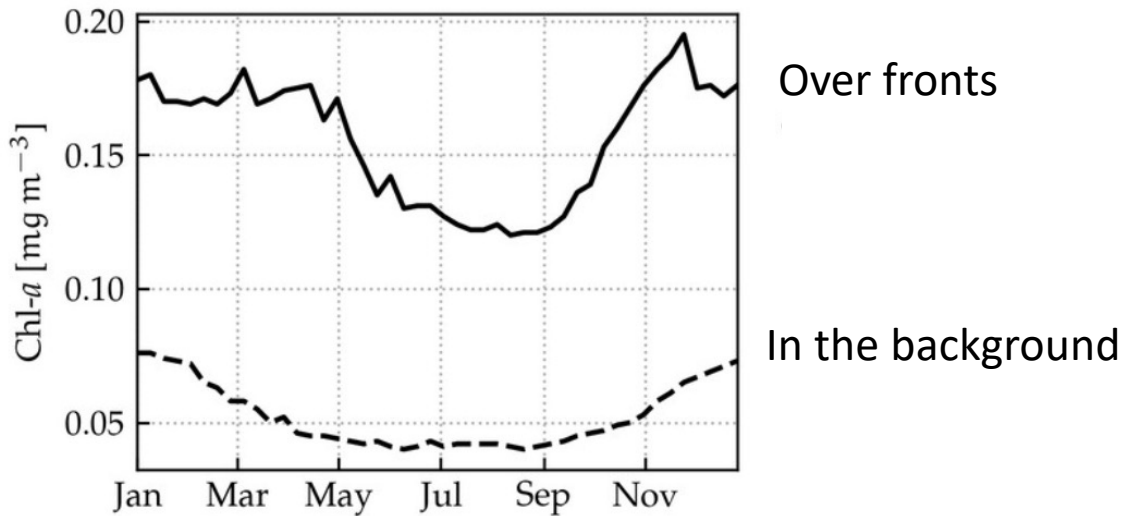


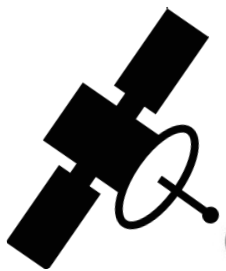
Temperate

Chl-a



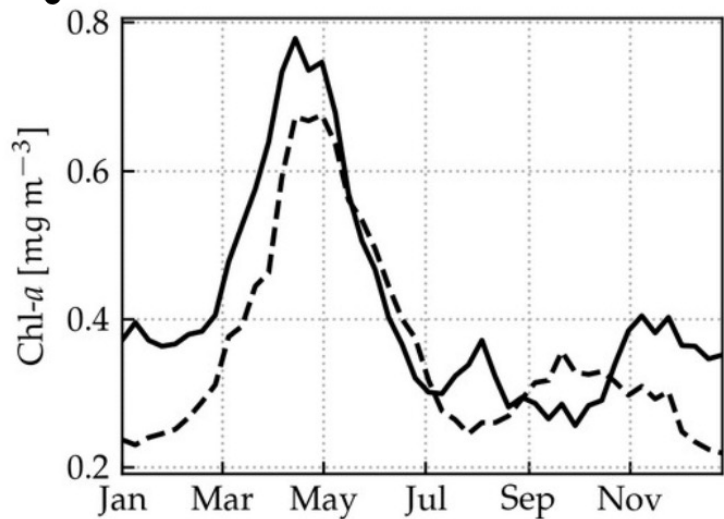
Subtropical



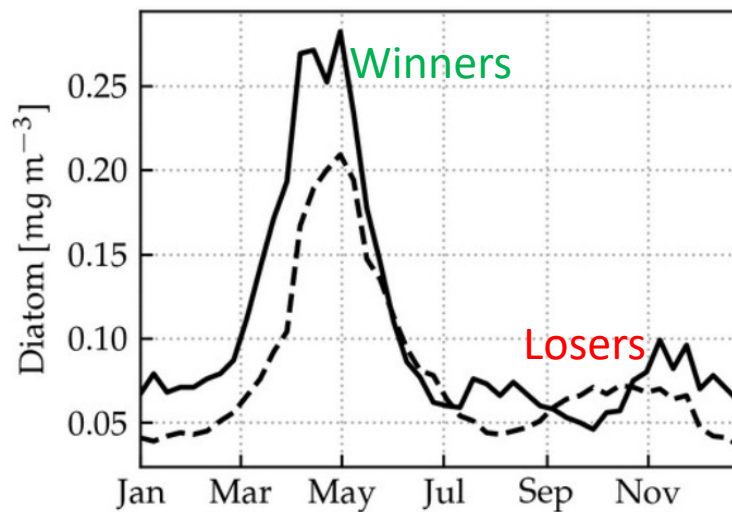


Temperate

Chl-a



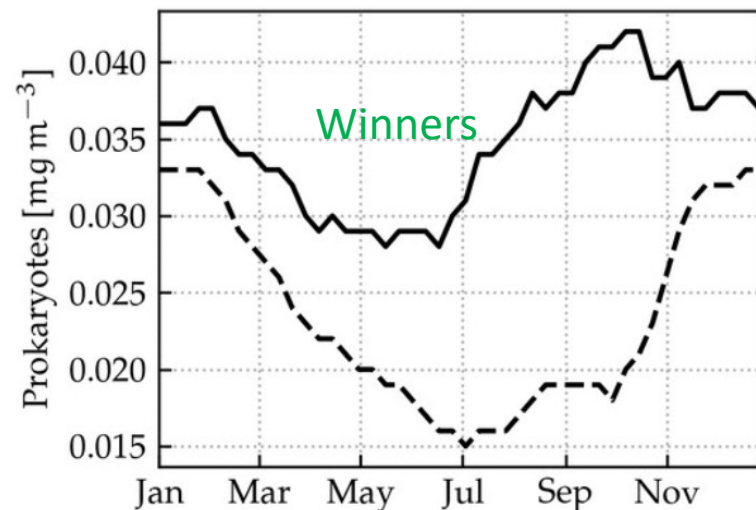
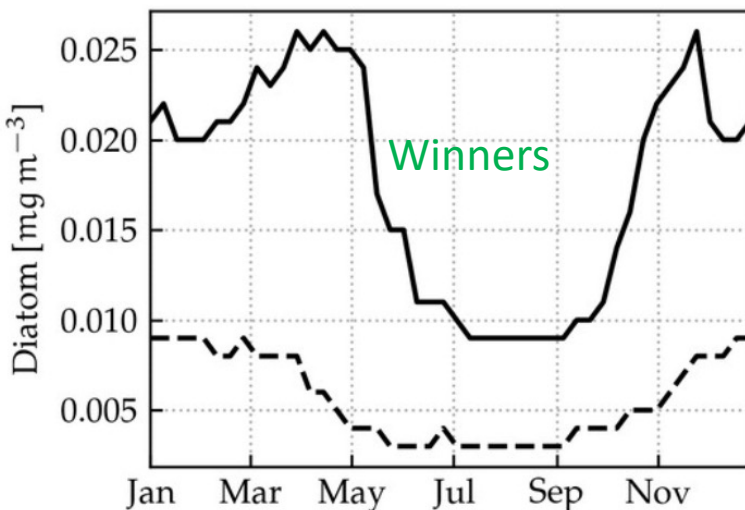
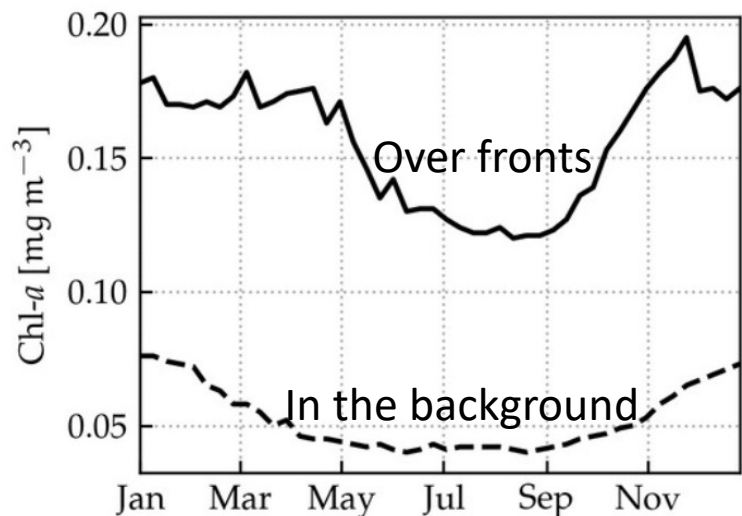
Diatoms



Prokaryotes

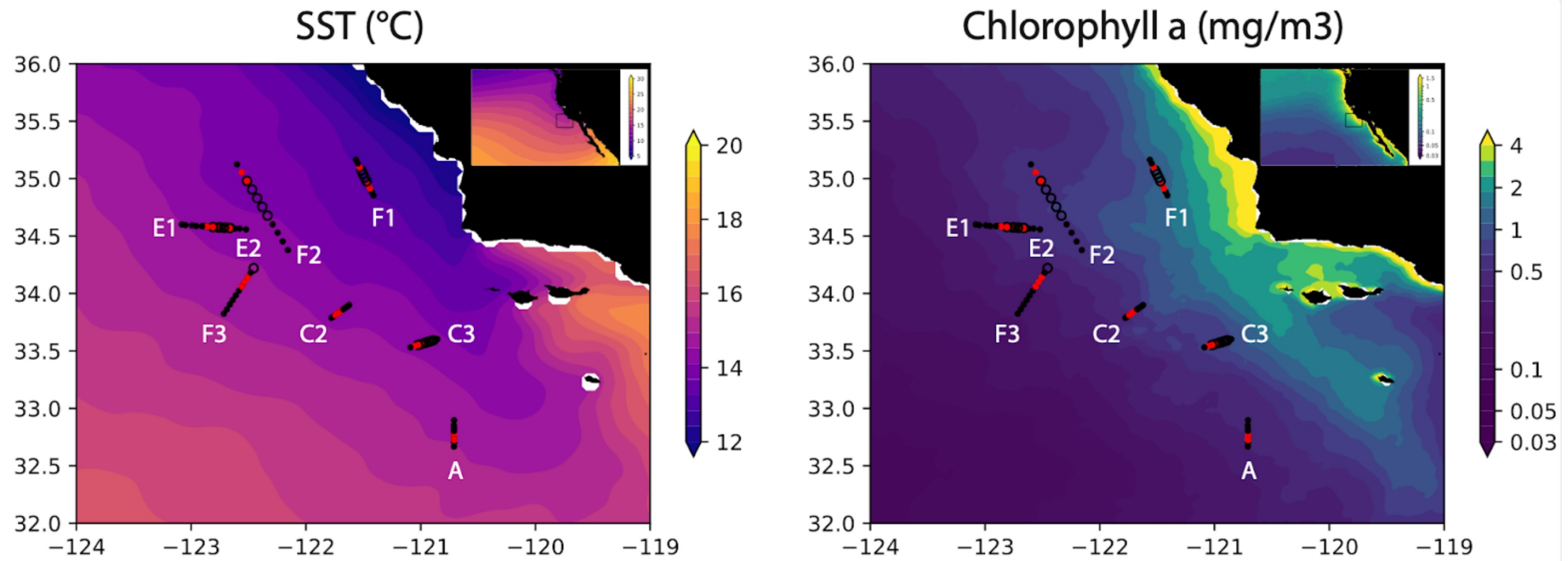


Subtropical



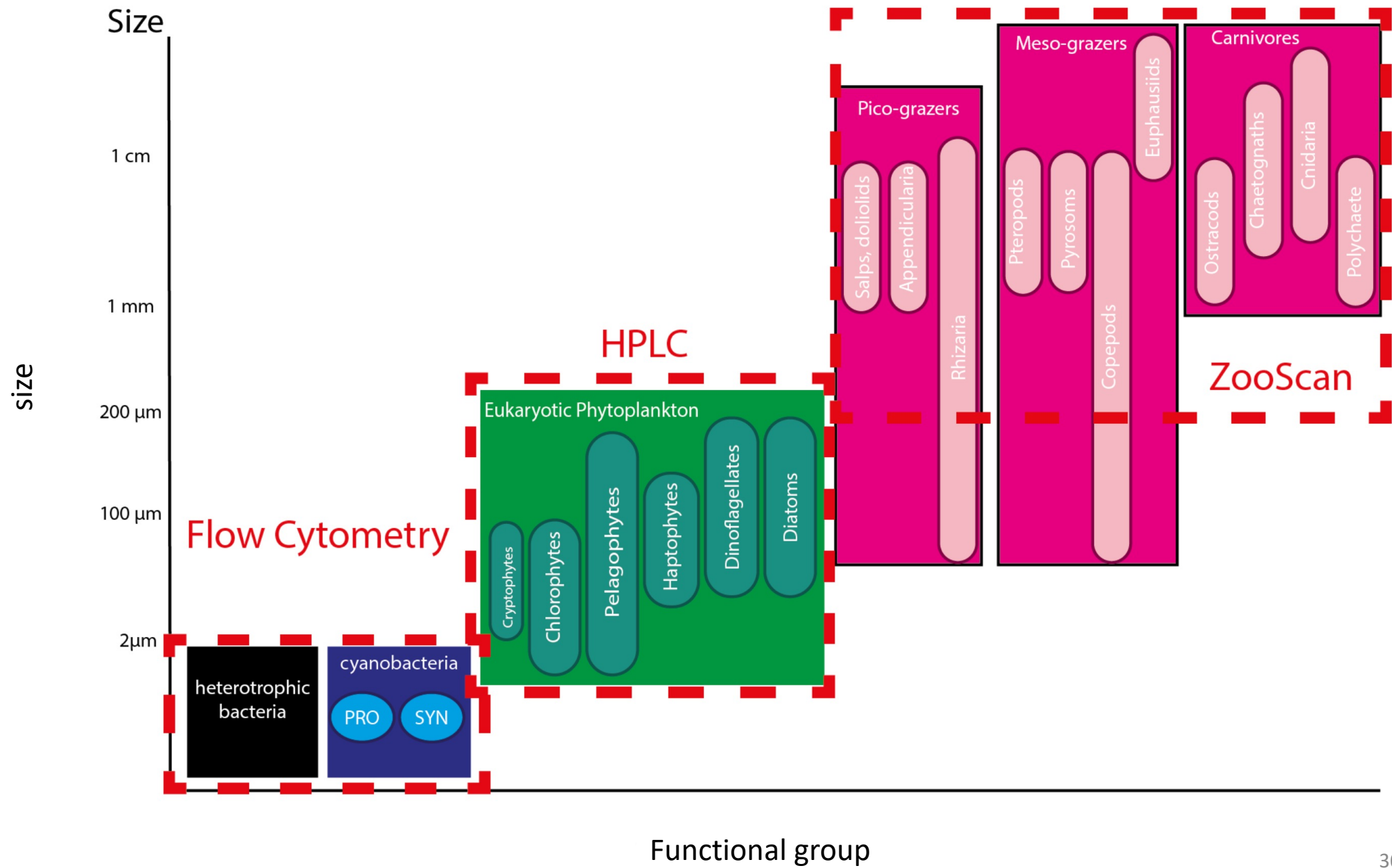
Meta-analysis of CalCOFI data

Responses of phytoplankton and zooplankton groups to fronts in the California Current region



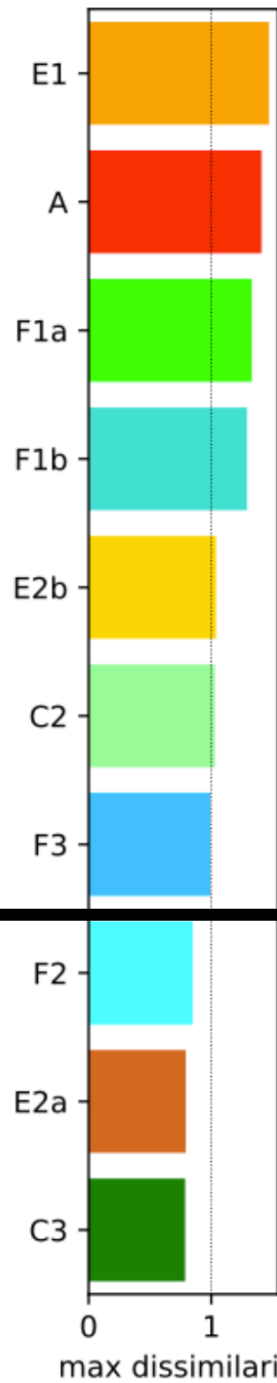
CalCOFI Data from 8 transects of ~20 km length between 2008-2017 with ~3-5 km resolution
10 fronts in total

© Ines Mangolte

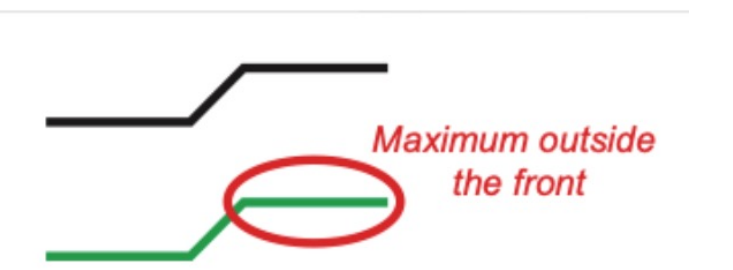
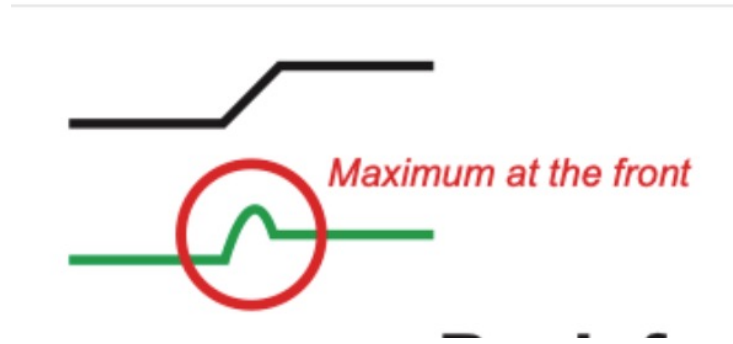


Dissimilarity between the front and both sides of the front

Peak fronts

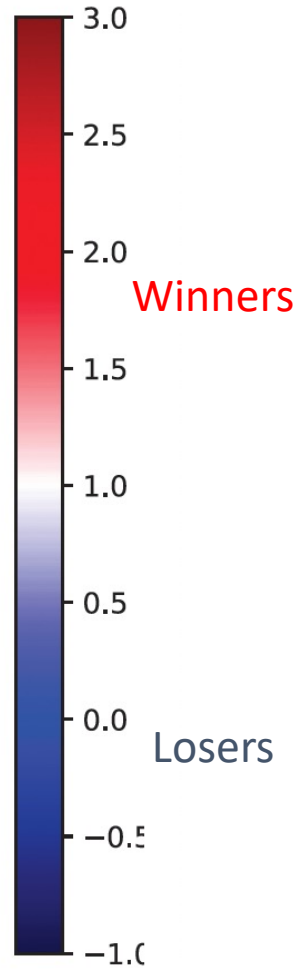
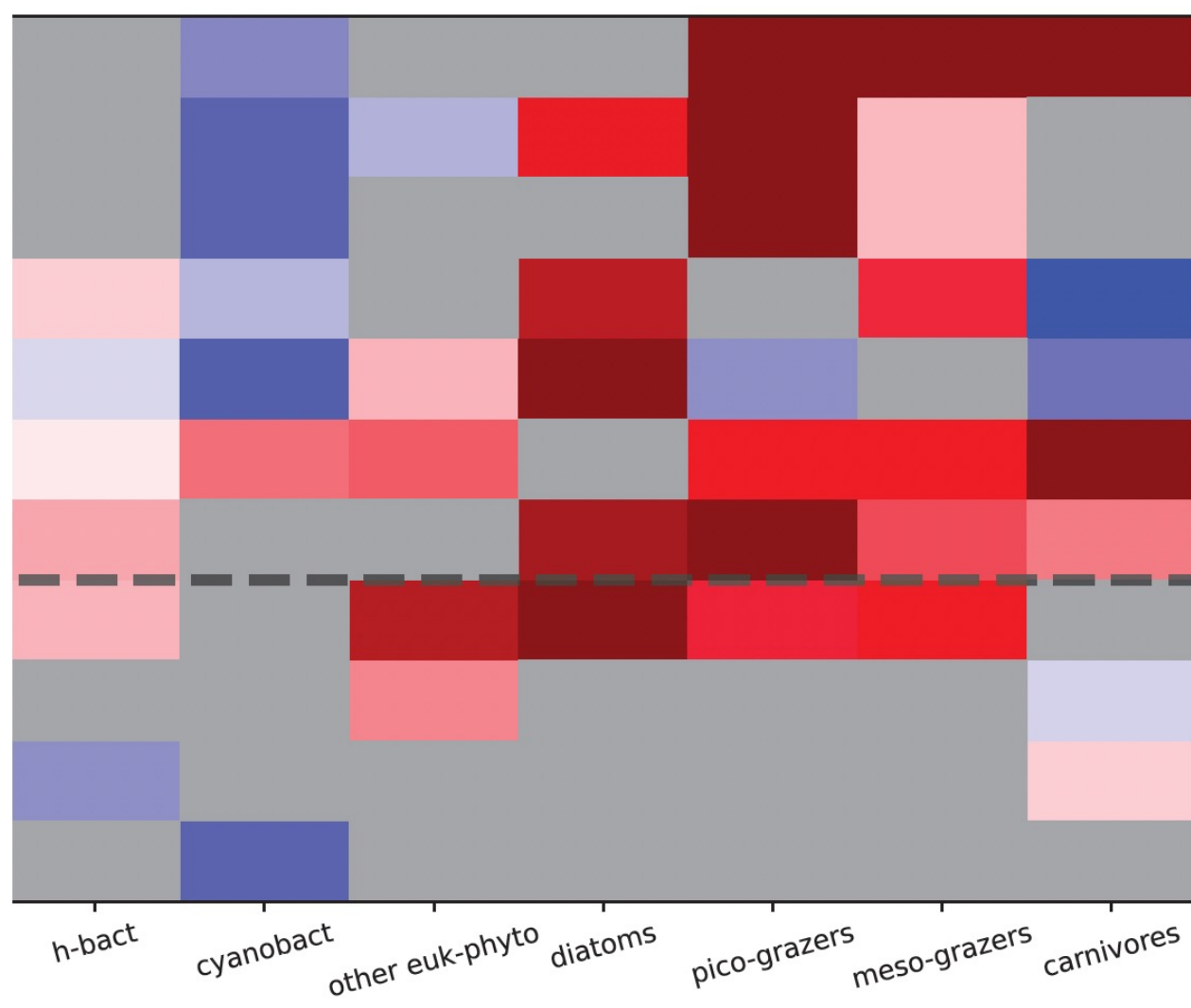
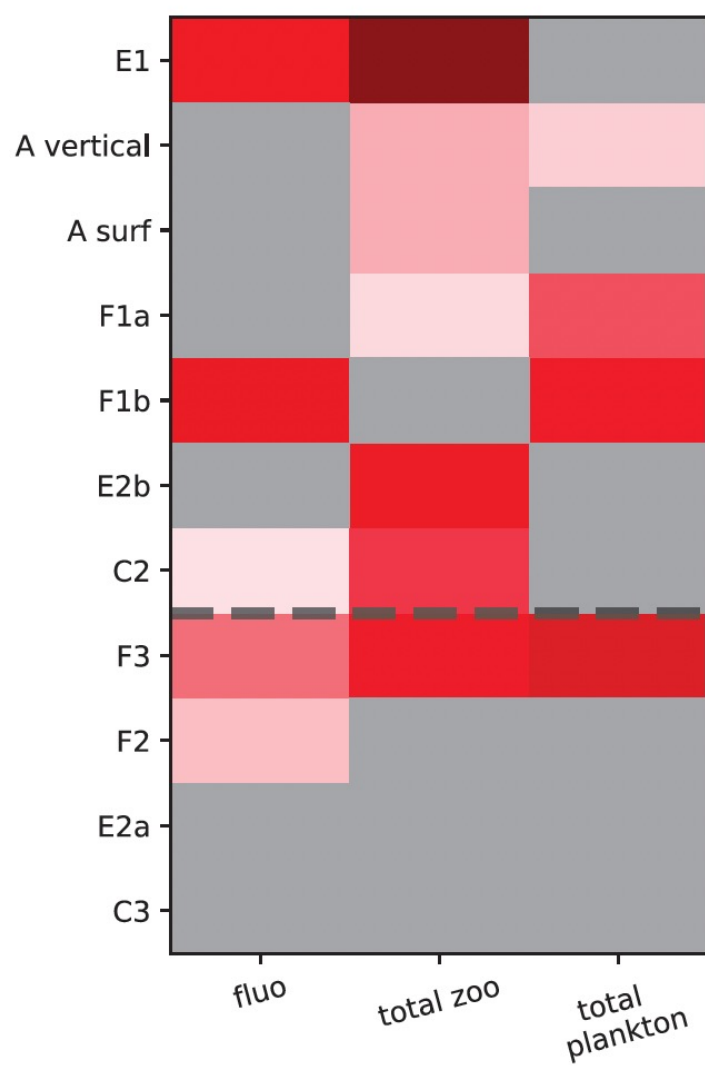


Transition fronts



Increase/decrease at the front compared to both sides of the front

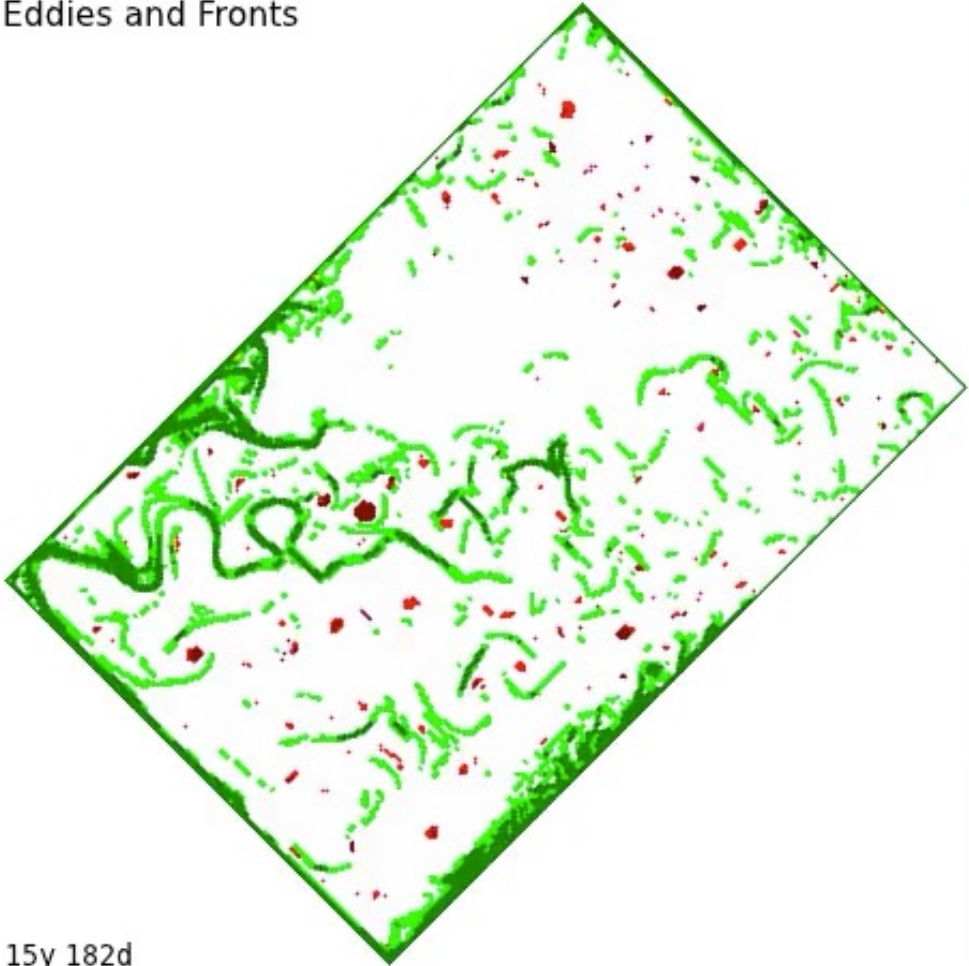




Model study

Identification of eddies and fronts in the model flow

Eddies and Fronts

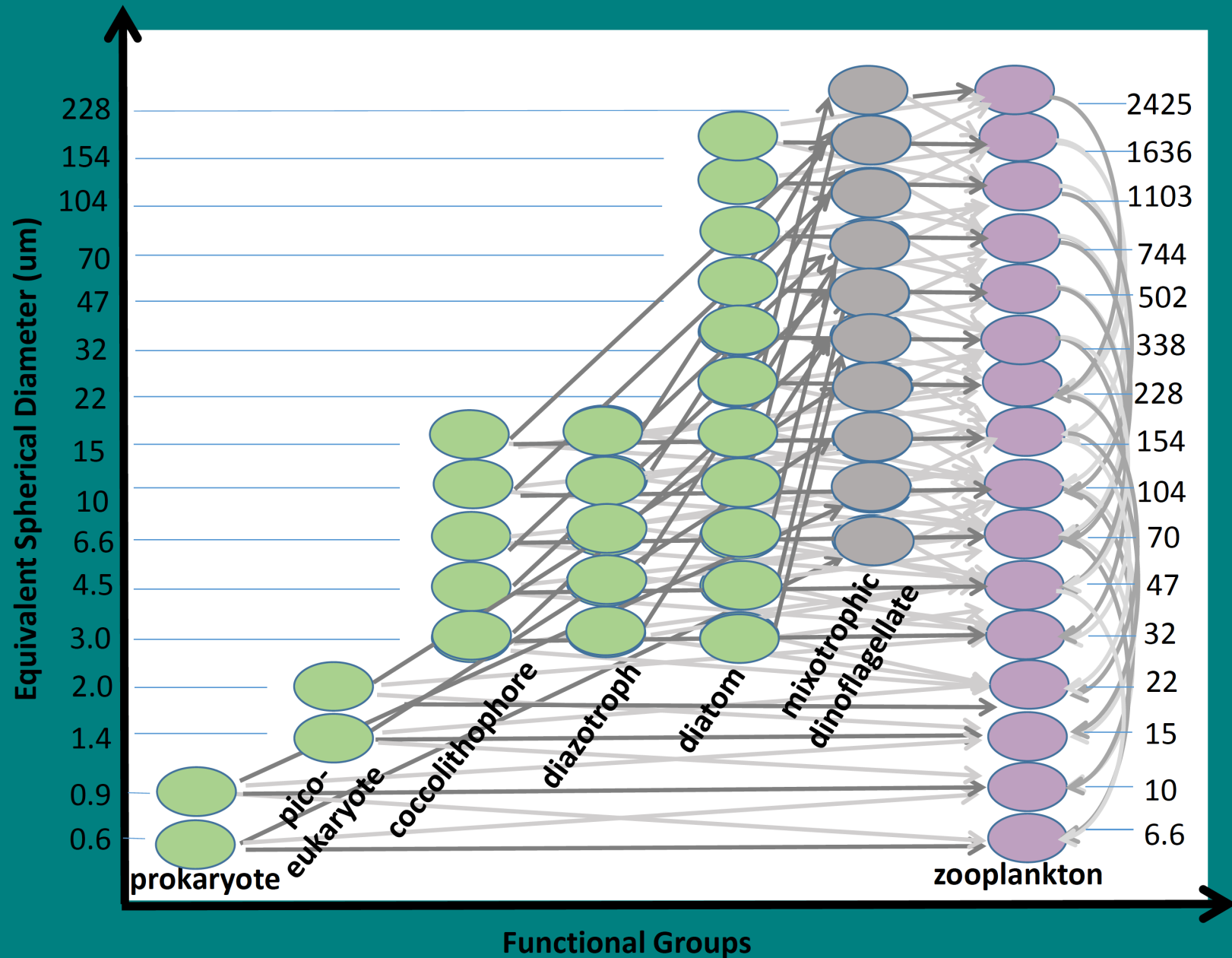


Eddies

Fronts

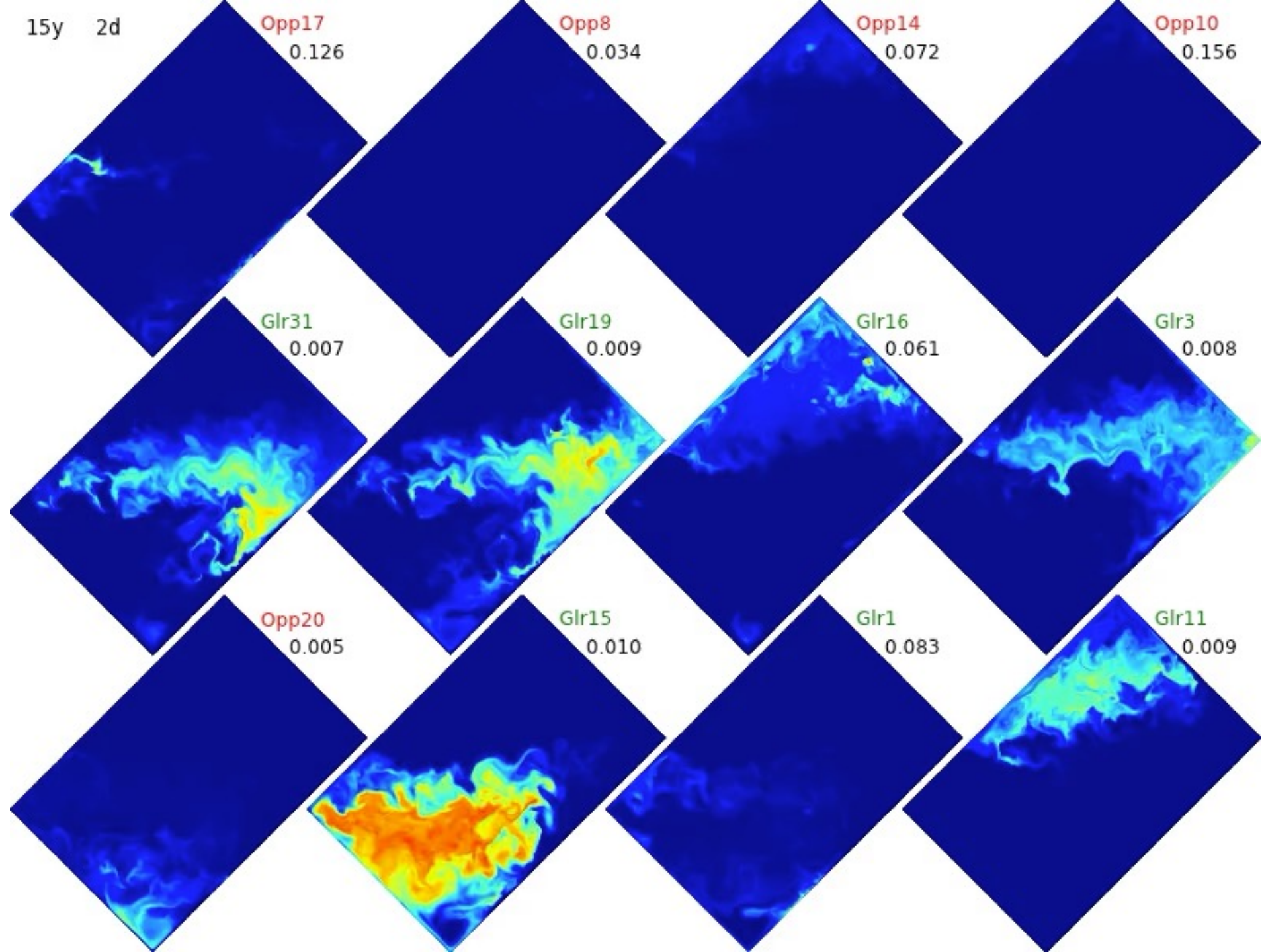
15y 182d

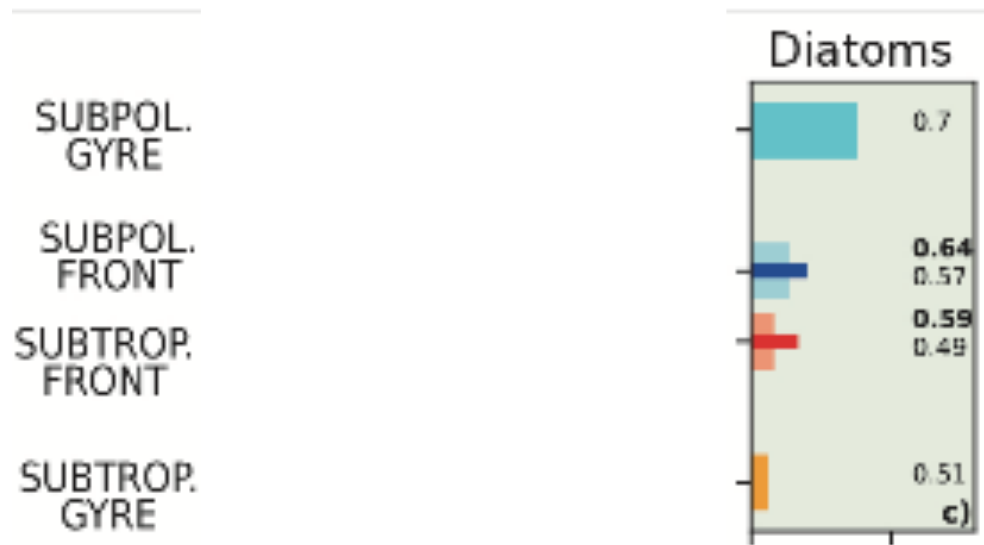
DARWIN model from MIT



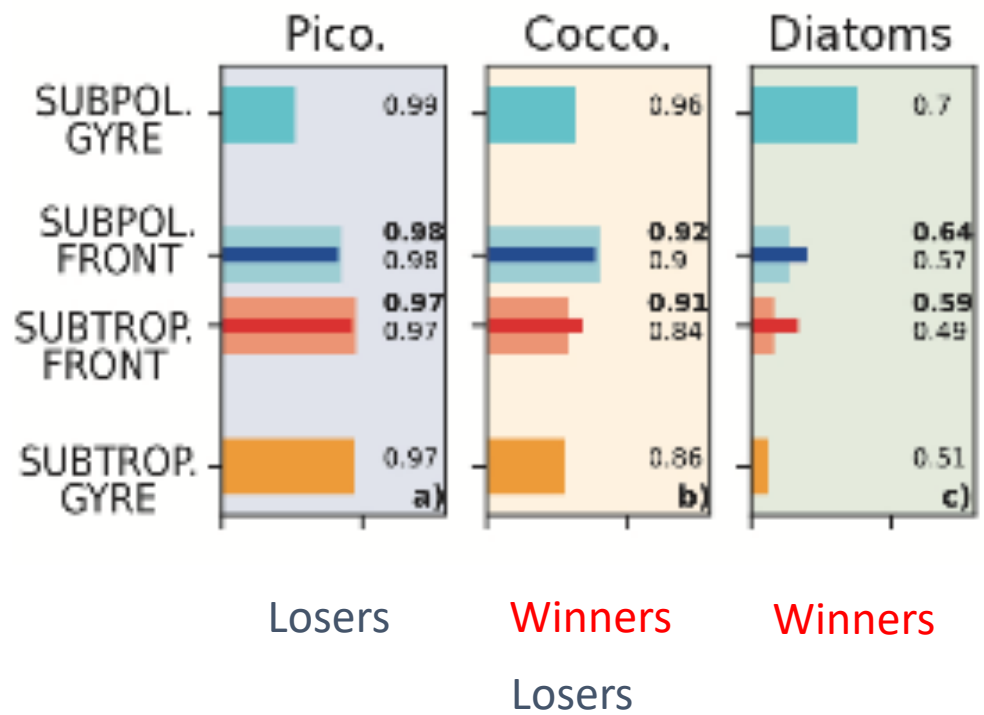
© Stephanie Diutkiewicz et al

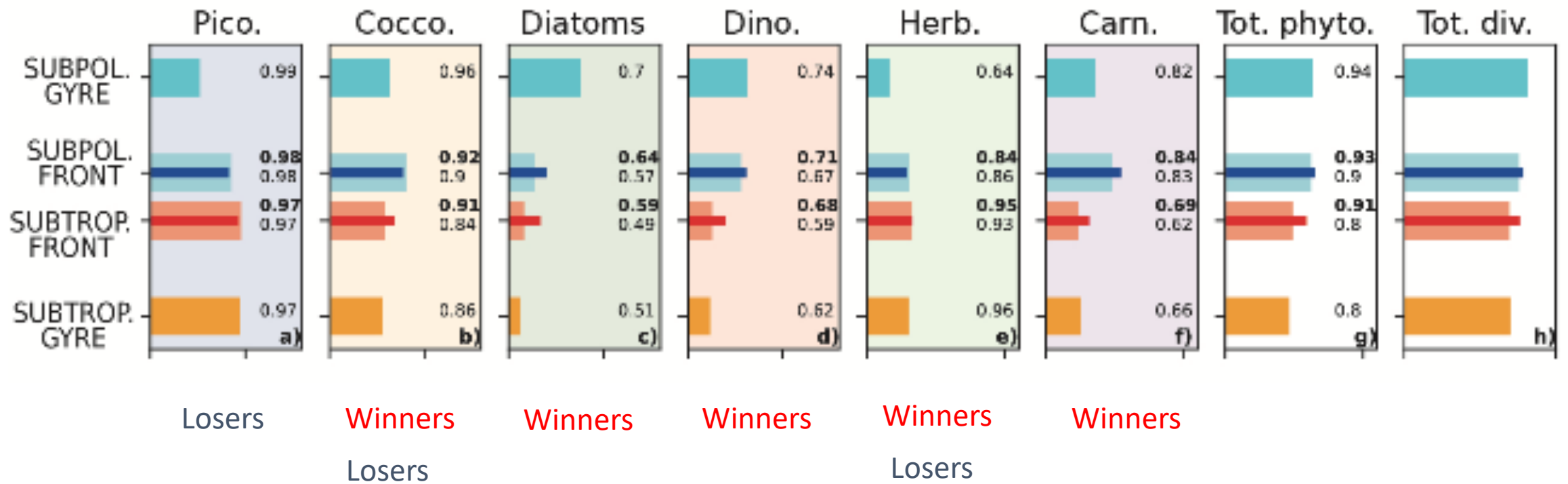
15y 2d

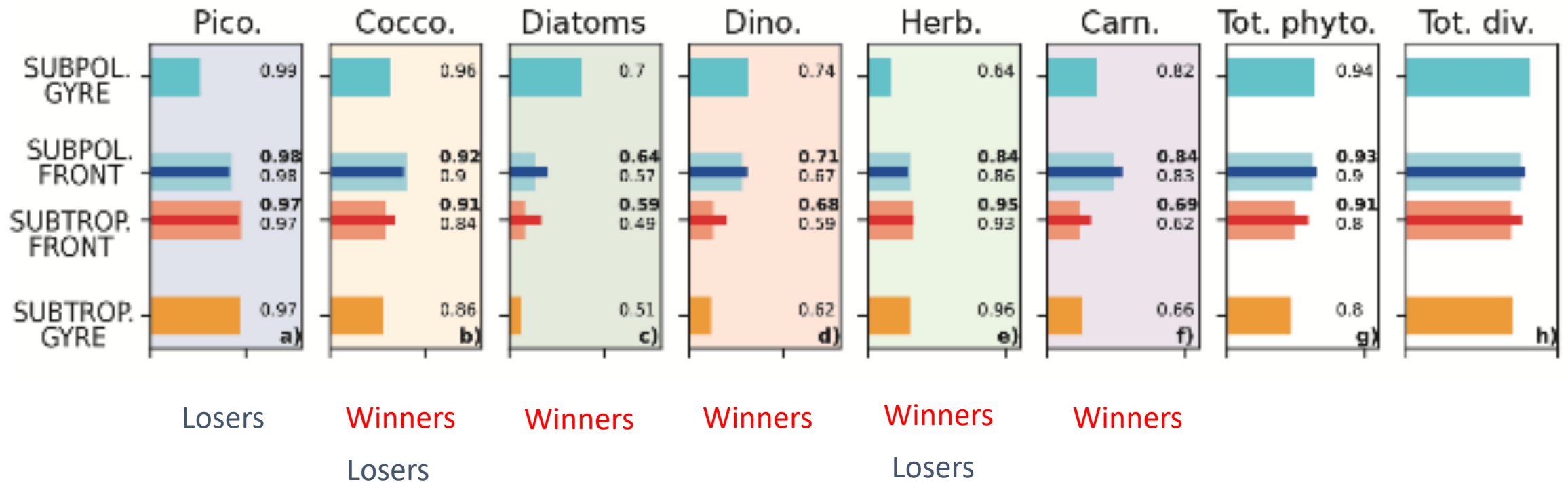




Winners





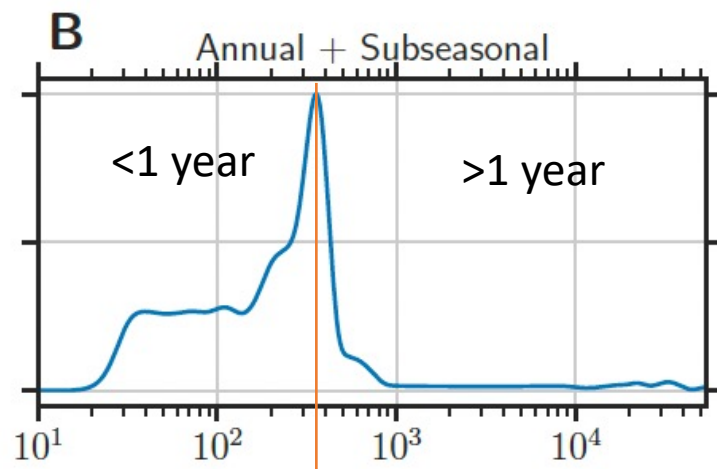


Why are picoplankton losers ? **Community shading**

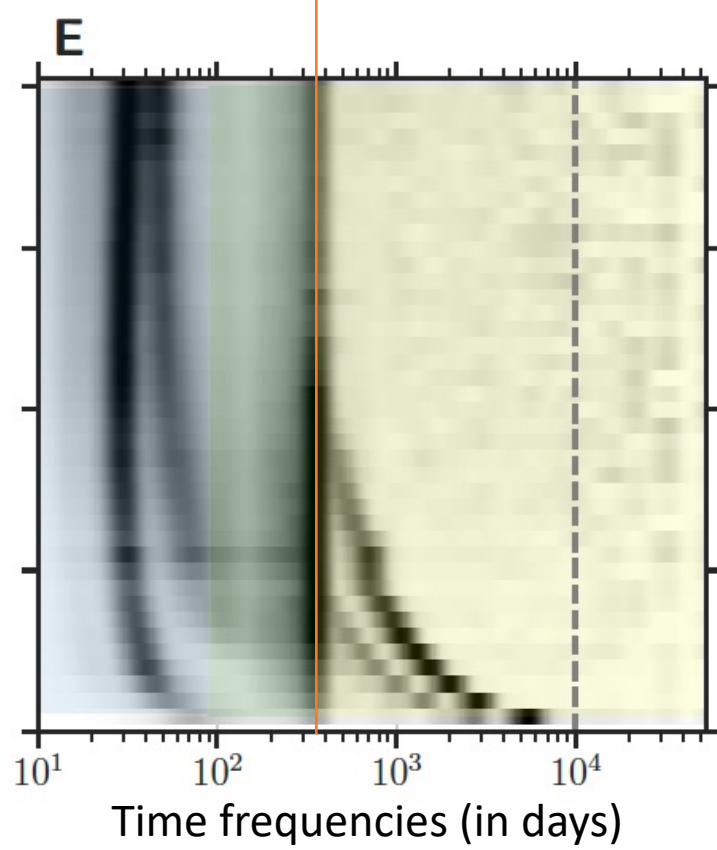
Why are Coccolithophores losers ? **Shared predation**

How does the physical 'noise' interact with the ecological 'noise' ?

Shape of nutrient flux



Shape of Phytoplankton response



More variability frequencies than the addition of the two !

Winners and losers

- Marine microbes evolve in a very dynamic environment
- Fronts are physical environment which are generally favorable to ocean life
- But not all plankton types can benefit, they are winners and losers
- Challenging to observe because need of resolution in multiple dimensions
- Fronts are local oasis that seed the ocean

Merci

ECR

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Olivier Aumont, IPSL
Laurent Bopp, IPSL

