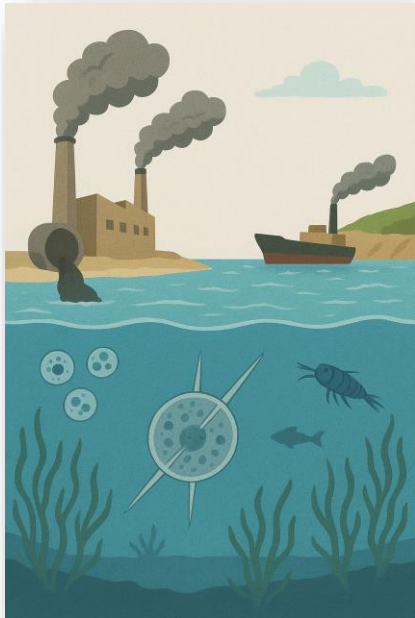
Preliminary studies on the quantification of the resilience of coastal ecosystems under anthropogenic pressures

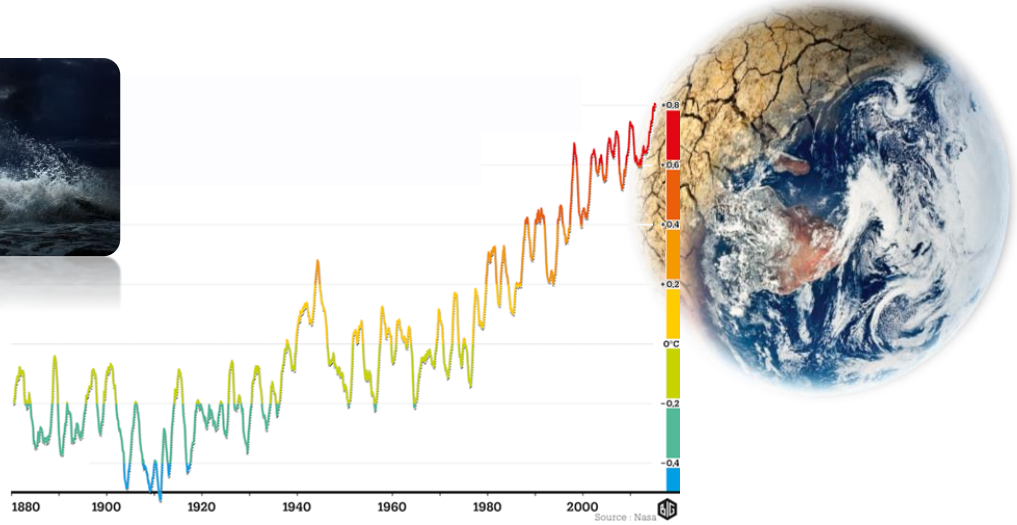
Eric GOBERVILLE

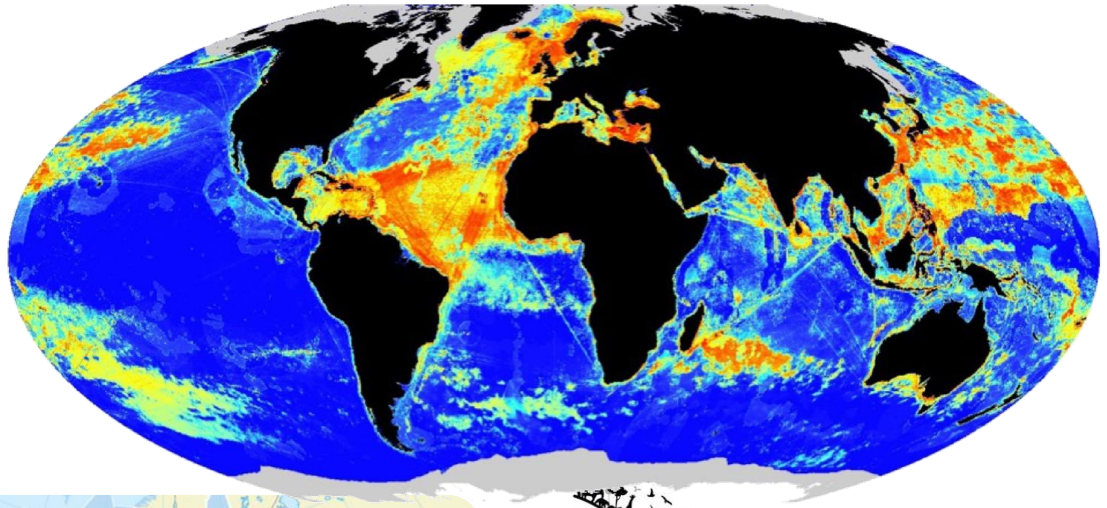
in collaboration with
Nicolas DJEGHRI, Loïc GUILLOUX, Philippe PONDAVEN, Peggy RIMMELIN-MAURY and Paul TREGUER

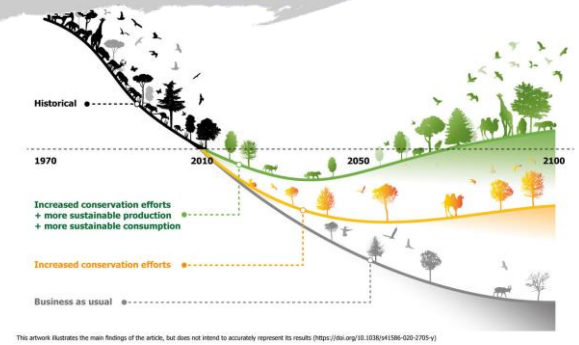
Master 2 internships
Lorène POURIAS (2024) and Lisa MOUQUE (2025)

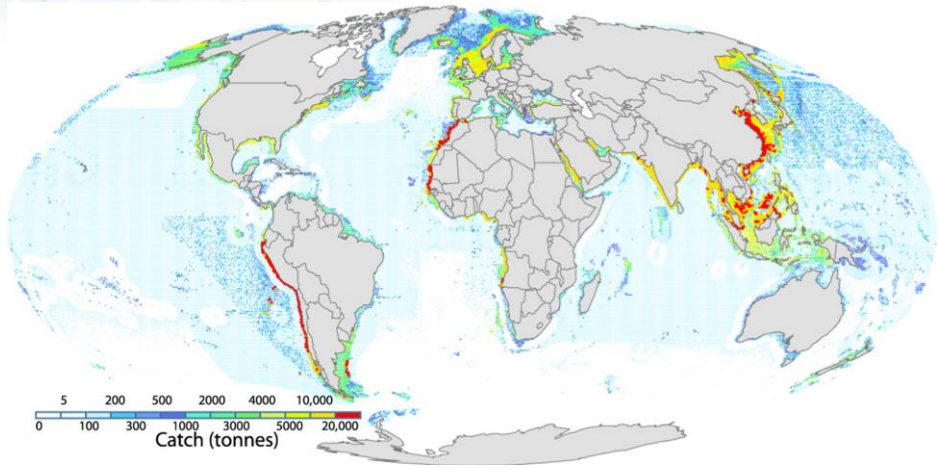


Coastal marine ecosystems are more and more highly impacted









Stock et al., 2018; EEA, 2017; WWF 2018; Watson & Tidd 2018

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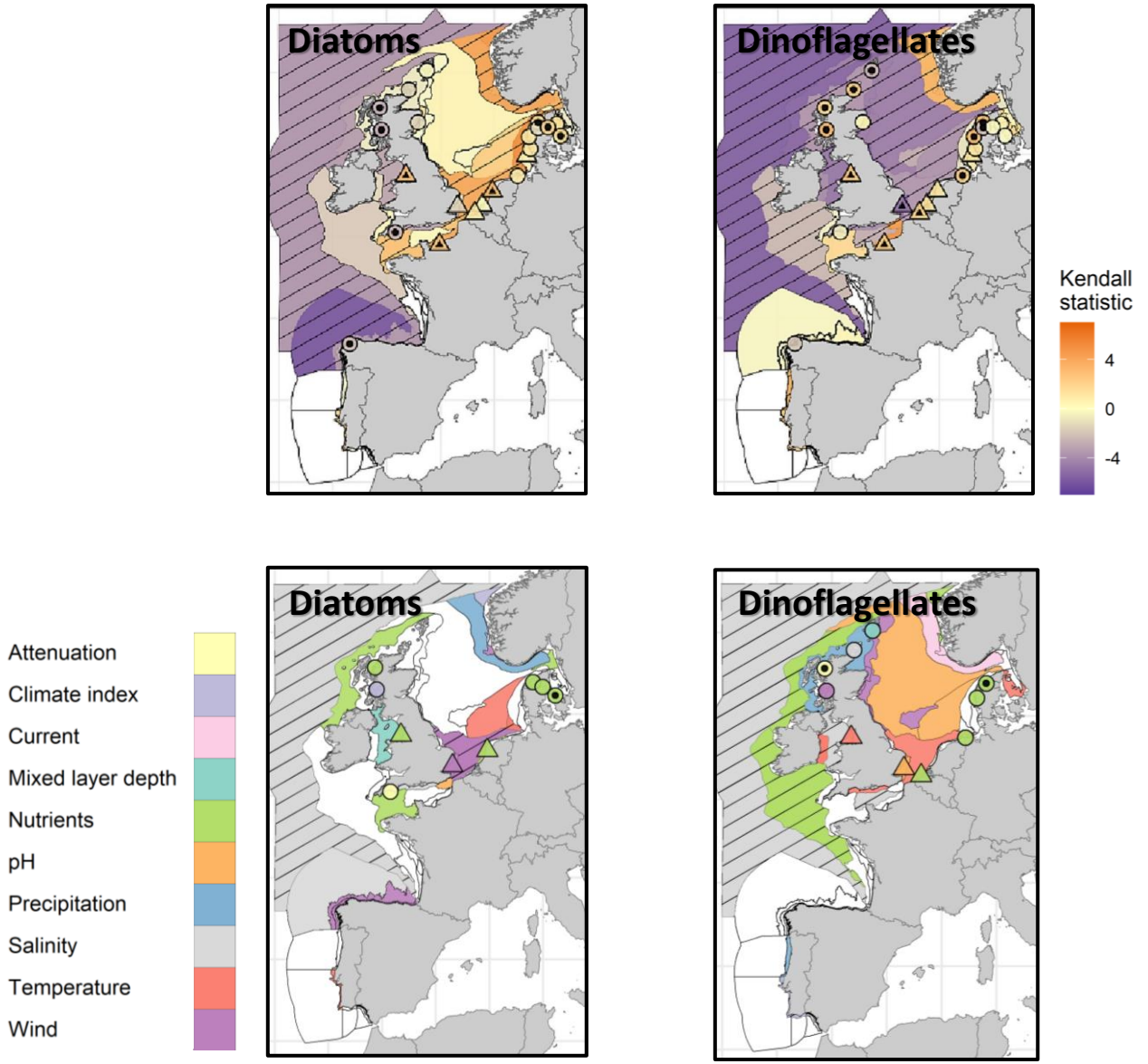
How European ecosystems have changed over the past decades?

Long-term changes in zooplankton and phytoplankton communities in European waters



QSR OSPAR 2023 – Holland et al. (2024)

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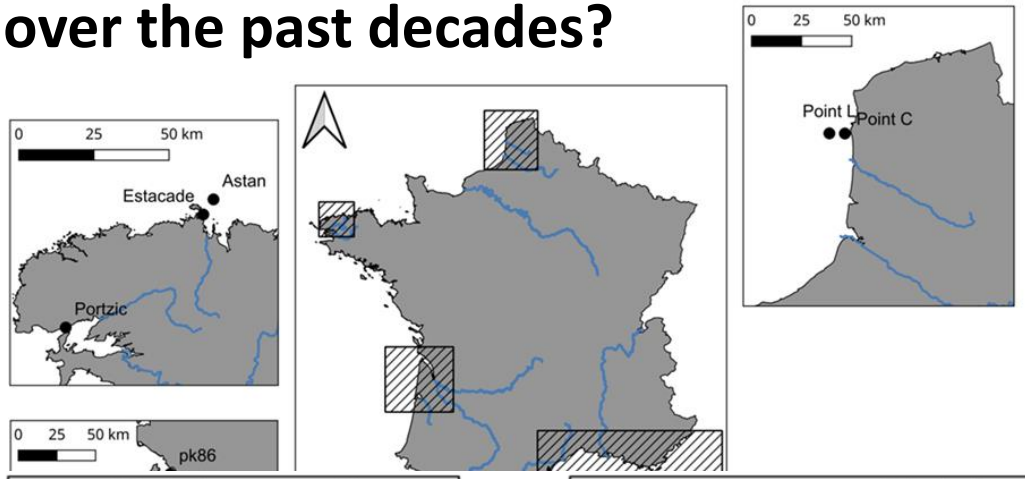

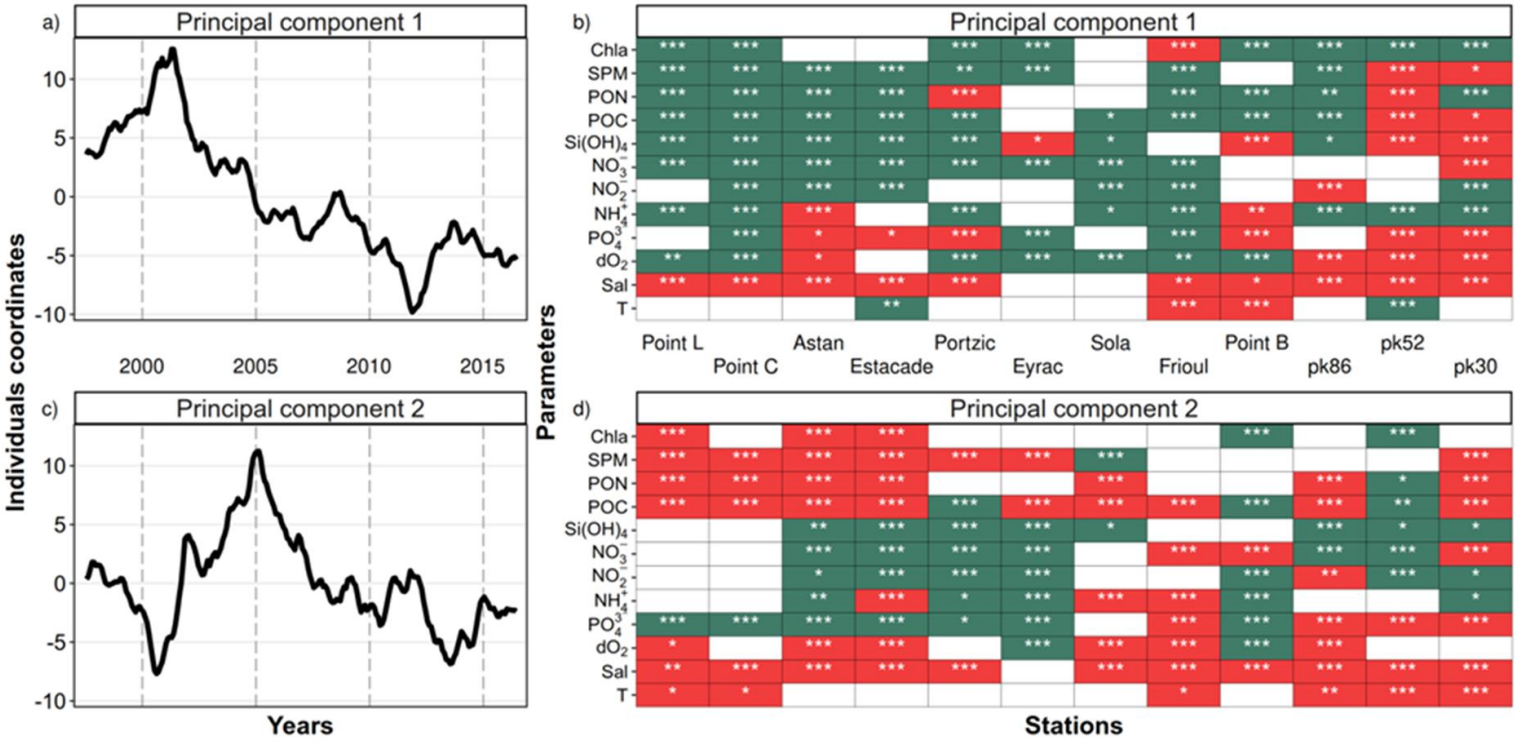

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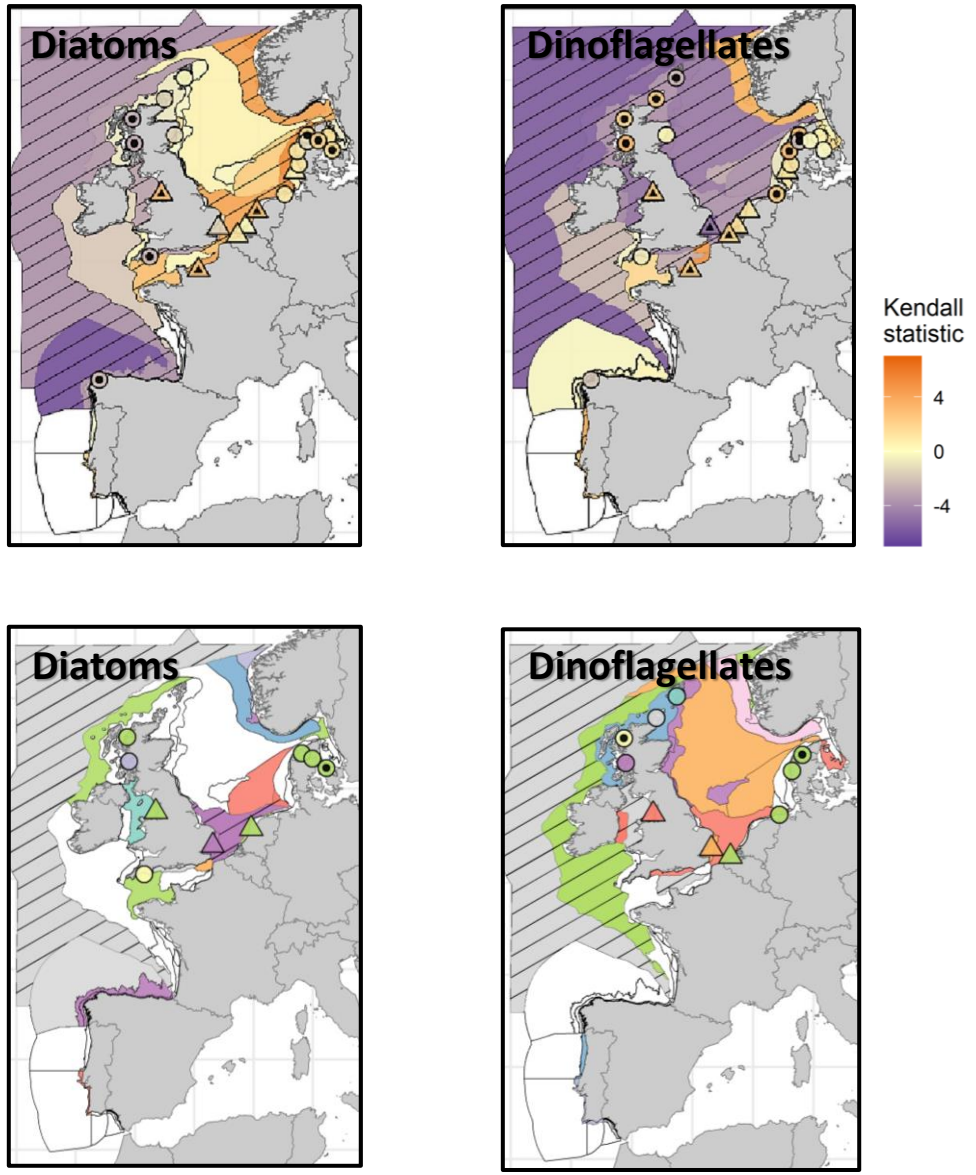

QSR OSPAR 2023 – Holland et al. (2024); Lheureux et al. (2021)

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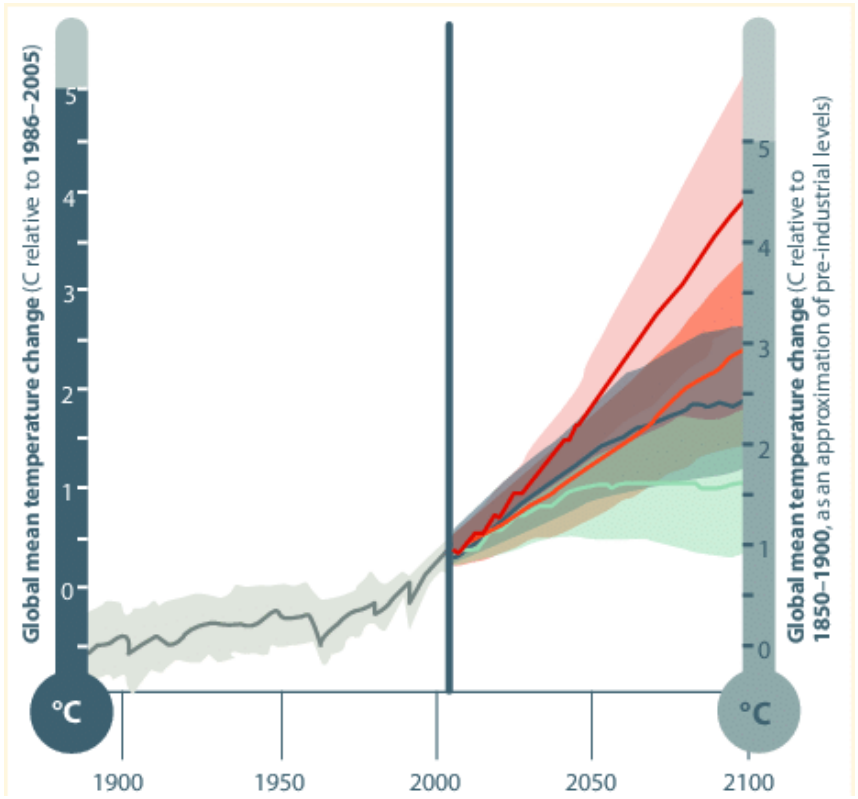


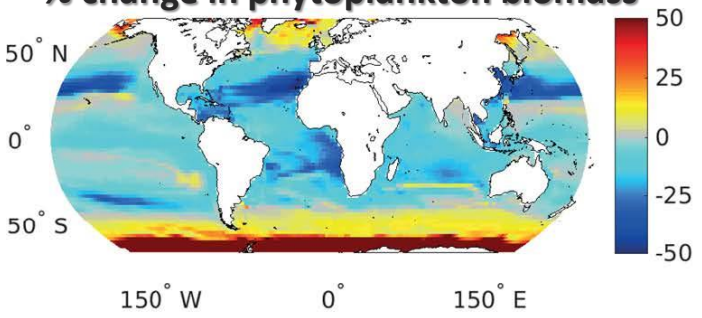
ARTICLE
https://doi.org/10.1038/s41467-021-25699-w OPEN
Check for updates

Future phytoplankton diversity in a changing climate

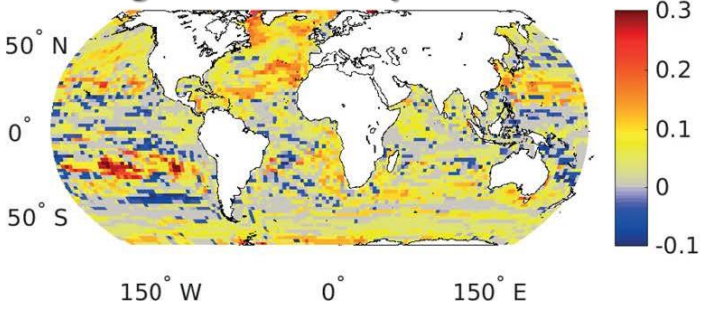
Stephanie A. Henson[1✉], B. B. Cael[1], Stephanie R. Allen[1,2,5] & Stephanie Dutkiewicz[3,4]

2080-2100 (RCP8.5) vs 2000-2020

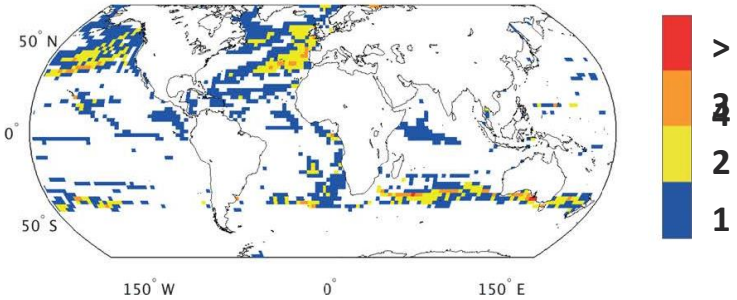
% change in phytoplankton biomass



Change in community turnover rate



Disappearance of phytoplankton types: diatoms



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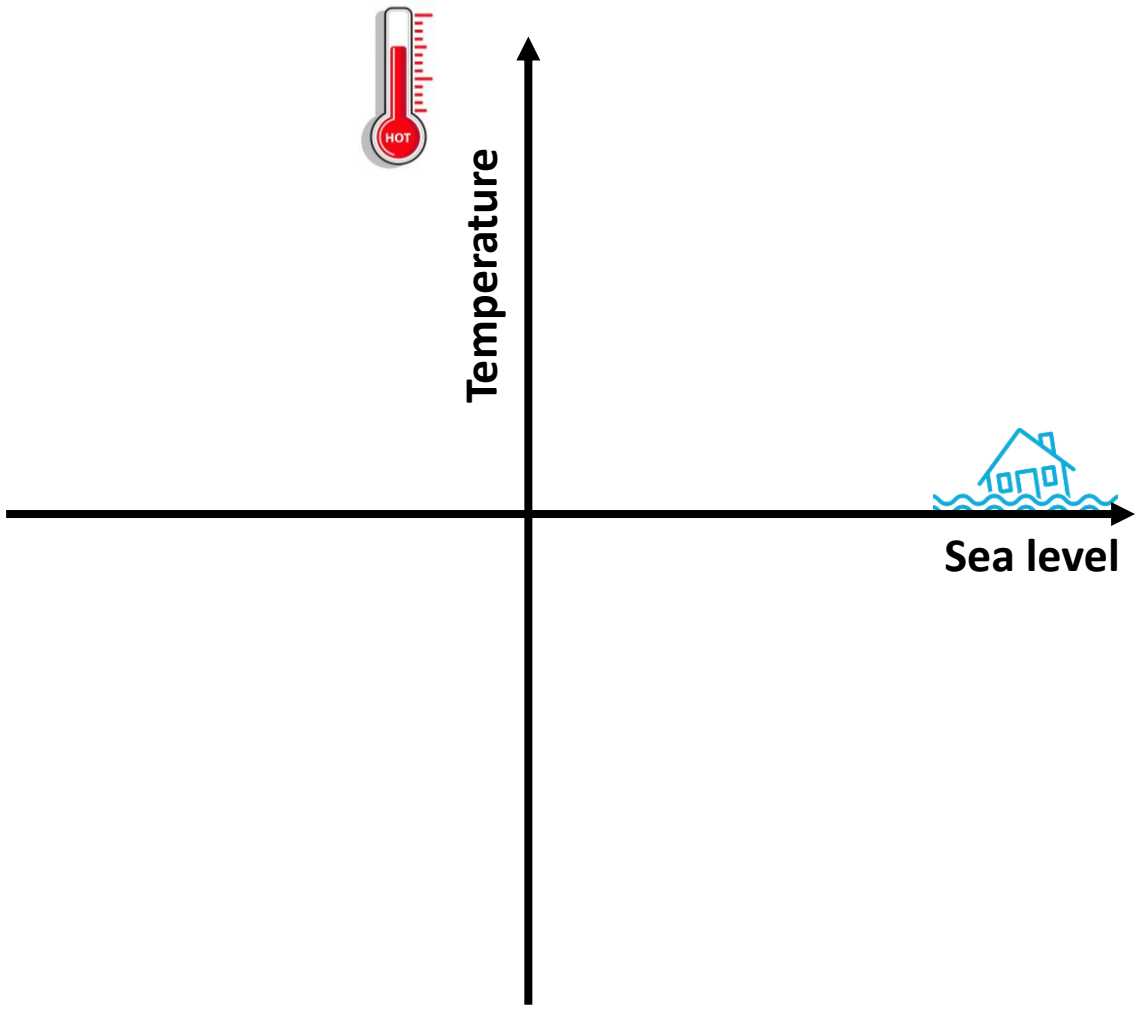
Trajectories of the Earth System in the Anthropocene: The Hothouse Earth Pathway

Illustration of possible future pathways of the climate against the background of the typical glacial–interglacial cycles



Steffen et al. 2018

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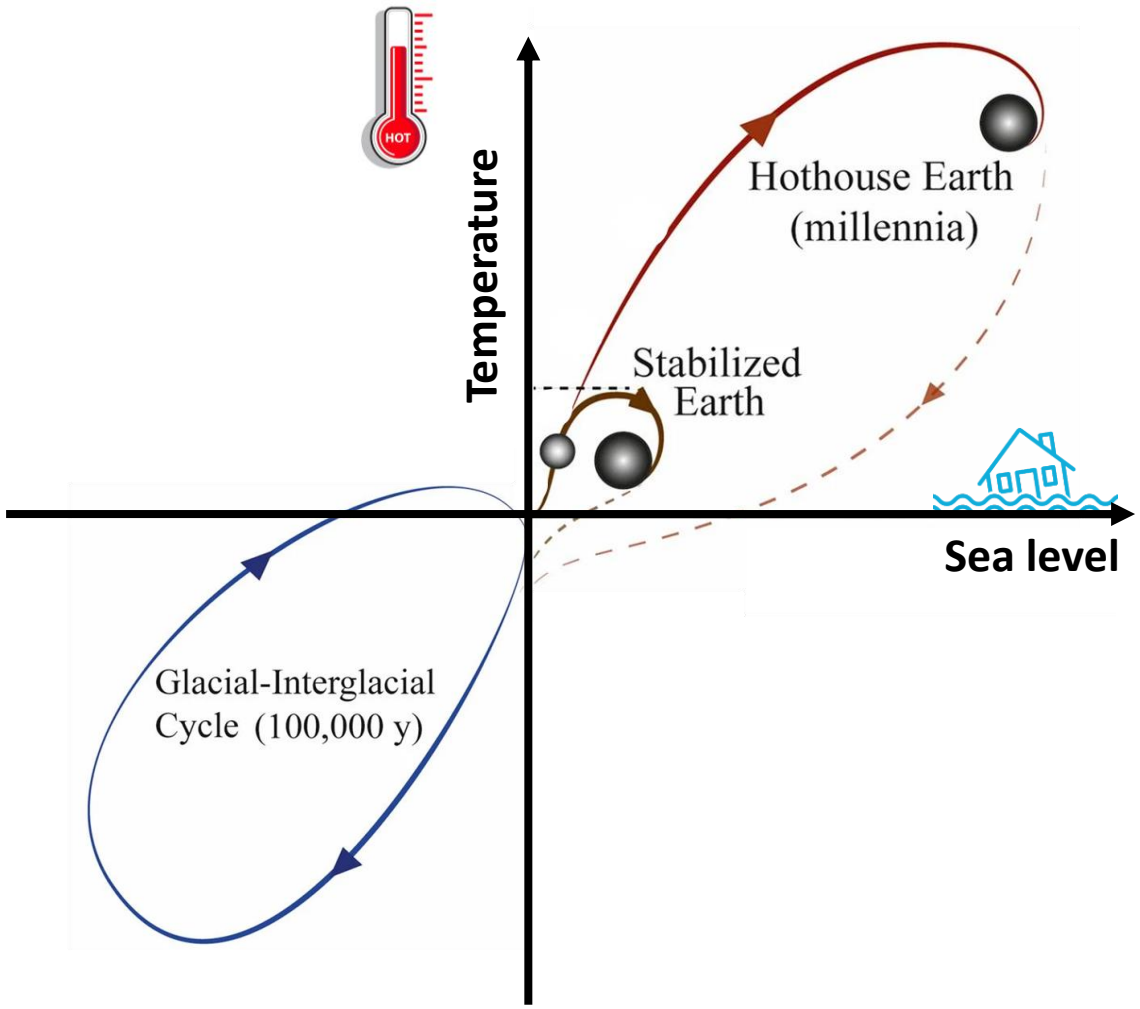
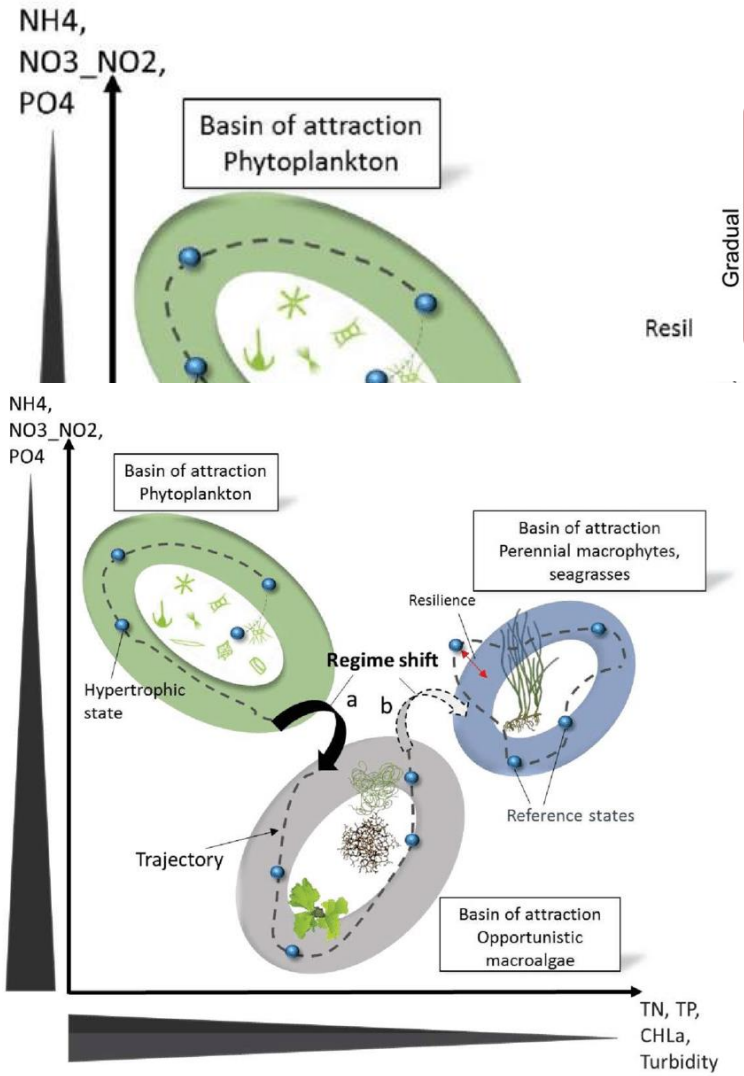
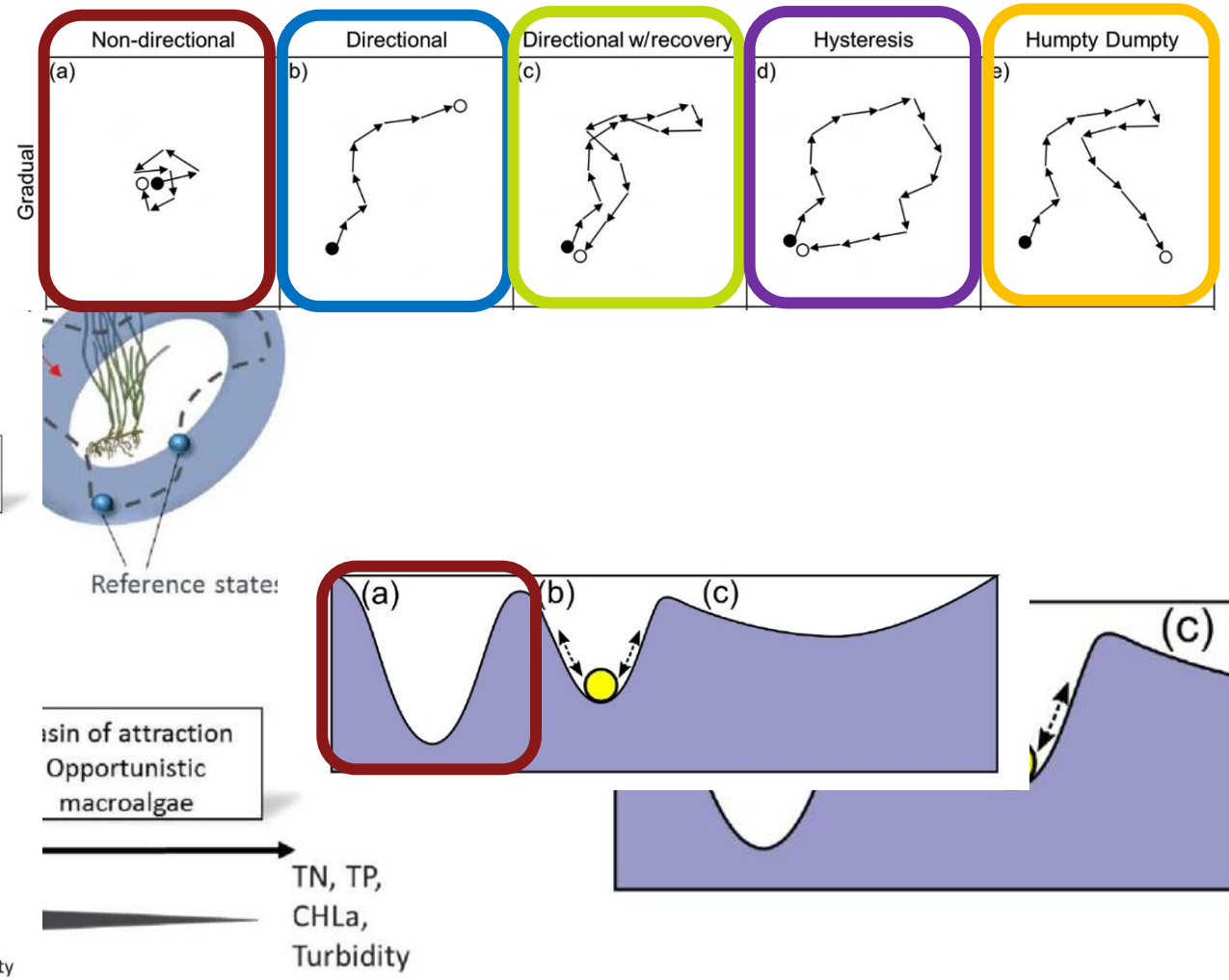
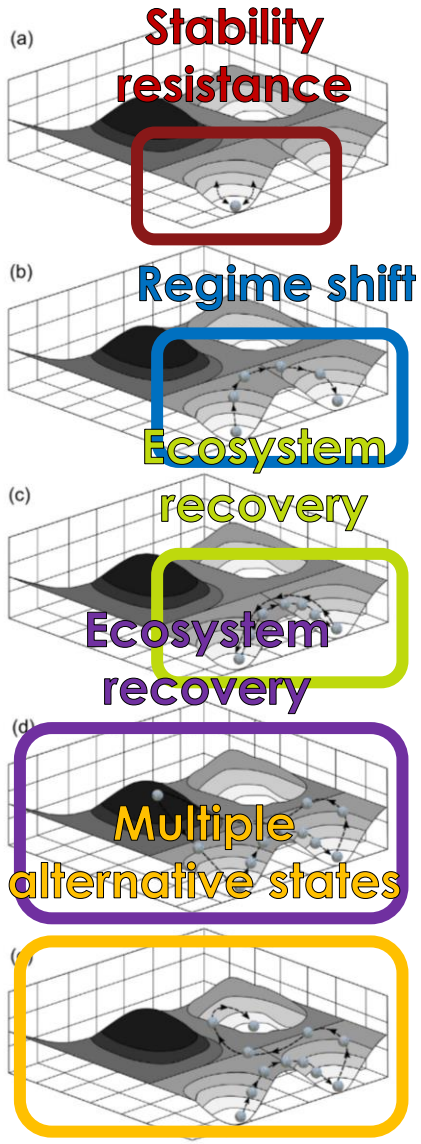


Steffen et al. 2018

Ordination trajectories and the ball-and-cup analogy







Le Fur 2018; Lamothe et al. 2019

Ecosystem recovery and resilience

… the speed with which the system returns to its initial state following a disturbance (Holling)

Aim
Assess stability and resilience of coastal ecosystems by comparing present biodiversity with pre-industrial baselines

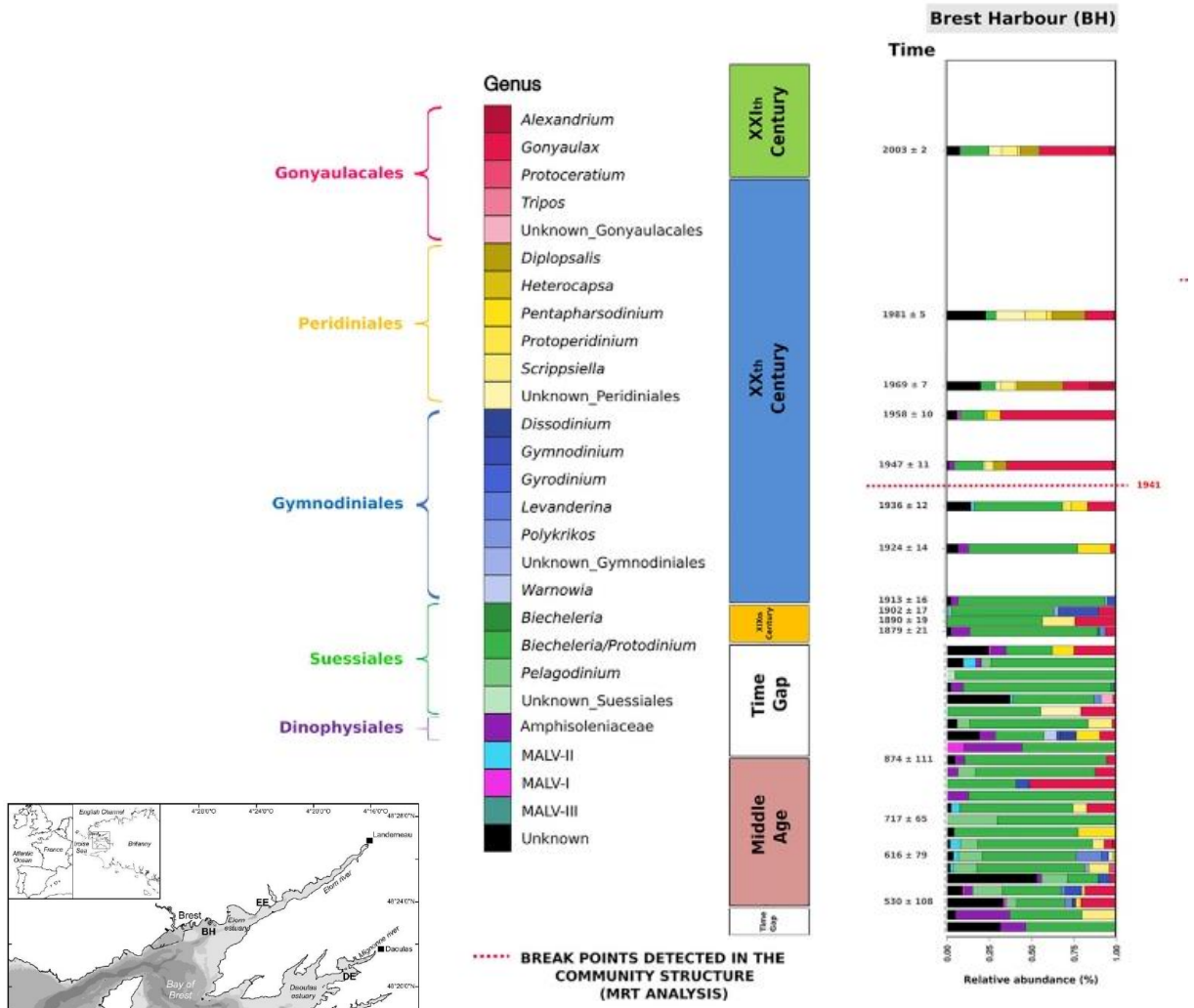
Method
DNA analyses from sediment cores (Bay of Brest, ~1,400 years) focusing on planktonic protists

Key findings
- WWII heavy-metal pollution → major community shifts
- 1980s–1990s agricultural pollution → further shifts in protist assemblages

Conclusion
No return to the Medieval baseline → irreversible shifts caused by cumulative anthropogenic pressures (war + agriculture)

Report

Sediment archives reveal irreversible shifts in plankton communities after World War II and agricultural pollution



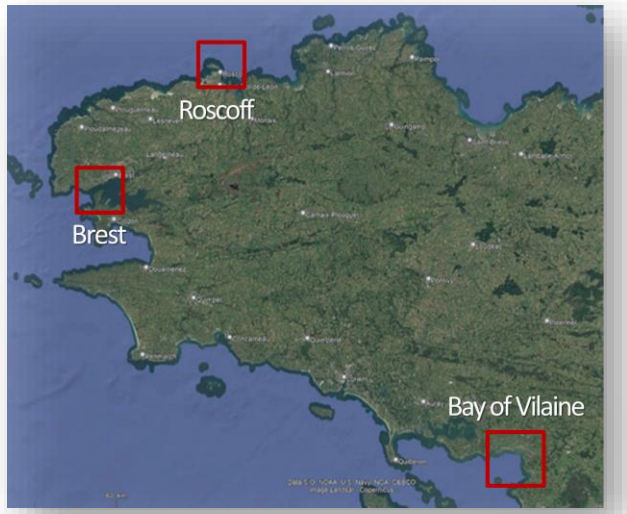
Siano et al. (2021)

How can the resilience of coastal ecosystems under anthropogenic pressures be quantified?

strong

low

mixing intensity



marine-dominated

open coastal

eutrophic

eutrophication

What factors control the temporal changes in oxygen concentrations in these coastal ecosystems? Can these changes be modelled — and therefore predicted?

How do local environmental conditions influence the spatio-temporal dynamics of phytoplankton groups? Can we observe changes in recent years?

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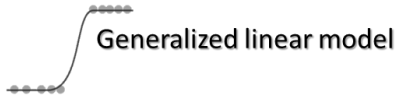
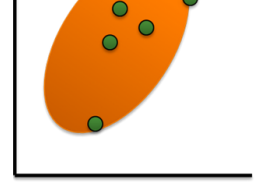
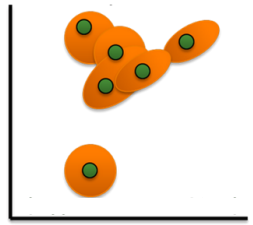
Pourias (2024), Mouque (2025)

How can the resilience of coastal ecosystems under anthropogenic pressures be quantified?







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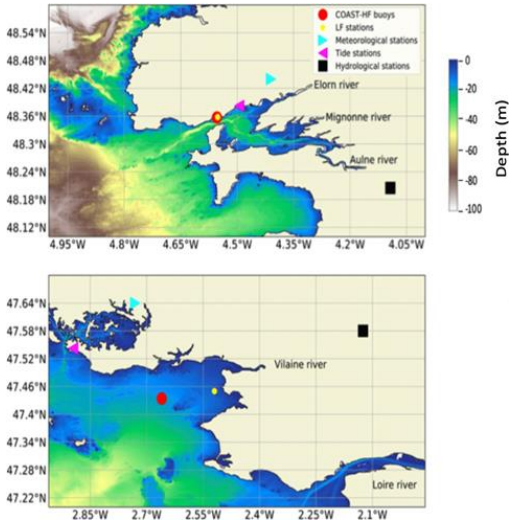

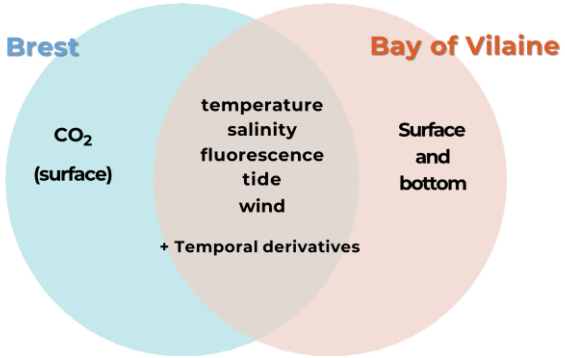

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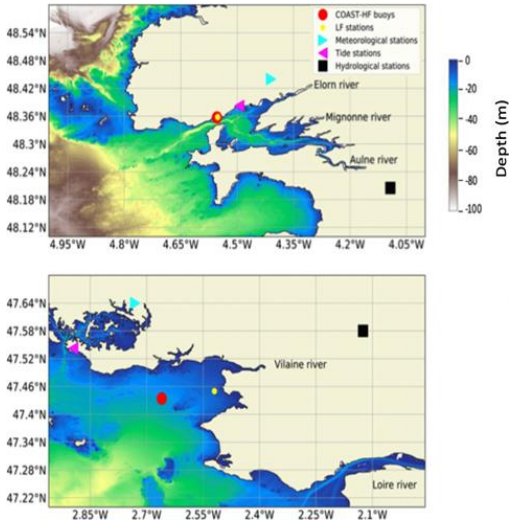

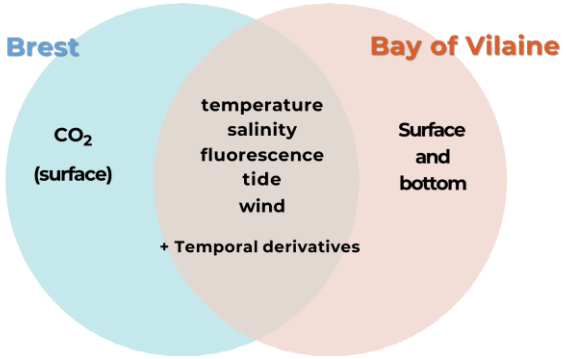

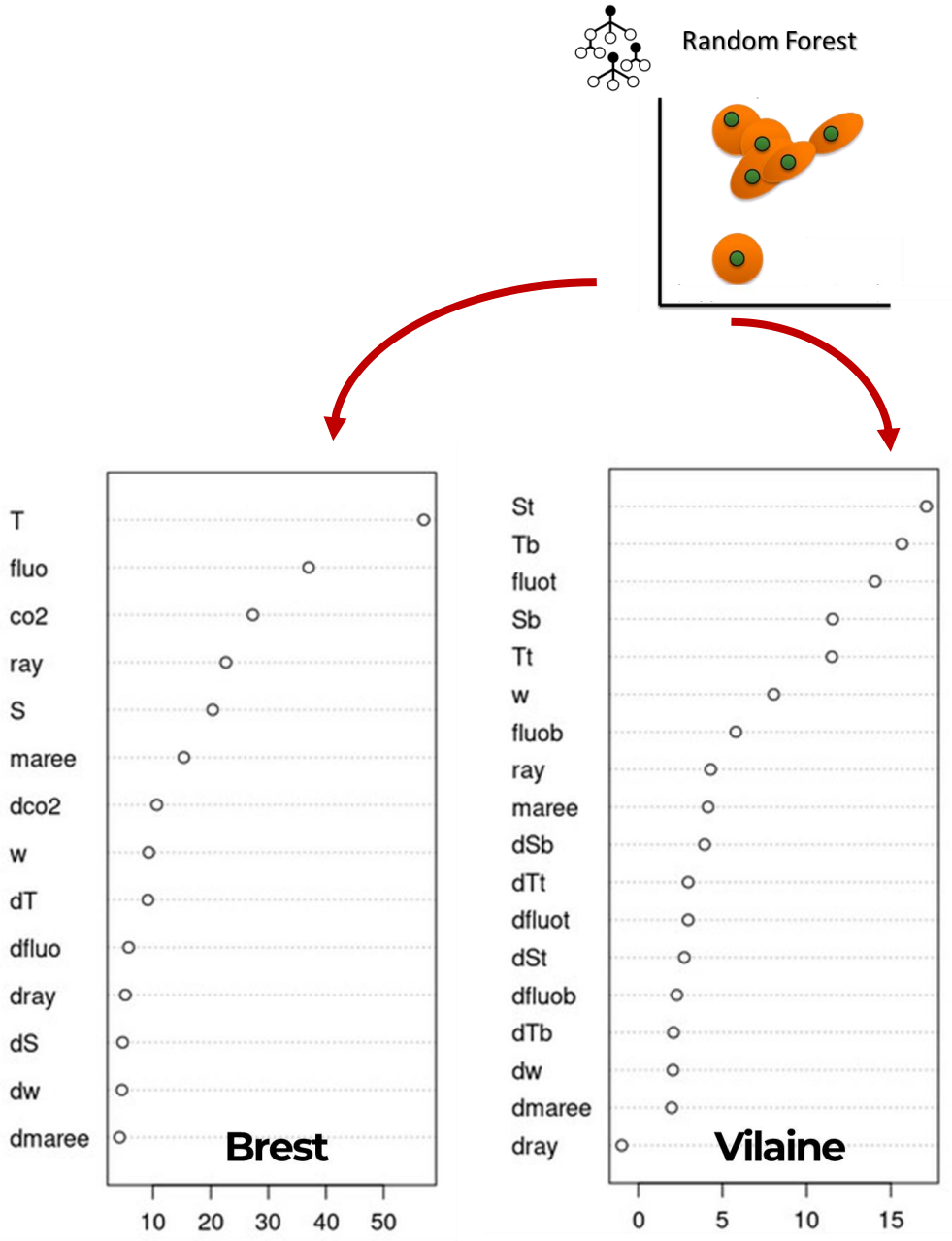

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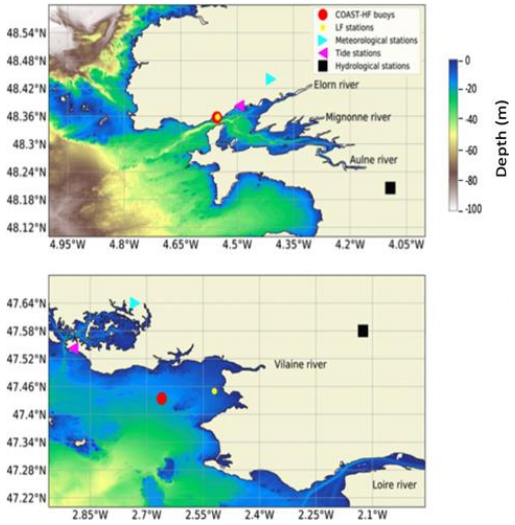

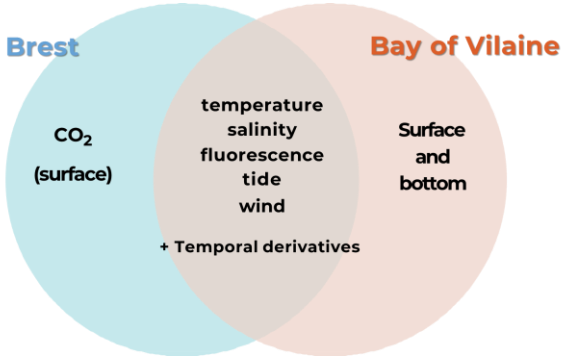

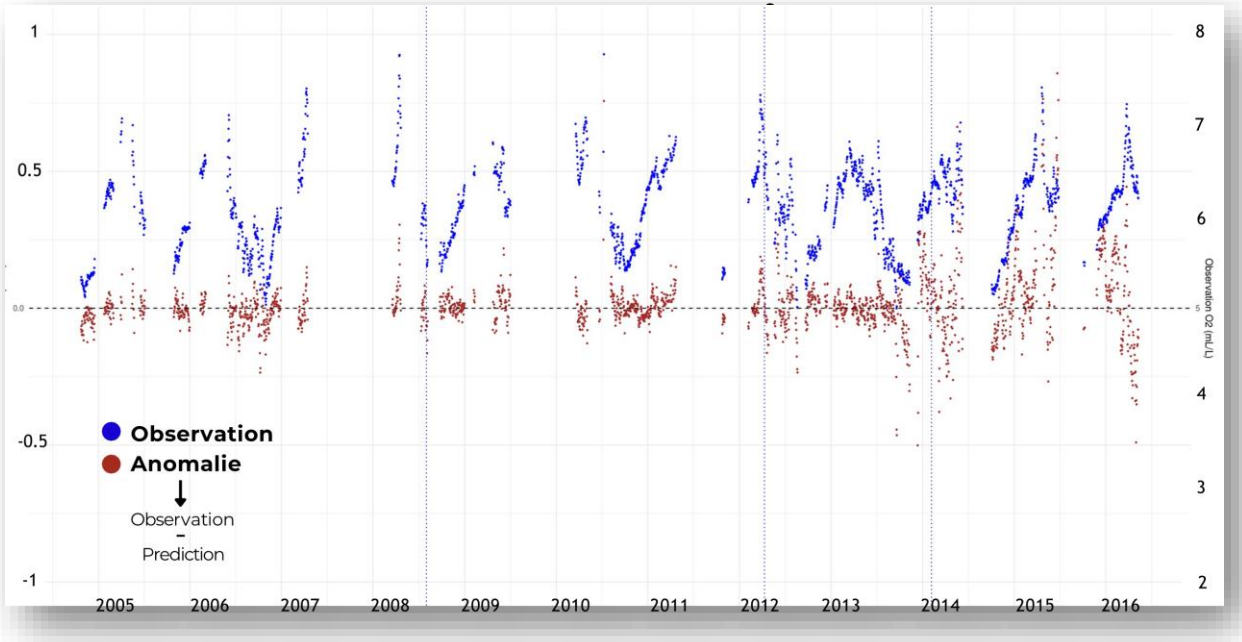

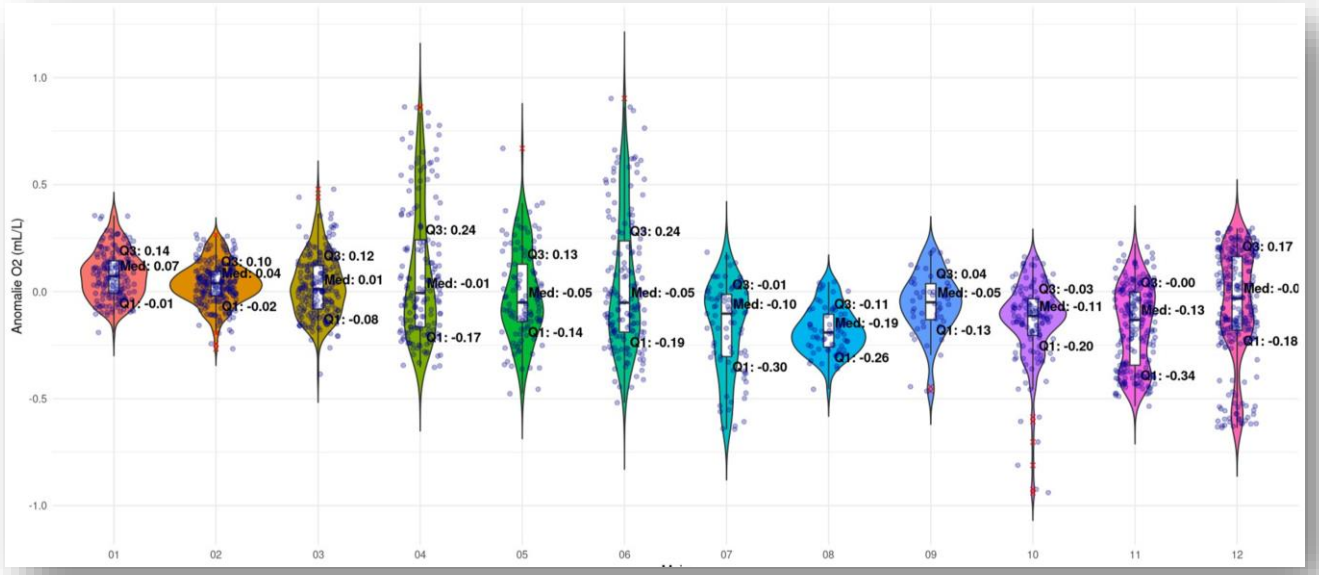

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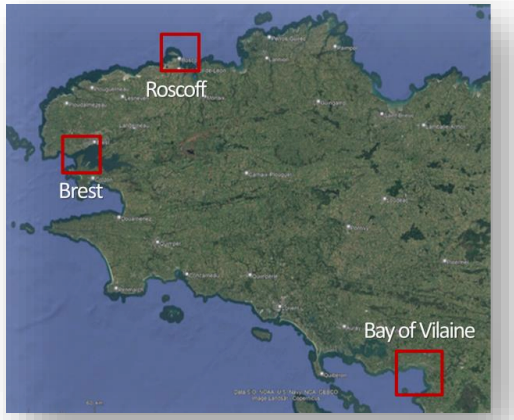

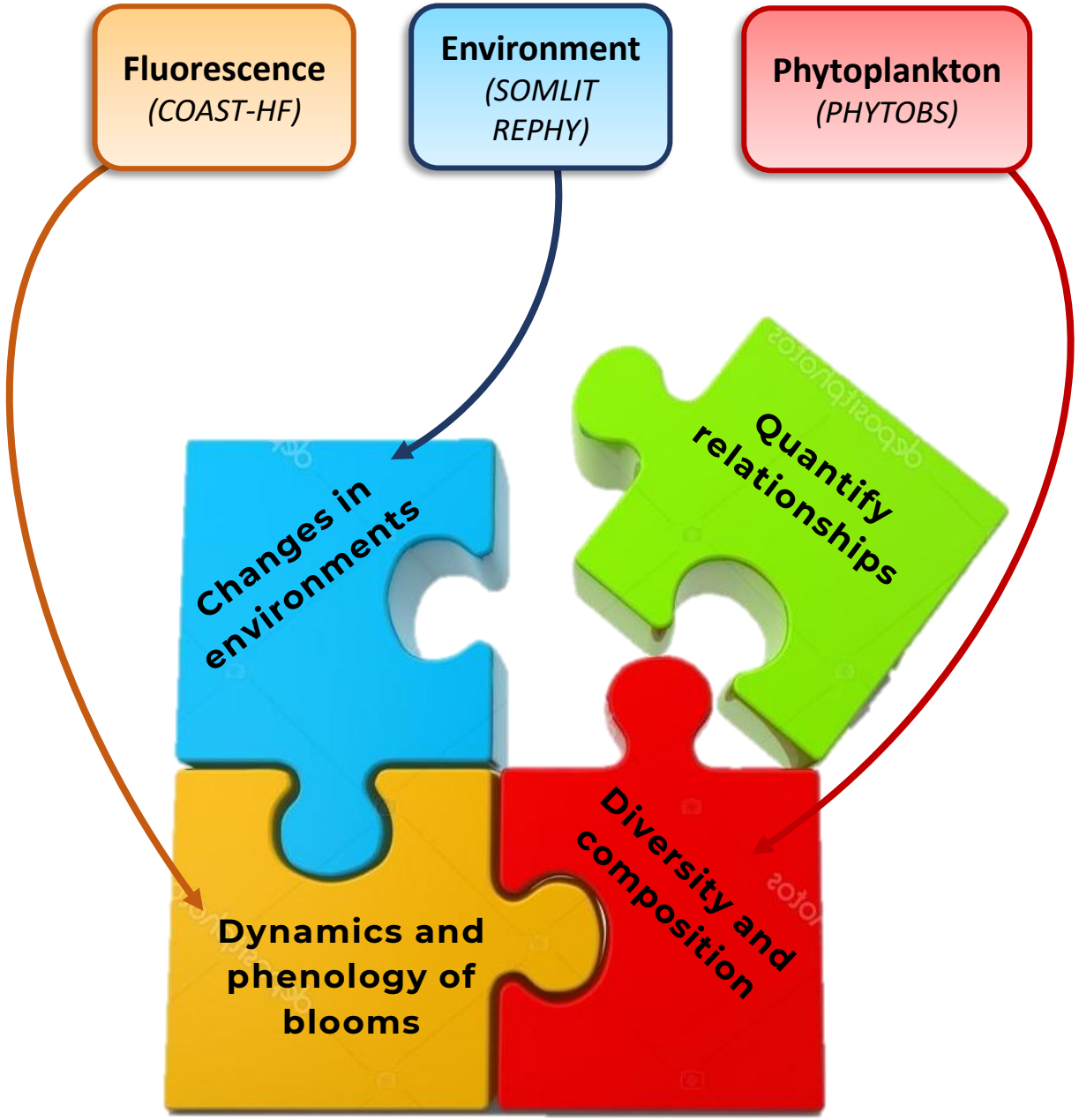

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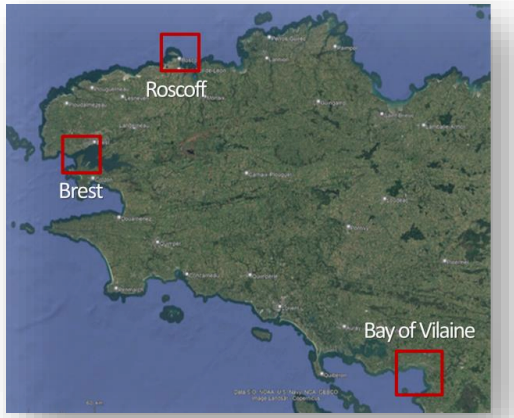


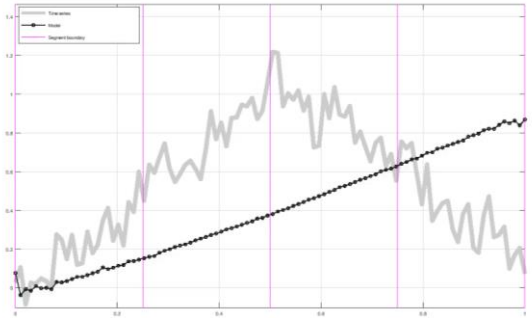
Environment *(SOMLIT REPHY)*

Phytoplankton *(PHYTOBS)*

Time-series decomposition

⇨ **different time scales**

trend, season, 'noise'/extremes



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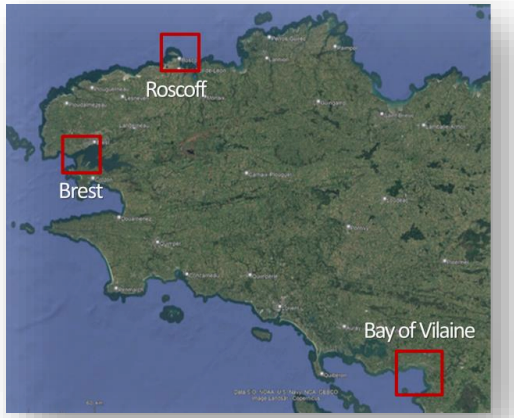

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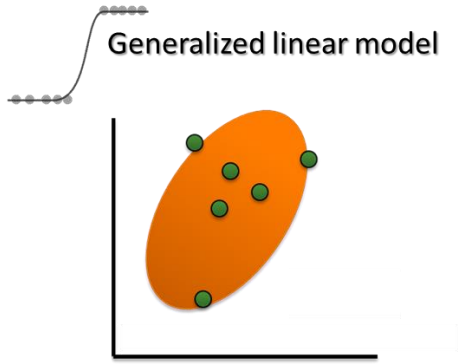
Quantification of relationships

⇨ **significant predictors at different time scales**



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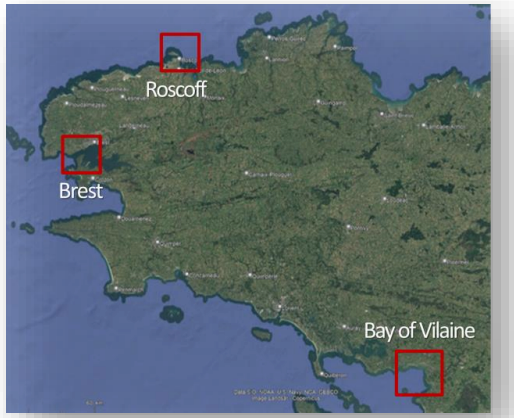

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Time-series decomposition

⇨ **different time scales**
trend, season, 'noise'/extremes

Quantification of relationships

⇨ **significant predictors at different time scales**

Multivariate analyses

⇨ **Changes in phytoplankton groups at different time scales in contrasted ecosystems**

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Mouque (2025)

How can the resilience of coastal ecosystems under anthropogenic pressures be quantified?

How do local environmental conditions influence the spatio-temporal dynamics of phytoplankton blooms? Can we observe changes in recent years?

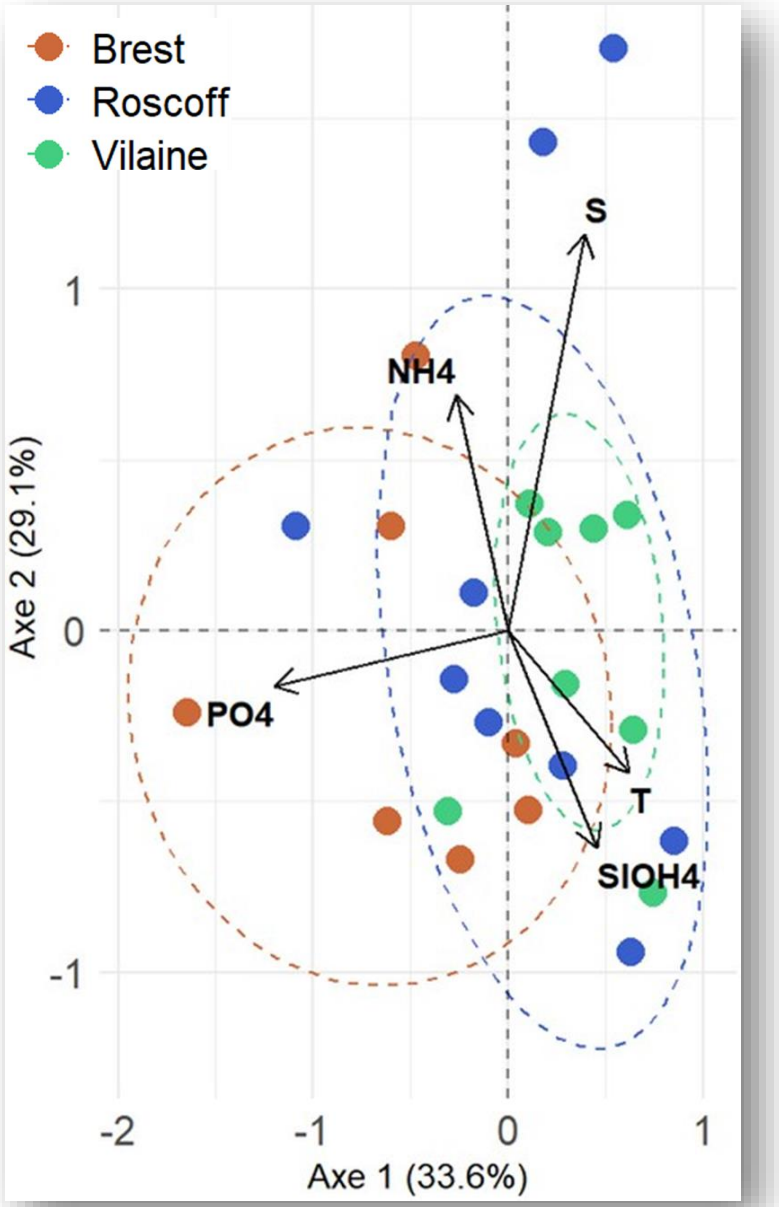
Main findings

- **Brest** ⇨ Spring profile
- **Roscoff** ⇨ Clearer seasonal gradient
- **Vilaine** ⇨ Strong riverine influence

Conclusion

Confirms the hypothesis that ecological responses are locally structured

Spatial patterns



Mouque (2025)

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Main findings

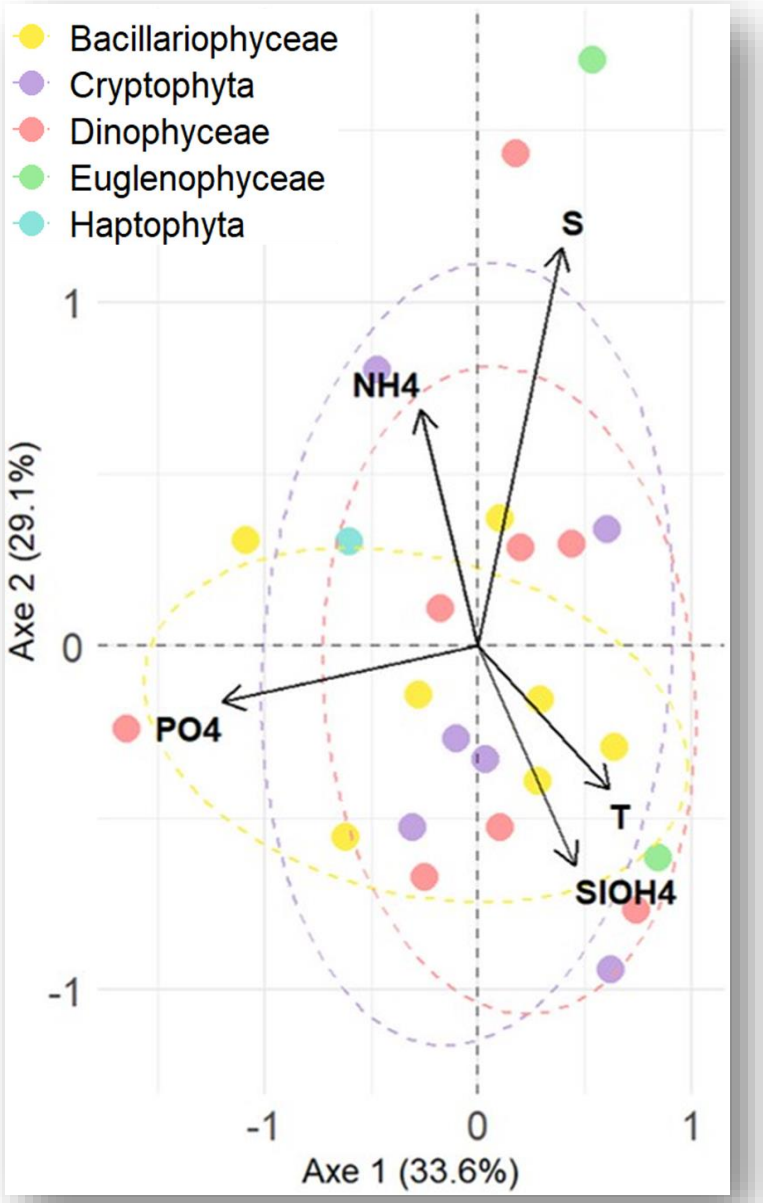
- **Bacillariophyceae**
- **Dynophyceae, Euglenophyceae**
- **Cryptophyta**

⇨ Nutrient-rich spring conditions
⇨ Summer conditions
⇨ Dispersal and ecological plasticity?

Conclusion

Helps identify the dominant ecological niches of each group

Phytoplankton patterns



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At seasonal scale

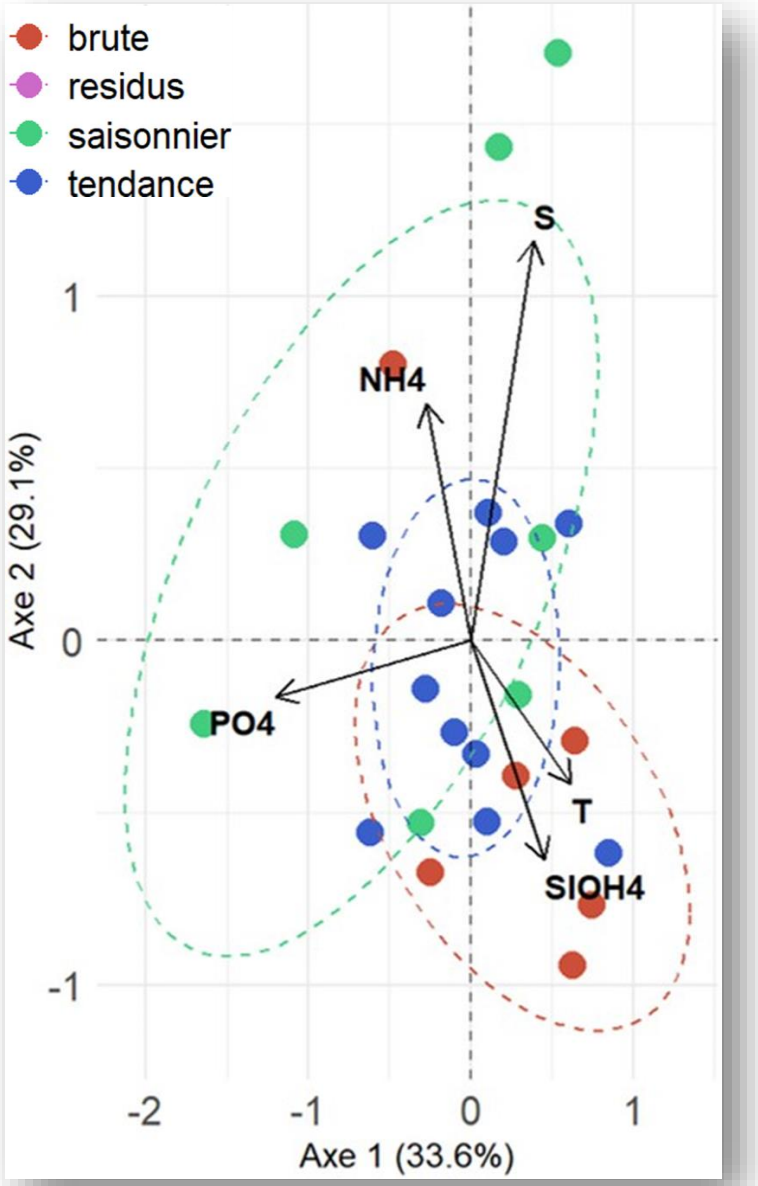
Components close to high phosphate concentrations

→ **typical spring blooms**

At long-term scale

→ **Potential signals of climate change**

Time-scale patterns



Mouque (2025)

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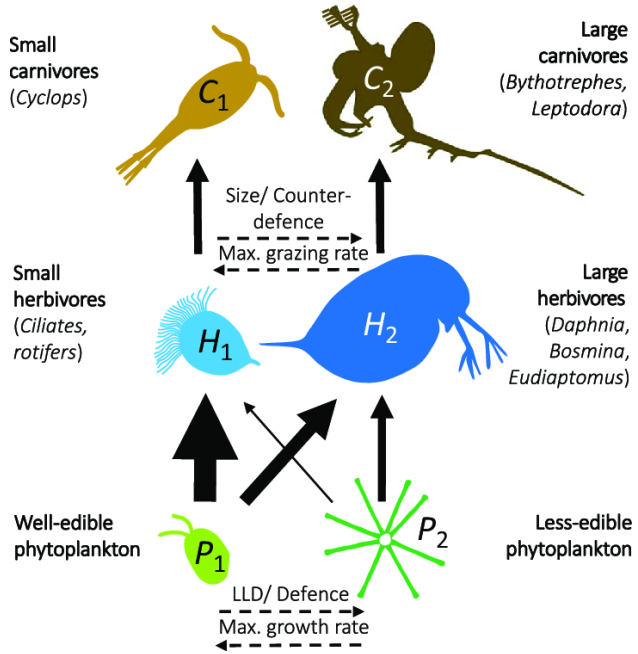
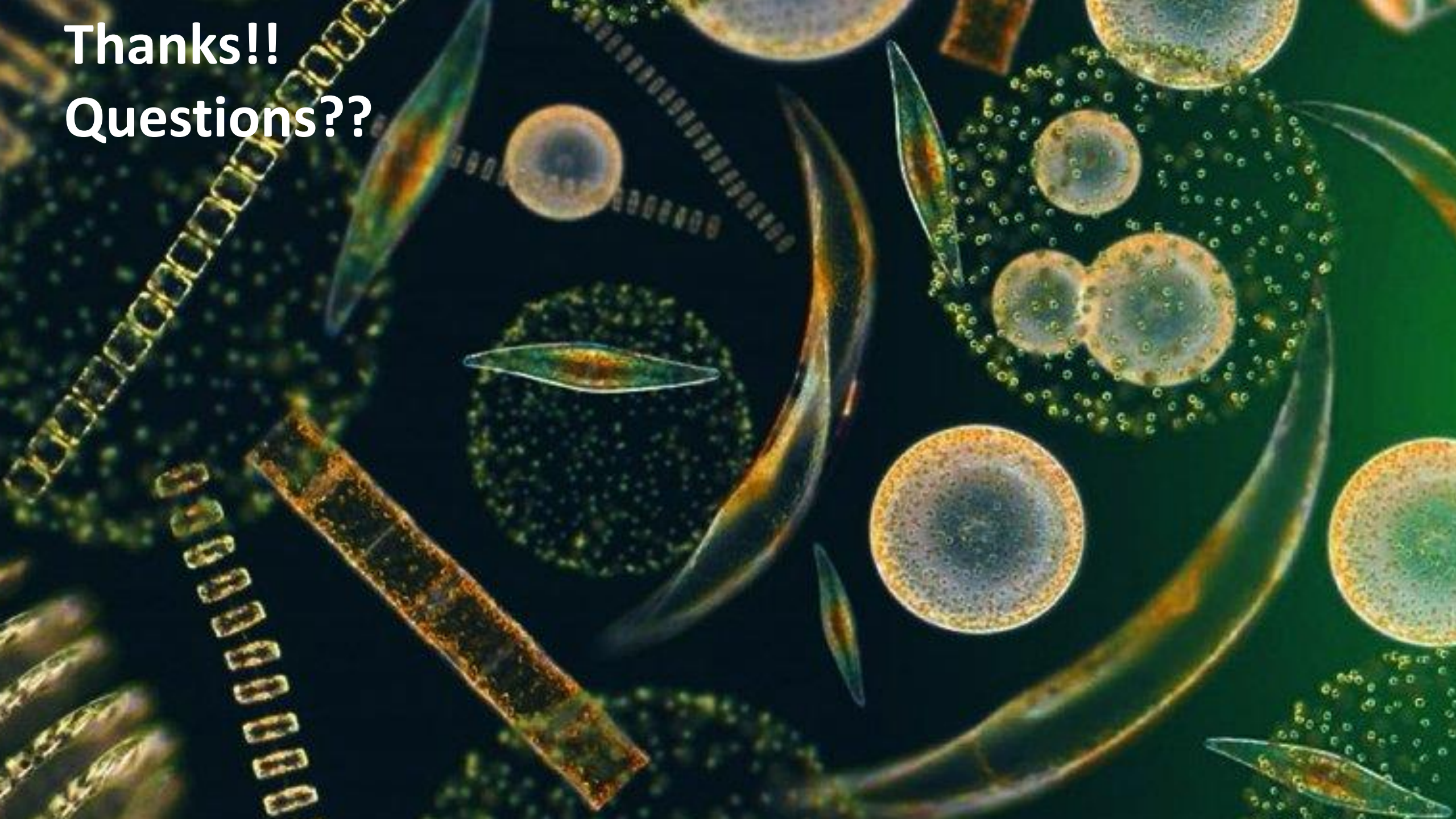
Contribution of plankton time series to quantifying the resilience of coastal ecosystems: study of the dynamics of trophic coupling between phytoplankton and zooplankton



Ehrlich & Gaedke (2020)


Thanks!!
Questions??