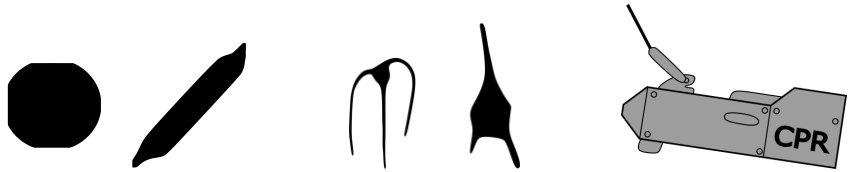
Using Continuous Plankton Recorder (CPR) data to understand past, present and future changes in Northeast Pacific phytoplankton

Loïck Kléparski, Clare Ostle, Sonia D. Batten, Nicolas Djeghri, Claudine Hauri, Rémi Pagès, Suzanne Strom. PICES-2026, Nanaimo, October 27th





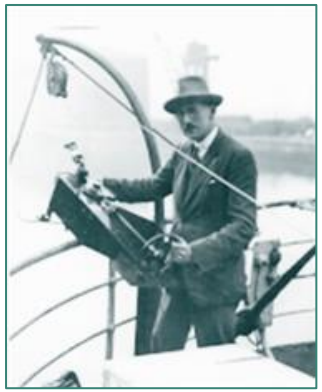
The Continuous Plankton Recorder (CPR) survey

Long-term plankton monitoring program

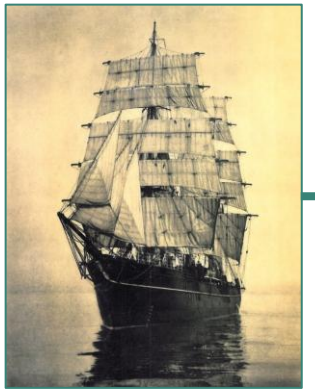
↓

Unchanged methodology since 1958

Alister Hardy (1896-1985)



RRS Discovery (1925-1927)



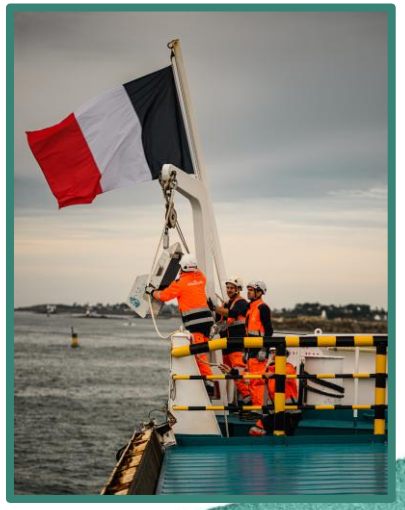


https://www.cprsurvey.org/

"Ships of opportunity"

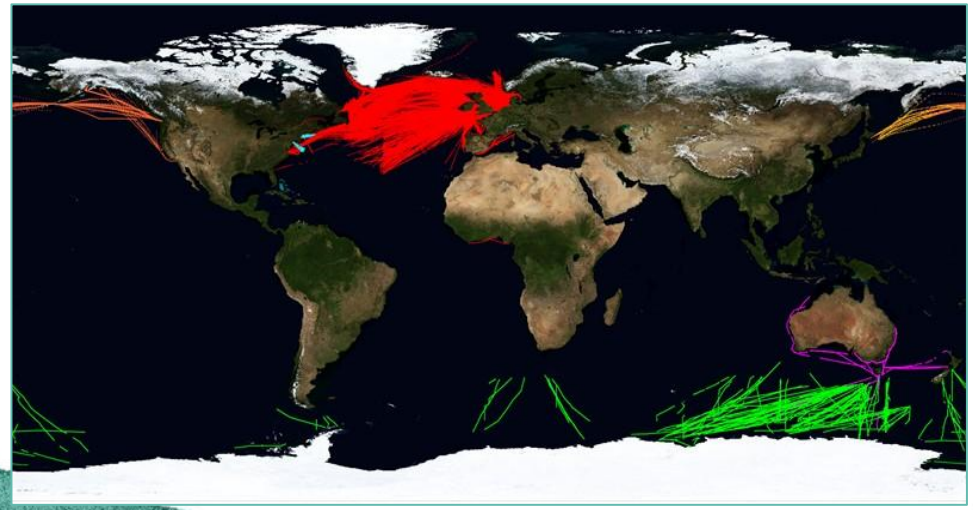


https://www.cprsurvey.org/



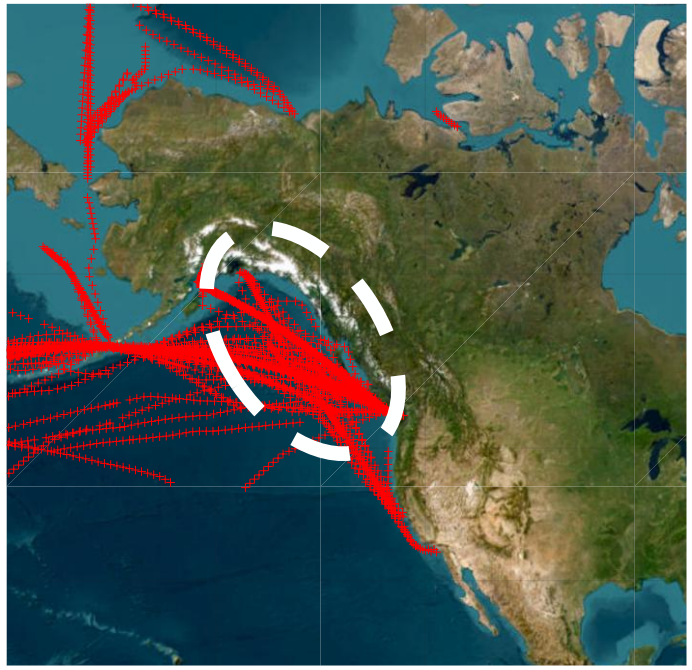
Sampling at 7-10m depth

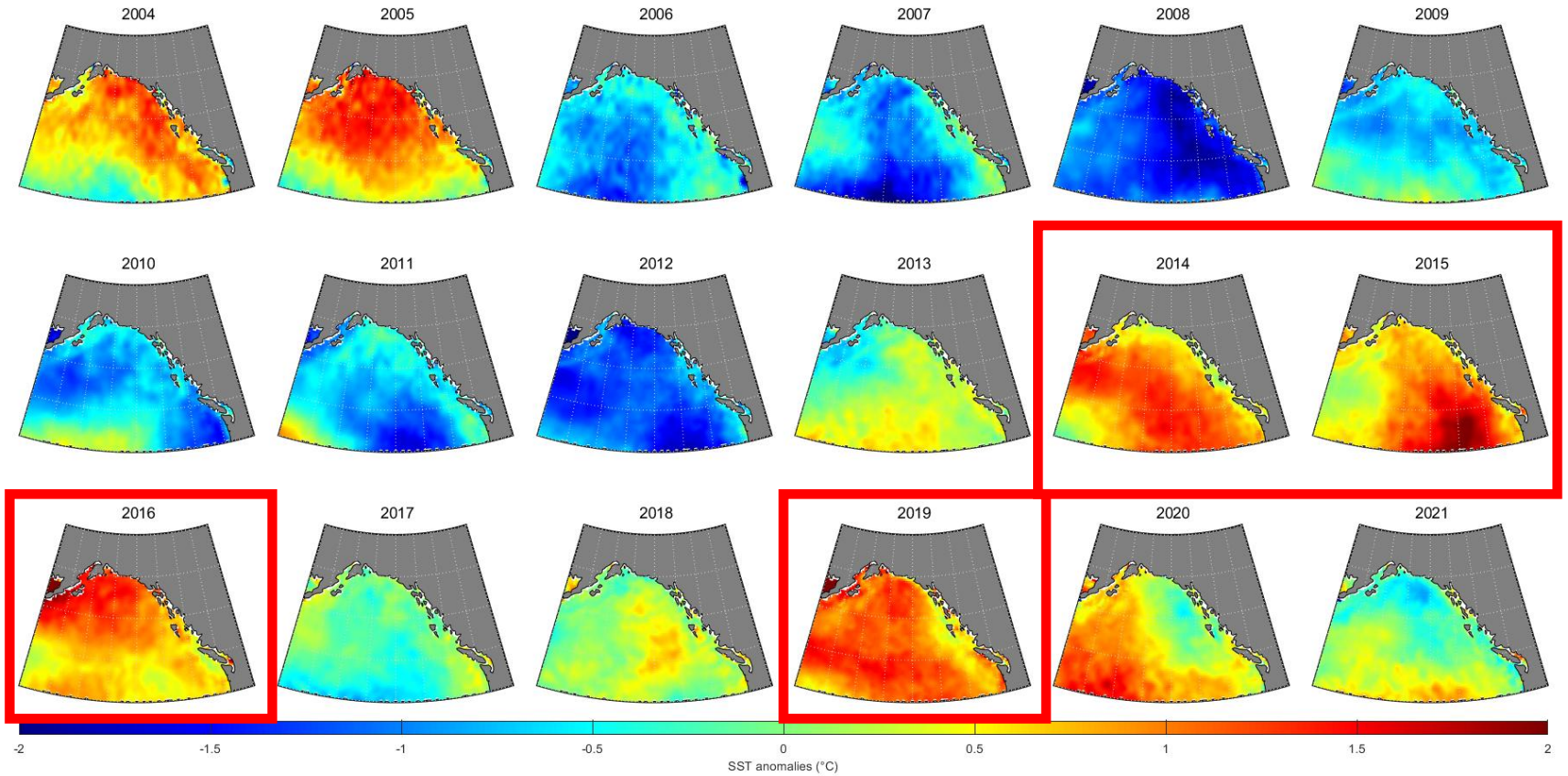
270µm filtering mesh silk



The North Pacific Marine Heatwaves

Northeast Pacific CPR data





Temperature anomalies between 2004-2021 → Two MHWs in 2015 and 2019

How have these events affected phytoplankton abundance and morphology?

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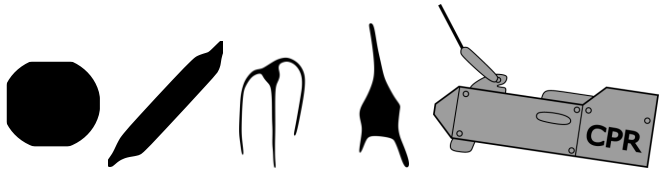
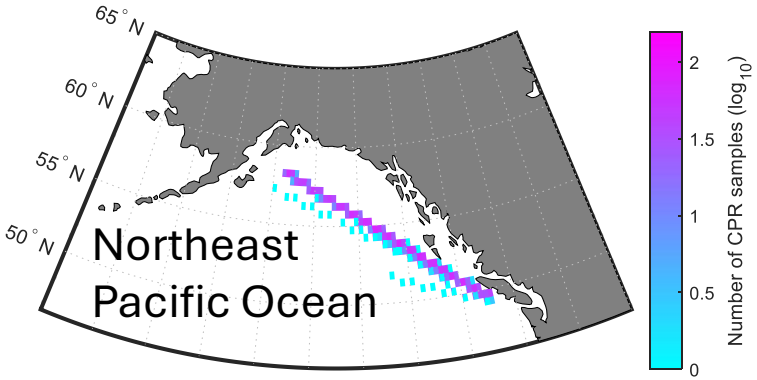
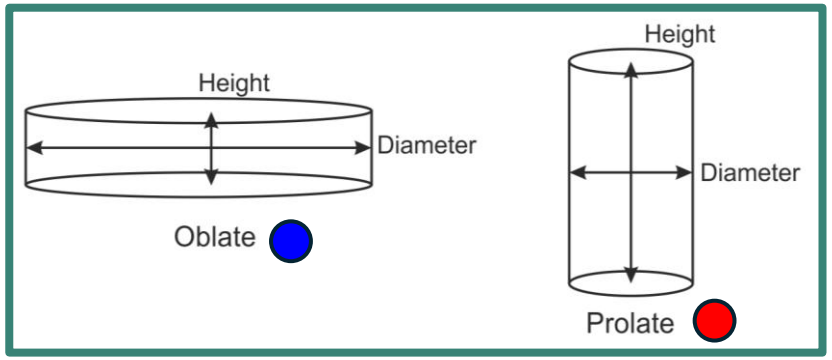
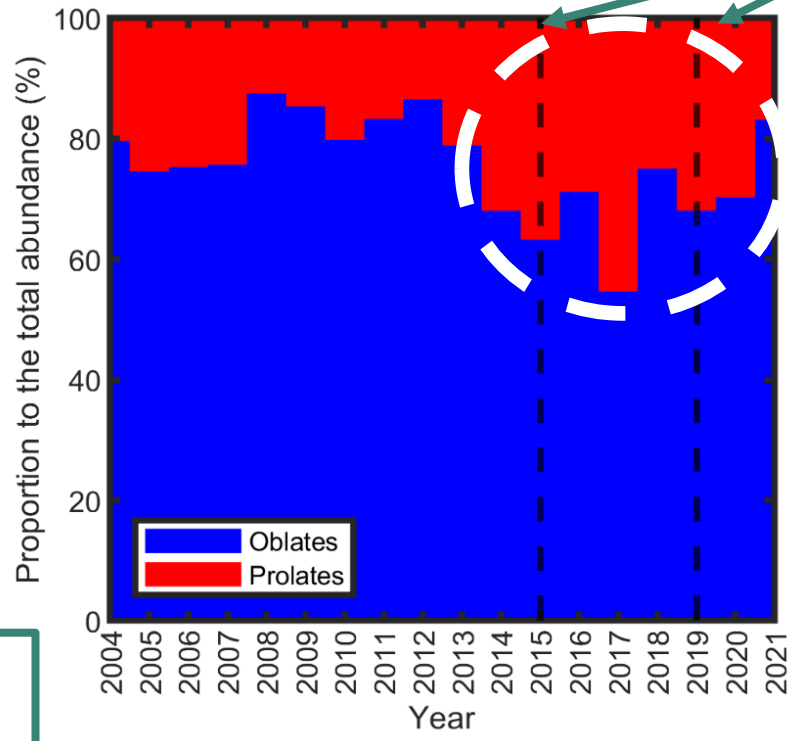


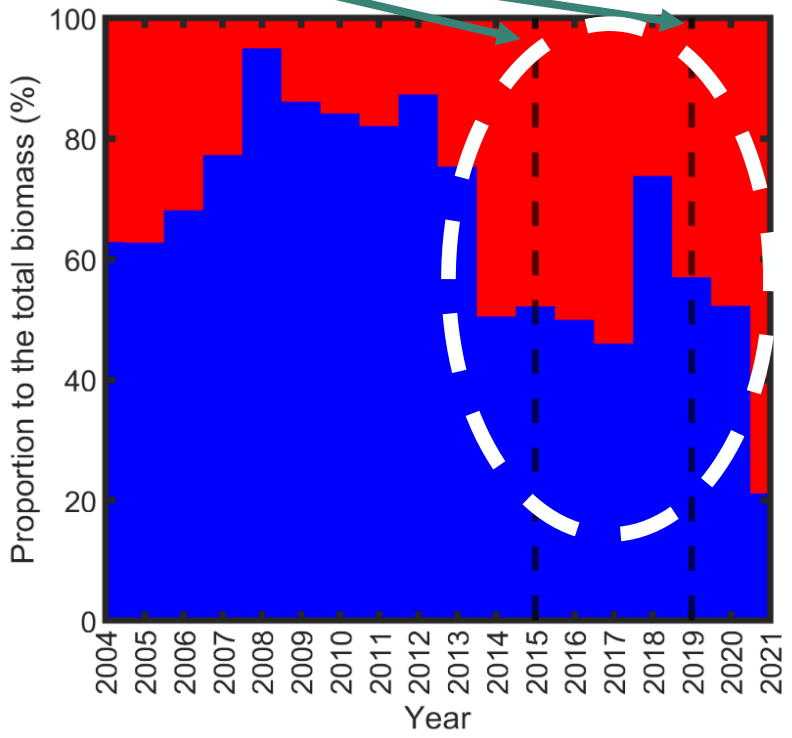


42 diatoms and dinoflagellates



North Pacific MHWs



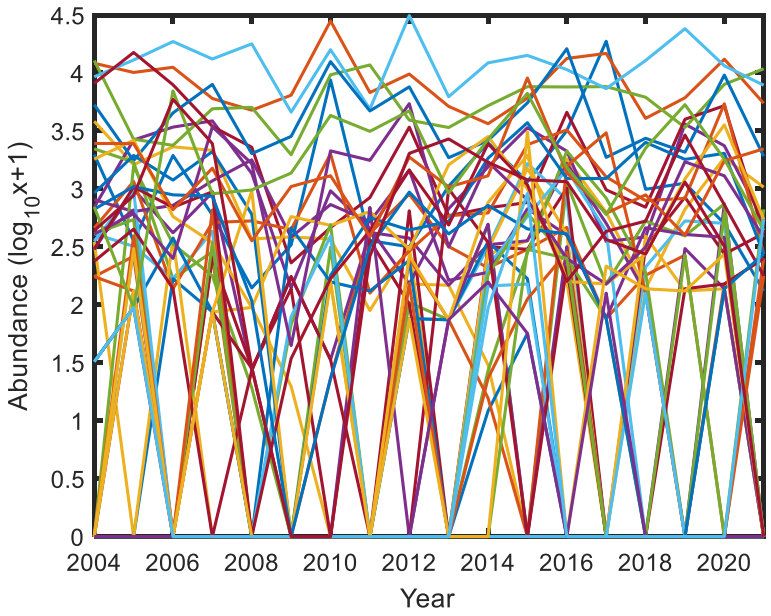


Increase in prolate abundance and biomass during MHW periods

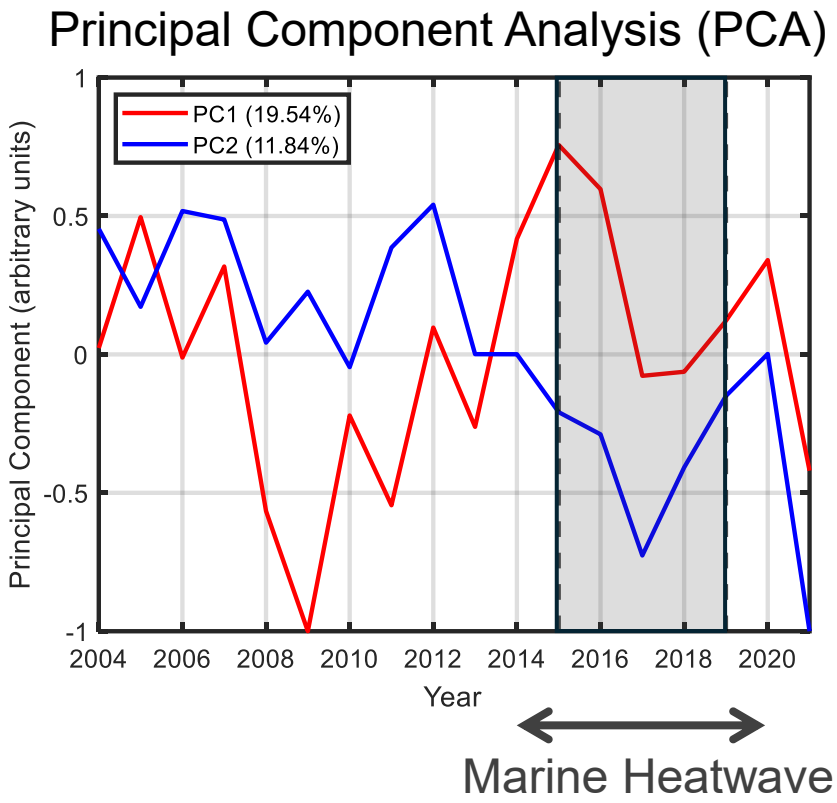
How have these events affected phytoplankton abundance and morphology?

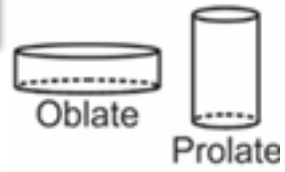


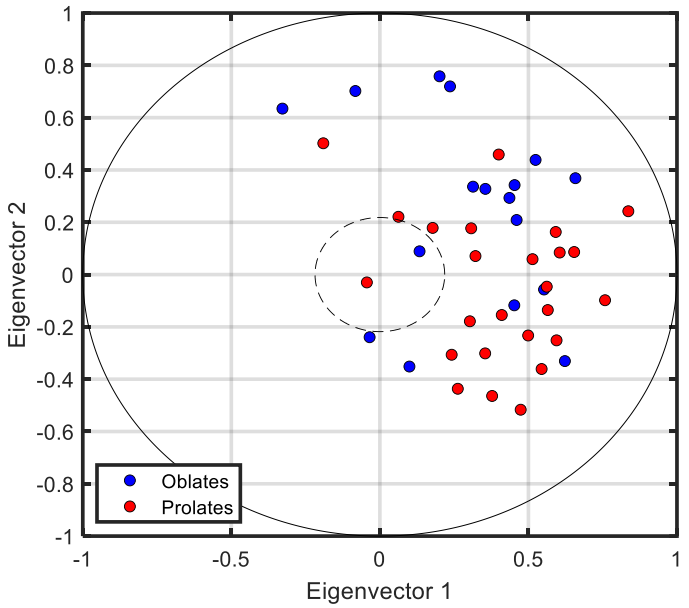
42 diatoms and dinoflagellates



Mean annual summer abundance







Confirm the increase in prolate abundance during the MHWs

Did the MHWs trigger the shift in abundance and morphology?

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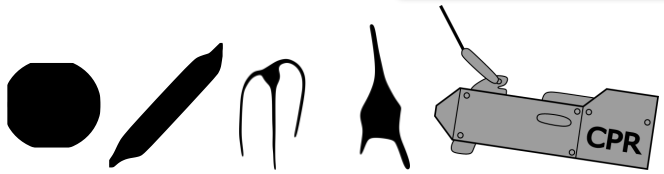
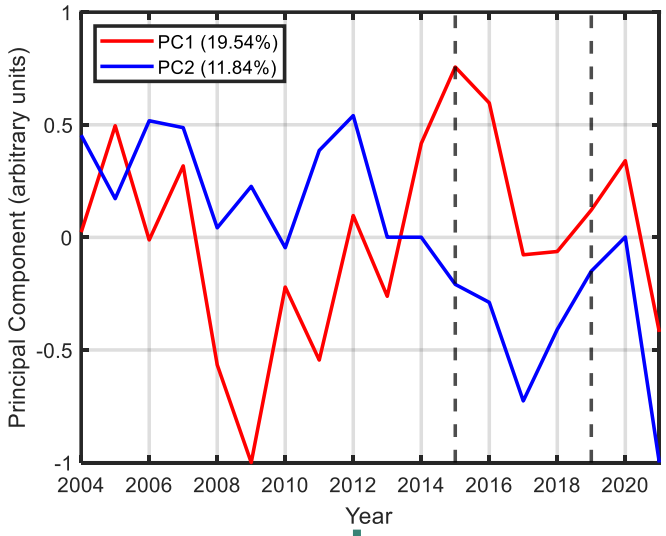
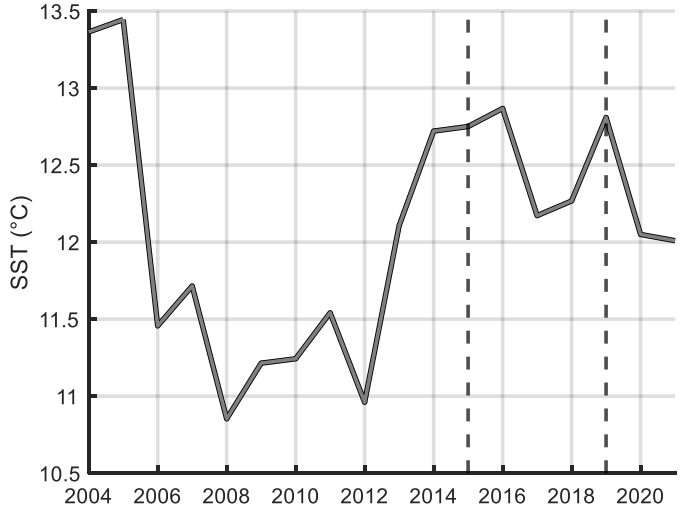
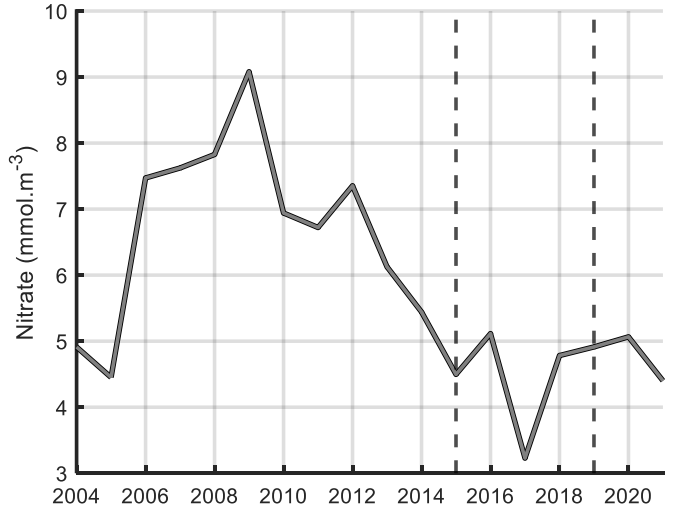
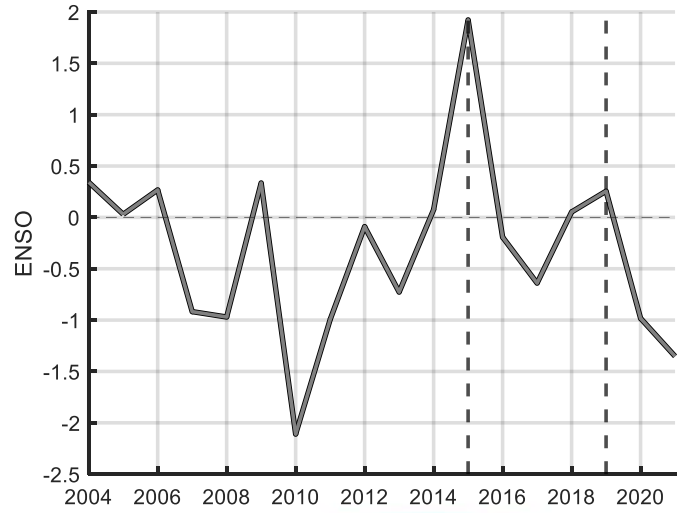


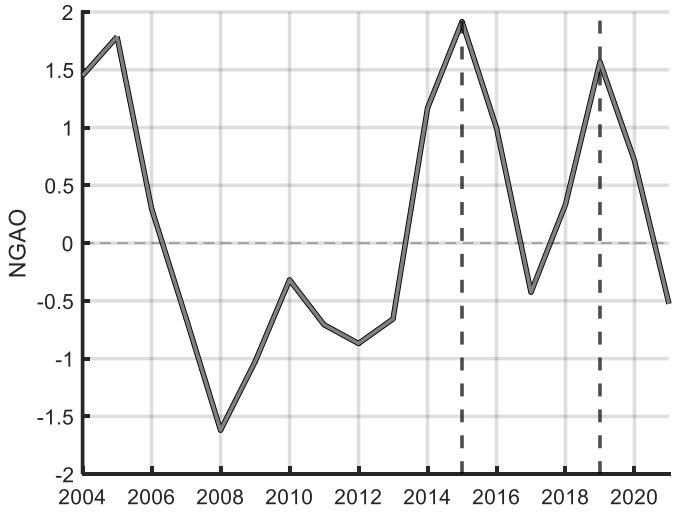


Increase in prolates in response to warmer temperatures and declining nutrients





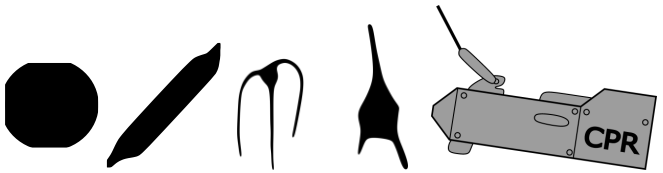


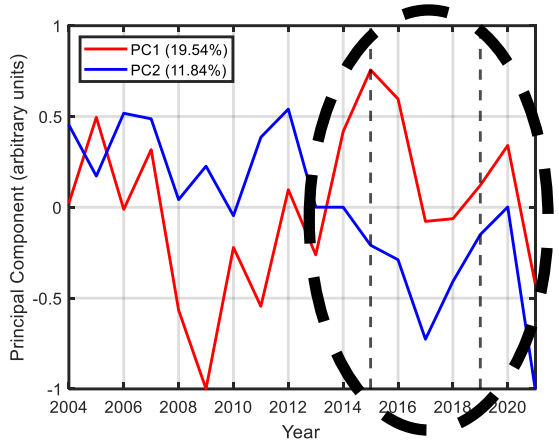


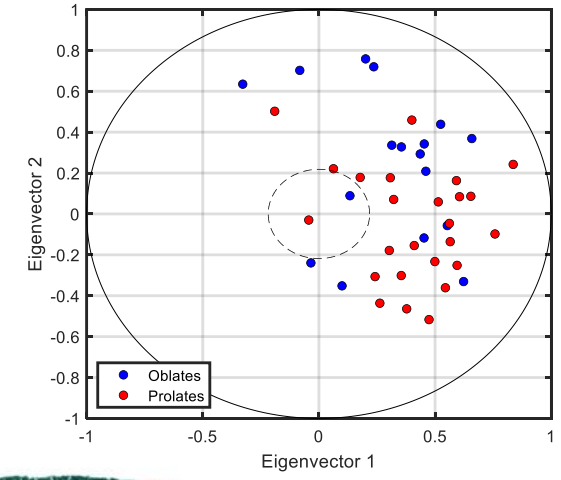
Weak cold-water upwelling

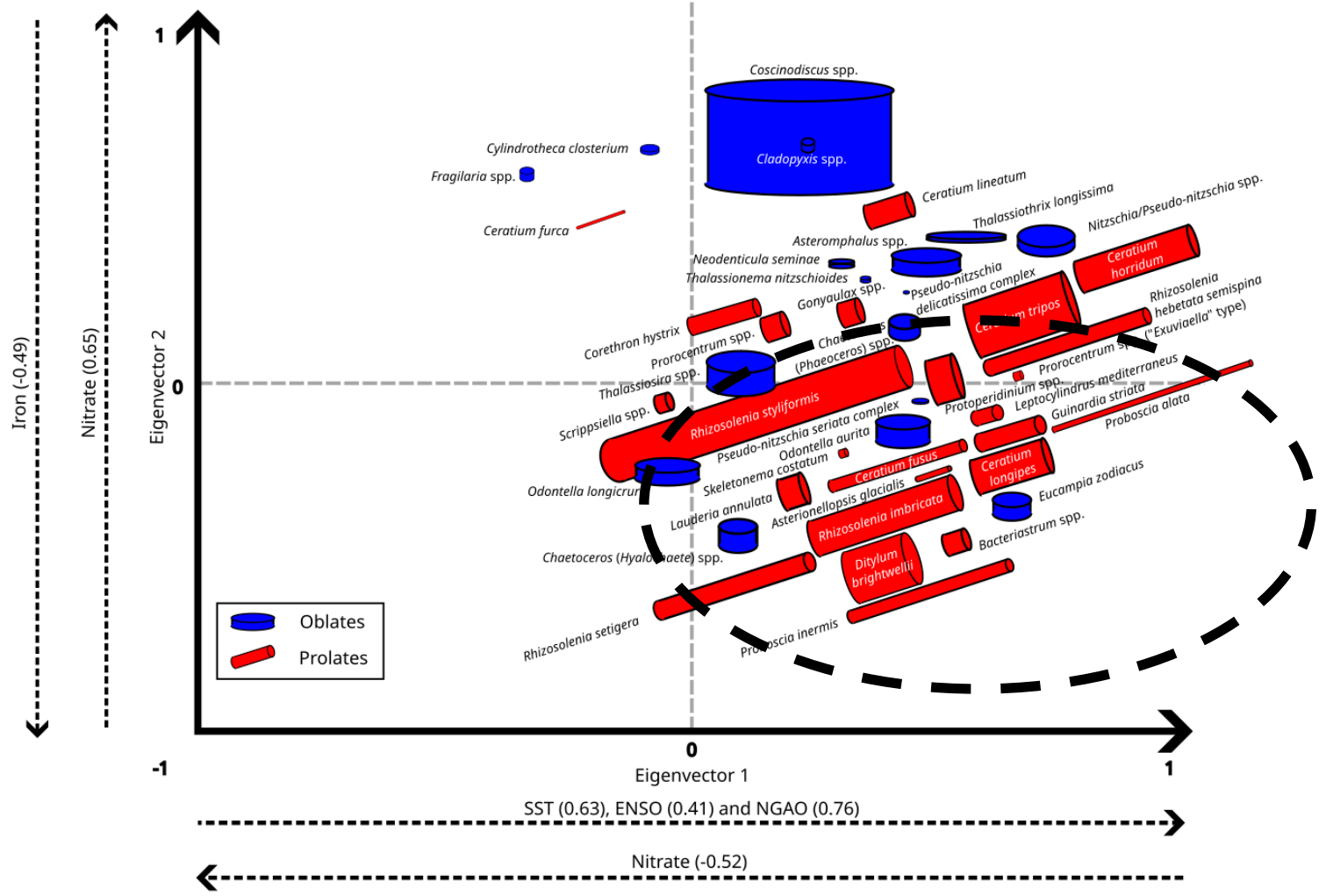
Strong cold-water upwelling

Did the MHWs trigger the shift in abundance and morphology?









How shifts in phytoplankton morphology affected the carbon cycle?

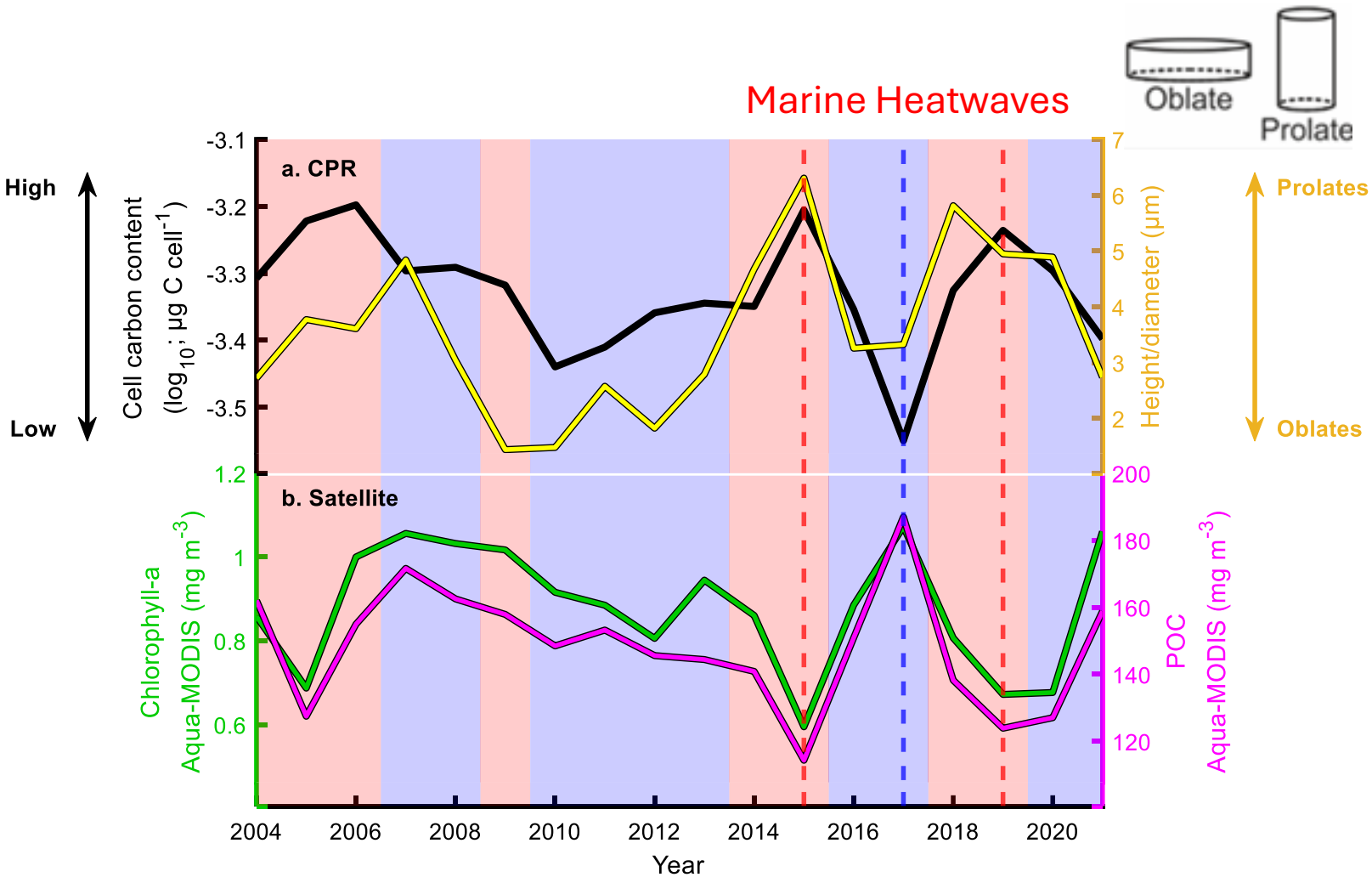
How shifts in phytoplankton morphology affected the carbon cycle?



Cold periods:
- Increase in oblates with low carbon content
- High chlorophyll-a and POC

Warm periods:
- Increase in prolates with high carbon content
- Lower chlorophyll-a and POC

Shifts in phytoplankton morphology are likely to impact the carbon cycle



Forecasts method

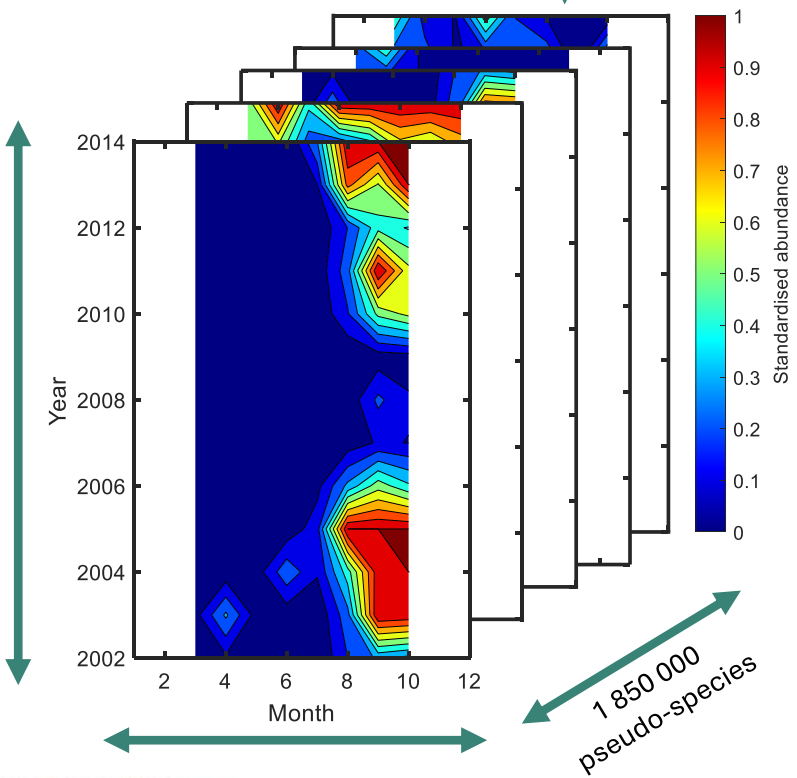
Numerical model

Pseudo-species generation (3D model)

$$A = ce^{-\frac{1}{2}\left[\left(\frac{x_1 - x_{opt1}}{t_1}\right)^2 + \cdots + \left(\frac{x_n - x_{opt\,n}}{t_n}\right)^2\right]}$$

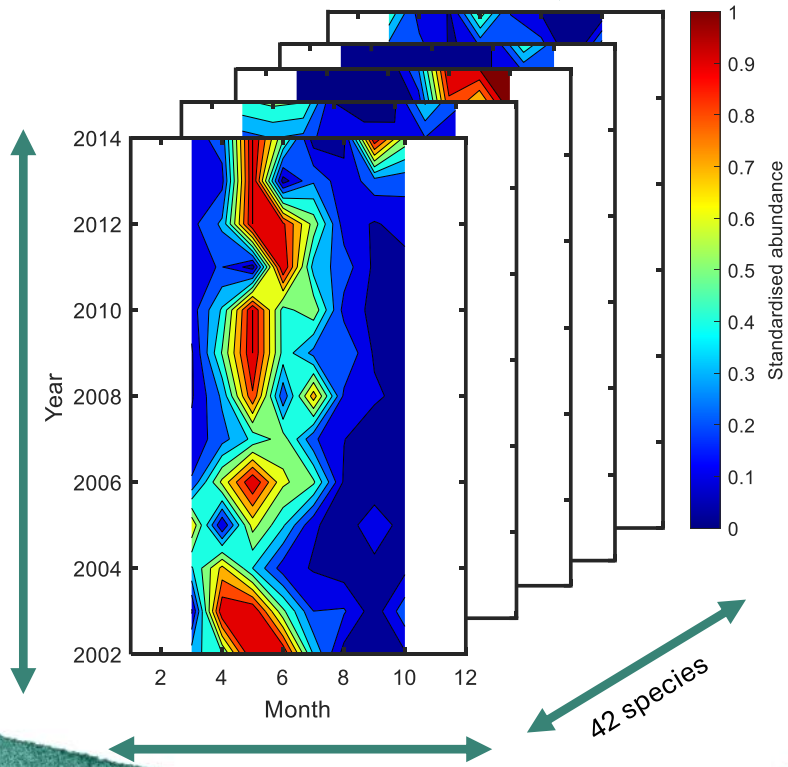
Nitrate, Solar radiation and SST from 6 ESMs

CPR data

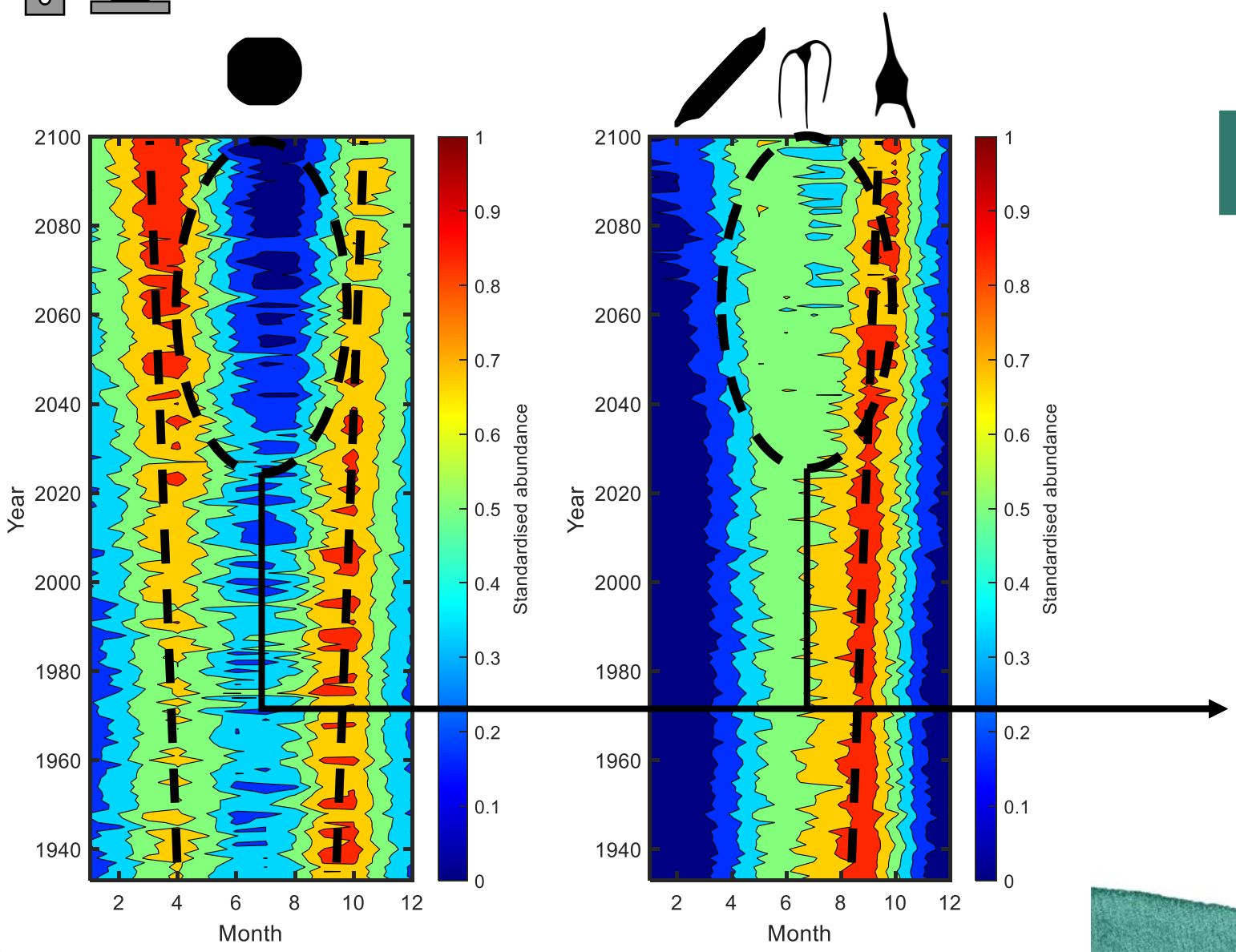


Comparison of the 42 CPR species with the 1 850 000 pseudo-species (MAE)

Attribute one pseudo-species to each CPR species

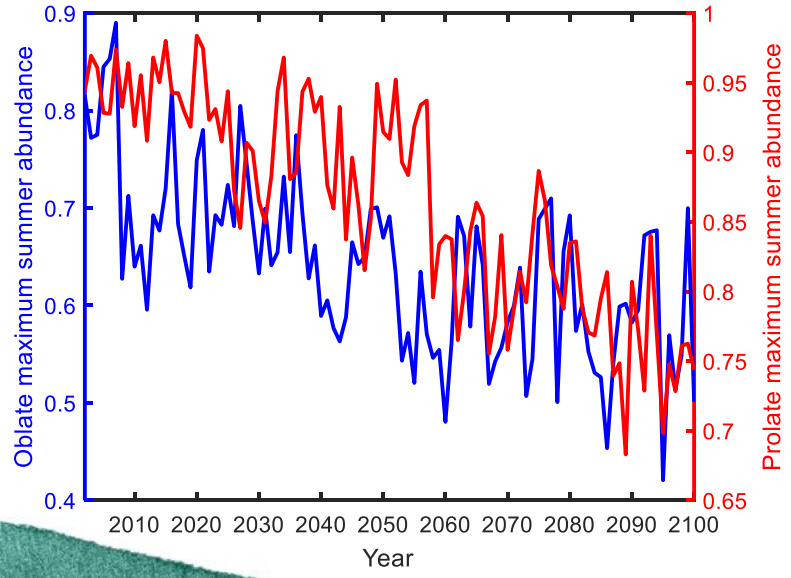


Preliminary results under SSP2-4.5



Phenological shifts toward earlier spring bloom and later autumn bloom

Strong decline in abundance between June and August

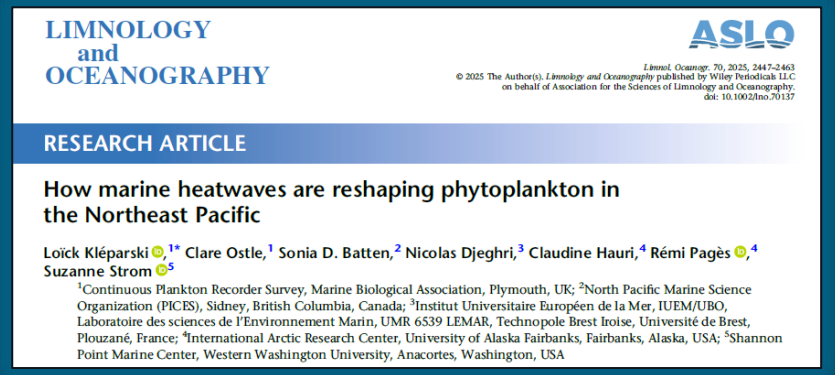


Conclusions

- Increasing temperature and declining nitrate during the marine heatwave have caused a shift toward large-elongated diatoms and dinoflagellates.

- Shift in phytoplankton morphology is likely to have affected the carbon cycle in the area.

- Model based on CPR data projected strong phenological shifts and decline in phytoplankton abundance (but to be confirmed).



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Limnol. Oceanogr. 70, 2025, 2447-2463
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doi: 10.1002/lno.70137

RESEARCH ARTICLE

How marine heatwaves are reshaping phytoplankton in the Northeast Pacific

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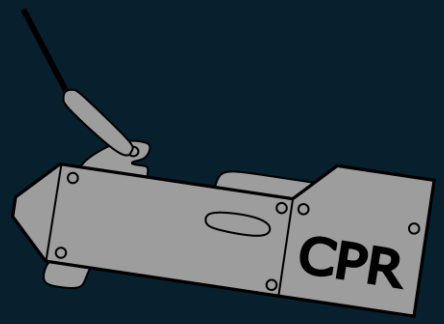

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