Phytoplankton community response to climate stress in an advanced ocean-biogeochemical model

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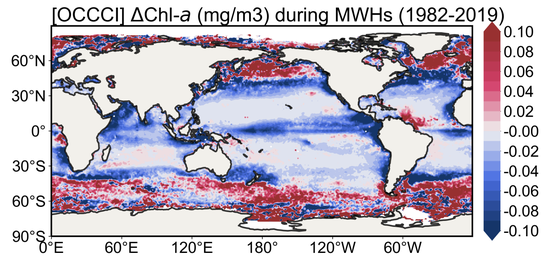
1. Background

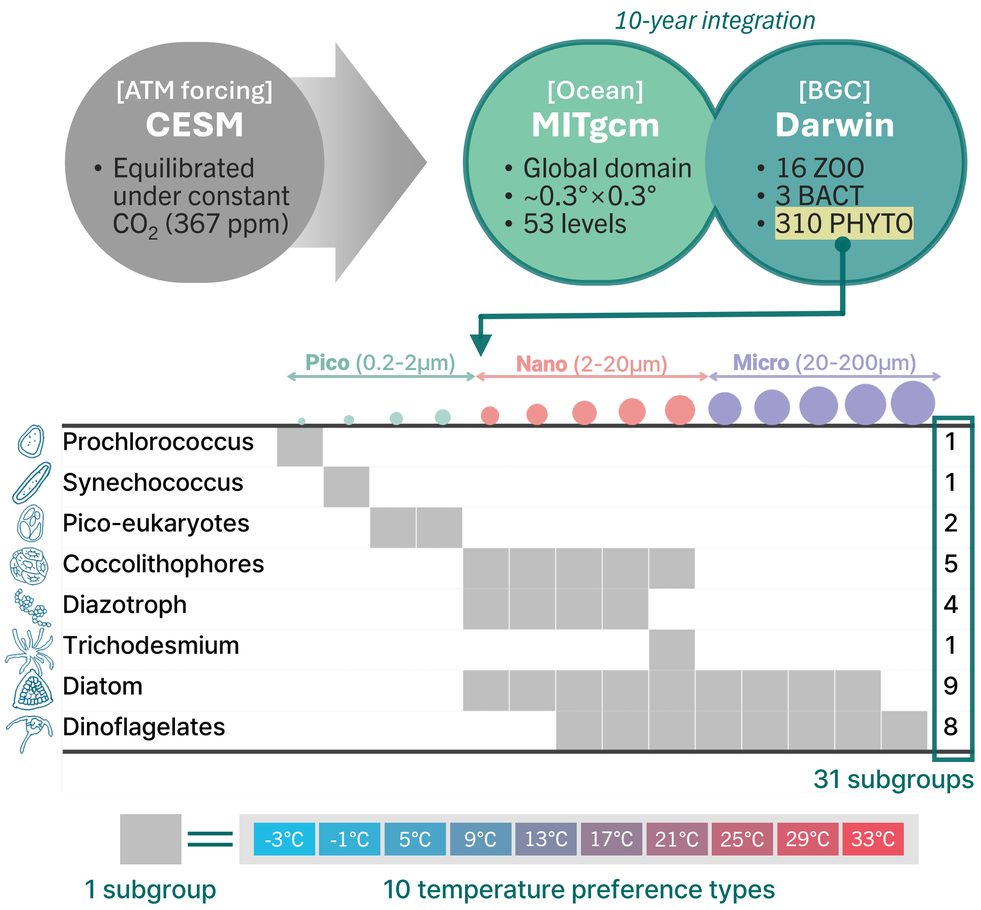
- Marine heatwaves (MHWs) are becoming more frequent, stronger, and longer[1-3], increasingly threatening ecosystems, including phytoplankton communities.



- Within phytoplankton community, each type exhibits different adaptability and/or vulnerability to climate stressors[4-6].
- Direct observations are challenging, leaving significant uncertainties in our understanding of how MHWs impact phytoplankton community structures.

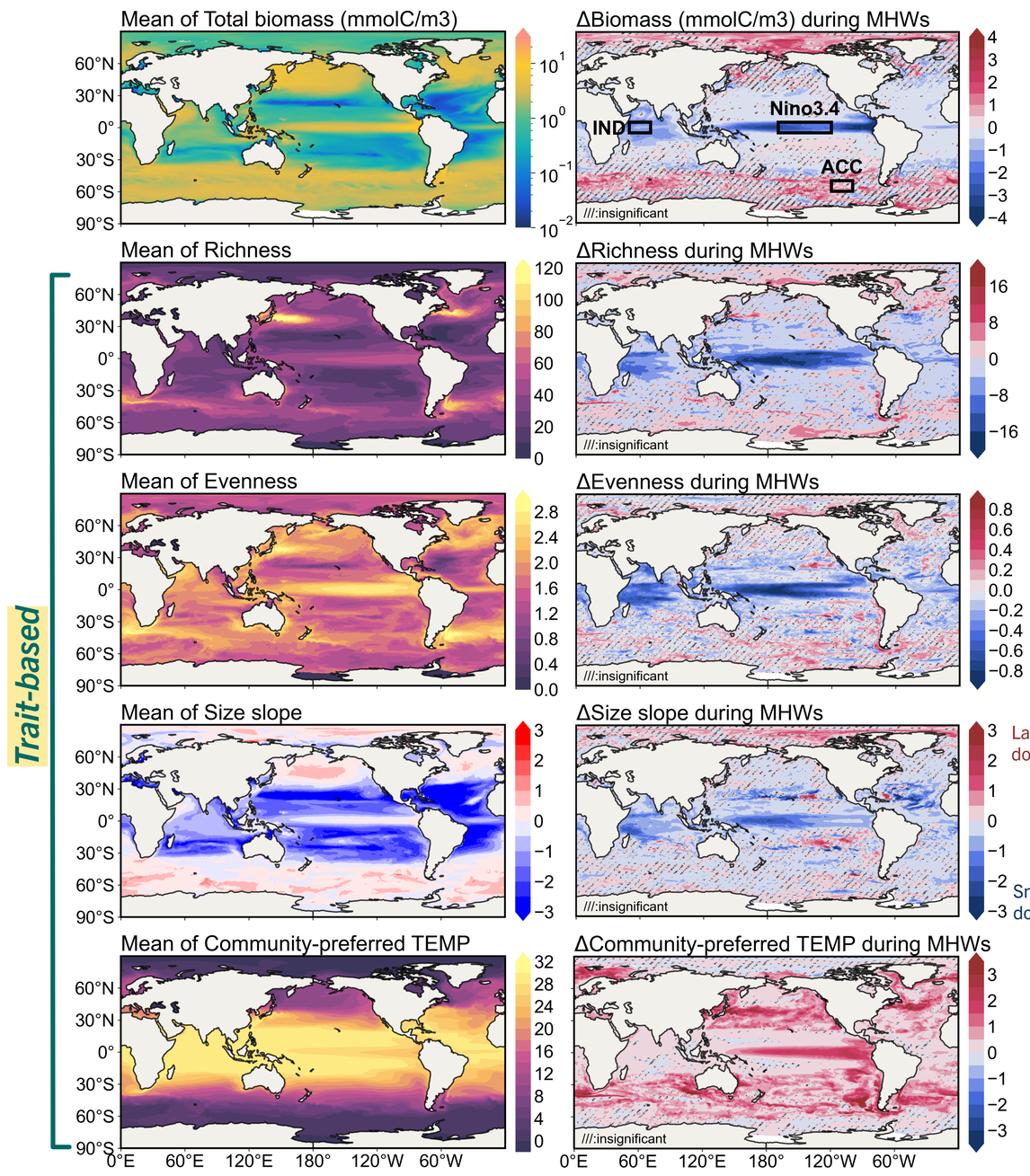
2. Experimental configurations

Ocean-BGC model with present-day atmospheric forcing



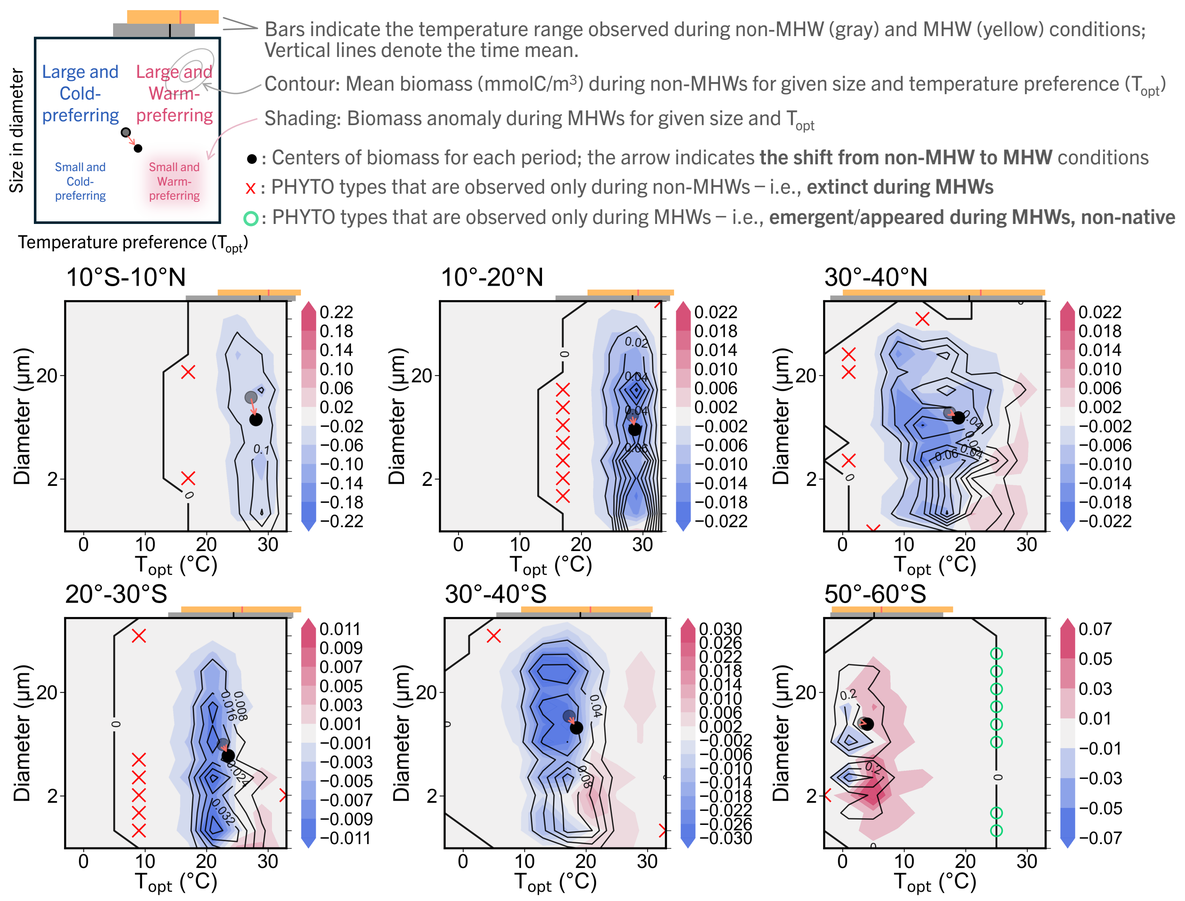
3. Results

Mean vs MHW response



▲(Left) Mean patterns for each variable at the surface.
(Right) Composite anomalies during MHW events.
Richness: Number of PHYTO types present at a given location.
Evenness: Degree of uniform coexistence among types.

Community Composition Shift Associated with MHW



4. Summary

- ✓ Produced large-scale, high-complexity simulation data that explicitly resolve phytoplankton community structures, expanding the scope of climate–biodiversity research.
- ✓ Enables previously limited trait-based analyses, particularly those examining temperature preference in phytoplankton responses to extreme thermal conditions.
- ✓ Reveals that during MHWs, low-diversity, few-dominant, warm-preferring, and small-sized communities tend to thrive across low- to mid-latitudes.
- ✓ Suggests that MHWs can locally drive the extinction of cold-preferring species and the emergence of warm-preferring alien species.

References

1. Oliver et al., 2018. *Nat Commun 9*, 1324
2. Cheng et al., 2023. *Sci Total Environ 881*, 163396
3. Deser et al., 2024. *J Clim 37*(6), 1877-1902
4. Henson et al.. 2021. *Nat Commun 12*(1), 5372
5. Brown et al., 2024. *Commun Biol 7*, 125
6. Zhan et al., 2024. *Commun Earth Environ 5*, 629

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