Signatures of the multiple scales of motion in shaping marine phytoplankton biogeography

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PROJECT GOALS

• Describing and understanding dynamic phytoplankton community biogeography from few kms to basin scales

• The observable signatures of these multiscale biogeographical patterns in satellite and in-situ data: how to monitor now and in future
MODELS

- Data constrained ocean circulation models
- Complex marine ecosystem model
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**MODELS**
- Data constrained ocean circulation models
- Complex marine ecosystem model

**OBSEVATIONS**
- Satellite data
- High resolution in situ data

flow cytometer derive biomass

schematic of ecosystem model

modelled eco-provinces
MODELS
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OBSEVATIONS
- Satellite data
- High resolution in situ data

Tools to explore these:
- Machine learning
- Lagrangian tracking
- Ecological Theory

\[ R^* = \frac{K_R}{\mu \mu} - 1 \]
\[ S_{Fe}^* - S_N^* \geq R^* \]
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Publications:

• Ribalet et al (2019) SeaFlow data 1.0: high-resolution abundance, size and biomass of small phytoplankton in the North Pacific. *Scientific Data*
• Kuhn et al. Phytoplankton community temporal and spatial scales of decorrelation. *Journal of Geophysical Research*
• Dutkiewicz et al (2020). Dimensions of phytoplankton diversity. *Biogeosciences*
• Henderikx Freitas (2020). Diel variability of bulk optical properties associated with the growth and division of small phytoplankton in the North Pacific Subtropical Gyre. *Applied Optics*
• Tréguer et al (2021). Reviews and syntheses: The biogeochemical cycle of silicon in the modern ocean. *Biogeosciences*
• Follett et al (in revision). Collapse of *Prochlorococcus* population in the transition between subtropical and subpolar gyres. *Proceedings of the National Academy of Sciences*
HIGHLIGHTED PROJECTS

1) Understanding basin scale patterns of *Prochlorococcus* distribution

2) Understanding role of sub-mesoscale in structuring plankton communities
Understanding basin scale patterns of *Prochlorococcus* distribution

*Prochlorococcus* is smallest, most abundant phytoplankton

Known to not be found at high latitudes

Understanding basin scale patterns of *Prochlorococcus* distribution

Explore with:
- Ecological theory
- Numerical model
- Observations

Understanding basin scale patterns of *Prochlorococcus* distribution: Theory

Previous ecological theory* does not predict this “collapse”

\[ P_j^* = \frac{m_z}{\gamma g_j} \]

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Understanding basin scale patterns of Prochlorococcus distribution: Theory

Previous ecological theory does not predict this “collapse”

But including shared predation with a similar sized heterotrophic bacteria does

Understandin... of Prochlorococcus distribution: Model

Explore using the MIT “Darwin” Ecosystem model

Simulation without explicit heterotrophic bacteria

Simulation with explicit heterotrophic bacteria

Understanding basin scale patterns of Prochlorococcus distribution: Observations

HIGHLIGHTED PROJECTS

1) Understanding basin scale patterns of *Prochlorococcus* distribution

2) Understanding role of sub-mesoscale in structuring plankton communities
Role of sub-mesoscale in structuring plankton communities

Regional high resolution model, with ecosystem including different size classes and functional groups of plankton

Focus on differences between front and backgrounds

Role of sub-mesoscale in structuring plankton communities

- not all groups of phytoplankton were enhanced at fronts

Role of sub-mesoscale in structuring plankton communities

Role of sub-mesoscale in structuring plankton communities

- Shading by enhanced blooms of diatoms at surface depleted some groups at depth

Role of sub-mesoscale in structuring plankton communities

- Shading by enhanced blooms of diatoms at surface depleted some groups at depth
- Increase grazers lead to higher grazing on less fast growing species


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