Integrating plankton observations and models: implications for ecological forecasting

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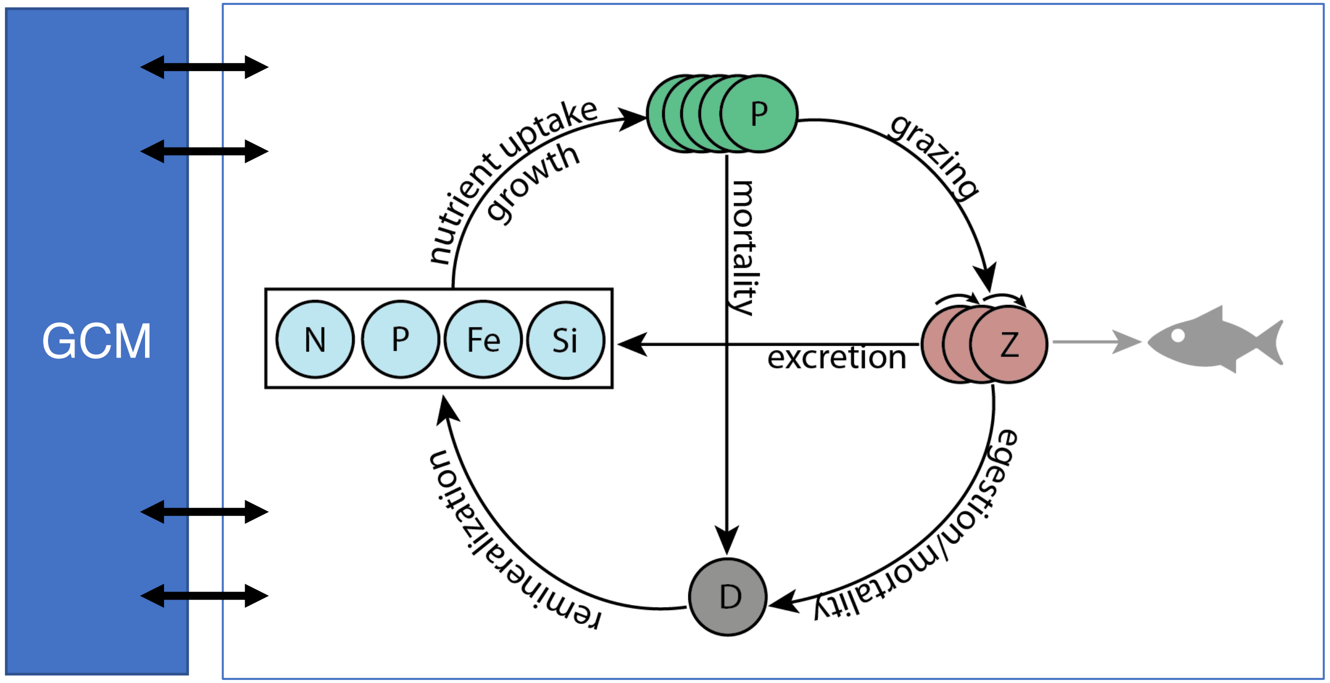
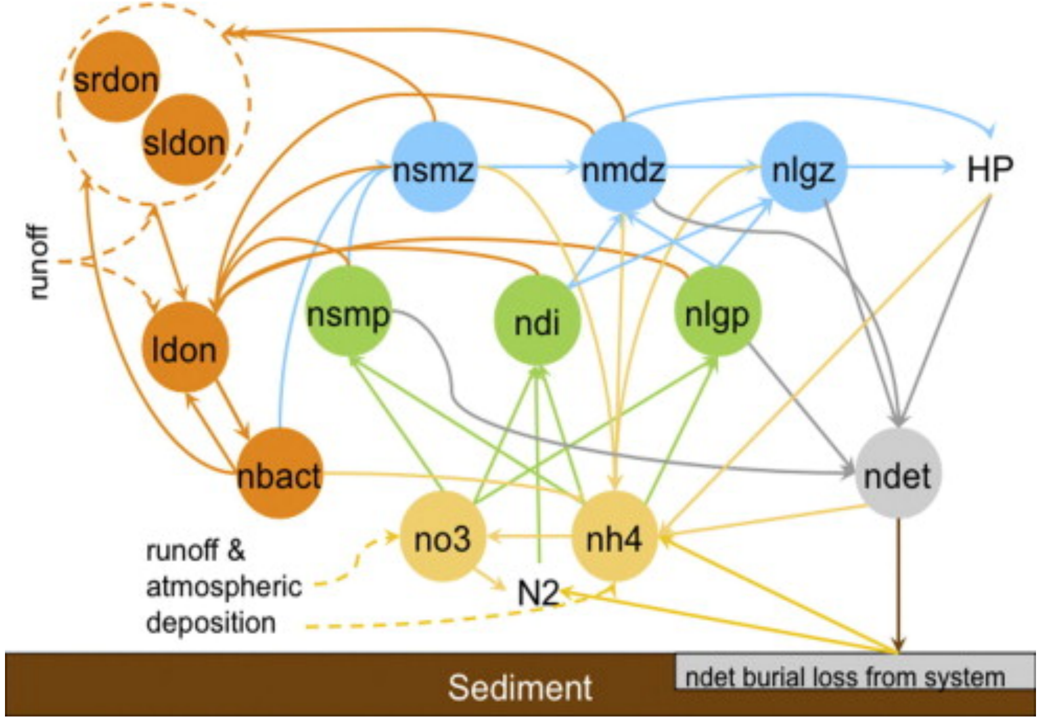
Ecological forecasting needs an integration of biological observations with ecosystem models

- Large-scale forecasting successes
- Plankton imaging systems for 3-D biological data
- Challenges and opportunities for models:
  - Representing soft bodied plankton
  - Reconciling scales of variability

Dynamical models simulate processes from the bottom-up

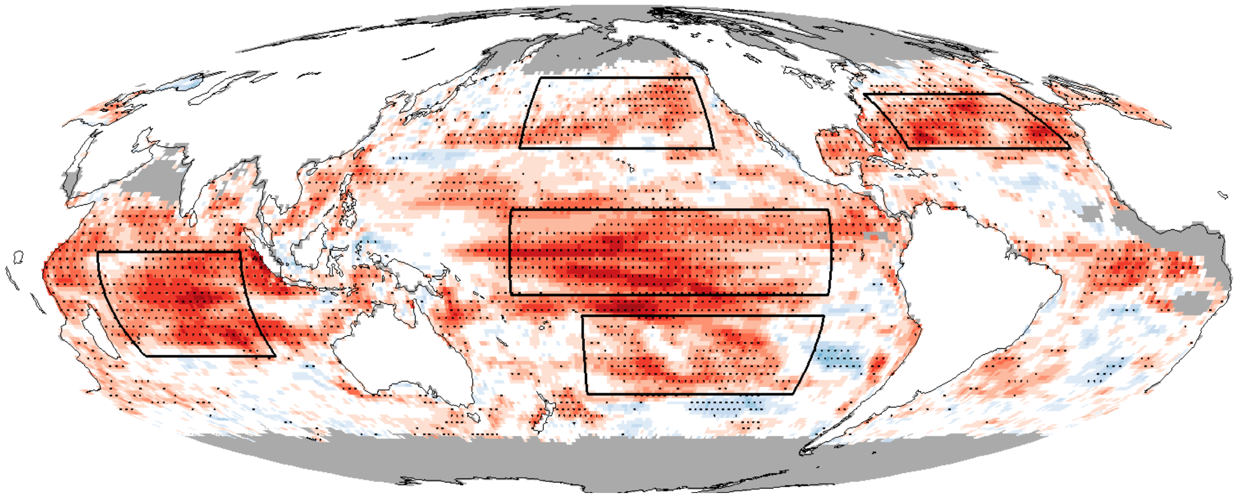


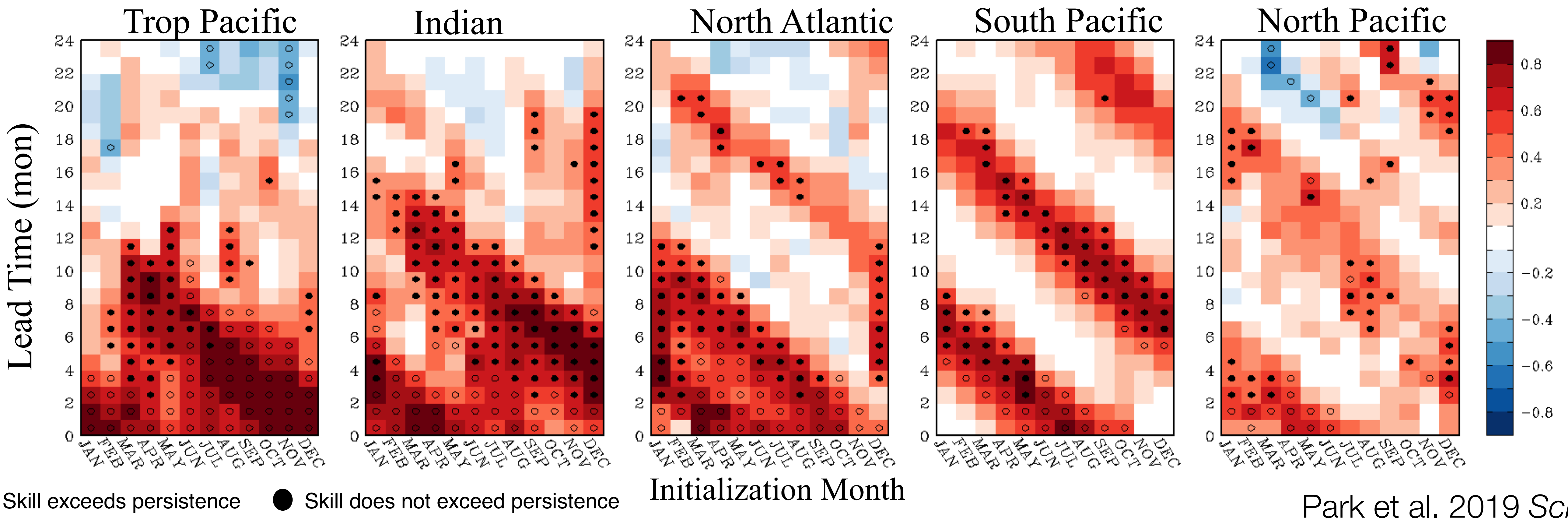


COBALT Ocean Biogeochemical Model

Stock et al. 2014

Chlorophyll prediction skill from an Earth System Model

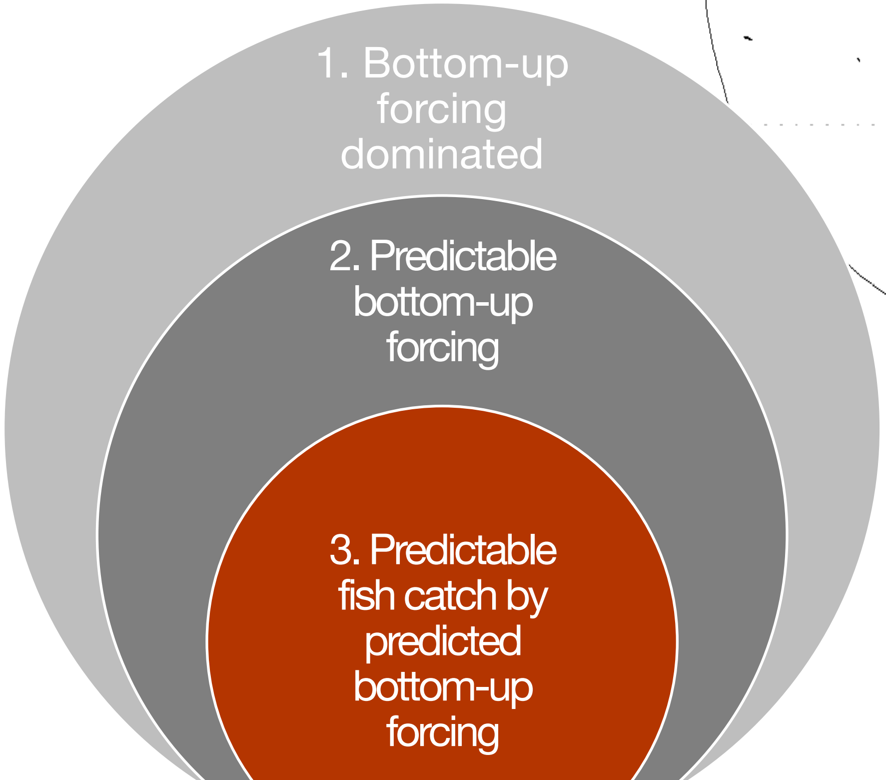


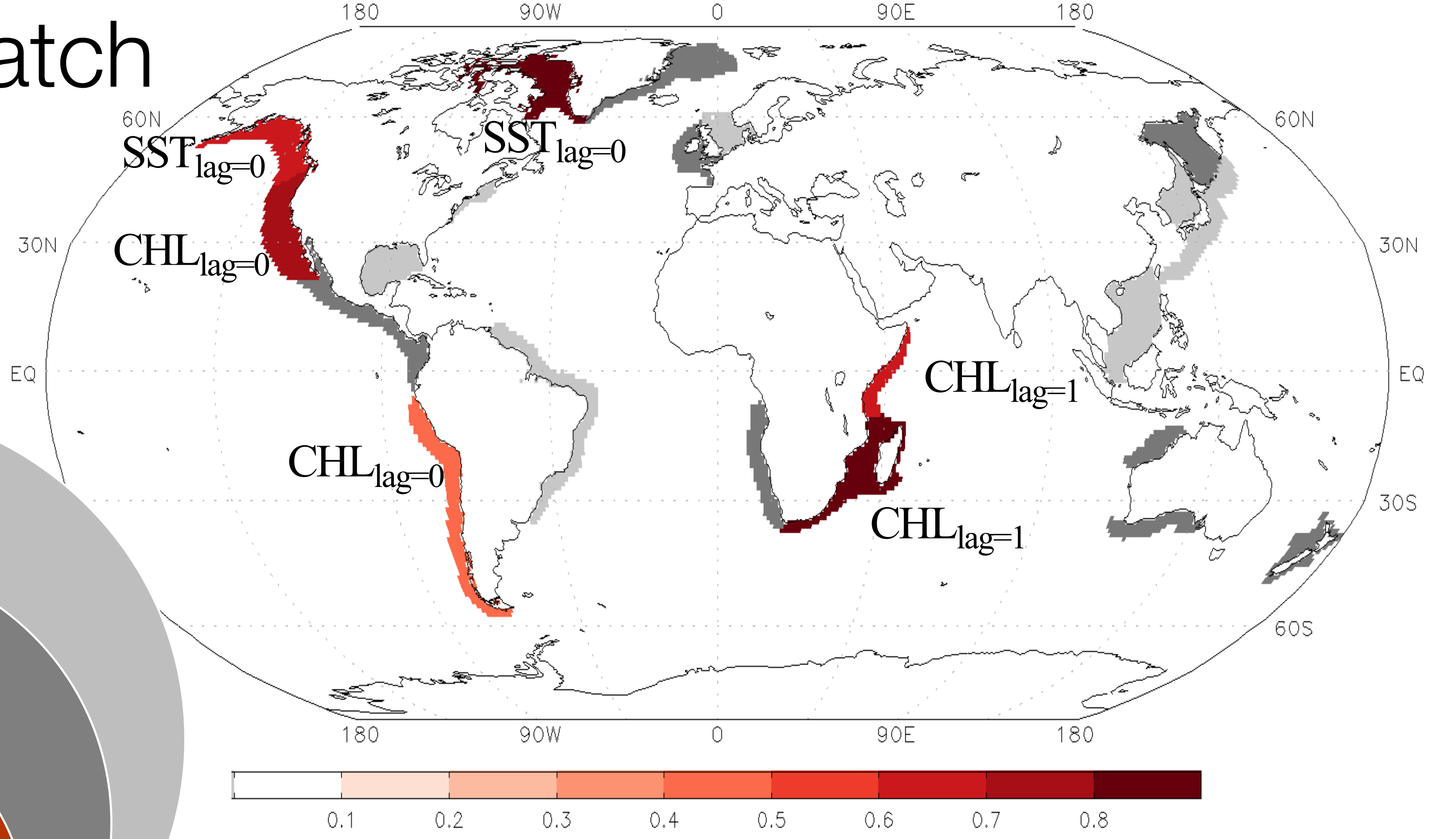


○ Skill exceeds persistence ● Skill does not exceed persistence

Park et al. 2019 *Science*

Annual fish catch prediction

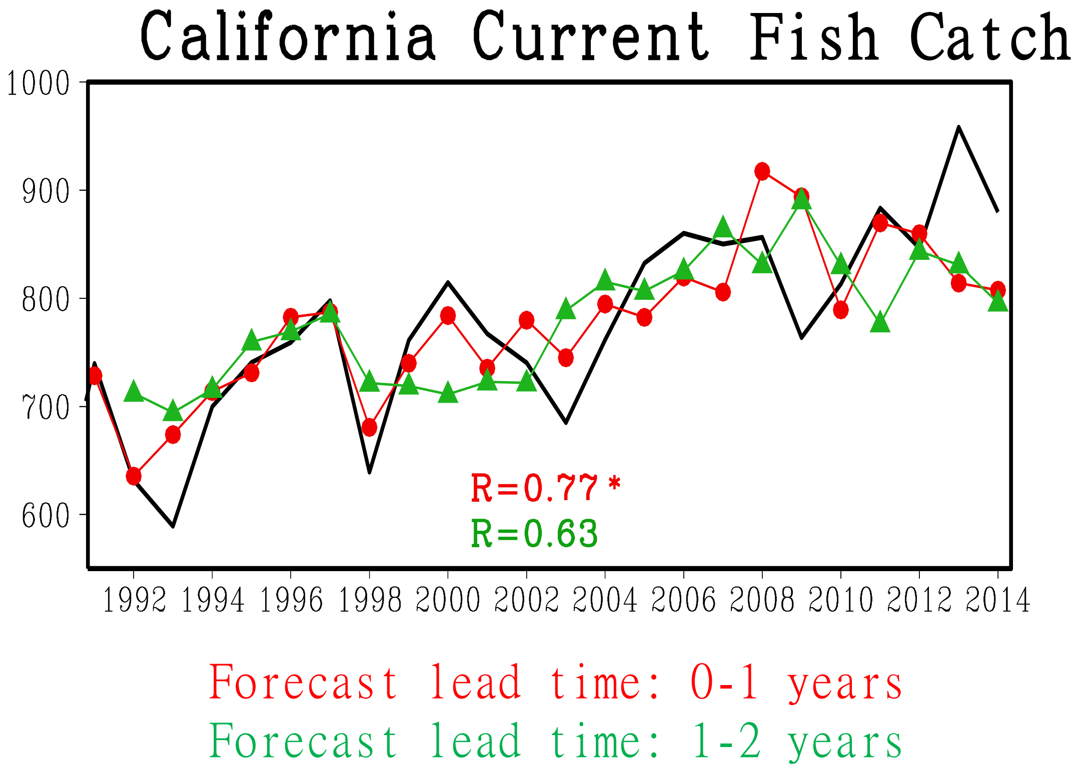


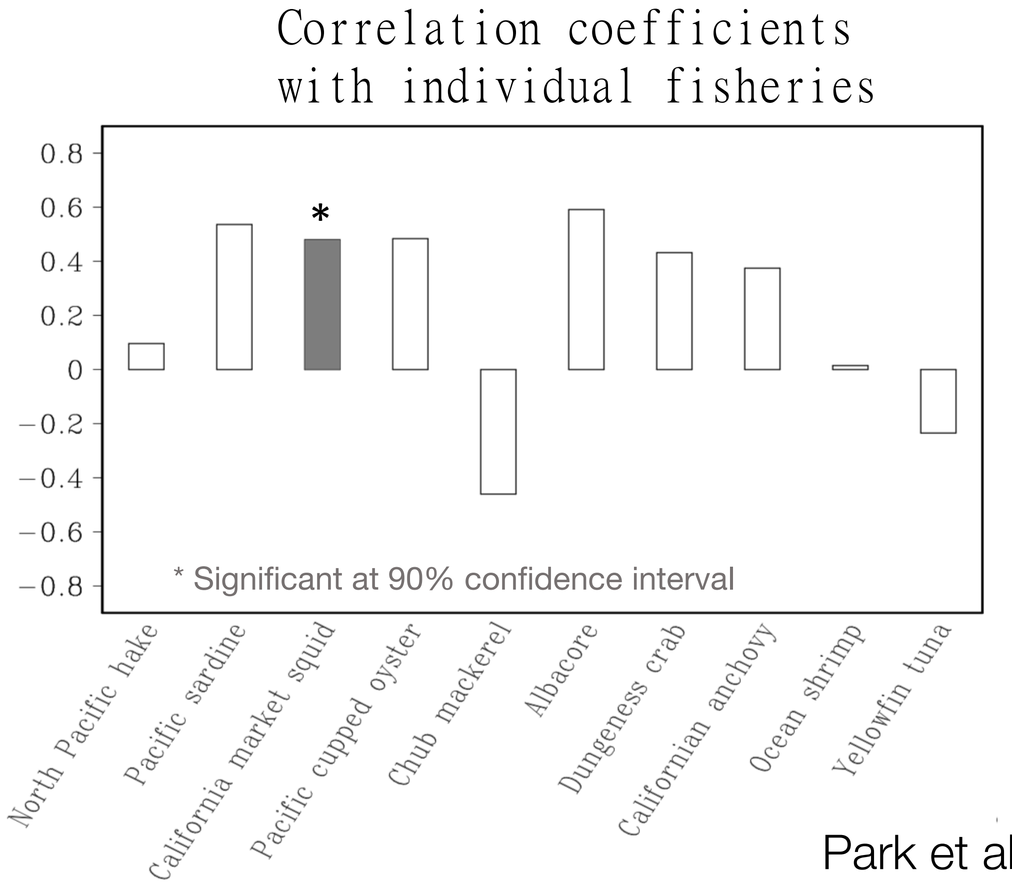


✓ Predictor: predicted SST or CHL

✓ Lead time: 1 year

Park et al. 2019 *Science*





Park et al. 2019

Shuttershock: Shane Gross

NOAA Fisheries

Red tide, Southern California Bight

Kai Schumann

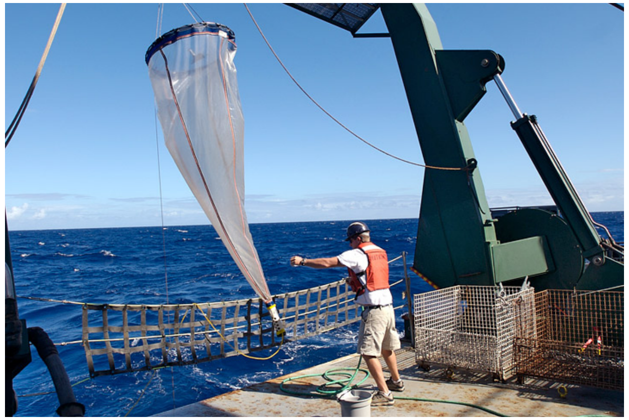
Gregg Langlois

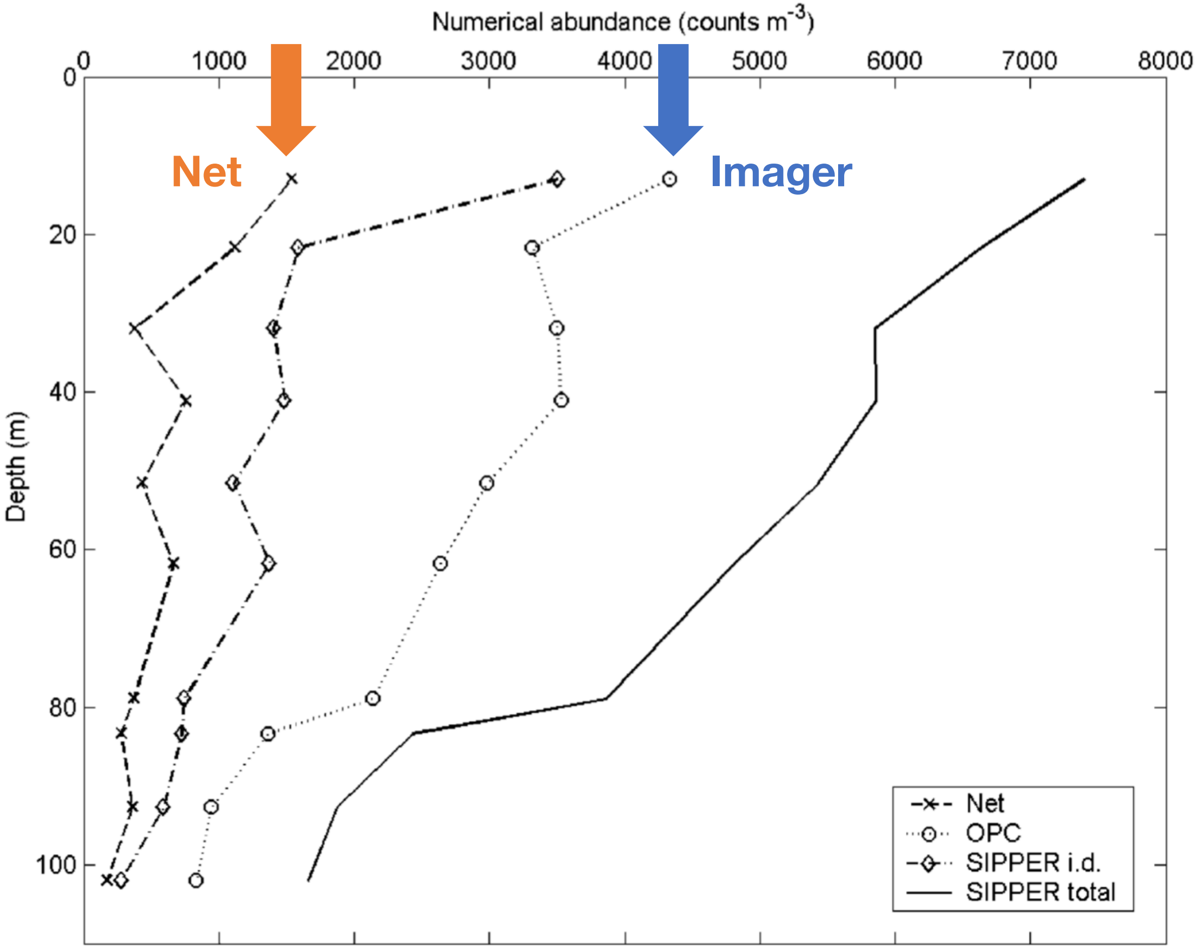
Pyrosome bloom, 2017

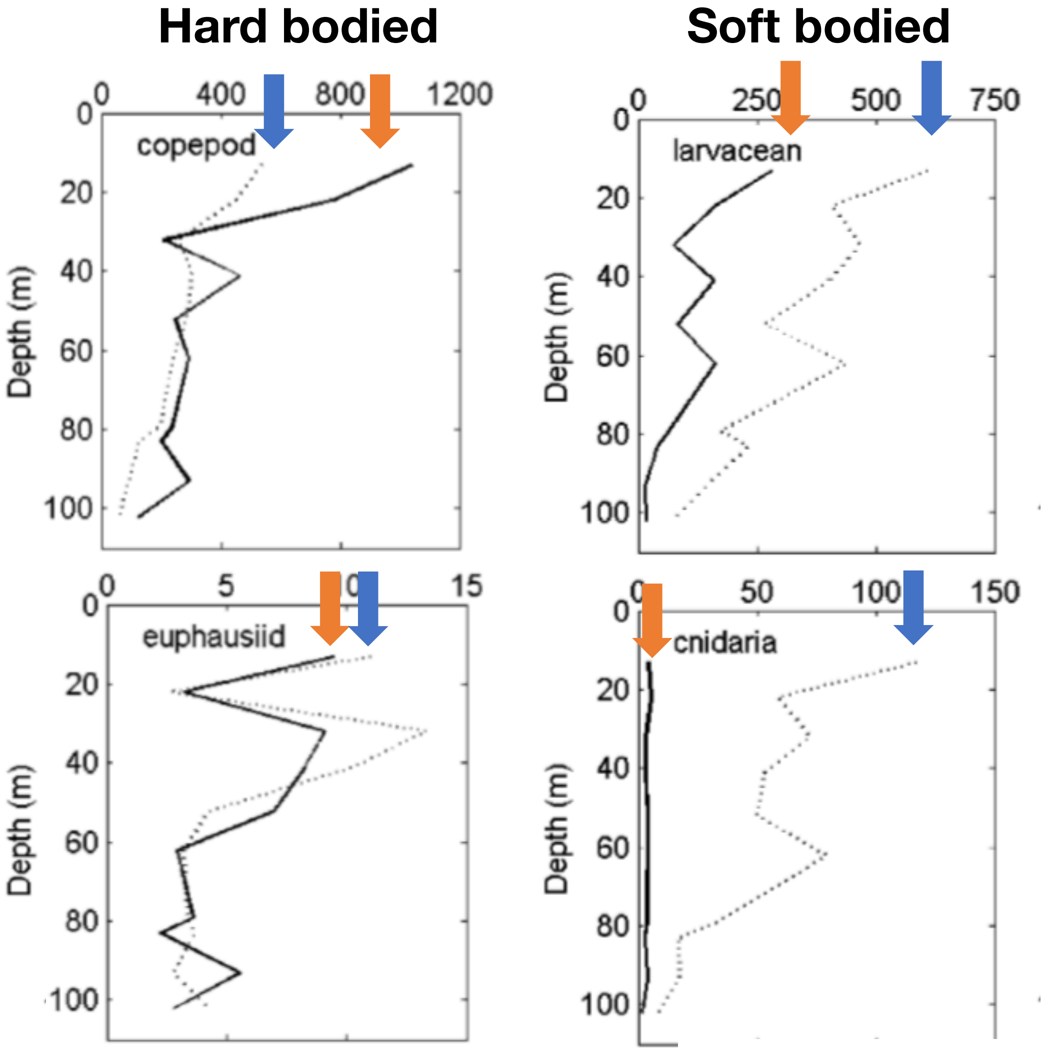
National Geographic

Path forward for ecological forecasting: integrating 3-dimensional biological observations

Plankton nets: labor intensive and systematically biased







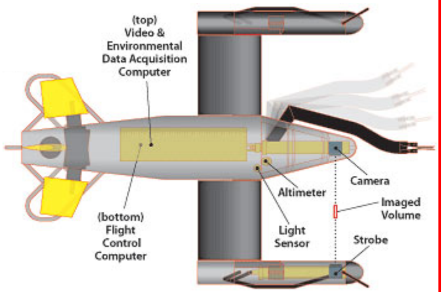
Remsen et al. 2004

Plankton imaging systems

Phytoplankton → Zooplankton

FlowCAM

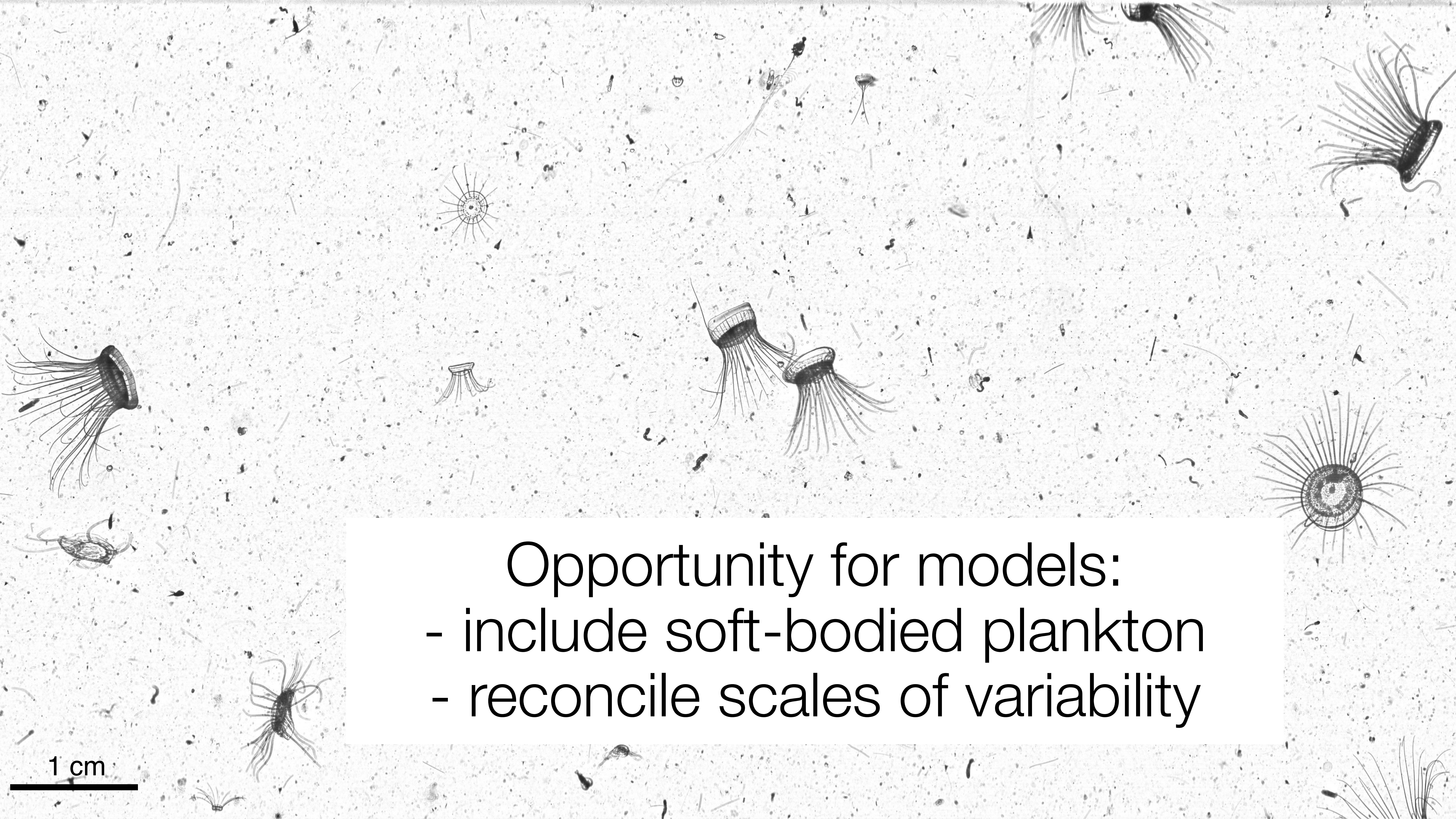
LOPC



VPR


UVP5

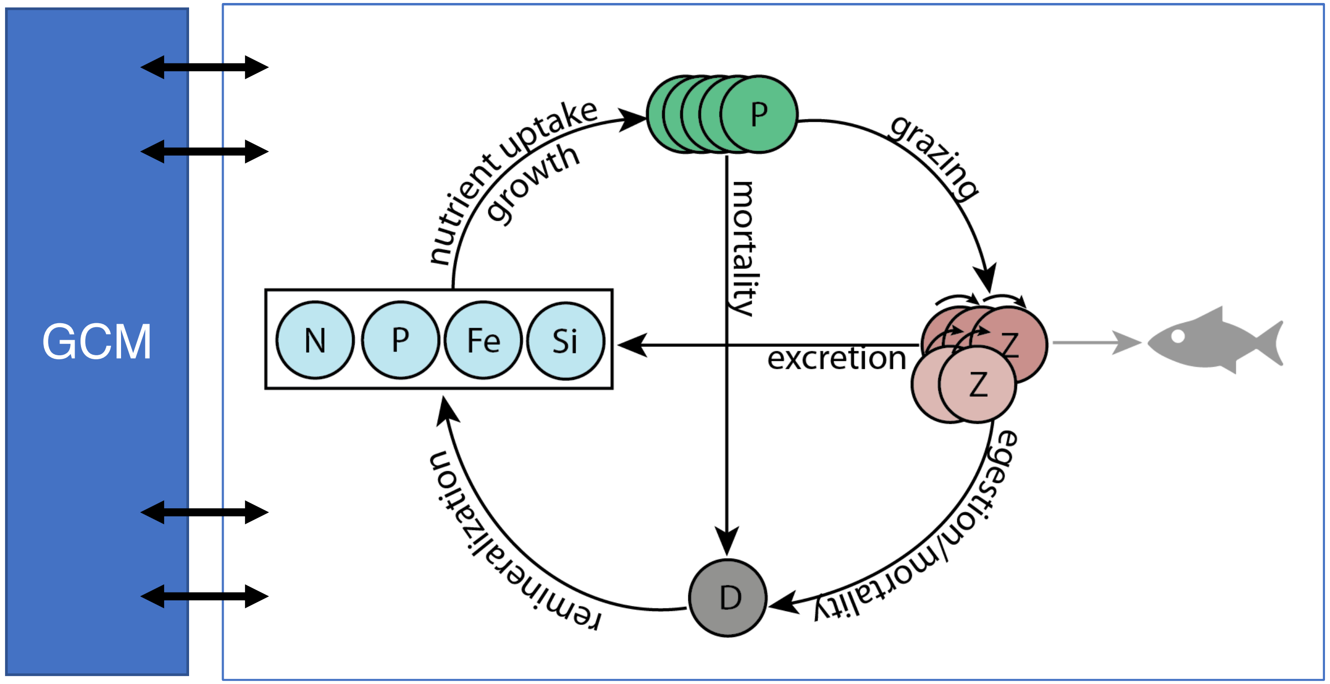
ISIIS



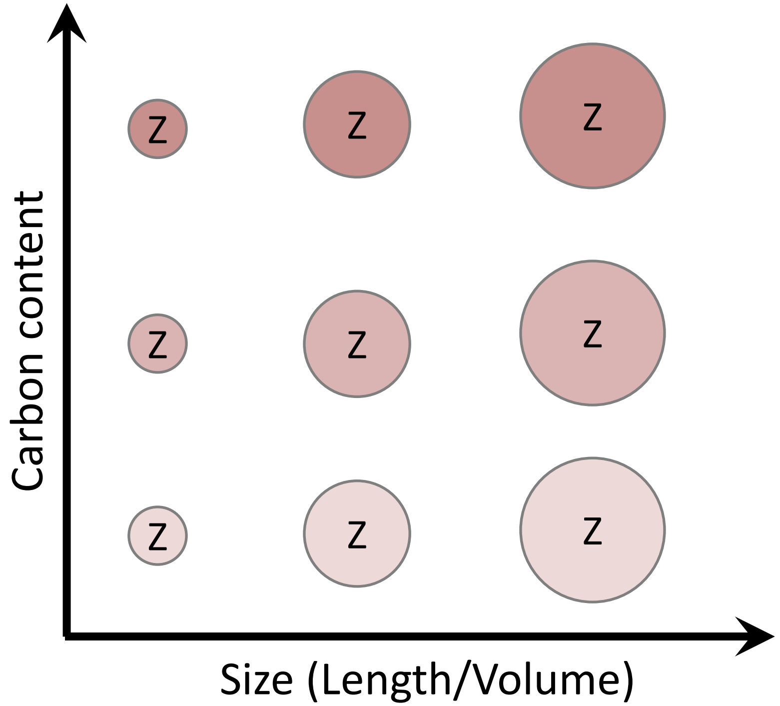
Opportunity for models:

- include soft-bodied plankton
- reconcile scales of variability

How to incorporate soft-bodied zooplankton?



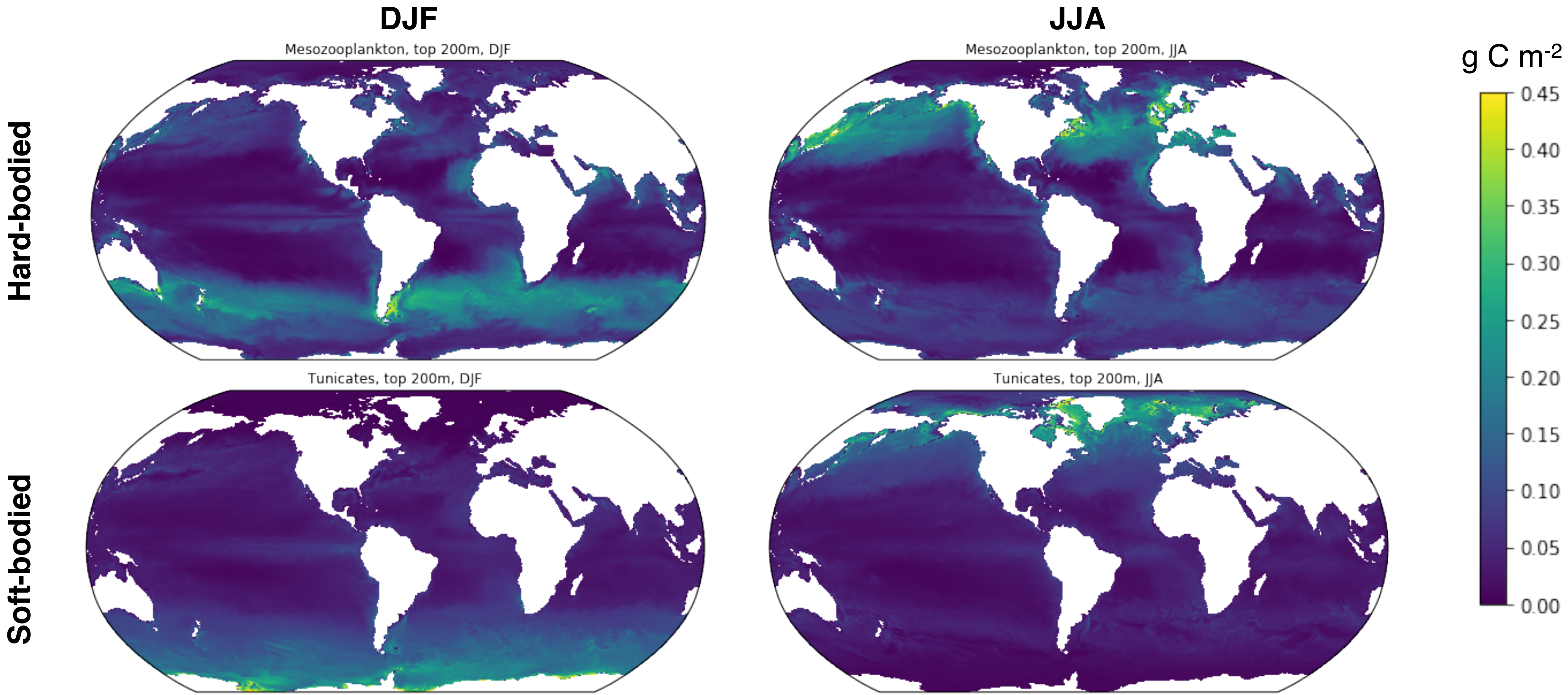
1. Explicit gelatinous zooplankton (GZ) functional groups



2. Trait-based zooplankton

Metabolic relationships based on C:Vol ratio?

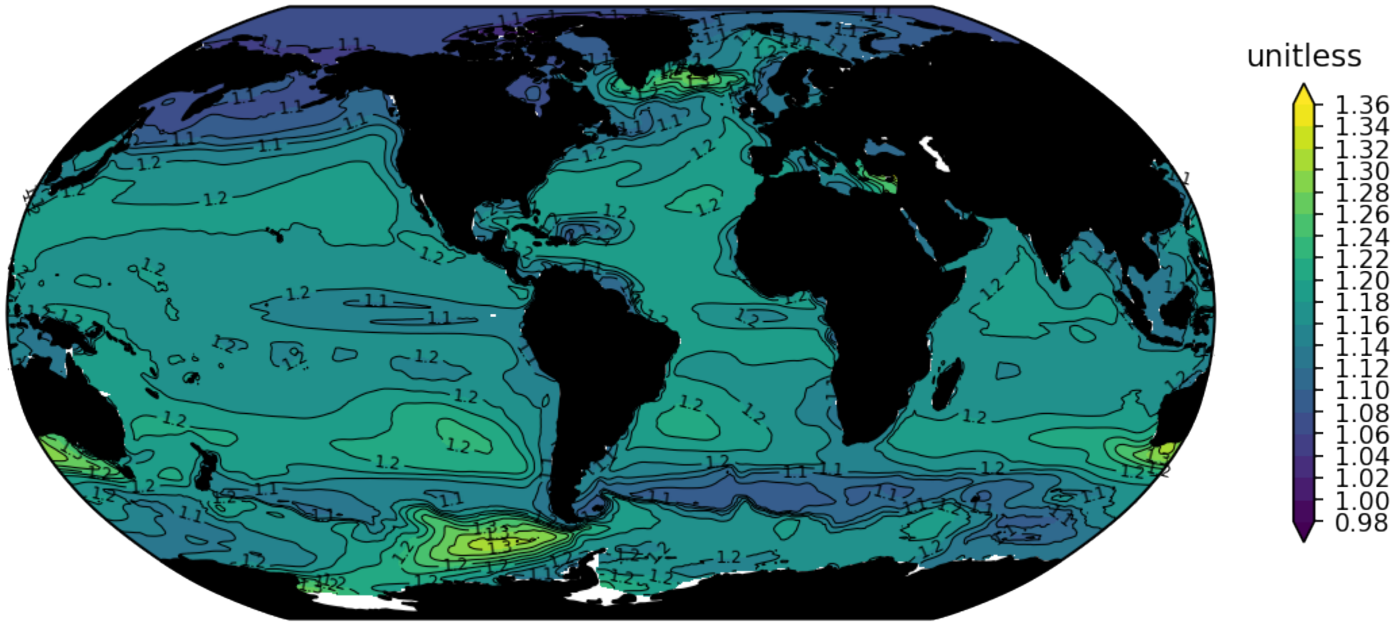
1. Explicit GZ:
Hard vs. soft bodied zooplankton simulation



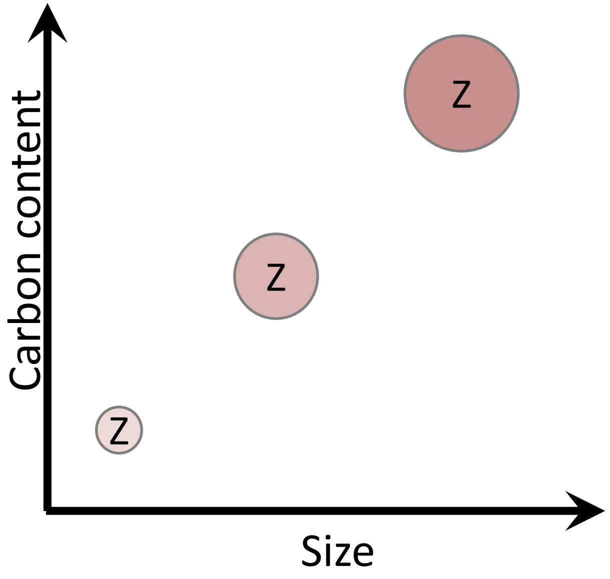
GZ-COBALT in GFDL-ESM4

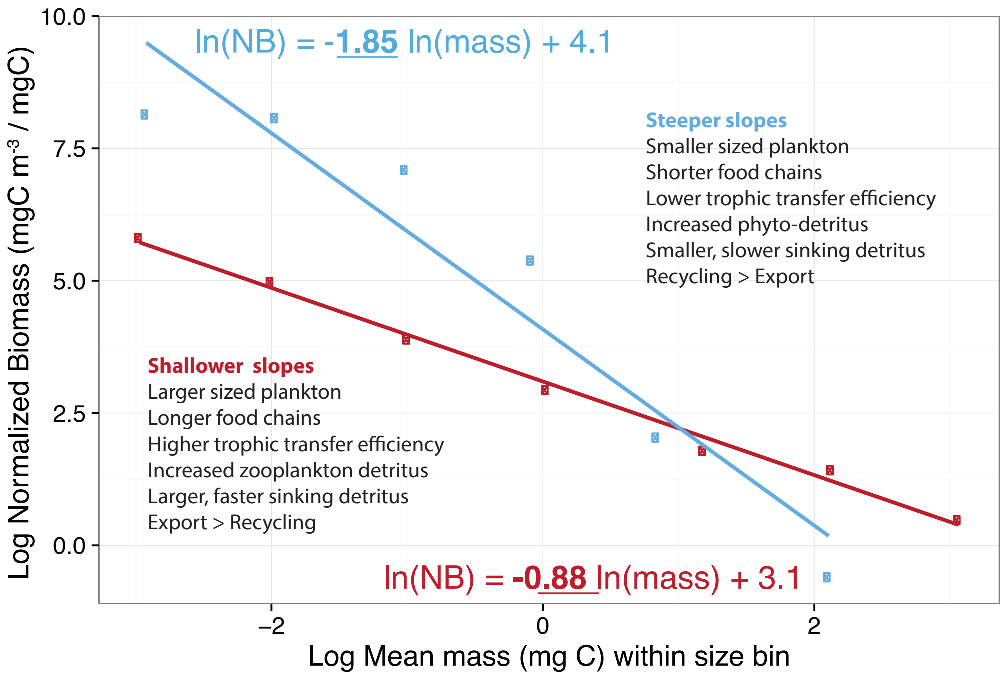
2. Trait-based zooplankton: Normalized biomass size spectra

Plankton size-spectra slope, 0-10 m

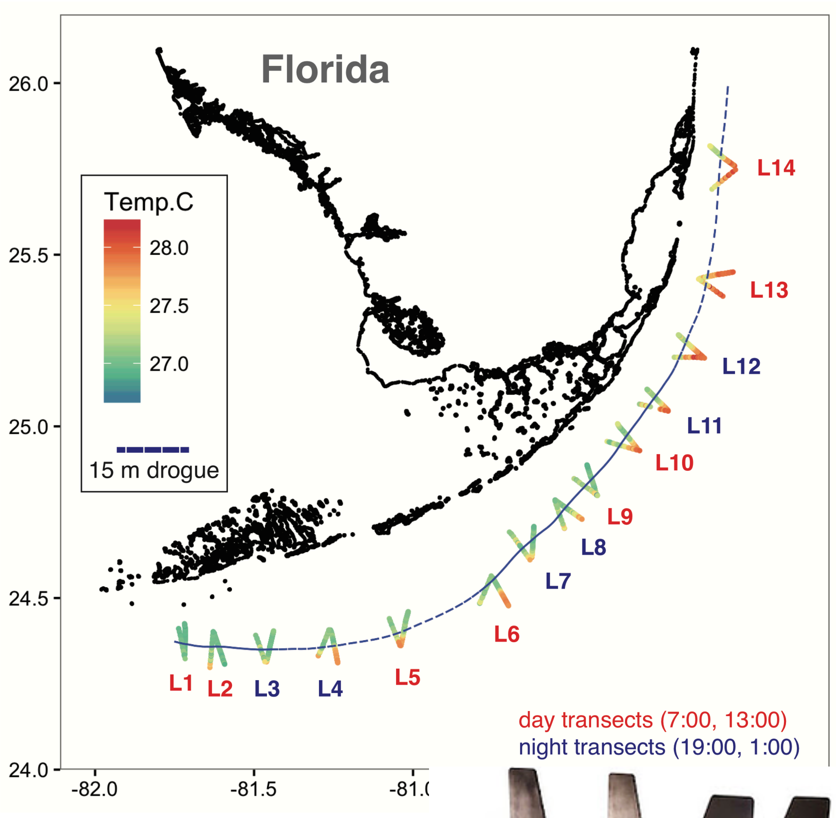


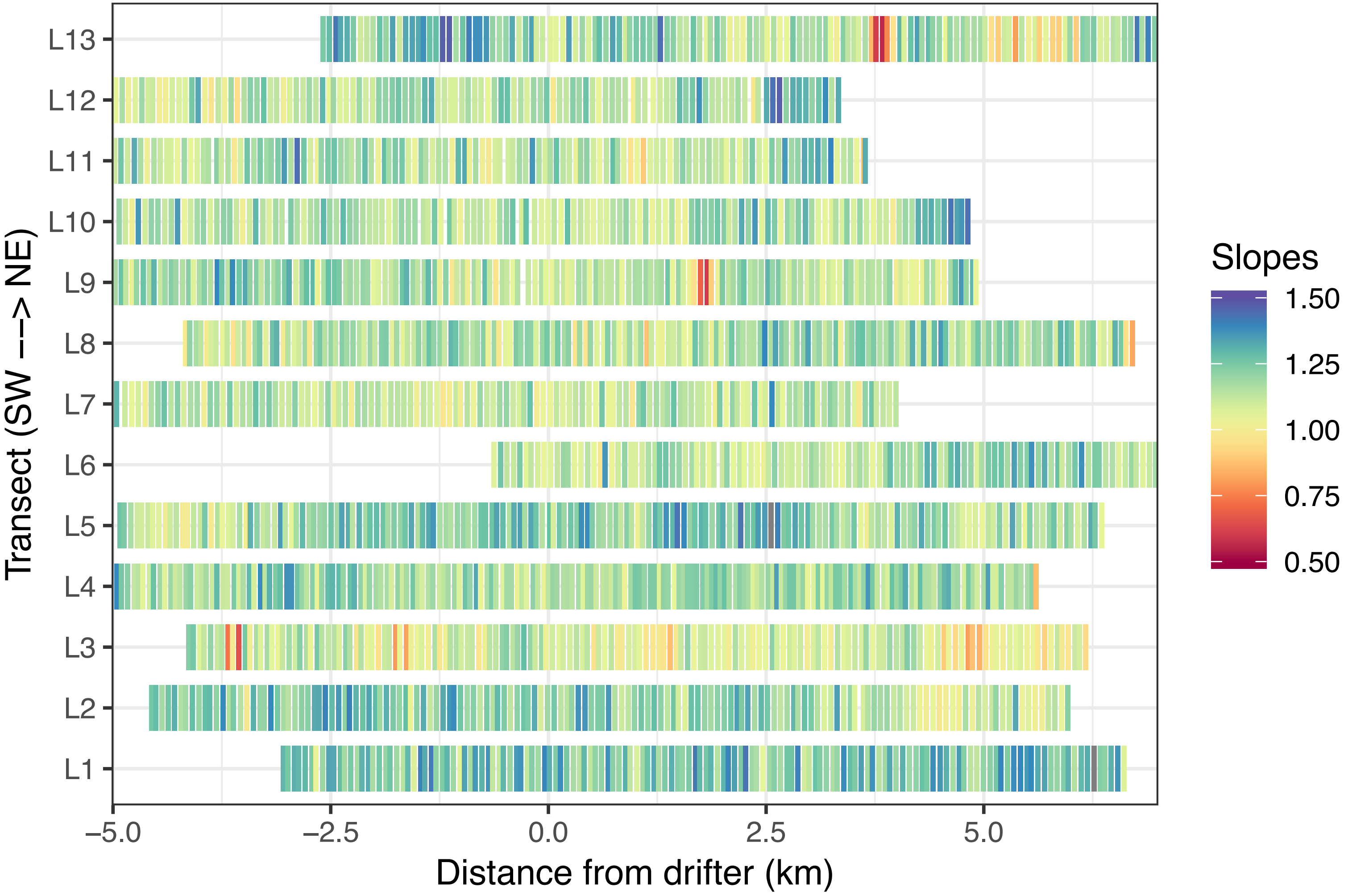
MARBL-SPECTRA model in CESM2



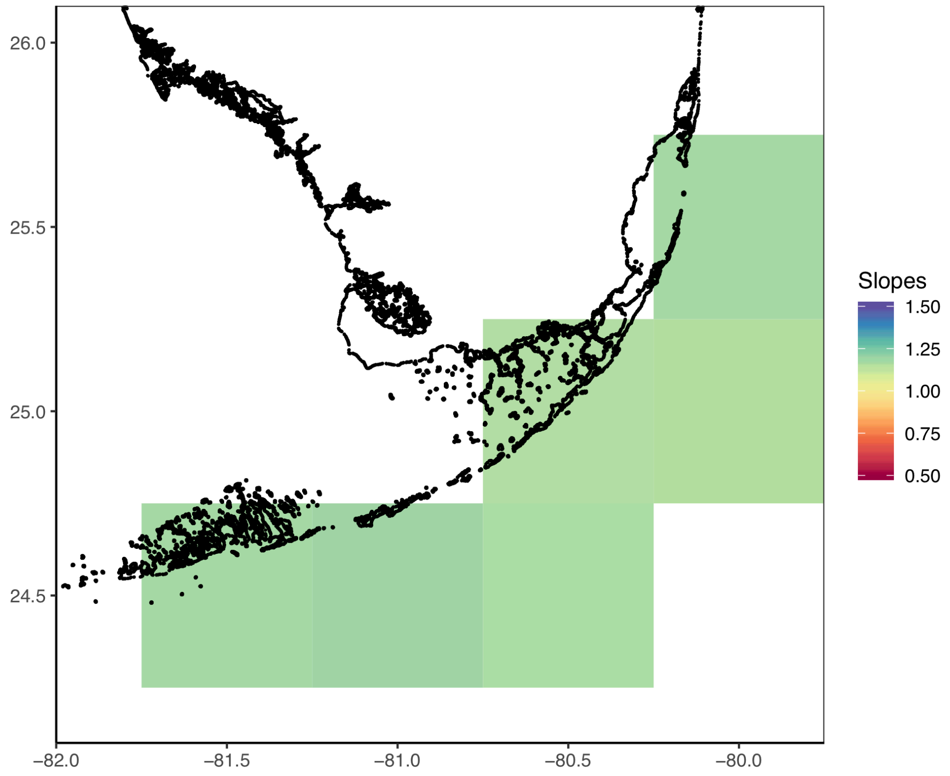


Plankton size spectra slopes from observations

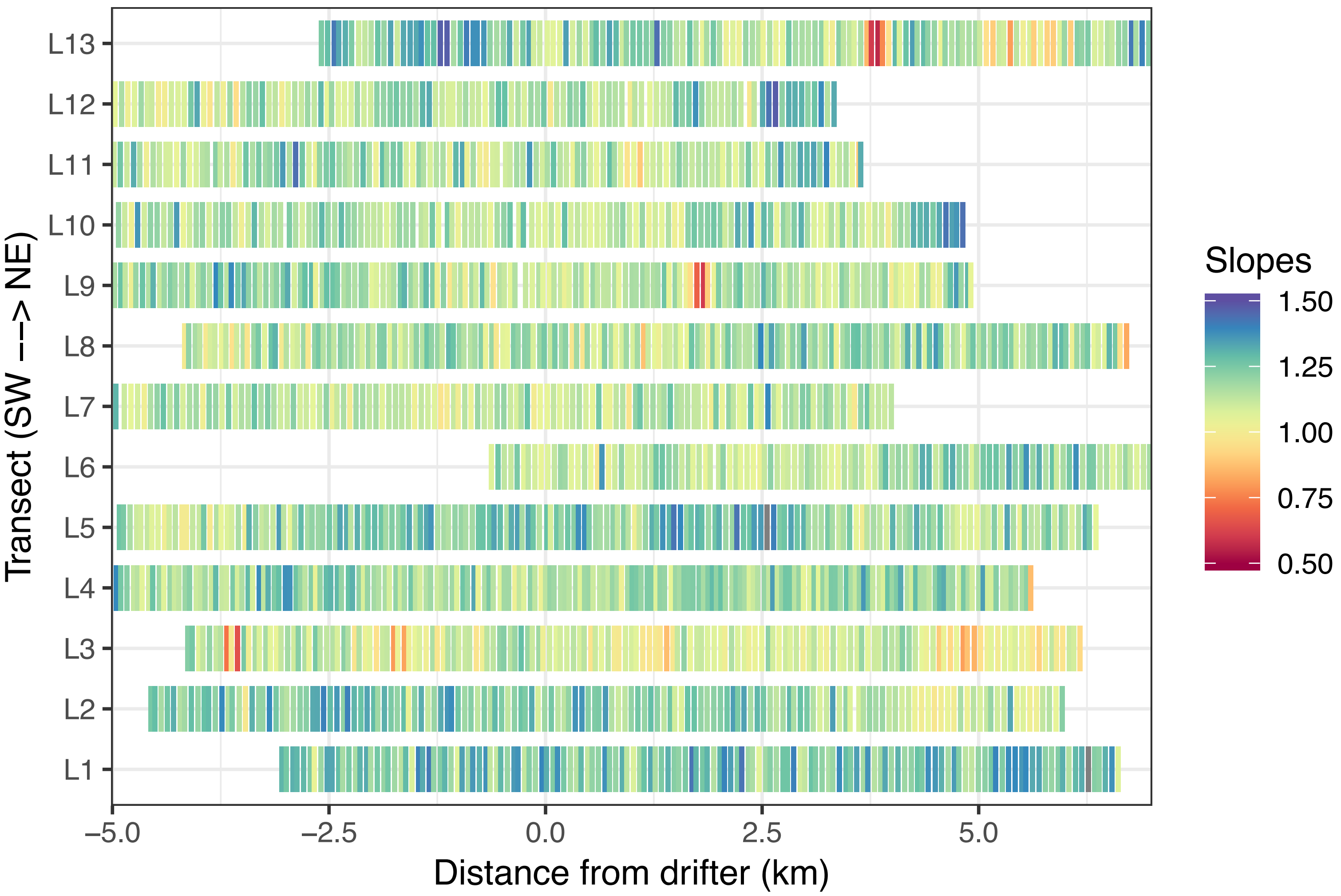




Plankton size spectra slopes from observations

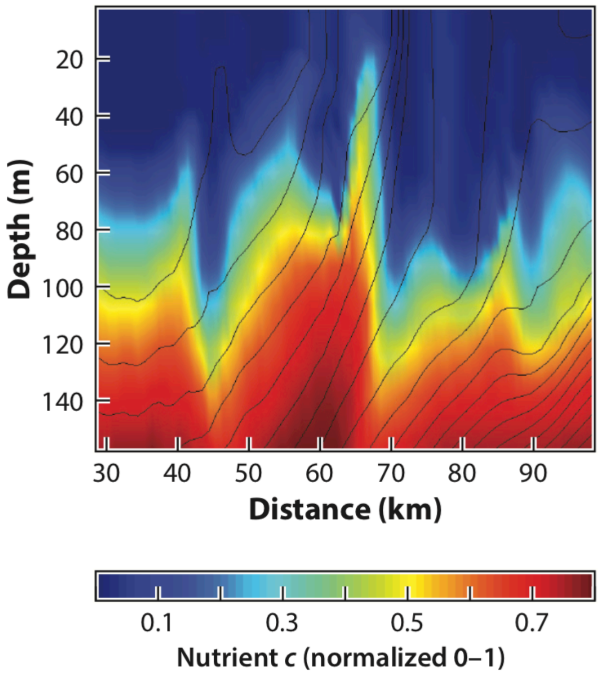


Size spectra slopes on a 0.5° grid



Submesoscale process studies at intermediate scales

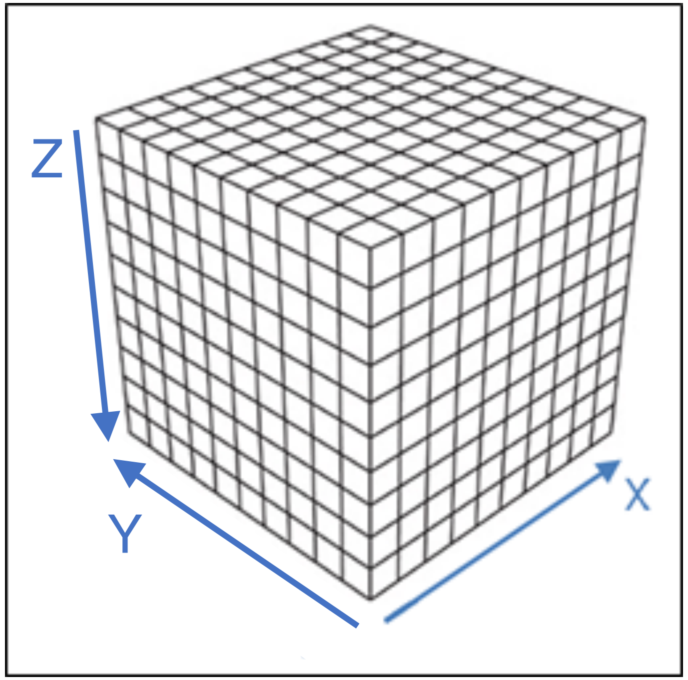
Process Study Ocean Model



100 km x 100 km domain
1 km resolution

Mahadevan (2016)

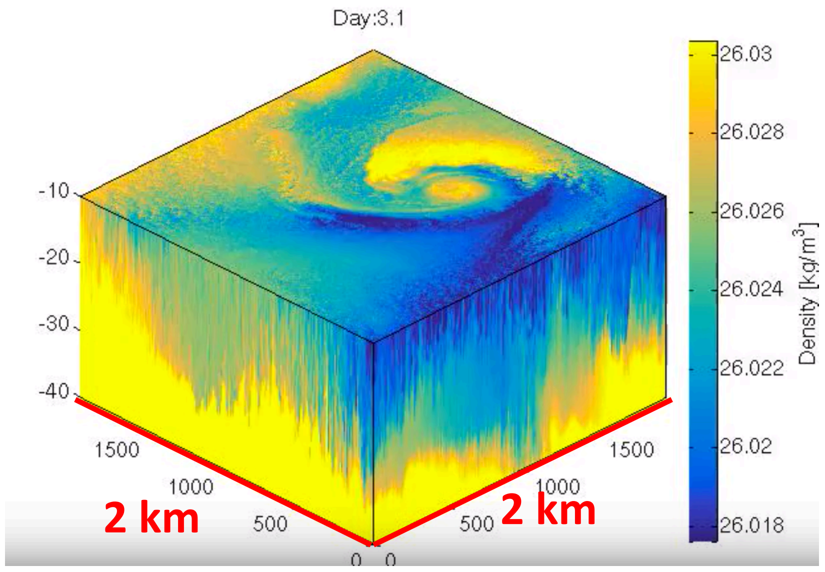
High resolution submesoscale model



10 km x 10 km domain
25 m resolution

Ideal scales for comparing with biological observations

Large Eddy Simulation



2 km x 2 km domain
1 m resolution

Whitt, Lévy, Taylor (2017)

Prime opportunity for integrating biological observations and models

- Next generation observational tools: imaging systems

How to integrate?

1. Various methods to include soft bodied plankton
2. Reconcile scales of variability between observations and models

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frontiers in Marine Science

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Advancing Marine Biogeochemical and Ecosystem Reanalyses and Forecasts as Tools for Monitoring and Managing Ecosystem Health

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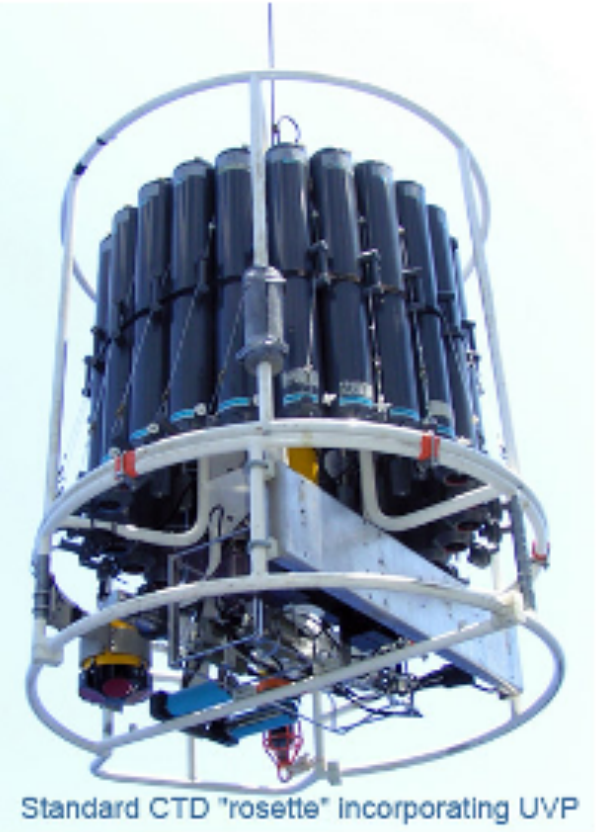
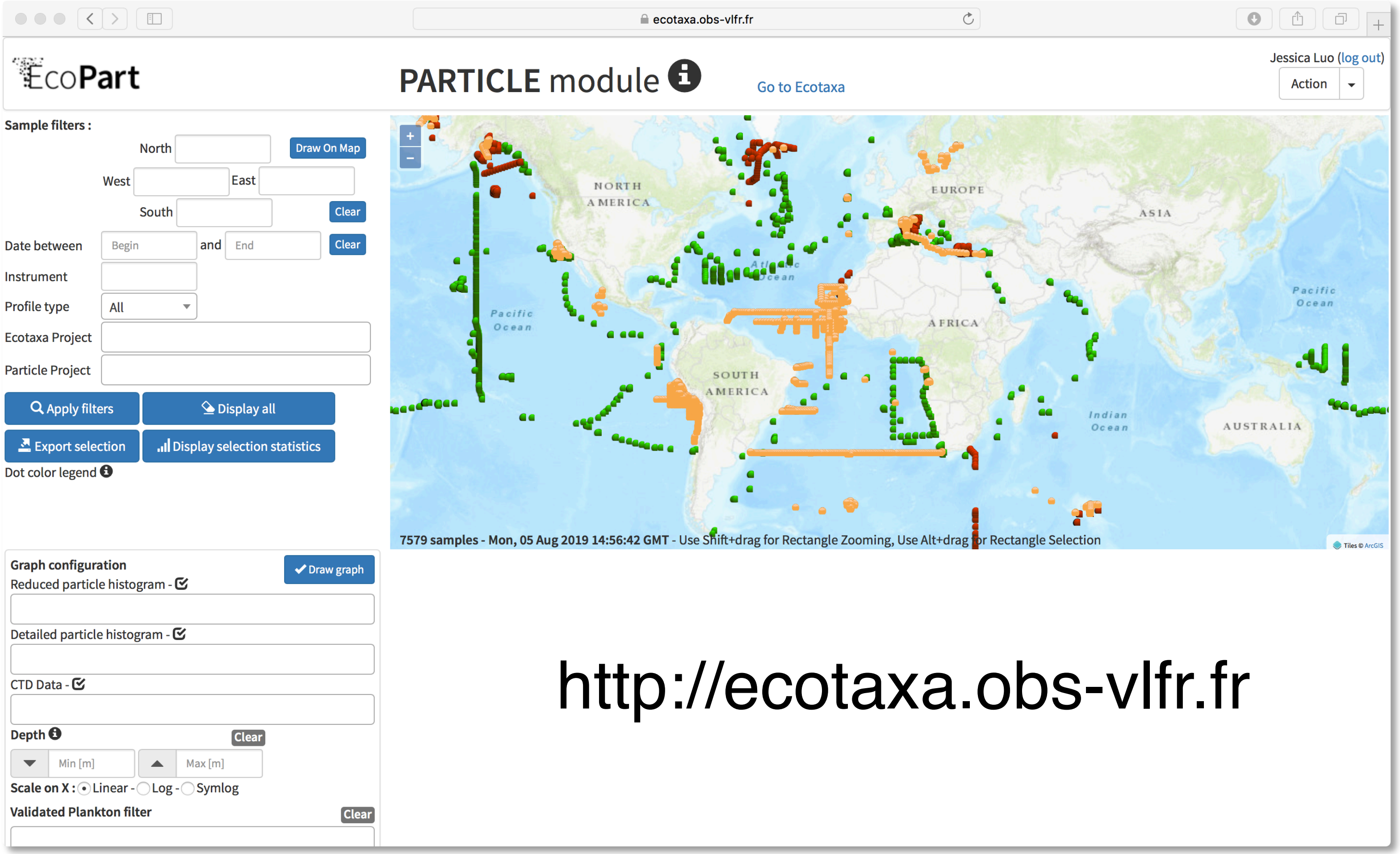
Underwater Vision Profiler 5 (UVP5)



Hydroptic



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