Lagrangian observations of the evolution of phytoplankton communities in upwelling filaments

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Overview

This study aims to understand the processes shaping offshore carbon flux by physical processes in the California Current system.

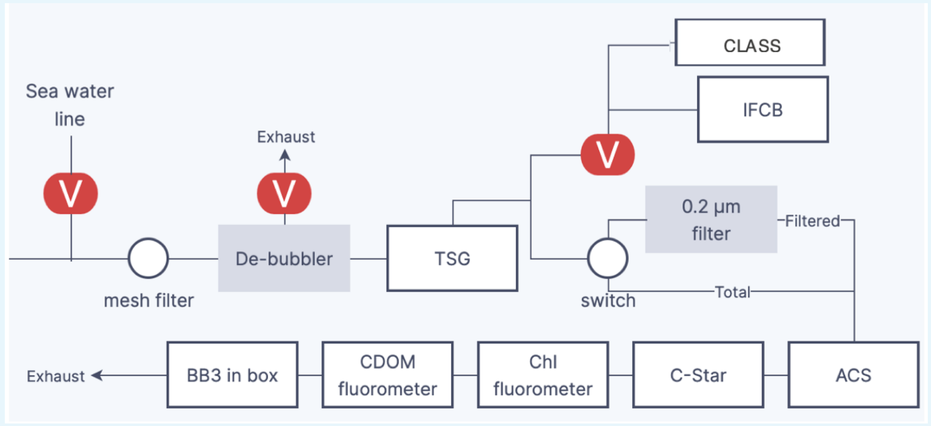
Phytoplankton carbon is transported offshore in filaments, but the evolution of communities in those filaments is affected by submesoscale processes that lead to vertical carbon export (Stukel et al. 2017) and that may directly impact productivity within the filaments.

In this preliminary study of observations collected in October 2022, we find:

- Both subduction and grazing contribute to dissipation of chlorophyll from the sea surface.
- Submesoscale frontal processes play an important role in shaping both the spatial distribution and fate of phytoplankton carbon.
- Substantial biological variation on 1 km scales.

Methods

Continuous optical observations



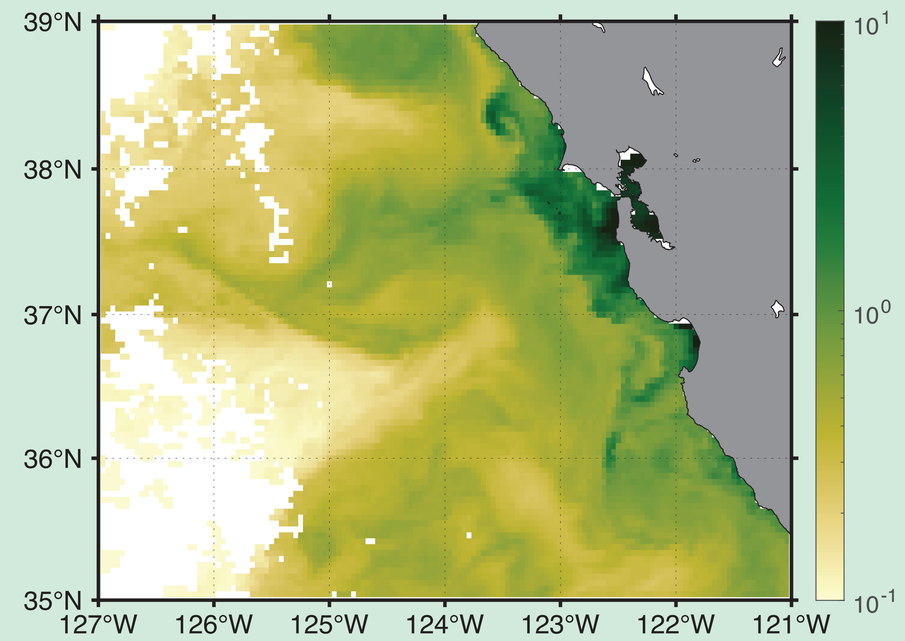
Towed profiler
Temperature, salinity, chlorophyll, backscatter, oxygen
(Dever et al. 2020)

Lagrangian observations
Drifters and a mixed layer float

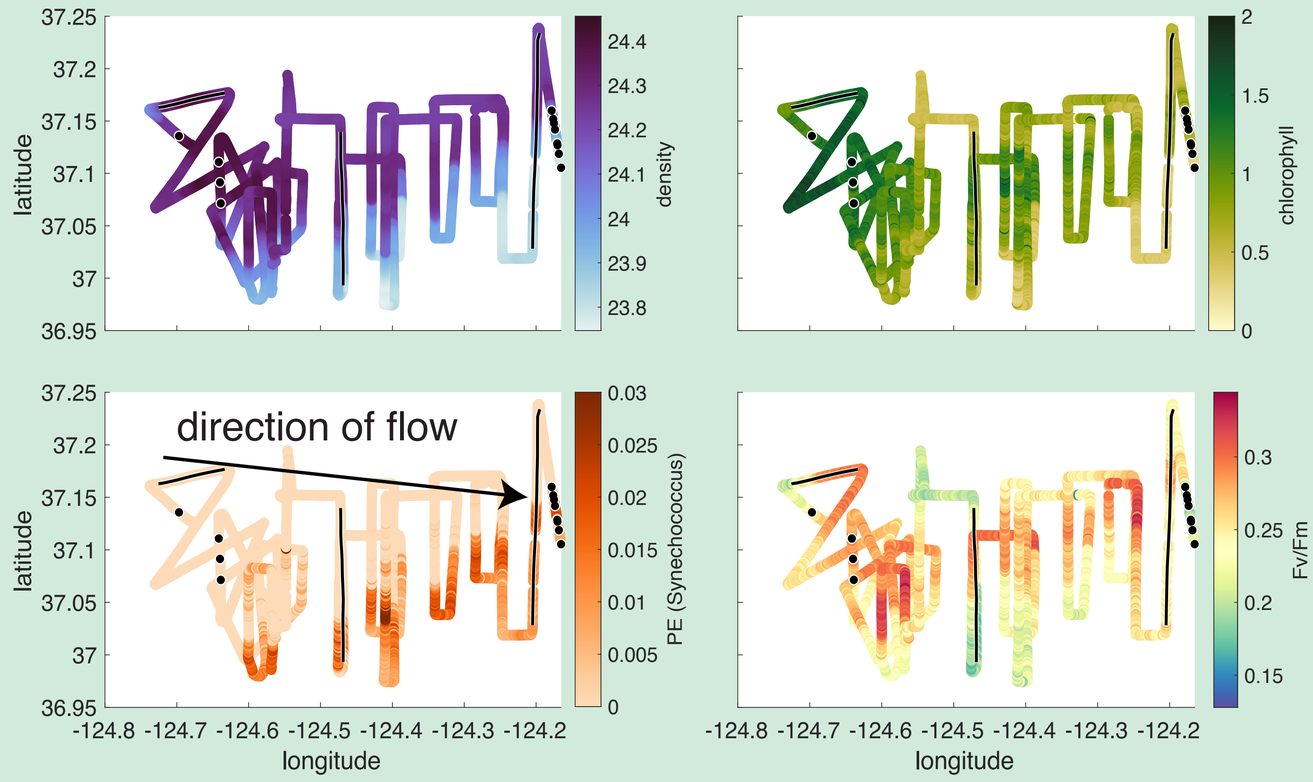
Plane-based remote sensing
Hyperspectral ocean color, ocean currents, waves, wind, sea surface temperature

Community composition (to be completed!)
amplicon sequencing, flow cytometry

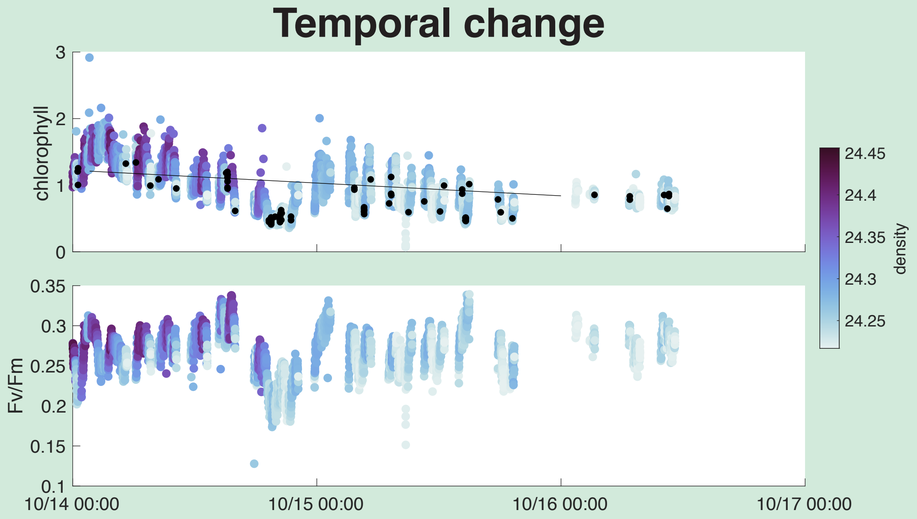
Lagrangian evolution



Spatial chanage



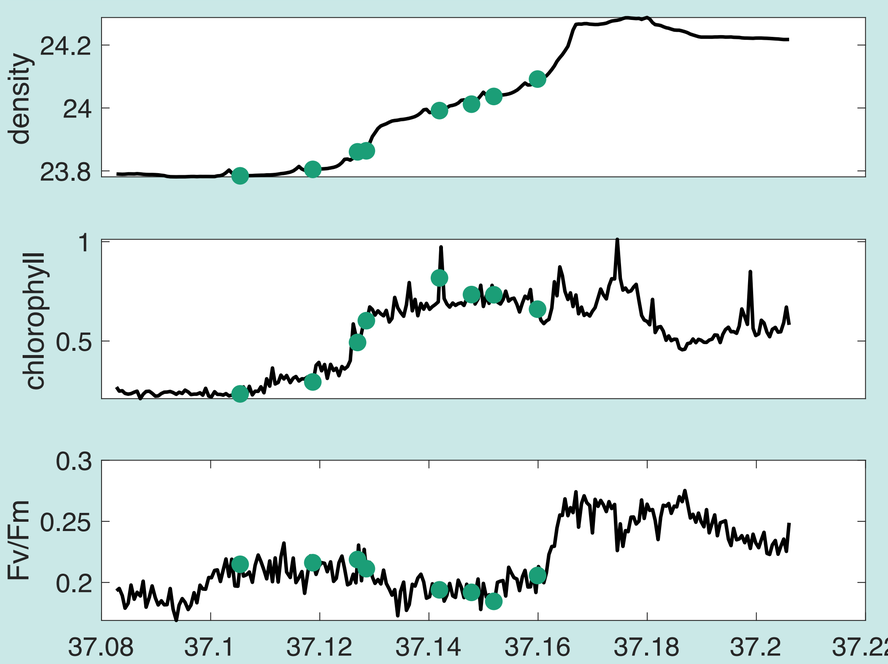
Temporal change



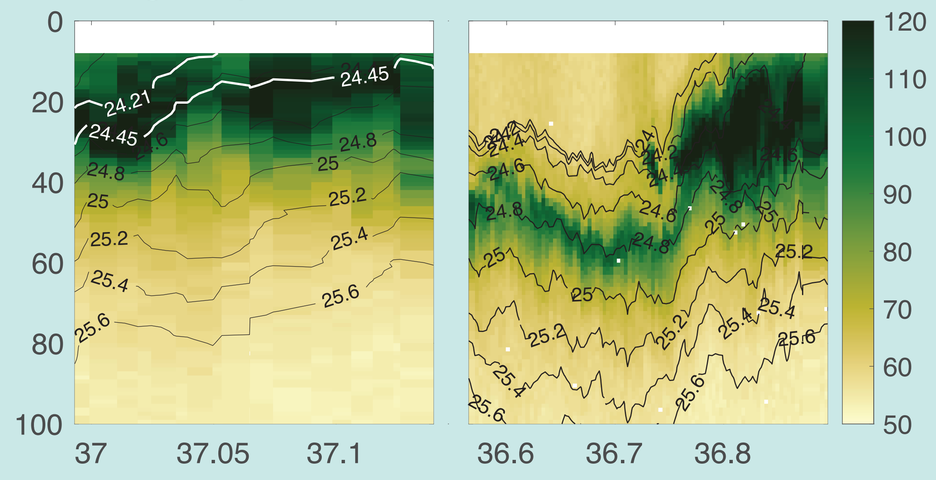
The optical observations suggest that the density front separates at least two distinct communities. Within the chlorophyll filament, there is also variation in the community properties along and across the filament.

Following surface waters using Lagrangian drifters while surveying across a filament, we find an overall decrease in chlorophyll concentration over the course of two days that appears to be due to both subduction of the dense water and mortality processes.

Submesoscale patchiness



(left) Within a density front there is substantial variation in chlorophyll concentration and Fv/Fm, suggesting variation in community composition on scales of 1-10 km. The density and biological fronts are not precisely aligned, suggesting an active role for biological processes.



Vertical sections show variation in chlorophyll concentration subsurface, evidence of subduction of chlorophyll by submesoscale dynamics, and a deep chlorophyll maximum that interacts with the front.