Phytoplankton Dynamics across Hydrographic Fronts and Mesoscale Features: Preliminary Results from the New NGA-LTER Ocean Optics Program

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Background

- Understanding patterns of primary production is of utmost importance for goals ranging from maintaining marine food webs, to healthy fisheries, to sustainable food resources for humans.
- This understanding is impeded in highly dynamic regions such as the Northern Gulf of Alaska (NGA).
- I am employing a novel bio-optical approach that compiles a range of biological estimates (including primary productivity) at sub-kilometer spatial scales.
- These data can resolve changes in biological properties across hydrographic frontal systems and eddies, oceanographic features thought to drive many of the observed patterns in primary production.
- The first step in my PhD research is to validate the bio-optical approach by comparing measurements from the underway optical system to biological samples.
- The project is tightly linked with the large multi-disciplinary Northern Gulf of Alaska Long-Term Ecological Research (NGA-LTER) program, which provides our group with discrete biological measurements to perform these on-station validation matchups.

Methods

- The underway system pumps water through two optical instruments:
  1. A hyperspectral absorption and attenuation meter (AC-S).
  2. An ECO-BB3 for measurement of the volume scattering function at 417 nm, 532 nm, and 650 nm
- Each hour, an automated 3-way valve diverts water through filtration array to measure ‘water-only’ optical properties. Optical properties of ‘particles’ are then determined by subtraction:


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\text{Total (water + particles)} = \text{‘water-only’} \cdot \text{Particles}
\]

- Data comes through in real time and the instrument requires little maintenance

Figure 1: 2020 July cruise track (2\textsuperscript{nd} to 10\textsuperscript{th}) and discrete sampling sites. The chlorophyll data is from the VIIRS satellite on the 3\textsuperscript{rd} of July. The boxes (b and c) denote the regions in the cruise track expanded on the right.

Results: Chlorophyll

- The Chlorophyll estimates from the Bio-optical system closely match the discrete samples.
- Our high-resolution measurement technique captures numerous features that are not resolved using traditional discrete sampling techniques.

Summary

Future

- Step 1: High resolution biological data products:
  - Chlorophyll via line height absorption at 676 nm
  - Phyto. Carbon via backscatter
  - Primary production via Carbon based Production Model
- Step 2: Use in situ data products to validate satellite data
  - MODIS/AQUA
  - PACE mission
- Step 3: Combine in situ and satellite data sets to:
  - assess carbon export
  - enhance fisheries forecast models

Figure 2: a- Line height absorption at 676 nm vs chlorophyll. b- System setup for the underway optics on the R/V Sikuliaq following the methods in Burt et al. 2018.

Figure 3: Underway optics chlorophyll estimates (black dots) compared to discrete HPLC samples (red circles). a- the full July cruise track with boxes showing the expanded portions, b-the area surrounding Middleton Island and c-the transition from HNL to shelf waters.

Acknowledgements: I would like to thank Dr. William Burt for his help, review and inspiration. I would like to thank Dr. Strom for her expertise and data which this work would not be possible with out. This project has been funded through the North Pacific Research Board and the LTER providing ship-board time.