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.

Results: Map of region.

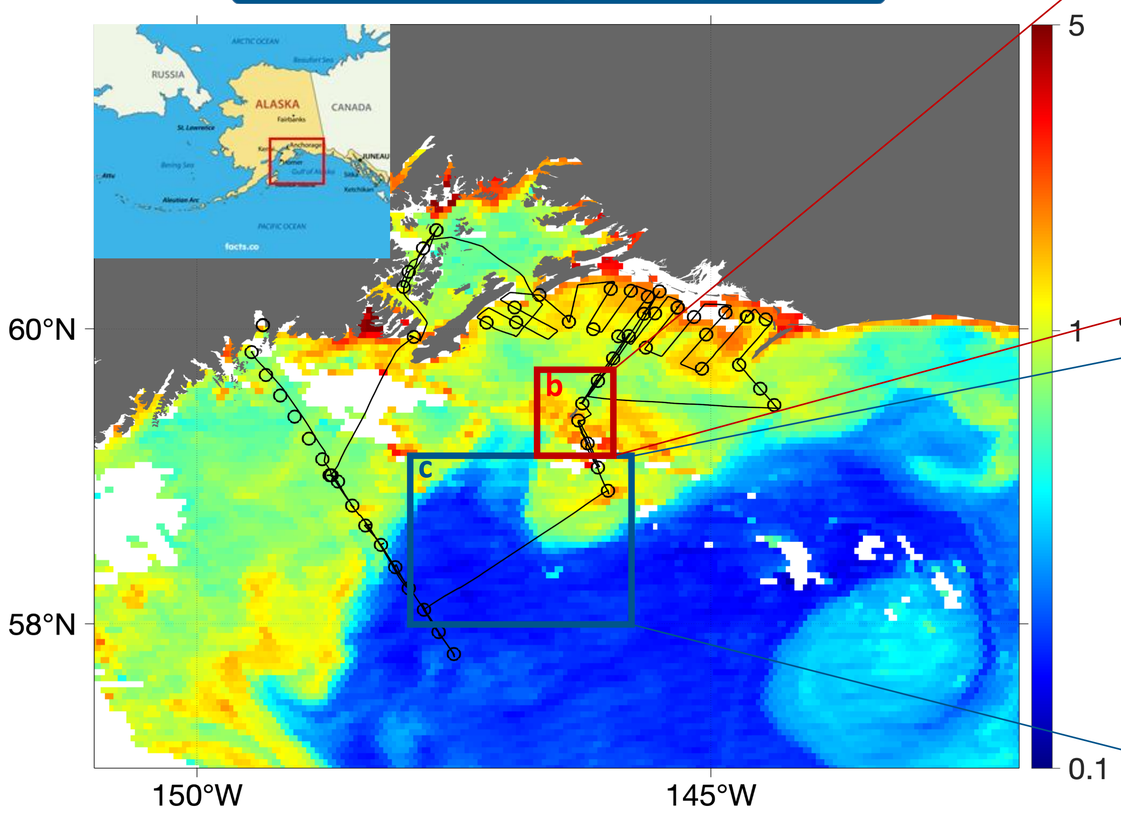

Figure 1: 2020 July cruise track (2nd to 16th) and discrete sampling sites. The chlorophyll data is from the VIIRS satellite on the 3rd of July. The boxes (b and c) denote the regions in the cruise track expanded on the right.

Results: Chlorophyll

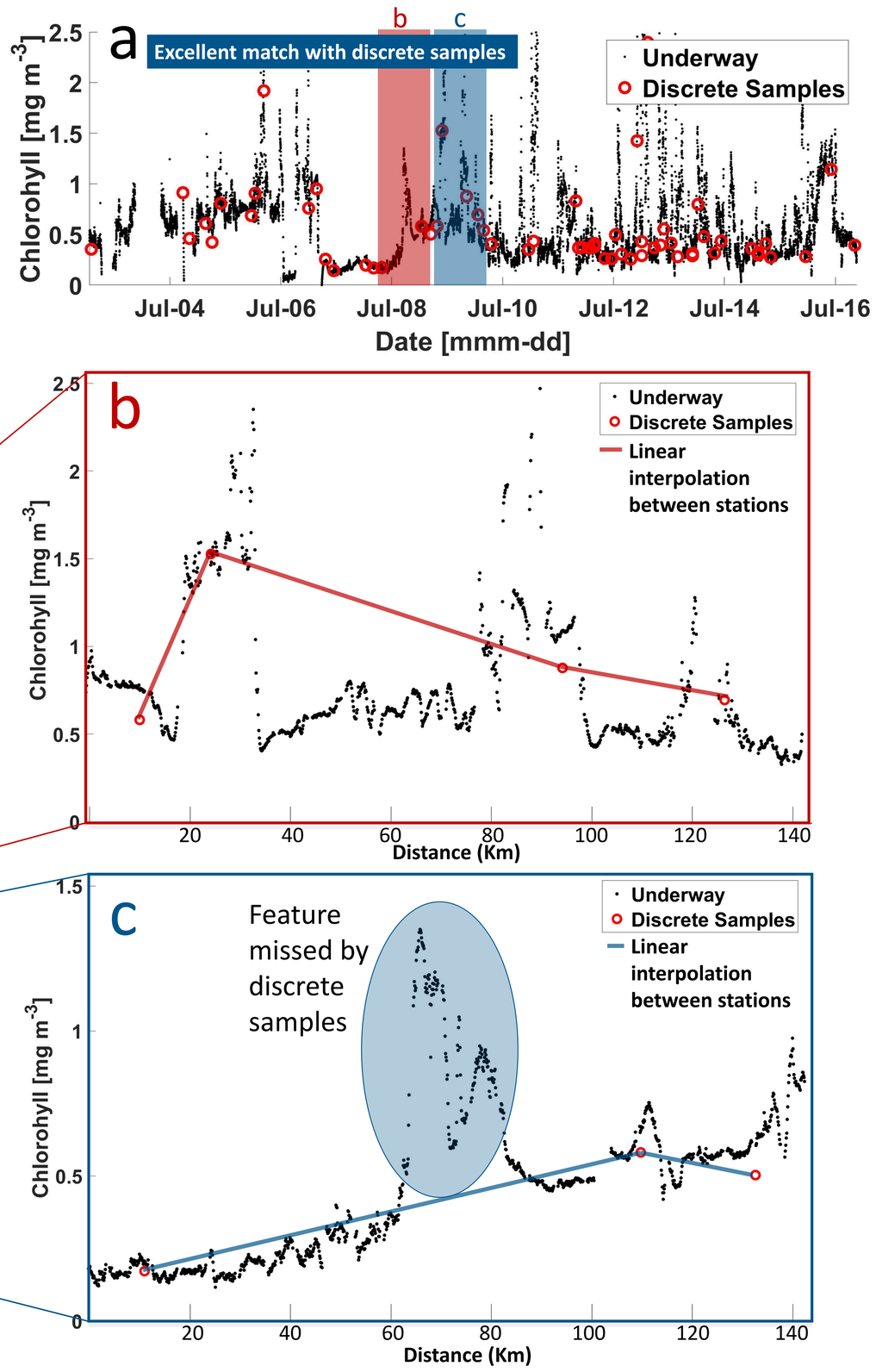

Figure 3: Underway optics chlorophyll estimates (black dots) comparted to discrete HPLC samples (red circles). **a-**the full July cruise track with boxes showing the expanded portions, **b-**the area surrounding Middleton Island and **c-**the transition from HNLC to shelf waters.

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 117° at 470nm, 532nm, 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:

Total (water + particles) – 'water-only' = Particles

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

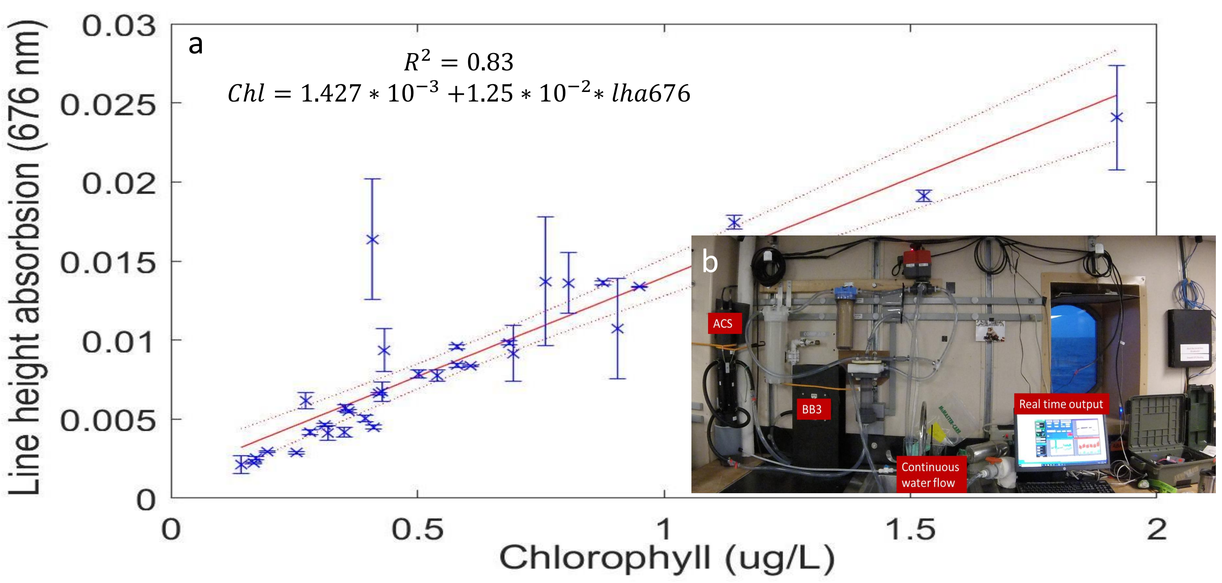

Figure 2 : a- Line height absorption at 676 nm vs chlorophyll. **b-** System setup for the underway optics on the R/V Sikuliaq following the methods in Burt el al. 2018.

Summary

- 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.

Future

2021

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

2022

Step 2
Use *in situ* data products to **validate satellite data**

-MODIS:AQUA
-PACE mission

Examine inter pixel variability

2023

Step 3
Combine *in situ* and satellite data sets to:

-assess carbon export

-enhance fisheries forecast models

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References: Burt, William J., Toby K. Westberry, Michael J. Behrenfeld, Chen Zeng, Robert W. Izett, and Philippe D. Tortell. 2018. "Carbon: Chlorophyll Ratios and Net Primary Productivity of Subarctic Pacific Surface Waters Derived From Autonomous Shipboard Sensors." *Global Biogeochemical Cycles* 32 (2): 267–88. https://doi.org/10.1002/2017GB005783.