Three-Channel Fluorescence to Characterize Harpswell Sound Phytoplankton Community Dynamics

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Abstract:

Chlorophyll fluorescence is a common method of estimating in-situ phytoplankton biomass. Unlike terrestrial plants, phytoplankton evolved the ability to synthesize different pigments for different parts of the light spectrum, depending on their depth. The presence or absence of certain pigments in different species will affect their absorption of varying wavelengths of light. Each wavelength is absorbed in varying amounts, which dip[illegible] ae[illegible]

Previous work h[illegible] tidal influence. I used a three-channel fluorometer on the Land-Ocean

Biogeochemical Observatory (LOBO) buoy. I also wanted to gain field and lab experience, and improve at using MATLAB for data visualization and interpretation.

Methods:

A 3-excitation 1-emission (3X1M) fluorometer on Dr. Roesler's Land-Ocean Biogeochemical Observatory (LOBO) buoy in the Harpswell Sound has taken hourly observations since its installation in 2014, along with tidal velocity, irradiance, temperature, and salinity. Raw data is taken in millivolts, so I therefore applied a separate calibration to each wavelength to convert fluorescence response to a chlorophyll concentration in µg/L. Each fluorometer must be calibrated individually due to small variations in their build: In the lab, a dilution series with diatoms was set up with linearly increasing cell concentrations. Due to the diatom's pigments, each wavelength of fluorescence response increases at a different linear rate as cell concentration increases, yielding different slopes (fig. 1). Now, say we're looking at a diatom in-situ (one species of phytoplankton); since the calibration slopes were set up with a diatom, the fluorescence response for each wavelength will yield the same Chl concentration (x-axis). Or, the ratios of y

yielding a greater Chl concentration according to the calibration slope. The ratio of FChl 532/FChl 440 is now >1, so this ratio is a proxy for identifying the presence of different species. Note: Because Chl a is found in all phytoplankton and its peak absorption is at 440 nm, FChl 440 is decided to be the denominator to make comparison between species easier.

Due to the spatial variability in Harpswell Sound caused by tides, quenching cannot be corrected by simply interpolating between night-time fluorescence values (this works for only areas with little tidal movement). Instead, the model I used to correct for NPQ uses LOBO's tide and irradiance data to find all the fluorescence values at night-time t

the tidal correction model I used. Much of the correction residual was negative, indicating quenching correction, but the positive regions indicate a higher biomass at mid-tide rather than at tidal maxima. Resolving for tidal influence may ignore significant peaks in fluorescence from other water masses that may reflect additional populations. Because of the complexity of the coastline, there are multiple distinct water masses that all mix together and certain significant populations may never be at LOBO at tidal extrema. However, using this model was essential in correcting fon ns

Fig. 3. Time series from July 2021 showing (a) 6 weeks of tidally corrected Fchl at tidal maxima; spring tides are red dashed lines, neap tides are blue (b) 1 week of tidally corrected Fchl at tidal maxima (c) 1 week of Fchl ratios, showing taxonomic variation

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