MEASURING OPTICAL PROPERTIES OF WATER IN CAYUGA AND CANANDAIGUA LAKES

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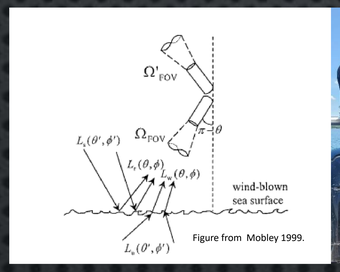
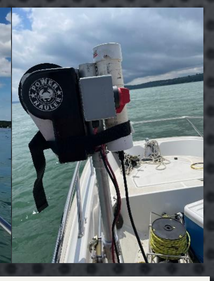
Introduction

Remote sensing is a powerful approach for monitoring algae growth including harmful algal blooms (HABs) and water quality over large temporal and spatial scales (Mobley 2000; Augusto-Silva et al. 2014; Salem et al. 2017; O'Reill and Werdell 2019). A prime indicator of trophic status is Chlorophyll-a (Chl-a) concentration. A high level of Chl-a often indicates poor water quality and is sometimes indicative of a toxic cyanobacterial bloom or HAB. We deployed Sea-Bird hyperspectral ocean color radiometer (HOCR) sensors to measure Spatial Irradiance Air (±3%), Irradiance Water ((±3%), Radiance Air (3°), and Radiance Water (8.5°) to calculate Remote Sensing Reflectance from nearshore and offshore sites to understand changes in water quality from June 2022 - September of 2022 at Cayuga Lake and Canandaigua Lake.





HyperOCR Radiometry Methods

Data collection & HOCR Deployment:

- Used SatView Software for the log set up, station set up, file naming, and set of physical parameters from the nearest weather station. Data was collected once a month between June and September at nearshore and offshore locations on Cayuga and Canandaigua Lakes.
- Used an external 12V power supply to power up all the radiometers and interfaced both 281 ∟-sky and 243 water-sky-facing radiometers with the SatView Software with spectral data collected over 136 channels between the 350 and 800 nm wavelength range.

Rrs Calculation:

Rrs is a ratio of water-leaving spectral radiance (μW/cm2/nm/sr) and downwelling spectral plane irradiance (μW/cm2/nm).

$$Rrs = \frac{Downwelling\ irradiance\ (243\ water) - [0.028 * Upwelling\ irradiance(243\ sky)]}{Total\ solar\ irradiance\ (281\ Sky)}$$

- Used ASCII data files to calculate the *Baseline corrected data: Light data (uW/cm^2/nm) - Avg Dark data (uW/cm²/nm).*
- Dark data values at each wavelength averaged for the entire log (~20% of total light data points) are subtracted from the light values at the same wavelengths for the entire time series in the log file.

Preliminary Data Analysis:

A correlation matrix to check differences and similarities in spectra was calculated using Rrs from 136 different channels for all samples.

Consideration:

In order to correct for sun glint effects, HOCR's 243 Sky-water-facing radiometer at a 90° angle and with a viewing direction of 40° from the sun and water was modified by a surface reflectance factor of 0.028 since the wind speed was less than 5 mph.

Figure 1

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CY 220907_3447.2

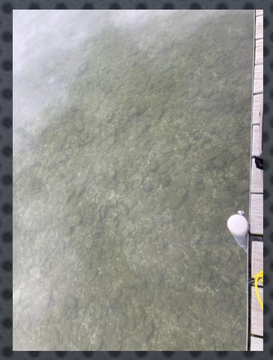

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Figure 2

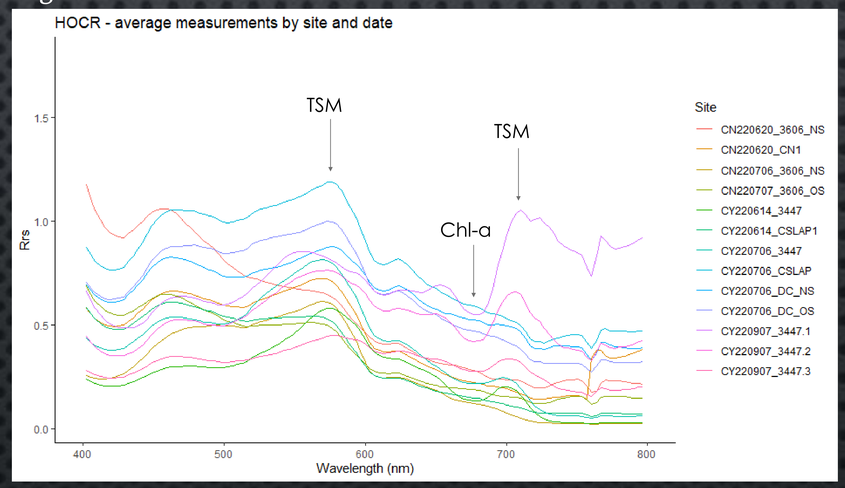
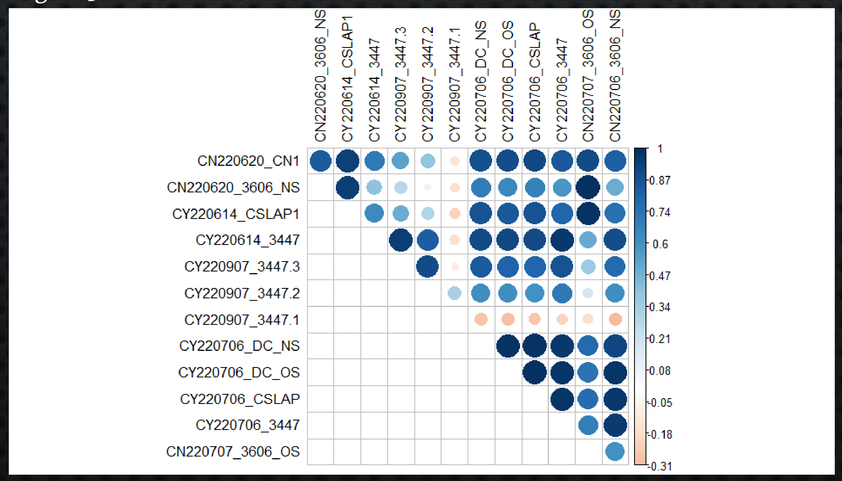


Figure 3



Results

- Figure 1 shows HAB conditions photographed at sites 3447-1, 3447-2, 3447-3 in Cayuga Lake that correspond to HAB event and Rrs measurements presented in Figure 2 and Figure 3.
- Rrs signatures are compared across lakes and sampling dates in Fig. 2. Highlighted Rrs wavelengths indicate expected inherent optical properties for the observed waterbodies. Wavelength specific total suspended matter (TSM) and chlorophyll-a (Chl-a) signatures are shown.
- Early season samples showed Rrs similarities between lakes and sampling sites while bloom sample 3447.1 showed no correlation to other sampling dates or sites.
- Correlation of spectral data among lakes and sampling dates are presented in the correlation matrix shown in Figure 3.

Discussion and Future Work

- These correlation matrix results are expected given the calculated Rrs signatures shown in Fig. 2 and the varying water conditions observed between early season and bloom samples.
- These data indicate that early season waterbodies with relatively low productivity as indicated by Chl-a will show similar optical properties between sites and lakes. As productivity increases in later season samples, Rrs signatures may differentiate from one another as optical properties and algal groups specific to lakes and sites may vary.
- Chlorophyll-a concentrations were obtained during these sampling events but are not presented in this poster.
- Future work will focus on incorporating additional data from these sampling events not used in these analyses. These results suggest that incorporating measured chlorophyll-a and estimated surface chlorophyll using Rrs may show correlation.

References

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