Relationships Between Optical Backscattering and Particle Composition in Coastal and Open Ocean Waters of the Northern Gulf of Mexico

Neeharika Verma and Steven Lohrenz (SLohrenz@umassd.edu)
School for Marine Science & Technology, UMass Dartmouth
New Bedford, MA 02744, USA

Objective

Our objective was to examine relationships of backscattering to total suspended matter, particulate carbon, and indices of photosynthetic pigment composition, including chlorophyll concentrations, and associated proxies for phytoplankton size classes in optically complex coastal waters as well as open ocean waters in the river-influenced, northern Gulf of Mexico.

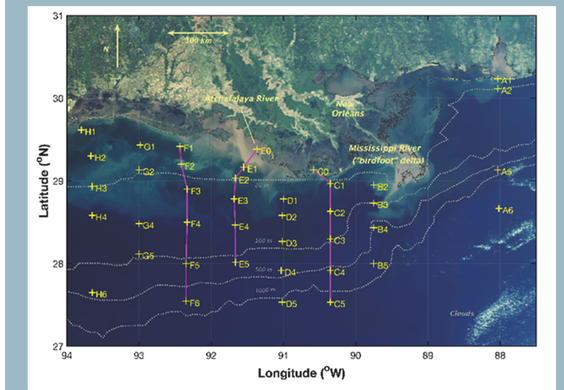

Figure 1. Sampling stations (yellow "+") and tracks for underway hyperspectral radiometry observation runs (magenta) overlaid on a mapped "true color" image acquired with MODIS Aqua on 14 April 2009. Outflow regions associated with the Mississippi and Atchafalaya rivers are evident in the image.

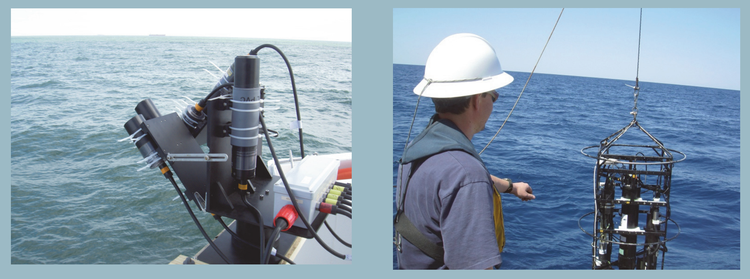

Figure 2. HyperSAS hyperspectral radiometry system (Satlantic, Inc.) deployed aboard the R/V Cape Hatteras in April 2009. In addition to radiometry measurements, discrete profiles of spectral absorption and backscattering were determined using a WETLabs, Inc. (now Seabird, Inc.) **ac-9 absorption/attenuation meter and ECO-BB9 and ECO-VSF3 backscattering meters**. Discrete water sample analysis included **HPLC phytoplankton pigments, total suspended particulate matter, and total particulate carbon**.

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UMass Dartmouth

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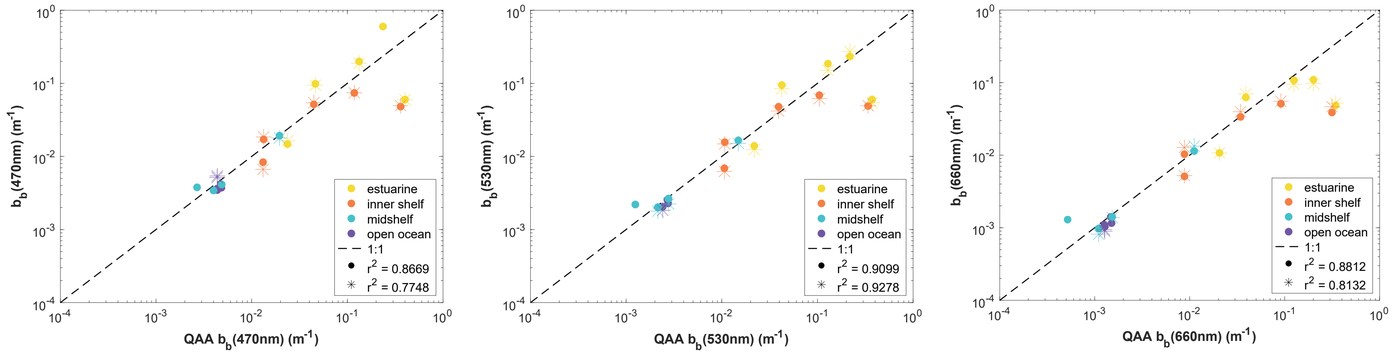

Figure 3. Comparison of hyperspectral retrieval and in-situ measurements of surface particulate backscattering. Good agreement was found between backscattering in surface waters obtained using the Quasi-Analytical Algorithm (Zhan et al. 2014) (QAA b_b) applied to above-water hyperspectral radiometery (HyperSAS) and in situ backscattering (b_b) obtained from the ECO-BB9 (●) and the ECO-VSF3 (✳).

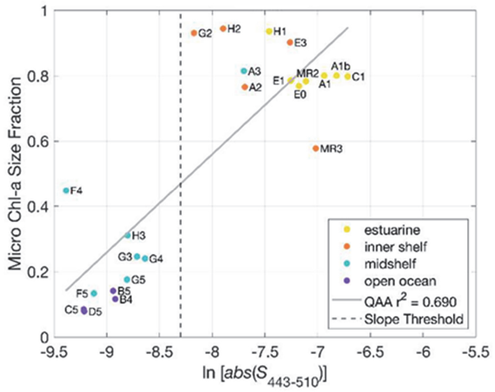

Figure 4. Slope indices ($\ln[abs(S_{443-510})]$), derived from phytoplankton absorption spectra ($a_{ph}(\lambda)$) retrieved from HyperSAS remote sensing reflectance using the QAA plotted in relationship to the microphytoplankton size fraction derived using pigment diagnostics (Uitz et al., 2006; Verma et al., 2021).

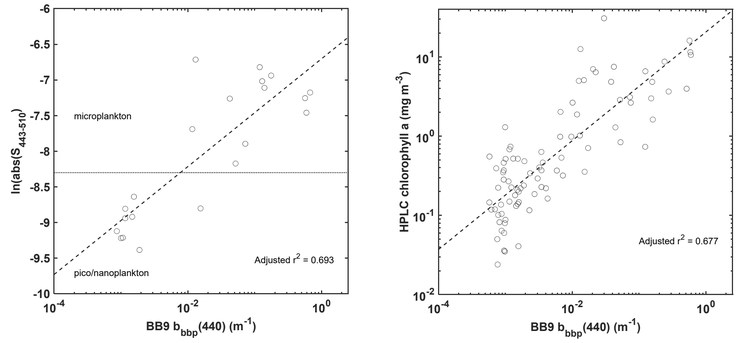

Figure 5. High particulate backscattering values were associated with microphytoplankton dominated communities (QAA slope, $\ln[abs(S_{443-510})] > -8.3$) and high chlorophyll concentrations (Chl-a >1 mg m^{-3}).

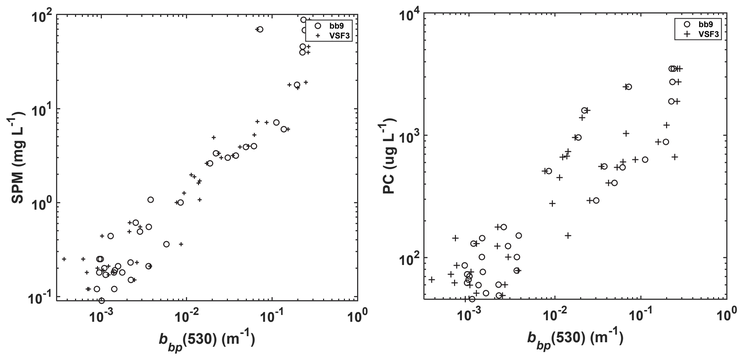

Figure 6. Suspended particulate matter (SPM) and total particulate carbon were strongly correlated with particulate backscattering at 530 nm.

References

Uitz et al., 2006, JGR-Oceans, 111(C8), C08005, doi:10.1029/2005jc003207

Verma et al., 2021, Remote Sensing, 13(17), 3346.

Conclusions

- Retrieval of backscattering from hyperspectral radiometry produced results consistent with in situ measurements.
- The strong relationship between particulate backscattering and pigment concentrations, SPM and PC should be useful for optical retrieval of biogeochemical properties and phytoplankton community composition indices in this river-influenced, ecosystem.