

# Temporal and Spatial Variability in Ocean Color Data of the Long Island Sound Region

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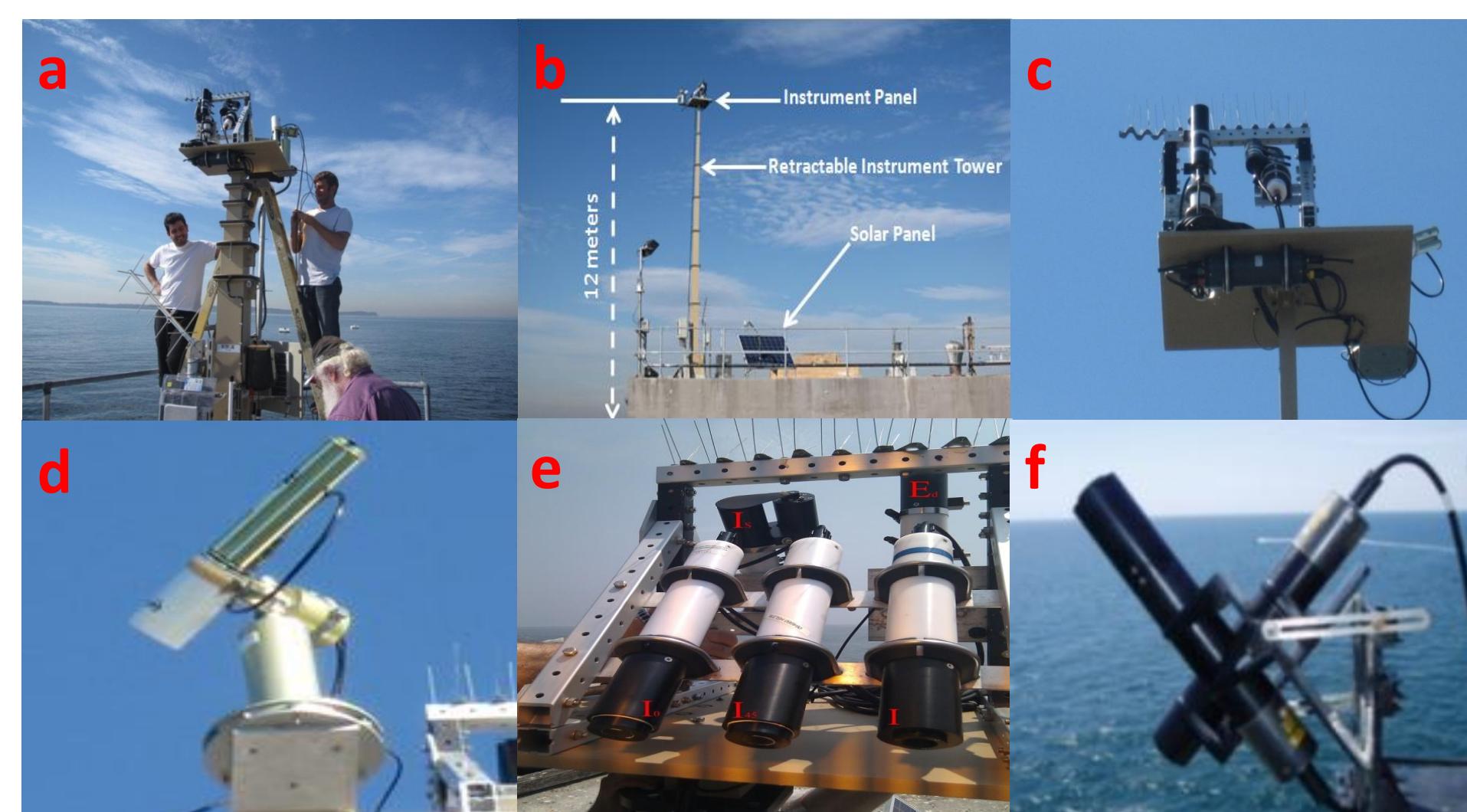
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## INTRODUCTION

In this research, we use ocean color data of the Long Island Sound region obtained from NASA's earth observing satellites to analyze the spatial chlorophyll\_a distribution within a single satellite pass as well as the seasonal variability over a 10 year period. Results are compared with ocean color data obtained from the Long Island Sound Coastal Observatory (LISCO) [1].

### LISCO (Long Island Sound Coastal Observatory)

- LISCO uniquely combines a SeaPRISM, part of the NASA AERONET – Ocean Color Network, with a co-located HyperSAS for multi and hyperspectral radiometer measurements.
- SeaPRISM autonomously performs multiple sky- and sea-radiance observations at programmable viewing and azimuth angles at eight center wavelengths in the 412-1024 nm spectral range.
- The HyperSAS optical remote sensing system provides high precision hyperspectral measurements of sky and upwelling spectral radiance, and downwelling spectral irradiance.
- The whole system provides comprehensive in-situ time series dataset for satellite ocean color data validation and calibration activities. These calibration activities are essential to support the creation of consistent data records from various Ocean Color Earth observing systems.



(a) Retractable Instr. Tower (b) LISCO Tower (c) Instr. Panel (d) SeaPRISM Instrument (e) Hyper-OCR with Polarization Filters (f) Total Sea and Sky Radiance sensors

## METHODS

- Images from MODIS (Moderate-resolution Imaging Spectroradiometer), a sensor launched in 1999 on board Terra and in 2002 on board Aqua, and VIIRS (Visible and Infrared Imager/ Radiometer Suite) launched on November 2011 onboard Suomi National Polar-orbiting Partnership, were downloaded from NASA's database [2] and opened with HDFView.
- MATLAB code was used to extract the chlorophyll a concentrations in the Long Island Sound (region bordered by N 41.3, W 73.85 and N 40.94, W 72.06)
- MATLAB code was used to match the images and measurements that were taken by VIIRS, LISCO, and MODIS.
- Microsoft Excel was used to plot trends in the chlorophyll concentration from 2003 to 2012 as well as compare and validate data obtained from VIIRS, MODIS, and LISCO.

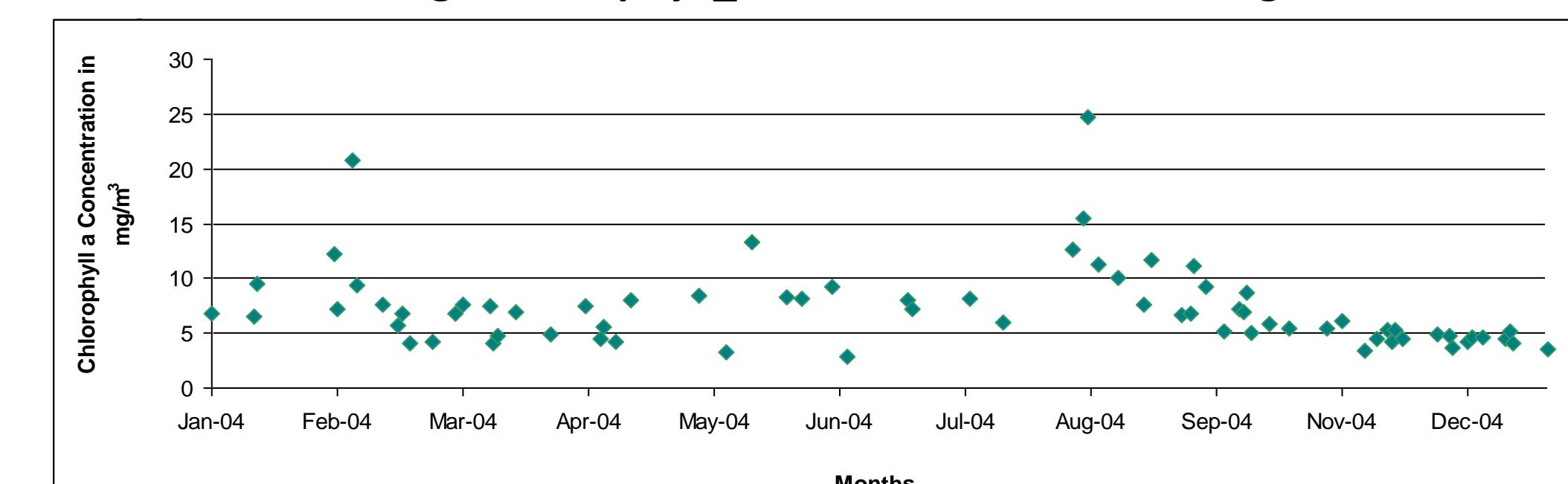
### MODIS Top of Atmosphere True Color Composite Image of Long Island Sound



Platform Location

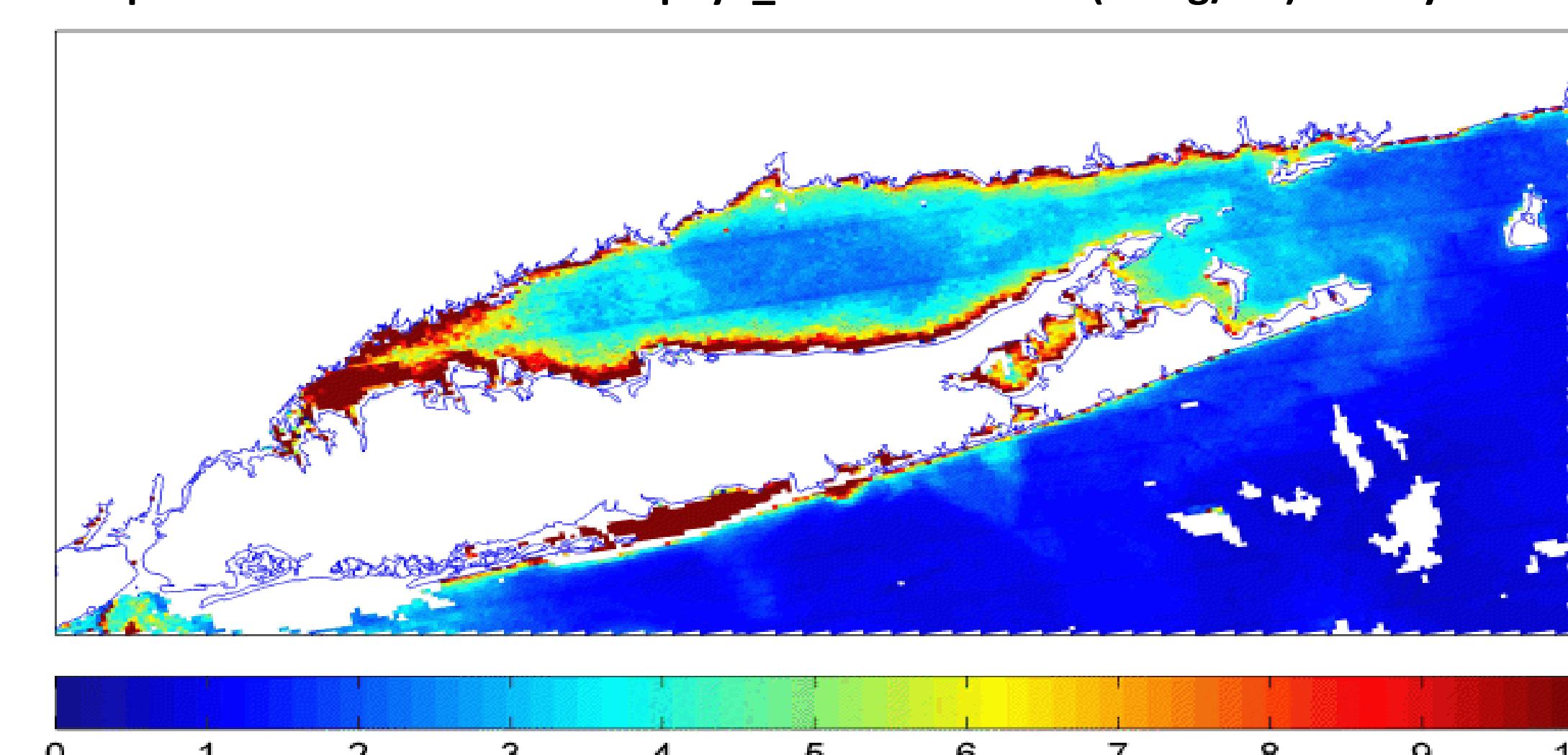
## RESULTS

### 2004 MODIS Average Chlorophyll\_a Concentration in the Long Island Sound



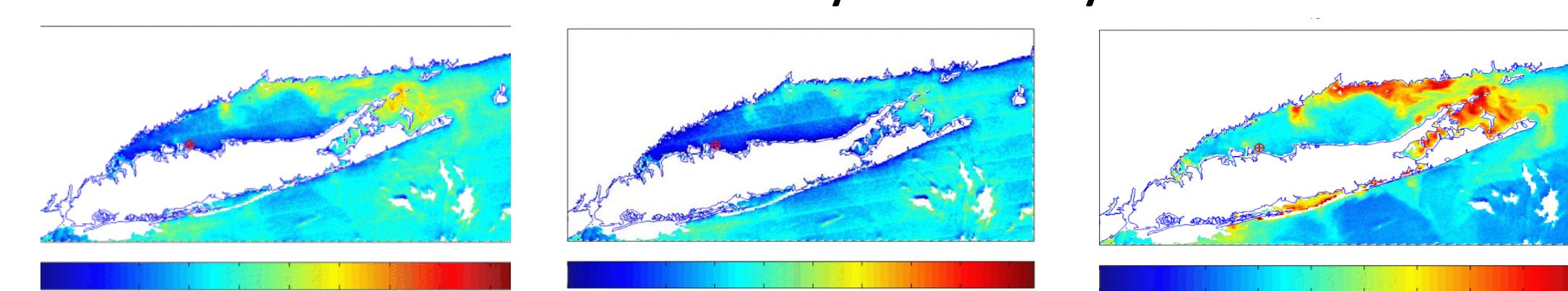
This time series displays the spatial average chlorophyll a concentration of the Long Island Sound (region bordered by N 41.3, W 73.85 and N 40.94, W 72.06) reported by MODIS in 2004. The concentration begins to increase in January, peaking in February, and then declining. In the summer, the concentration begins to increase again, peaking in August, and then slowly decreasing for the rest of the year.

### Spatial Distribution of Chlorophyll\_a Concentration (in mg/m³) on July



The chlorophyll concentration as reported by VIIRS on July 8<sup>th</sup> 2012. The orange and red colors represent higher concentrations of chlorophyll a (only concentrations < 10 mg/m<sup>3</sup> are shown) while the blue colors represent low concentrations. Note the high concentrations of chlorophyll a near the headlands of Long Island Sound due to an abundance of phytoplankton. The bay areas have a lower chlorophyll a concentration.

### Remote sensing reflectance (Rrs) corresponding to the light wavelengths of 443, 488 and 551nm taken by VIIRS on July 8<sup>th</sup> 2012.



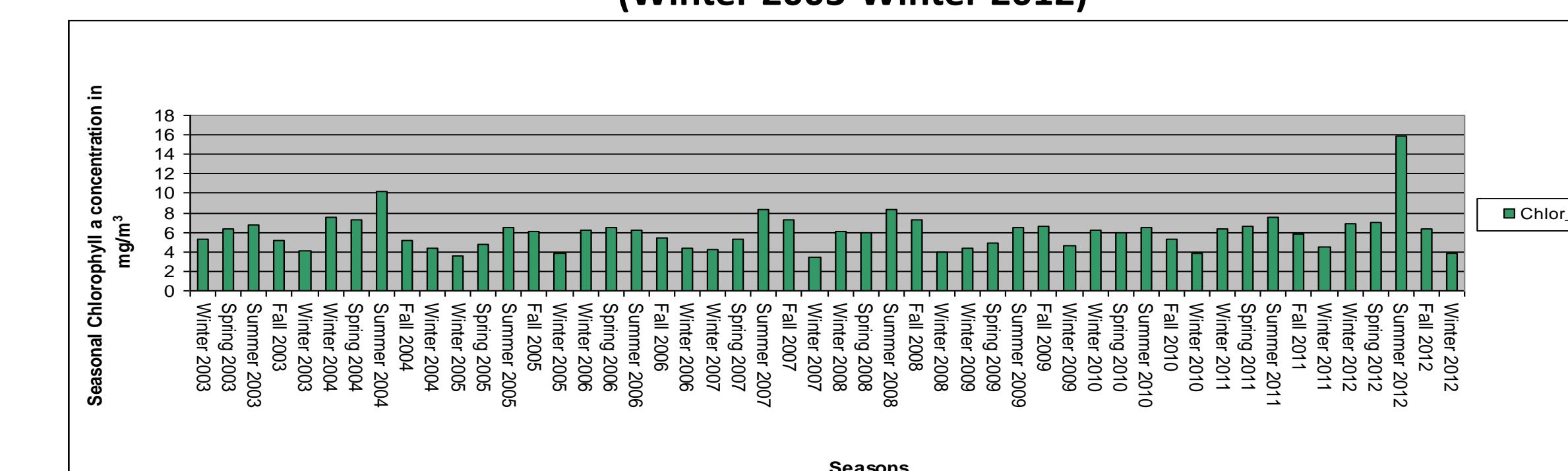
The above  $R_{443}$ ,  $R_{488}$  and  $R_{551}$  are the remote sensing reflectance of the violet, blue and green light spectrum respectively.

The above reflectance are related to the chlorophyll a concentration (Chl<sub>a</sub>) by the following OC3 algorithm:

$$Chl_a = 10 (0.283 - 2.753R + 1.457R^2 + 0.659R^3 - 1.403R^4) \text{ Where}$$

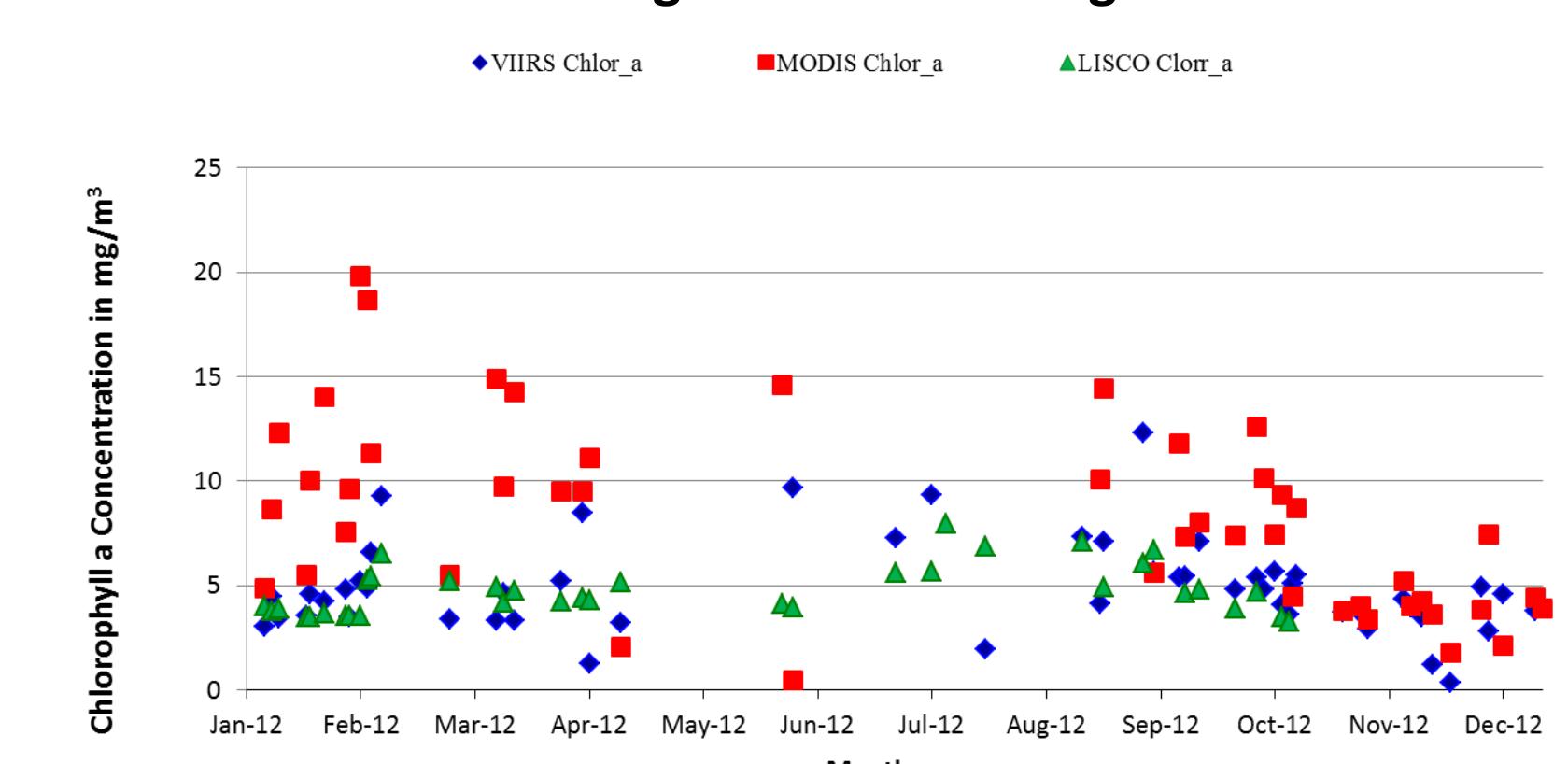
$$R = \log_{10} \left( \frac{R_{443} - R_{488}}{R_{488} - R_{551}} \right)$$

### MODIS Average Seasonal Chlorophyll\_a Concentration in the Long Island Sound Region (Winter 2003-Winter 2012)



Time series displaying the spatial average of the MODIS Chlorophyll a concentration (mg/m<sup>3</sup>) over the Long Island Sound which has then been temporally averaged seasonally (Winter 2003 to Spring 2012). Trends show a marked increase in chlorophyll a concentration during the summer months, with seasonal lows during the fall and winter.

### 2012 MODIS, VIIRS and LISCO Chlorophyll\_a Concentration in the Long Island Sound Region



This time series analysis displays the chlorophyll a concentration in 2012 as reported by LISCO (green triangle), the chlorophyll a concentration reported by MODIS (red rectangle) and VIIRS (blue diamond). MODIS and VIIRS values reported subsume the LISCO site to within 9km<sup>2</sup>. The time series shows that MODIS generally overestimates the chlorophyll a concentration, while VIIRS generally tracks the LISCO data quite well. Notice that there is no LISCO data after the month of October due to the fact that the site was damaged by hurricane Sandy.

## SUMMARY

- From the analysis carried out with the ocean color imagery data of 10 year period obtained from NASA's earth observing satellites, seasonal trends in the chlorophyll\_a concentration of the whole Long Island Sound area has been discerned.
- Comparisons of the satellite retrieved chlorophyll concentration data of the LISCO area and that of the whole Long Island Sound area exhibit linear relationship with moderate correlation.
- In-situ retrieved chlorophyll\_a concentration data of the LISCO area is also within the range of the satellite retrieved data for the location.
- LISCO's in-situ chlorophyll data can be used to estimate the average chlorophyll concentration of the Long Island Sound. This can be useful when satellite data is not available because of the cloud coverage or the failures in satellite data processing particularly due to atmospheric correction.
- These findings open the possibilities of utilizing the ocean color data obtained from LISCO's comprehensive instrument set to enhance the regional ocean color and water quality monitoring.

## REFERENCES

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## ACKNOWLEDGEMENTS

We would like to thank Robert Foster and Dr. Soe Hlaing for providing assistance and encouragement and Dr. Alexander Gilerson for providing laboratory space throughout the research. Also, we would like to thank the National Science Foundation REU Program Grant #1062934 for funding this research.