

OCEAN COLOR PRODUCTS
FOR WATER QUALITY AND
USER INTERACTIONS FOR
PUERTO RICO, US VIRGIN
ISLANDS AND WEST MAUI, HI

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VIQUEIRA

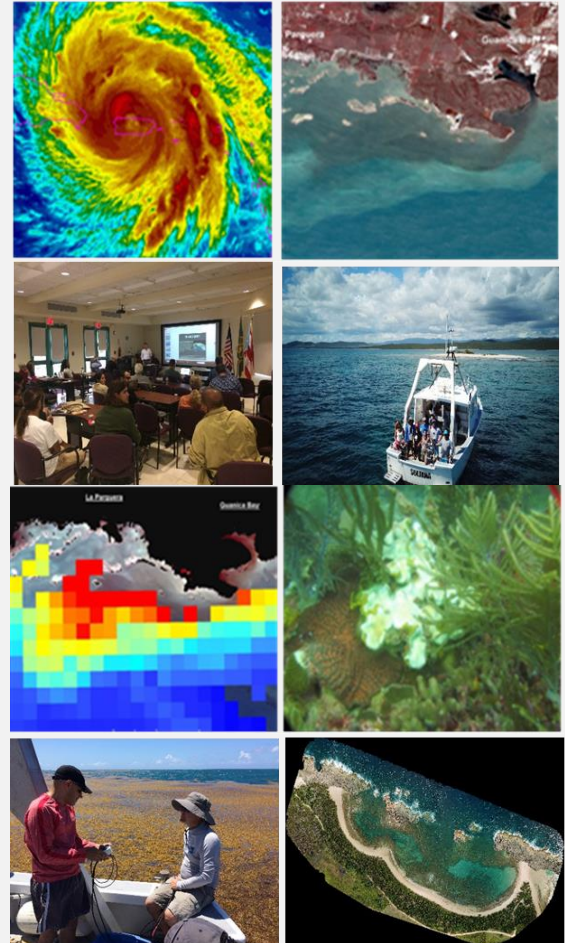
NOAA Ocean Color Coordinating Group
August 14, 2019

Overview

- What We Do
- Current Collaborators/Partners
- Ocean Color for Water Quality
- User Interactions
 - Puerto Rico and US Virgin Islands
 - West Maui, Hawaii'
- Next Steps
- Acknowledgements

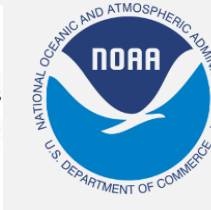
What We Do

- Remote Sensing and GIS Coastal and Marine Ecosystems:
- Support NOAA Mission
 - Resilient coastal communities and economies
 - Healthy oceans
- Water optics and validation of local ocean color data.
- Water quality and Land-based Sources of Pollution (LBSP)
- Benthic habitat mapping.
- Data dissemination tools for managers.
- UxS technologies for coastal and marine areas.



Collaborators

- Federal: NOAA, NASA
 - Robert A. Warner, NOAA/NOS/NCCOS
 - Erick F. Geiger, NOAA/NESDIS/STAR, CICS-UMD
 - C. Mark Eakin, NOAA/NESDIS/STAR
 - Menghua Wang, NOAA/NESDIS/STAR
 - Chris Brown, NOAA/NESDIS/STAR
 - Juan Torres-Perez, NASA AMES
- NGO/Universities/ State
 - Protectores de Cuencas Inc.
 - West Maui Ridge 2 Reef
 - University of Puerto Rico Mayaguez
 - City College New York
 - University of Hawaii Maui College
 - PR DNER Coastal Zone Management



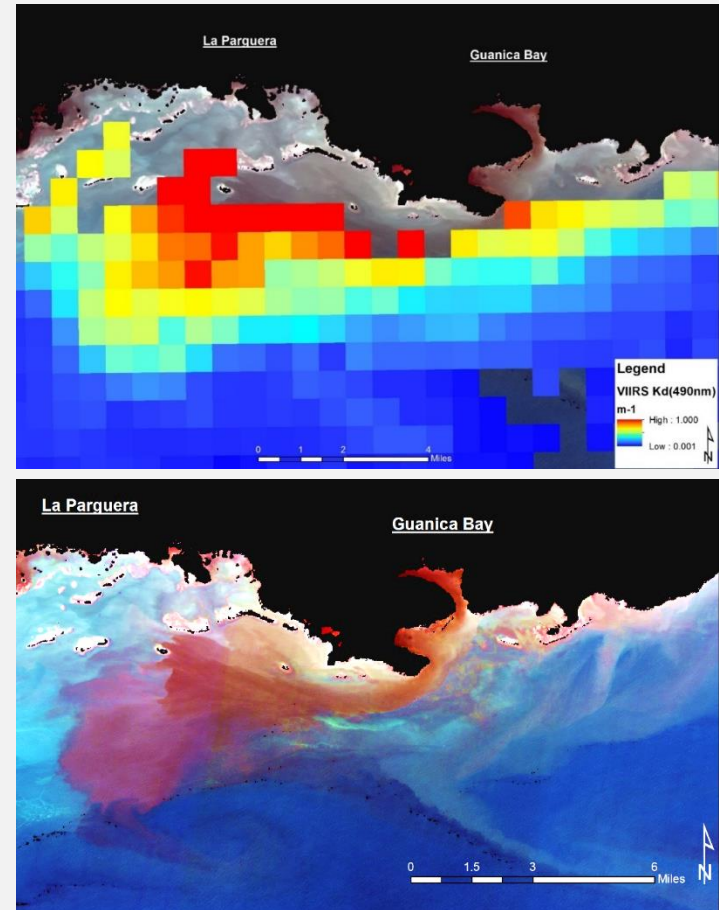
Ocean Color and Water Quality

- VIIRS Ocean Color Time Series Analysis.
- Collect field data for water quality parameters and optical properties.
- Dates:
 - Once per month
 - 2016-present
- Support NOAA CREST Research Themes:
Coastal Resilience
 - CREST Coastal Ocean Observing Systems.
 - Ecosystem health towards sustainability.
- Support NOAA Offices:
 - NESDIS STAR CRW (College Park, MD)
 - NOS NCCOS (Silver Spring, MD)



Why Use Ocean Color?

- Satellite ocean color data provide a synoptic view of water quality.
- Continuous monitoring
- **Chlorophyll-*a* (Chl-*a*)**
 - Monitoring phytoplankton biomass.
 - Nutrient status (*i.e.* **productivity**).
- **K_d(490)**
 - Diffuse attenuation coefficient at 490nm.
 - **Turbidity**
 - (measure of the total organic and inorganic matter held in solution and suspension).
- In the case of Hurricanes Irma and María
 - source of information on water quality and light availability due to lost or *damaged in situ* sensors and lack of field observations after the storm.

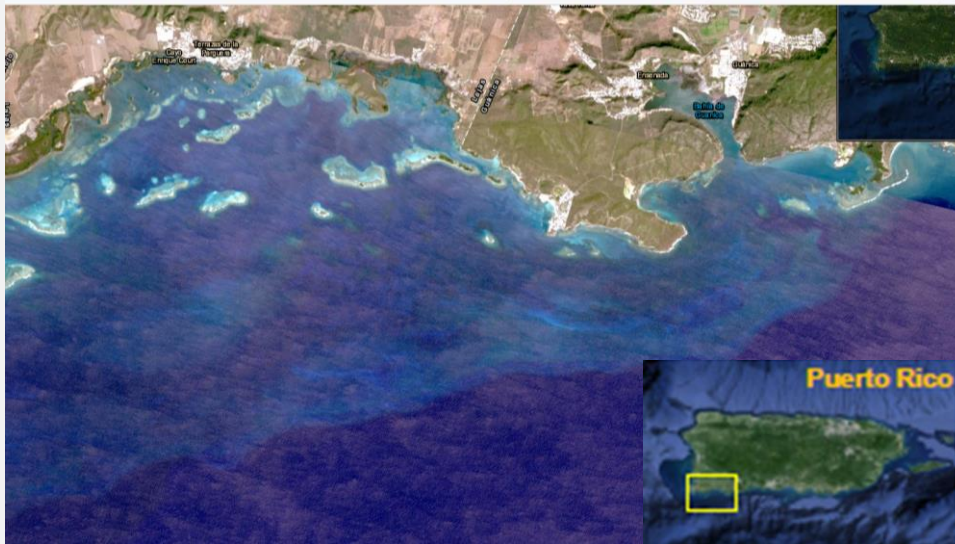


(Top) VIIRS image of turbidity, K_d (490 nm) wavelength and (Bottom) Landsat 8 OLI False Color image. Nov. 11-13, 2014 after 6 inches of rain in Guánica area.

Study Area

U.S. Coral Reef Task Force priority watershed sites:

- Guánica Bay (Puerto Rico)
- Ka'anapali (West Maui, Hawai'i)



LBSP and Water Quality



Guánica Bay (Dry Season)



Guánica Bay (Rainy Season)



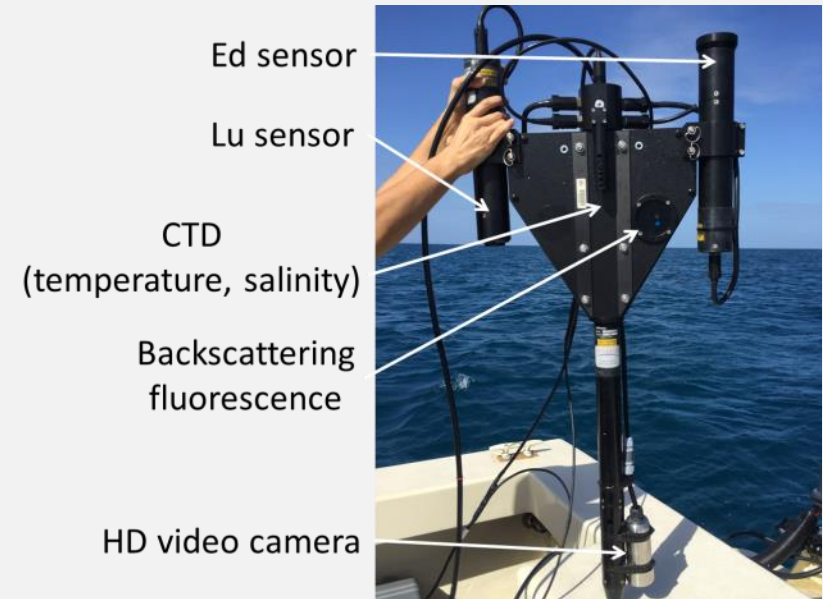
West Maui, HI

Image courtesy of Mark Deacons-
Hui O Ka Wai Ola

Field Sampling (Optics/ Water Quality)



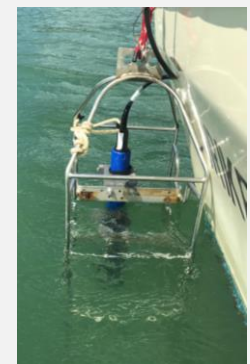
- Simultaneous with Landsat 8 OLI or Sentinel 2 MSI image capture
- Instruments
 - **Satlantic Hyperpro Profiling radiometer (Lu, Ed, Rrs, Lw, Kd)**
 - GER 1500 Spectro-radiometer (Lw, Ed, Rrs)
 - SolarLight Datalogging Radiometer (PAR)
 - Hydroscat-6 (backscattering, fluorescence)
 - YSI EXO 1 (Chl-a, TSS, CDOM, CTD)
 - Water quality samples
 - Chl-a, TSS, CDOM



Hydroscat-6



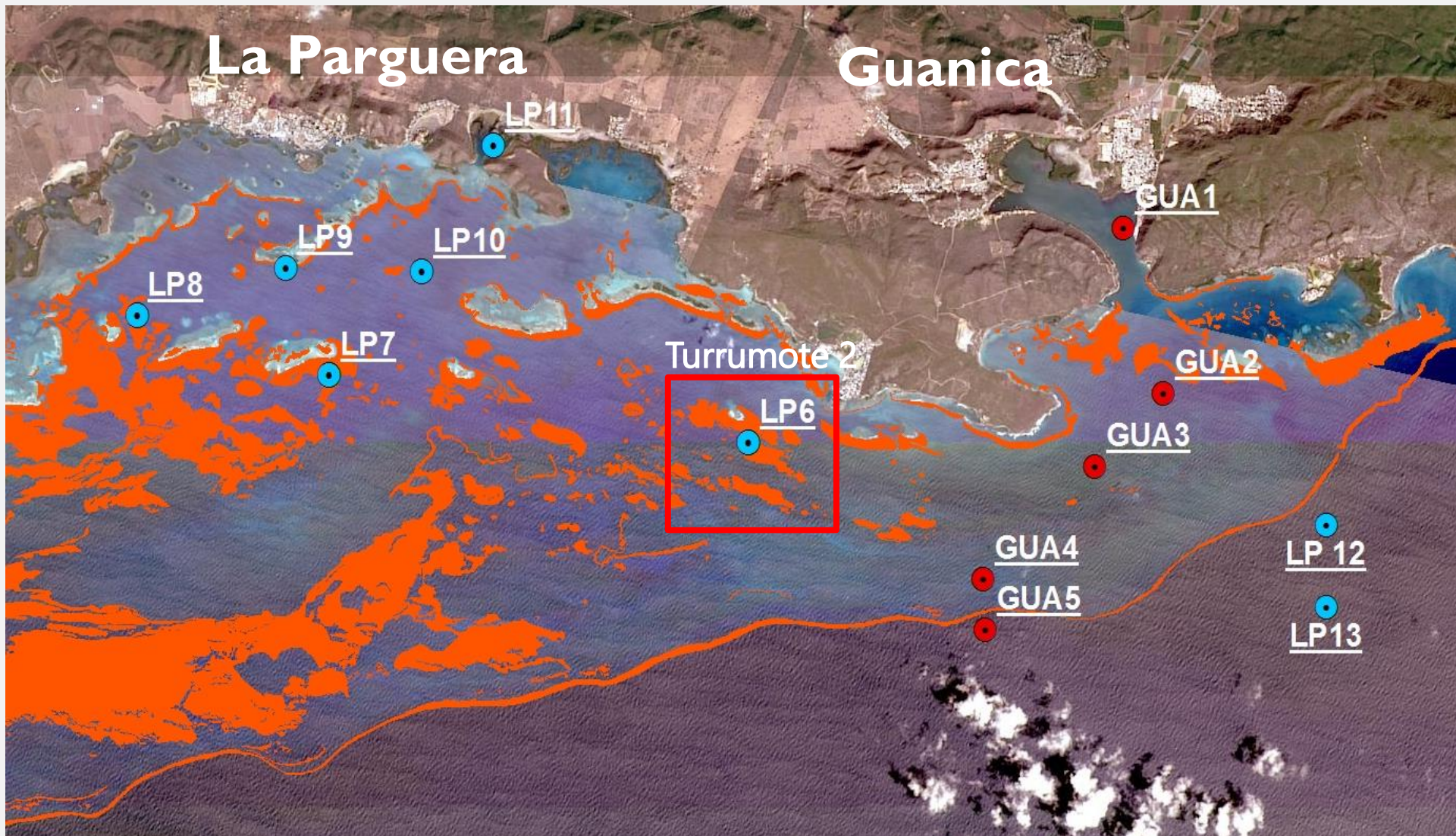
GER 1500



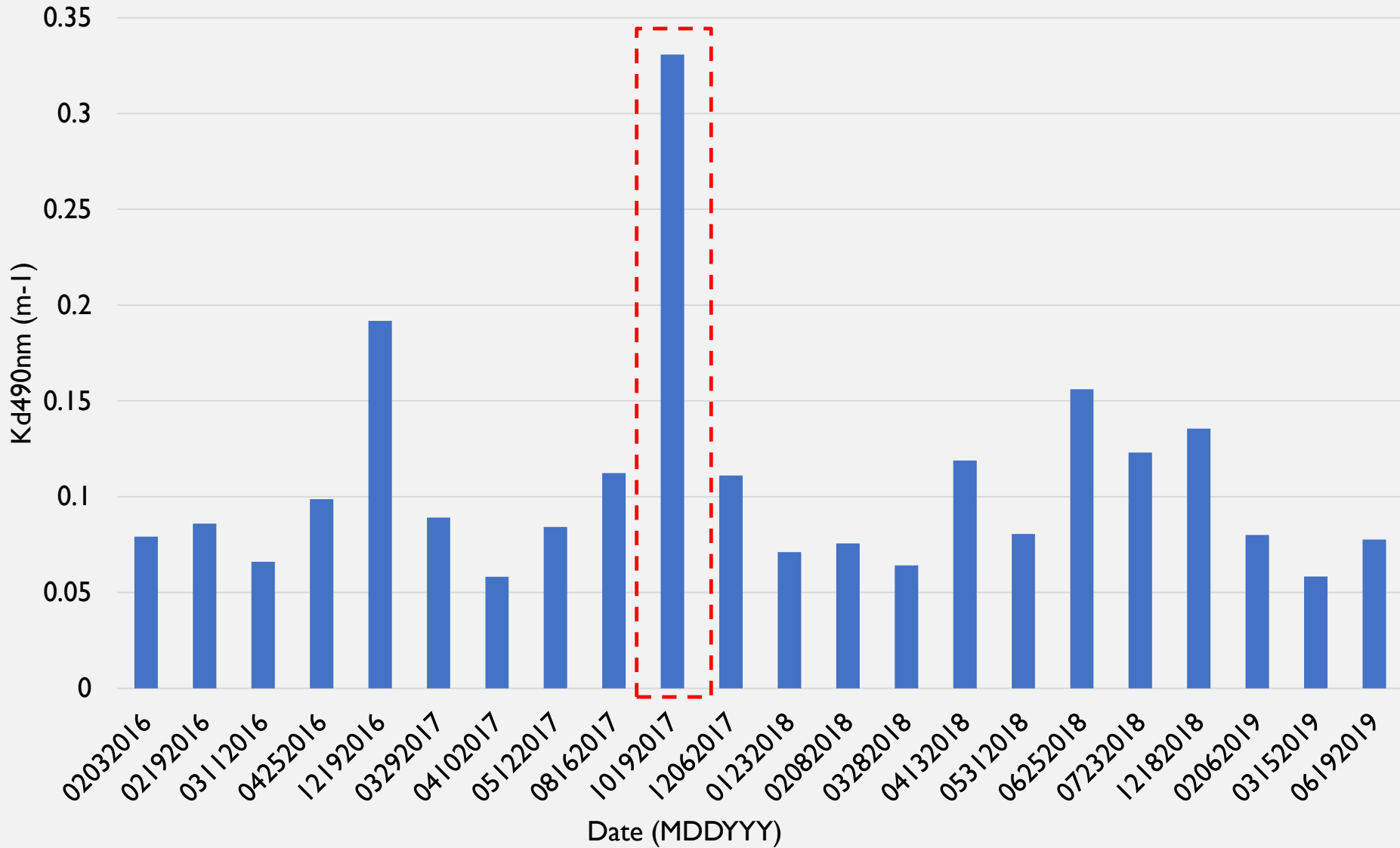
YSI

EXO

Guánica Bay and La Parguera



Kd490 nm for Station LP6 Turrumote 2 (from Satlantic Hyperpro)



67°5'0"W

67°0'0"W

66°55'0"W

18°0'0"N

La Parguera

Guanica Bay

Turrumote-2

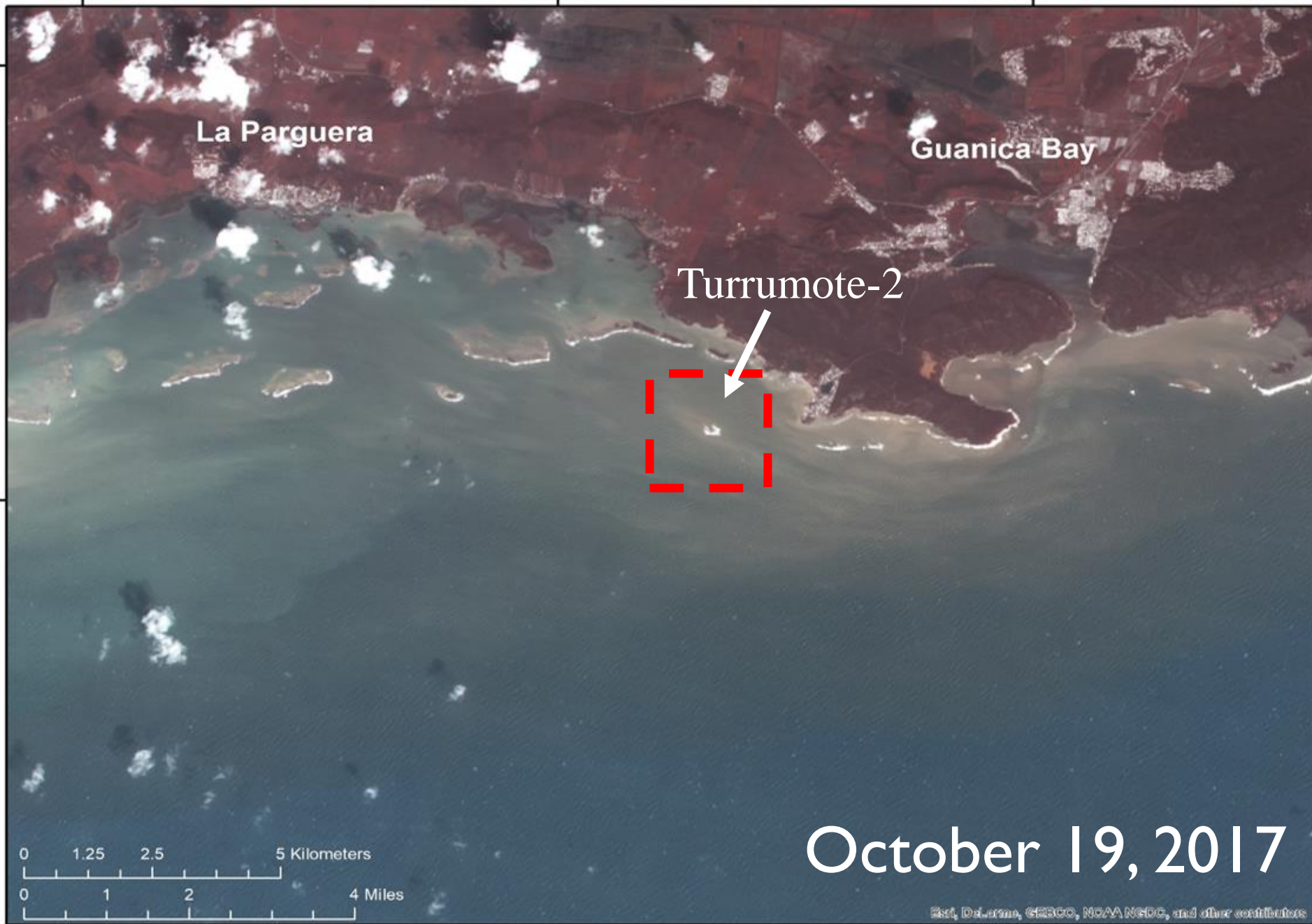
17°55'0"N

0 1.25 2.5 5 Kilometers

0 1 2 4 Miles

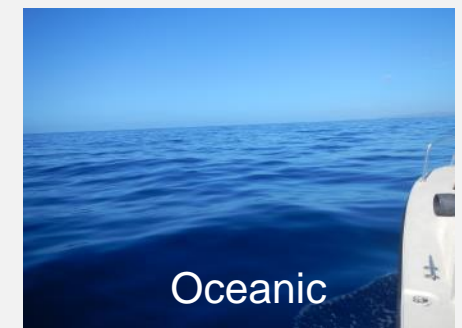
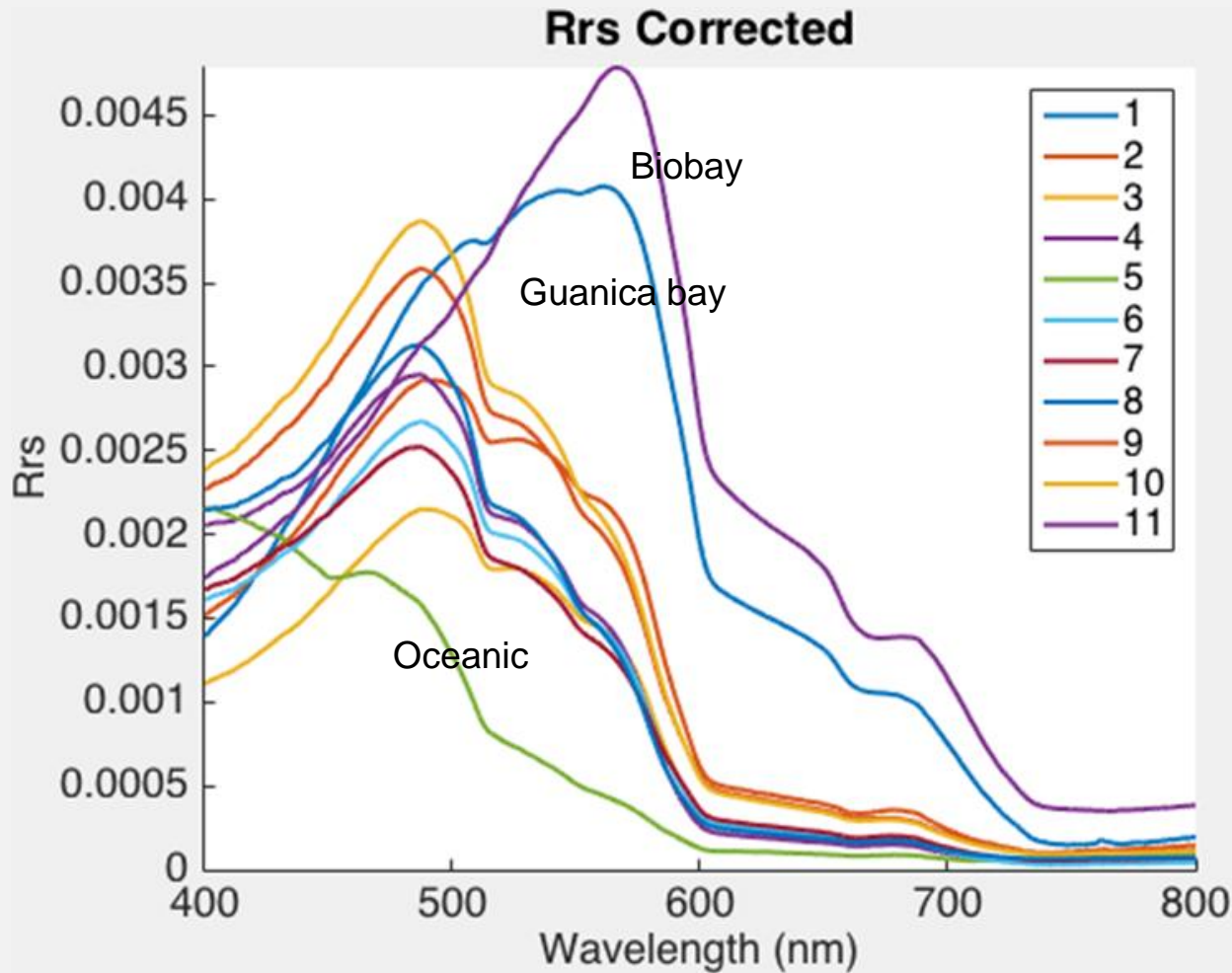
October 19, 2017

Esri, DeLorme, GEBCO, NOAA/NGDC, and other contributors

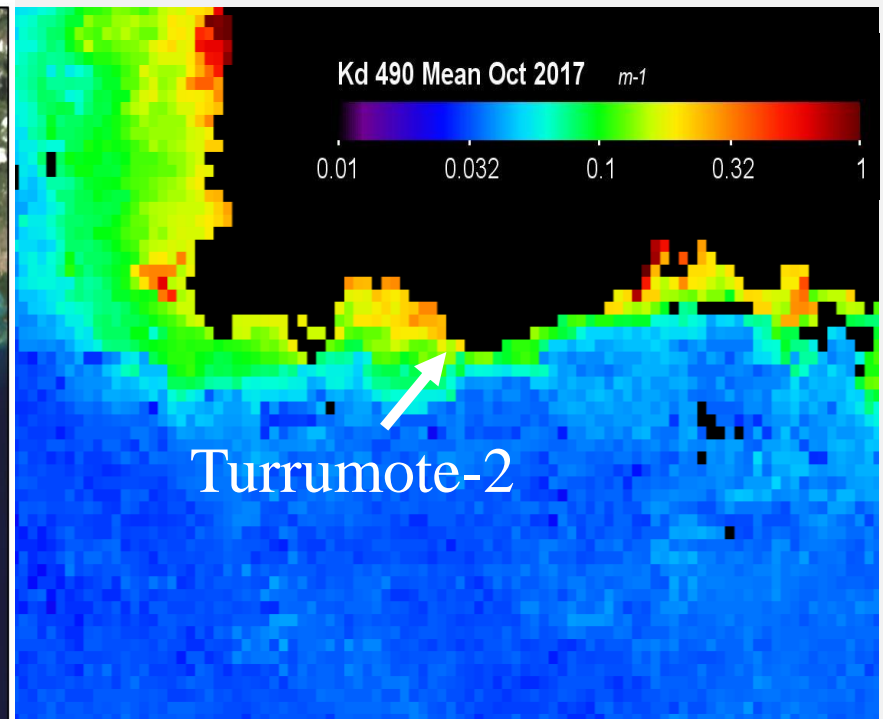


Field Sampling – Rrs (GER 1500)

GER1500 surface remote sensing reflectance

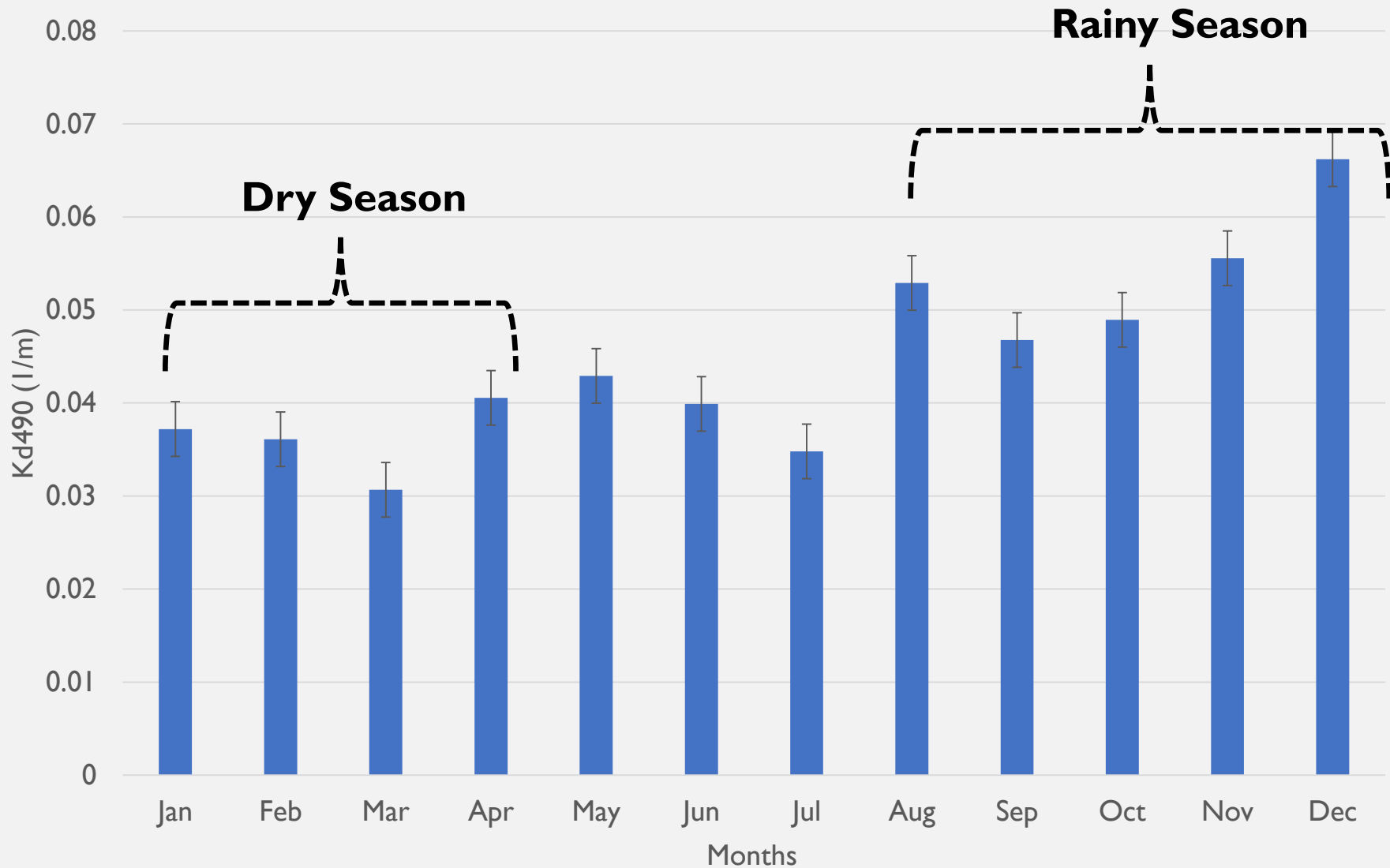


VIIRS Ocean Color Science Quality (750m)

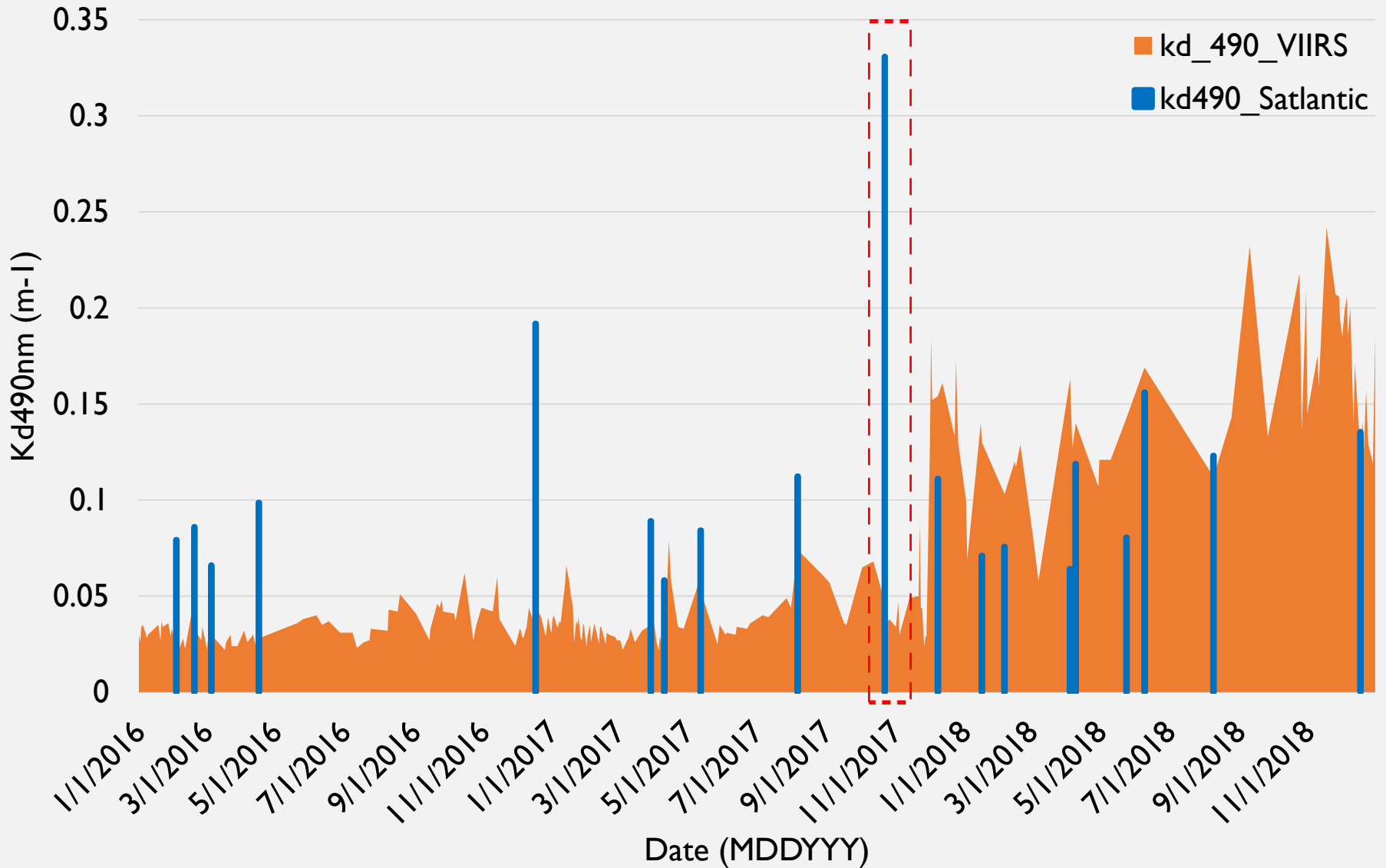


Kd490 Monthly Averages 2012-2018

Turrumote 2 Station

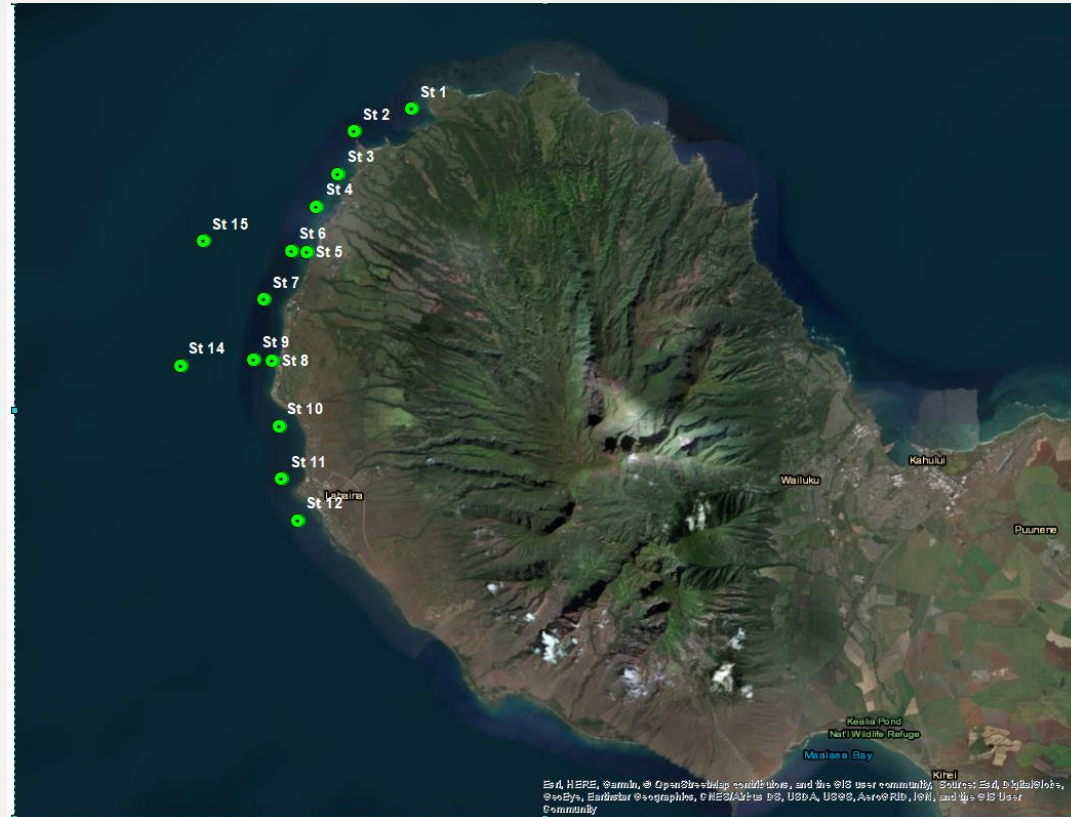


Kd490 nm for Station LP6 Turrumote 2 (from Satlantic Hyperpro and VIIRS L2 SCI)

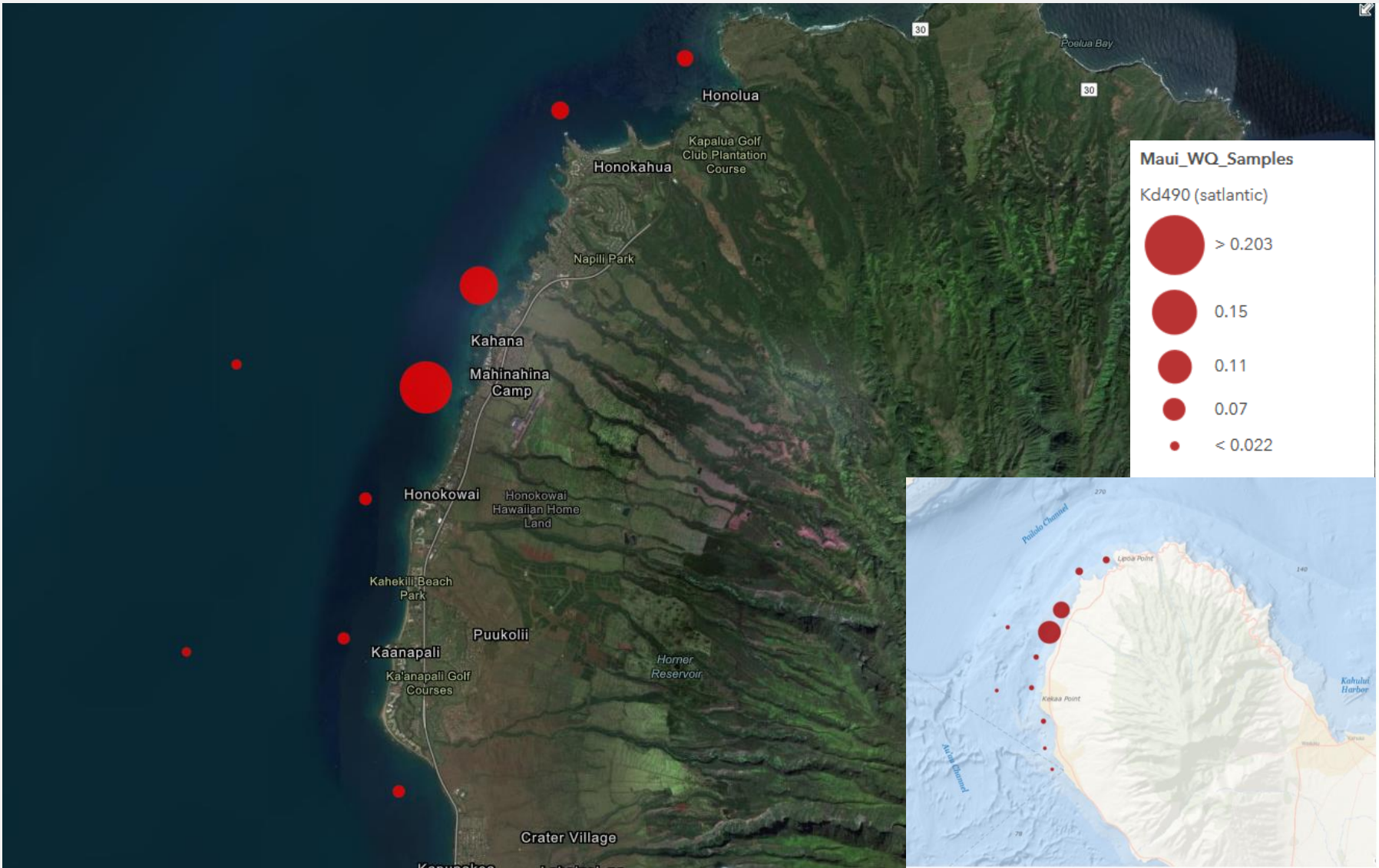


Ocean Color West Maui

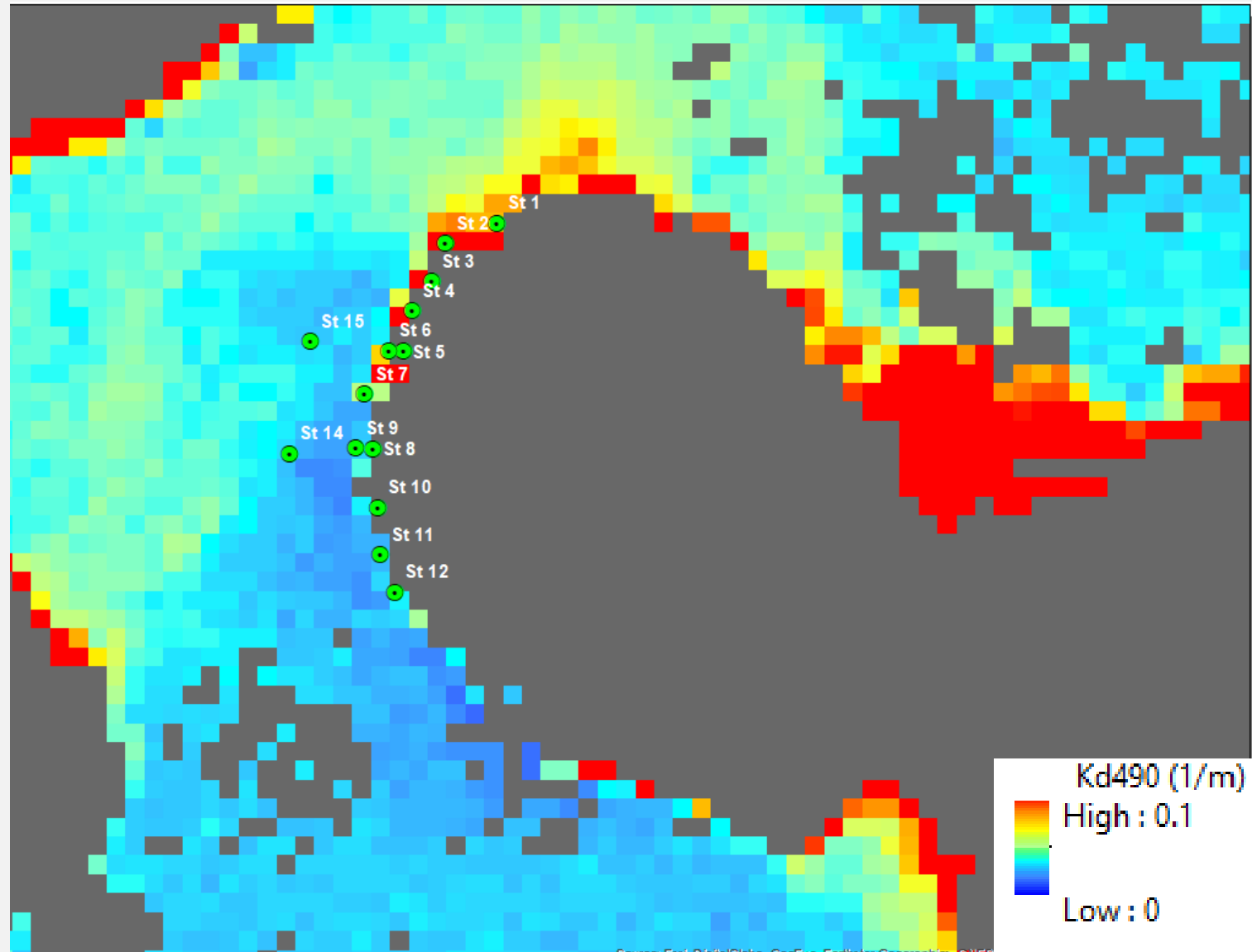
- Nov 26-28, 2018
- Instruments
 - **Satlantic Hyperpro Profiling radiometer (Lu, Ed, Rrs, Lw, Kd)**
 - GER 1500 Spectroradiometer (Lw, Ed, Rrs)
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 - Water quality samples
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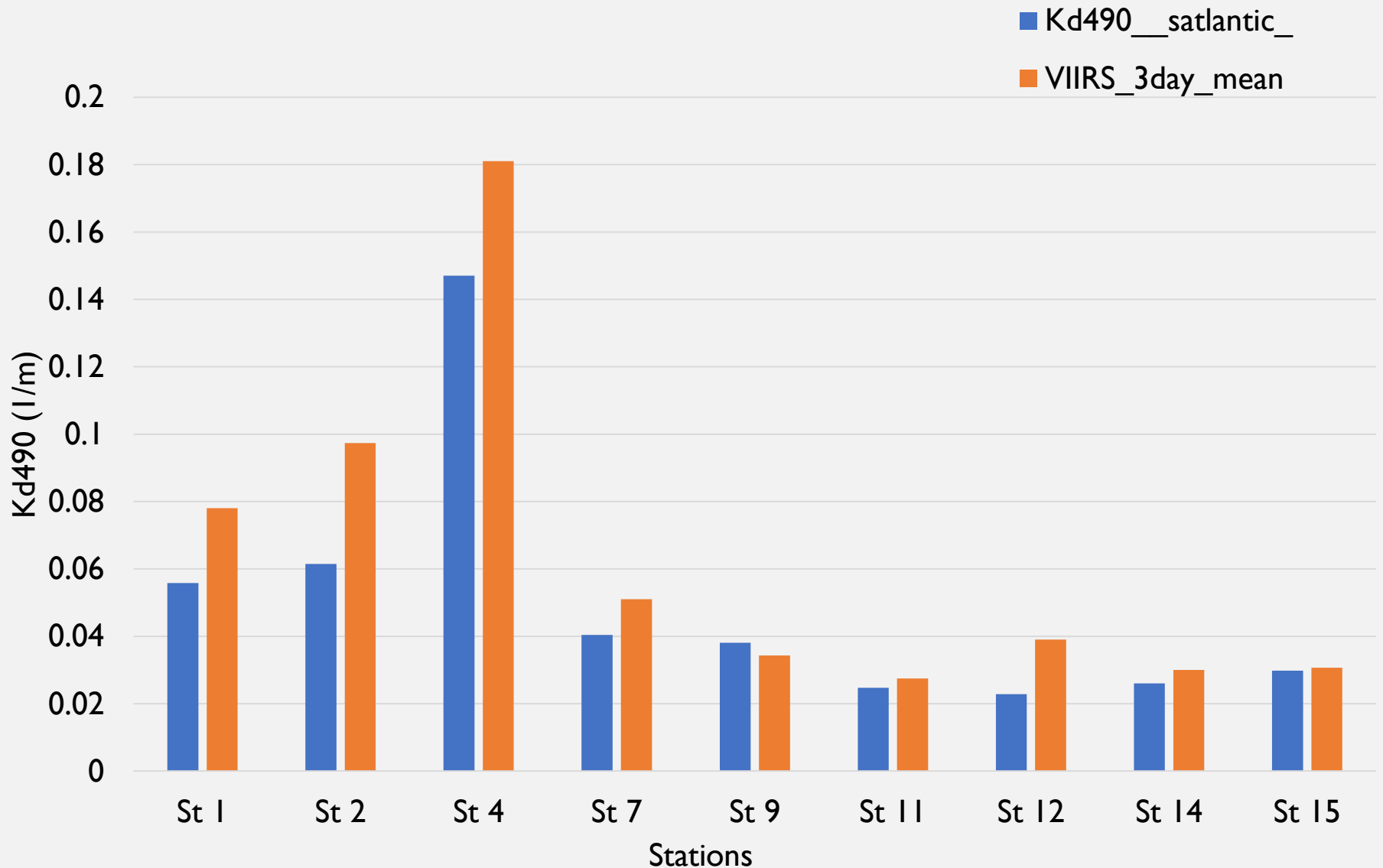
Ocean Color West Maui – Field Observations



Ocean Color West Maui – VIIRS MSL SCI (750m)

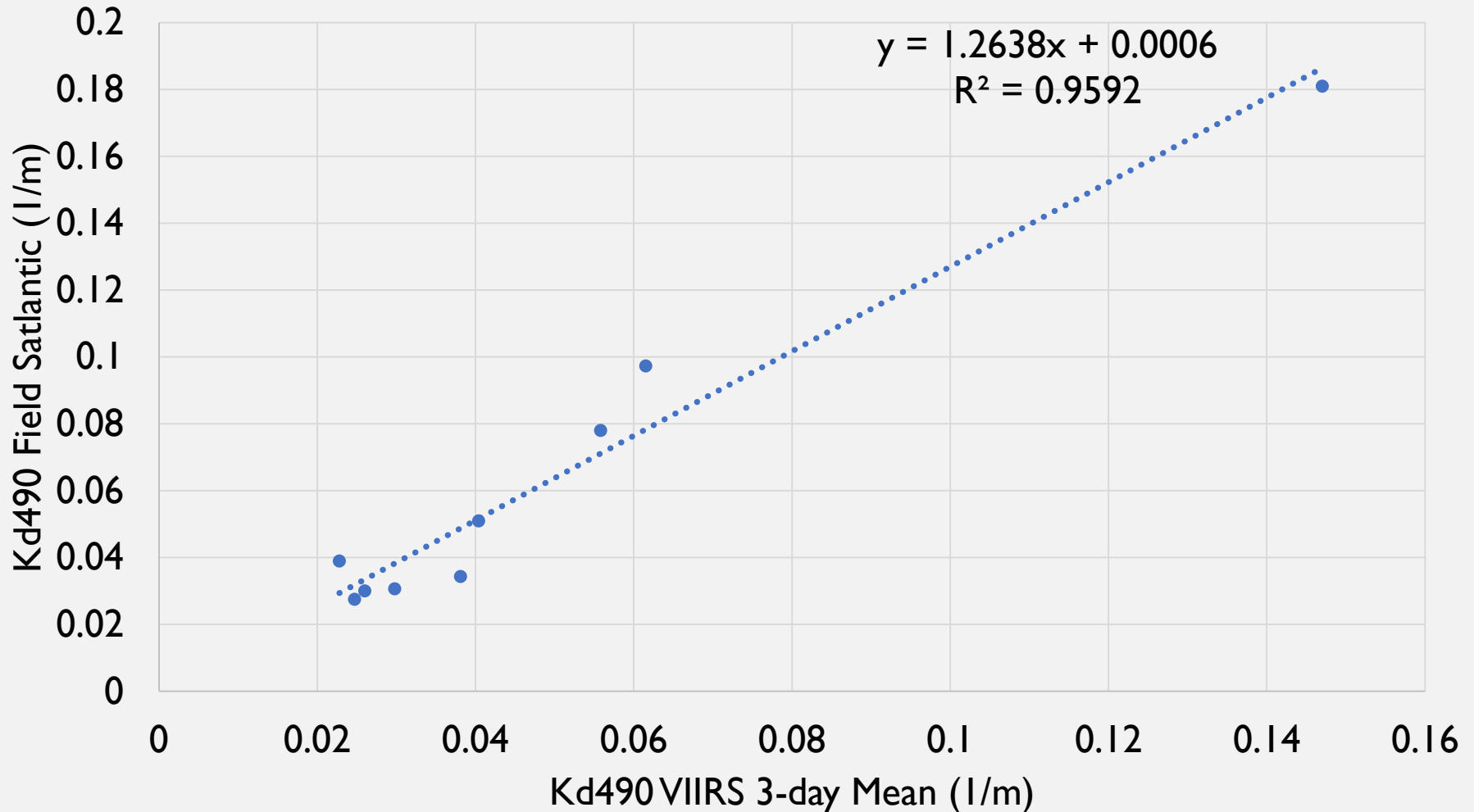


Ocean Color West Maui – VIIRS MSL SCI vs Field Observations

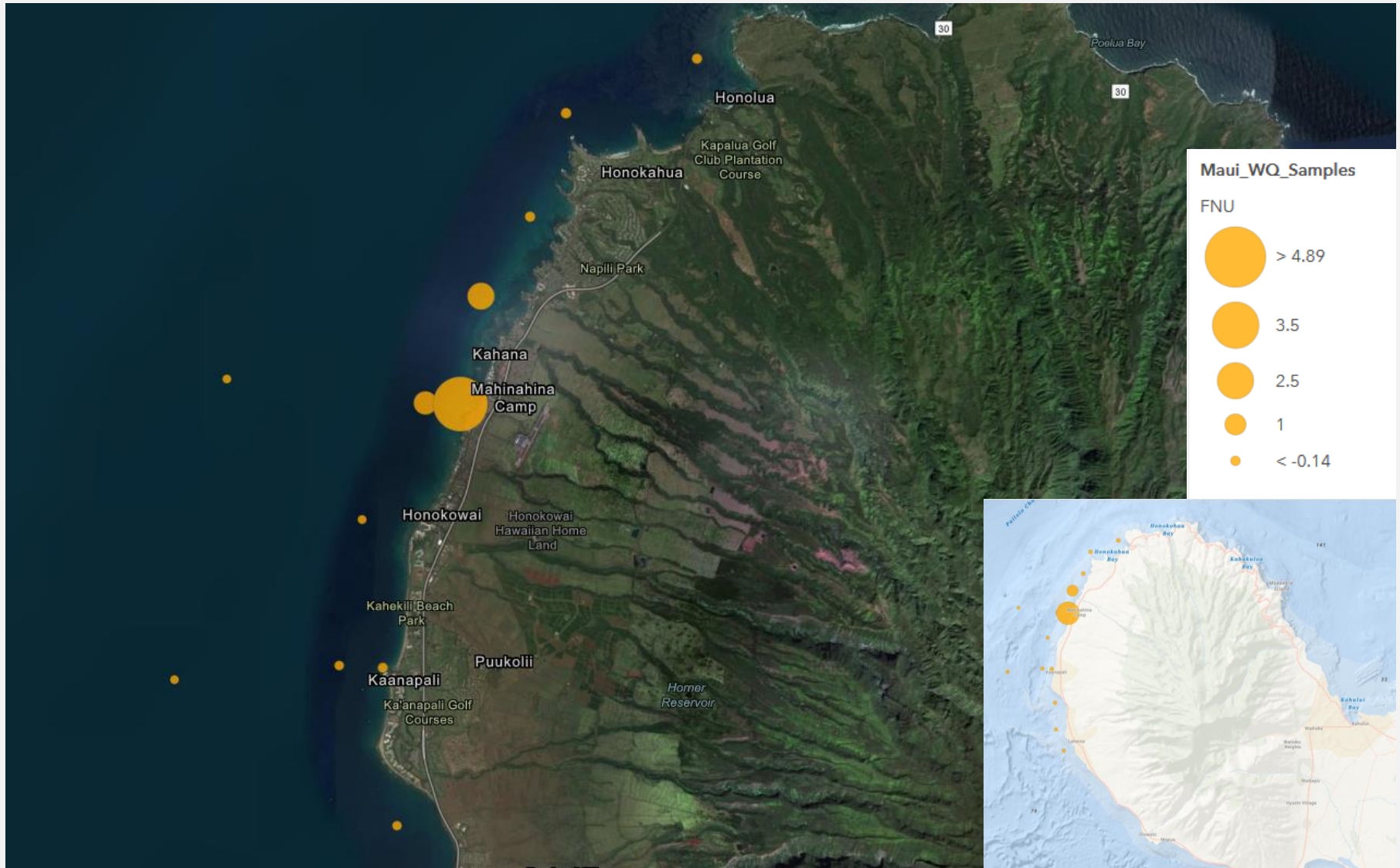


Ocean Color West Maui -VIIRS MSL SCI vs Field Observations

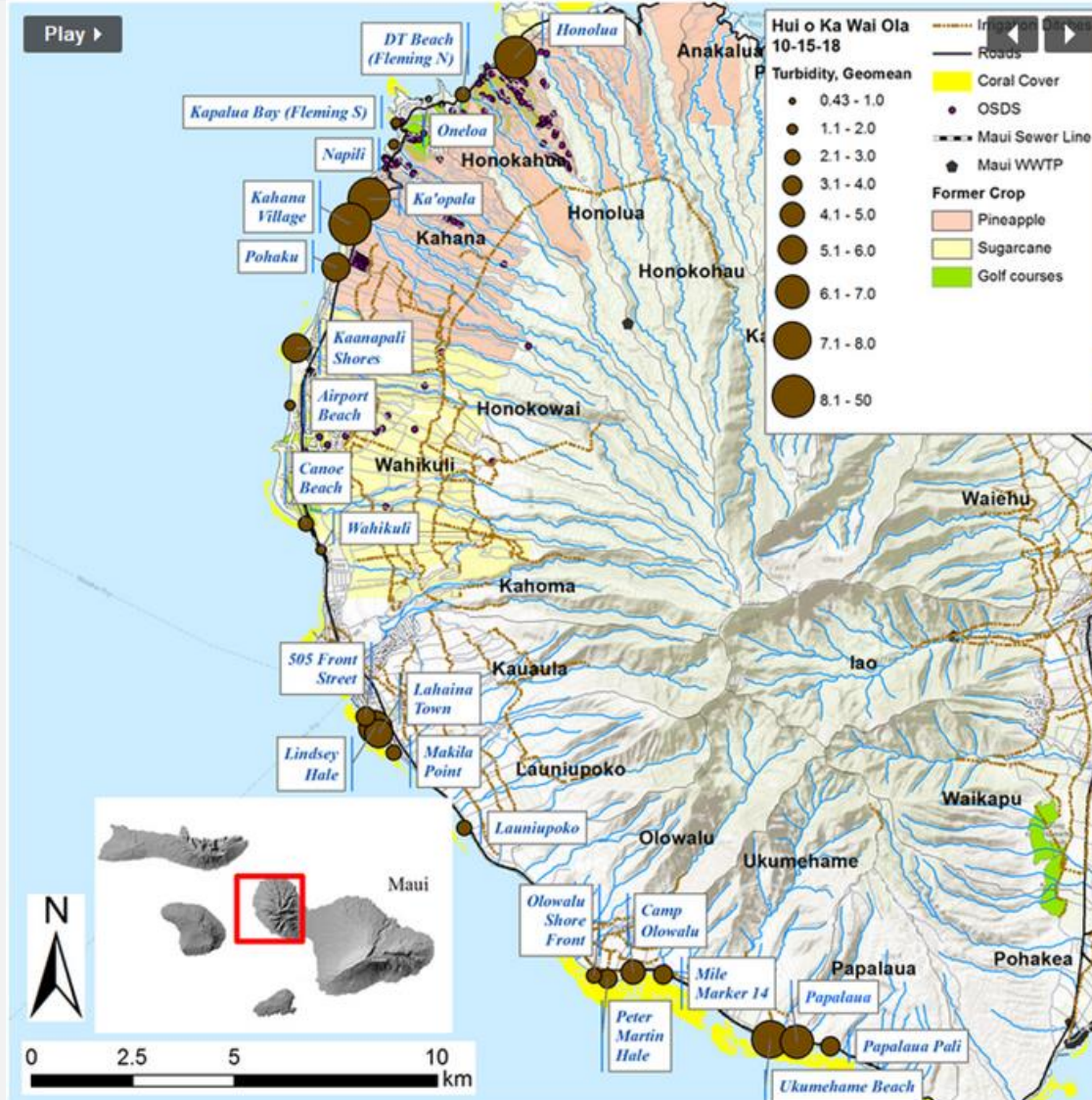
Kd490 Field (Satlantic) vs Kd490 VIIRS 3-day Mean



Ocean Color West Maui – Field Observations



HUI O KA WAI OLA- WATER QUALITY

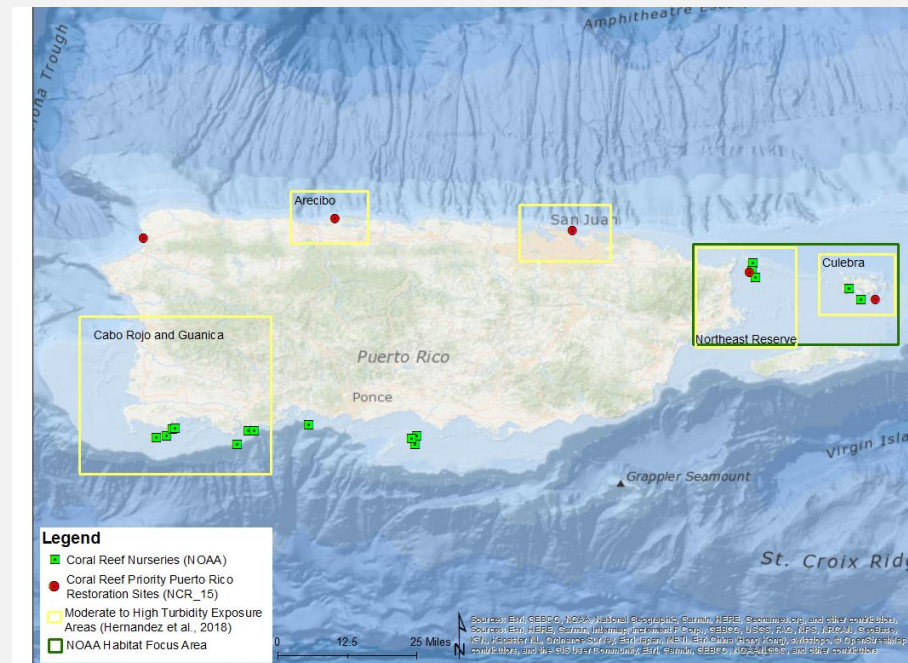


<https://www.huiokawaiola.com/data.html>

User Interactions

NOAA Scientists Support

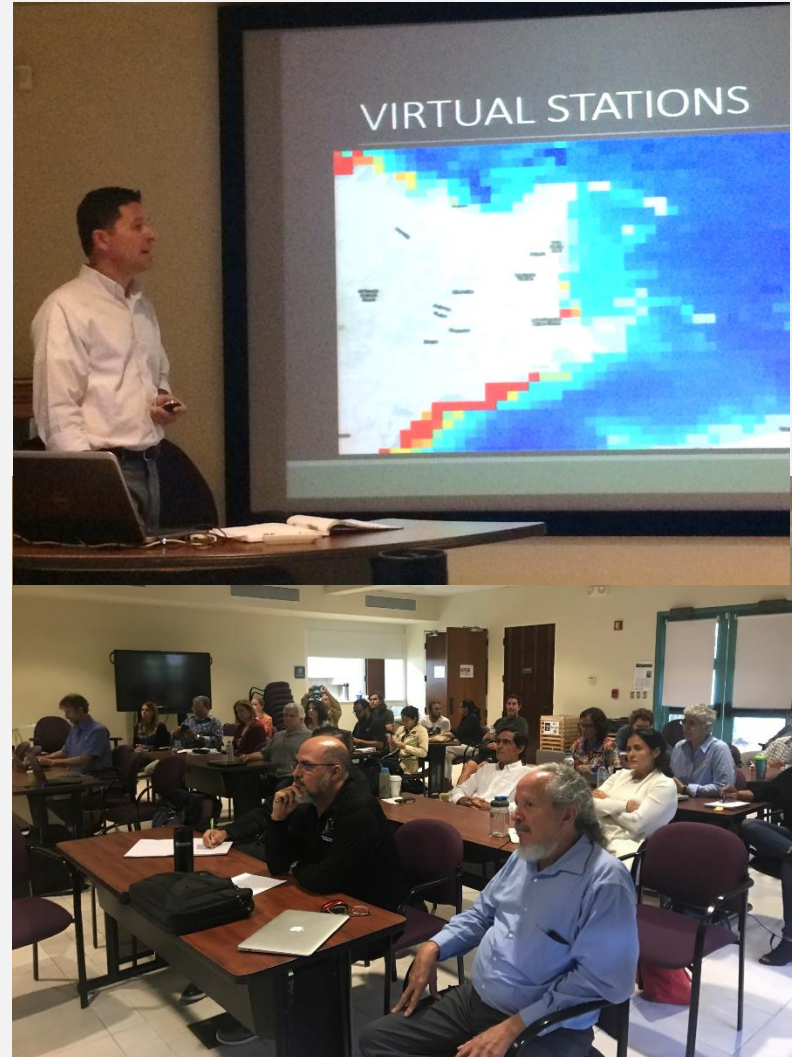
- **NOAA Office of Response and Restoration**
- Aguadilla, PR
- Scientists: Sean Griffin, Michael Nemeth
- Integration of ocean color remote sensing tools and drone imagery.
- NOAA restorations sites, coral nurseries and habitat focus areas in PR.
- CRCP Domestic 2019 funded project.



Presentations and Outreach

Ocean Color Workshop and CRW User Outreach Meeting

- April 19, 2018, San Juan, PR
- **32** key coral reef ecosystem and watershed managers and research partners
- **16** different organization that included State/Federal Agencies, NGO's and Academia.
- NESDIS/STAR/CRW
- NOS/NCCOS



Presentations and Outreach

Coastal Water Quality Remote Sensing Tools for Watershed Managers Lajas, PR

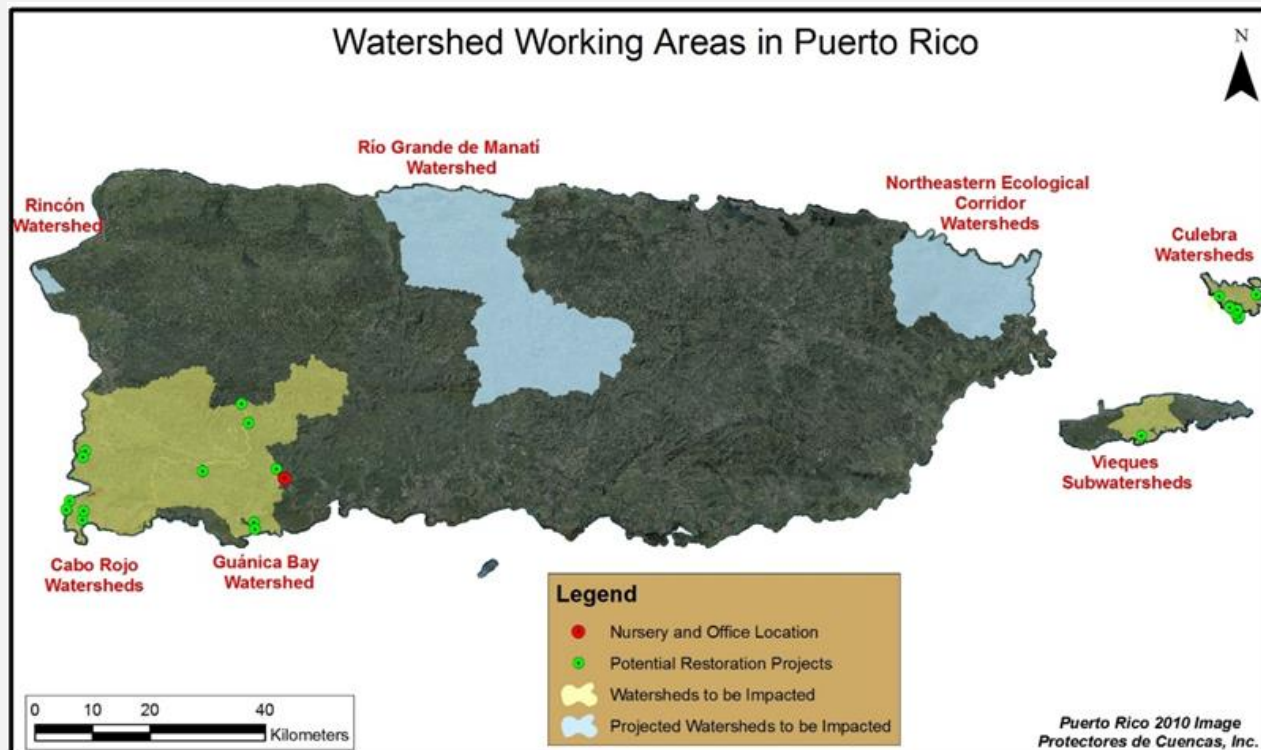
- November 6-9, 2018.
- Nine coral reef ecosystem and watershed managers and a NOAA Fellow participated from Puerto Rico, the US Virgin Islands, Hawaii, Guam, & American Samoa.
- Training and field work in ocean color imagery from VIIRS and their importance to monitor coastal environments.



NGO Support

Protectores de Cuencas Inc.

- Support NGO with water quality information, satellite and drone imagery for NOAA-sponsored watershed and coral restorations sites.



NGO Support

Ocean Color Validation and Water Quality Field Campaign West Maui, HI

- Nov. 24-Dec. 1, 2018.
- Ocean Color for Water Quality and Field Validation for VIIRS.
- NESDIS STAR ORS 18 Internal Funding
- Support local NGO's and watershed managers for water quality measurements.
 - Ridges2Reefs (Tova Callender)
 - Hui O Ka Wai Ola (James Strickland)

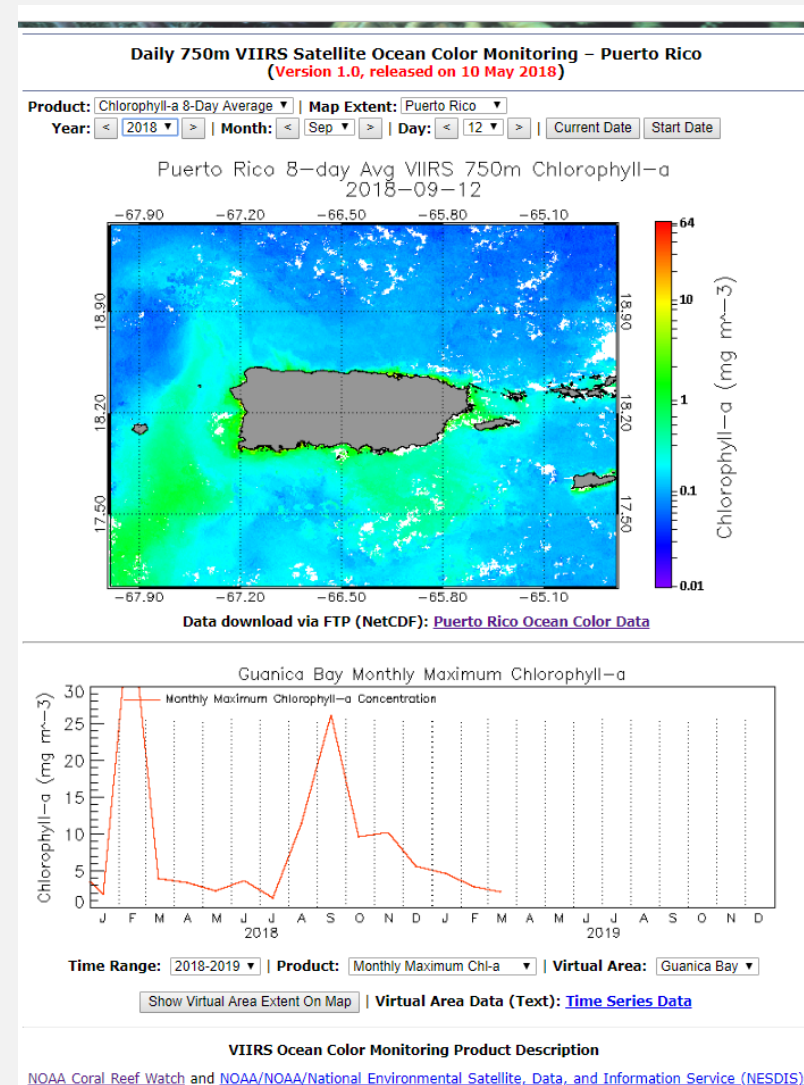


(Top) Doctoral student Suhey Ortiz-Rosa, Dr. Roy Armstrong and James Strickland (Hui O Ka Wai Ola) with the EXO-I.

(Bottom) Dr. William J Hernandez with the Satlantic Hyperpro profiler of the coast of West Maui, HI.

Ocean Color Prototype Manager's Portal

- Developed by STAR/Coral Reef Watch Ocean Color Team.
 - Erick Geiger, Mark Eakin
- Provides 1 Km VIIRS Time-Series data for Chl-a and Kd490.
- Daily, 3-day, 8-day, monthly averages.
- Developed with feedback from coral reef ecosystem managers to monitor variable water turbidity $K_d(490)$ from LBSP following high precipitation events.
- <https://coralreefwatch.noaa.gov/satellite/research/oceancolor.php>



Next Step: Drone vs Satellite Imagery

Posa de Lido, Vega Baja



Drone: Mavic Pro Platinum
RGB Camera
4-5 cm pixel
May 2018



Satellite: WorldView 3
Multi-spectral: B1, B2, G, Y, R, NIR1, NIR2
1.8 m pixel (0.33m RGB pan-sharp.)
November 2017

Next Steps: Drones in Aquatic Science

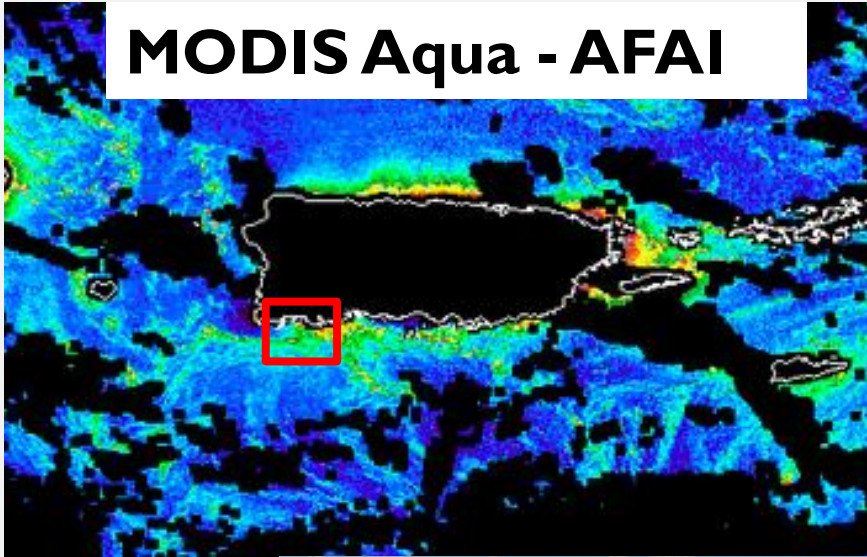
Images credit: Omar López



Next Steps: Sargassum Impacts

May 2018

MODIS Aqua - AFAI



Landsat 8 OLI

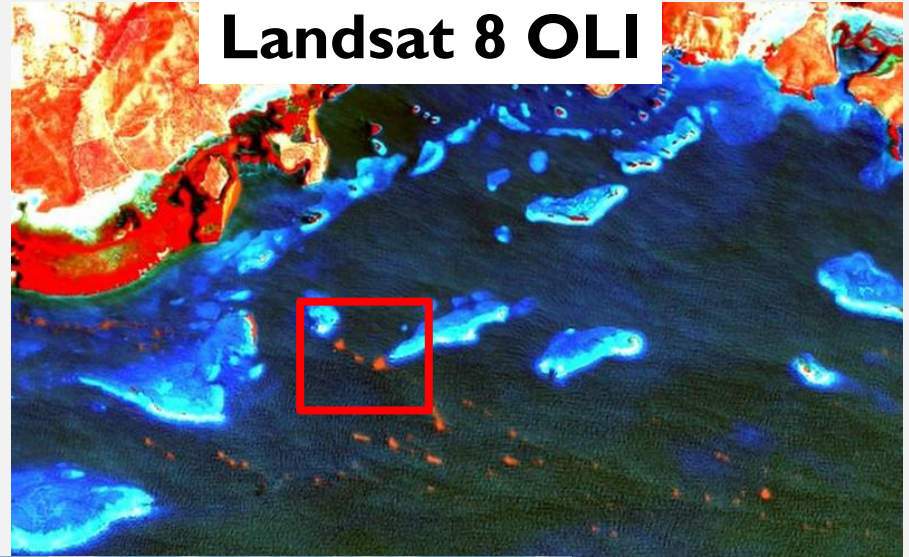


Image credit: USF OOL.
Satellite-based Sargassum
Watch System (SaWS)
<https://optics.marine.usf.edu/projects/SaWS.html>



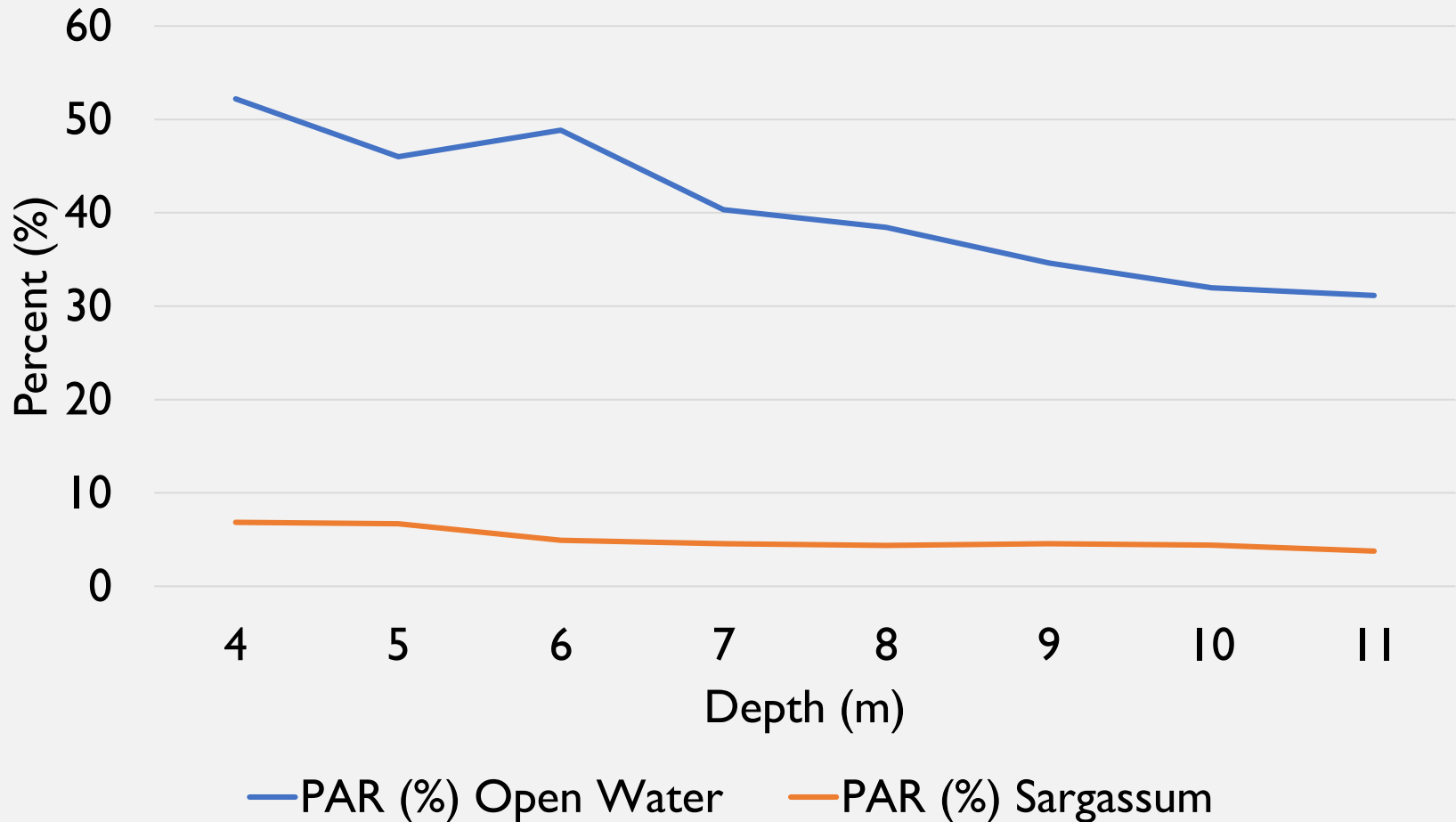
Next Steps: Sargassum Impacts



**Downwelling Irradiance (PAR)
Profile**

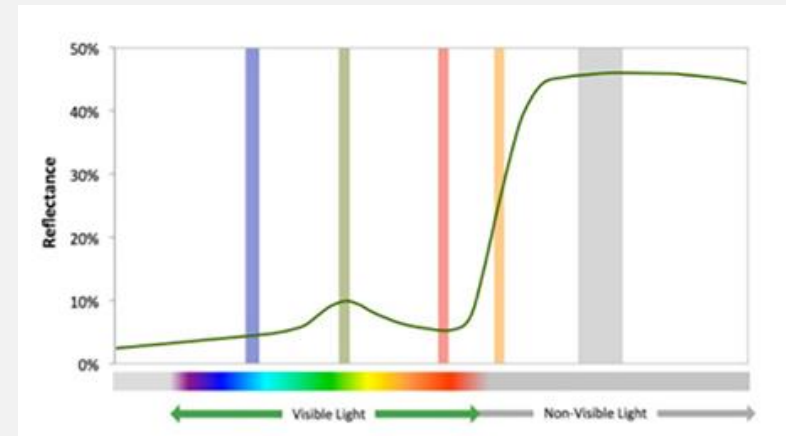
Next Steps: Sargassum Impacts

Satlantic Profiler PAR (%) by Depth
Open Water and Sargassum



Next Steps

- Multispectral Imaging from Drones
- Supplement Ocean Color products
- Expand field instrumentation and sampling in critical areas
- Develop an early warning system
- Establish recommendations on local BMP to manage Sargassum beachings

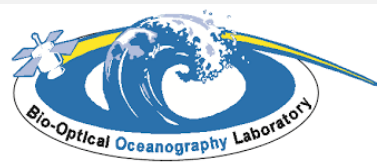




Acknowledgements



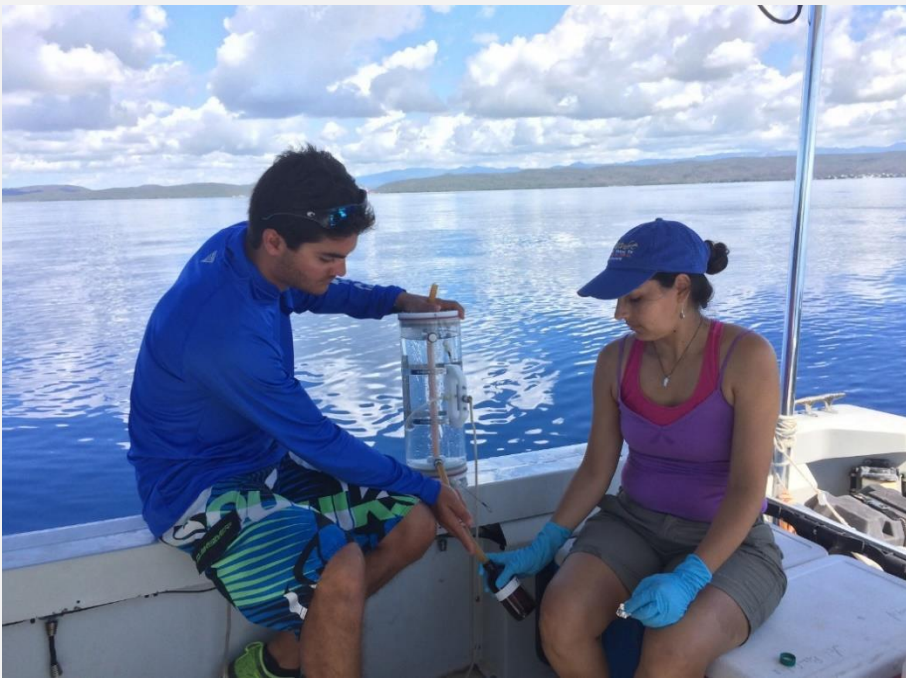
This study is supported and monitored by The National Oceanic and Atmospheric Administration – Cooperative Science Center for Earth System Sciences and Remote Sensing Technologies (NOAA-CESSRST) under the Cooperative Agreement Grant # NAI6SEC4810008. The authors would like to thank The City College of New York, NOAA-Cooperative Science Center for Earth System Sciences and Remote Sensing Technologies (aka NOAA-CREST) program and NOAA Office of Education, Educational Partnership Program for full fellowship support for Dr. William J Hernandez. The statements contained within the manuscript/research article are not the opinions of the funding agency or the U.S. government, but reflect the author’s opinions.



Bio-Optical Oceanography Laboratory Team Members



- Dr. Roy Armstrong -Director
- Dr. Yasmin Detres - Researcher
- Graduate Students: Suhey Ortiz (NOAA CESSRST), Maria Cardona (NOAA NCAS-M), Carla Mejias (NOAA NCAS-M), Jennifer Perez, Omar Lopez.
- Luis Lugo – Staff UPRM



QUESTIONS?



SUPPORTING SLIDES