

UAS High Resolution Assessment of Carbon Dynamics in Seagrass and Coral Reefs Biomes

Preliminary Results and Plans

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Background

Shallow tropical coral reefs and sea grasses play important roles in coastal carbon and nutrient cycles, in coastal biodiversity and in the economy of coastal zones

The global surface area of both coral reefs and sea grasses has decreased by ~30% in the last 100 years

- Natural and human factors interact to cause decline

Growing sense that we are unable to understand large-scale biodiversity and rate processes (productivity, respiration, calcification, etc., without significant advances in remote sensing technologies:

- Hyperspectral observations
- Time series

High relevance of HypsIRI and of 'synergistic' missions including PACE/ACE, GeoCAPE, other US and international missions

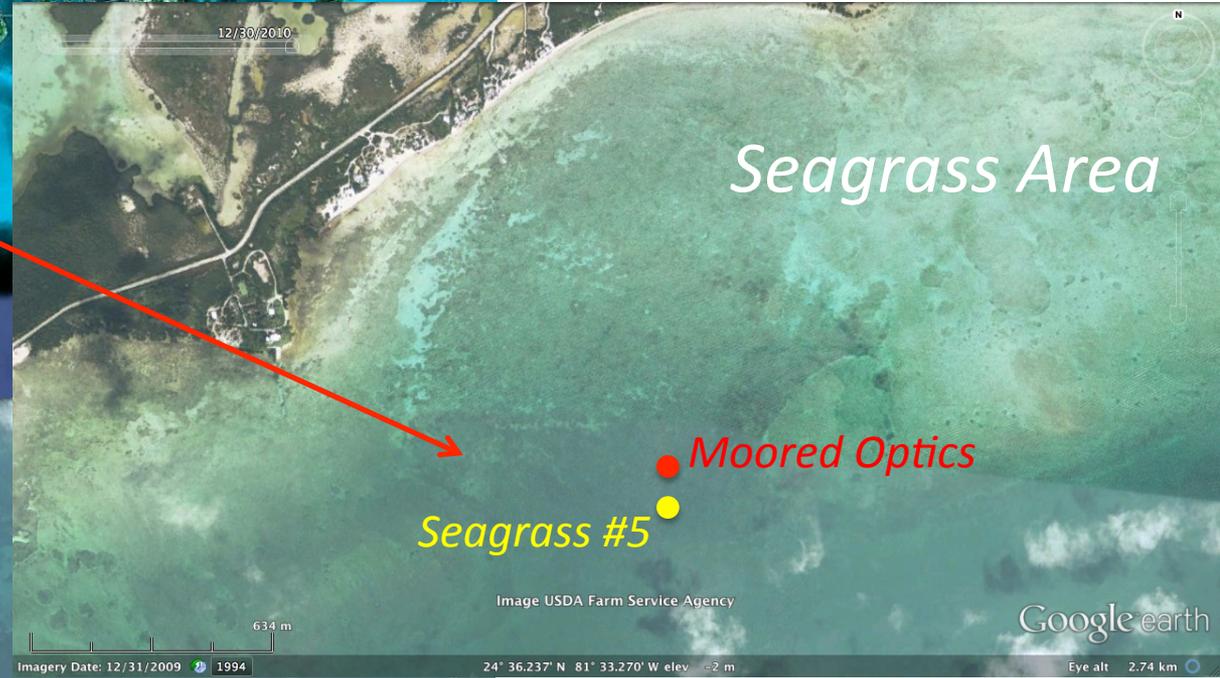
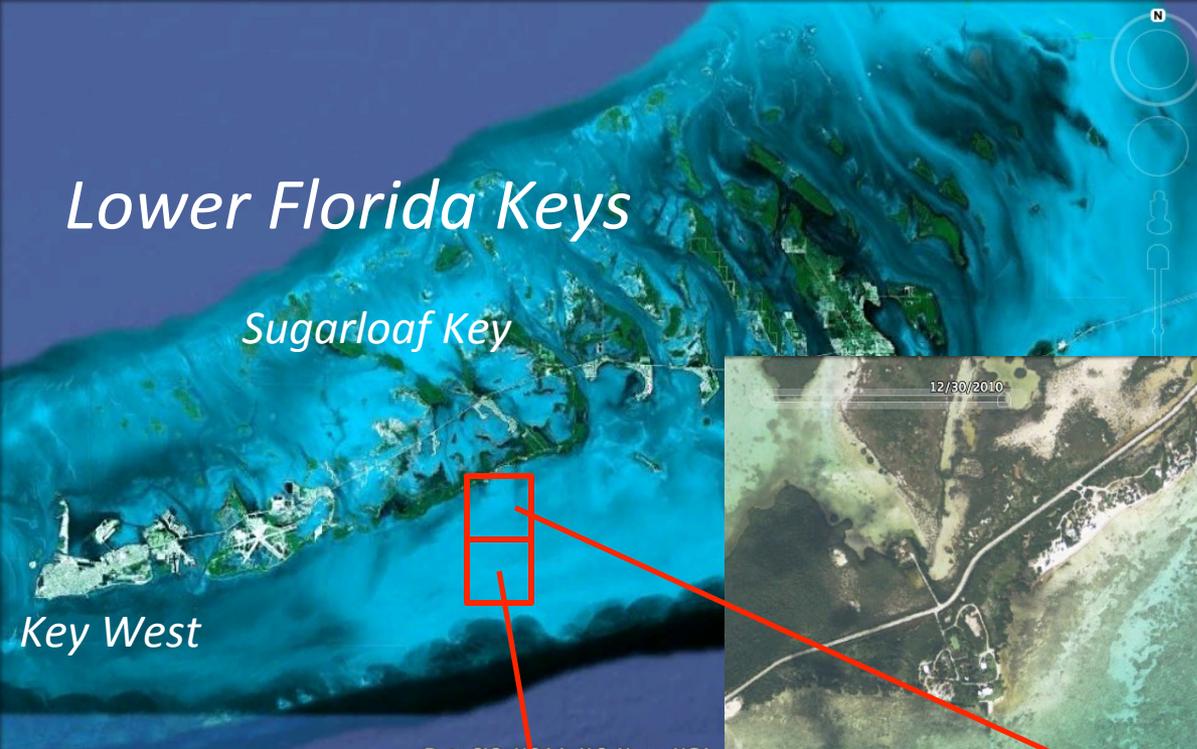
Project

- 2011 Proposal in response to NASA UAV RFP
- Objectives: Assess unmanned aerial vehicle (UAV) technologies and hyperspectral observations to better understand seagrass and coral physiology in the Florida Keys:
 - Are UAV platforms accessible to scientists?
 - Is UAV technology ready to conduct useful science or surveys?
 - Are there hyperspectral sensors for UAVs to complement in situ and satellite observations?
 - Help develop understanding on: Depth, coral cover, water column effects, productivity, calcification, respiration, etc.

Approach

- Define / select Study Area
- Coordinate with NASA and *UAS Collaborative* on UAV and sensor package and field deployment
 - Above Water Optics
 - Subsurface optical Profiles
 - Moored Packages (time series)
 - Incubation tents (USGS/K Yates, FWRI/P Carlson)
 - Data Processing / archive / distribution
(C. Hu, FM-K, D Ramsewak, N Melo, S Cerdeira, D Turk, M Vega, G Toro Farmer, W McGillis)

Field Deployment



Location of the moored optical packages. Location of closest benthic chamber experiments are shown as a reference.



UAV COLLABORATIVE



NASA Research Park
Moffett Field, CA



Stan Herwitz, CEO
(project PI)



Project Team with NASA *Sierra* UAV at Key West Naval Air Station

Pre-Deployment Preparatory Activities

- Assemblage of optical profiling drop-package.
- Tested optical profiler for leaks and data collection.

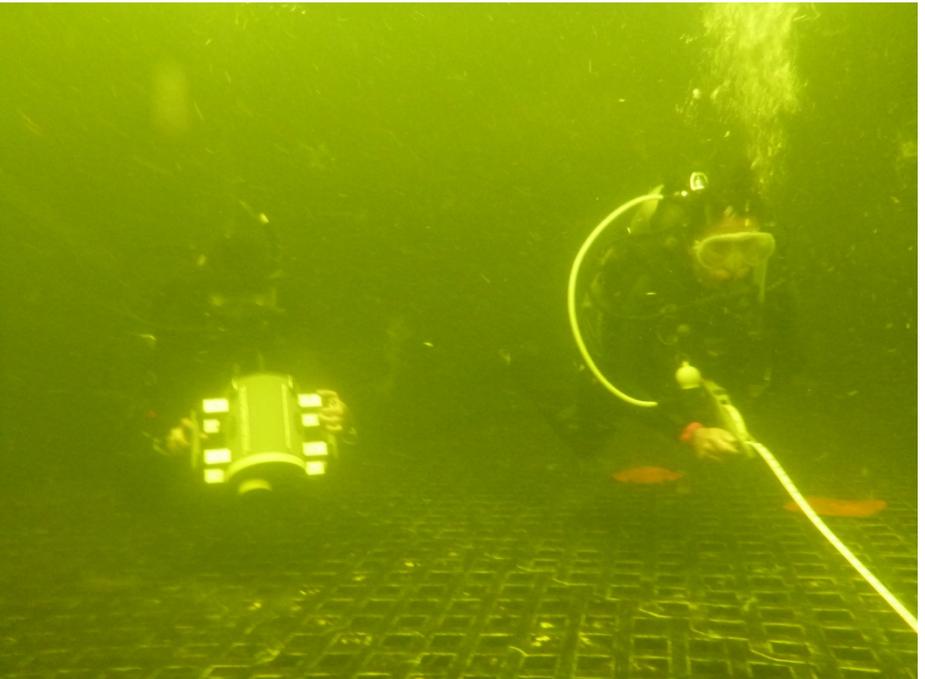


Pre-Deployment Preparatory Activities

- Tested Buoyancy and manipulation of underwater equipment.
- Tested bottom data collection procedures



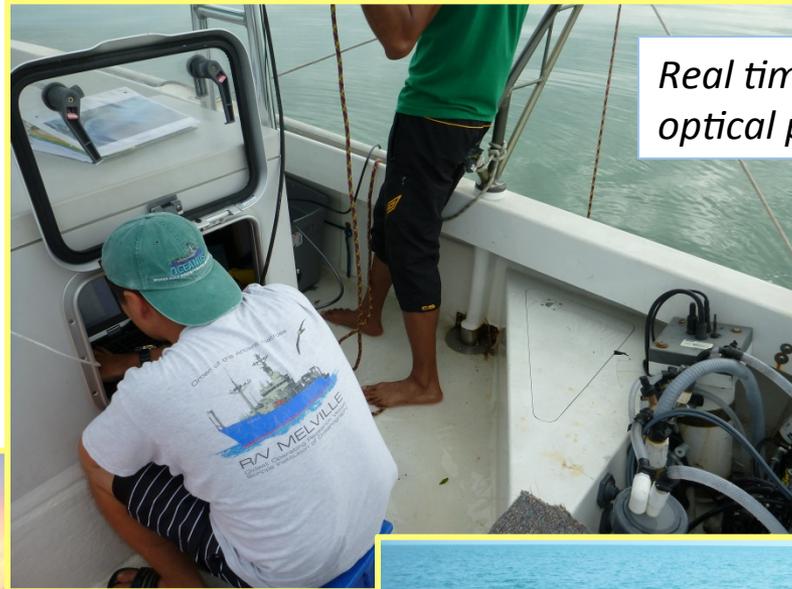
Underwater Spectrometer (GER)



Testing Bottom Coverage Procedures

Field Deployment: May and Oct 2012

*Loads and loads of
equipment and
materials*



*Real time visualization of
optical profiles*

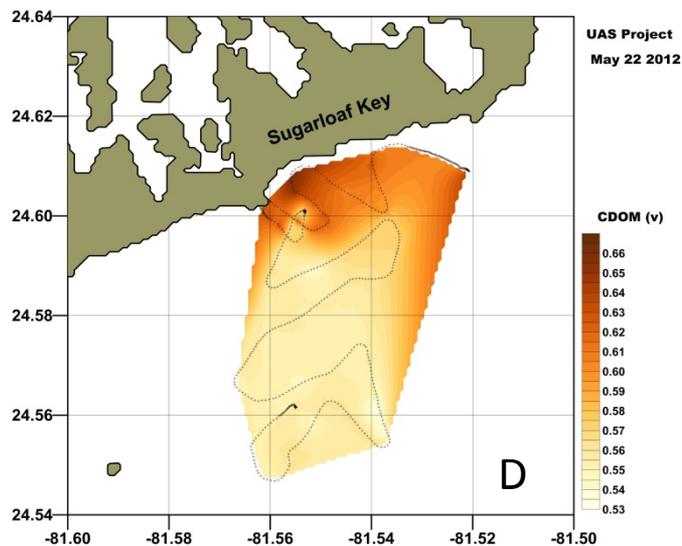
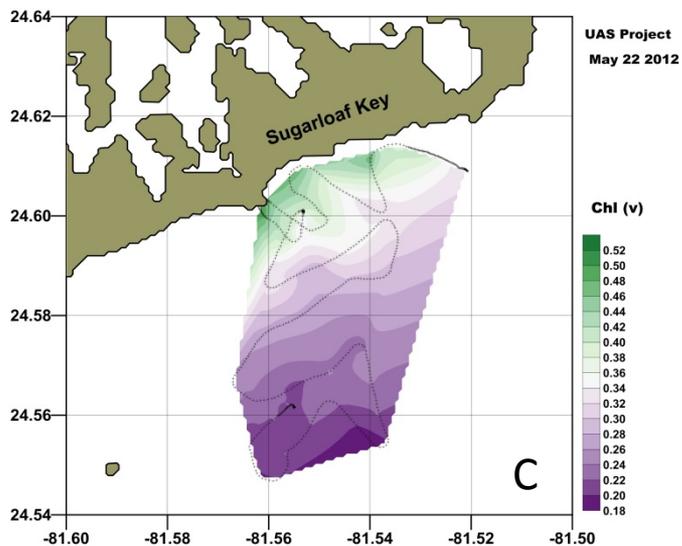
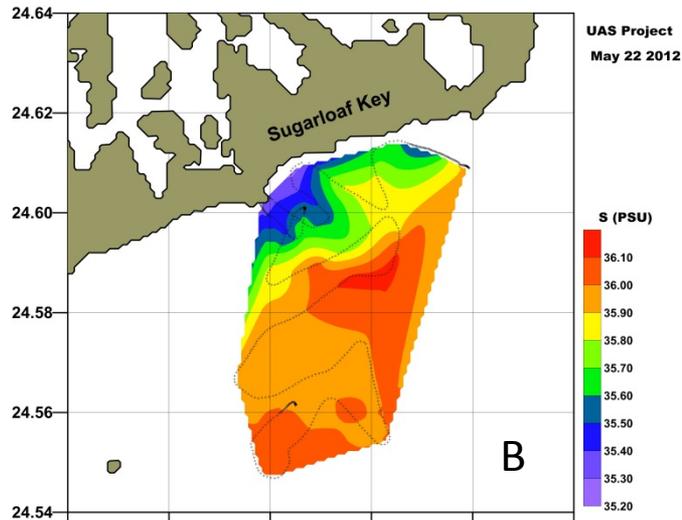
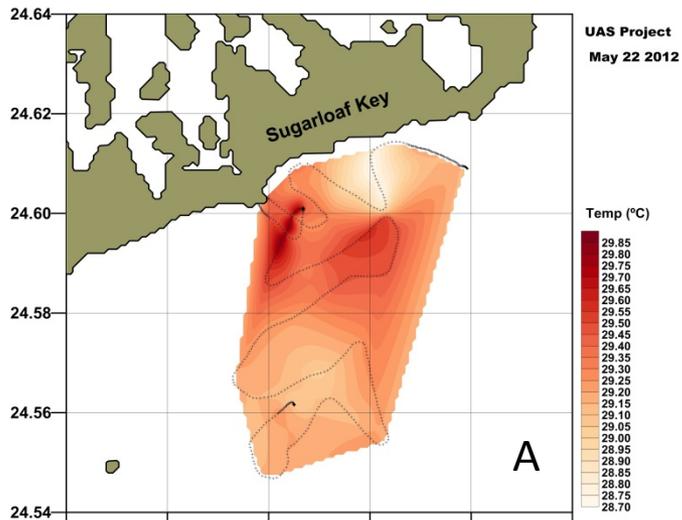


Work boat



*Divers getting ready to measure
bottom reflectance*

Flow-through system – Preliminary Results



May 22, 2012

Horizontal distribution:

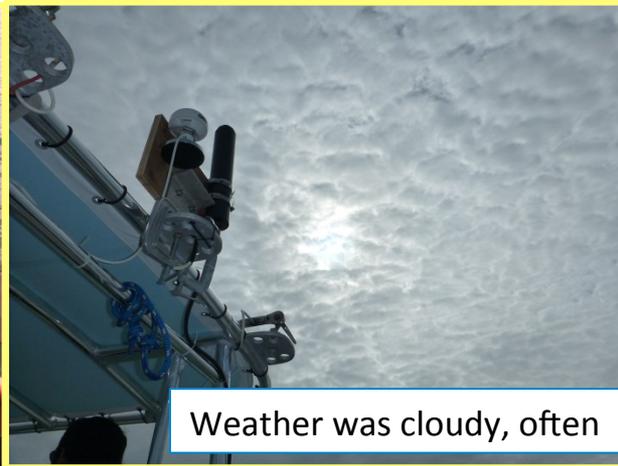
- A. Temperature (°C)
- B. Salinity
- C. Chlorophyll (Volts)
- D. Colored dissolved organic matter (CDOM, Volts)

Above Water Bio-Optics Measurements

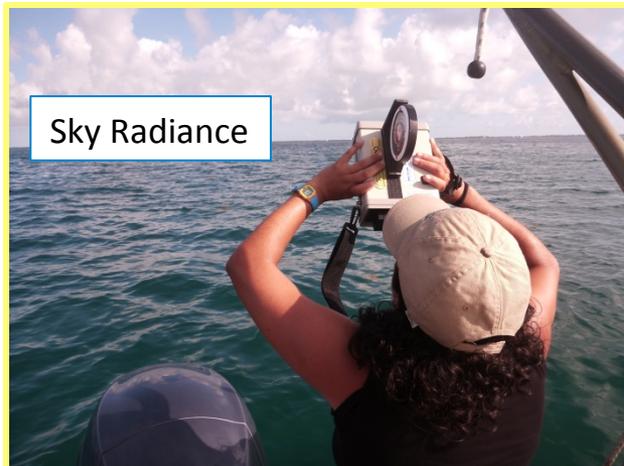
Remote Sensing Reflectance



Above Water Irradiance

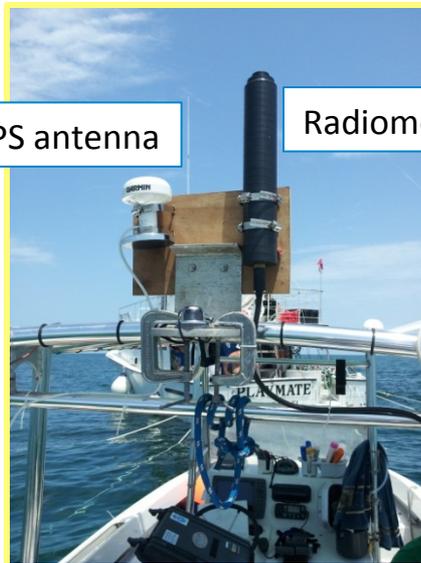


Flow-through System



GPS antenna

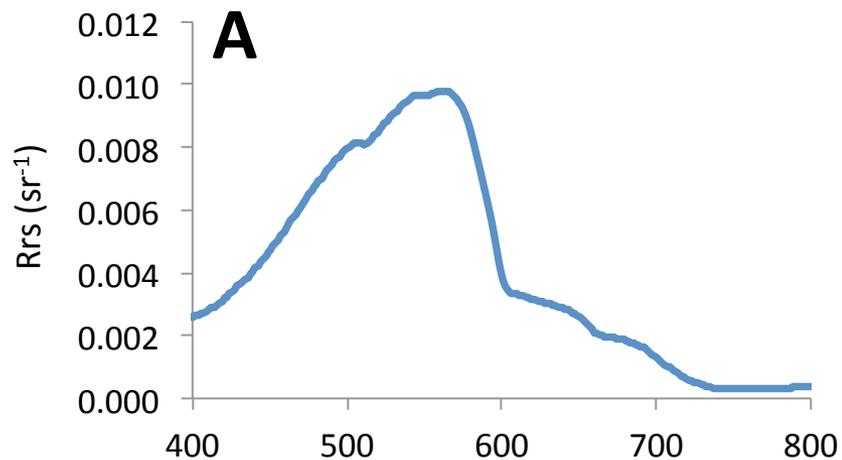
Radiometer



Flow-through system with temperature, salinity, turbidity, chlorophyll and organic matter fluorometers

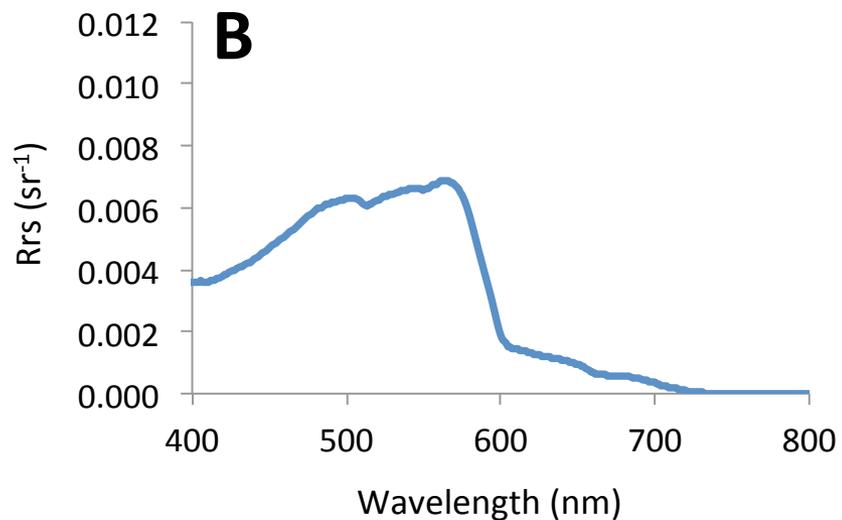


Remote Sensing Reflectance – Preliminary Results



Remote Sensing Reflectance (R_{rs}) for
May 22, 2012:

A. Over Seagrasses, 10:45 AM
(Light-green waters
~ 20% cloud cover).



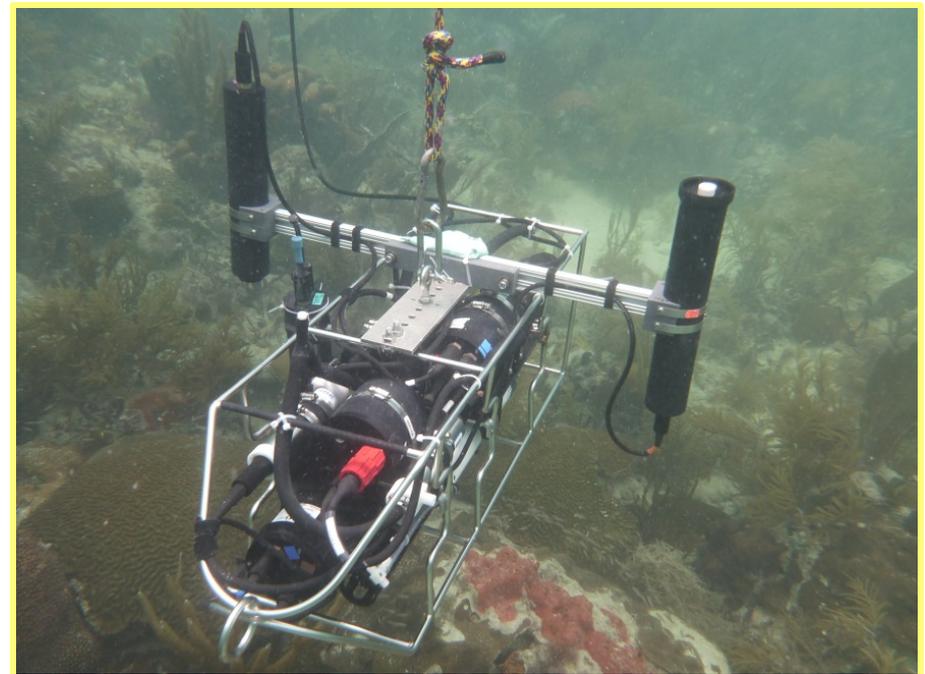
B. Over Patch Reefs, 2:05 PM
(Green waters
~ 40% cloud cover)

Optical Profiles



Deployment of the optical profiler

Optical profiler + CTD above patch reefs.
Measurements: hyperspectral radiance and irradiance, hyperspectral absorption and scattering, chlorophyll and colored dissolved organic matter (CDOM) fluorescence, backscattering, temperature and salinity.

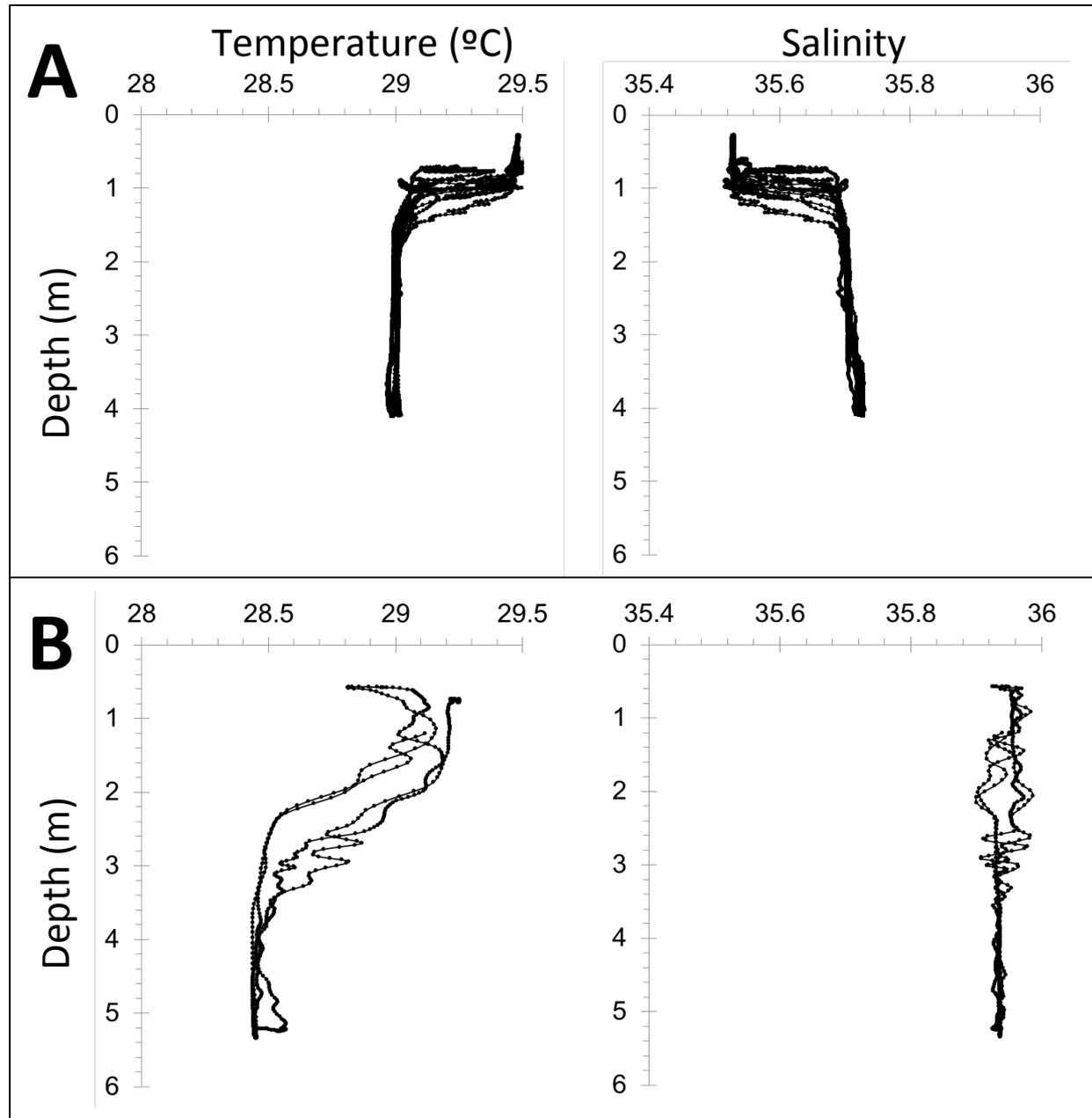


Profiles – Preliminary Results

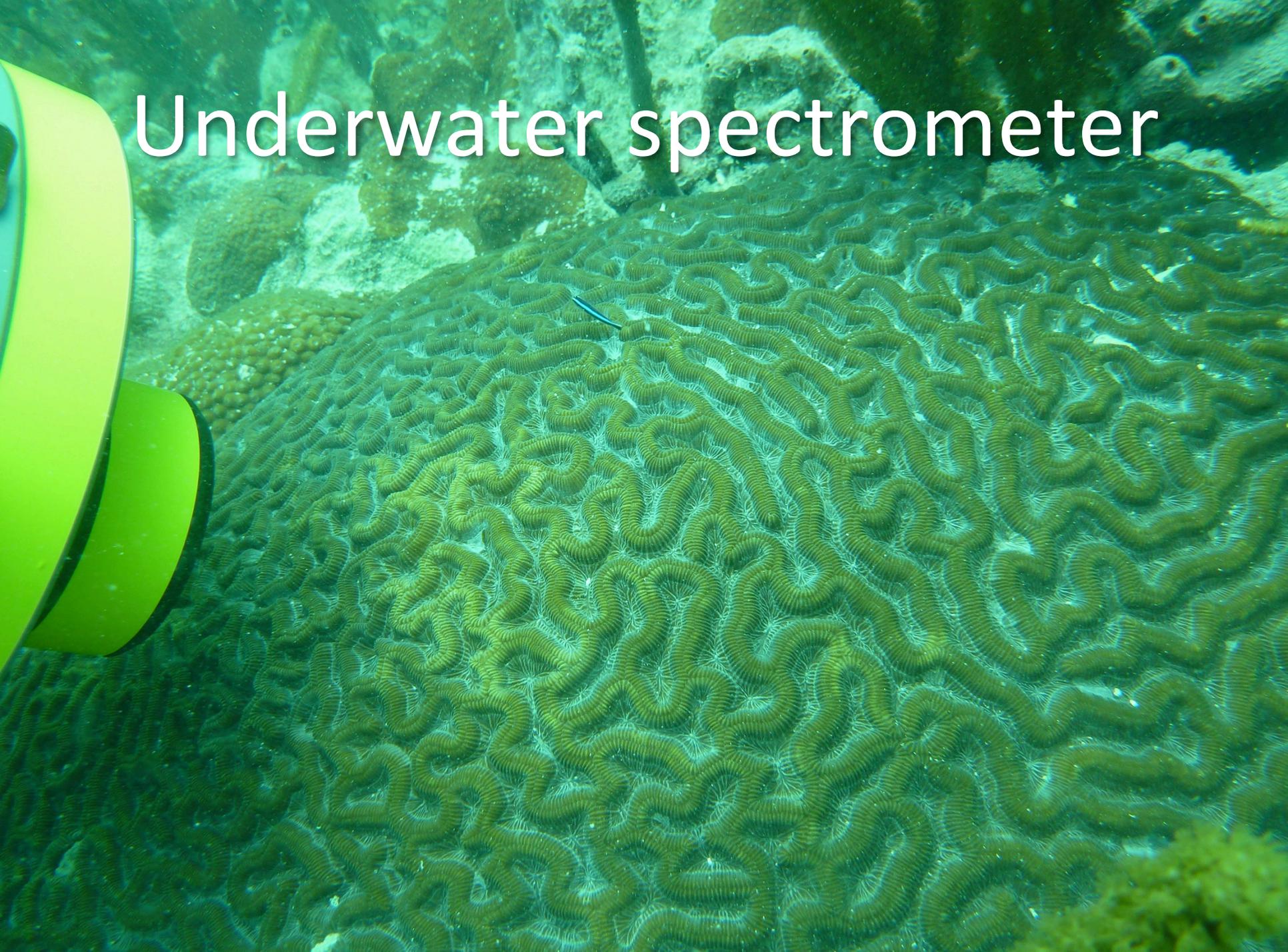
Vertical profiles of
temperature and salinity:

- A. Seagrass area.
- B. Patch Reefs.

Data from [May 22, 2012](#)
near the moored optical
packages.



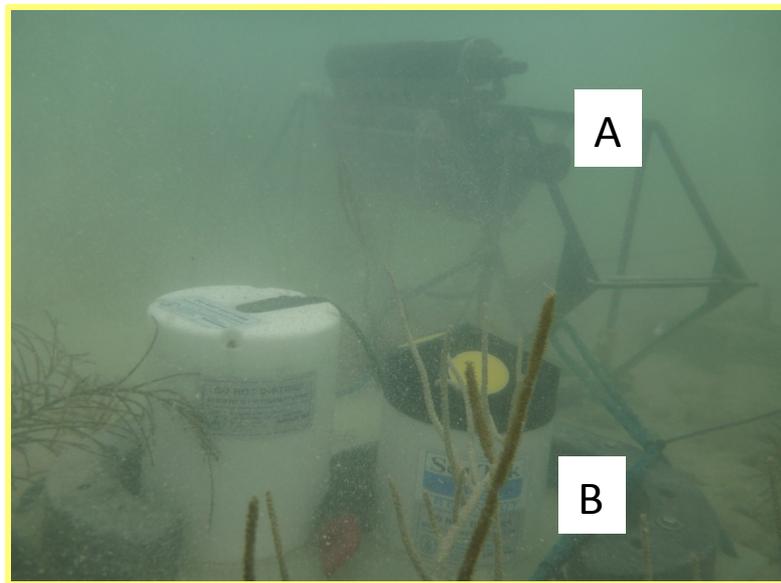
Underwater spectrometer



Moored Packages

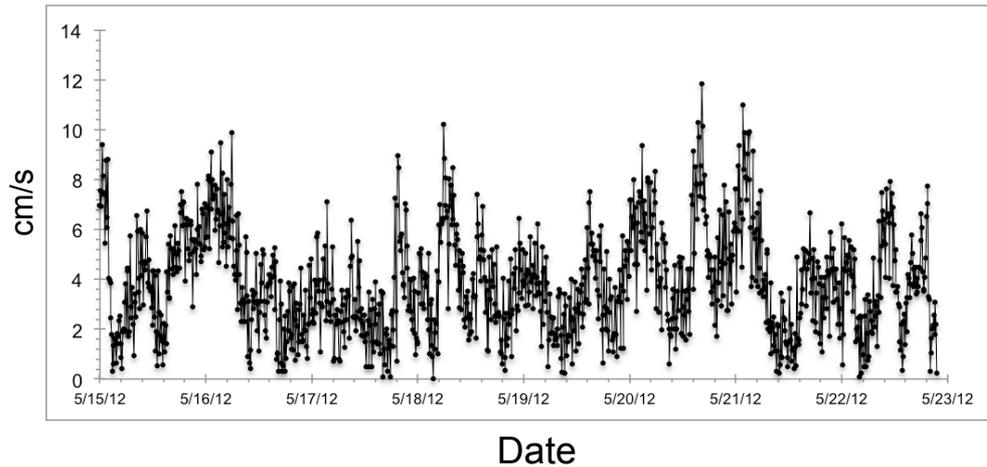


Optical package (Seagrass area).
Measurements: chlorophyll and colored dissolved organic matter (CDOM) fluorescence, turbidity, and backscattering.



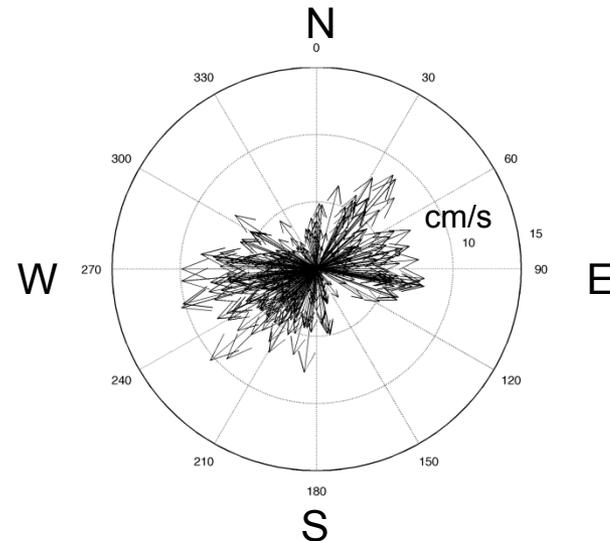
- A. Optical package + CTD (Patch Reefs area). Measurements: chlorophyll and colored dissolved organic matter (CDOM) fluorescence, turbidity, and backscattering, temperature and salinity.
- B. ADCP current meter: measures vertical profile of speed and direction of water.

Moored Packages – Preliminary Results

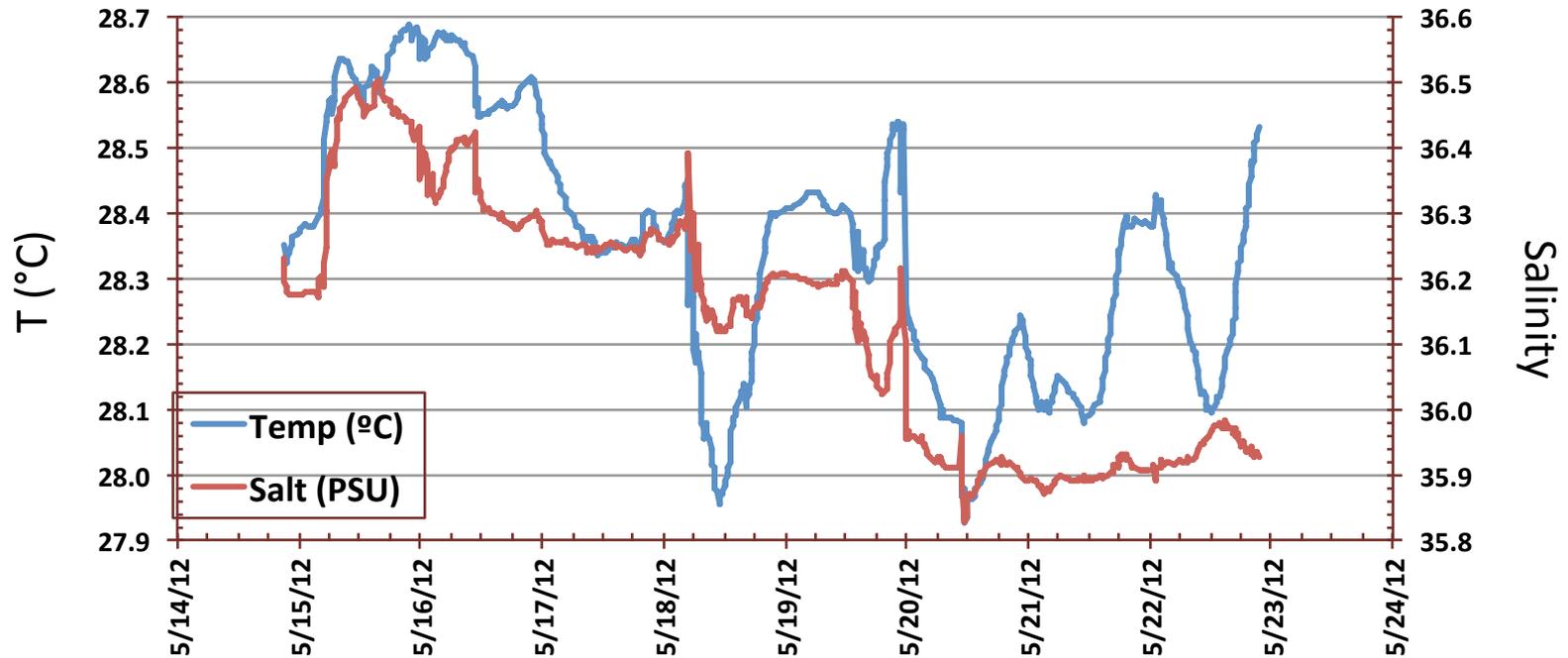


Current Speed (cm/s) from [May 15 to 22, 2012](#) every 10 minutes. Data integrated from 2 to 7.5 m depth (± 0.5 m). Data from the mooring at 8 m deep (Patch Reef area).

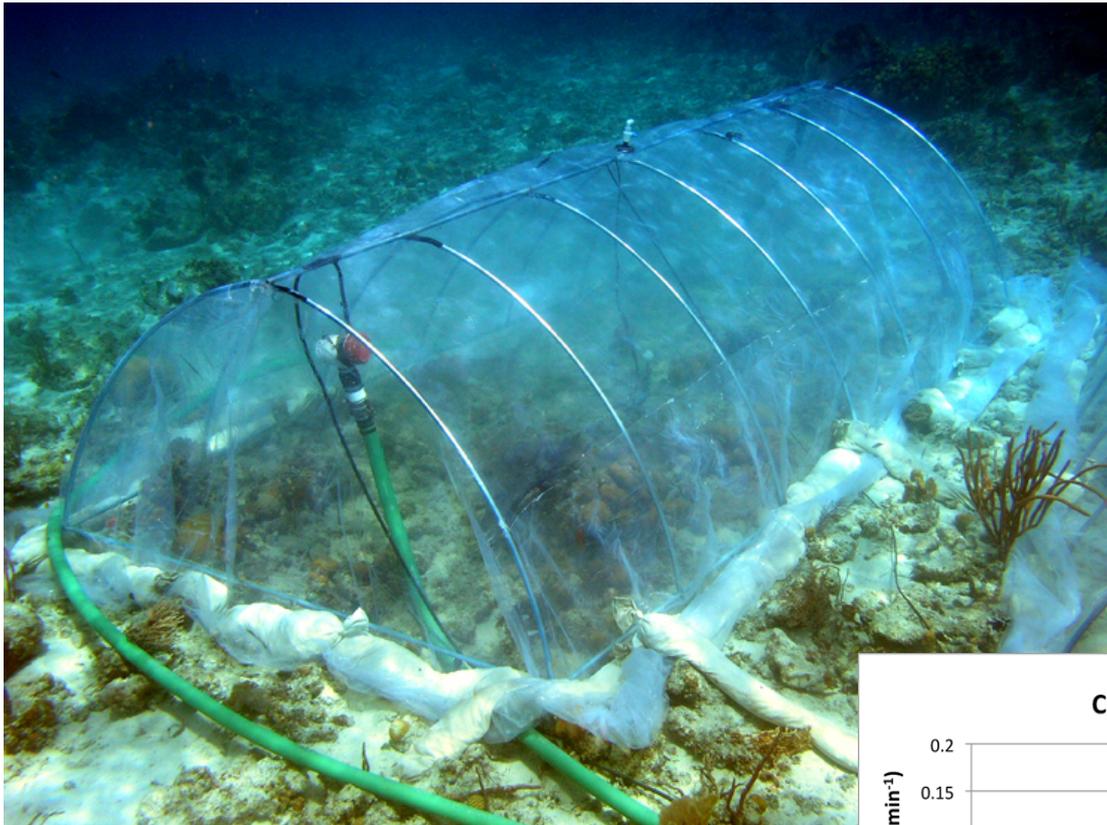
Current Direction (degrees) from [May 15 to 22, 2012](#) every 30 minutes. Magnitude of arrows represent speed (cm/s). Data integrated from 2 to 7.5 m depth (± 0.5 m).



Moored Packages – Preliminary Results



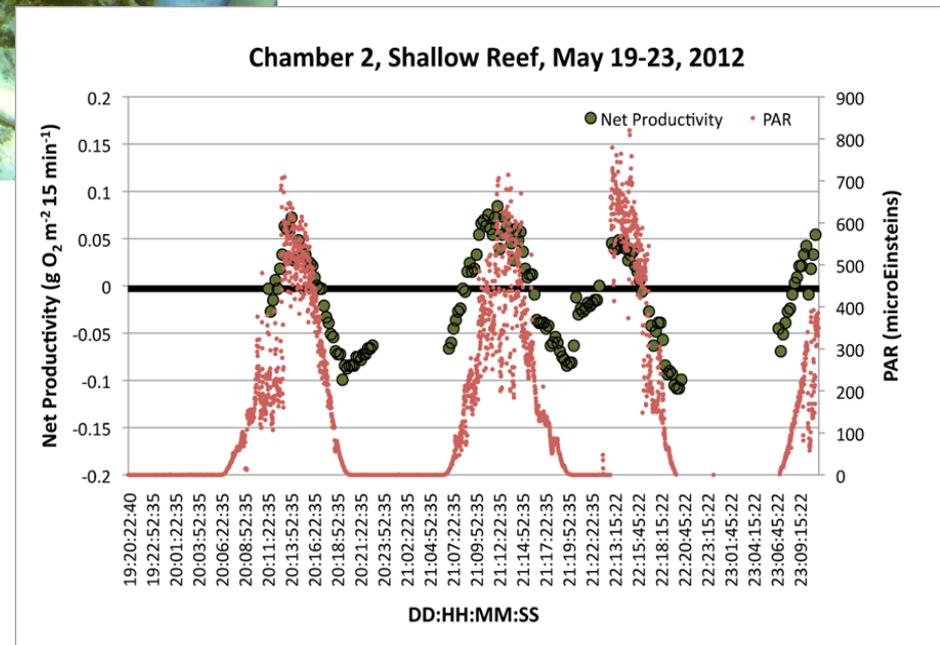
Temperature (°C) and Salinity (PSU) from [May 15 to 22, 2012](#) every 10 minutes. Data from the mooring at 8 m deep (Patch Reefs area).



SHARQ Tent:

Kim Yates / USGS

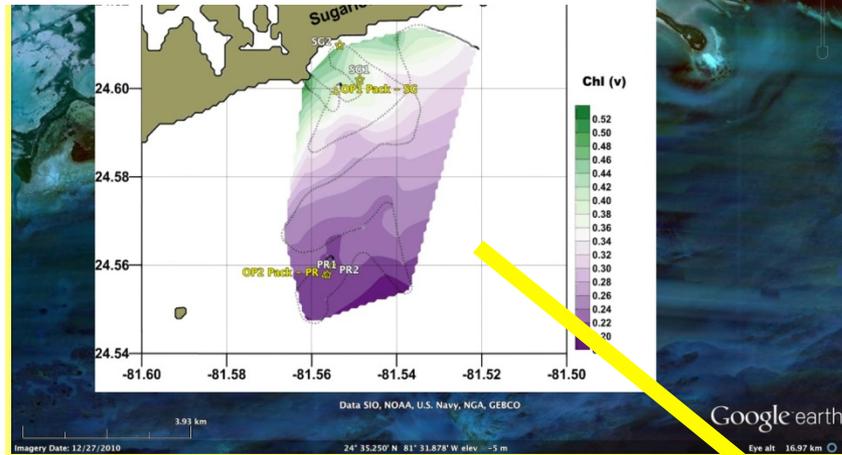
Continuously measure community respiration, calcification rates, and various other biogeochemical parameters



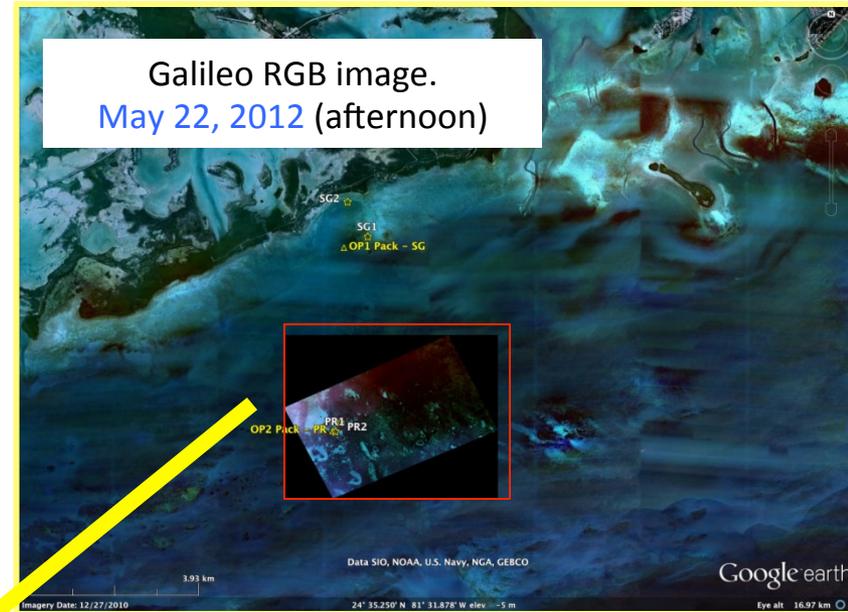
In situ measurements vs. aerial data

Chlorophyll a fluorescence (counts)
from the flow-through system.

May 22, 2012



Galileo RGB image.
May 22, 2012 (afternoon)



In situ and aerial data
co-located for
comparison of multi-
and hyperspectral
signatures.

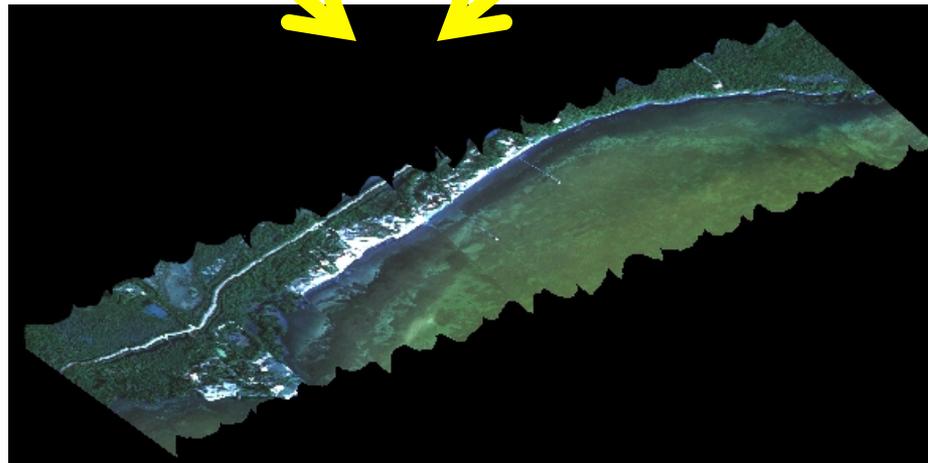


Image courtesy of
Zhihong Pan
(Galileo)

Data Status

Status	Progress	Dates preliminary results	Contact	
Waiting for chl-lab for regression	80%	9/21/2012	Gerardo	0 - 25%
Need Inter-calibration with "in situ"	55%	9/21/2012	Nelson	26 - 50%
Done	100%	9/14/2012	Nelson	51 - 75%
				75 - 99%
				100%
Organizing and processing data.	75%	9/14/2012	Maria - Nelson - Gerardo	
Processing data.	40%	9/14/2012	Gerardo	
Processing data.	60%	9/7/2012	Gerardo	
Organizing and processing data.	10%	9/7/2012	Gerardo	
Organizing and processing data.	40%	9/14/2012	Gerardo	
Processing data	50%	9/14/2012	Gerardo	
Processing data	90%	9/7/2012	Gerardo	
Organizing and processing data.	40%	9/14/2012	Gerardo	
Processing data			David English	
Organizing and processing data.	40%	9/21/2012	Maria - Gerardo	
Done	100%	9/14/2012	Nelson - Gerardo	
Running samples	10%	9/14/2012	Maria - Gerardo	
Running samples	10%	9/14/2012	Maria - Gerardo	
On Hold	--	9/28/2012 ??	Maria - Gerardo	

Preliminary Observations

- In situ:
 - Theoretical background for shallow-water habitats still being developed
 - Significant effort to collect sufficient data for ground-air match ups (weather, sea state, turbidity, etc. etc.)
- UAV technologies have their own universe of complexities for science deployments:
 - FAA, military, other rules and regulations
 - Area of operations, observers,
 - Communications between different field teams, UAV team
 - Weather and cost are major limitations
 - Sensors:
 - Small hyperspectral technology for aquatic operations still maturing
 - Very large data rates
 - Issues with geolocation, navigating large dataset

UAV technology holds significant promise to examine remote areas where very high spatial resolution, low altitude, long-duration flights (day-long) can provide unique observations

Upcoming Activities

- Complete present deployment in FL Keys
- Databases:
 - Complete an open, online database
 - Submission to
 - SeaBASS
 - HyspIRI spectral library
- Continue integration of physiological and bio-optical data for assessments of diversity, biomass and rate processes
- Plan for next deployment (May 2013)