PRISM

Portable Remote Imaging Spectrometer

Floating Vegetation and Export Carbon Flux

Dr. Heidi Dierssen

University of Connecticut

Department of Marine Sciences/Geography

Acknowledge

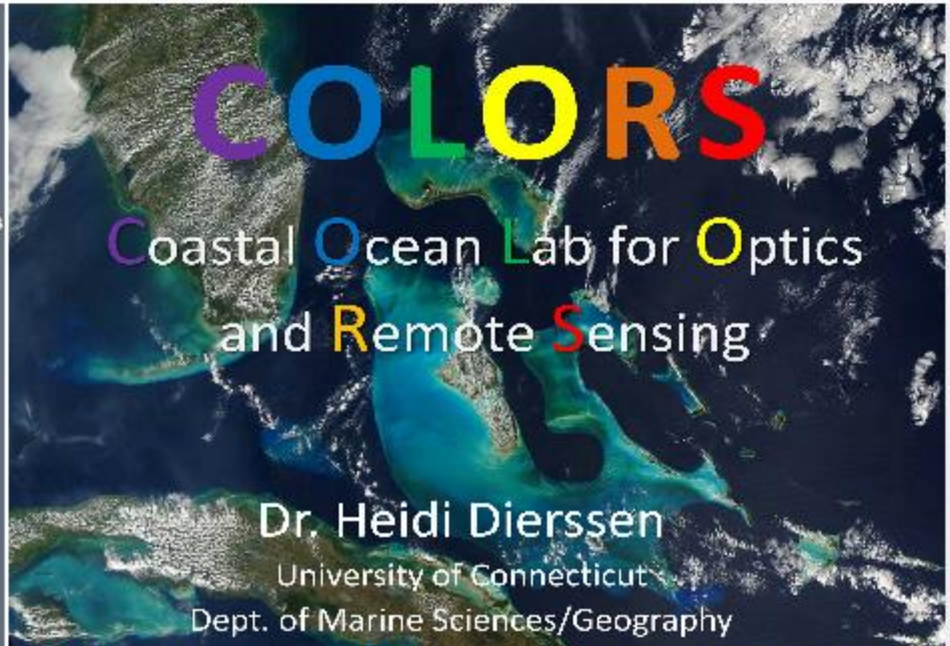
- Jet Propulsion Lab
  - Zakos Mouroulis, Rob Greene,
  - Ian McCubbin and flight crew
- Bo-Cai Gao, NRL
- John Hedley, Environmental Computer Science LTD

University of Connecticut

Coastal Ocean Lab for Optics and Remote Sensing

COLORS HOME | MARINE SCIENCES | PEOPLE | PUBLICATIONS | PROGRAMS | VIDEOS | INSTRUMENTS | CONTACT US

- Hyperspectral Remote Sensing of Coastal Habitats
- Imaging of Organismal Color and Camouflage
- Arctic Optics and Aerosols
- Long Island Sound Color and Exchange
- Southern Ocean Sources of Backscattering
- Remote Sensing of Seagrasses (MODIS)
- Backscattering of Phytoplankton
- California Coastal Optics
- Hyperspectral Remote Sensing of Seagrass

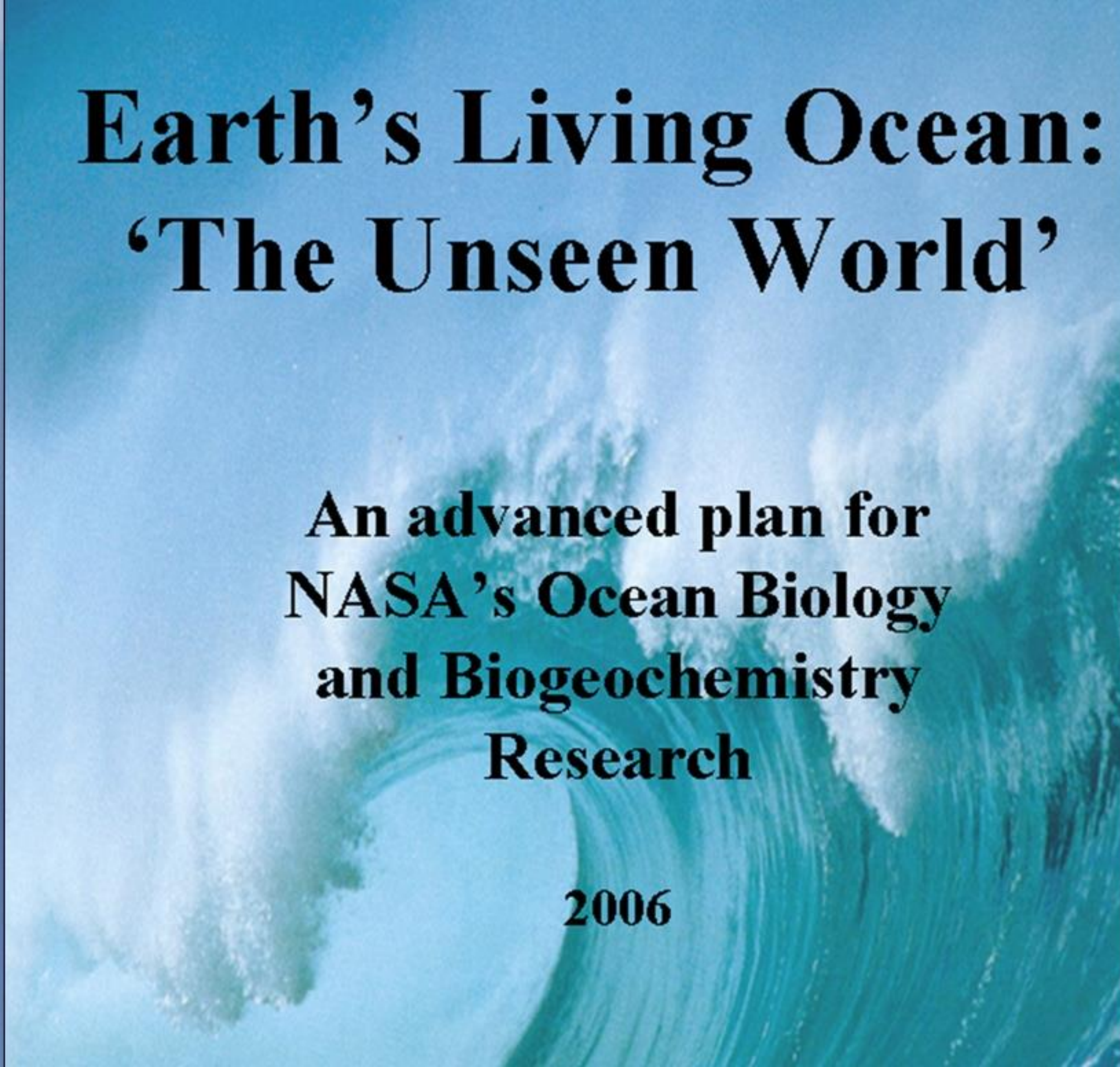


COLORS.UCONN.EDU

Welcome to the Coastal Ocean Laboratory for Optics and Remote Sensing (COLORS) led by Dr. Heidi Dierssen, Associate Professor in Marine Sciences and Geography, at the University of Connecticut Avery Point. Our current projects involve optics and remote sensing of the coastal zone throughout the world ocean. We are primarily involved in hyperspectral imaging with airborne and in-water sensors to study the optics of coastal habitats and organisms at a variety of space and time scales. Our laboratory has a variety of imagers, spectroradiometers and other instruments to measure the optical and physical properties of the water column that can be loaned out to students or investigators.

Also please visit our youtube website for videos from field studies.

<< http://www.youtube.com/user/OceanColorsLab >> CLICK LINK TO COLORS VIDEOS



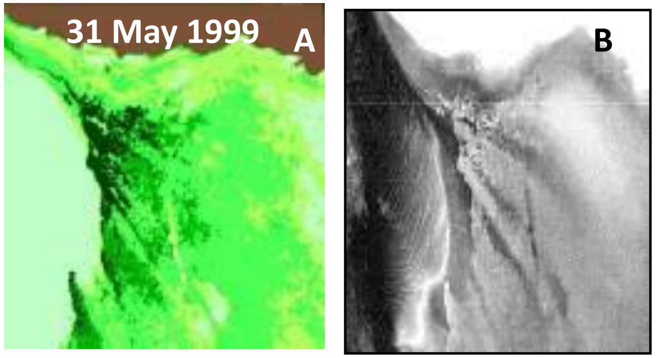
Earth's Living Ocean: 'The Unseen World'

An advanced plan for NASA's Ocean Biology and Biogeochemistry Research

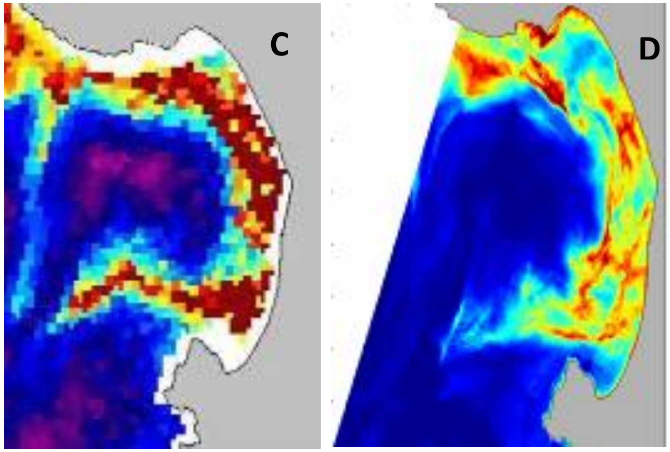
2006

OBB Plan outlines:
Portable Sensors from Suborbital Platforms

- Imagery with spatial resolution of meters or less
- Fine-scale features along coastal margins, including river plumes, flooded land regions, and seafloor features
- Hazardous and episodic events require repeat sampling on the order of hours and not days or weeks
- Water quality of Inland waters and coastal estuaries



Seagrass Leaf Area Index (LAI) and B) shallow water bathymetry 0-6 m estimated from the PHILLS sensor at Lee Stocking Island, Bahamas.



A dense algal bloom or red tide in Monterey Bay measured from C) SeaWiFS satellite imagery at 1 km resolution and D) AVIRIS airborne imager at 30 m resolution

4. Portable Sensors on Suborbital Platforms

Immediate (1-5 years)
Continued development of airborne lidar and imaging systems for algorithm and technology improvement in coastal waters. Develop partnerships with science and technology groups at NASA to develop strategies for sub-orbital platforms for use in understanding habitats and hazards in coastal ecosystems.
Near-term (5-10 years)
Develop and implement portable sensor technologies which can be deployed on Unmanned Aerial Vehicles (UAV). Deploy the prototype coastal ocean habitat / hazard UAV system.
Long-term (10-25 years)
UAV fleet development with portable sensors deployable throughout the globe at short notice to track hazardous spills, storm surges, changes in critical coastal habitats, red tides, and shipping lanes. Development activities include optimization algorithms for UAV deployment.

NASA Hazards Lack Ocean Component

Near Real-Time Data   Land Atmosphere Near Real-time Capability for EOS

Near Real-Time Data

- Data
  - Instrument
  - Platform
  - **Hazards and Disasters**
    - Air Quality
    - Ash Plumes
    - Drought
    - Dust Storms
    - Fires
    - Floods
    - Severe Storms
    - Shipping
    - Smoke Plumes
    - Vegetation
  - Fire Email Alerts
  - Active Fire Data
  - Science Quality Products
  - Datacasting

Feedback

Home » Data » Near Real-Time Data » Data

Hazards and Disasters

LANCE EOS data and imagery enable users to get a snap shot of the Earth in near-real time. This timely data is useful for a range of applications e.g. to detect fires, track smoke, ash and dust plumes; to monitor aerosols, carbon monoxide and sulfur dioxide, which in turn are useful for air quality assessments; and to determine the extent of sea ice, snow, and flooding which are useful to support shipping in the polar regions and to allow rapid assessment of areas worst affected by snow or flood water. Visualize the data by category in Worldview.

Register to start downloading data.
Please read the disclaimer for more information about using the data.

Air Quality
AIRS data have been used to track propagation of toxic gases like Carbon Monoxide (CO) from massive fires; accurate early warnings of such pollution spikes are useful because they give people the option to reduce their risk of exposure to poor air by limiting outdoor activity at these times. Air quality forecasters use NRT data from LANCE to improve some local and national air quality forecasts.

Ash Plumes
MODIS imagery are useful for identifying and tracking ash plumes from volcanic eruptions. The use of NRT satellite data for monitoring volcanic plumes is undergoing further developments to enable quantitative retrievals to be produced, which should enable a global capability for volcanic ash monitoring to be introduced.

NASA Hazards Continued

Floods
Mapping floodwater extent for active floods is critical for local and regional officials and for disaster relief organizations that need to ascertain where to focus their efforts. LANCE provides data to the Dartmouth Flood Observatory and the NRT Global MODIS Flood Mapping initiative.

Severe Storms
MODIS data are used to revise or confirm 24-hour forecasts related to weather systems approaching the land from the oceans, which in turn gives confidence for flood warnings. Satellite images are also useful in providing everyone with the same 'big picture' of severe storms.

Shipping
In polar regions, NRT MODIS images provided by LANCE are routinely used by the Polar Geospatial Center, in combination with other data, to provide up to date information on ice conditions to ships and research vessels.

Smoke Plumes
MODIS true color imagery are frequently used to track the source, duration and transport of smoke plumes across large areas. It is not uncommon for smoke from large wildfires to be lofted high enough into the atmosphere that winds push plumes long distances; a process that can often be tracked in near real-time using data from LANCE.

NASA RFP Feb. 2008

2.1 Development of airborne instrument

NASA's Ocean Biology and Biogeochemistry program, in partnership with the Airborne Science Program within the Earth Science Division, is soliciting a project that seeks to develop a portable sensor from airborne (e.g., aircraft, Unmanned Aerial Systems (UAS).

Instruments proposed should be focused on radiometry to enable estimation of ocean biological and biogeochemical properties, specifically to encourage broad NASA ocean research community use. A field test plan of the instrument must be included in the proposed statement of work, along with a clearly defined plan for instrument calibration

Optical design of a coastal ocean imaging spectrometer

Pantazis Mouroulis,[1*] Robert O. Green,[1]
and Daniel W. Wilson[1]

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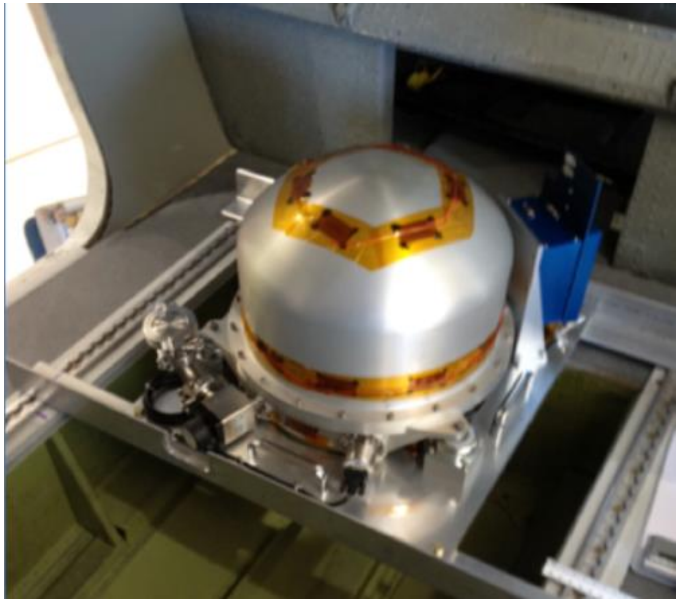
[*]*Corresponding author:* pantazis.mouroulis@jpl.nasa.gov

Abstract: We present an optical design for an airborne imaging spectrometer that addresses the unique constraints imposed by imaging the coastal ocean region. A fast (F/1.8) wide field system (36°) with minimum polarization dependence and high response uniformity is required, that covers the spectral range 350-1050 nm with 3 nm sampling. We show how these requirements can be achieved with a two-mirror telescope and a compact Dyson spectrometer utilizing a polarization-insensitive diffraction grating.

#94845 - $15.00 USD Received 8 Apr 2008; revised 28 May 2008; accepted 28 May 2008; published 4 Jun 2008

PRISM Sensor

- UV-NIR sensor
  - 350-1050 nm
- Approx. 3 nm spectral resolution
- Up to 30 cm spatial resolution
- Two-channel SWIR radiometer



PRISM Validation

- Two science flights of NASA's new PRISM sensor
  - Portable Remote Imaging Spectrometer
- July 17-28 2012
  - diverse coastal targets
  - Elkhorn Slough/M Bay CA
- January 13-19, 2014
  - Greater Florida Bay

Portable Remote Imaging Spectrometer coastal ocean sensor: design, characteristics, and first flight results

- Mouroulis et al. 2014
  - Appl. Optics Vol 53. p. 1363-1380

Table 1. Spectrometer Characteristics

Spectral	Range	349.9–1053.5 nm
	Sampling	2.83 nm
	Resolution (FWHM)	3.5 nm typ
	Calibration uncertainty	<0.1 nm
Spatial	Field of view (FOV)	30.7°
	IFOV sampling	0.882 mrad
	IFOV resolution (FWHM)	0.97 mrad
	Cross-track spatial pixels	608
Radiometric	Range	0%–99% *R*
	Sampling	14 bit
	Calibration uncertainty	<2%
	Signal-to-noise ratio[a]	500 at 450 nm
	Polarization variation	<1%
Uniformity	Spectral cross-track uniformity	>95%
	Spectral IFOV uniformity	>95%

[a]At a single integration (167 Hz rate) and three-band aggregate (8.5 nm), 5% reflectance, 45° solar zenith, MODTRAN standard atmosphere.

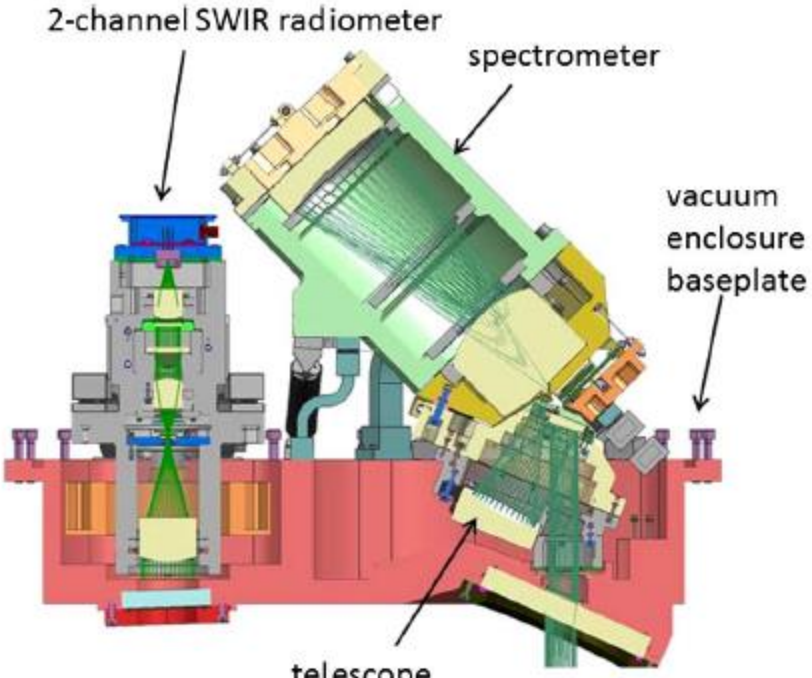


Fig. 1. PRISM instrument optical head assembly layout.

PRISM Engineering and Calibration

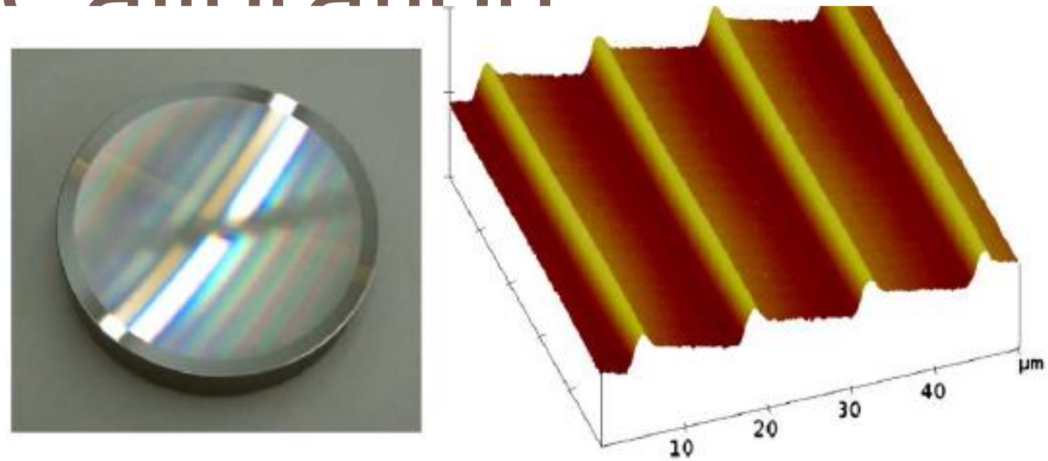


Fig. 3. Photograph of the concave diffraction grating and measured groove profile of the same. The blazed first-order can be seen displaced from the zero-order observed most strongly on the unexposed outside ring.

Mouroulis et al. 2014

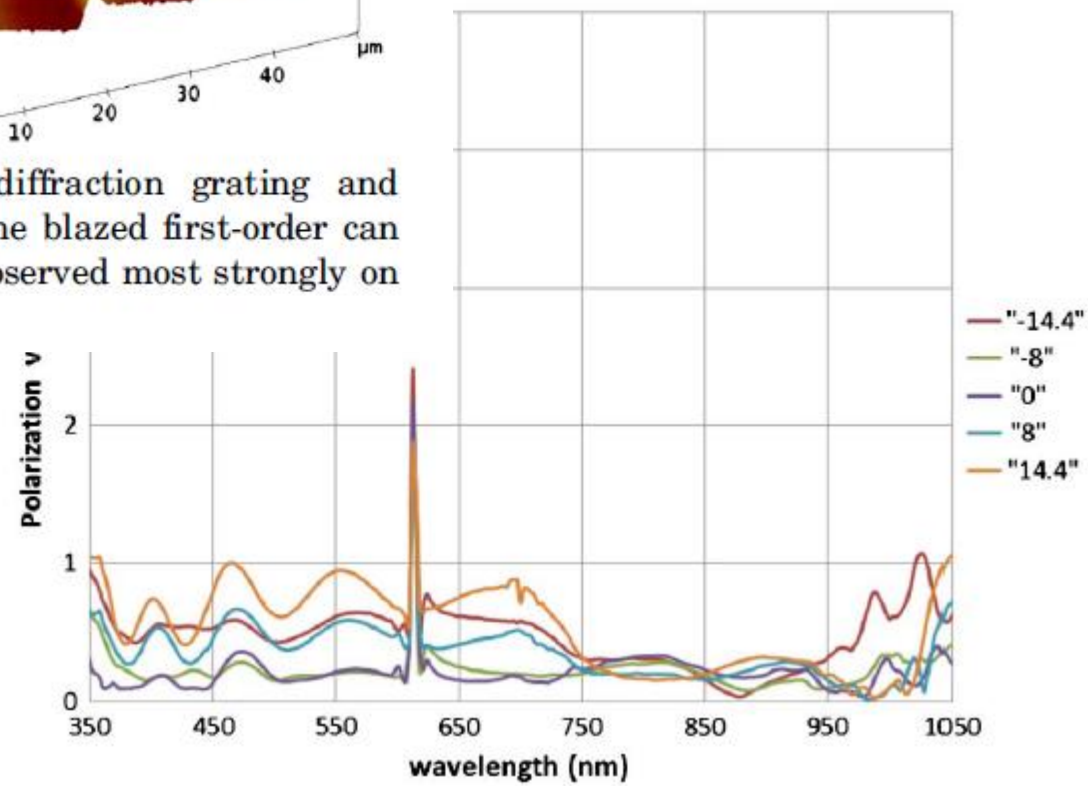
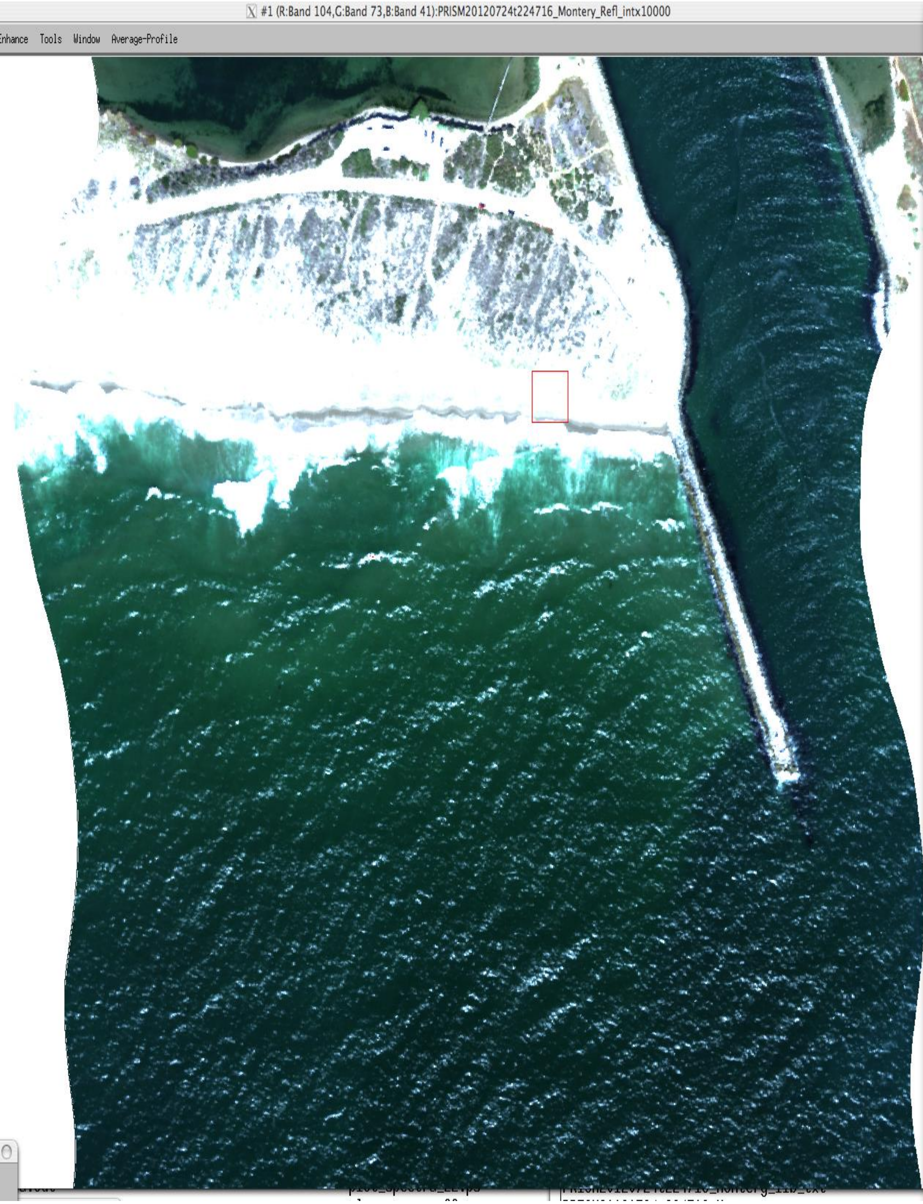
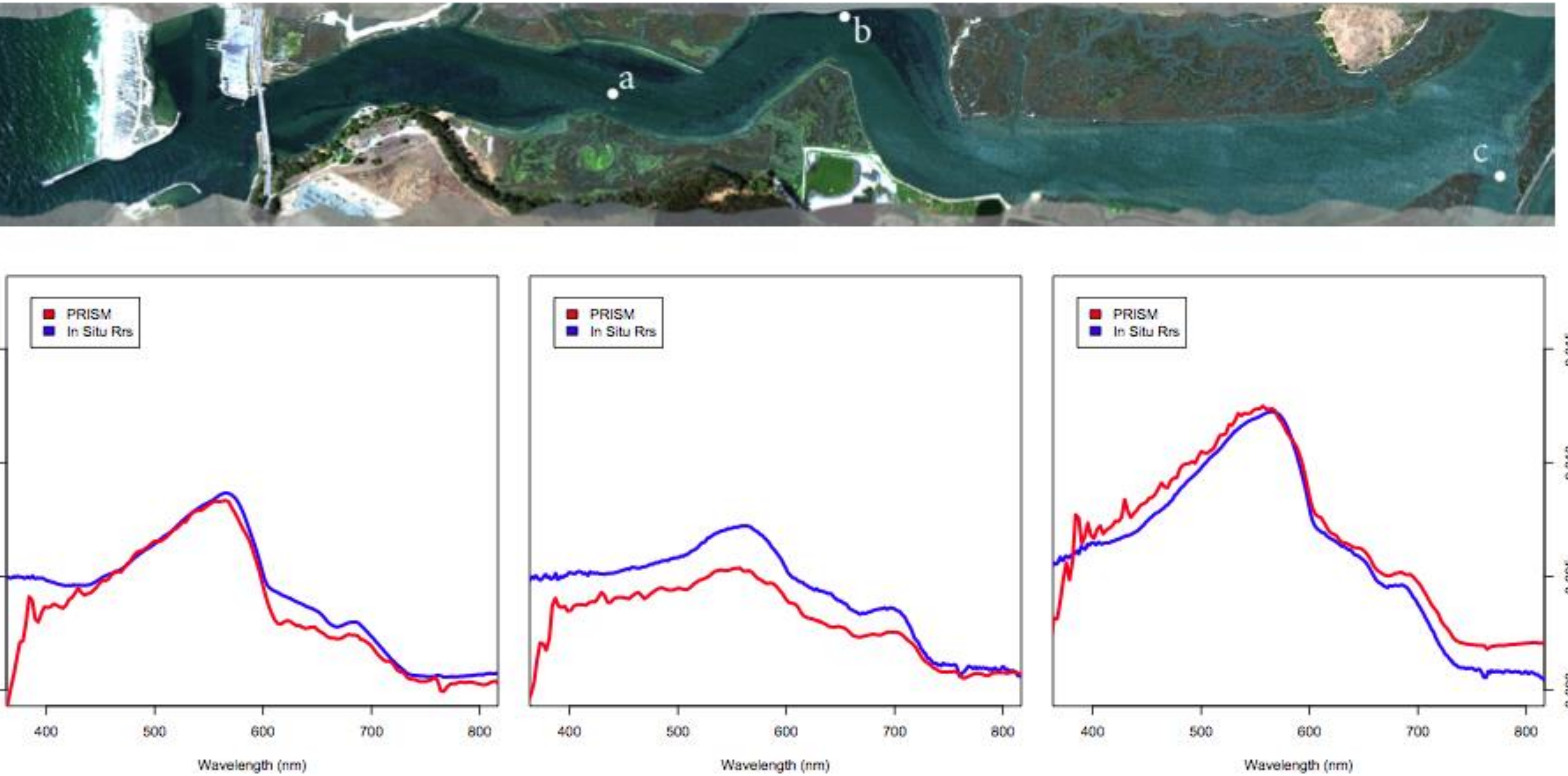


Fig. 15. Polarization variation throughout the spectral range for five positions spanning the FOV.

Sample Spectrum After 7-nm Smoothing, Sunglint + Cloud Removal – Green Water (the center pixel of the red box in the left image) Bo-Cai Gao

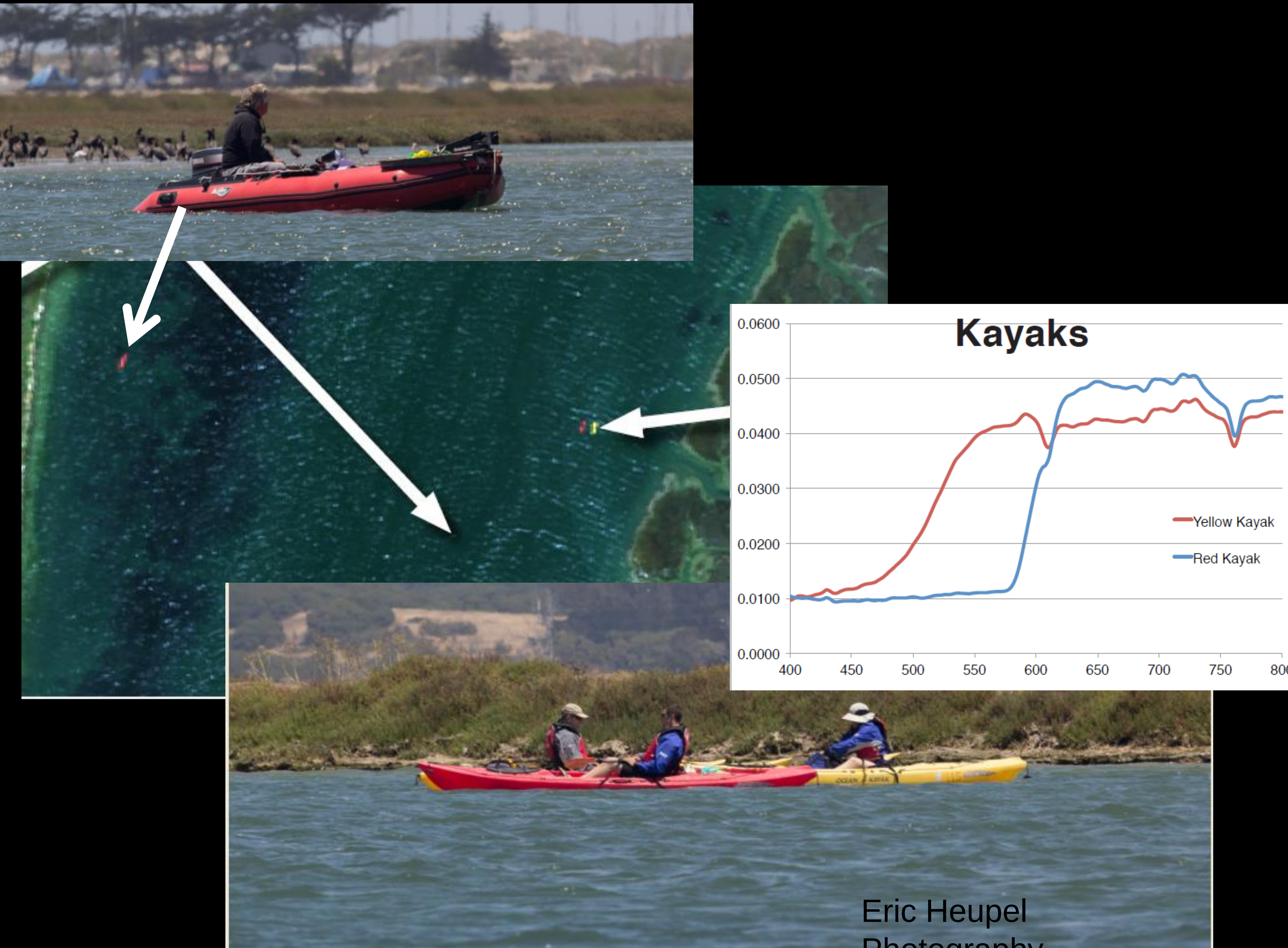


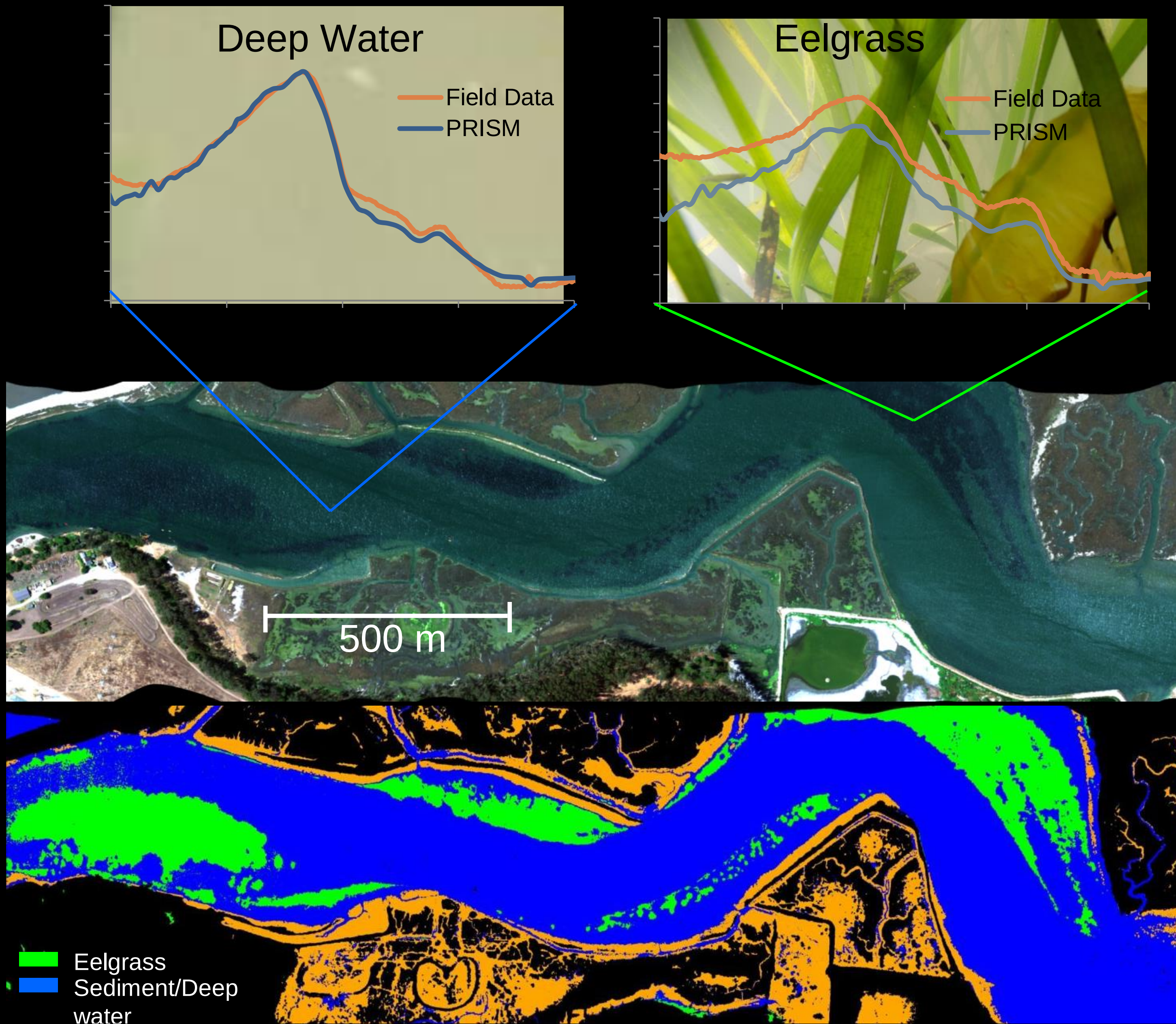


(a) West LOBO Buoy

(b) Seal Bend Dense Eelgrass

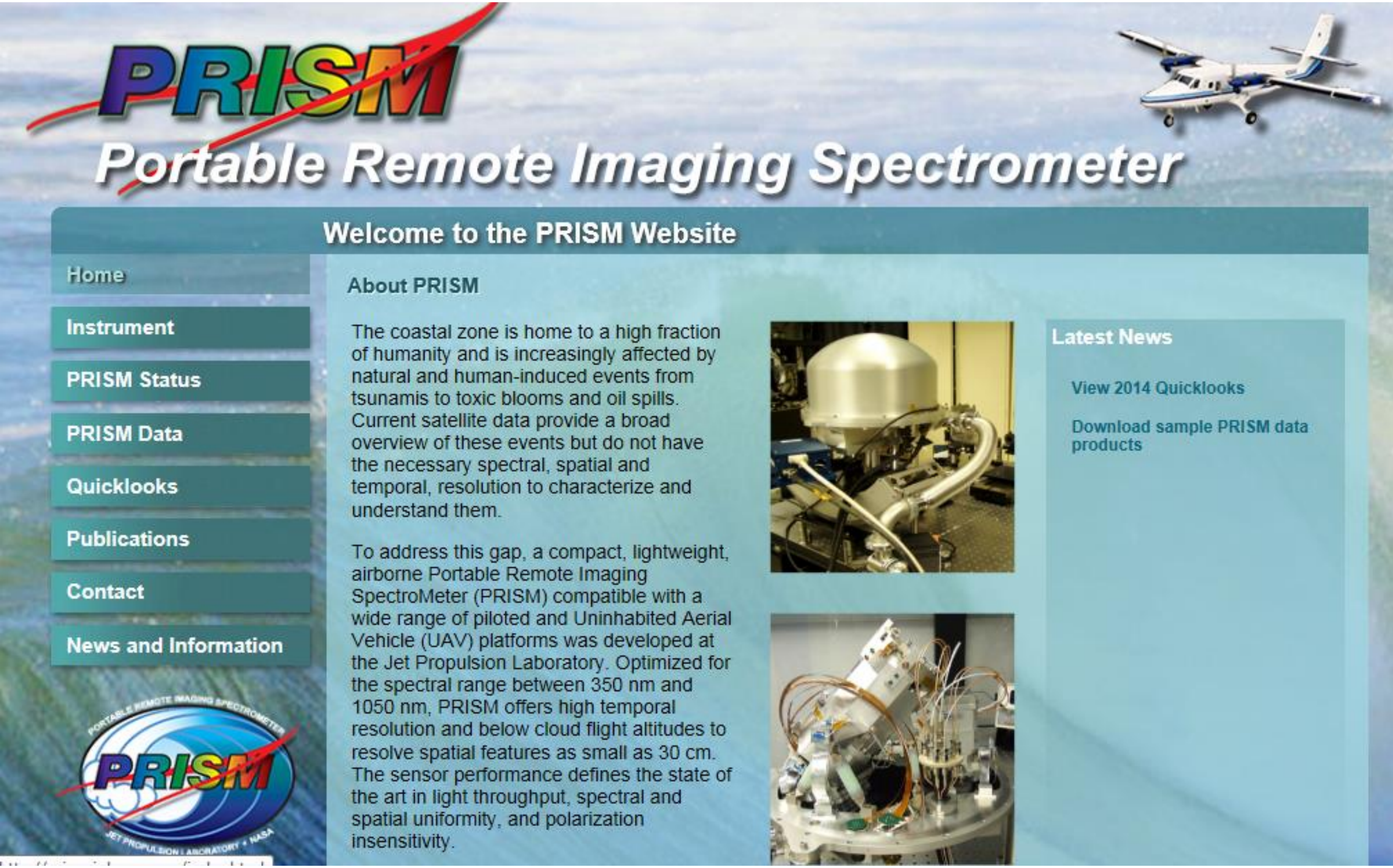
(c) East LOBO Buoy


Kayaks
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
400
450
500
550
600
650
700
750
Yellow Kayak
Red Kayak
Eric Heupel
Photography



Dierssen, H.M. 2013. Overview of hyperspectral remote sensing. Proceedings of SPIE Imaging Spectrometry XVIII. San Diego, CA September, 2013. 8870-21. p. 1-7.

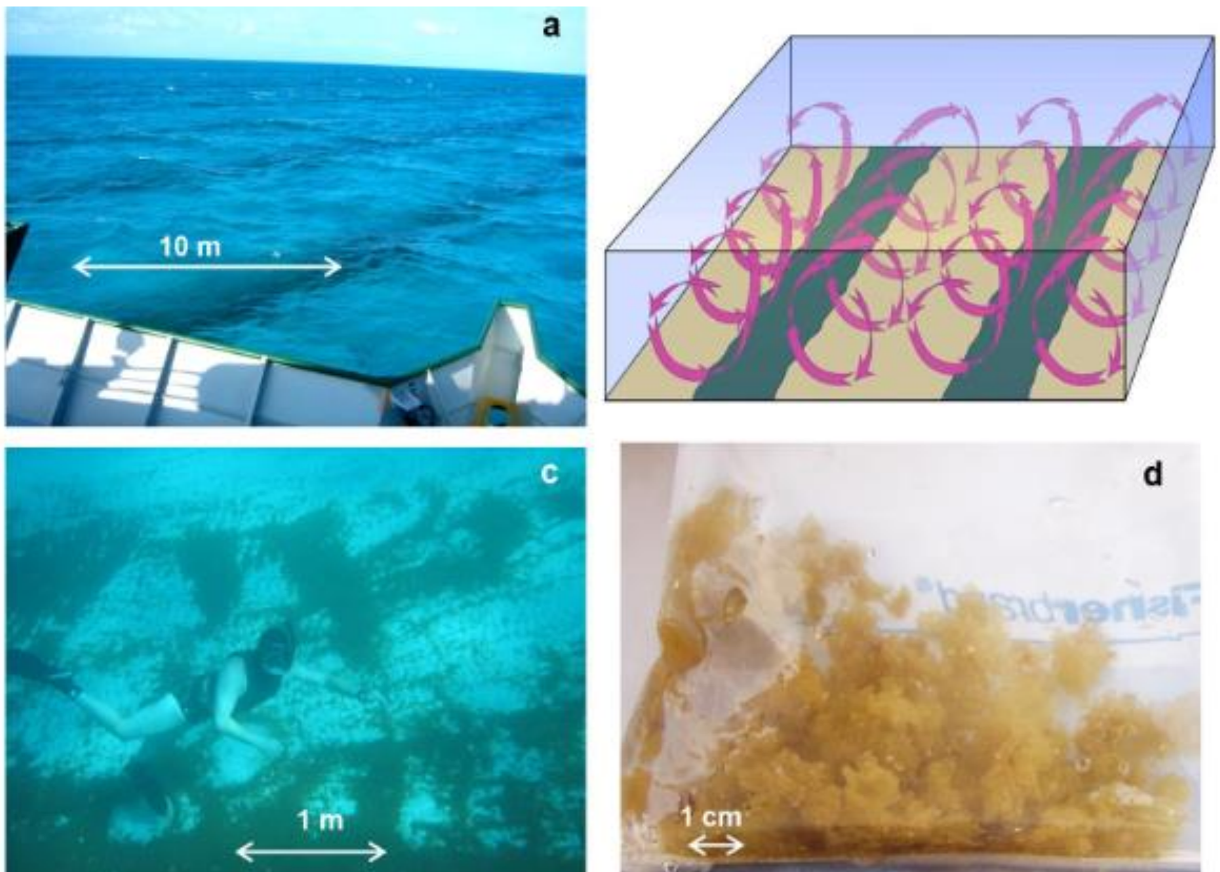
http://prism.jpl.nasa.gov/



GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L04602, doi:10.1029/2008GL036188, 2009

Potential export of unattached benthic macroalgae to the deep sea through wind-driven Langmuir circulation

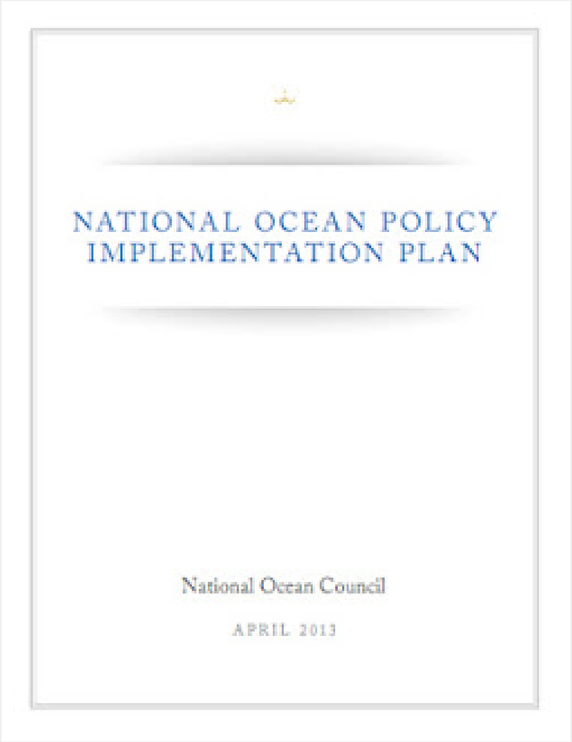
H. M. Dierssen,[1] R. C. Zimmerman,[2] L. A. Drake,[2,3] and D. J. Burdige[2]



BLUE Carbon

Coastal carbon included in White House plan

In the National Ocean Policy Implementation Plan, just released by the White House, carbon capture and storage is included as one of the important services coastal ecosystems provide.


NATIONAL OCEAN POLICY IMPLEMENTATION PLAN

National Ocean Council

APRIL 2013

rich organic soil layer

when disturbed

releases centuries of accumulated carbon

"The health and integrity of coastal habitats - such as coral reefs, wetlands, mangroves, salt marshes and sea grass beds - are key to sustaining our Nation's valuable coastal and ocean ecosystems and the wealth of benefits they provide to us. ... they capture and store carbon..."

bluecarbonblog

Field Experiments in January 2014

Seagrass Wrack Experiments

1) Wrack fallout rates
2) Wrack spectral reflectance
3) Nutrient production
4) CDOM production
5) Cage debris production
6) Bin debris production
7) Seagrass density/buoyancy
8) Percent Cover Surface Wrack
9) Surface buoy drifter

Coastal Habitat Validation

1) Seagrass Benthic Reflectance

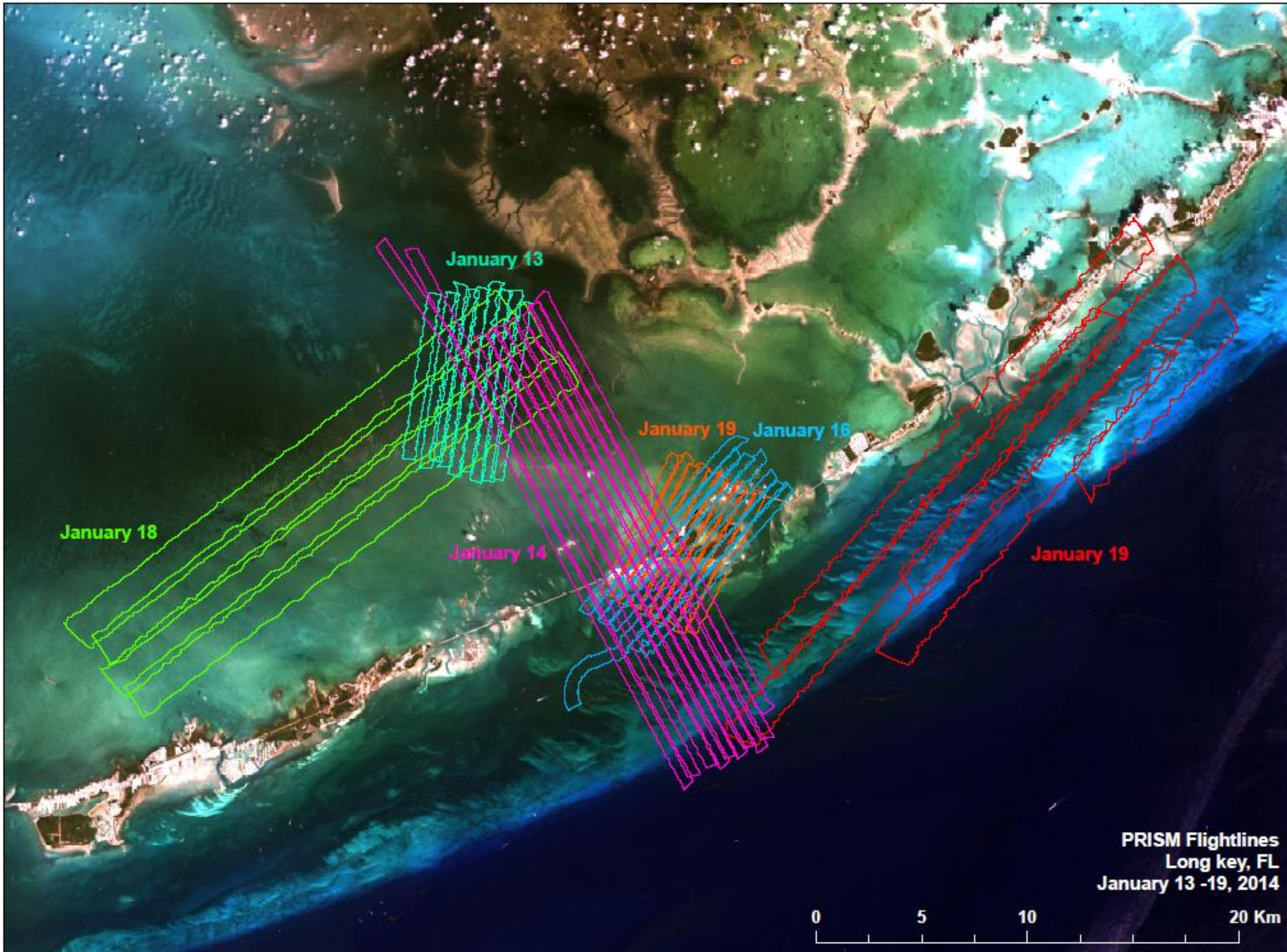
canopy reflectance
canopy height
shoot density
leaf collection
leaf area and width
GPS location

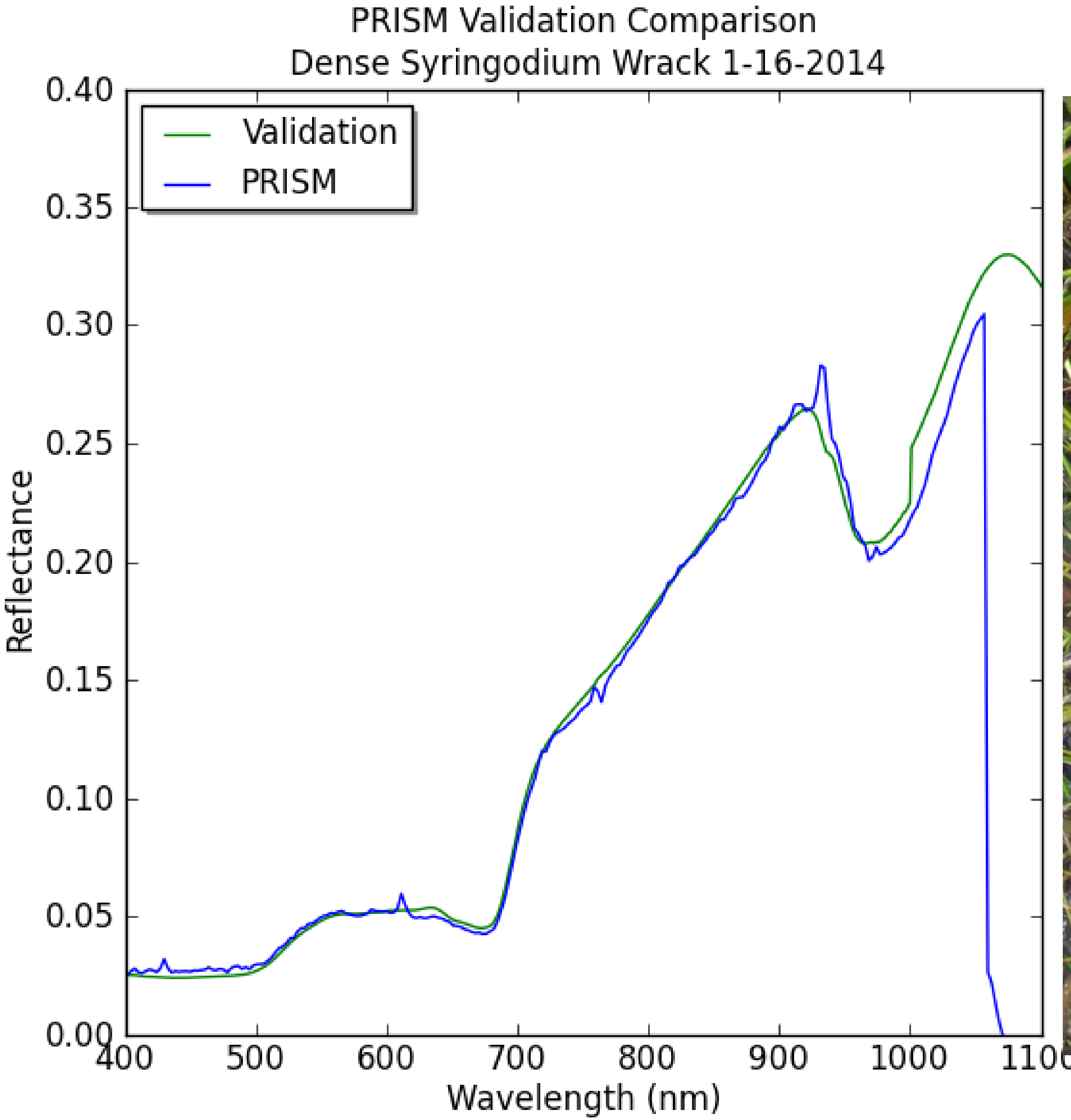
2) Mangrove validation

Individual leaf reflectance
Canopy level reflectance
GPS of Species and Locations

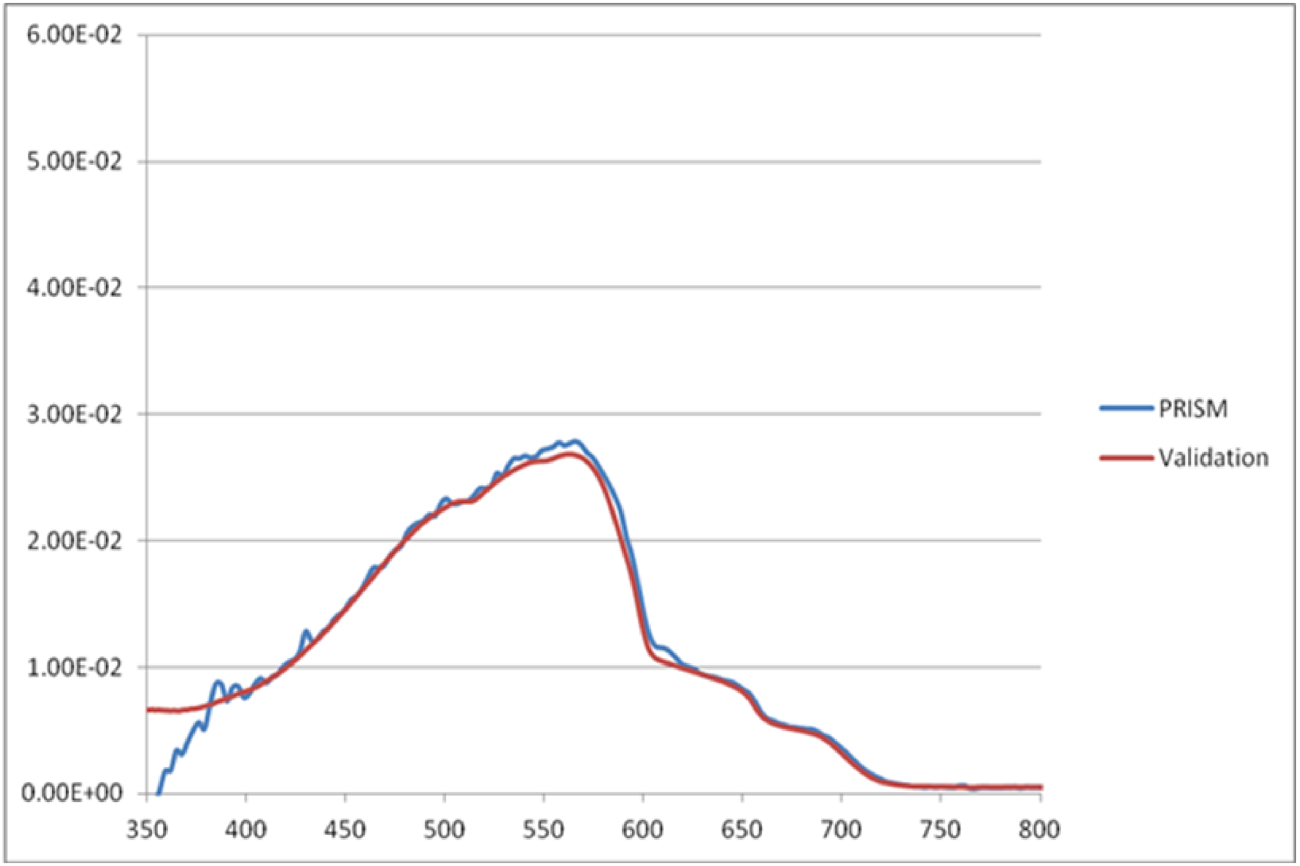
- PRISM Overflights In-water Validation
- Instrumentation: Rrs ASD, IOP cage, LISST
- Bottles: Filtering for HPLC and TSM

- Deployed drifter buoys through NOAA NEFSC program
- James Manning
- Cheap and effective GPS technology
- http://www.nefsc.noaa.gov/drifter/


January 13
January 19
January 16
January 18
January 14
January 19
PRISM Flightlines
Long key, FL
January 13 -19, 2014
0
5
10
20 Km


PRISM Validation Comparison
Dense Syringodium Wrack 1-16-2014
Validation
PRISM
Reflectance
Wavelength (nm)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
400
500
600
700
800
900
1000
1100

Atmospheric Correction is conducted independent of validation data



Improvement in the knowledge of the fine-scale solar spectrum and atmospheric lines is needed to support the 3 nm sampling of PRISM

CONCLUSIONS

- PRISM data available in a variety of habitats
  - Independent atmospheric correction
  - 2 week turnaround

- Future NASA Assets to address questions related to:
  - Assess Blue Carbon Stores
  - Episodic export events
  - Hazards

- My future vision is a <u>fleet of drones (UAVs) </u>with portable imagers, ocean lidars
  - coupled to in water sensors and biogeochemical climate models