Looking Backwards to Look Forwards

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Earth's Living Ocean: 'The Unseen World'

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An advanced plan for NASA's Ocean Biology and Biogeochemistry

Science Questions

- **How are ocean ecosystems and the biodiversity they support influenced by climate and environmental variability and change, and how will these changes occur over time?**
- **How do carbon and other elements transition between ocean pools and pass through the Earth System, and how do biogeochemical fluxes impact the ocean and Earth's climate over time?**
- **How (and why) is the diversity and geographical distribution of coastal marine habitats changing, and what are the implications for the well-being of human society?**
- **How do hazards and pollutants impact the hydrography and biology of the coastal zone? How do they affect us, and can we mitigate their effects?**

Timeline / Mission Themes	Immediate (1 – 5 Years)	Near-Term (5 - 10 Years)	Long-Term (10 - 25 Years)				
Global Separation of In-water Constituents & Advanced Atmospheric correction	**Advanced radiometer & scattering lidar** • 5nm resolution from UV through visible • Ozone & extended NIR atmosphere bands • Atmosphere & subsurface particle scattering profiles	**Ocean radiance and atmosphere aerosols** • Advanced radiometer • Scattering lidar for aerosol speciation • Polarimeter for global aerosol coverage •500 m passive resolution	**Radiometry, aerosols, and physiology lidar** • Global radiometry system • Aerosol height & species • Midnight/noon obs of variable stimulated fluorescence				
High Spatial & Temporal Resolution Coastal	**GEO partnership** **Support analysis of current satellite data** **Landsat DCM partnership** **Development of suborbital sensor systems**	**High-res coastal imager** • 20 bands from UV - NIR • 10 m res – 100 km swath **GEO carbon mission** **Deployment of suborbital systems**	**Constellation of imaging spectrometers** • High temporal res • LEO, MEO or GEO • Include SAR **Continued deployment of suborbital systems**				

Plant Physiology & Functional Composition	**Support analysis of global passive data** • Assess functional groups using hyperspectral data • Estimate algal carbon & chlorophyll to characterize physiology	**Support analysis of global & GEO data**	**Variable fluorescence lidar constellation** •Map physiological provinces at different times of day • Dawn/dusk variable fluorescence lidar • Noon/midnight lidar				
Mixed Layer Depth	**Synthesis/analysis of observational forecast fields & on orbit remote sensing** **Mixed layer model development**	**Prototype mixed layer sensor development** • field testing of novel approaches for remote detection of mixed layer depth & light availability	**Mixed layer depth mission** •Space-borne proof-of-concept mission for global mixed layer depth mapping				

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1. global hyperspectral imaging radiometer in sun synchronous orbit, focused on the accurate separation of in-water constituents and correction of the contribution of aerosols,
2. global hyperspectral imaging radiometers in geostationary orbit, which will enable global and regional observations of dynamic and complex coastal and shelf processes and discrimination of in-water constituents on sub-daily time scales and at high spatial resolution (200 m or better) at nadir,
3. multi-spectral, high spatial resolution imager to observe coastal habitats and ecosystems at unprecedented scales and accuracies,
4. deployment of active approaches for probing plant physiology and functional composition from polar satellite orbit using laser technologies
5. implementation of portable sensors on suborbital platforms
6. development of new technologies for the assessment of ocean mixed layer depth from satellite orbit, and
7. development of new technologies to obtain ocean particle profiles and aerosol column distributions.

International Planned OC Sensors

SENSOR	AGENCY	SATELLITE	SCHEDULED LAUNCH	SWATH (km)	SPATIAL RESOLUTION (m)	# OF BANDS	SPECTRAL COVERAGE (nm)	ORBIT
OLCI	ESA/ EUMETSAT	Sentinel 3A	Oct 2015	1270	300/1200	21	400 - 1020	Polar
COCTS CZI	CNSA (China)	HY-1C/D (China)	2015	2900 1000	1100 250	10 10	402 - 12,500 433 -885	Polar
SGLI	JAXA (Japan)	GCOM-C	2016	1150 - 1400	250/1000	19	375 - 12,500	Polar
COCTS CZI	CNSA (China)	HY-1E/F (China)	2017	2900 1000	1100 250	10 4	402 - 12,500 433 - 885	Polar
HSI	DLR (Germany)	EnMAP	2017	30	30	242	420 - 2450	Polar
OCM-3	ISRO (India)	OCEANSAT-3	2018	1400	360 / 1	13	400 - 1,010	Polar
OLCI	ESA/ EUMETSAT	Sentinel-3B	2017	1265	260	21	390 - 1040	Polar
VIIRS	NOAA /NASA (USA)	JPSS-1	2017	3000	370 / 740	22	402 - 11,800	Polar
Multi-spectral Optical Camera	INPE / CONAE	SABIA-MAR	2019	200/2200	200/1100	16	380 - 11,800	Polar
GOCI-II	KARI/KIOST (South Korea)	GeoKompsat 2B	2019	1200 x 1500 TBD	250/1000	13	412 - 1240 TBD	Geostationary
OCI	NASA	PACE	2022/2023	*	*	*	*	Polar
HYSI-VNIR	ISRO (India)	GISAT-1	*(planned)	250	320	60	400-870	Geostationary (35.786 km) at 93.5°E
OES	NASA	ACE	>2020	TBD	1000	26	350-2135	Polar
Coastal Ocean Color Imaging Spec (Name TBD)	NASA	GEO-CAPE	>2022	TBD	250 - 375	155 TBD	340-2160	Geostationary

Other "Land" Satellites Proving Useful

- Landsat 8

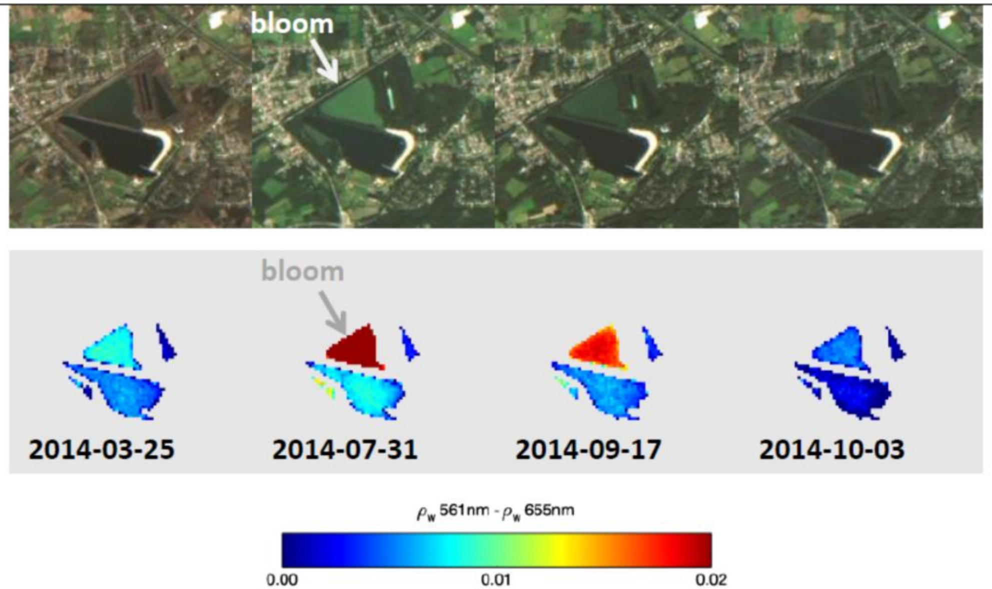
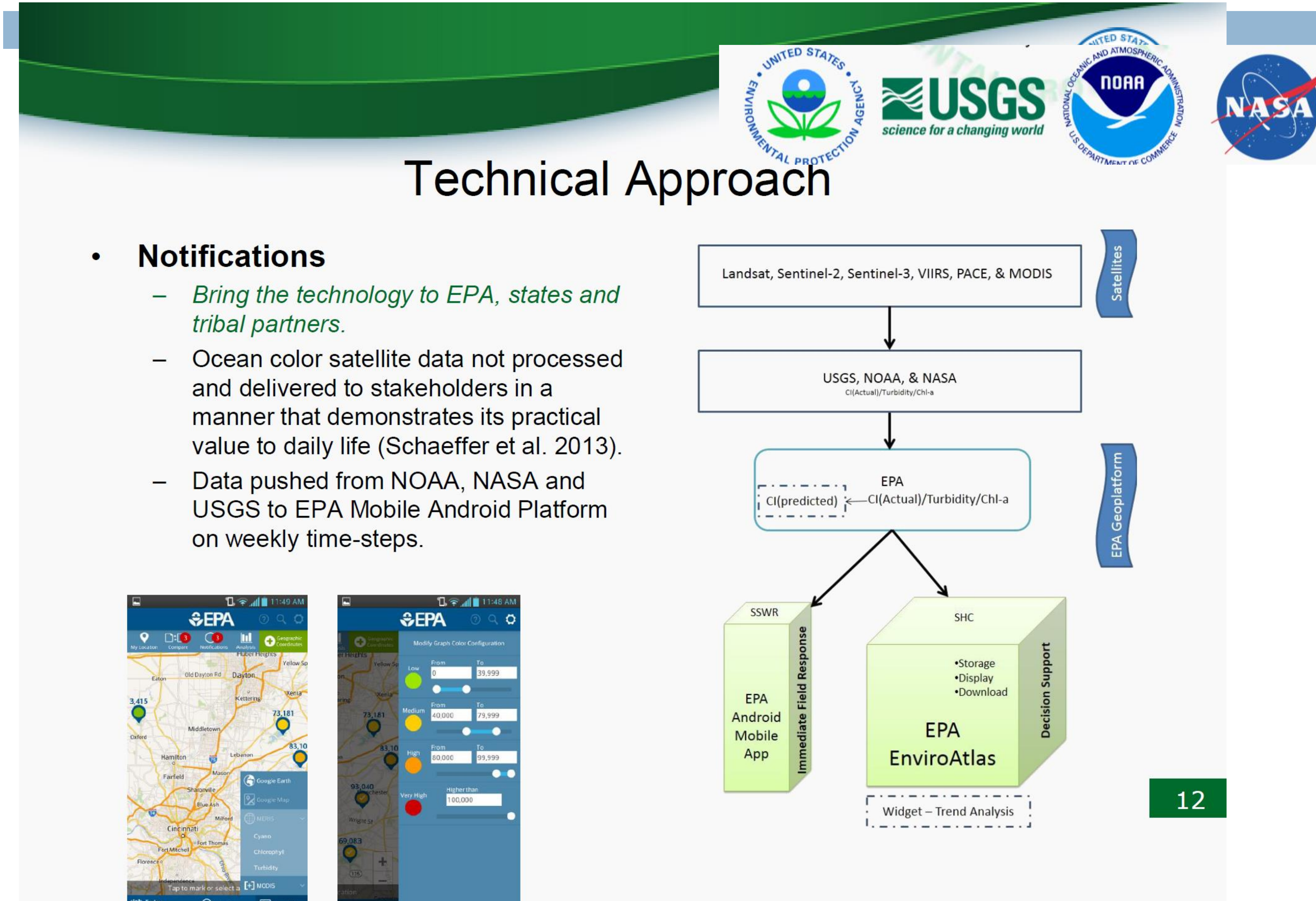


Figure 2. A time-series of Landsat-8 images of the Hofstade domain, a recreational water

- PROBA-V (Belgium) 100-300 m sediments

What Proba4Coast will bring: The non-OC Proba-V mission with daily coverage at 300 m, a 5-daily coverage at 100m resolution records data up to at least 100 km away from the coastlines.

Cyanobacteria Assessment Network (CyAN)



Pleiades Images at 50 cm Multiangle

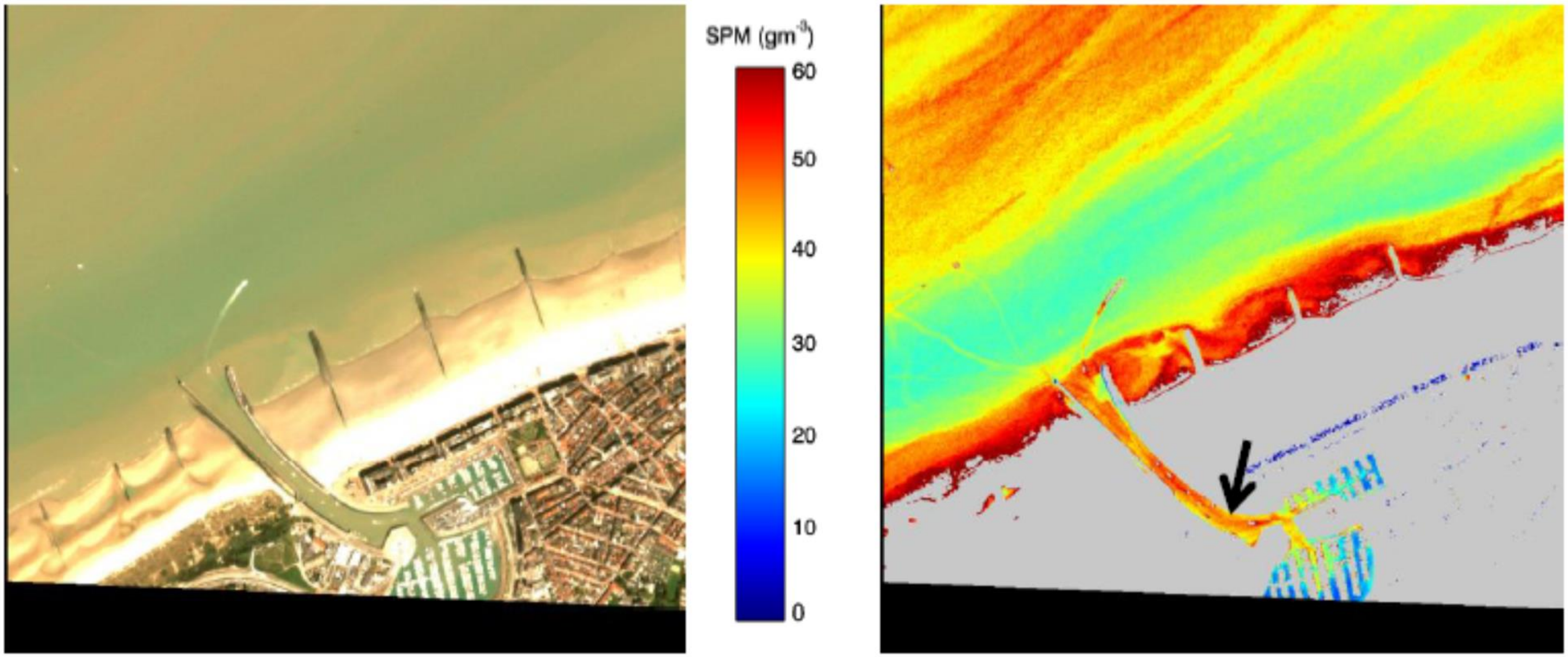
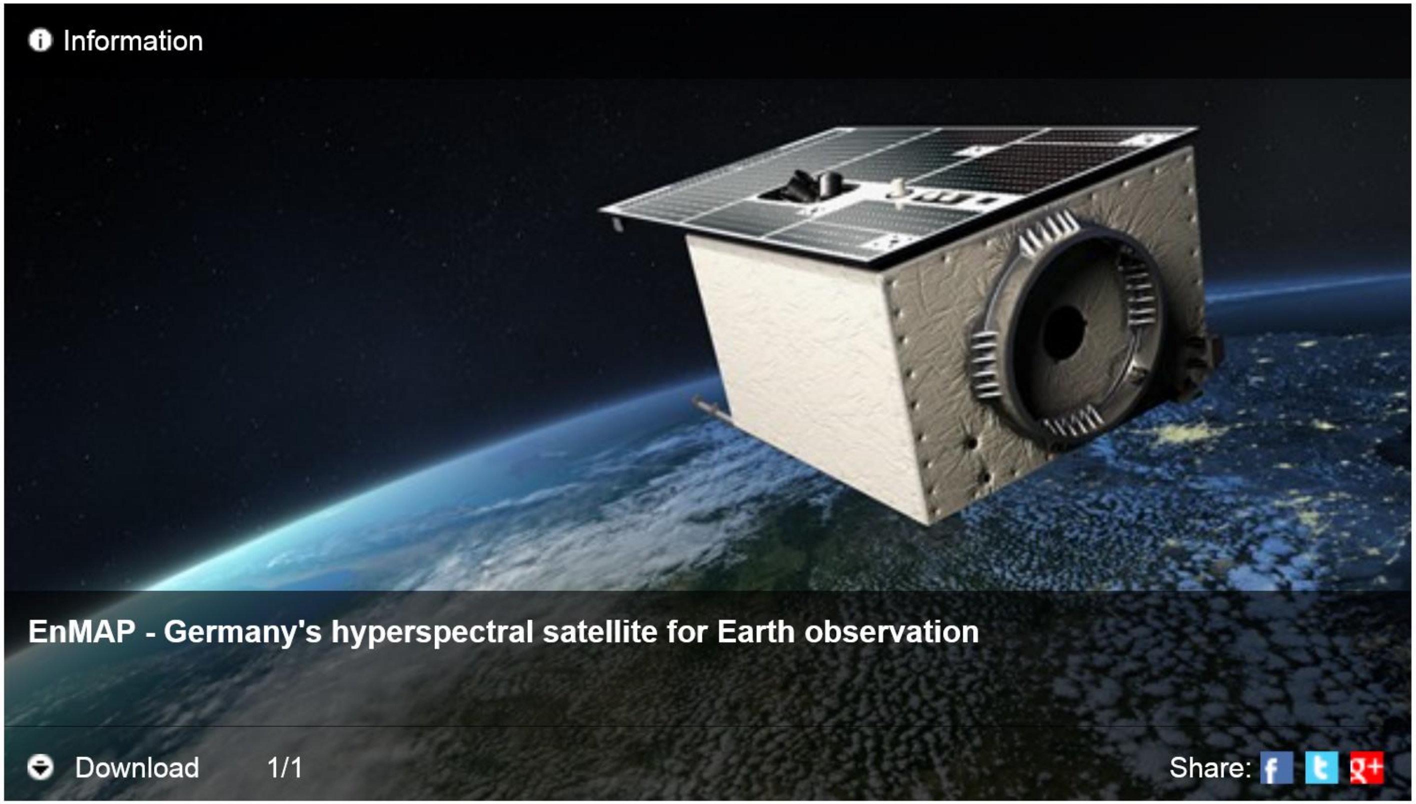


Figure 1: Sediment concentrations in and around Blankenberge harbour derived from a Pléiades image on 2014-07-17. (source: Vanhellemont, unpublished results) The entrance channel width ranges from 45 to 80 m.

30 m

EnMAP - Germany's hyperspectral satellite for Earth observation



The instruments on Germany's hyperspectral Earth observation satellite, Environmental Mapping and Analysis Programme (EnMAP), will observe the sunlight reflected from Earth across a wide range of wavelengths from the visible to the short wave infrared. This will make it possible to accurately study the condition of Earth's surface, and the changes affecting it. The mission is scheduled to launch in 2018 and is designed to continuously operate for five years.

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.

PRISM

Portable Remote Imaging Spectrometer

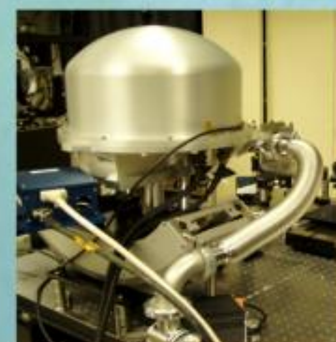
Welcome to the PRISM Website

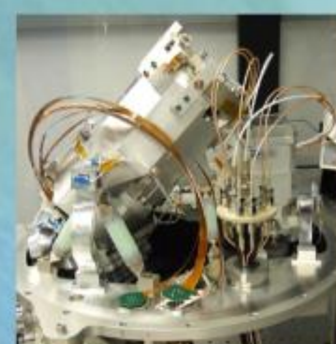
- Home
- Instrument
- PRISM Status
- PRISM Data
- Quicklooks
- Publications
- Contact
- News and Information

About PRISM

The coastal zone is home to a high fraction of humanity and is increasingly affected by natural and human-induced events from tsunamis to toxic blooms and oil spills. Current satellite data provide a broad overview of these events but do not have the necessary spectral, spatial and temporal, resolution to characterize and understand them.

To address this gap, a compact, lightweight, airborne Portable Remote Imaging SpectroMeter (PRISM) compatible with a wide range of piloted and Uninhabited Aerial Vehicle (UAV) platforms was developed at the Jet Propulsion Laboratory. Optimized for the spectral range between 350 nm and 1050 nm, PRISM offers high temporal resolution and below cloud flight altitudes to resolve spatial features as small as 30 cm. The sensor performance defines the state of the art in light throughput, spectral and spatial uniformity, and polarization insensitivity.





Latest News

View 2014 Quicklooks

Download sample PRISM data products

Hyperspectral PRISM Airborne Flights

Completed (Low Altitude)

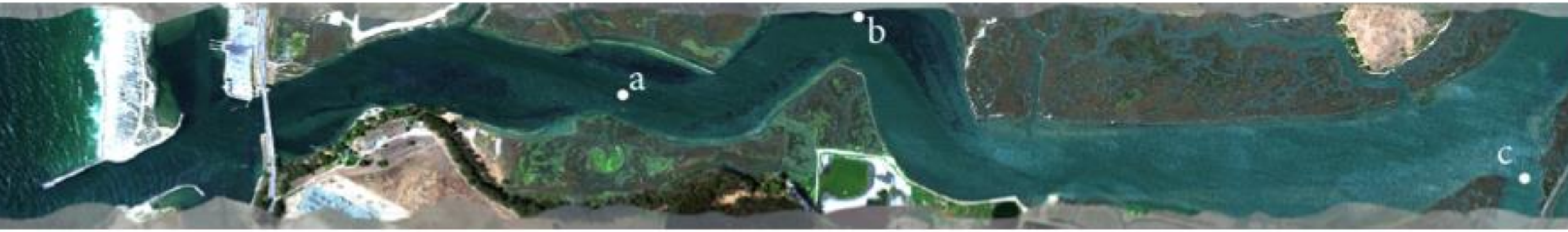
1-3 m pixels

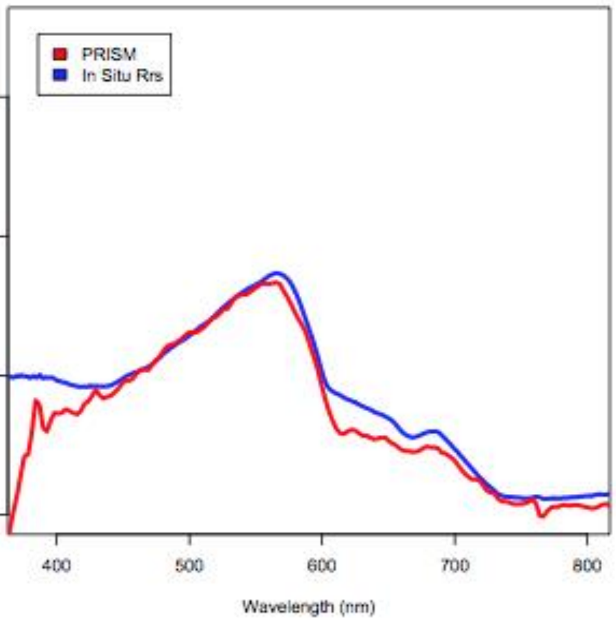
- 2012 July 17-28
  - diverse coastal targets
  - Elkhorn Slough/M Bay CA
- 2013
  - Monterey Bay
- 2014 January 13-19
  - Greater Florida Bay
  - Seagrass, Corals, Mangroves

Upcoming (Higher Altitude)

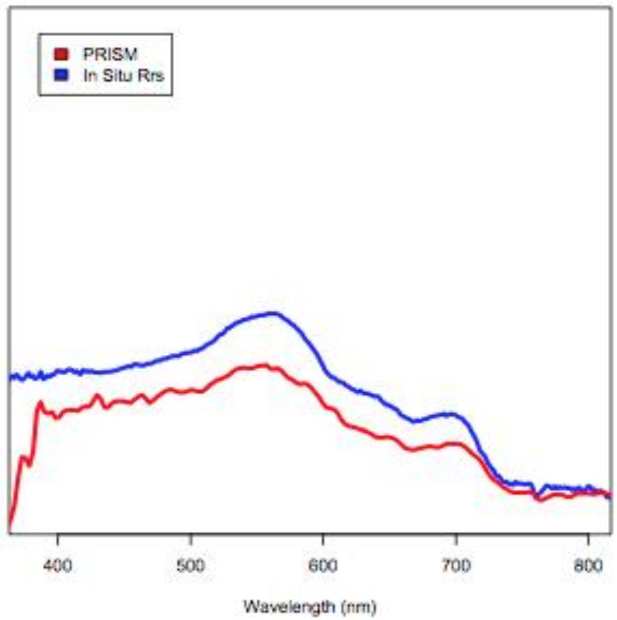
10 m pixels

- 2016 January
  - Southern Ocean ORCAS
  - Gas Exchange
- 2016-2017
  - CORALS – Coral Reef
    - Florida, Guam, Palau, Australia

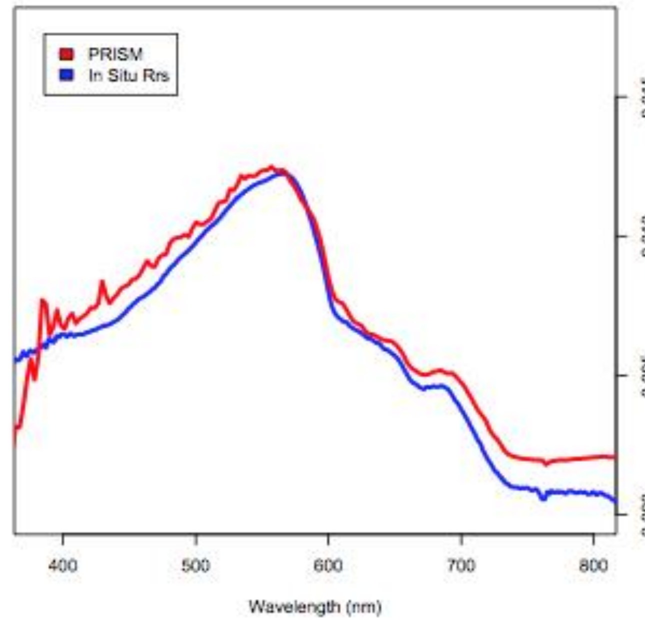




(a) West LOBO Buoy



(b) Seal Bend Dense Eelgrass



(c) East LOBO Buoy

LIDAR Advances (M. Behrenfeld)

- Satellite
  - CALIOP not optimal vertical resolution
  - retrieved integrated plankton stocks within the first retrieval bin of the lidar
- Past Airborne campaigns
  - 2012 Azores
  - 2014 SABOR North Atlantic
- Upcoming Airborne Lidar Mission
  - North Atlantic Earth Venture Suborbital (NAAMES)
  - coupling ship measurements and aircraft lidar

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WHERE TO NEXT?????