

A diagonal strip of a hyperspectral image, likely representing a coastal area, is shown against a black background. The strip displays a variety of colors including blue, green, yellow, and orange, which represent different spectral signatures of the water and land. The image has a slightly jagged, torn-edge appearance.

Hyperspectral Studies of Coastal and Inland Waters of California – Data Collected and Lessons Learned

Raphael Kudela¹ (PI), Liane Guild² (Co-PI)

Sherry Palacios³, Juan Torres-Pérez³

Kendra Negrey¹

1 UC – Santa Cruz, 2 NASA Ames Research Center, 3 Bay Area Environmental Research Institute/NASA Ames

Outline

- Data Collected
 - *In situ*
 - Imagery
 - Ongoing issues
- Data Management
- Some of our Science
 - *Application of hyperspectral remote sensing to cyanobacterial blooms in inland waters*
 - *Remote sensing of phytoplankton functional types in the coastal ocean from the HysplRI Preparatory Flight Campaign*

In Situ Monterey Bay Observations

Ocean:

HPLC measured pigments (e.g. chl-a)

Phytoplankton cell counts

IOPs

absorption (a_p , a_d , a_{CDM})

ac-s measured total absorption
and attenuation

backscattering

AOPs

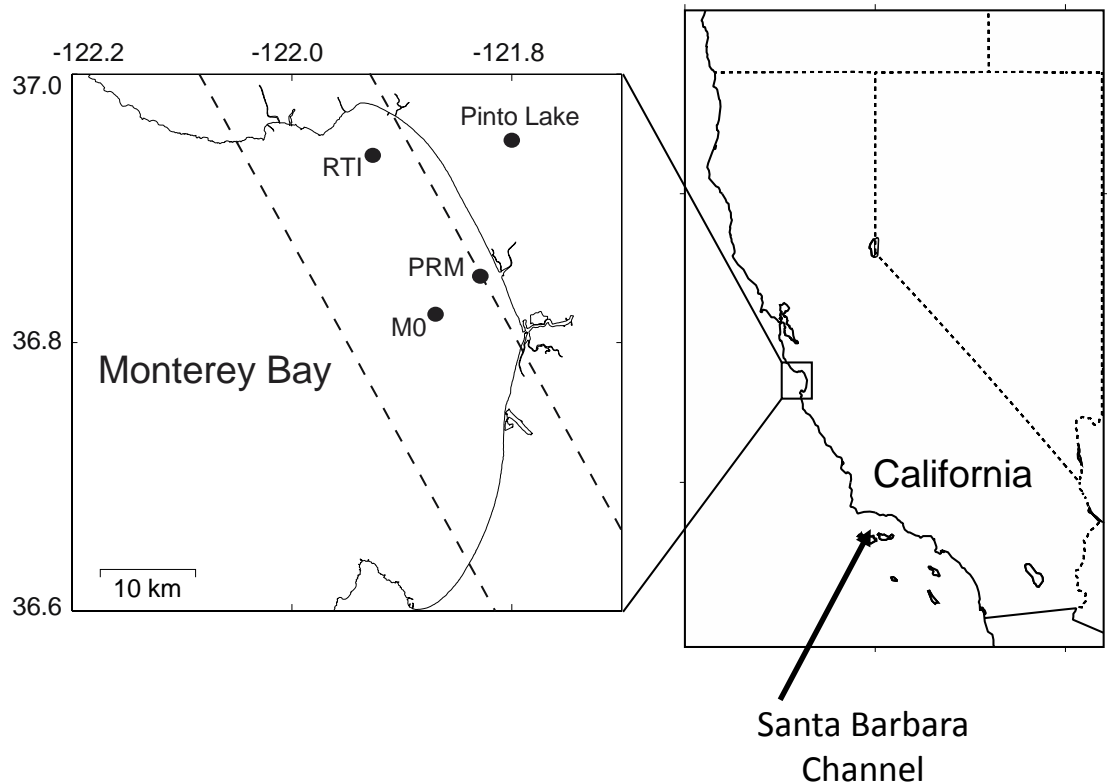
water-leaving radiance

remote sensing reflectance

Water

salinity

temperature



Pinto Lake:

Pigments (chl-a)

Backscattering

AOPs

Aerosol Optical Depth (AOD)

In Situ Plumes & Blooms Observations



Pigments (e.g. chl-a)

IOPs

absorption (a_p , a_d , a_{CDM})

backscattering

AOPs

water-leaving radiance

remote sensing reflectance

Water

salinity

temperature

In situ Monterey Bay Observation Dates

Field Season	Flight Date(s)	Location (box)	In-water Measurements	RTI	PRM	M0	SCW	Pinto	White Plains
Spring 2013	4/10/13	SF Bay	y	x	x	x		x	x
Summer 2013	6/7/13	SF Bay	y	x	x	x		x	x
Autumn 2013	10/30/13	SF Bay	y	x	x	x			
	10/31/13	SF Bay	y	x	x	x		x	
	11/5/13	SF Bay	no imagery	x	x	x			
	11/22/13	SF Bay	n						
	12/5/13	SF Bay	y	x	x	x		x	
Spring 2014	4/23/14	SF Bay	no imagery	x	x	x		x	x
	4/28/14	SF Bay	y	x	x	x		x	x
	5/7/14	SF Bay	y				x		
Summer 2014	5/28/14	SF Bay	Pinto only					x	
Autumn 2014	10/6/14	SF Bay	no imagery					x	
	10/23/14	SF Bay	no imagery	x	x	x			
	10/27/14	SF Bay	y	x	x	x		x	
	10/30/14	SF Bay	no imagery		x				
	11/24/14	SF Bay	n						
Spring 2015	4/17/15	SF Bay	no imagery	x	x	x		x	
	4/30/15	SF Bay	y				x	x	
	4/30/15	Monterey Bay & Pinto Lake	y					x	
Summer 2015	TBD	SF Bay							

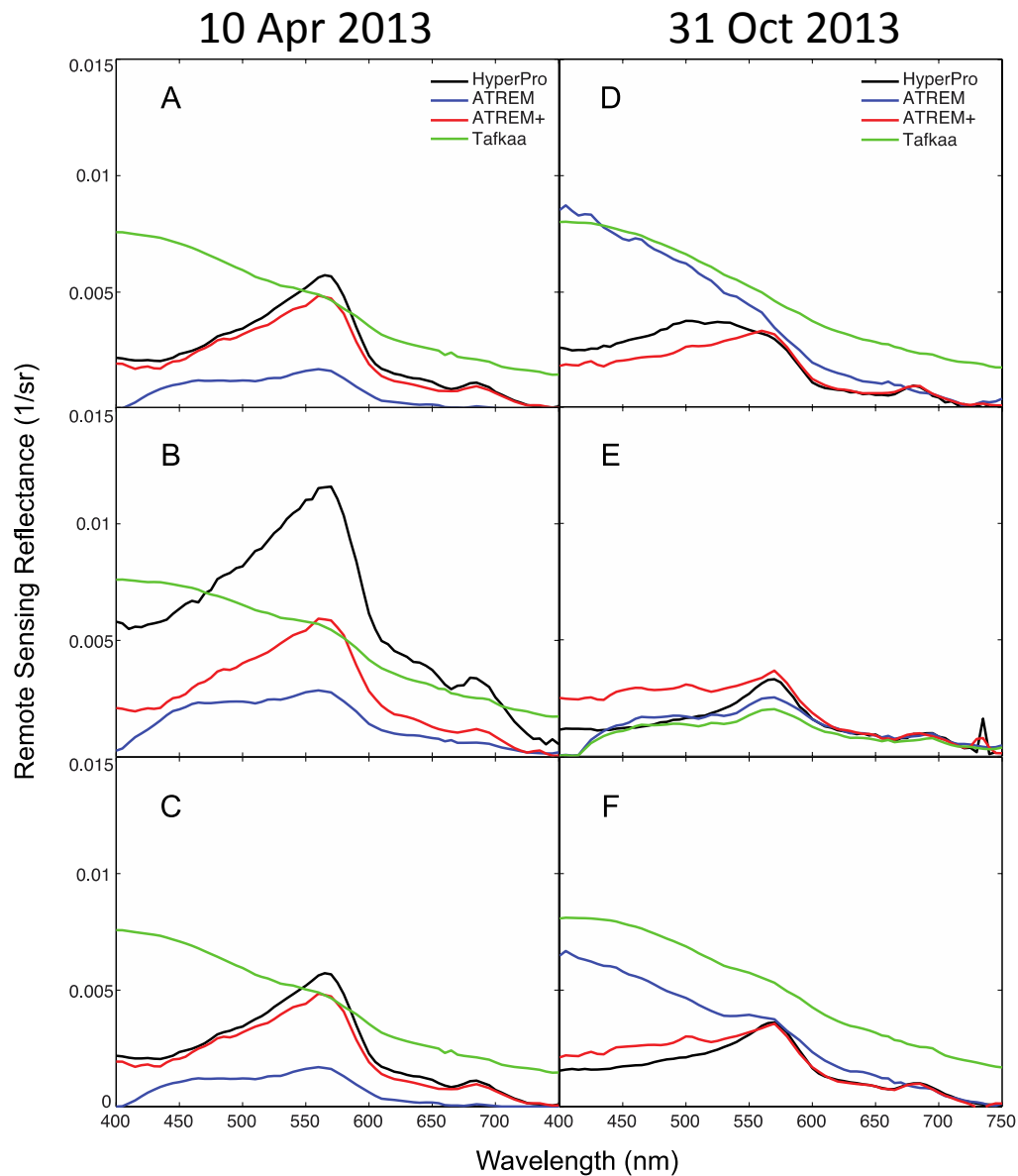


Coastal Imagery Dates

Field Season	Flight Date(s)	Location (box)	AVIRIS	MASTER	In-water Measurements
Spring 2013	4/10/13	SF Bay	y	y	y
	4/11/13	SB Channel	y	y	n
Summer 2013	6/7/13	SF Bay	y	y	y
	6/6/13	SB Channel	y	y	n
Autumn 2013	10/30/13	SF Bay	y	y	y
	10/31/13	SF Bay	y	n	y
	11/22/13	SF Bay	y	y	n
	11/25/13	SB Channel	y	y	n
	12/5/13	SF Bay	y	y	y
Spring 2014	4/16/14	SB Channel	y	y	y
	4/28/14	SF Bay	n	y	y
	5/7/14	SF Bay	y	y	y
Summer 2014	5/28/14	SF Bay	y	y	n
	6/4/14	SB Channel	y	y	n
	6/6/14	SB Channel	y	y	n
Autumn 2014	8/29/14	SB Channel	y	y	n
	10/6/14	Monterey Bay & Pinto Lake	AVIRIS-NG	n	y
	10/21/14	SB Channel	y	y	y
	10/27/14	SF Bay	y	y	y
	11/24/14	SF Bay	y	y	n
Spring 2015	4/16/15	SB Channel	y	y	y
	4/17/15	SF Bay	n	y	y
	4/30/15	SF Bay	y	y	y
	4/30/15	Monterey Bay & Pinto Lake	AVIRIS-NG	n	y
Summer 2015	6/2/15	SB Channel	y	y	n
	TBD	SF Bay			

☹️ rosette

Ongoing Issues with Imagery



2015: We live in interesting times

Large bloom of toxic algae under way in Monterey Bay and beyond

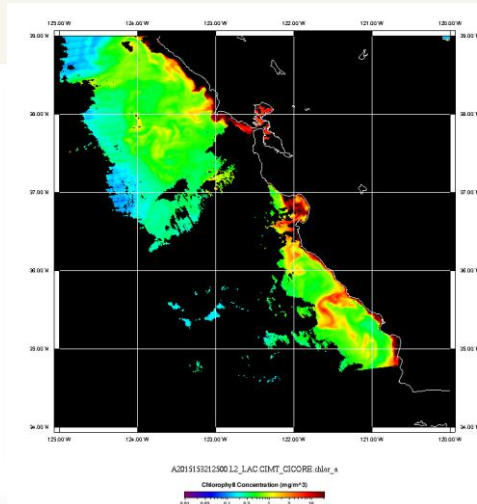
Monitoring program led by UC Santa Cruz has detected high levels of the toxin domoic acid in Monterey Bay; more blooms reported elsewhere along the west coast

June 02, 2015

By Tim Stephens

Researchers have detected large blooms of toxin-producing algae in Monterey Bay, raising concerns about potential effects on marine mammals and seabirds. The bloom involves microscopic algae called *Pseudo-nitzschia* (a type of diatom), which produce a potent neurotoxin called domoic acid. The toxin was first detected in early May, and by the end of the month researchers had detected some of the highest concentrations of domoic acid ever observed in Monterey Bay.

"It's a pretty massive bloom. The domoic acid levels are extremely high right now in Monterey Bay, and the event is occurring as far north as Washington state. So it appears this will be one of the most toxic and spatially



<http://news.ucsc.edu/2015/05/algal-bloom.html>

**New domoic acid
optical signature being developed**

Updates: Things to know about the Santa Barbara oil spill

UPDATED 2:10 PM PDT Jun 01, 2015



KSBBY

LOS ANGELES —
Central Coast two weeks ago spilled 100,000 gallons of crude into the ocean.

The May 19 spill occurred after an oil platform blowout in the Santa Barbara Channel.



Data Management

- Where will the *in situ* Monterey Bay data be available?

SeaBASS

SeaWiFS Bio-optical Archive and Storage System

Home Data Users ▾ Data Contributors ▾ Data Search NOMAD Data Archive Wiki Lists ▾ Contact Us

Welcome to SeaBASS, the publicly shared archive of in situ oceanographic and atmospheric data maintained by the NASA Ocean Biology Processing Group (OBPG). For information on how to search for data, please refer to the "Data Users" menu options. For information about preparing files for submission to SeaBASS, refer to "Data Contributors."

Processing Version Labels

Apr 22
2015

The validation search results and stats download now include the actual processing version used to produce the extracts.

Minor UI Changes

Nov 19
2014

We've finally replaced the gaudy, Google Maps pins with a slightly less gaudy circle! The 'Download 'All' button in the bio-optical search results has also been moved above the results table (plotting/mapping buttons are still located at the bottom).

Multi- vs. Hyper-spectral Searching

Apr 22
2014

<http://seabass.gsfc.nasa.gov/>

Our Contribution to Coastal and Inland Science using the HyspIRI Airborne Campaign Dataset

Application of hyperspectral remote sensing to cyanobacterial blooms in inland waters

RM Kudela, SL Palacios, DC Austerberry, EK Accorsi, LS Guild, J
Torres-Perez *RSE Special Issue*

Remote sensing of phytoplankton functional types in the coastal ocean from the HyspIRI Preparatory Flight Campaign

SL Palacios, RM Kudela, LS Guild, KH Negrey, J Torres-Perez, J
Broughton *RSE Special Issue*

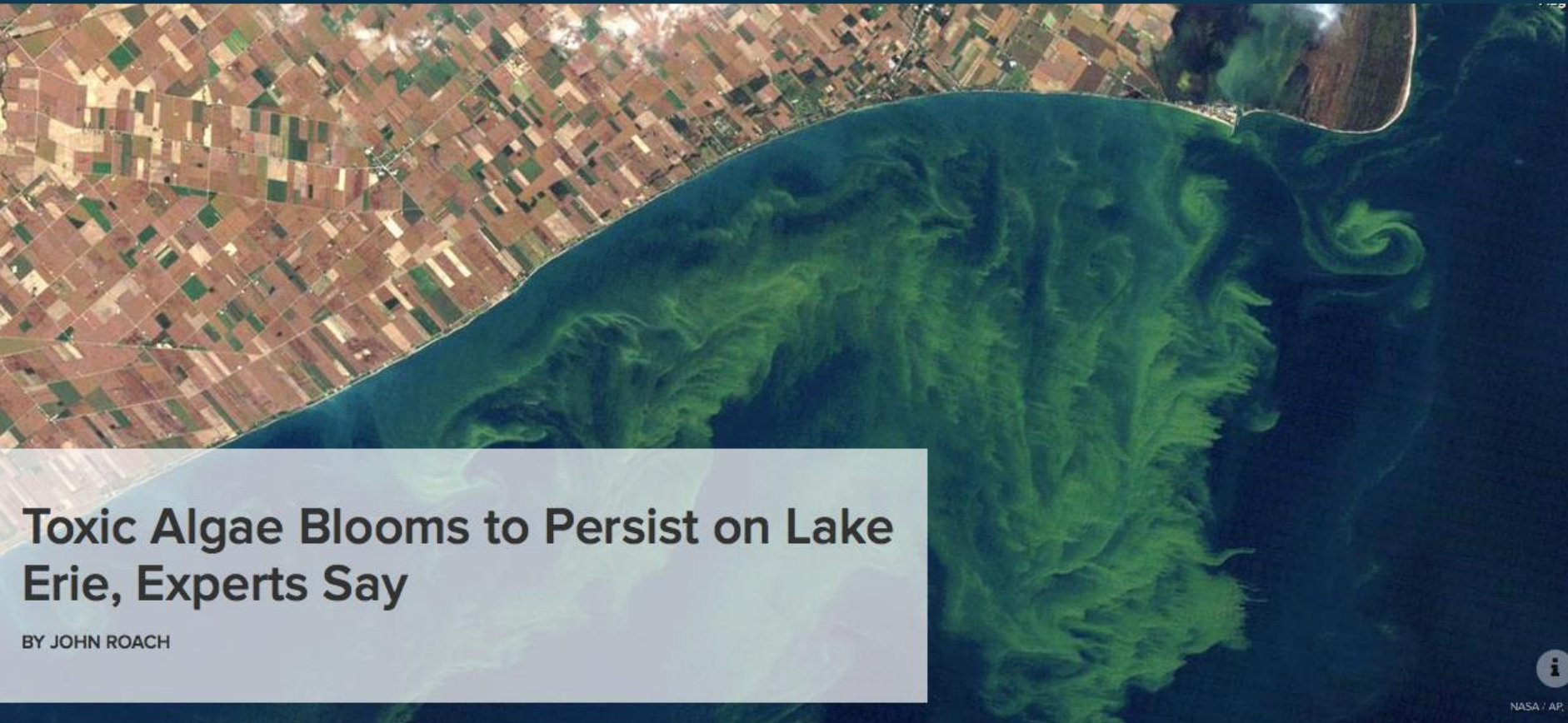
“Application of hyperspectral remote sensing to cyanobacterial blooms in inland waters”

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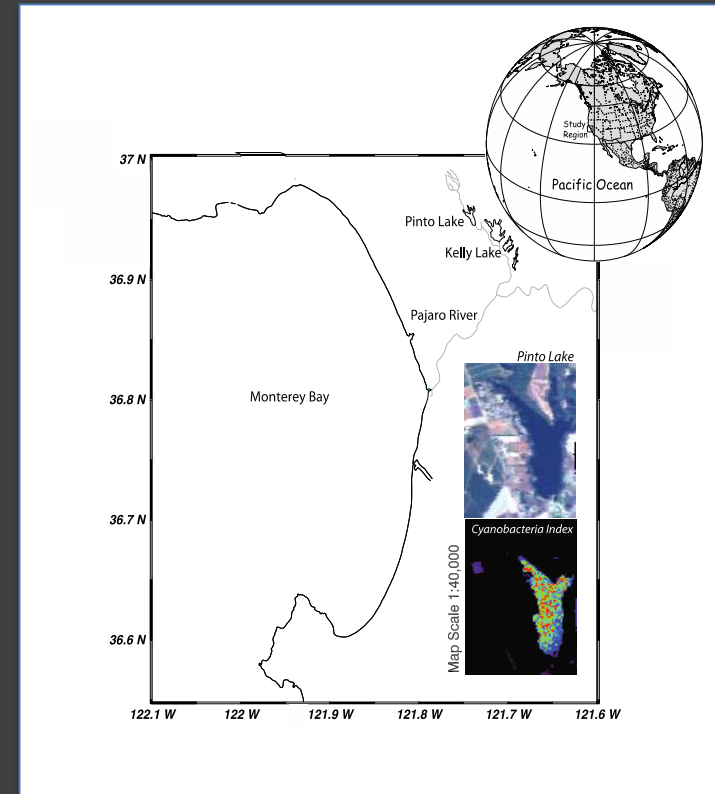
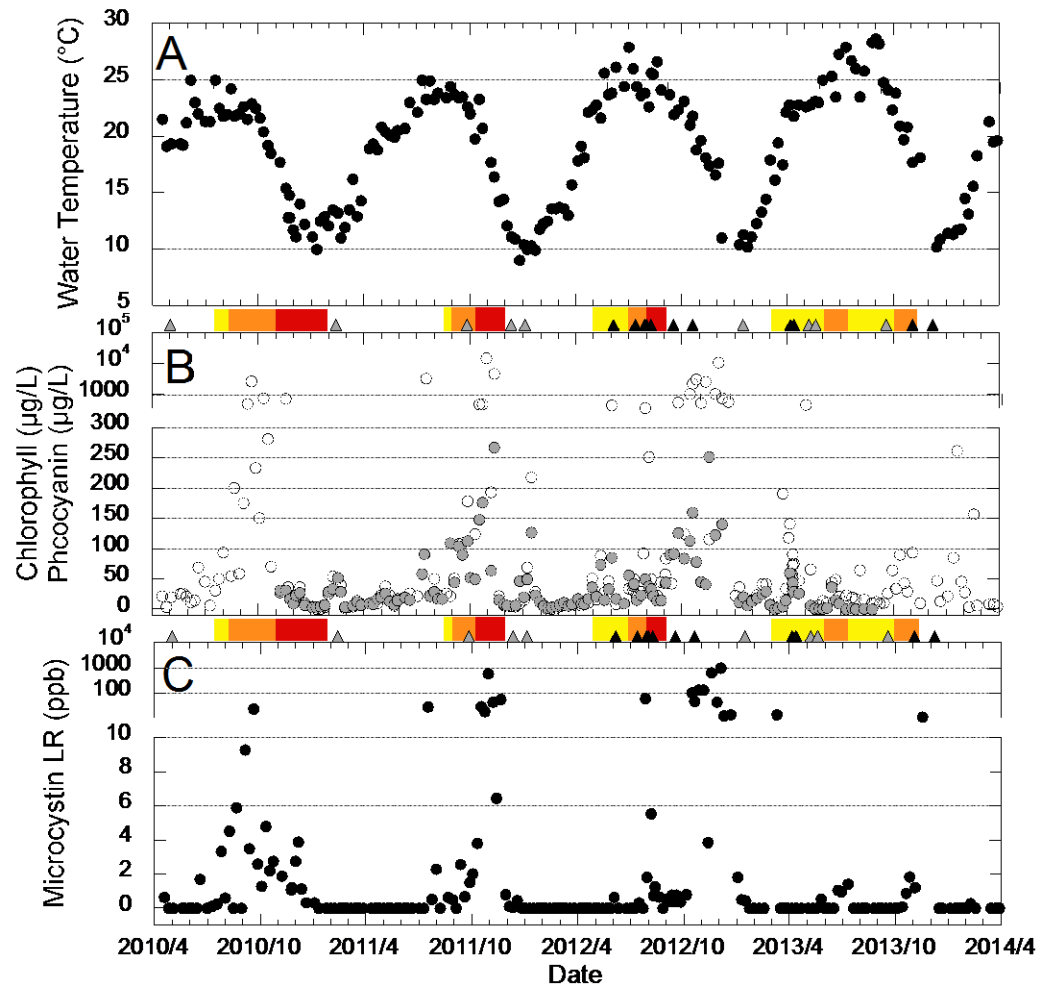
Toxic Algae Blooms to Persist on Lake Erie, Experts Say

BY JOHN ROACH

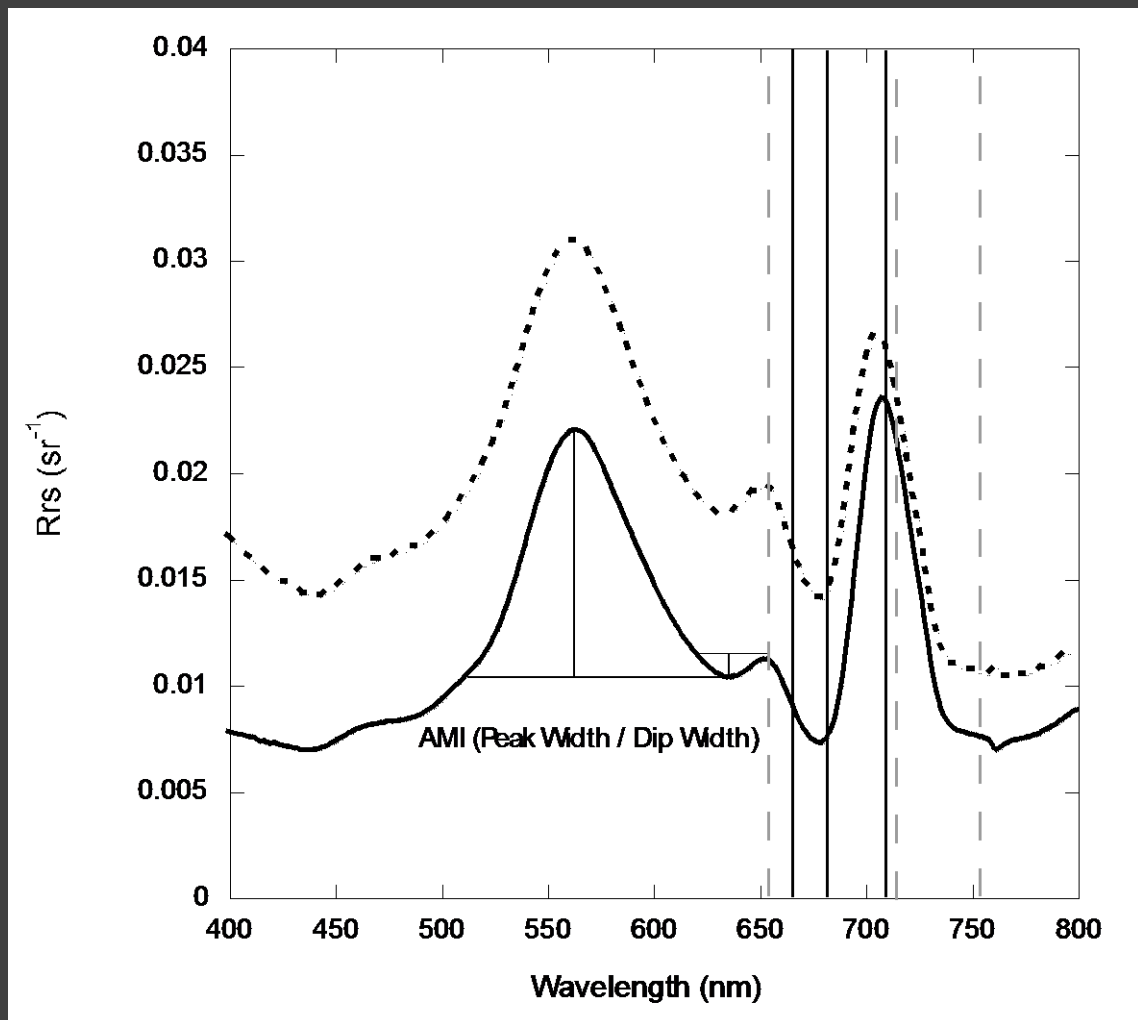


NASA / AP, FILE

Pinto Lake, Our Favorite Toxic Cesspool



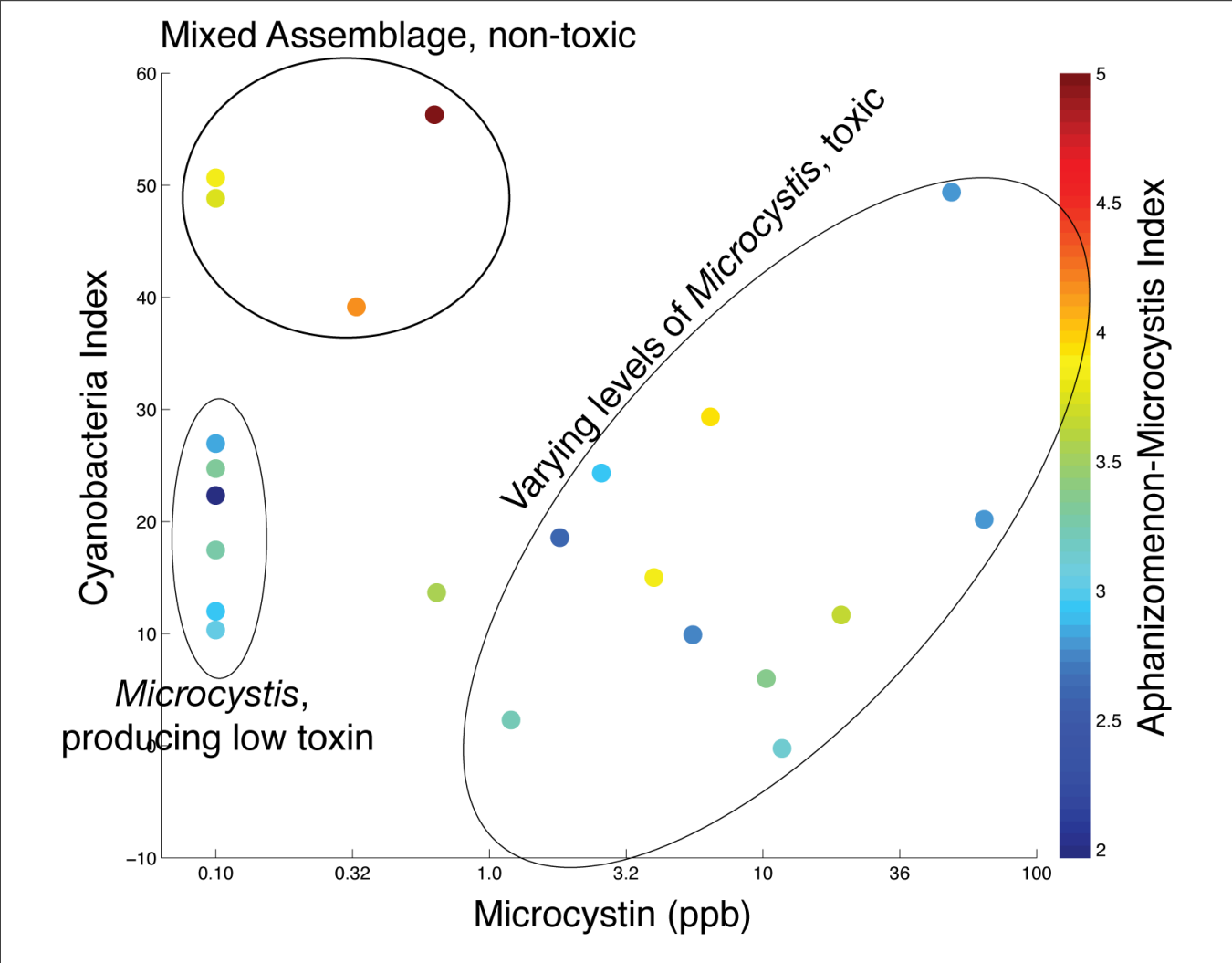
Detecting Blue-Green Algae



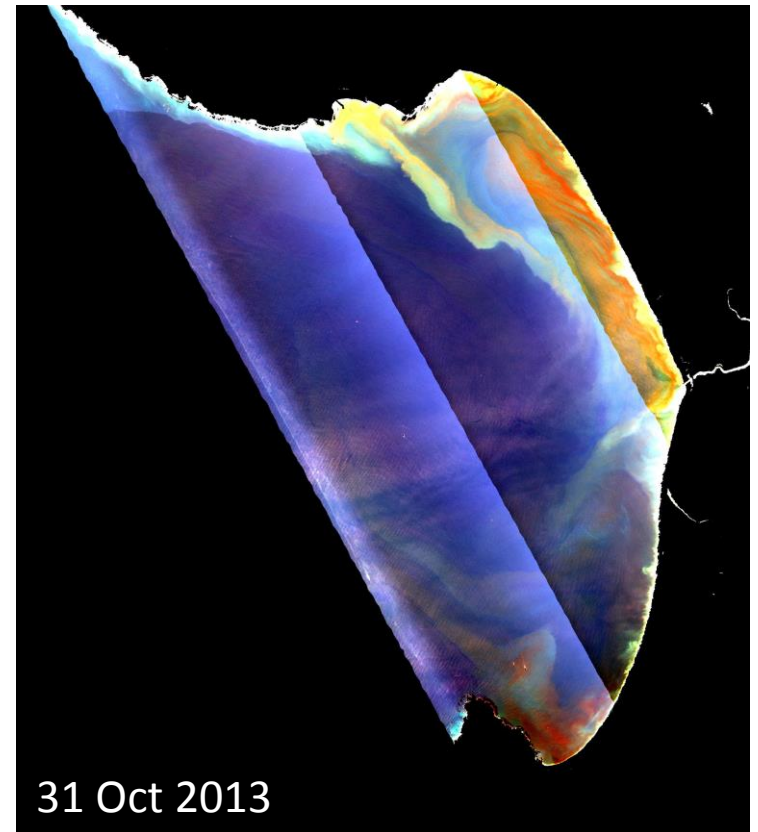
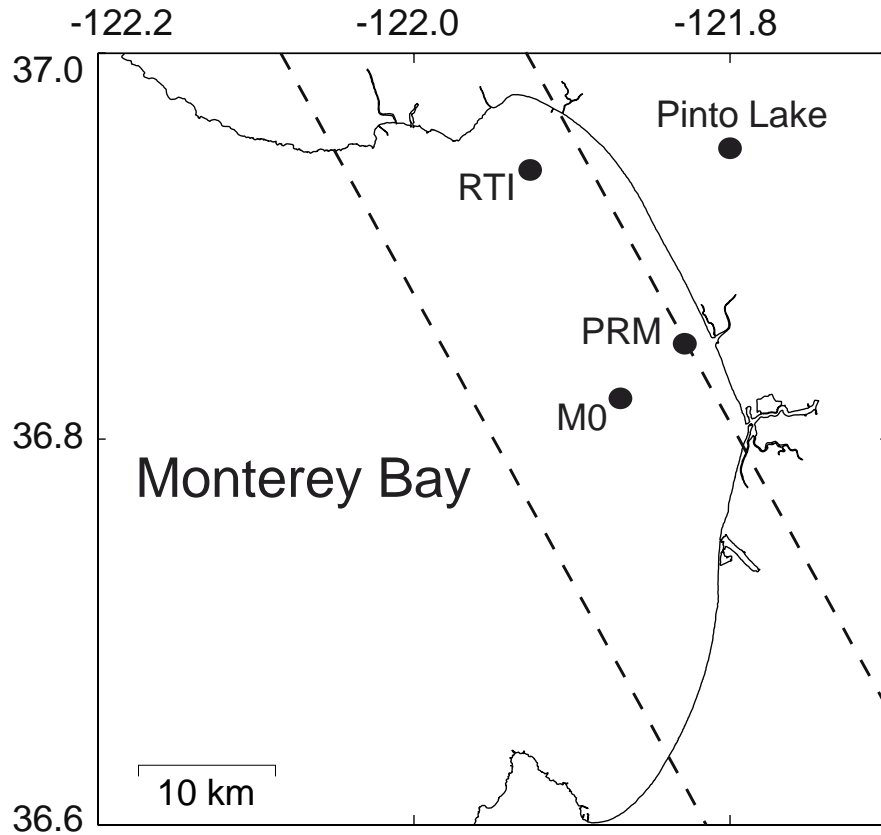
Several algorithms have been developed, including the Cyanobacterial Index (CI) and various phycocyanin absorption methods.

We generalized the spectral shape methods to take advantage of hyperspectral data, and also developed a Scattering Line Height (SLH) algorithm which works with almost any sensor, including MASTER

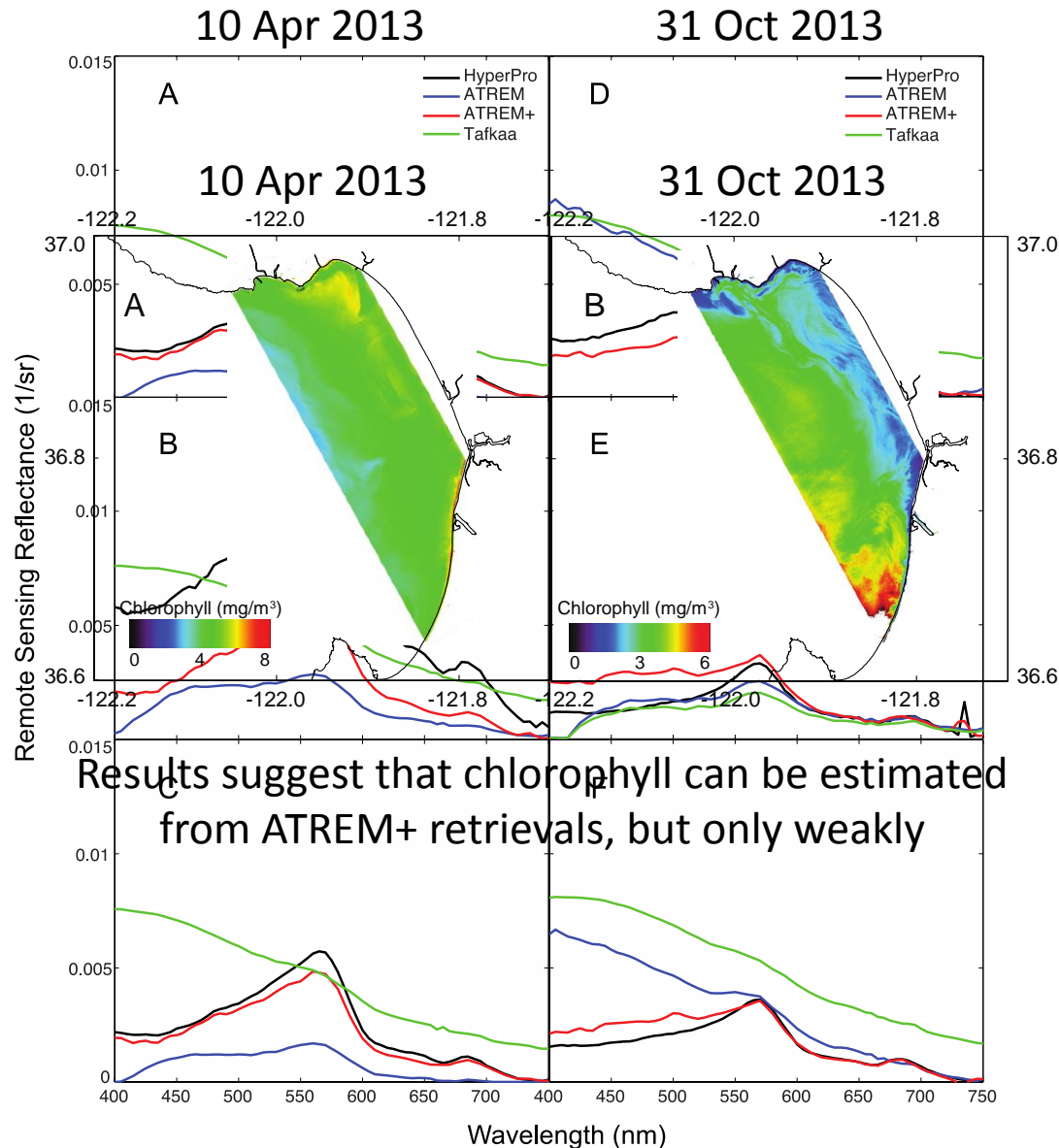
Predicting Toxic Blooms



“Remote sensing of phytoplankton functional types in the coastal ocean from the HyspIRI Preparatory Flight Campaign”



First Rule of Ocean Color Remote Sensing: Accurate Retrievals



First Rule of Ocean Color Remote Sensing: Accurate Retrievals

10 Apr 2013

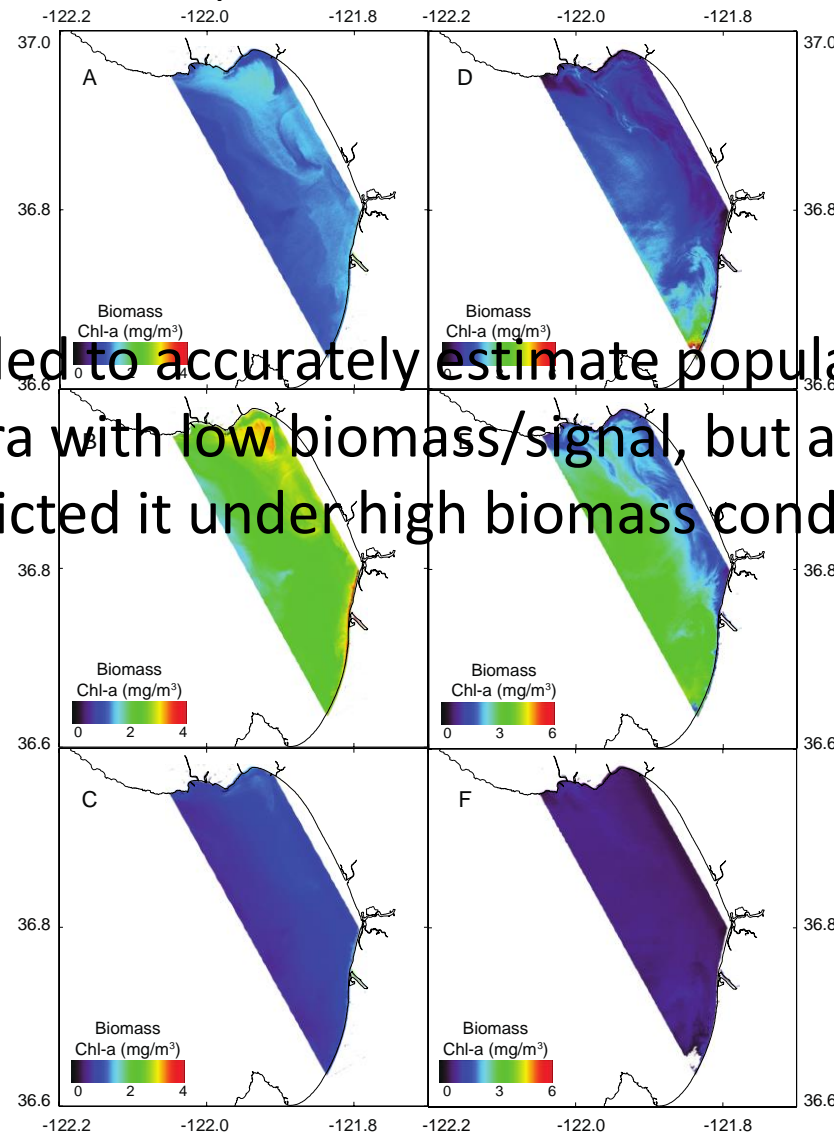
31 Oct 2013

Dinoflagellates

PHYDOTax failed to accurately estimate population structure
in spectra with low biomass/signal, but accurately
predicted it under high biomass conditions

Diatoms

Cyanobacteria



Lessons Learned

Hyperspectral remote sensing of coastal and inland waters has special needs with respect to

instrument calibration
signal-to-noise
atmospheric correction

Summary

- Data Collected
 - A robust *in situ* data set collected in Monterey Bay and Pinto Lake for all years and seasons: 2013, 2014, 2015
 - Matchups for Santa Barbara Channel Plumes & Blooms cruises on 4/16/14 & 10/21/14
 - Currently, **two dates** of experimentally processed “scientific quality” AVIRIS images for Monterey Bay only (4/10/2013 & 10/31/2013)
- Data Management
 - Preparing *in situ* data to target upload to SeaBASS in winter 2016
 - AVIRIS over water targets, needs further discussion with JPL
- Lessons Learned
 - Hyperspectral imagery has special needs with respect to instrument calibration, signal-to-noise, and atmospheric correction
 - It is possible to forecast blooms of the toxic cyanobacterium, *Microcystis*, using hyperspectral data

The Un-Sung Heroes

- Kendra Negrey
- The Kudela Lab, mobilizing again, and again, and again (etc...) at very early hours
- The UC-Santa Barbara Plumes & Blooms Team
- Ian McCubbin
- David Thompson