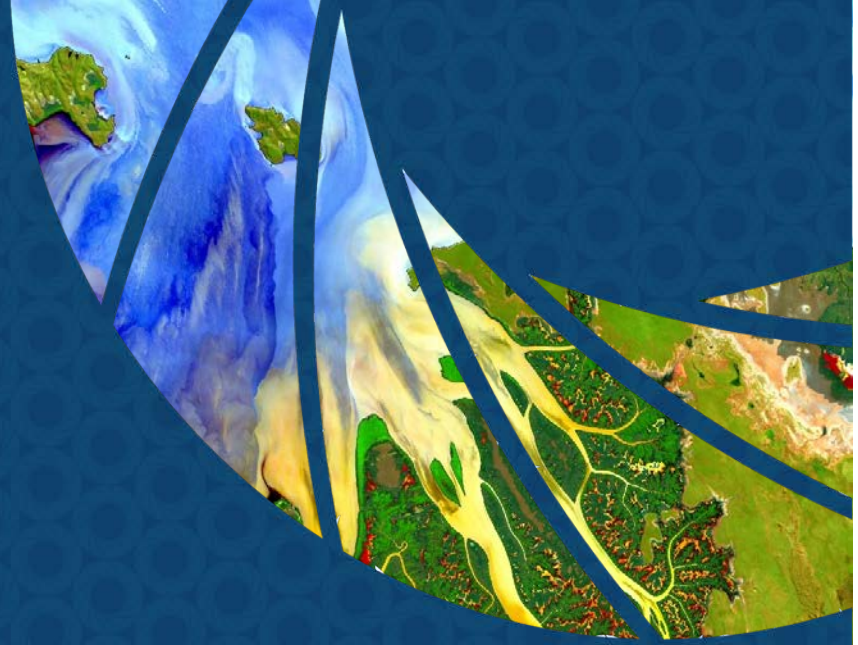


National Aeronautics and
Space Administration

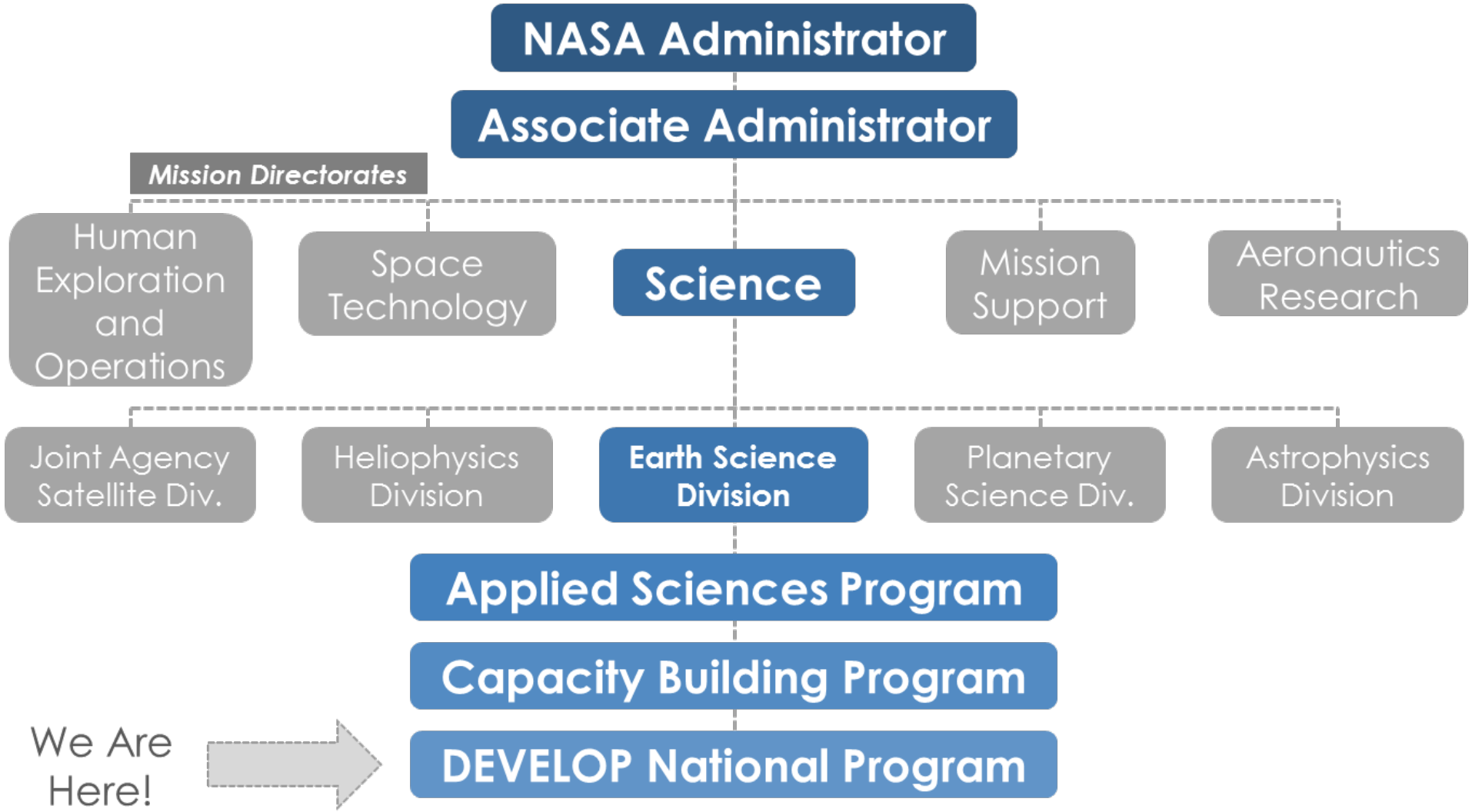
NASA DEVELOP National Program

Focusing on Partnerships with project example

NASA Ames Research Center

Jenna Williams
Center Lead

Where DEVELOP Fits @ NASA



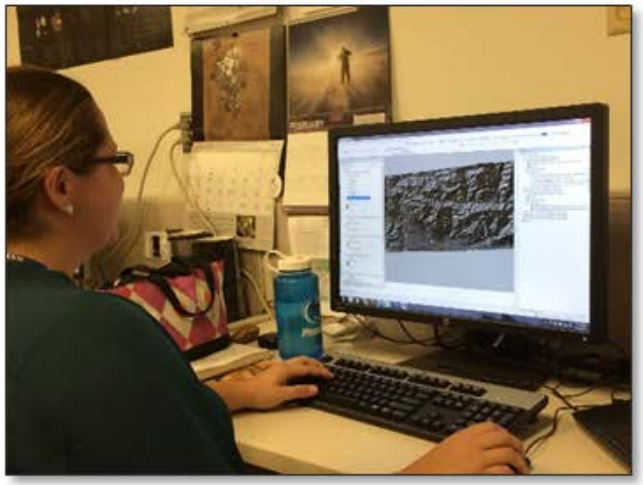
NASA Applied Sciences

National Application Areas + Capacity Building Elements

What is DEVELOP?

"Shaping the future by integrating Earth observations into global decision making."

Participants + Earth Observations + Decision Makers



DEVELOP bridges the gap between NASA Earth Science and society, building capacity in both its participants and end-user organizations to better prepare them to handle the environmental challenges that face society.

Where are all the DEVELOPers?

12 Locations

10 week projects

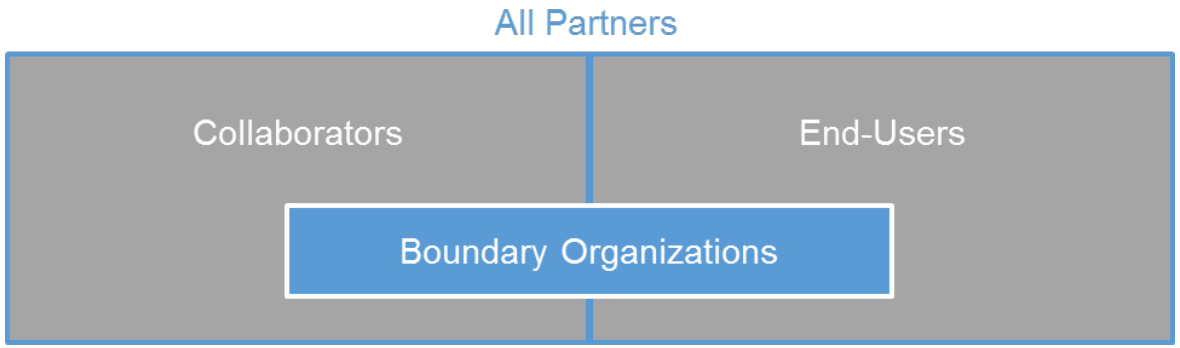
3 Terms/year
fall, spring, summer

Types of Parnerships

Partner: Umbrella term for any outside organization DEVELOP engages with through projects, at our locations, or other activities

Types of Partners

- **End-User:** Receives results and methodologies from DEVELOP and can **use** the project's products or methodologies to make a decision or policy.
- **Collaborator:** Works directly with a DEVELOP project team and provides some kind of leveraged resource (advising, data, model, software, funding, etc.), but are not actually using the project's products or methodologies to make a decision or policy.
- **Boundary Organization:** Organization or individual that disseminates the project's results to other end-users, decision-makers, policy-makers, etc.



Parner Expectations

Project Development

- Project planning (2 to 3 telecons)
- Proposal review/input
- Relevant Data (if applicable)
- Pre-term project survey

In Term Communication

- Bi-monthly telecons
- Email correspondence
- Site-visit (if applicable)

Post Project

- Post-term project survey
- Follow up on implementation/use of results

2017 Summer Portfolio

1st TERM (20)

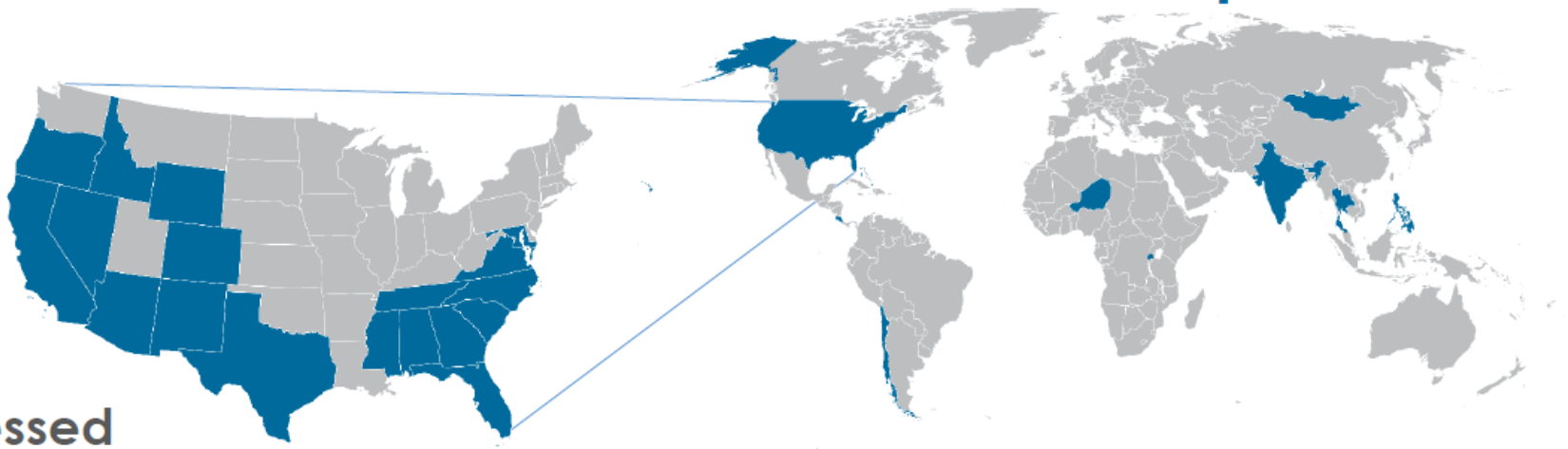
2nd TERM (9)

3rd TERM (1)

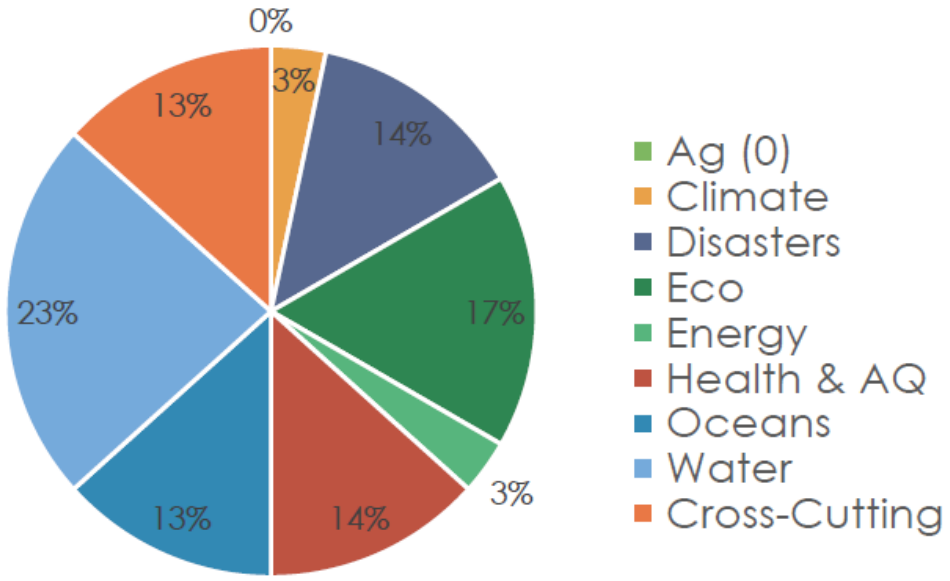
30 Projects

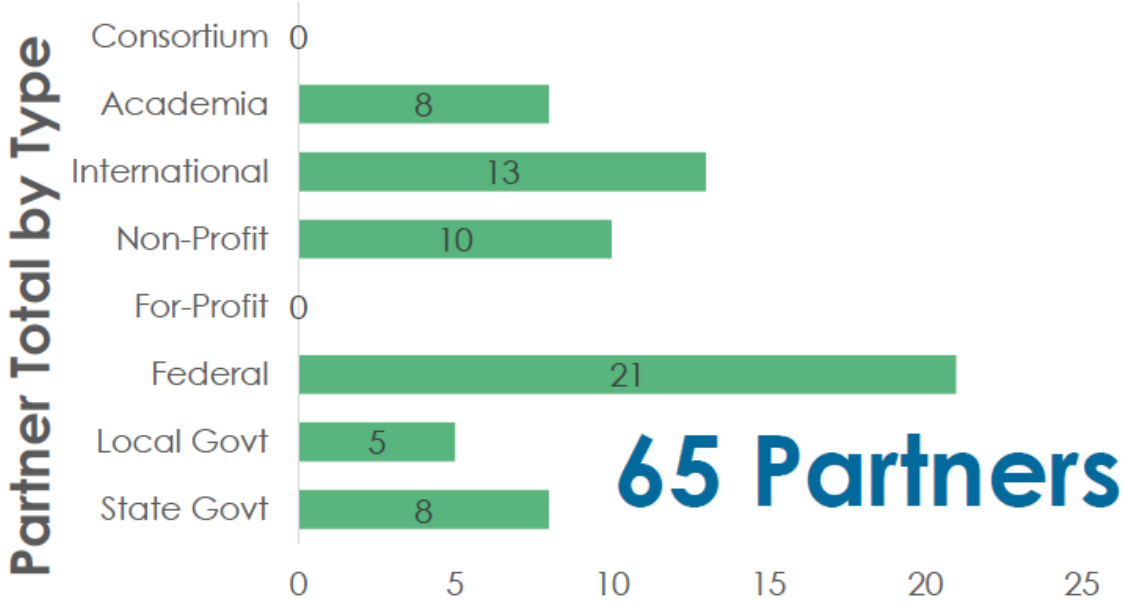
77% Domestic
23% International

19 States & 7 Countries Impacted



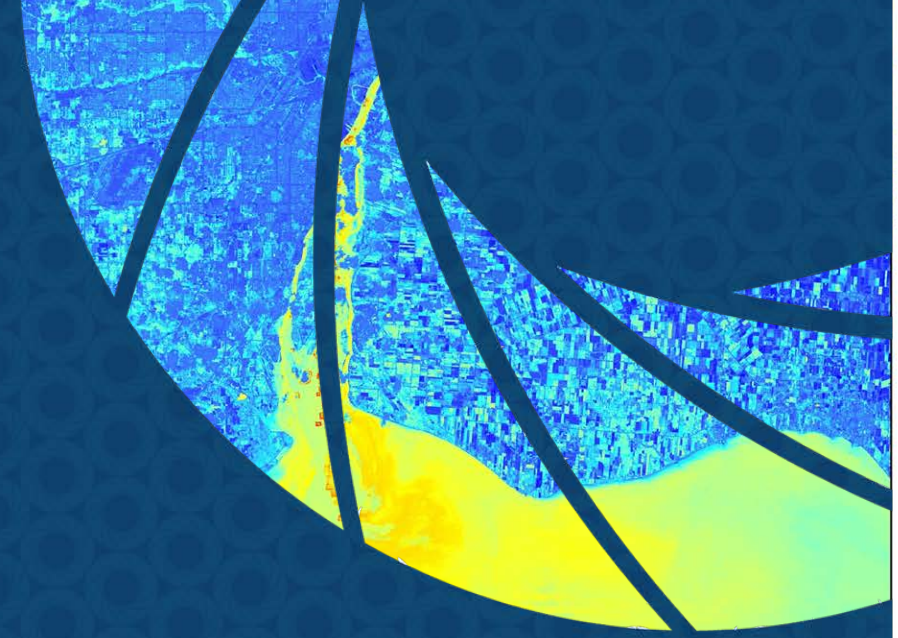
Application Areas Addressed





65 Partners

*Impacts and partners are not final



National Aeronautics and
Space Administration

LAKE ERIE WATER RESOURCES

Leveraging Earth observations to Identify Harmful Algal Blooms in Lake Erie's Western Basin

Presenter

Jenna Williams

DEVELOP Research Team

Rachel Green

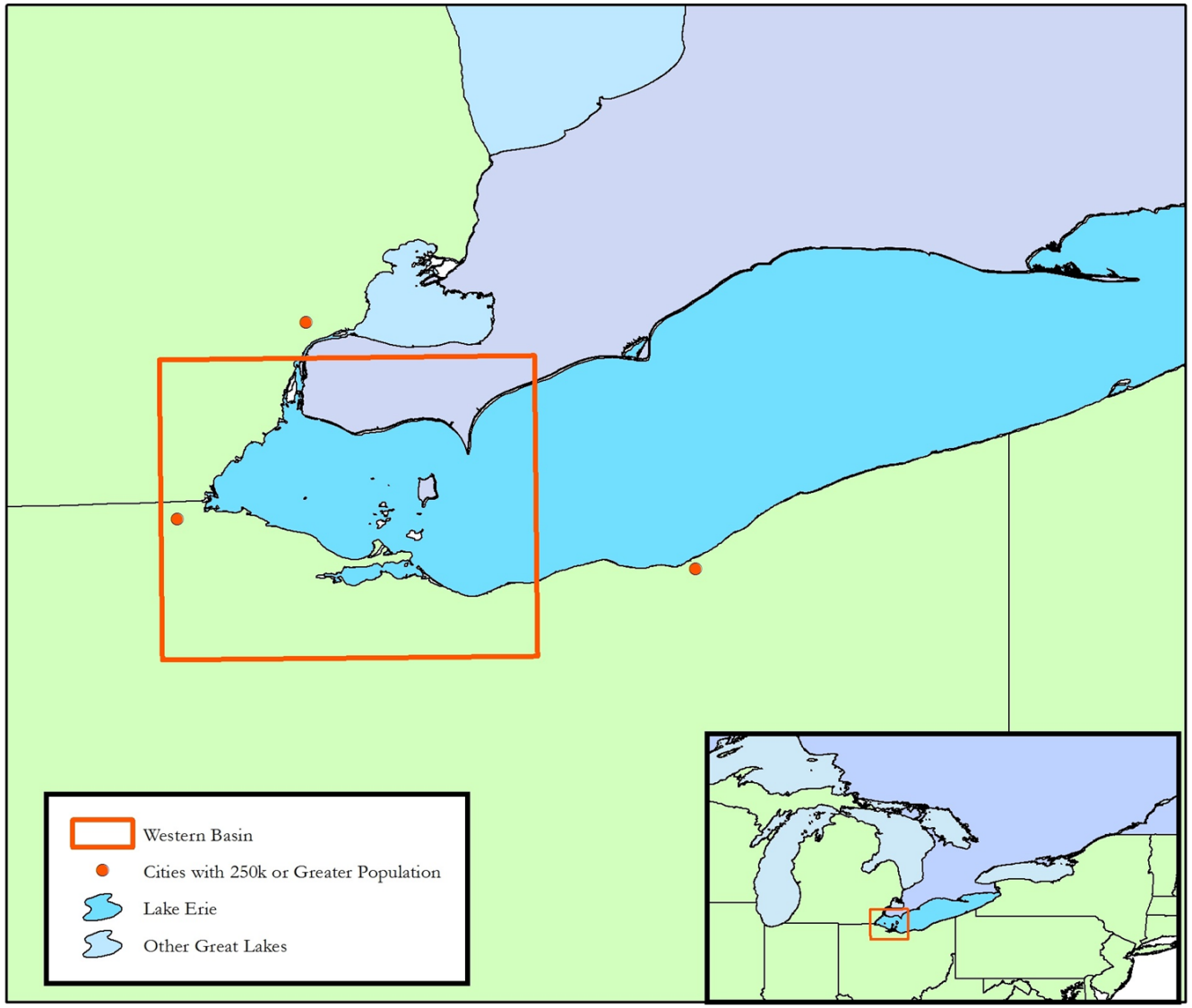
John Dilger

Rachel Johnson

NASA Ames Research Center

2017 Spring

Study Area & Period



Area

- Western Basin of Lake Erie

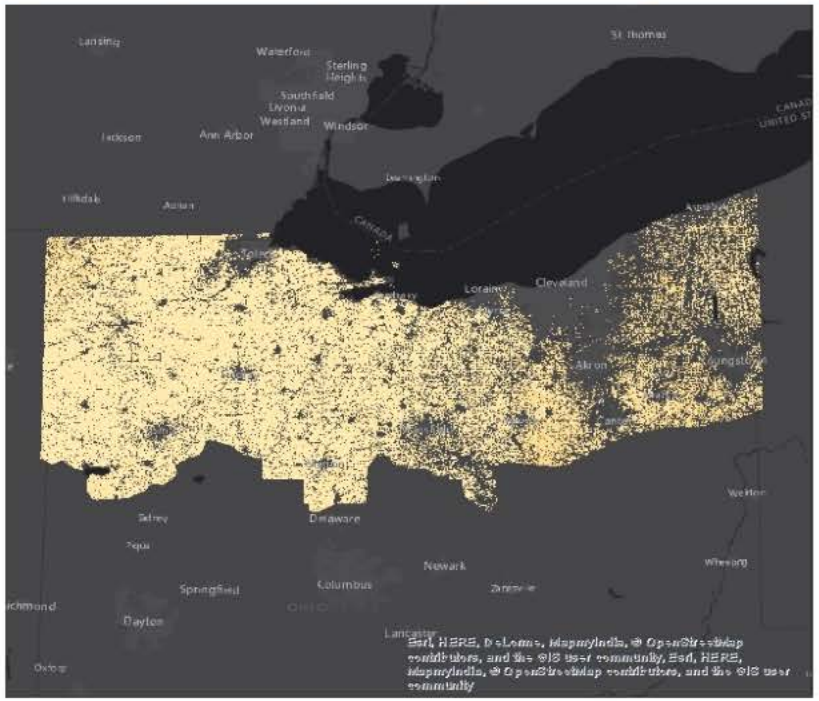
Period

- March to October 2015
- March to November 2016

Factoids

- 12th largest lake by area in the world
- Shallowest of the 3 basins
- 3 intake cribs in the western basin

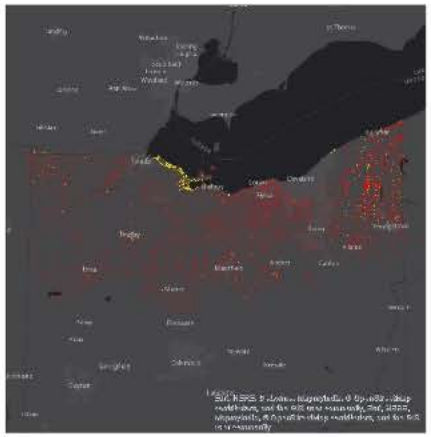
Land Use in Lake Erie Watershed, Ohio



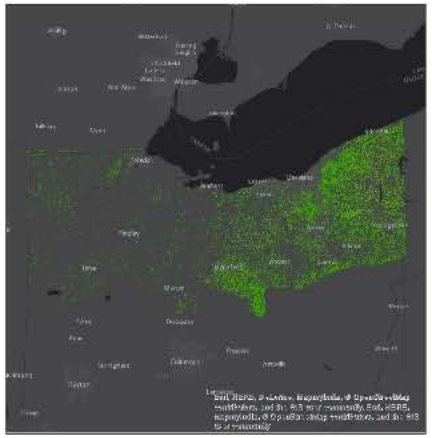
Agriculture

Water

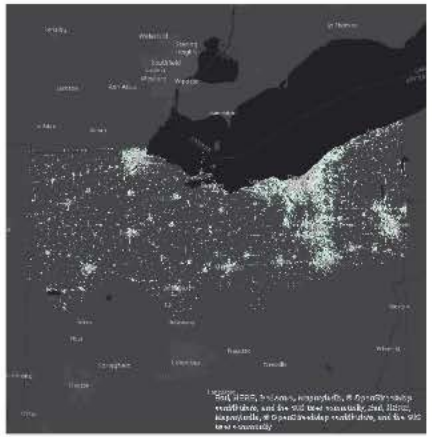
Bare



Wetland



Forested



Developed

Land Use Data from Ohio Department of Natural Resources GIS Mapping Services

Terminology

- **HAB**: Harmful Algae Bloom
- **Microcystis**: Genus of Algae
- **Microcystin**: Toxin produced by microcystis
- **Cyanobacteria**: phylum of algae in Lake Erie
- **Phycocyanin**: pigment specific to cyanobacteria
- **Chlorophyll-a**: pigment in all algae

Credit: NOAA GLERL

Community Concerns

Image Credit: Tom Archer

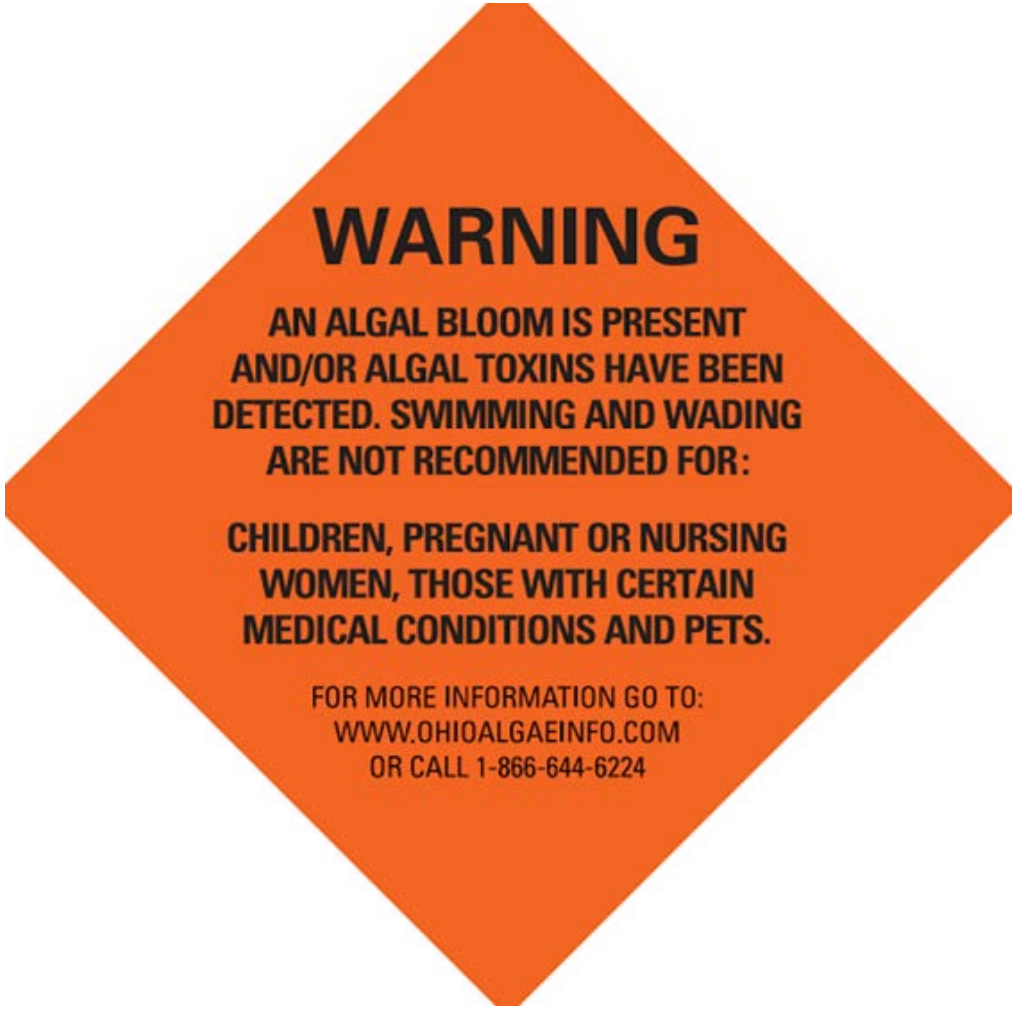
- Rising lake **temperatures**
- Increased **eutrophication**
  - Nitrogen & phosphorus
- More frequent **harmful algal bloom (HAB) events**
  - Overgrowths of algae in water
- **Health threats** to humans, fish, and wildlife from contact with **cyanobacterial toxins**
- **Economic** losses

Community Concerns

- **Impact**
  - **Carroll Township: emergency water shutdown**

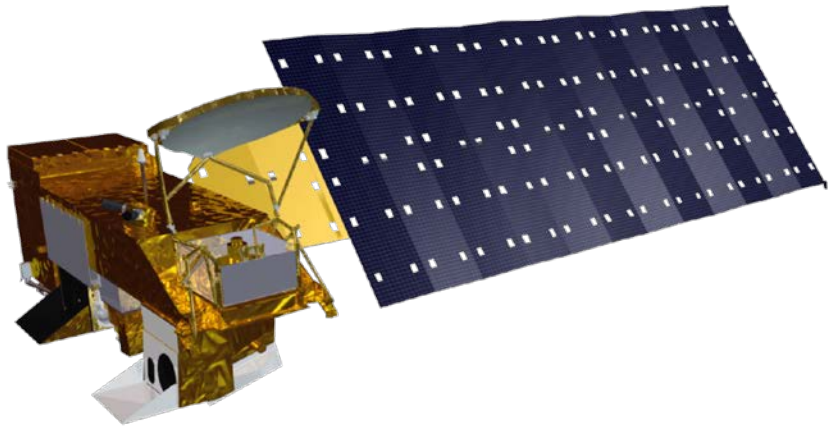
    September, 2013
  - **Toledo: do-not-drink advisory**

    August, 2014
    - **Half a million residents in Maumee Bay Area** without access to potable tap water

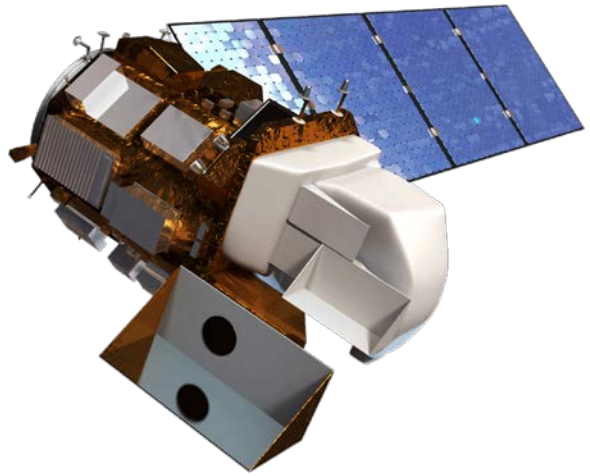


Earth Observations

Glenn HSI II



Aqua MODIS



Landsat 8 OLI

Temporal Range

	MODIS	Landsat 8	HSI
Spectral Resolution	36	11	170
Spatial Resolution	1 km	30 m	1 m
Temporal Resolution	Daily	16 days	flexible
Historical Archive	2002 – present	1972 – present	2013 – present

Data	3-Aug 2015	21-Sep 2015	7-Oct 2015	18-May 2016	19-Jun 2016	7-Sep 2016
Landsat 8	X	X	X	X	X	X
Aqua MODIS	X	X	X	X	X	X
HSI		X				
***In Situ* sampling**	X	X			X	

Objectives

- **Investigate** effectiveness of hyperspectral verses multispectral sensors
- **Implement** algorithms
- **Conduct** comparative analysis
- **Provide** statistical analysis and enhanced algorithm

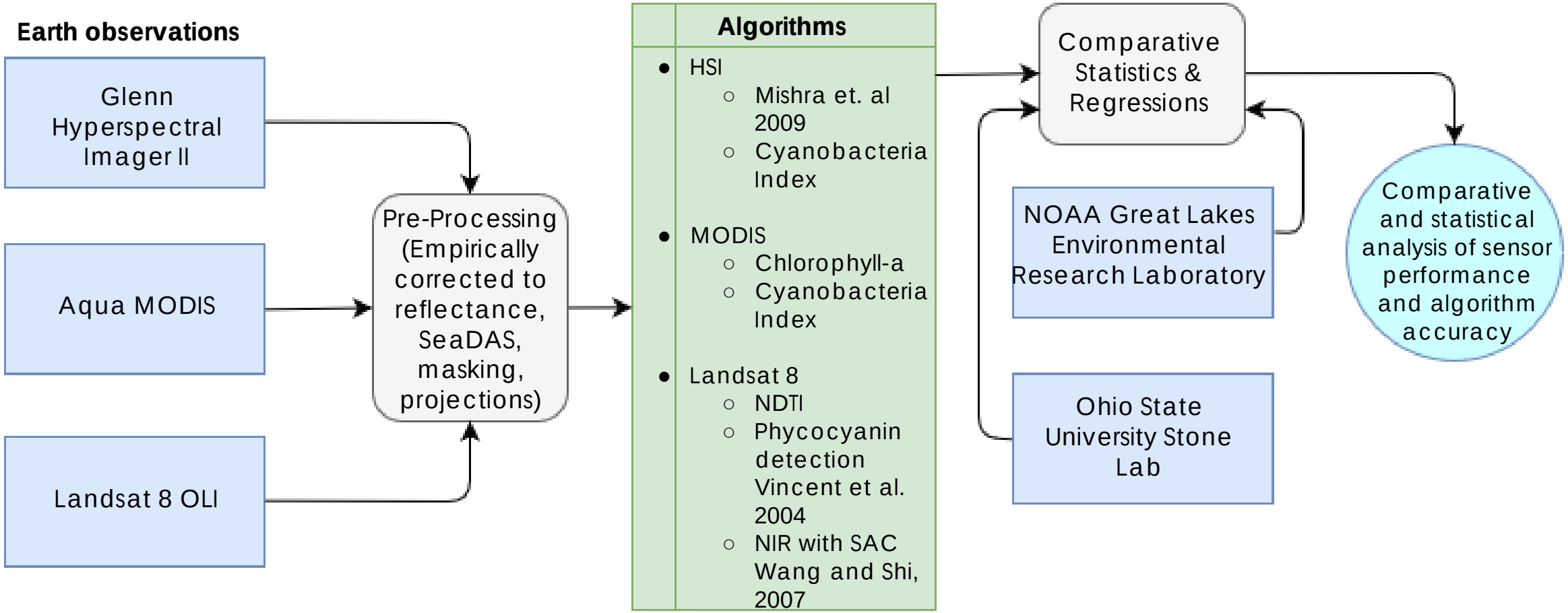
Image Credit: the SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE

Image Credit: Bob McKay

Image Credit: Jesse Allen and Robert Simmon

Image Credit: Max Pixel

Methodology



In Situ Data

Ohio State University Stone Laboratory

Acquired *in situ* datasets (2013-2016)

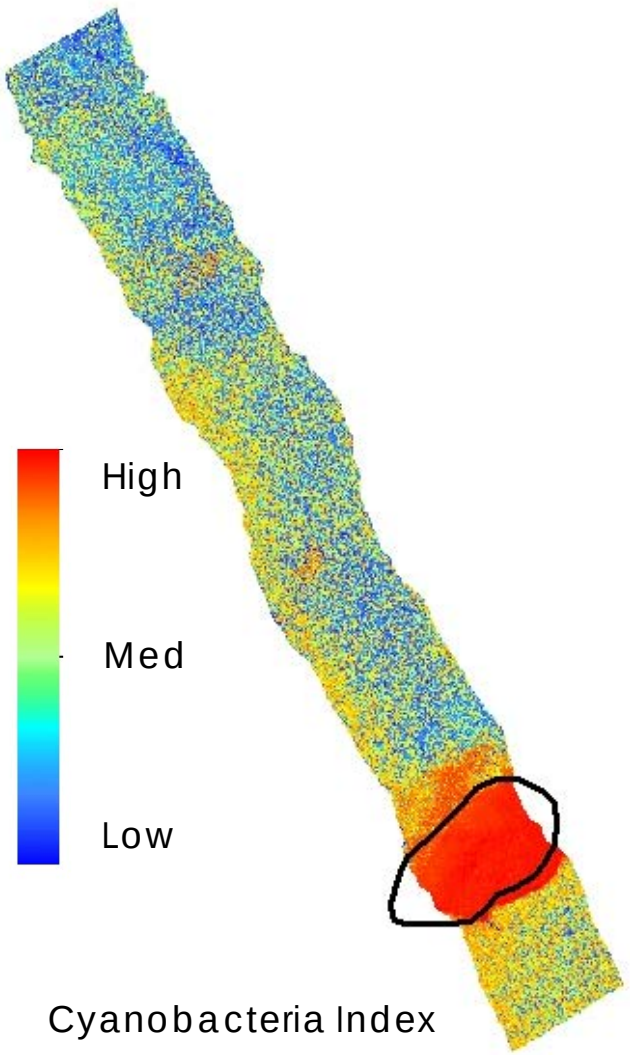
- Extracted Chlorophyll-a
- Total Microcystin

NOAA GLERL

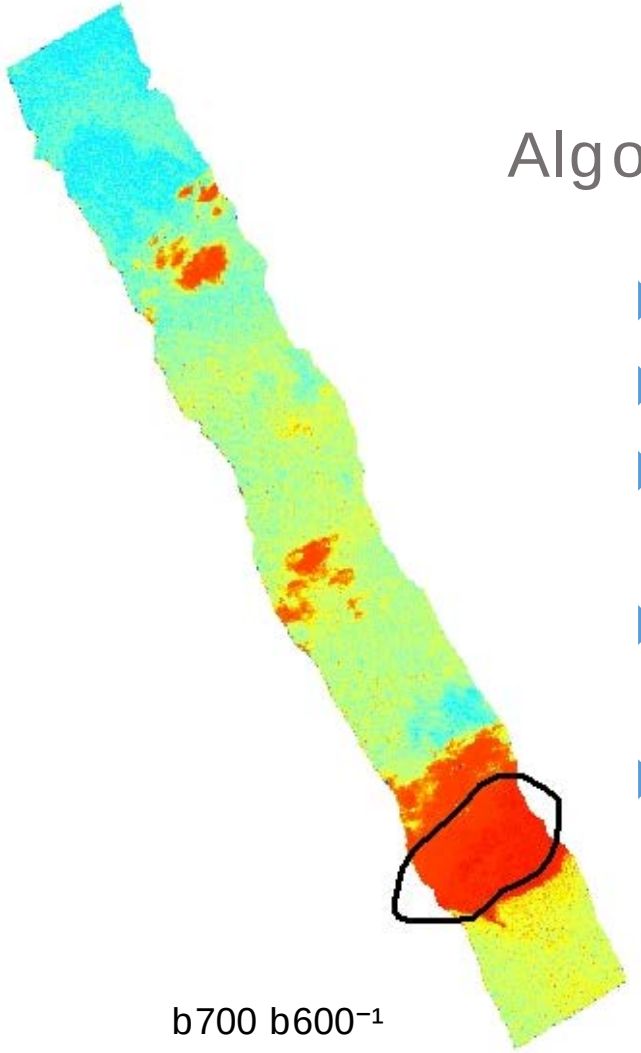
Acquired weekly *in situ* datasets (2008-2016)

- Particulate and dissolved microcystin
- Extracted phycocyanin
- Extracted chlorophyll-a
- Turbidity

Results: Glenn Hyperspectral Imager II



Cyanobacteria Index



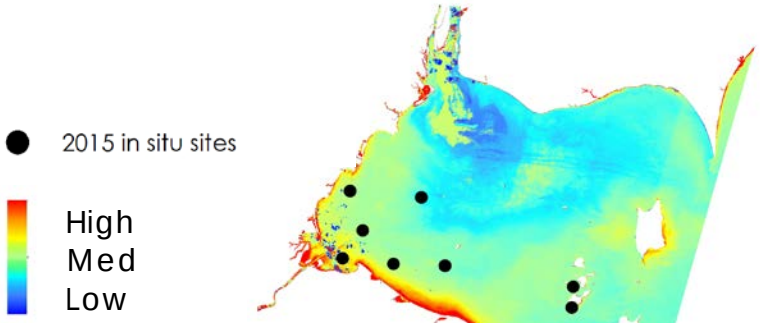
b700 b600^{-1}

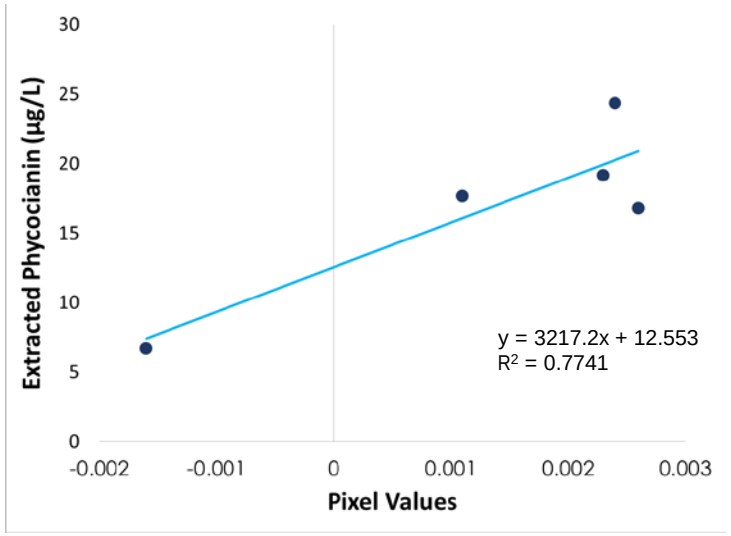
Algorithms:

- Cl and b700/b600
- Phycocyanin detection
- Cyanobacteria detection
- Indicative of MODIS and Landsat
- Variance in noise

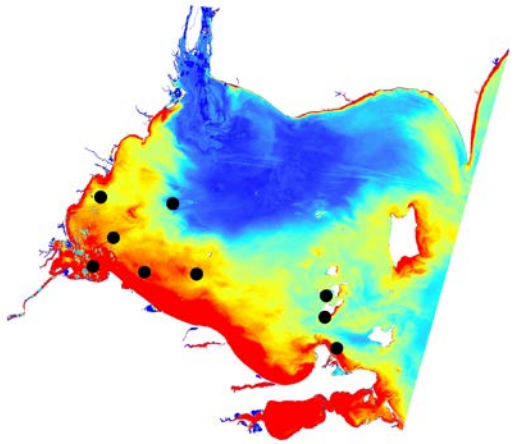
Results: Landsat 8 - OLI

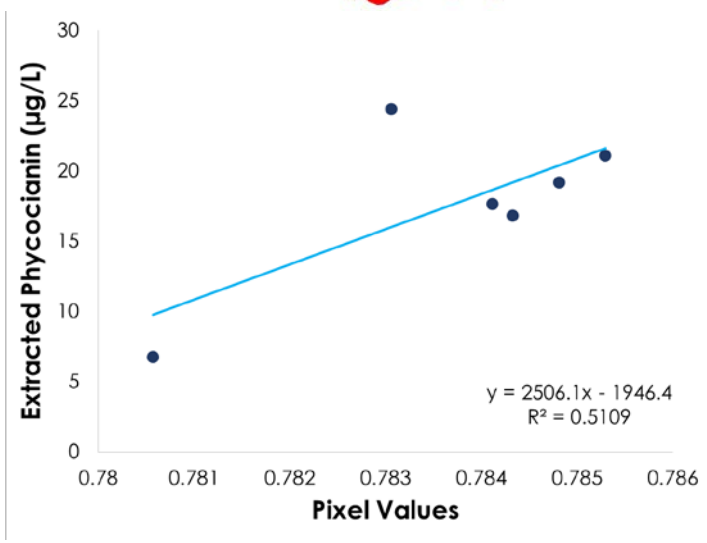
Near Infrared with Simple Atmospheric Correction



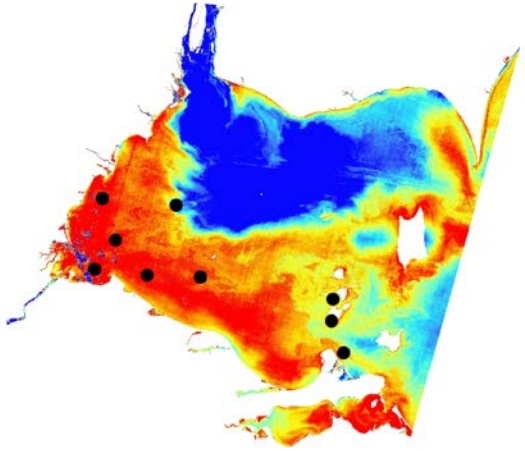


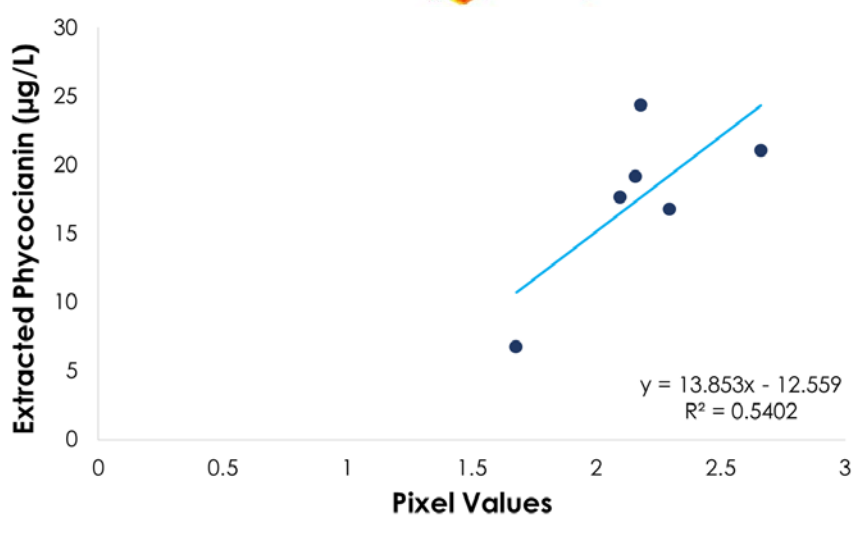
Phycocyanin Detection





Green to Blue Band Ratio



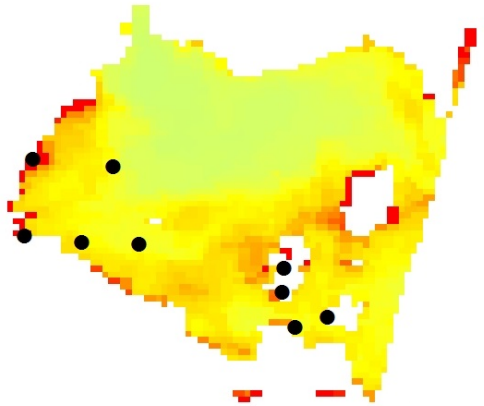


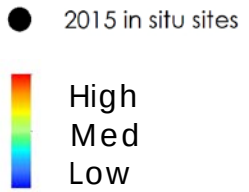
Results: Aqua MODIS

Algorithms:

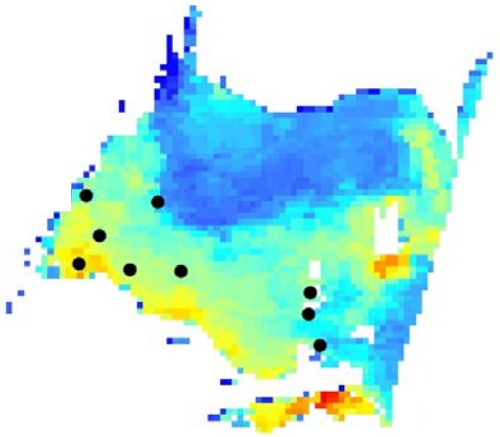
- Chlorophyll-a algorithm not strongly correlated with *in situ* extracted chlorophyll-a measurements
- Cyanobacteria Index (CI) is strongly correlated to measured total microcystin

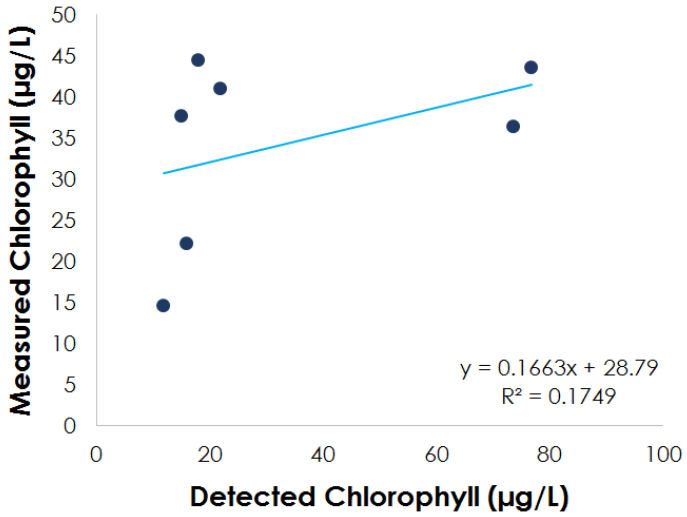
Chlorophyll-a

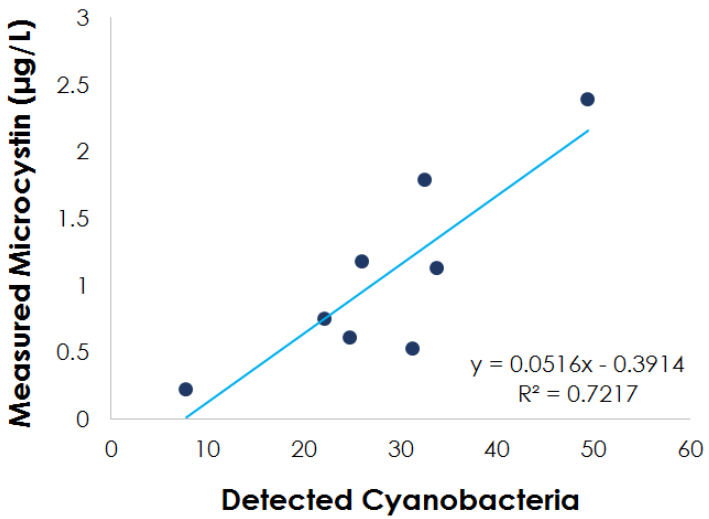




Cyanobacteria Index







Errors & Uncertainties

- *In situ* measurements & revisit time
  - Rapid changes in HAB movement
- Incongruent water sample collection between organizations
- Refining algorithms
- Waterbody specific algorithms

Image Credit: NOAA GLERL

Conclusions

- **Hyperspectral Imagery**
  - Excellent spatial and temporal resolution
  - Processing feasibility
- **Aqua MODIS**
  - Able to more accurately detect microcystin than chlorophyll-a
- **Landsat 8 OLI**
  - Results indicate that it is capable of detecting phycocyanin
- **Temporal and spatial differences**
- **Spectral differences**
  - Incompatible algorithms

What We've Learned

- Remote sensing **can be used** to detect HAB events
- Can help **monitor** rapid changes
- Hyperspectral offers significant **benefits** for detection as well as **limitations**
- **Strong need** for more in-situ datasets

Credit: NOAA GLERL

Future Work

- **Consistent and constant** monitoring
- *In situ* sampling for hyperspectral imagery– **validation**
- Applying algorithms to imagery **before & after bloom period**
- Further improvement of **Dissolved Microcystin equation** by **validating accuracy** with historical data

Credit: NOAA GLERL

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DEVELOP Management

Brittany Zajic, NASA Ames Research Center DEVELOP Center Lead

Jenna Williams, NASA Ames DEVELOP Assistant Center Lead

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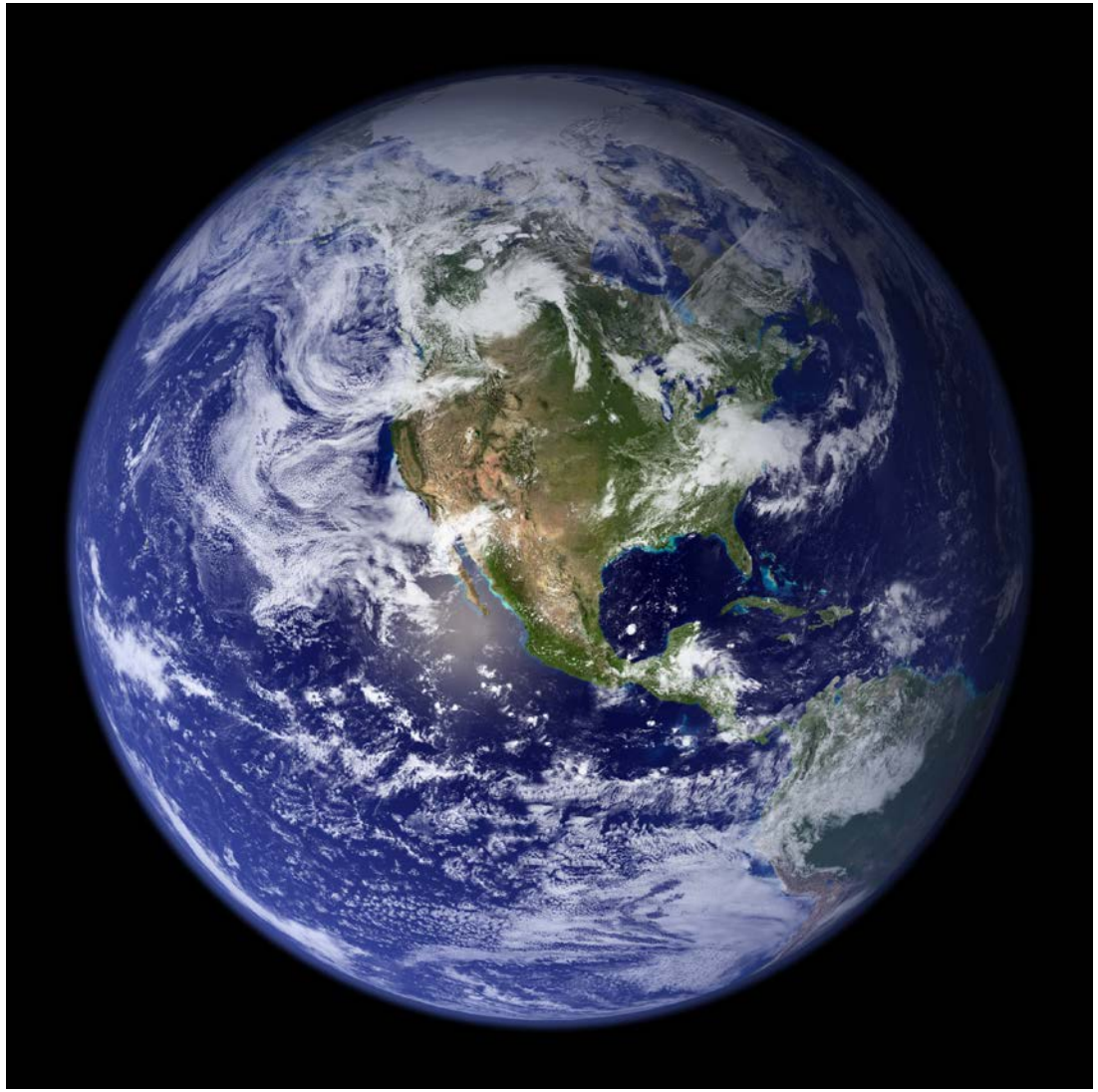
Parnter with DEVELOP



If you want to Partner, Collaborate, or Advise

Jenna Williams
jenna.l.williams@nasa.gov
650.604.3237

We do ~80 projects a year!
We can always use more ideas and partners