NASA DEVELOP National Program
Focusing on Partnerships with project example

NASA Ames Research Center
Jenna Williams
Center Lead
Where DEVELOP Fits @ NASA

NASA Administrator

Associate Administrator

Mission Directorates

Science

Human Exploration and Operations

Space Technology

Mission Support

Aeronautics Research

Joint Agency Satellite Div.

Heliophysics Division

Earth Science Division

Planetary Science Div.

Astrophysics Division

Applied Sciences Program

Capacity Building Program

DEVELOP National Program

We Are Here!
NASA Applied Sciences

National Application Areas + Capacity Building Elements

- Agriculture
- Eco Forecasting
- Oceans
- Climate
- Energy
- Water Resources
- Disasters
- Health & AQ
- Weather

+ ARSET

+ DEVELOP

+ SERVIR
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 Partnerships

**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.
**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

19 States & 7 Countries Impacted

30 Projects

77% Domestic
23% International

Application Areas Addressed

- Ag (0)
- Climate
- Disasters
- Eco
- Energy
- Health & AQ
- Oceans
- Water
- Cross-Cutting

Partner Total by Type

- Consortium: 0
- Academia: 8
- International: 13
- Non-Profit: 10
- For-Profit: 0
- Federal: 21
- Local Govt: 5
- State Govt: 8

65 Partners

*Impacts and partners are not final*
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

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
Community Concerns

- 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

Image Credit: Tom Archer
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

**WARNING**

AN ALGAL BLOOM IS PRESENT AND/OR ALGAL TOXINS HAVE BEEN DETECTED. SWIMMING AND WADING ARE NOT RECOMMENDED FOR:

CHILDREN, PREGNANT OR NURSING WOMEN, THOSE WITH CERTAIN MEDICAL CONDITIONS AND PETS.

FOR MORE INFORMATION GO TO: WWW.OHIOALGAEINFO.COM OR CALL 1-866-644-6224
## Temporal Range

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Objectives

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

Earth observations

- Glenn Hyperspectral Imager II
- Aqua MODIS
- Landsat 8 OLI

Pre-Processing (Empirically corrected to reflectance, SeaDAS, masking, projections)

Algorithms

- HSI
  - Mishra et al. 2009
  - Cyanobacteria Index
- MODIS
  - Chlorophyll-a
  - Cyanobacteria Index
- Landsat 8
  - NDTI
  - Phycocyanin detection: Vincent et al. 2004
  - NIR with SAC: Wang and Shi, 2007

Comparative Statistics & Regressions

- NOAA Great Lakes Environmental Research Laboratory
- Ohio State University Stone Lab

Comparative and statistical analysis of sensor performance and algorithm accuracy
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

Algorithms:

- CI 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

$y = 3217.2x + 12.553$

$R^2 = 0.7741$

$y = 2306.1x - 1946.4$

$R^2 = 0.3109$

$y = 13.853x - 12.559$

$R^2 = 0.5402$
Algorithms:
- Chlorophyll-a algorithm not strongly correlated with in situ extracted chlorophyll-a measurements.
- Cyanobacteria Index (CI) is strongly correlated to measured total microcystin.

Results: Aqua MODIS
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

Credit: NOAA GLERL
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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Dr. Sherry Palacios, Bay Area Environmental Research Institute

**DEVELOP Management**
Brittany Zajic, NASA Ames Research Center DEVELOP Center Lead
Jenna Williams, NASA Ames DEVELOP Assistant Center Lead
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