Cyanobacteria Assessment Network (CyAN)
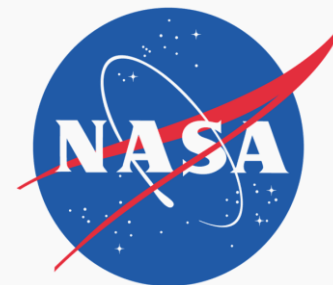
Ocean Color Research Team Meeting: May, 2014

Blake Schaeffer – EPA

Keith Loftin - USGS

Richard Stumpf – NOAA

Jeremy Werdell – NASA

Introduction

- HABs = $2.2 billion annual freshwater degradation (Dodds et al. 2009).

The Columbus Dispatch
Toxic algae in Hoover Reservoir cost city

The New York Times
Choking on growth, part III

The Washington Post
Polluted farm runoff linked to toxic green algae

- Cyanobacteria and their toxins are addressed differently by each state (Graham et al. 2009)

- Timely and useful delivery of satellite data is needed (Schaeffer et al. 2013).

Introduction

- Mainstreaming satellite ocean color capabilities into U.S. water quality management decisions.

    – health and welfare of human society

    – consequences of land use change for human societies

    – ecosystem change

- NASA expertise assures stakeholders

   – Optimize federal partnerships to achieve common goal

Partners and Stakeholders

- Previous support
  - EPA - NASA Applied Science Program announcement NNH08ZDA001N
  - NOAA - NASA Applied Science Program announcement NNH08ZDA001N
  - EPA - Office of Research and Development, Pathfinder Innovation Project II

- EPA Office of Water
  - Office of Wetlands, Oceans, and Watersheds
  - Office of Wastewater Management
  - Office of Science and Technology

- States
  - Ohio EPA
  - St. Johns River WMD
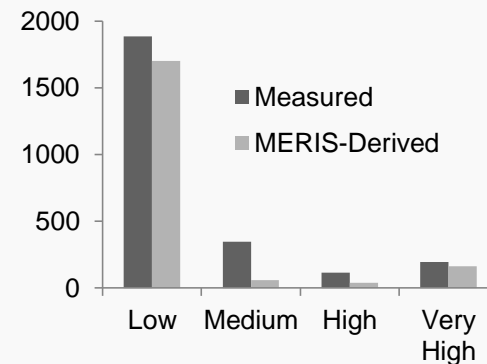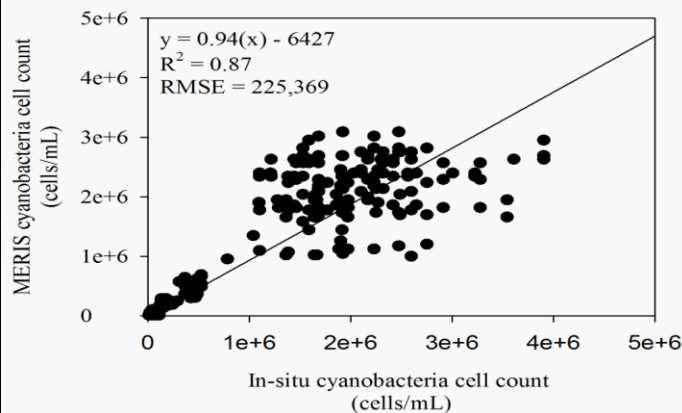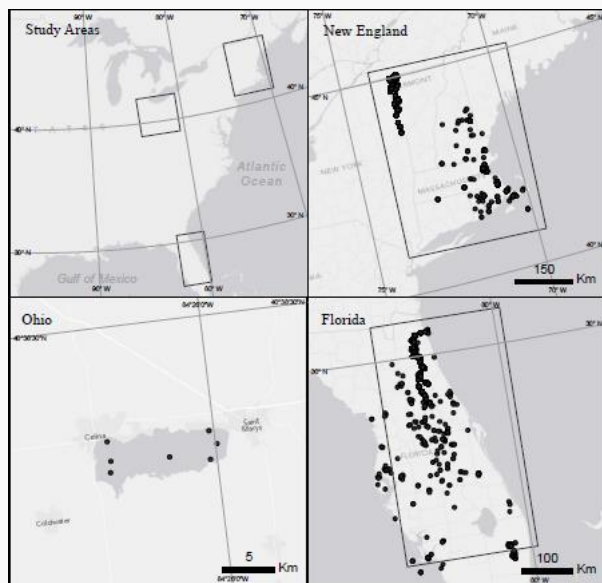 - S. Florida WMD
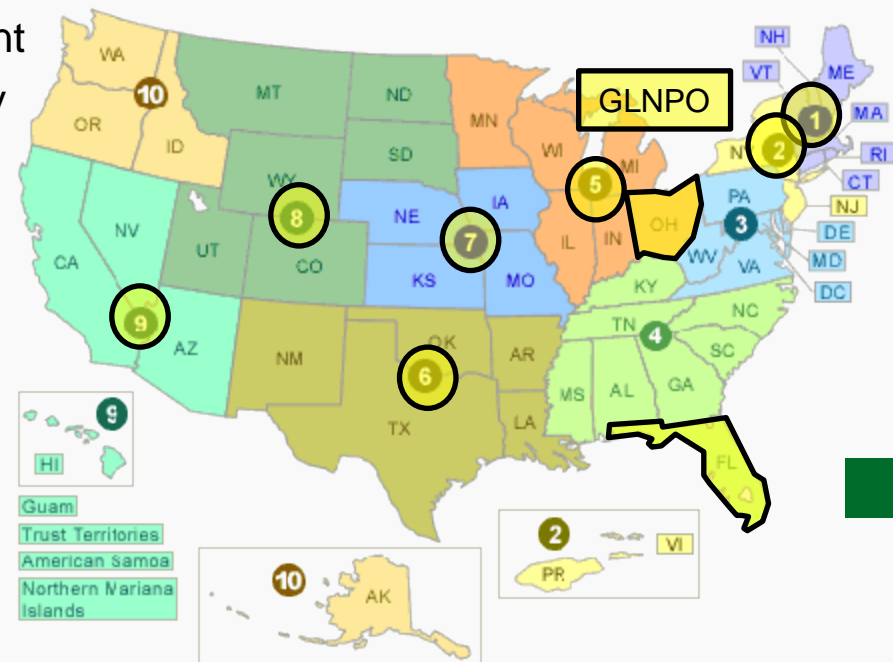
Technical Approach
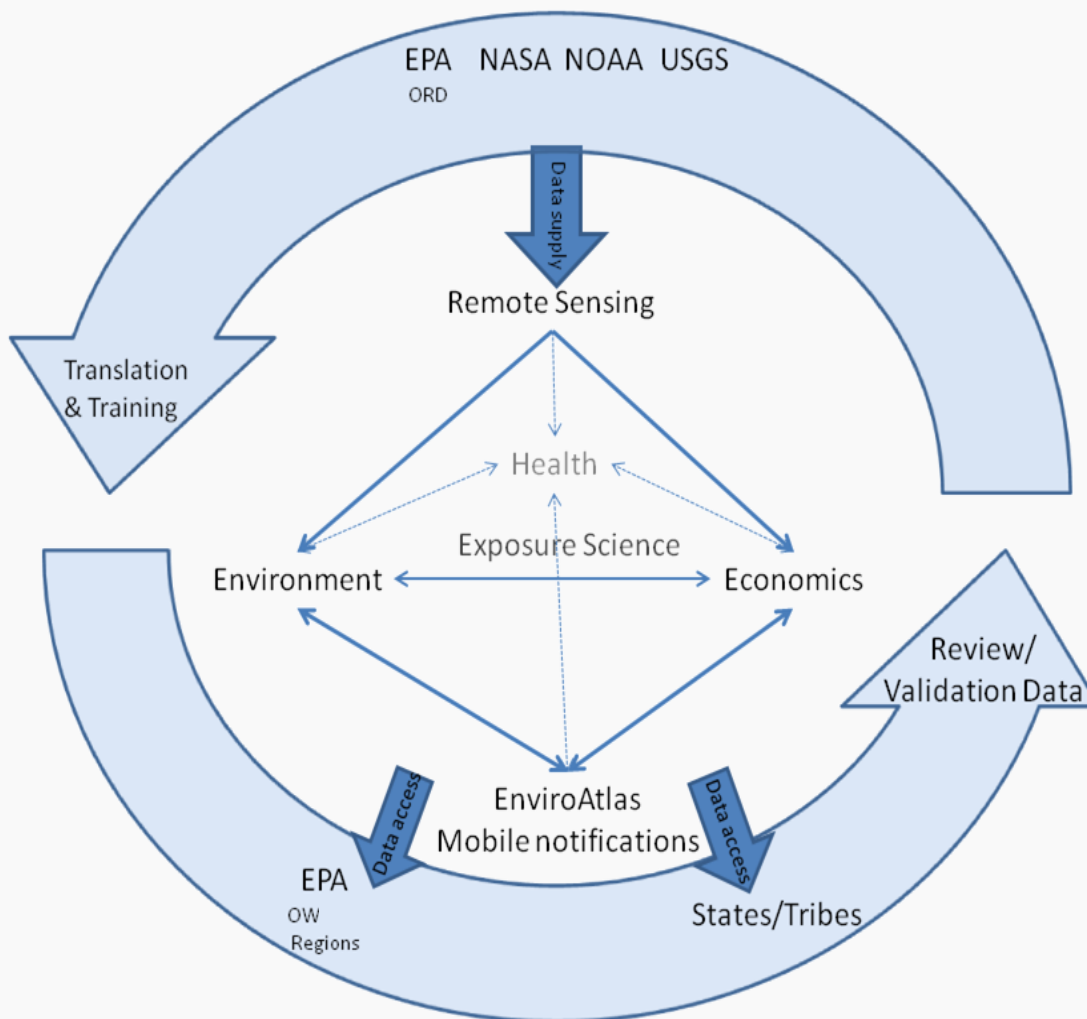
Technical Approach

- ***Remote Sensing***

  - *Uniform and systematic approach for identifying cyanobacteria blooms.*
  - *Strategy for evaluation and refinement of algorithms across platforms.*

- ***Environment***

  - *Identify landscape linkages causes of chlorophyll-a and cyanobacteria.*

- ***Health***

  - *Exposure and human health effects in drinking and recreational waters.*

- ***Economics***

  - *Behavioral responses and economic value of the early warning system.*

- ***Notifications***

  - *Bring the technology to EPA, states and tribal partners.*

Technical Approach

- **Remote Sensing**
  - *Uniform and systematic approach for identifying cyanobacteria blooms.*
    - Second derivative spectral shape algorithms (SS; Wynne et al. 2008)

$$SS(\lambda) = \rho_s(\lambda) - \rho_s(\lambda_-) + \{\rho_s(\lambda_-) - \rho_s(\lambda_+)\} * \frac{(\lambda - \lambda_-)}{(\lambda_+ - \lambda_-)}$$

Lunetta et al. (In Review) RSE

Technical Approach

- **Remote Sensing**
  - *Strategy for evaluation and refinement of algorithms across platforms.*
  - Model output from *in situ* radiometry vs. *in situ* metrics for cyanobacteria.
  - Satellite radiometry vs. *in situ* radiometry and model output from satellite radiometry vs. *in situ* metrics for cyanobacteria (Bailey and Werdell 2006; Werdell et al. 2009)
  - Model outputs from multiple satellite instruments such as MERIS and Landsat (Franz et al. 2005).

Technical Approach

- **Environment**
  - *Identify landscape linkages causes of chlorophyll-a and cyanobacteria.*
  - Evaluate chlorophyll-a concentrations and cyanobacteria cell count trends.
  - Identify changes related to land-cover modifications (2001–2016).
  - 13+ years of data observations across Great Lakes Basin, including all inland lakes (≥100 ha), focus on sources of potable water.
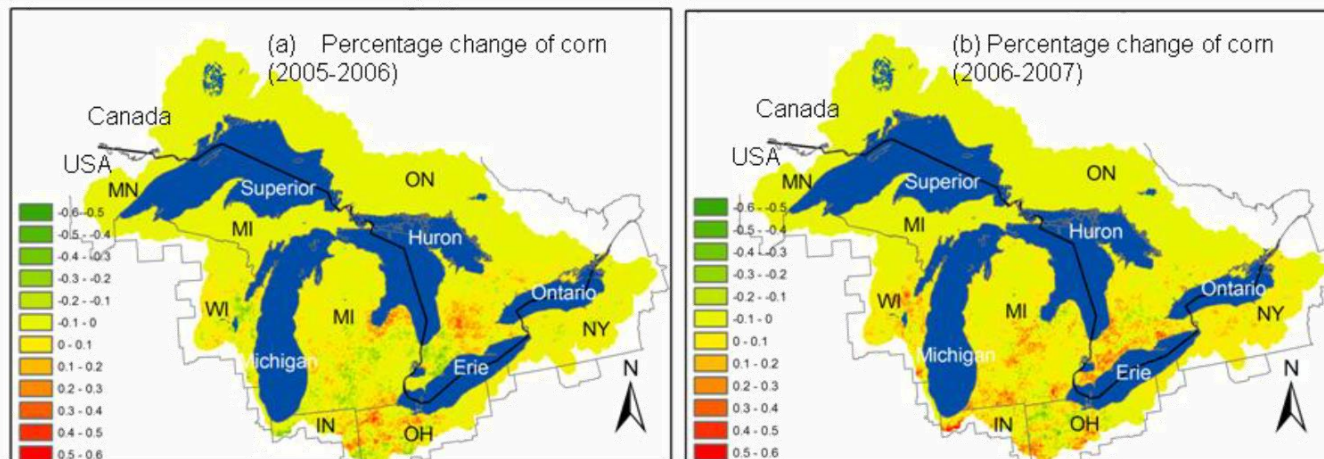
Technical Approach

- **Health**
  - *Exposure and human health effects in drinking and recreational waters.*
  - Remote sensing provides opportunity to estimate human exposure to cyanotoxins over specific geographic areas
  - Health care partner surveillance for potential cyanobacteria exposure and health effects will collect biological samples.
  - Veterinary practices and wildlife health agencies collect biological samples and records from exposed animals.
  - Retrospective evaluation of existing health records among communities with a past history of cyanobacteria blooms detected via satellite.
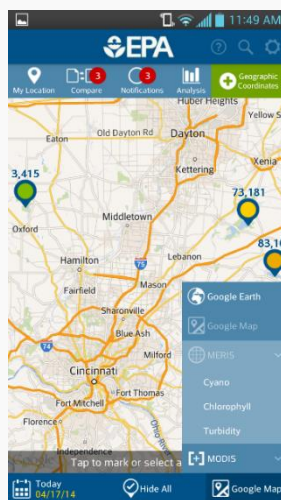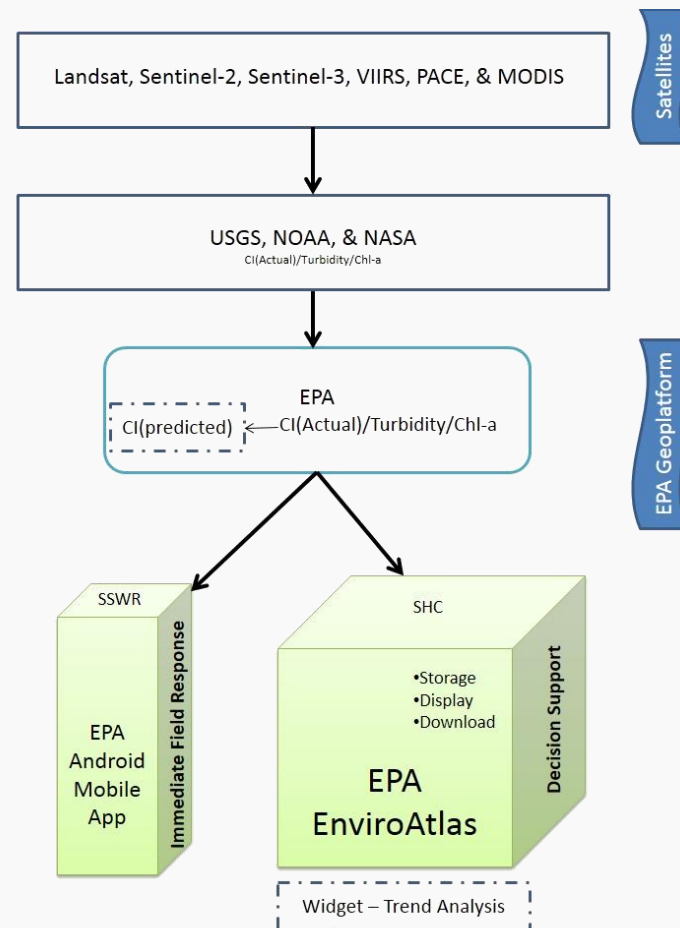
Technical Approach

- **Economics**
  - *Behavioral responses and economic value of the early warning system.*
  - Database of public resources spent on monitoring or responding to HABs. Assessment of the potential value of more comprehensive monitoring by satellite.
  - Economic impact of avoiding toxic and nuisance bloom events in freshwater lakes.

Technical Approach

- **Notifications**
  - *Bring the technology to EPA, states and tribal partners.*
  - Ocean color satellite data not processed and delivered to stakeholders in a manner that demonstrates its practical value to daily life (Schaeffer et al. 2013).
  - Data pushed from NOAA, NASA and USGS to EPA Mobile Android Platform on weekly time-steps.

Landsat, Sentinel-2, Sentinel-3, VIIRS, PACE, & MODIS

Satellites

USGS, NOAA, & NASA
CI(Actual)/Turbidity/Chl-a

EPA
CI(predicted) ← CI(Actual)/Turbidity/Chl-a

EPA Geoplatform

SSWR

EPA Android Mobile App

Immediate Field Response

SHC

•Storage
•Display
•Download

EPA EnviroAtlas

Decision Support

Widget – Trend Analysis

12
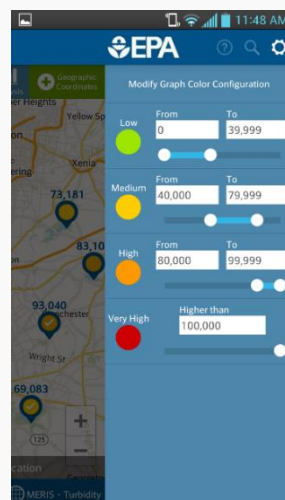
Satellite Health Bulletin, Florida Dept. of Health and NOAA, continuing with MODIS

Impacts

- Inform water quality standards, advisories and guidelines under the Clean Water Act and Safe Drinking Water Act.

- Complement National Aquatic Resource Surveys

- Applied novel sophisticated tool to assist in management of events that may involve significant risk to the public.

- Increased use of remotely sensed water quality data to improve decision support in EPA and state agencies

- Decrease costs of monitoring, improve resource allocations, and reduce exposures