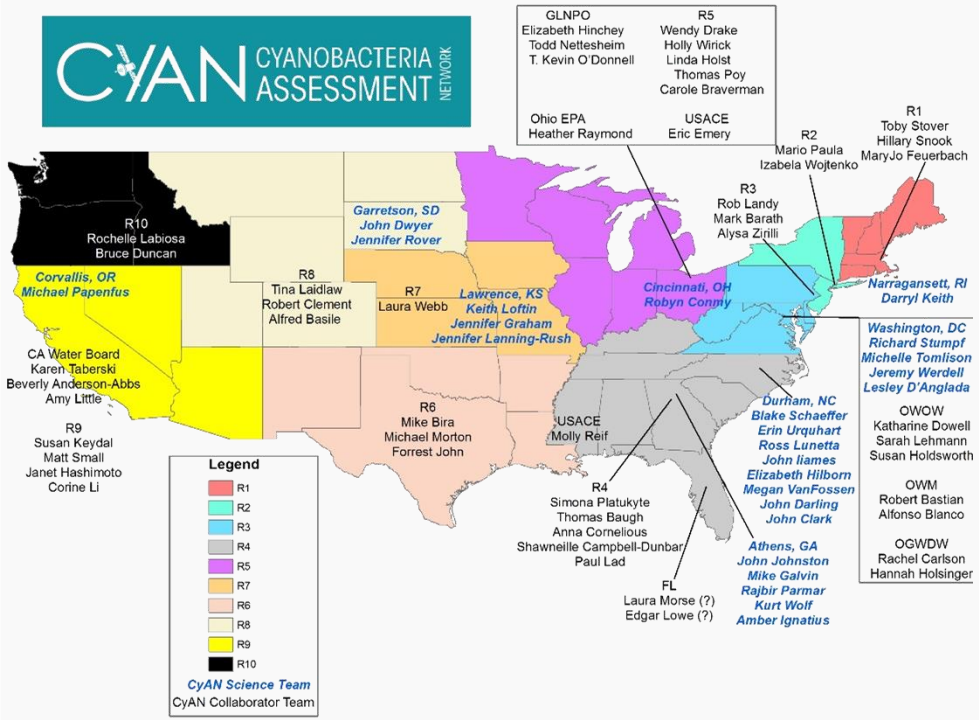
USEPA Region 10

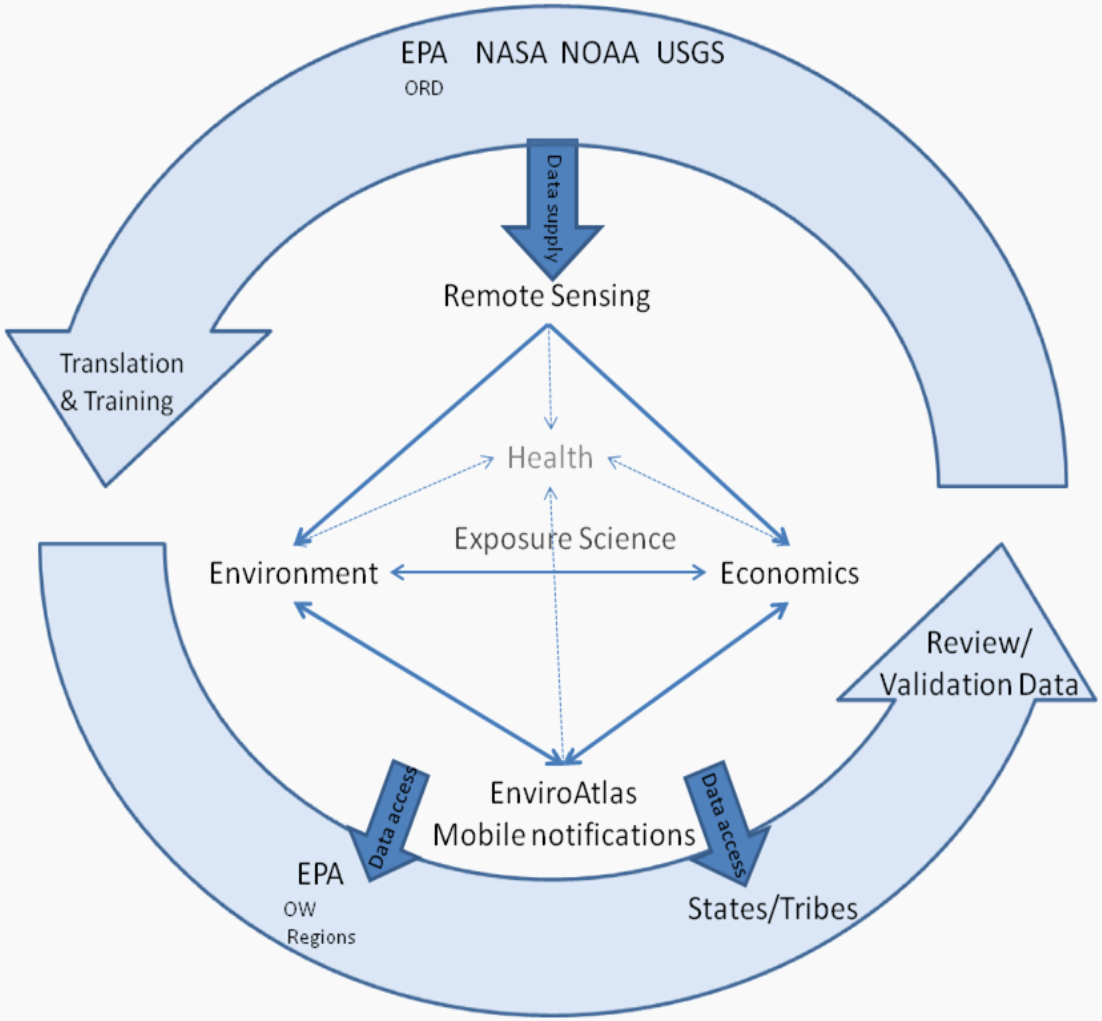
March 2016

Partners and Stakeholders

- EPA Office of Water
  - Office of Wetlands, Oceans, and Watersheds
  - Office of Wastewater Management
  - Office of Science and Technology
  - Office of Ground Water and Drinking Water
- EPA Regions
- U.S. Army Corps of Engineers
- States
  - Ohio EPA
  - St. Johns River WMD
  - S. Florida WMD
  - California Water Board



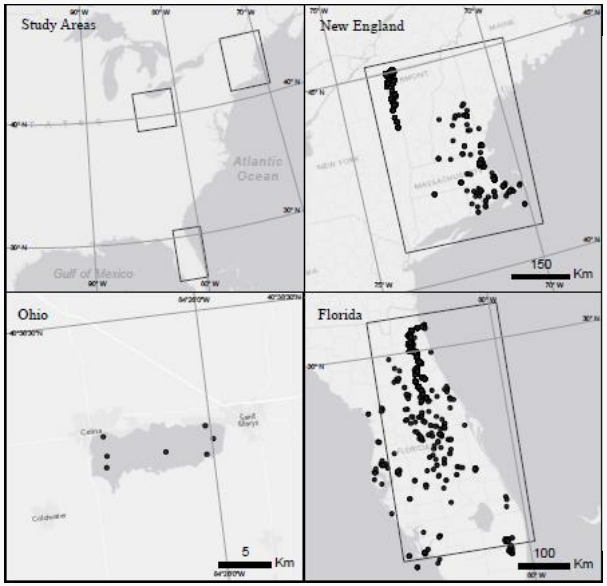
Technical Approach

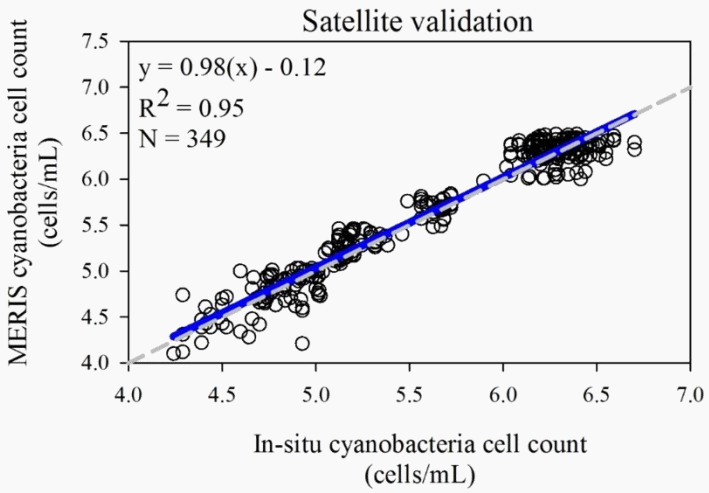


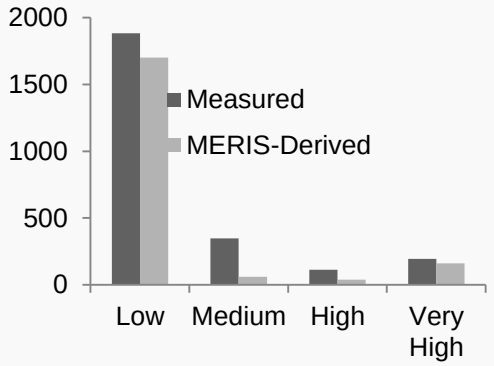
Technical Approach

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

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







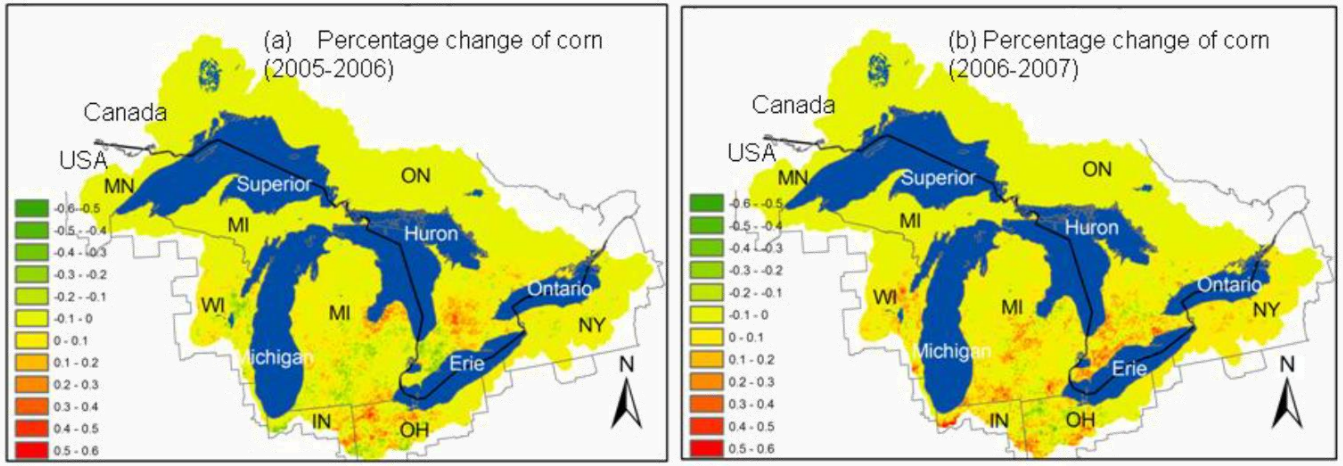
Lunetta et al. (2015) Remote Sensing of Environment

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

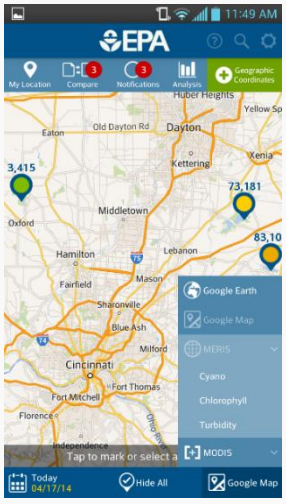
- **Health**
  - *Exposure and human health effects in drinking and recreational waters.*
  - Remote sensing provides opportunity to estimate human exposure to cyanotoxins over specific geographic areas
  - Retrospective evaluation of existing health records among communities with a past history of cyanobacteria blooms detected via satellite.

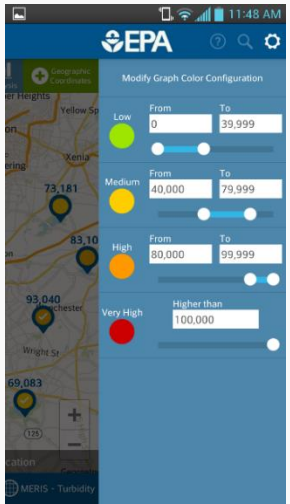
Technical Approach

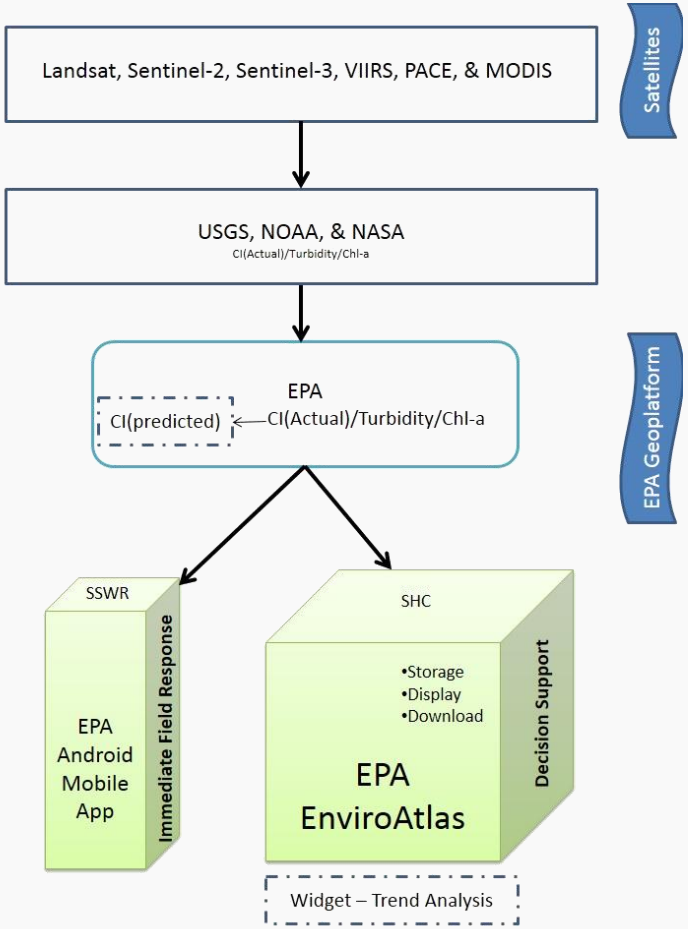
- **Economics**
  - *Behavioral responses and economic value of the early warning system.*
  - Database of public resources spent on monitoring or responding to HABs. Assessment of the potential value of more comprehensive monitoring by satellite.
  - Economic impact of avoiding toxic and nuisance bloom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

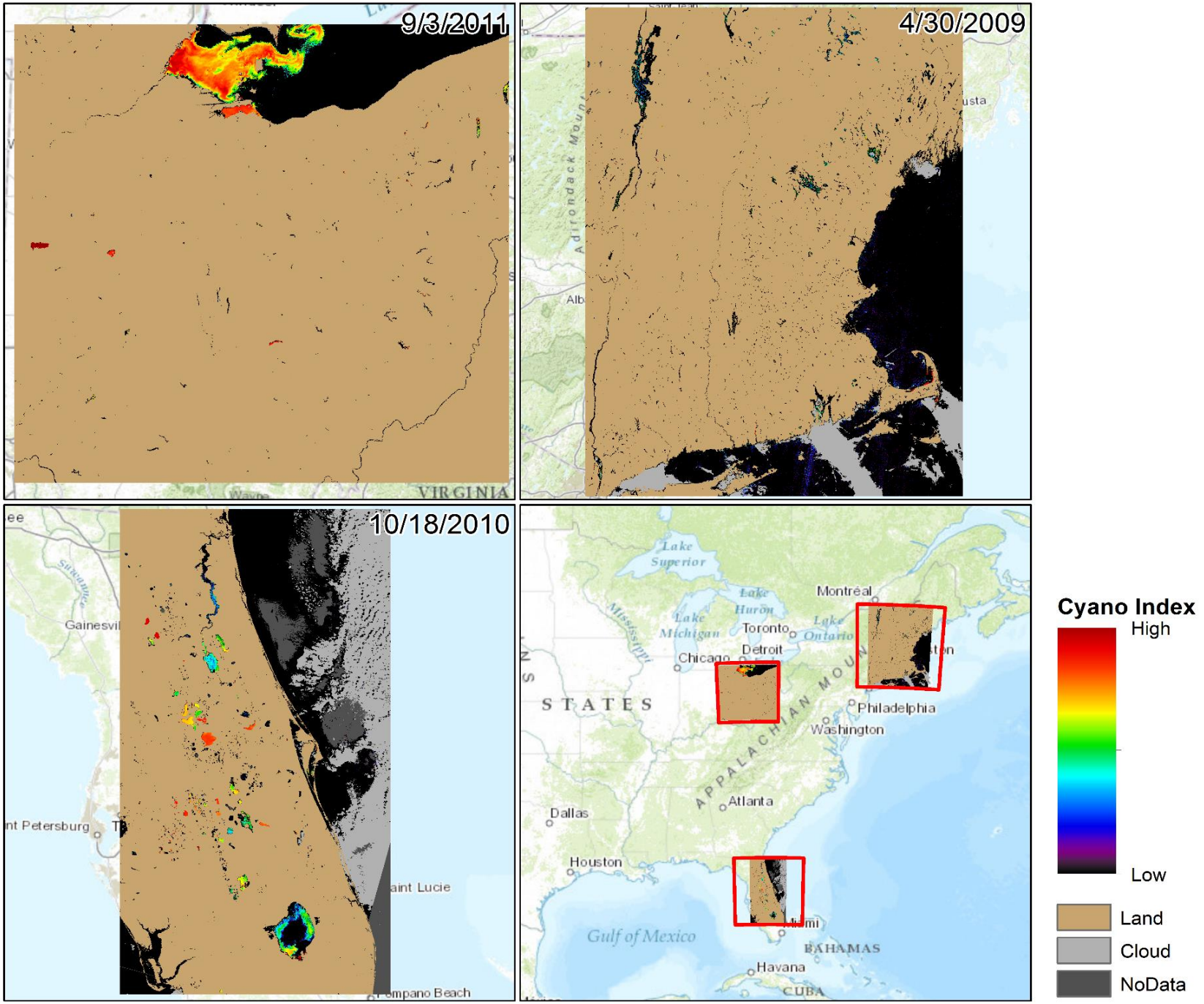


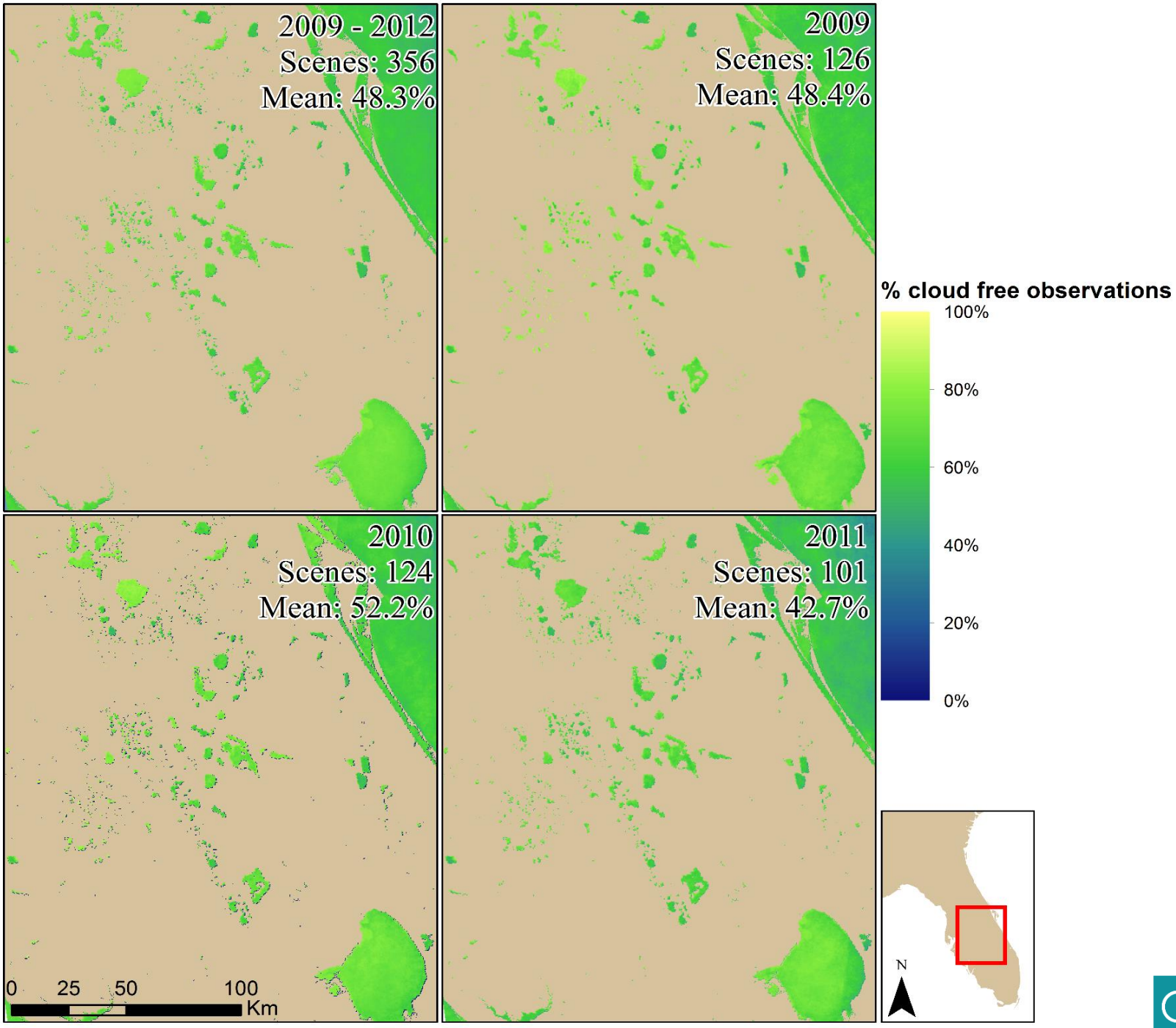


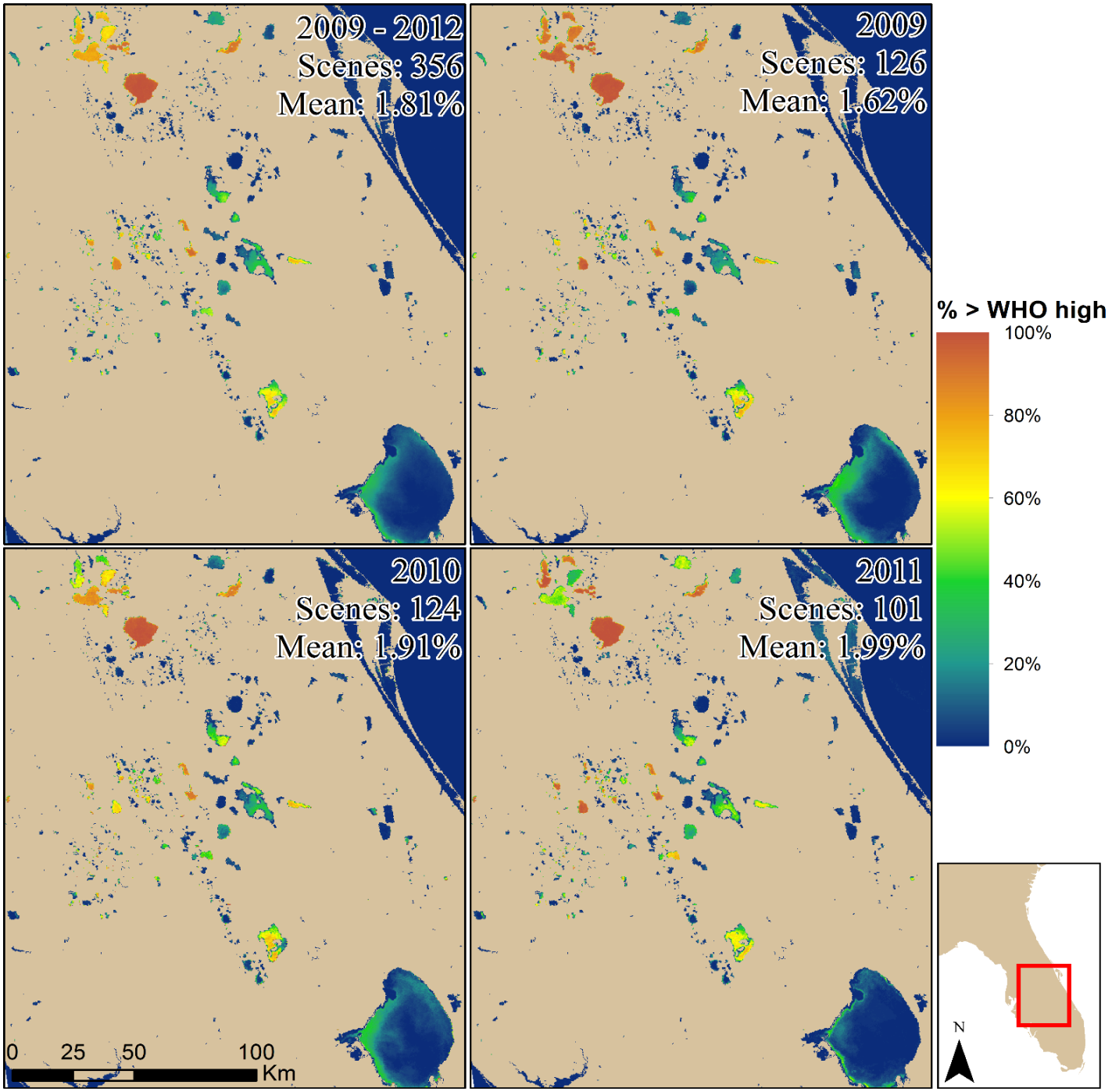


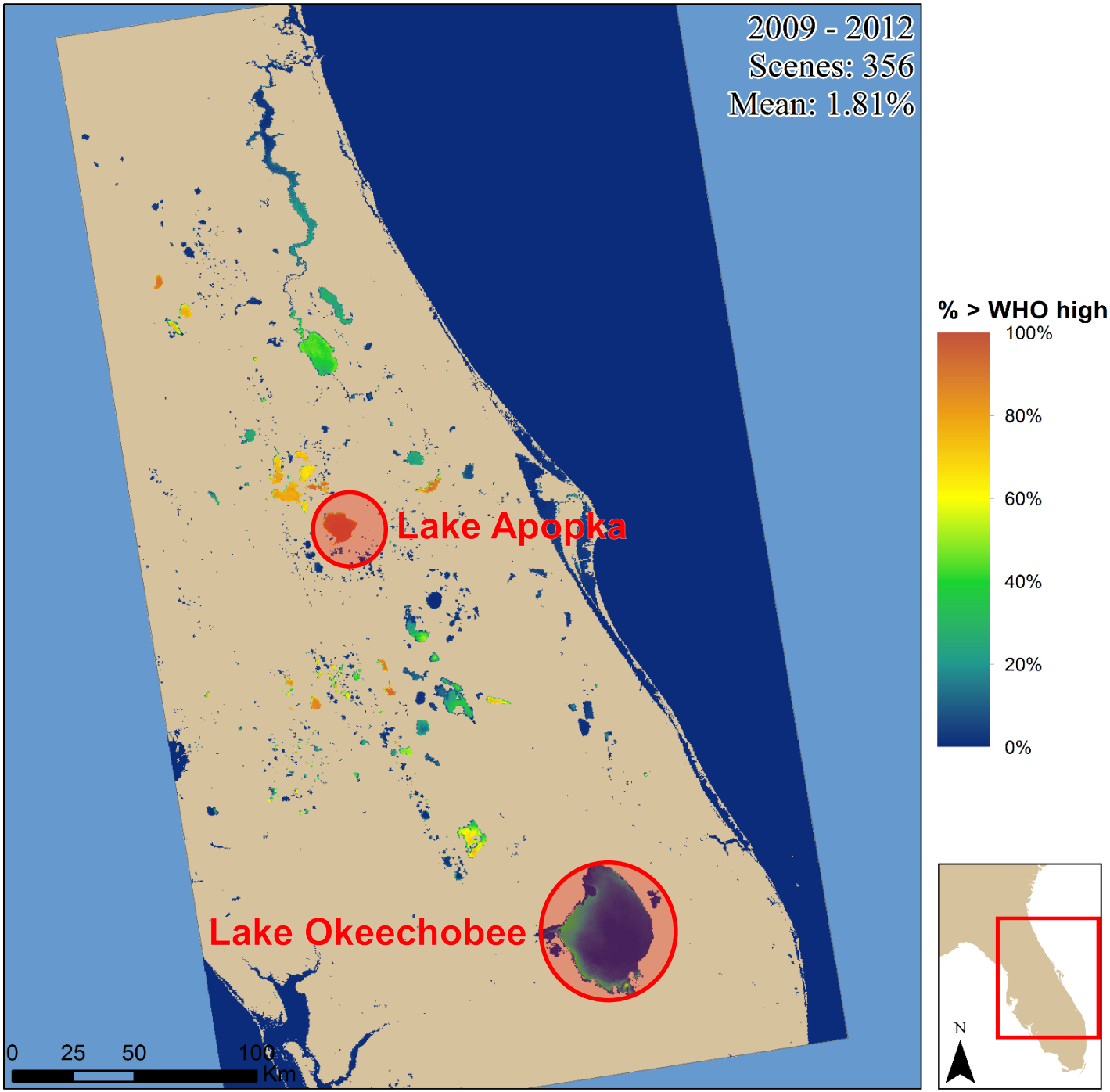
Technical Approach

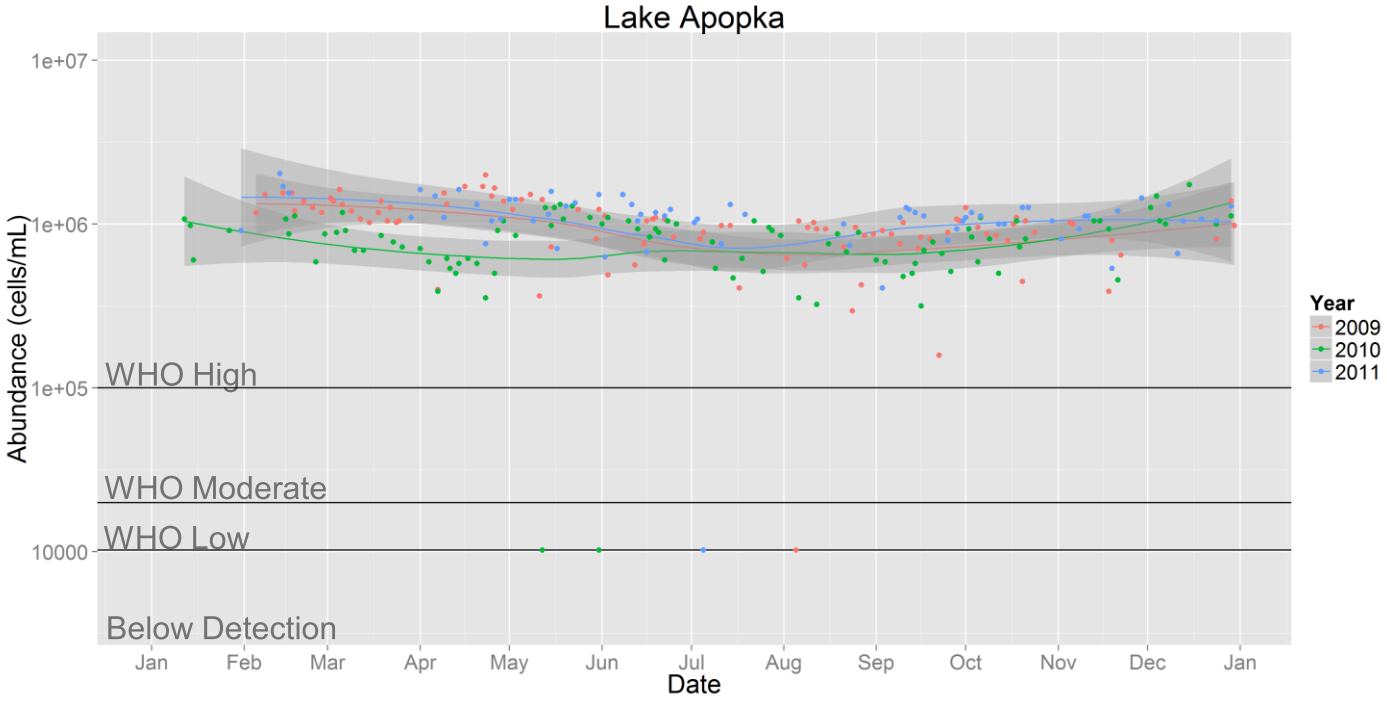
- FY16
  - Florida, Ohio, California, New England
- FY17
  - Continental US
  - Lakes, reservoirs, and estuaries
- Satellite derived products
  - Cyanobacteria concentration
  - Chlorophyll-a concentration
  - Turbidity
  - Temperature
- Satellite updates
  - Sentinel – 2A/3A

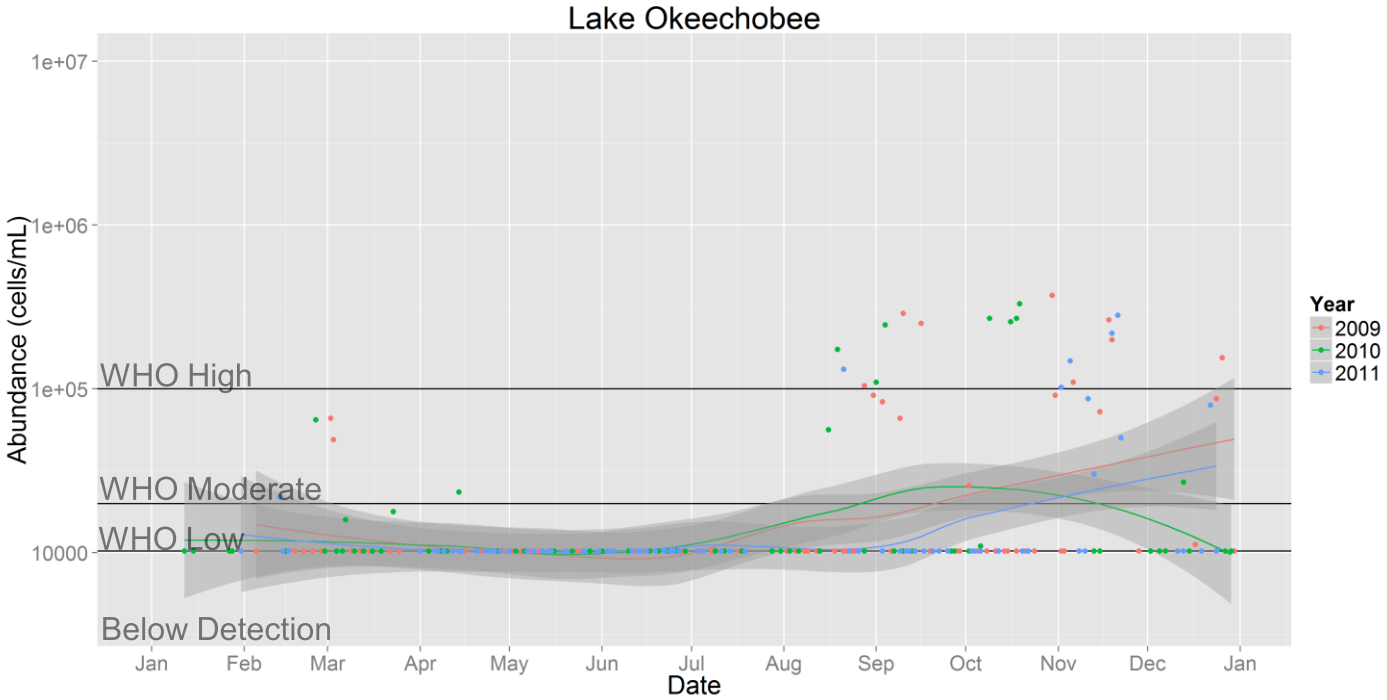

9/3/2011
4/30/2009
10/18/2010
VIRGINIA
Gainesvil
Pompano Beach
Lake Superior
Lake Huron
Lake Michigan
Lake Ontario
Montréal
Toronto
Detroit
Chicago
Philadelphia
Washington
Atlanta
Dallas
Houston
Gulf of Mexico
Havana
CUBA
BAHAMAS
STATES
Cyano Index
High
Low
Land
Cloud
NoData


2009 - 2012
Scenes: 356
Mean: 48.3%
2009
Scenes: 126
Mean: 48.4%
2010
Scenes: 124
Mean: 52.2%
2011
Scenes: 101
Mean: 42.7%
% cloud free observations
100%
80%
60%
40%
20%
0%
0 25 50 100
Km
N


2009 - 2012
Scenes: 356
Mean: 1.81%
2009
Scenes: 126
Mean: 1.62%
2010
Scenes: 124
Mean: 1.91%
2011
Scenes: 101
Mean: 1.99%
% > WHO high
100%
80%
60%
40%
20%
0%
0
25
50
100
Km
N


2009 - 2012
Scenes: 356
Mean: 1.81%
Lake Apopka
Lake Okeechobee
0 25 50 100
Km
% > WHO high
100%
80%
60%
40%
20%
0%
N


Lake Apopka
1e+07
1e+06
1e+05
10000
Abundance (cells/mL)
WHO High
WHO Moderate
WHO Low
Below Detection
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date
Year
2009
2010
2011


Lake Okeechobee
1e+07
1e+06
1e+05
10000
Abundance (cells/mL)
WHO High
WHO Moderate
WHO Low
Below Detection
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Date
Year
2009
2010
2011

Target Data Criteria

- Natural and manmade lakes/ponds, Coastal data (will be covered by EPA)
- Temporal/spatial datasets within same waterbody
- Low, medium, and high concentrations for each variable:
  - Turbidity
  - Phytoplankton
  - Cyanotoxins
  - Pigments
  - Nutrients

Data Sets

- **Phytoplankton (cyanobacteria)**
  - Abundance
  - Relative Abundance
  - Biovolume
- **Pigments**
  - Chlorophyll including pheophytin data
  - Phycocyanin
- **Cyanotoxins**

CYAN CYANOBACTERIA ASSESSMENT NETWORK

Sample Location

- **Date/Time** -
- **Latitude/Longitude** – Continental United States
- **Sampling Depth** – Prefer surface samples – integrated photic zone or shallower.
- **Sample Type** (Grab, Composite, Depth Integrated, Width Integrated, Depth-Width Integrated)

General Water Quality

- **pH** - QC for phytoplankton abundance and bloom status (e.g. elevated pH during daylight (9.5 – 11) = very active bloom.
- **Dissolved Oxygen (DO)** – QC for phytoplankton abundance and bloom status (e.g. supersaturated DO during daylight = very active bloom, anoxic/anaerobic bloom possible bloom undergoing senescence.
- **Conductivity**
- **Surface Water Temperature**
- **Organic Matter** -Support development of derived turbidity product and QC for phytoplankton data.
  - Total Organic Carbon (TOC)
  - Dissolved Organic Carbon (DOC)

General Water Quality

- **Nutrients** – Support development of derived eutrophication/chlorophyll product.
  - Total Nitrogen (TN)
  - Total Phosphorus (TP)
  - Speciated Nutrients
- **Particulates** – Support development of derived turbidity product.
  - Secchi Depth
  - Turbidity
  - Suspended Solids

Spectrometry and Other Surrogate Measures

- **Digital Field Pictures** – Does field observation support data (QC), capture other interferences not captured by other field data measures (e.g. aquatic plant cover, etc.)
- **Water Color** (not as crucial if above data available).

Data Sources

- USGS
- US EPA
- US ACE – no national database, but might be willing to load into WQX.
- US BOR (need to contact)
- US National Parks (have a contact)
- US Fish and Wildlife (need to contact)
- States (Rick – CA, FL, OH); Inland HAB Discussion group, ASDWA, etc.
- Tribes – inland HAB discussion group, states, USGS/US EPA tribal liasons

Other Details

- Supporting (hopefully citeable) sample collection and laboratory methods documents.
- Defined (formal) QA/QC plan.
- Field and Laboratory QA/QC data
  - Blanks
  - Replicates
  - Spiked replicates
  - Calibration
- Any caveats we should know

Work Package 1: Team Contact Info

- Keith Loftin, USGS, Organic Geochemistry Research Laboratory (OGRL), Kansas Water Science Center, Lawrence, KS.
  - kloftin@usgs.gov; 785-832-3543 (office); 785-764-1408 (cell)