Monitoring and Forecasting Cyanobacterial Blooms for Public Health Protection and Response

NASA - Decision Support through Earth Science
NNH08ZDA001N-Decisions

Rick Stumpf, Shelly Tomlinson, Tim Wynne, NOAA
Andy Reich, Florida Department of Health
Sonia Joseph-Joshi, Michigan Sea Grant and Center of Excellence for Great Lakes and Human Health
Juli Dyble-Bressie, NOAA Great Lakes Environmental Research Lab
Lorrie Backer, Centers for Disease Control, Environmental Health

Lake Erie July 2009

What is the problem with Cyanobacteria?

Cyanobacteria can produce toxins with various hazards(hepatotoxins, neurotoxins, dermotoxins).
Microcystis aeruginosa produces microcystin.
WHO standard < 1 ug/L drinking water,
< 20 ug/L recreational exposure.

Kills dogs and cattle.

Expense for drinking water supplies (taste, odor, filtration

Beach posting becoming more common.

Photo credit: Tom Archer, 2009

Microcystis, credit: J. Dyble

Team

NOAA/NOS *Center for Coastal Monitoring and Assessment: Rick Stumpf, Tim Wynne, Shelly Tomlinson*
Overall project coordination, satellite remote sensing for detection of cyanobacteria, forecast system development, overseeing the transition of research capabilities into operations and skill assessment

Center of Excellence for Great Lakes and Human Health (and Sea Grant): *Sonia Joseph*
Leads the education and outreach component in the Great Lakes

NOAA Great Lakes Environmental Research Lab : Juli Dyble-Bressie
Evaluate the ecological models for detection and forecasts and assist in field data collection

Florida Department of Health: *Andrew Reich*
Leads user interaction in Florida and develop plans that integrate the forecasts into response systems, and aid in identifying appropriate products

Center for Disease Control and Prevention: Lorraine Backer
To incorporate products into the HAB Illness Surveillance System (HABISS) to make them available to the user community

Some background: developed operational Harmful Algal Bloom Forecast System for the Gulf of Mexico

An operational system to inform the user community on the current and possible future Harmful Algal Bloom conditions
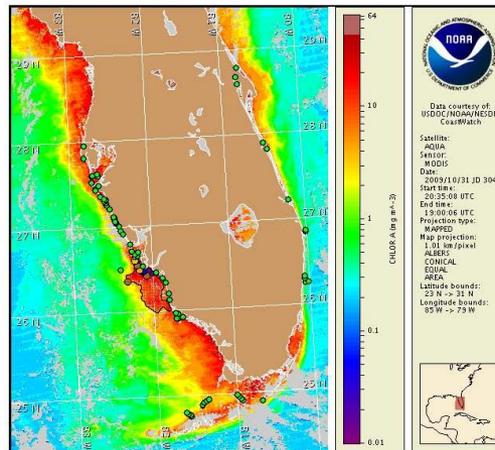
- HAB Bulletin for managers includes imagery, meteorological conditions, field data and analysis

- Web site and Conditions Report for the General Public

- Developed in cooperation with State and county agencies, citizens groups, and tourism bureaus

Goals of Project

Help managers with public health and safety

Reduce cost of impact

Educate the public

Reduce impacts to the public

Establish procedures for routine support and for an operational capability

Algal foam on St Johns River
Photo credit: Dana Morton, city of Jacksonville,
26 July 2010

Cyano Management and Forecast System
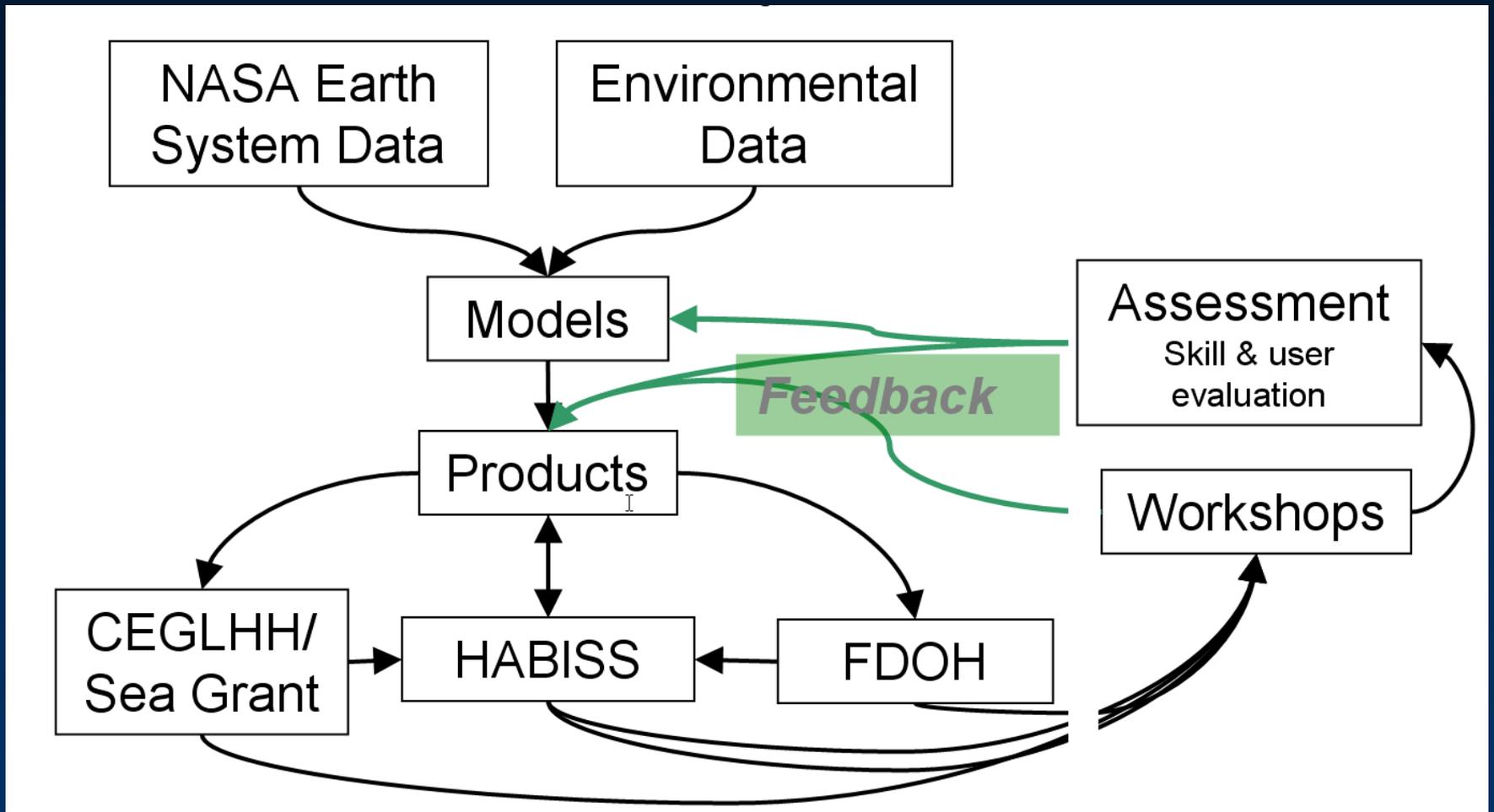
First year successes

Improved forecasts for Lake Erie:

Higher resolution, weekly analysis, 100 subscribers,

Success on locating blooms

Active engagement with Ohio and water suppliers

Examination of inland lakes

Interest by Maryland, testing Erie models in Chesapeake Bay

Products distributed to Florida and Maryland

First Year challenges

Getting Florida & Michigan sub-contract set up (delays in Florida analyses)

Increased interest by managers in products have slowed climatological analyses.

More products, more users.

2010 HAB Stakeholder Workshops

- Lake Erie Beach Conference, 22 Jan

     Cuyahoga Co. Dept of Health

    met with health and natural resource mgrs

- Algal Toxin Workshop (OSU Sea Grant and Ohio EPA, Stone Lab, 8-9 Aug)

       instruct water supply and environmental mgrs on remote sensing and forecasting

- CDC HAB program, Atlanta, 29 Oct 2009

     review of capabilities with HABISS state mgrs

Public interest

To Whom It Concerns,   July 2009

We live on Catawba Island and when we came home yesterday, the shoreline around our house smelled and the water was bright green and thick like pea soup. I've attached a photo of this phenomena as it's almost impossible to believe. Obviously we stayed out of the water. But this has us greatly concerned.

Can you please supply us with some sort of explanation, if you have one yet?

Photo credit: Diane D. Straw

Components of the forecast

Develop bloom field

Observations, satellite data
NASA OCBP

Heuristic
Model

Nowcast/Forecast
Transport Model

ANALYSIS

Inform Public Health and
Environmental Managers

Locating blooms

MERIS is used for cyano-index

No Bloom "Negative Cyano Index"

No Bloom

Bloom

Bloom negative "Positive Cyano Index"
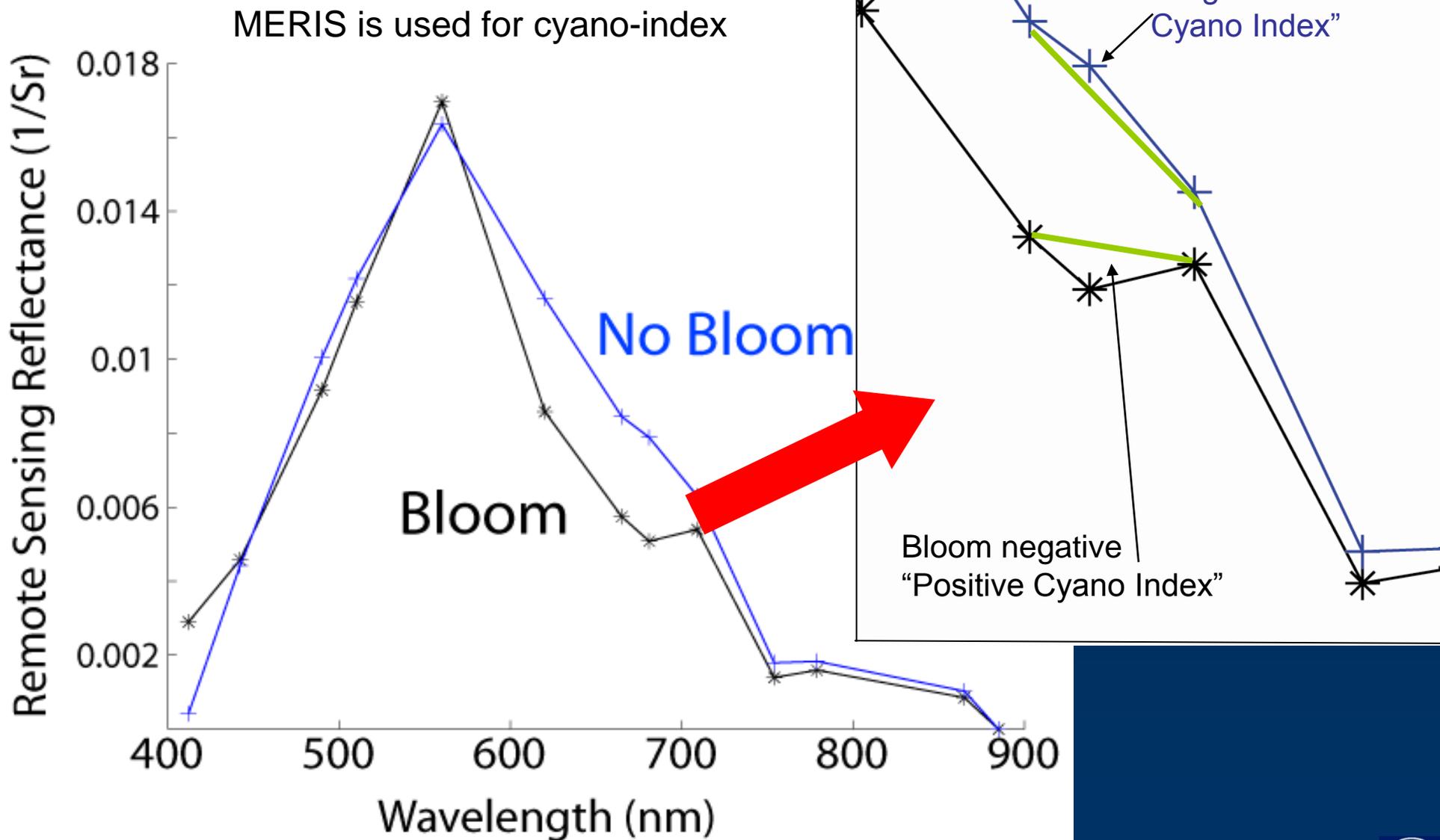
Obtaining cell counts from satellite
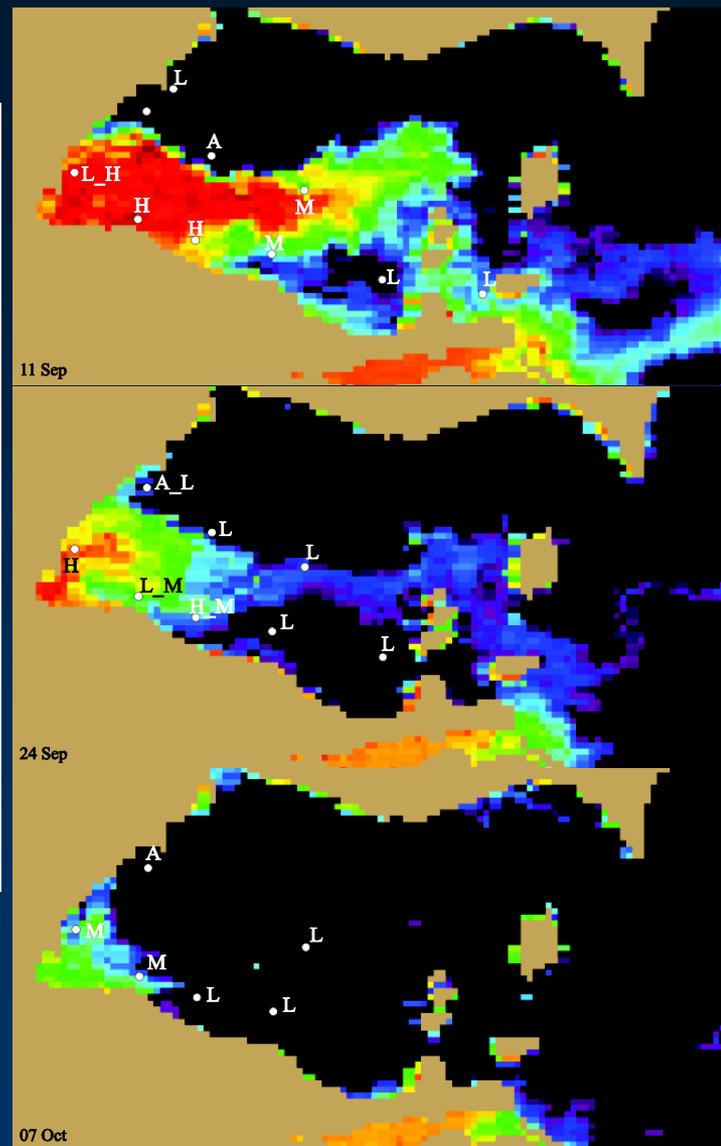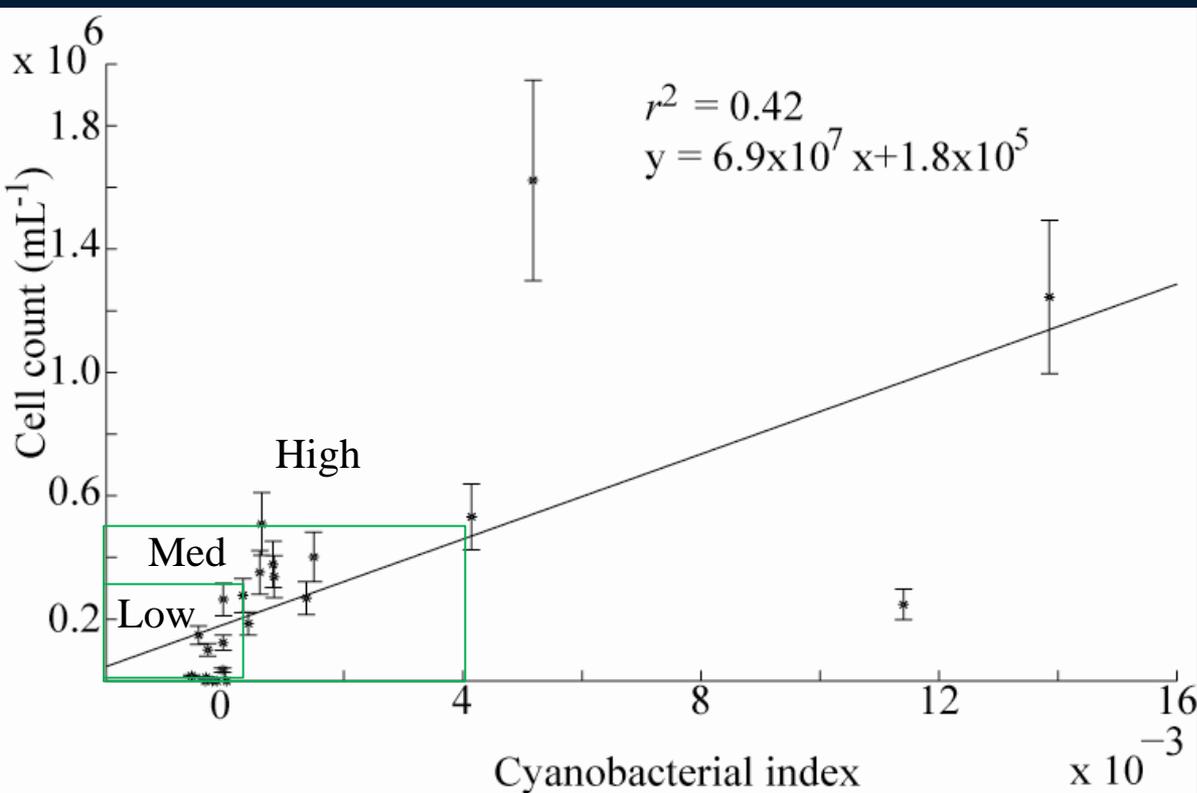
Satellite against field cell counts (now working on field radiometry)

Great Lakes Coastal Forecasting System provides nowcast and forecast of currents
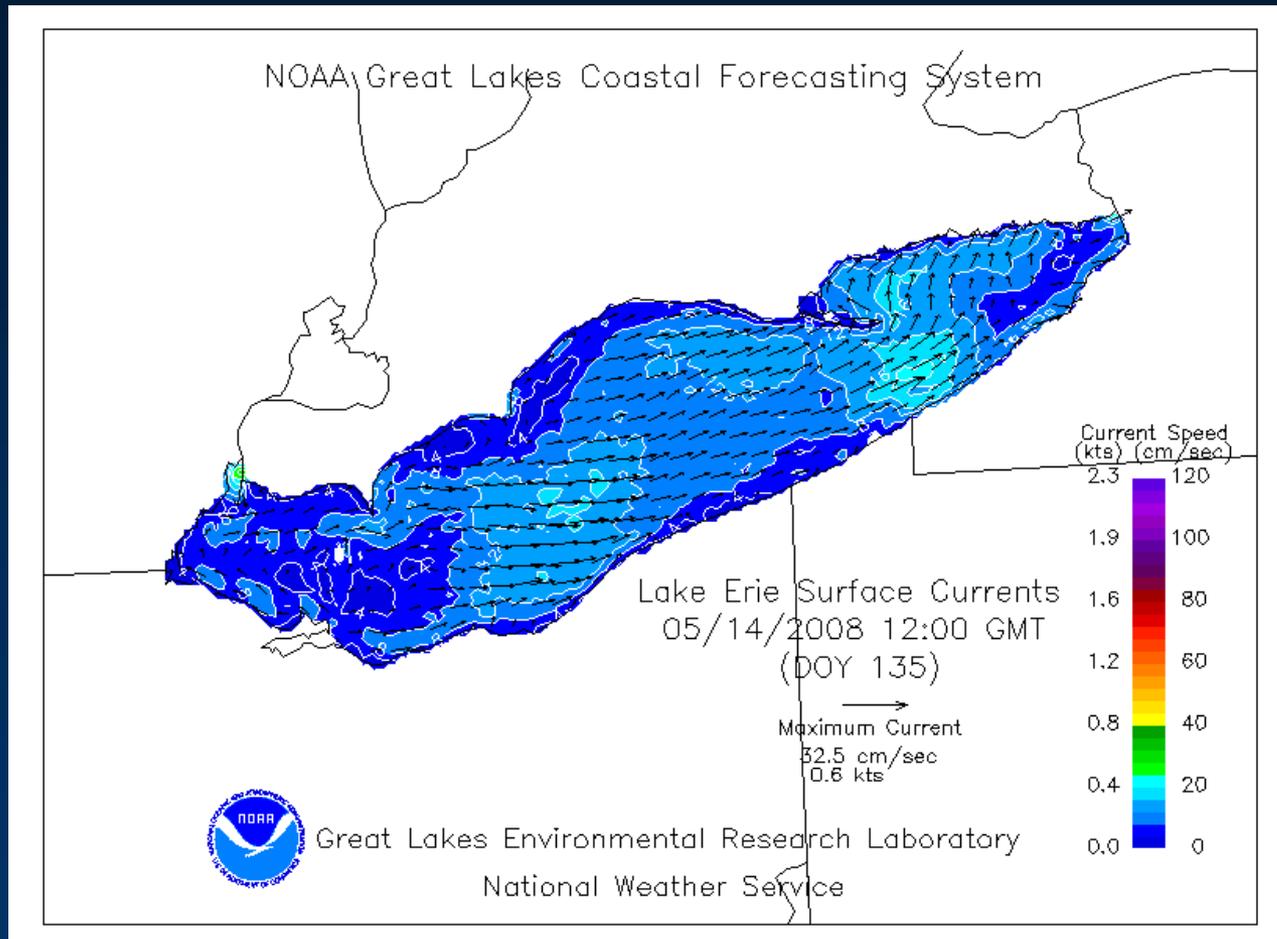
Concentration estimated from satellite converted to particles

09/11
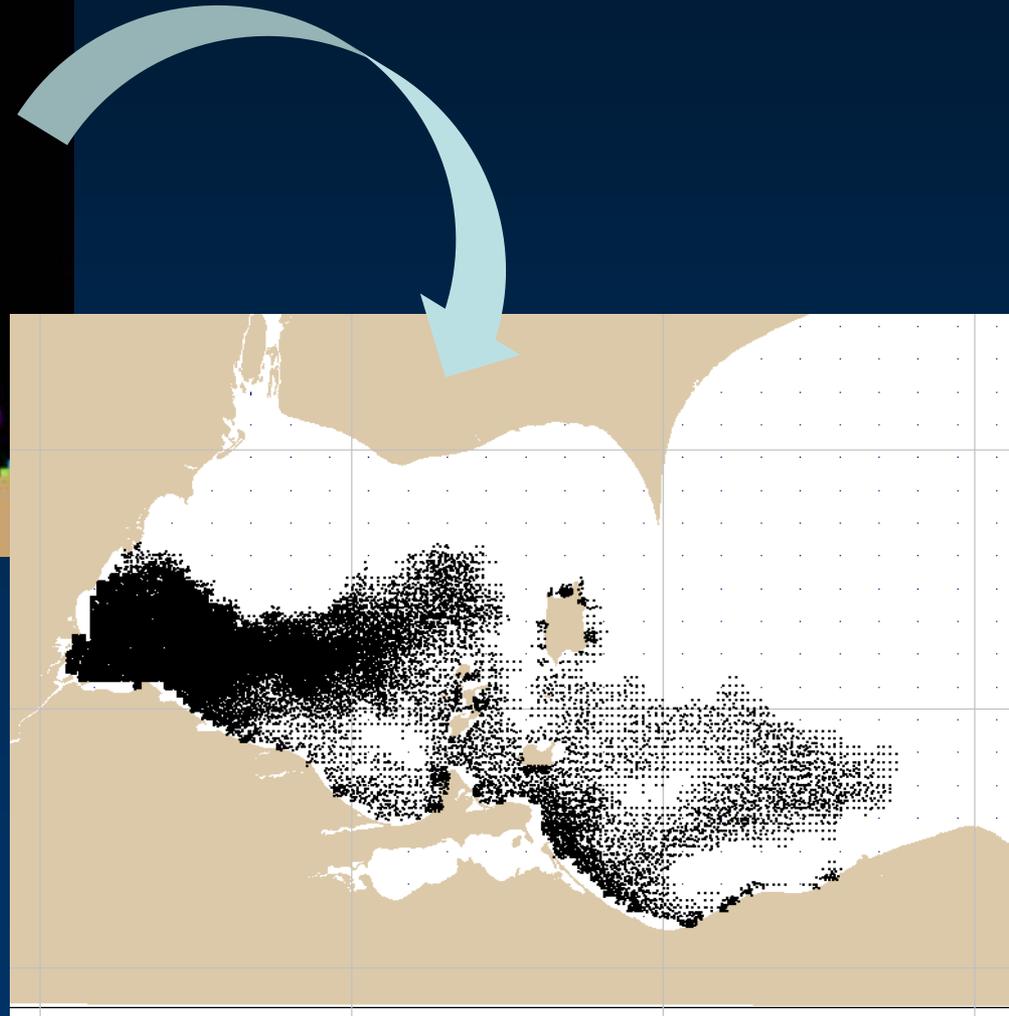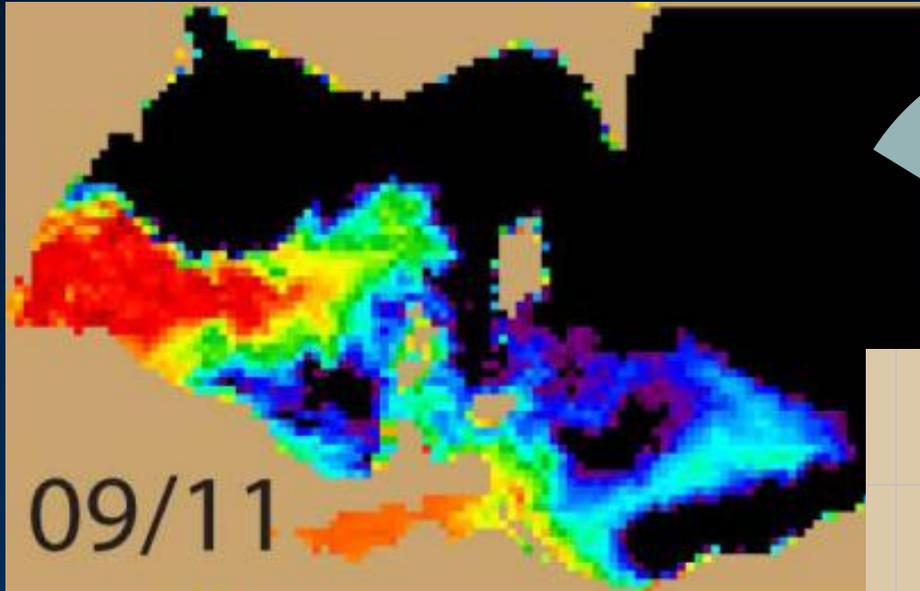
Particles are combined in GNOME with currents

NASA Public Health, Sep 2010

Experimental
Lake Erie Harmful Algal Bloom Bulletin
2009-004
13 August 2009
National Ocean Service
Great Lakes Environmental Research Laboratory
Last bulletin: 06 August 2009

Conditions: A *Microcystis* spp. bloom has been identified in Maumee Bay and the adjacent waters to the northeast. The bloom may be visible from the shore, or near shore areas outside of Maumee Bay. A mixed cyanobacterial bloom is also present in Sandusky Bay. Moderate taste and odor issues have been observed and may continue to persist as a result of the bloom.

*Analysis:* The *Microcystis* spp. bloom in Western Lake Erie continues to persist and increase in both area and concentration. The bloom in Sandusky Bay is a mixed bloom dominated by *Planktothrix* spp. Wind stress is expected to be low for the next several days, which may intensify the bloom. The bloom is forecasted to remain relatively stationary, with a tendency to drift slightly to the NE. The feature present around the South Bass Islands has been identified as having very low concentrations of *Microcystis*. The feature has spread in area since last week's bulletin and may continue to spread. It should be noted that clouds covered Maumee Bay (gray pixels in the observed imagery). As a result of these clouds, the nowcast and forecast show no (or very little) concentration in Maumee Bay.

-Wynne, Dyble, Meredith
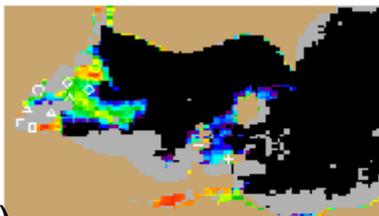
Satellite index (MERIS 2-days old)

Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from August 11, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from August 11 shown as white squares (very high), circles (high), diamonds (medium), triangles (low), + (very low) and X (not present). Please note: Colored pixels in Sandusky Bay are due to a mixed bloom dominated by *Planktothrix* spp.
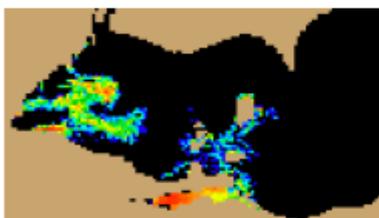
Nowcast to today

Figure 2. Nowcast position of *Microcystis* spp. bloom for August 13 using GLCFS modeled currents to move the bloom from the August 11 image. Please note: Colored pixels in Sandusky Bay are due to a mixed bloom dominated by *Planktothrix* spp.
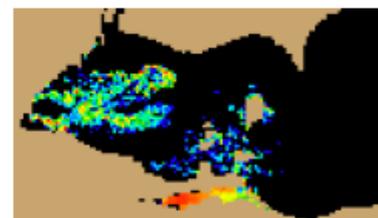
Forecast to 3 days

Figure 3. Forecast position of *Microcystis* spp. for August 16 using GLCFS modeled currents to move the bloom from August 11 image. Please note: Colored pixels in Sandusky Bay are due to a mixed bloom dominated by *Planktothrix* spp.

Please note:
- MERIS imagery was distributed by the NOAA CoastWatch Program and provided by the European Space Agency
- Cell counts were collected by the Great Lakes Environmental Research Laboratory
- The wind data is available through the National Data Buoy Center and the National Weather Service
- Modeled currents were provided through the Great Lakes Coastal Forecasting System

1

Lake Erie nowcast/forecast (also Ohio detection)

Experimental
Lake Erie Harmful Algal Bloom Bulletin
2010-009
05 August 2010
National Ocean Service
Great Lakes Environmental Research Laboratory
Last bulletin: 29 July 2010

Conditions: A bloom of Microcystis cyanobacteria has been identified from Maumee Bay to Catawba Island.

Analysis: Imagery and field samples indicate very high concentrations of Microcystis in Maumee Bay and north along the coast to La Plaisance Bay. Very high concentrations of Microcystis are also present east of Catawba Island. Models indicate an eastward offshore transport of the bloom area north of Maumee Bay. Additionally, no transport is predicted for the area east of Catawba Island. Winds are forecasted to decrease into the weekend.
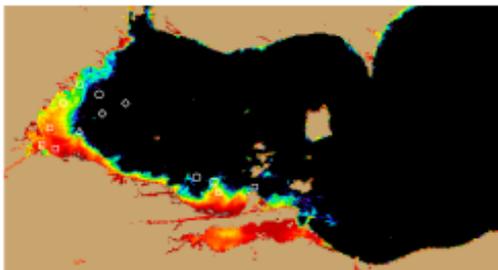
-Briggs

Satellite index

Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from July 30, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from shown as white squares (very high), circles (high), diamonds (medium), triangles (low), + (very low) and X (not present).
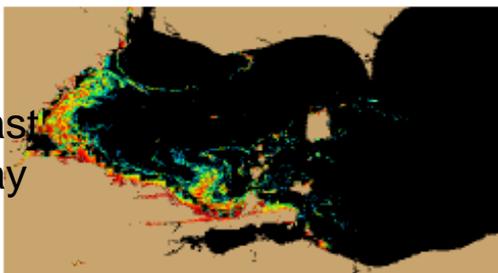
Nowcast to today

Figure 2. Nowcast position of *Microcystis* spp. bloom for August 05 using GLCFS modeled currents to move the bloom from the July 30 image.
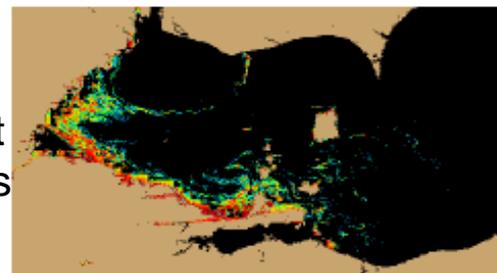
Forecast to 3 days

Figure 3. Forecast position of *Microcystis* spp. for August 08 using GLCFS modeled currents to move the bloom from July 30 image.

Please note:
- MERIS imagery was distributed by the NOAA CoastWatch Program and provided by the European Space Agency
- http://www.glerl.noaa.gov/res/Centers/HABS/lake_erie_hab/lake_erie_hab.html
- Cell counts were collected by the Great Lakes Environmental Research Laboratory
- The wind data is available through the National Data Buoy Center and the National Weather Service
- Modeled currents were provided through the Great Lakes Coastal Forecasting System
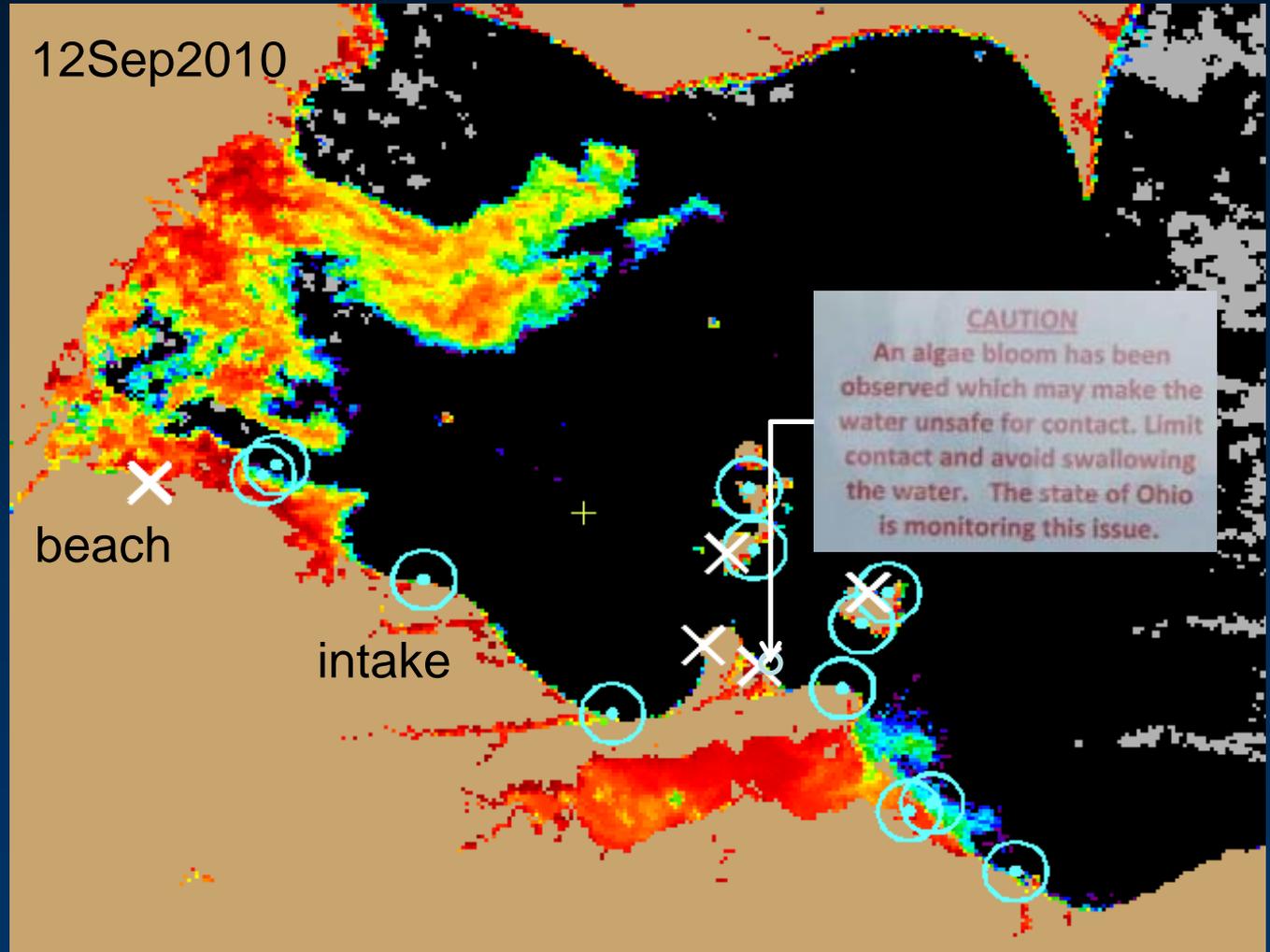
esa

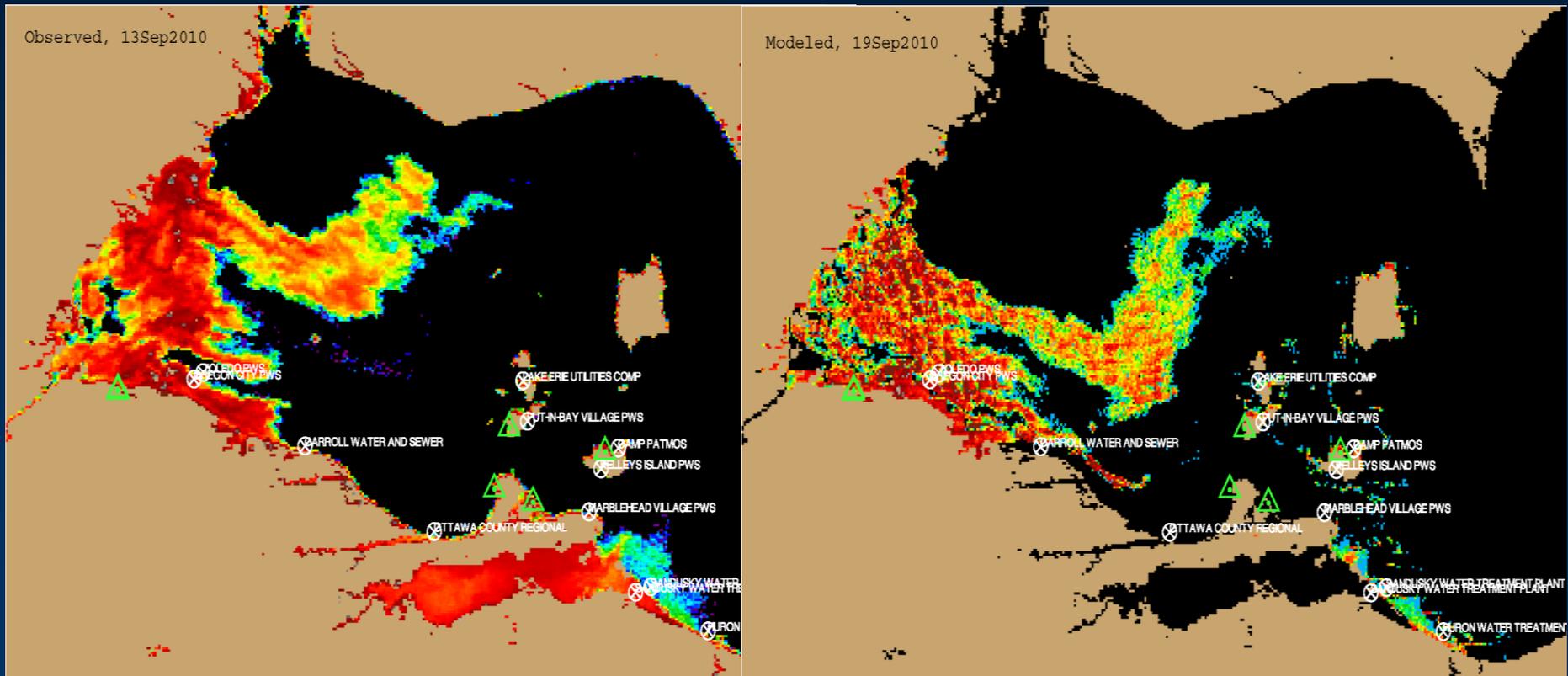# Comparison of modelled CI for Aug 05 (based on July 29) and observed Aug 06, 2010
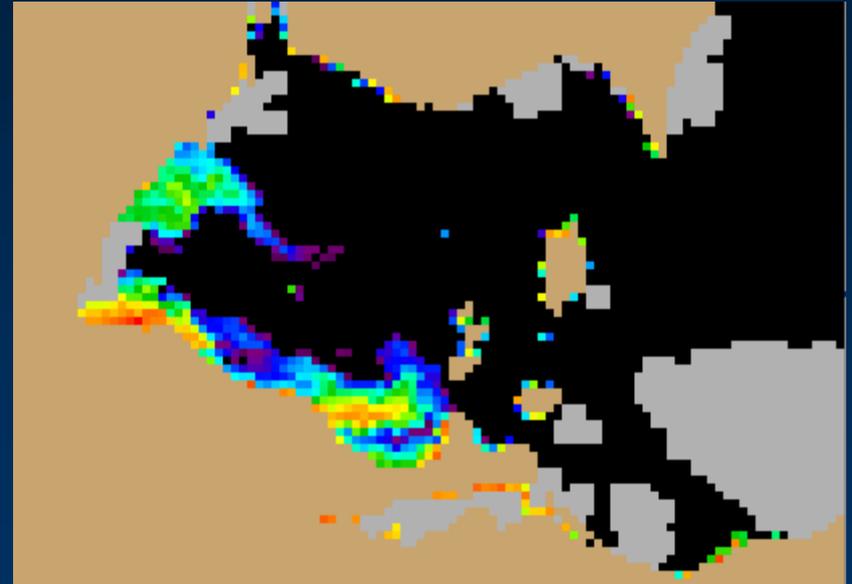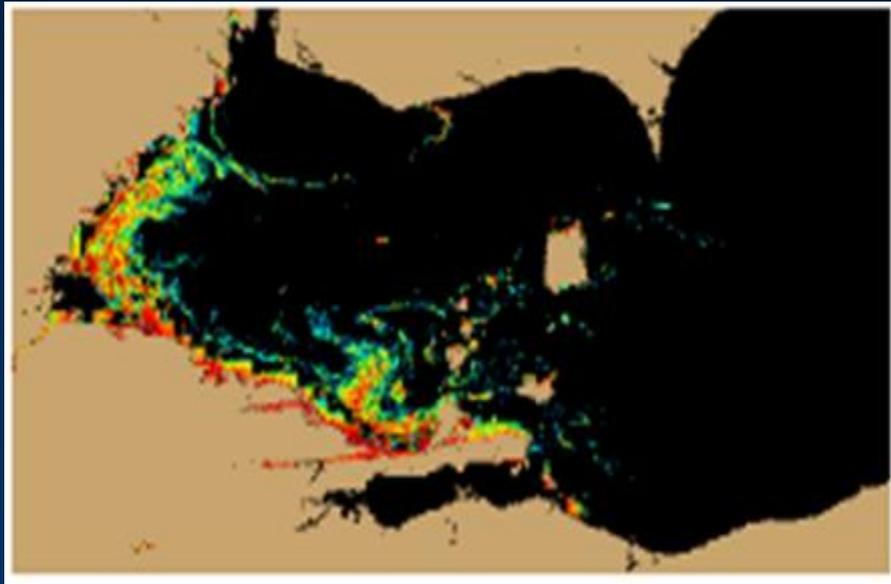
Intakes and Park Beaches.
12 Aug: first beach closure on Lake Erie in years

Supporting Ohio EPA and Ohio DNR

12Sep2010

CAUTION
An algae bloom has been observed which may make the water unsafe for contact. Limit contact and avoid swallowing the water. The state of Ohio is monitoring this issue.

beach

intake

Forecasting impact at intakes

Observed, 13Sep2010

Modeled, 19Sep2010

Scum detection with MODIS

25 Aug 2003 MODIS
simulated color-IR

Islands

ratio:
Rho_s(NIR)/Rho_s(red)
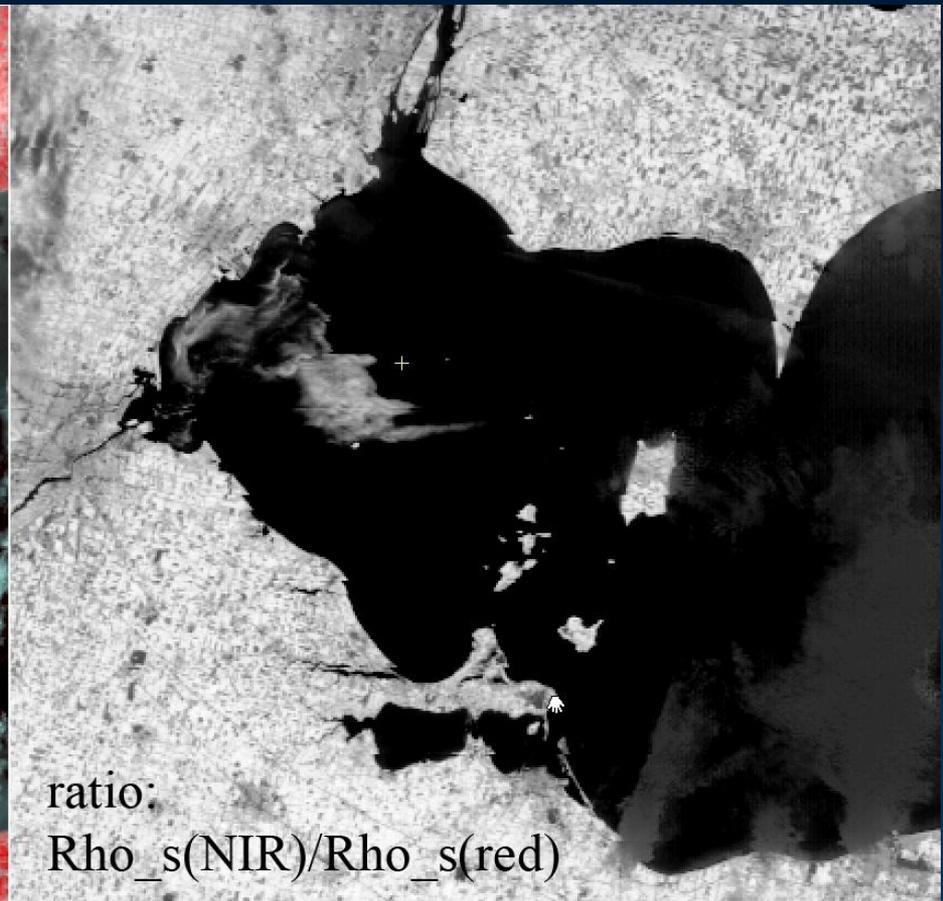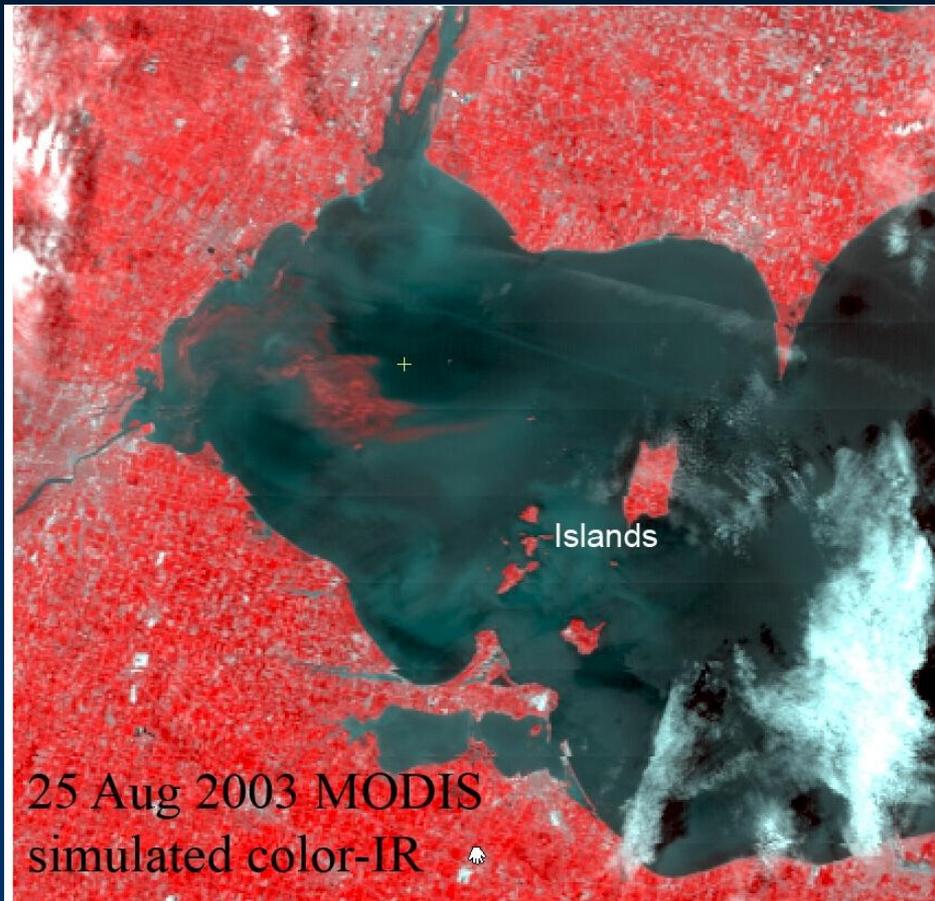
Working to quantify
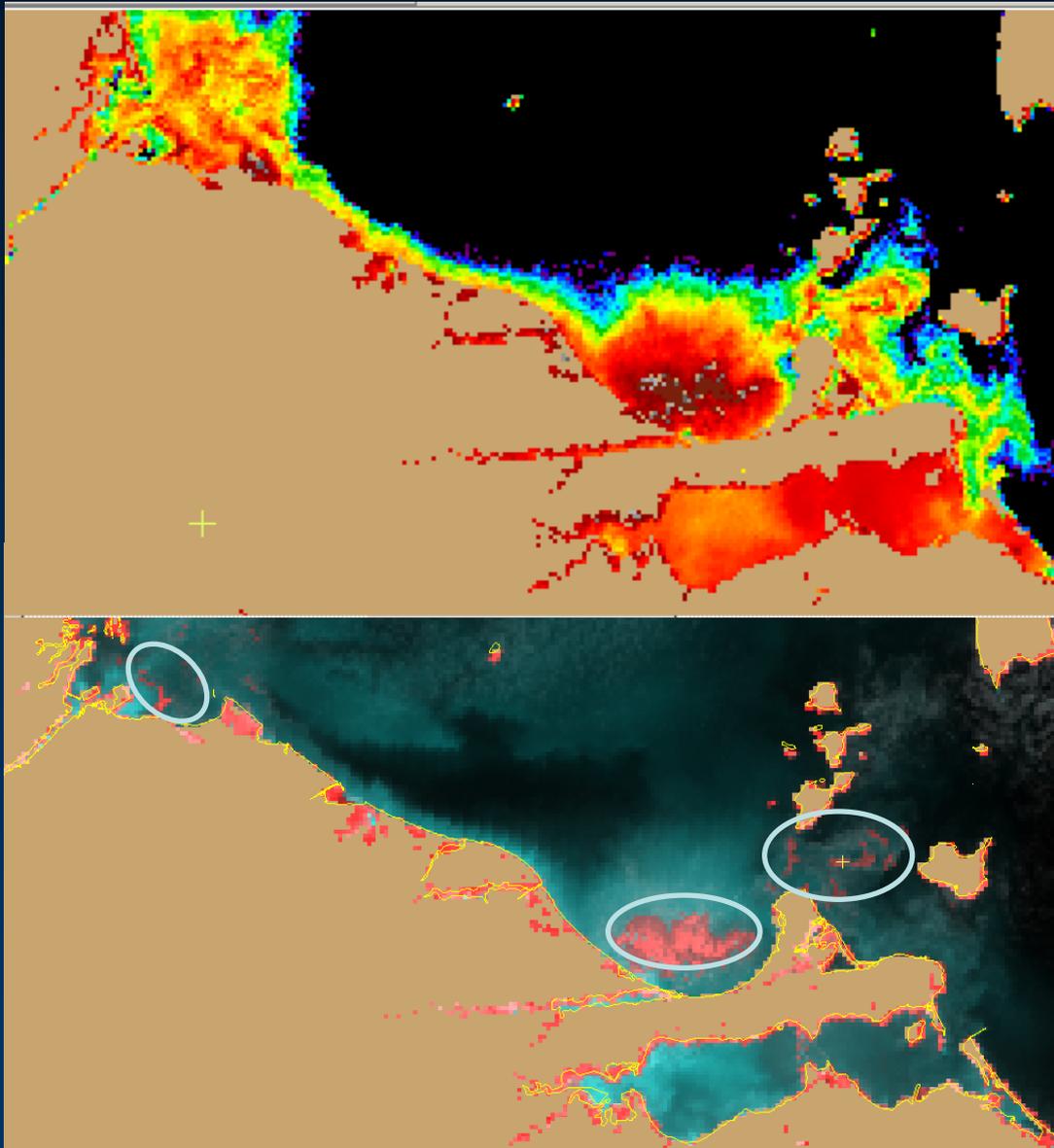
27 July 2010
Cyano-index
from MERIS

27 July 2010,
NIR/red fixed
pink indicates
scum

Ability to respond to public interest

Date: Friday, August 13, 2010 am

Subject: lake erie

To: hab-glakes@noaa.gov

I plan on boating in Lake Erie this weekend, probably in the Cleveland area. Is there a problem with algae right now? Is the water safe for swimming?

Thank you.

Reply

Date: Friday, August 13, 2010 am

Subject: Re: lake erie

From: hab-glakes@noaa.gov

We see no indication of anything in the Cleveland area.

Experimental
Lake Erie Harmful Algal Bloom Bulletin
2010-011
12 August 2010
National Ocean Service
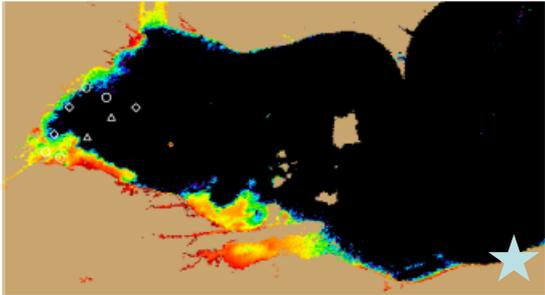Great Lakes Environmental Research Laboratory
Last bulletin: 12 August 2010

Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral sha... from August 09, where colored pixels indicate the likelihood of the last known position of... spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data fro... white squares (very high), circles (high), diamonds (medium), triangles (low) , + (very low... present).
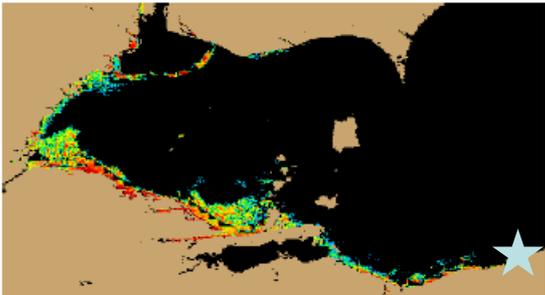
Figure 2. Nowcast position of *Microcystis* spp. bloom for August 12 using GLCFS model... move the bloom from the August 09 image.

Web page, reaching a broader audience

http://www.glerl.noaa.gov/res/Centers/lake_erie_hab/lake_erie_hab.html

Harmful Algal Bloom Field Observation Survey
Page One

If you are seeing a bloom, please fill out this survey and let us know details.
Fill out as best as you can.

1. Sample Location: *

2. GPS Location (lat, long):

3. Date:

4. Time:

5. Wind Direction:

-- Please Select --

6. Wind Strength

-- Please Select --

6. Wind Strength

-- Please Select --

7. Weather Conditions:

-- Please Select --

8. Water Temperature (in Fahrenheit):

9. Wave Height (in meters):

10. Secchi Depth Reading (in meters):

11.

	Yes	No
Rainfall within 48hrs:	☐	☐
Visible scum:	☐	☐
Health warning posted at the location:	☐	☐
Closure posted at location:	☐	☐
Complaints received about conditions at location:	☐	☐

12. Amount of Algae in Nearshore Water:

☐ None

☐ Low (1-20%)

☐ Moderate (21-50%)

☐ High (> 50%)

13. Amount of Algae on Beach:

- ☐ None
- ☐ Low (1-20%)
- ☐ Moderate (21-50%)
- ☐ High (> 50%)

14. Number of People at location:

[   ]

15. Number of birds present at location:

[   ]

Type(s) of birds:

[   ]

16. Domestic animals present at location:

[   ]

Type(s) of domestic animal(s):

[   ]

17. Litter/debris present (please give detailed description of materials present at the location):

[   ]

18. Any additional information about this location? For example: was there visible scum of foul smelling water the previous week or day(s)?

[   ]

19. Do you have an image of the bloom?
If yes, please e-mail image to hab-glakes@noaa.gov with the subject including the date and location of the bloom.

- ○ Yes
- ○ No

[Submit]
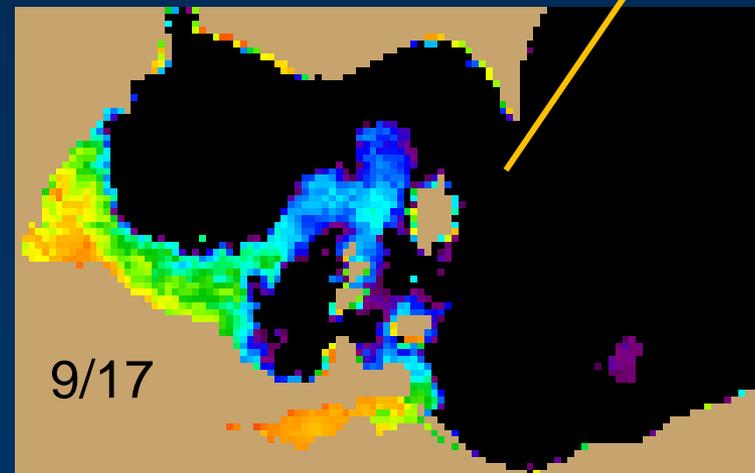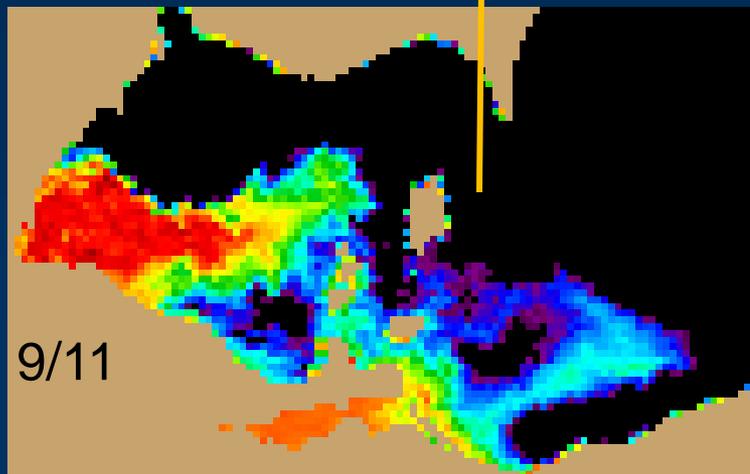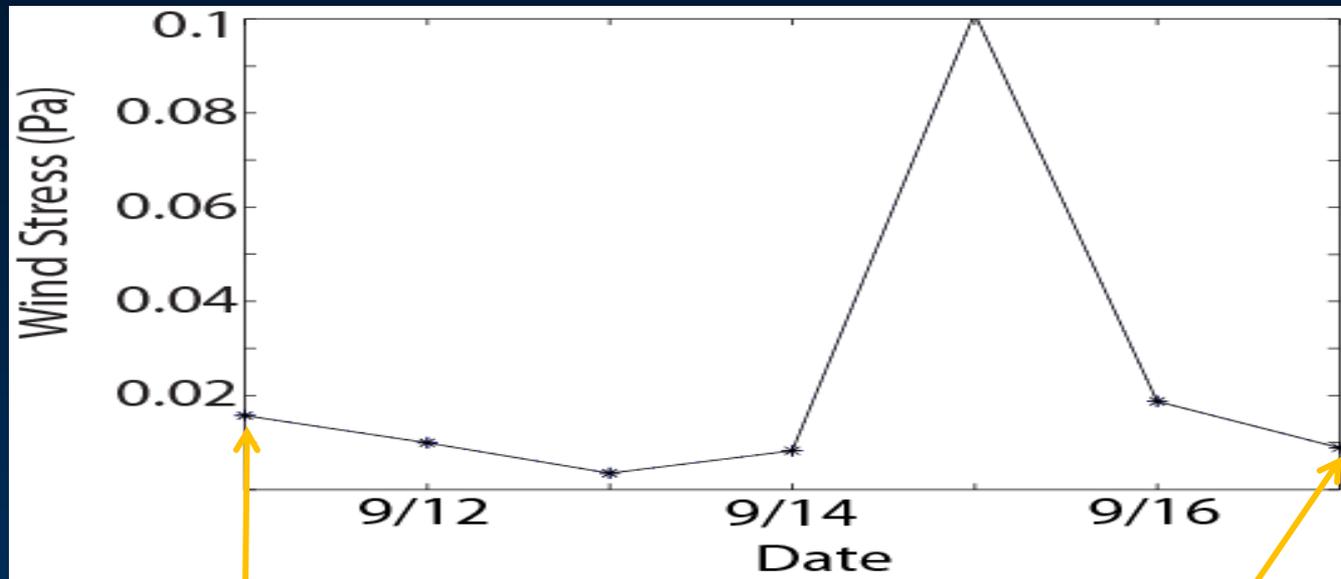
0%

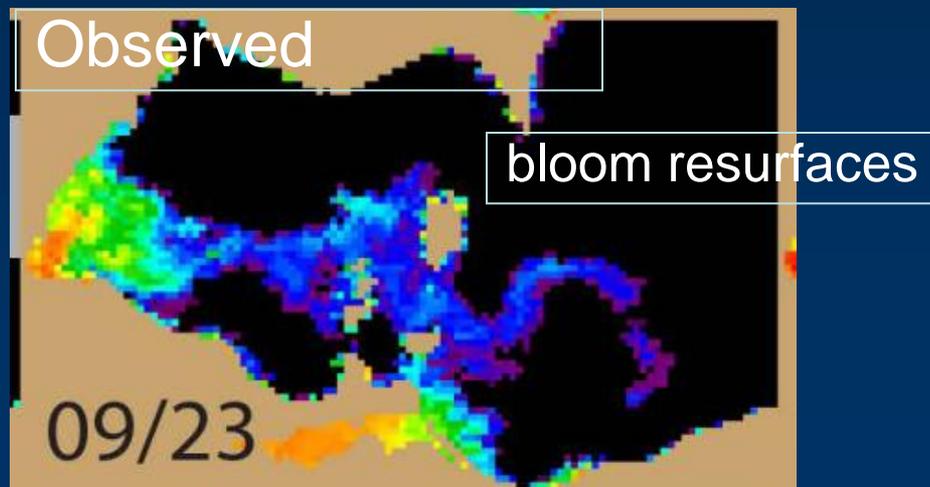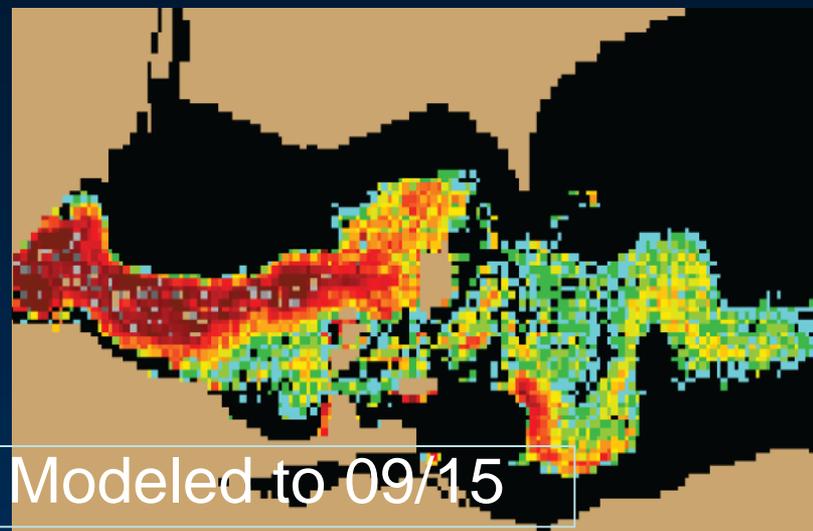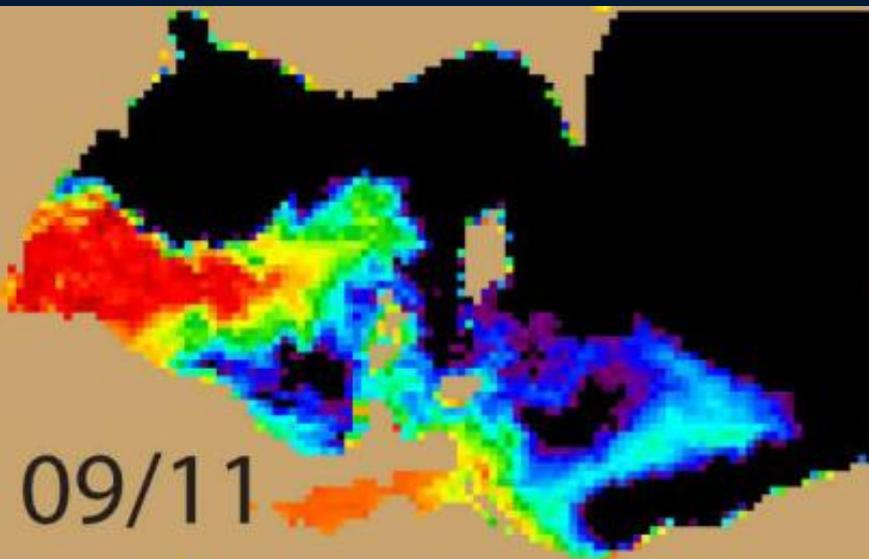# Grand Lake St Marys, Ohio largest lake in Ohio, major state issue

Cyano index for this summer
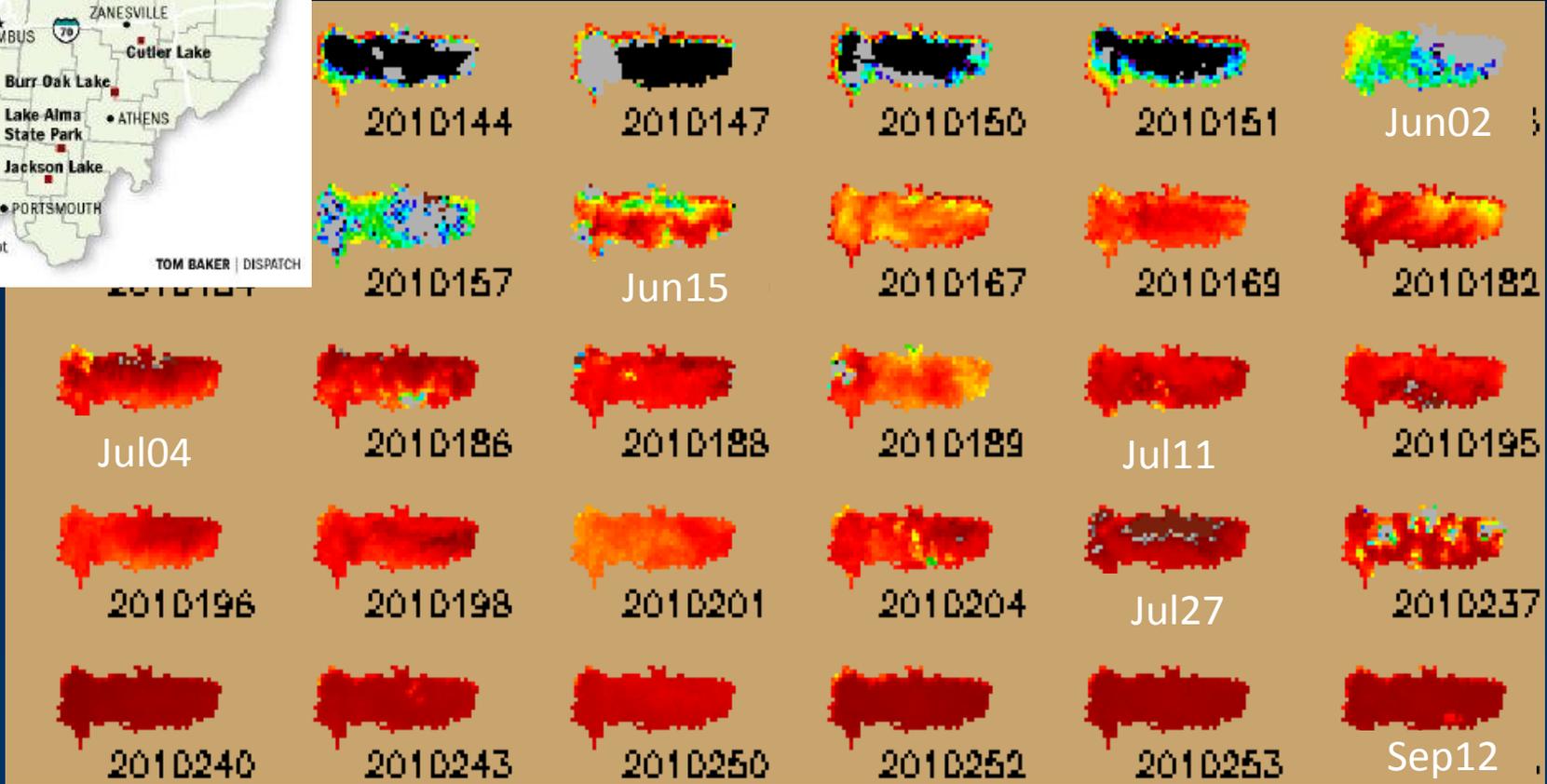
Images will need to be interpreted with winds based on Wynne et al.
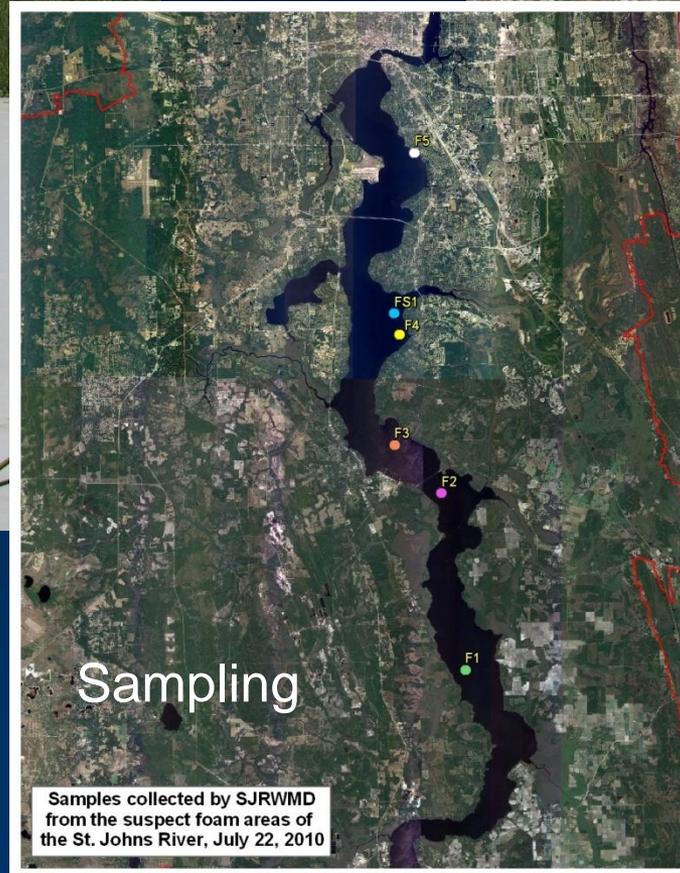

9/11

9/17

Wind events can cause underestimates of Microcystis blooms in satellite interpretation

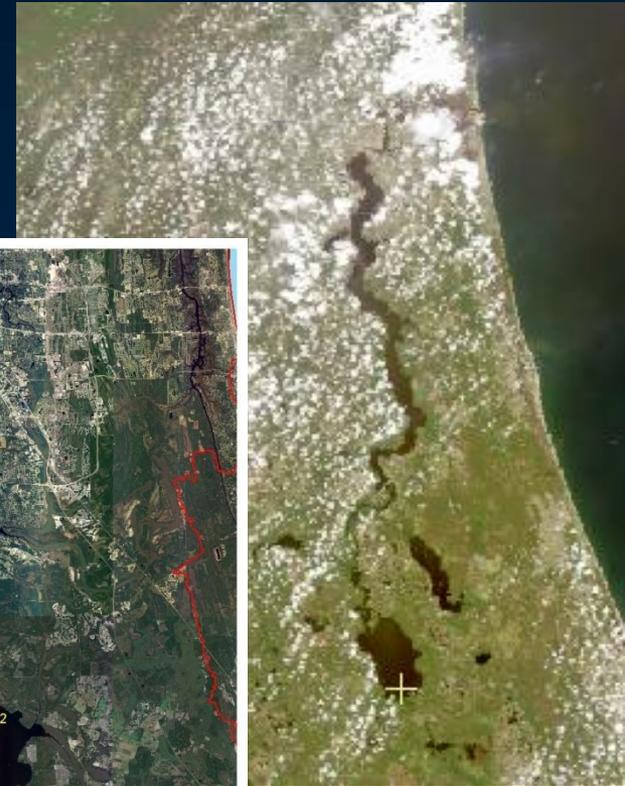# Cyanobacterial blooms and the St. John's River system.

Cyano blooms, then algal Foam in 2010

Sampling

Samples collected by SJRWMD from the suspect foam areas of the St. Johns River, July 22, 2010

MERIS & MODIS Imagery

Cyanobacterial blooms and the St. John's River system

Problem areas in summer 2010

Bloom id

Chlorophyll estimate

always has an algal bloom

2010171-True

2010171-CI

2010171-MCI
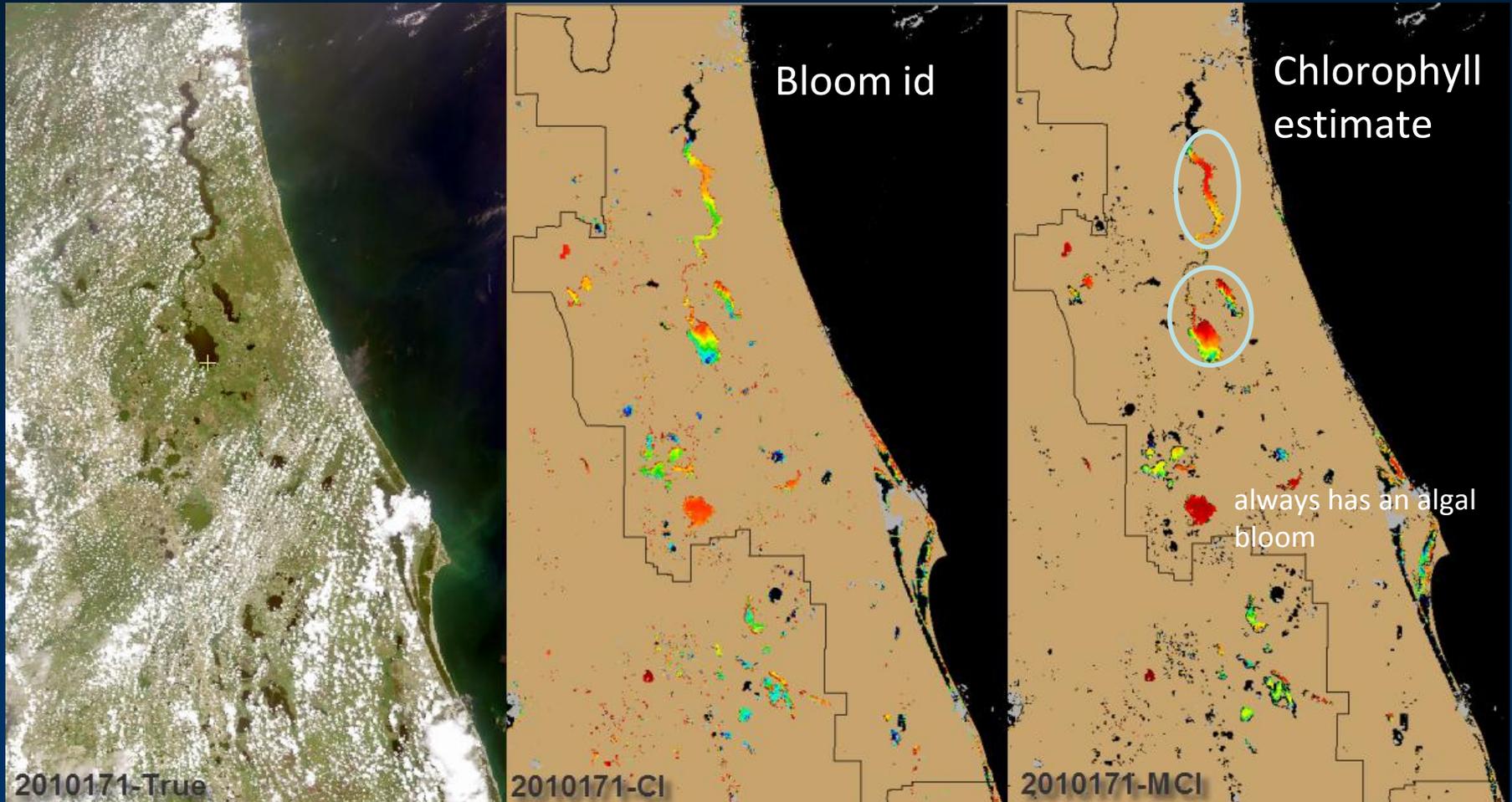
Chesapeake analysis, identify different HABs

Salinity habitat

freshwater

Moderate salinity

blooms

=
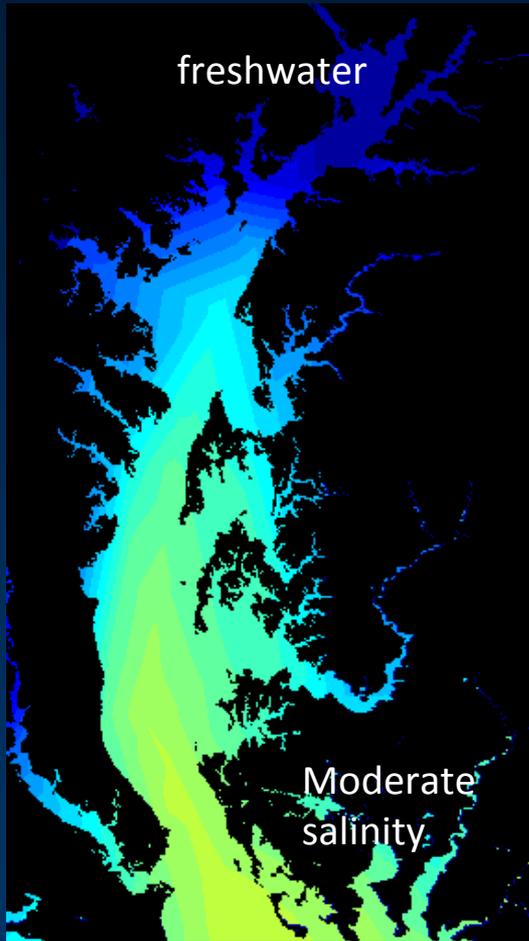
Other species

Low salinity: potential cyano blooms

Year 2

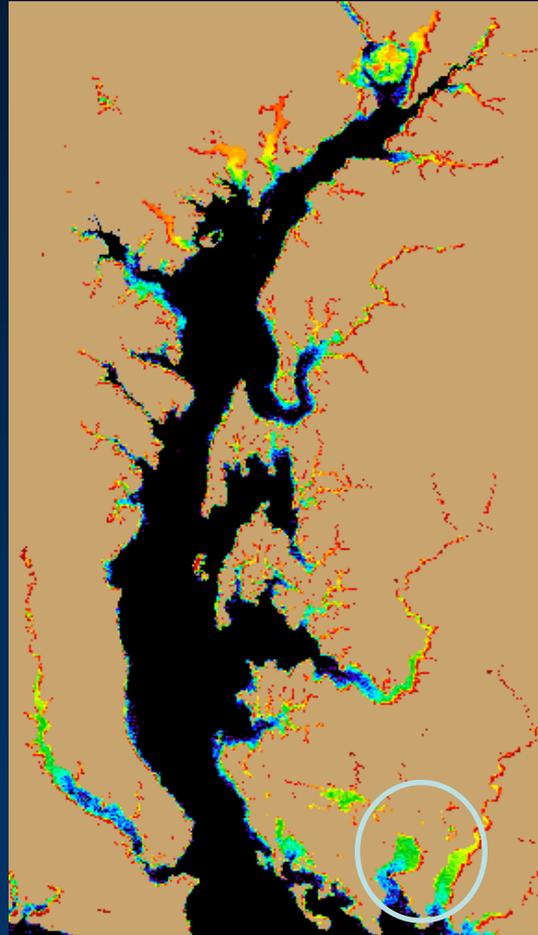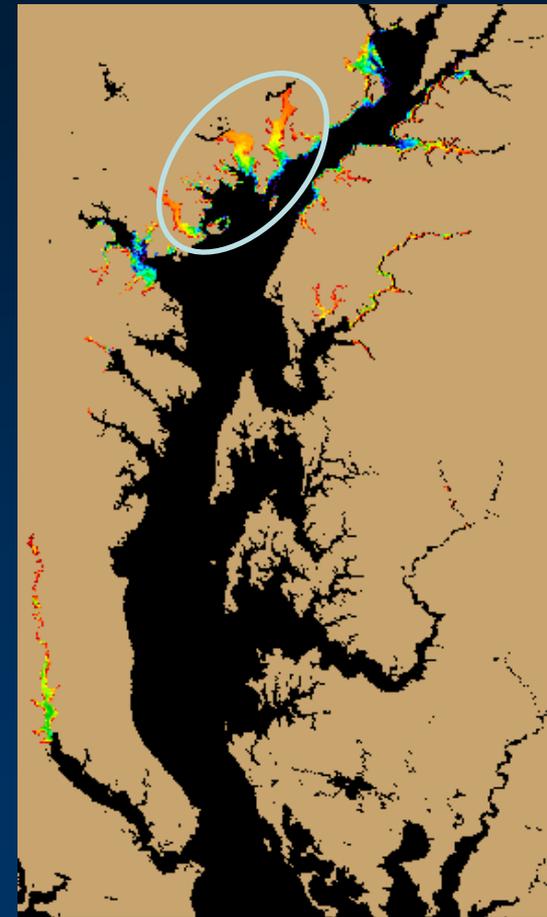**National**: Identify monitoring methods used by other states (through CDC HABISS)

Coordinate with CDC Environmental Monitoring (mtg in Dec)

examine foam and scum detection

Coordinate with NASA P/ACE program for next sensor

Florida: Meeting with mgrs of St Johns River WMD this week, identify needs, especially quantitative data

Ohio: Continue this fall in Erie

Improve forecasts for Erie and Ohio in 2010

Work with Ohio EPA and Ohio DNR on other lakes

Implement cell count, chlorophyll numbers

Climatology of extent and frequency

Maryland: (New) Started evaluations for cyanos and other HABs in MD Chesapeake (MD DNR, MD Dept Health).

Metrics

Metric	Measures		
Total forecasts	Ohio monitor: FL, MD	multiple	0-3 day OH
Use of forecasts	100 subscribers OH < 6 FL 10 MD	OH: multiple MD: multiple FL: multiple	2 products OH 1 product MD 1 product FL
Data access **# agencies** **contributing**	OH, 3 MD, 3 FL, 1	multiple	# data records in HABISS, pending
Response plans	Under development	OH yes MD yes	# changes in response
Skill	Assessibility: weekly	% accuracy, pending	% increase in accuracy during project
Outreach/ **education**	Training in OH	Several agencies	# of individuals, 16 OH
Reliability	% of products created each season	% products assessed each year	% of users engaged each year