Experimental Harmful Algal Bloom Forecast for Saginaw Bay

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NOAA GLERL

Outline

- NOAA information products for Lake Erie HABs
- Experimental Lake Erie HAB Tracker
- Proposed Experimental Saginaw Bay HAB Tracker

NOAA National Ocean Service HAB Information Products

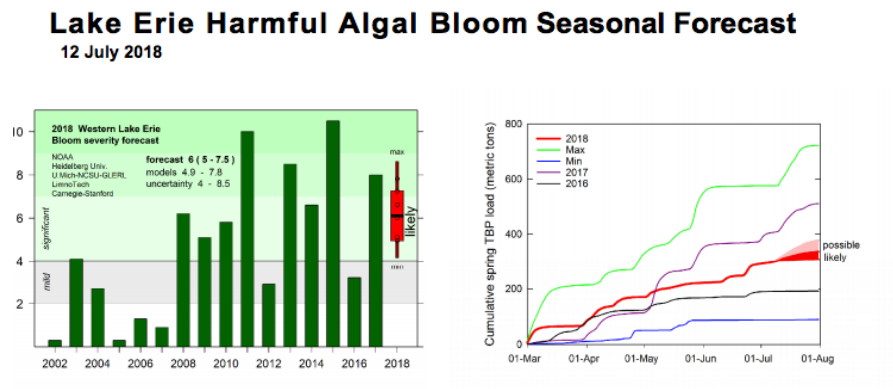


Figure 1. Bloom forecast compared to previous years. The wide bar is the range of likely severity (5-7.5). The narrow bar captures the maximum uncertainty in all the models.

Figure 2. Cumulative total bioavailable phosphorus (TBP) loads for the Maumee River (based on Waterville). Each line denotes a different year. 2018 is in red through July 18, the solid line is the measured load. Loads over the remainder of July will have a negligible impact on the bloom size.

Lake Erie Harmful Algal Bloom Bulletin

30 July, 2018, Bulletin 12

Analysis

The *Microcystis* cyanobacteria bloom continues in the western basin. Recent satellite imagery (7/29) indicates the bloom is present in Maumee Bay, extending north alongshore the Michigan coast to Brest Bay, east towards the Bass Islands, and along the Ohio coast to Catawba Island. Observed winds yesterday (7/29) reduced mixing and may have lead to scum formation. Measured toxin concentrations are detectable at all samples sites, but still below the recreational threshold throughout most of the bloom extent. *Keep pets and yourself out of the water in areas where scum is forming*. The persistent cyanobacteria bloom in Sandusky Bay continues.

Forecasts

Forecast winds (5-11 kn) tomorrow through Thursday (7/31-8/2) will promote slight mixing of surface waters and eastward transport of surface *Microcystis* concentrations. --Davis, Keeney

The images below are "GeoPDF". Please visit https://go.usa.gov/xReTC for instructions on viewing longitude and latitude.

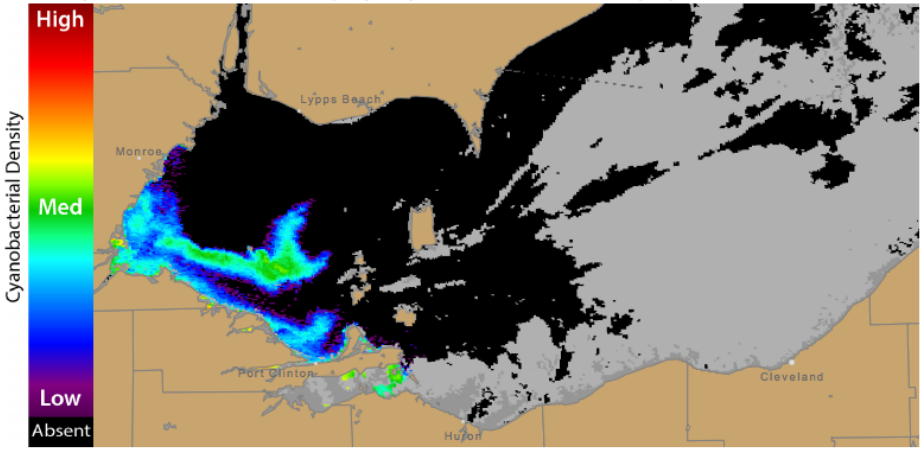
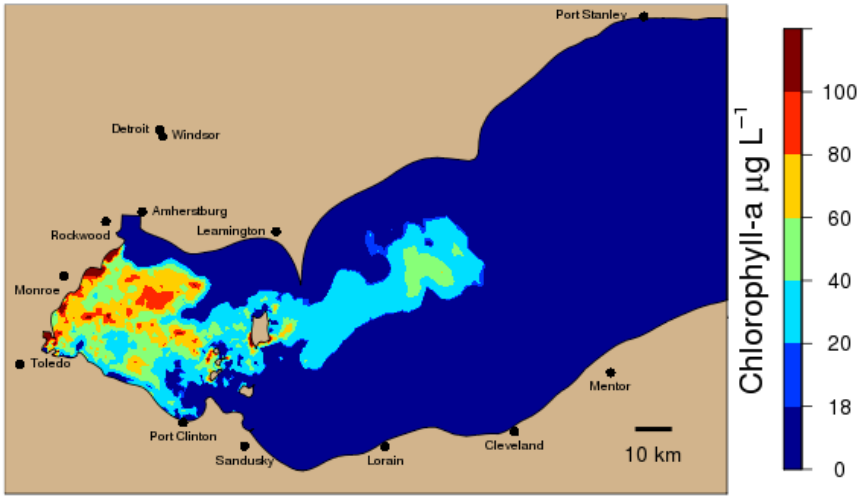


Figure 1. Cyanobacterial Index from modified Copernicus Sentinel 3 data collected 29 July, 2018 at 11:19 EST. Grey indicates clouds or missing data. The estimated threshold for cyanobacteria detection is 20,000 cells/ml

Concept of the short term HAB forecast

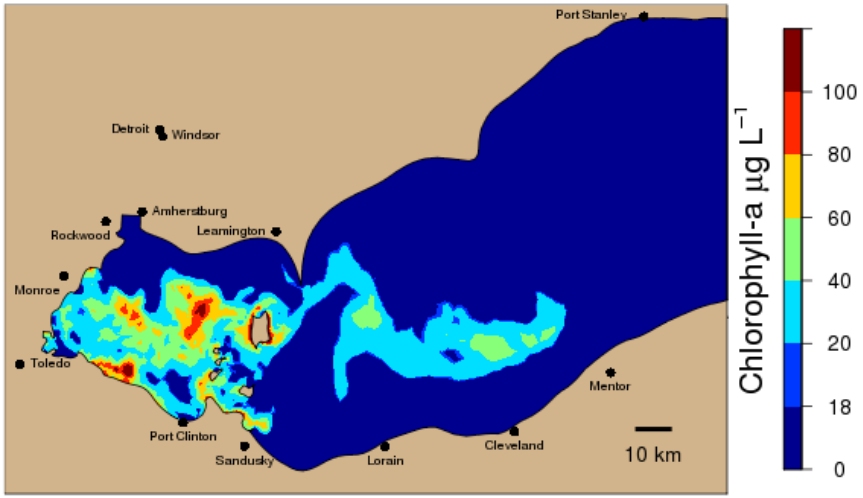
Nowcast

2015-08-23 20:00 EDT



Five-day forecast

2015-08-29 21:00 EDT



Initialize bloom location and intensity in a model based on satellite remote sensing imagery

Five-day forecast of bloom intensity and location based on

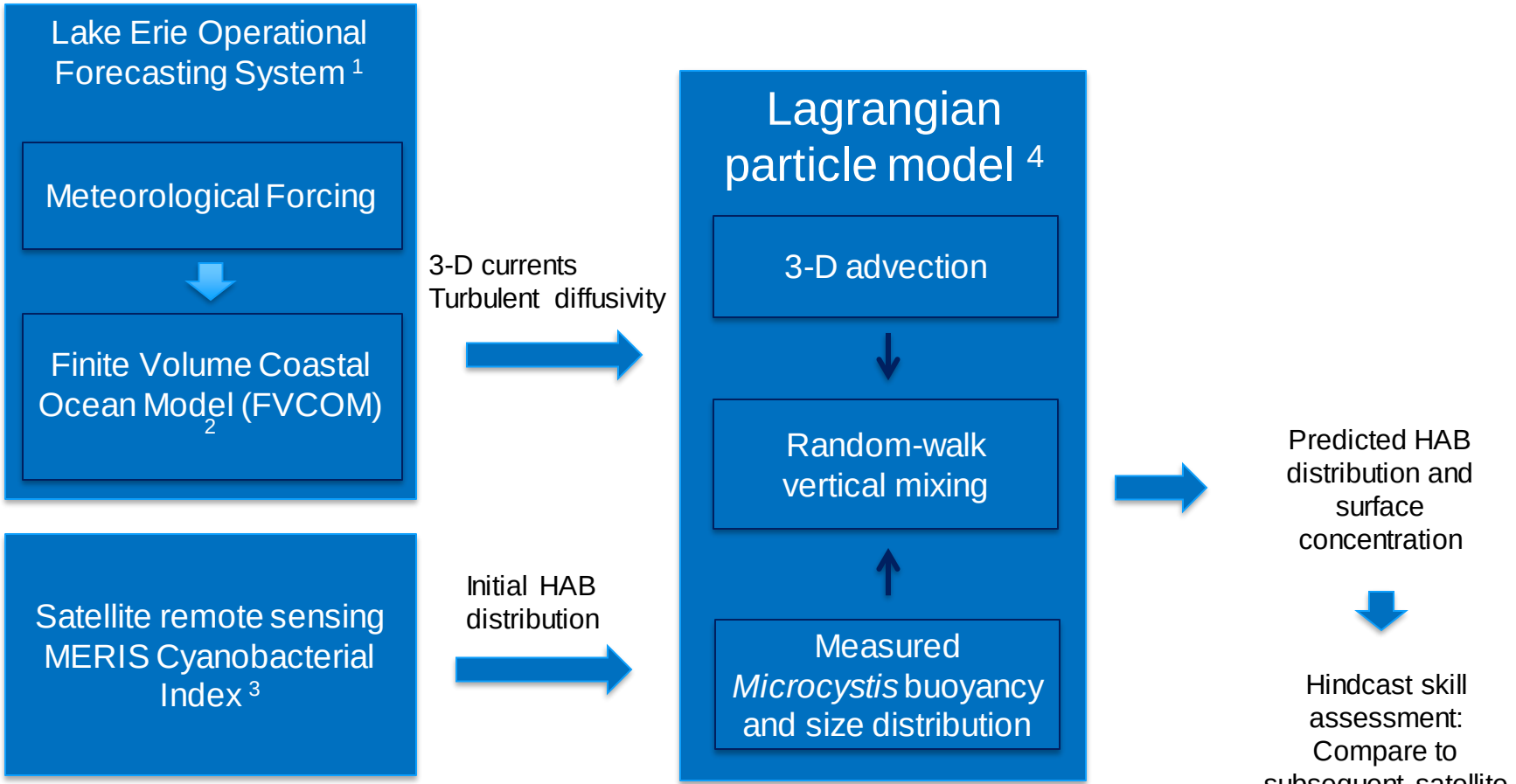
1. Forecast meteorology
2. Currents from a hydrodynamic model
3. Lagrangian particle tracking model

Potential users of short-term HAB forecasts

- Drinking water plants
- Anglers
- Beach users and recreational boaters


RKC
WYANDOTTE MICHIGAN

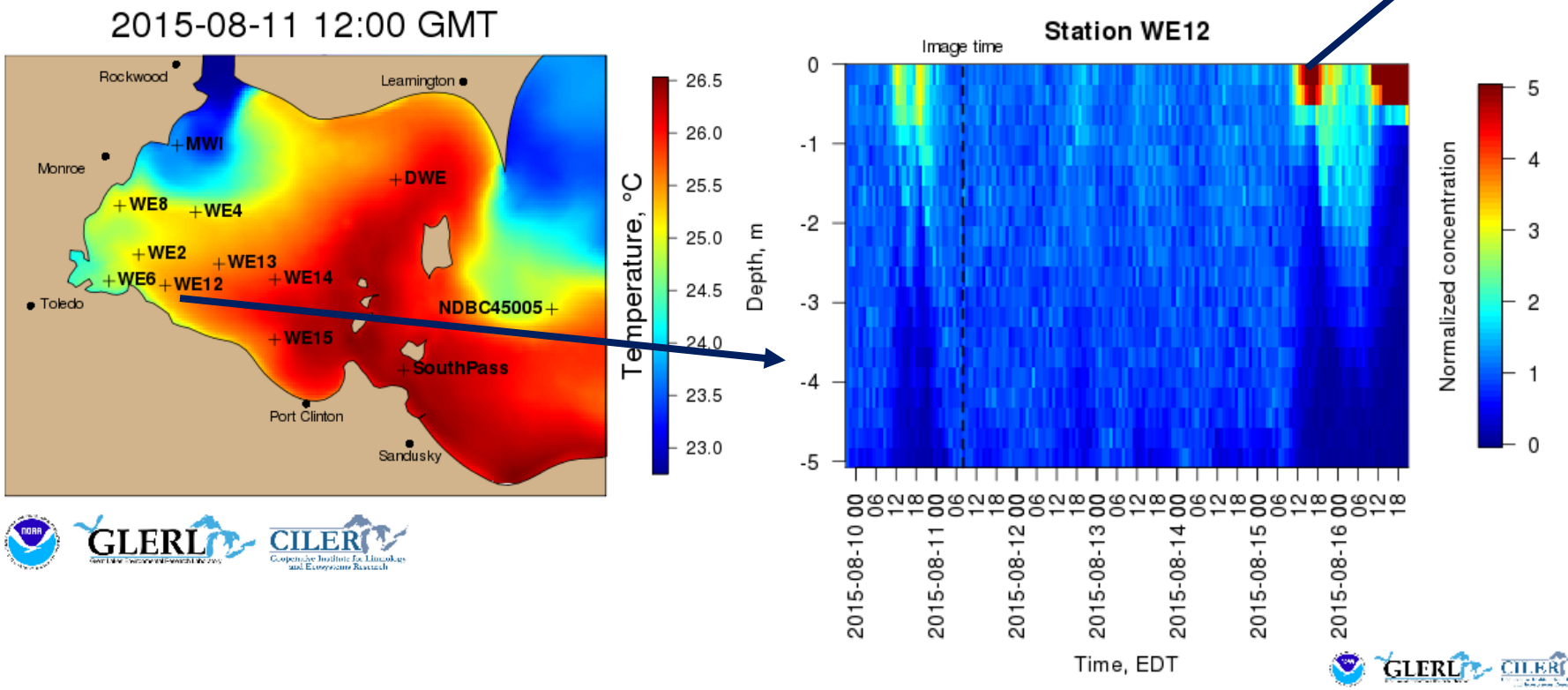
Components of the Lake Erie HAB Tracker



1. Anderson et al.
2. Chen, C. et al. 2003. J. Atmos. Ocean. Technol., 20, 159-186.
3. Wynne et al. 2010. Limnol. Oceanogr. 55(5), 2025-36
4. Gilbert, C.S. et al. 2010. Prog. Oceanogr., 87: 37-48.

Prediction of surface scums

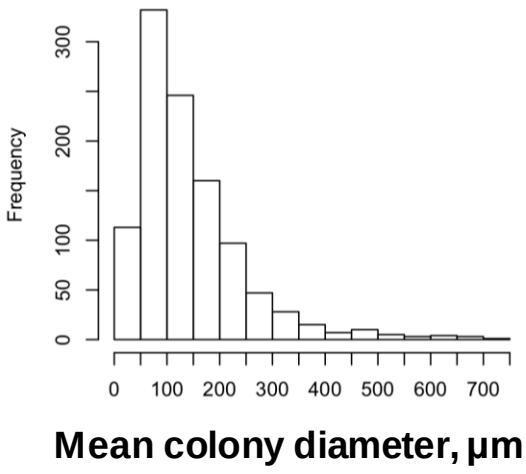
Vertical Mixing Analysis



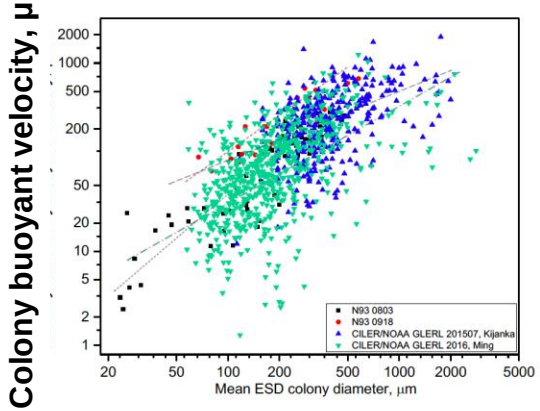
Measurement of *Microcystis* colony buoyancy and size distribution

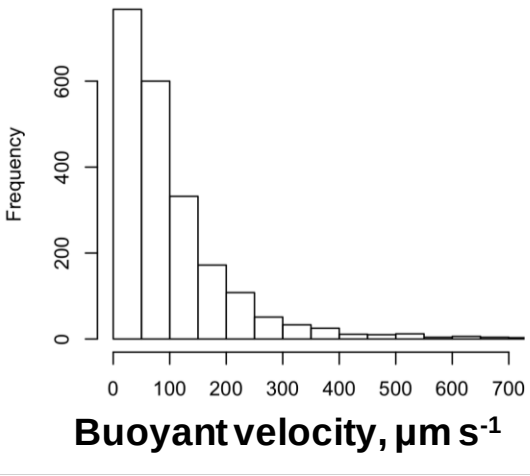
Microcystis colony size distribution measured by FlowCam,
Lake Erie, August 4, 2014

Source: David Fanslow, NOAA GLERL

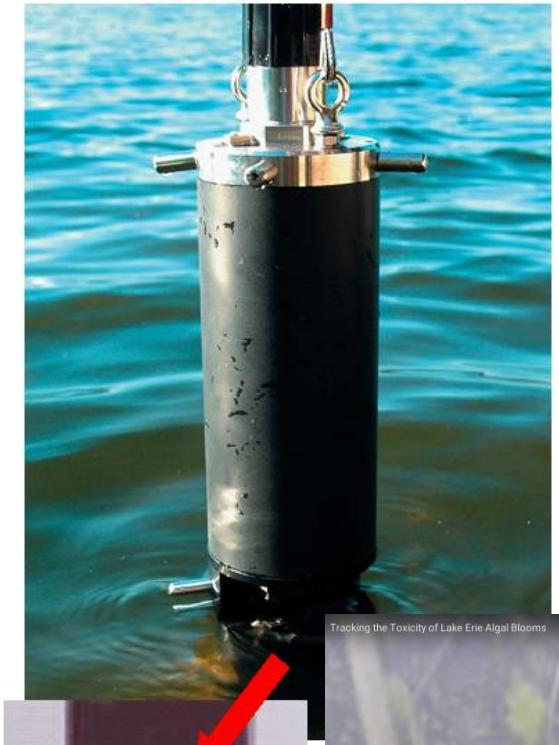


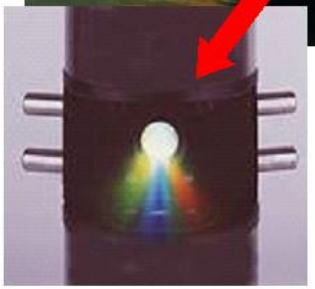
Measured *Microcystis* colony buoyant velocity vs. diameter



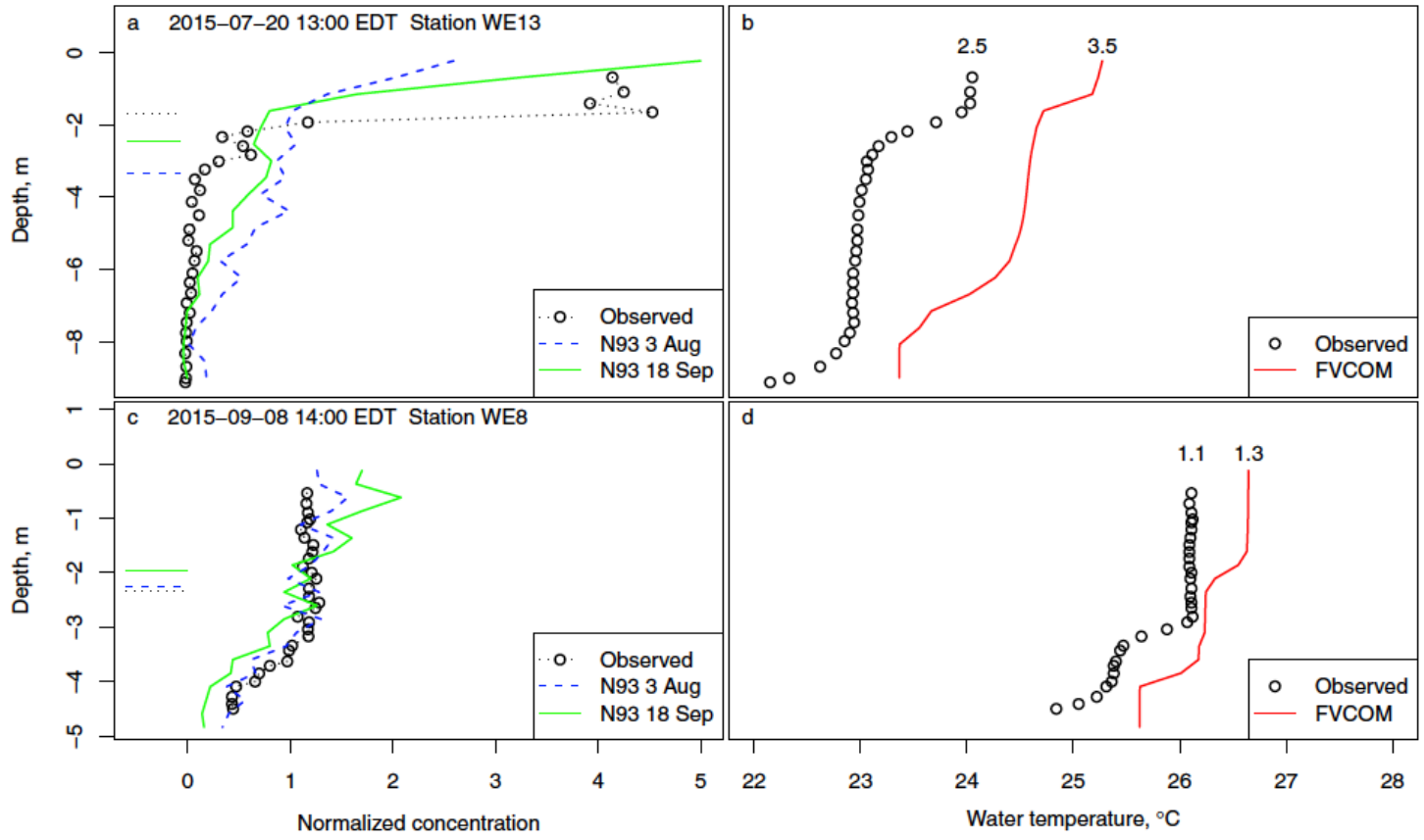


Vertical profiles of cyanobacterial chlorophyll concentration were collected with the fluoroprobe



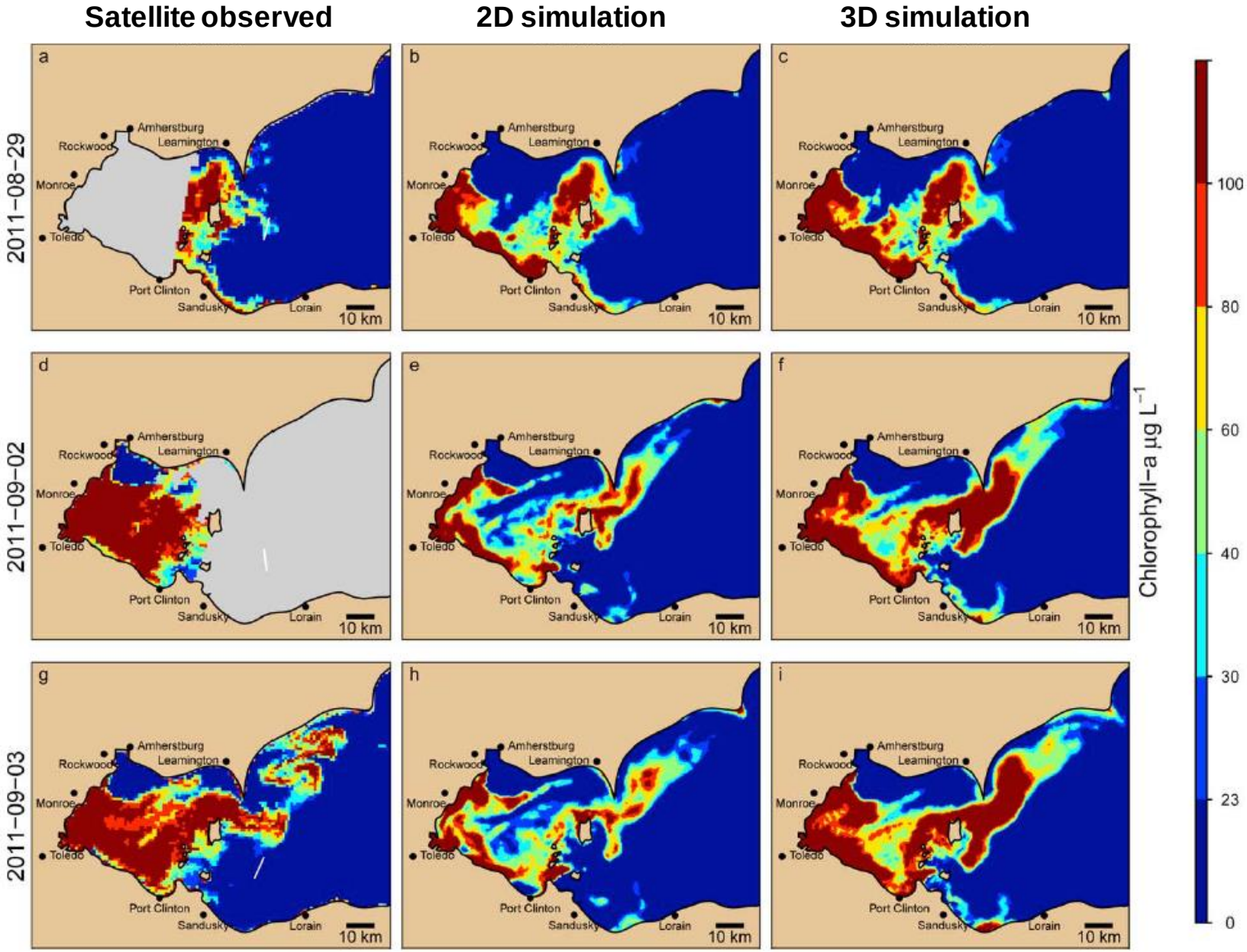


Model assessment of predicted *Microcystis* vertical distribution



Rowe et al. 2016. J. Geophys. Res. Oceans, 121, doi:10.1002/2016JC011720.

Model assessment



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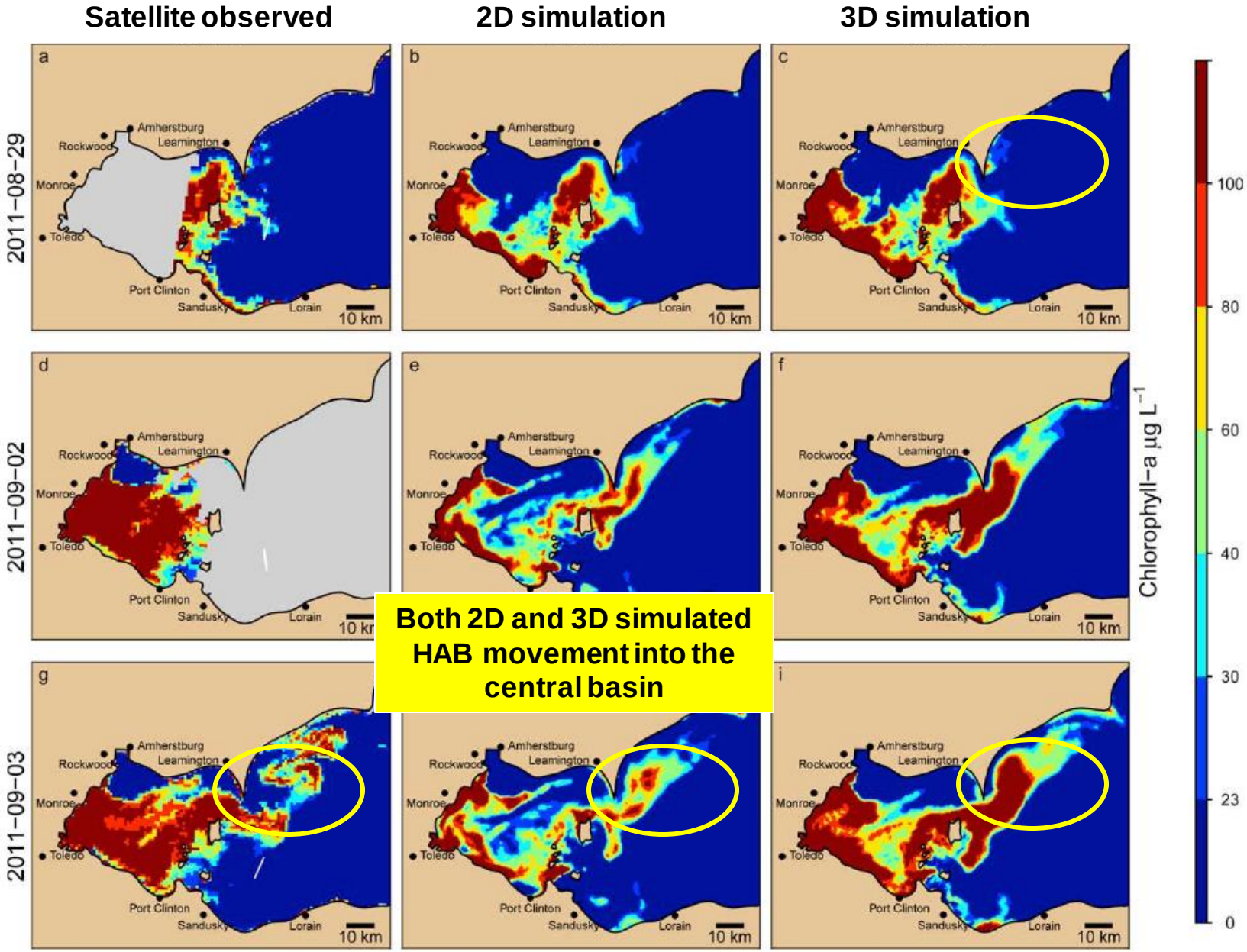

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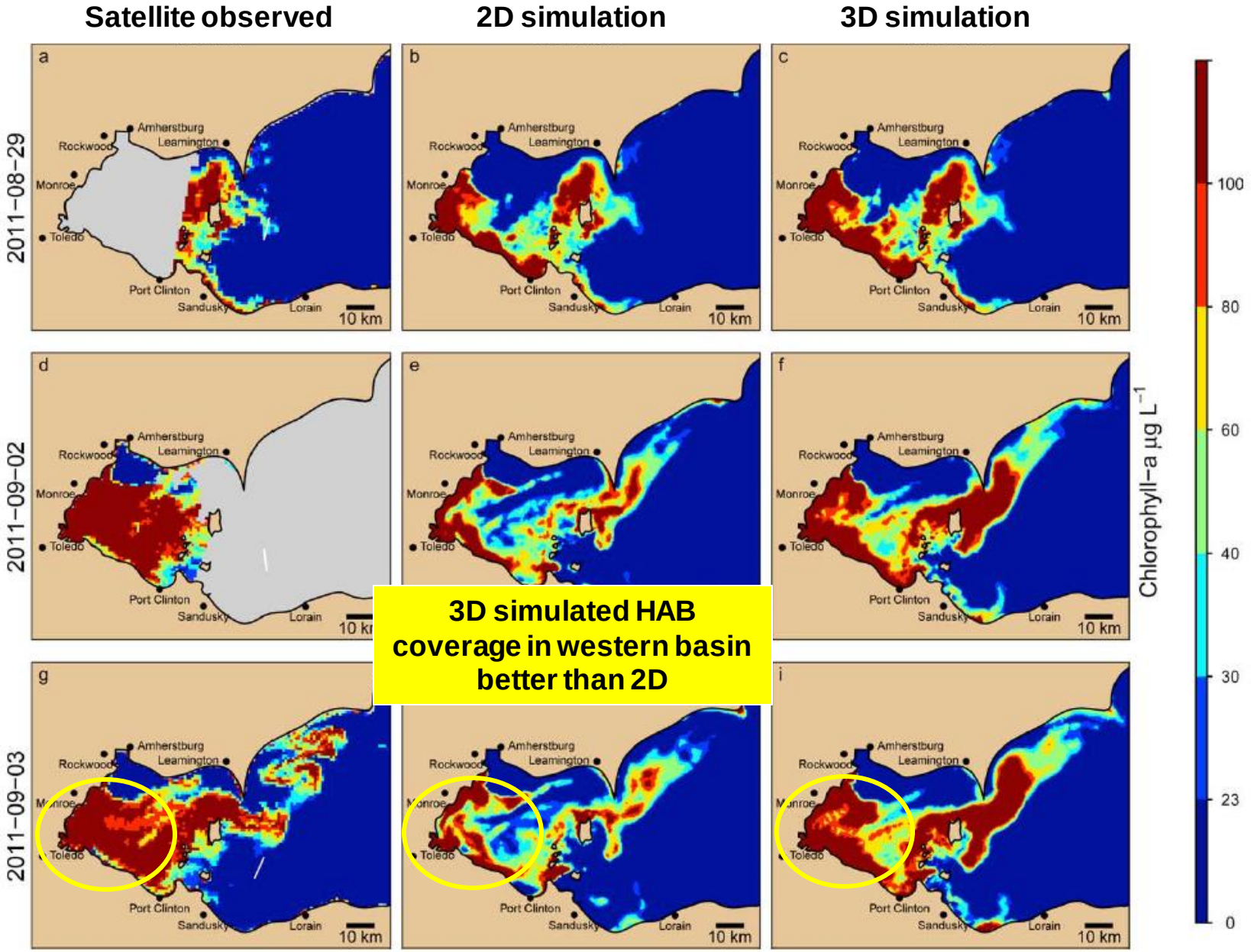

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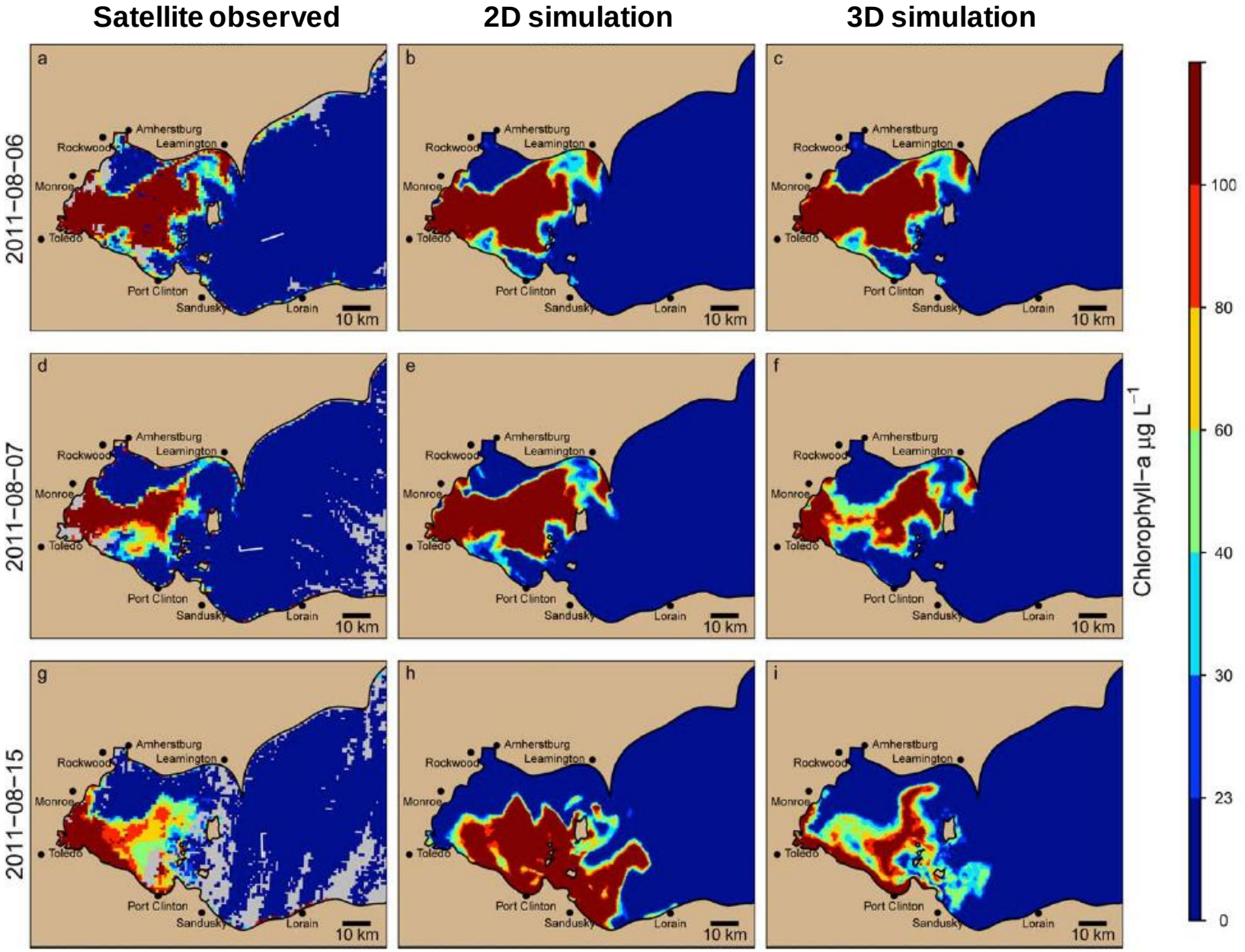

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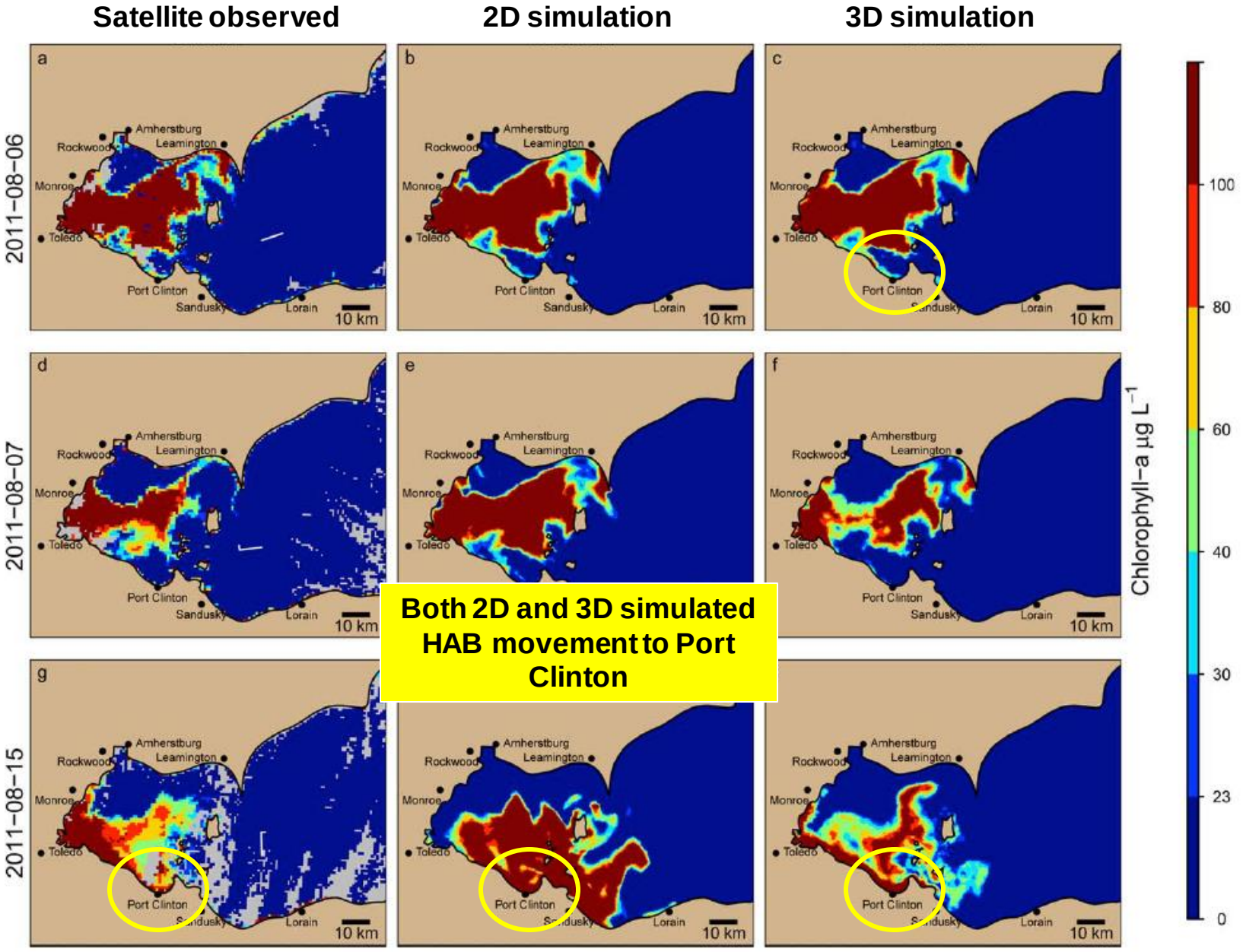

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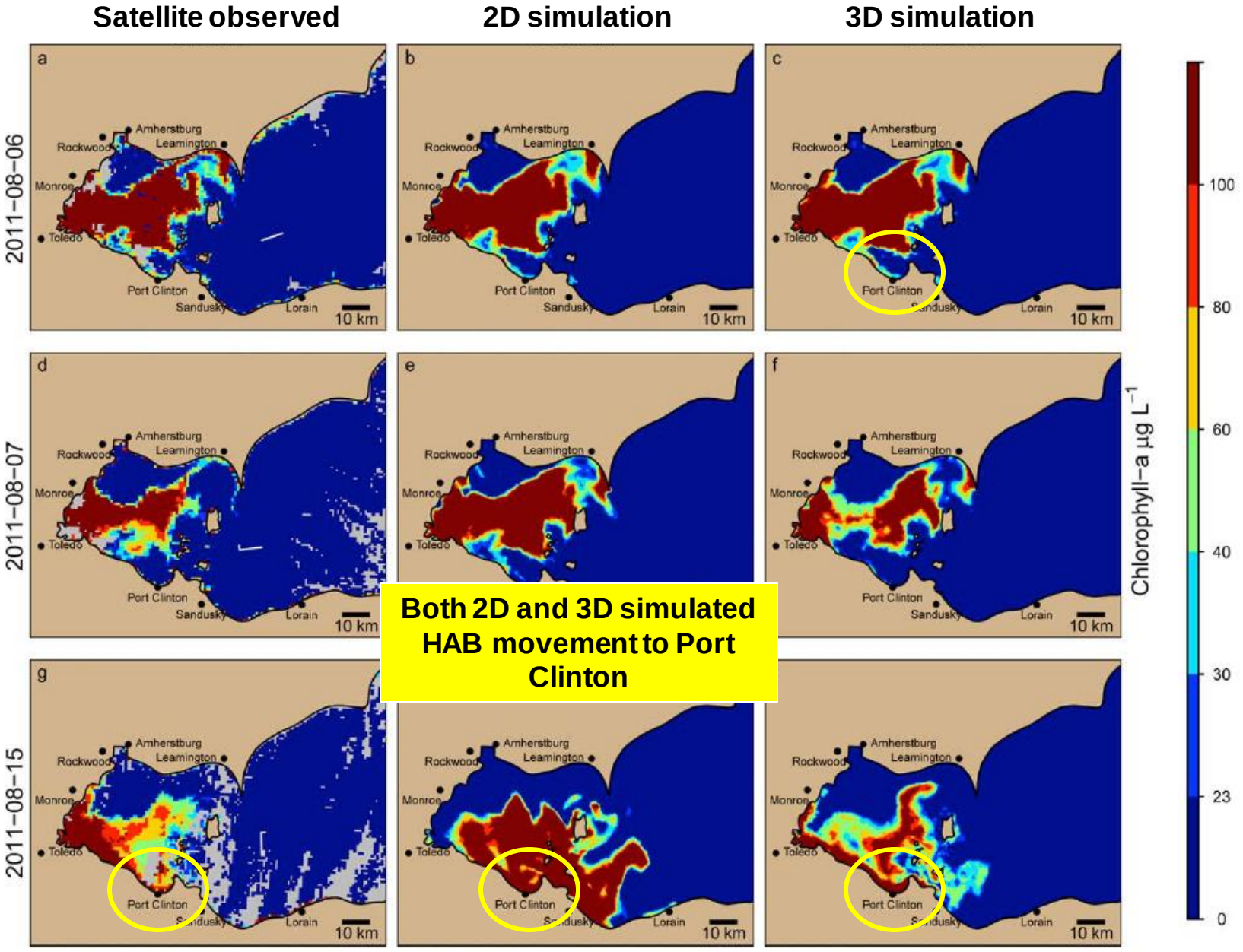
Model assessment



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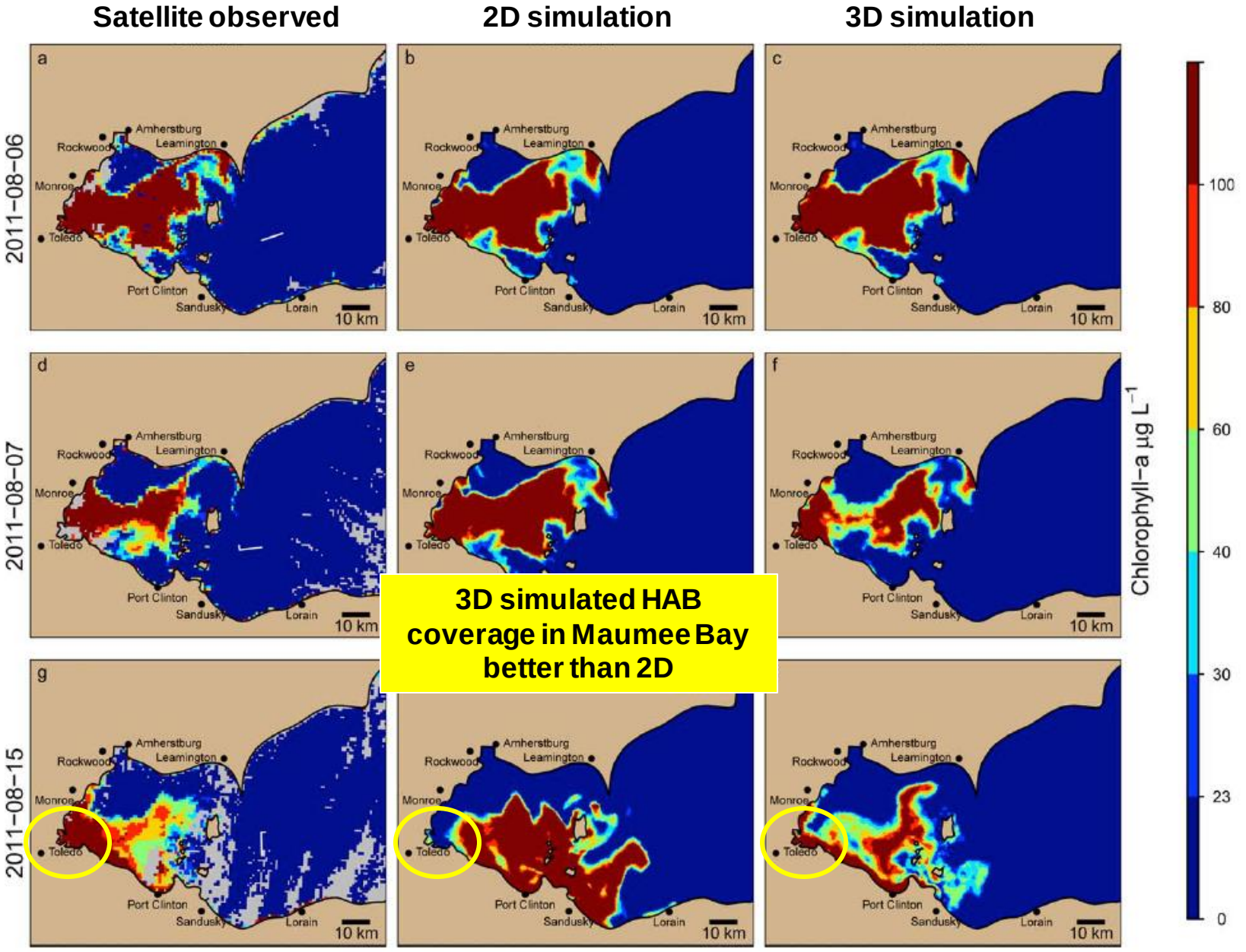
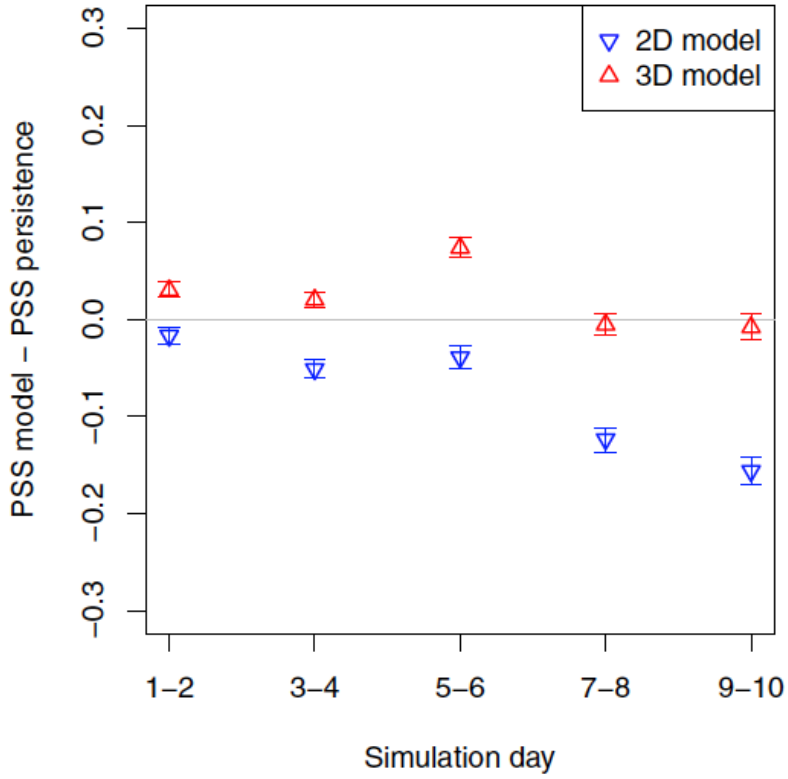


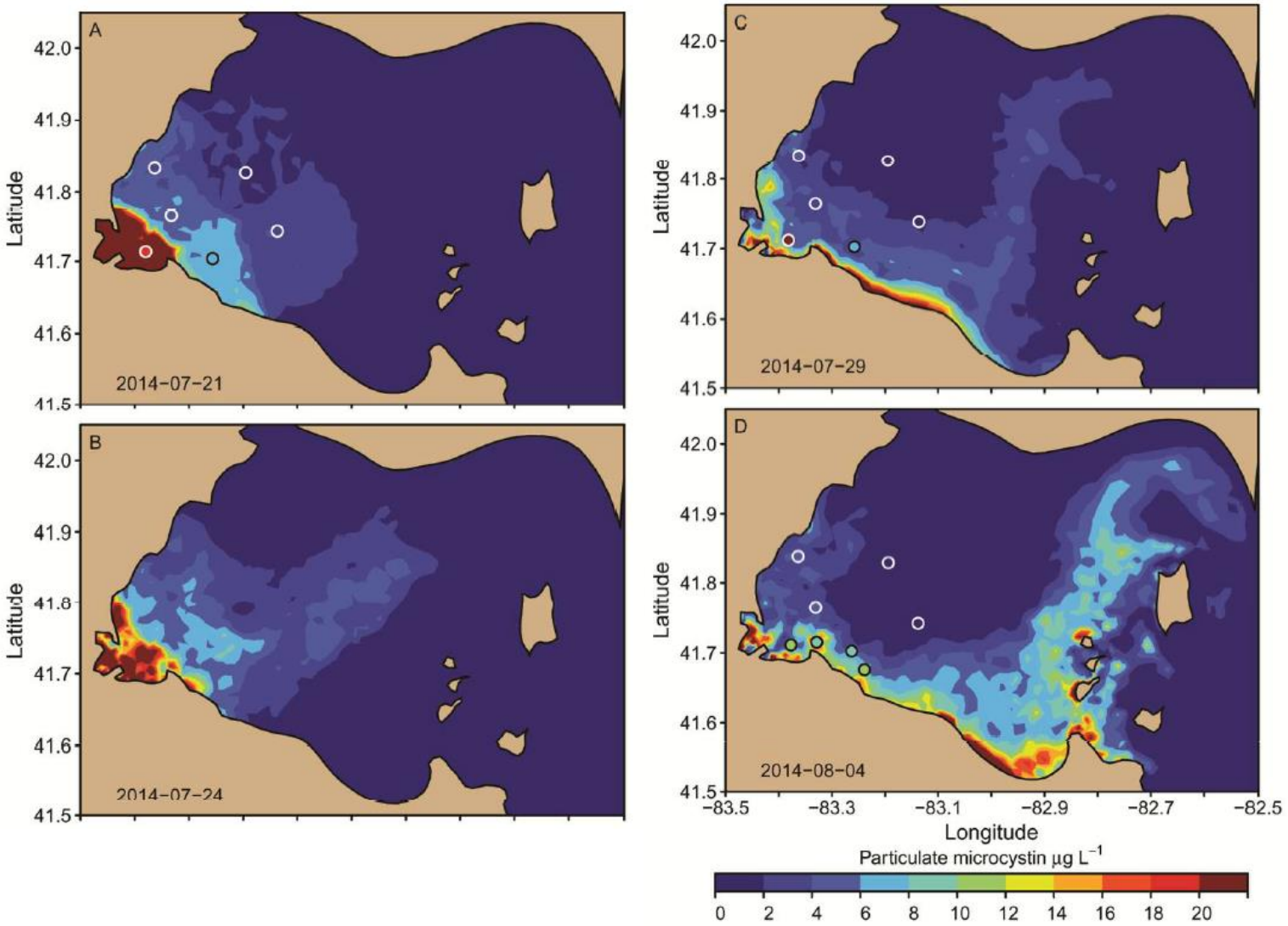
Rowe et al. 2016. J. Geophys. Res. Oceans, 121, doi:10.1002/2016JC011720.

Improved prediction statistics relative to previous model and “persistence forecast”



Rowe et al. 2016. J. Geophys. Res. Oceans, 121, doi:10.1002/2016JC011720.

Modeled transport of algal toxins out of Maumee Bay during 2014 Toledo water crisis event



Steffen et al. 2017. Environ. Sci. Technol. 51, 6745−6755

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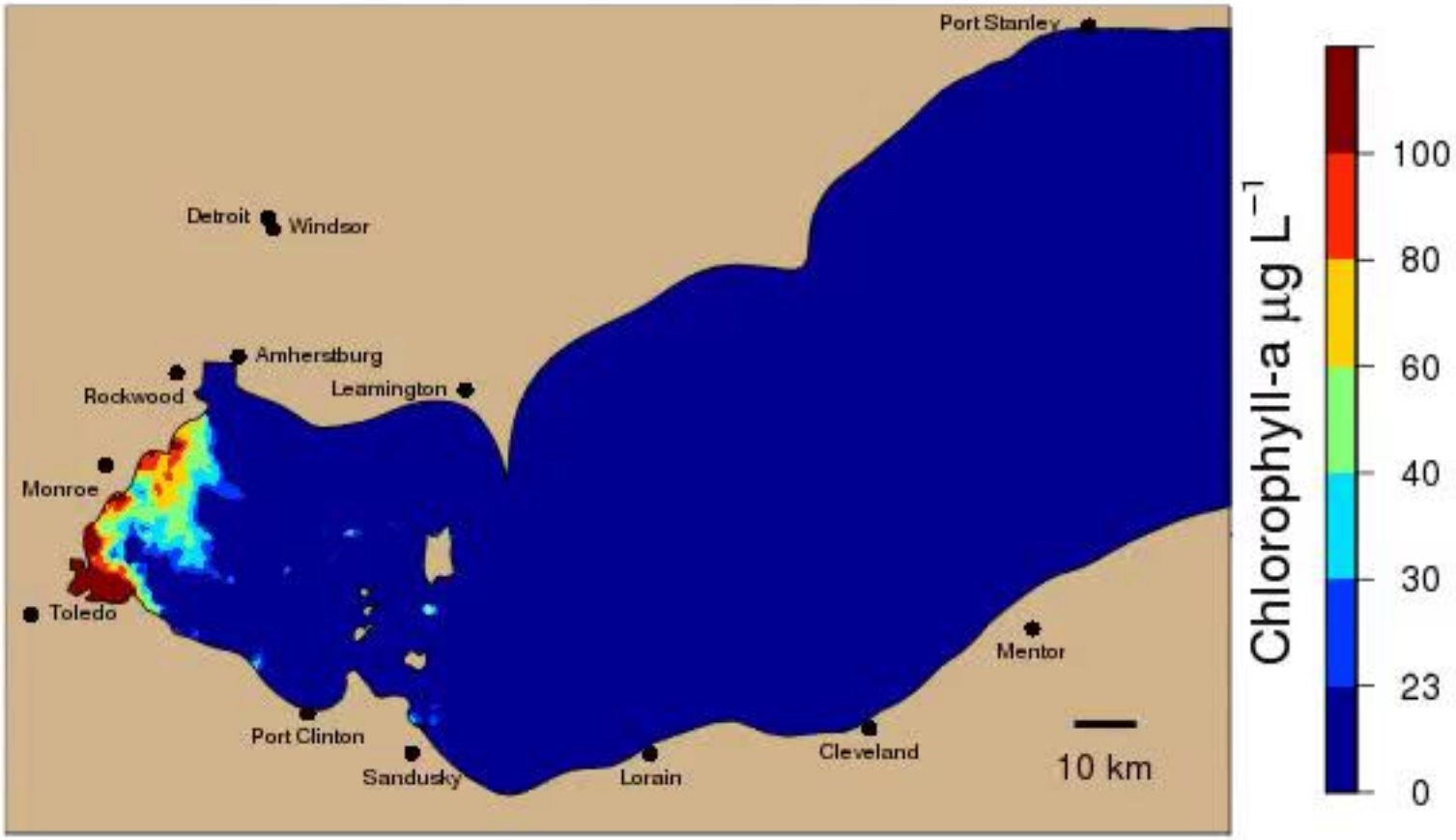
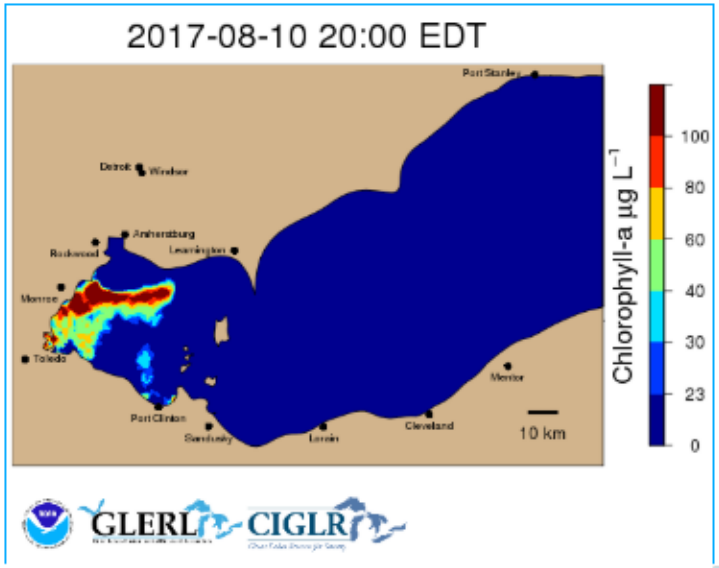


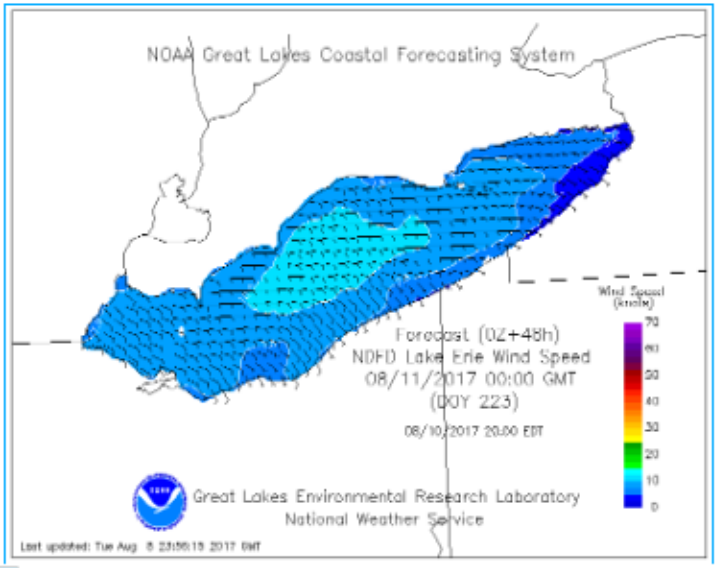
Lake Erie HAB Tracker website

https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html

HAB Tracker forecast



GLCFS nowcast & 5-day wind speed forecast



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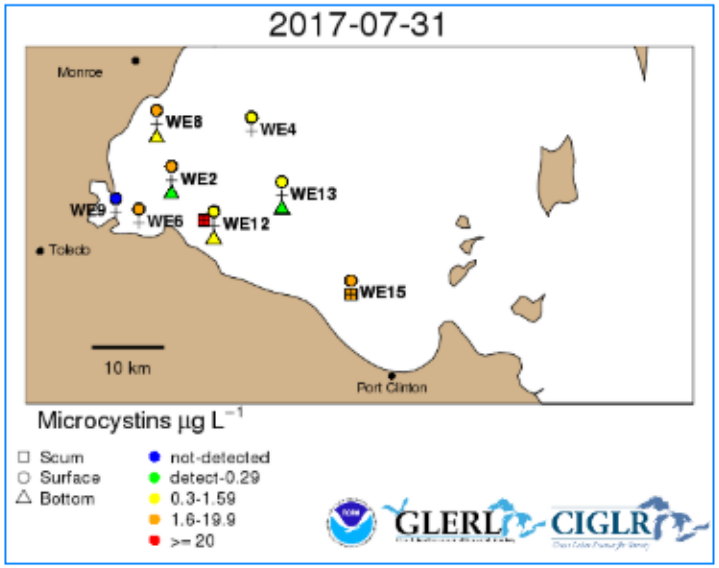
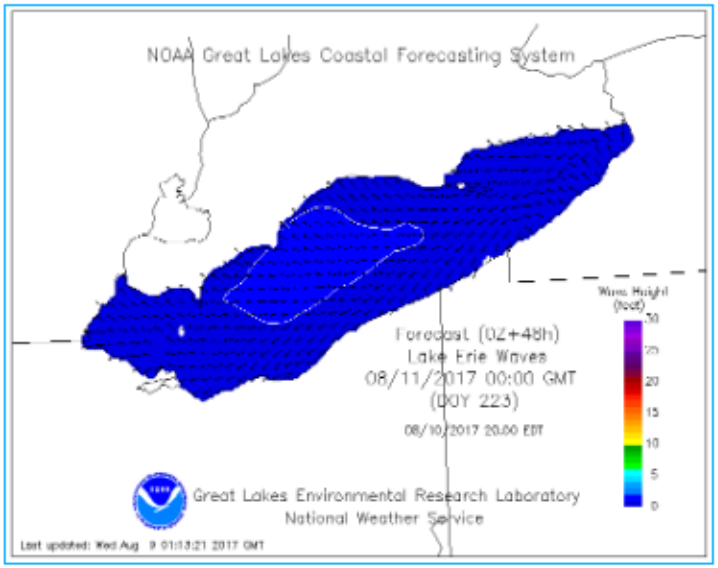
Latest reported microcystins concentrations

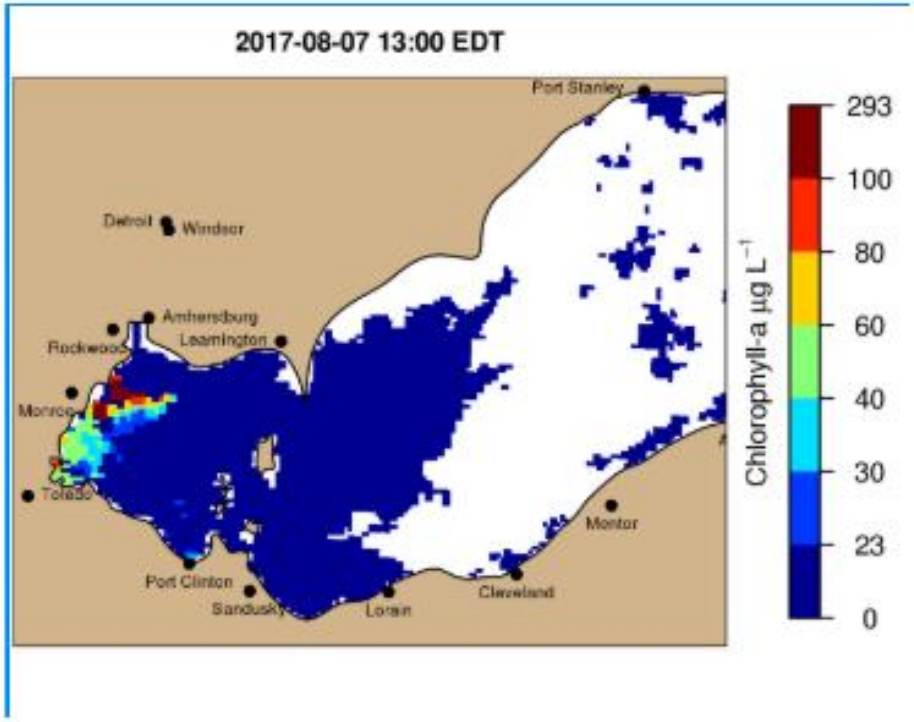


GLCFS nowcast & 5-day wave height forecast

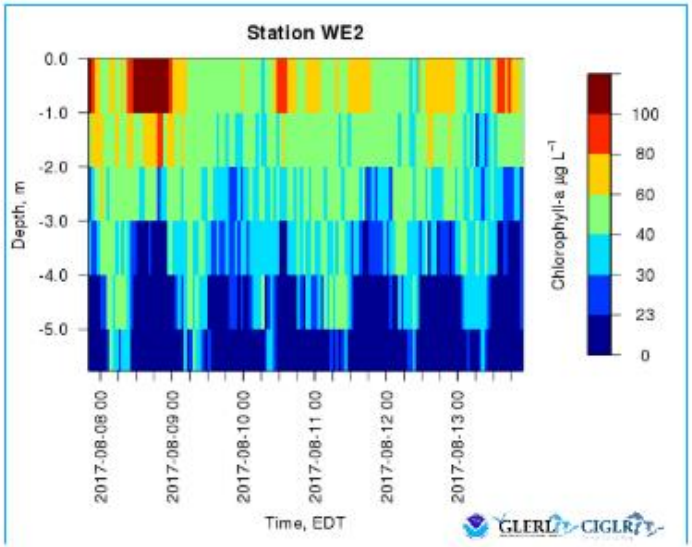


True-color satellite image of Lake Erie

HABs extent analysis

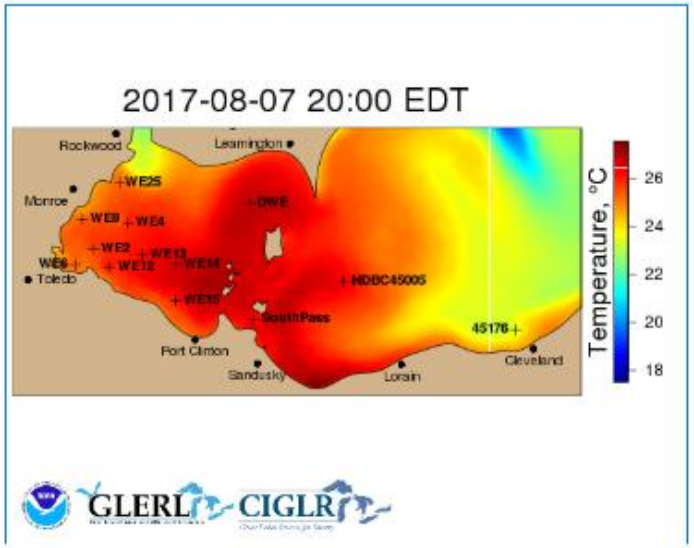


HAB Tracker forecast at selected station



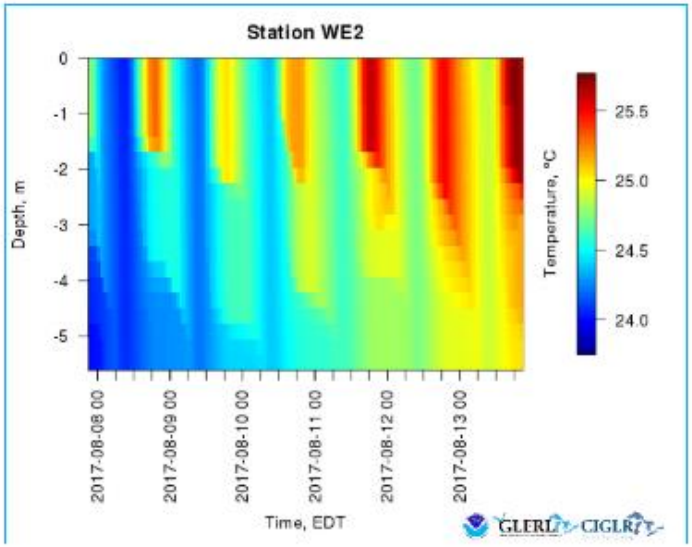
Vertical distribution of buoyant *Microcystis* colonies at the selected station.

Click on + to select station and update plots

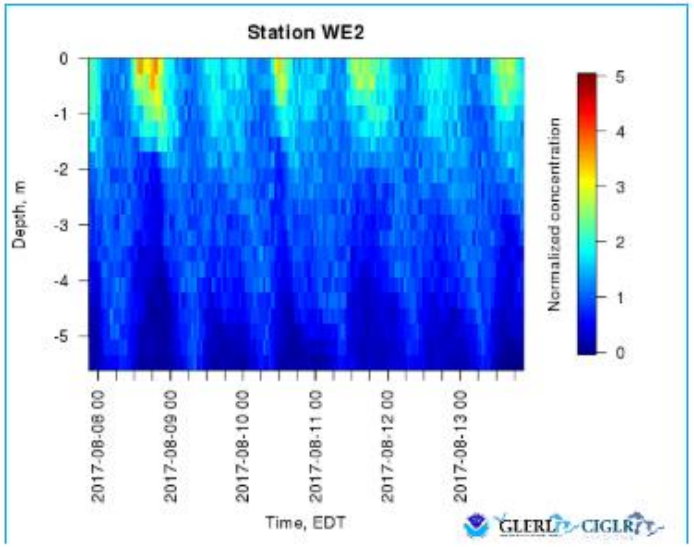


Station locations and modeled lake surface temperature.

Modeled water temperature at selected station

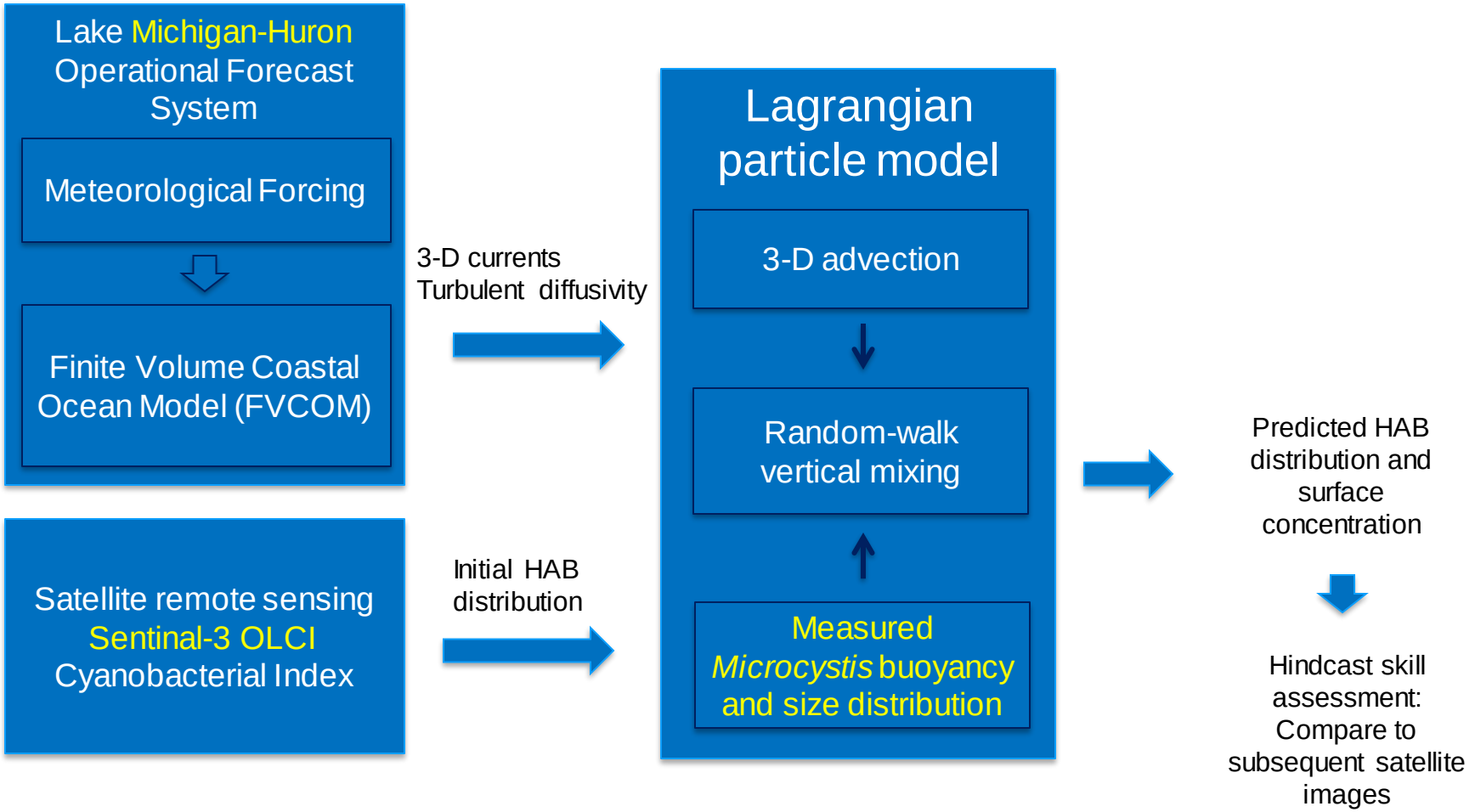


Vertical mixing conditions for buoyant *Microcystis*



Proposed Experimental Saginaw Bay HAB Tracker

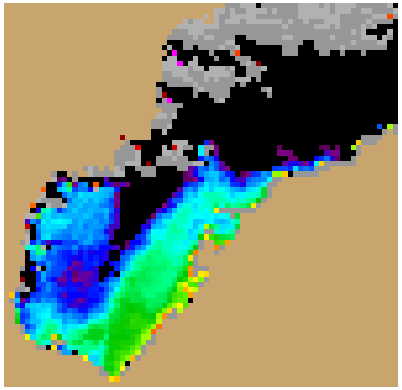
Components of the Saginaw Bay HAB Tracker

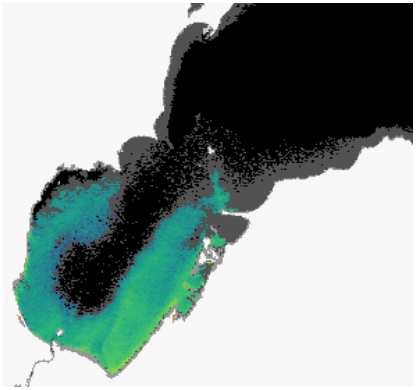


NASA Aqua
Moderate Resolution Imaging Spectroradiometer (MODIS)

ESA Sentinal-3
OLCI (Ocean and Land Color Instrument)

2017-8-15





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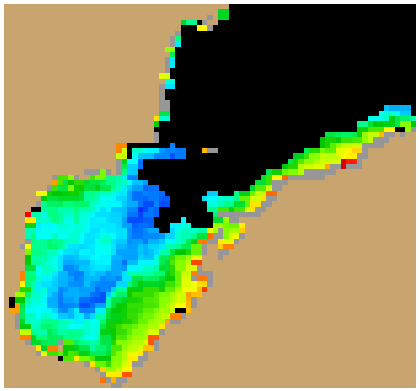

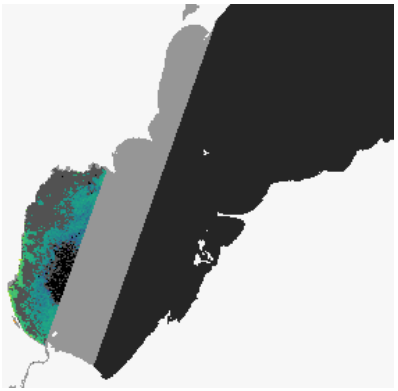

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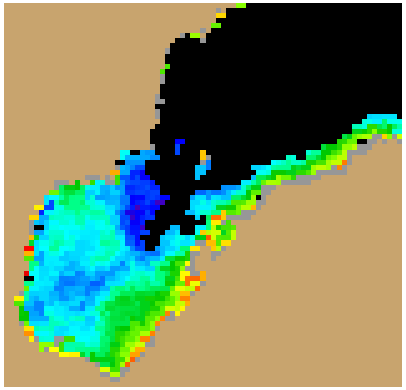
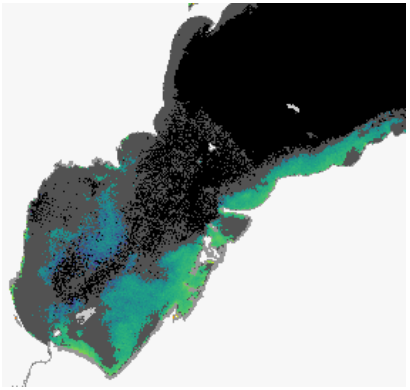
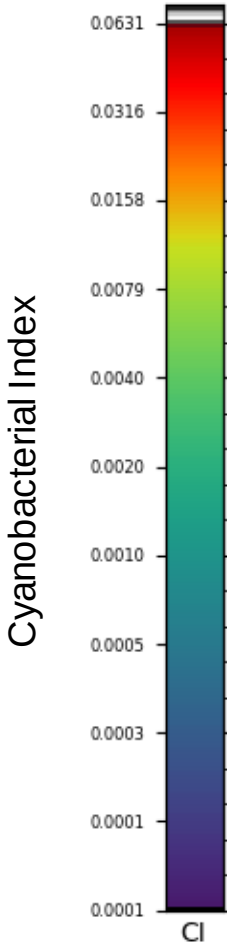


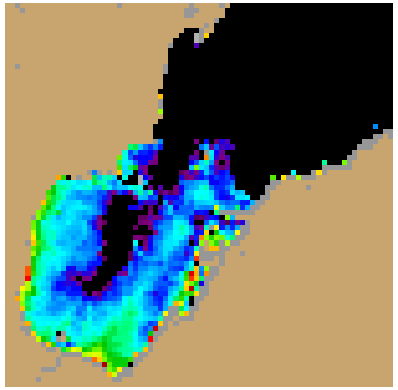


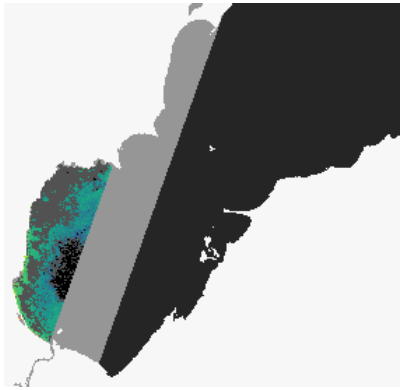


NASA Terra
Moderate Resolution Imaging Spectroradiometer (MODIS)

ESA Sentinal-3
OLCI (Ocean and Land Color Instrument)

2017-8-25





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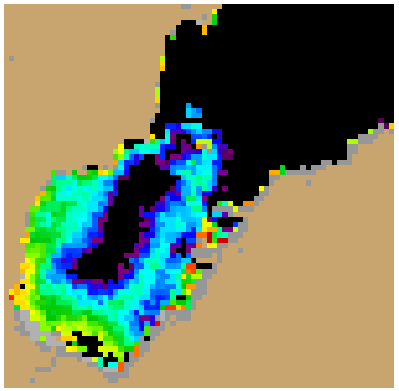

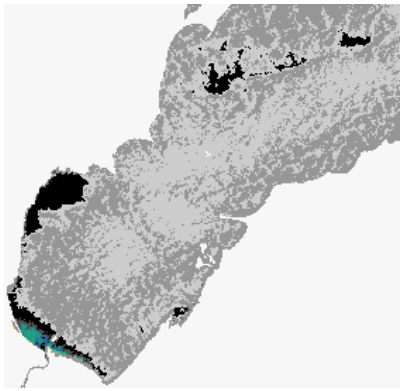

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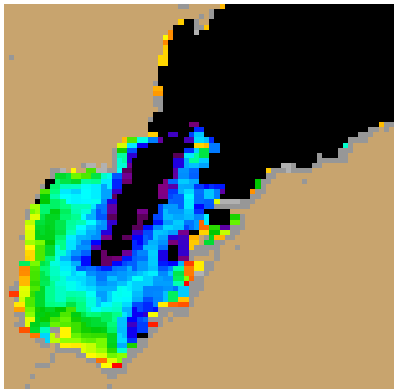
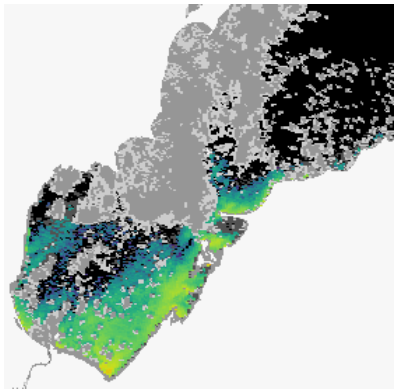
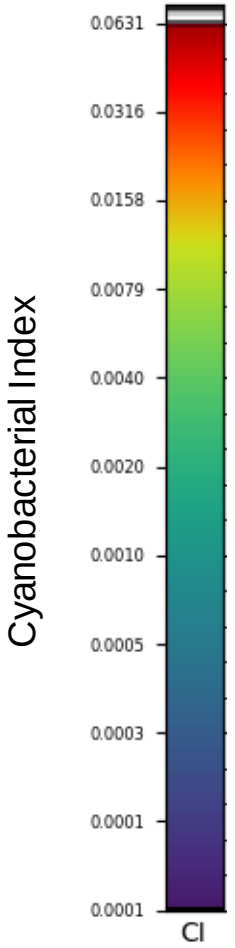
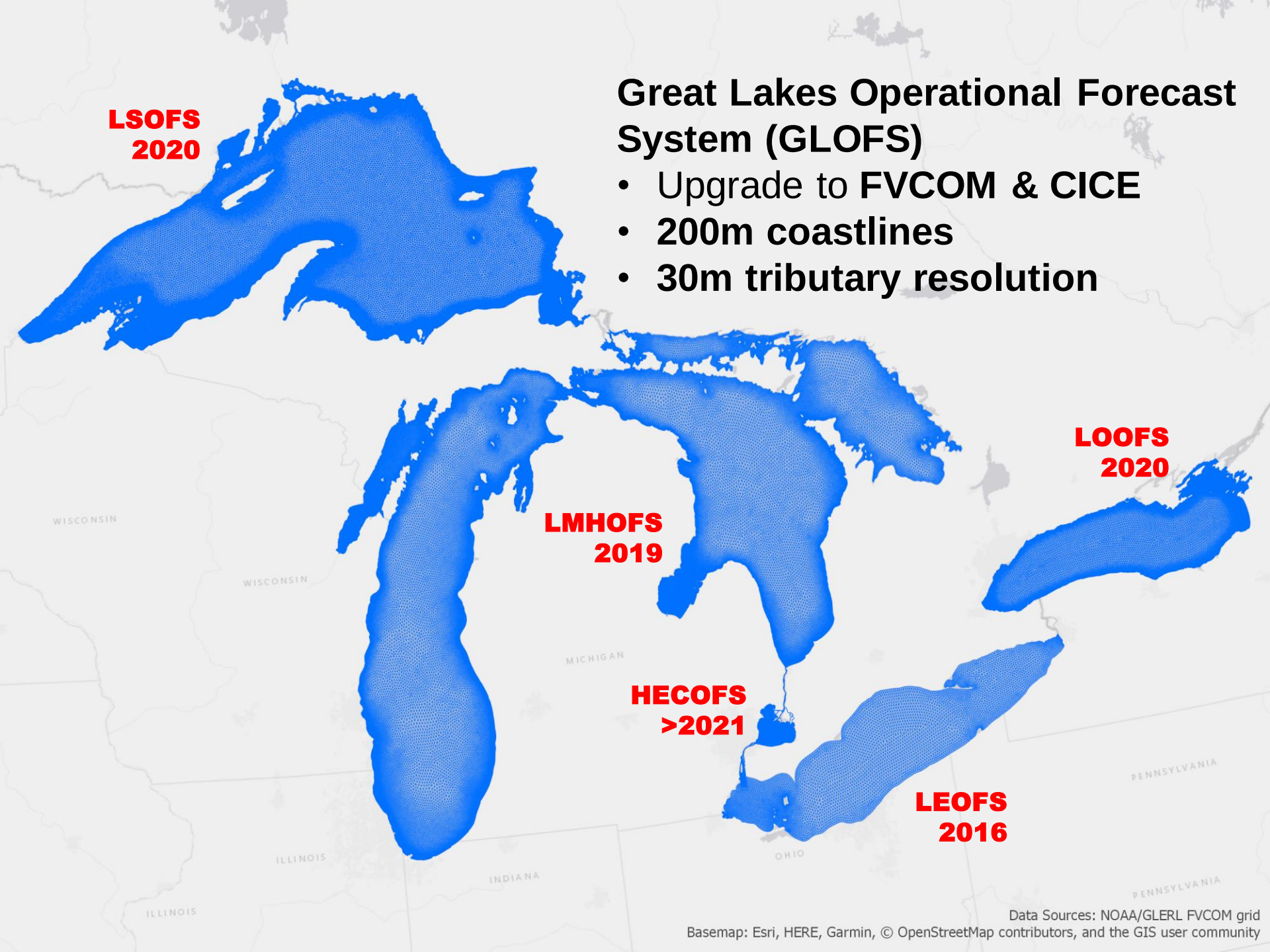




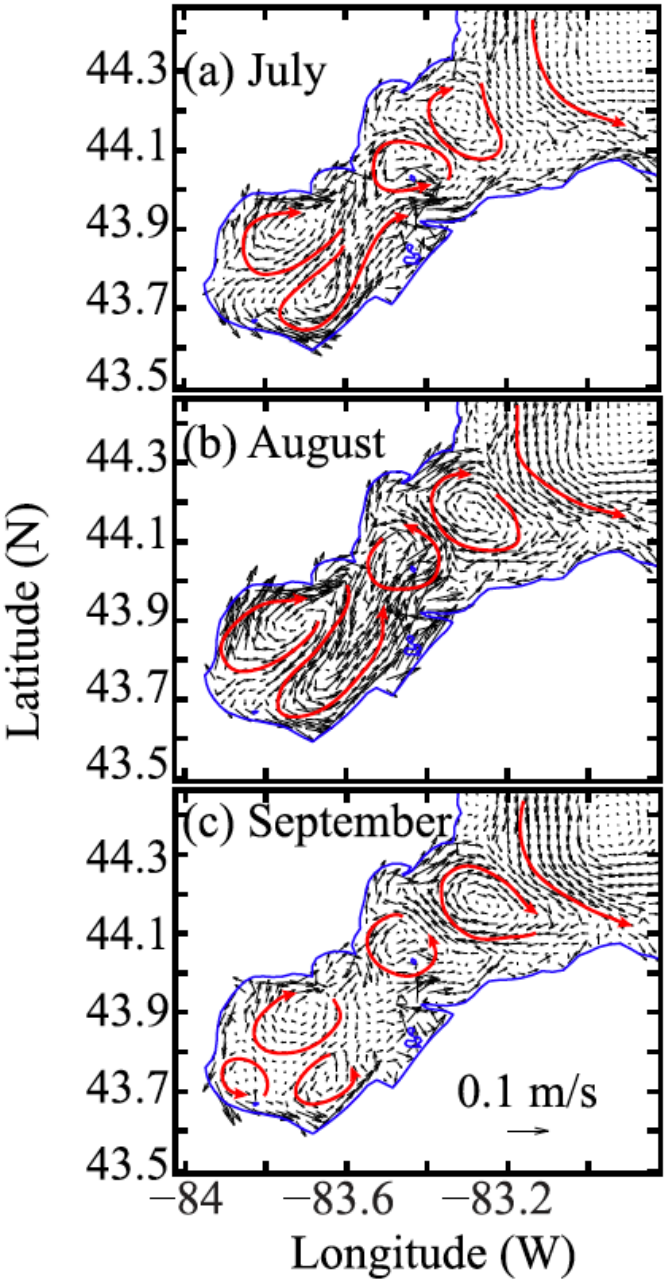




Great Lakes Operational Forecast System (GLOFS)

- Upgrade to **FVCOM & CICE**
- **200m coastlines**
- **30m tributary resolution**

Data Sources: NOAA/GLERL FVCOM grid
Basemap: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community



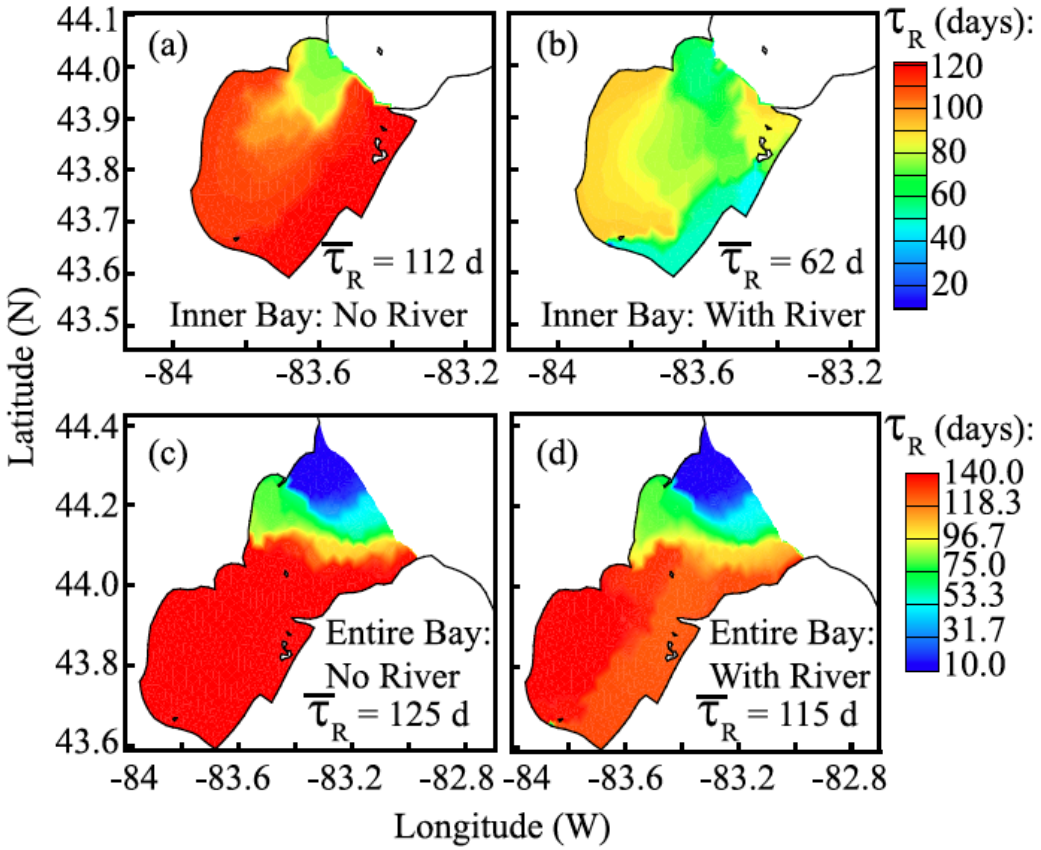
Mean summer circulation of Saginaw Bay Lake Huron

- Anti-cyclonic (clockwise) lake-wide circulation
- Greater current speed nearshore than lake-wide mean (~20 cm/s vs 3 cm/s)
- Mean flushing time for inner bay ~10 days, also affected by river discharge and water level

Nguyen et al. 2014. J. Geophys. Res. 10.1002/2014JC009828

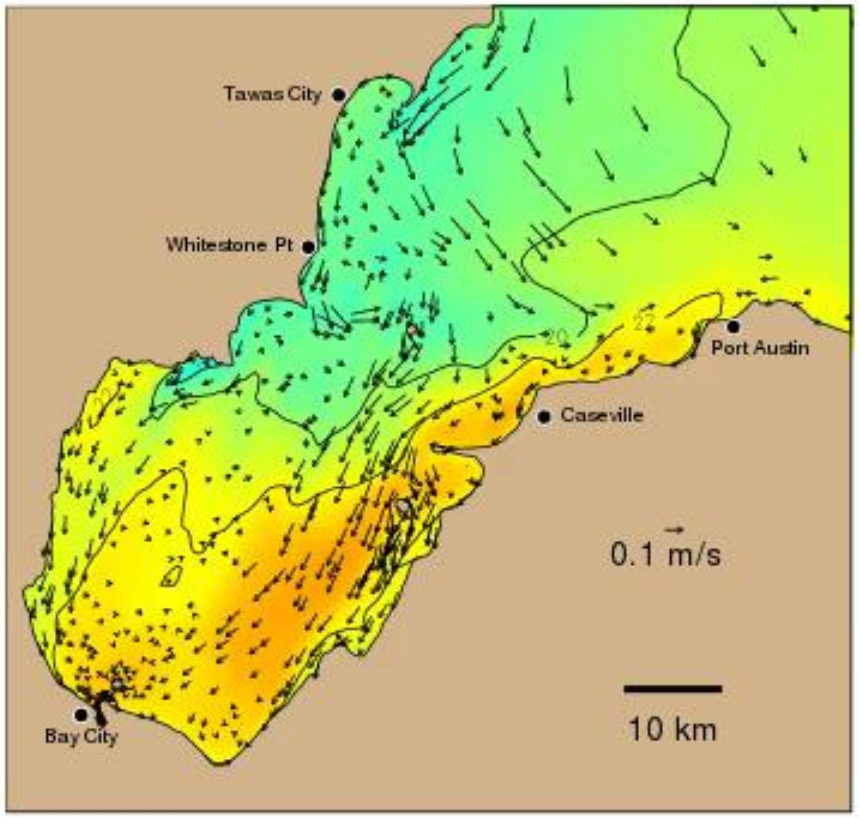
Mean flushing time of Saginaw Bay Lake Huron

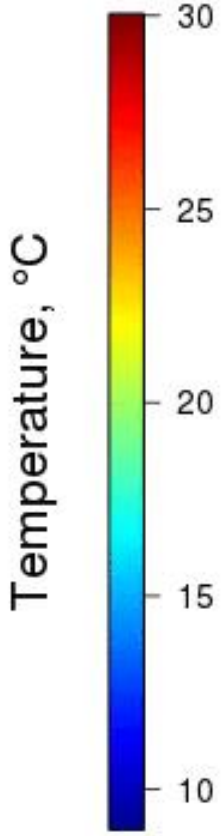
- Mean flushing time for inner bay ~10 days, also affected by river discharge and water level



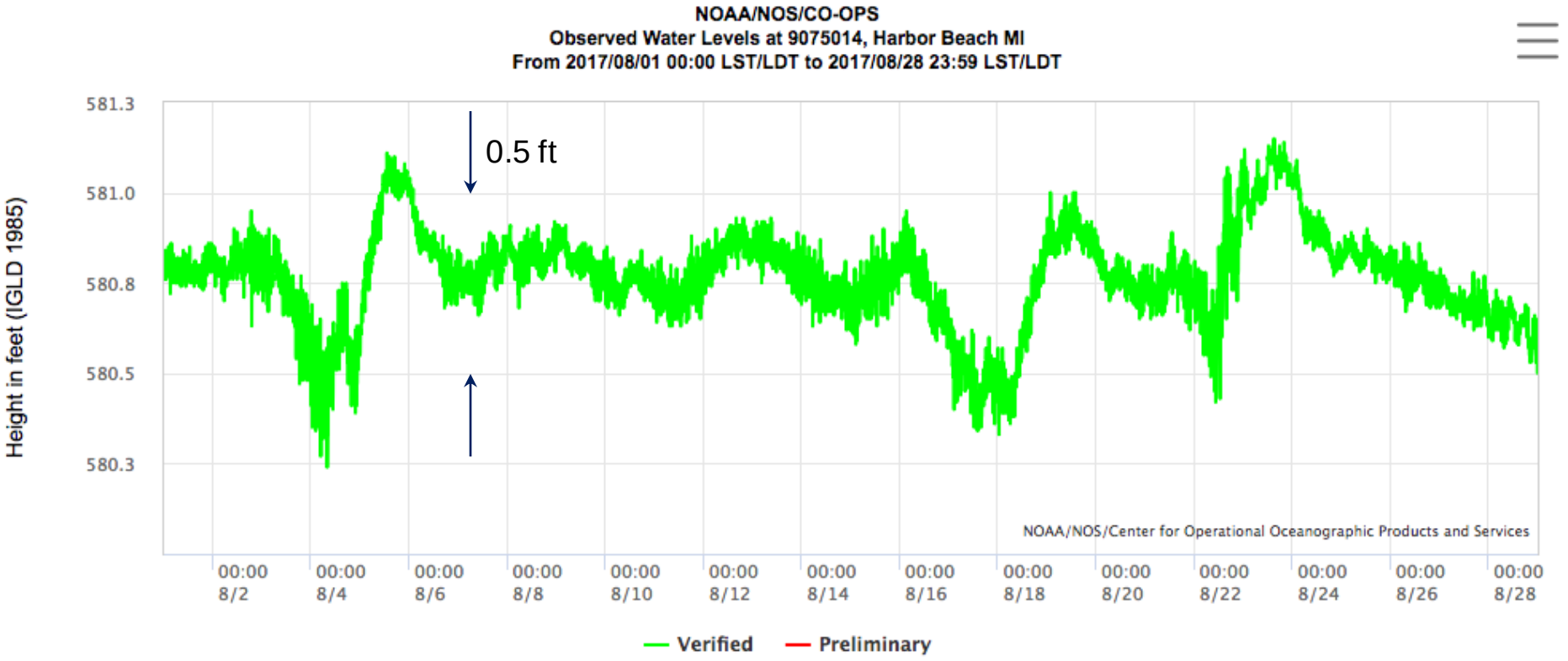
Nguyen et al. 2014. J. Geophys. Res. 10.1002/2014JC009828

2017-07-15 01:00:00





Water level varies due to seiche, causing flow in or out of Saginaw Bay



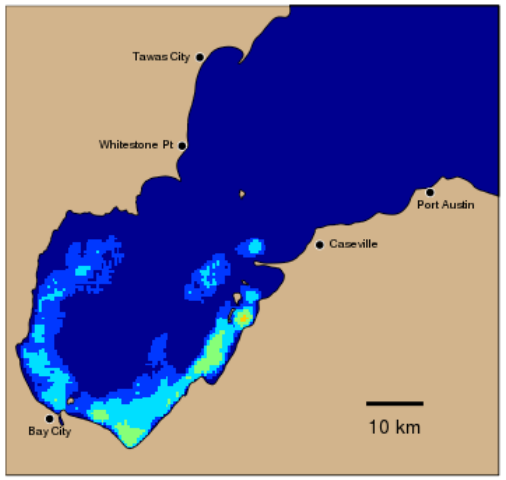
https://tidesandcurrents.noaa.gov/waterlevels.html

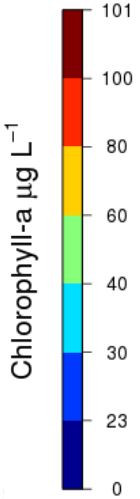
Satellite observed

Model

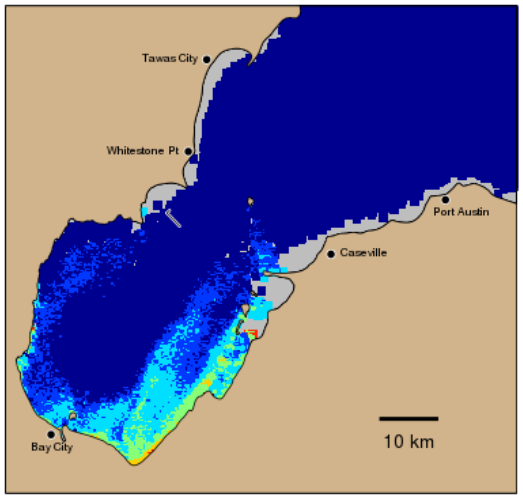
Initial condition

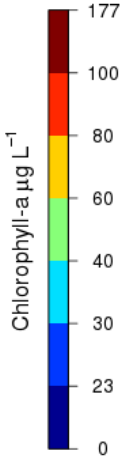
2017-08-15 12:00 EDT





2017-08-15 11:44 EDT

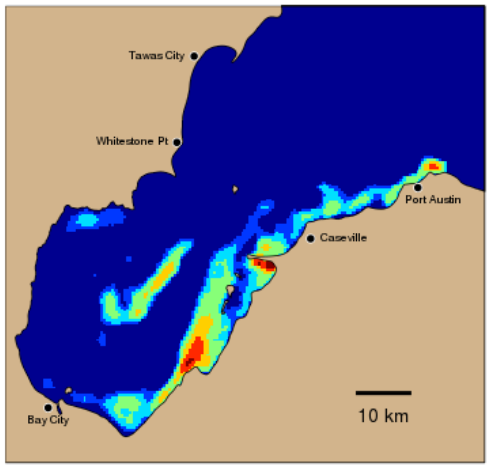




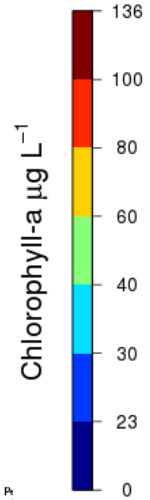
pct good = 87.6 pct HAB = 16.5 pct > Chl threshold = 16.5

Predicted day 4

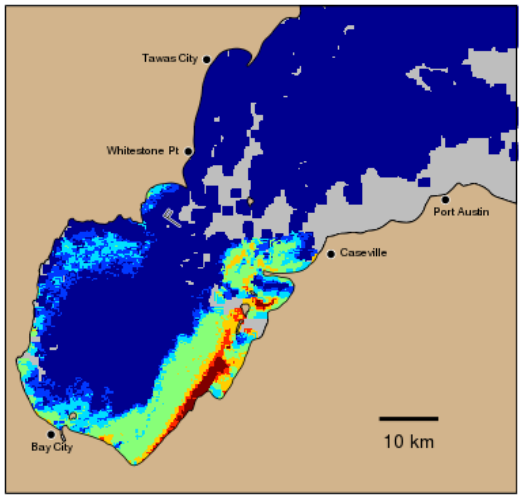
2017-08-19 11:00 EDT

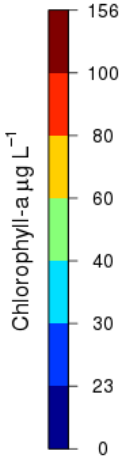


nObsHab	nObsNoHab	nPredHab	nPredNoHab	pctAccHab	pctAccNoHab	pctAccAll	chlPctBias	chlRmse	chlCor
2257	2961	1957	3261	73	90	83	-32	19	0.77
2257	2961	1509	3709	53	89	73	-26	21	0.65



2017-08-19 11:40 EDT





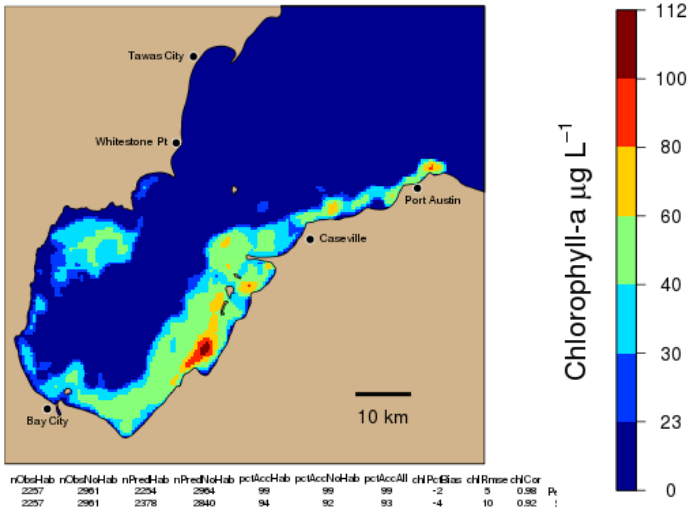
pct good = 76.6 pct HAB = 21.4 pct > Chl threshold = 21.4

Satellite observed

Model

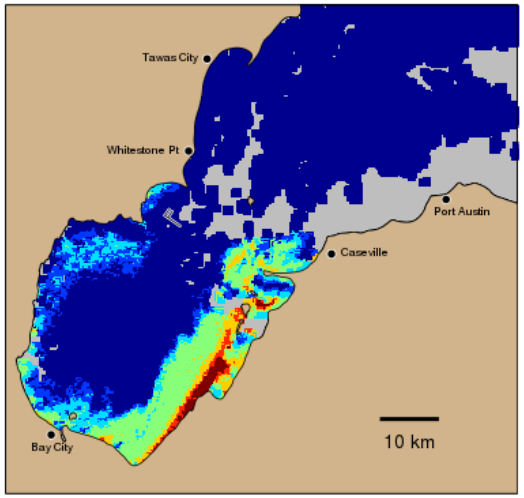
Initial condition

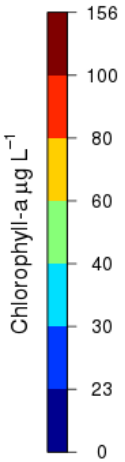
2017-08-19 11:00 EDT



nObsHab	nObsNoHab	nPredHab	nPredNoHab	pctAccHab	pctAccNoHab	pctAccAll	chlPctBias	chlRmse	cNCor
2257	2961	2254	2964	99	99	99	-2	5	0.98
2257	2961	2378	2840	94	92	93	-4	10	0.92

2017-08-19 11:40 EDT

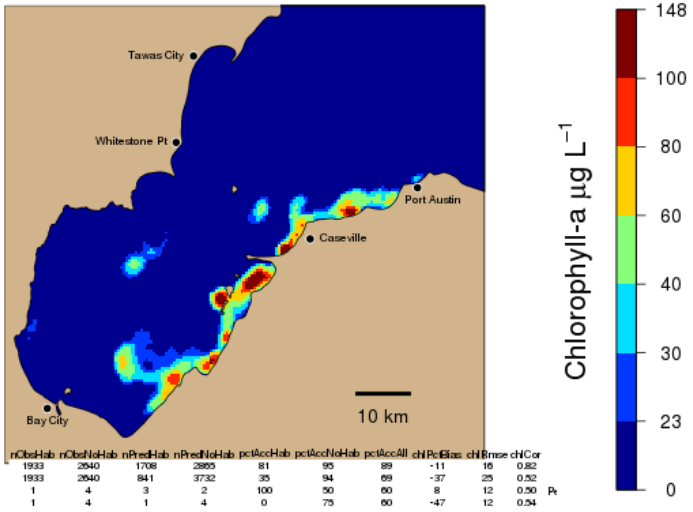




pct good = 76.6 pct HAB = 21.4 pct > Chl threshold = 21.4

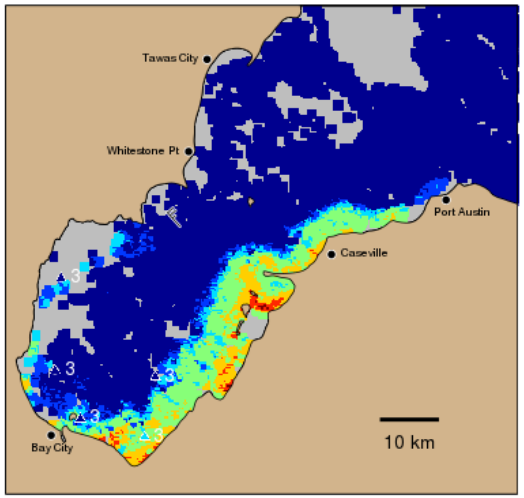
Predicted day 4

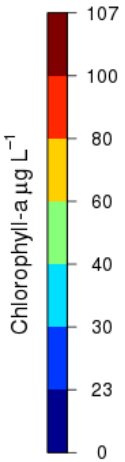
2017-08-23 11:00 EDT



nObsHab	nObsNoHab	nPredHab	nPredNoHab	pctAccHab	pctAccNoHab	pctAccAll	chlPctBias	chlRmse	cNCor
1933	2640	1708	2865	81	95	89	-11	16	0.82
1933	2640	841	3732	35	94	69	-37	25	0.52
1	4	3	2	100	50	60	8	12	0.50
1	4	1	4	0	75	60	-47	12	0.54

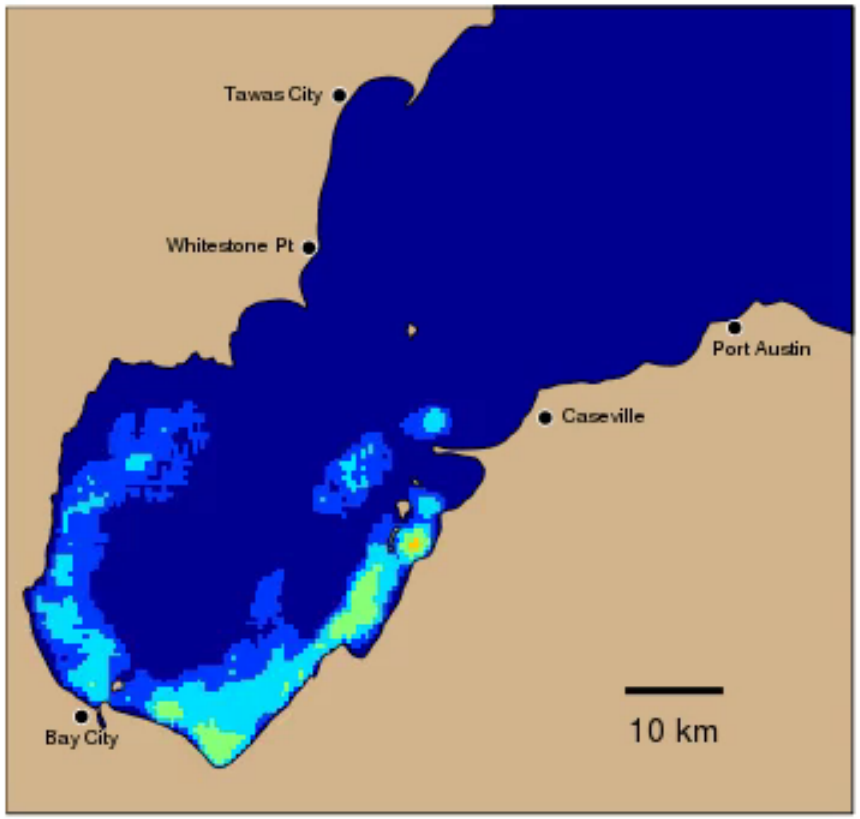
2017-08-23 11:36 EDT

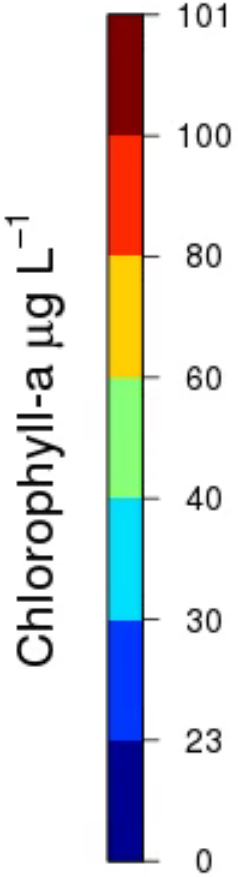




pct good = 70.4 pct HAB = 20.8 pct > Chl threshold = 20.8

2017-08-15 12:00 EDT





Summary

A short-term forecast for HAB distribution and movement could be adapted to Saginaw Bay, making use of the new Lake Michigan-Huron Operational Forecast System, and Cyanobacterial Index from new Sentinal-3 satellite.