

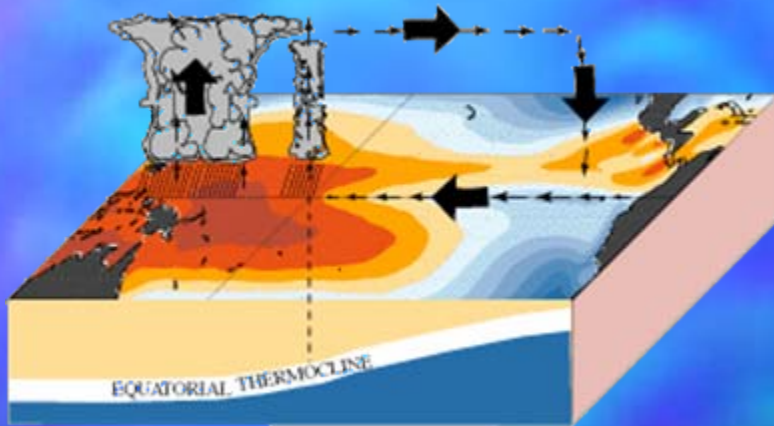
Climate-Altered Hydrology and Ecosystem Forecasting Tools

Presented by Cynthia Sellinger with generous contributions from: Stephen Brandt, David Schwab, Tom Croley and Steve Ruberg
NOAA Great Lakes Environmental Research Laboratory
Ann Arbor, MI

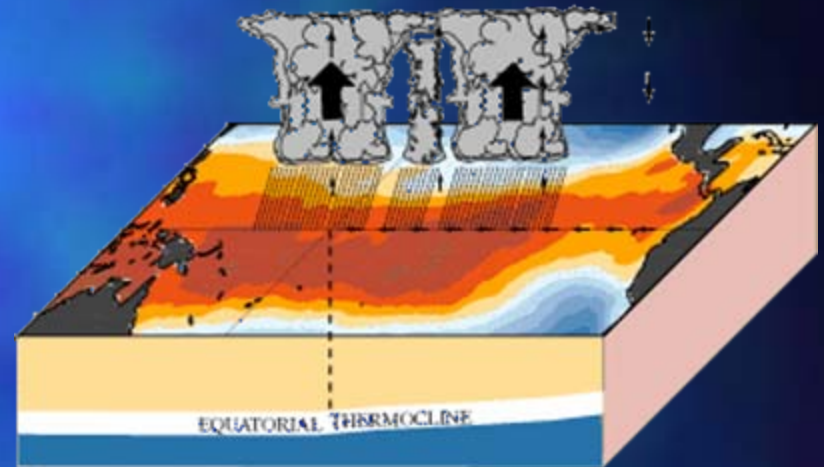


El Nino & La Nina

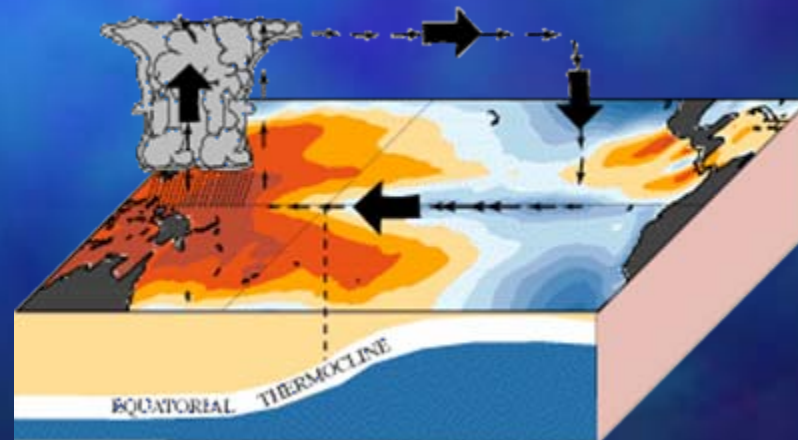
December - February Normal Conditions



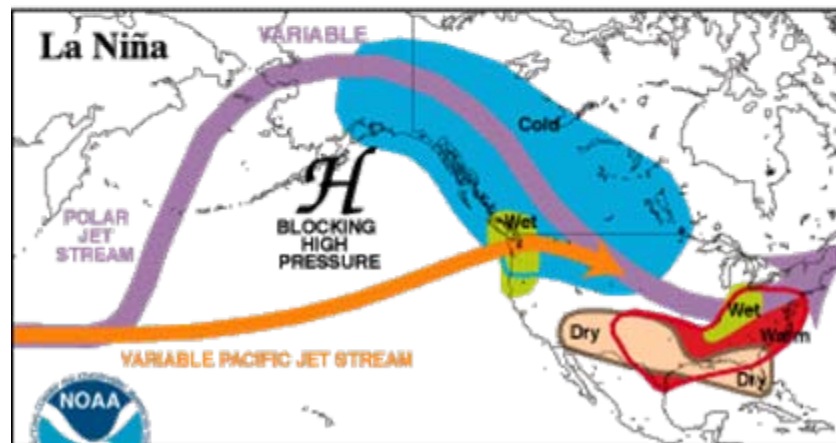
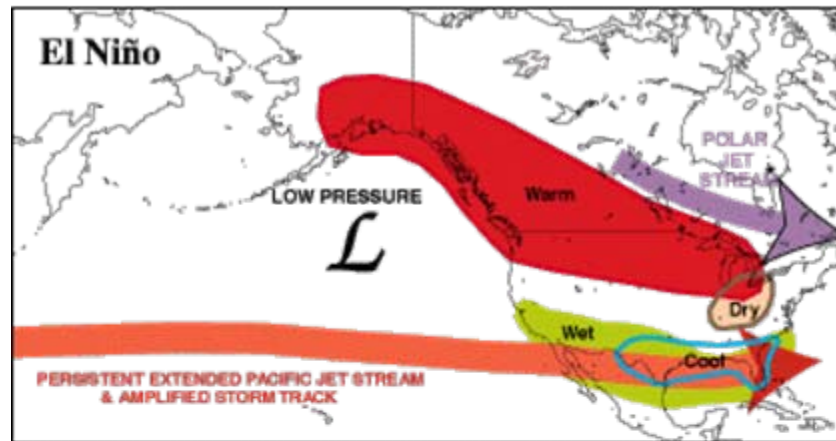
December - February El Niño Conditions



December - February La Niña Conditions



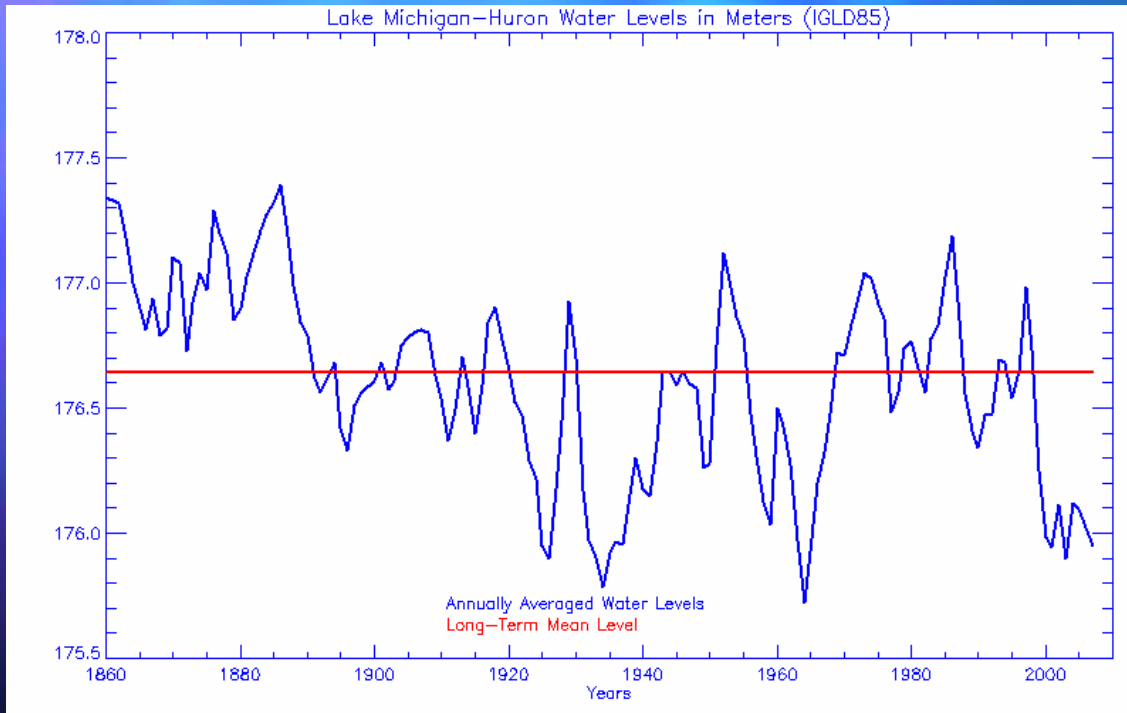
The Jet Stream



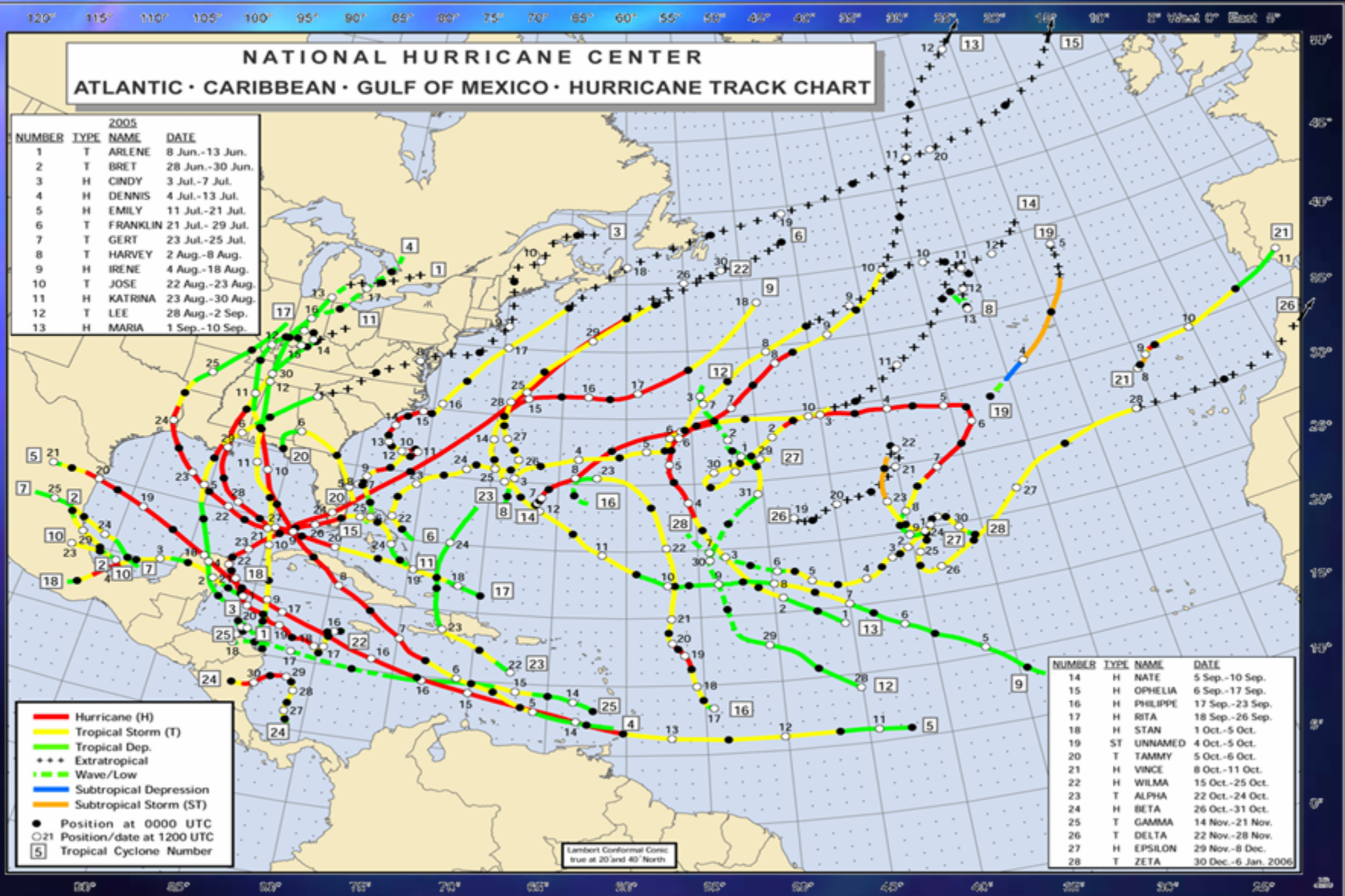
Climate Prediction Center/NCEP/NWS

Lakes Michigan-Huron Hydrograph

Old Mission Point—
October 2007



Additional Moisture to the Lower Lakes



Ohio Flooded due to remnants of Tropical Storm Erin; 22 August 2007



WTOL-TV Toledo—22
August 07; 4 – 9 inches
of rain left roads, cars
and basements
flooded.



Residents hoped to return to their water-soaked homes Thursday after heavy downpours brought the city's deepest flood waters in nearly 100 years (MSNBC—Findlay Ohio)

What Does it Mean for Water Quality?

■ Lower Water Levels



- ❖ Concentrated Pollutants?
- ❖ Increased Dead Zone?

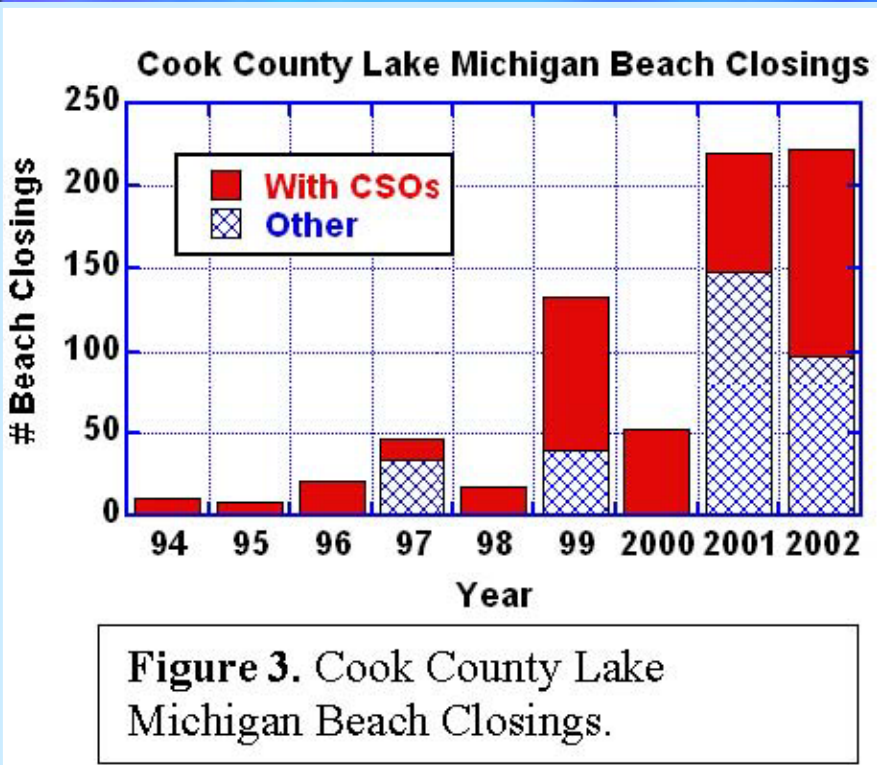
■ Increased Storm Frequency



- ❖ Flushing of Nutrients?
- ❖ Beach Closures?
- ❖ Drinking Water Quality?

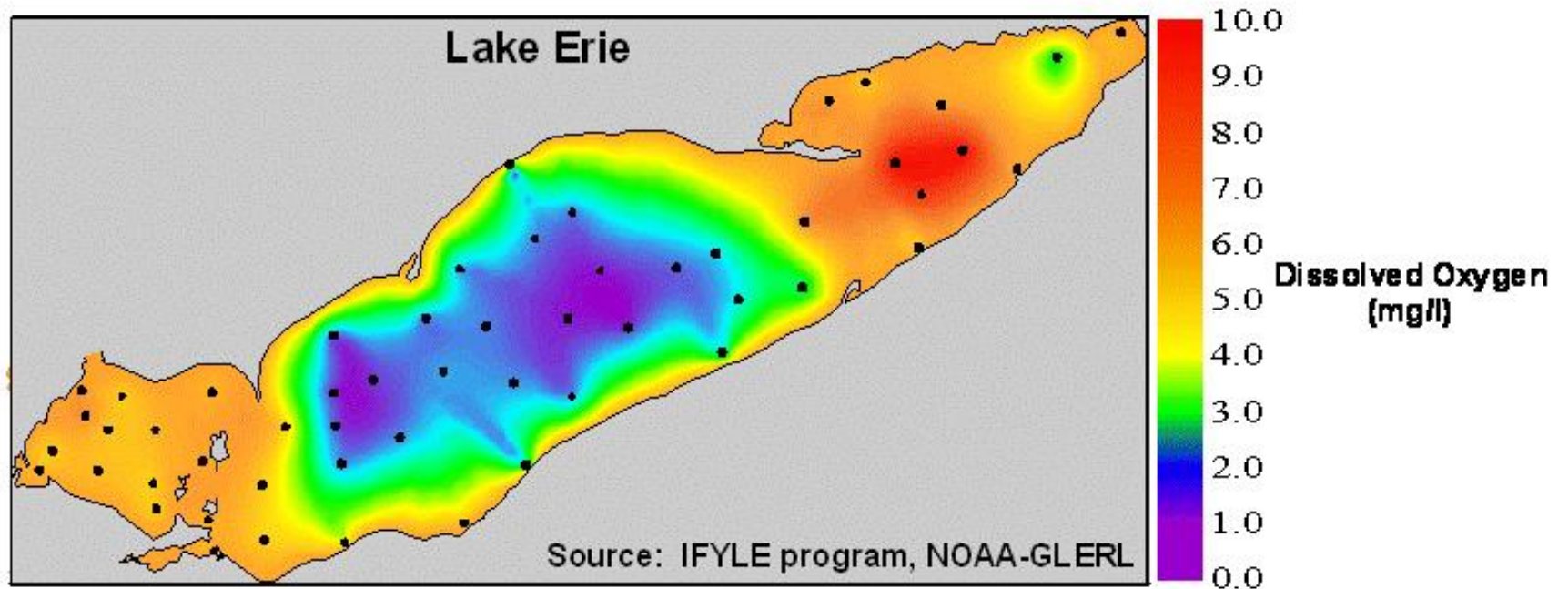


Beach Closures

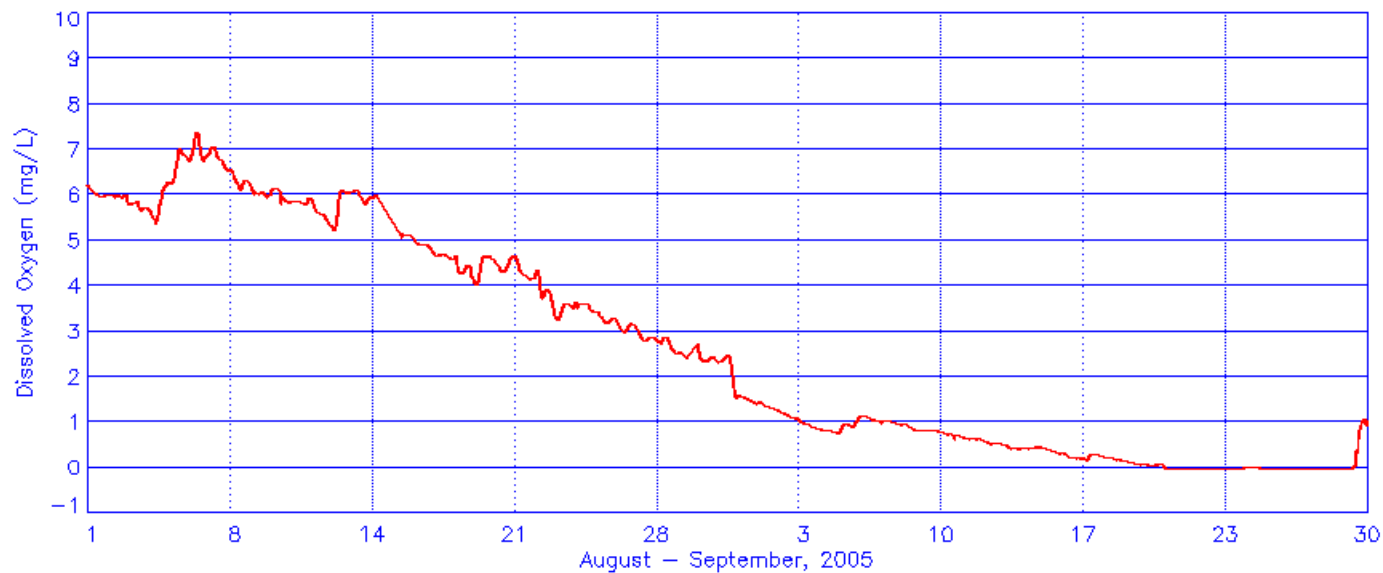
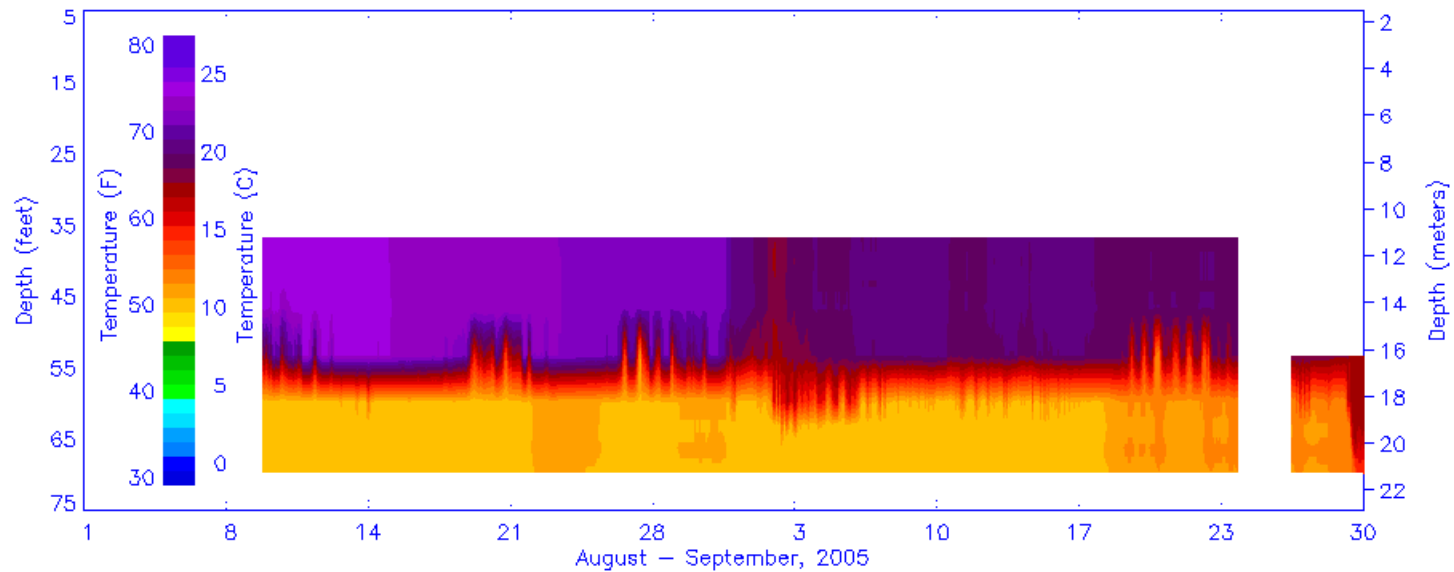


- Major health risk of microbial contamination by bacteria, viruses and protozoa in recreational waters

Lake Erie Hypoxia, September 2005



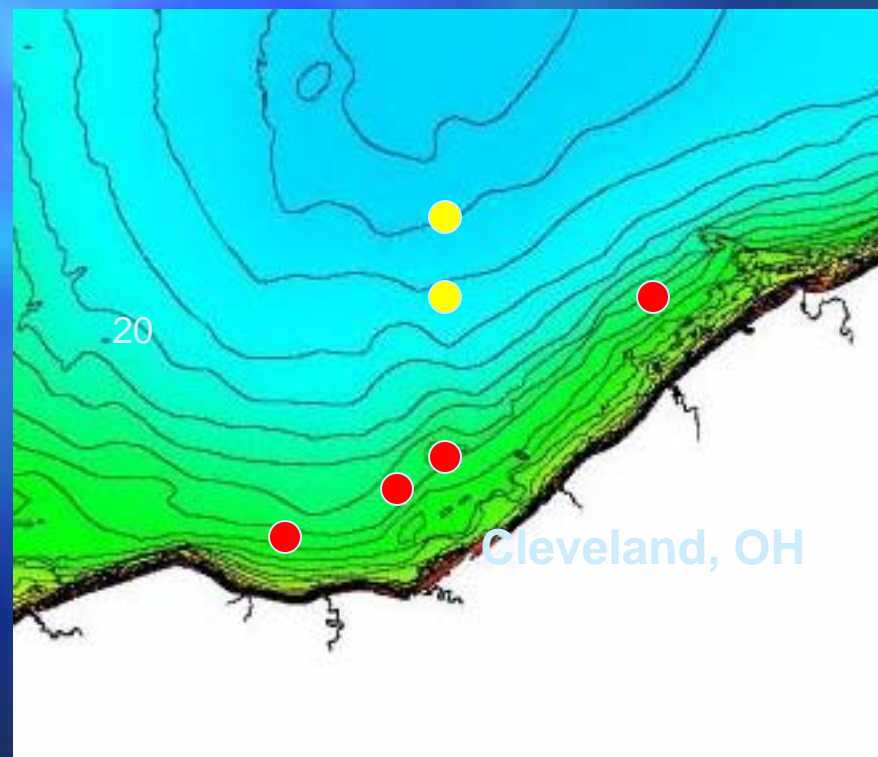
Cleveland ReCON Observations - 2005



Lake Erie Hypoxia and Drinking Water Processing

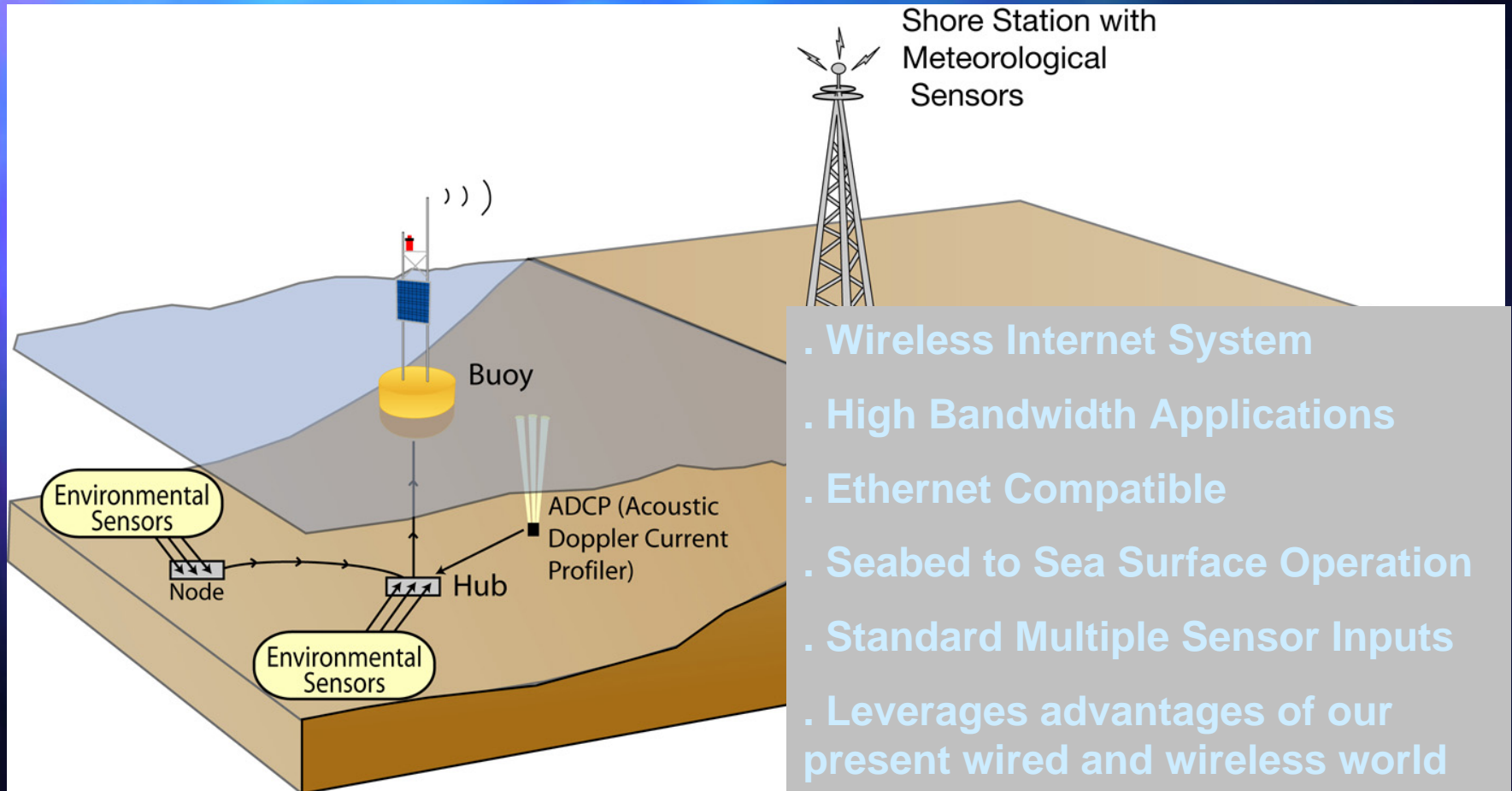
- . Hypoxic water has significantly lower temperature, lower pH, and higher Manganese levels than shore waters
- . Real-time information can allow managers to respond with alternative processing methods.

- ReCON Buoy Locations, 2007
- Water Intakes

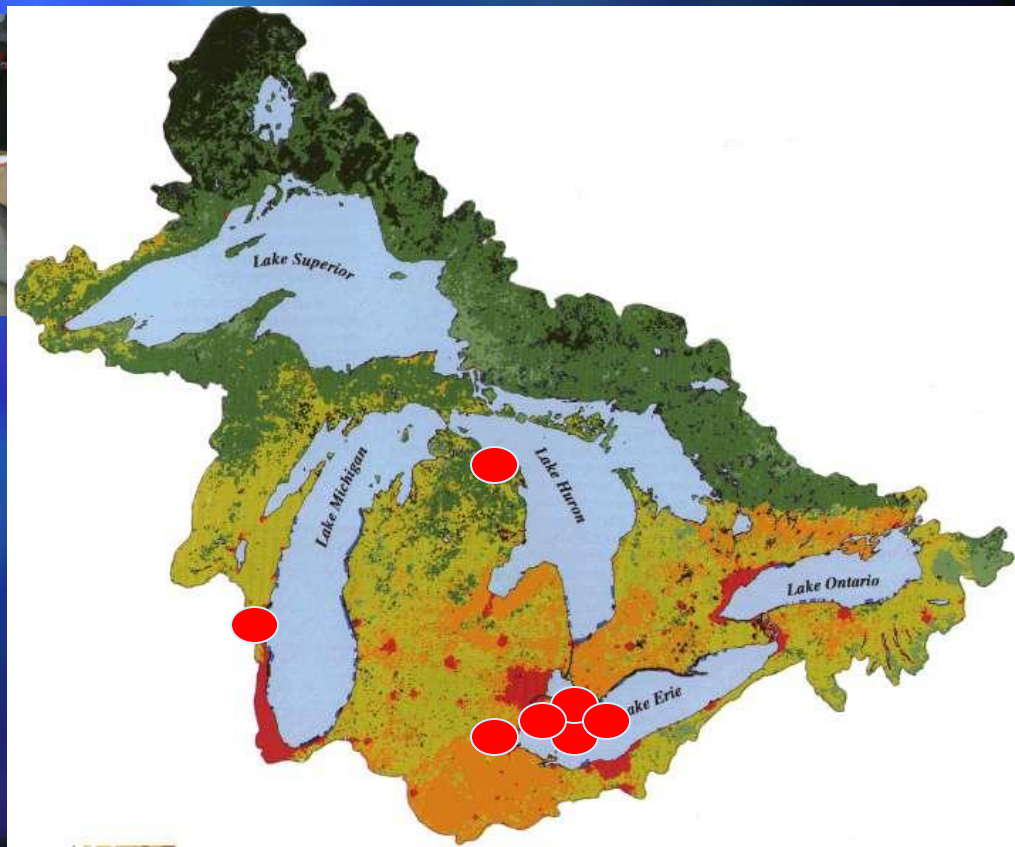
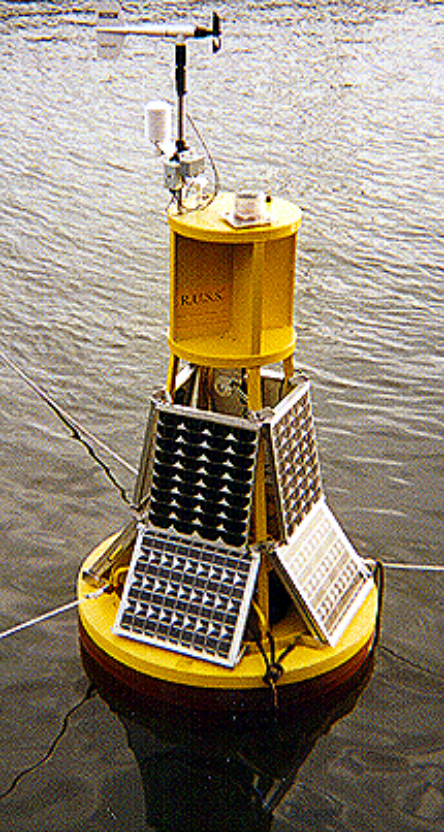


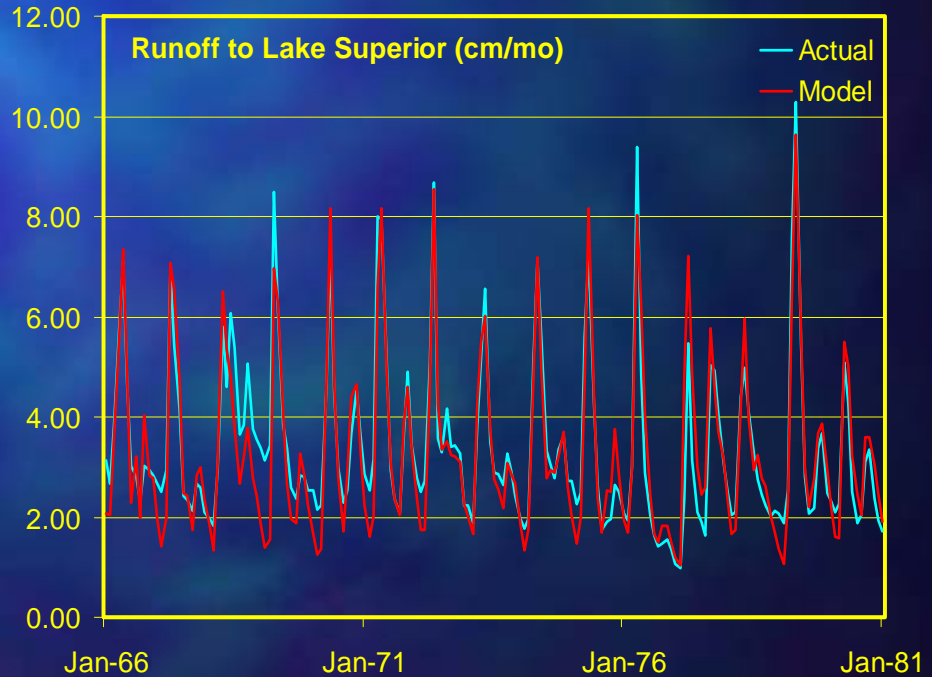
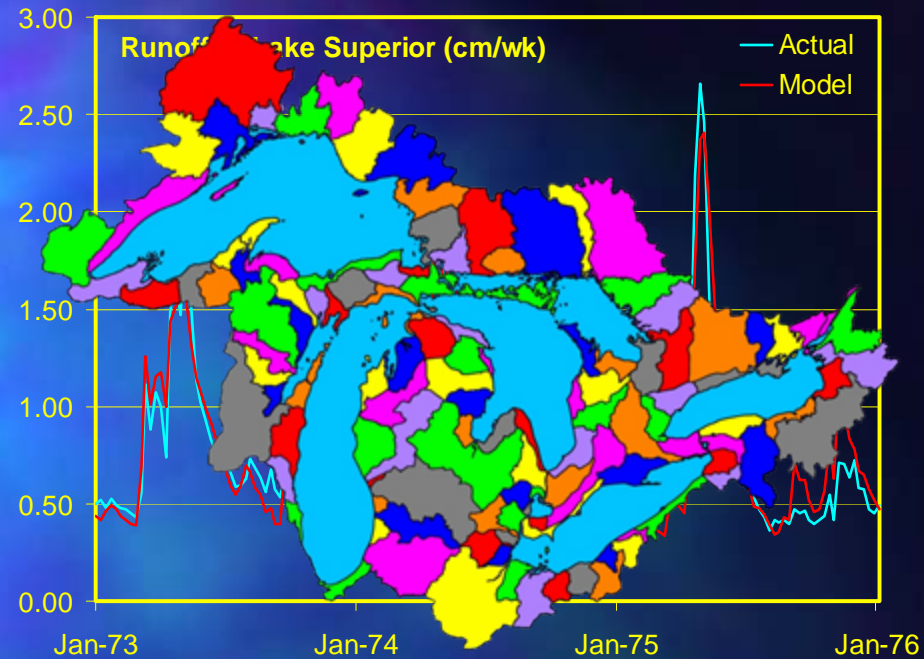
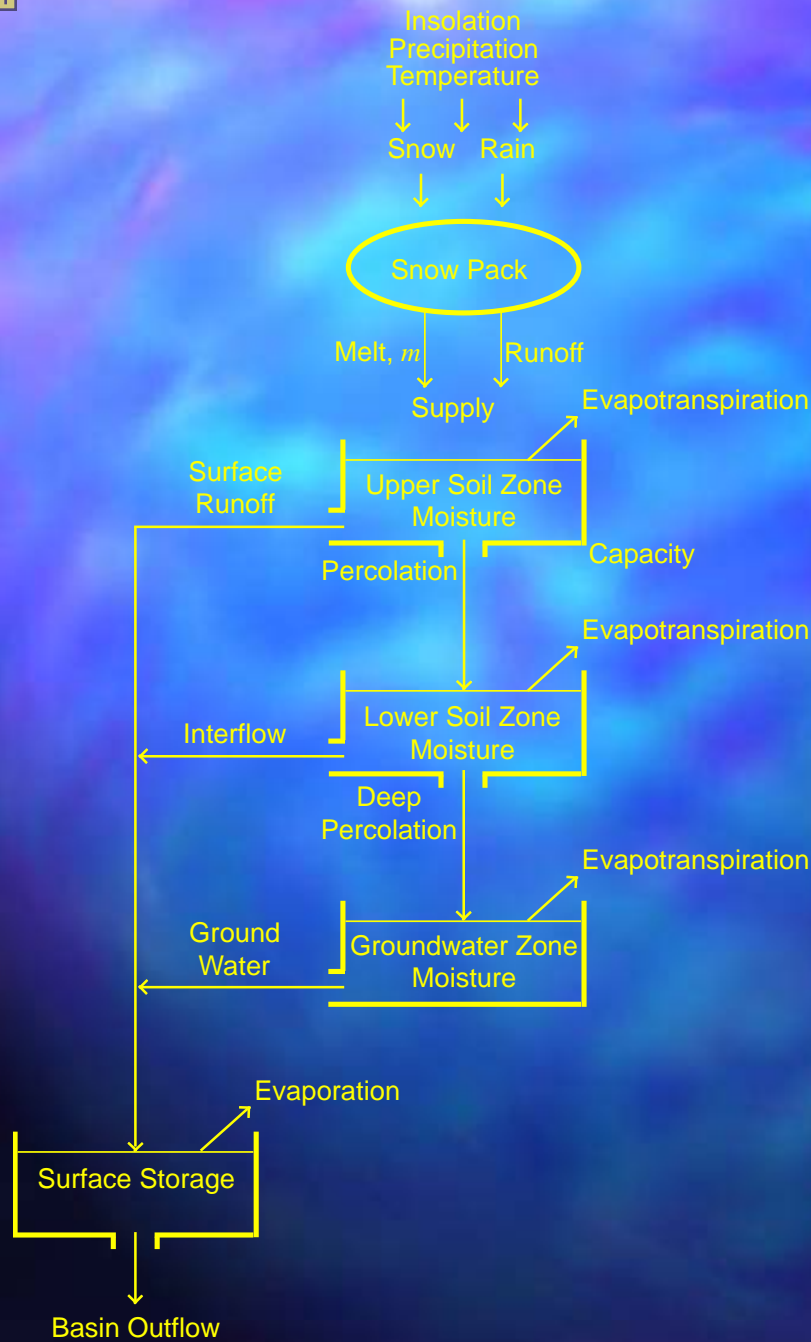
Real-time Coastal Observation Network (ReCON)

Successful ecosystem forecasting and forecast validation depend on the availability of data describing the present state of coastal waters at a variety of time and space scales (2006 GLERL Science Strategy)



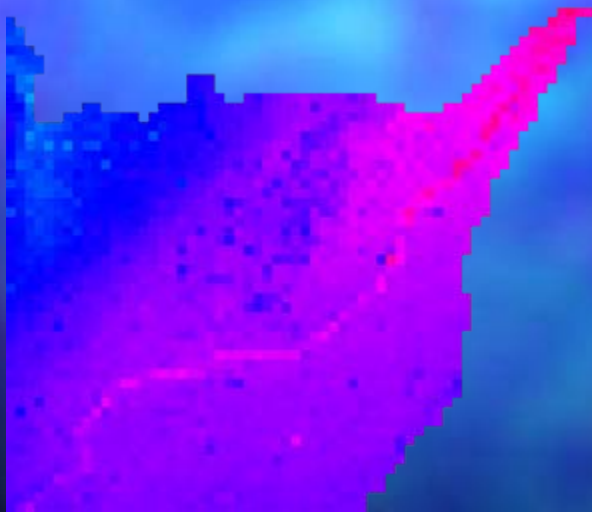
Real-time Environmental Coastal Observation Network



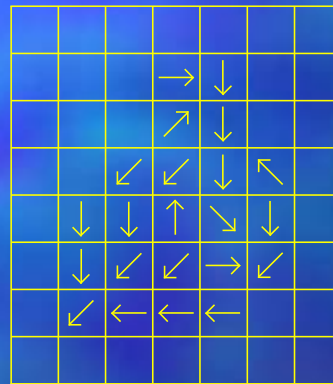


The Distributed Large Basin Runoff Model

- Watersheds are subdivided into a grid of square pixels (1 km x 1 km)
- Water and pollutants move horizontally according to the difference in elevation between neighboring pixels

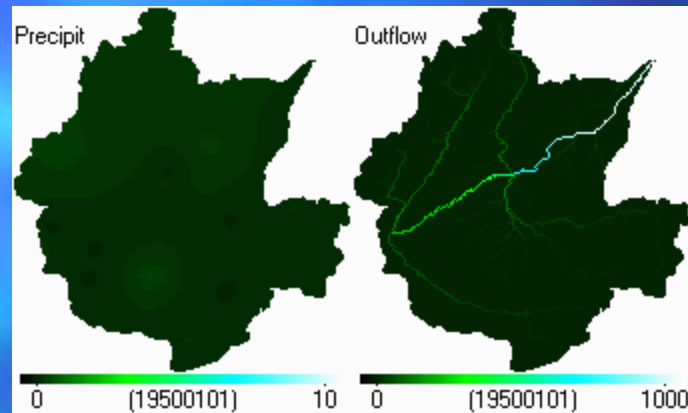


Elevation



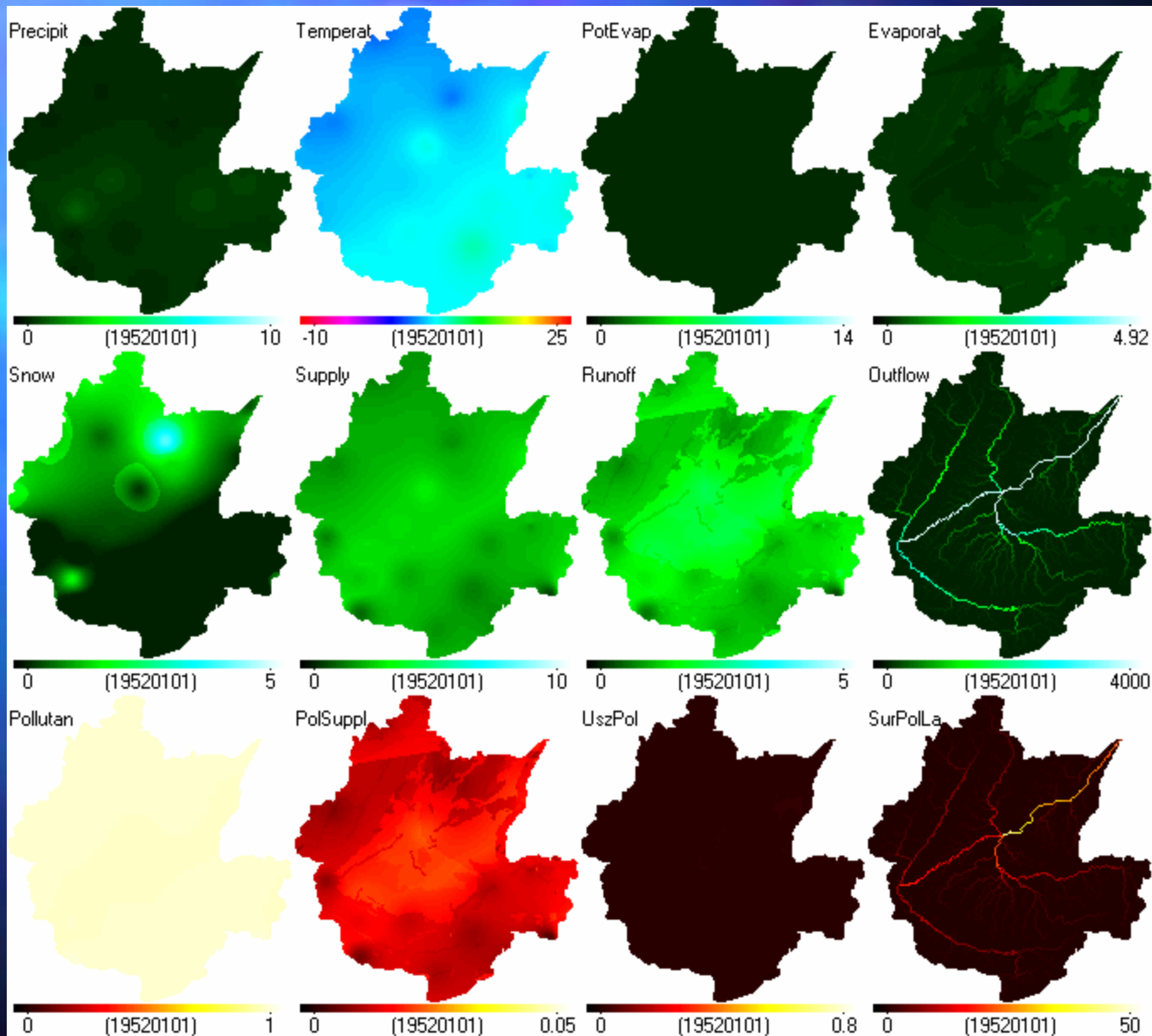
Flow network

Simple Maumee River Watershed Simulation



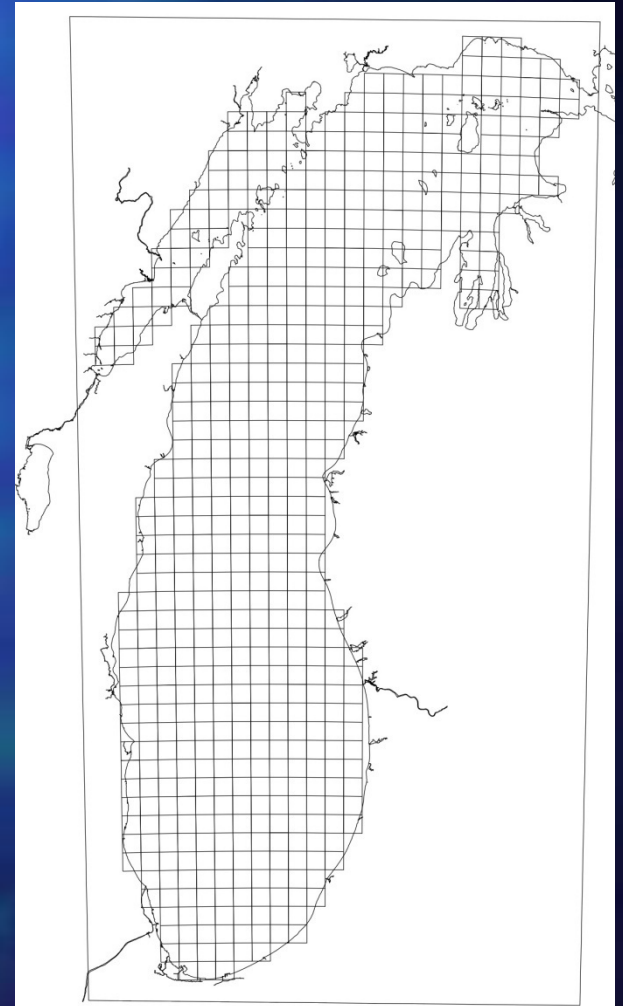
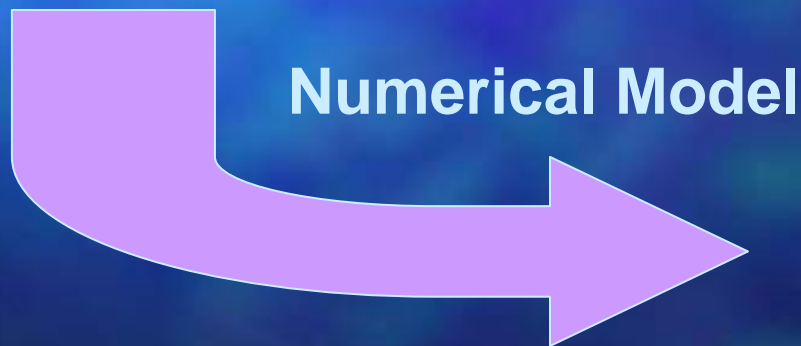
2 FPS

Maumee River Distributed LBRM with Pollutant Movement Summary (inverted square distance; 19520101—19531231)

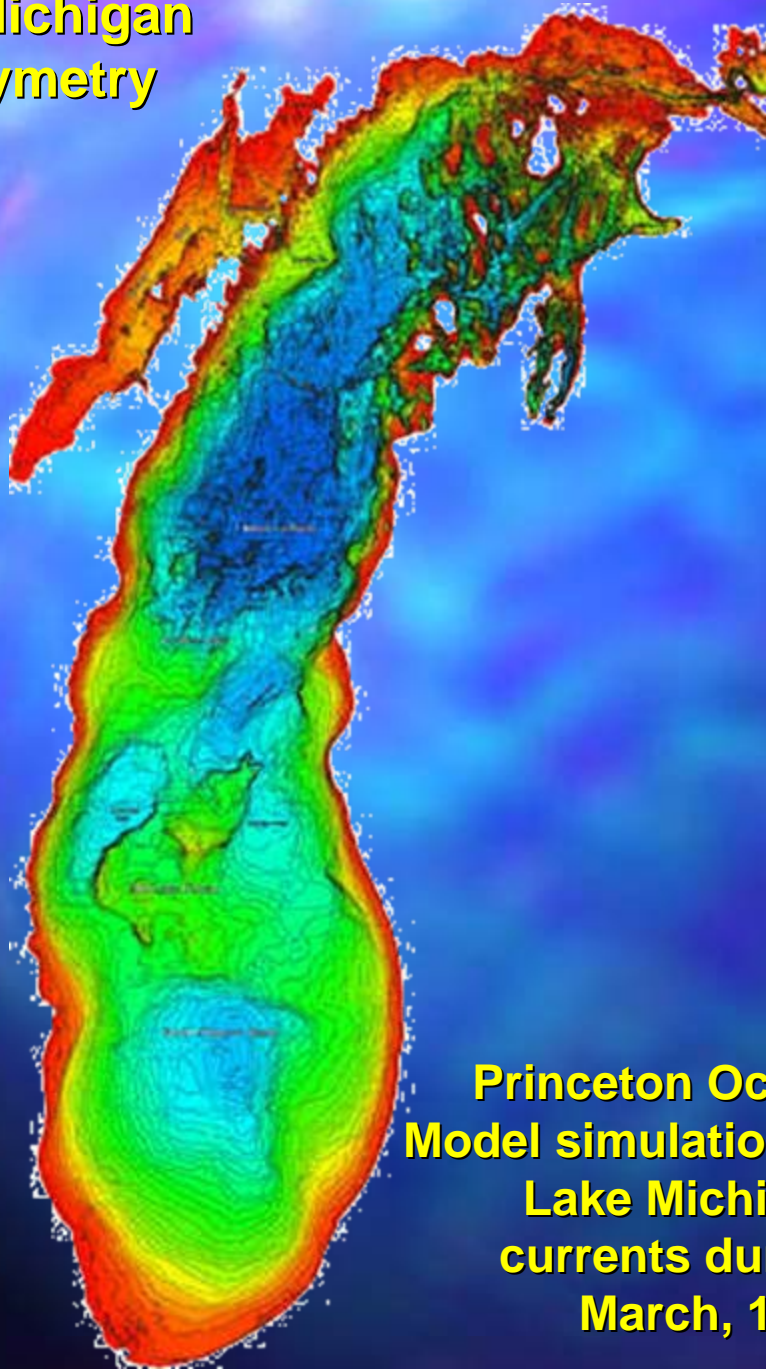


Factors Affecting Lake Circulation

- Wind stress
- Bottom topography
- Earth's rotation
- Temperature gradients

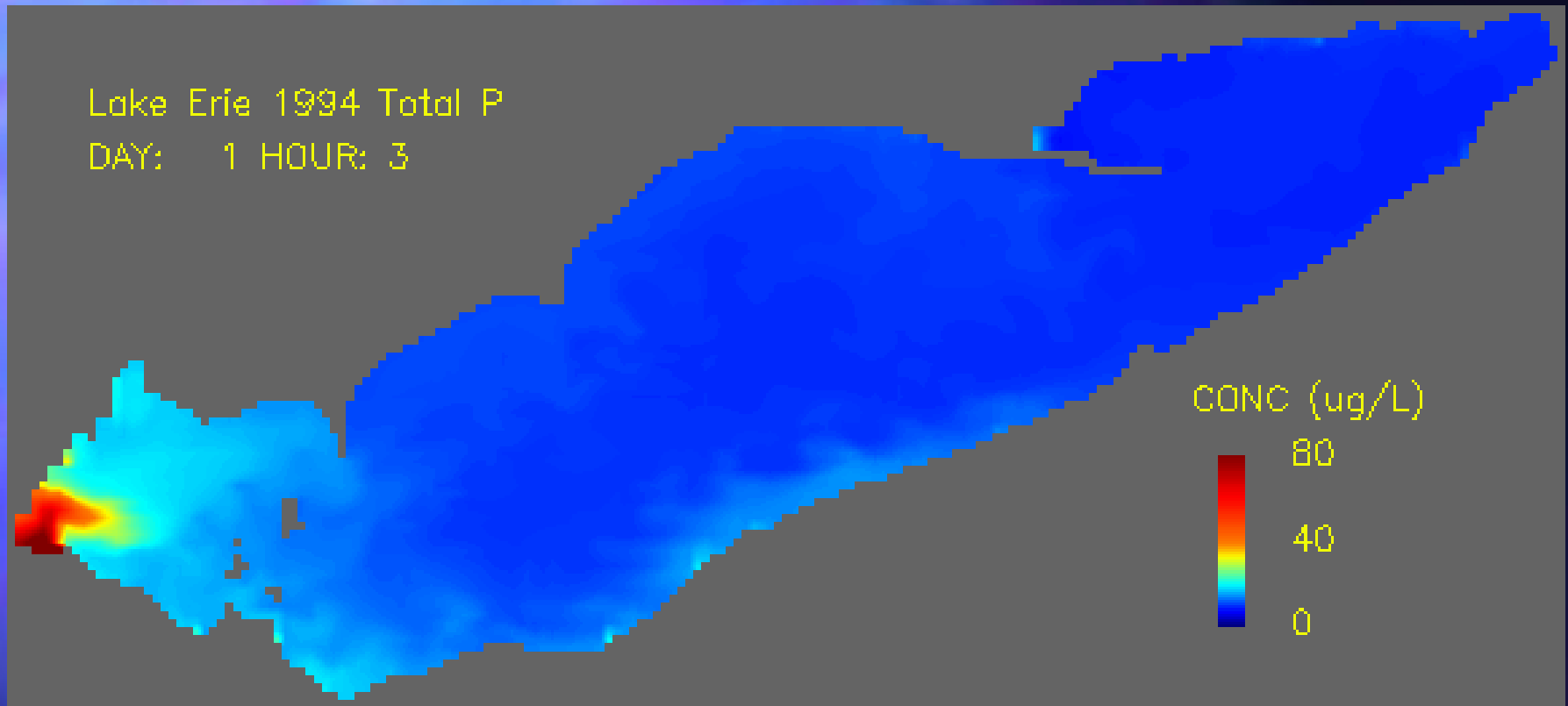


Lake Michigan Bathymetry



QuickTime™ and a
BMP decompressor
are needed to see this picture.

**Princeton Ocean
Model simulation of
Lake Michigan
currents during
March, 1998**



Hydrodynamics

- Great Lakes version of POM
- 20 vertical levels, 2 km horizontal grid (~6500 cells)
- Hourly meteorology (1994, JD 1-365)
- Realistic tributary flows
- Accounts for ice cover

Mass balance for P

- POM hydrodynamics (2d for now)
- Realistic P loading
- Constant settling velocity (for now)

JUNE 15, 2004

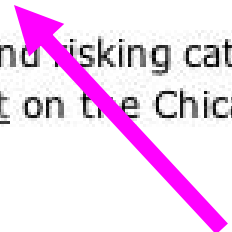
Chicago's Beaches Closed



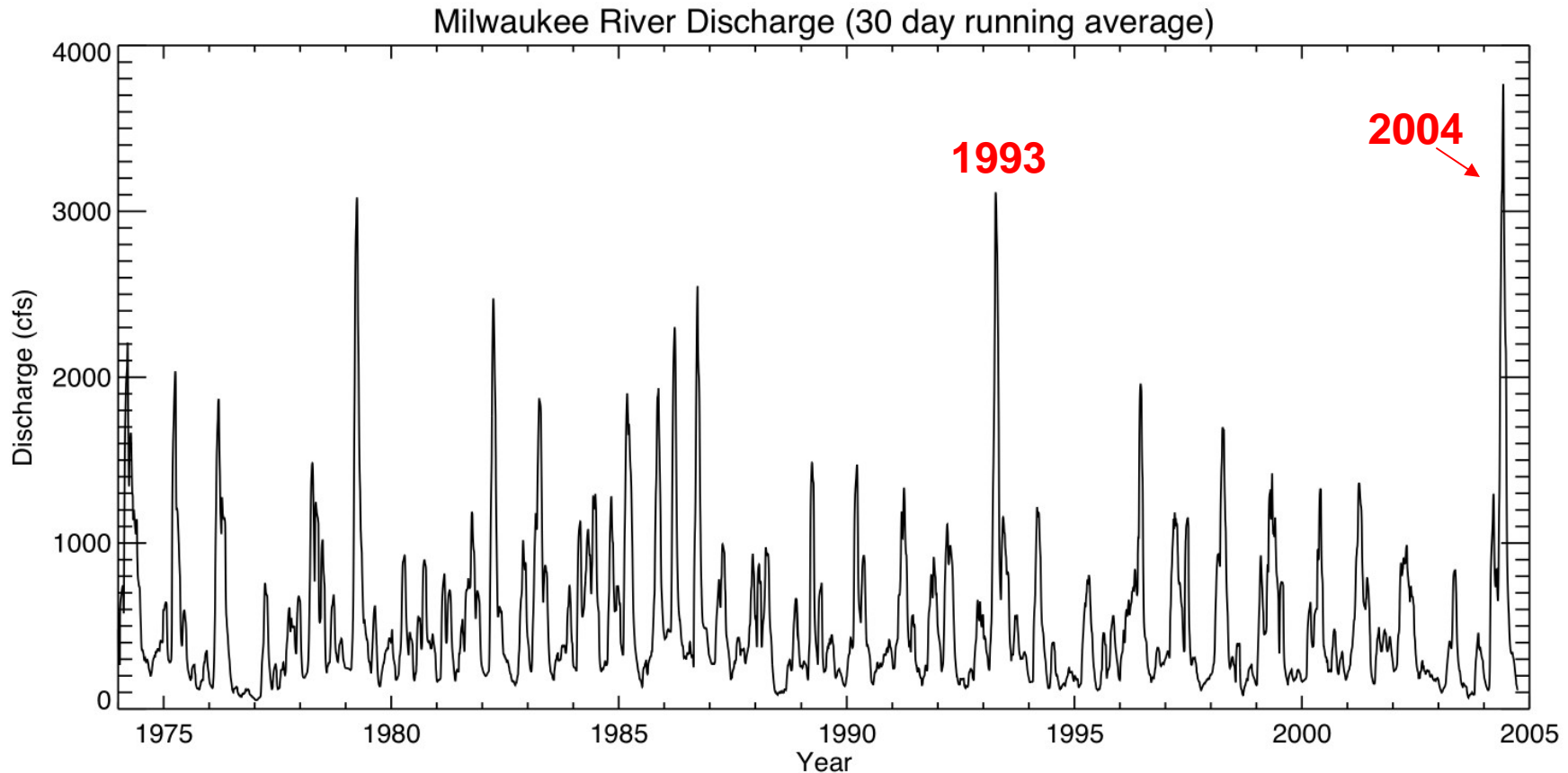
As a result of Milwaukee's dumping of raw sewage into Lake Michigan, **more** than half of the Chicago's beaches have been temporarily closed due to high bacteria levels. The beaches remain open for sunbathers and volleyball players, but lifeguards are told to keep swimmers out of the water. The Chicago Park District closed 16 of the 31 beaches to swimmers after tests of water samples showed high counts of E. coli bacteria. Officials blame the Cheeseheads.

Before heading to your favorite Chicago beach and **risking** catching a nasty infection, you should check out the Swim Report on the Chicago Park District's site.

Posted by Rachelle Bowden in News: Chicago



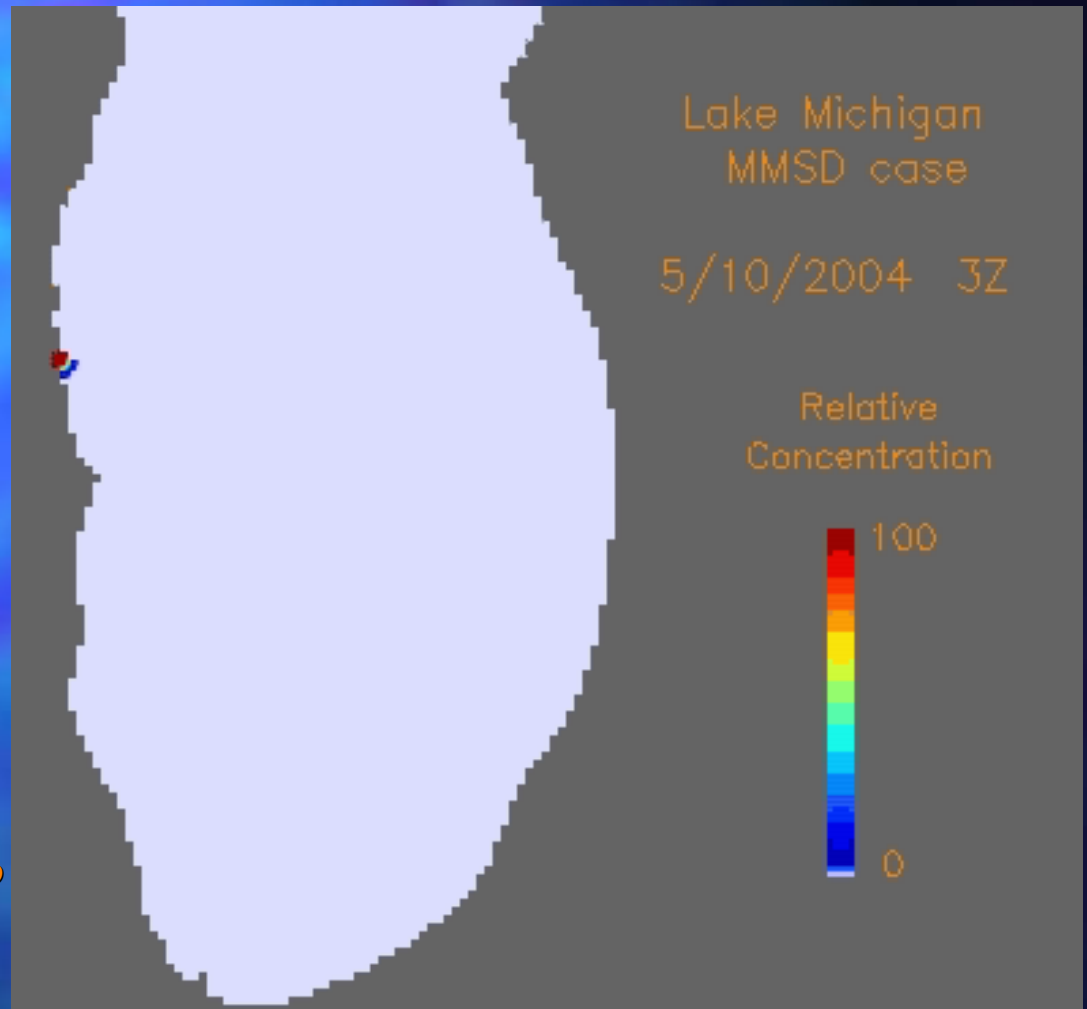
Long-term record of Milwaukee River discharges (1974-2005)



**Over 4 billion gallons of sewer overflow released
between May 10-24**

The lake circulation model was used to simulate the dispersion of a passive tracer released continuously from the Milwaukee harbor area from 10 May - 25 May, 2004.

Milwaukee
Racine
Kenosha
Waukegan
Chicago



The final frame of the simulation shows water from the Milwaukee River released between 10 May - 25 May 2004 could not have reached Chicago area beaches by 20 June 2004.

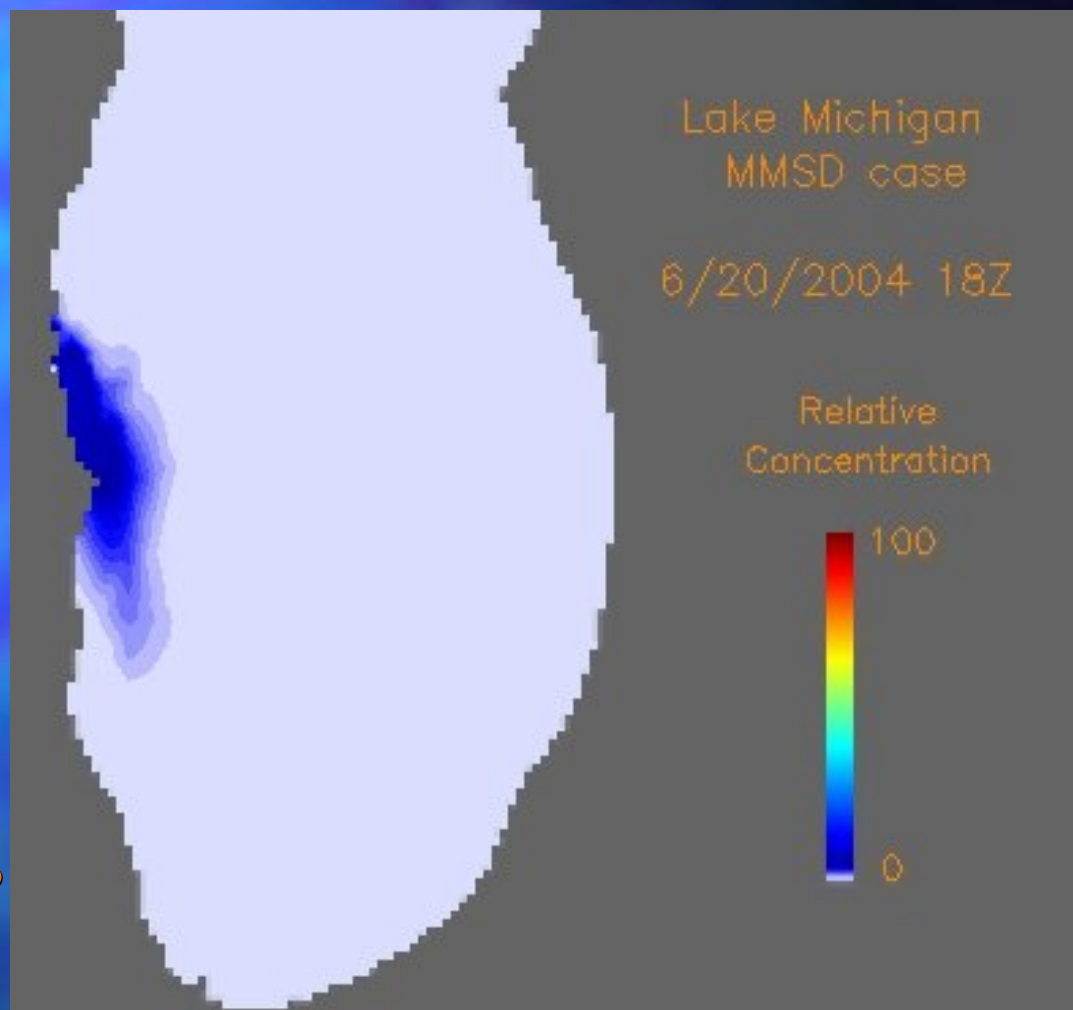
Milwaukee

Racine

Kenosha

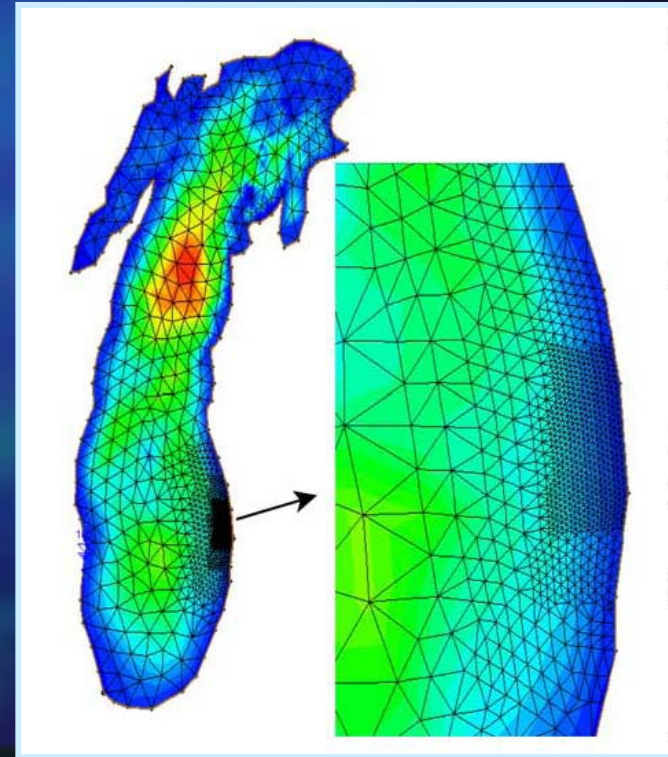
Waukegan

Chicago

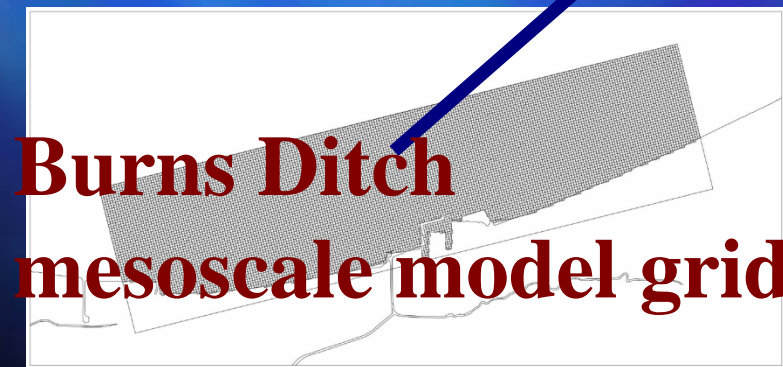
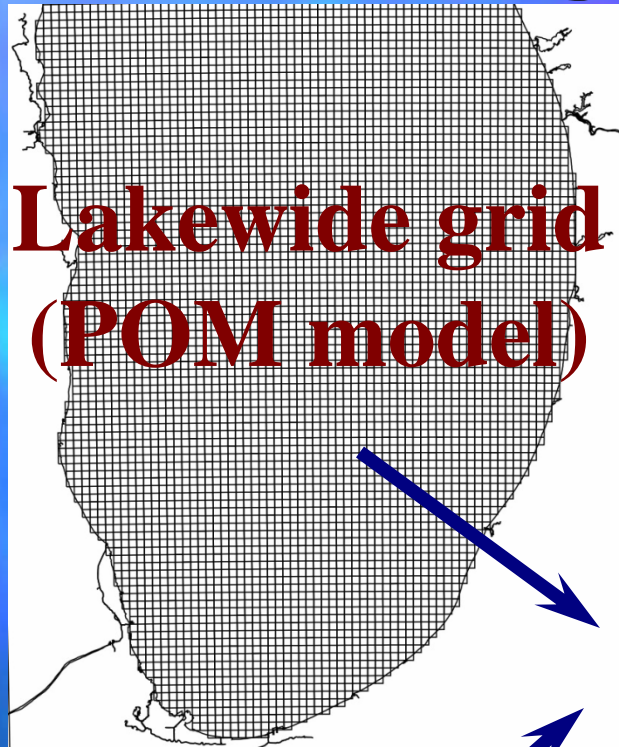


Beach Closure Forecasting Details

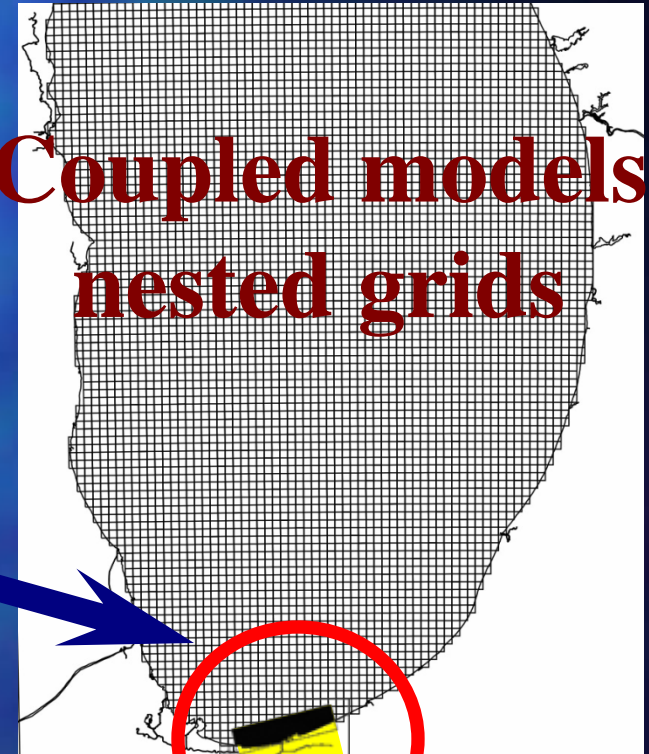
- Development of a re-locatable high-resolution hydrodynamic model for predicting currents near beaches
- Coupled and nested with GL Coastal Forecasting System
 - Provide real-time now-casts
 - Provide forecasts of bacterial transport from point sources of contamination



Lake Michigan Model Grids



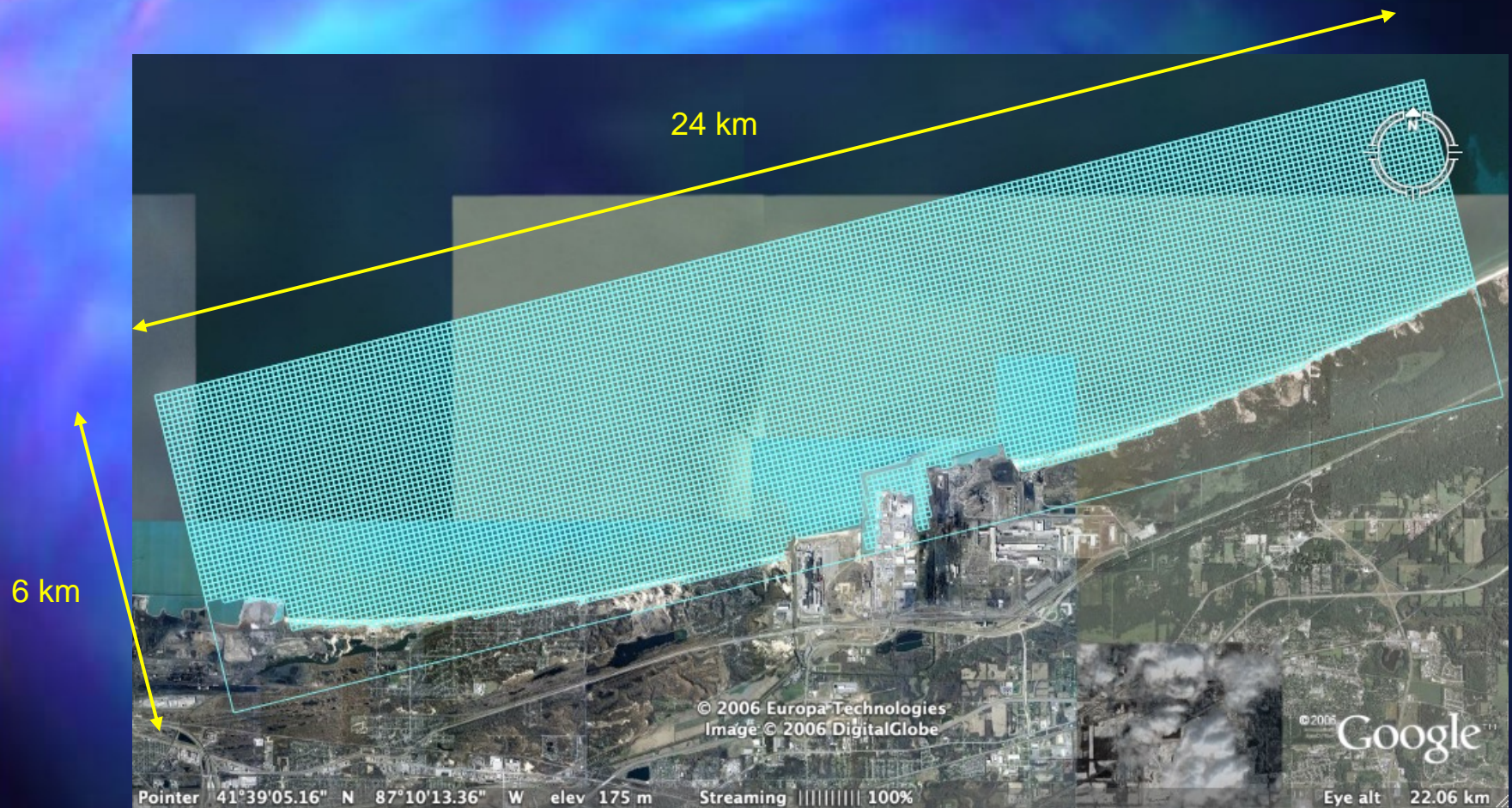
+



Nested grid hydrodynamic models in Lake Michigan



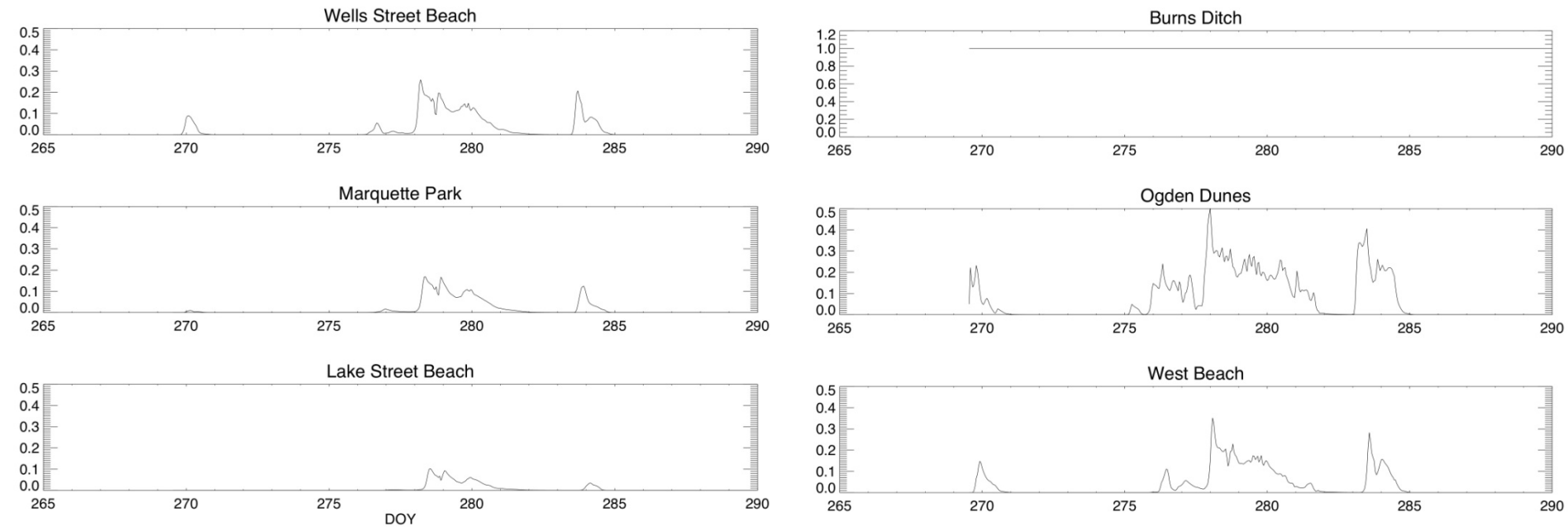
Burns Ditch 100m computational grid



Great Lakes Coastal Forecasting System - Operational Nowcast

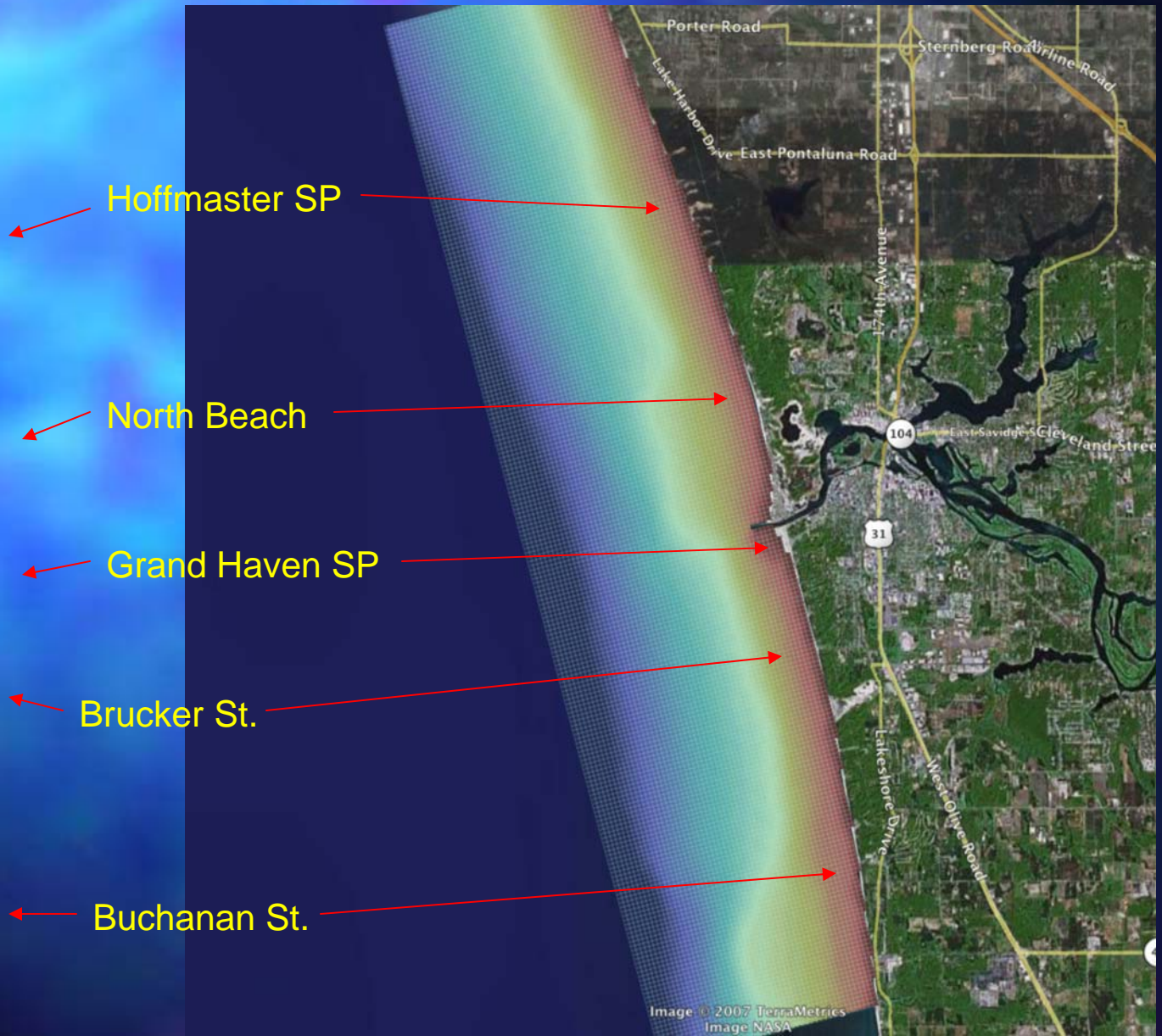
20 day sample using vertically averaged currents

QuickTime™ and a
Cinepak decompressor
are needed to see this picture.



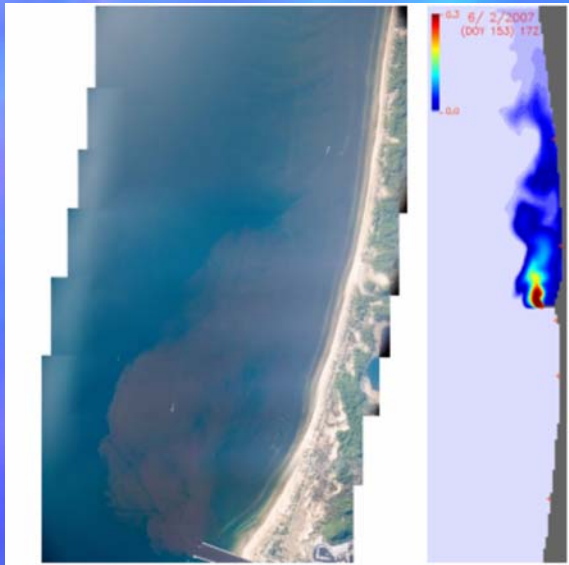
Grand Haven, MI 100 m nested grid

QuickTime™ and a
Cinepak decompressor
are needed to see this picture.



Grand River Plume Aerial Photography and Model Simulations

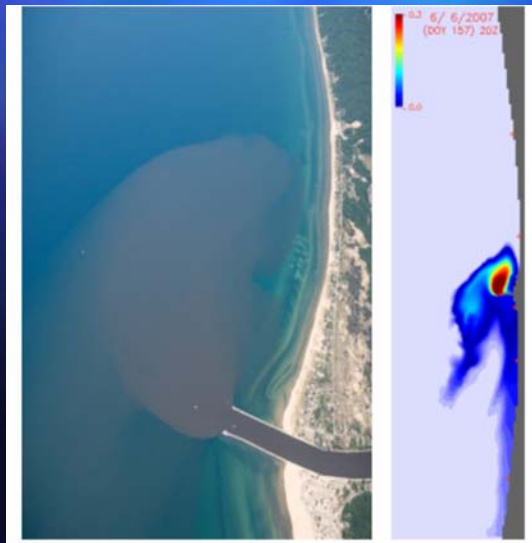
June 2, 2007



June 10, 2007



June 6, 2007



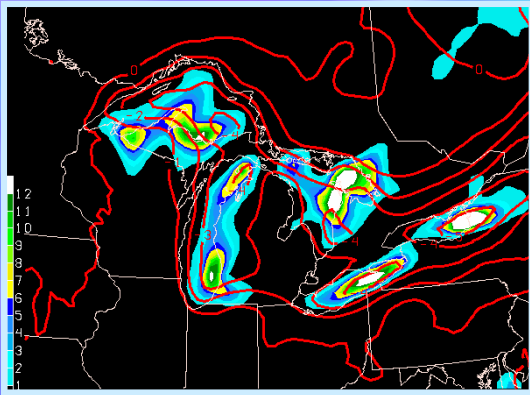
June 20, 2007



Ecosystem Forecasting

Ecosystem forecasting predicts the effects of biological, chemical, physical and human-induced changes on ecosystems and their components

- What will happen in the future?
- When will it happen?
- At what spatial scales?



Ecosystem Forecasting

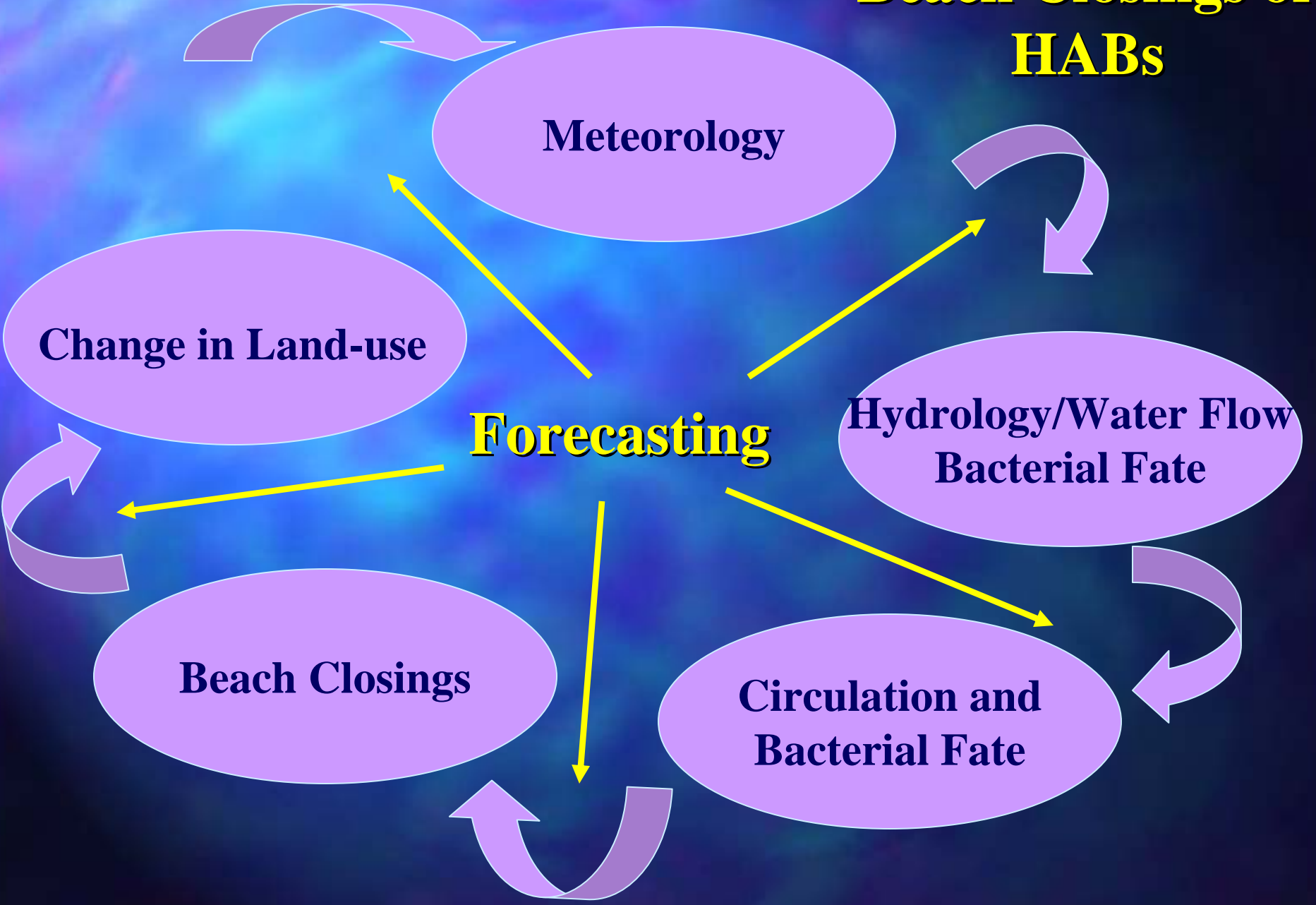
- Aids in
 - Improved decision making
 - Reductions in risks
 - Mitigation of natural events and human activities
 - More effective prioritization of observing systems and sciences, across disciplines

Watershed → **Nearshore Ecotone** ↔ **Offshore**



Questions?

Beach Closings or HABs

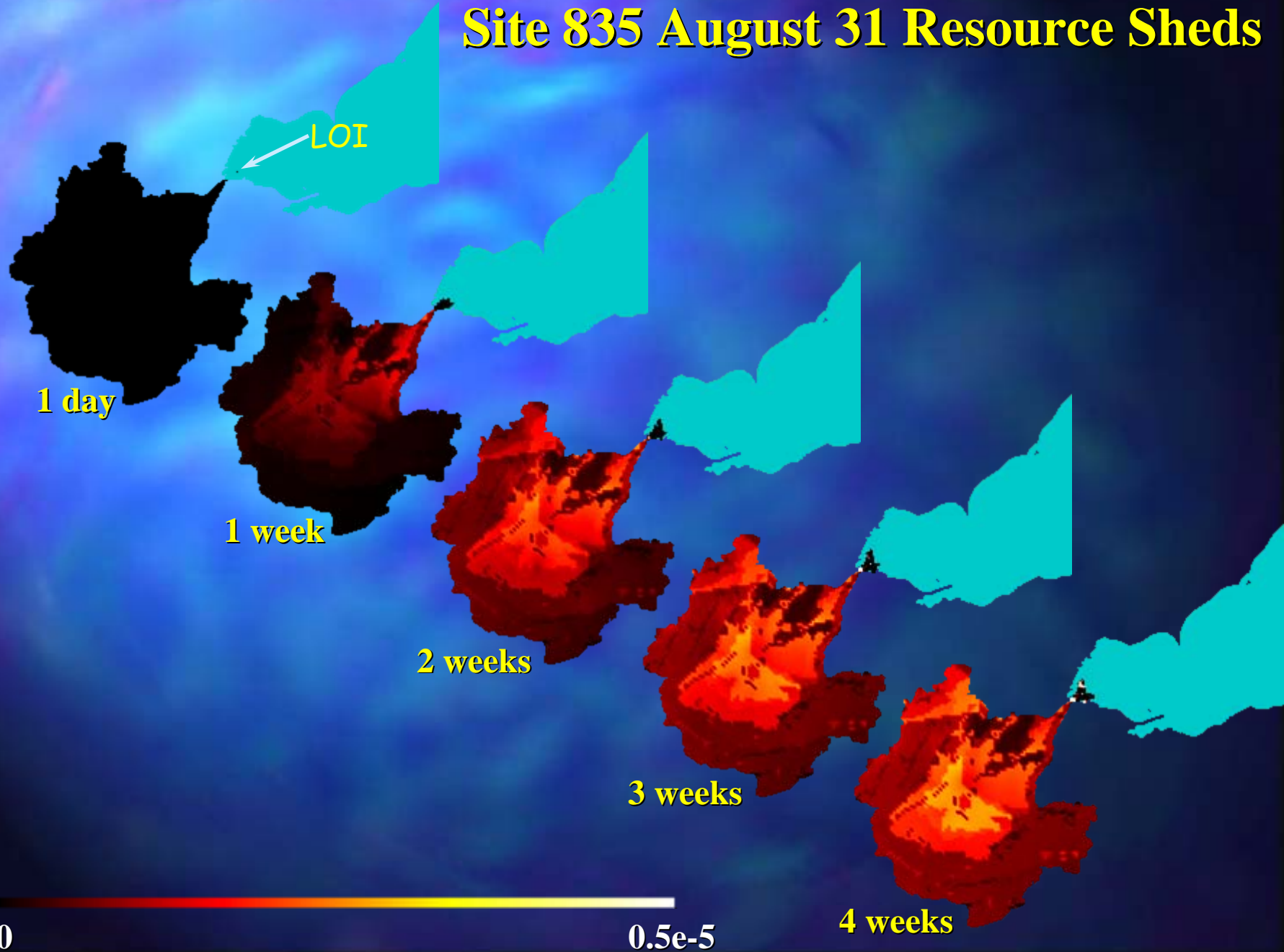


Thousand-Footer Runs Aground in Muskegon Channel—22 August 2007

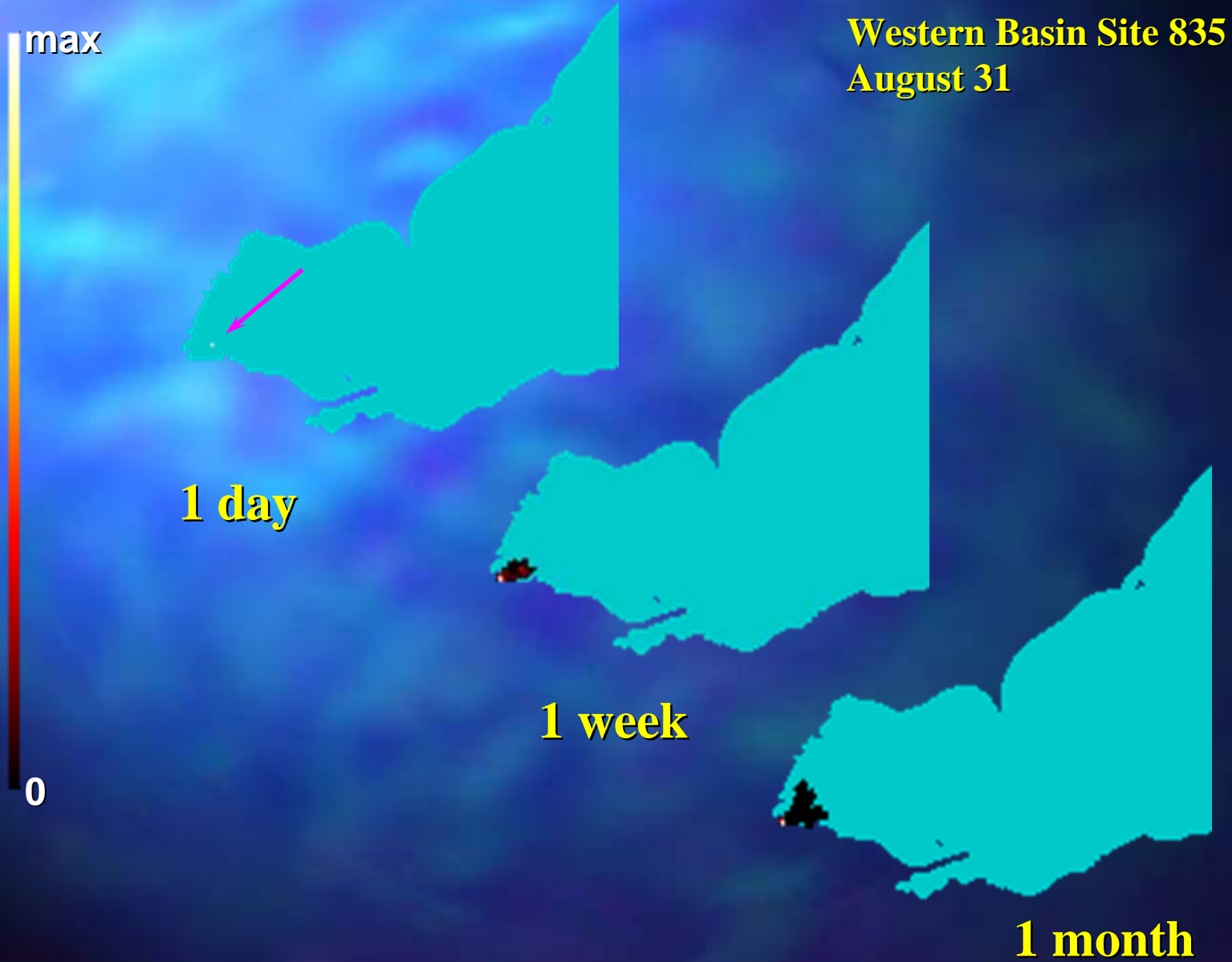
LMFS1 Wed Aug 22 14:00:01 2007



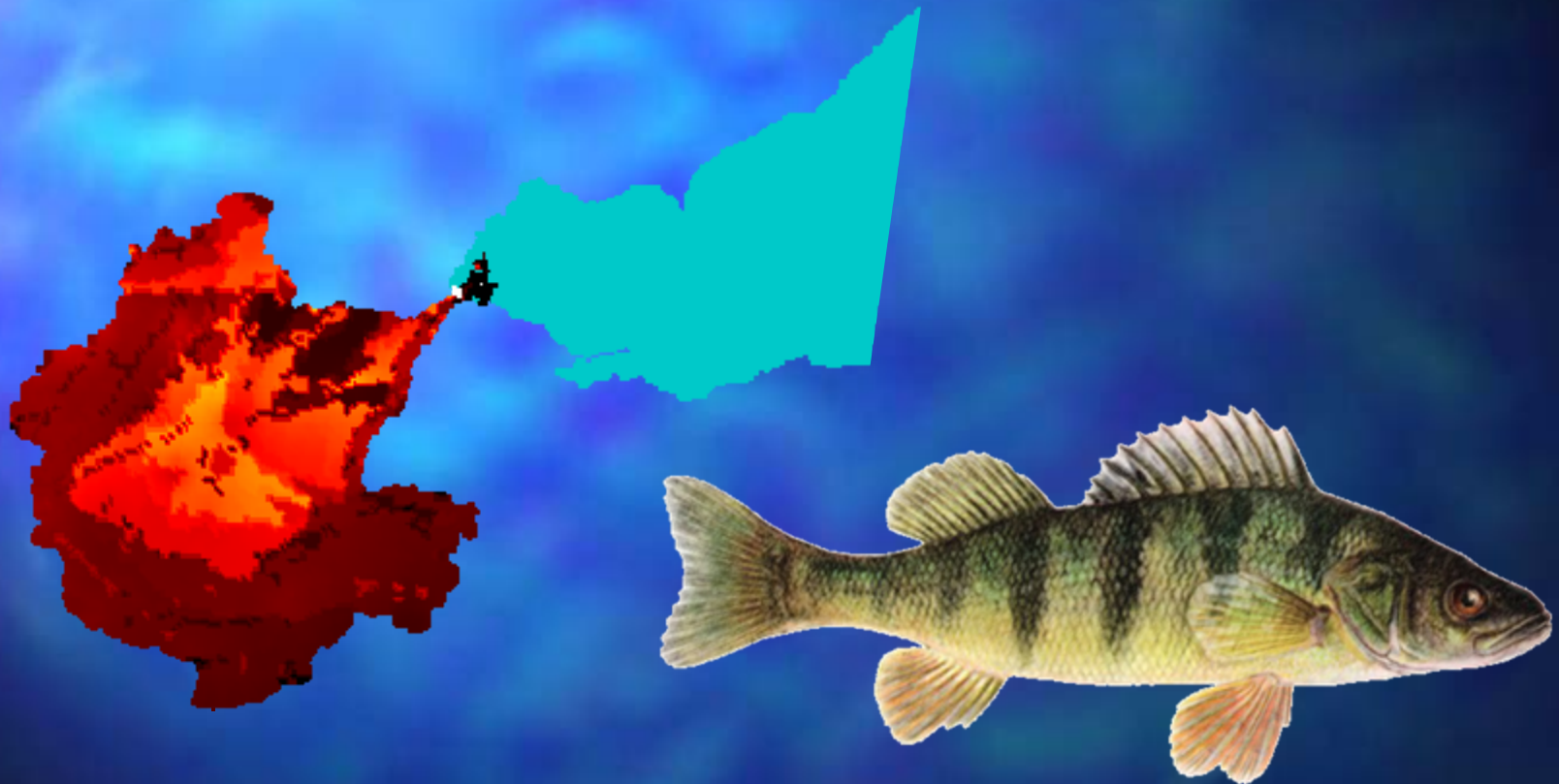
Linked Maumee & Western Basin Site 835 August 31 Resource Sheds



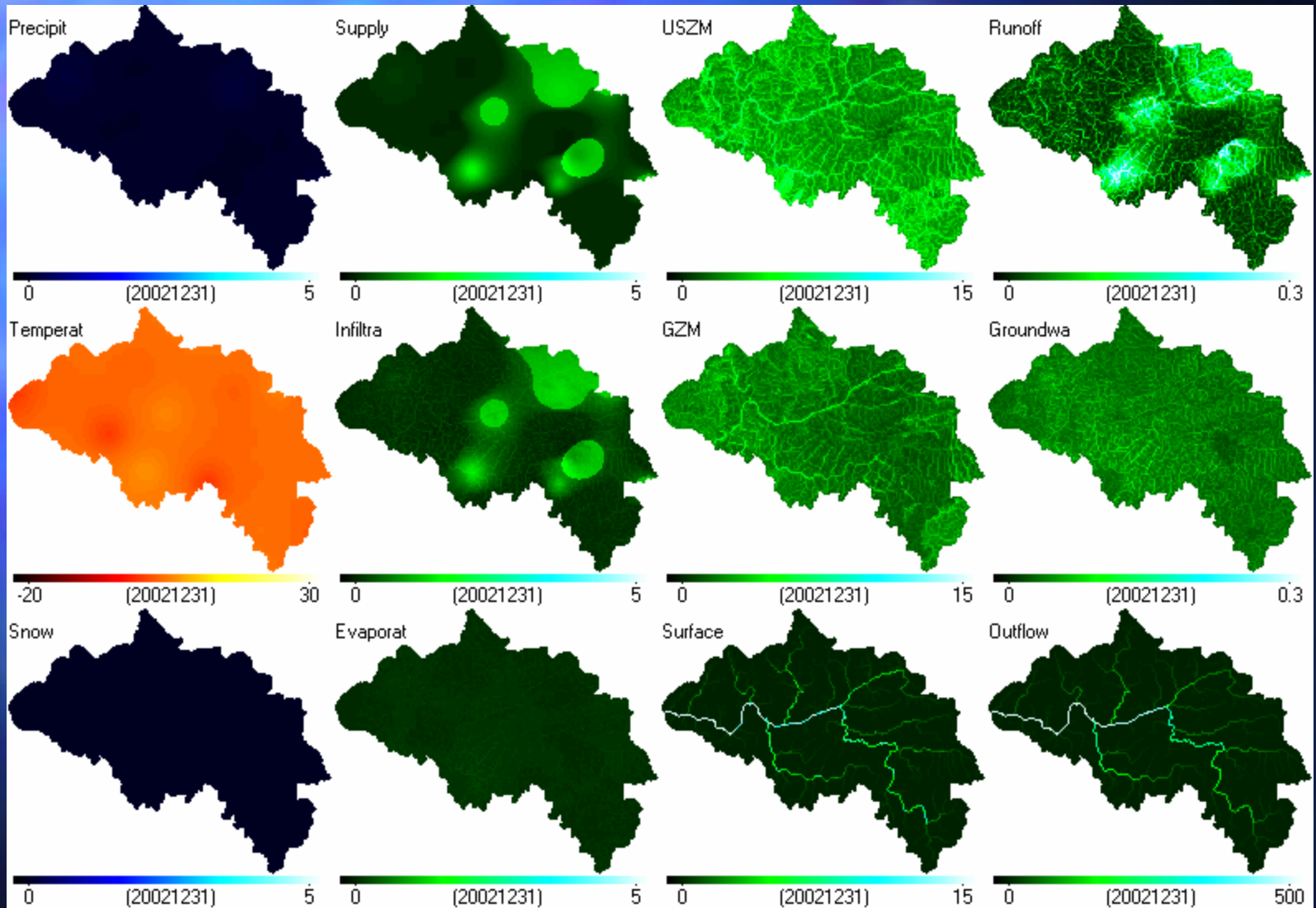
Example Resource Shed Distributions Defined with Particle Backtracking (in Western & Central Lake Erie)



Fish Recruitment



Grand River Watershed Simulation



4 FPS