National Oceanic and Atmospheric Administration
Great Lakes Environmental Research Laboratory
(NOAA-GLERL)

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State of Michigan GIS Users
May Meeting, Lansing, Michigan
May 3, 2018
Overview

GLERL

Lake Michigan Field Station
Vessels

- NOAA GLERL Vessels work in support of NOAA in the Great Lakes
- Ranges of size classes give flexibility to work in both nearshore and offshore environments
- GLERL operates and maintains 13 vessels.
OBSERVING SYSTEMS & ADVANCED TECHNOLOGY

Developing and deploying advanced technology to collect data year round across the Great Lakes using buoys, satellites, and research vessels.

GLERL’s observing systems are providing real-time data on lake conditions to help users make informed decisions.

ECOSYSTEM DYNAMICS

Gathering long-term observations of biological, chemical, and physical variables in the Great Lakes ecosystem.

Conducting targeted monitoring and fundamental research on ecosystem processes, including impacts of invasive species.

INTEGRATED MODELING & FORECASTING

Developing evaluative and predictive models to forecast physical variables such as ice cover and water levels, and help understand how such factors impact the entire ecosystem.

Delivering timely information on harmful algal blooms to beachgoers, recreational anglers, water utility managers, and other users and decision-makers.
Observing Systems and Advanced Technology
NOAA Great Lakes Coastwatch

MODIS Satellite Imagery

CPA (Color Producing Agent)

Key Scientific Drivers:
Can satellite and airborne remotely sensed data provide accurate, synoptic retrievals of key Great Lakes parameters?
Hyperspectral Imaging

- HABs are detectable from hyperspectral sensors mounted to small airplanes.

- Because the flyovers are done at low altitude, cloud cover interference, as often seen in satellite images, is minimized.

- Information is distributed to water intake managers in the Western Basin of Lake Erie.
Real-time Coastal Observation Network (ReCON)

- MET Stations
- E.C. Stations (Evaporation)
- GLERL Buoys (seasonal)
Integrated Physical and Ecological Modeling and Forecasting
Great Lakes water levels: Long, continuous record; High variability; Ideal research platform
Great Lakes Operational Forecast System (GLOFS)
Experimental Lake Erie HAB Tracker

HAB Tracker forecast

2017-08-08 19:00 EDT

GLCFS nowcast & 5-day wind speed forecast

https://www.glerl.noaa.gov/res/HABs_and_Hypoxia/habTracker.html
Ecosystem Dynamics
Long-term research

- Lower Food Web Collections
- Moorings (year-round)
- Nearshore Transect
- Fish Ecology
- Lake Whitefish Recruitment
Understand invasive mussel ecology and impacts to the lower food web
Predict Invasive Species Establishment, Distribution and Impacts in the Great Lakes
Forecasting Invasive Species Habitat Suitability

Envt’l Niche Model Algorithm/Approach

Occurrence Records + Environmental Layers = Estimate

(Diagram From A. Kramer and J. Drake, Univ. Georgia)
## GLAHF Comprehensive Database

- **Administrative Boundaries** - 16
- **Lake & land units, Political boundaries**
- **Management Units**

### Biological – 61+
- **Aquatic invasive species, Benthos, Fish**

### Environmental/Chemical – 37
- **Water chemistry**

### Geomorphology/Topobathymetry – 28
- **Substrate, Elevation, Relief, Slope**

### Landscape – 132
- **Land use/cover, Geology, Soils**

### Mechanical Energy – 19
- **Circulation, Upwelling, Waves**

### Rivers/Hydrology – 14
- **Flowlines, Watersheds, Dams & barriers**

### Temperature Energy – 19
- **Upwelling, Water temperature at depth, Growing Degree Days**

### Other Stressors – 4
Example: Grass carp and Hydrilla

Grass carp - *Ctenopharyngodon idella*  
(Established and reproducing naturally)

Hydrilla - *H. verticillata*  
(Not yet established in Great Lakes)
Grass Carp – Niche Centrality

Grass carp niche – modeled using GL climate data and Climate data where carp occur outside GL basin

Above clipped using GL SAV, wetlands data + Hydrilla niche
Hydrologic Modeling in the Great Lakes Basin
Hydrologic Modeling at GLERL
Why is it so difficult to model the Great Lakes basin?

Complex lake-atmosphere interactions

Data set consistency & reconciliation across international border

Encoding regulatory guidelines for controlling outflows
How do we further hydrologic modeling in the Great Lakes basin?

National Water Model
http://water.noaa.gov/about/nwm

Supported by the National Water Center (NOAA NWS + USGS, FEMA, visiting scientists & contractors).

Modeled using the WRF-Hydro package, part of the Weather Research and Forecasting (WRF) system for CONUS

Version 1: Operational September 2016
What’s so unique about the National Water Model?
What’s so unique about the National Water Model?

- Stream segments & catchments with land surface attributes
- Water routing through stream network (slope & From-To Nodes)
- Report stream flow at stream segment scale
WRF-Hydro Inputs

Digital elevation model (DEM) OR hydrofabric representing the channel, lake & water management parameters

Geofabric representing land use & land cover, soil types, & greenness fraction

Meteorological Forcings
WRF-Hydro Outputs

Column Land Surface Models:
- Evapotranspiration
- Soil moisture/Soil Ice
- Snowpack/snowmelt
- Runoff
- Radiation Exchange
- Energy Fluxes
- Plant Water Stress

Terrain Routing Models:
- Overland, subsurface flow

Output Variables:
- Stream Inflow, Surface Water Depth, Groundwater Depth, Soil Moisture

Channel & Reservoir Routing Models:
- Hydrologic and Hydraulic
- Streamflow
- River Stage
- Flow Velocity
- Reservoir Storage & Discharge

Output Variables:
- 1-way coupling or 2-way coupling
- Interflow
- Surface Runoff
- Baseflow

2-way coupling
Developing a Hydrofabric
Developing a Hydrofabric
Developing a Hydrofabric

NHD Plus Version 2

NHD Plus V2 + GLHD (after harmonization)
Developing a Hydrofabric

- Lake water body features: 7
- Stream segments: 151,641
- Land catchments: 154,475
- Stream-to-lake connections: 3,807
- USGS stream gages: 392
- ECCC stream gages: 348
- Grid-to-basin correspondence
  - 1km grid weights: 1,425,269
  - 250m grid weights: 11,602,357

National Water Model features: 2.7 million
Extending the domain: Lake Champlain

NHDPlus V2
1:100,000
Current NWM operational extent

NHDPlus HR (beta)
1:24,000
Partnerships

Michigan DNR
Institute for Fisheries Research

Great Lakes Aquatic Habitat Framework
https://www.glahf.org/

U.S. Environmental Protection Agency

U.S. Geological Survey
Further Information

NOAA-GLERL

https://www.glerl.noaa.gov/

Newsletter

https://www.glerl.noaa.gov/education/newsletter.html

Infographics

https://www.glerl.noaa.gov/pubs/brochures/infographics.html

Data

https://www.glerl.noaa.gov/data/

Blog

https://noaaglerl.blog/

Great Lakes Aquatic Habitat Framework

https://www.glahf.org/

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