

Mapping and Visualizing Lake Level Changes for the U.S. Great Lakes

OSU Climate Change Webinar

05/19/2015

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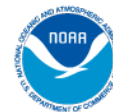
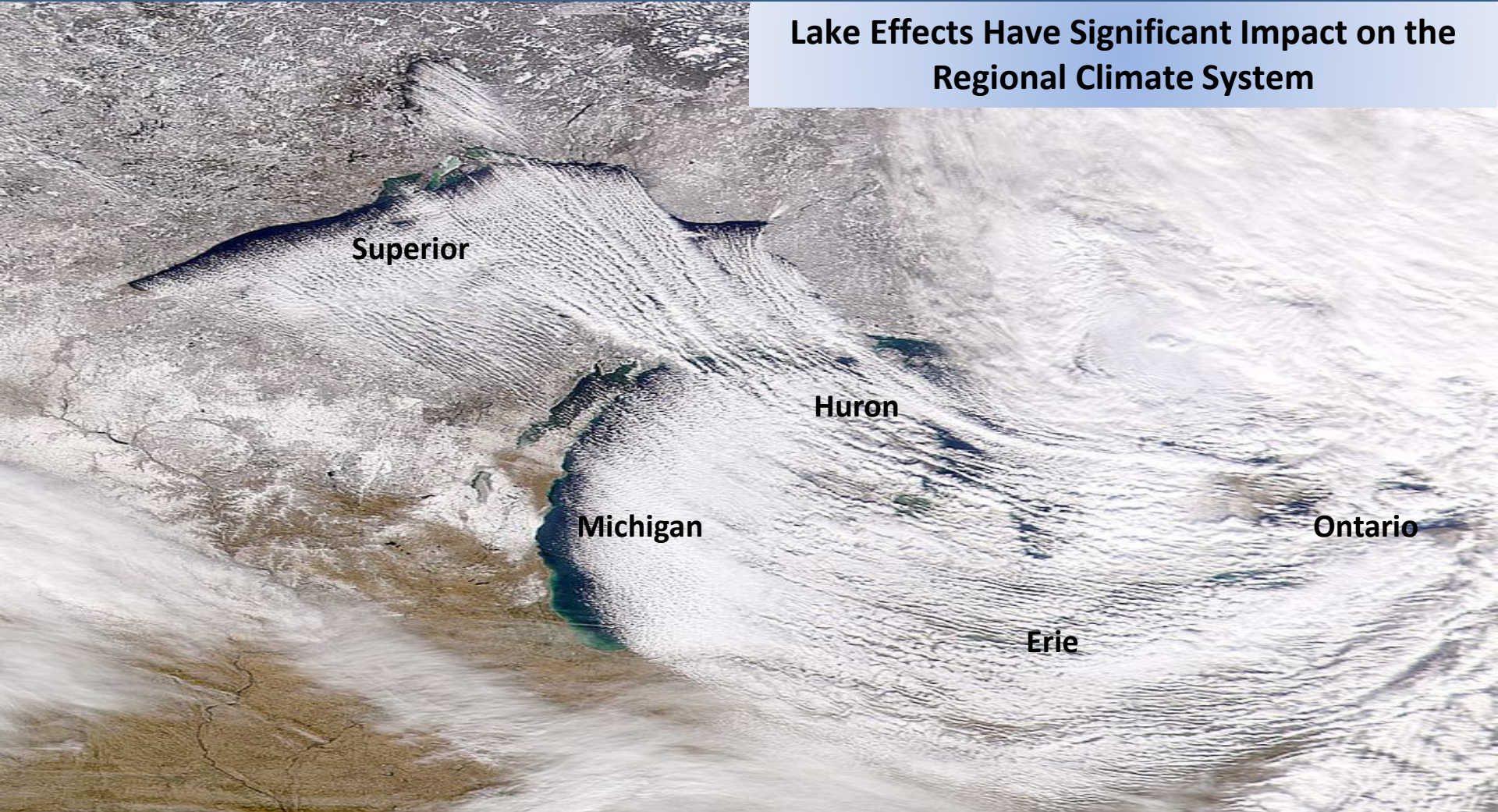
Overview

- Overview of Great Lakes climate science and historical lake levels
- Need for visualizing potential impacts
- Lake Level Viewer for the U.S. Great Lakes
 1. *Lake level viewer development*
 2. *Web mapping tool demonstration*
 3. *How to get the data and map services*
 4. *Future work*

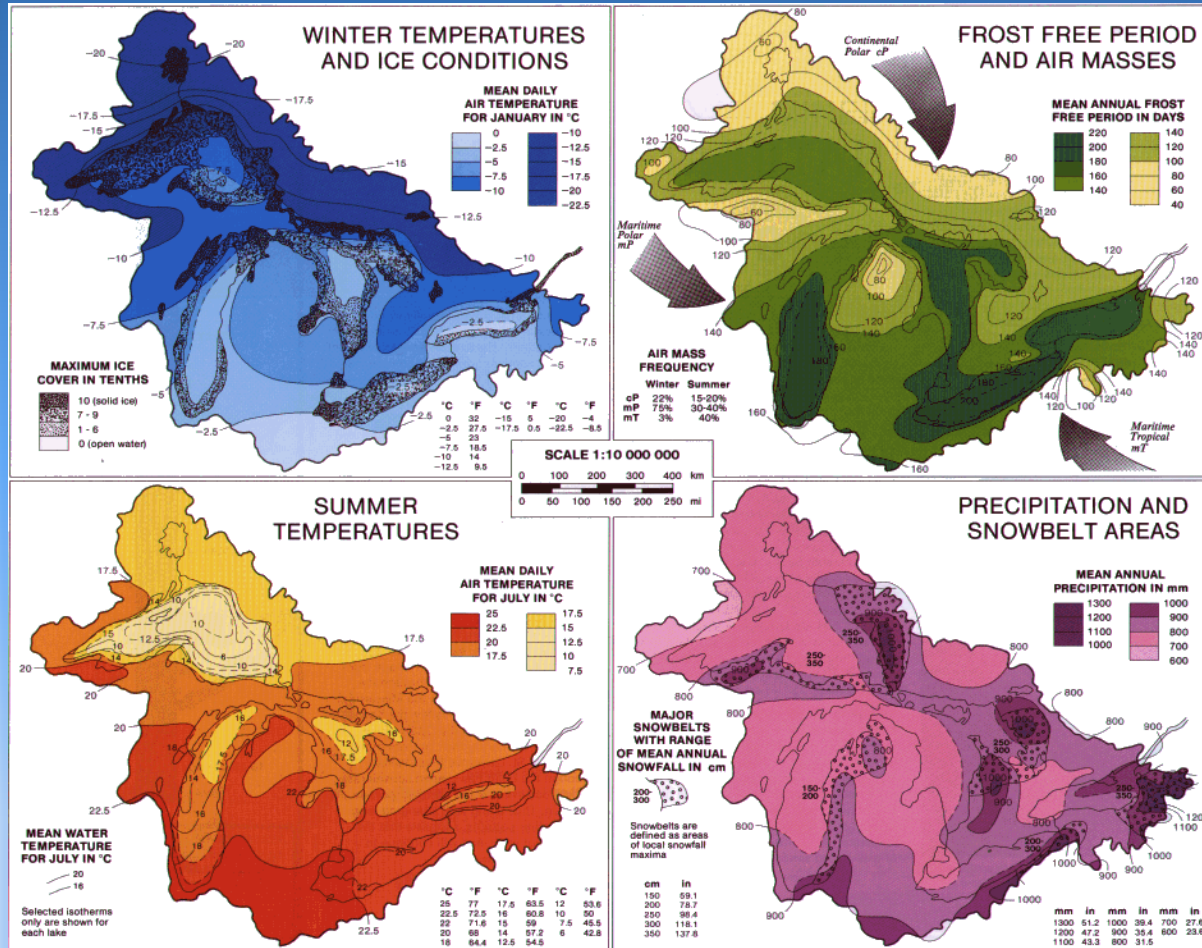


The Great Lakes Climate

Lake Effects Have Significant Impact on the Regional Climate System

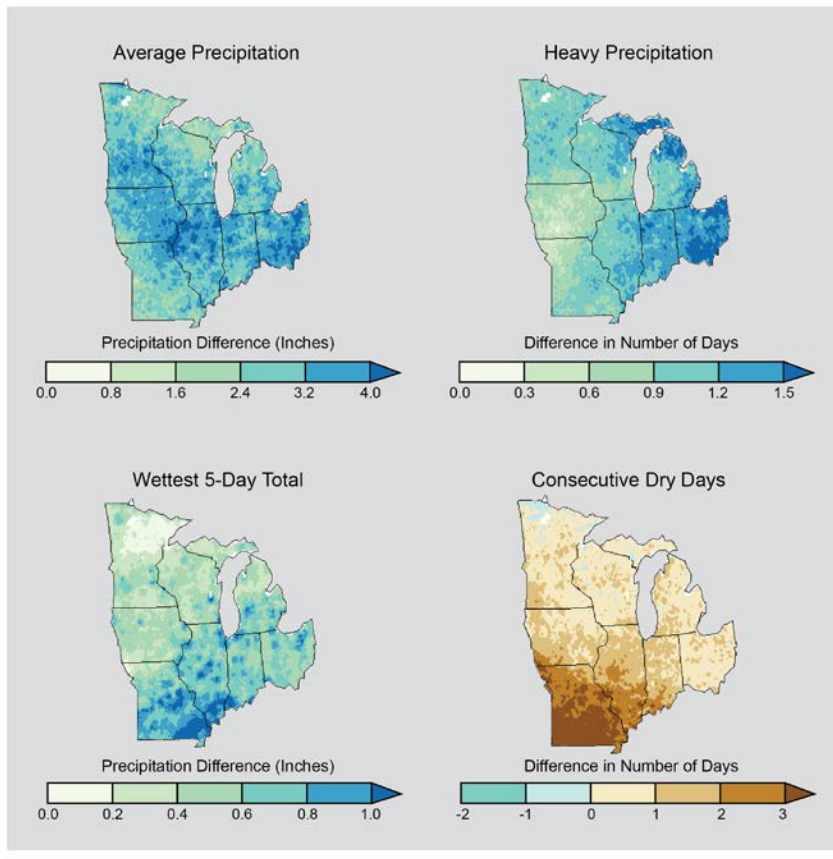


Climate Influence

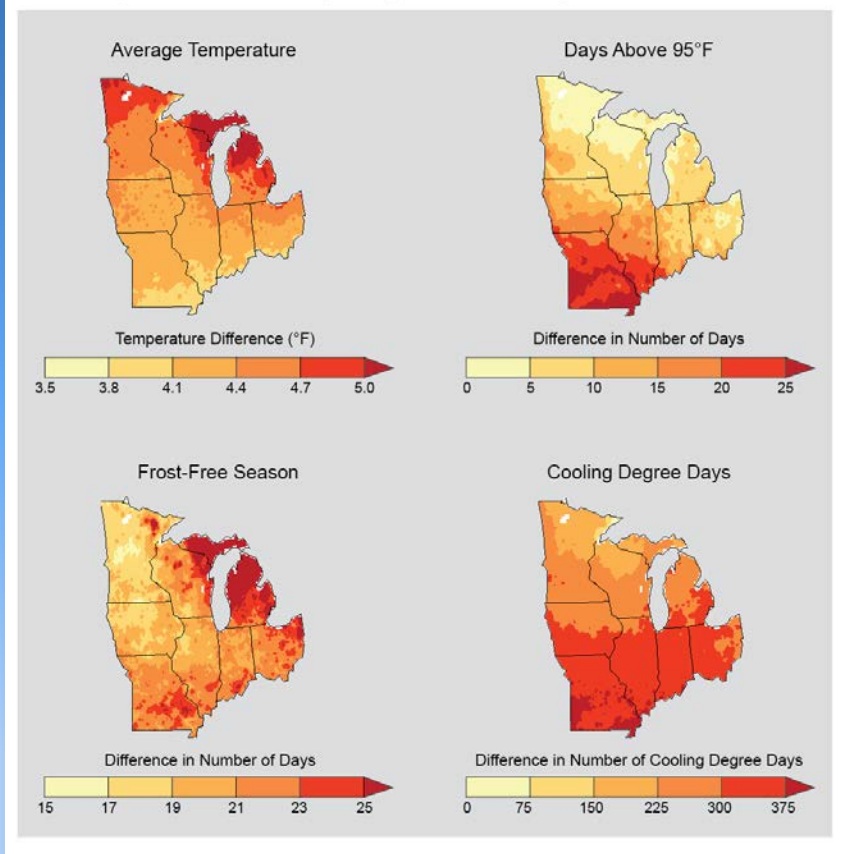


Climate Change in the Great Lakes Region: Projected Changes

When it Rains, it Pours



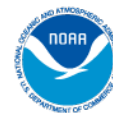
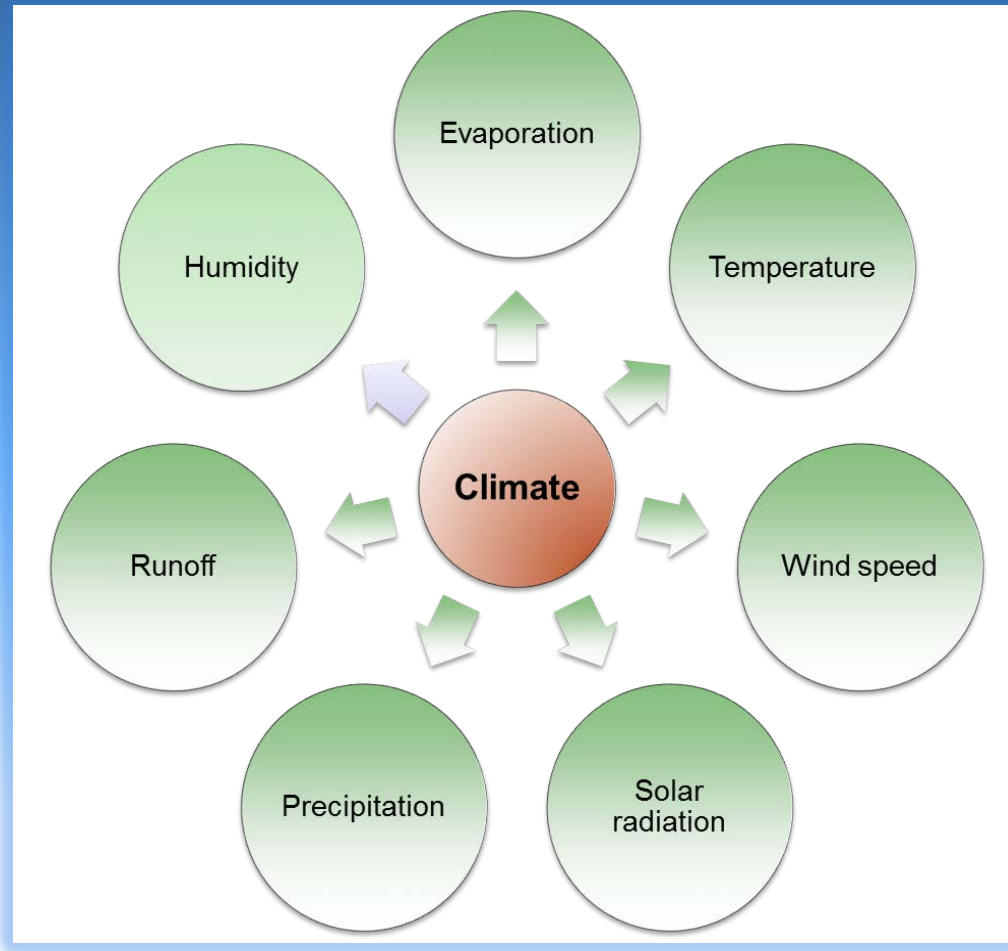
Projected Mid-Century Temperature Changes in the Midwest



Kenneth Kunkel, Cooperative Institute for Climate and Satellites, North Carolina

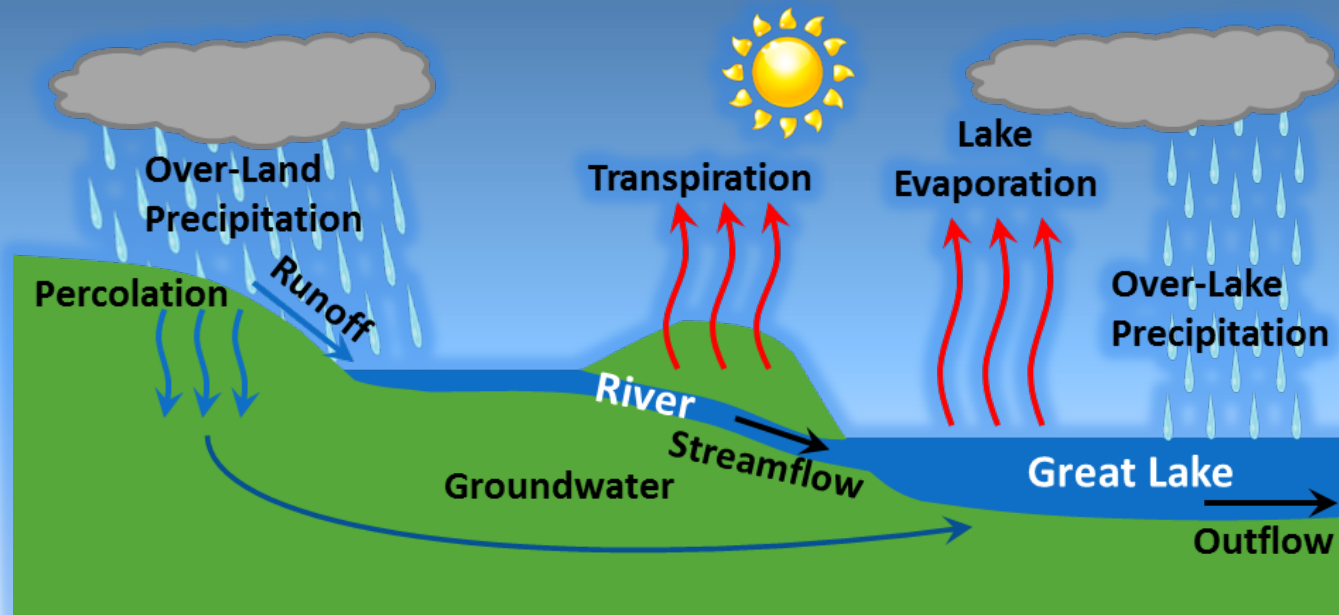


Many Climate Variables



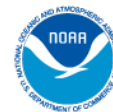
Water In Water Out

The Hydrologic Cycle

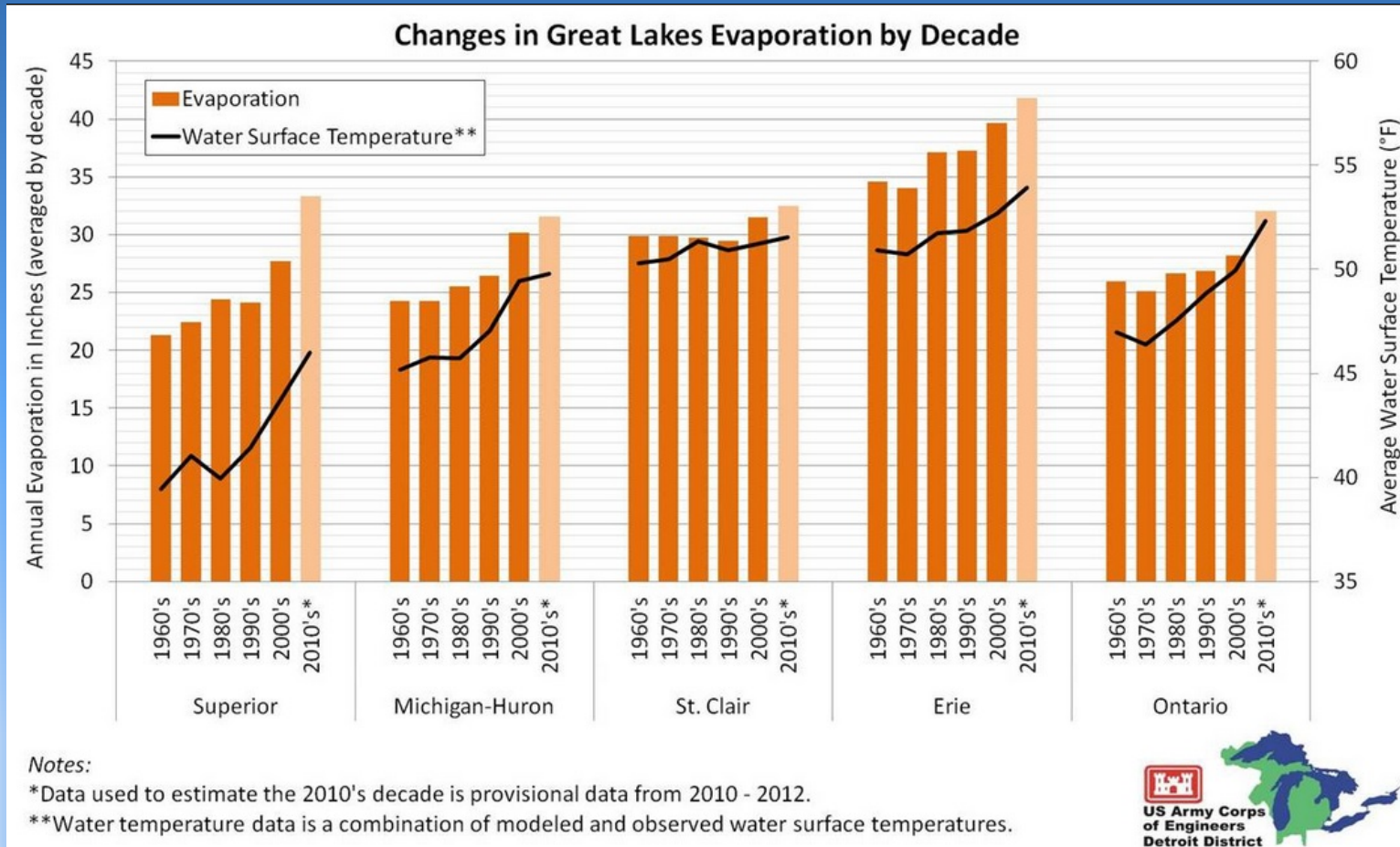


Net Basin Supply (NBS)

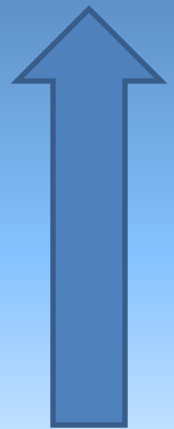
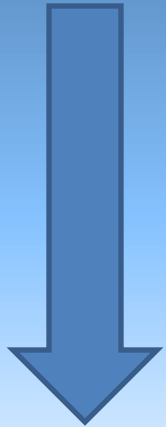
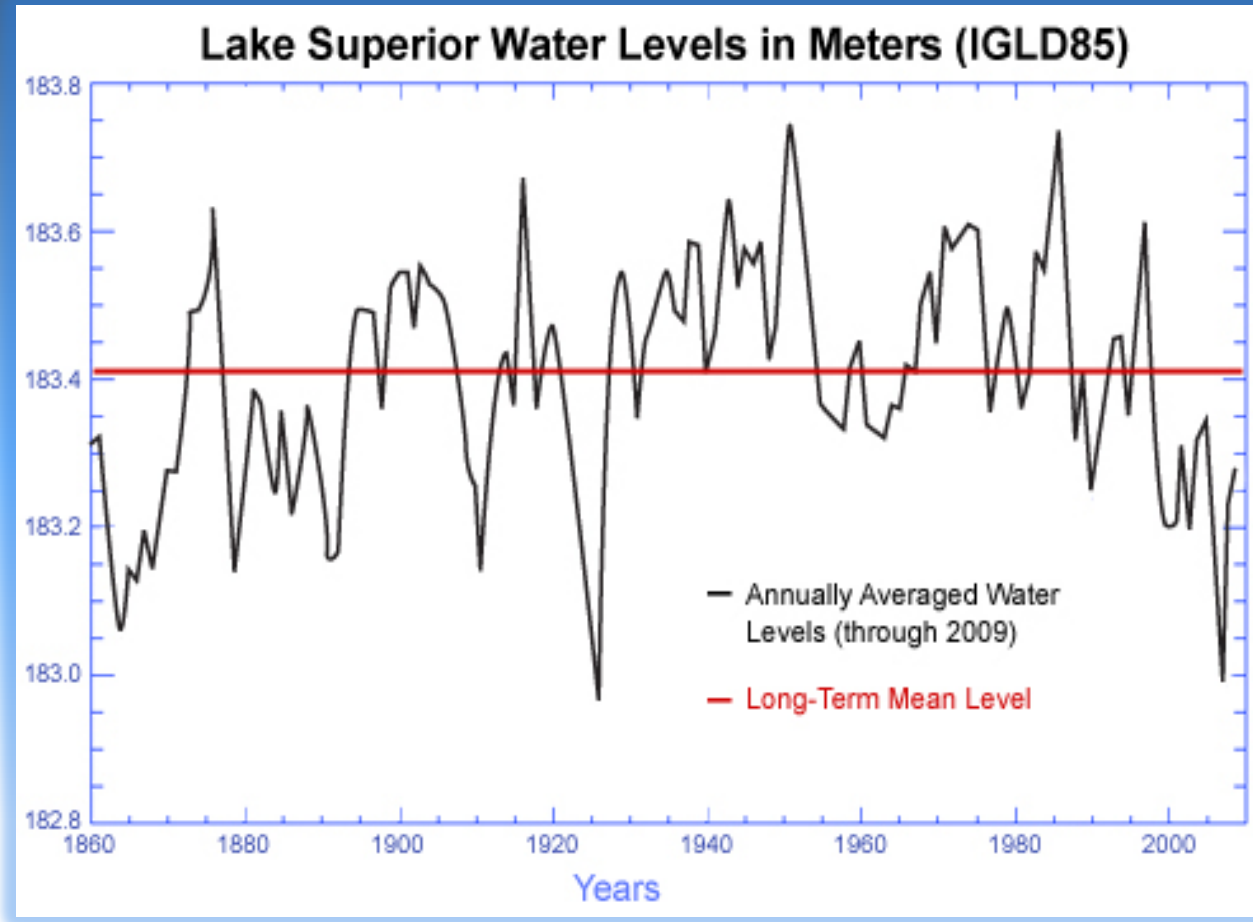
NBS = Overlake precipitation – Overlake evaporation + runoff from land
+ groundwater from land



Evaporation Rates



Lake Levels?

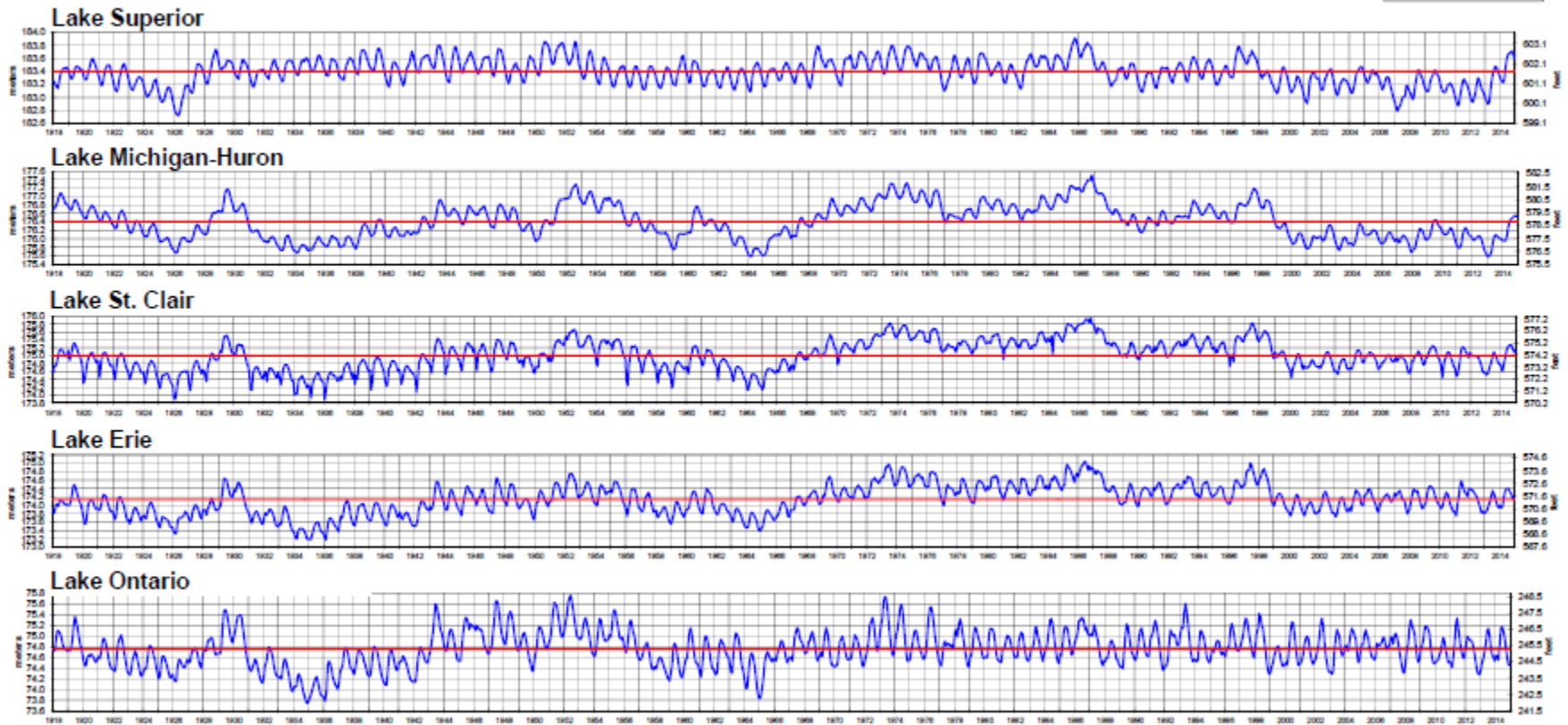


They All Vary



Great Lakes Water Levels (1918-2014)

— Monthly Mean Level
— Long Term Annual Average



The monthly average levels are based on a network of water level gauges located around the lakes.

Elevations are referenced to the International Great Lakes Datum (IGLD).



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National Climate Assessment

- The Second National Climate Assessment predicted **significant drops** in Great Lakes lake levels by 2100.
- Previous studies overestimated the amount of evapotranspiration, and the Third National Climate Assessment predicts a **slight decrease or even a slight rise** in water levels.
- Recent climate studies, along with the large spread in existing modeling results, indicate that projections of Great Lakes water levels represent evolving research and are still **subject to considerable uncertainty**.



2013 Record Lows

2 Great Lakes Hit Record Low Water Levels

John Flesher | Associated Press

Published: February 6, 2013



The sun rises over Chicago on the shores of Lake Michigan, which – along with Lake Huron – has hit its lowest water level ever recorded.



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Low Water Impacts

- Impacts shipping, power generation, tourism, fishing, the ecology of the Great Lake ecosystem, shoreline property owners, and recreational boating.
- During low level periods, lake carriers transporting iron ore, coal, grain, and other commodities are forced to carry fewer goods.
- Also, as water levels recede, marinas have fewer slips to sell to boaters and often must dredge boat slips, channels, and harbor to accommodate boater needs, costing millions.

But lower water can be advantageous for expansion of wetland habitats



High Water Impacts

Enhanced seiche effect causing bluff, beach, and lake-bed erosion, coastal flooding, and sediment transport, which have cascading consequences for shoreline hazards, water quality, and habitats.

Understanding the nature and distribution of impacts associated with lake-level change is critical for targeting watersheds, habitats, and species for Great Lakes Restoration Initiative project funding.



Lake Level Viewer: U.S. Great Lakes

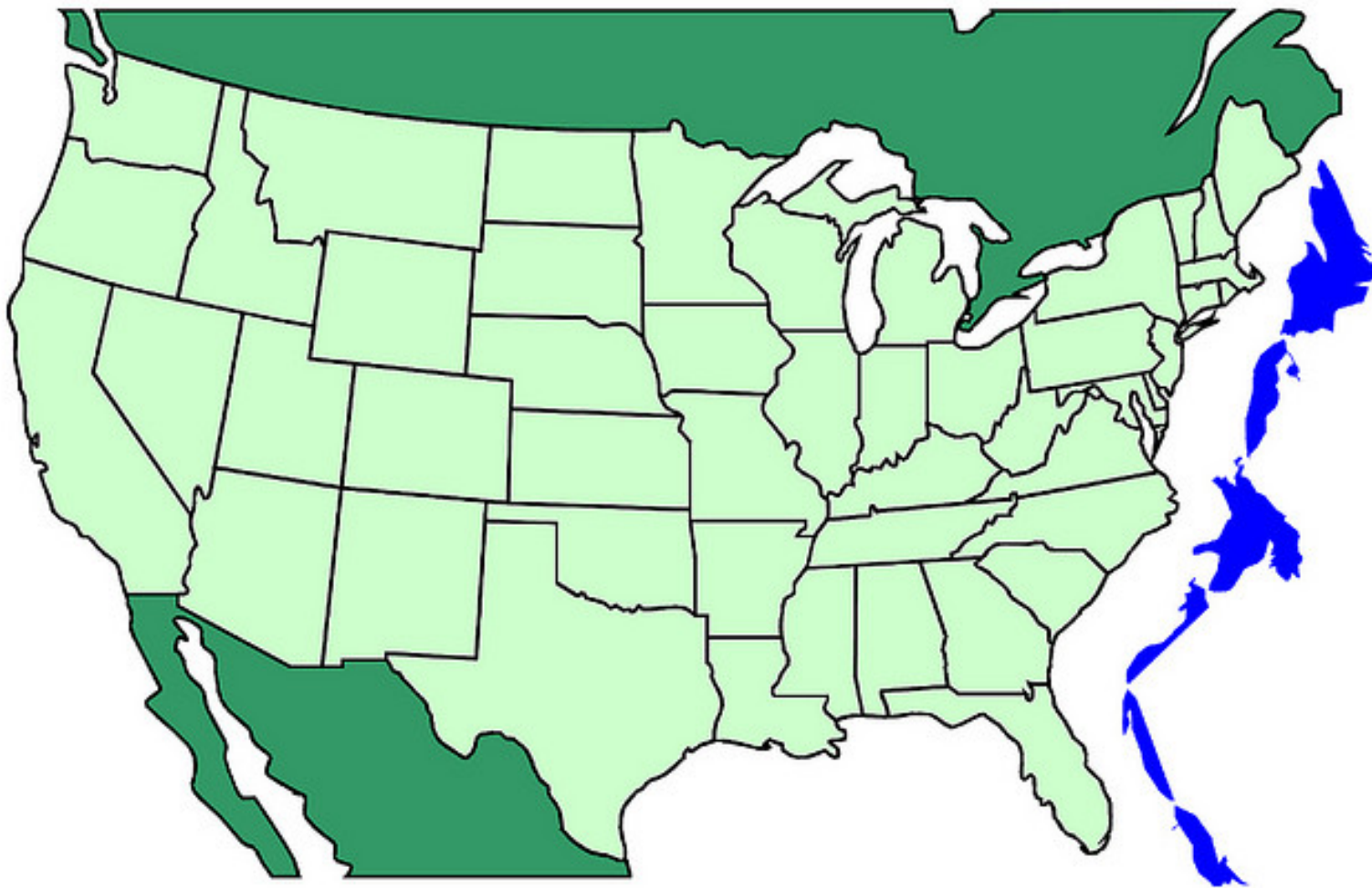
- Funded by President Obama's Great Lakes Restoration Initiative
- Fills a critical information data gap:
 - 40% of Coastal Storms Program survey respondents said current data on future lake level changes are inadequate
 - Only 26% said existing tools to work with or visualize these data are adequate

Source: 2013 Shoreline Change Workshop: Perspectives on the Great Lakes Survey





Great Lakes Coastlines



Lake Level Viewer Requirements

- Use best available, high accuracy topo/bathy Lidar data to build a seamless digital elevation model (DEM) for Great Lakes coastline
- Map lake levels below and above each lake's long-term average level to visualize the impacts of both flooding and low lake levels
- Develop photo simulations at local landmarks to see impacts
- Link visualizations to historical water levels (water level dashboard) for context
- Define elevation data gaps for future collection efforts
- Access map services
- Download elevation and lake level data



Use Best Available Topo/Bathy Lidar

www.coast.noaa.gov/inventory

United States Interagency Elevation Inventory

Logos: NOAA, USGS (science for a changing world), FEMA

Select State/Territory: [Dropdown]
Select County/Island: [Dropdown]

Instructions | FAQ
Download Inventory | Metadata
Map Service | More Information
Contact Us

Data Type

- Topographic Lidar
- Topobathy Shoreline Lidar
- IfSAR Data
- Bathymetric Lidar

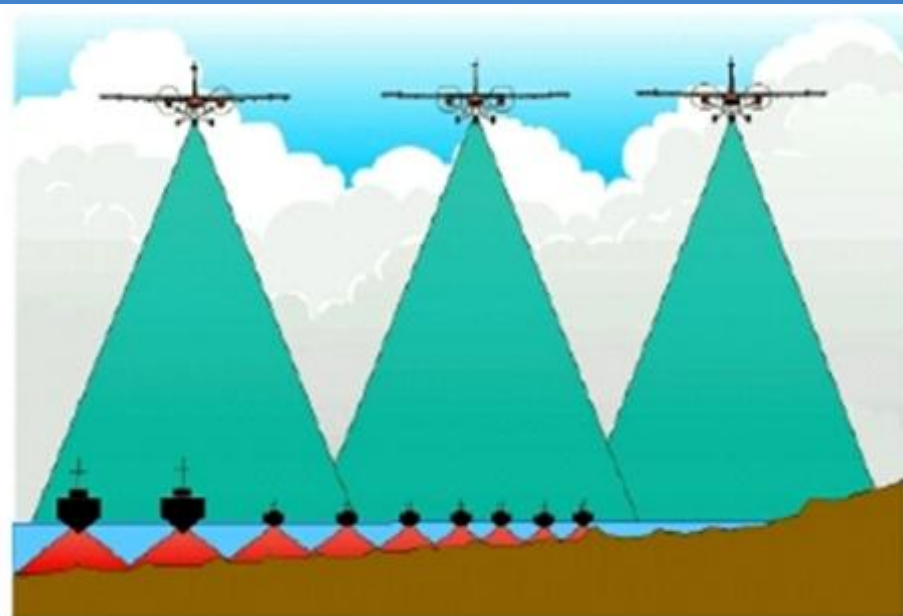
Current Location: 47.209711, -88.203072

Data Set Name	Data Access	Metadata Access	Collection Date	Project Status	Res
2010 EPA Great Lakes Restoration Initiative (GLRI) Bathymetric Lidar: Lake Superior (MI, MN, WI)	NOAA Digital Coast	NOAA Digital Coast	2 July - 12 Aug 2010	Complete	Put
2011 U.S. Army Corps of Engineers (USACE) MI/NY Great Lakes Topobathy Lidar	NOAA Digital Coast	NOAA Digital Coast	June 6 - Sept 23, 20	Complete	Put

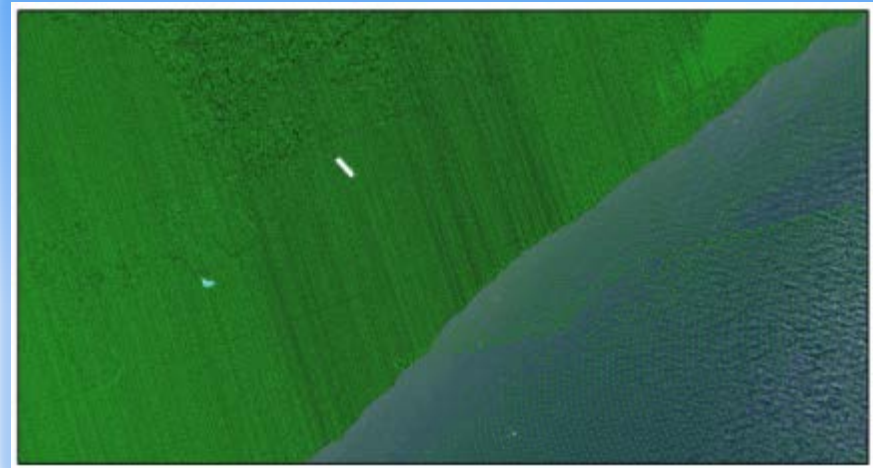
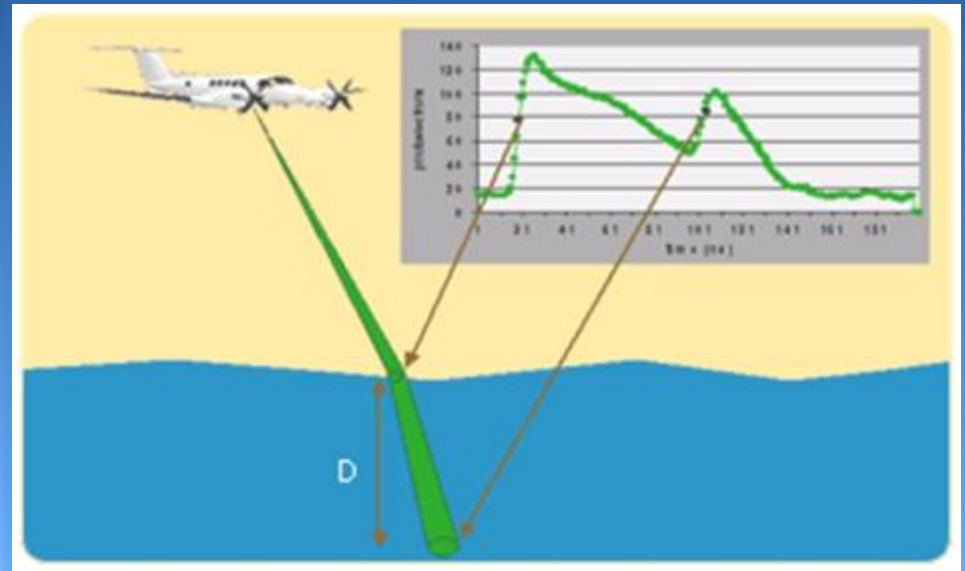
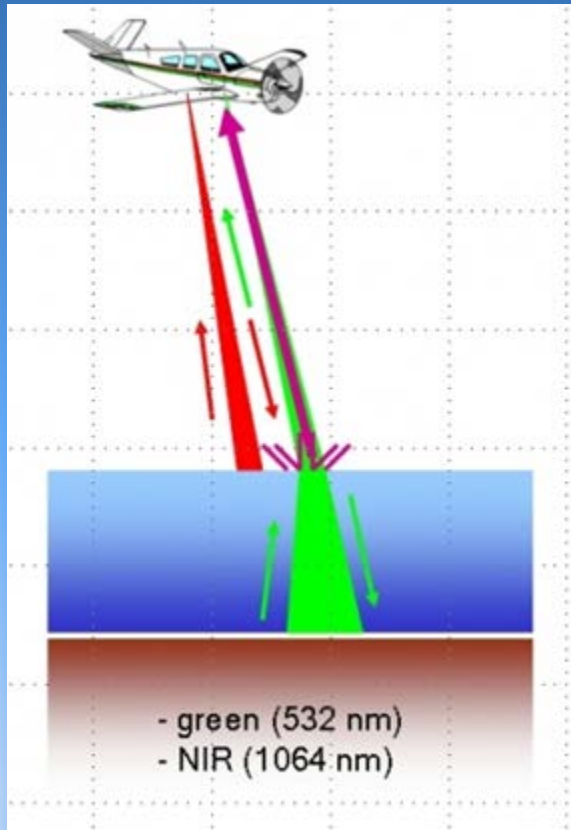


Topo/Bathy Lidar

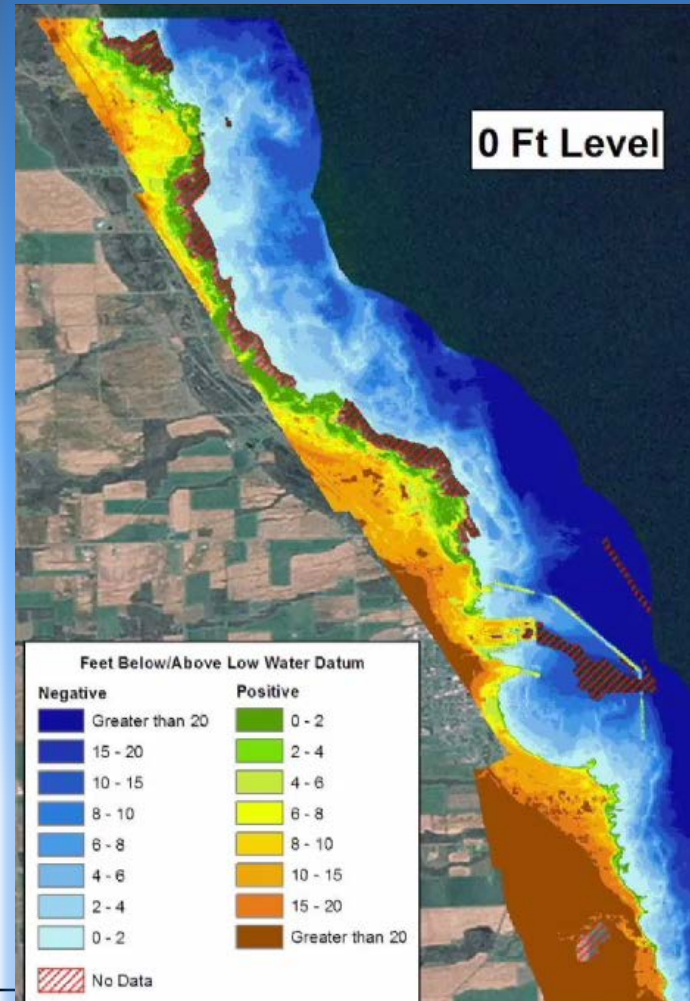
Very Efficient vs. Ship-Based Methods



But Has Some Challenges



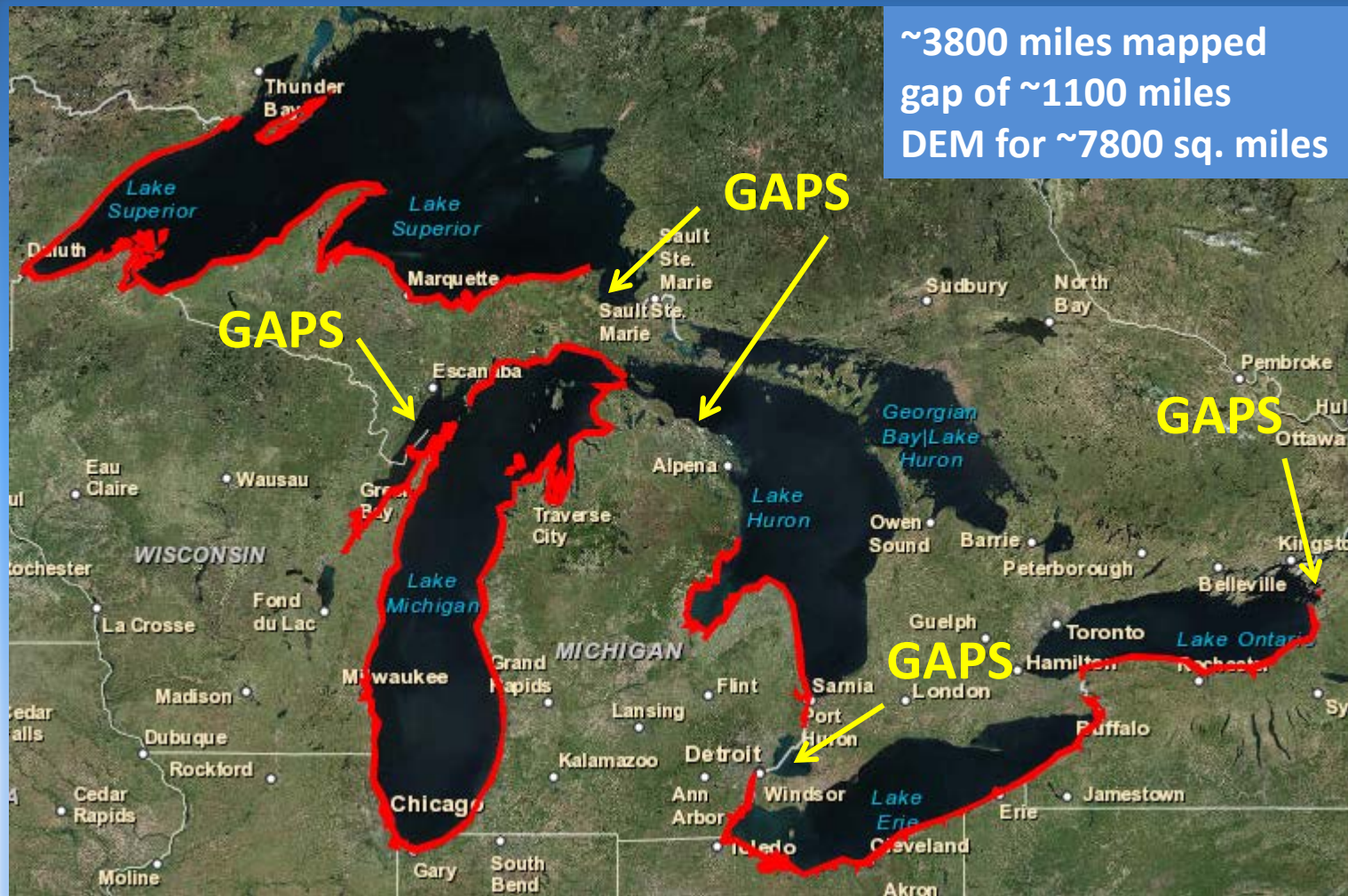
Digital Elevation Models From Topo/Bathy Lidar



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Current Data Coverage



Gaps Within Coverage

Topography with No Bathymetry
(much more common)



Bathymetry with No Topography
(much less common)



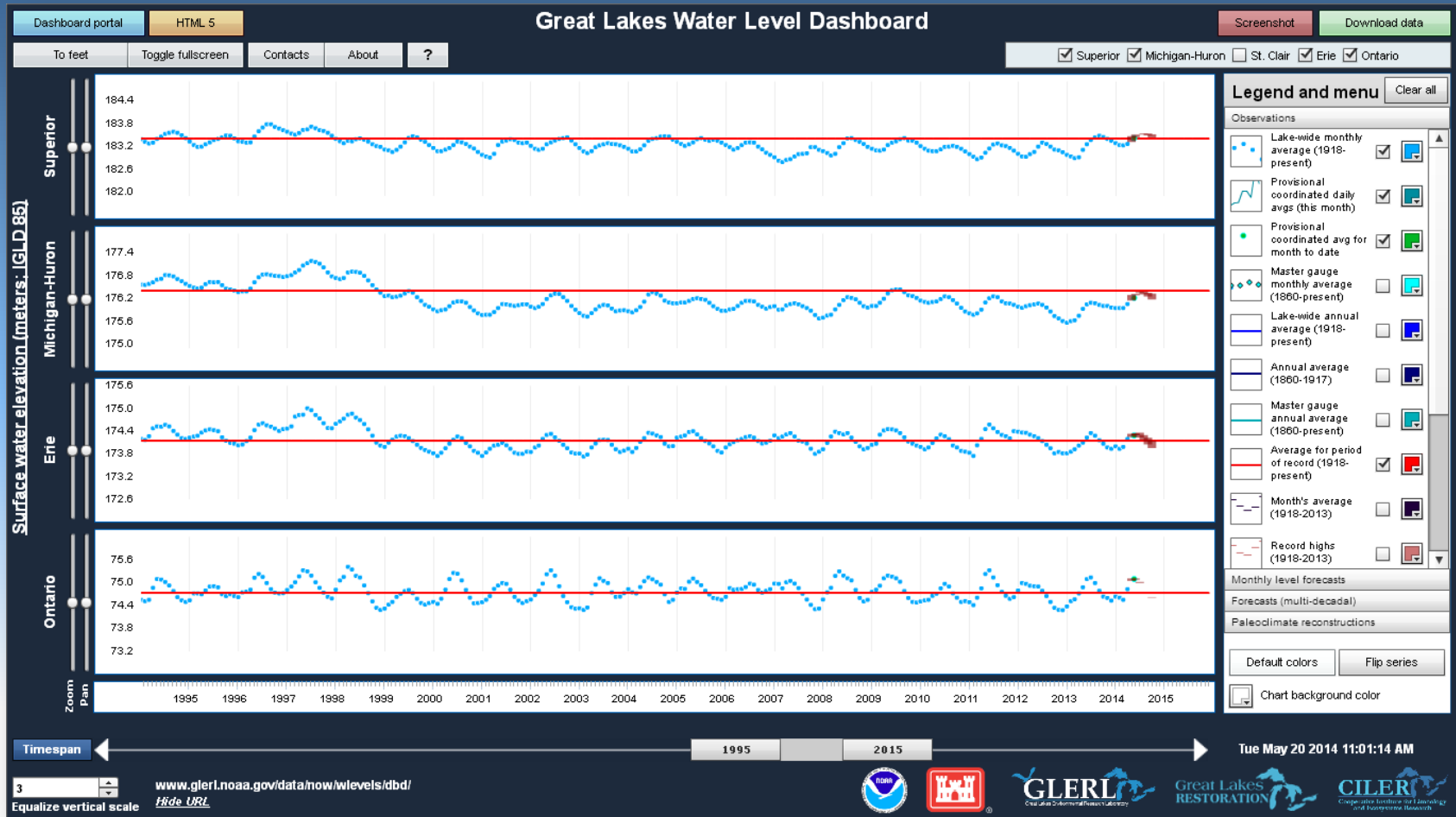
Gaps in Harbors



Flooding Information, but missing water depth information in some harbors



Connection to Water Level Dashboard



Source: NOAA GLERL



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Water Level Elevation Challenges

- Lake Michigan
- Lake Erie
- Lake Huron
- Lake Ontario
- Lake Superior

IGLD	
584.8ft	6.0ft
583.8ft	5.0ft
582.8ft	4.0ft
581.8ft	3.0ft
580.8ft	2.0ft
579.8ft	1.0ft
578.8ft	0.0ft
577.8ft	-1.0ft
576.8ft	-2.0ft
575.8ft	-3.0ft
574.8ft	-4.0ft
573.8ft	-5.0ft
572.8ft	-6.0ft

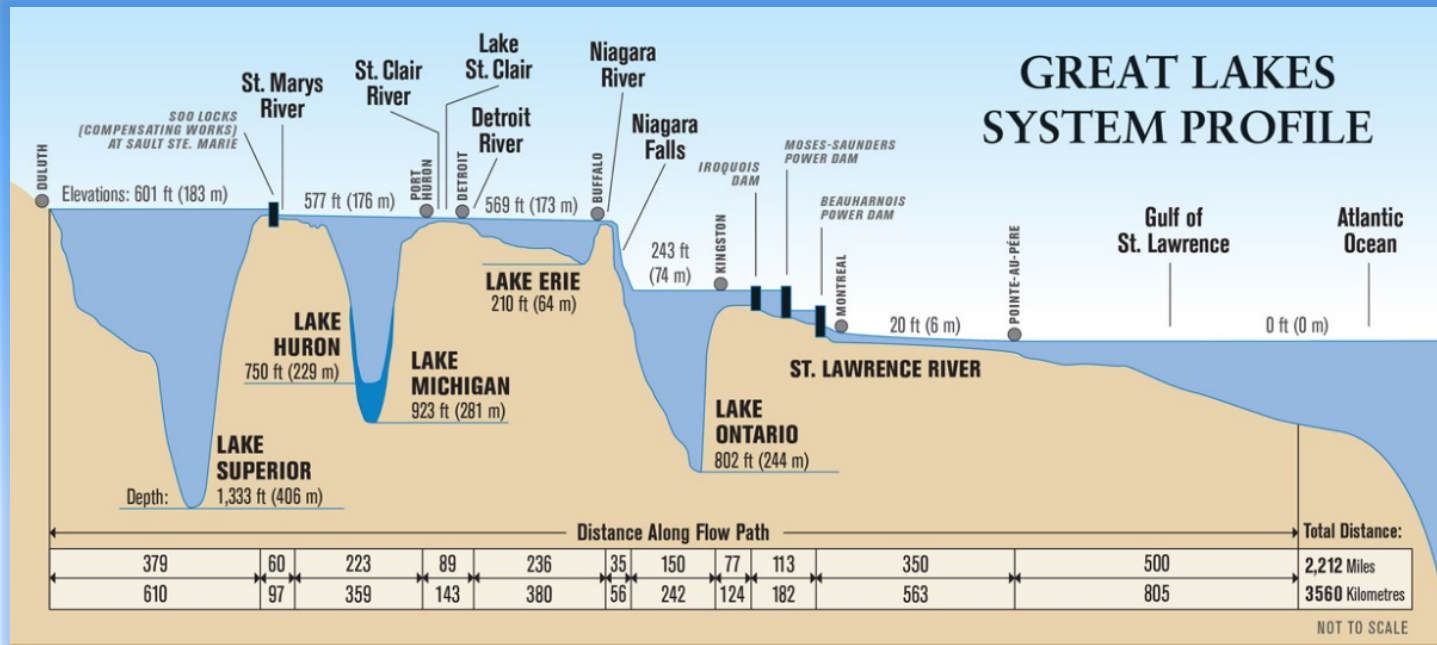
High (582.4 ft)

578.8ft Long Term Current Average

575.8ft Low (576.0 ft)

Records & Avg. On

Unit of Measure Ft



Demonstration

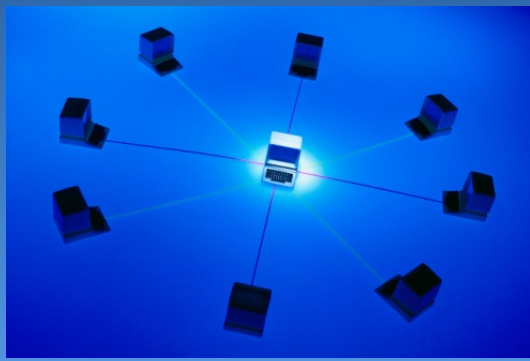
www.coast.noaa.gov/llv



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Data Distribution

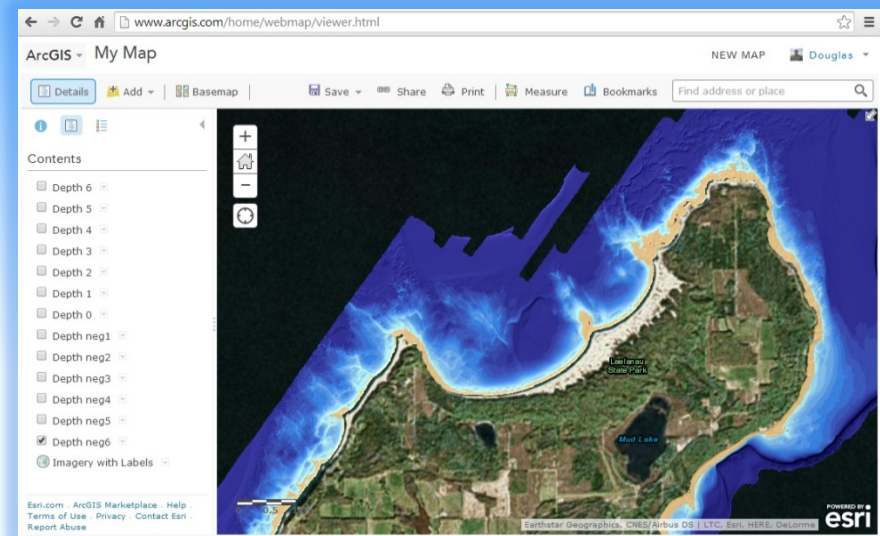


Lots of Ways to Distribute

- Raster geodatabases via HTTP
- ESRI Representational State Transfer (REST) map services
- Web map services (WMS)

Lots of Layers

- Lake level change layers
- Uncertainty layers
- Socioeconomic layers
- Conditioned DEMs



Four-Pronged Approach

- Visualize water level changes at a screening level (education/outreach, start the discussion)
- Use the web map services in other tools, with other data
- Get the data layers to use for hazards profile/vulnerability assessment
- Use the underlying DEMs for other purposes (storm water, hydrology, erosion etc.)



Future Work

- Bathymetric Data Inventory
- Update with new topo/bathy data and fill in data gaps
- Collect user feedback on version 1.0
- Enhancements for management applications based on user feedback



Updates Underway

Update Areas

Esri, HERE, DeLorme, Mapbox, and the GIS user community, Esri, HERE, DeLorme, Mapbox, and the GIS user community



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Resources

NOAA Digital Coast

[*www.coast.noaa.gov/digitalcoast*](http://www.coast.noaa.gov/digitalcoast)

Lake Level Viewer

[*www.coast.noaa.gov/digitalcoast/tools/llv*](http://www.coast.noaa.gov/digitalcoast/tools/llv)

U.S. Interagency Elevation Inventory

[*www.coast.noaa.gov/inventory*](http://www.coast.noaa.gov/inventory)

Coastal Lidar Data

[*www.coast.noaa.gov/digitalcoast/data/coastallidar*](http://www.coast.noaa.gov/digitalcoast/data/coastallidar)

CanVis

[*www.coast.noaa.gov/digitalcoast/tools/canvis*](http://www.coast.noaa.gov/digitalcoast/tools/canvis)

NOAA GLERL Water Level Dashboard

[*www.glerl.noaa.gov/data/dbportal*](http://www.glerl.noaa.gov/data/dbportal)



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Thank You!

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