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The Lake Superior water monitoring and information system

Robert A. Shuchman
Michigan Technological University

Chris Roussi
Michigan Technological University

W. Charles Kerfoot
Michigan Technological University

Sarah A. Green
Michigan Technological University

Guy Meadows
University of Michigan

See next page for additional authors

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Authors

Robert A. Shuchman, Chris Roussi, W. Charles Kerfoot, Sarah A. Green, Guy Meadows, Tyler A. Erickson, Colin Neil Brooks, K. Arthur Endsley, Michelle Wienert, Michael J. Sayers, Nathaniel Jessee, Jamey Anderson, and Michael Abbott

The Lake Superior Water Monitoring and Information System

*Long Term Water Quality,
Meteorological and Wave
Parameter Measurements in
Lake Superior*



Limnotech Webinar: 28 January 2012

Dr. Robert Shuchman¹, Chris Roussi¹, Dr. Charlie Kerfoot², Dr. Sarah Green², Dr. Guy Meadows³, Dr. Tyler Erickson¹, Colin Brooks¹, K. Arthur Endsley¹, Michelle Wienert¹, Mike Sayers¹, Nate Jessee¹, Jamey Anderson¹, Michael Abbot²

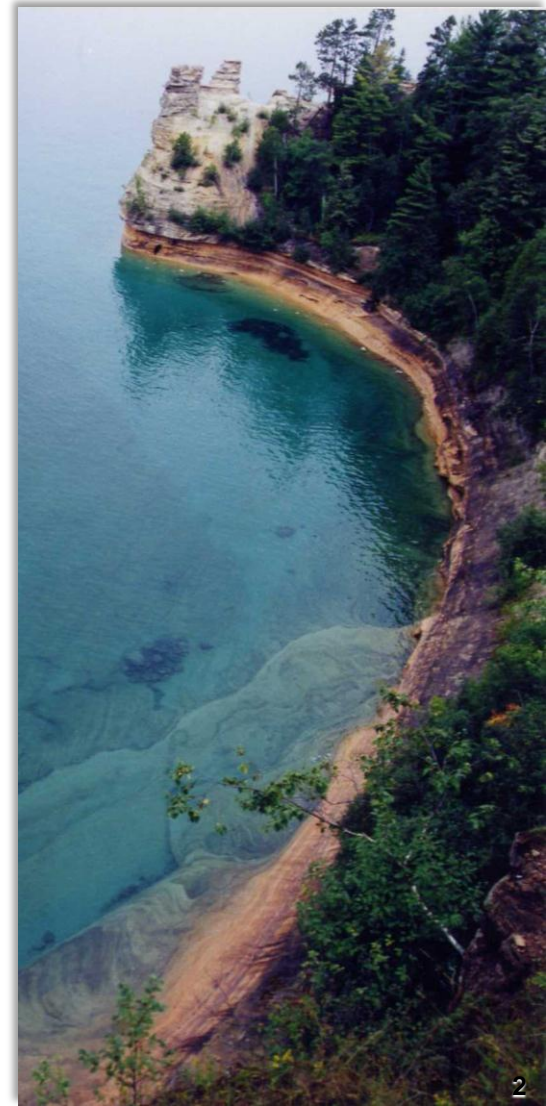
¹ = Michigan Tech Research Institute (MTRI), Ann Arbor, MI

² = Michigan Technological University, Houghton, MI

³ = University of Michigan, AOSS, Ann Arbor, MI

Objectives and Purpose

- Support the four priority issues outlined by the Great Lakes Observing System (GLOS):
 - **Climate Change Impacts**
 - **Ecosystem and Food Web Dynamics**
 - **Protection of Public Health**
 - **Navigation Safety and Efficiency**
- Support Great Lakes Restoration Initiatives
- *In situ* measurements support GLERL GLCFS model and provide data for satellite derived product validation
- Assist Michigan to lead in research and development of Great Lakes resources
- Connect research to public awareness of issues facing these resources





Michigan Tech Buoy and Ferry Box Program

- University of Michigan (UofM) and S2 Buoy development allowed for immediate participation by Michigan Tech in the GLOS near-shore monitoring program
 - **Mooring expertise**
 - **Deployment expertise**
 - **High quality / cost effective instrumentation**

- Michigan Tech is leveraging acquired technology from UofM and S2 and adding its own Intellectual Property (IP)
 - **Power improvements**
 - **Wave sensor (3rd Generation)**
 - **Temperature sensor (thermistor) chain (2nd Generation)**
 - **Iridium communication**

Michigan Tech Buoy and Ferry Box Program

- Funding
 - GLOS
 - MTU V.P. Infrastructure Enhancement Award
 - MTRI IR&D
 - Cooperative arrangements with National Park Service (NPS)
 - In process of setting up an endowment, related to Michigan Tech's *Great Lakes Research Center (GLRC)*

Moored Buoys

- Buoy at north and south entrances of Keweenaw Waterway measure:
 - Weather conditions
 - Wave dynamics
 - Water quality
 - Currents
 - Temperature Profiles



Temperature Sensor Chains

- Seasonal campaigns; measures thermal gradient in the Portage Canal

Ferry Boxes

- Ranger III passenger vessel to Isle Royale outfitted with water quality sensors

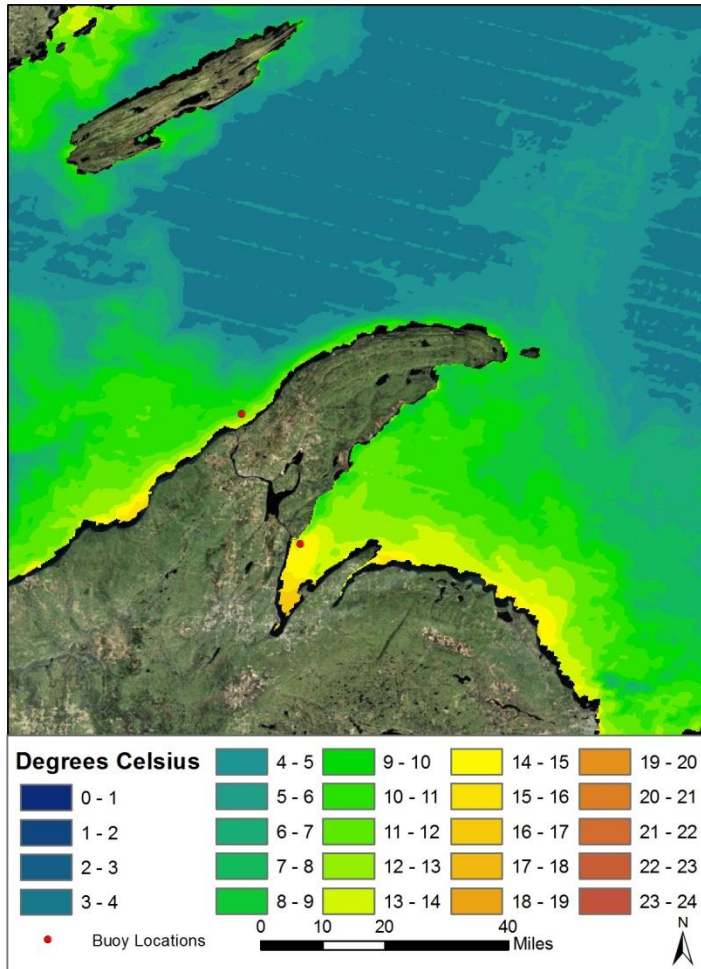
Keweenaw Waterway Buoys

- South entrance buoy (45025) deployed 27 May 2011 operated continuously until 21 October 2011 when removed for winter
- New buoy (45023) at north entrance was deployed on 11 June 2011, recovered 20 July 2011, redeployed 28 August 2011 and recovered for the season on 25 September 2011.
- Each buoy was visited three times for QA/QC
- Ranger box was installed on 25 April 2011 and recovered for the season on 6 October 2011.
- iButtons deployed at North and South entrances on 30 April 2011. They were both recovered for the season on 28 October 2011.

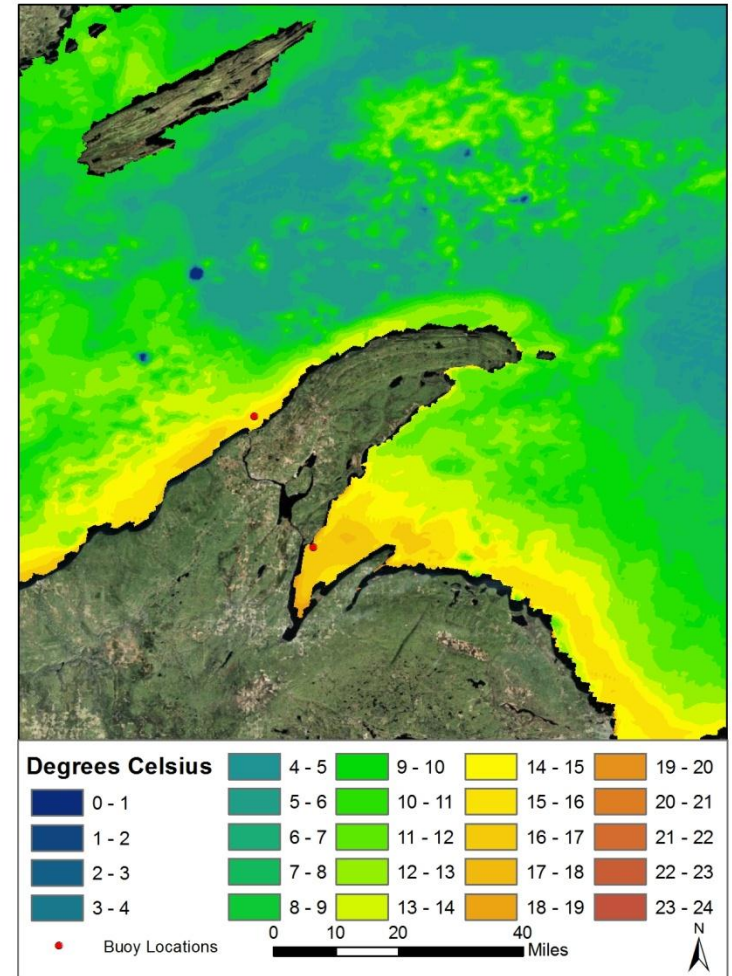


Keweenaw Waterway Buoys Compliment Remote Sensing

July 6, 2011 Lake Surface Temperature



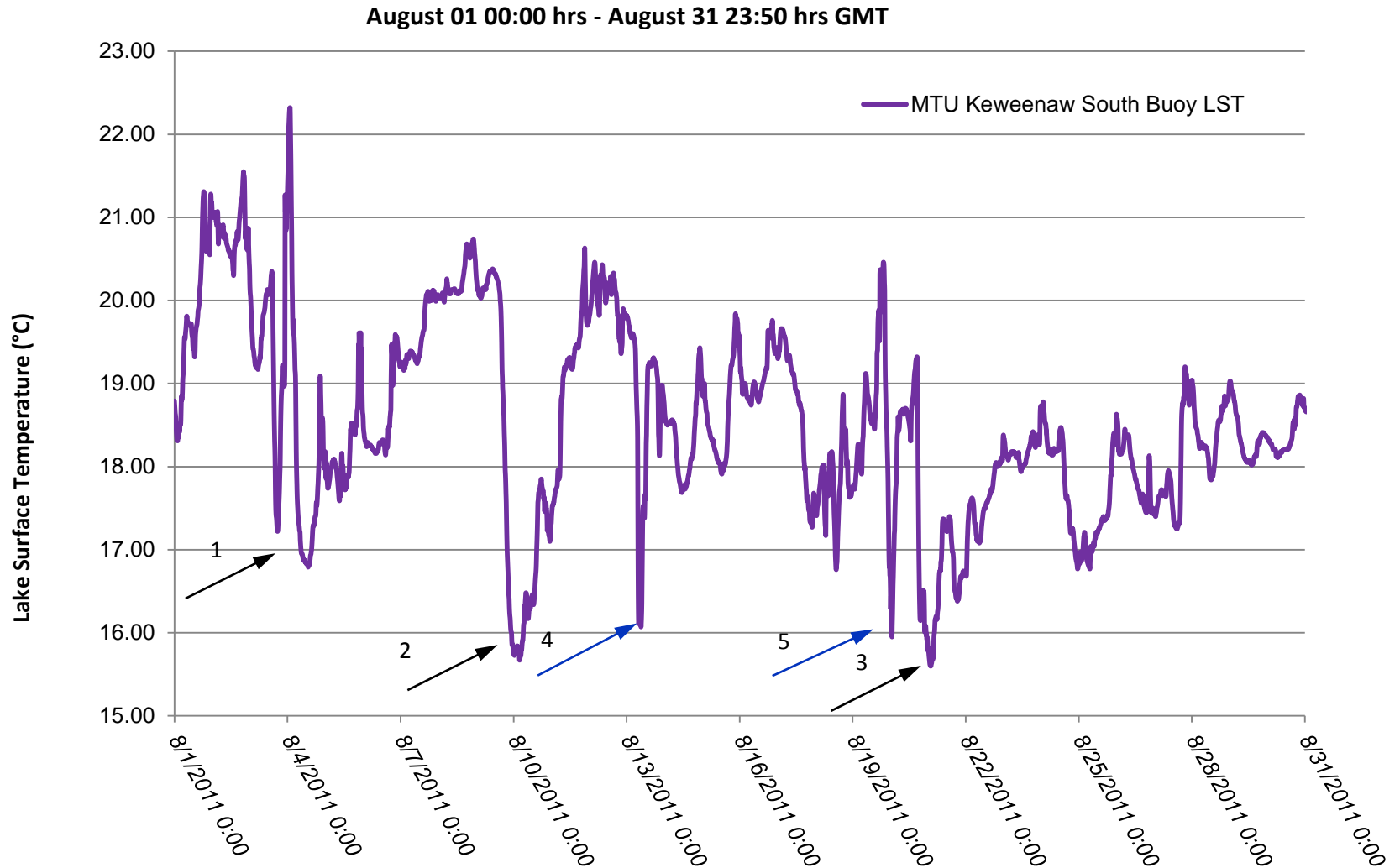
July 10, 2011 Lake Surface Temperature



Planned Buoy Upgrades: FY 2012

- Upgrade solar cells
- Redesign mooring (bottom weight and tether)
- Install buoy adrift sensor
- Deploy new single wire thermistor chain (1-meter depth intervals/0.5°C)
- Deploy 6 DOF wave sensor
- Utilize Iridium as data communication device for thermistor and wave sensor

MTU Keweenaw South Buoy LST

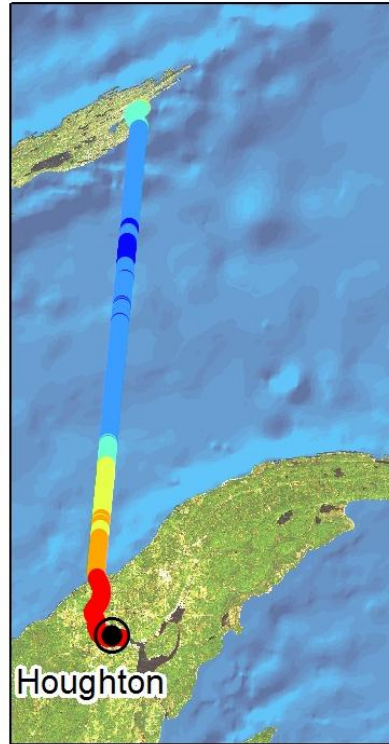


Example Ranger III Instrumentation Data



Turbidity (NTU)

- 0-5
- >5-10
- >10-20
- >20-50
- >50-100
- >100



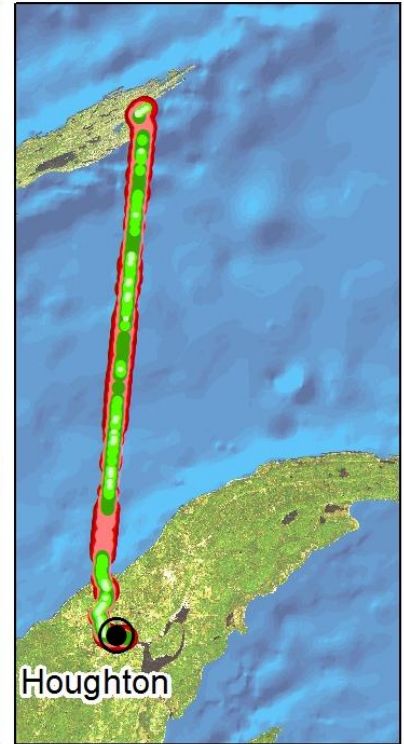
Temperature - C (water)

- 8-10
- >10-12
- >12-14
- >14-16
- >16-18
- >18-20



Conductivity

- 0.093 - 0.096
- >0.096 - 0.098
- >0.098 - 0.100
- >0.100 - 0.102

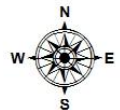


Wind Speed (meters / second)

- 0-2
- >2-2.5
- >2.5-3
- >3-3.5
- >3.5-4
- >4-7

0 5 10 20 Miles

0 5 10 20 30 40 50 Kilometers



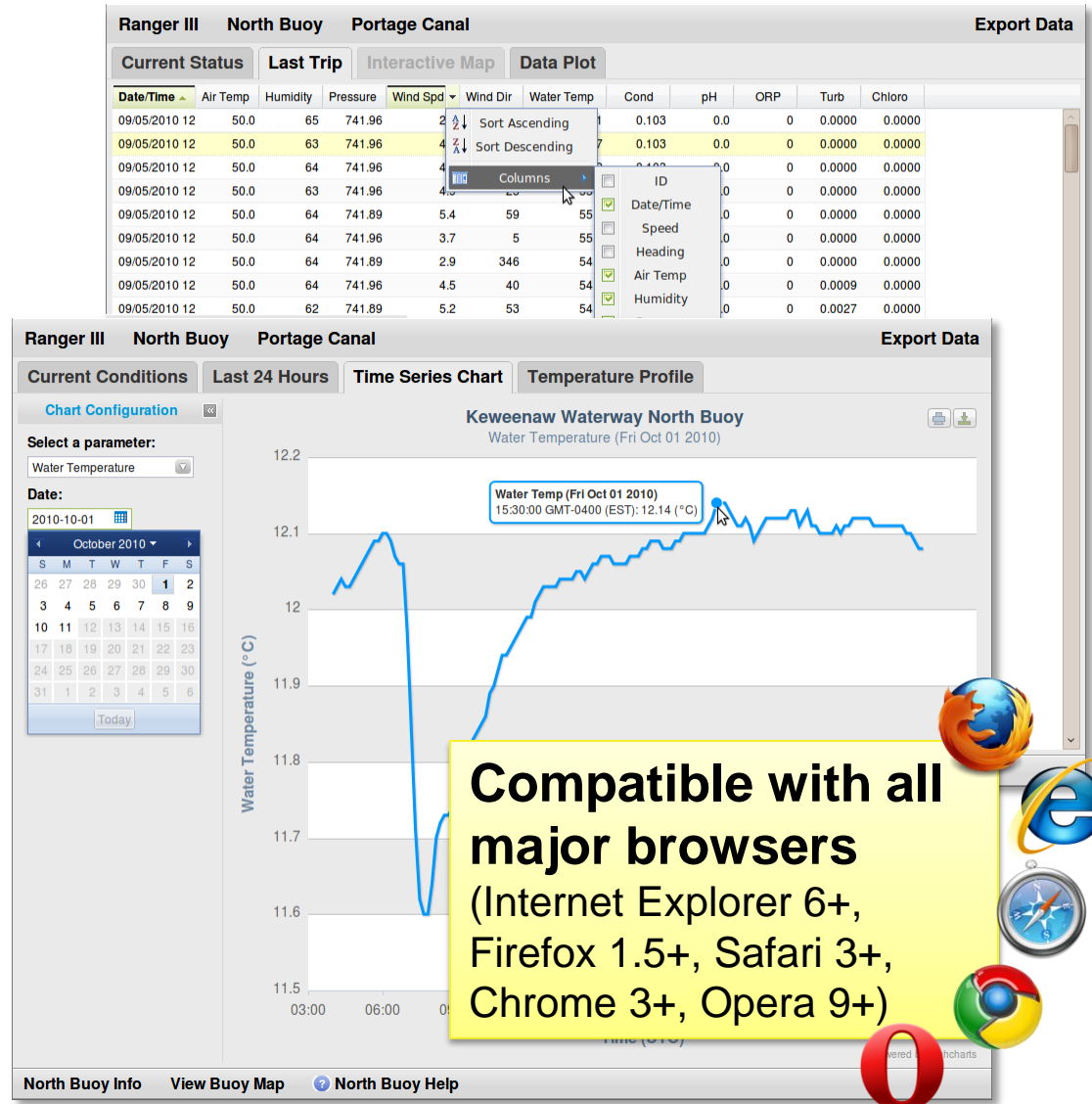


Data Sharing of Michigan Tech Buoy, Ferry Box. And iButton Data

- *Main delivery mechanism is Michigan Tech's website*
www.michigantechlakesuperior.org
- Buoy data (45023 and 45025) are available at the National Data Buoy Center (NDBC)
www.ndbcnoaa.gov
- Ocean Engineering Lab website
www.uglos.engin.umich.edu
- All data is also referenced on the GLOS website
www.glos.us
- In the future, data will also be available via the GLOS DMAC

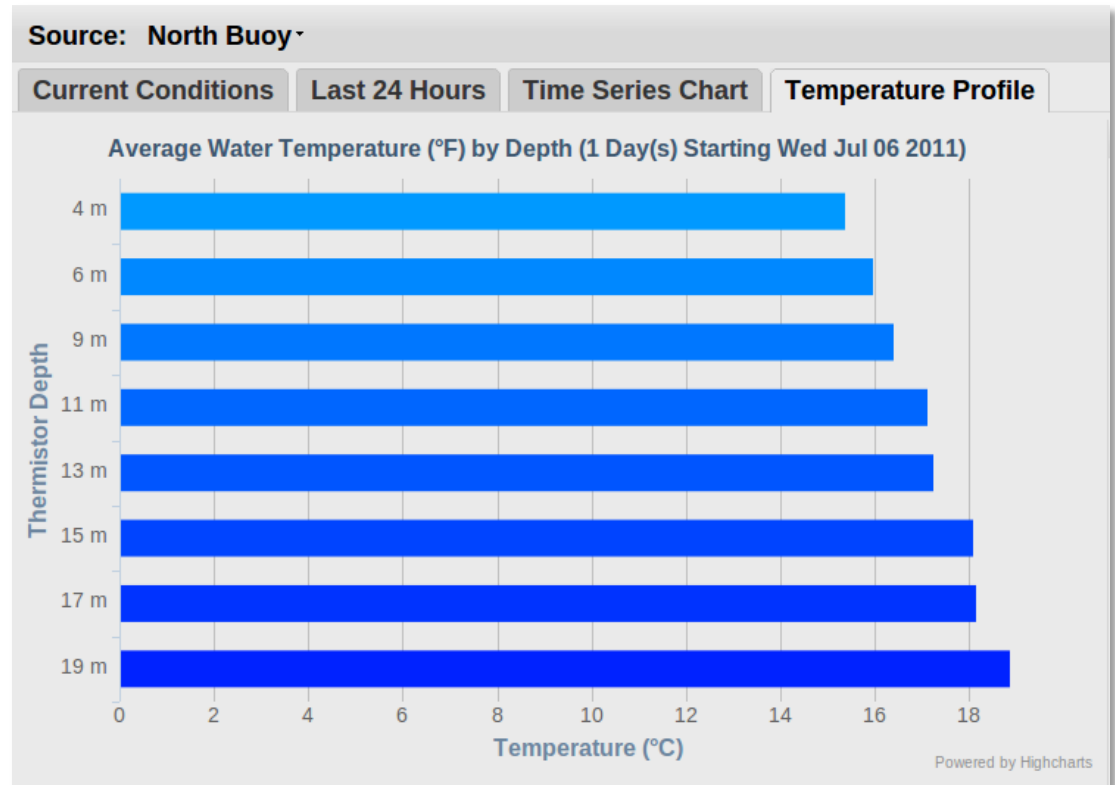
Data Services and Visualizations

- *Dynamic tables and grids* — Quickly view the last 24 hours of buoy, Ranger III data
- *Interactive charts plotted on demand* — Explore spatial, temporal relationships of *in-situ* data

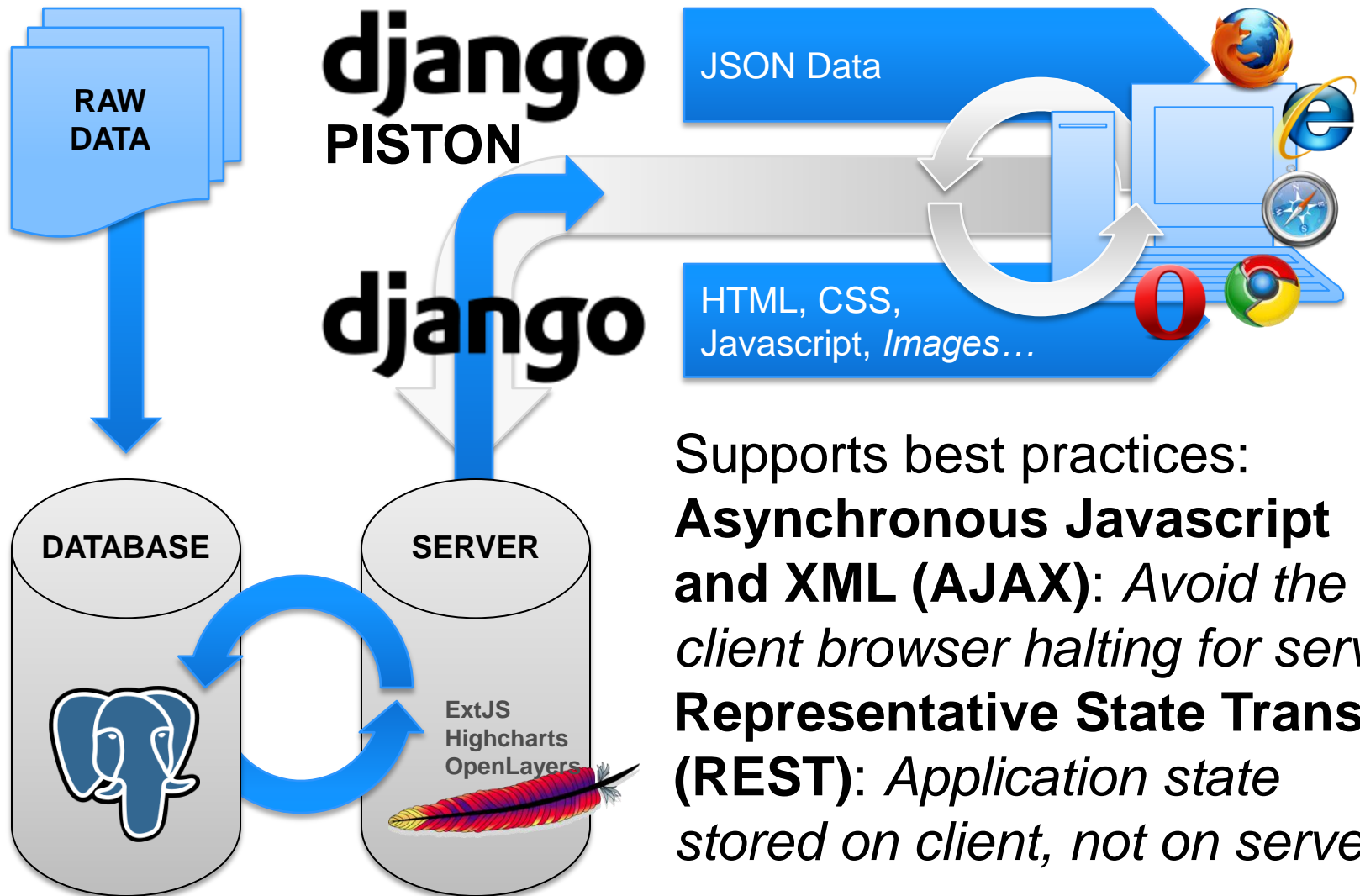


Activities Supported

- Investigation of the relationship between surface winds and coastal upwelling
- Verification of a thermocline (see figure at right) off the coast of the Keweenaw
- Real-time observations of great importance to recreational boaters, commercial fishers, and search and-rescue operations



Client-Server Model



Supports best practices:
Asynchronous Javascript and XML (AJAX): *Avoid the client browser halting for server*
Representative State Transfer (REST): *Application state stored on client, not on server*

Concluding Remarks

- The data collected are presently used to support commercial fishing, provide inputs to models, and to provide validation for remote sensing-derived products
- Combining single location time series data with remote sensing observations and GLCFS model was useful in describing upwelling events
- Buoy platforms are useful platforms for evaluation of new instrument and measuring approaches

Lake Superior Water Monitoring and Information System
www.MichiganTechLakeSuperior.org