



*Real-Time Continuous Observations of Lake Erie Chemical, Biological,  
and Physical Parameters*

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1. NOAA – Great Lakes Environmental Research Lab (GLERL)
2. Ohio Supercomputing Center

Lake Erie Millennium Network: IFYLE



## **Real-time Environmental Coastal Observation Network (RECON)**

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**Co-principal Investigators: Steve Brandt, Doran Mason, Stuart Ludsin,  
Dave Schwab, Tom Johengen, Tom Bridgeman**

**Co-workers: Ron Muzzi, John Lane, Terry Miller, Steve Constant,  
Dave Fanslow**

**Ron – lead project design engineer**

**Terry – buoy design, assembly, field  
maintenance**

**John – RF and DAS design, assembly,  
maintenance**

**Steve – instrument calibration,  
assembly, field maintenance**

**Dave – field maintenance**

**Ruberg – lead PI, engineering, field work**

**Brandt – program management, funding,  
transition to operation, fisheries acoustics**

**Mason – Indian River Lagoon System**

**Ludsin – Lake Erie Integrated Project**

**Schwab, Bridgeman – Lake Erie  
Physics/Nutrients**

**Johengen – Calibration Lab, ACT**

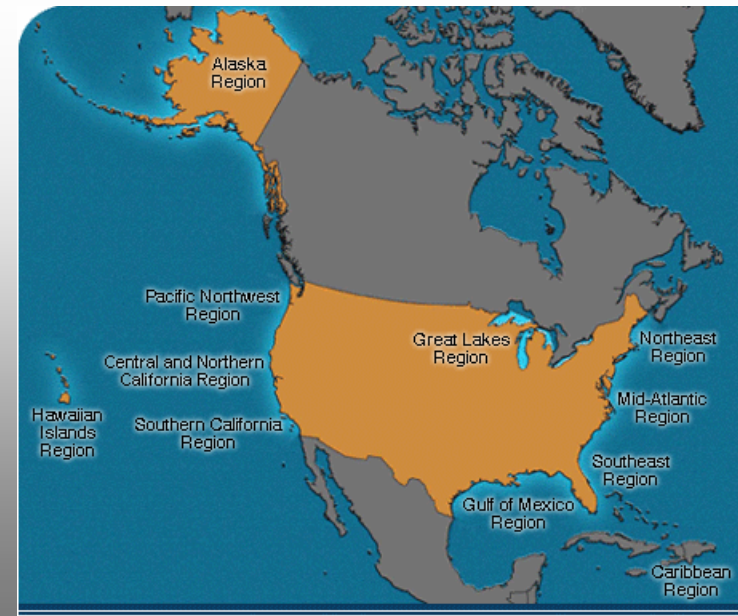
## **US National Emphasis on Observing Systems:**

Ocean.US was created by the National Oceanographic Partnership Program to coordinate the development of an operational and integrated and sustained ocean observing system (IOOS). The IOOS system will serve US national needs for:

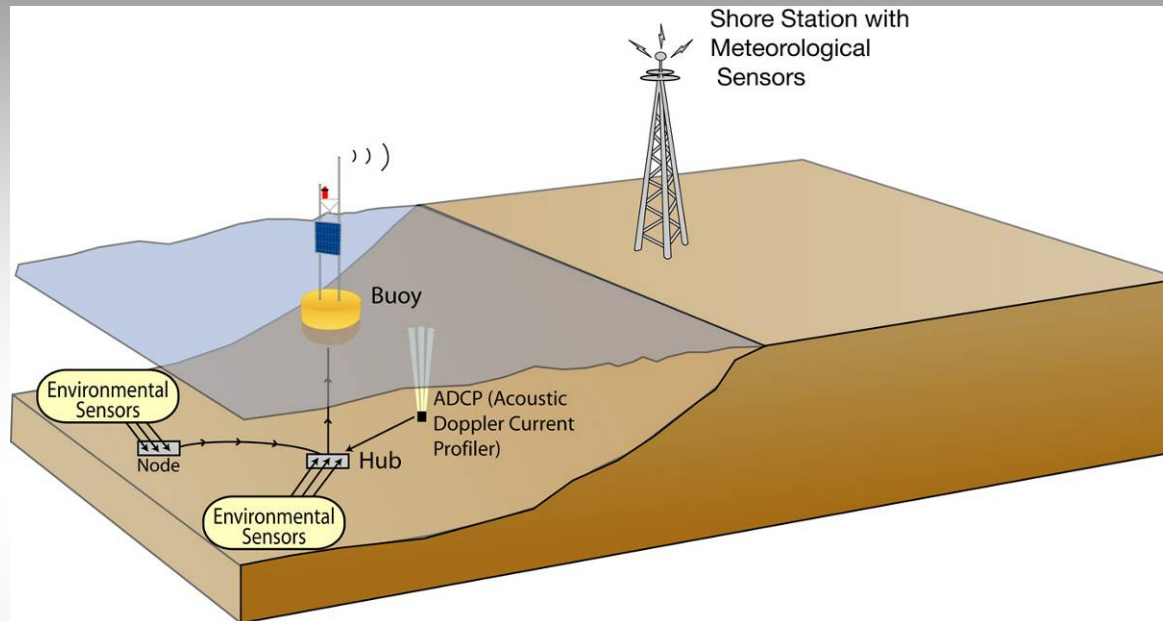
- . Detecting and forecasting oceanic components of climate variability
- . Facilitating safe and efficient marine operations
- . Ensuring national security
- . Managing resources for sustainable use
- . Preserving and restoring healthy marine ecosystems
- . Mitigating natural hazards
- . Ensuring public health

## **Participants:**

- . NOAA, EPA, Navy, NASA, NSF, etc
- . Regional Associations – coordinate regional needs ([www.glos.us](http://www.glos.us))



## Real-time Environmental Coastal Observation Network (RECON)



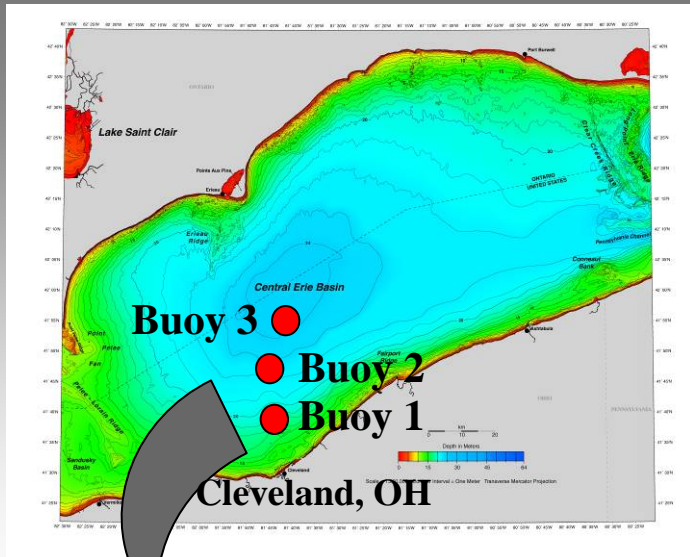
- High bandwidth, wireless Ethernet-based system
- Real-time, secure data access
- Portable, low cost buoys and fixed platforms of opportunity
- Universal sensor interfaces
- Guest port access: data delivered to a common database or a single user
- Developing partnerships with Federal, University, and State components to operate and maintain Observation sites

## Rationale:

- Provide real-time observations of chemical, biological, and physical parameters to scientists, managers, educators, and the public
- Allow data collection during extreme weather events
- Facilitate modification of sampling parameters in anticipation of episodic events
- Trigger vessel-based sampling in response to environmental events
- Improve sensor and system reliability
- Support sensor and system development

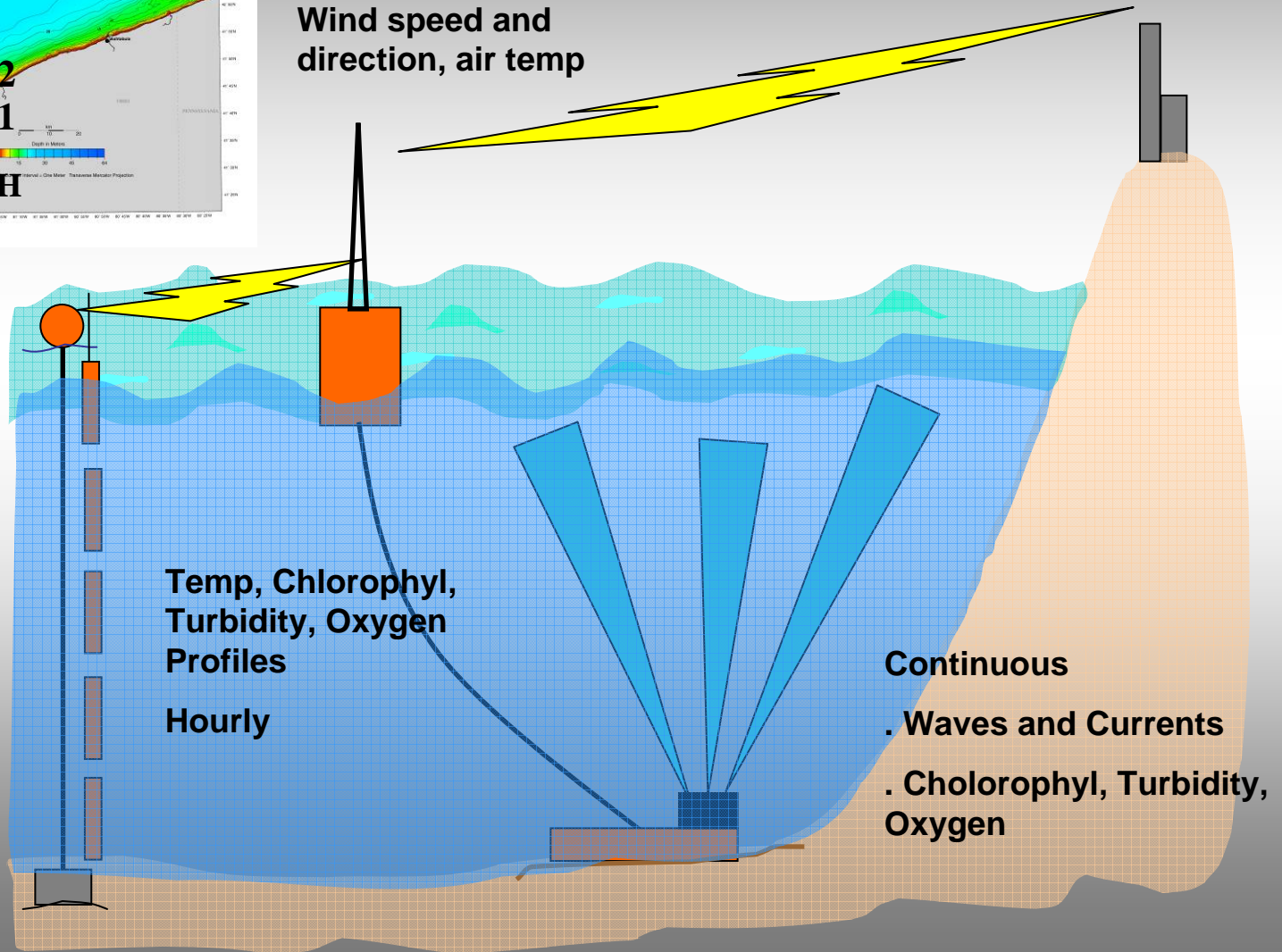


# RECON Buoy Operation

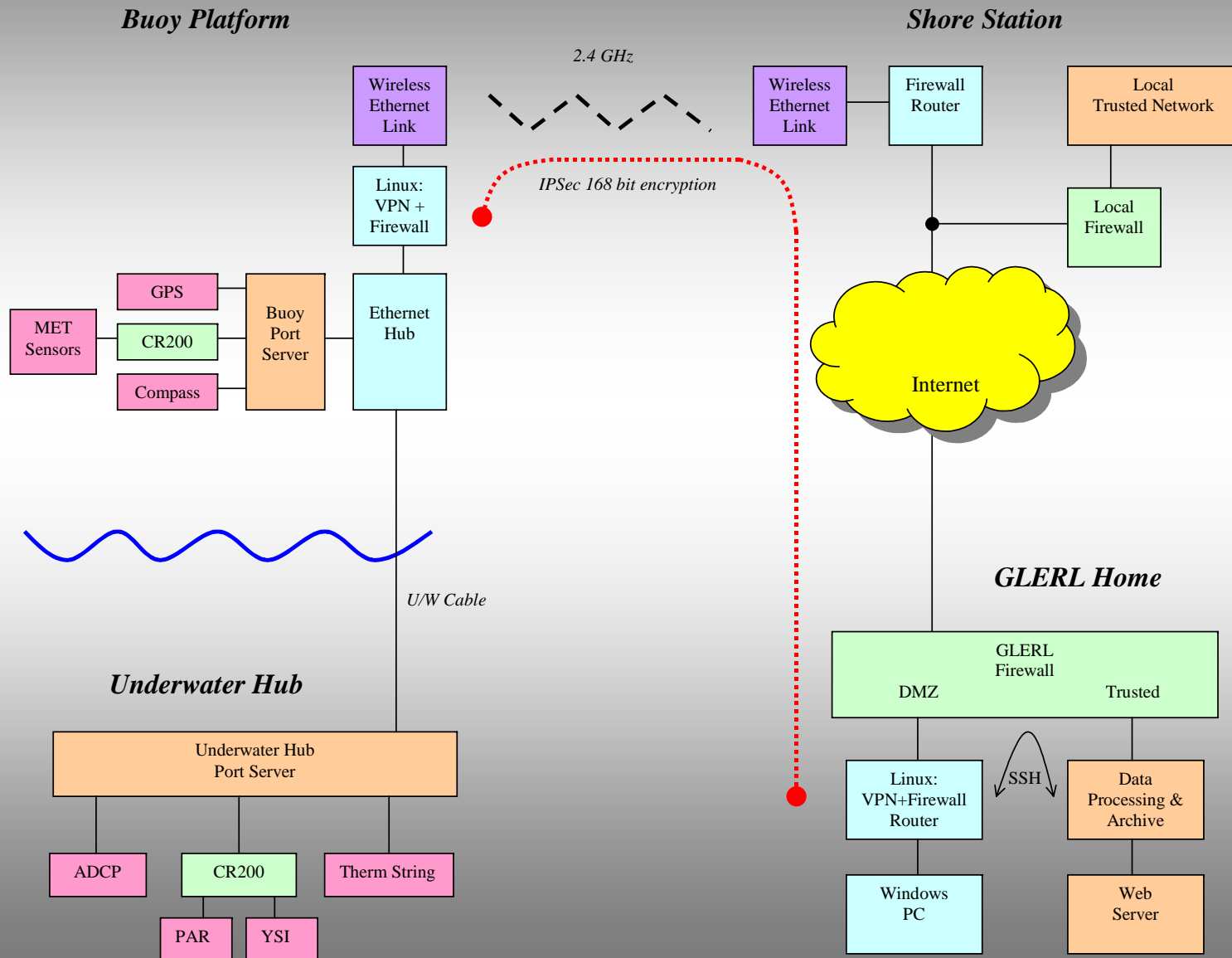


Wind speed and direction, air temp

21 m

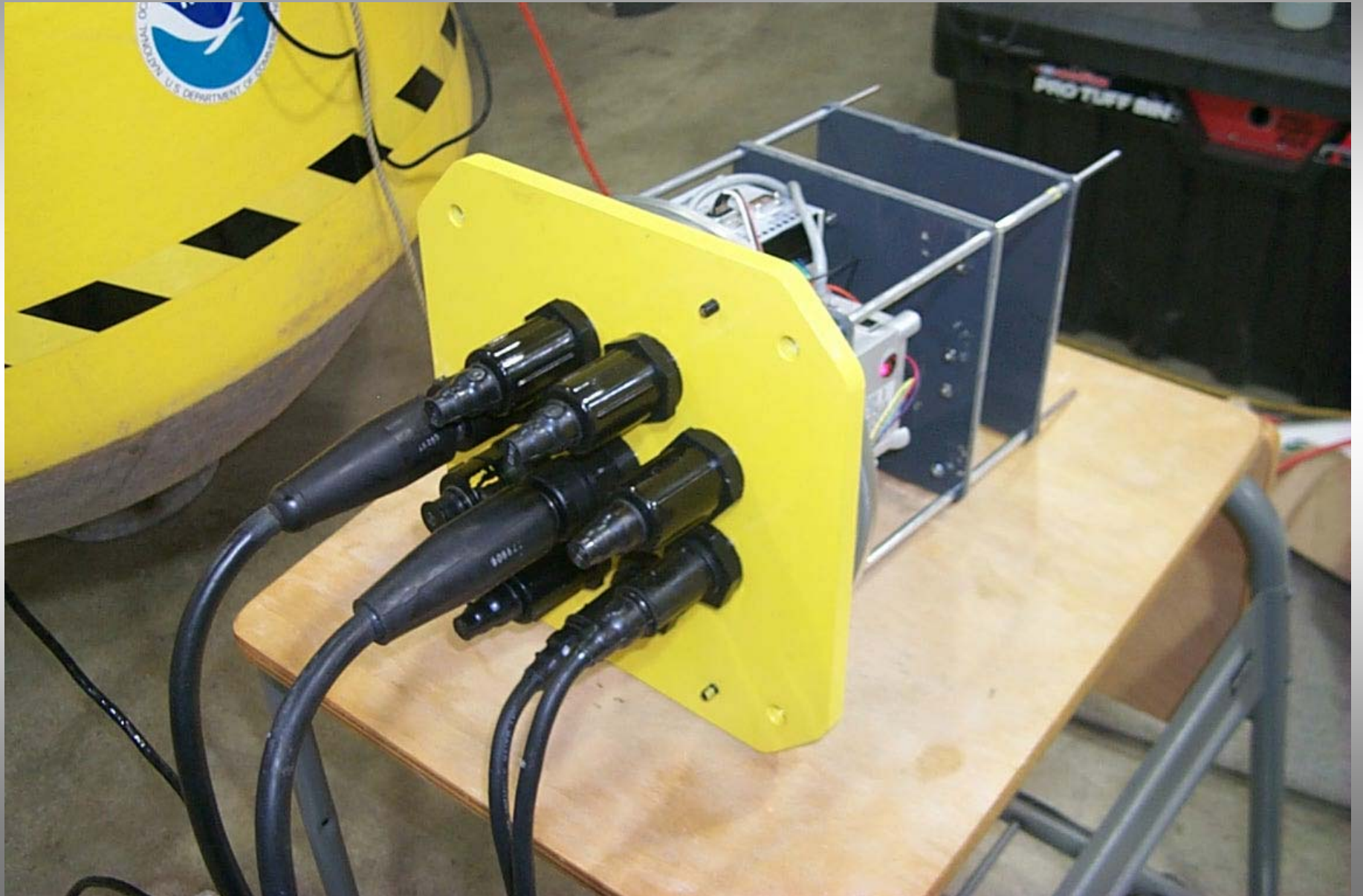


# System Block Diagram



# Hub with Linux Buffer, Port Server, A/D Interfaces

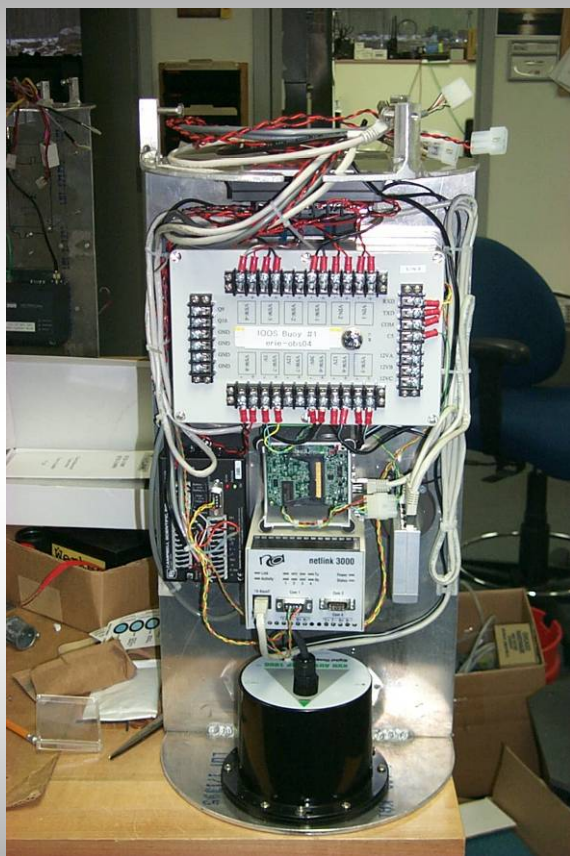
- guest port concept





# Network Components and Instrumentation

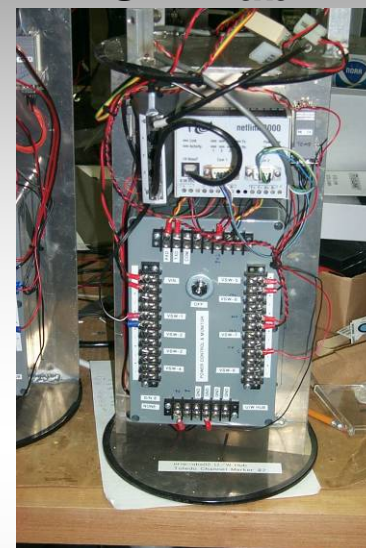
## Buoy Electronics



## Vertical Profiler



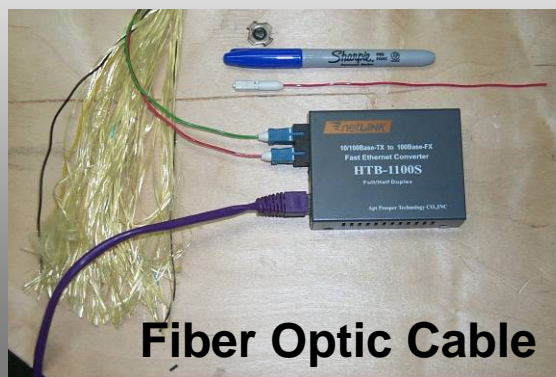
## UW Hub



## Webcam



## Fiber Optic Cable



## RECON Locations and Applications

Wireless systems deployed on Great Lakes coasts in collaboration with universities, Thunder Bay NMS, and NASA

Applications in 2005,6:

- Real-Time Fisheries Acoustics
- NWS Marine Wave Forecast Verification in Convergence Zone
- Beach Closure Forecast Model Development, NOAA Oceans and Human Health
- Thunder Bay National Marine Sanctuary - Shipwreck Imagery, Met Data
- Yellow Perch Recruitment Model Development
- University Benthic and Fisheries Studies (UT, OSU)
- Science Education (Monroe Public Schools hypoxia project)
- Public Information (explanation of H<sub>2</sub>S odor associated with lake turnover in media)

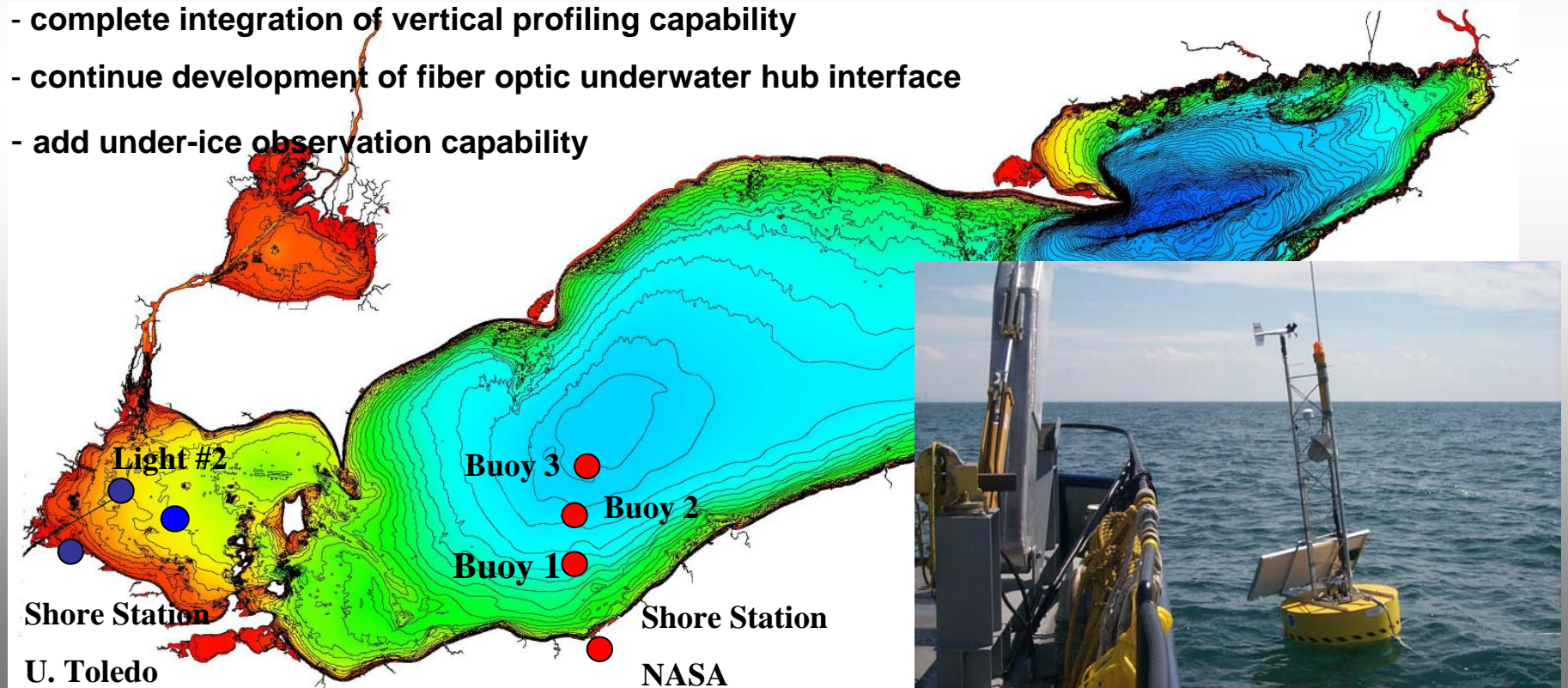


## Results to Date:

- demonstrated the feasibility of wireless buoy data transfer in array and relay
- maintains connection in high waves, heavy rain, snow
- demonstrated ability to obtain high-bandwidth data and provide instrument control
- demonstrated streaming video in educational “live dives” broadcasting environmental science and archeological outreach programs from 10 miles (at TBNMS)
- developed a real-time web accessible data display

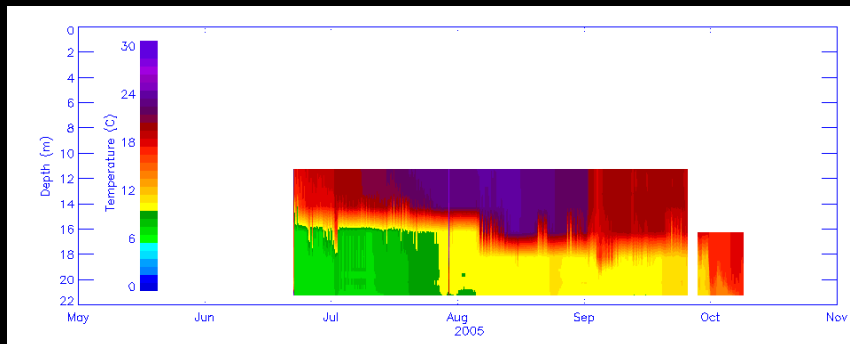
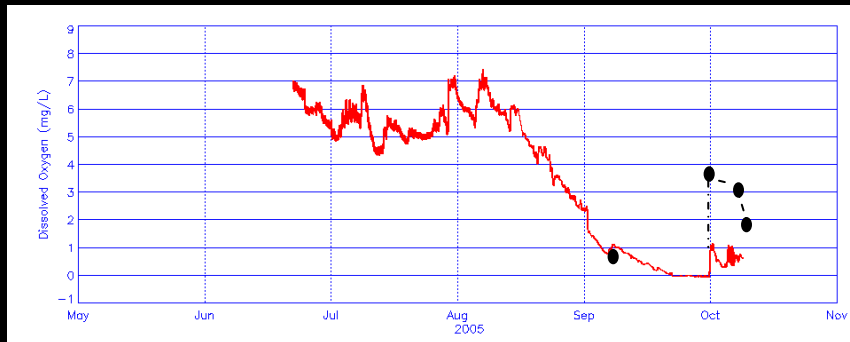
## In 2006,7:

- develop real-time database management system with the Ohio State Supercomputing Center
- complete integration of vertical profiling capability
- continue development of fiber optic underwater hub interface
- add under-ice observation capability

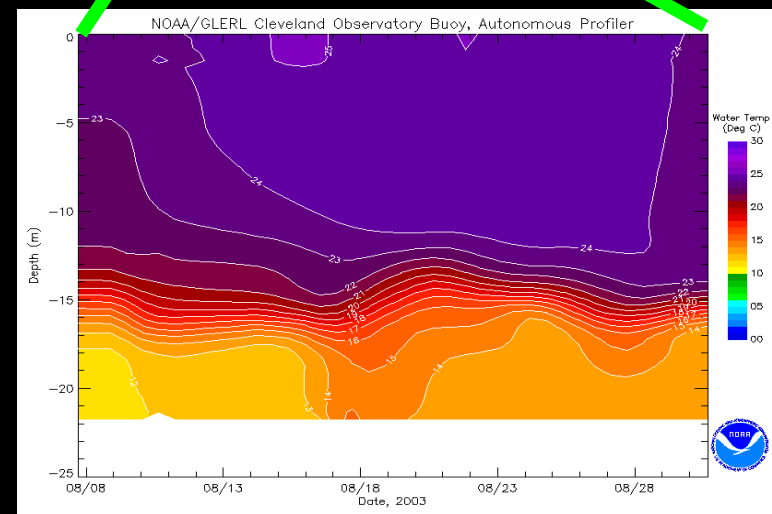
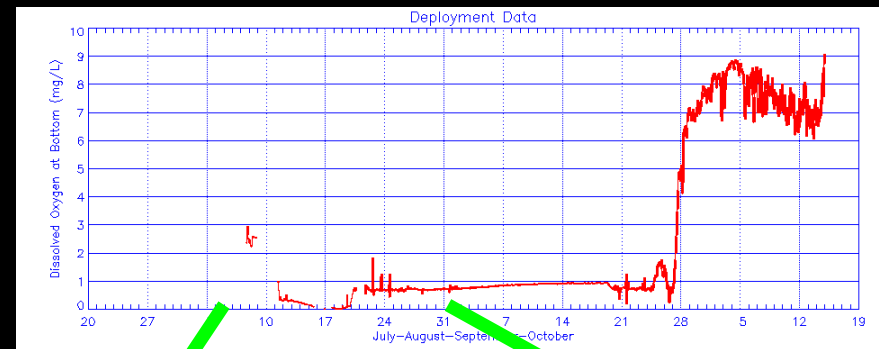


# Observations of Oxygen and Temperature

## 2005 Data



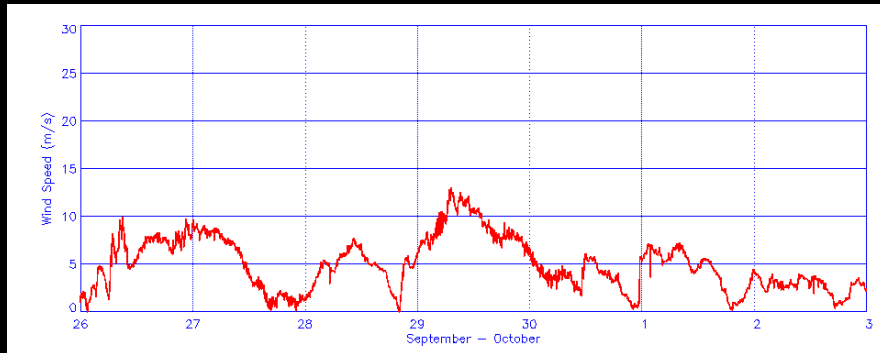
## 2003 Data



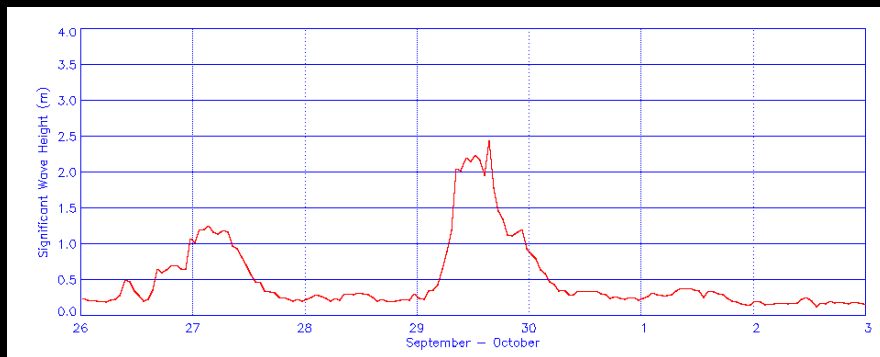
**Comparison of oxygen decline in Erie central basin. Thermocline in 2005 is slightly thicker and lower in temperature than 2003 results. Oxygen decline (less than 3mg/l) in 2005 occurs later in the year falling at a slower rate.**

# Lake Erie Mixing Event

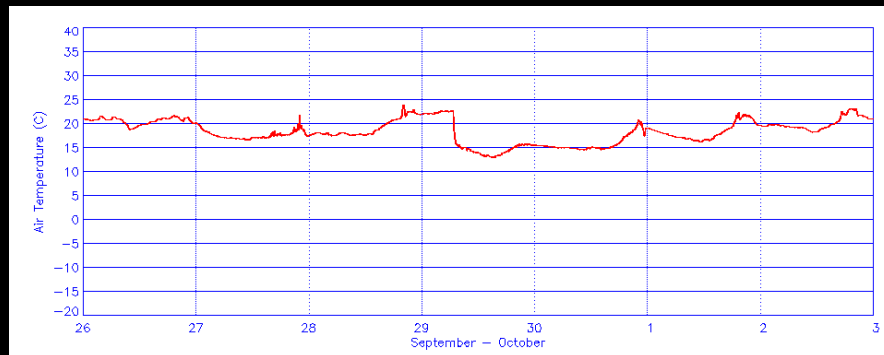
Lake mixing resulted in increased oxygen and bottom temperatures – also associated with reported H<sub>2</sub>S odor along south shore of Lake Erie.



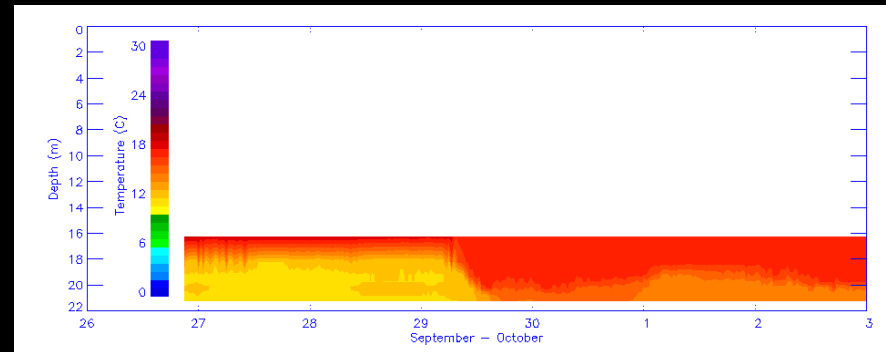
## Wind Speed



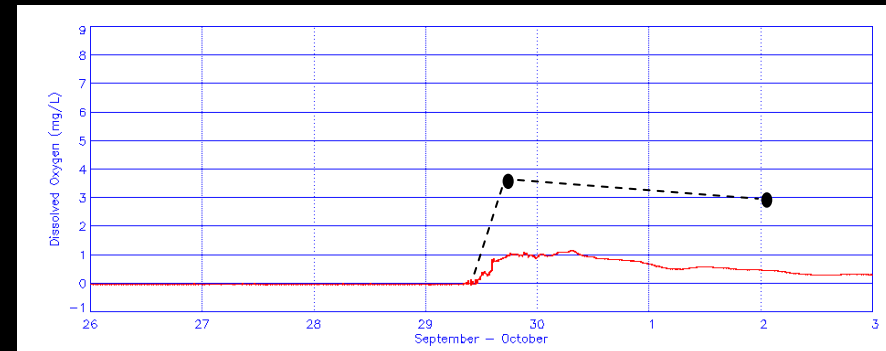
## Wave Height



## Air Temperature



## Water Temperature



## Oxygen at Bottom



Questions?



Questions?



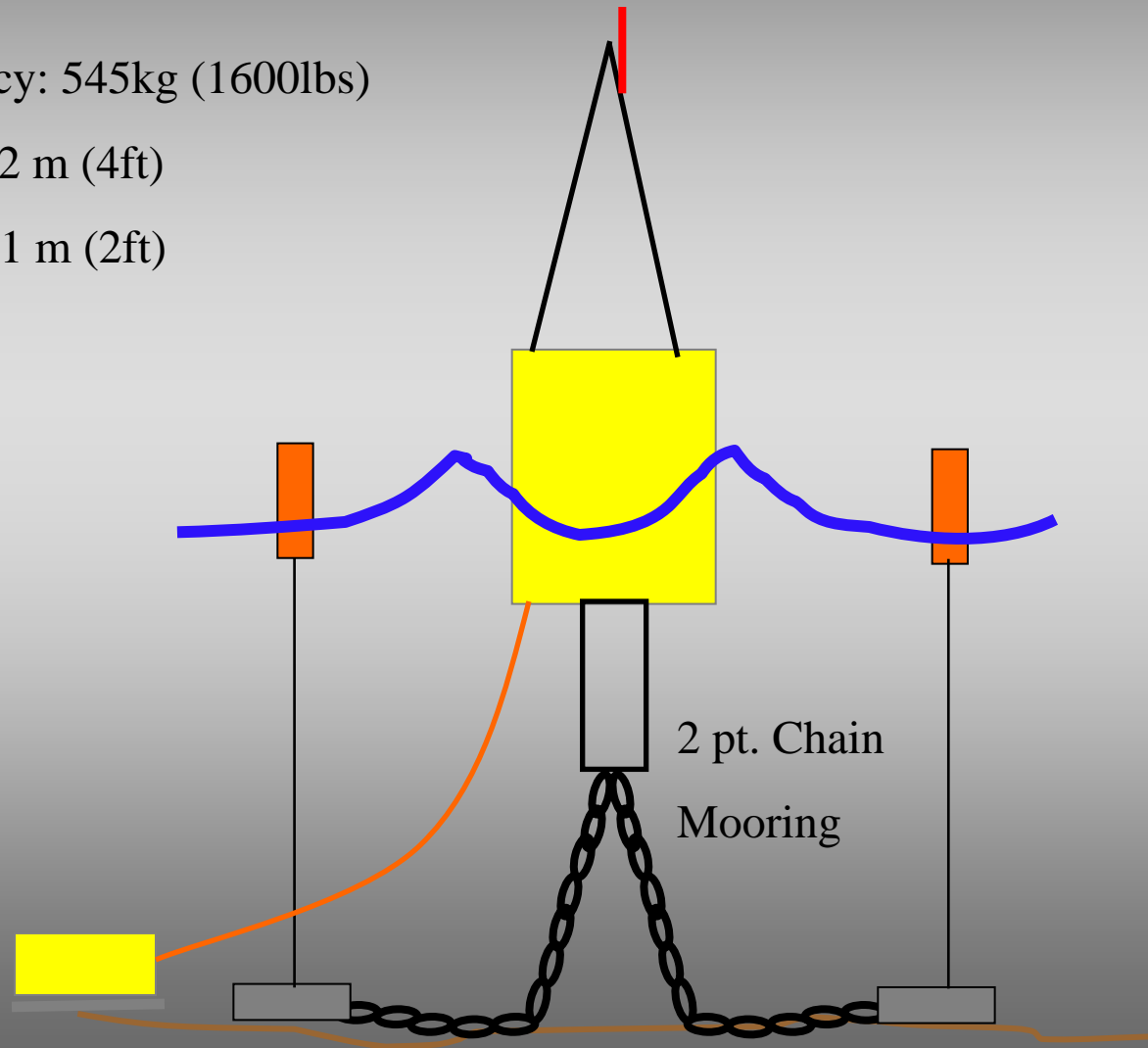


## Buoy General Specifications and Mooring

Buoyancy: 545kg (1600lbs)

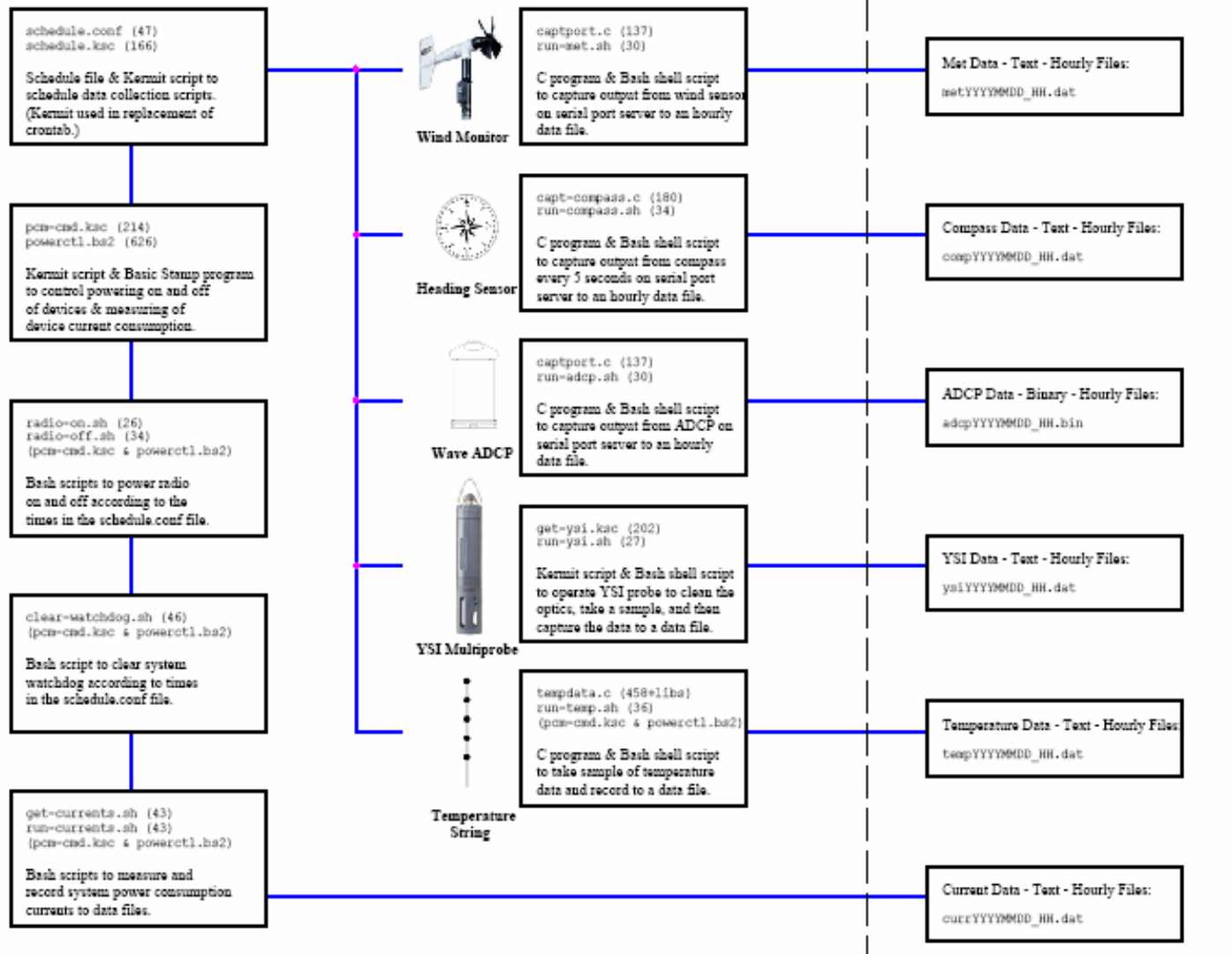
Dia: 1.22 m (4ft)

Ht: 0.61 m (2ft)

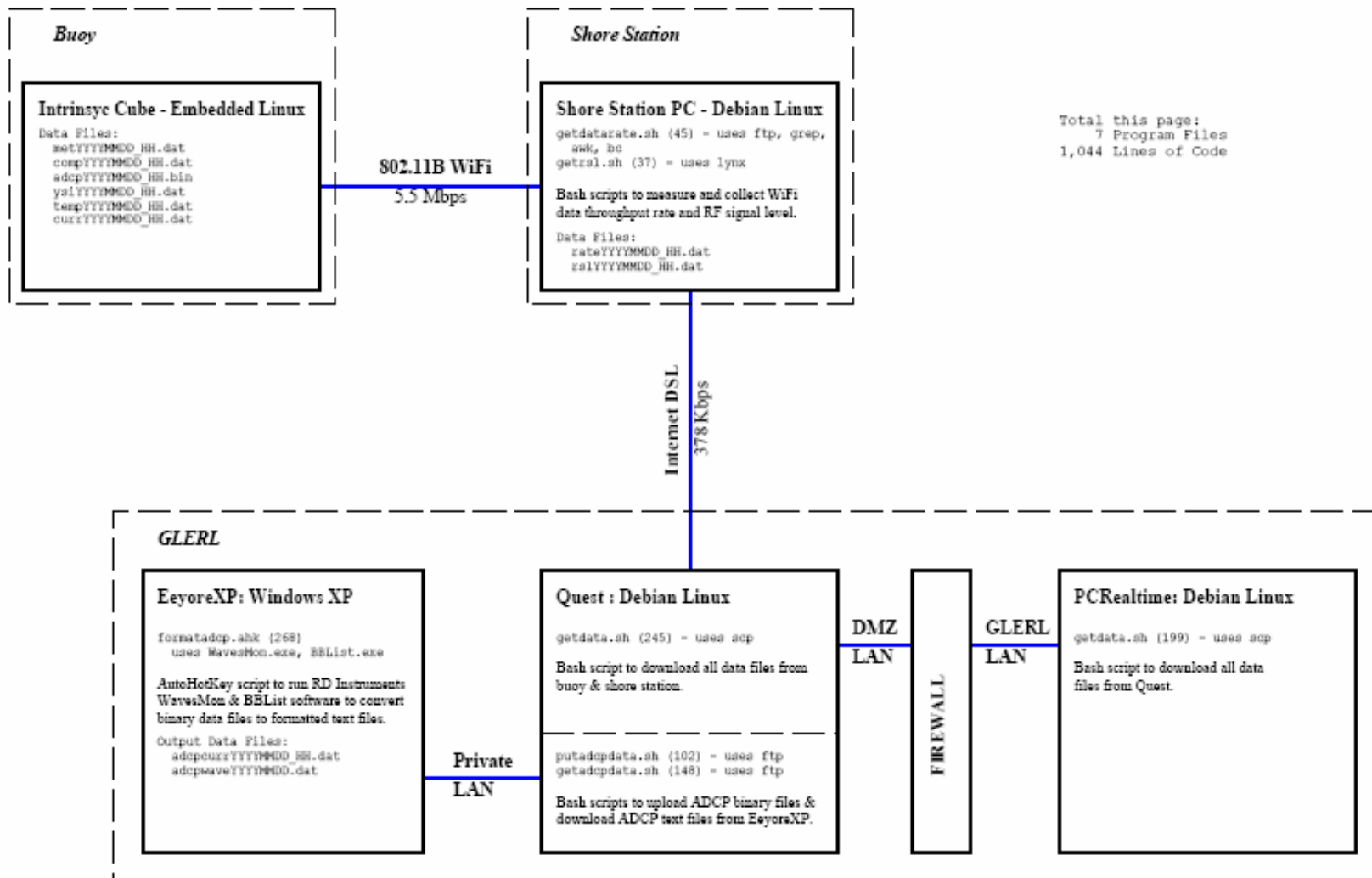


# Software Chart -- Buoy

Total this page:  
18 Program Files  
2,348 Lines of Code



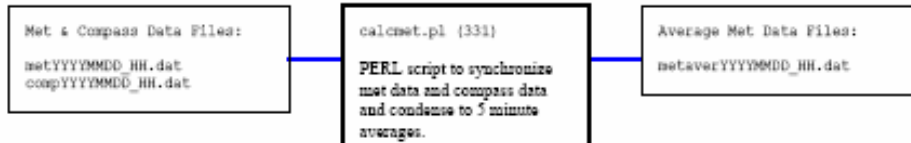
# Software Chart -- Data Transfer



# Software Chart -- Data Processing

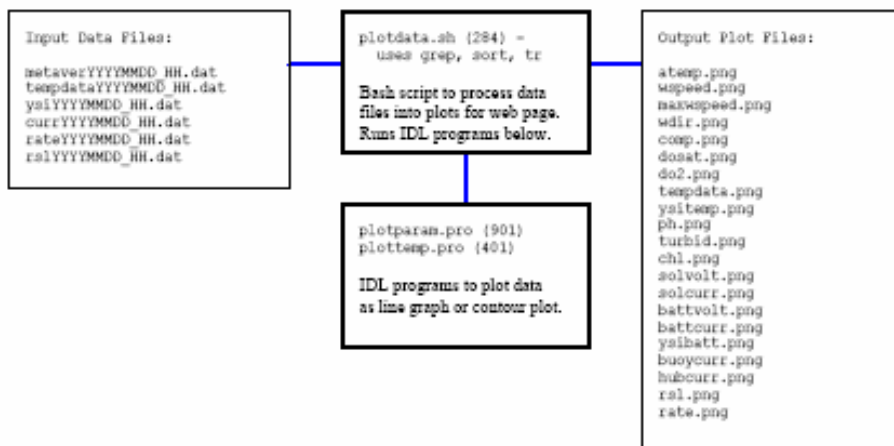
Total this page:  
9 Program Files  
3,400 Lines of Code

## Average Data:



Grand Total:  
34 Program Files  
6,792 Lines of Code

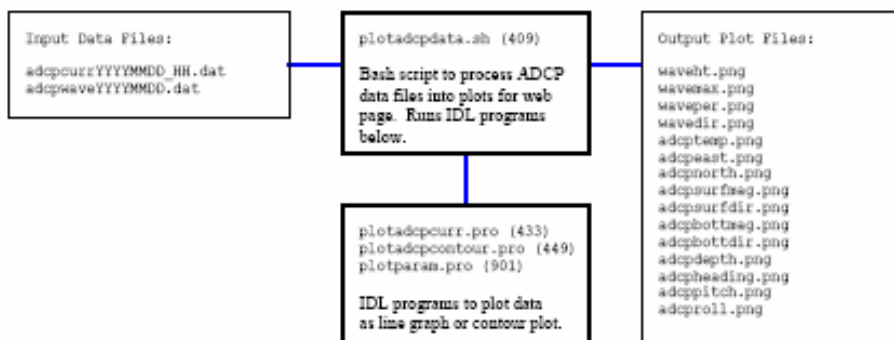
## Plot Data:



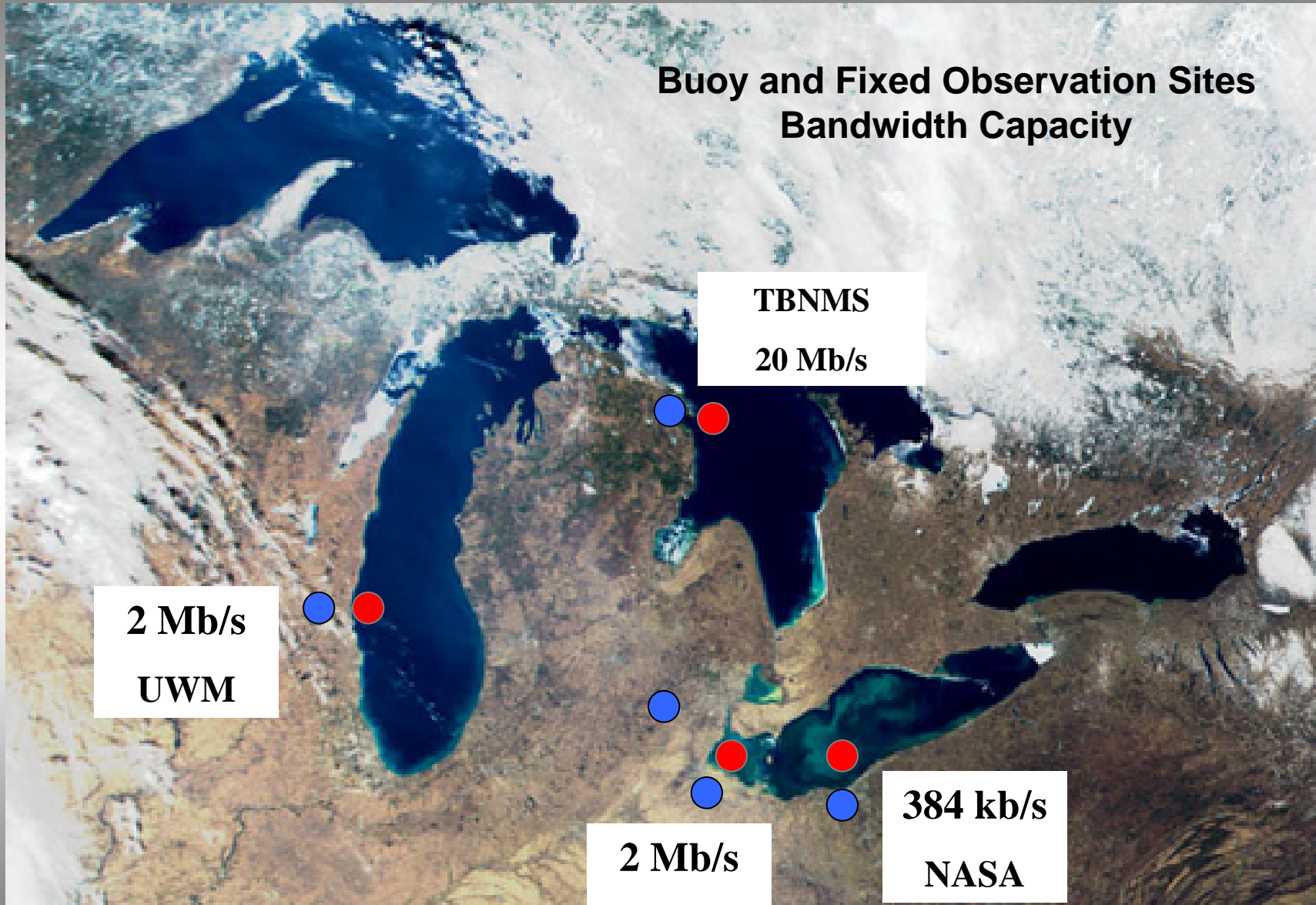
## Archive Data:



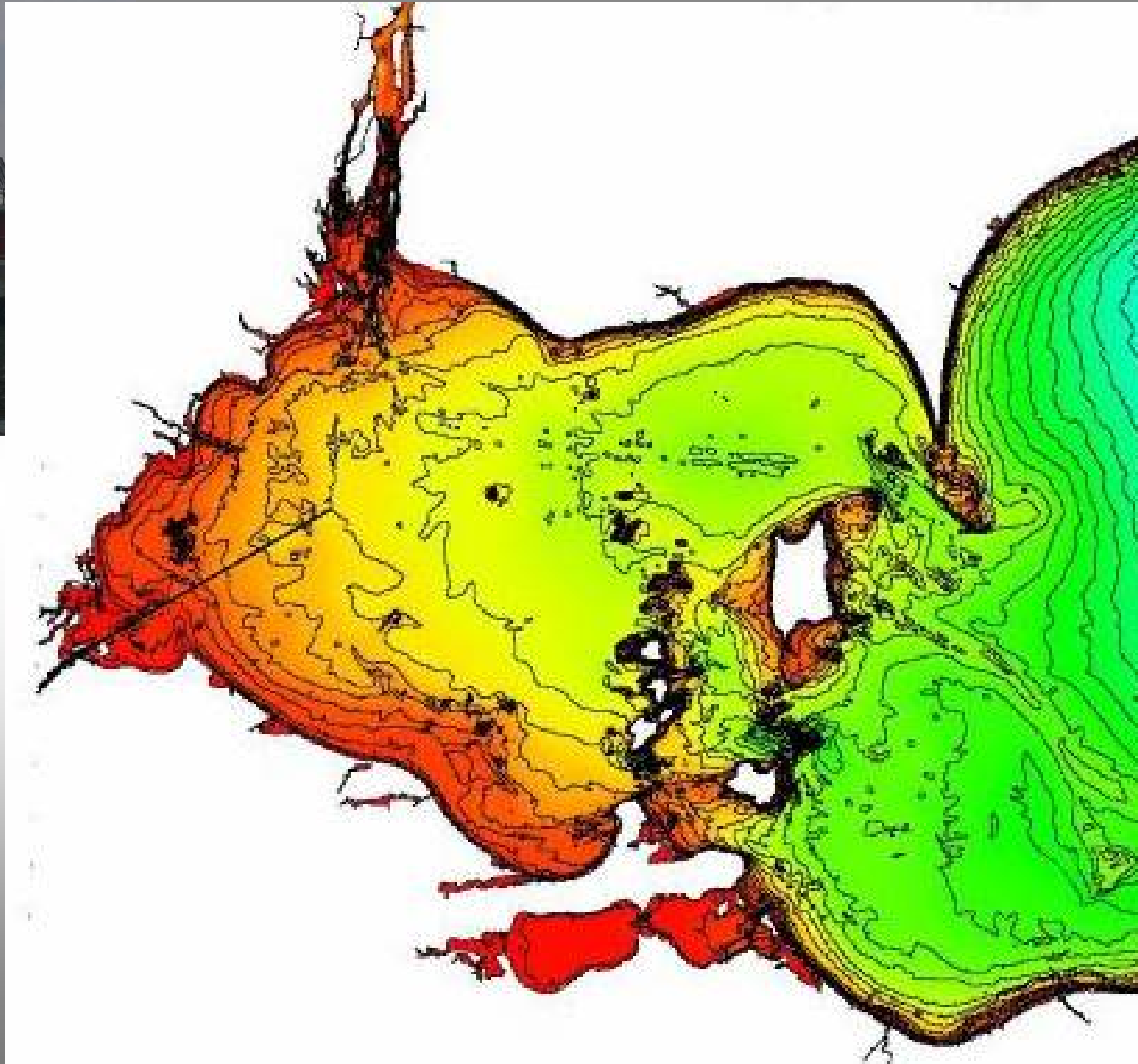
## Plot ADCP Data:



## Buoy and Fixed Observation Sites Bandwidth Capacity



## Networking Possibilities: Western Lake Eire



## CISCO 350 Wireless Internet Radio

- IEEE 802.11b Standard
- Access Point capable of 2048 connections
- Reliable range tested to date: 14 miles
- . Allows design of system based on currently available networking hardware and open source software
- meets requirement for high-bandwidth, low-cost

