

Lake Erie 2004: Physical and bio-chemical Observations

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Support

Tech Ops & Eng Services (NWRI)

Data Analysis: Bob Rowsel, Jacqui Milne

Major Issues relevant for NWRI Lake Erie Water Quality Research:

- ***Nutrient and Contaminant loadings and distribution***
- Exotic species effects
- ***Anoxic events in the central basin***
- Fluctuating fisheries
- Occurrence of blue-green algae
- ***Upwelling of low DO water along the north shore of LE***

Background

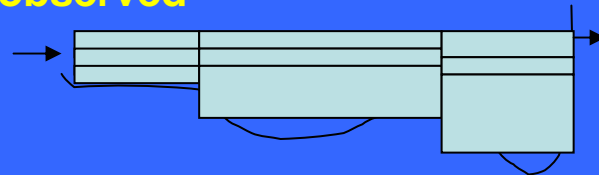
Project Hypo (1970) & Bi-National Program (1979)

Motivation

Water Quality Simulations (Lam et al. 2002)

NWRI Lake Erie water quality model simulations (post zebra mussel scenarios) indicated that

- Dreisenna can affect the phosphorous concentrations in the Lake
- Simulations have not shown any affect of Dreisenna on the DO in the central basin
- DO is found to be related to the interannual variability observed in the meteorological conditions.



Limitations of these simulations and future needs

- lack of nearshore-offshore compartments in the model, incorporating these effects
- substantial experimental data such as horizontal and vertical exchanges, circulations, thermal structure and biochemical data needs to incorporated to improve the predictions.
- More work on model parameters

Objectives of 2004 & 2005 field experiments

To conduct intensive measurements in Lake Erie for providing hydrodynamic and thermal observations required to assess/predict changes in water quality and aquatic ecosystem components.

Simultaneously, intensive monitoring efforts were conducted in 2004.

- To estimate Water and Phosphorous residence times*
- To estimate Inter basin transports on daily scale for model input*
- Monitor bottom currents and dissolved oxygen in the hypolimnion of the central basin*
- Estimate onshore-offshore exchanges during summer episodic events (upwelling) along the north shore of the central basin*
- Develop a data base for calibration and verification of hydrodynamic models*

Comparison of 2004 (post-zebra mussel) monitoring results with earlier data

Parameters to be measured:

- **Meteorology: Winds (speed and direction)**
Radiation (shortwave & longwave)
Humidity, air temperature
- **Water Temperature profiles (minimum 3 m resolution)**
- **Current Profiles: Interbasin transports and at stations for model validation**
- **Time series of Dissolved oxygen, transmission, turbidity etc**
- **Waves**
- **Biochemical parameters (Surveillance cruises)**

Great Lakes Surveillance Program

- 8 CCGS LIMNOS surveys
- Spring sampling = surface
- Summer sampling
 - a. 1 m below water surface, plus
 - b. 1 m above the thermocline, plus
 - c. mid-thermocline, plus
 - d. 1 m below the thermocline, plus
 - e. bottom minus 10 and 2 meters.

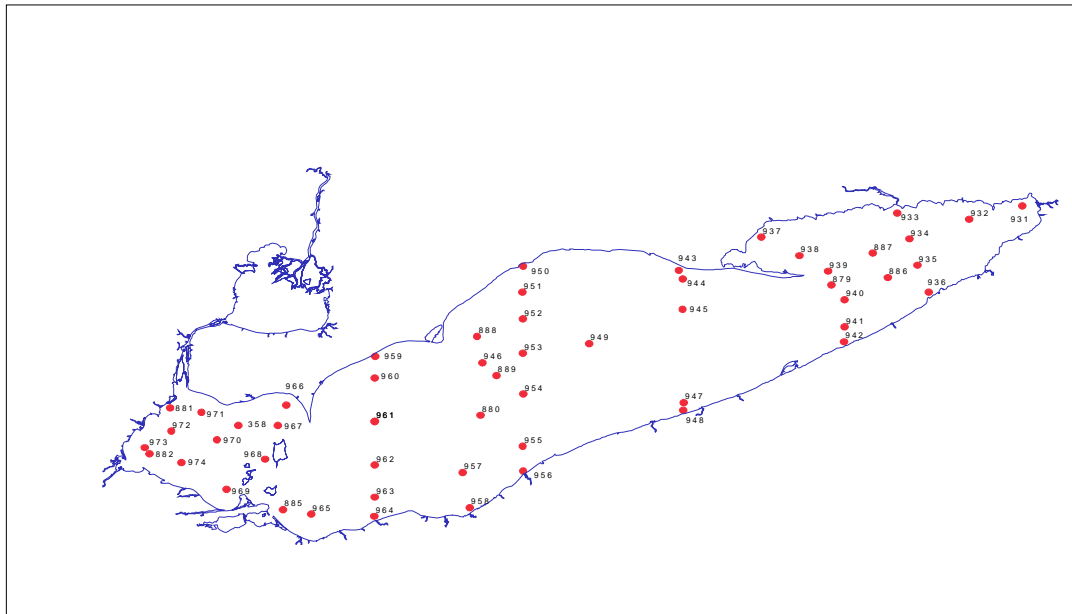
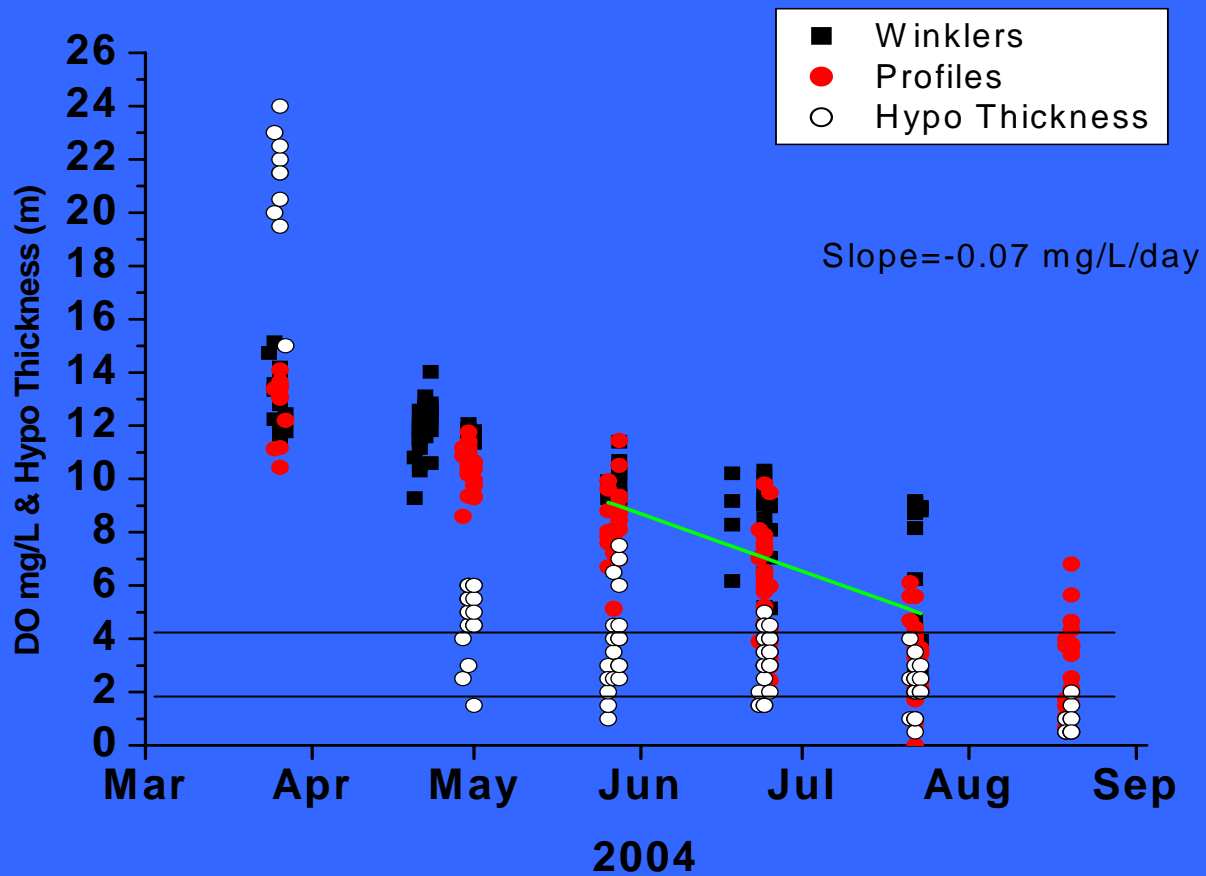


Figure 2. Station locations for the Lake Erie surveillance program 1994-1998.

Canadian Great Lakes Surveillance Program Parameter Listing

Conventional Parameters	Metals*	Organic Parameters*	(D= Dissolved phase only)	In-Use Pesticides*
SECCHI DISK	Ag	A-BHC-D	NAPHTHALENE-D	ATRAZINE
FOREL ULE COLOR	Al	LINDANE-D	1-MTHNAPHTHALENE-D	BARBAN
TEMPERATURE		HEPTACHLOR-D	B-CHLORONAPHTHALENE	BUTYLATE
TEMPERATURE EBT	Boron	HEPTACHLOR EPOXIDE-D	ACENPHTHYLENE-D	DIALATE
% TRANSMISSION		ALDRIN-D	FLUORENE-D	D-ETHYL-ATRAZINE
SPECIFIC CONDUCTIVITY	Ba	DIELDRIN-D	PHENANTHRENE-D	ENDAVEN
pH	Be	ENDRIN-D	PYRENE-D	HOEGRASS
pH Temperature	Cd	METHOXYCHLOR-D		METRIBUZIN
FILTERED ALKCO3	Co	A-CHLORDANE-D		METOLACHLOR
INTEGRATED POC	Cr	G-CHLORDANE-D		SIMAZINE
DOC *	Cu	A-ENDOSULPHAN-D		TRIALATE
I-POC	Ga	B-ENDOSULPHAN-D		TRIFLURALIN
DISSOLVED O2 W	La	p,p-DDE-D		
% SATURATION	Li	o,p-DDT-D		
TOTAL PHOSPHORUS		p,p-DDT-D		
SOLUBLE REACTIVE PHOSPHORUS*	Mn	p,p-TDE-D		
TOT FILT PHOSPHORUS	Mo	MIREX-D		
TOTAL FILT KJELDAHL NITROGEN	Ni	12-DICHLOROBENZENE-D		
N TOT PARTICULATE	Pb	13-DICHLOROBENZENE-D		
NH3	Rb	14-DICHLOROBENZENE-D		
NO3NO2 FILTERED	Sb	135-TCHLOROBENZENE-D		
SO4 FILTERED	Sr	124-TCHLOROBENZENE-D		
CHLORIDE FILTERED	Tl	123-TCHLOROBENZENE-D		
SOLUBLE REACTIVE SILICA	U	1234-TECHLOROBENZE-D		
CA FILTER ATOMIC ABS	V	PENTACHLOROBENZE-D		
MG FILTERED	Zn	HEXACHLOROBENZENE-D		
K FILT PHOTOMETRIC	Fe	FLUORANTHENE-D		
NA FILT PHOTOMETRIC		BENZO(BK)FLUORANTHENE-D		
CHLOROPHYLL A UNC INT		BENZO(A)PYRENE-D		
CHLOROPHYLL A COR INT		INDENO(123CD)PYRENE-D		
		BENZO(GH)PERYLENE-D		
		2-MTHNAPHTHALENE-D		

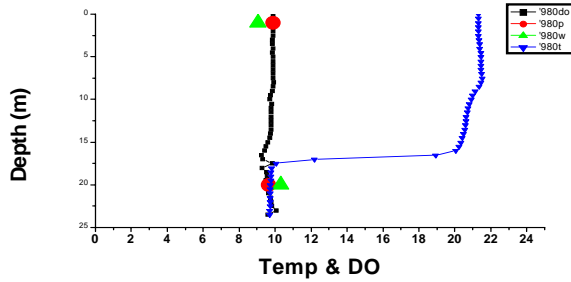
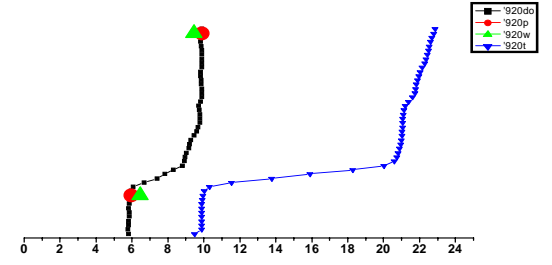
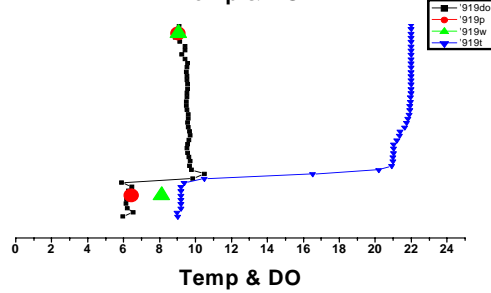
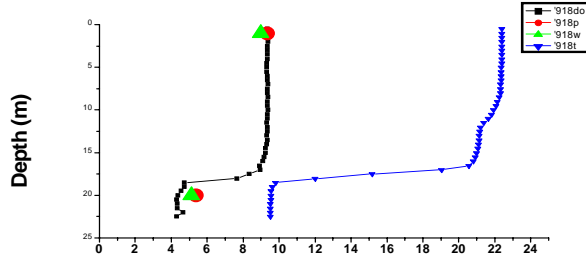
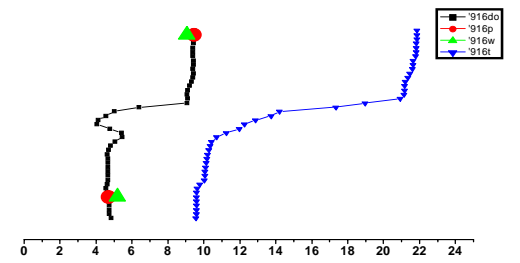
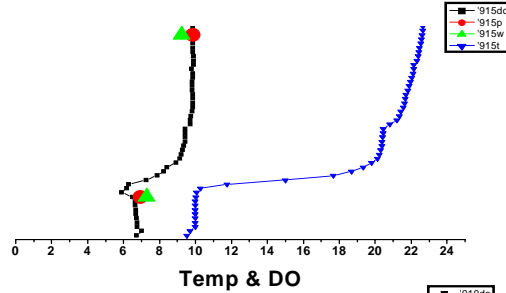
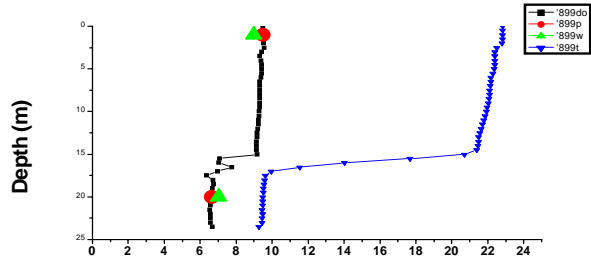
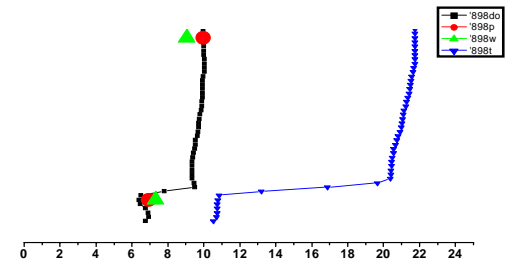
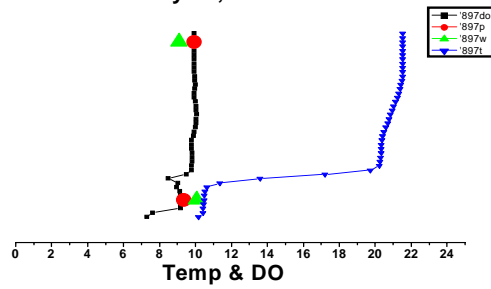
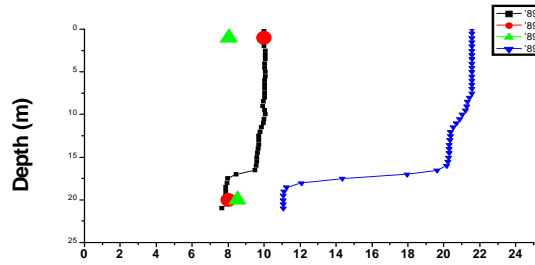
* These parameters are sampled at a subset of the depicted station pattern and only in the spring



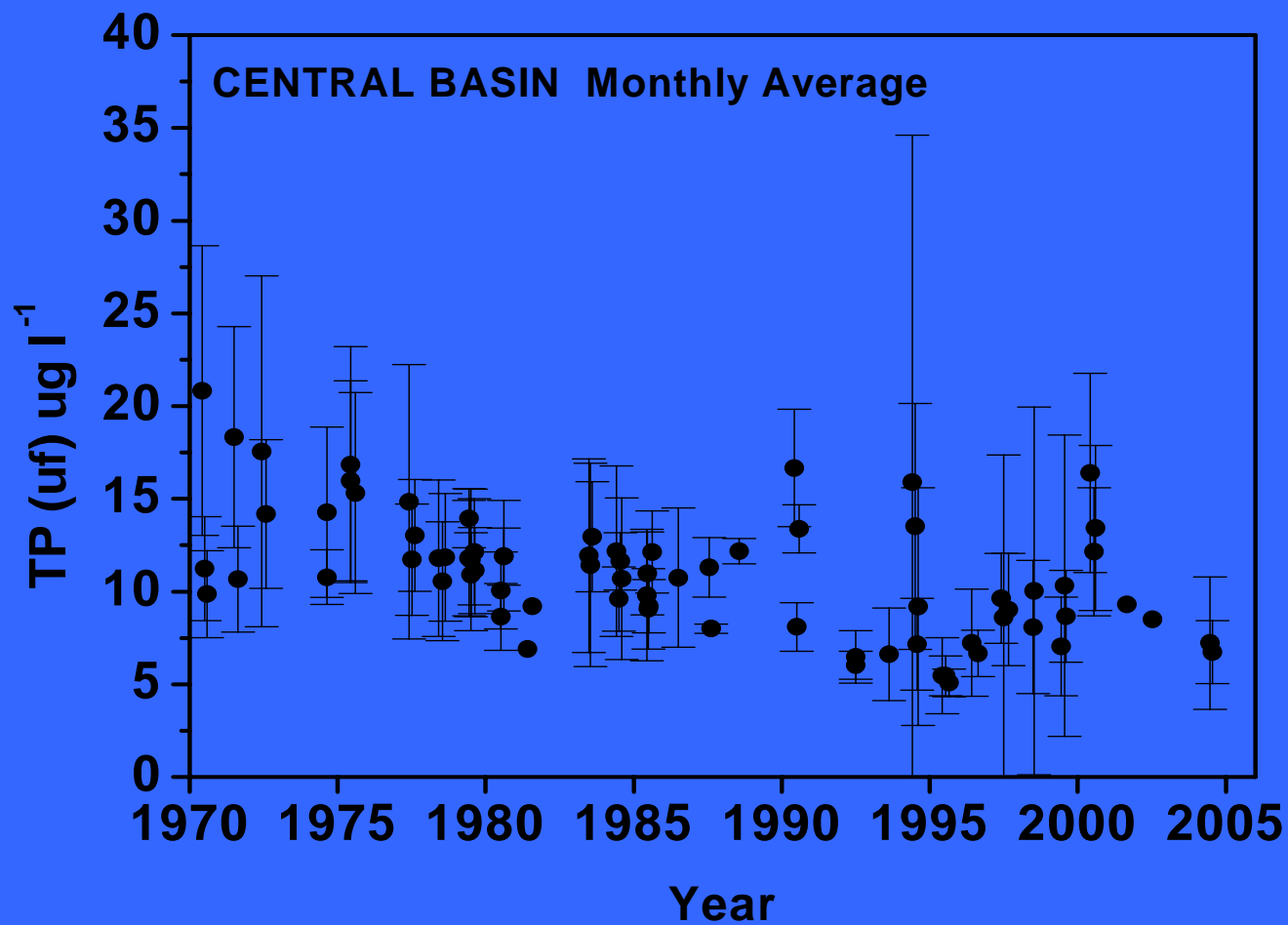
The linear slope shows a depletion of 0.07 mg/L/d.
 Some stations show anoxic conditions in from Mid July to the middle of August.

(M. Charlton & J. Milne)

Lake Erie
Central Basin
GLNPO stns
July 21, 2004



(M. Charlton & J. Milne)



Updated (2004) TP concentrations trends for the central basin

(M. Charlton & J. Milne)

Physical Measurements (Moorings component)

Currents

- *4 RDI-ADCPs for inter-basin transports,*
- *1 RDI-ADCP (bottom mounted)*
and a Sontek Hydra station (+75 cm above bottom)
in the central basin for studying the hypolimnion characteristics.
- *1 RDI-ADCP in the east basin*
- *5 NOBSKA MAVs for Coastal exchange processes*

Temperature

Thermistor chain moorings near all ADCP stations.

Meteorology

3 Meteorological buoys in three basins

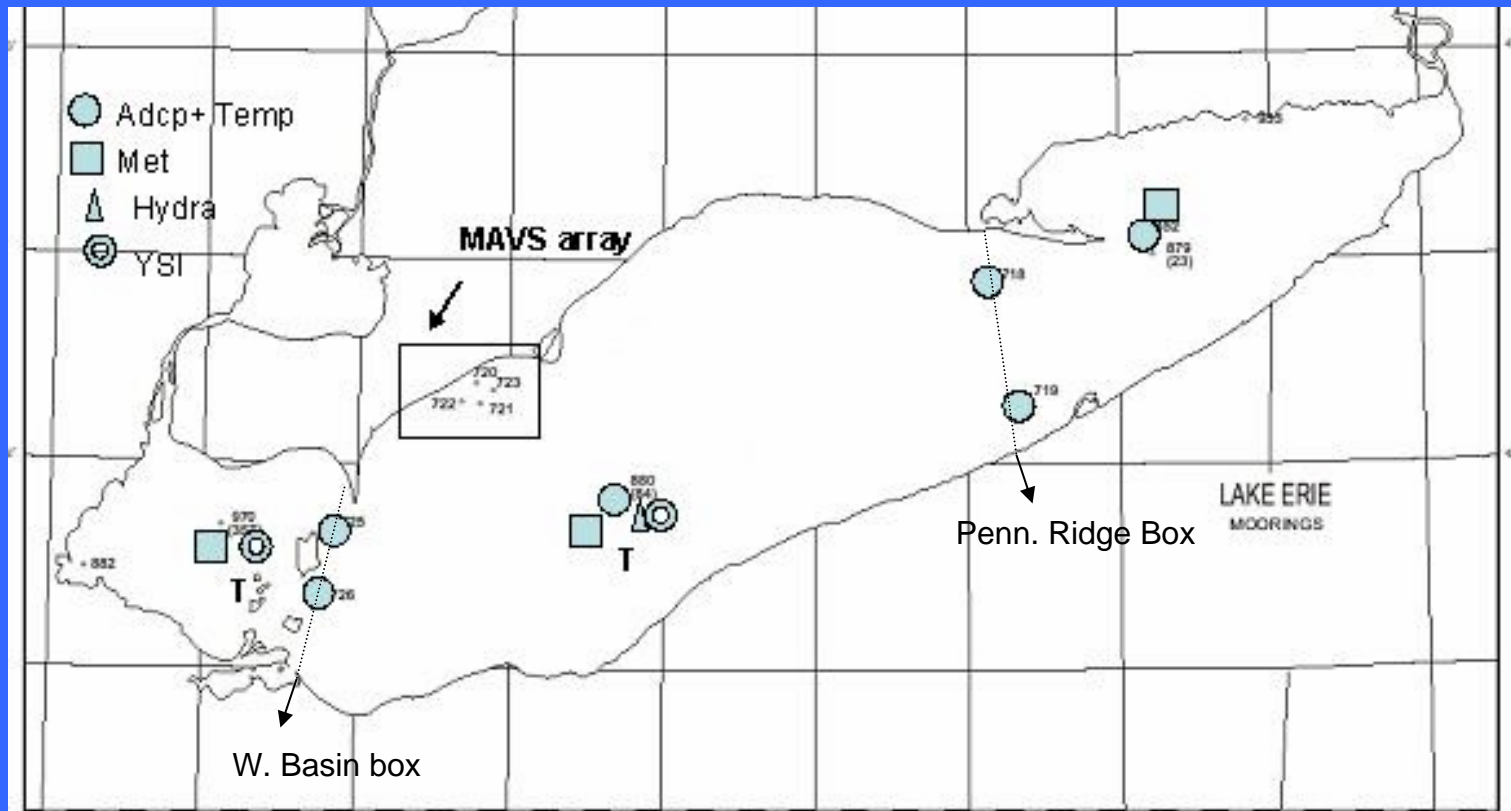
Water Quality

2 Stations with transmissometers at two depths

DO

3 YSI 6600 (2 in the central basin); Hydrolab stations in the western basin

Experimental Set-up (Physical measurements)



Deployed: 12-16 April 2004

Refurbished: July & August 2004

Retrieved: First week of October

Lessons learned from previous deployments in Lake Ontario:

- ADCP issues with low scatterers in cold water
- Deployment of MAVS
- Temperature accuracy problems with Tidbits in the spring
- Non-Inclusion of pressure sensors -XR-420 TDs at one level

Data Return & Quality

Currents: Except for one MAV current meter, the rest of MAVs and ADCPs returned good quality data.

Meteorology: Some problems encountered in one or two stations for brief periods- required maintenance

Buoy struck and Kd/Ld, Ta/Rh arm removed at 117/0100, fixed 148/1650. Tw cut at 117/1100, fixed 148/1650.

YSI 6600 long term deployments- Out of three stations- one station experienced problems with DO sensor (replaced in the second deployment) and batteries. Overall, the performance needs to be verified for 100-120 days deployments.

Transmissometers require regular maintenance (data records are suspicious after a couple of weeks)

Failure of **pressure sensor on Hydra-** affects wave characteristics

Temperature: Some loggers (6 of 42) had data recovery problems

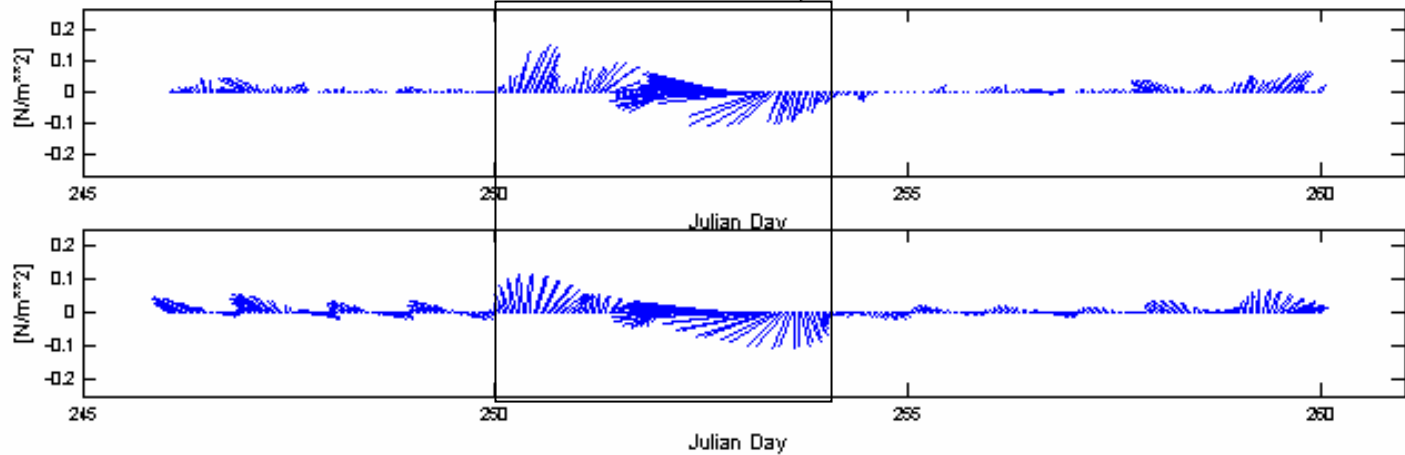
Sediment Traps: Three, one in each basin

Meteorology

Central basin buoy



Early September storm



Current meter Moorings

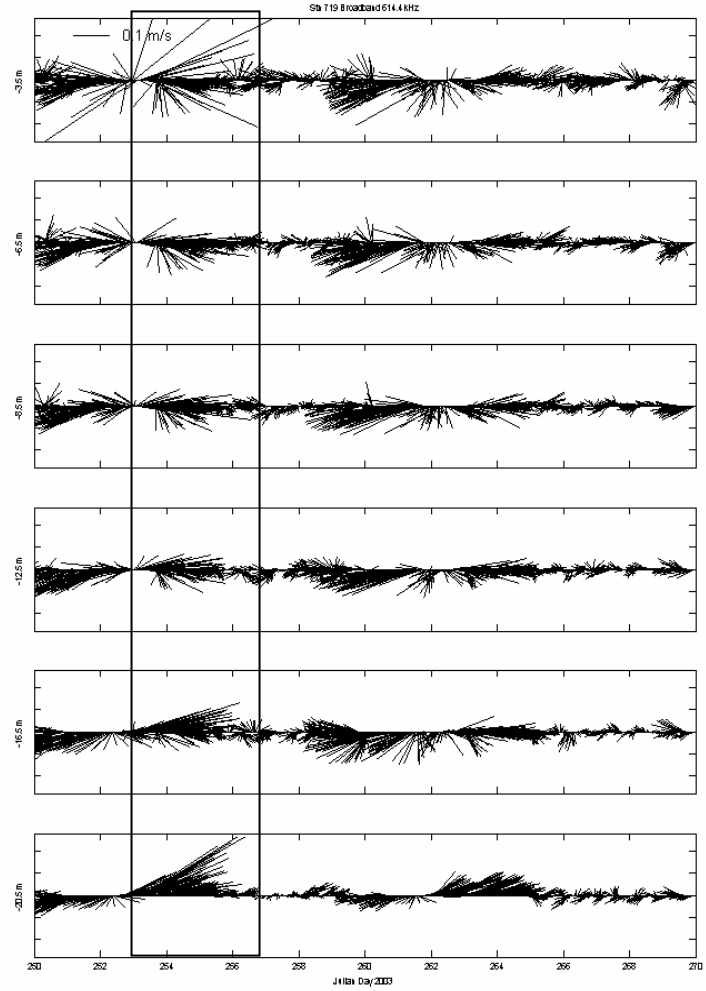
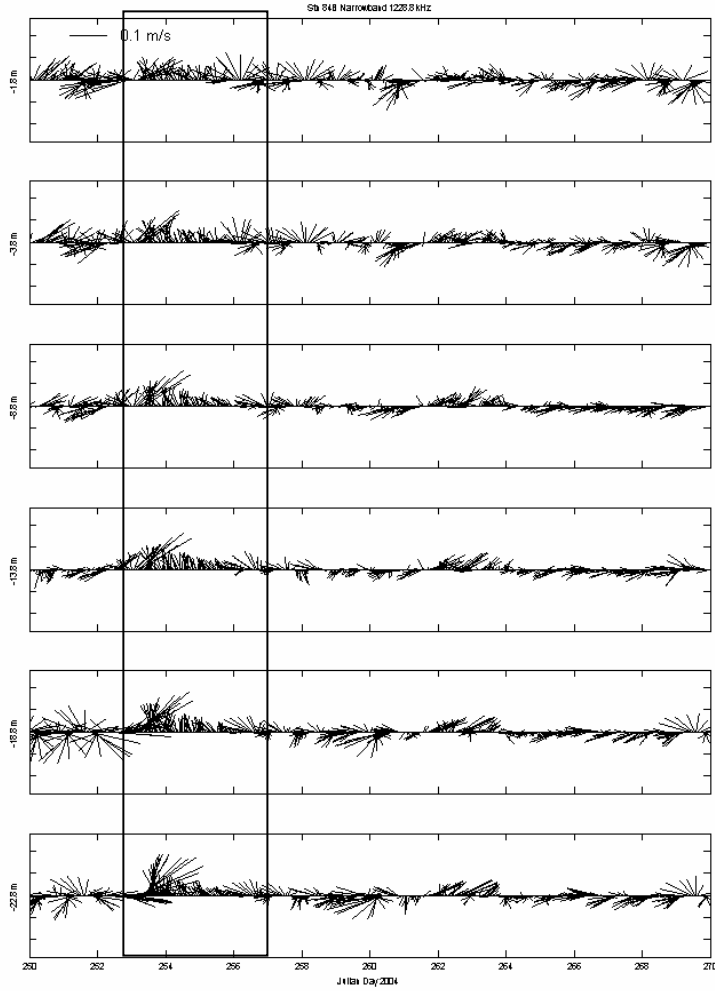


Performance of both
MAVS and ADCPs are good

Central basin

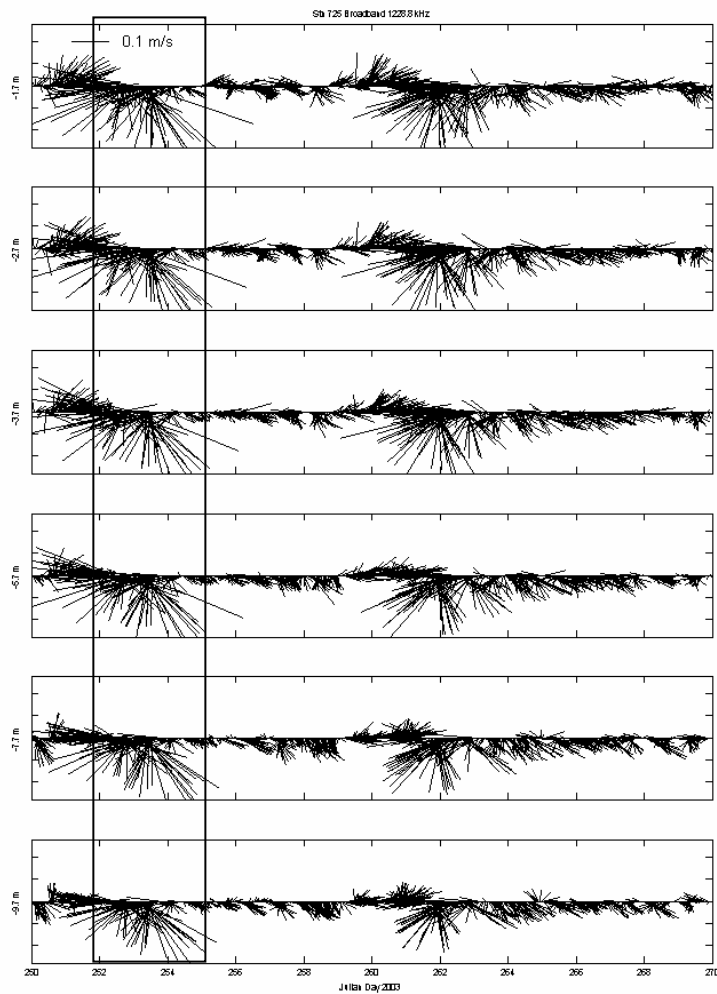
Stick plots at ADCP stations

Penn Ridge S

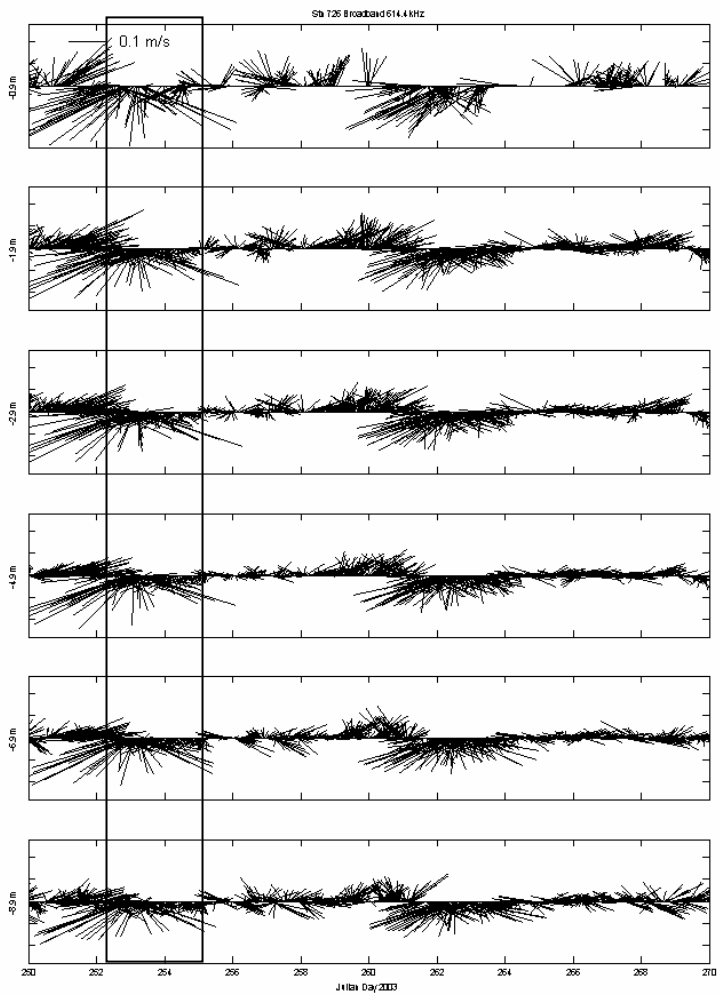


Stick plots at ADCP stations

Pelee S



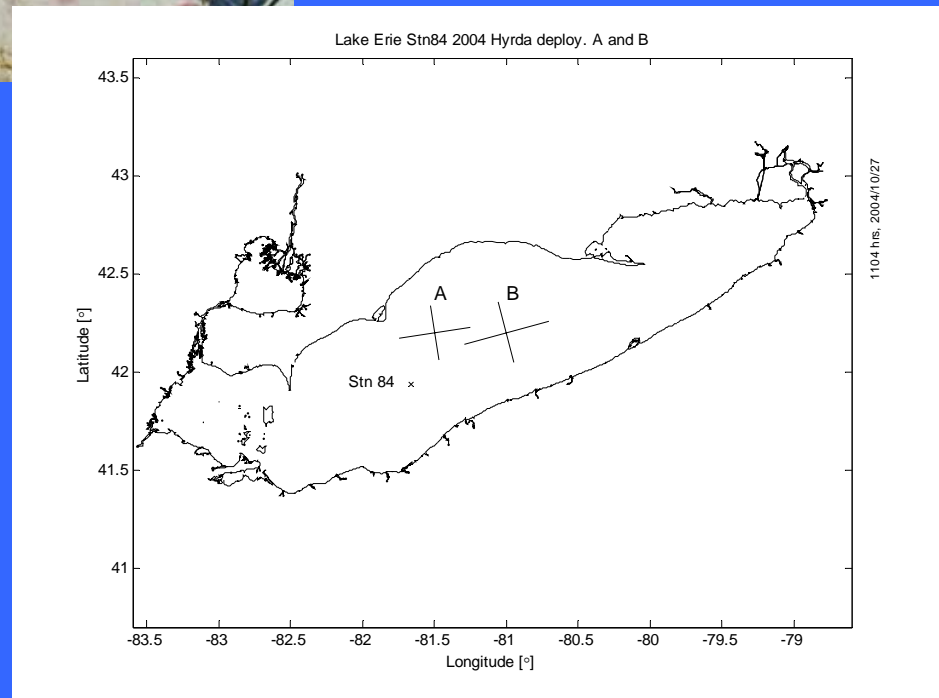
Pelee N



Sontek Hydra



A: major: 3.3 cm/s, 80.8°T; minor: 2.6 cm/s. For B: major: 4.1 cm/s, 85.4°T, minor: 2.9 cm/s



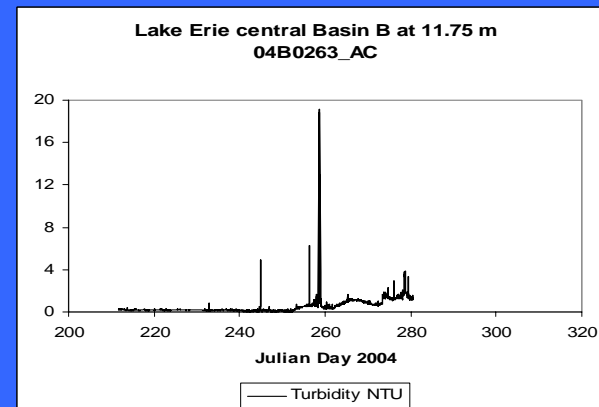
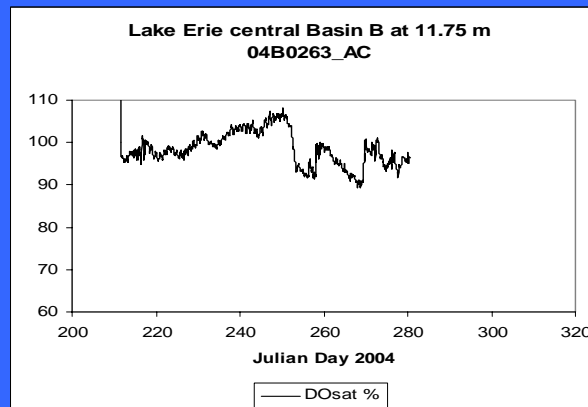
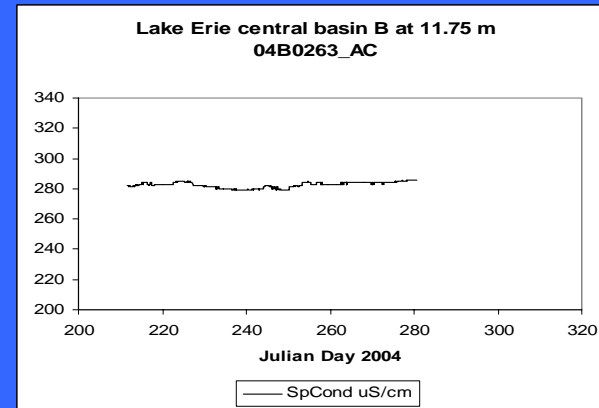
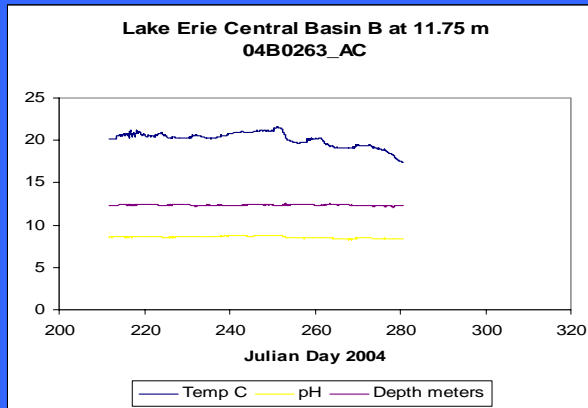


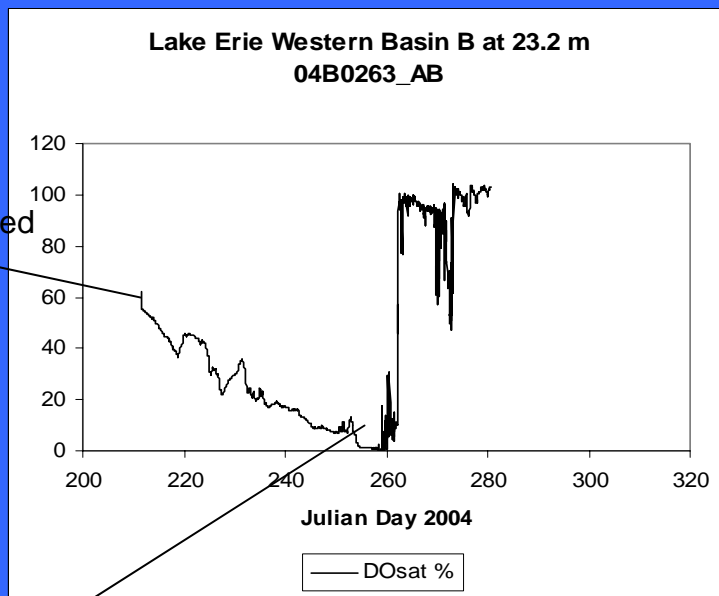
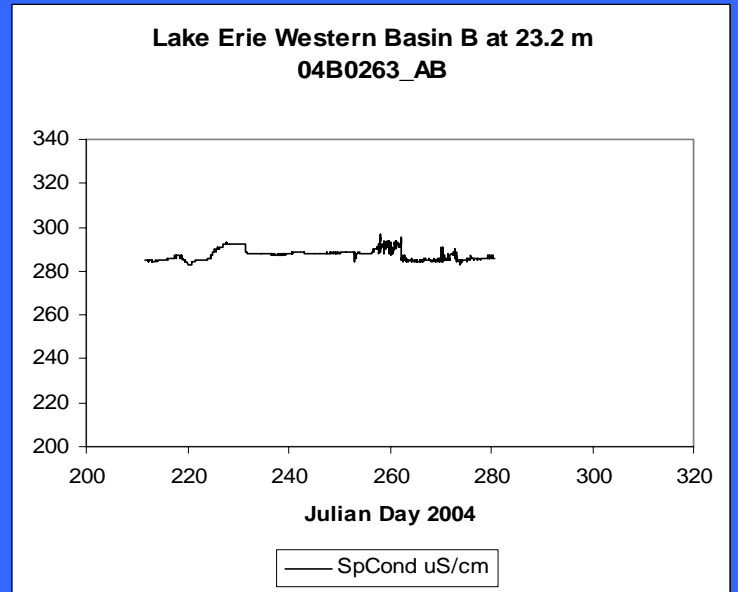
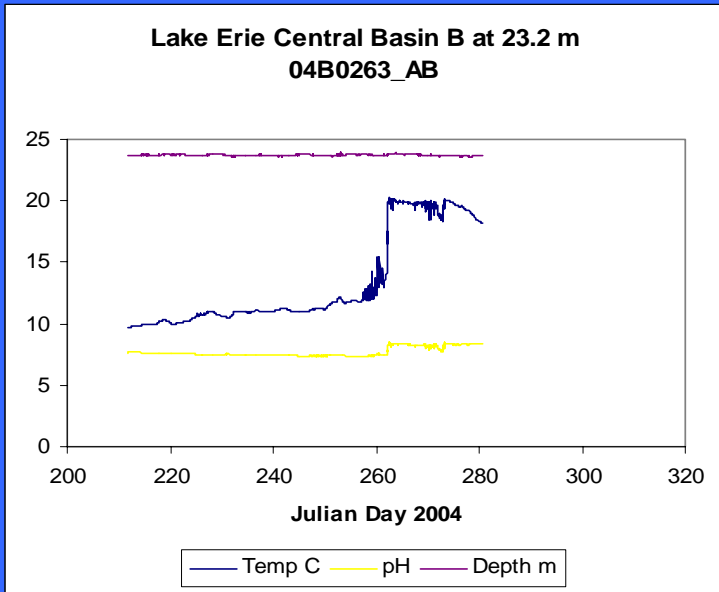
YSI 6600

DO, Conductivity, pH,
turbidity
No Chlorophyll

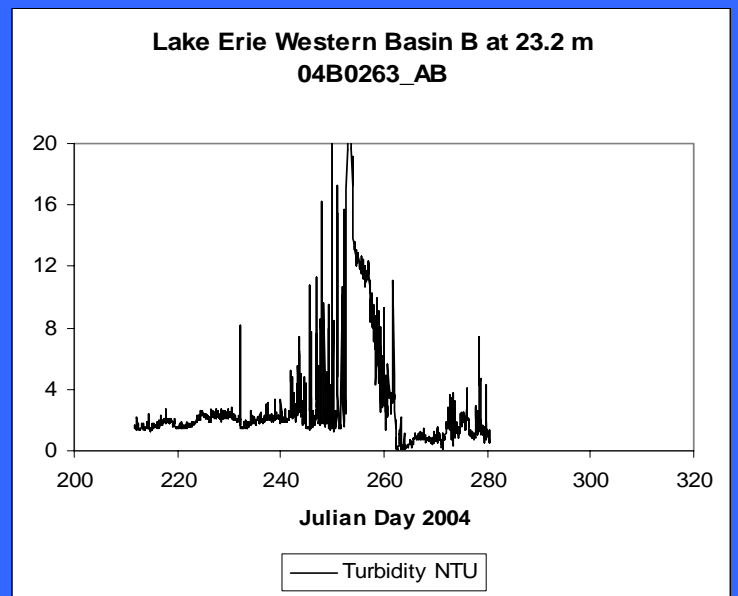
Deployed in the central and west basins

Cross-validation of DO and temperature
data is being carried out in Hamilton Harbour



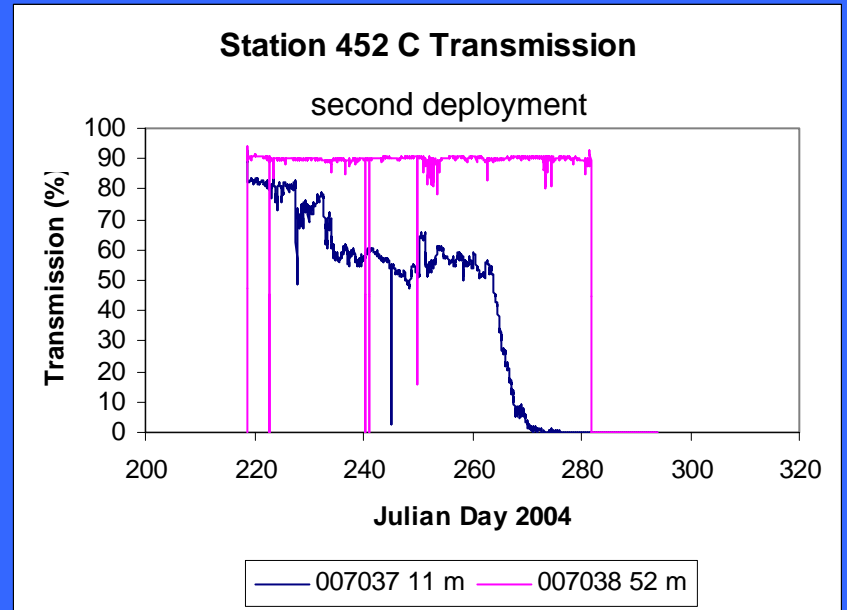
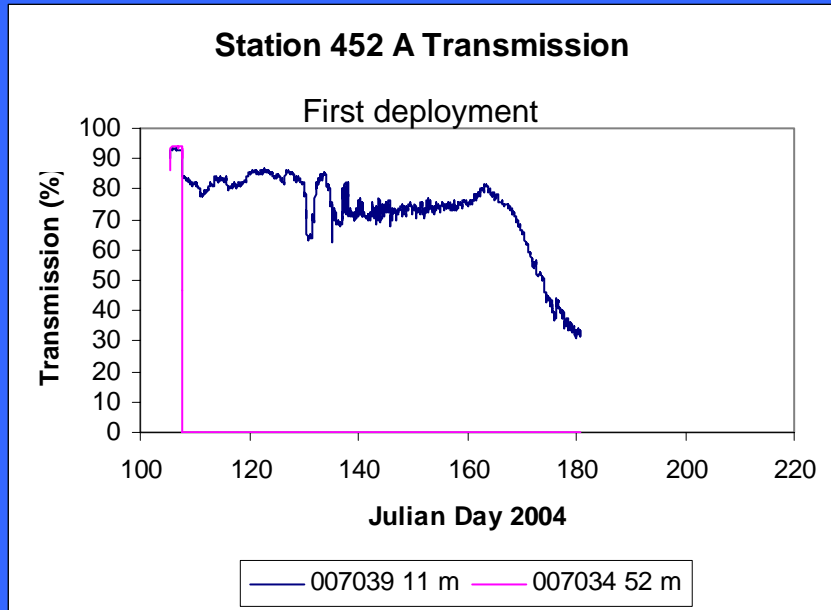


recalibrated



DO is practically zero?, and sudden recovery due to easterly storm

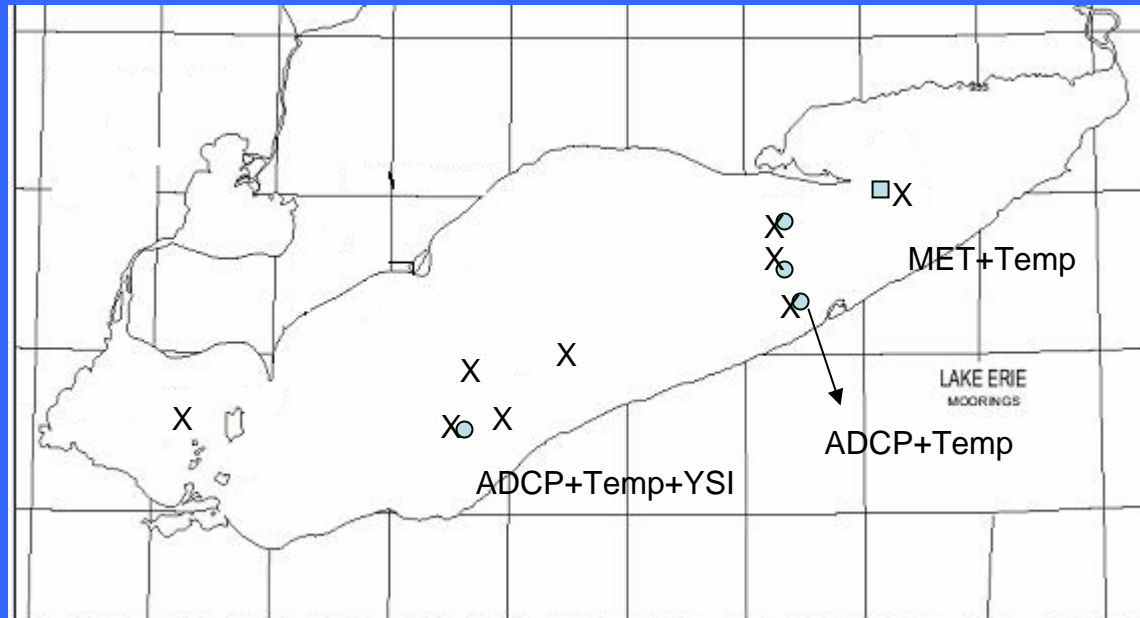
Transmissometer Data in the East basin



2005- Physical experiment will have

Higher vertical and spatial resolution of temperature and DO
in the central basin for studying Hypoxia

Increase ADCP coverage at the ridge to understand the east- and
central basin exchanges



2005 Field work in Lake Erie (in collaboration with U Waterloo):

Fast repetition rate Fluorometry and Microstructure profiles on
three cruises to understand spatial and temporal dynamics of
phytoplankton photosynthesis and nutrient status.

Summary

2004 Measurements:

Physical oceanography and surface meteorology parameters data return and quality are reasonably good

YSI 6600 data need to be verified with other types of measurements for long-term deployments

2005 Measurements:

Higher resolution is required in the BBL

Long-term deployments of YSI at four stations in the central basin

Inter-basin transports