Cycle-PO4: In-situ meter for soluble phosphate monitoring in environmental waters

SEA-BIRD Coastal

Justin Reale (NM Army Core) and Dave Van Horn (UNM) on the Rio Grande

Speaking today - Doug Wilson

CARIBBEAN WIND LLC

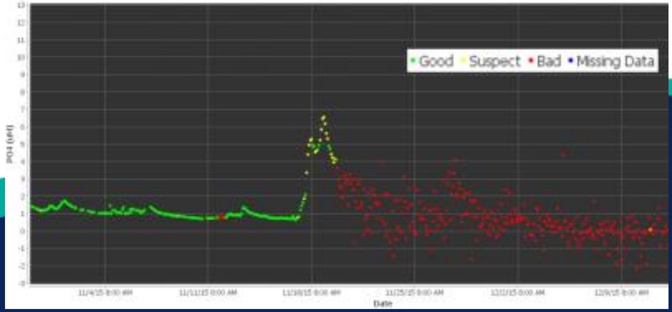
OCEANOGRAPHIC CONSULTING SERVICES

doug@coastaloceanobs.com

- 30 years with US NOAA
- Specializing in Ocean, Coastal, and Estuarine Observing Systems
- US IOOS P.I. (MARACOOS, CariCOOS)
- GOOS Regional Chair (IOCARIBE-GOOS)
- Clients include
  - AXYS Technologies
  - Rutgers U
  - NOAA
  - University of Puerto Rico
  - University of the Virgin Islands
  - RPS Applied Science Associates
  - US National Park Service
- Consultant to Sea-Bird Coastal on Integration, Applications, Analysis

Cycle-PO4 Overview

- On board reagent cartridges (5 mo best-by)
- On-board spike calibration (NIST Traceable Standard)
- Over 1500 samples and
- Deployments more than three months
- Smart sampling minimizes power consumption
- Calibrated output
- User Definable units and conversions
- Large single intake filter 7.5 µm (to exclude particles)
- Copper mesh screens on intake filter to prevent fouling on intake
- Pressure compensation for internal pumps
- Real-time QC flags with each data point
- Easy-to-use software
- Fluidics for high-oxygen saturation conditions



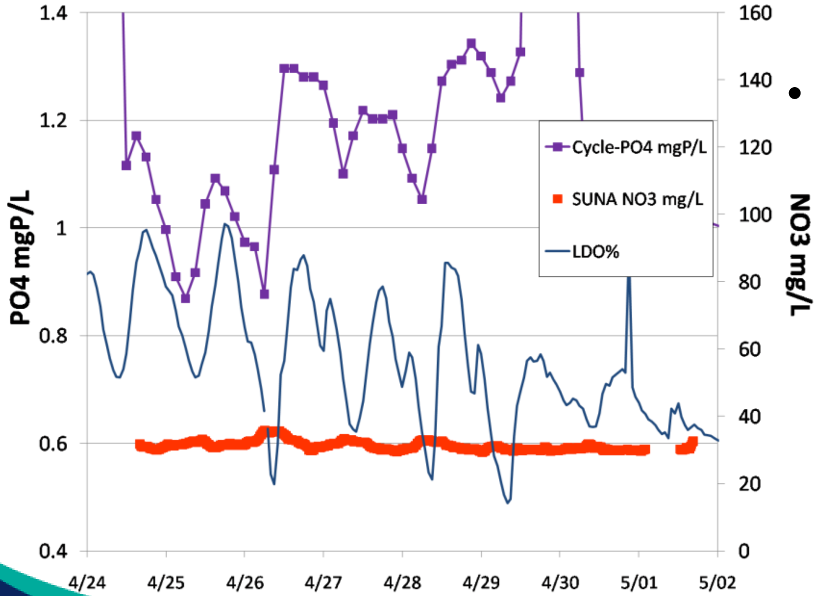
Performance Specifications

- ~ Soluble reactive ortho-phosphate
  - Based on common Autoanalyzer methods (e.g., EPA method 365.5, Molybdenum Blue method)
- LOD, IDL: $3*\sigma \leq$ 0.0023 mgP/L (75 nM PO_4-P)
- LOQ: $10*\sigma \leq$ 0.0077 mgP/L (250 nM PO_4-P)
- Calibrated Range: 0-0.3 mgP/L (0-10 µM PO_4-P)
- Linear Range: ~0-1.2 mgP/L (0-40 µM PO_4-P)
- Maximum 4 samples per hour

- Standard of Deviation of 2.6 µM (lab standard) $\leq$ 0.0015 mgP/L (50 nM PO_4-P)

Tomato Farming

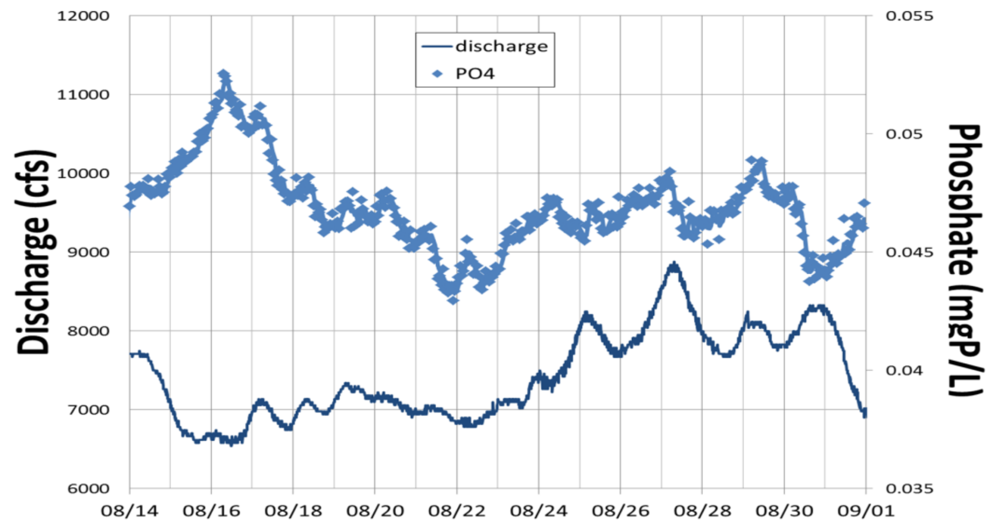
- Experimental tomato farm
  - UF: Best practices research
  - DEQ: nutrient loading from Ag
- Challenges
  - Intermittent water
  - High values
- User now sampling from Lysimeter under tomato rows
- Other users targeting Edge-of-field application

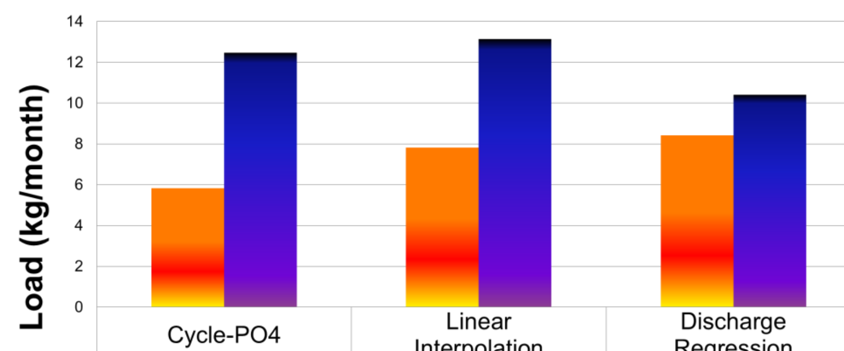


Dr. Kelly Morgan and Kevin Locher

Brownlee Reservoir Loads

- Real-time phosphate yields more accurate loadings
- Three loadings methods are compared based on:
  - 1)Cycle-PO4 measurement
  - 2)Linear Interpolation of grab samples
  - 3)Linear regression of grab samples with discharge.
- Traditional loadings models over-or-under estimate loads
  - Interpolation results in smoothing events
  - Regression relationships do not have strong correlations due to complexity of phosphate-discharge relationships.



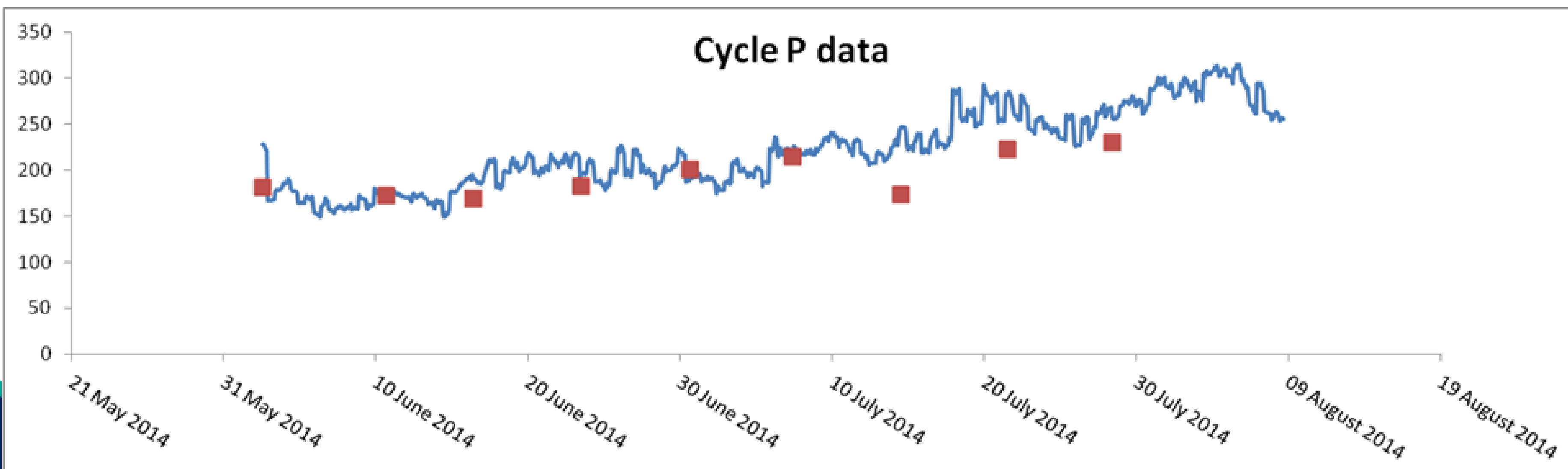


	Cycle-PO4	Linear Interpolation	Discharge Regression
Aug Load (kg)	5.8	7.8	8.4
Sept Load (kg)	12.5	13.1	10.4

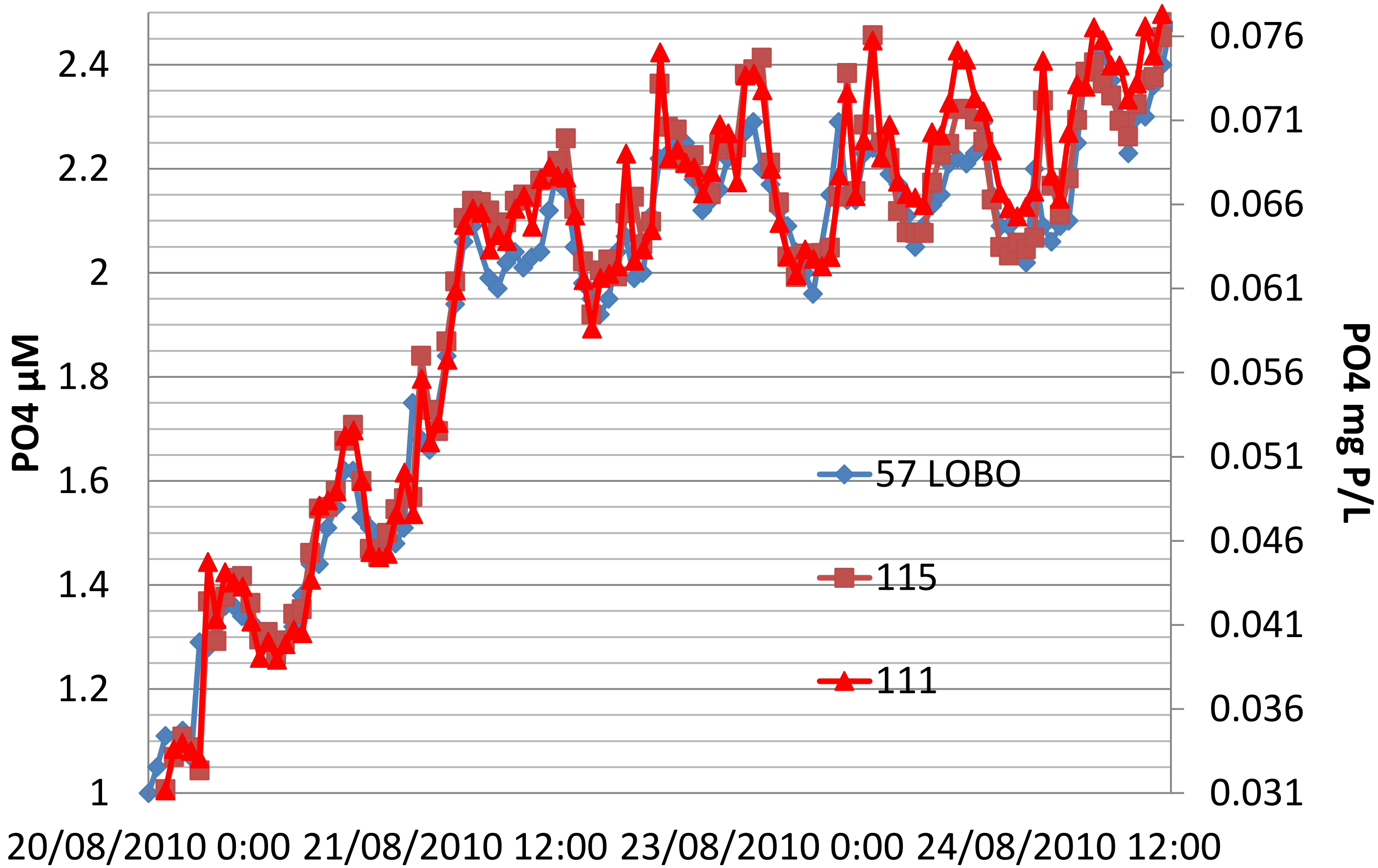
WIN Weather INnovations Consulting LP

High Accuracy in River Thames, UK

SEA·BIRD COASTAL

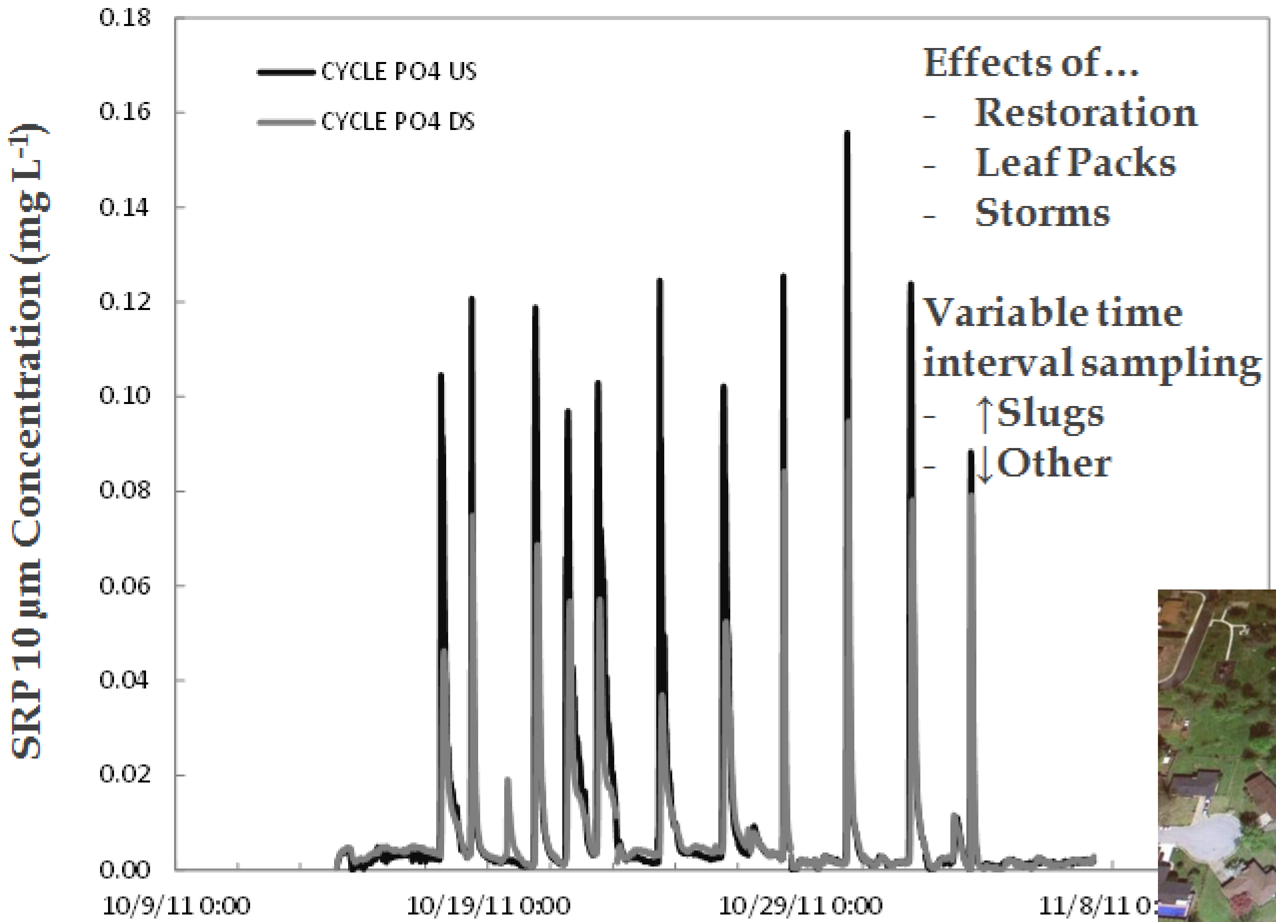


High meter-to-meter agreement



- **Tracks environmental variability: changes ≤ 2µgP/L (50 nM) coherent between data sets**

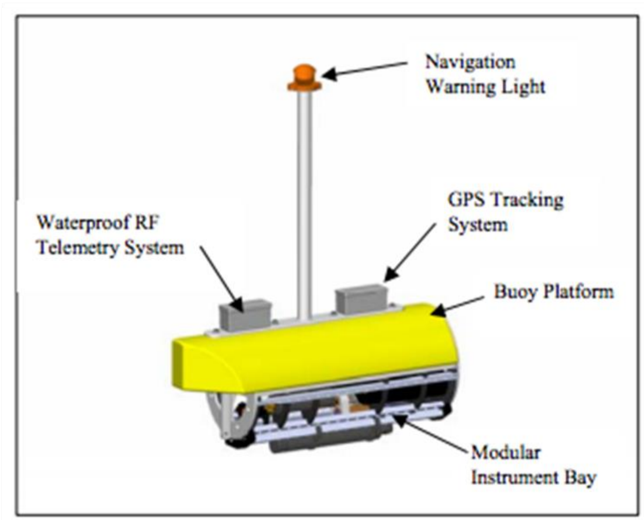
Phosphorus Slug Dynamics in an Urban Stream



Haggard B.E., L.B. Massey, C.R. Koch, J.T. Scott, M.A. Evans-White, B.J. Austin, E.E. Scott, and D. Procyk **University of Arkansas System. Wet Labs. Hach – Hydromet**

UNIVERSITY OF ARKANSAS SCHOOL OF LAW

LOBO, Studying the relationship between phosphate and blooms in Western Lake Erie 2013-2015

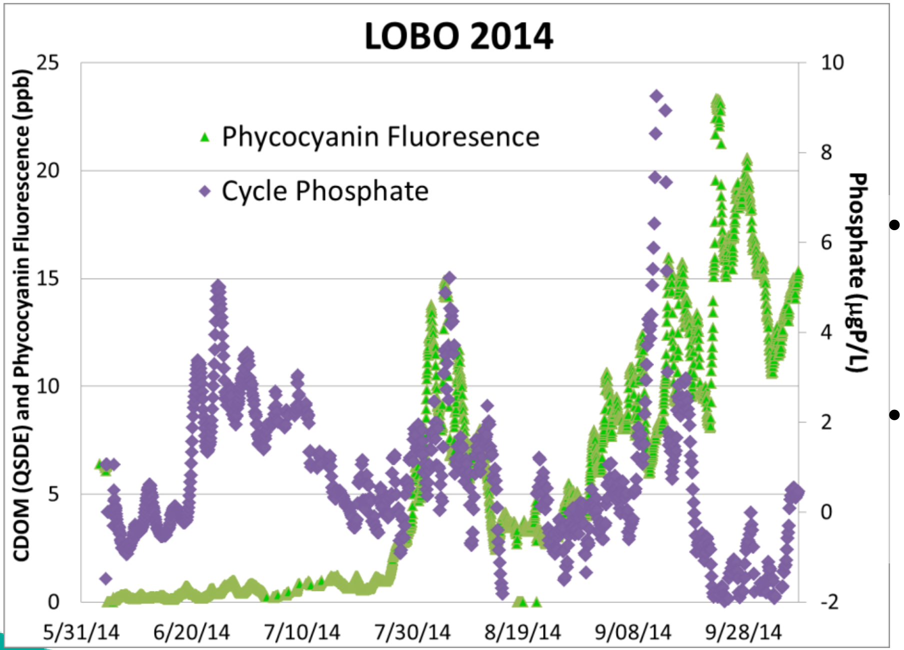


<u>Hourly observations from SEA-BIRD LOBO</u>

- Satlantic LOBO (data control, management, power)
- Cycle-PO4 (phosphate sensor)
- WQMX (Salinity, Temperature, DO, Turbidity, Chlorophyll Fluorescence, CDOM Fluorescence)
- ECO-PC (Phycocyanin Fluorescence)
- Data publicly available
- Serviced every 8-12 weeks
- Deployed June 4 – Oct. 14, 2013 at TCM #2
- Data delivery via cell modem every 60 minutes

Application Example: LOBO

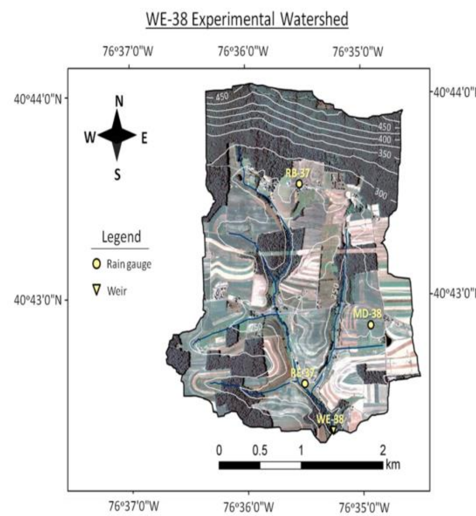
- PO_4 pulses lead to early season phycocyanin fluorescence
- Phycocyanin fluorescence and extracted samples correspond with particulate mycrocystin.



- Driving factors of PO_4 are complex. The Maumee River and wind events likely source PO_4 to the site while the Detroit River may dilute apparent concentrations.
- Conductivity and CDOM often correlate with phosphate, suggesting wind driven and resuspension sources.

Ongoing Demonstration Project
with the US Department of Agriculture Agricultural Research Service
Pasture Systems and Watershed Management Research

Long-Term Effects of Climate Variability and Land Management Change on Hydrology and Water Quality of Mahantango Creek Watershed



Long-term deployment In-situ Nutrient, Water Quality, and bio-optical sensors

- Cycle-P Phosphate Sensor
- SUNA V2 Optical Nitrate Sensor
- LOBO Buoy System
- HydroCat Multi- Parameter Sonde
  - Dissolved Oxygen, Conductivity, Temp., Depth, pH, NTU, Chlorophyll
- Hydro-pH pH Sensor
- ECO Optical Sensors
  - Chlorophyll, Dissolved Organic Matter, NTU, Dye tracers