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Assessment of RBR*coda* T.ODO performance on long-term deployment and profiling in Bedford Basin

Eric Siegel, Rui Zhang, Mark Halverson, Jon Taylor, Greg Johnson

- T.ODO introduction
- Sensor technology
- Field validations
  - Moored
  - Profiling
- Applications
- Questions

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RBR*coda* T.ODO

Optical accuracy and stability similar to Aanderaa Optode

Standard accuracy: 8 µmol/l

High accuracy temperature measurement

Power consumption: only 36 mJ/sample

Rated to 6000m

Wiper available for |slow

Time constant options

- |fast — 1s response (profiling)
- Standard — 8s response
- |slow — 30s response (moored)

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Interface

- RS-232 polled or autonomous streaming

Output values

- Temperature (°C)
- Dissolved O2 concentration (µmol/l)
- Dissolved O2 concentration (salinity comp (µmol/l))
- Dissolved O2 saturation (%)
- Dissolved O2 phase (°)

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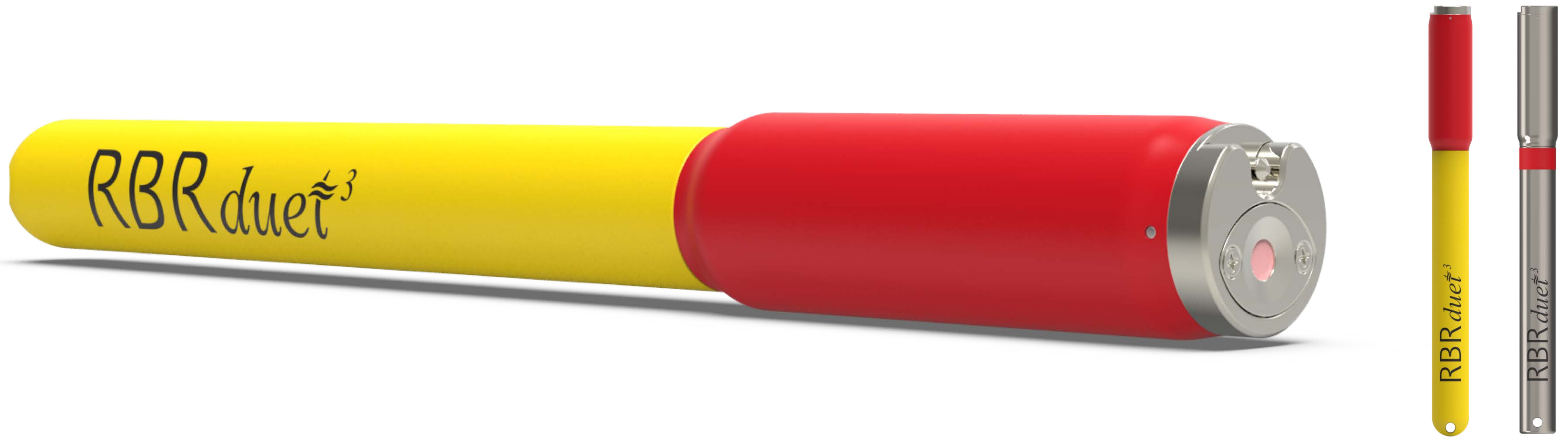

RBR*duet*^{3} T.ODO

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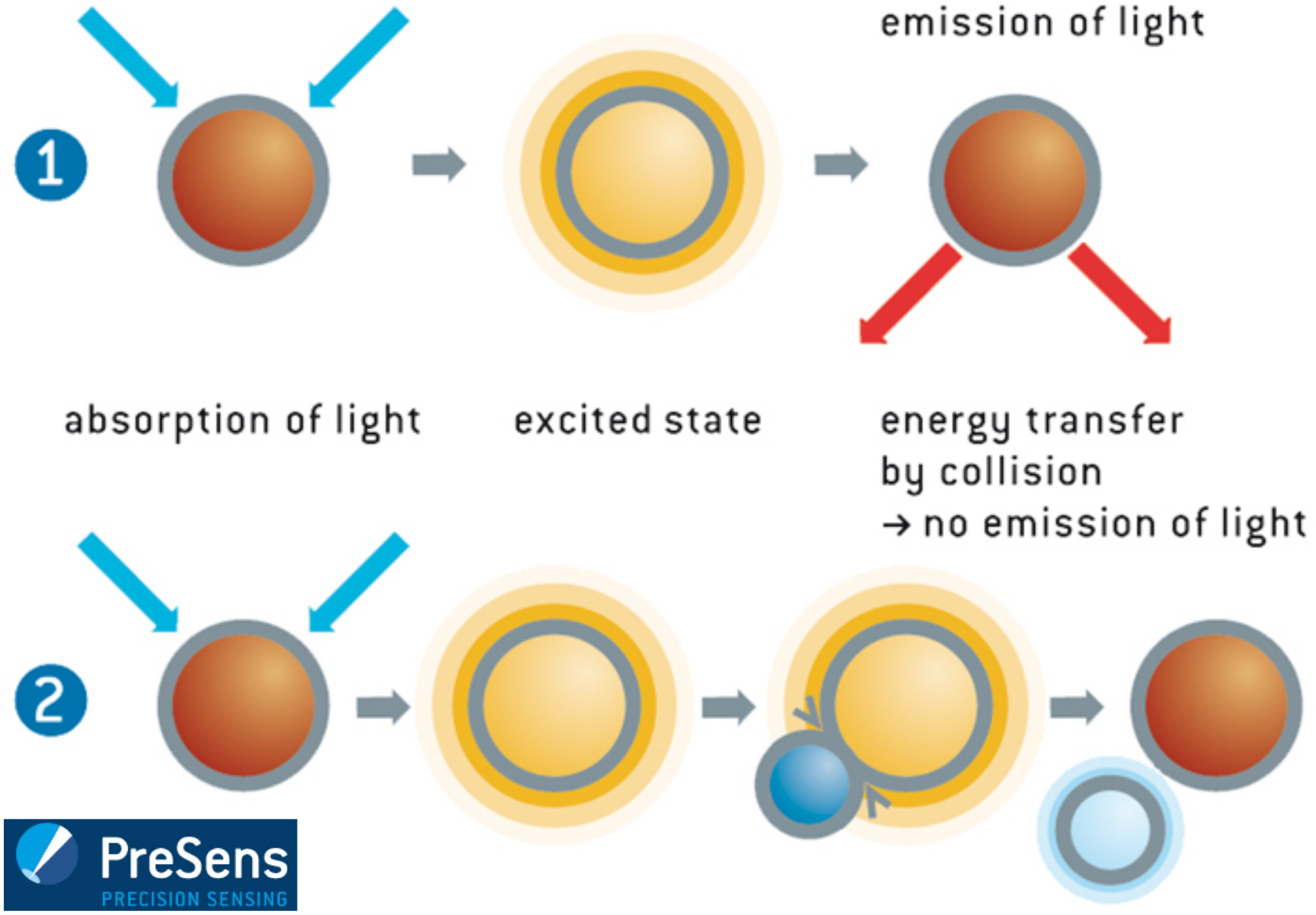
Sensor Technology

Luminescence quenching by molecular oxygen



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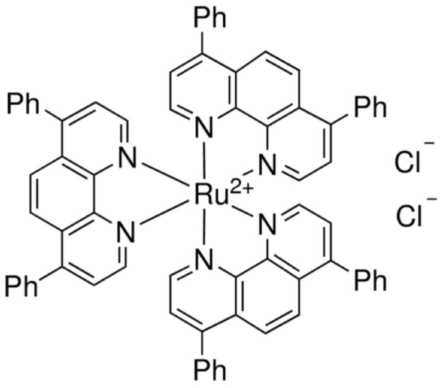
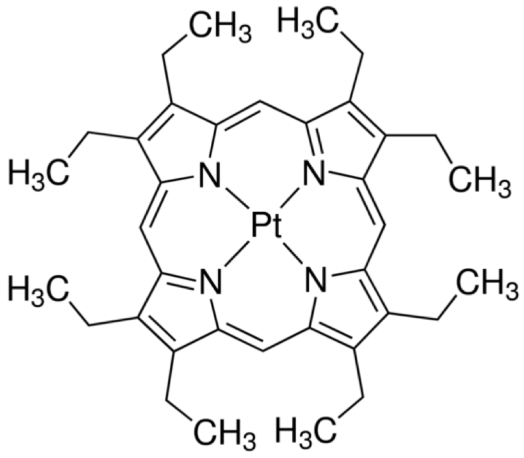
RBR*coda* T.ODO



Ruthenium(II) complex

|fast

- Tau ~1sec (Temperature dependent)
- Drift <0.6 µmol/l per month (2.5 million samples)



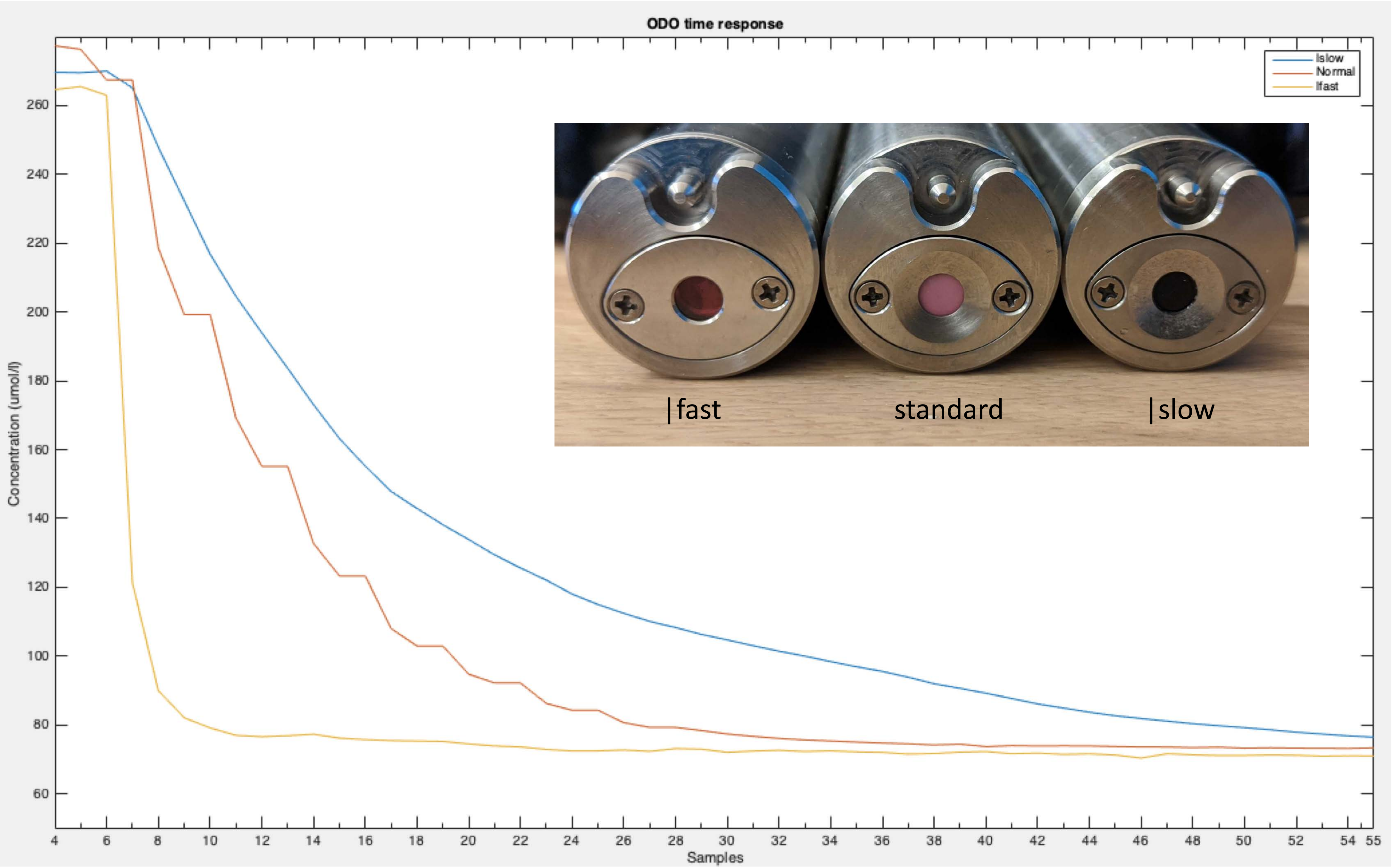
Platinum octaethylporphyrin

regular & |slow

- Tau ~8, 30 sec (Temperature dependent)
- Drift - negligible

PreSens
PRECISION SENSING

RBR


ODO time response
Islow
Normal
Ifast
|fast
standard
|slow
Concentration (umol/l)
Samples
260
240
220
200
180
160
140
120
100
80
60
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
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50
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55

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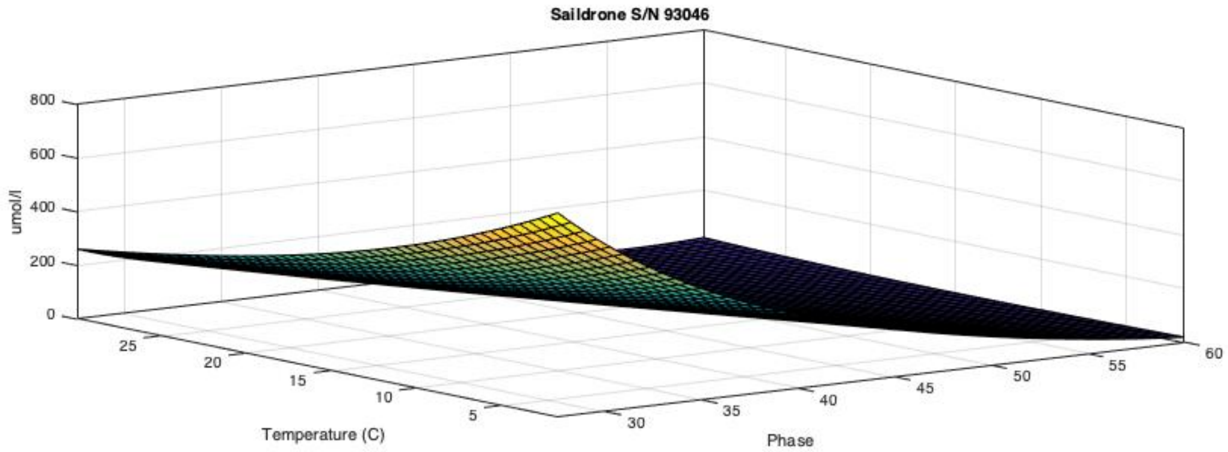
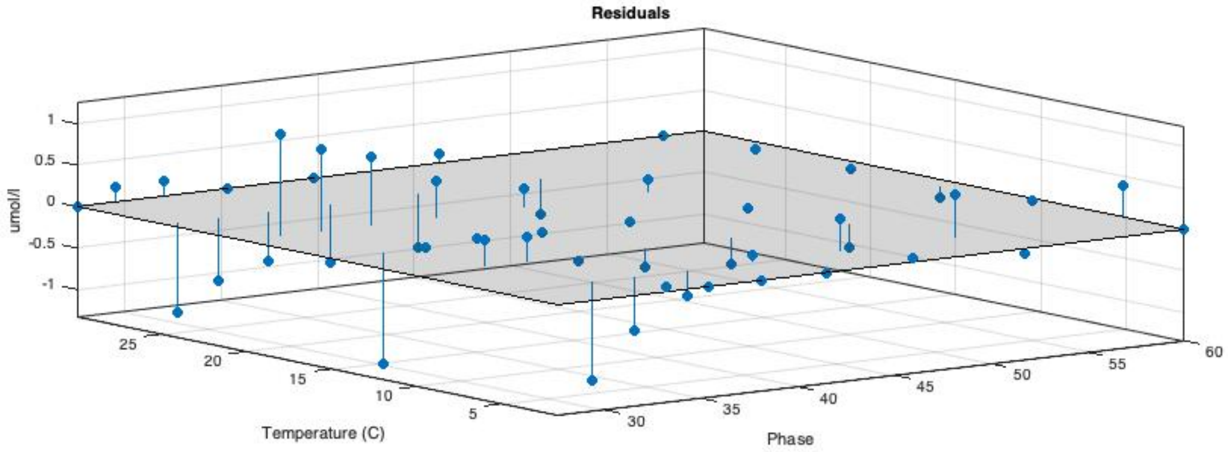
RBR*coda* T.ODO - Calibration





Dissolved Oxygen calibration

- 49 plateaus
- Temperature range: 1.5 – 30 °C
- Saturation: 0 – 120%
- Residuals: < 4 µmol/l

Temperature

- Accuracy: 0.002 °C
- Range: -5 to 35°C

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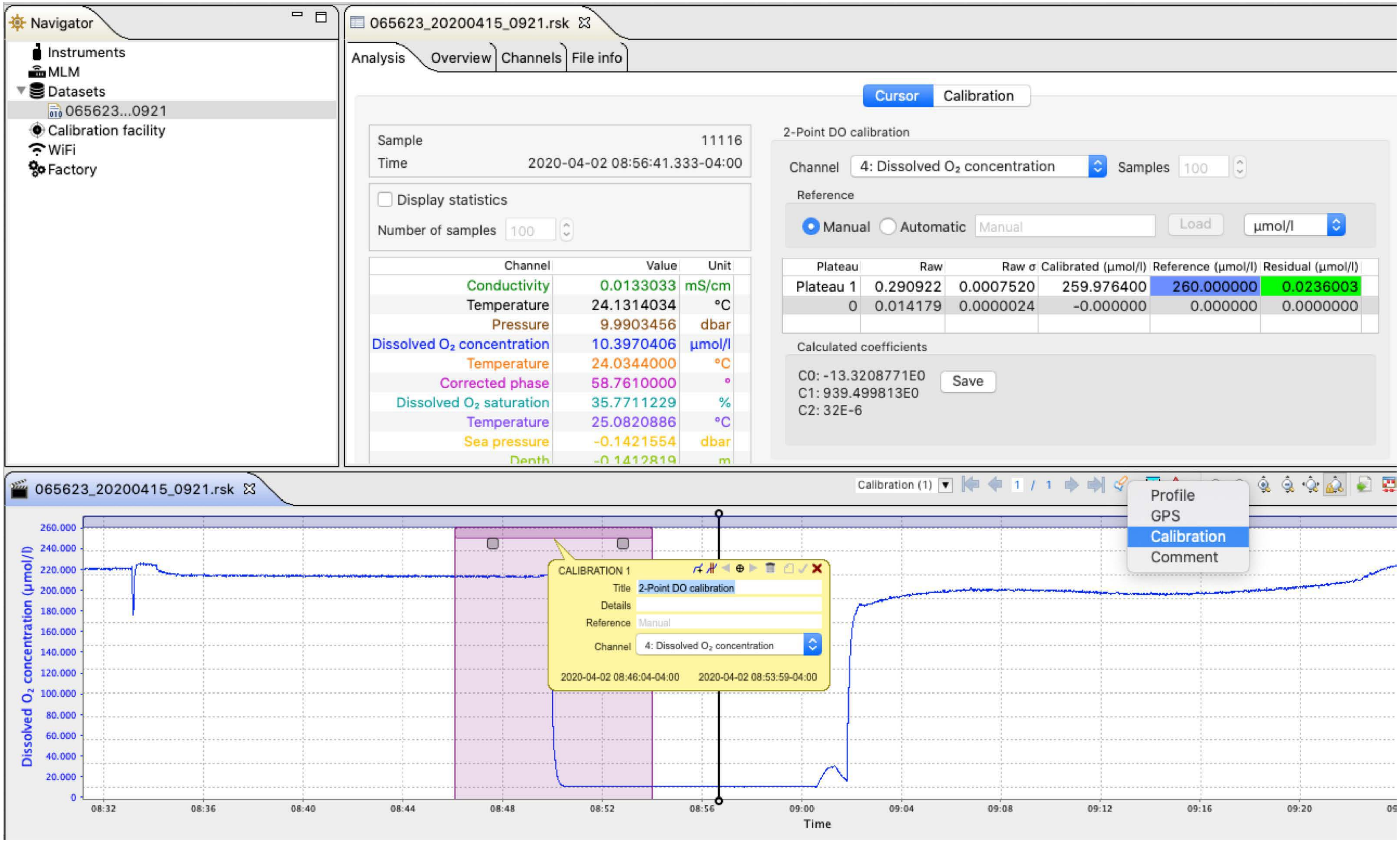
RBR*coda* T.ODO - Customer calibration



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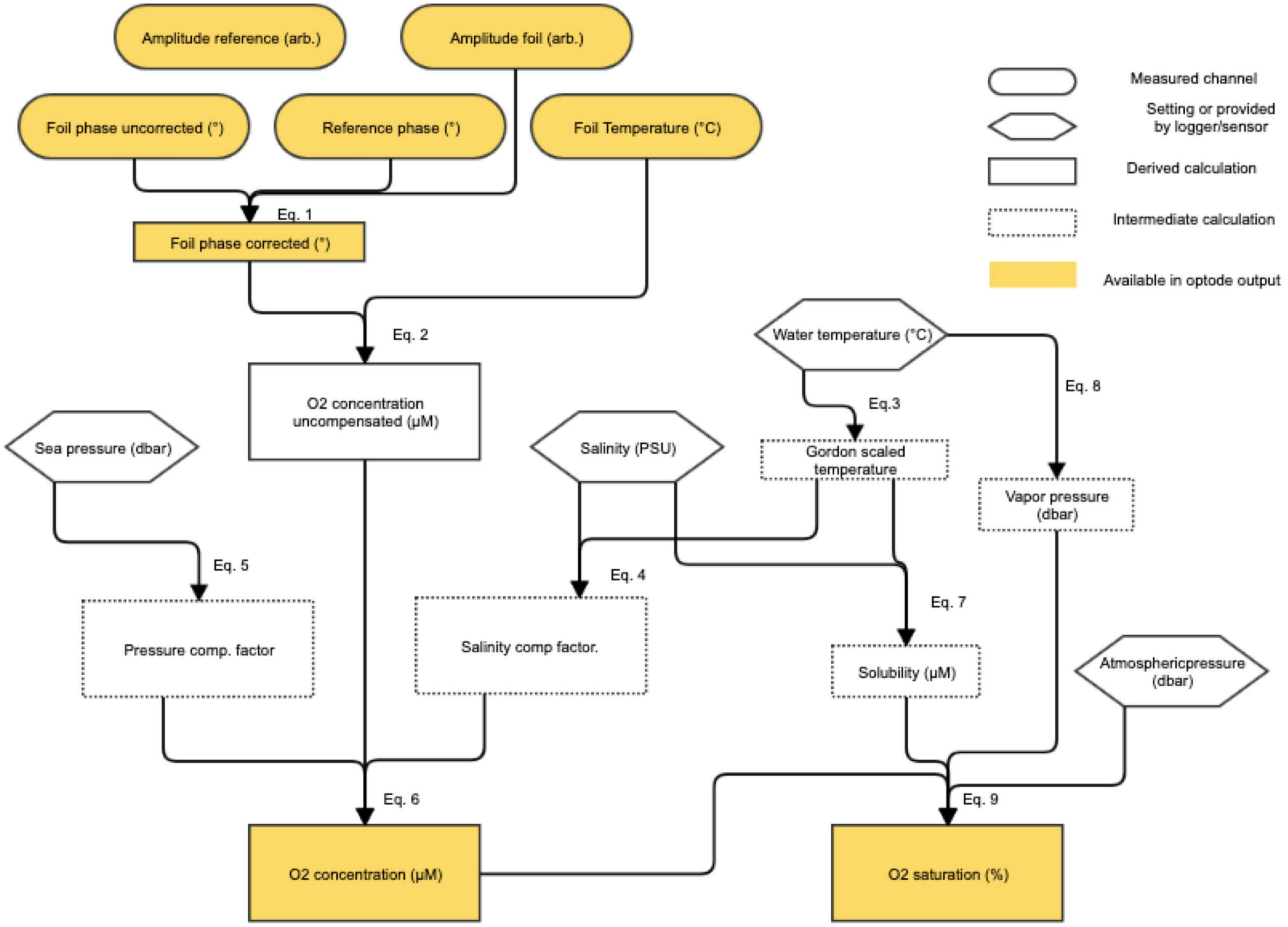
Equations used by the RBR DO Sensor



Eq. 2

$$C(t,\phi) = \begin{bmatrix}\phi^0 & \phi^1 & \phi^2 & \phi^3 & \phi^4\end{bmatrix} \begin{bmatrix} c_{00} & c_{01} & c_{02} & c_{03} \\ c_{10} & c_{11} & c_{12} & c_{13} \\ c_{20} & c_{21} & c_{22} & c_{23} \\ c_{30} & c_{31} & c_{32} & c_{33} \\ c_{40} & c_{41} & c_{42} & c_{43} \end{bmatrix} \begin{bmatrix} t^0 \\ t^1 \\ t^2 \\ t^3 \end{bmatrix}$$

Eq. 4

$$F_{cs} = e^{\left(S\left(\sum_{i=0}^{3} G_{bi} t_s^i\right) + G_{c0} S^2\right)}$$

Eq. 5

$$F_{cp} = 1 + P \times C_p$$

Eq. 6

$$C_c = C_u \times F_{cp} \times F_{cs}$$

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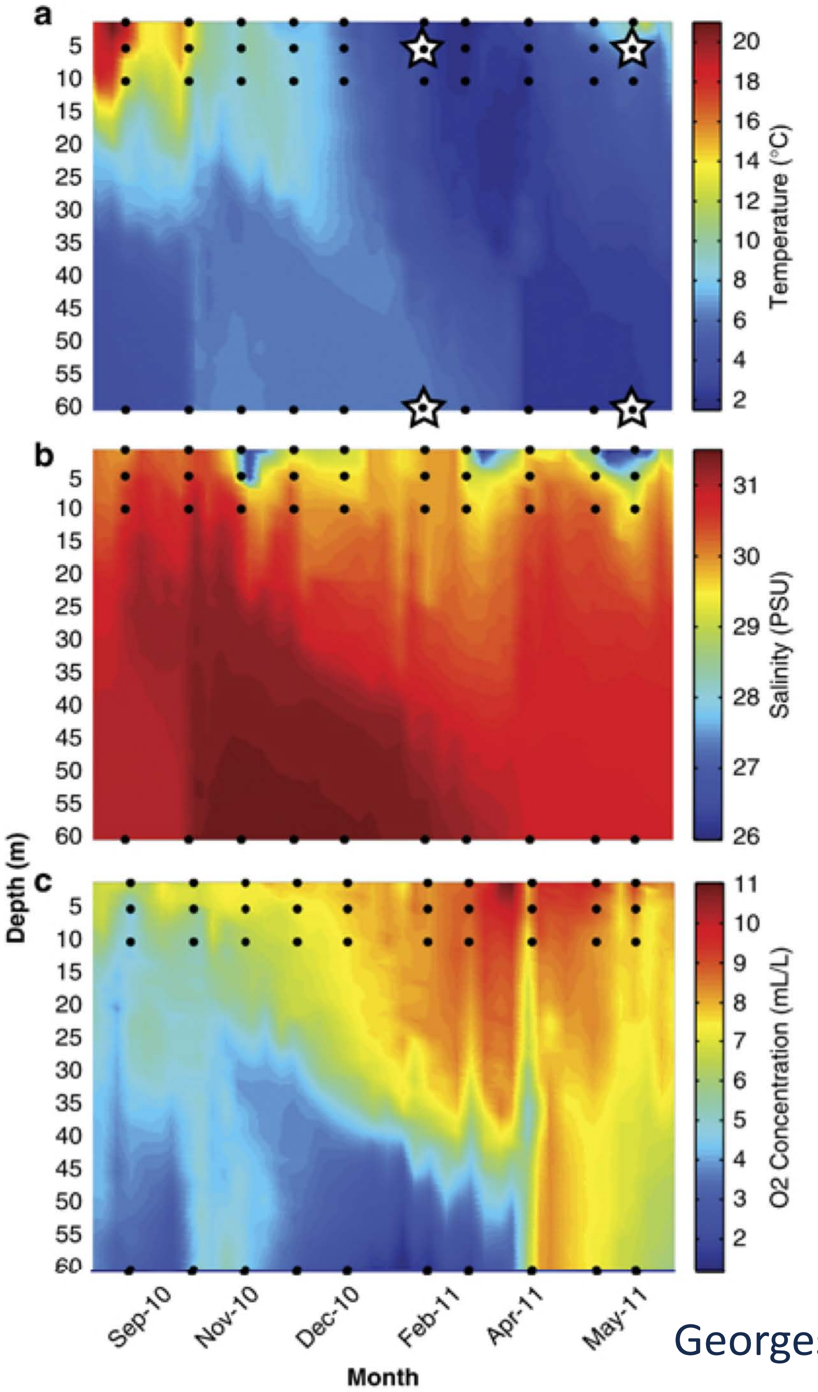
Field Validations

Why Bedford Basin?



Georges et al. 2014

Compass Buoy Station (44°41′37″N, 63°38′25″W)

Strong seasonal variation of dissolved oxygen

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Mooring

Deployed in partnership between Dalhousie University and DFO Bedford Institute of Oceanography

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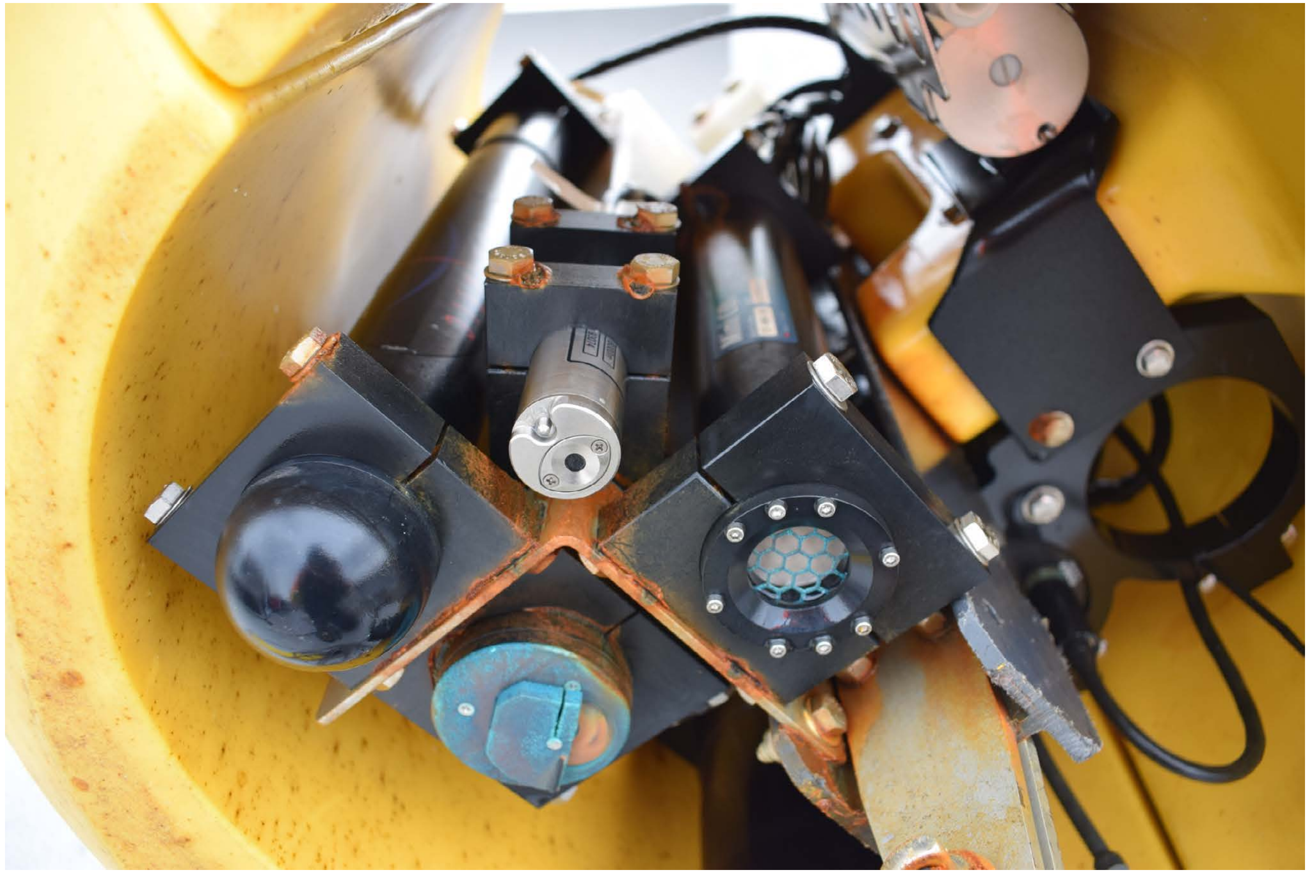
Mooring



- RBR*coda* T.ODO|slow (30s time constant)
- SBE-37 CTD
- 60m depth
- Sep – Dec 2018
- Sample at 1Hz for the first minute of every hour

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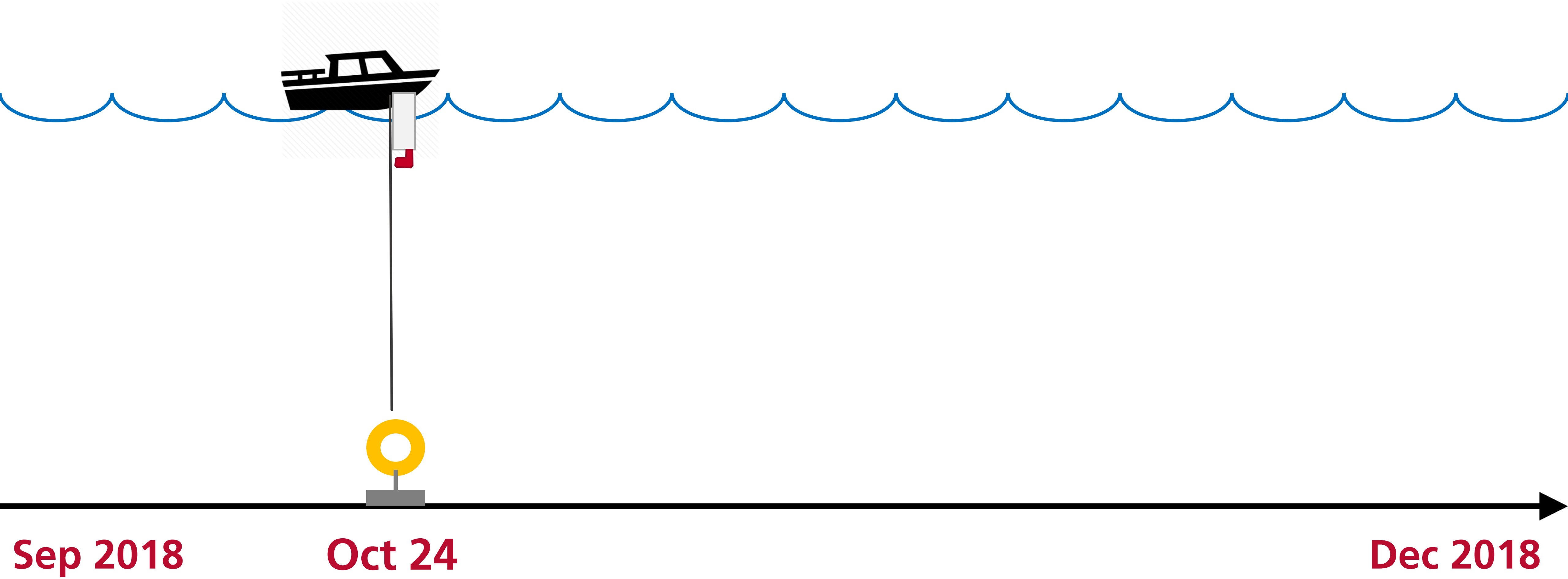
Deployed in partnership between Dalhousie University and DFO Bedford Institute of Oceanography

Profiling

- Bedford Basin Monitoring Program
- Weekly vertical profiles over mooring
- Date: Oct 24, 2018
- Instruments:
  - RBR*coda* T.ODO (8s time constant)
  - RBR*coda* T.ODO|fast (1s time constant)
  - SBE-25 CTD
  - SBE-43 DO
  - Water bottles

Instruments and deployment



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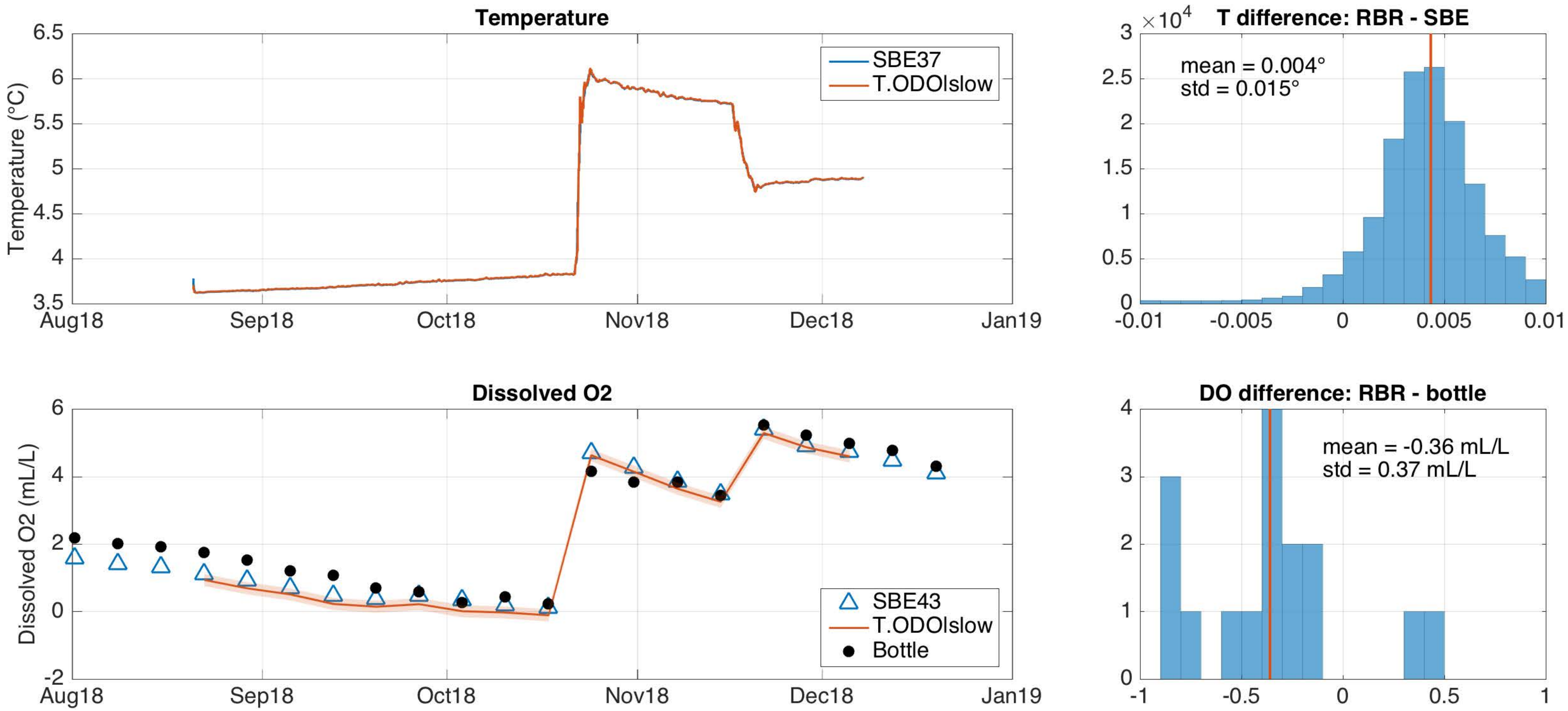
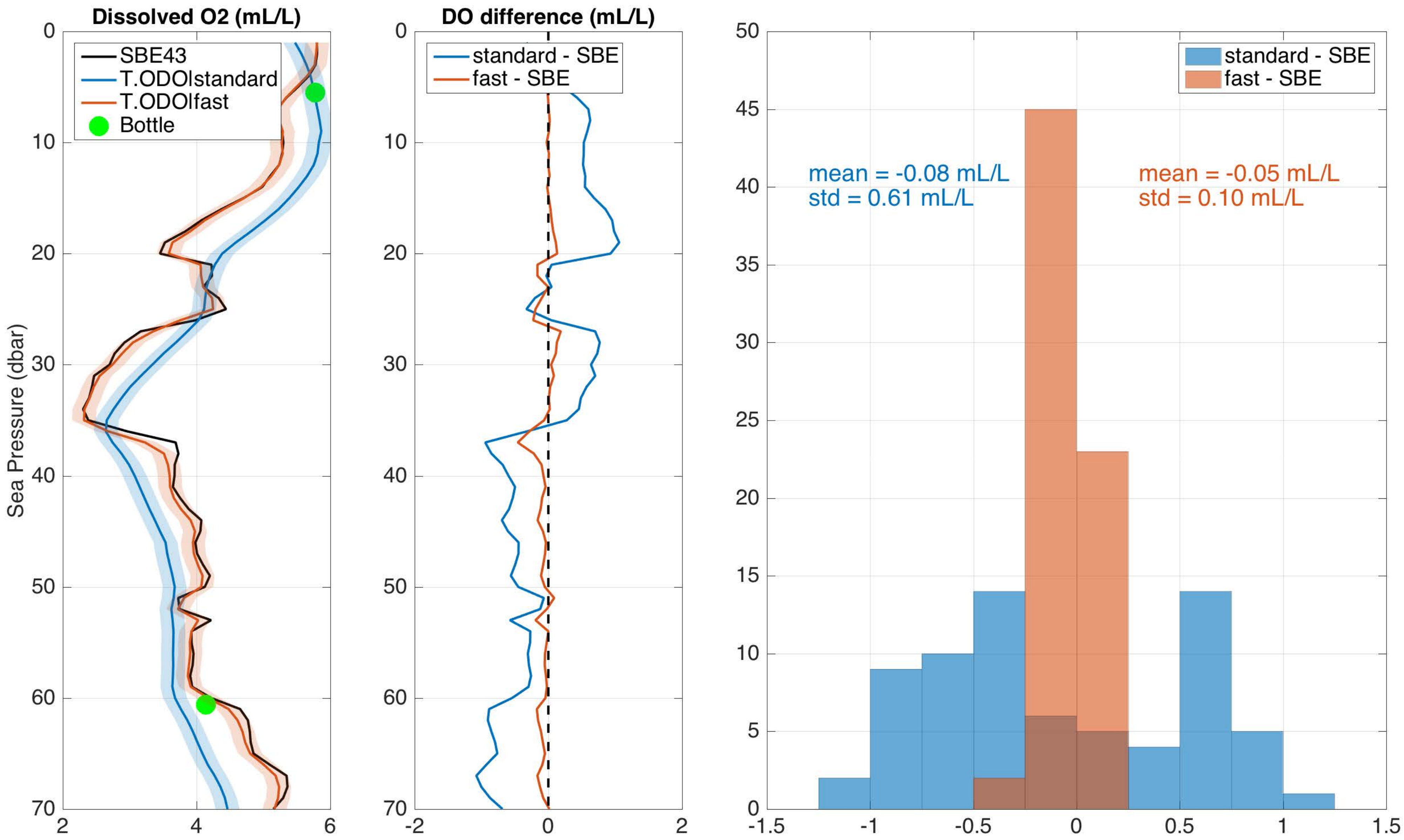
Results - Mooring

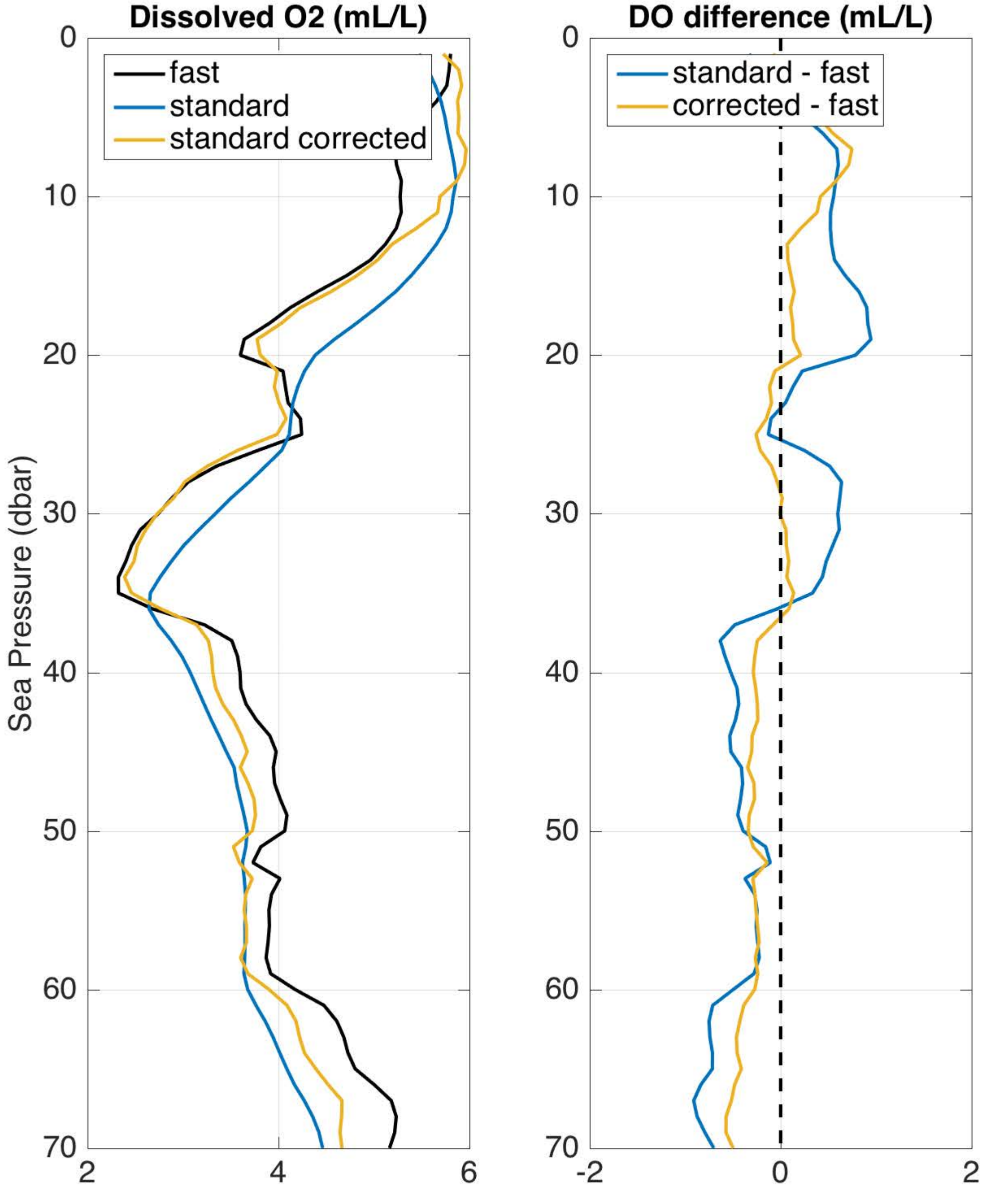


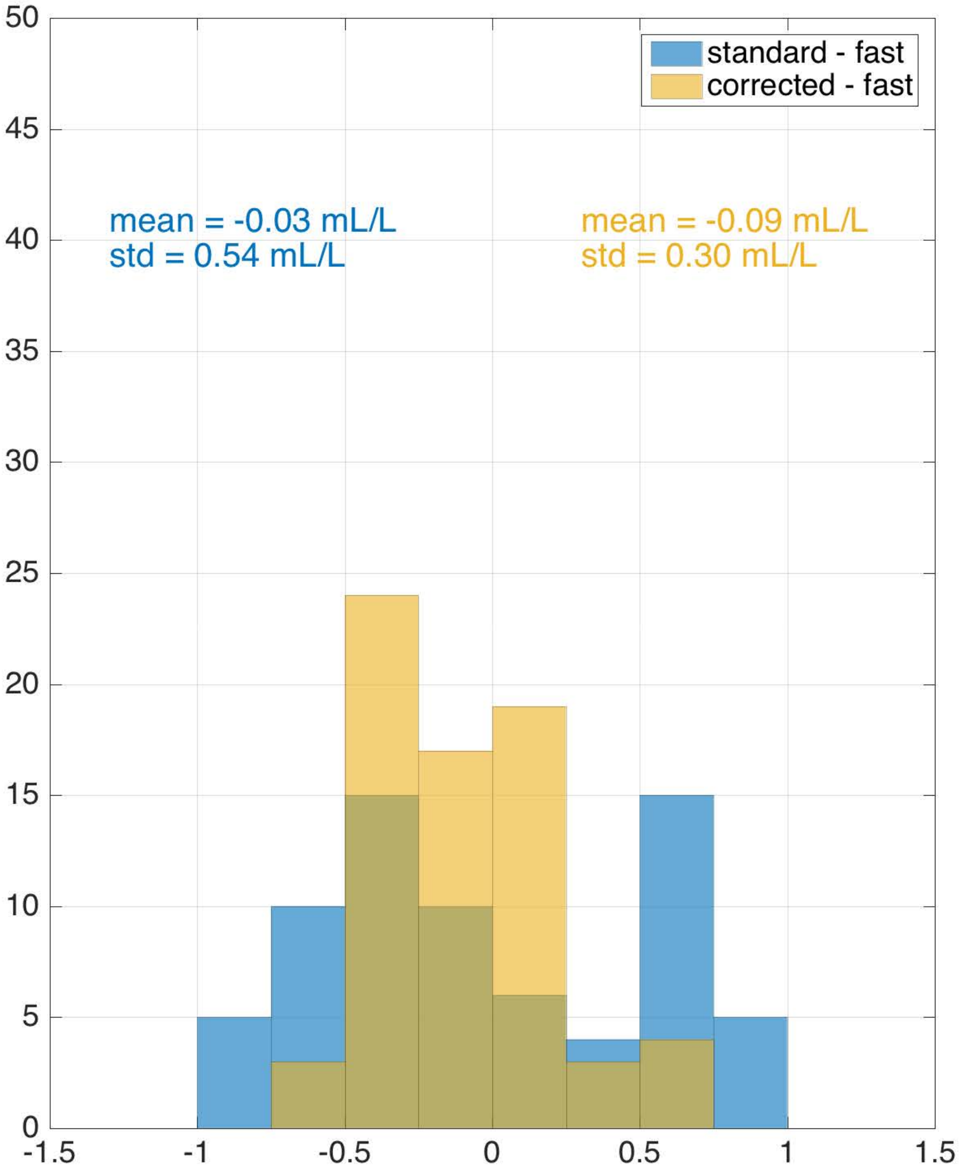
Results - Profiling



Results - Profiling

$$T = T_m + \tau \frac{dT_m}{dt}$$





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Field Validation Summary

- T.ODO|slow – Stable for mooring application
- T.ODO|fast – Accurate for profiling application
- T.ODO standard – Expected time constant lag during profiling which can be improved in post-processing

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Acknowledgements

- Coastal Environmental Observation Technology and Research (Dalhousie University)
  - Richard Davis, Madison Evans, Darrell Adams, Anna Haverstock

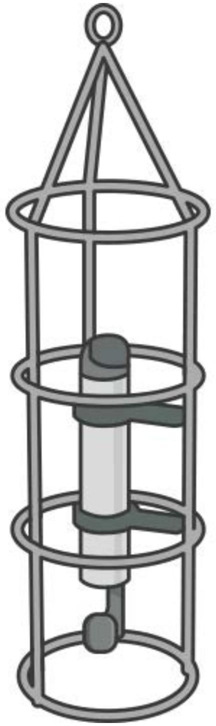
- Bedford Institute of Oceanography
  - Clark Richards, Kevin Pauley, Andrew Cogswell, Peter Thamer
  - Captain and crew of *Sigma T*

CEOTR DALHOUSIE UNIVERSITY Fisheries and Oceans Canada

Applications

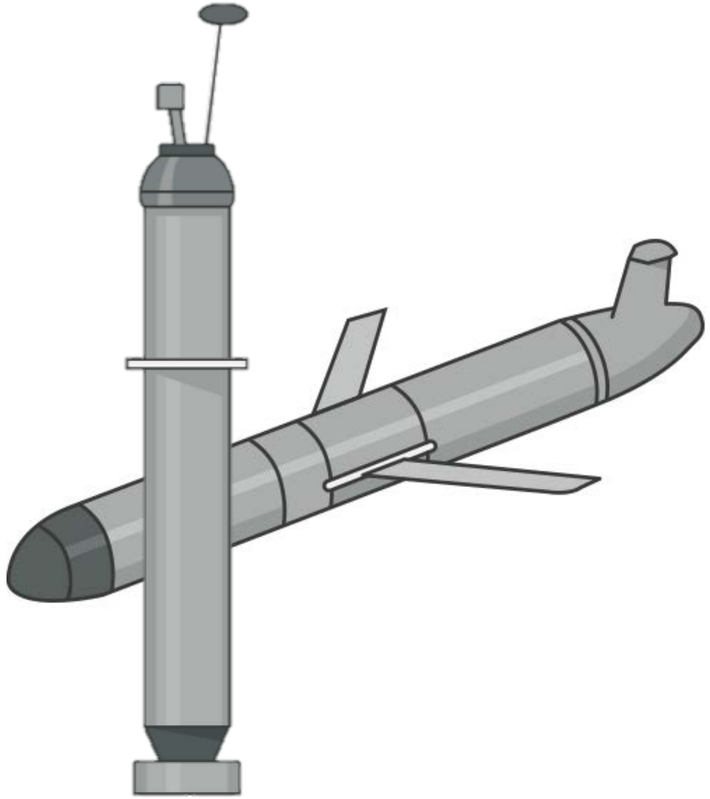
Applications

T.ODO|fast



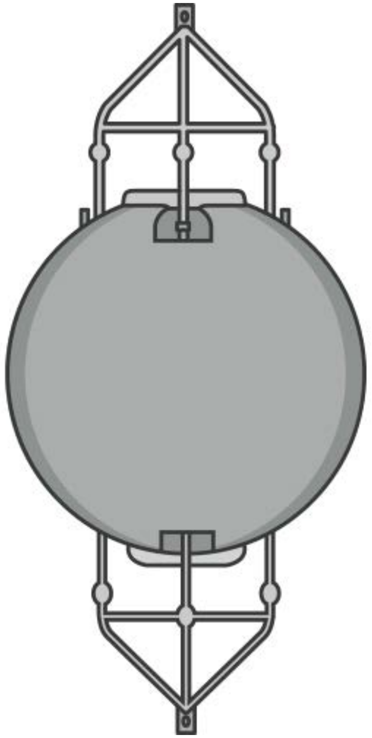
Vertical Profiling

T.ODO



Vehicles & Floats

T.ODO|slow



Moorings

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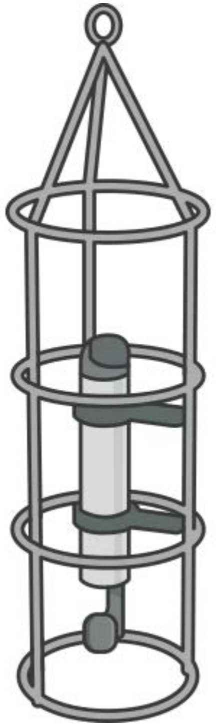
Vertical Profiling

T.ODO|fast



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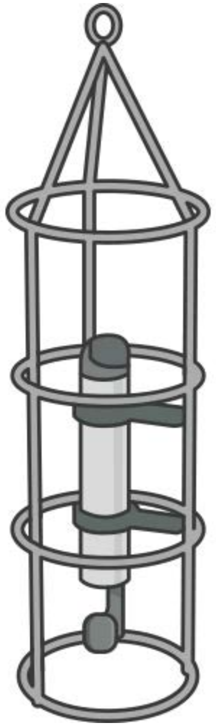
Vertical Profiling

Photo from Nature Trust of British Columbia

T.ODO|fast



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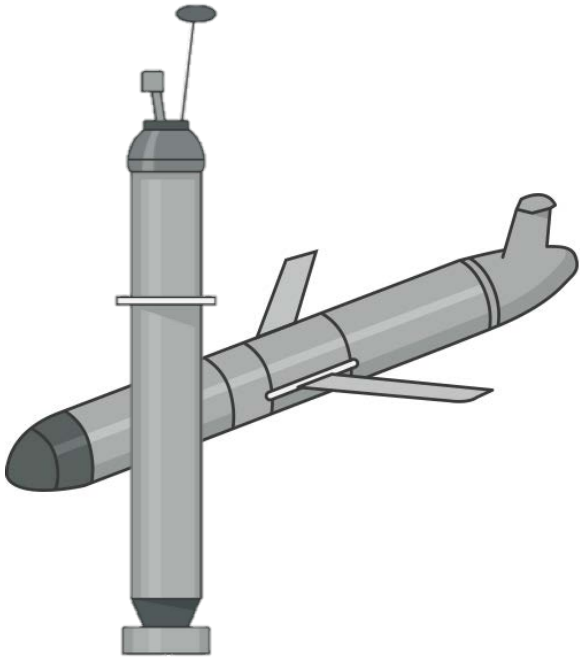
Vehicles and Floats

MRV ALTO profiling float

T.ODO



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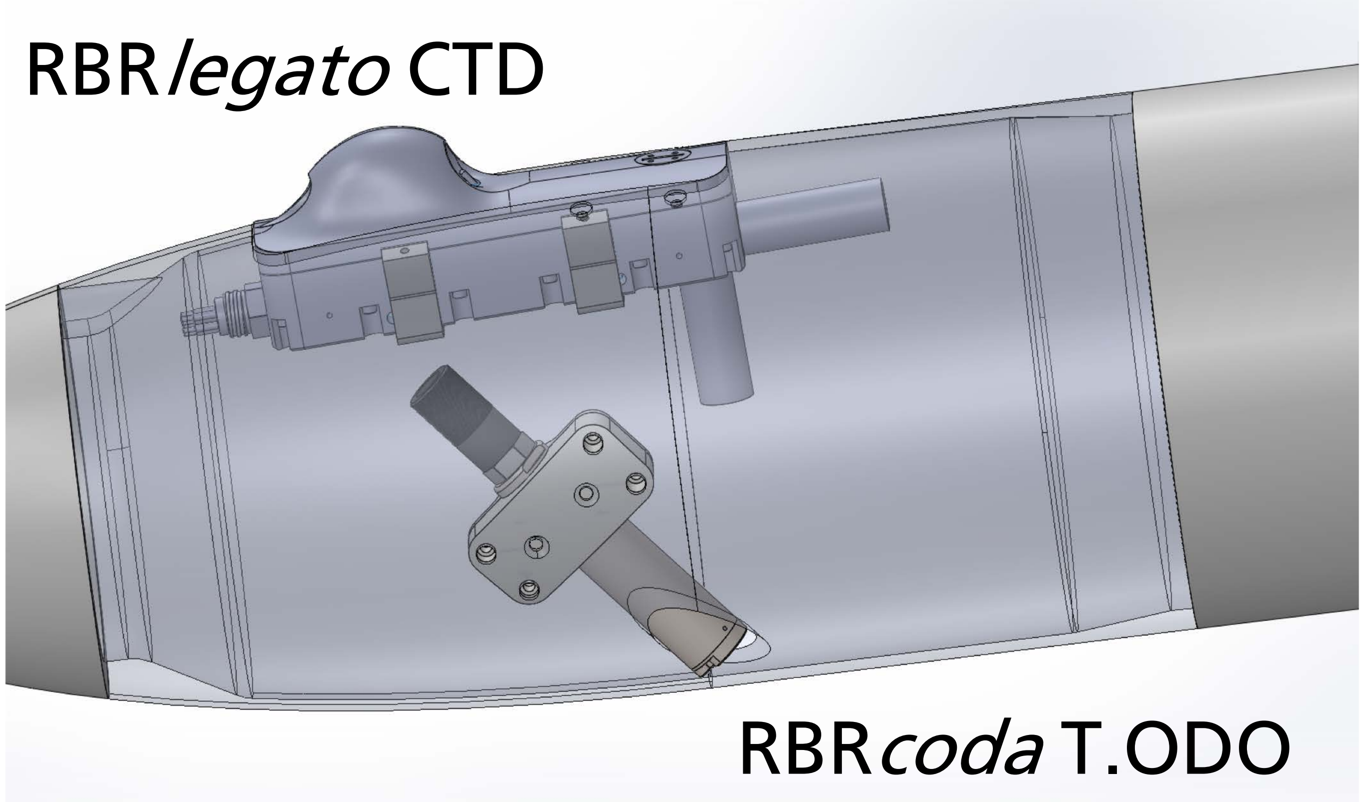
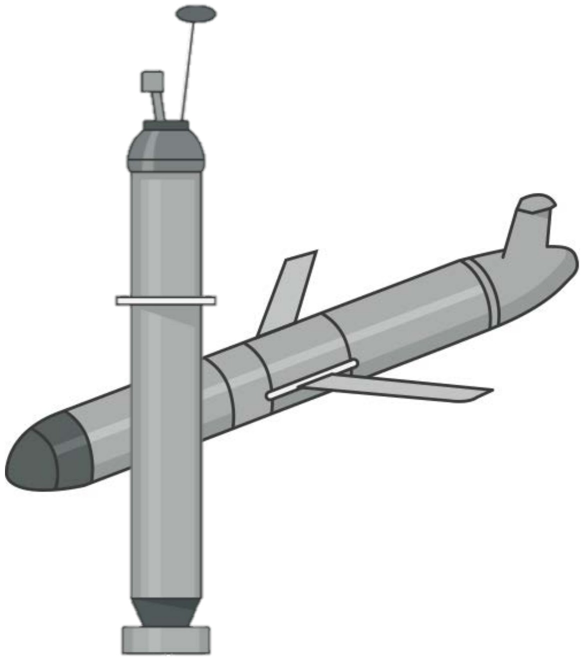
Vehicles and Floats



T.ODO



Kongsberg/Hydroid Seaglider

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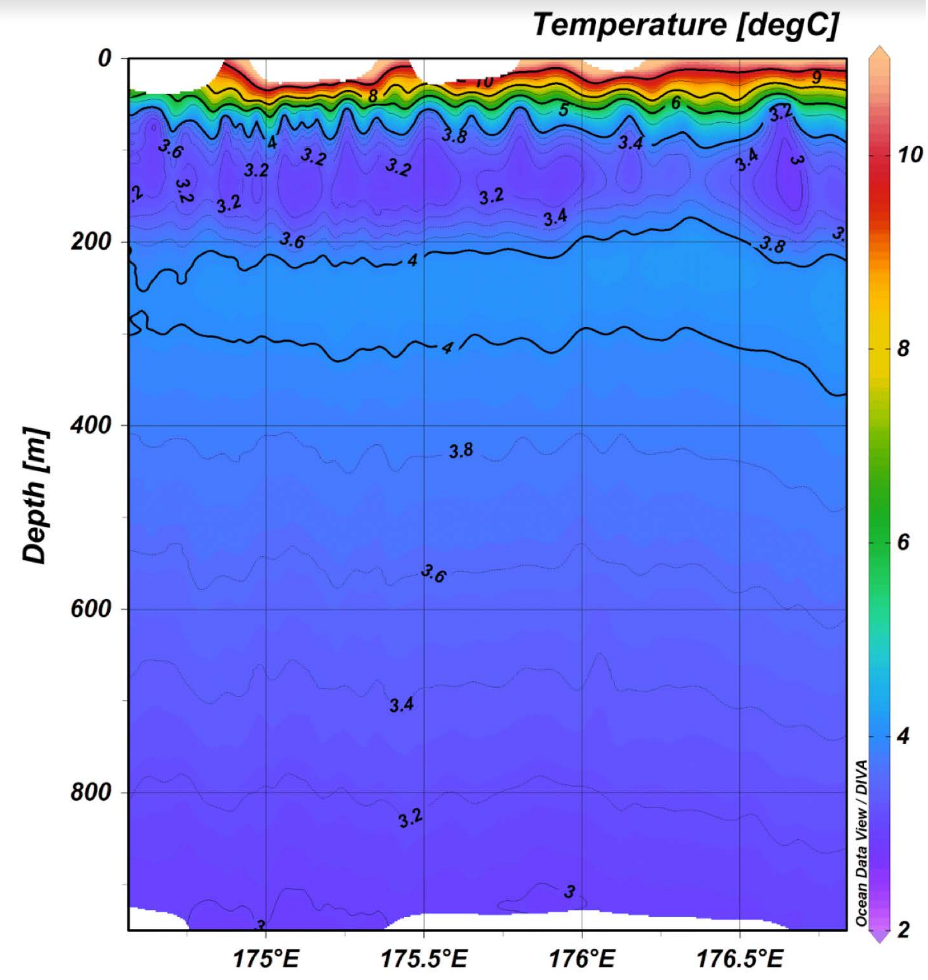
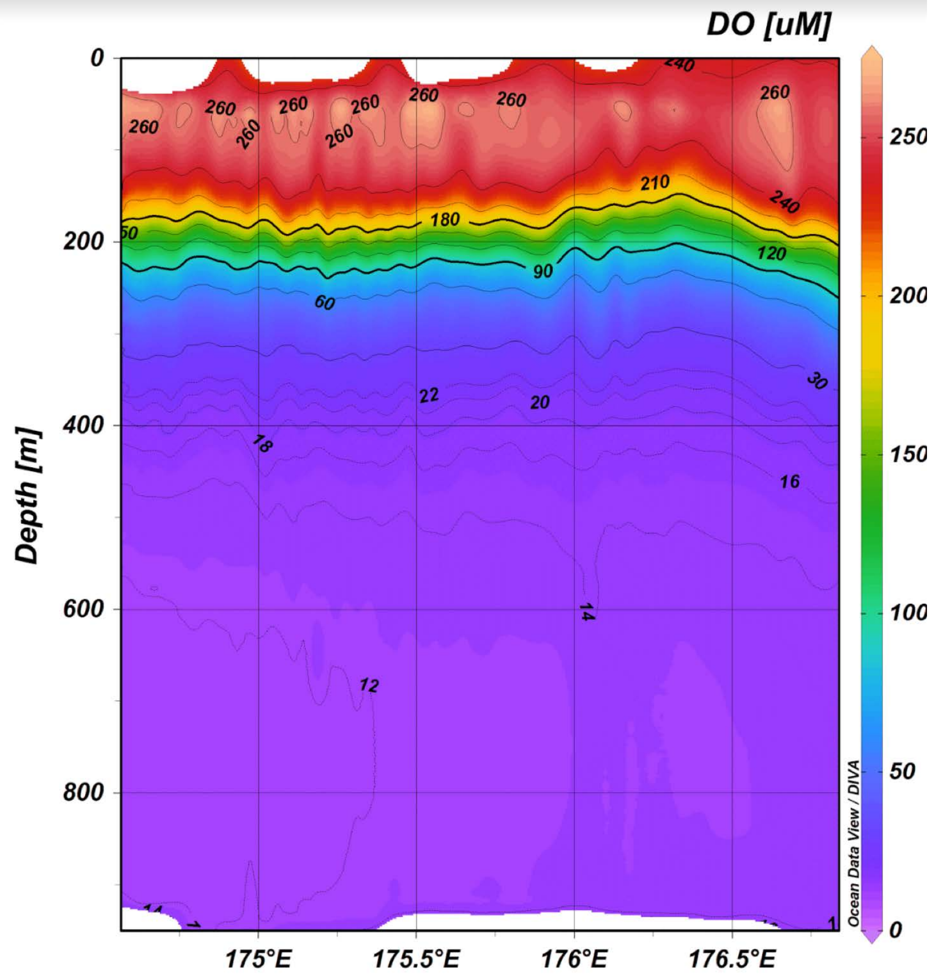
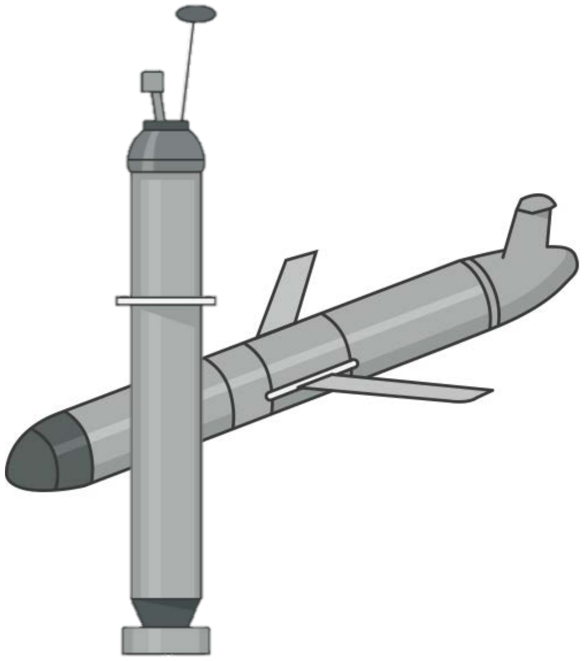
Vehicles and Floats

T.ODO







Data from AMT

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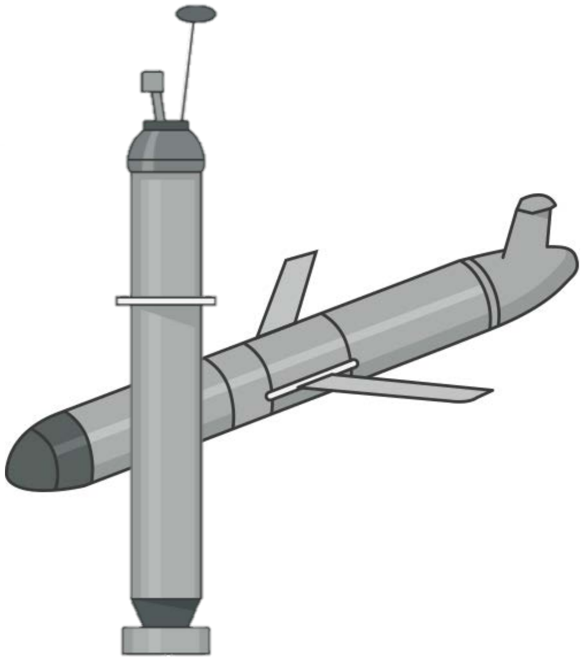
Vehicles and Floats

T.ODO



RBR*saildrone*³ CTD with RBR*coda* T.ODO

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Moorings

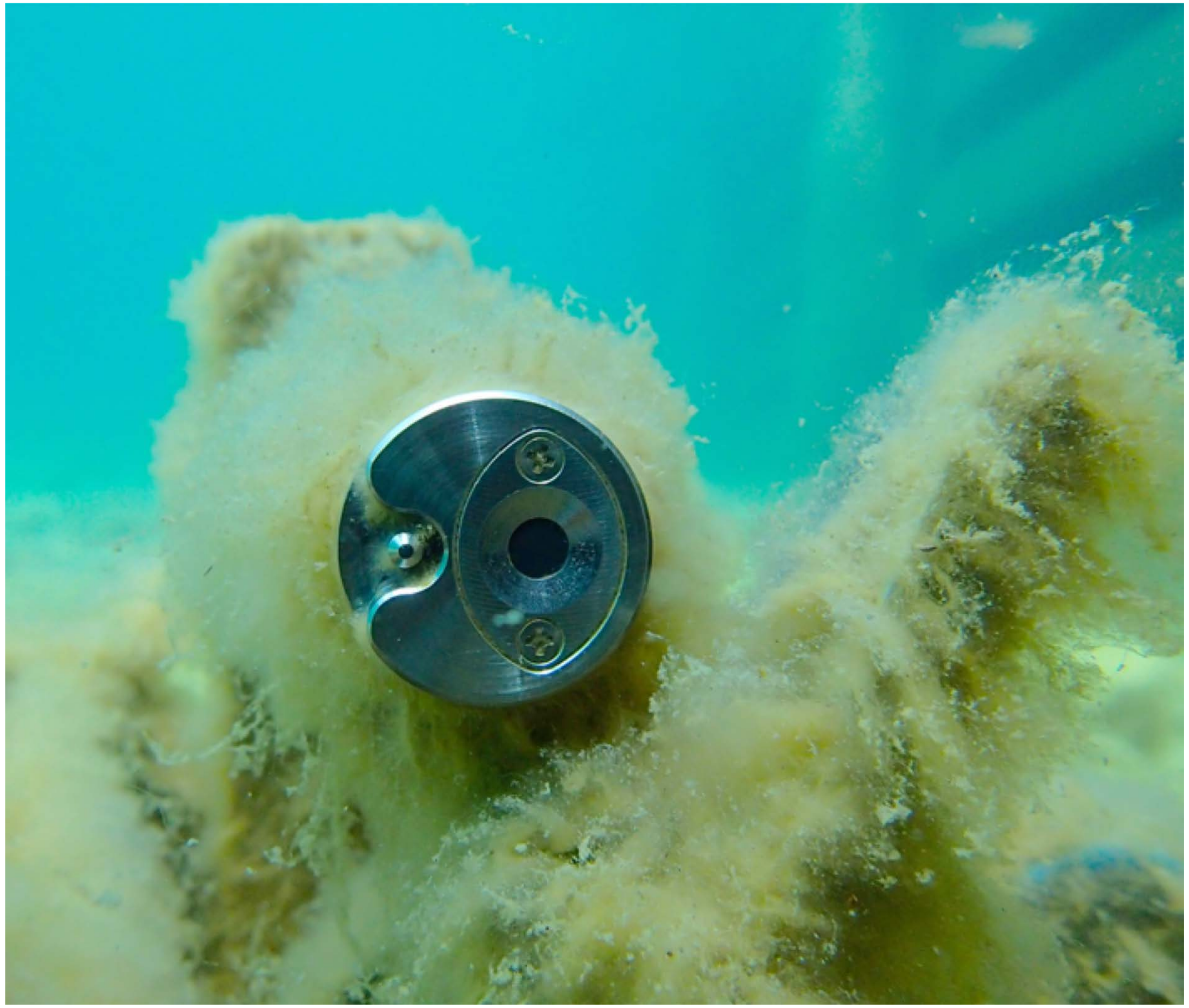
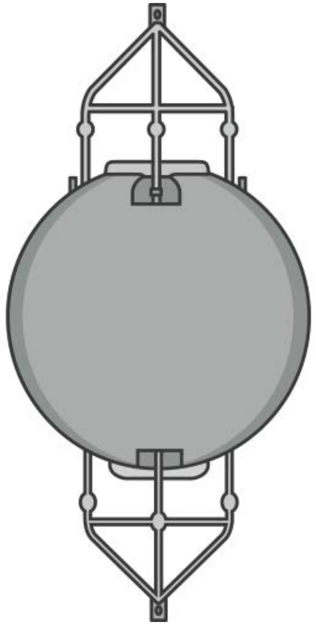


Photo from UC Davis Tahoe Environmental Research Center

Zebra-Tech Hydro-Wiper

T.ODO|slow



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Thank You

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