OCEAN OBSERVATORIES INITIATIVE

OCEANOBSERVATORIES.ORG

# Endurance Array: Operational status, improvements in marine carbonate systems, and community science

Ed Dever and OOI Endurance Array team
(slides contributed by C. Wingard, B. Cervantes, J. Fram)

2025-05-07

# Outline

- Staffing
- 2025 Turn Cruises
- Operational status
- Data Improvements in carbonate systems and friends
- Community Science examples



# The EA Team

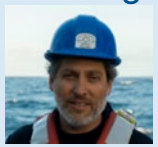
Associate project scientist on hold

13 FTE
Fully staffed

Principal Investigator/
Project Scientist

Ed Dever
0.6 FTE

Project Management



Jon Fram
0.9 FTE

Finance

Pei Kupperman
0.45 FTE

Field Ops And
Mechanical Lead

Alex Wick
1 FTE

Electronics Lead

Steve Lambert
1 FTE

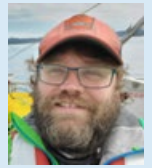
Data Lead

Chris Wingard
1 FTE

Moorings

Taylor Viti
1 FTE

Platform Leads
Gliders/CyberSec



Stuart Pearce
0.9/0.1 FTE

CSPPs

Mari Aguirre
0.7 FTE

WFP

Raelynn Heinitz
0.2 FTE

Undergraduate Student
Research Assistants
0.2 FTE

Surge
Technicians
1.65 FTE

Platform
Technicians
2 FTE

OCEANOBSERVATORIES.ORG

NSF | OCEAN OBSERVATORIES INITIATIVE

# Endurance Array Turn Cruises

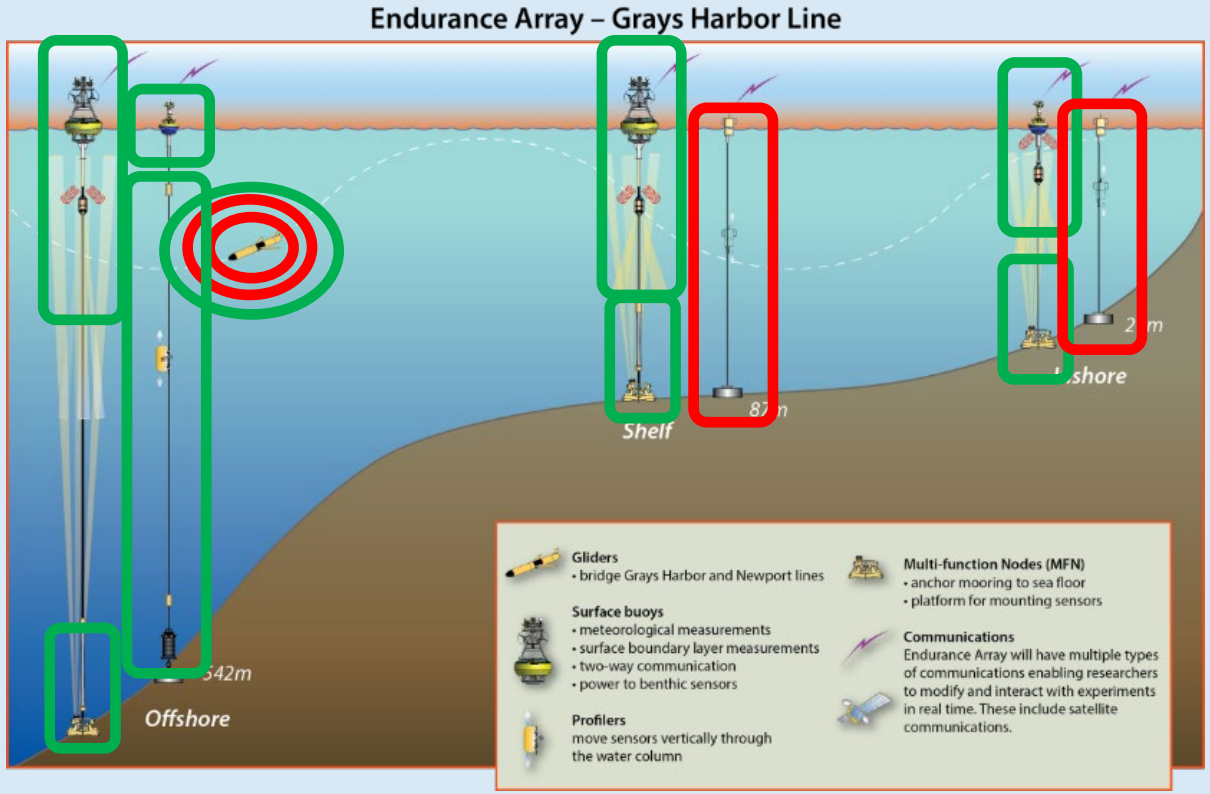
Endurance 22 Spring 2025

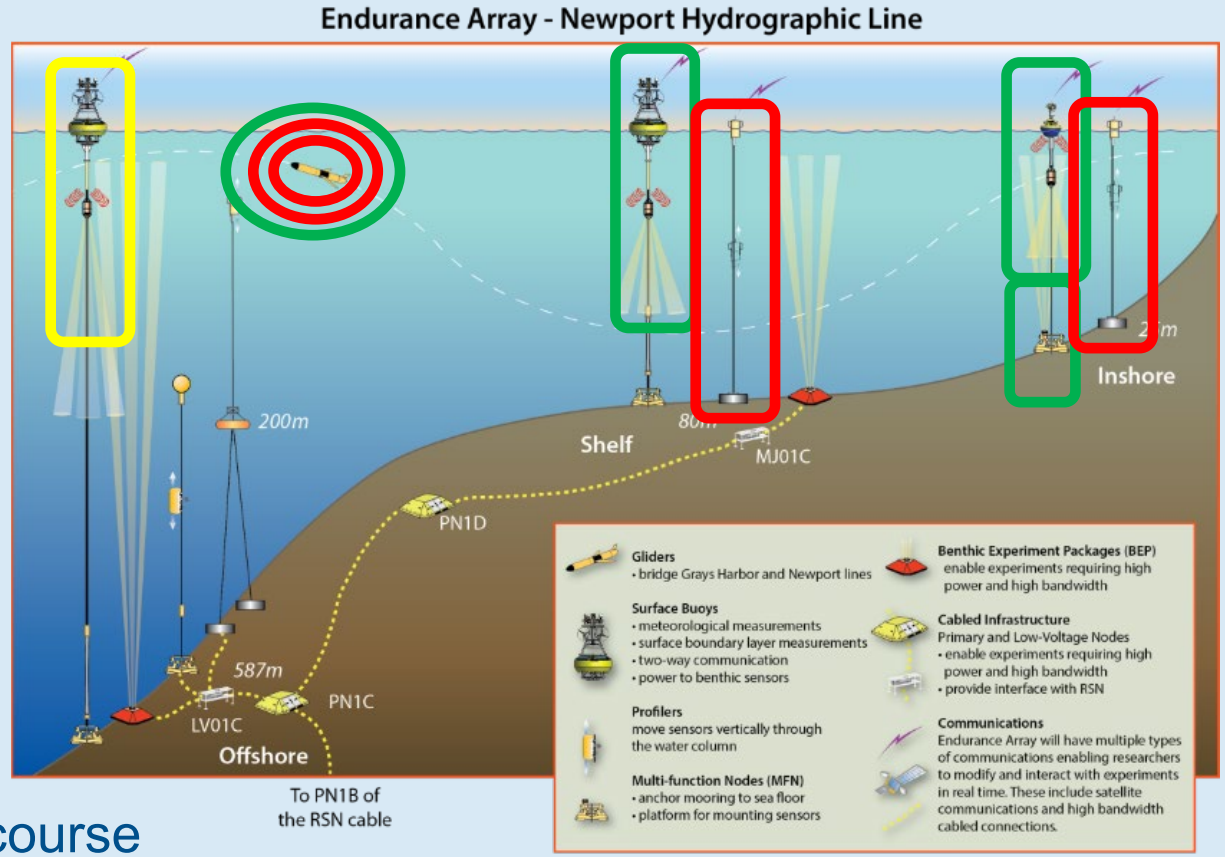
- R/V Sally Ride
- 16 May – 1 June 2025
- Newport – Newport, 3 legs
- Installation Readiness Review held 1 May 2025

Endurance 23 Fall 2025

- R/V Sally Ride
- 17 Sep – 1 Oct 2025
- Newport – Newport, 3 legs

# Endurance Array platform status




[Array status updates are posted weekly to OOI Discourse]

OCEANOBSERVATORIES.ORG

NSF | OOI OCEAN OBSERVATORIES INITIATIVE

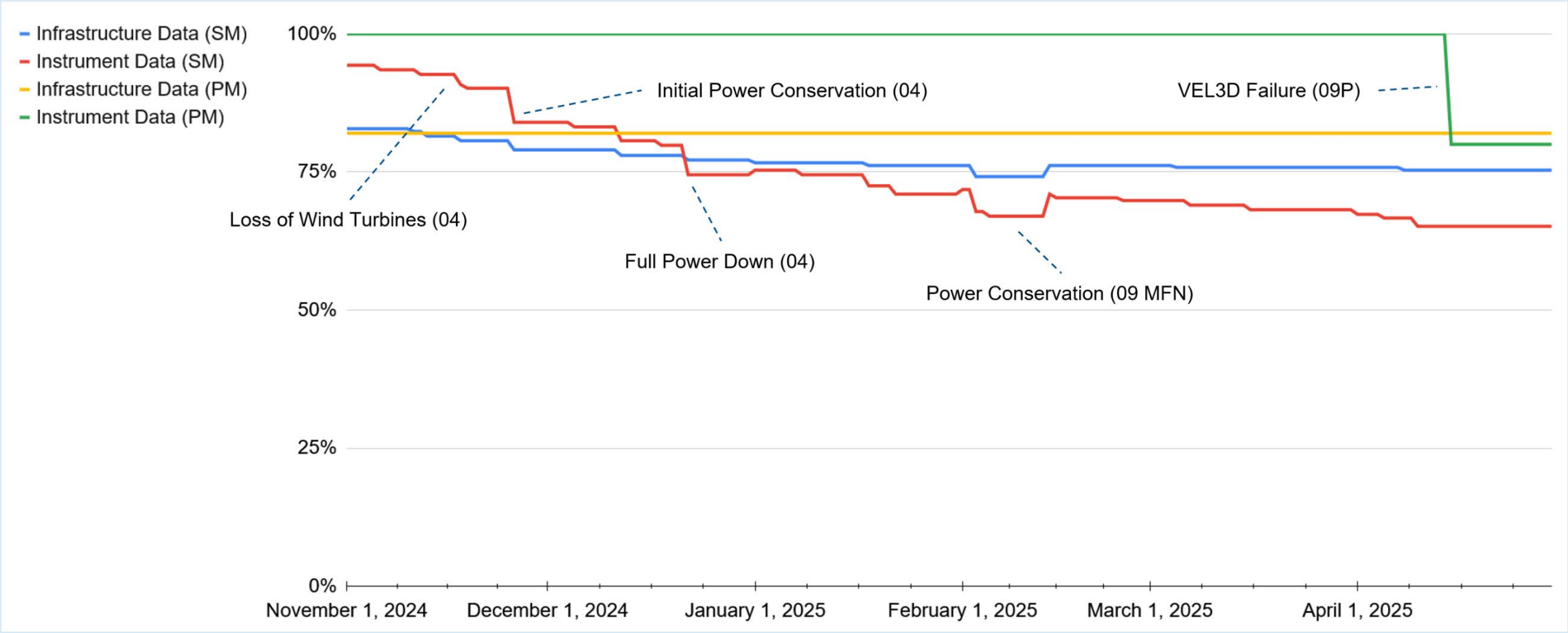
# Endurance 21 Mooring Status

| Platform | Infrastructure % | Instruments Deployed % | Near Real Time Delivered % | Data Collected % |
|---|---|---|---|---|
| Oregon inshore | 88% | 100% | 78% | 90% |
| Oregon shelf | 80% | 100% | 100% | 100% |
| Oregon offshore | 44% | 100% | 19% | 46% |
| Washington inshore | 88% | 91% | 82% | 91% |
| Washington shelf | 82% | 100% | 81% | 88% |
| Washington offshore | 80% | 100% | 88% | 100% |
| Washington offshore profiler | 82% | 100% | 98% | 98% |

% takes into account electronics intentionally turned off (e.g., acoustic modems, FreeWave etc.)


OCEANOBSERVATORIES.ORG

# Operational Statistics: Last 6 Months

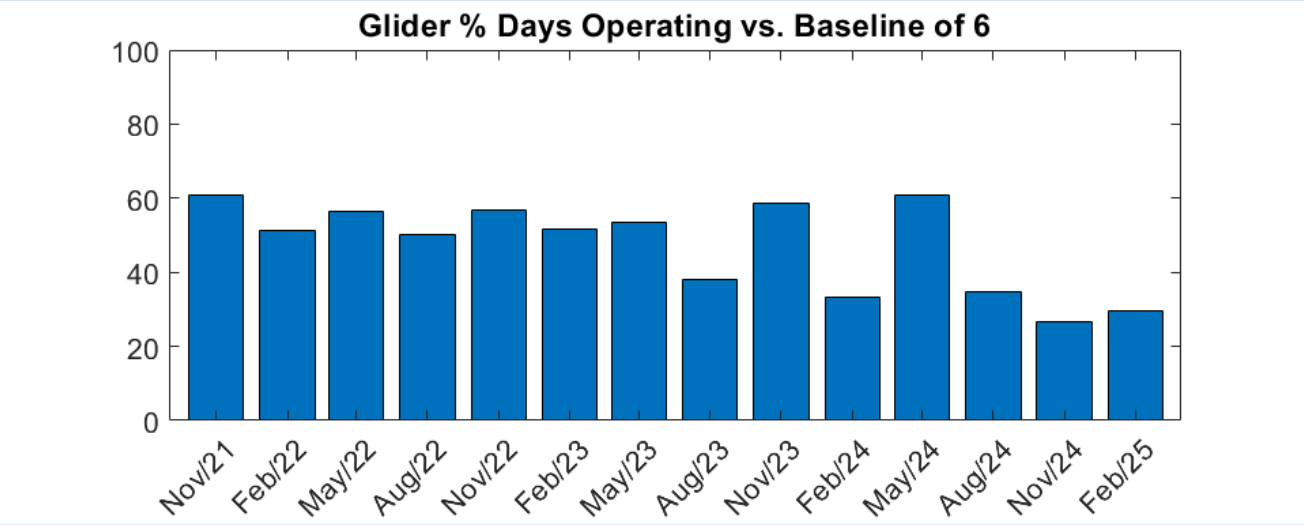


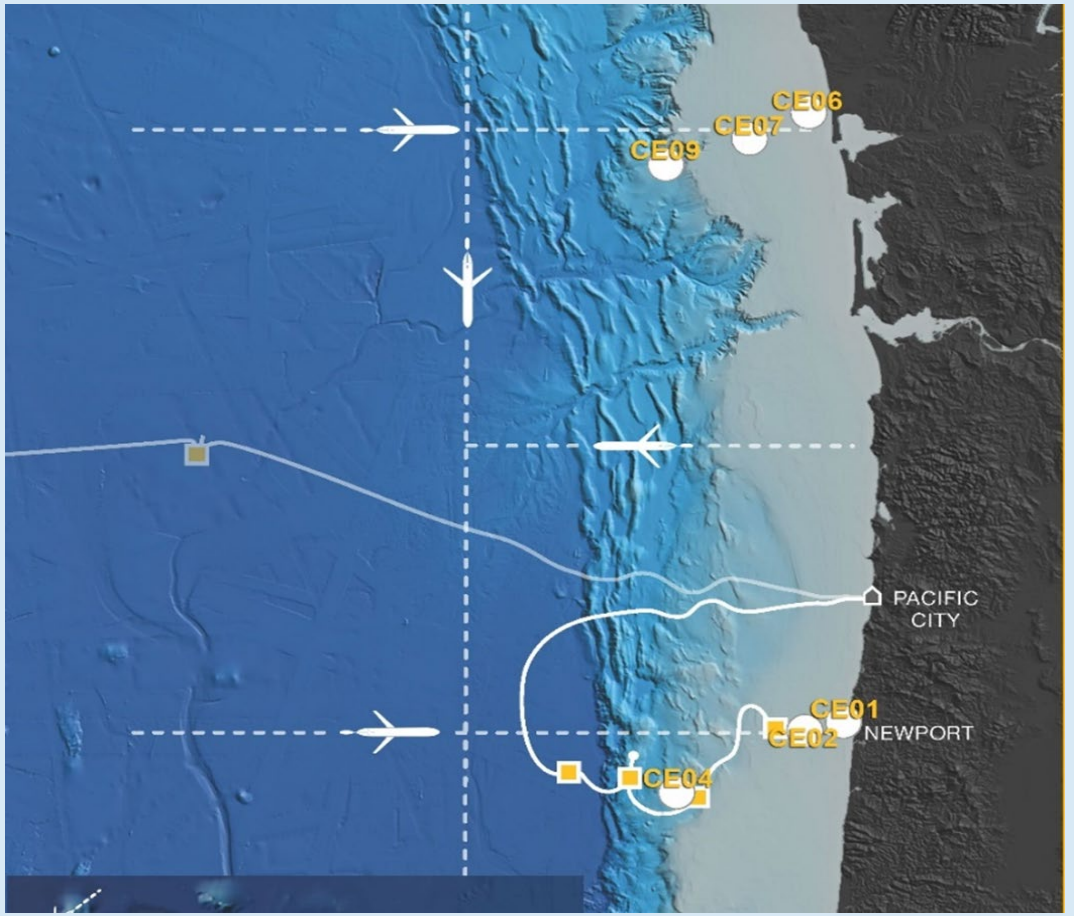

SM – surface mooring (coastal surface mooring and inshore surface mooring)

PM – McLane Profiler mooring

# Endurance Array Glider Coverage

- Several G3 glider issues continue to be worked and solved (*e.g.*, Iridium crosstalk and altimeter)
- G3 glider build quality issues have been addressed under warranty
- Have stopped cycling G2 gliders through trade-in to G3 gliders
- Recent glider losses have reduced glider days operating relative to baseline.



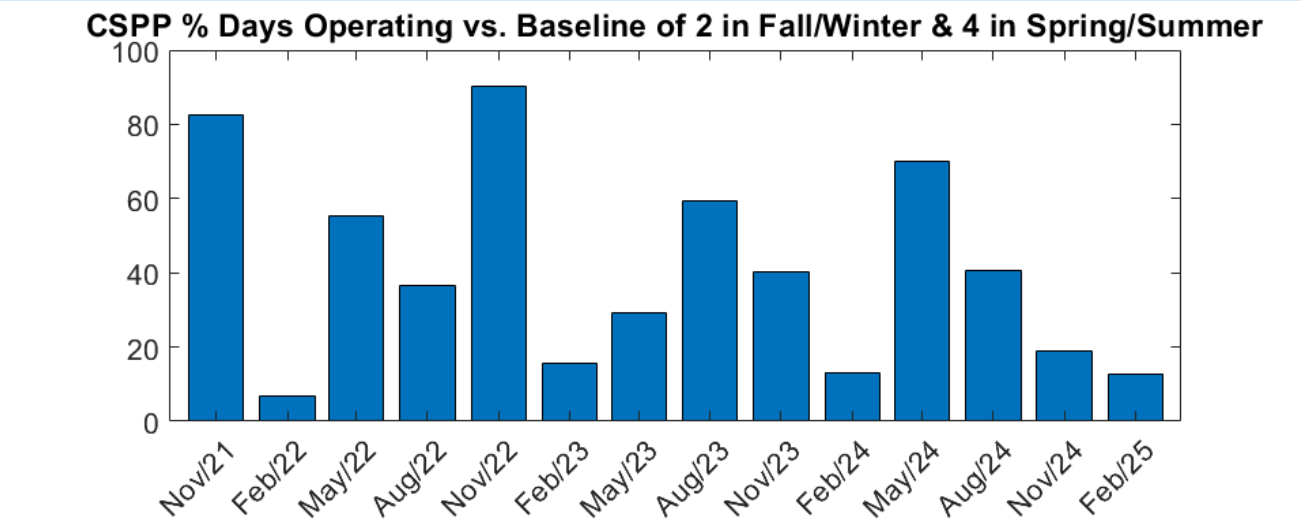




OCEANOBSERVATORIES.ORG

NSF | OCEAN OBSERVATORIES INITIATIVE

# Endurance Array CSPP Deployment Summary

- Deployed Oregon Shelf CSPP on the fall 2024 cruise, recovered in December. This winter we lost contact with the mooring acoustic modem, so did not redeploy.
- No CSPP at Washington Shelf because we haven't been able to get a vessel there over winter. Will deploy on the spring cruise.
- No inshore CSPPs in fall/winter
- Planning to deploy four CSPP's on upcoming spring cruise.

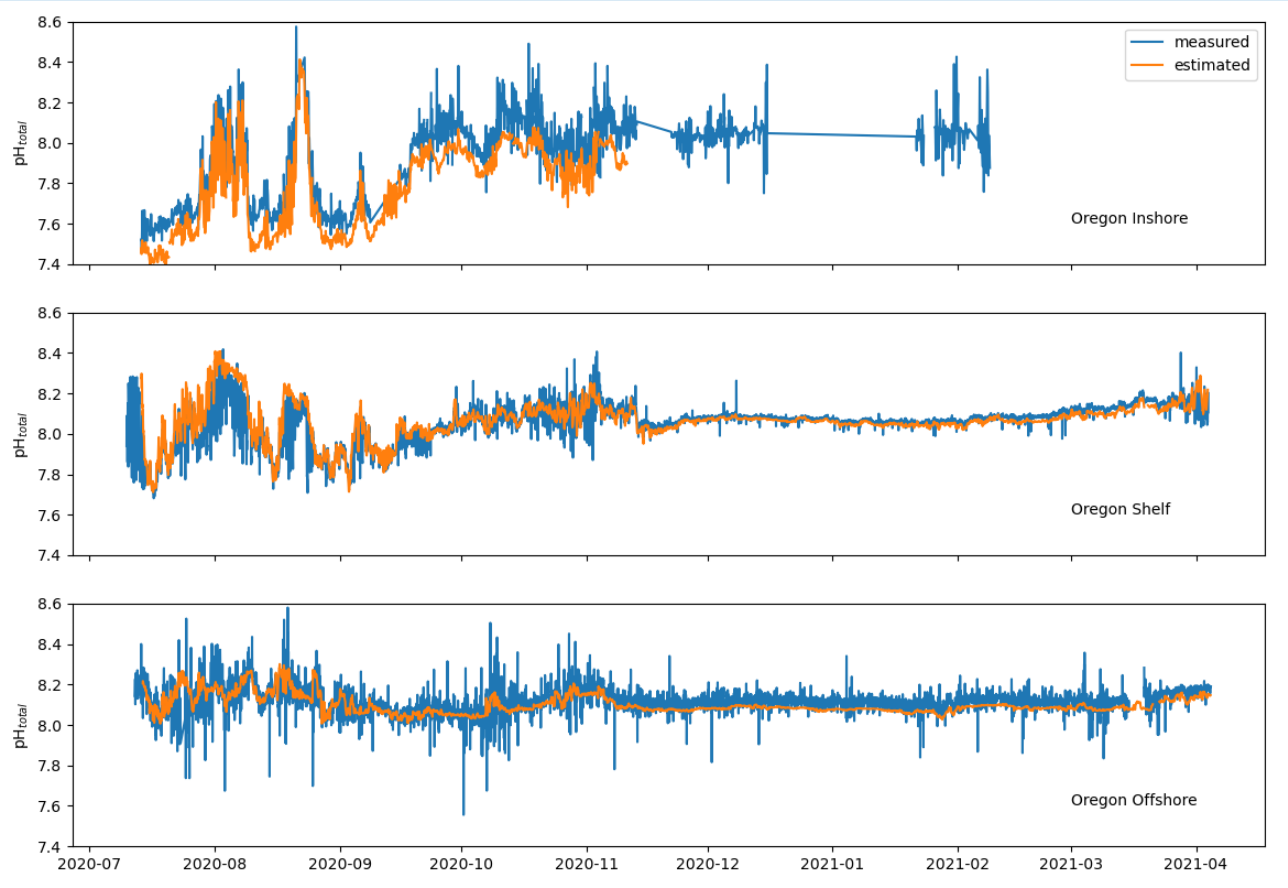



OCEANOBSERVATORIES.ORG

NSF | OCEAN OBSERVATORIES INITIATIVE

# PyCO2SYS for QC Assessments

- PyCO2SYS is a Python toolbox for solving marine carbonate system seawater properties. (Humphrey *et al.*, 2022).
- Provide a cross-check pH and $pCO_2$ sensors with estimated alkalinity (Lee *et al.*, 2006) for data QC with an eye towards developing merged datasets for use in the creation of refined/updated QARTOD test values.
- Data at right shows measured pH (SAMI-pH, 7 m) compared to estimated pH (SAMI-$pCO_2$, 7 m Inshore, or Pro-Oceanus Pro-$CO_2$, 1 m Shelf and Offshore) across the Oregon line of the Endurance Array.

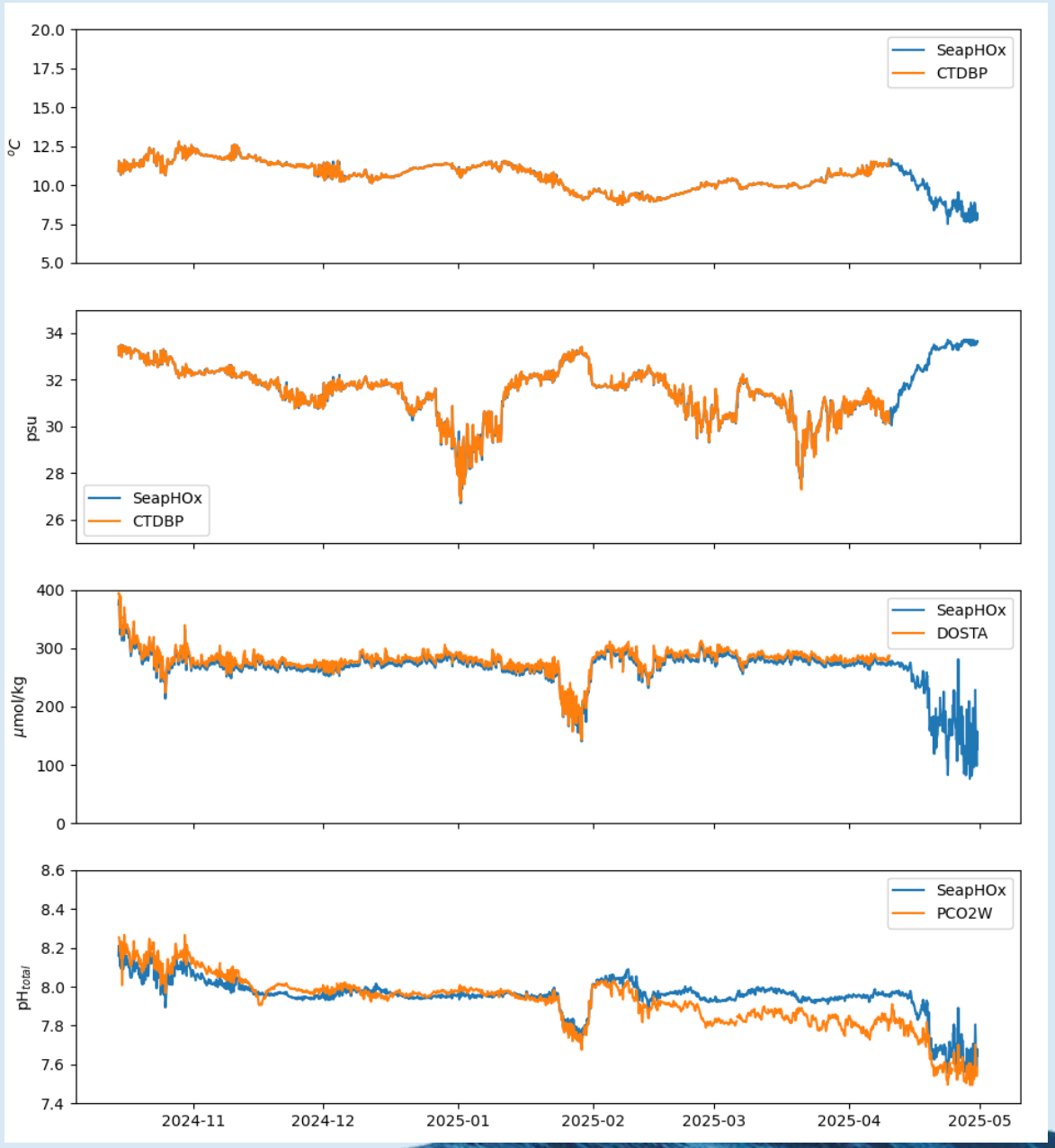



OCEANOBSERVATORIES.ORG

NSF OCEAN OBSERVATORIES INITIATIVE

# Deep SeapHOx V2

- The Deep SeapHOx™ V2 combines the SeaFET™ V2 pH sensor with the SBE 37-SMP-ODO MicroCAT CTD+DO sensor. See Sea-Bird Scientific for more information.
- OOI is phasing in these sensors to replace the Sunburst Sensors SAMI-pH
- Four SeapHOx are being deployed each turn on Endurance Array (1 spare). Deployed on the inshore and shelf 7 m platforms. (sites with the highest particulate loads and biofouling)
- Larger flow path and integrated biofouling control help improve pH measurements success rate (SAMI-pH success rate ~44%, with clogging as the primary failure mode).
- Working with Sea-Bird to address documentation, configuration and care and handling (*e.g.*, seawater during bench testing and to pre-condition the FET prior to deployment).

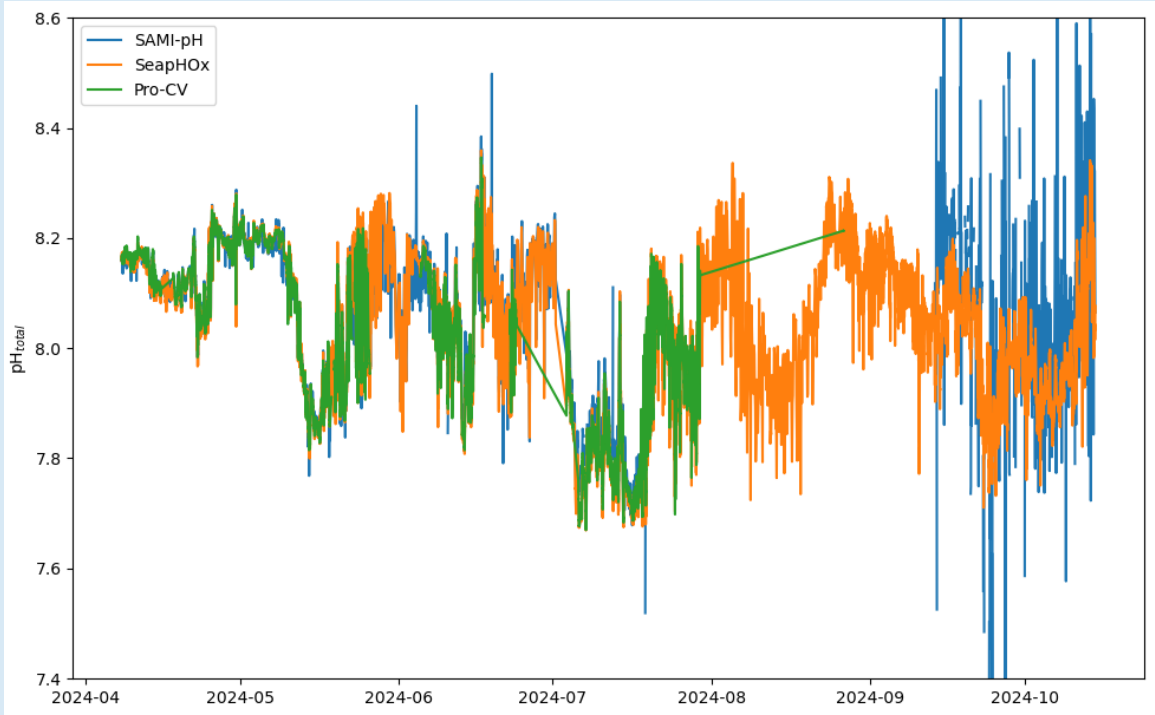


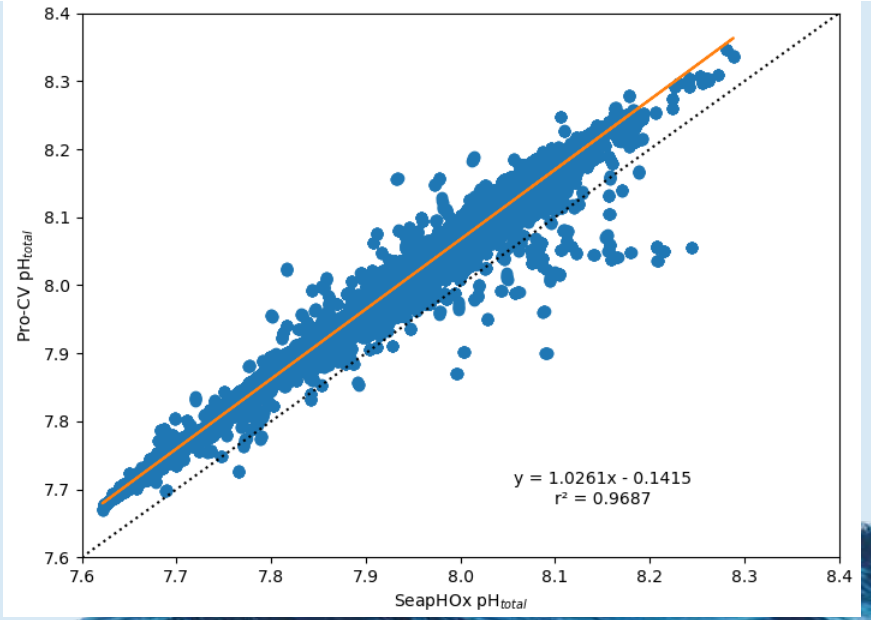

OCEANOBSERVATORIES.ORG

OCEAN OBSERVATORIES INITIATIVE

# Pro-Oceanus $CO_2$-Pro CV Testing

- Pro-Oceanus $CO_2$-Pro CV (measures the partial pressure of $CO_2$ gas dissolved in water using infrared detection (PCO2W))
  - Second test of the sensor on the Oregon Shelf Surface Mooring 7 m platform.
  - First test, while providing good accuracy, started to fail ~2 months into the deployment, with complete failure at ~4 months.
  - Can be used as a duplicate/alternate PCO2W. Reagent-free, more compact, and no requirement for pumping, minimizing possible clogging issues.
  - Data will be made available in real-time.



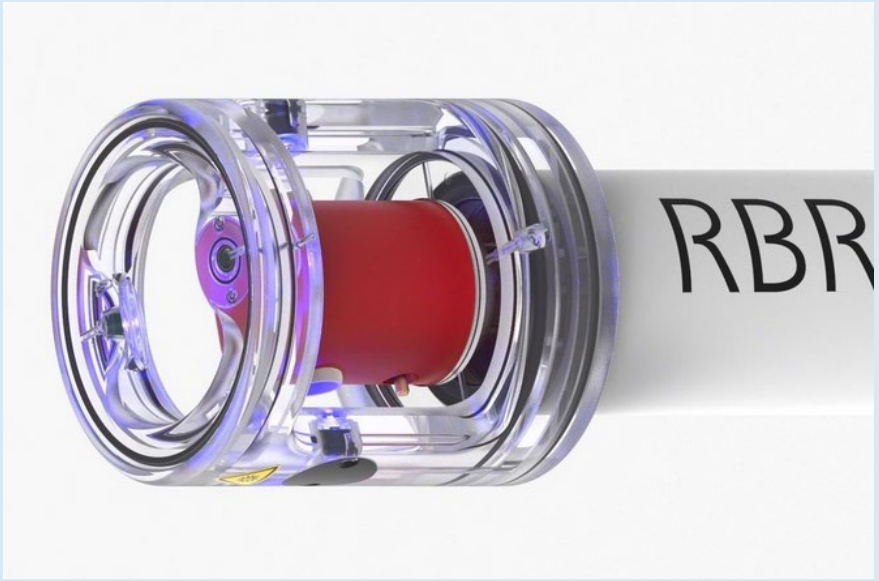




OCEANOBSERVATORIES.ORG

NSF OCEAN OBSERVATORIES INITIATIVE

# Instrument Testing

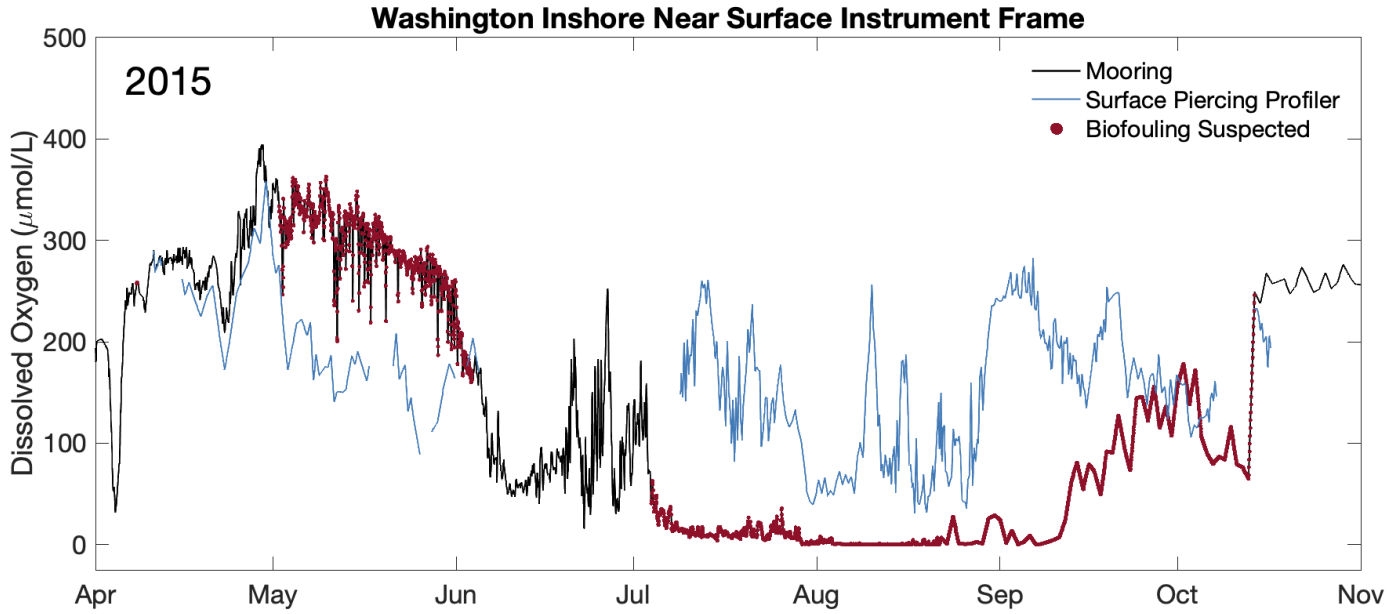
- ANB Sensors OC300 (calibration-free pH sensor for ocean and coastal monitoring)
  - Unpumped sensor should be less affected by sediment clogging that affects the SAMI-pH.
  - Encountered multiple issues in past tests. Vendor has been very responsive and has focused on improving sensor performance.
  - Data will be made available in real-time.
- RBR*concerto* CTD|UV (loggers with active antifouling)
  - Will assess use of UV lamps to control biofouling (addressing issue with TBT capsule cost and availability).
  - Open flow cell will reduce sediment clogging.
  - Data will be internally recorded and made available after mooring is recovered in Fall 2025.

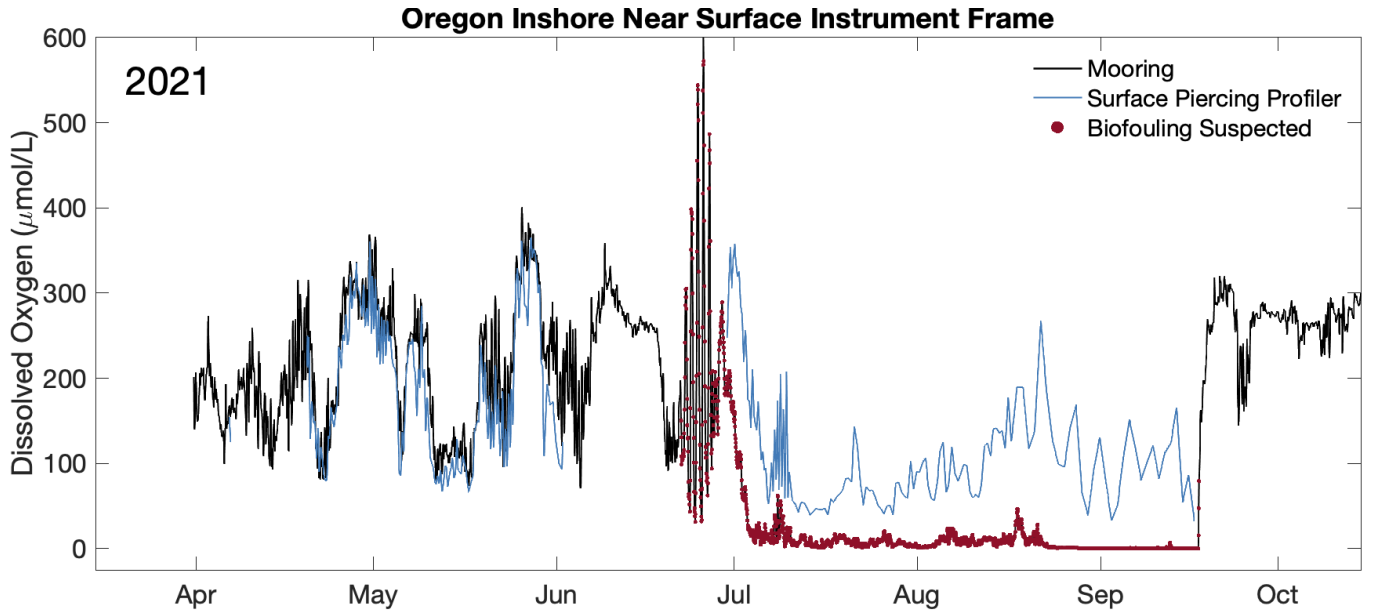


# Gap-Filled Dissolved Oxygen at the Endurance Array Inshore Moorings

Quality-control includes flags during biofouling periods generated from human-in-the-loop analyses.

Gaps in the near surface time series are filled with profiler data during periods of biofouling or other instrument failure.



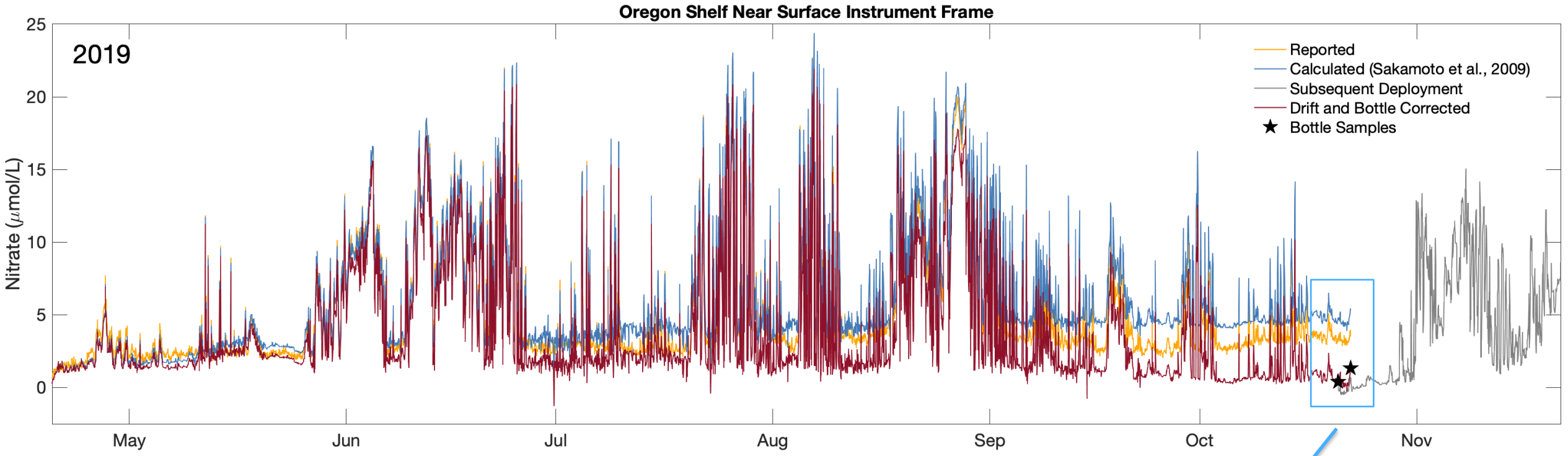




OCEANOBSERVATORIES.ORG

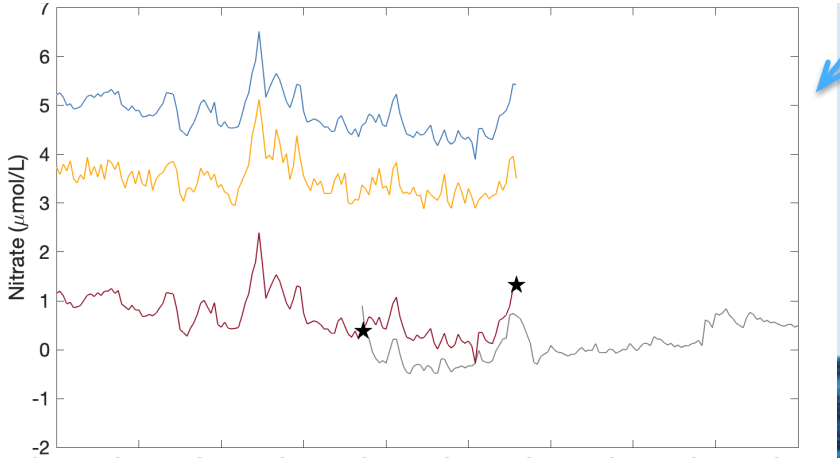
NSF | OCEAN OBSERVATORIES INITIATIVE

# Nitrate Correction at the Endurance Array Moorings






Drift between instrument-reported nitrate (yellow) and TS-calculated nitrate (blue) is corrected using overlapping deployments, recovery calibrations, and bottle samples



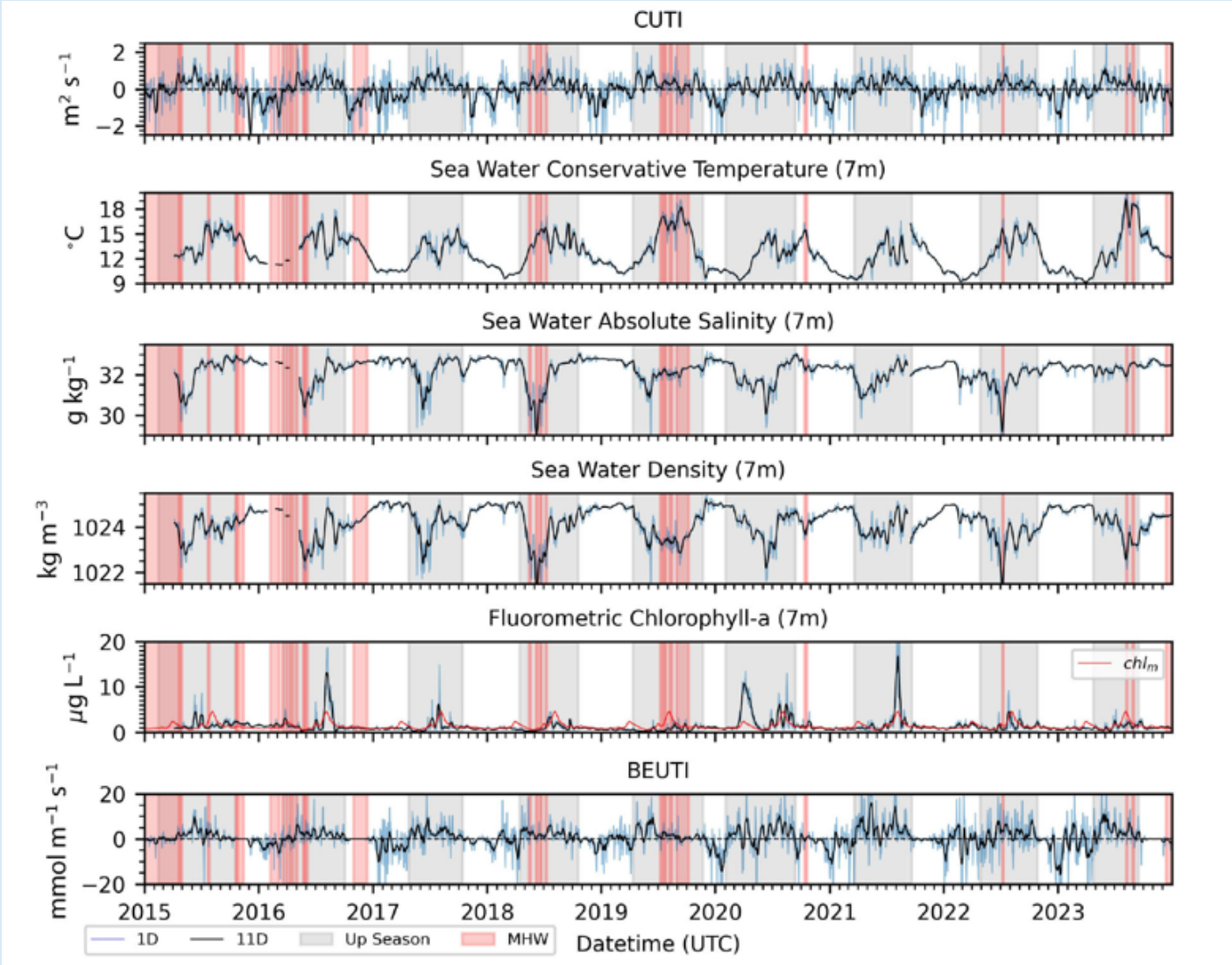

NSF | OCEAN OBSERVATORIES INITIATIVE

# Community Science (OOI connected)

- Example Black *et al.* (2024)

Bloom compression alongside marine heatwaves contemporary with the Oregon upwelling season

- More use of biogeochemical data
- More use of subsurface, profiler data
- Ongoing work includes Andrew Scherer (yesterday's presentation)

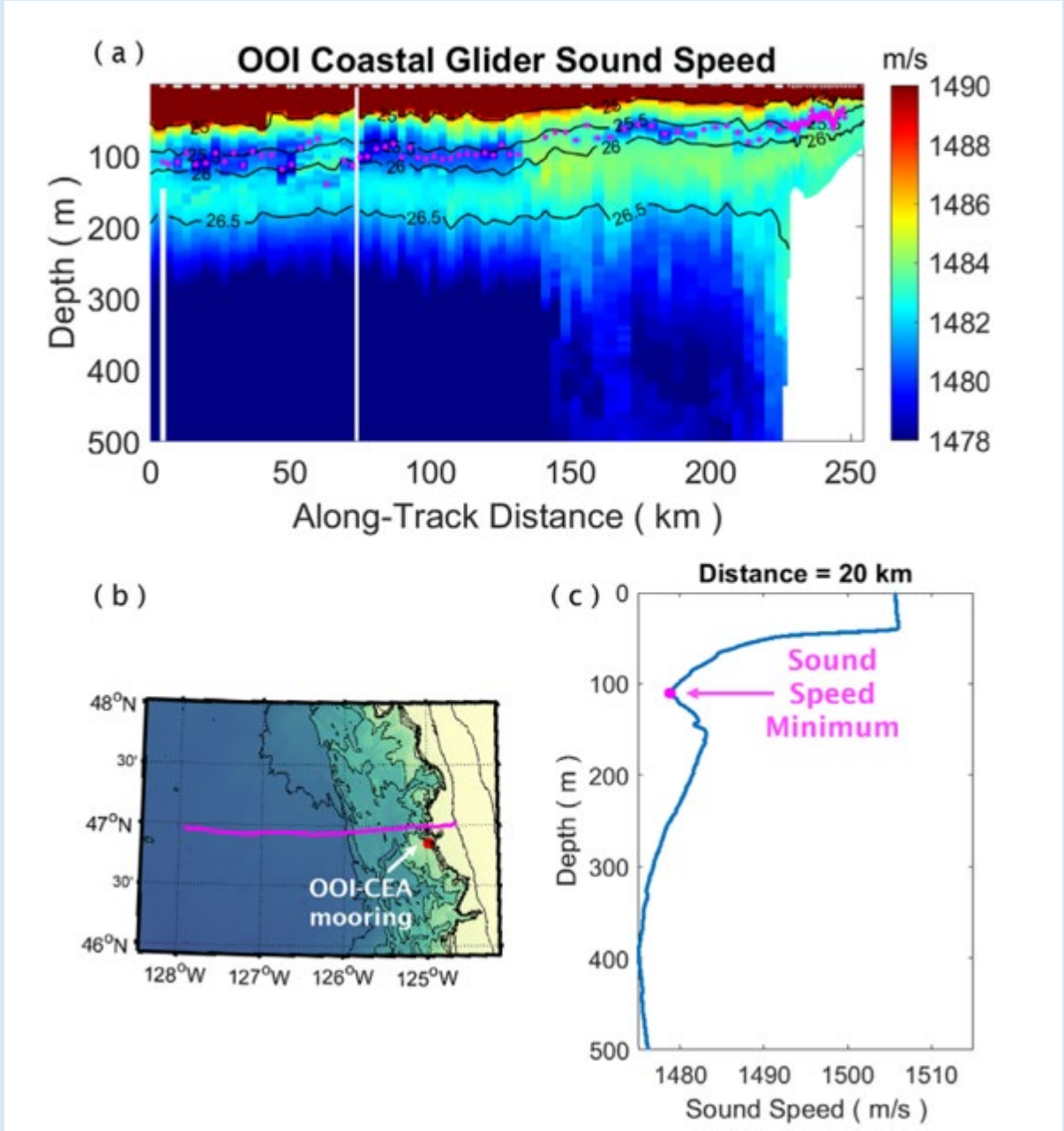


# Community Science (external)

- Example Xu *et al.* (2024)

Subsurface acoustic ducts in the Northern California current system

- Often glider, physical oceanographic buoy data sometimes through GTS or NDBC without acknowledgement
- Include model/data comparisons
- Some external users of biogeochemical data (*e.g.*, Zhu 2024)



OCEAN OBSERVATORIES INITIATIVE

# Questions?