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INITIATIVE

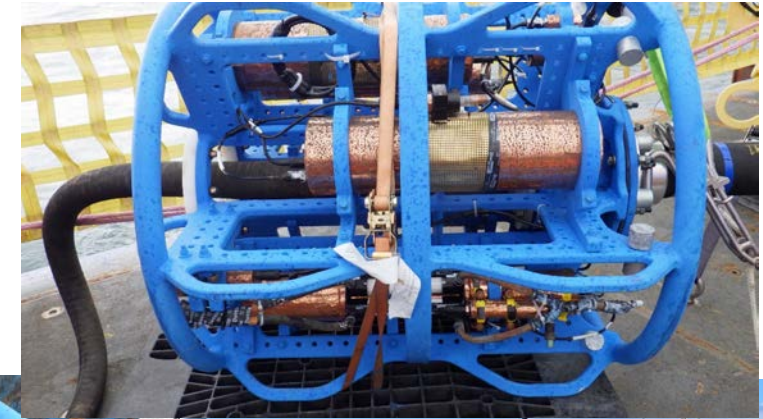
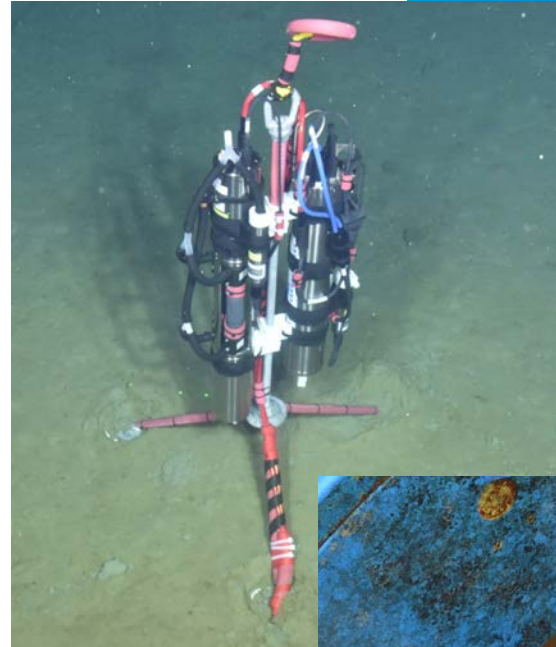
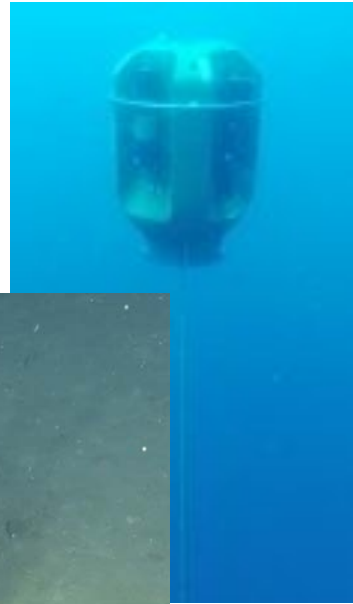
# OOI Observatory Overview

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With contributions from many others across OOI  
July 18, 2023



# Outline

- Introduction to OOI Science Goals and Arrays
- Types of Measurements
- Data Access
- Data Quality Assurance
- AC-S (aka OPTAA aka spectrophotometer)
- Locations/platforms
- Related measurements
- Quality Assurance
- Data Explorer Views
- Help and Connections to External User Groups



# OOI Vision

- Real-time data from more than 800 instruments to enable research & education in Earth & Ocean sciences
- Six interdisciplinary science themes articulated in updated Science Plan
- Marine arrays at global, regional, and coastal scales
- Served by a united Cyberinfrastructure
- Data freely available online
- 25-year lifetime



Sponsored by National Science Foundation

Operated & managed by WHOI, UW, and OSU



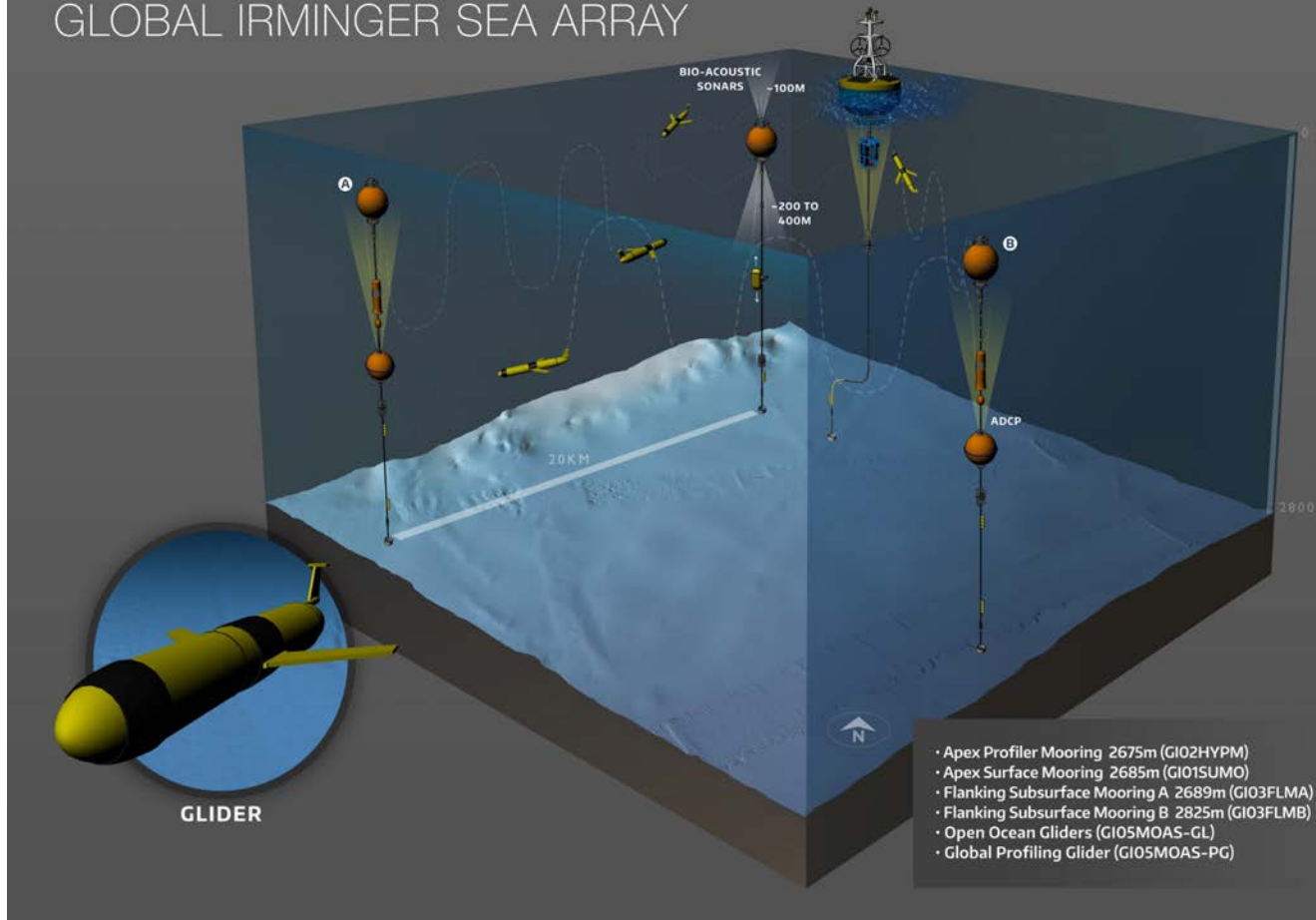
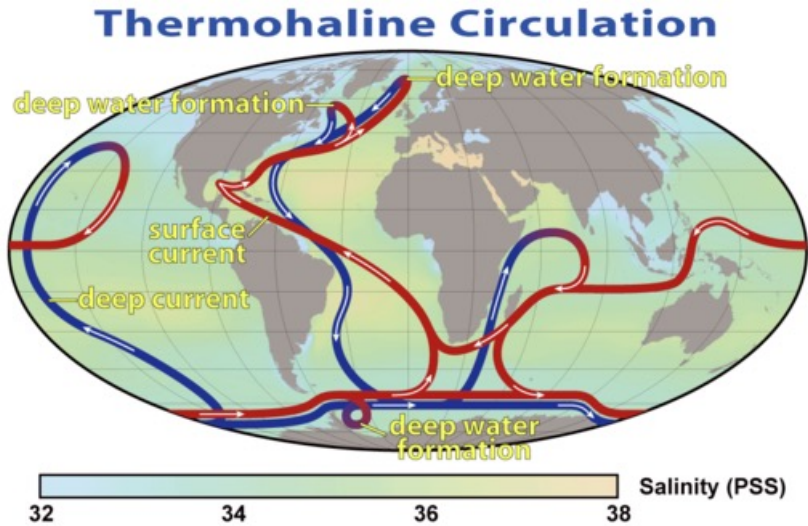
# OOI measurements

- Over 800 instruments
- >30 distinct instrument types
- Instrument procurements made 2011-2012
- Updates to processing algorithms
- Technology refresh is occurring, *e.g.*,
  - UV nitrate measurement with Satlantic ISUS replaced with Satlantic (Sea-Bird) SUNA
  - digital still cameras updated
  - Cabled Array PAR sensor updated
  - UV biofouling mitigation added to several types of bio-optical instruments
  - pH sensor refresh being considered
  - **Replacement of AC-S lamps with LED lamps (longer life) by Sea-Bird starting this summer/fall**

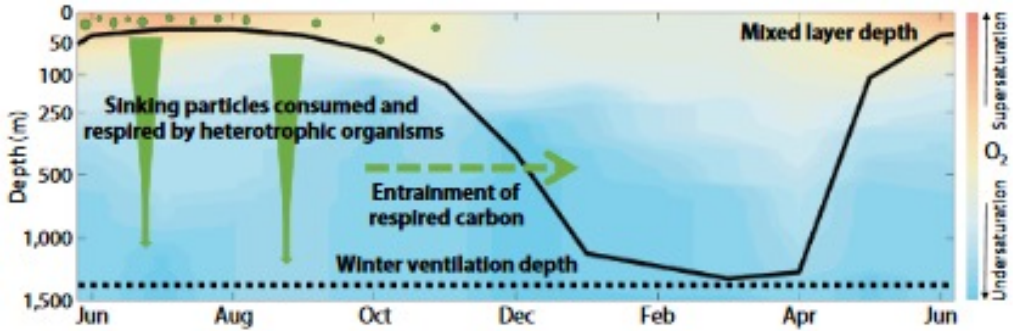


# Global Irminger Sea Array

## GLOBAL IRMINGER SEA ARRAY



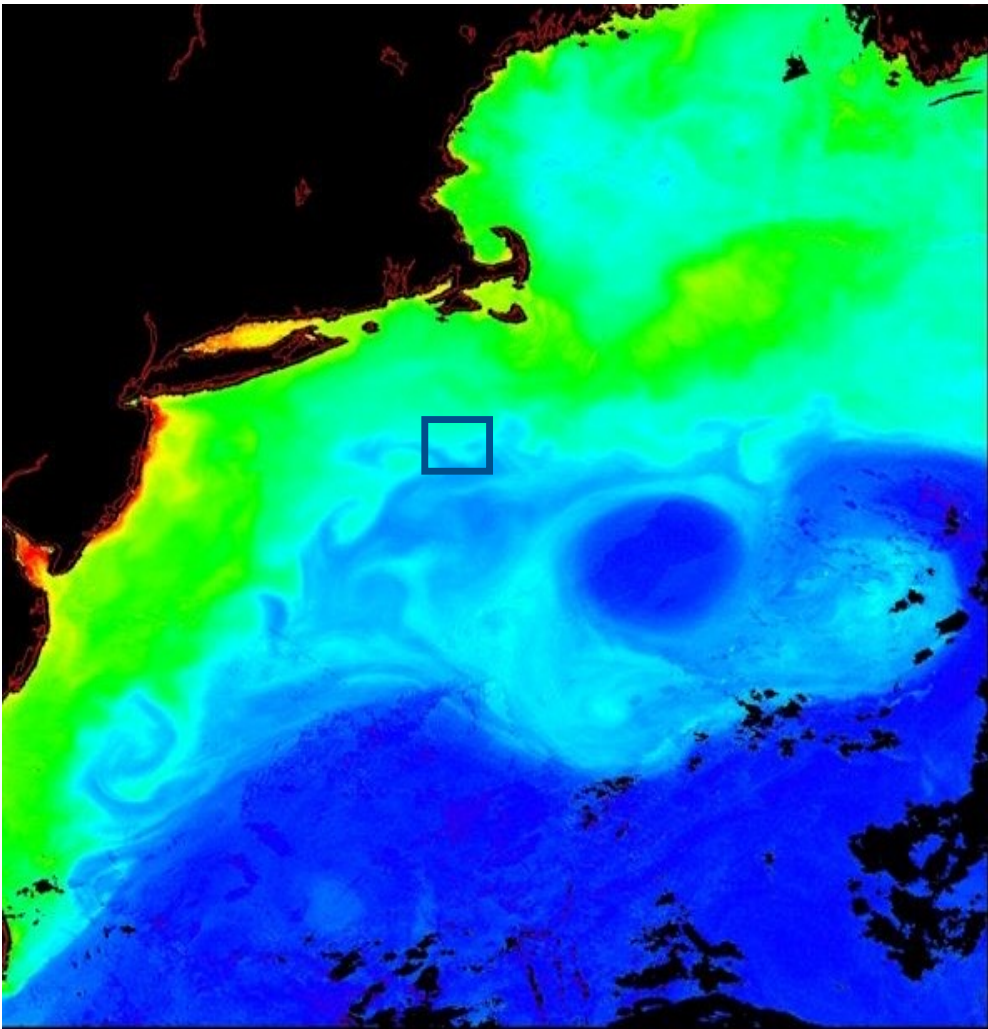
## CO<sub>2</sub> sequestration



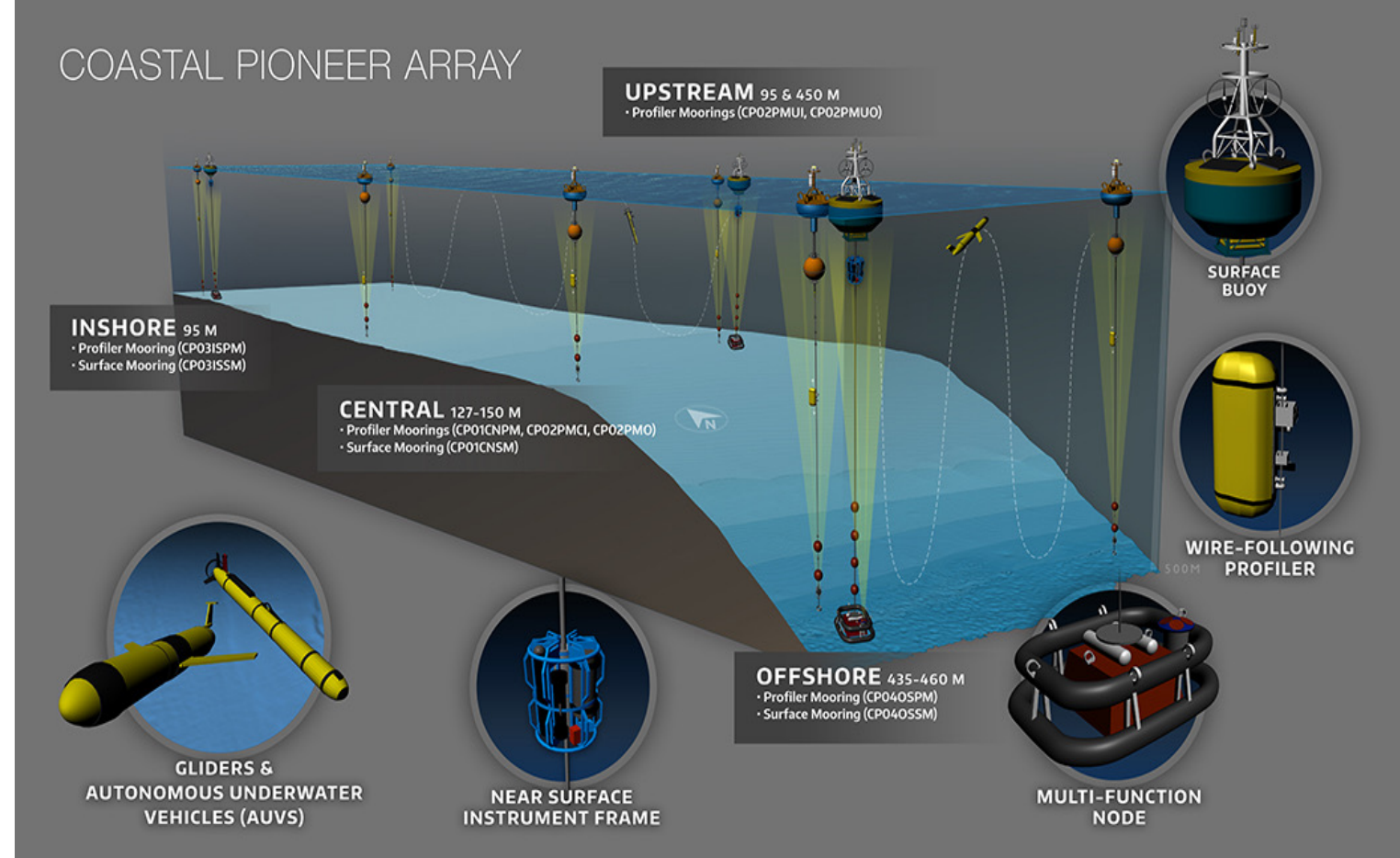
Operated by WHOI (Co-PI Al Plueddemann)

- First year-long measurements of deep-water formation, air-sea heat exchange, and biological carbon pump
- Fundamental climate science & societal impacts

# Coastal Pioneer Array



Satellite Chlorophyll Image



Operated by WHOI (Co-PI Al Plueddemann)

- Two newly discovered mechanisms for shelf-ocean exchange
- Dominant & rapidly evolving Gulf Stream influence
- Impacts on ecosystems, fisheries, hurricane & storm intensities
- New site just north of Cape Hatteras in 2024



# Proposed Pioneer Array Relocation to Mid-Atlantic Bight south of Cape Hatteras

The surface (green circles) and profiler moorings (blue triangles) have bio-optics familiar to Pioneer and Endurance. The shallow water moorings (red squares) are details TBD.

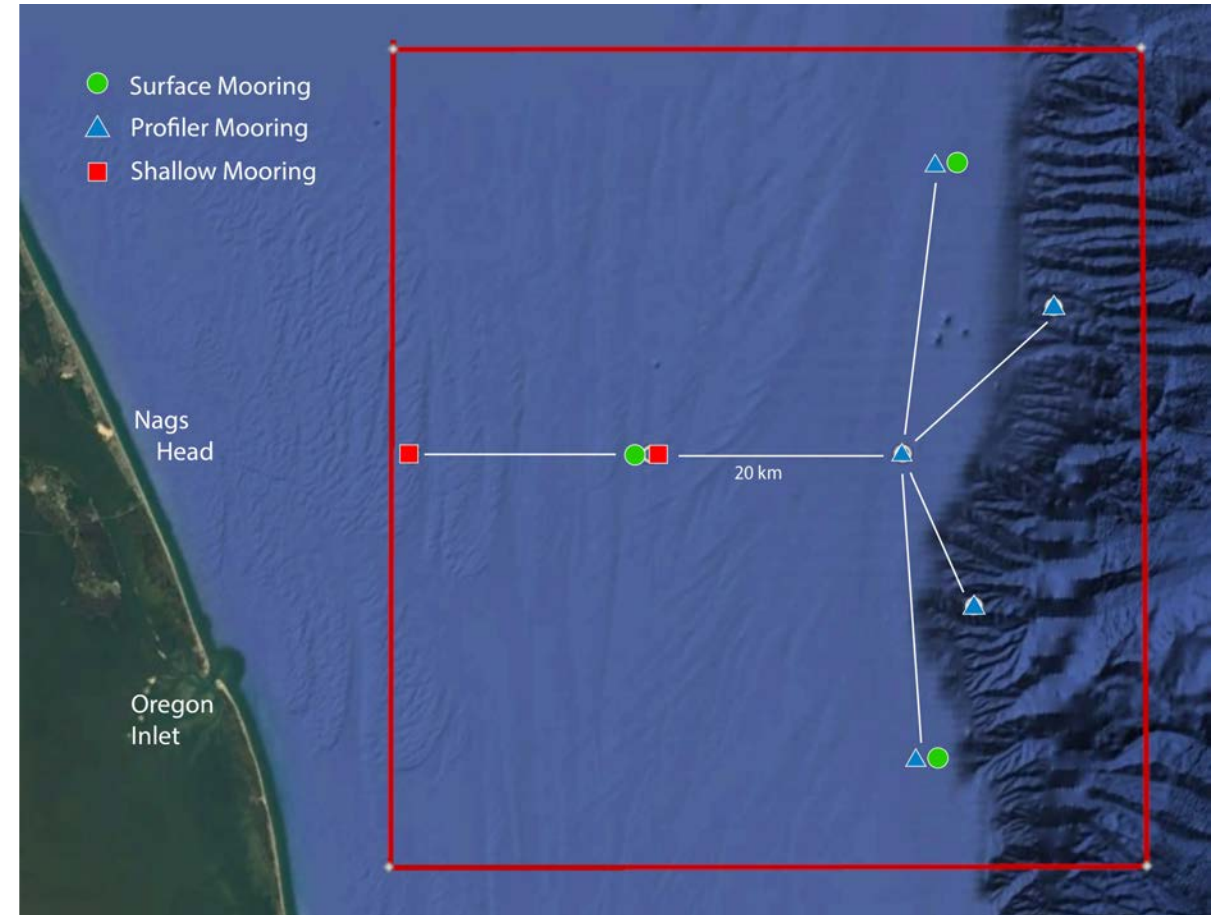
Proposed bio-optical instrument additions include:

Turbidity (surface moorings): Sea-Bird ECO-NTU

Suspended particulates (surface moorings): Sequoia LISST

Phytoplankton imaging (surface mooring (1)): McLane IFCB

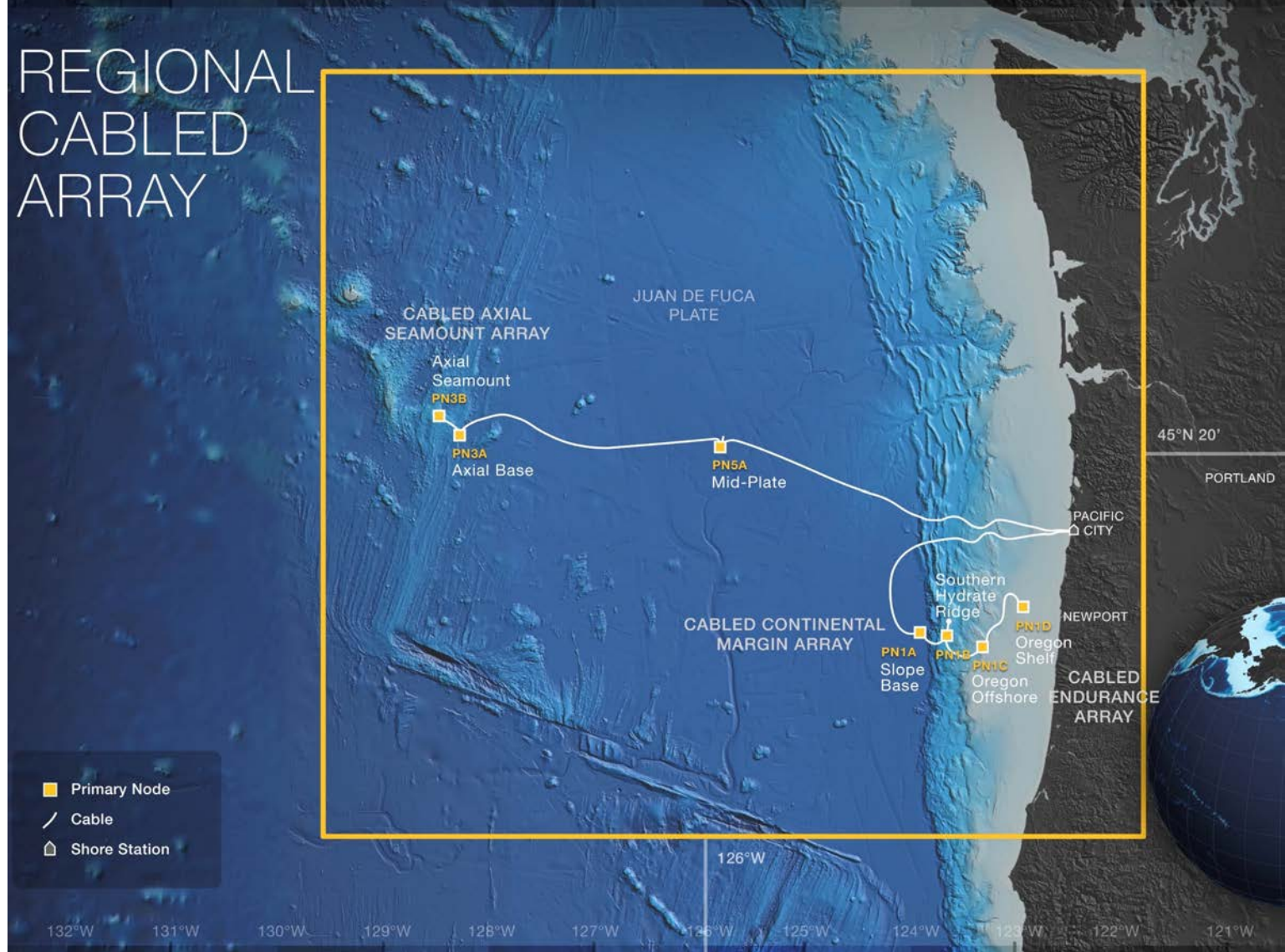
Incident radiation (surface and profiler mooring buoys)



# Regional Cabled Array

- 900 km fiber-optic cable provides unprecedented power and bandwidth for two-way, real-time communication and data flow
- More than 150 core instruments and multiple additional “PI” sensors
- Observation of 2015 eruption of Axial undersea volcano, tidal triggering of earthquakes, methane seeps, marine mammals. Next eruption predicted circa 2023.
- Fundamental geophysics, unique ecosystems, tsunami hazards

## REGIONAL CABLED ARRAY



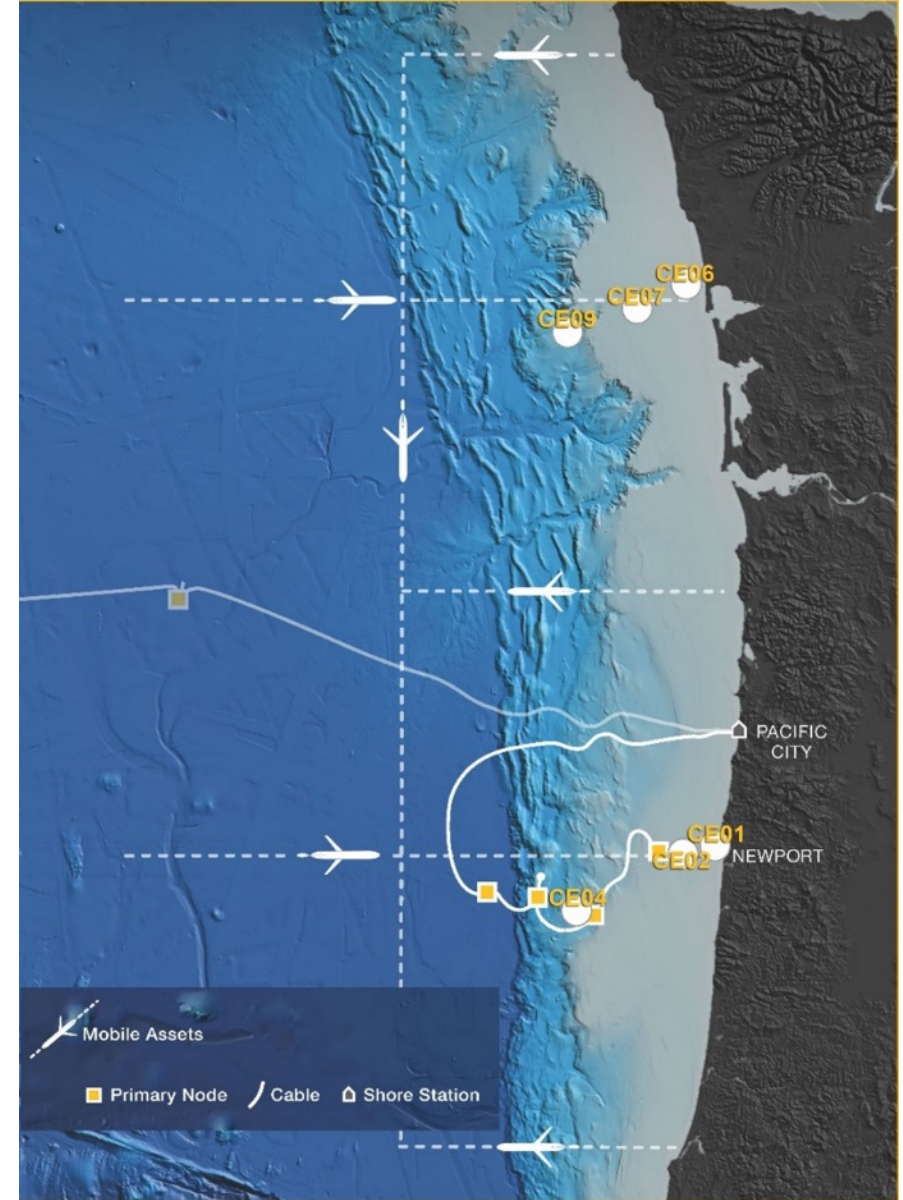
Operated by UW (PI Deb Kelley)





# Coastal Endurance Array

- Long-term observations of fundamental scientific and societally relevant processes including marine heat waves, **hypoxia** and **ocean acidification**
- Six sites: two lines north and south of the Columbia River. Each line has three sites at the inner-shelf, mid-shelf, and continental slope
- Fixed depth (surface mooring) and profiling measurements at the sites
- Oregon shelf and slope sites include Regional Cabled Array bottom and profiling measurements
- Glider lines link sites and extend measurements offshore



# OOI Data Team Activities

- About 8 persons across the program (WHOI+UW+OSU) funded to work on data quality
  - Carrying out weekly human in the loop quality control on current deployments and annotating data
  - Responding to user comments, concerns, and requests
  - Updating algorithms
  - Developing user tools for download and visualization of data
    - Profiler Toolbox
    - **AC-S tools**
    - General download and plotting of data via M2M
- Completed activities
  - Review of metadata
  - bottle data in common format, available through Data Explorer and Alfresco
  - glider data distribution to IOOS glider DAC



# Biogeochemical Measurements on Endurance Array

## Notes:

- QC quality control
- HITL Human in the Loop, review by an OOI data team member (now weekly)
- Automated QC flags are based on IOOS QARTOD

Measurement	Instrument	Remarks
Dissolved oxygen	Aanderaa Optode 4831	Multi-point calibration, UV light biofouling mitigation since 2018, HITL annotations historical and current in progress
Chl-a, CDOM, OBS	WET Labs (Sea-Bird) ECO triplet-w	HITL annotations current, historical annotations in progress done
Downward irradiance	Satlantic (Sea-Bird) OCR507 ICSW	HITL annotations current, UV light biofouling mitigation since fall 2019 historical in progress
nitrate	Satlantic (Sea-Bird) SUNA V2	ISUS replaced by SUNA in 2018, HITL annotations current in progress
<b>Spectrophotometer (Optical attenuation and absorption)</b>	<b>Sea-Bird (WET Labs) AC-S</b>	<b>No QC annotations current, QC tools here</b>
pH	Sunburst SAMI pH	HITL annotations current, automated QC flags applied
pCO <sub>2</sub> water	Sunburst SAMI pCO <sub>2</sub>	HITL annotations historical and current, automated QC flags applied
pCO <sub>2</sub> air-sea	Pro-Oceanus pCO <sub>2</sub> -pro	HITL annotations historical and current, automated QC flags applied
Bio-acoustic sonar	ASL AZFP (uncabled) Kongsberg EK-60 (cabled)	Raw data available, standardized plots using Echopype in progress



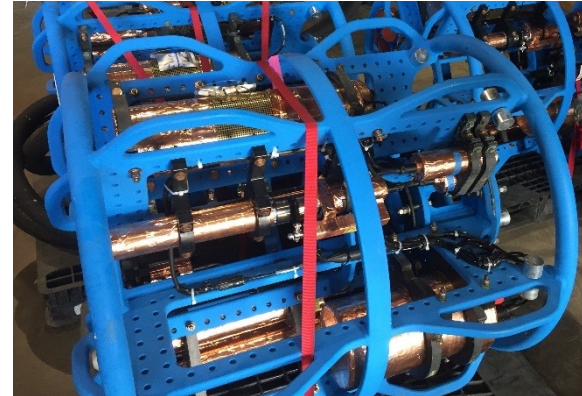
# OOI Observation and Sampling Approach (document 1102-00200)

- The sampling approach is informed by determined by science needs, limits of platform and instrument technologies
- Physical deployment and operation of the platform
- Battery limitations
- Storage and telemetry limits
- Lamp life limits
- Useable data determined by biofouling and other instrument performance issues
- Power management issues
- Fixed sample depths
- Fixed sample frequencies
- Profiling sample locations
- Profiling sample frequencies

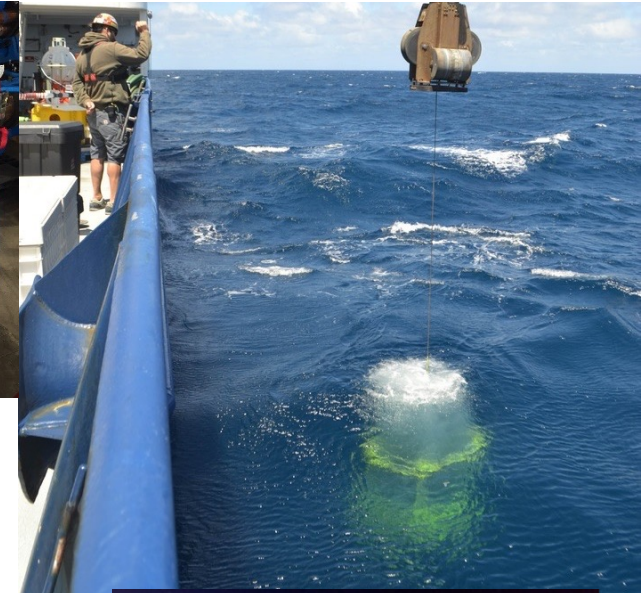


# Quality Assurance/Quality Control

- QA: Instrument preparation
  - Calibration between deployments by manufacturers
  - Two sets of instruments with overlapping deployments where possible
  - Shipboard CTD/physical sampling
  - Common bio-fouling mitigation strategies employed
  - Yearly meetings with instrument manufacturers to review refurbishment schedule and work quality, components, firmware updates, etc.
  - Metadata including specifically instrument serial numbers, calibration coefficients and instrument assignments available to users
- Human in the loop (HITL) QC with data annotation
  - Data reviews by operators
  - User-prompted data reviews
  - We are in the beginning stages of AC-S QC



Endurance near surface instrument frame prior to deployment on spring 2018 cruise.



CTD is deployed off the R/V Revelle during the Visions '18 cruise, RCA shallow profiler, and an undergraduate student performing sampling. Credits: M. Elend, UW

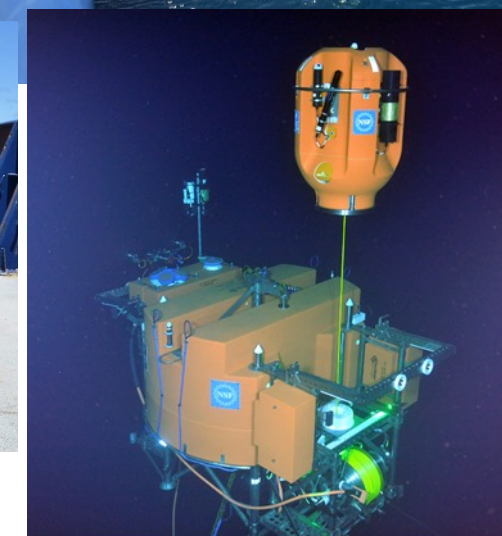


Photo Credit UW/NSF-OOI/CSSF



# Some methods of accessing OOI data and use cases

We've tried to take the FAIR principles into account and make OOI data accessible in different ways for different user groups.

Still about one year out from assigning DOI's to data.

AC-S not available through all these

method	Use cases	remarks
OOI Data Explorer	Exploration, Classroom, proposals	First stop for exploration and access
OOI M2M API behind Data Portal	Routine access of telemetered and recovered data	For expert user, most complete source of data, metadata, annotations
OOI Data Portal GUI	Exploration, Classroom, proposals	Largely superseded by Data Explorer
NANOOS	OOI data in context of other regional measurements	Endurance (including cabled Endurance), only archives last 60 days of data
GOA-ON	OOI data in context of other related OA measurements	Endurance data
Interactive Oceans	Exploration, Classroom, proposals	Focus on Regional Cabled Array, Endurance also there
Glider DAC	Exploration, OOI data in context of regional measurements	All OOI glider data are submitted to the DAC, OOI Data Explorer pulls from the DAC
NDBC	Exploration, OOI data in context of regional measurements	Buoy data only, 10-minute averages
IRIS	Seismological data, OOI data in context of other measurements	NSF facility for seismological data

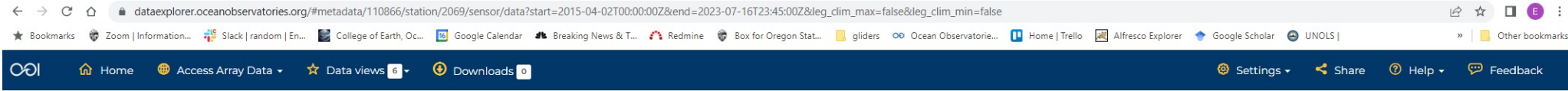


# OOI AC-S data notes

- OPTAA = AC-S = spectrophotometer
- Temperature, salinity, other collocated sensors (chl, CDOM fluorescence, optical backscatter) can be helpful for data quality control and science analysis
- Profiling AC-S measurements may lag relative to collocated measurements due to sample volume, pumping etc.
- AC-S is a relatively power-hungry instrument and may be turned off when (uncabled) mooring power is low
- Biofouling happens
- Workshop notebooks load data from gold copy THREDDS server used by Data Explorer
- Data Explorer does not yet plot profiles of AC-S data



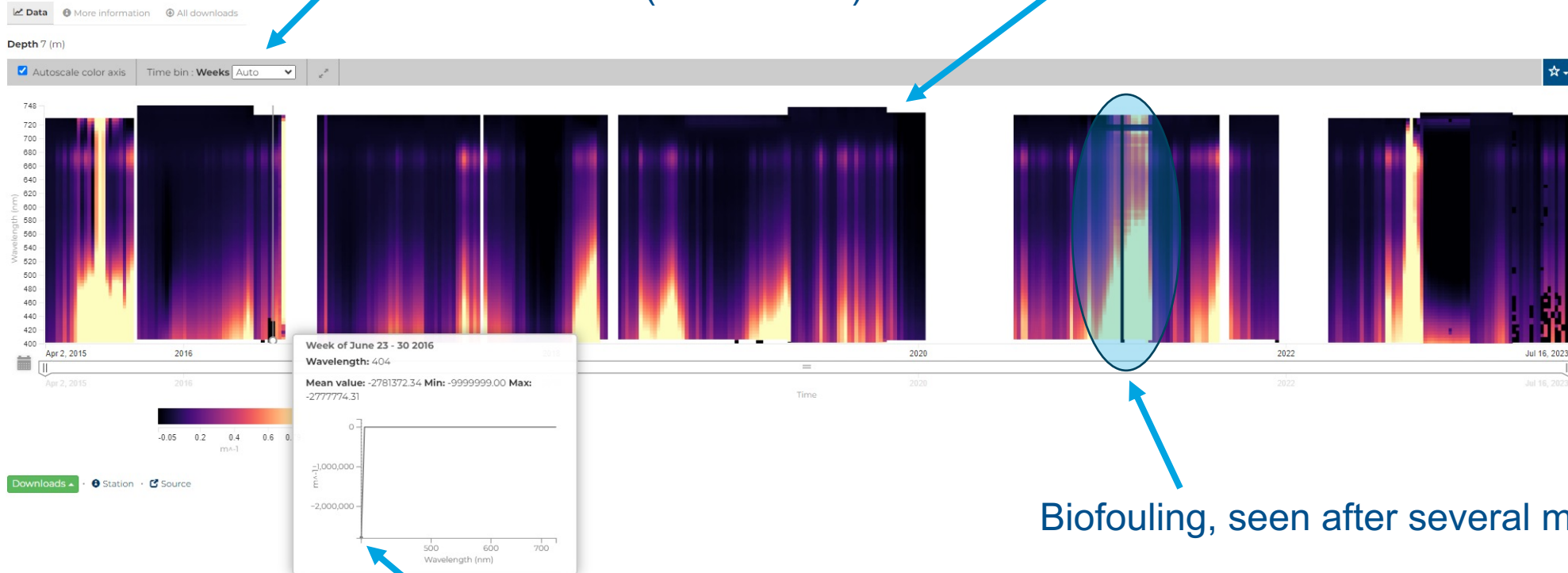
# Accessing Fixed Depth AC-S data through the Data Explorer: Endurance Array Oregon Shelf Near Surface Instrument Frame: April 2015 – Jul 16, 2023



Coastal Endurance Oregon Shelf Surface Mooring Near Surface Instrument Frame: Spectrophotometer  
Optical Absorption Coefficient

Auto Time binned (here weeks)

Wavelength filters change with deployment



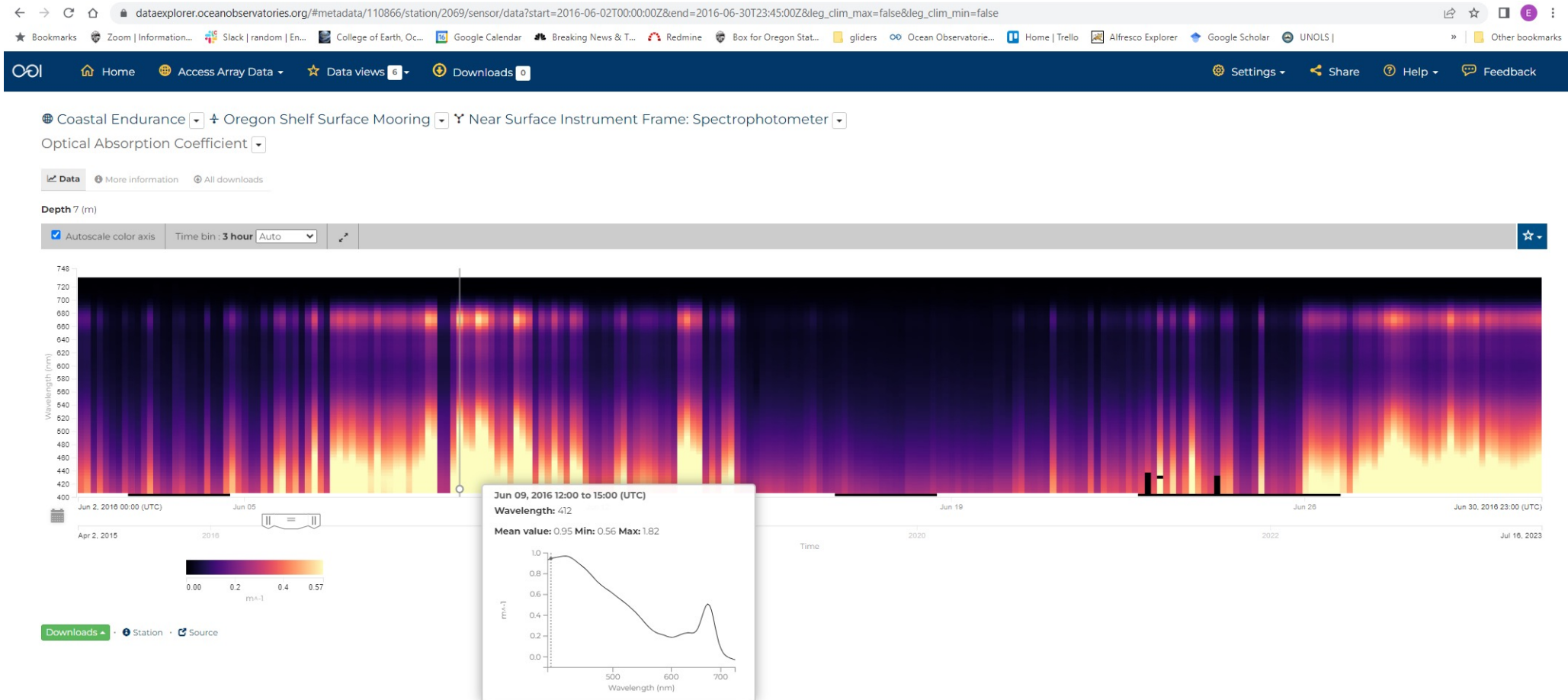
Biofouling, seen after several months

Fill Value for Data Explorer impacts averaging

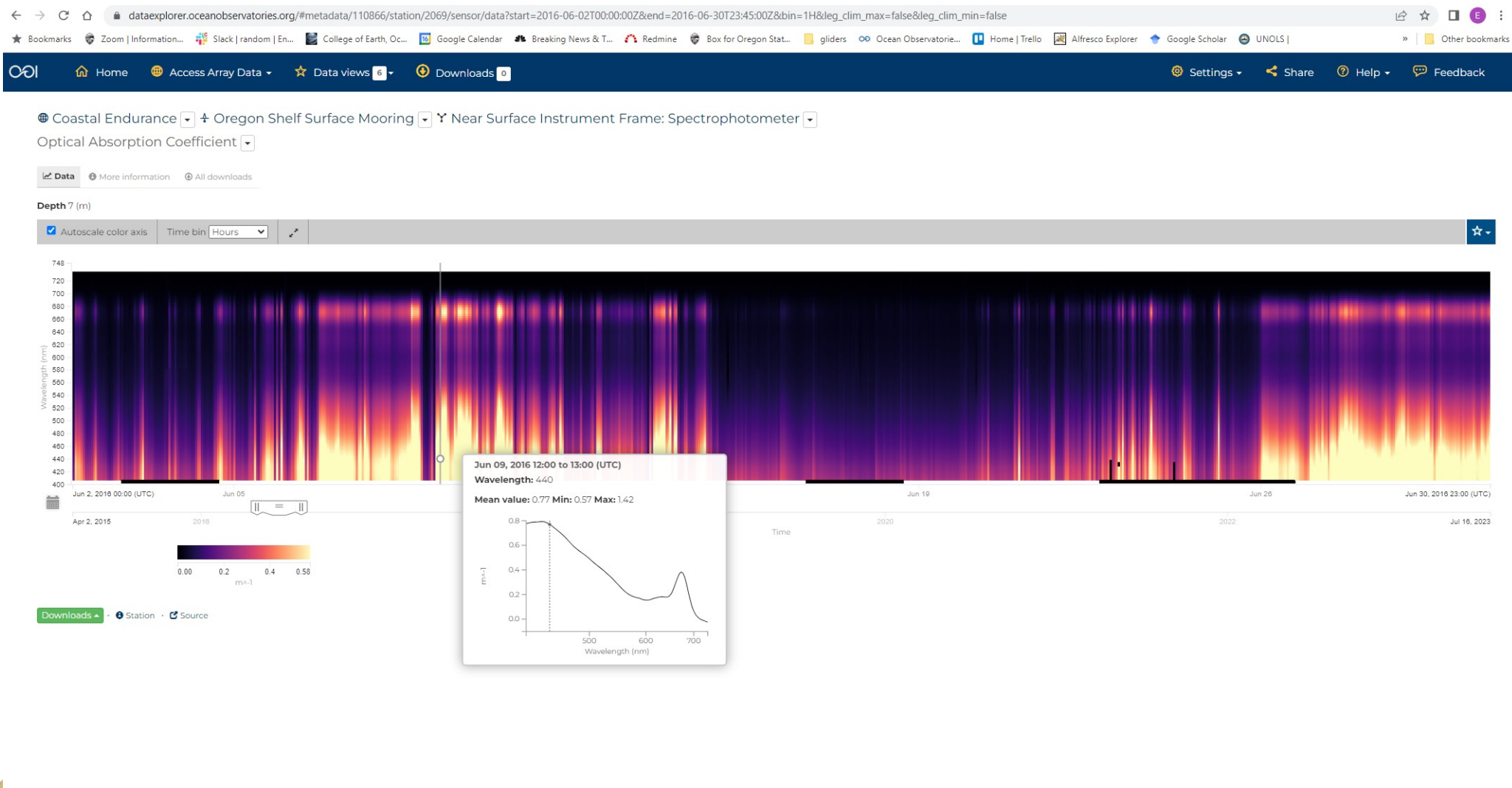




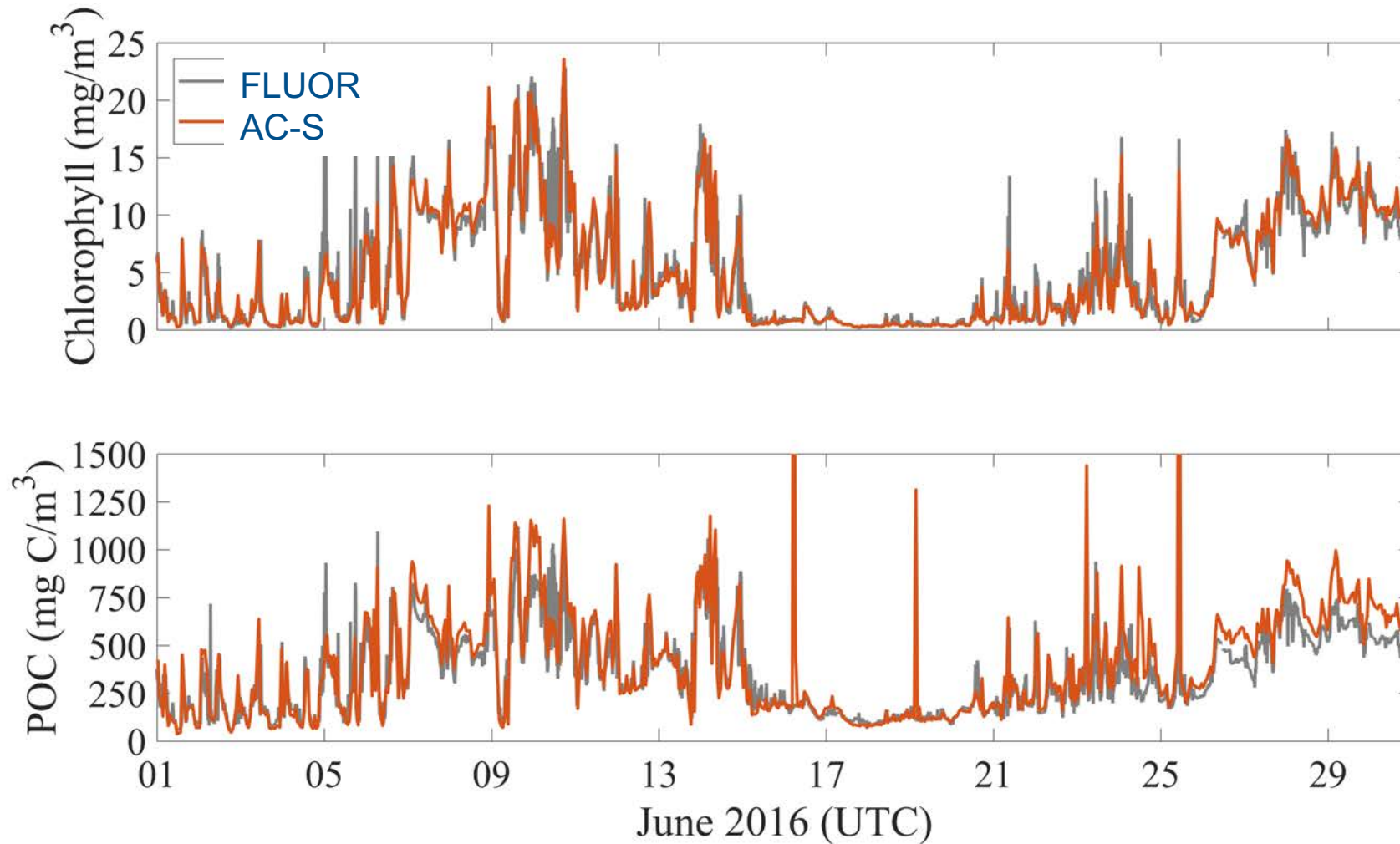
# Accessing Fixed Depth AC-S data through the Data Explorer: Endurance Array Curated Example 1: June 2016 (3 hour average)



# Accessing Fixed Depth AC-S data through the Data Explorer: Endurance Array Curated Example 1: June 2016 (hourly)



# Independent estimates of chl-a and POC derived from a fluorometer (gray) and AC-S (orange) Spectral Absorption and Attenuation



# Accessing Fixed Depth AC-S data through the Data Explorer: Regional Cabled Array Oregon Shelf Benthic Experiment Package



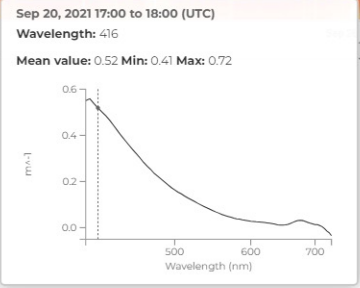
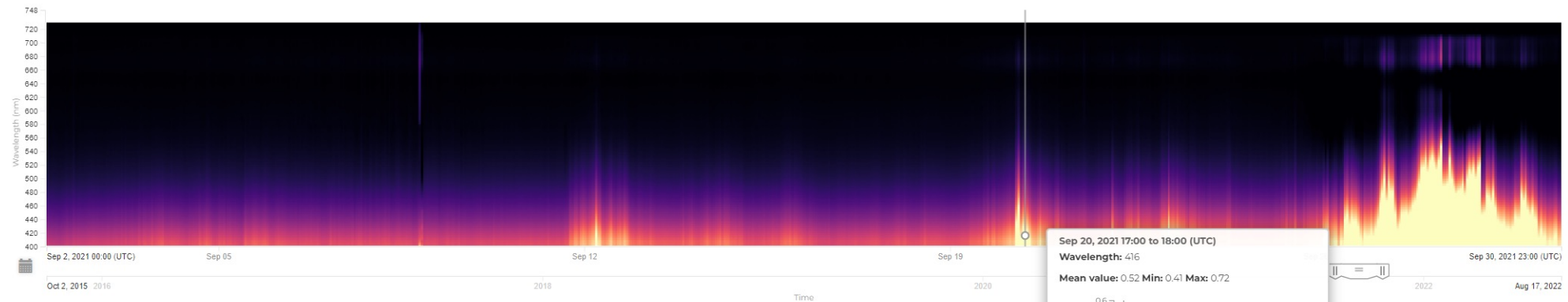
Coastal Endurance Oregon Shelf Cabled Benthic Experiment Package Low-Power JBox (LJ01D): Spectrophotometer

Optical Absorption Coefficient

Data More information All downloads

Depth 80 (m)

Autoscale color axis Time bin Hours



# Accessing Fixed Depth AC-S data through the Data Explorer: Endurance Array Oregon Shelf Surface Mooring: Sep 2021



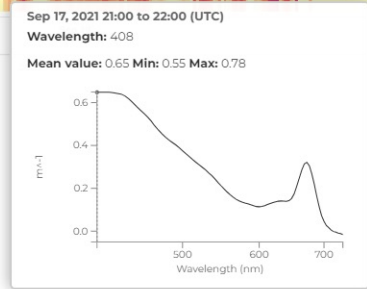
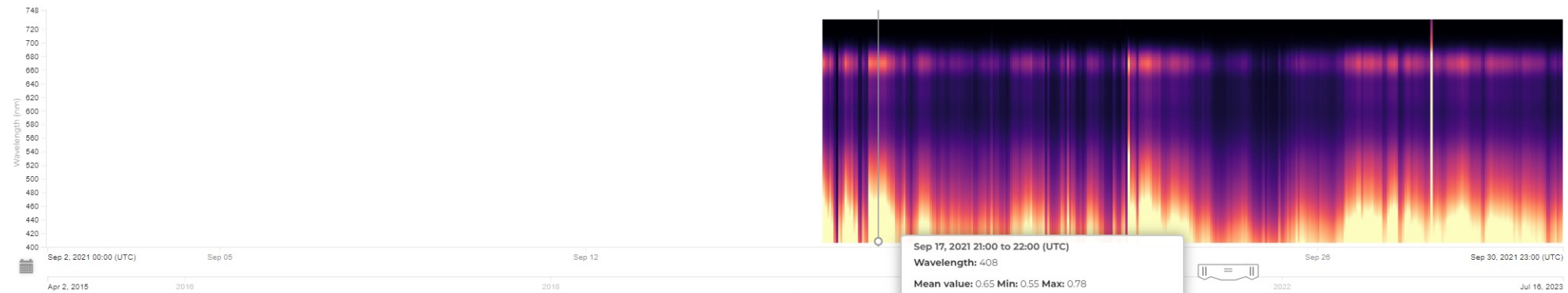
Coastal Endurance Oregon Shelf Surface Mooring Near Surface Instrument Frame: Spectrophotometer

Optical Absorption Coefficient

Data More information All downloads

Depth 7 (m)

Autoscale color axis Time bin Hours



# Accessing Fixed Depth AC-S data through the Data Explorer: Pioneer Array:



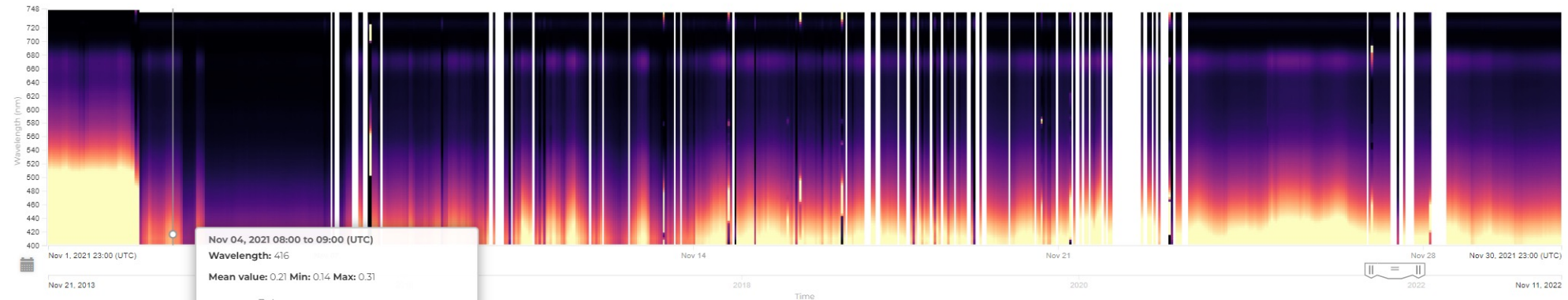
Coastal Pioneer Central Surface Mooring Near Surface Instrument Frame: Spectrophotometer

Optical Absorption Coefficient

Data More information All downloads

Depth 7 (m)

Autoscale color axis Time bin Hours



Downloads Station Source



# Terminology Decoder (see comments in Chris's AC-S notebook)

## Array

One of 5 major research regions that make up OOI (e.g., Global Station Papa (**GP**) or Coastal Endurance (**CE**))

## Site

A specific geographic location within an array (e.g., Coastal Endurance Oregon Inshore = **CE01**)

## Platform

An assembly/infrastructure at a site that hosts a complement of integrated scientific instruments. May be fixed (mooring) or mobile (profilers or gliders) (e.g., Coastal Endurance Oregon Inshore Surface Mooring = **CE01ISSM**)

## Node

A section of a platform with one or more data loggers and power controllers. Instruments on platforms are plugged into nodes. (e.g., the data logger on the Near Surface Instrument Frame (NSIF, 7 m), part of the mooring riser, of the Coastal Endurance Oregon Inshore Surface Mooring = **CE01ISSM-RID16**)

## Instrument/Sensor

Terms often used interchangeably. An instrument is a piece of equipment used to collect data. A sensor is a part of an instrument which measures a specific quantity. Each instrument has a Unique ID (e.g., the dissolved oxygen sensor on the NSIF of the Coastal Endurance Oregon Inshore Surface Mooring = **03-DOSTAD000**)

## Reference Designator

Identifies a particular instrument on a particular node/platform at a particular site

Example: **CE01ISSM-RID16-03-DOSTAD000** = Coastal Endurance Oregon Inshore Surface Mooring - Mooring Riser - Dissolved Oxygen Sensor

## Data Delivery Method

- **telemetered**: Data returned wirelessly. May be truncated or decimated due to size.
- **recovered\_host/recovered\_inst**: Data downloaded directly from either the platform computer and/or from the instrument after the system is recovered
- **streamed**: Data accessible in real-time, streamed over the fiber optic network from the Regional Cabled Array (including cabled Endurance platforms)

## Data Stream Name

Data feed from a sensor that has been read, parsed, and separated based on content (e.g., “engineering”, “science”, “metadata”, etc.) into a named dataset, or “stream”. Stream names are often method specific

## Parameters (data variables)

A particular value returned from a sensor (e.g., practical salinity from a CTD). There are multiple parameters in a data stream, some of which may be identified as an OOI Data Product



# Resources

- Information: [oceanobservatories.org](https://oceanobservatories.org)
- Data access: [dataexplorer.oceanobservatories.org/](https://dataexplorer.oceanobservatories.org/)
- Help: [help@oceanobservatories.org](mailto:help@oceanobservatories.org)
- Discourse: [discourse.oceanobservatories.org](https://discourse.oceanobservatories.org)
  - Questions and discussions about data
  - Responses archived
- Data tools: [oceanobservatories.org/data-tools](https://oceanobservatories.org/data-tools)
- Educational modules:
  - [interactiveoceans.Washington.edu](https://interactiveoceans.Washington.edu)
  - [datalab.marine.Rutgers.edu](https://datalab.marine.Rutgers.edu)
  - [serc.carleton.edu/eddie/index.html](https://serc.carleton.edu/eddie/index.html)
- Facebook, Instagram, LinkedIn, Twitter

## OOI Data Explorer

> Data Access

> Interactive Data Views

**Welcome to the Ocean Observatories Initiative Data Explorer, where you can:**

- > Search and download cabled, uncabled, and recovered data for physical, chemical, geological, and biological observations from the field
- > Compare datasets across regions and disciplines
- > Generate and share custom data views
- > Download full datasets using ERDDAP







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# Questions?

**OOI Discourse**

<https://discourse.oceanobservatories.org/>

**OOI HelpDesk**

[helpdesk@oceanobservatories.org](mailto:helpdesk@oceanobservatories.org)

