



Ocean Observatories Initiative

Where are we?

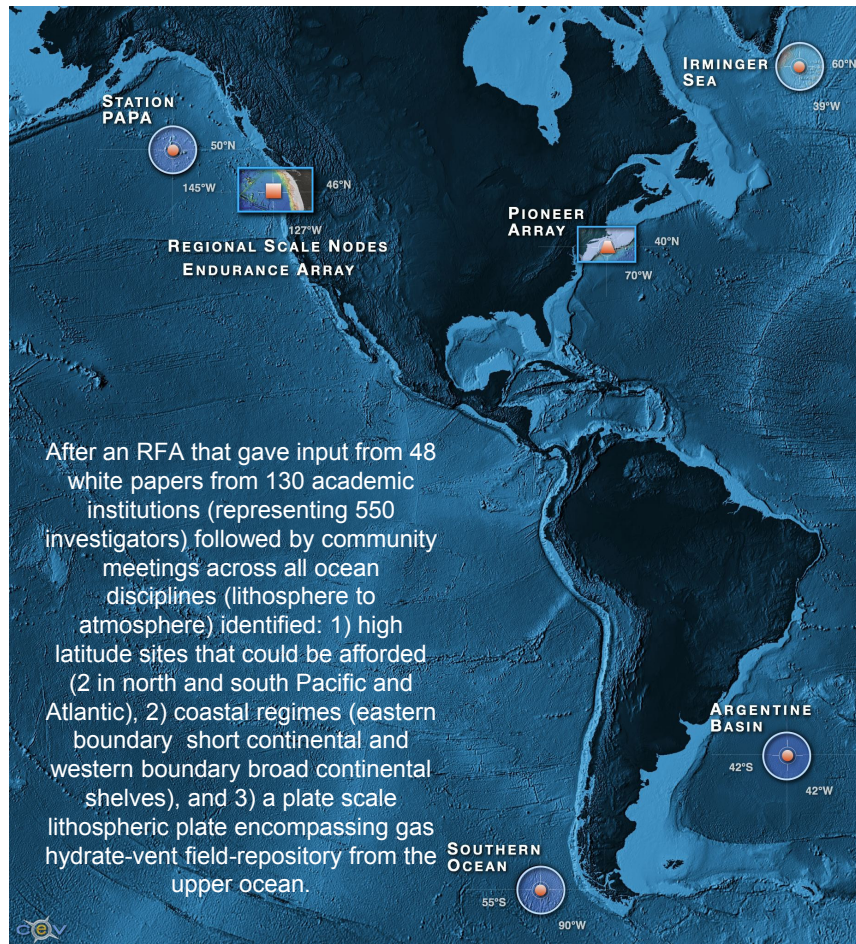
Oscar Schofield on behalf of many
oscar@marine.rutgers.edu



Themes to be covered

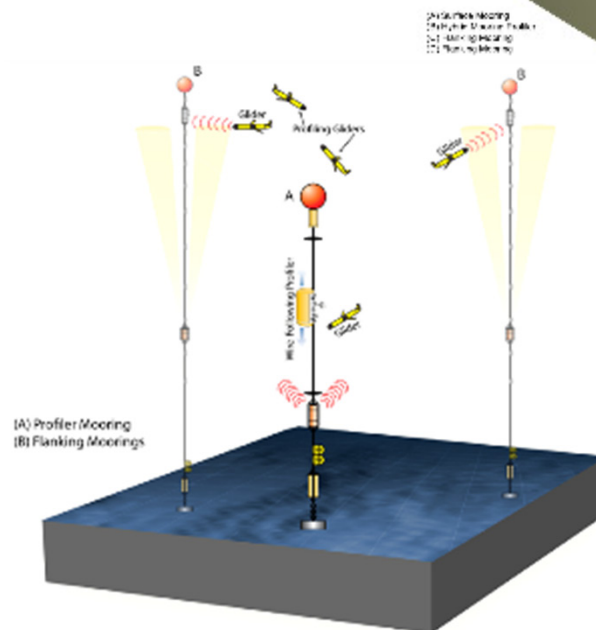
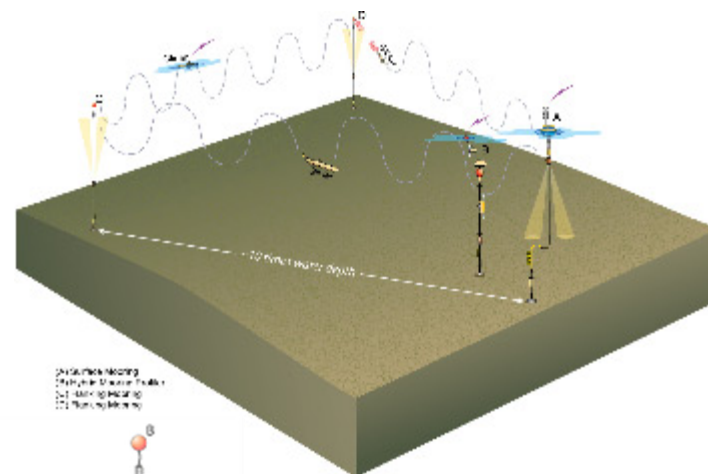
- History and status
- Basic system
- Science Potential
- Procedures For Data Quality

What is being built?



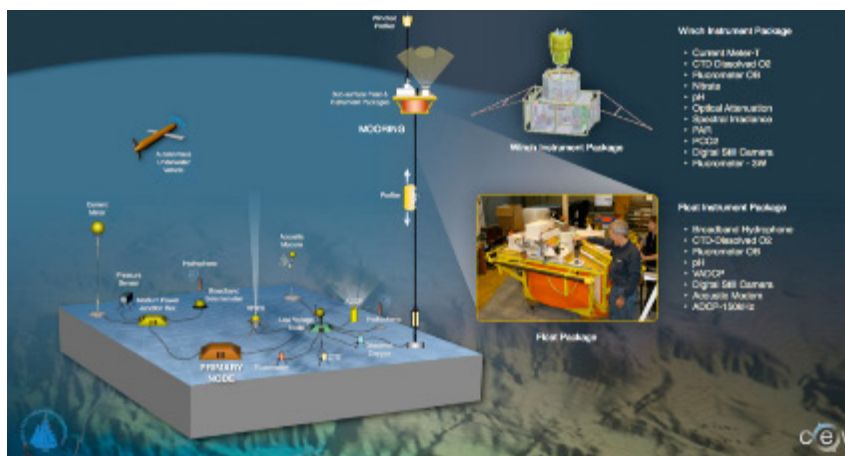
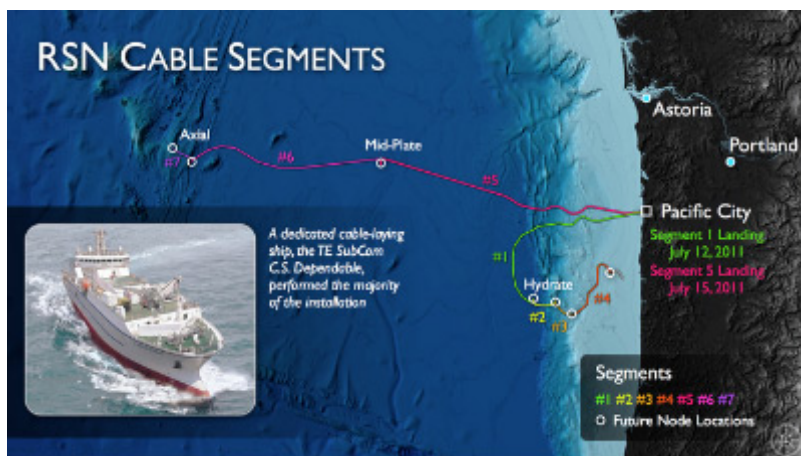
- A distributed network of fully open access data for sustained periods open to anyone with open access to the web the democratization of oceanography
- Ability to characterize the importance of episodic versus seasonal, annual variability over eddy, shelf and plate scales
- >800 unique sensors deployed at any given time on the network
- A network capable of absorbing new sensors as they are developed by the wider scientific community
- A scalable cyber infrastructure providing a service orientated architecture
- A system that provides web service data management with visualization
- An integrated education and public engagement suite of tools that can be directly integrated into undergraduate education modules

OOI Components: Global Component



- Four Global Sites
 - Flanking Moorings
 - Profiler Mooring
 - Gliders (5)
 - Acoustics

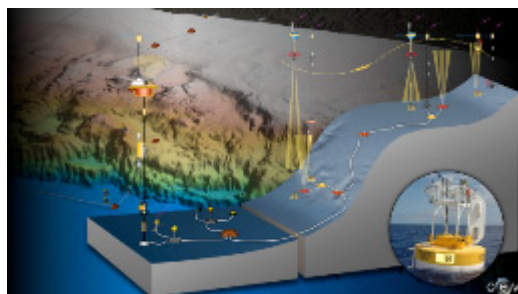
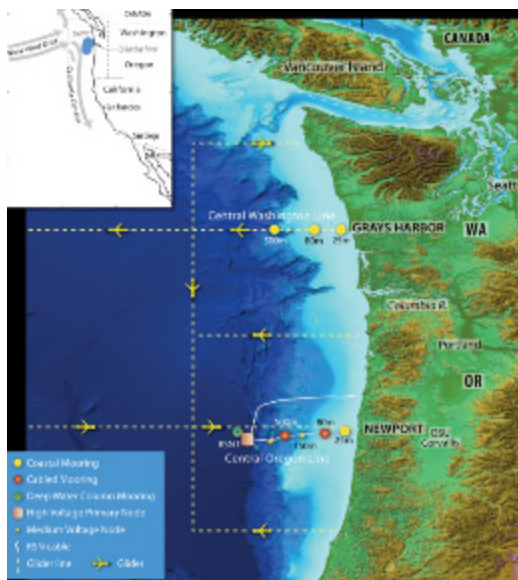
OOI Components: Cabled Array



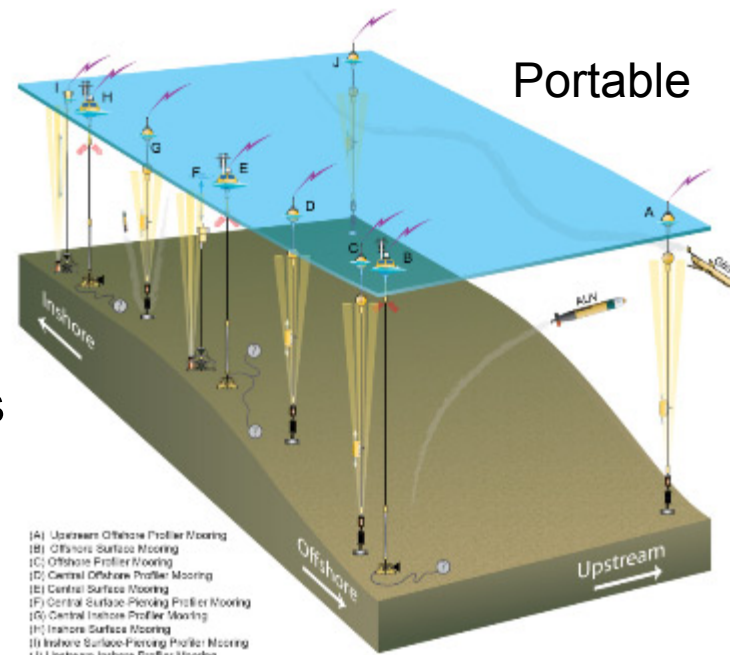
- Moorings
- Profilers
- HD Video
- Met Data

OOI Components: Coastal Component

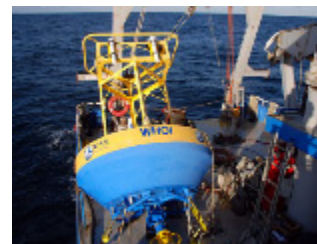
West Coast: Endurance Array



East Coast: Pioneer Array

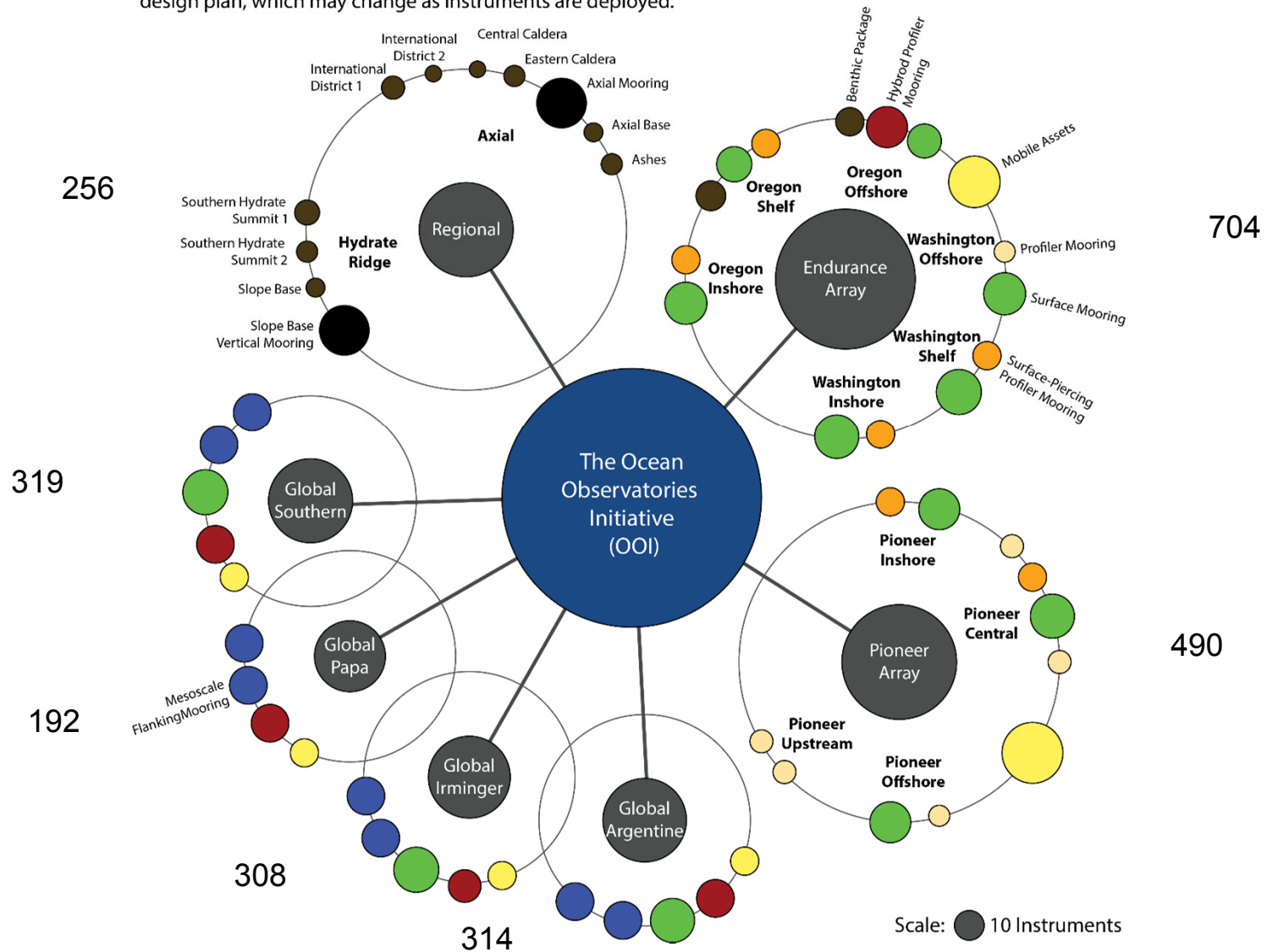


- Glider AUVs
- REMUS AUVs
- Moorings
- Profilers
- Met Data



Arrays and Sites

Each circle is sized by the number of instruments that will be deployed in each array (black circles) and site (colored circles) within the OOI. This figure reflects the initial design plan, which may change as instruments are deployed.



Deployed Scope of OOI (over 800 instruments distributed over all moorings, benthic packages, seafloor nodes, gliders and AUVs)

Global Arrays

Subsystems	Components	Instruments	Service Frequency
Global Arrays			
Station Papa	1 Subsurface Hybrid Profiler Mooring 2 Flanking Moorings 3 Gliders	12 32 9	Yearly
Irminger Sea	1 Surface Mooring 1 Subsurface Hybrid Profiler Mooring 2 Flanking Moorings 3 Gliders	23 12 32 9	Yearly
Southern Ocean	1 Surface Mooring 1 Subsurface Hybrid Profiler 2 Flanking Moorings 3 Gliders	23 12 32 9	Yearly
Argentine Basin	1 Surface Mooring 1 Subsurface Hybrid Profiler 2 Flanking Moorings 3 Gliders	23 12 32 9	Yearly

Coastal Arrays

Subsystems	Components	Instruments	Service Frequency
Coastal Arrays			
Pioneer	3 Surface Moorings 2 Surface-Piercing Profilers Moorings 5 Profiler Moorings 3 AUVs 6 Gliders	60 18 29 18 30	Twice a year
Endurance (Oregon Line)	3 Surface Moorings 2 Surface-Piercing Profilers Moorings 1 Hybrid Profiler Mooring 1 Benthic Experiment Package 1 Multi-Function Nodes	50 18 16 10 8	Twice a year
Endurance (Washington Line)	3 Surface Moorings 2 Surface-Piercing Profilers Moorings 1 Profiler Mooring 6 Gliders	68 18 5 30	Twice a year

Cabled Arrays

Subsystems	Components	Instruments	Service Frequency
Regional Scale Nodes			
Hydrate Ridge	Seafloor: Primary and Secondary Profiler – Winched Profiler – Wire crawler Midwater Platform@ 200m Bottom Instrument Package	16 10 5 8 6	Yearly
Axial Seamount	Seafloor: Primary and Secondary Profiler – Winched Profiler – Wire crawler Midwater Platform @ 200m Bottom Instrument Package	26 10 5 8 6	Yearly

Cyberinfrastructure

Computing platforms, software applications, storage, and high speed network equipment

Cyber Points of Presence (CyberPoPs)
Acquisition Points
Distribution Points

Integrated Observatory Network – OOI Net
Hardware / Software

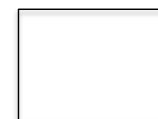
Redundant computing environment

Connected by 880km of seafloor cable, with 10KW power, internet connectivity between 7 primary nodes, multiple secondary nodes, and all distributed instrumentation

Extensive details about each component can be found on the OOI website (<http://oceanobservatories.org>)

Data Products from NE Pacific observatories

Data Products (Types)	Air-Sea Interface	Water Column	Seafloor
Physical/Geological			
Humidity	★		
Air Temperature	★		
Precipitation	★		
Barometric pressure	★		
Wind Velocity	★		
Turbulent fluxes	★	★	★
Wave properties	★	★	★
Water Temperature	★	★	★
Salinity	★	★	★
Density	★	★	★
Water velocity	★	★	★
Barotropic velocity		★	
Suspended Solids		★	★
Seismic activity		★	★
Pressure (Depth)		★	★
Imagery (optical)		★	★
Seafloor temperature			★
Ground motion			★
Seafloor pressure and tilt			★
Seafloor uplift/deflation			★
Benthic fluid flow			★
Scanning sonar		★	★
Hydrothermal discharge flux			★



Data Products from NE Pacific observatories

Data Products (Types)	Air-Sea Interface	Water Column	Seafloor
Chemical/Biological			
pCO2	★ ★	★ ★	★
Irradiance	★ ★	★	
Inherent Optical Properties	★ ★	★ ★	
Chlorophyll a (fluorescence)	★ ★	★ ★	★
CDOM	★ ★	★ ★	
pH	★ ★	★ ★	★ ★
Dissolved O2	★ ★	★ ★	★ ★
Nitrate		★ ★	★ ★
Hydrophones		★ ★	★ ★
Hydrothermal vent water samples			★ ★
Microbial particulate DNA		★ ★	★ ★
Vent/Seep Fluid Chemistry			★ ★
Resistivity (e.g. [Cl ⁻])			★ ★
Bioacoustic scattering		★ ★	
Sedimentation rate			★



Pioneer Array: deployments



Pioneer surface moorings, Fall 2014.

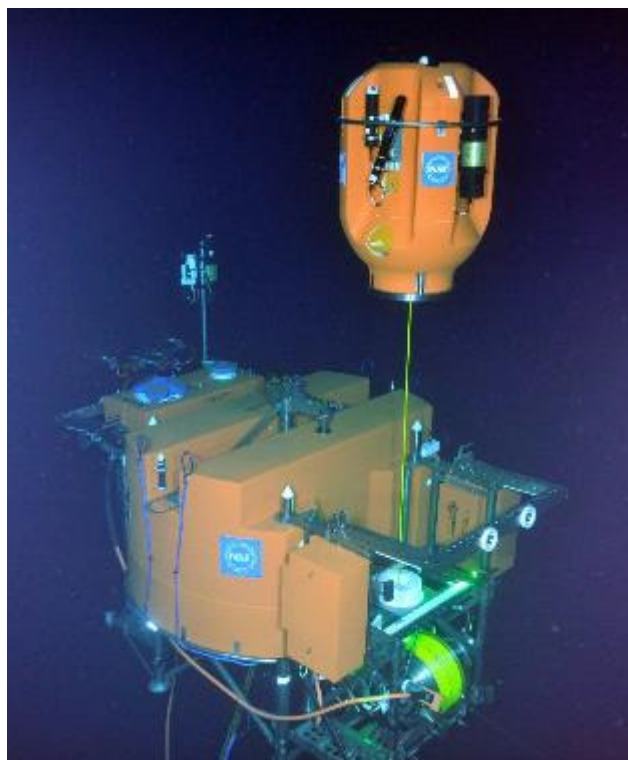


REMUS 600 AUV Testing at Pioneer, May 2015.

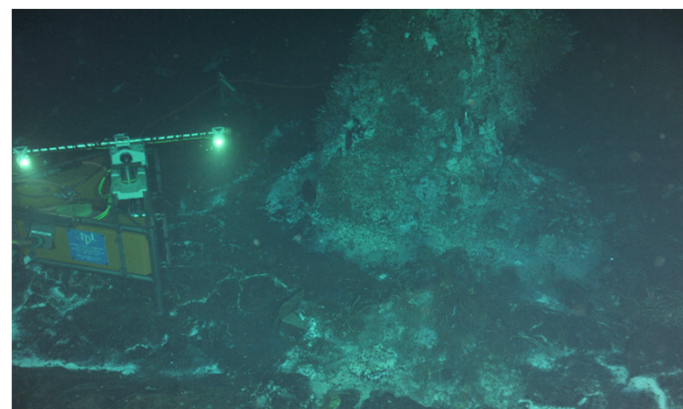


Ocean glider deployments, Spring 2015.

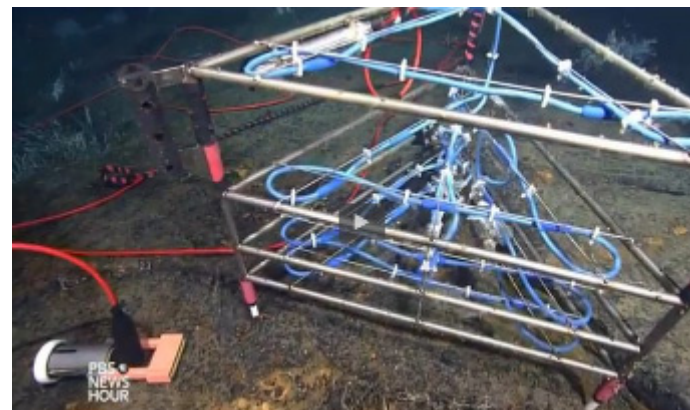
Cabled Observatory: deployments



Shallow Profiler platform on a 2700 m-tall, 2 legged mooring hosting acoustic doppler current profilers, a digital still camera, and chemical and biological sensors (summer 2015).



Digital Still Camera, summer 2014).



3D Temperature Sensor, summer 2015.

Endurance Array: deployments



Benthic Experiment Package (ADCP visible on top), summer 2014.

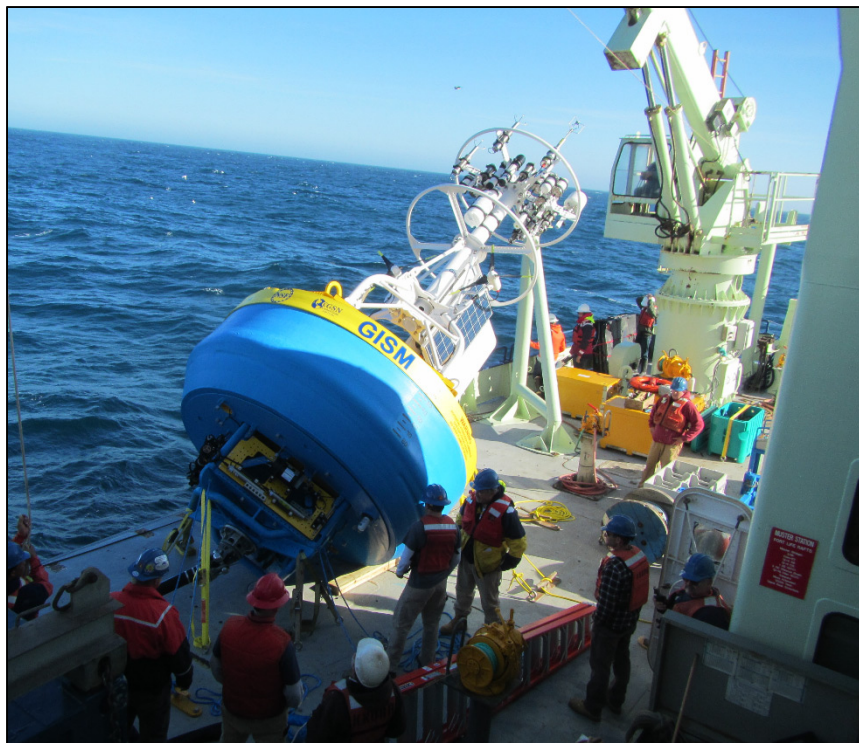


ROPOS ROV and Benthic Experiment Package pre-deployment, summer 2014.

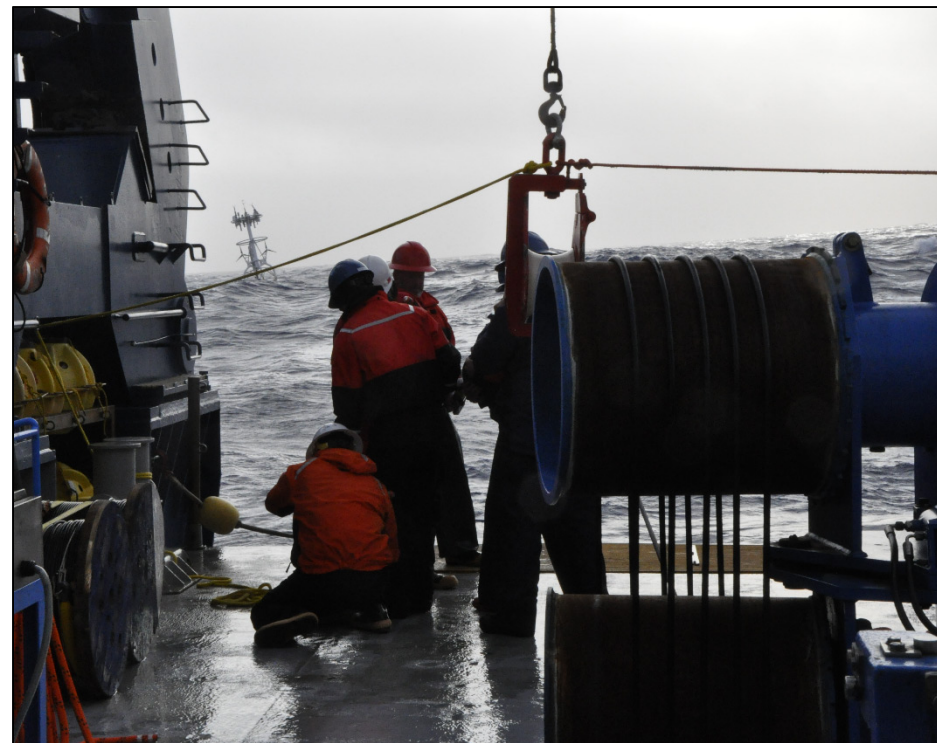


Endurance surface mooring deployment, July 2015.

Global Array: deployments



Irminger Surface Mooring, Winter 2014.



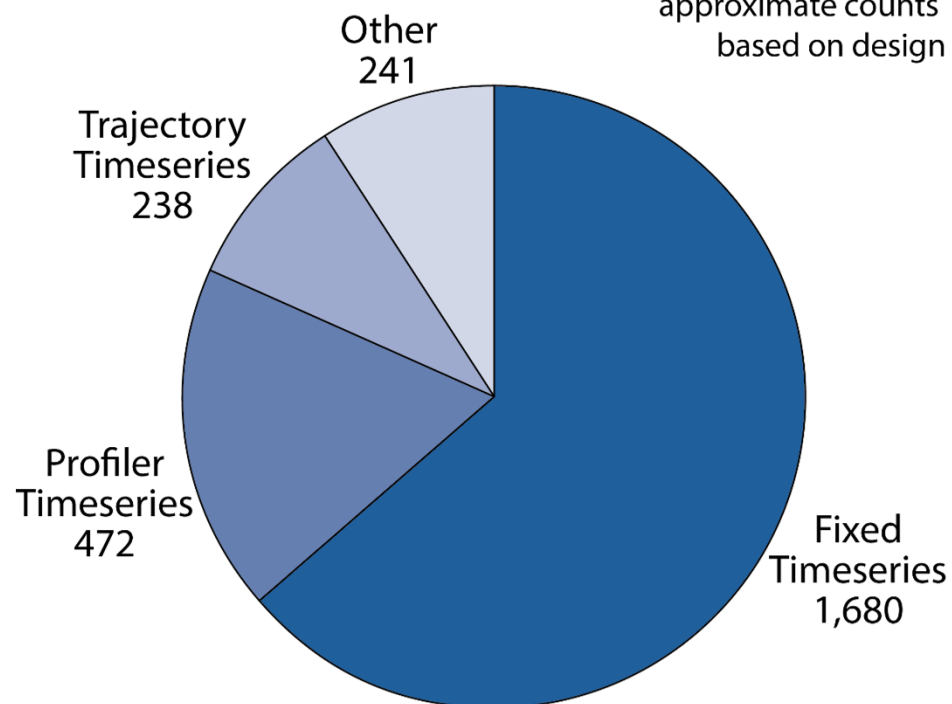
Southern Ocean, July 2015.

OOI By the Numbers

7 Arrays
50 Sites
 Moorings, Profilers, Nodes
26 Mobile Assets
 Gliders, AUVs
762 Planned
 Instruments
2,631 Potential Data
 Product Streams
 (2,583 yesterday)

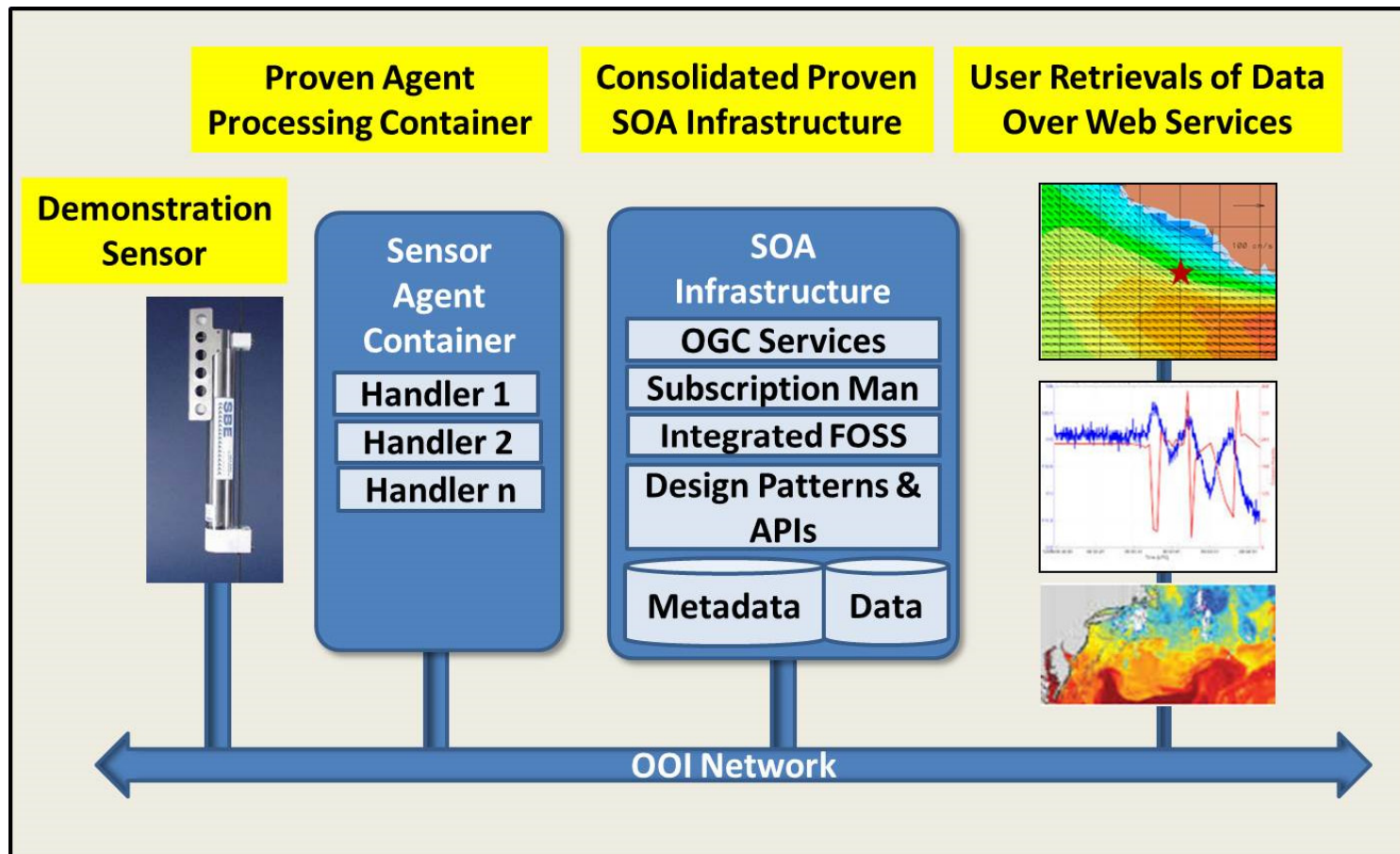
Data Product Types

approximate counts
based on design



Web based services

Technical Approach Uses Proven SOA Infrastructure to Integrate OOI Data



Data Access

- Time Series

OOI Science

Search... [Reset]

- COASTAL ENDURANCE 0
- GLOBAL STATION PAPA 0
- COASTAL PIONEER 34
- GLOBAL ARGENTINE BASIN 114
- GLOBAL IRMINGER SEA 142
 - Global Irminger Sea Flanking Subsurface Mooring
 - Mooring Riser 2
 - Mooring Riser 1
 - Global Irminger Sea Southern Hydrate Ridge Summit Surface Mooring
 - Mooring Riser 11
 - Global Irminger Sea Flanking Subsurface Mooring
 - Global Irminger Sea Mobile (Open Ocean)
 - Glider 001: 1
 - CTD Glider
 - Glider 002: 2
 - Global Irminger Sea Southern Hydrate Ridge Summit Profiler Mooring
- GLOBAL SOUTHERN OCEAN 36
- CABLED ARRAY 0

MAP SECTION

Map of the North Atlantic Ocean showing the Labrador Sea, Labrador Basin, and various ridges and plains. A red dot on the map indicates the location of the CTD Mooring (Inductive) in the Irminger Sea.

OOI Science

ITEM SELECTION

arrays > moorings > platforms > instruments > streams > parameters

Global Irminger Sea > Global Irminger Sea 1 > Mooring Riser > CTD Mooring (Inductive) > ctdmo_ghq_r_sio_mul > ctdmo_seawater_tem

GRAPH

Plot Type: Time Series

Events: OFF

Start Time: 10/01/2014 12:00 PM

End Time: 02/08/2015 7:00 PM

Update

Global Irminger Sea Flanking Subsurface Mooring - Mooring Riser - CTD Mooring (Inductive)

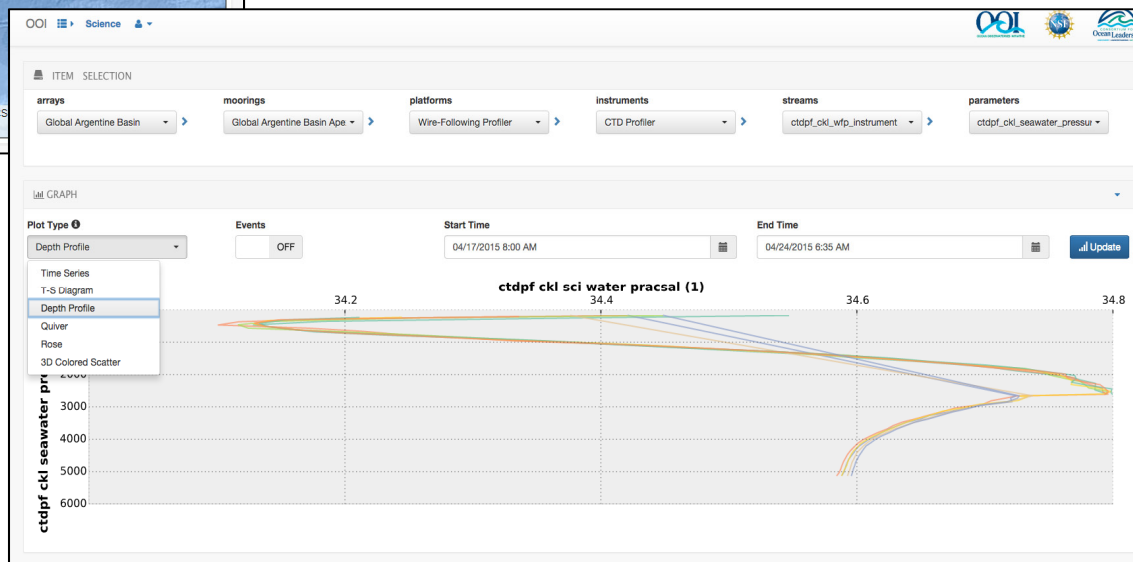
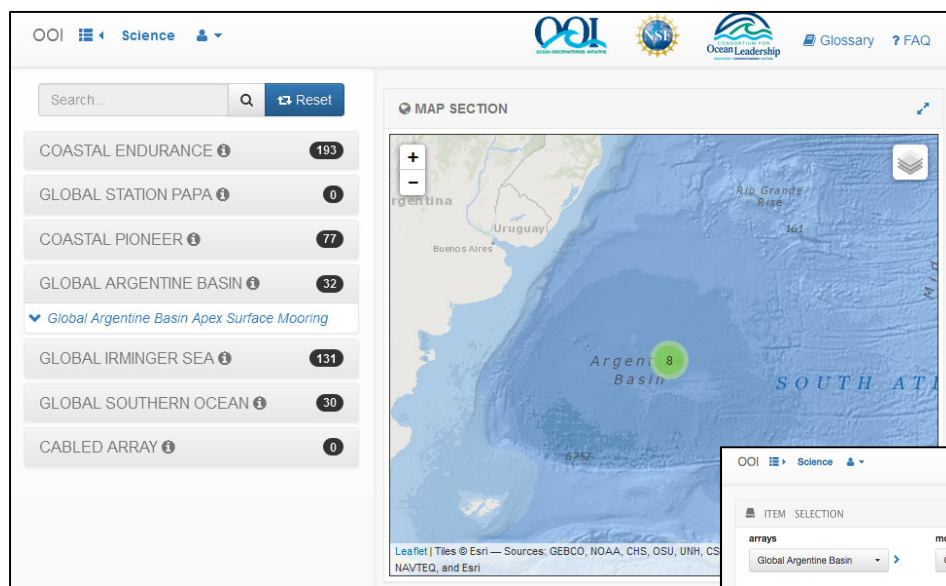
ctdmo seawater temperature (deg C)

3.9
3.8
3.7
3.6
3.5

2014-10-12 2014-10-26 2014-11-09 2014-11-23 2014-12-07 2014-12-21 2015-01-04 2015-01-18 2015-02-01

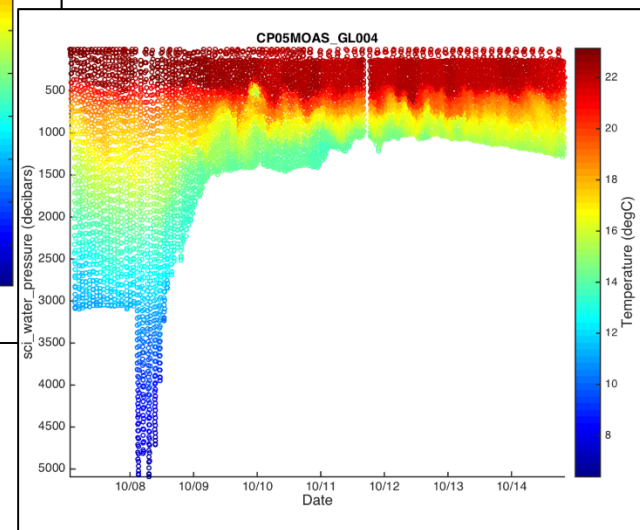
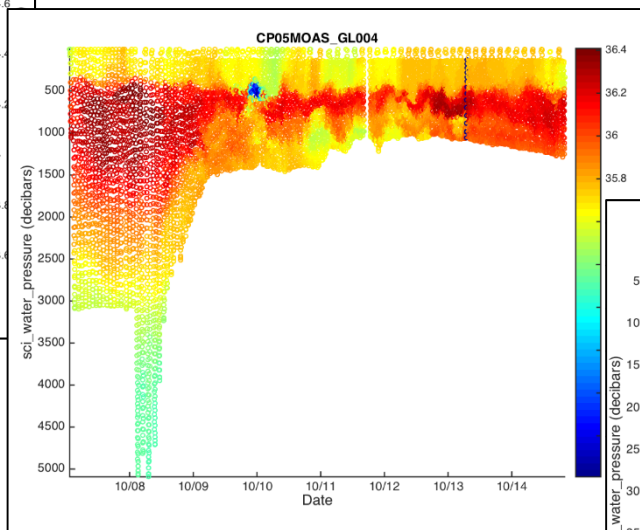
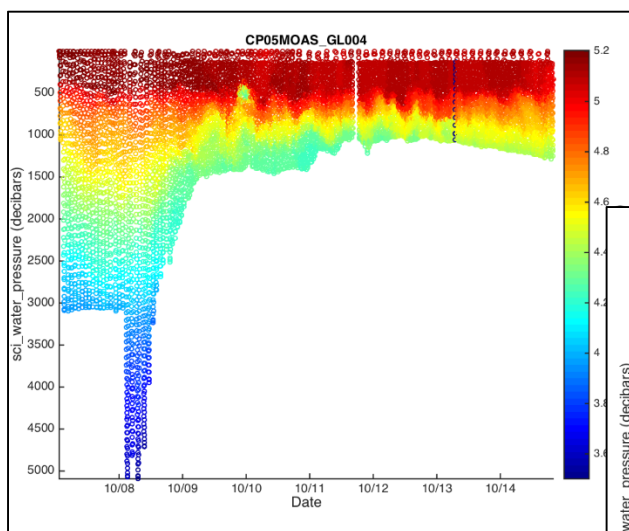
Data Access

- Available Plots
 - Time Series
 - T-S Diagrams
 - **Depth Profiles**
 - Quiver
 - Rose
 - 3D Colored Plots



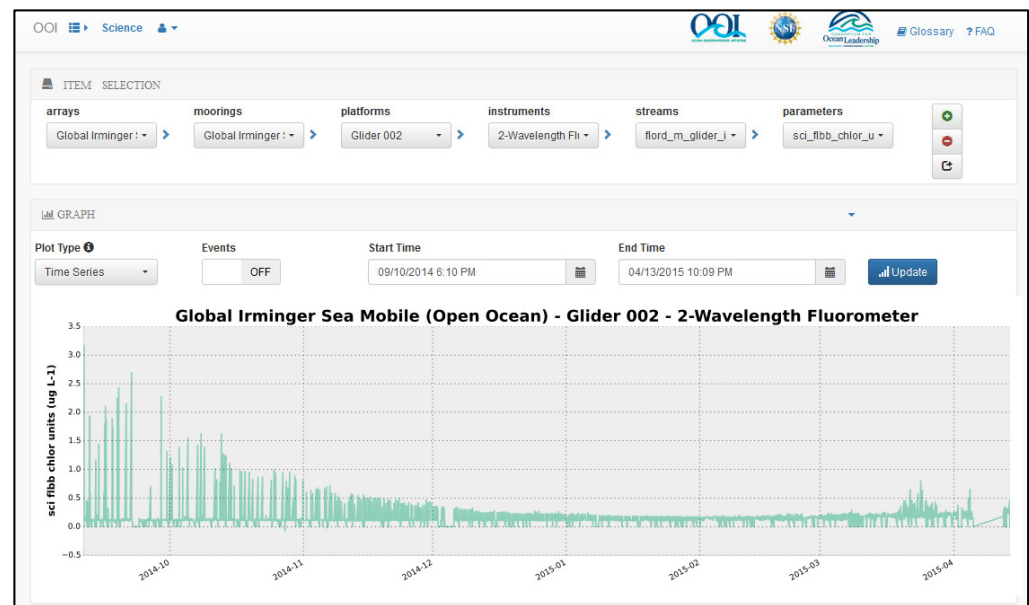
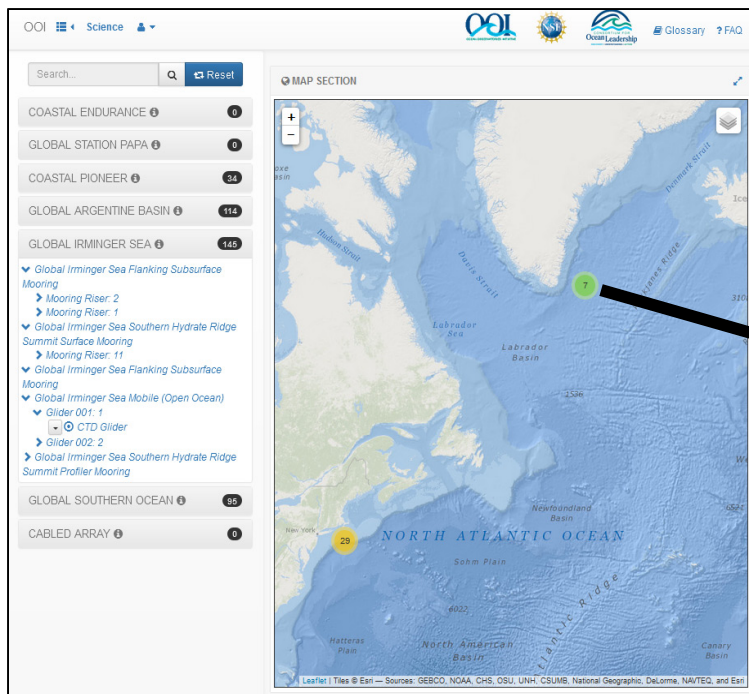
Data Access

- Pioneer Glider Time Series Cross Sections



Data Access

- Data are available through a GUI to display or download
- Data are also available through web services for automatic download
- NetCDF, JSON & csv available



Software Testing

Upcoming software tests of the OOI GUI and web services used to access scientific (L0, L1, L2), engineering and meta data:

- Alpha 2 Test: Early August, 2015
 - 25 selected users testing GUI
 - Beta Test: Early September, 2015
 - ~30 users expanding outside OOI Project
 - Final Test: End September, 2015
 - Numerous testers from the community
-
- Data tests (reasonable, acceptable, etc, more to follow)
 - Surface Moorings: Late September, 2015
 - PH & PCO2: October, 2015
 - Sea Floor Sensors: October 2015



Ship and Shore-based sensor verification

FIELD VERIFICATION- MOORINGS



SHIPBOARD DEPLOYMENTS

- 4 CTD casts/turn- 2 pre-turn, 2 post-turn
- 24 bottles- 10 in upper 200m, 14 in 200-3000m

SAMPLING/ANALYSIS

- Duplicate samples drawn for each analysis
- Sample Draw (location for analysis):
 - O₂ (shipboard- Winkler titration)
 - pH (shipboard- spectrophotmetric)
 - Alkalinity (UW-RSN- open-cell titration)
 - Nutrients- N, P, Si (UW-ChemOcean)
 - Chlorophyll-a (shipboard- fluorometry)
 - Salinity (UW-ChemOcean)

At-sea protocols

Deployment and post-deployment procedures

Deployment documentation

- Pre-deployment checklists [*CP02PMUI-00001_checklist.pdf*]
- Mooring deployment logs [*CP02PMUI-00001_deployment-log.pdf*]

Post-deployment data assessment

- Adjacent CTD cast(s) (temp,sal,oxy,chl,turb) [*see quick look report*]
- Shipboard systems (met, surface t-sal, ADCP) [*SCS_WSPD.gif, SCS_WDIR.gif*]
- Water samples and lab analysis (sal,oxy,chl,etc) [*Pioneer1_salinity_oxygen.xlsx*]

At-sea procedures

Post-deployment procedures

Deployment documentation

- Pre-deployment checklists [*CP02PMUI-00001_checklist.pdf*]
- Mooring deployment logs [*CP02PMUI-00001_deployment-log.pdf*]

Post-deployment assessments

- Adjacent CTD cast(s) (temp,sal,oxy,chl,turb) [*see quick look report*]
- Shipboard systems (met, surface t-sal, ADCP) [*SCS_WSPD.gif, SCS_WDIR.gif*]
- Water samples and lab analysis (sal,oxy,chl,etc) [*Pioneer1_salinity_oxygen.xlsx*]
- Quick-look report [*3204-00023_Poioneer_1_Quick_Look_Cruise_Report.pdf*]
- Lessons learned [*internal working documents*]

Aligning with accepted community standards

ARGO QC Test	OOI QC Test
1. Platform ID*	1. Data is sorted by reference designator so this needs to be correct for the data to go into the file
2. Impossible date*	2. Time series check in quick look plots. An automated algorithm has been suggested
3. Impossible location*	3. Quick look maps generated for glider/mooring locations to determine close approach times for mobile and fixed assets are already being used for this
4. Position on land*	4. Same as 3
5. Impossible speed*	5. Same as 3. Could be automated
6. Global range test*	6. Already part of automated QC algorithms
7. Regional parameter range*	7. Already part of automated QC algorithms
8. Pressure increasing	8. Less relevant. Profilers move both directions and can be impacted by turbulence or shallow water waves
9. Spike test	9. Already part of automated QC algorithms
10. Top - bottom spike - obsolete	10. Obsolete
11. Gradient test	11. Already part of automated QC algorithms
12. Digit rollover	12. Digital rollover? Not sure what this is
13. Stuck value	13. Already part of automated QC algorithms
14. Density inversion	14. Hope to implement this as part of automated QC as level 2 products are produced
15. Grey list	15. Grey list? Not sure what this is
16. Gross salinity or temperature drift	16. Part of the multi-time scale quick look plot examination
17. Visual QC - not mandatory in real time	17. Weekly visual QC is mandatory
18. Frozen profile	18. Part of out of range test or stuck value test
19. Pressure not great than Deepest_Pressure = 10%	19. Pressure outliers identified in quick looks

AUTOMATED QC tests

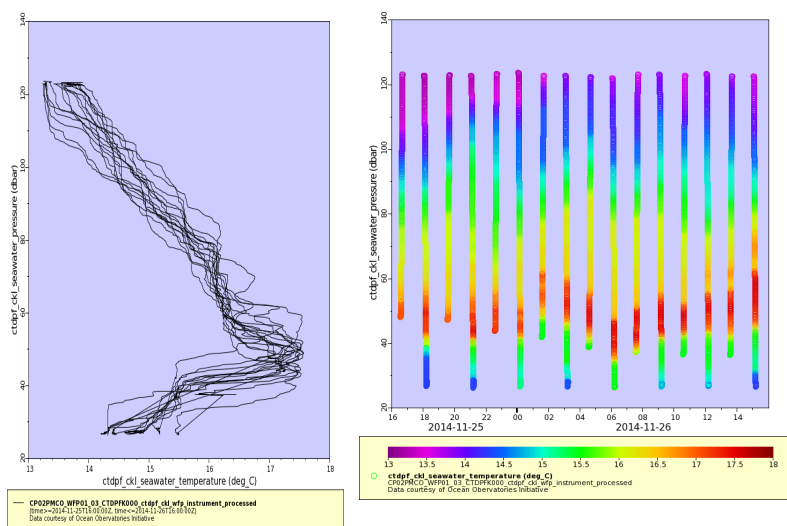
1. Global Range
2. Local Range
3. Spike Test
4. Gradient Test
5. Trend Test
6. Stuck Value Test

FOLLOWED BY HUMAN IN THE LOOP
-flagged data linked to data products

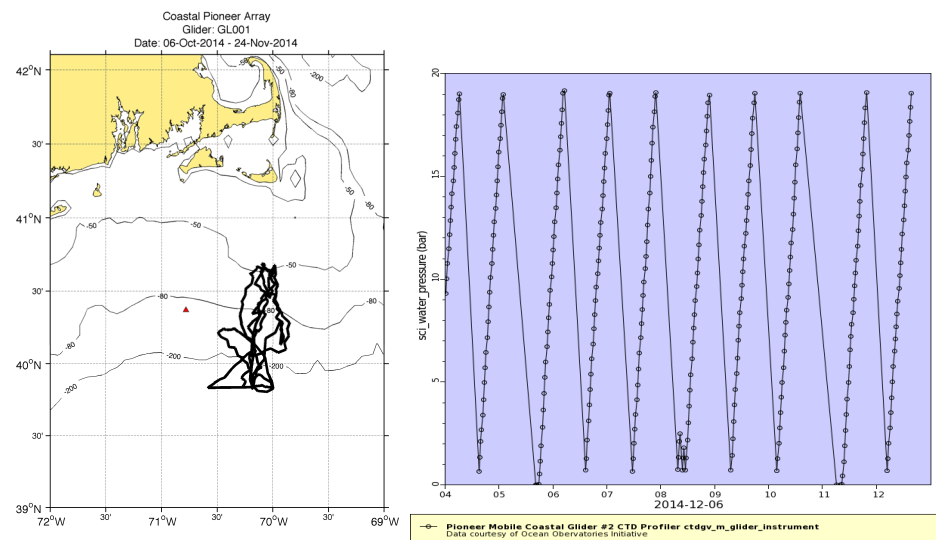
Data Qa/Qc is ongoing using uFrame tools now running at Rutgers

- 1) Science data flowing from in-water assets through OOI net
- 2) Data is provided to scientist available through a series of quick look plots
- 3) Science and engineering data is then used to identify issues warranting a “deep dive”

Wire following profile pioneer array



Glider pioneer array



OOI Commissioning Schedule

Construction of the OOI will be completed this fall. Final commissioning of the arrays is as follows:

- Irminger Sea & Station Papa: 1st week of October
- Southern Ocean, Argentine & Endurance: mid October
- Cabled Array: Late October
- Pioneer Array: End October



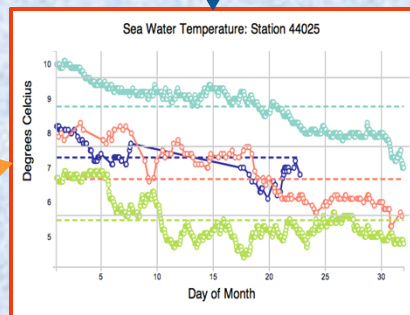
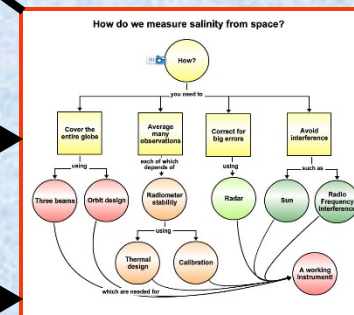
EPE System Architecture

Three primary tools, accessible through a single website, and sharable through a resource database:

Data Investigation Builder

Single Integrated Web-based Portal

External Data

Visualization

Resource Database

Concept Maps

Educational Visualization Service

- Building flexible and customizable visualization tools
- Focused on time series and profiles
- Goal is to balance capability and usefulness
- Multiple entry points (teacher, student, developer)

Tool Controls

Real Time Archived
 Start Date: End Date:

EPE Data Browser

Parameters

air_pressure
 air_temperature
 salinity
 water_temperature
 significant_wave_height
 wind_speed

Networks

NDBC
 CO-OPS

Date Range

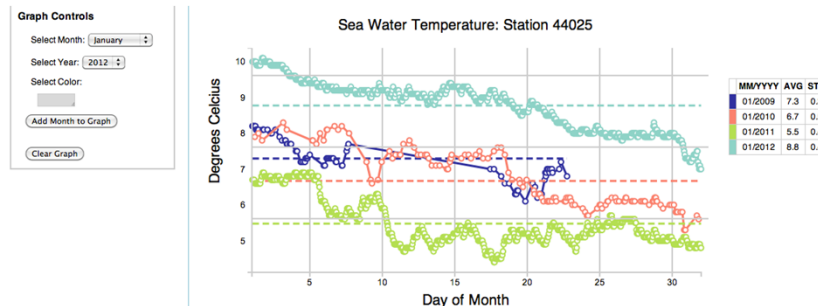
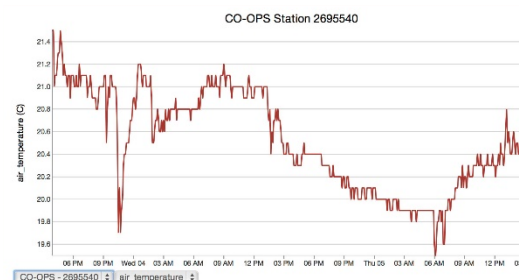
Start Date:
 End Date:

Station Details

Selected Station List

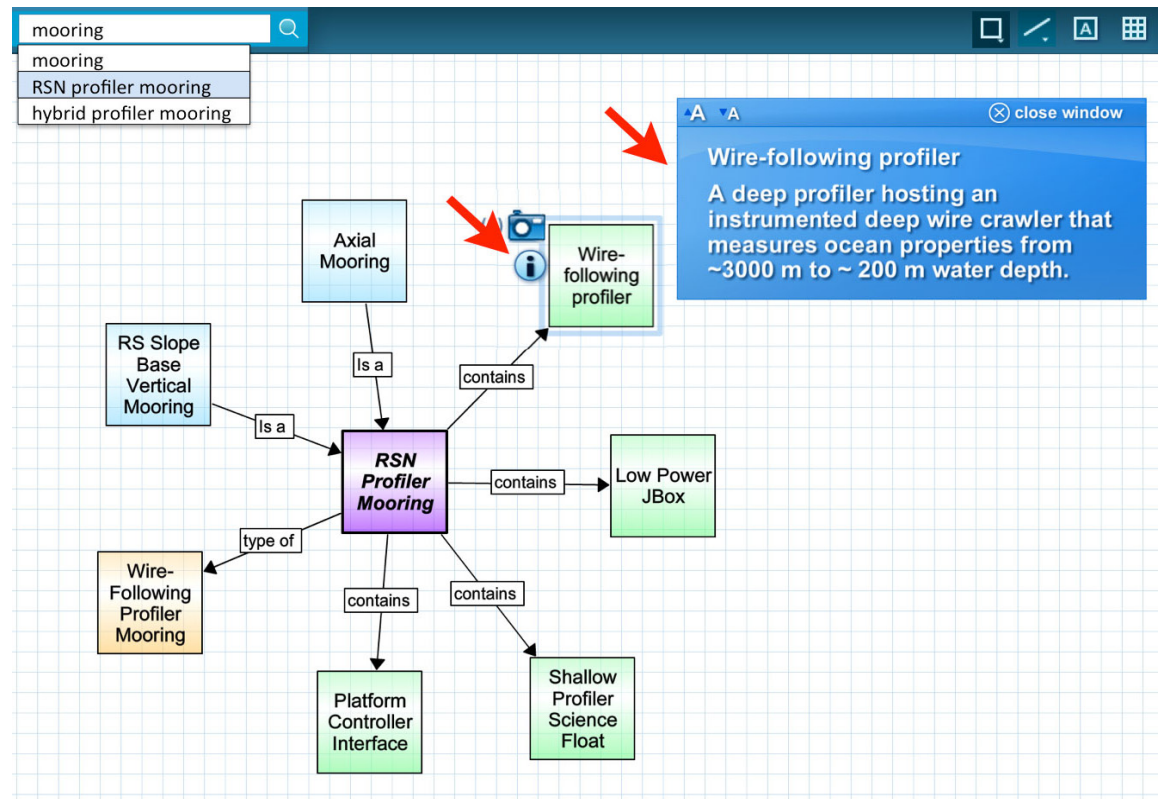
NDBC 44025
 air_pressure
 air_temperature

CO-OPS 2695540
 air_pressure
 air_temperature
 measured_tide



Concept Mapper

- Concept Map Builder (create & edit) and Viewer
- Concept & linking phrase suggestions (ontologies)
- *Embedded content* resources such as descriptions, data visualizations, photos & videos from OOI & outside resources



Data Investigation Builder

- Community library of lessons
- Online lesson template
- Lesson Builder Wizard (step by step design process)
- EPE resource integration

Establish your Content Goals

Let's get started. Before we delve into creating your investigation, take a moment to think about the science concepts you would like your students to investigate in the activity.

Come up with between 1 to 3 science content goals that address what ideas or processes would you like the students to learn about and how those ideas relate to larger ideas.

Enter your content goals here.

Examples

- how changes in CO₂ emissions affect ocean pH and how those changes impact calcifying organisms in the ocean. Carbon is the backbone to life on earth and it plays an important role in our atmosphere as well as our oceans.
- the relationship between temperature and dissolved oxygen. Understanding the properties of water is critical for understanding oceanic ecosystems.
- how temperature and salinity vary over the course of a year at coastal locations. Understanding the spatial and temporal variability of these parameters will help students identify different habitat zones.

Establishing science content goals up front will help you keep focus as you develop your activity. The datasets you include and the questions you ask students to think about should support the goals you identified. If you find that you have additional content you wish students to learn that go beyond these goals, you might consider creating a separate activity to target the investigation focused.

Don't worry about perfecting this right away, you can always come back and adjust them later.

If you have any specific learning objectives you wish to cover, you can enter them here for your reference.

Enter your learning objectives here.

Next >

In this step we will walk through how to create a lesson that takes into account your students' prior knowledge.

Design Process
Content Type
Pathology

Enter the text you would like to appear on this page.

Text area for content.

Question(s)

Enter your questions here.

Also, let's provide some context about the lesson students are about to complete. This could consist of one of the following:

- General information in a study area
- An introduction to how an instrument collects and processes data
- An overview of a scientific experiment or expedition
- Background on how a scientific process works
- Why the process or experience students are about to investigate matters

Enter the text you would like to appear on this page.

Text area for context.

Introductory SlideShow

Upload slide show.

Next >

Create Lab Lesson Builder

Welcome to the Investigation Builder

This tool will help you create an online homework assignment, lecture demonstration, or laboratory using archived or real time data from the Ocean Observing Initiative (OOI).

The OOI is a long-term, NSF-funded program to provide 25-30 years of sustained ocean measurements to study climate variability, ocean circulation and ecosystem dynamics, air-sea exchange, seafloor processes, and plate-scale geodynamics. The OOI will enable powerful new scientific approaches for exploring the complexities of Earth-ocean-atmosphere interactions, thereby accelerating progress toward the goal of understanding, predicting, and managing our ocean environment.

Use this tool to help your undergraduate students learn how interpret scientific data and draw conclusions. We have made this software "smarter" in attempts to help you apply the latest and best information from the learning sciences to help you improve your students' ability to learn science content. The activities created with this tool are ideal for introductory undergraduate classes or as engagement activities for senior level classes.

Definitions

- Homework Assignment**
Ideally these would be videos of professors describing these categories of use. We can use folks from the usability testing record them and publish to the tool interface
- Lecture Demonstration**
- Laboratory Exercise**

- 1) Identify your content goals and learning objectives
- 2) Identify the datasets you would like to use as evidence
- 3) Develop a Challenge Question your students will investigate
- 4) Organize your datasets and add questions to each dataset to assist students in their investigation



- 5) Add summative questions to help students develop an Explanation
- 6) Add questions to help students think about their prior knowledge.
- 7) Add an introduction to help provide a motivating context for your investigation.

Design Process
Content Type
Pathology

How that you have identified the science concepts and datasets you wish to use, we are ready to begin assembling your activity.

The first step is to identify the research challenge you wish your students to pursue. This may or may not be the specific method or research question you would like your students to investigate, depending on whether you would like them to identify a research question or relationship themselves.

We suggest using one of the following approaches, which are based on typical science practices:

- Develop a conceptual model to explain
- Analyze data from... to identify a pattern
- Construct an explanation using the data provided that describes...

The challenge you give to your students should connect your science content goals with applied skills you hope them to develop.

In this activity you will investigate the following challenge:

Image: [No file selected]

Design Process
Content Type
Pathology

The heart of your investigation is the **Explanation** step, in which students view each of the datasets you have selected and consider the questions you have presented.

First, identify the datasets or evidence you would like students to investigate during this activity. Then, for each dataset, add a description and one or more investigation questions.

These datasets will be the evidence students will use to answer the research challenge question while conduct their investigation using data provided. The objective is to help students understand the process and value of science by building from science skills in analyzing and interpreting data, constructing explanations and building models.

To help guide students on how to investigate the datasets, you should provide some additional instructions or questions to help focus their research on the research challenge. This text will appear at the top of the list section.

The objective is to help students understand the process and value of science by building and interpreting data, constructing explanations and building models.

Dataset	Dataset Description	Investigation Question
Add another Dataset	Add ECV Trail Data	Add Inquiry
Add Content Map	Add ECV Trail Data	Add Multimedia
		Add Documents

Design Process
Content Type
Pathology

After student have reviewed all of the datasets, they will be able to summarize and synthesize the information presented. We suggest adding questions that lead to one of the following outcomes:

- Develop a conceptual model. Students can use the EPE Concept Mapping tool to document their model
- Analyze integral data. For example, recognize and describe a phenomenon seen in the data
- Construct an explanation.

These questions should be designed to help students interpret the data and make inferences to the science concepts you wish them to learn (see below).

If you wish students to simply confirm an observed process, students should be able to summarize the dataset and confirm that it matches the expectations set out in the problem and background sections.

If you are hoping for a deeper understanding, you should give students to combine several pieces of evidence to develop their own conclusions based on the data.

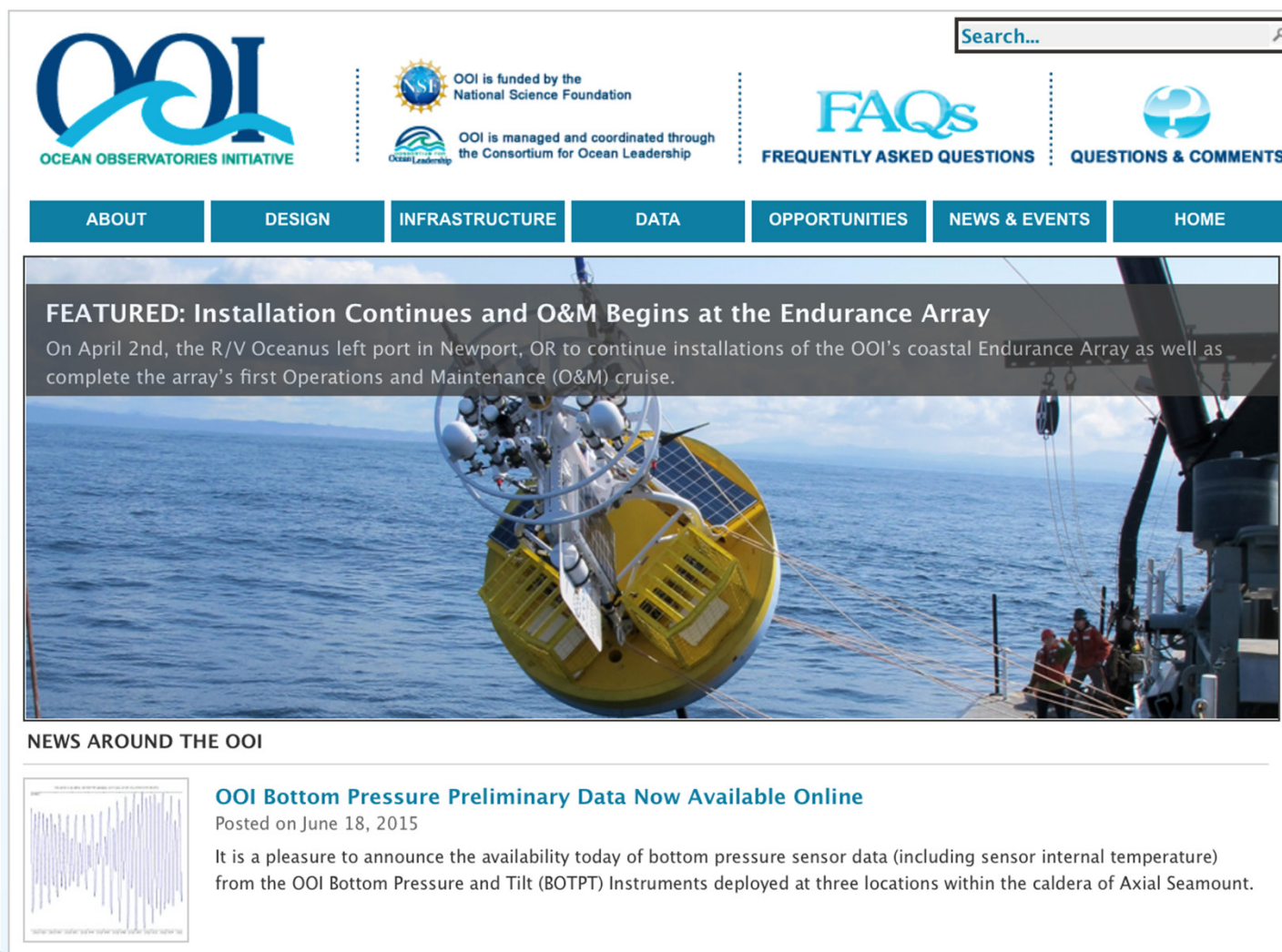
Recall that the research question you are trying to address is:
 Analyze data from observations and models to identify possible relationships between hurricanes and the ocean.
 As you take into account the data you just viewed, consider the following inference questions:
 Add one or more summary questions that requires students to make inferences from the data.

Example Summary Questions

- Blank
- Blank
- Blank

Add another question

Website: <http://oceanobservatories.org>



The screenshot shows the OOI website homepage. At the top right is a search bar. Below it are navigation links for 'FAQs' and 'QUESTIONS & COMMENTS'. A central navigation bar contains links for 'ABOUT', 'DESIGN', 'INFRASTRUCTURE', 'DATA', 'OPPORTUNITIES', 'NEWS & EVENTS', and 'HOME'. The main content area features a featured article titled 'Installation Continues and O&M Begins at the Endurance Array' with a photograph of a yellow buoy being hoisted by a crane on the deck of the R/V Oceanus. Below this is a 'NEWS AROUND THE OOI' section with a sub-headline 'OOI Bottom Pressure Preliminary Data Now Available Online' and a small line graph showing data fluctuations.



OOI is funded by the National Science Foundation



OOI is managed and coordinated through the Consortium for Ocean Leadership

FAQs

FREQUENTLY ASKED QUESTIONS



QUESTIONS & COMMENTS

ABOUT

DESIGN

INFRASTRUCTURE

DATA

OPPORTUNITIES

NEWS & EVENTS

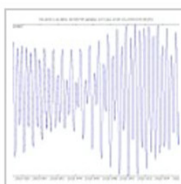
HOME

FEATURED: Installation Continues and O&M Begins at the Endurance Array

On April 2nd, the R/V Oceanus left port in Newport, OR to continue installations of the OOI's coastal Endurance Array as well as complete the array's first Operations and Maintenance (O&M) cruise.



NEWS AROUND THE OOI



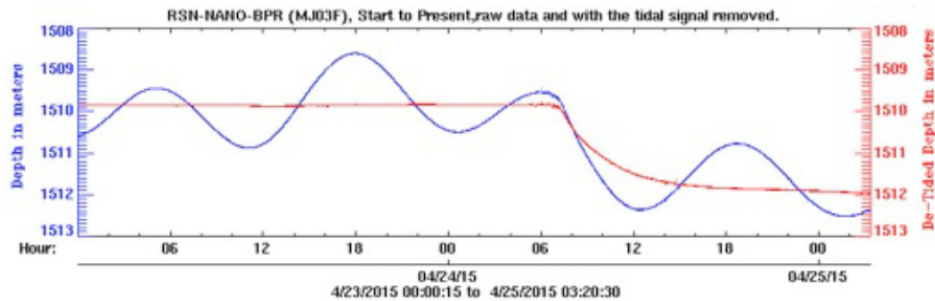
OOI Bottom Pressure Preliminary Data Now Available Online

Posted on June 18, 2015

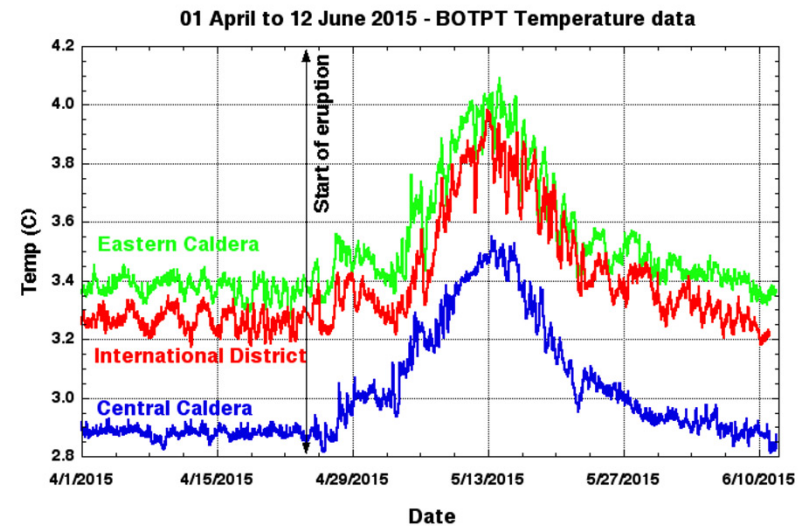
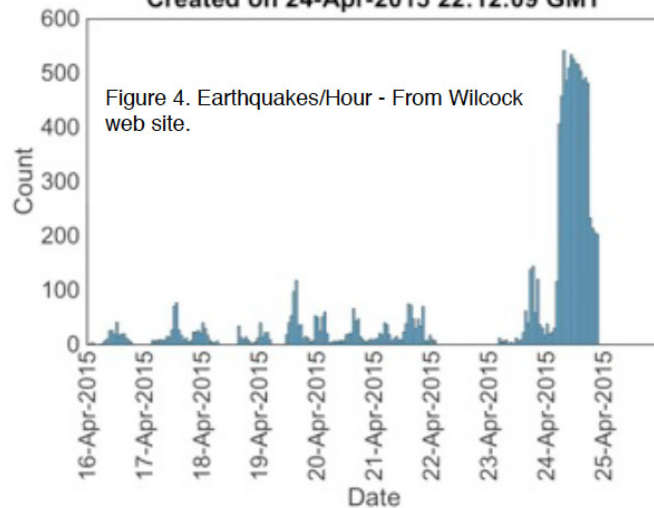
It is a pleasure to announce the availability today of bottom pressure sensor data (including sensor internal temperature) from the OOI Bottom Pressure and Tilt (BOTPT) Instruments deployed at three locations within the caldera of Axial Seamount.

4/23/2015 (Capturing an Earthquake)

Seafloor pressure (red detided)



Preliminary Earthquake histogram by hour for 72128 events
Created on 24-Apr-2015 22:12:09 GMT



Special thanks to Al Herrington, William Chadwick, John Delaney, Deb Kelly, and William Wilcock

Conclusions

- Open access high frequency diverse data for sustained periods of time
- Ability to enable science as is, provide a infrastructure to expanded by investigators, and can provide leverage to other programs
- Coupled to tools to enable teaching and shared community education resources