Ocean Observatories Initiative

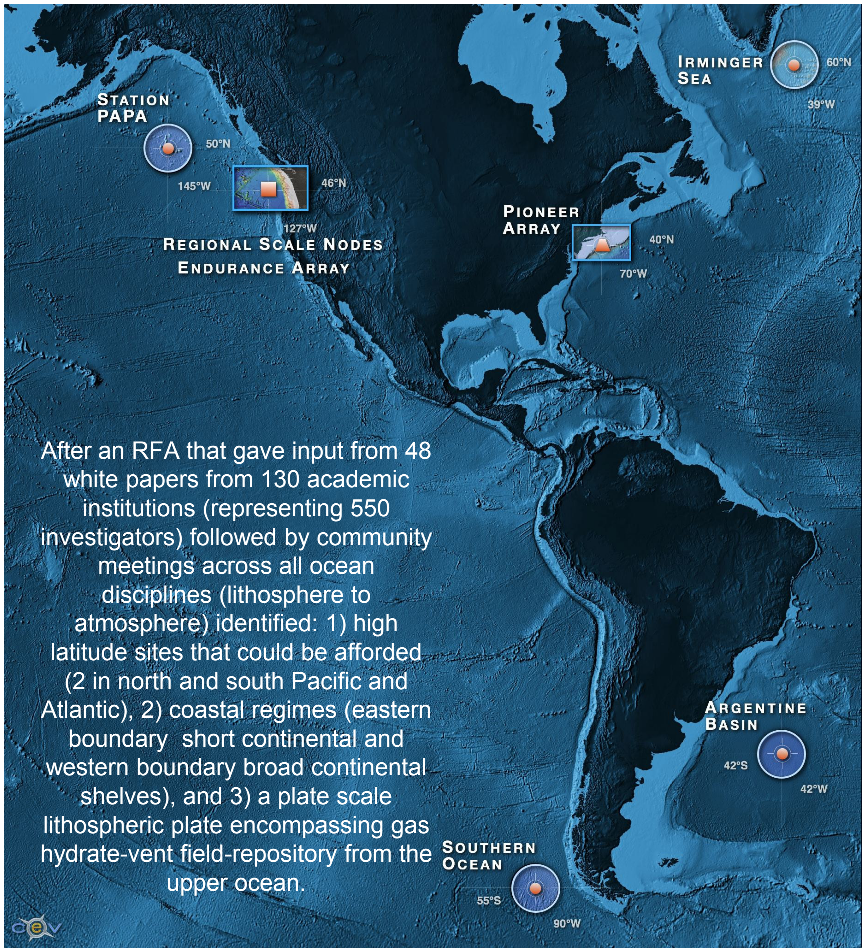
Where are we?

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

Themes to be covered

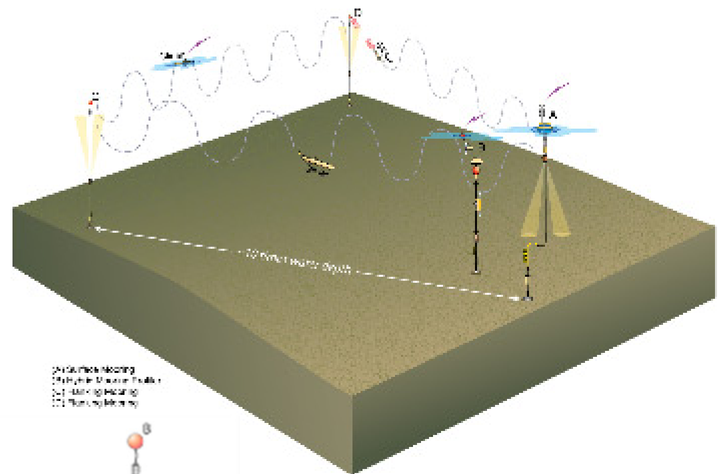
- History and status
- Basic system
- Science Potential
- Procedures For Data Quality

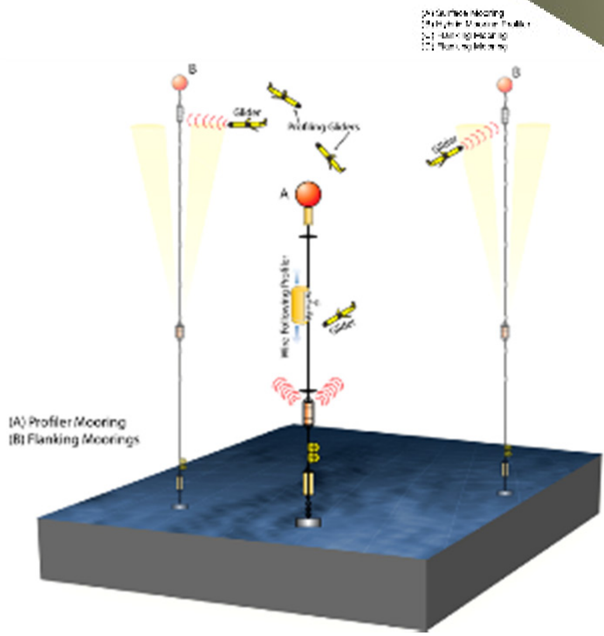
What is being built?



- 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

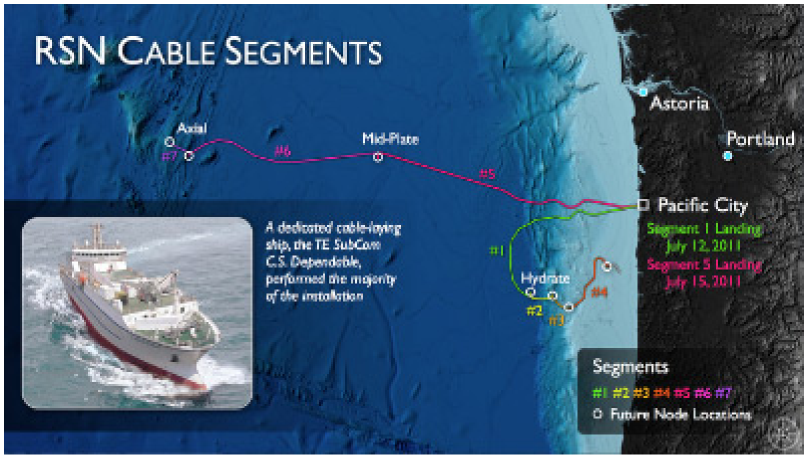
OOI Components: Global Component

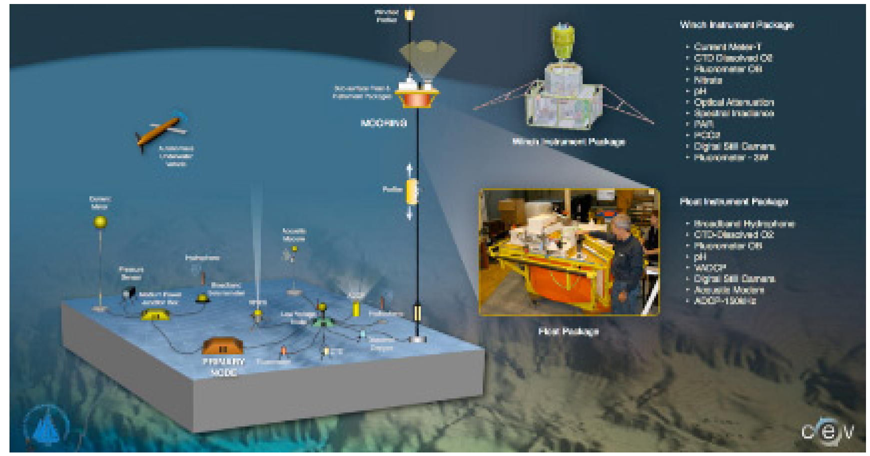




- Four Global Sites
  - Flanking Moorings
  - Profiler Mooring
  - Gliders (5)
  - Acoustics

OOI Components: Cabled Array

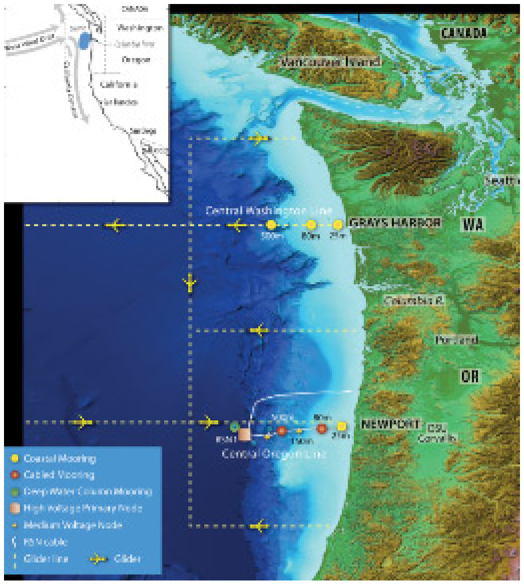


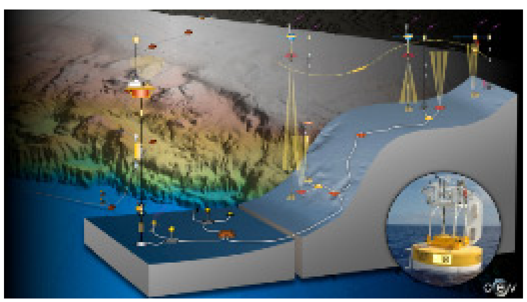


- Moorings
- Profilers
- HD Video
- Met Data

OOI Components: Coastal Component

West Coast: Endurance Array

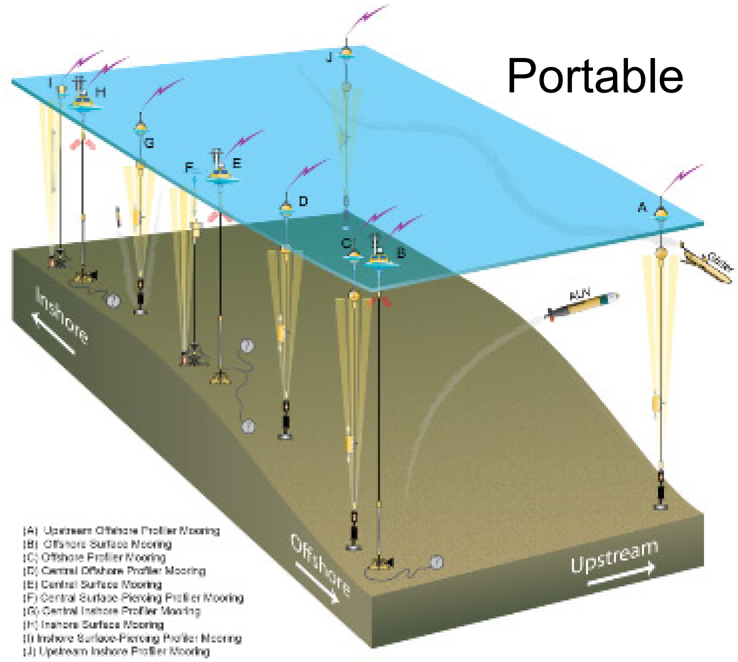




- Glider AUVs
- REMUS AUVs
- Moorings
- Profilers
- Met Data

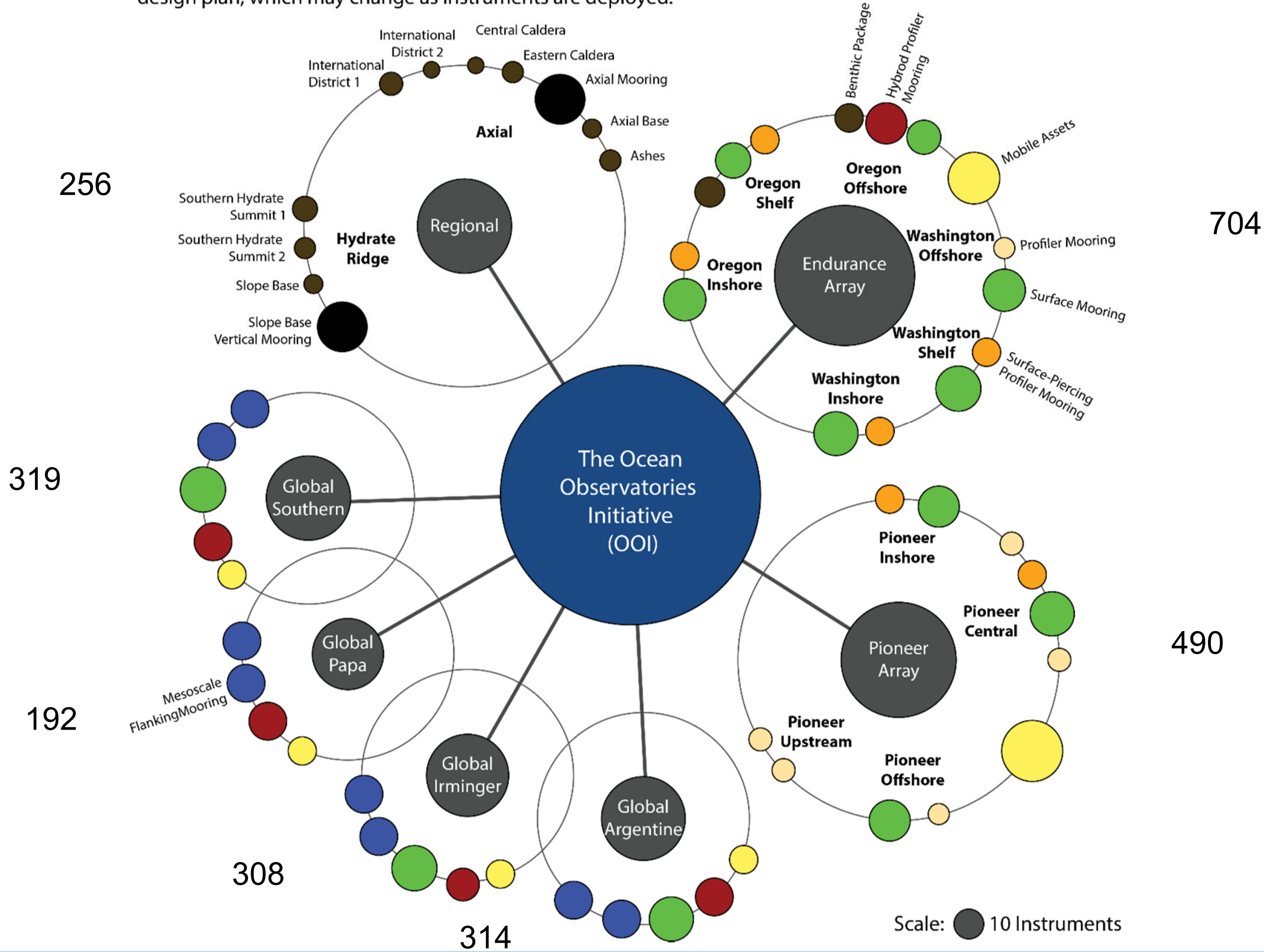
East Coast: Pioneer Array

Portable



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

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

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

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			🍁

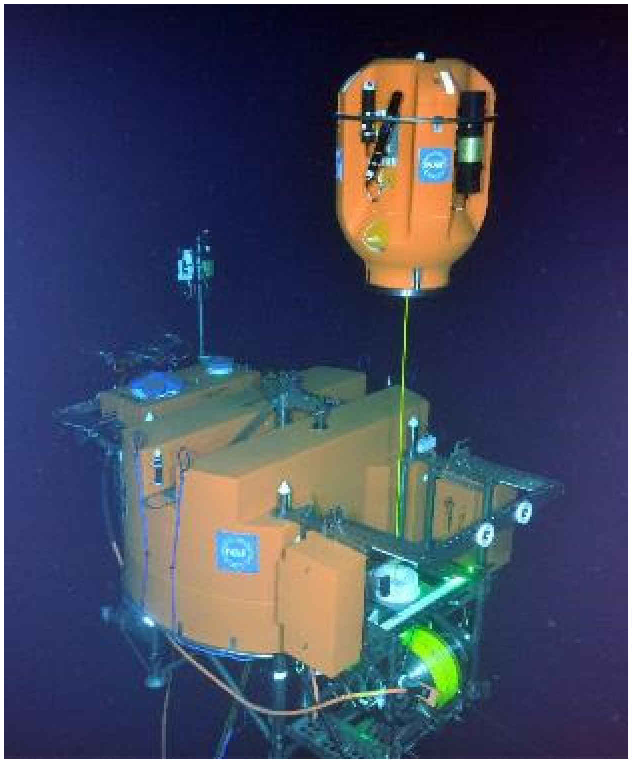
Pioneer Array: deployments

Pioneer surface moorings, Fall 2014.

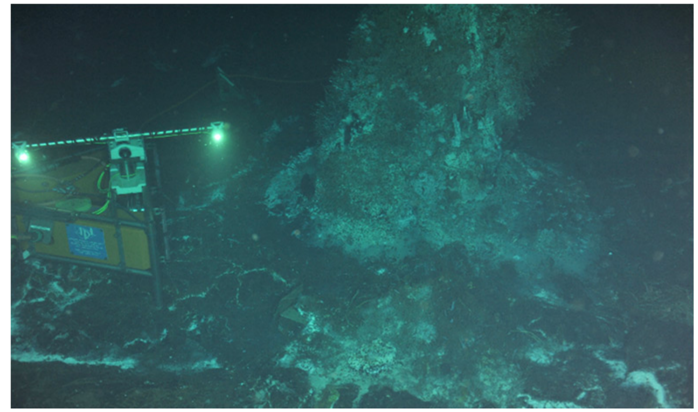
REMUS 600 AUV Testing at Pioneer, May 2015.

Ocean glider deployments, Spring 2015.

Cabled Observatory: deployments



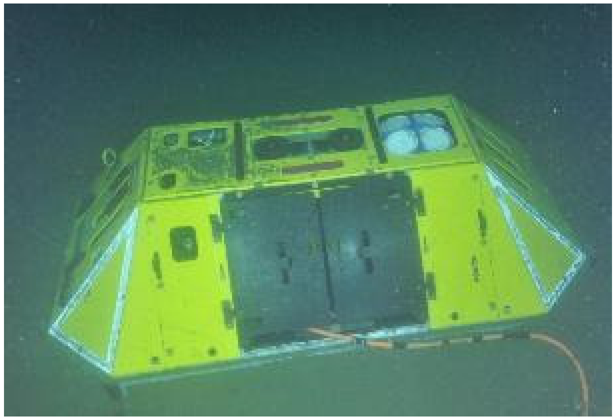
Shallow Profiler platform on a 2700 m-tall, 2 legged mooring hosting acoustic doppler current profilers, a digital still camera, and chemical and biological sensors (summer 2015).



Digital Still Camera, summer 2014).

3D Temperature Sensor, summer 2015.

Endurance Array: deployments

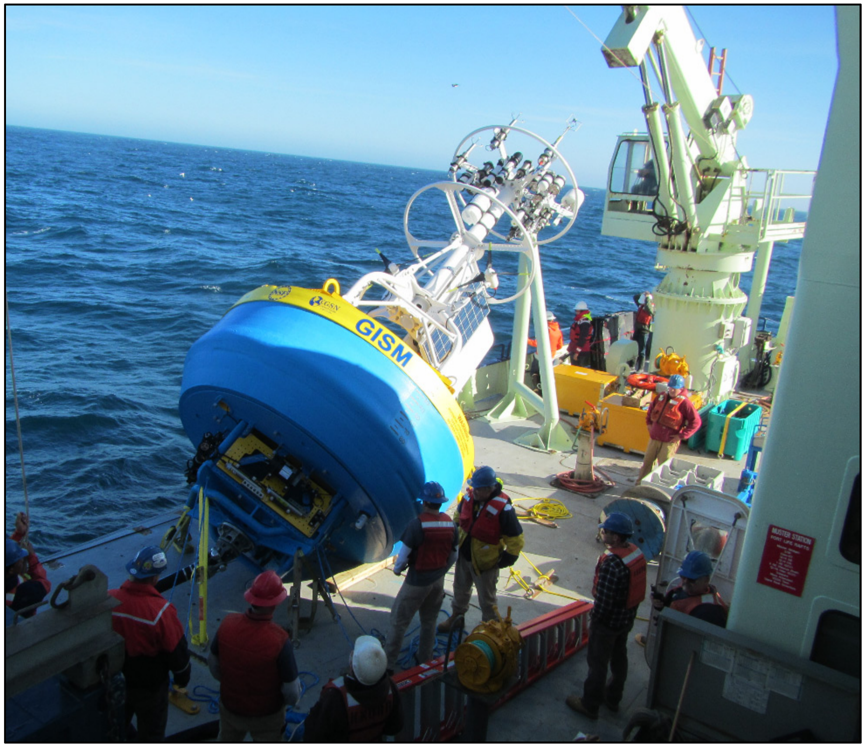


Benthic Experiment Package (ADCP visible on top), summer 2014.

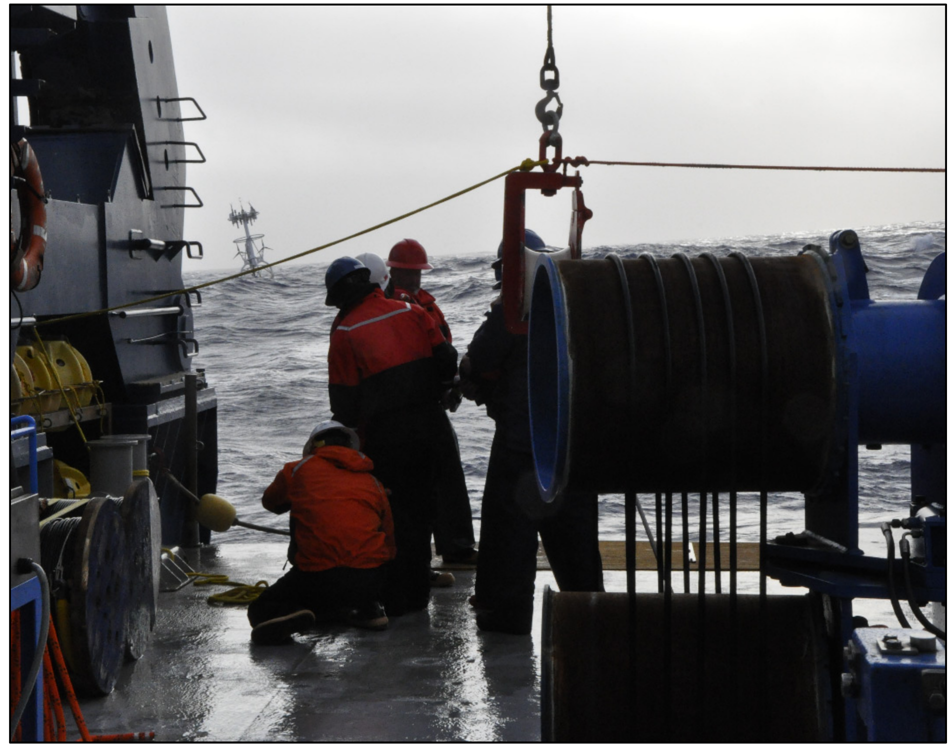
ROPOS ROV and Benthic Experiment Package pre-deployment, summer 2014.

Endurance surface mooring deployment, July 2015.

Global Array: deployments



Irminger Surface Mooring, Winter 2014.



Southern Ocean, July 2015.

OOI By the Numbers

7 Arrays

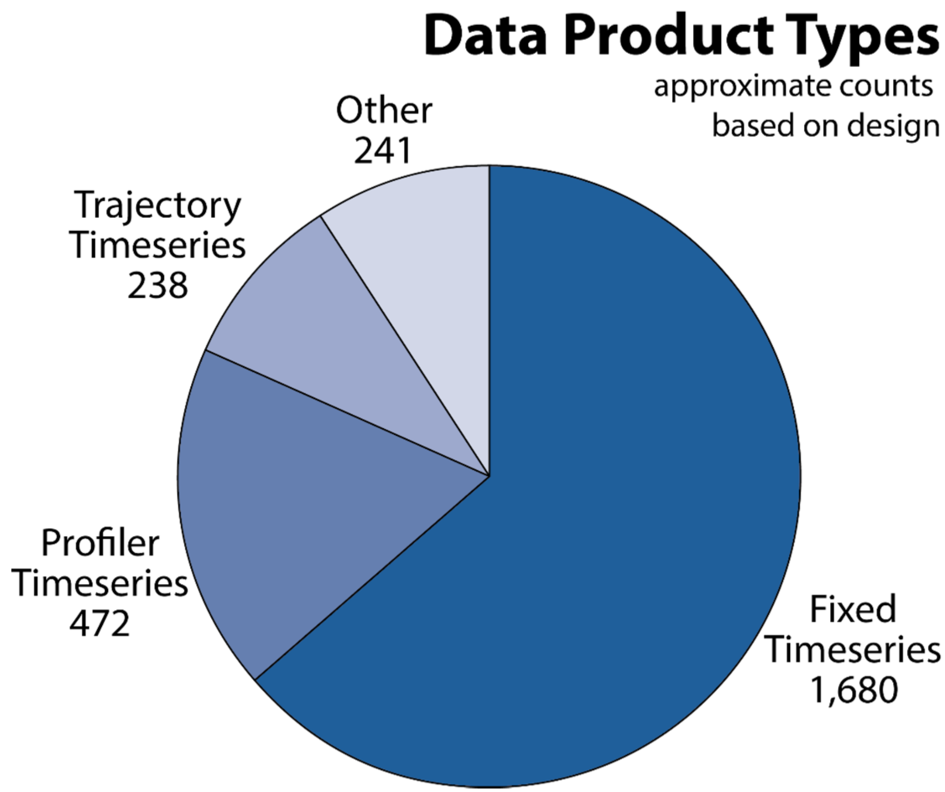
50 Sites
Moorings, Profilers, Nodes

26 Mobile Assets
Gliders, AUVs

762 Planned Instruments

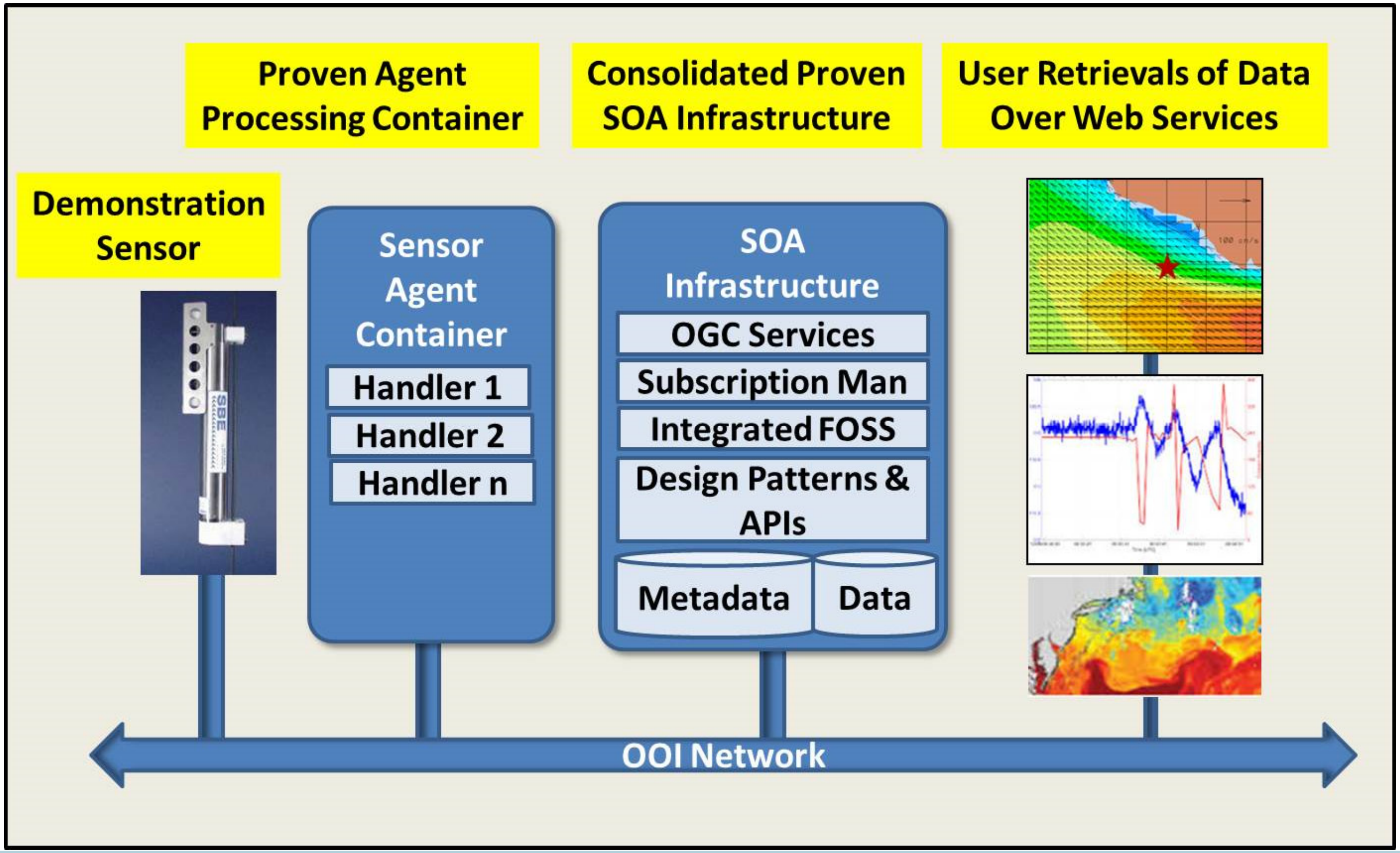
2,631 Potential Data Product Streams

(2,583 yesterday)



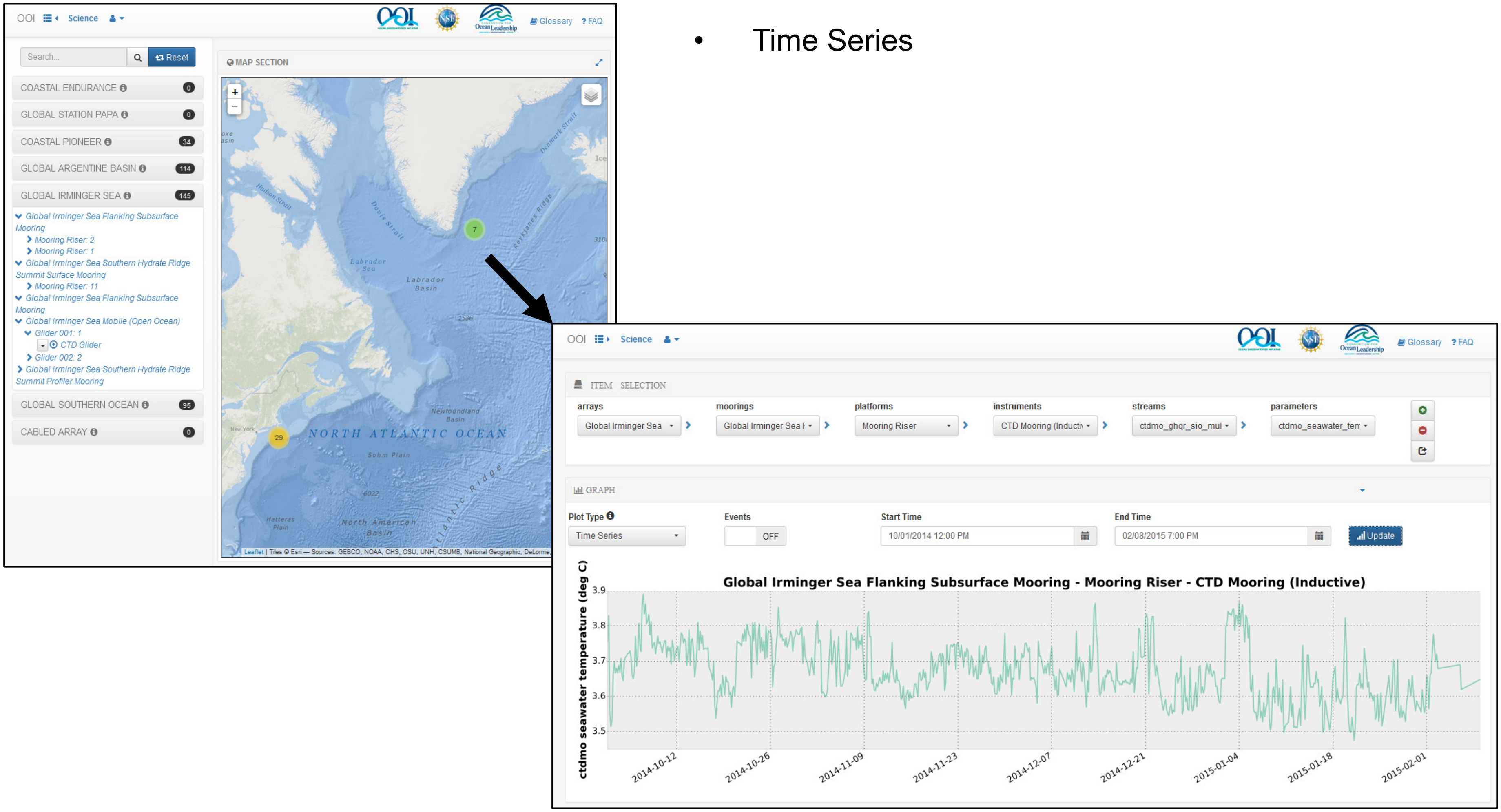
Web based services

Technical Approach Uses Proven SOA Infrastructure to Integrate OOI Data

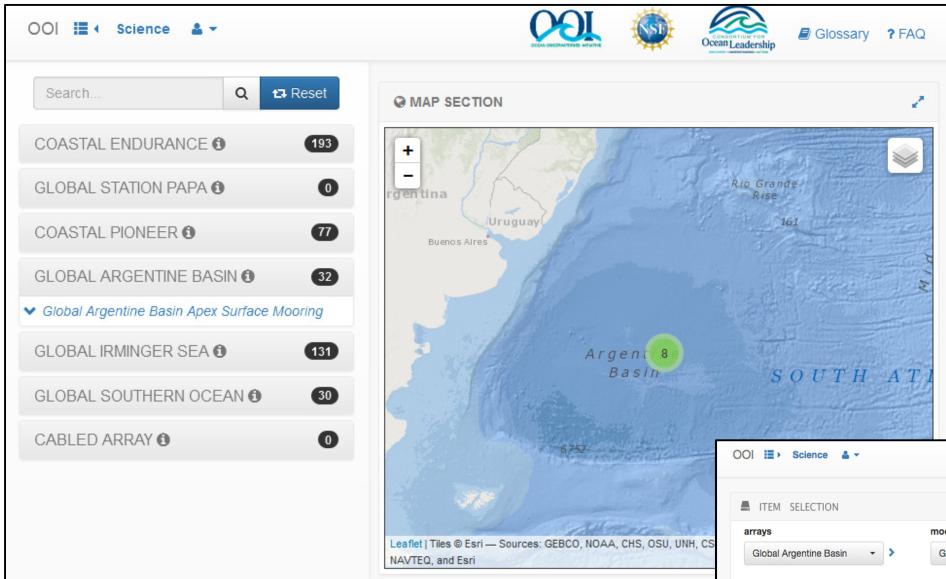


Data Access

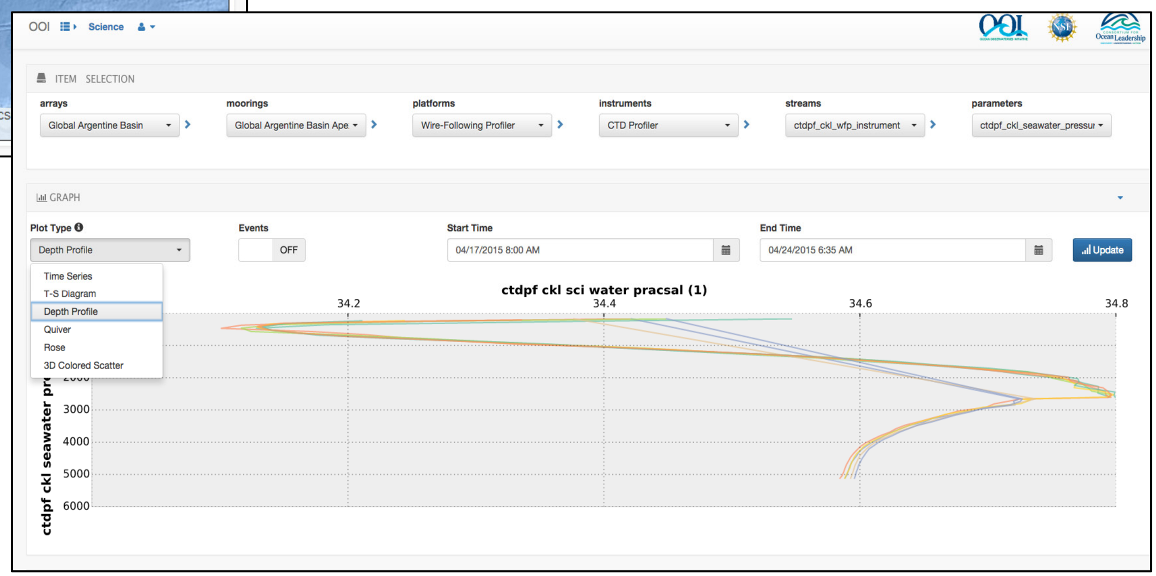
- Time Series



Data Access

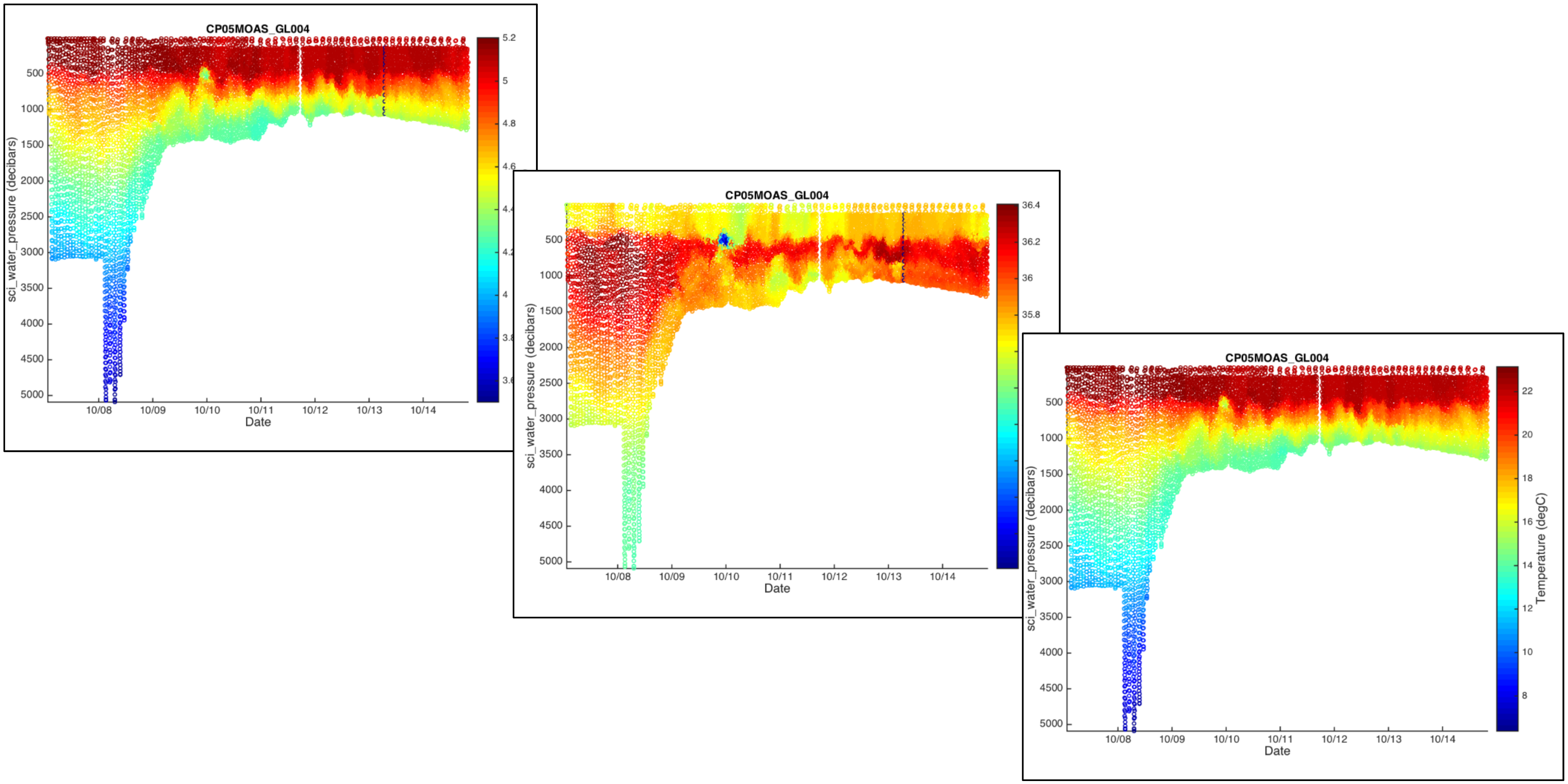


- Available Plots
  - Time Series
  - T-S Diagrams
  - Depth Profiles
  - Quiver
  - Rose
  - 3D Colored Plots



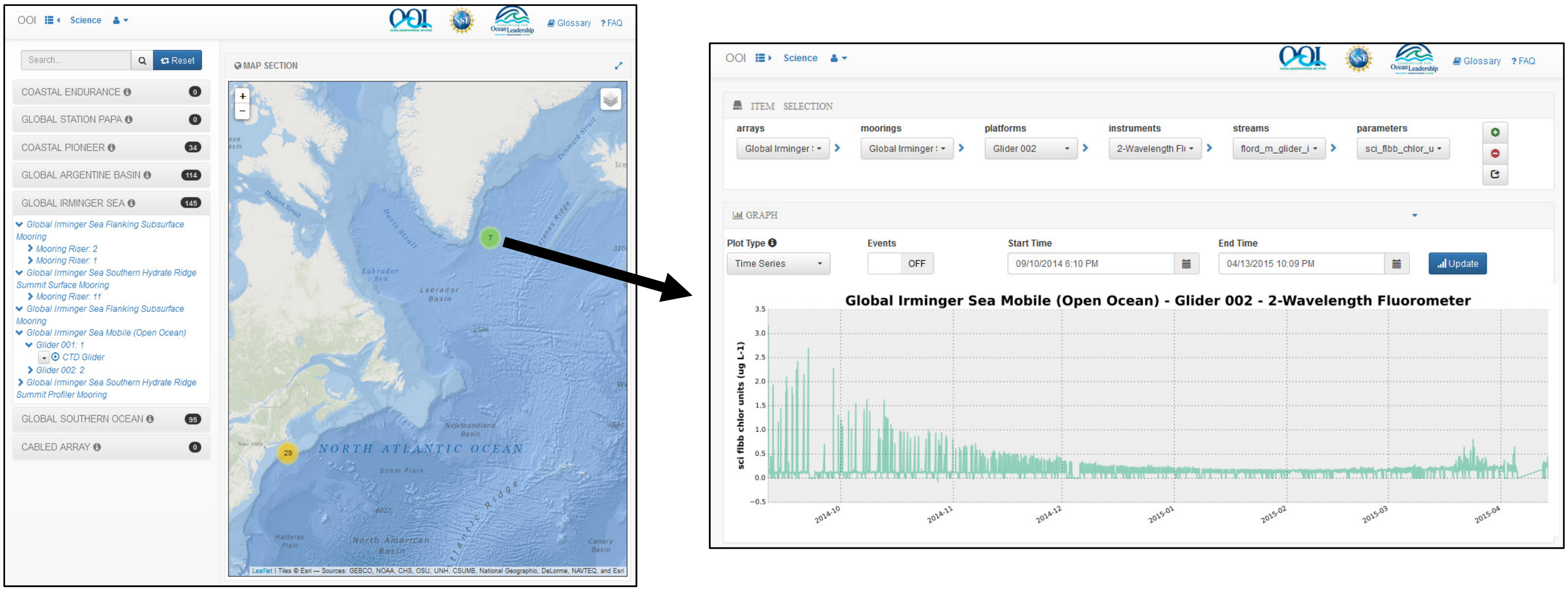
Data Access

- 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



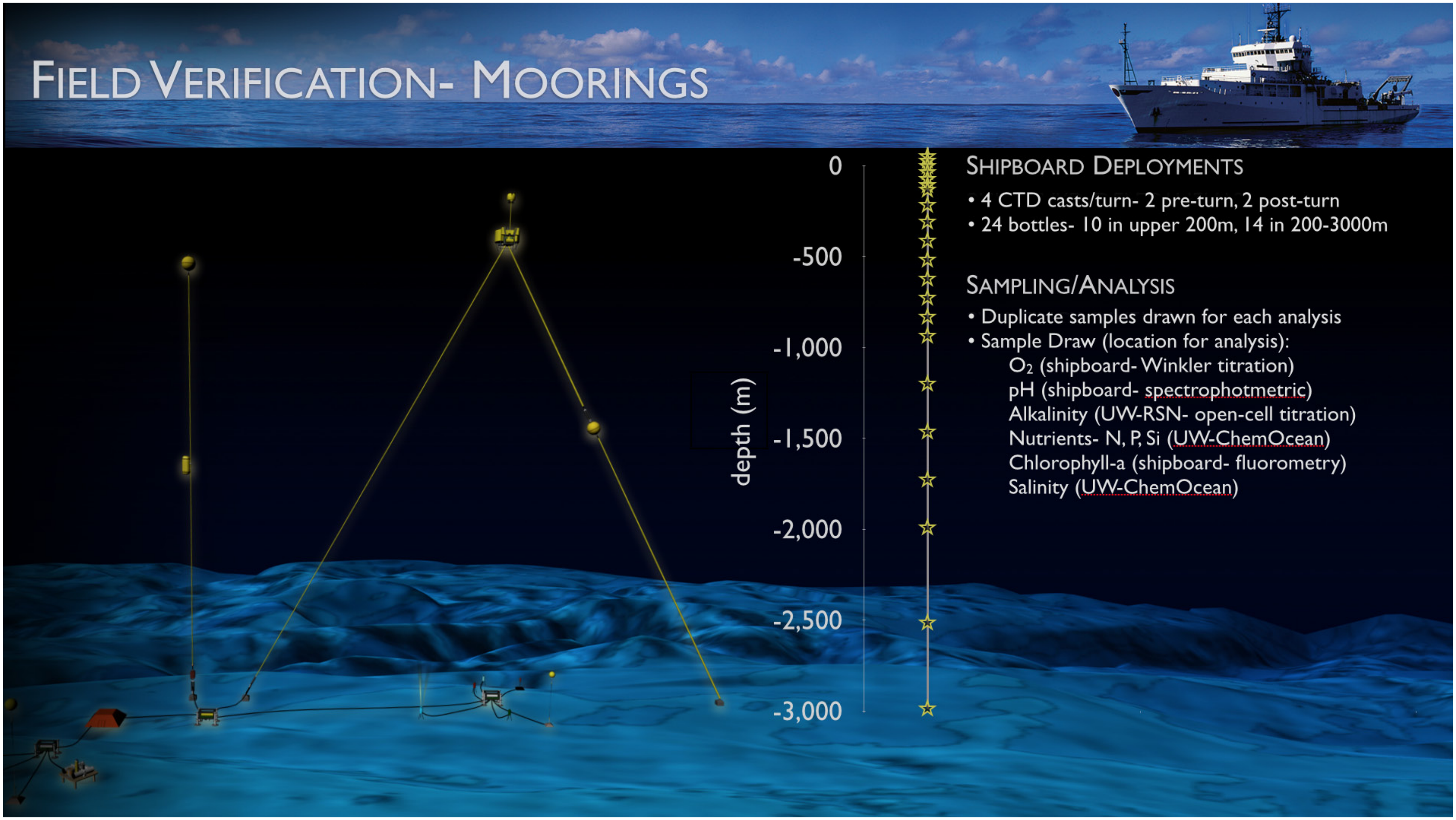
Software Testing

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



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_Poineer_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

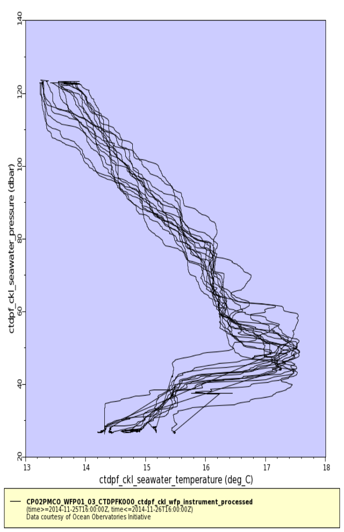
1. Global Range
2. Local Range
3. Spike Test
4. Gradient Test
5. Trend Test
6. Stuck Value Test

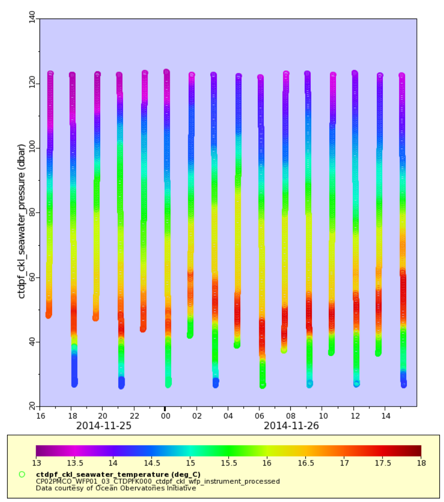
FOLLOWED BY HUMAN IN THE LOOP
-flagged data linked to data products

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

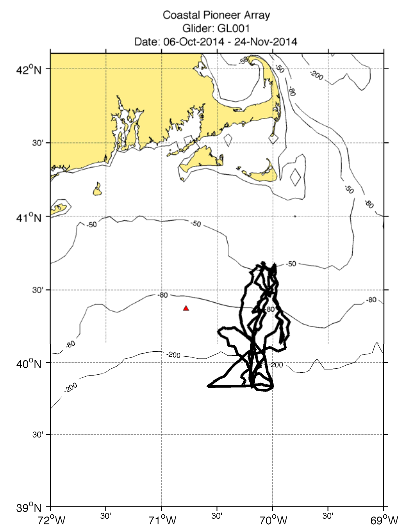
1) Science data flowing from in-water assets through OOInet
2) Data is provided to scientist available through a series of quick look plots
3) Science and engineering data is then used to identify issues warranting a “deep dive”

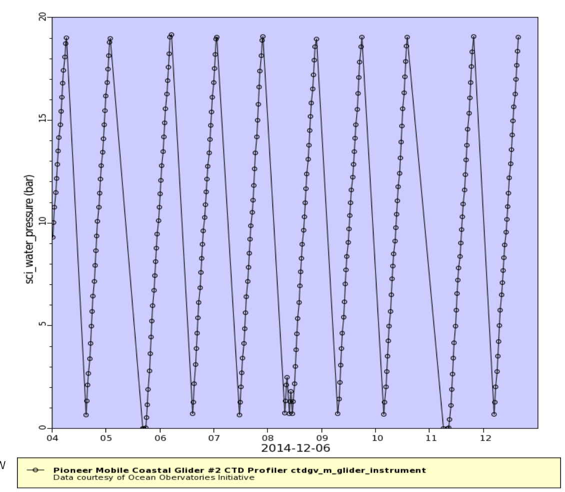
Wire following profile pioneer array





Glider pioneer array





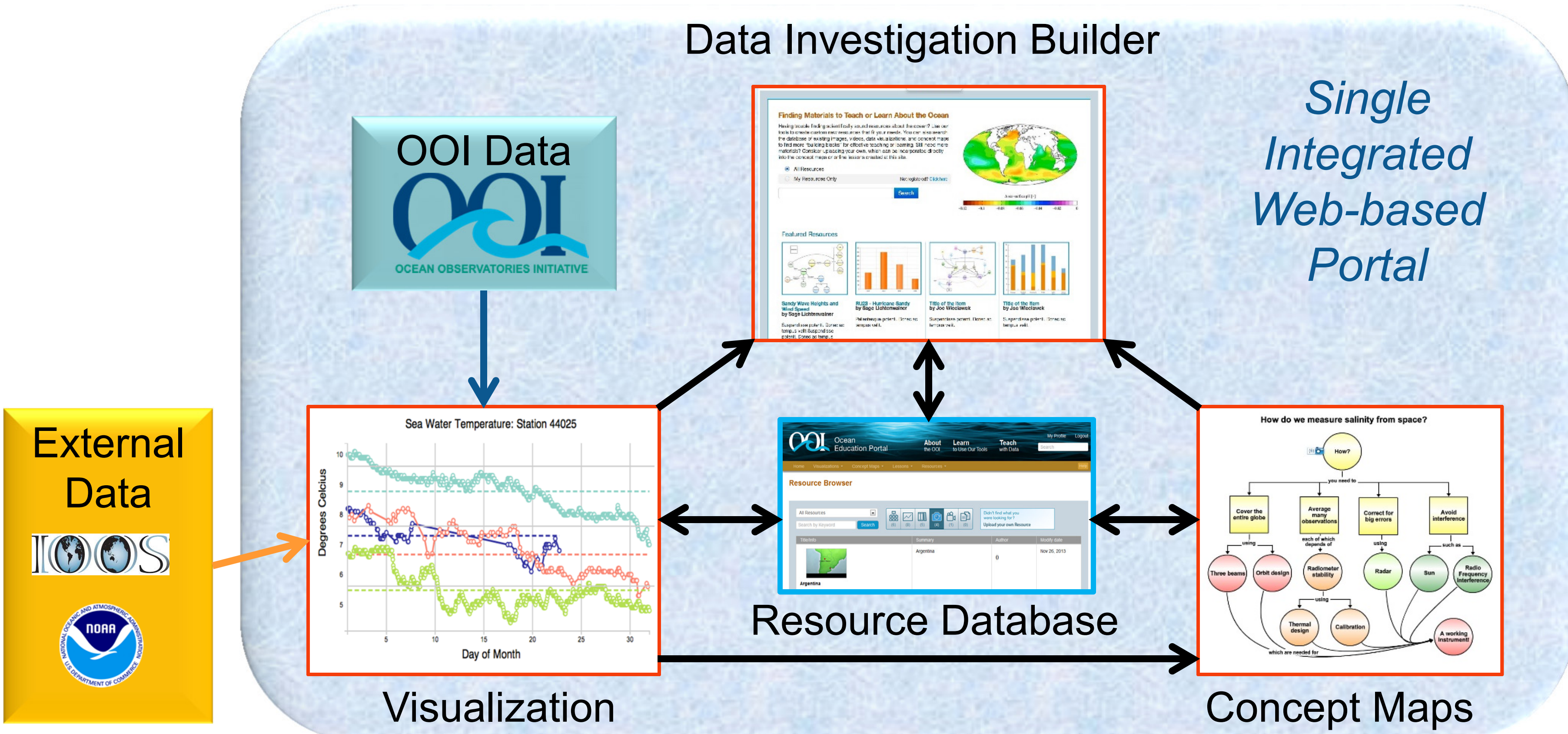
OOI Commissioning Schedule

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

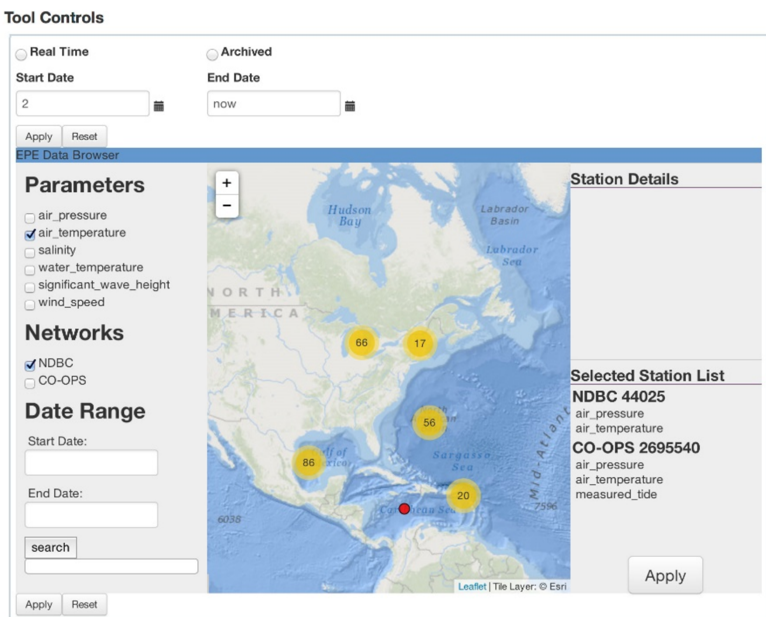
EPE System Architecture

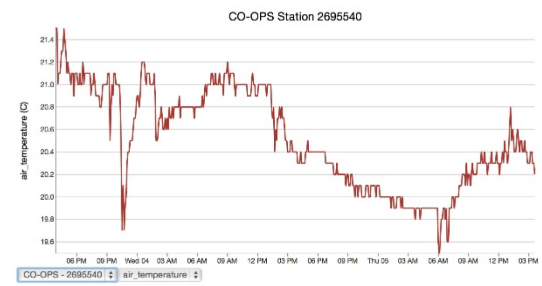
Three primary tools, accessible through a single website, and sharable through a resource database:

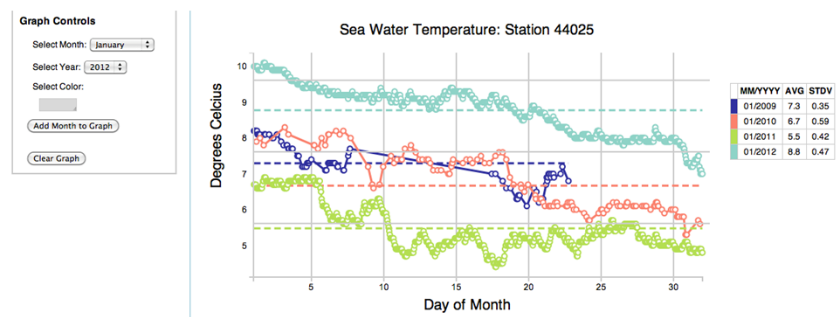


Educational Visualization Service

- 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)

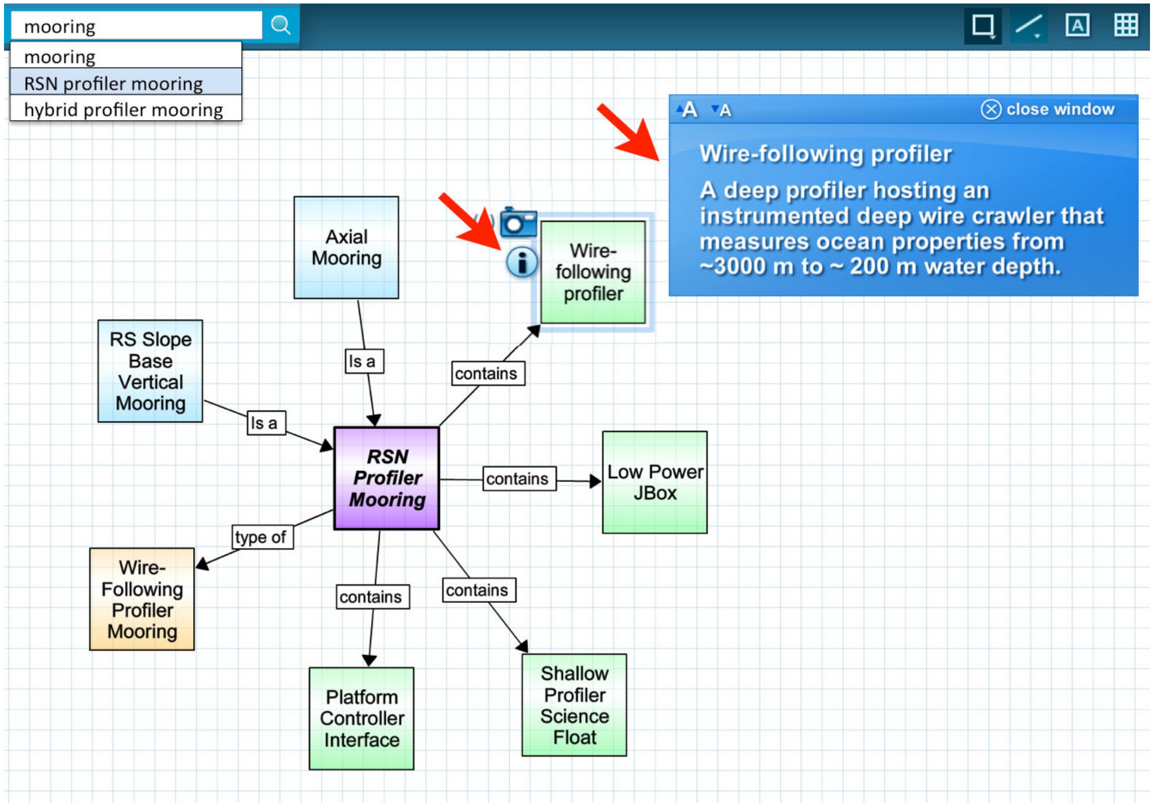






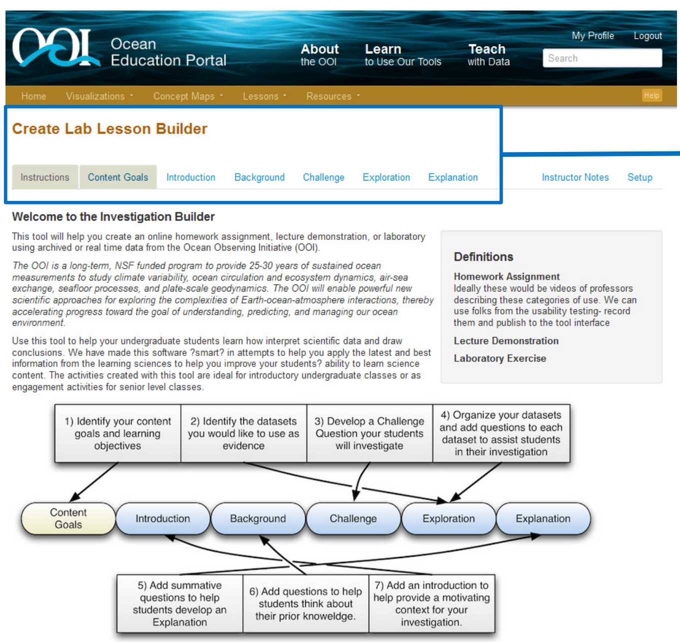
Concept Mapper

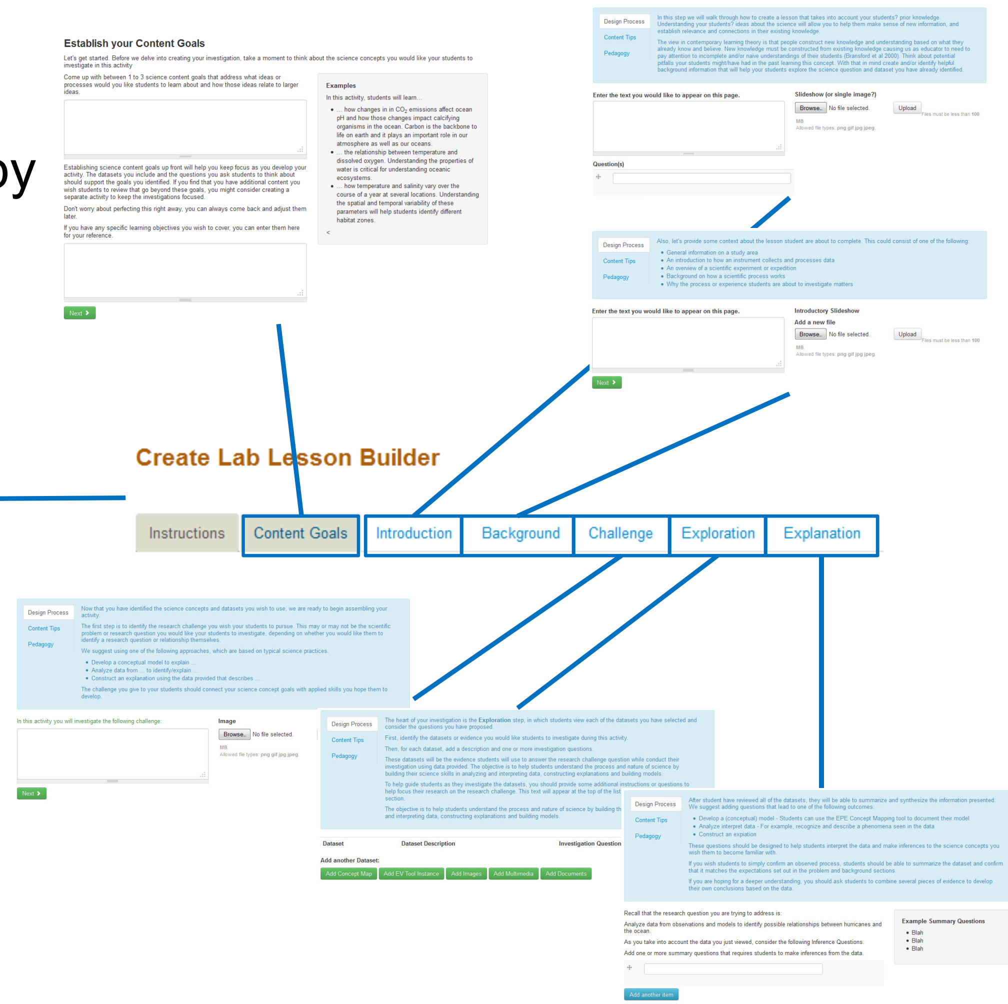
- Concept Map Builder (create & edit) and Viewer
- Concept & linking phrase suggestions (ontologies)
- *Embedded content* resources such as descriptions, data descriptions, data visualizations, photos & videos from OOI & outside resources



Data Investigation Builder

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

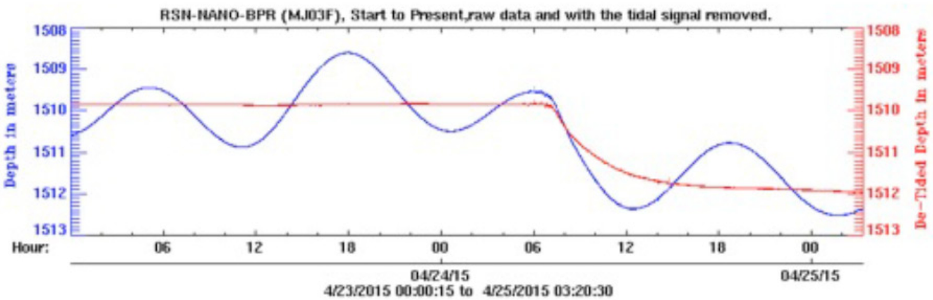


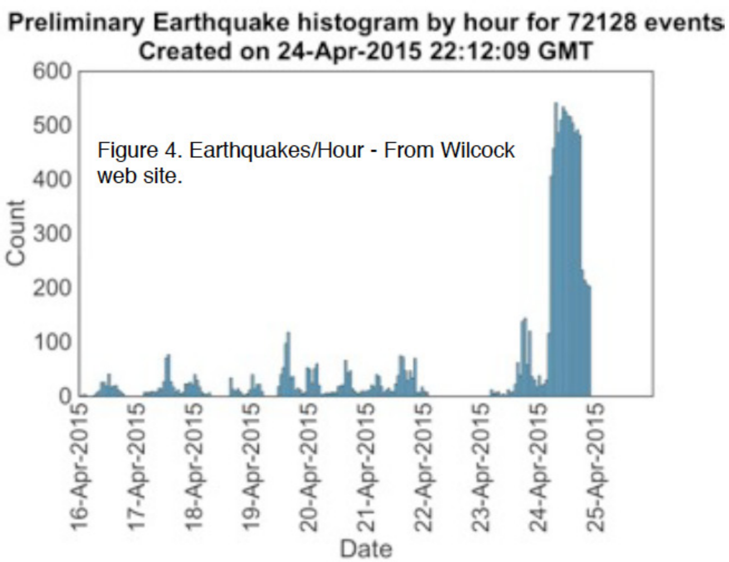


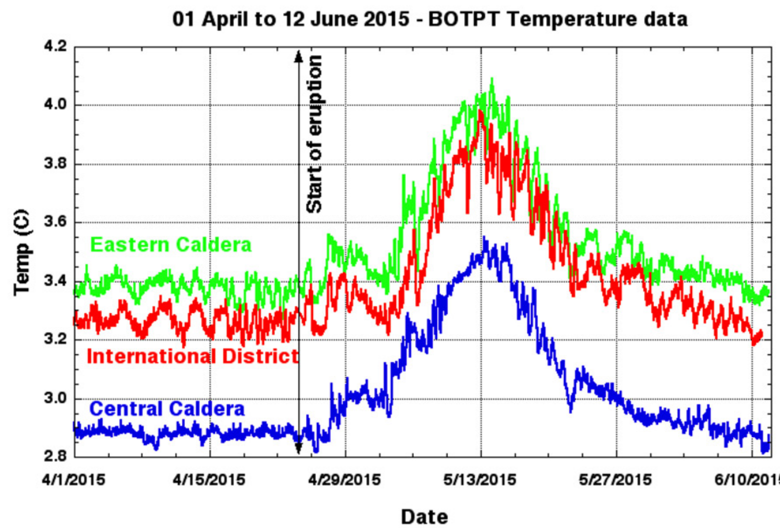
Website: http://oceanobservatories.org

4/23/2015 (Capturing an Earthquake)

Seafloor pressure (red detided)







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