Ocean Data Labs
And an introduction to plotting OOI Profiler data in Python

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Presented to the WHOI Ocean Informatics Working Group

August 4, 2020

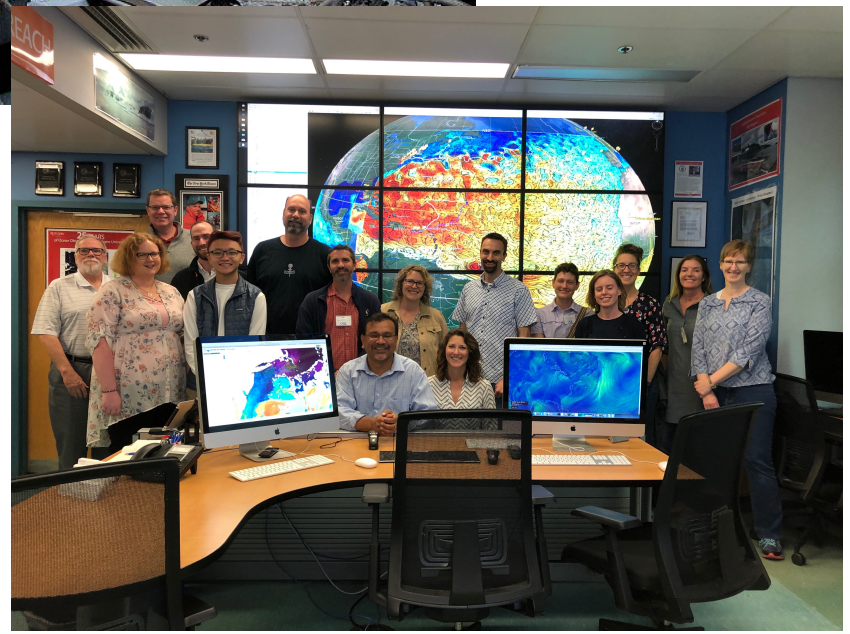
datalab.marine.rutgers.edu

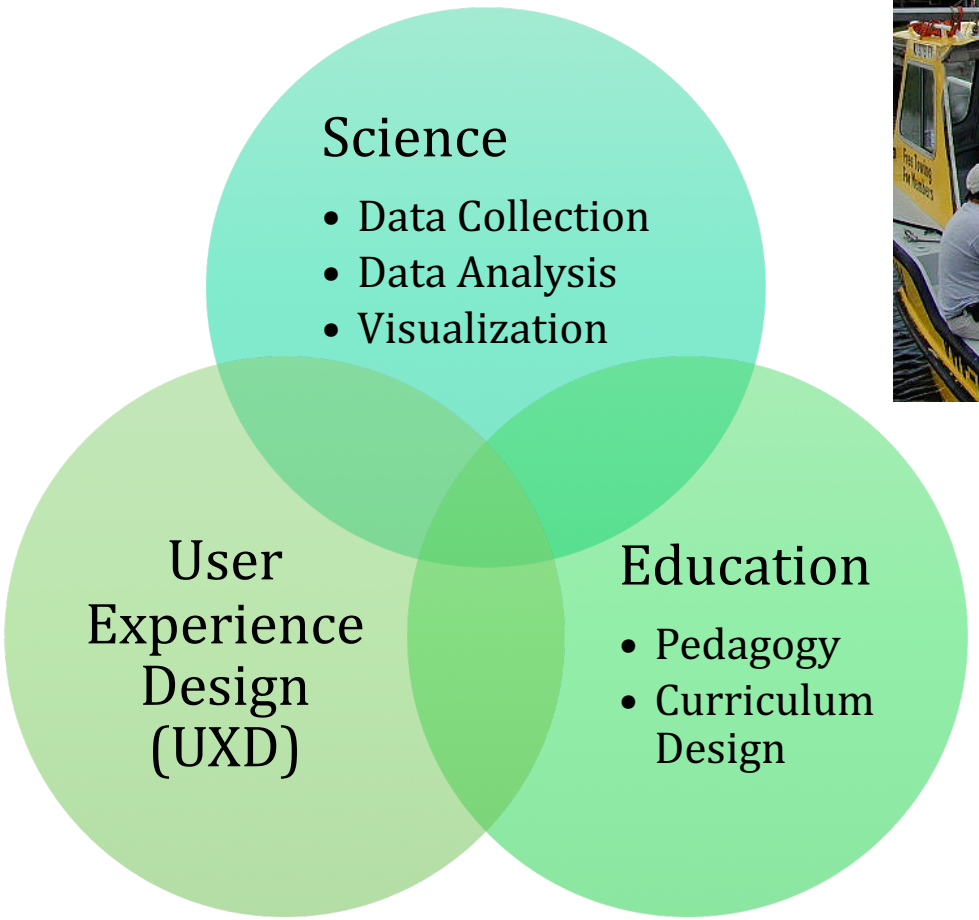
@ooidatalab

Today's Agenda

- The Data Labs Project
- Reproducible Research
  - Why should we use programming notebooks?
- A nickel tour of the OOI
- OOI Profiler Python Tutorial

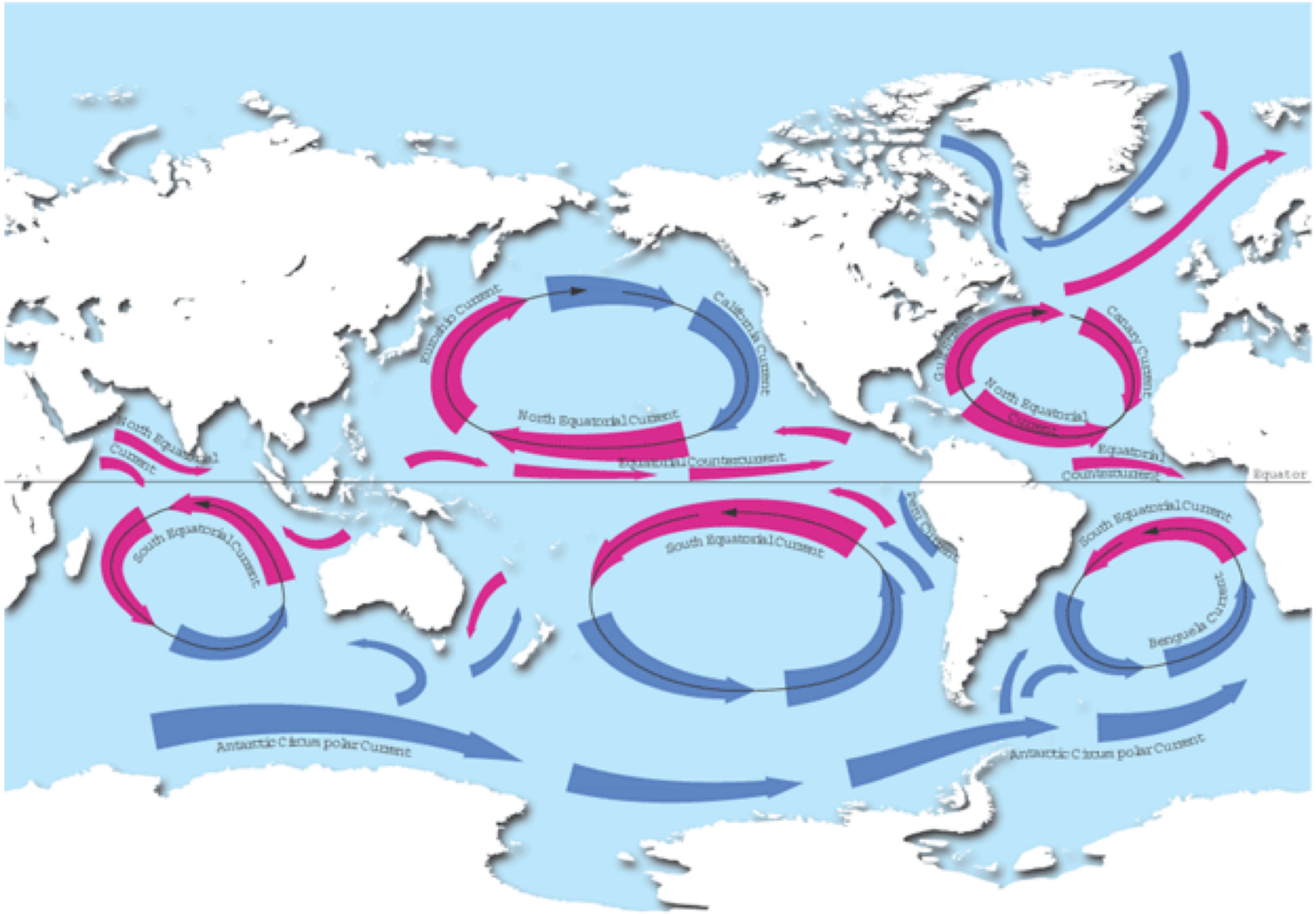
My Background



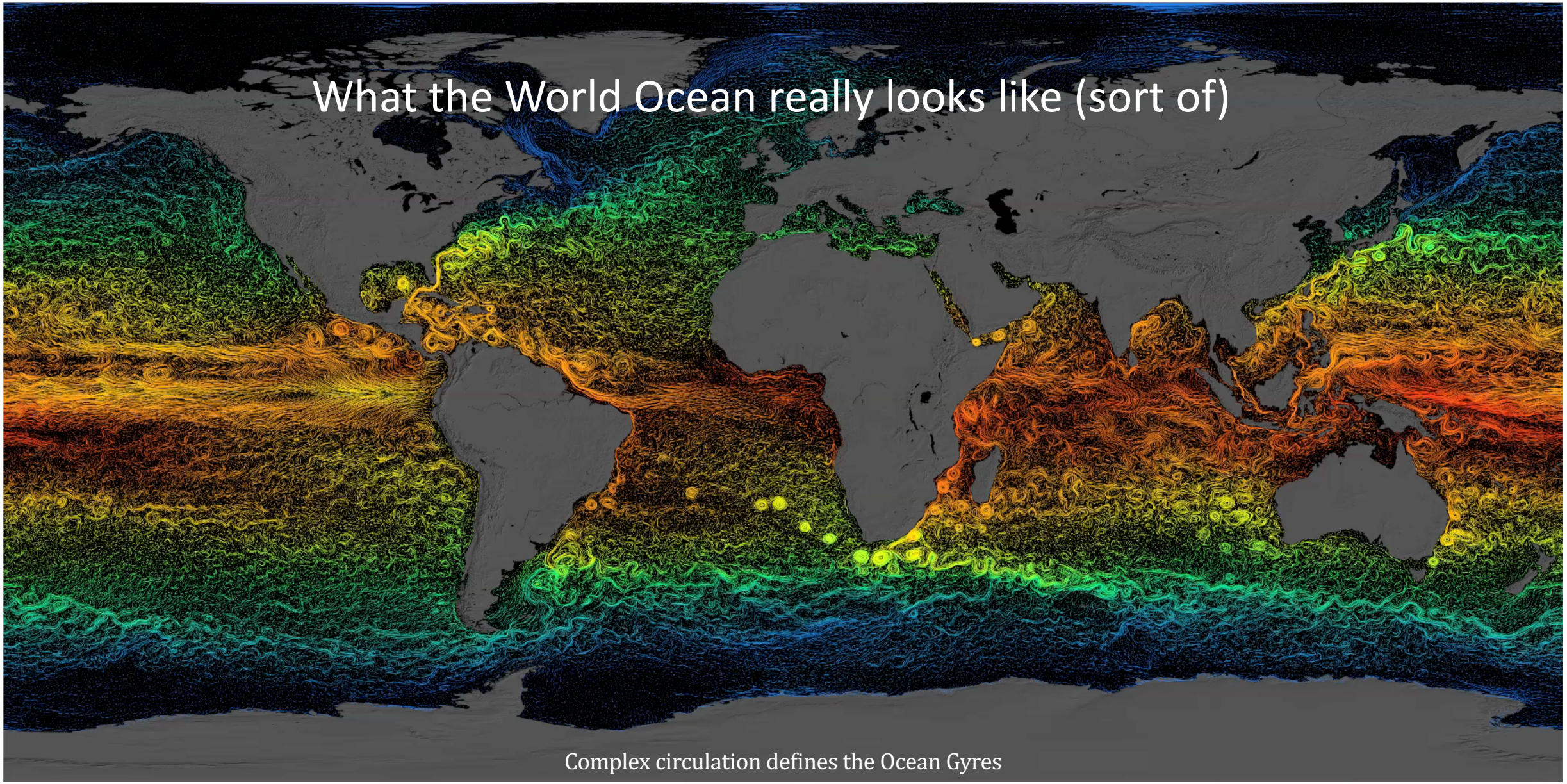


What We Teach

6ish Ocean Gyres
+ Thermohaline
Circulation



What the World Ocean really looks like (sort of)



Complex circulation defines the Ocean Gyres

OOI Data Labs Project

Key Goals

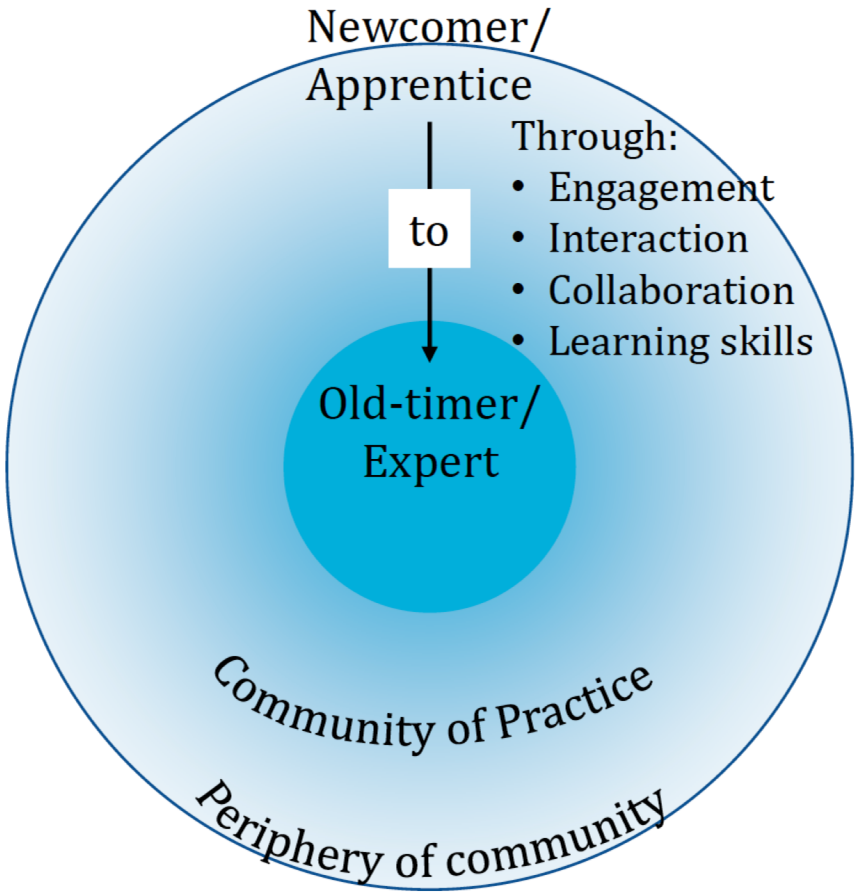
- Build a **Community of Practice (CoP)** of undergraduate educators, interested in using OOI data with their students

- Create and compile tools to make OOI data more **accessible** to educators and students

Community of Practice (CoP)

Learning defined as …growth in one's ability to participate meaningfully and centrally in communities of practice [Lave, 1991]

- Novices begin by taking on simple but valued tasks
- As novices continue to participate and learn, they move towards the center of the community



OOI Data Labs

A Summary of our project milestones

Comprehensive Database

Fall 2018

590 scientists

2 undergraduates built a database of professors from around the country teaching Oceanography 101 like courses.

Development Workshops

Spring 2019

56 professors

4 week long workshops.

- Chauncey Center - Princeton, NJ.
- Rutgers University - New Brunswick, NJ.
- Asilomar- Monterey, CA.
- Western Washington University - Bellingham, WA.

Implementation Workshops

Summer 2019

60 professors

2 workshops focused on using OOI Data Labs in the classroom.

- Earth Science Teachers Rendezvous in Nashville, TN July 2019
- Ocean Science Meeting in San Diego, CA in February 2020.

Webinar Series

Fall 2019

11 professors

4 webinars featuring data labs developed by workshop participants.

11 professors led these webinars

Open Source Lab Notebook

Winter 2020

11 professors

1 design workshop to develop an open source and online laboratory notebook that will serve as a companion online lab manual for oceanography courses.

Fellowship Program

Winter 2020

11 fellows

7 professors are collecting data and feedback from students on the efficacy of the Data Labs.

4 are creating new Python notebooks with OOI data.

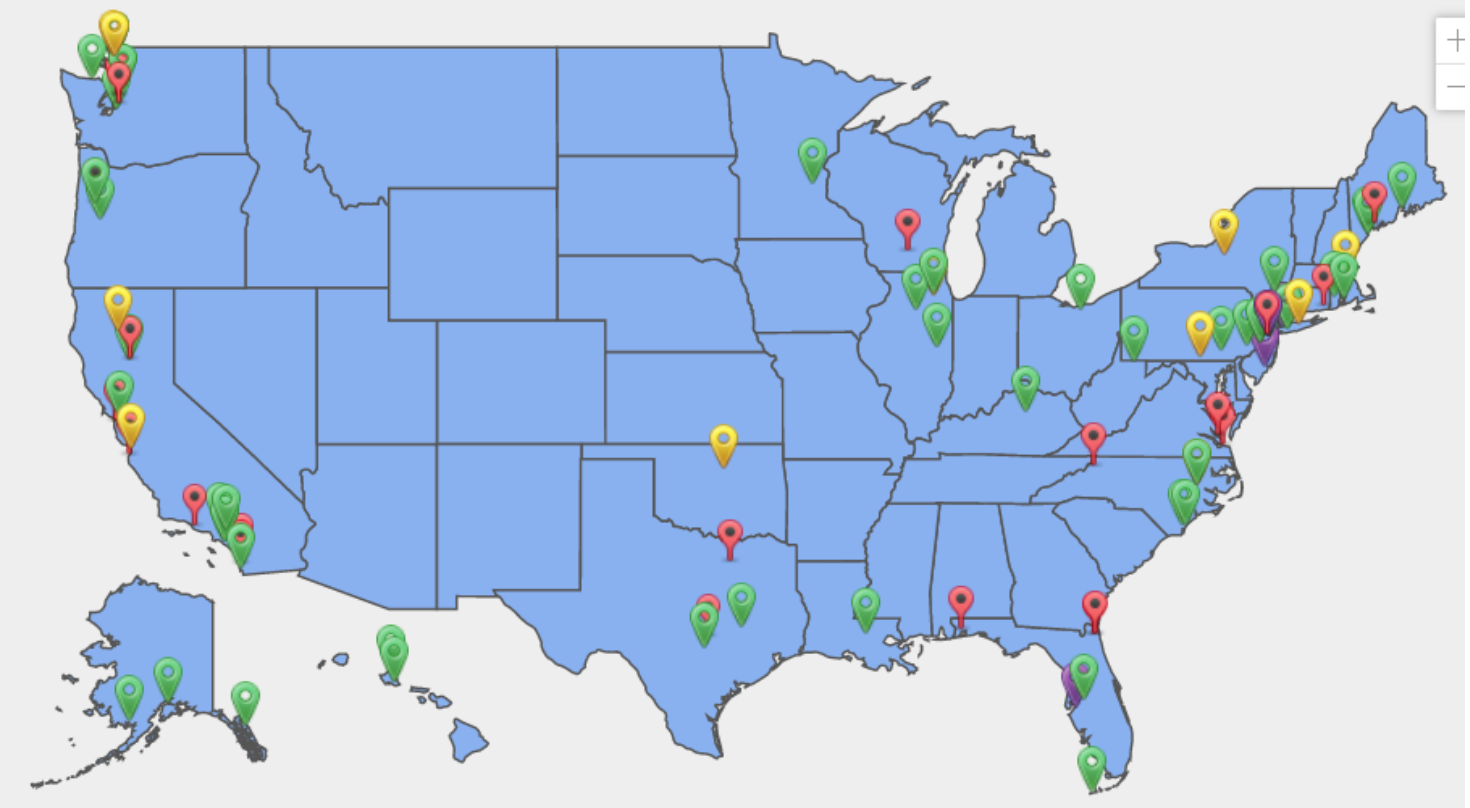
REU Program

Summer 2020

13 professors

13 professors volunteered to be mentors in a virtual REU using OOI data in an online REU program

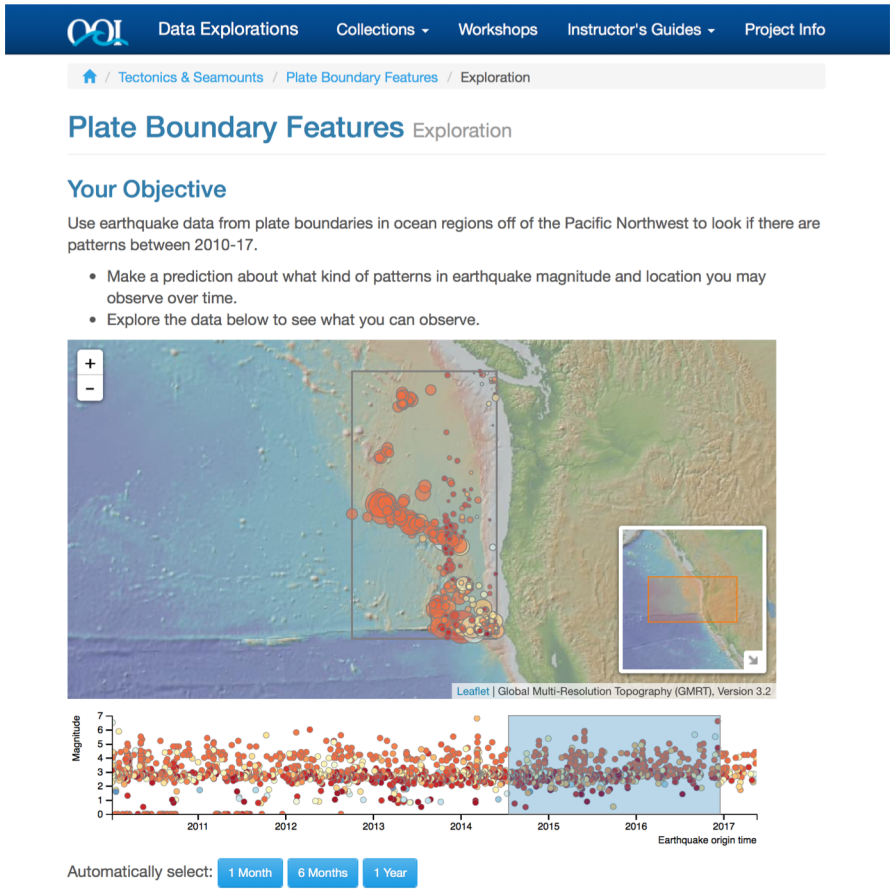
The growing Ocean Data Labs community



- Data Exploration pilot testers (24)
- Data Lab developers (50)
- 2020 Data Lab Fellows (11)
- Data Lab project team leaders

https://datalab.marine.rutgers.edu/community-map/

What is a Data Exploration?



Data Tips

When the site loads, you are able to see all of the earthquake data from 2010 throughout the Coastal Endurance Array. You can interact with the data by:

- Selecting a different part of the time series to explore the data in ways that interest you by moving the highlighted section of the bottom graph to the right or left.
- Zooming in and out of the data to look at different time scales that interest you by changing the width of the highlighted section of the bottom graph (it loads with all of the data highlighted).
- Zooming in and out of the map to see more or less of the area of the ocean the earthquakes occurred.

Note, the color denotes earthquake depth, with darker blues representing deeper depths (up to 50km) and dark red representing shallower depths (0km). The yellows are in-between. The circles on the map are sized by the earthquake magnitude.

Questions for Thought

Orientation Questions

- Across what geographic area are you able to observe earthquake data in this map?
- What is the range of earthquake size (magnitude) in these data?

Interpretation Questions

- What changes or patterns did you observe in earthquake location over this time period in the Northern Pacific Ocean?
- Where did you see these changes or patterns?
- What changes or patterns did you observe in earthquake magnitude over this time period in the Northern Pacific Ocean?
- What questions do you still have about what we can learn about plate boundaries from earthquake data over time?

Background Information

Click on the images below to learn more about where and how the dataset above was collected.

Dataset Information

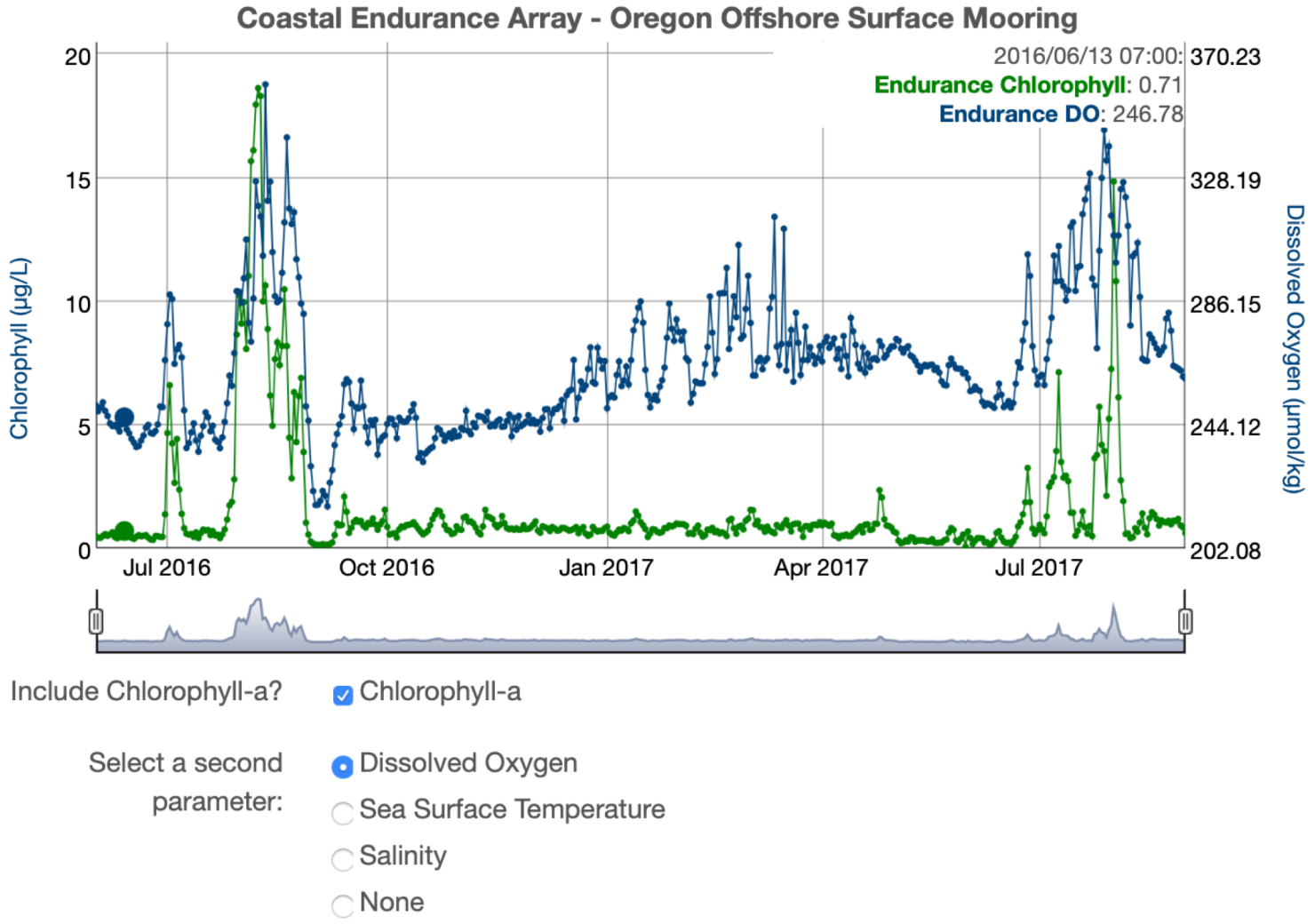
Data for this activity were retrieved from the USGS Earthquake Catalog.

Finished the activity? Please take our quick Student Survey

Exploring Data

Chlorophyll-a in Upwelling and Stratified Temperate Regions

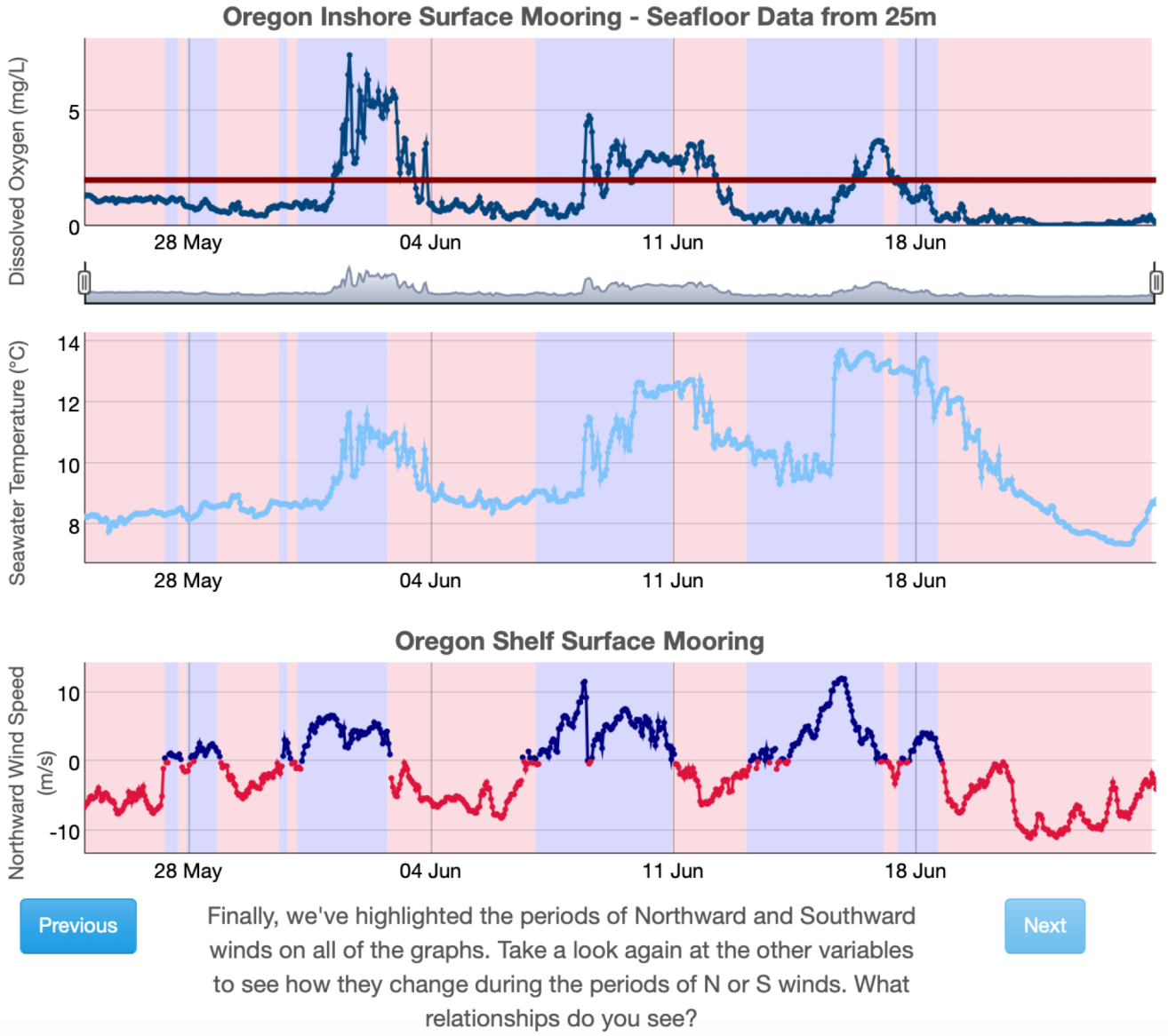
- Karen Baker, Orange Coast College
- Claire Condie, Middlesex County College
- Robert Ellis, Orange Coast College
- Colleen Petrik, Texas A&M University



Guided Learning

Anoxic Events

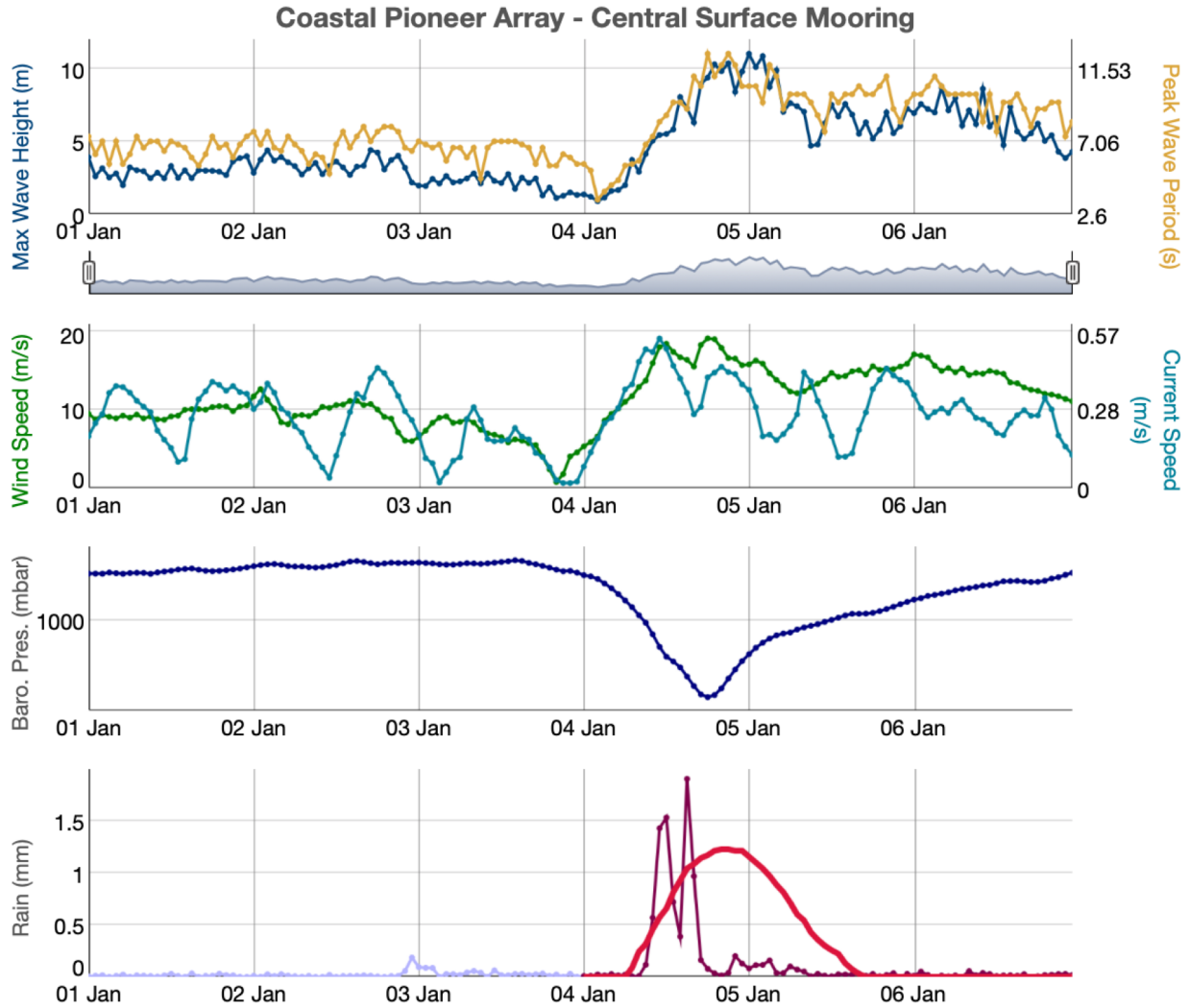
- Kathy Browne, Rider University
- Lauren Sahl, Maine Maritime Academy
- Rebecca Freeman, University of Kentucky
- Gabriella Smalley, Rider University
- Carol White, Southern Maine Community College



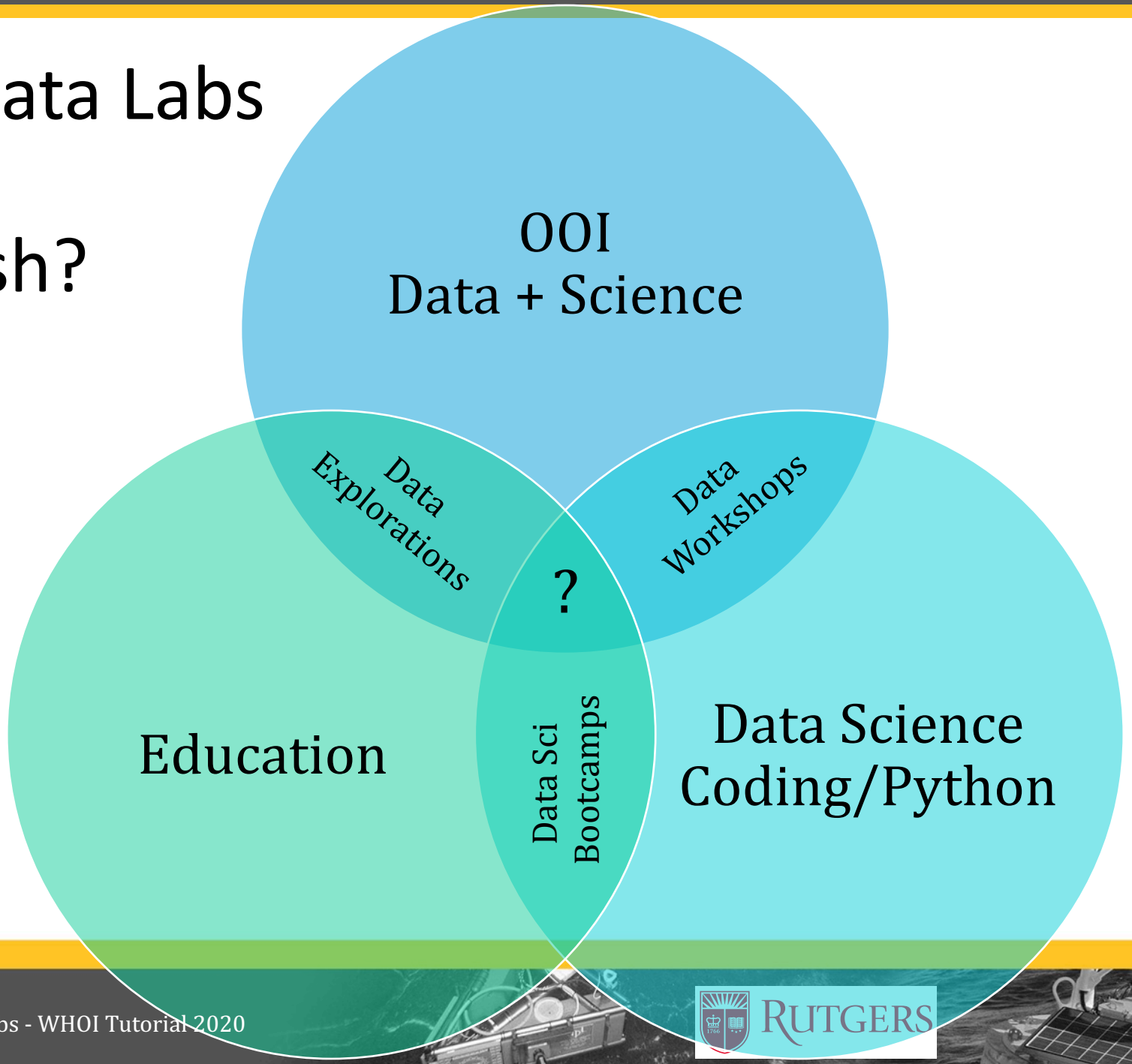
Student Predictions

Dynamic Air-Sea Interactions

- Jacqui Degan, Cape Fear Community College
- Melissa Hicks, Onondaga Community College
- Siddhartha Mitra, East Carolina University
- Paul Webb, Roger Wiliams University



What is Data Labs trying to accomplish?



Development Workshop– Python/Matlab/R Notebooks

Notebooks can be used for:

- Tutorials
- Exercises/practice (in-class or out)
- Guided discovery
- Self-directed inquiry (aka research projects)

Enables Community Driven interactive datasets, lessons and research

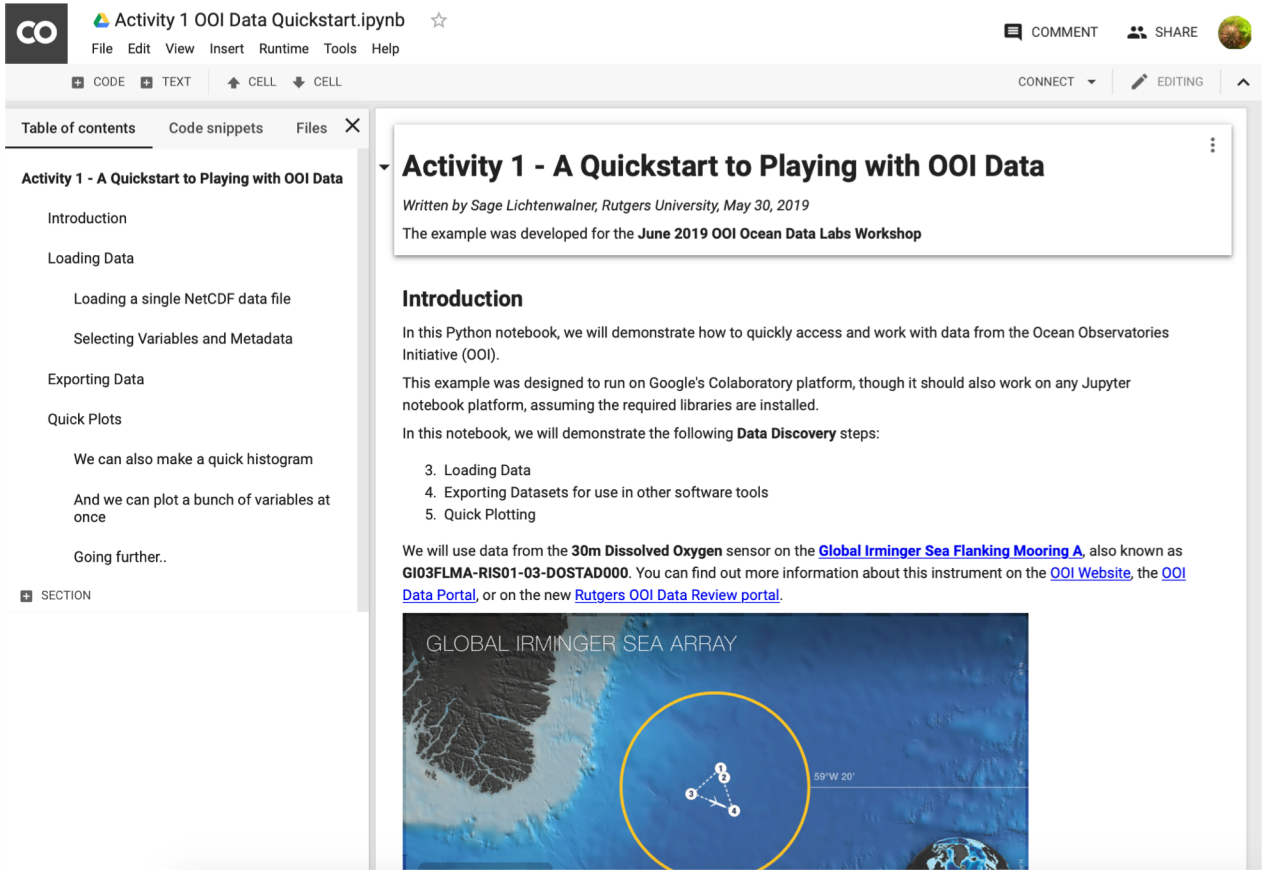
- 31 Example OOI Data Processing Notebooks to date
  - https://github.com/ooi-data-lab/data-lab-workshops
- 4 “Data Labs Fellows” working on Educational notebooks

New visualization libraries enable interactive exploration

- Altair
- HoloViz

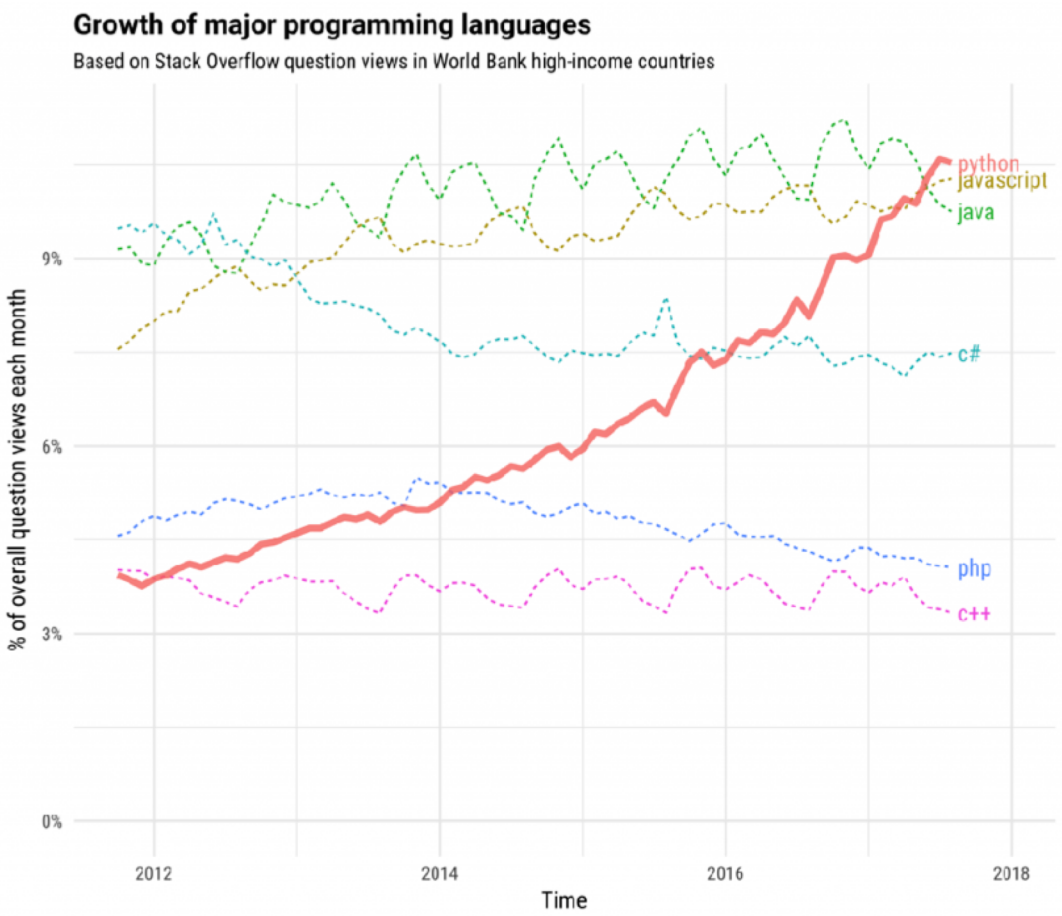
The Power of Notebooks & Google Colab

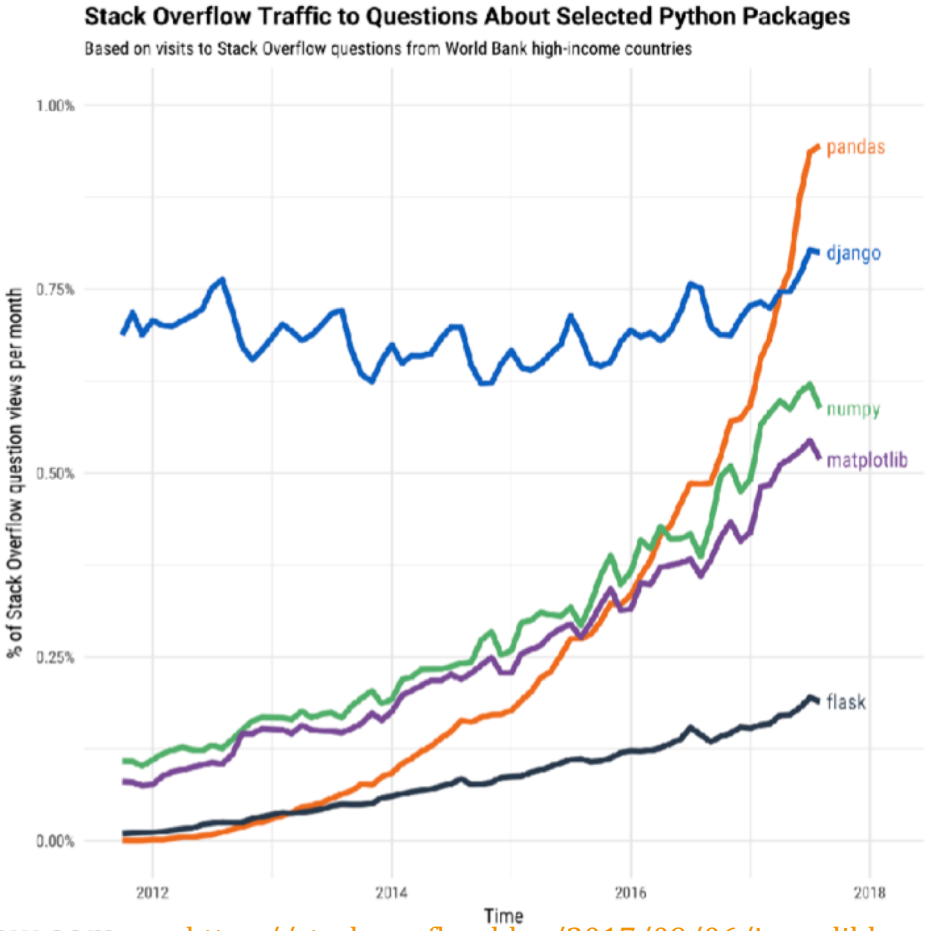
- A streamlined “linear” development approach
  - Code blocks are independent
  - With an IDE you would have to use debug breakpoints
- No need to download files
  - Files can be accessed and concatenated on the fly
  - Thanks to xarray we can easily perform multi-dimensional analysis



PANGEO

SCIENTIFIC PYTHON FOR DATA SCIENCE

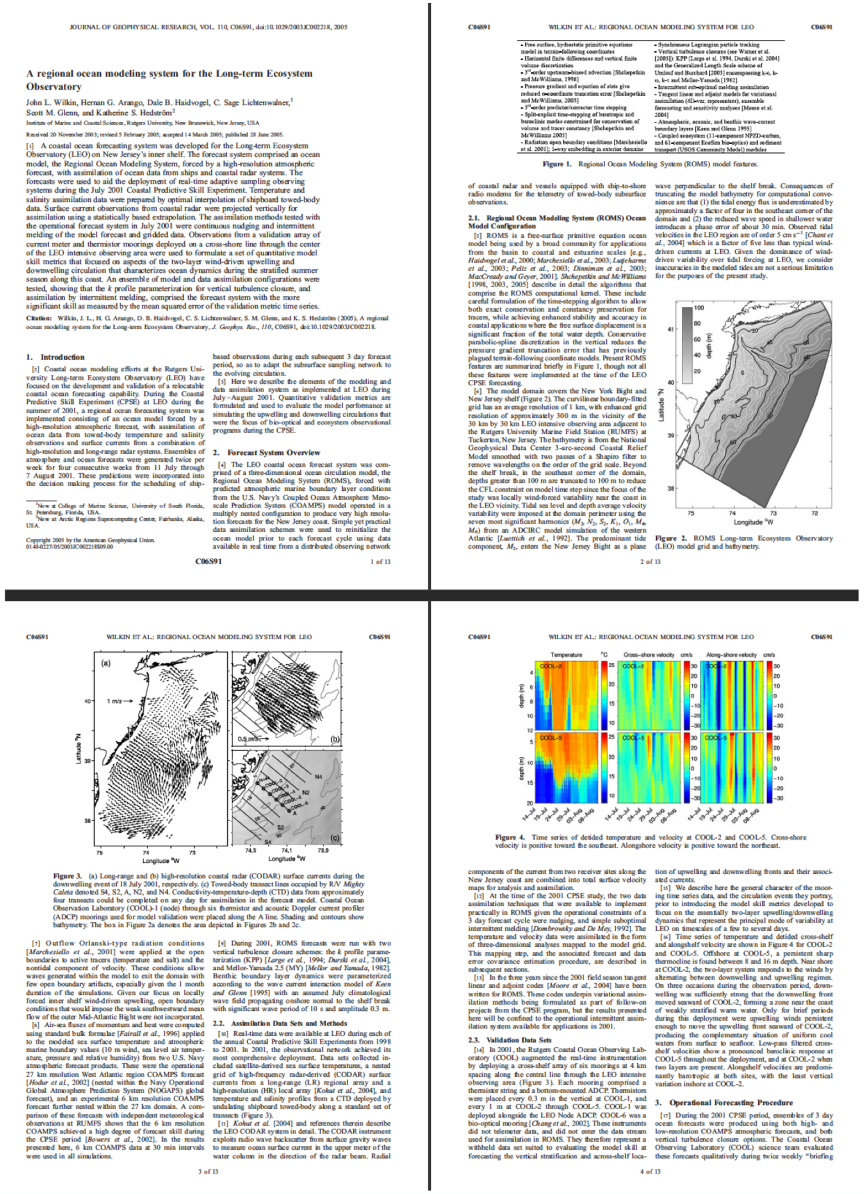




source: stackoverflow.com

https://stackoverflow.blog/2017/09/06/incredible-growth-python/

The Scientific Paper Is Obsolete. Here's what's next.

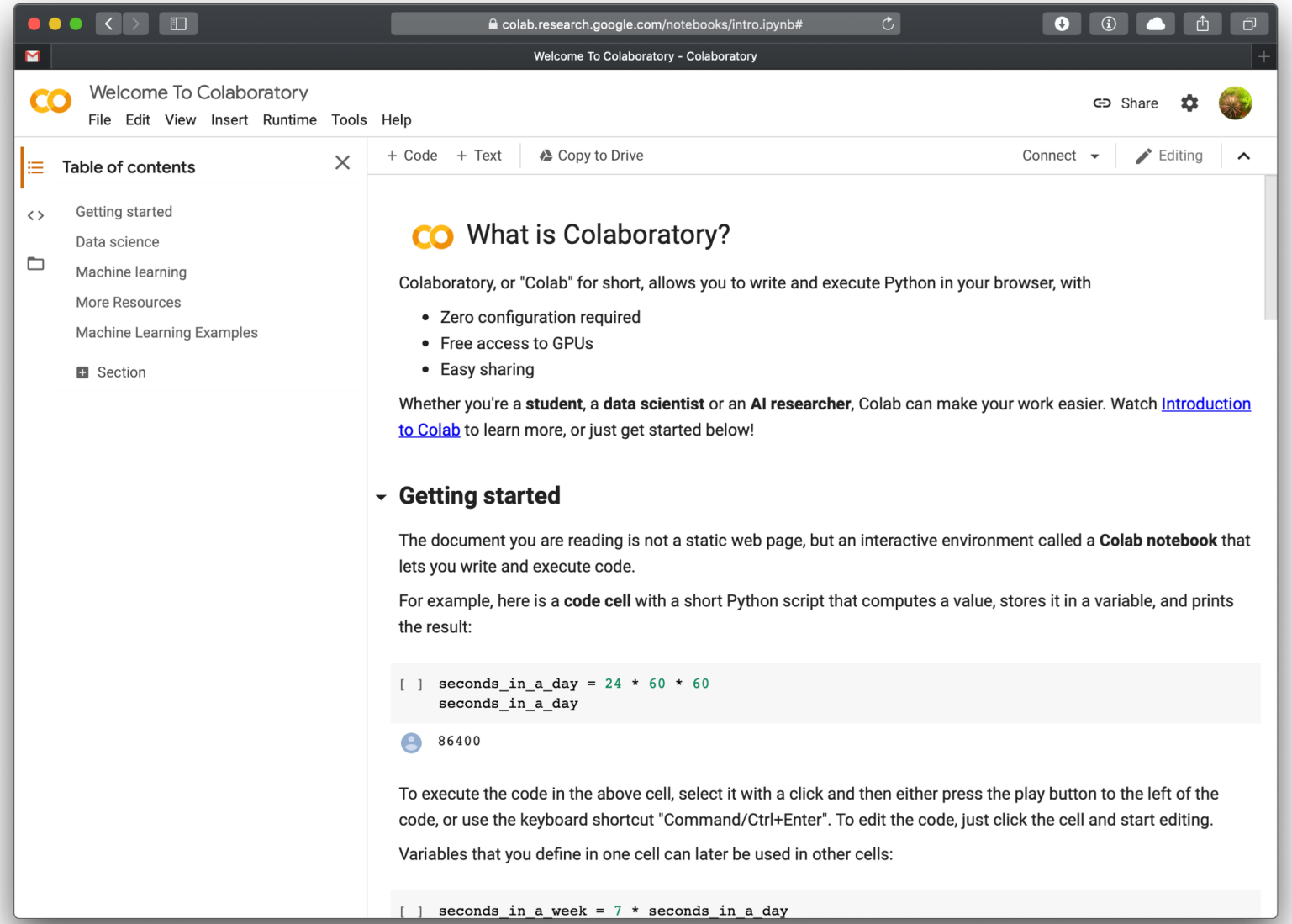


https://www.theatlantic.com/science/archive/2018/04/the-scientific-paper-is-obsolete/556676/

Google Colab

To start your own Colab Notebook, simply go to your Google Drive and click New!

Or go to https://colab.research.google.com



Figuring out the Ocean: A Big Data Problem

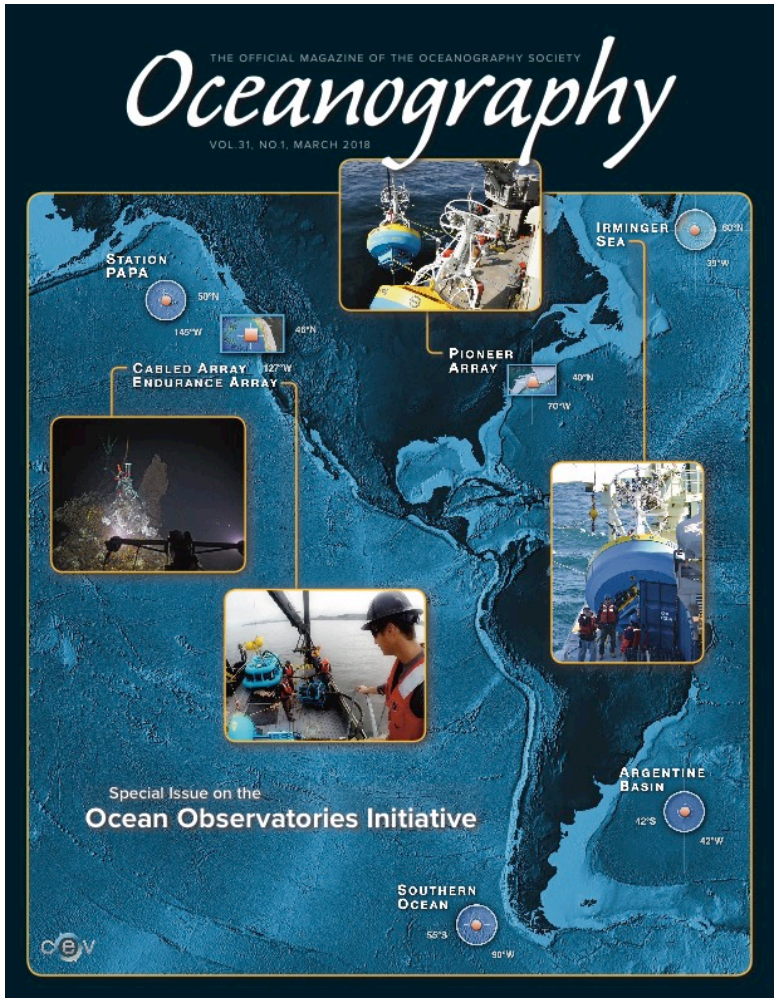
NSF's Ocean Observing Initiative

Integrated Components

- 4 High Latitude Global Sites
- Regional Plate-scale Cable
- 2 Coastal Dynamics Arrays
- Data Management System

Interested in OOI Science?

Check out the March 2018 *Oceanography* Special Issue!



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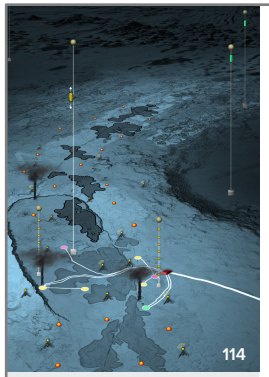
SPECIAL ISSUE ON
The Ocean Observatories Initiative



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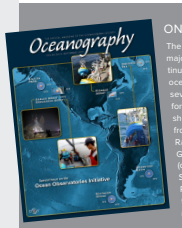
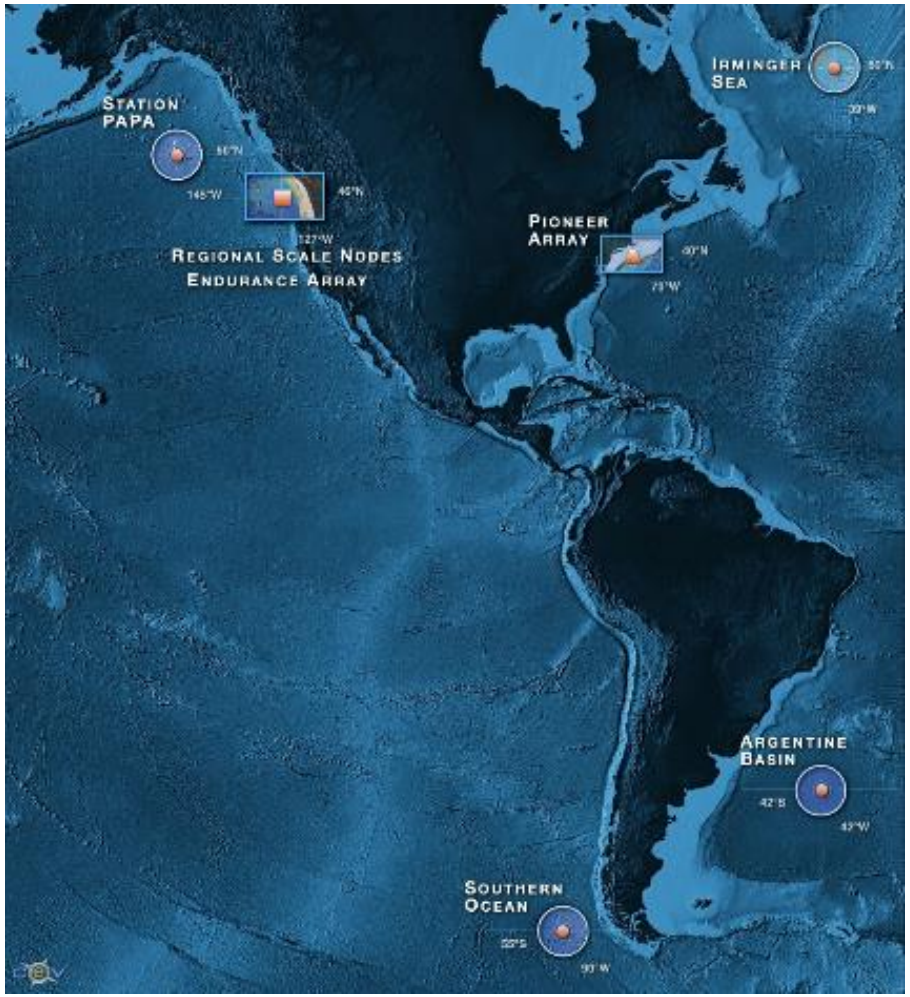


ON THE COVER
The Ocean Observatories Initiative (OOI) is a National Science Foundation major research facility operated as a community resource, providing continuous delivery of ocean and seafloor data from the coast to the open ocean in the Atlantic and the Pacific. The map shows the locations of the seven OOI arrays (image credit: OOI Cabled Array program & the Center for Environmental Visualization, University of Washington). Inset photos show infrastructure from the Coastal, Global, and Cabled Arrays (clockwise from top): deployment of a Pioneer Array Coastal Surface Mooring from R/V *Atlantis* (credit: OOI Pioneer Array Program, WHOI); Irminger Sea Global Surface Mooring waits on the deck of R/V *Knorr* for deployment (credit: OOI Global Array Program, WHOI); Endurance Array Coastal Surface Mooring components await deployment (credit: OOI Global Array Program, OSU); digital still camera deployed on Axial Seamount captures the El Gordo hydrothermal vent and attached OOI Cabled Array instrumentation (credit: NSF-OOI/UW/ISS; Dive R1839; V15).

OOI by the Numbers



7 Arrays
(2 suspended)

58 Stable Platforms
Moorings, Profilers, Nodes

34 Regularly Planned Mobile Assets
Gliders, AUVs

56 Instrument Types

1,313 Instruments (~850 deployed)

9,557 Science Data Products

153,589 Science/Engineering Data Products

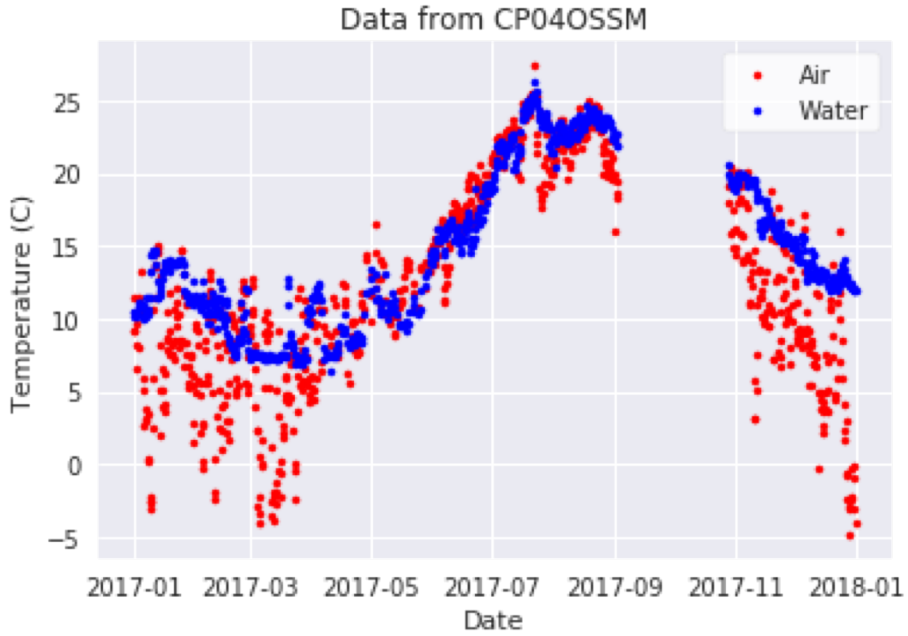
As of 2/9/18

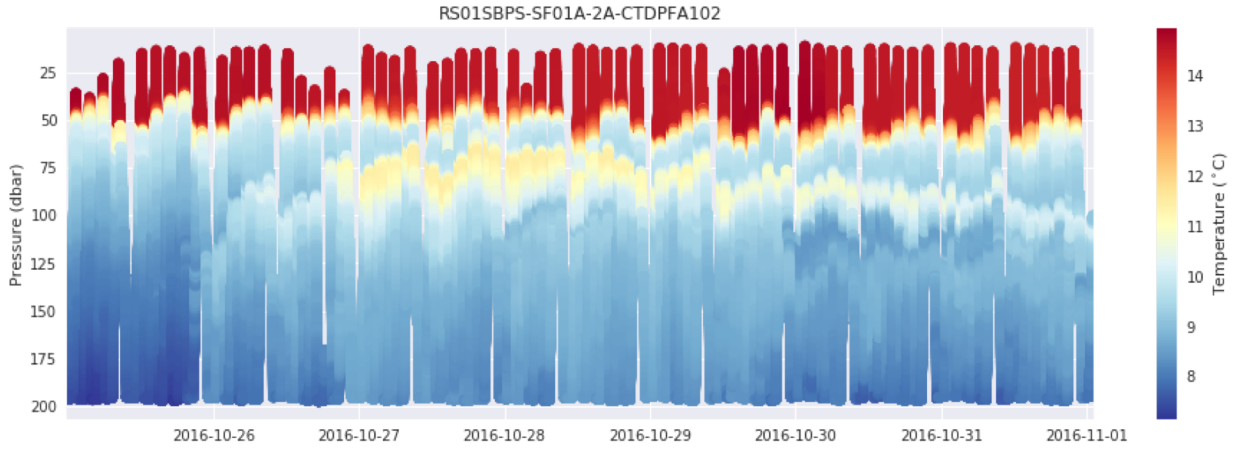
These are not like your typical coastal buoy.

Available Datasets

What types of data are available?

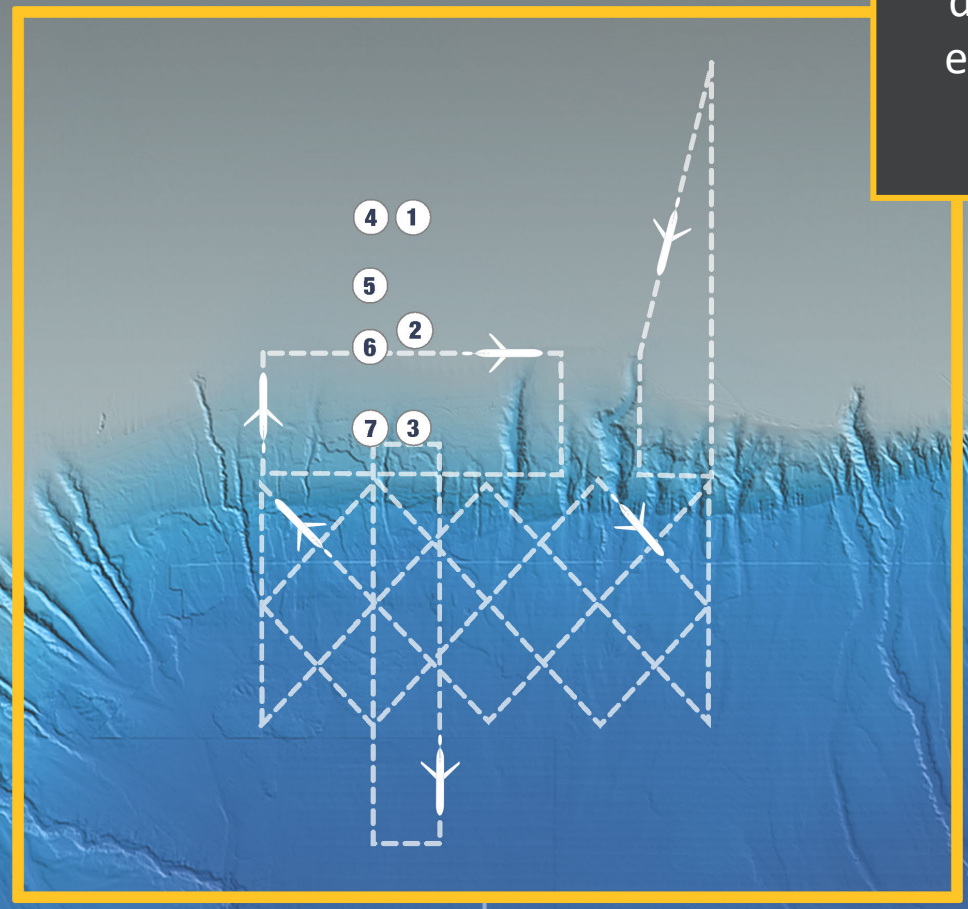
- Point Timeseries
- Profiles
  - Wire Following
  - Glider
  - ADCP
- Multi-point Timeseries Profiles
- And others…
  - Seismic/Earthquake
  - Hydrophones
  - Sonar
  - Camera
  - Optical OPTAA/SPIKR





COASTAL PIONEER ARRAY

Located over the continental shelf and slope in the NW Atlantic, the Pioneer Array is centered near the shelf-break front. It's data enable scientists to examine how exchange processes structure physical, chemical, and biological properties.



Pioneer Array

1. Upstream Inshore Profiler Mooring
2. Central Surface Mooring & Profiler Mooring
3. Upstream Offshore Profiler Mooring
4. Inshore Surface Mooring & Profiler Mooring
5. Central Inshore Profiler Mooring
6. Central Offshore Profiler Mooring
7. Offshore Surface Mooring & Profiler Mooring

Mobile Assets

40°N
39°N 40'
39°N
70°W 40'
73°W
72°W
71°W
70°W
69°W
68°W

“Data Discovery” Process

1. Discovering OOI Data to Use
2. Requesting OOI Data
3. Loading Data
4. Exporting Data for Use in Other Software
5. Quick Plots
6. Basic Statistics and Analysis

Let’s go to the notebook…

GitHub: https://github.com/ooi-data-lab/data-lab-workshops/blob/master/Other_Examples/Profile_Examples_for_WHOI.ipynb

Colab: https://colab.research.google.com/github/ooi-data-lab/data-lab-workshops/blob/master/Other_Examples/Profile_Examples_for_WHOI.ipynb

GI03FLMA-RIS01-03-DOSTAD000

Array: Global Irminger Sea

Site: Flanking Mooring A

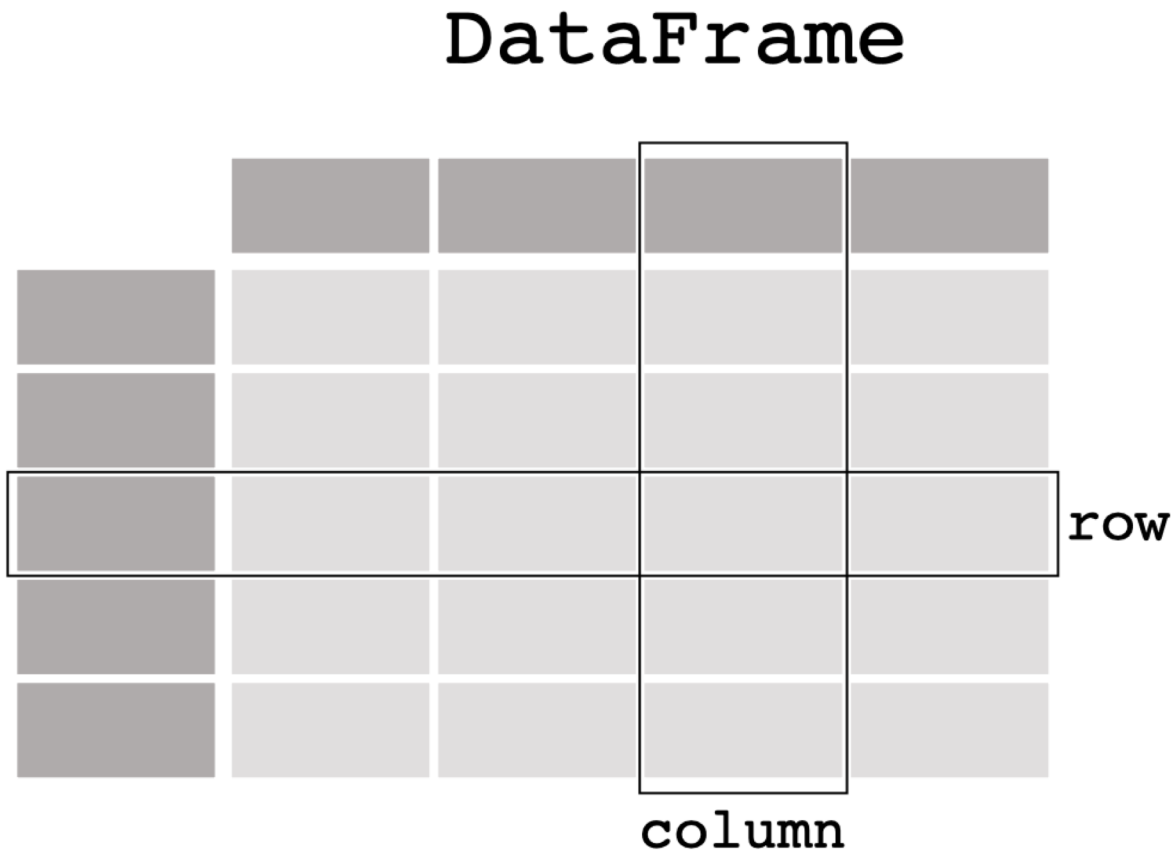
Node: Mooring Riser

Instrument Type:
Dissolved Oxygen

Notes:

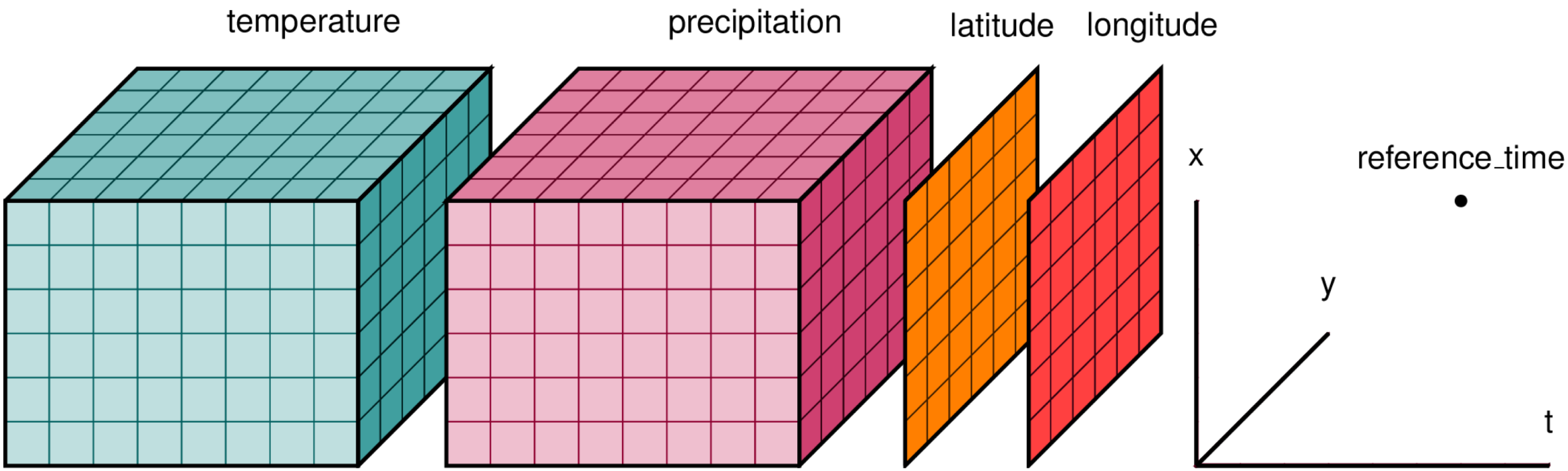
- Reference Designators effectively denote a physical deployment location in the OOI.
- Asset IDs represent the individual serial-numbered instruments that are swapped in and out at each spot.

Pandas can handle “spreadsheet” like data



https://pandas.pydata.org/docs/getting_started/intro_tutorials/01_table_oriented.html

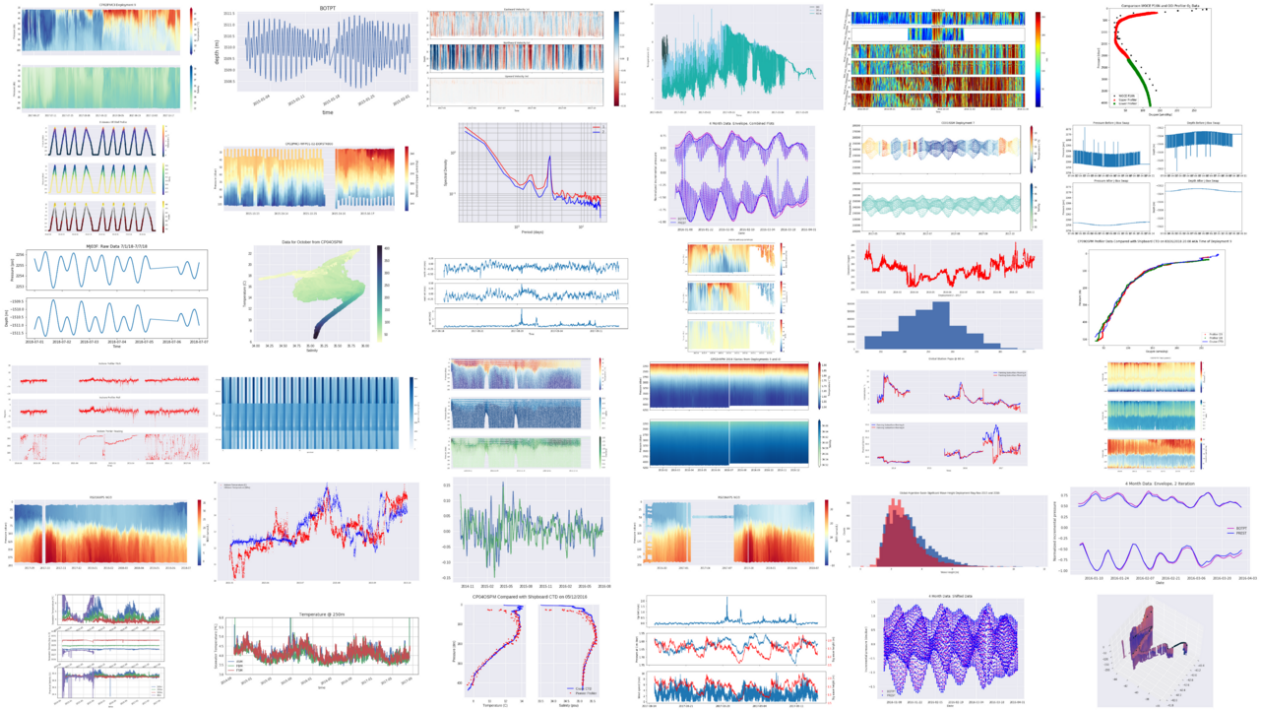
Xarray can handle complex Data Structures



http://xarray.pydata.org/en/stable/data-structures.html

Start your Data Exploration!

- Data Explorations
- Python Notebooks
- Blog / Tutorials
- Webinar recordings
- Join our mailing list



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GLOBAL IRMINGER SEA ARRAY
60°N
39°W
GLOBAL STATION PAPA ARRAY
50°N
145°W
CABLED ARRAY
46°N
127°W
COASTAL PIONEER ARRAY
40°N
70°W

FIN