



OCEAN  
OBSERVATORIES  
INITIATIVE

# Graduate & Undergraduate Student Engagement

Anna Pfeiffer-Herbert & Sage Lichtenwalner  
OOI Pioneer MAB Community Workshop  
September 12, 2024



# How do we effectively connect students to OOI data?



## **Challenges**

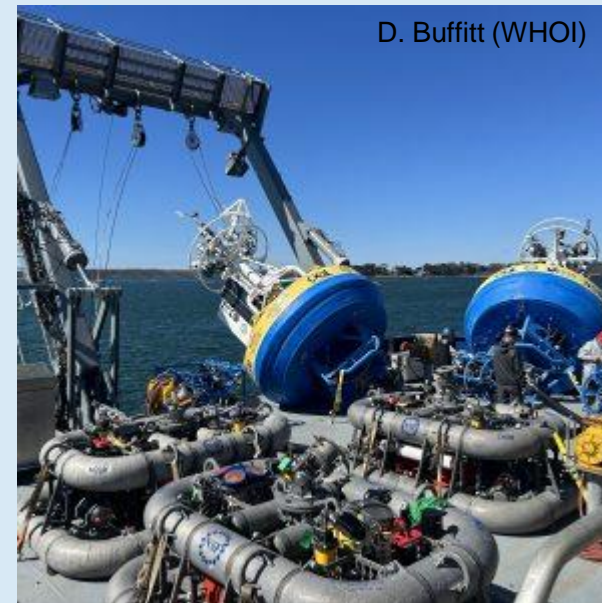
- OOI arrays sample oceanographically complex regions
- Data curation requires time and expertise
- Learners need scaffolded data skills

## **Opportunities**

- Broaden access to OOI data
- Prepare students for STEM careers
- Develop a data literate society
- Instill curiosity and the excitement of discovery



# Ways we use data

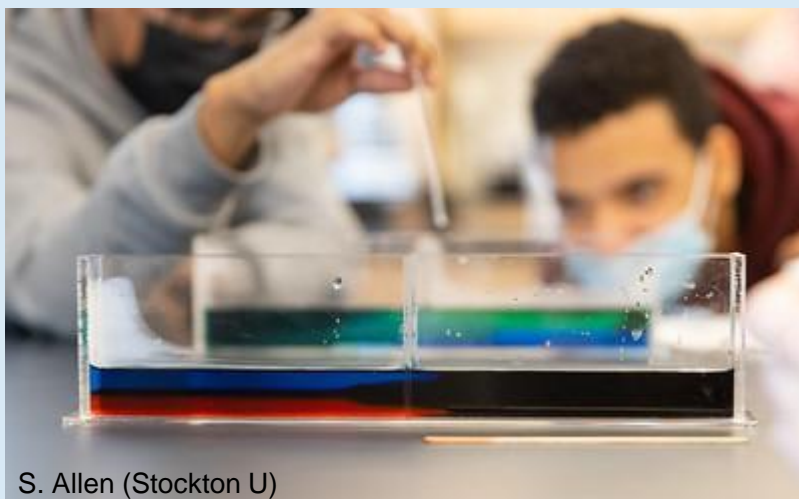


D. Buffitt (WHOI)

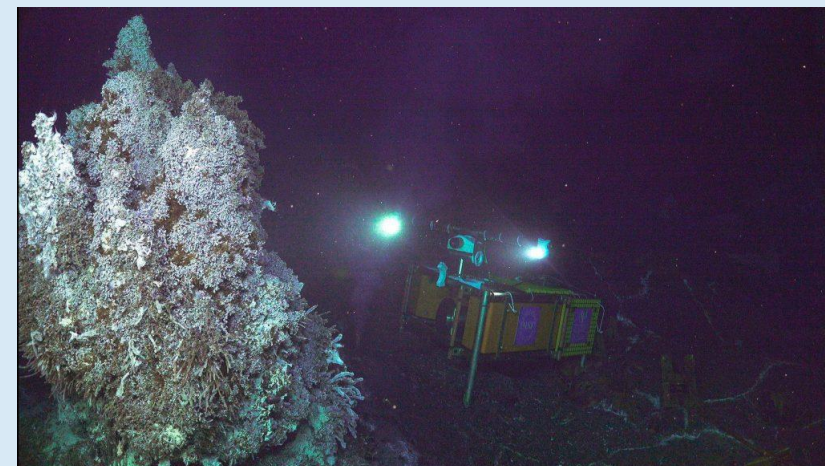
Reinforcing known phenomena



Generating new knowledge

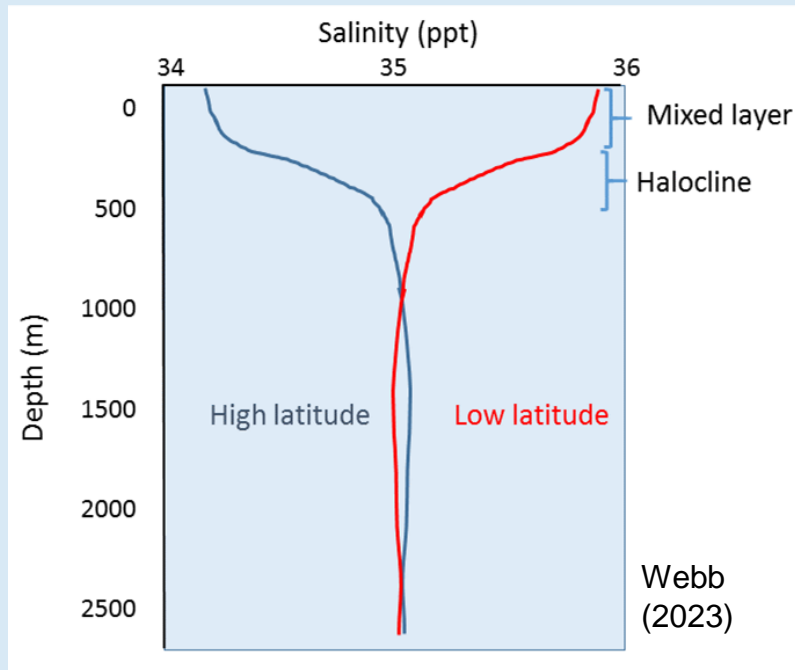
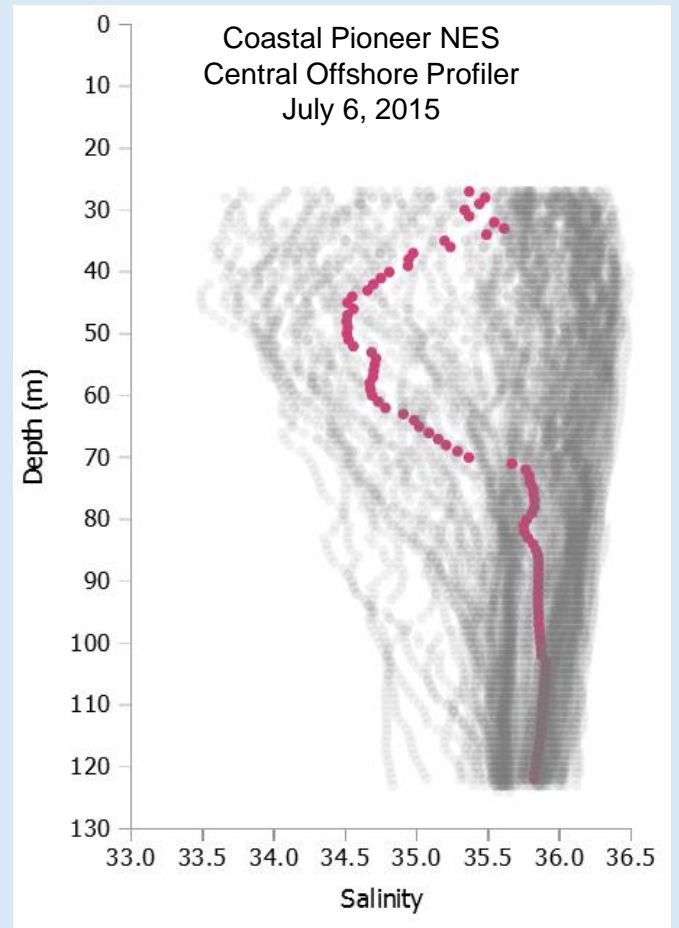


S. Allen (Stockton U)



# Types of data we use

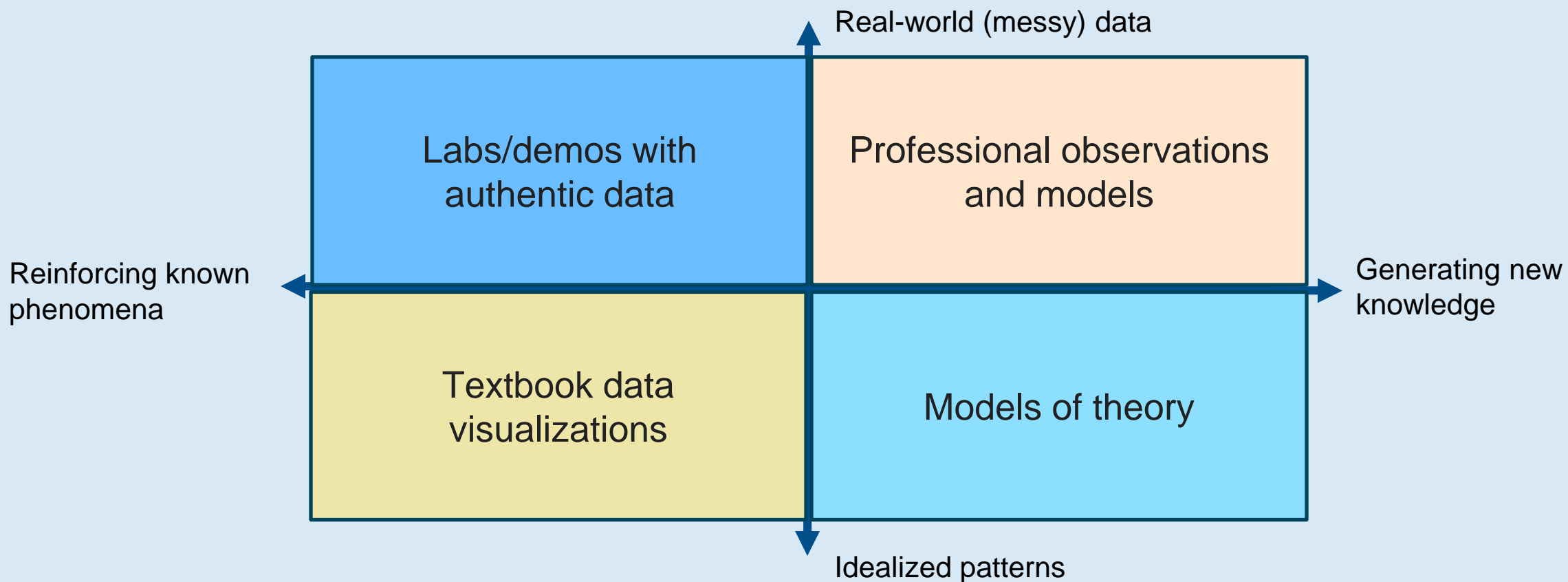
Real-world (messy) data



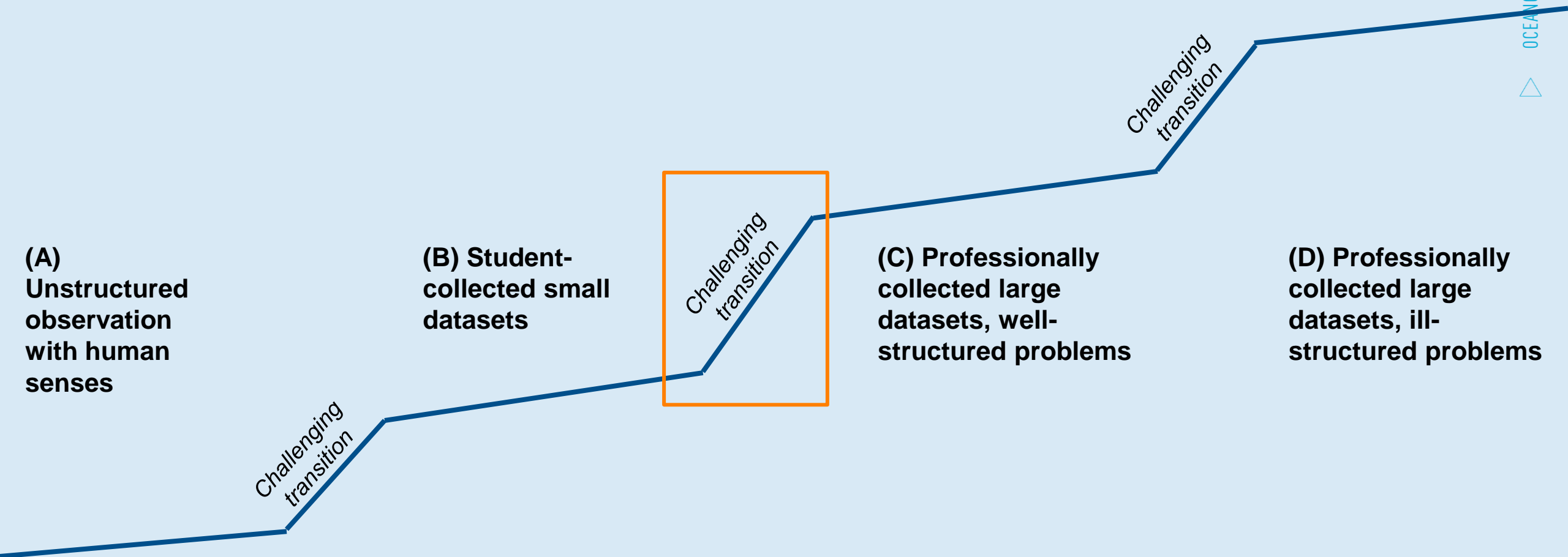
Idealized patterns



# Four aspects of using data in teaching



# Data skills learning curve



Modified from Figure 1 in Kastens et al., 2015, The Science Teacher 82(5):25-31





# OOI Data Labs Project – Key Goals



- Build a **Community of Practice (CoP)** of professors, interested in using OOI data with their undergraduate students.
- Make OOI data more **accessible** to educators and students.

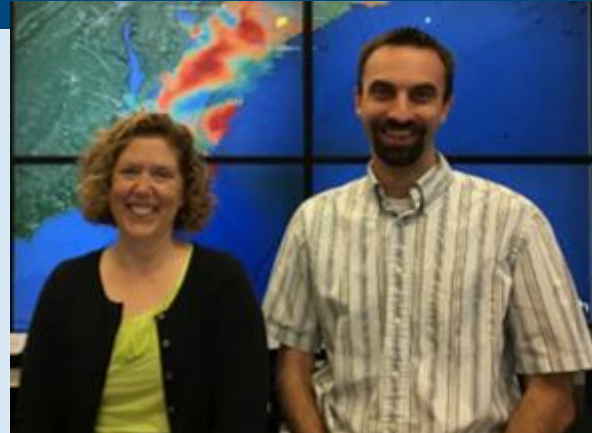


# Project Team

NSF Grant #1831625  
and # 2316075

OCEANOBS

OCEANOBS



Janice McDonnell, Sage Lichtenwalner  
Rutgers University



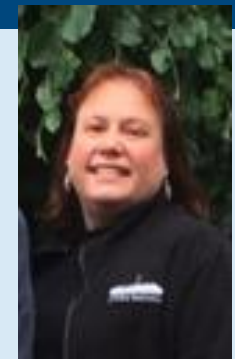
Dax Soule  
Queens College CUNY



Kristin O'Connell  
SERC



Anna Pfeiffer-Herbert  
Stockton University



Denise Bristol  
Hillsborough CC





# Data Labs Project History

## Data Explorations Workshops

- 2016-2017
- Undergrad Educators

## OOI Early Career Data Workshops

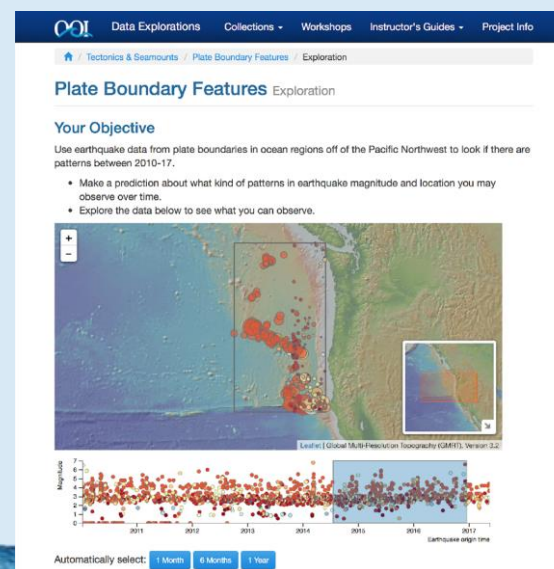
- 2018
- Research Graduate Students, Post-docs and pre-tenure faculty

## Data Labs 1.0

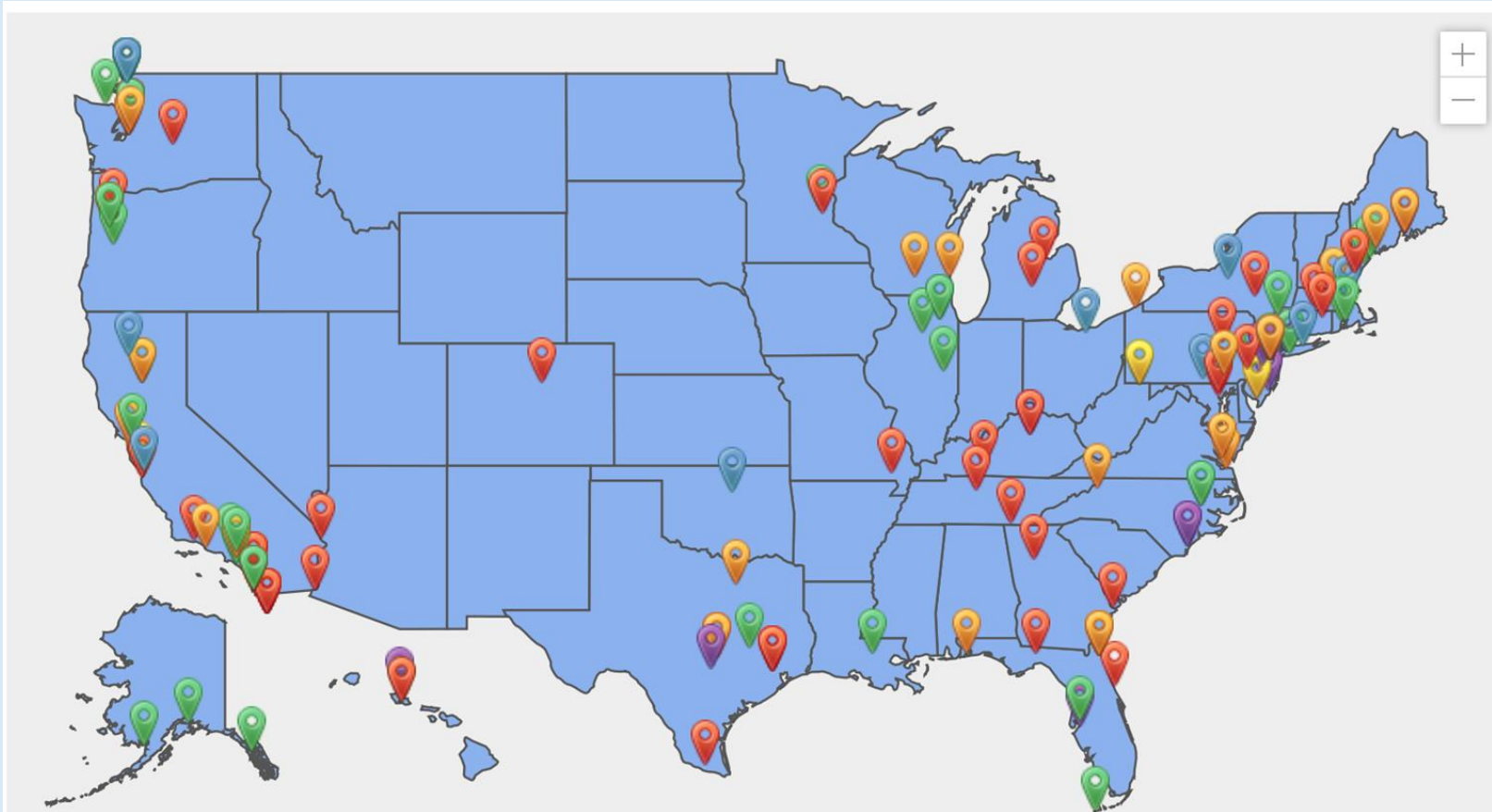
- 2018-2021
- Introductory Undergrad Educators
- Esp. 2YC and PUI

## Data Labs 2.0

- 2023-2025
- Intro and Advanced Undergrad Educators
- Focus on Python
- And new MAB array



# The growing Ocean Data Labs community!



**Developer (green)**

Participated in one of our week-long development workshops in 2019

**Piloter (orange)**

Attended one of our weekend pilot workshops in 2016-2017, or who have pilot tested our OOI Lab Manual.

**Fellows (blue)**

2020 implementation and dev cohorts

**REU Mentors (yellow)**

Faculty who helped mentor our 2020 Virtual REU students

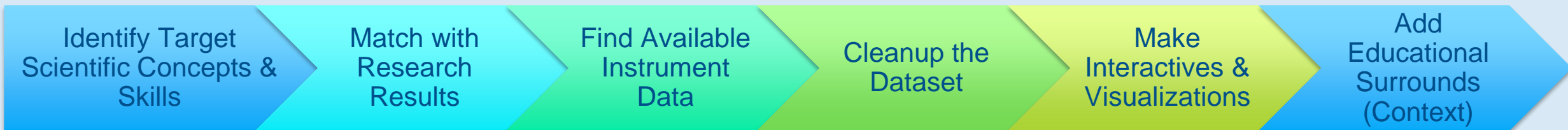
**Leaders & Staff (purple)**

Members of the core project team

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



# Translating OOI data into educational resources



Resource collection created by the community through curricular workshops, fellows, pilot testers and more...



# OOI Data Labs Resource Collection

Want a series of lab activities with built-in student assessments?



Data Lab Manual

Want a ready-made lesson plan incorporating OOI datasets?



Lesson Plans

Want a modular set of activities that you can adapt?



Data Explorations

Want to start from scratch using curated OOI datasets?

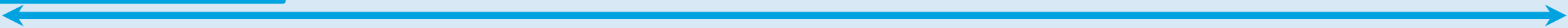


Data Nuggets

Want to introduce coding notebooks with OOI datasets?



Python Notebooks



*More guided*

*More open-ended*

OOI Data Explorer  
Direct access to data



# Inspiration for the OOI Lab Manual

Wouldn't it be great to have a lab manual of OOI data activities aligned to our oceanography classes?



Dr. Sid Mitra



2020 OOI Data  
Lab Manual  
Dev. Team

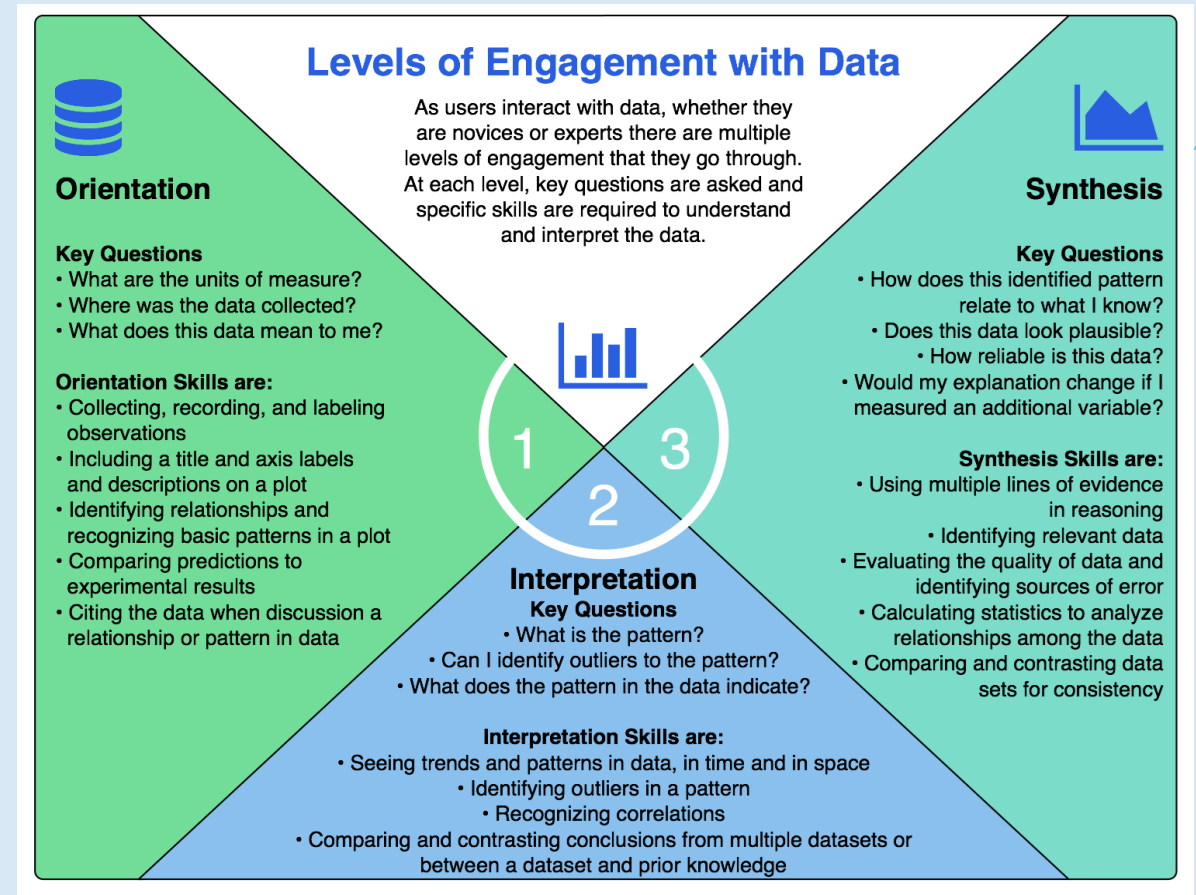
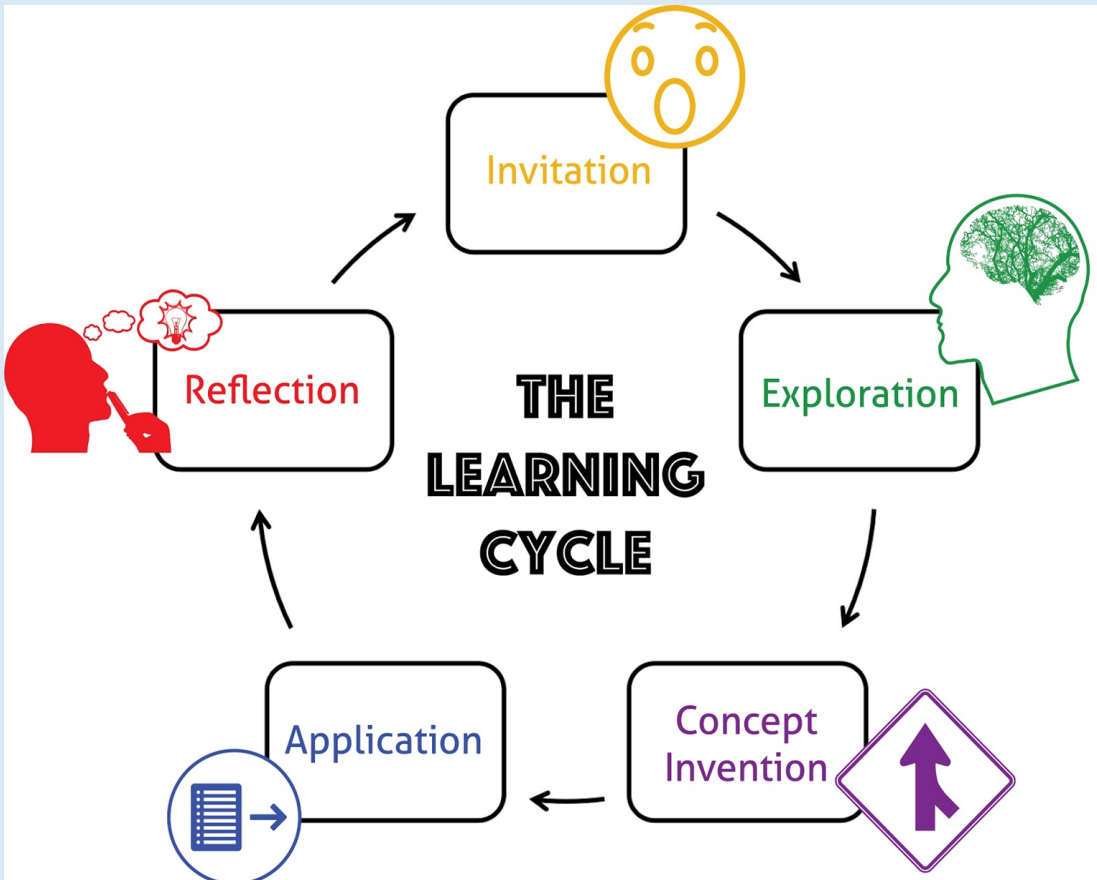


# Goals of the OOI Lab Manual

- Build **data literacy** and critical thinking skills in undergraduate students using **authentic** (“messy”) scientific data
- Visualize data in a user-friendly, **interactive** and authentic way
- Engage students with data activities that reinforce student confidence in scientific questioning, data analysis, and synthesis
- Provide a real-world context for **key concepts** in oceanography



# Design of data activities - based in learning science:



University of California Lawrence Hall of Science

Hotaling et al. (2019)

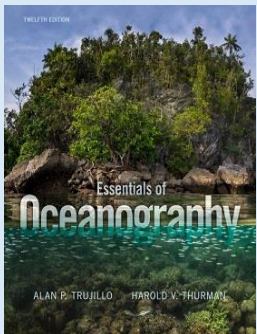


# Alignment to Intro Oceanography curriculum

OOI science themes and data availability



common Oceanography textbooks



Topic	Chapter
Ocean geography Ocean technology	<b>Lab 1:</b> Introduction to the OOI, the collection of oceanographic data
Data skills for oceanography	<b>Lab 2:</b> Building data skills
Marine Geology	<b>Lab 3:</b> Plate tectonics and the seafloor <b>Lab 4:</b> Seafloor changes in a volcanically active setting
Ocean Chemistry	<b>Lab 5:</b> Investigating density stratification
Physical Oceanography	<b>Lab 6:</b> Waves generated by large storms
Biological Oceanography	<b>Lab 7:</b> Primary production <b>Lab 8:</b> Anoxic events





# A Quick Lab Example

- <https://datalab.marine.rutgers.edu/ooi-lab-exercises/>



# Design Process – Lessons Learned



- Community Building – Defined process helps divide tasks and keep everyone on track
- Takes time and effort – Development is highly iterative (esp. 3&5)
- Educators can spearhead content selection and lesson development
  - Training is essential for new faculty to learn about the tools and instruments to find appropriate datasets, esp. those not familiar with OOI or using OOS.
  - With better data portals, they might also help with data and visualizations

# Evaluation & Impacts

*Conducted by Dr. Ellen Altermatt, SERC at Carleton College*

The purpose was to:

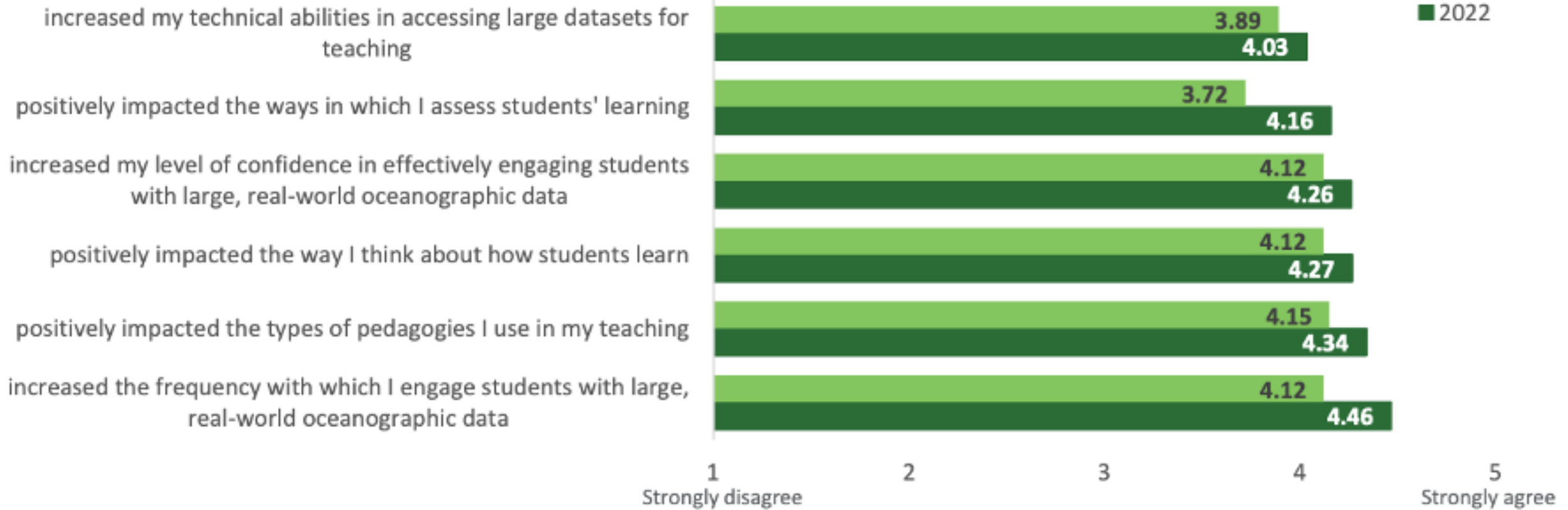
1. better understand current ***perceptions of and practices in using large, real-world oceanographic datasets*** in undergraduate classrooms,
2. assess ***levels of involvement*** in past and current OOI Ocean Data Labs initiatives,
3. examine the ***impact of participation*** in these initiatives on faculty teaching and perceptions of community belongingness, and
4. assess planned ***levels of future involvement*** and to understand how current resources might better meet community needs.



# How has participants' involvement in the OOI Data Labs Project influenced their teaching?

*My involvement [with the OOI Ocean Data Labs Project] has...*

■ 2020  
■ 2022



# OOI Data Labs 2.0 (2023-2025)

## Project Goals

- Continue to build and support the OOI educator community
  - Especially MSI, 2YC, PUI and R2
  - Special focus on the Mid Atlantic
- Develop “next level” activities
  - Fill in gaps in the existing OOI Data Labs manual
  - Domain-specific and level-appropriate programming notebook-based activities

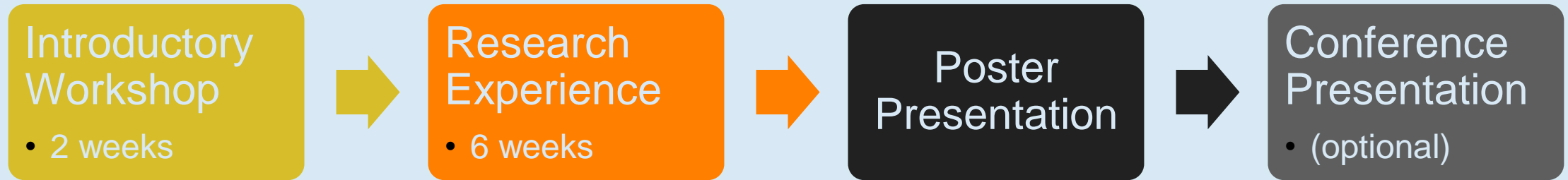


# Existing Opportunities for Engaging Students

- REU Sites
- REU Project Supplements
- Cruise Opportunities (e.g. Visions and CGSN)
- Individual research projects with faculty mentors
- Classroom Activities
- Others?

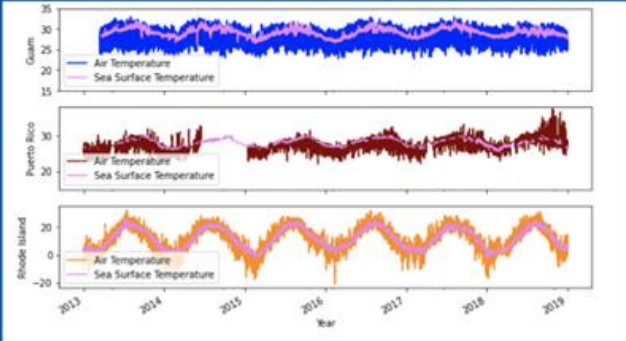


# 2020 Virtual REU Goals



- Develop and apply their **data analysis skills** using **Python notebooks** to access, analyze, and present ocean data.
- Learn about the variety of ocean data collection **methodologies** and **datasets** available to oceanographers.
- Participate in a variety of **professional development** sessions, including scientific question development, science communication, the graduate school process, and Diversity, Inclusion, and Research Ethics.
- Have the opportunity to participate in Career and Graduate Student Panels.
- Develop, carry-out, and summarize a **research experience** using an online dataset, under the guidance of a faculty mentor. (8-week participants only)

## Air Vs. Sea Surface Temperature

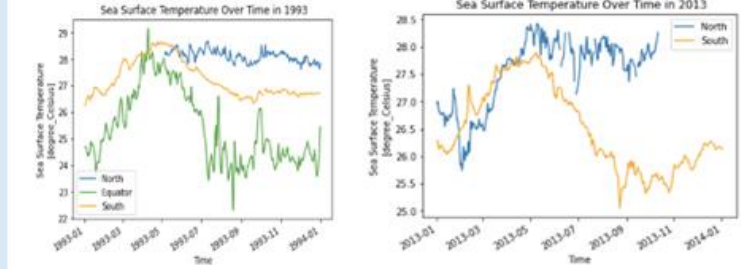


How does temperature and air pressure vary between Guam, Puerto Rico and Rhode Island?

# Virtual REU Initial Group Projects

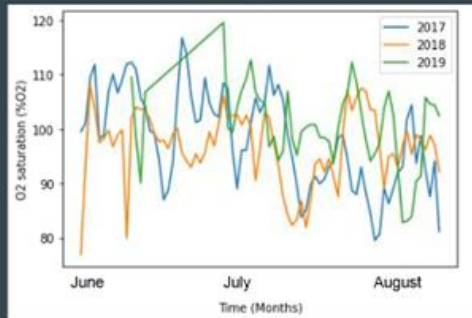
A wide variety of data investigations in just 1.5 weeks of coding using NDBC data!

Results: 1993  
2013



Do points within the N and S Equatorial Currents have more variability in SST?

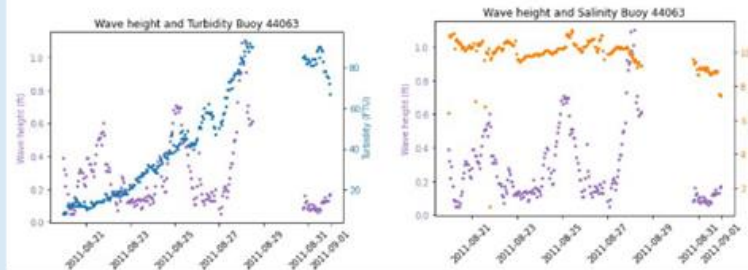
## Analysis & Results - O<sub>2</sub> Saturation



Post-restoration shows potential increased oxygen saturation

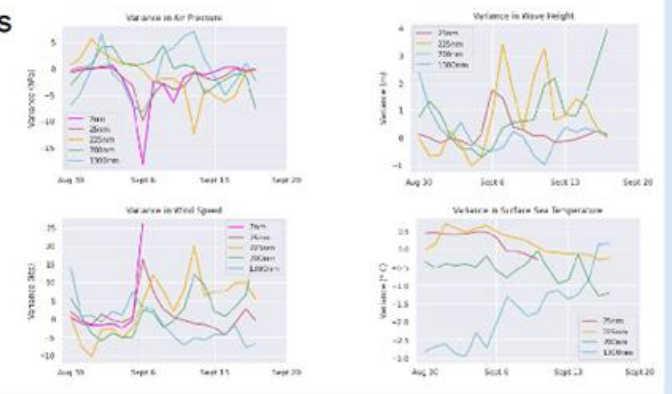
Effects of Oysters on Water Quality in the Elkhorn Slough

As wave height peaks, turbidity also reaches a high. Salinity has a more slow response to the storm



How do hurricanes impact the salinity and turbidity of an estuary?

Results

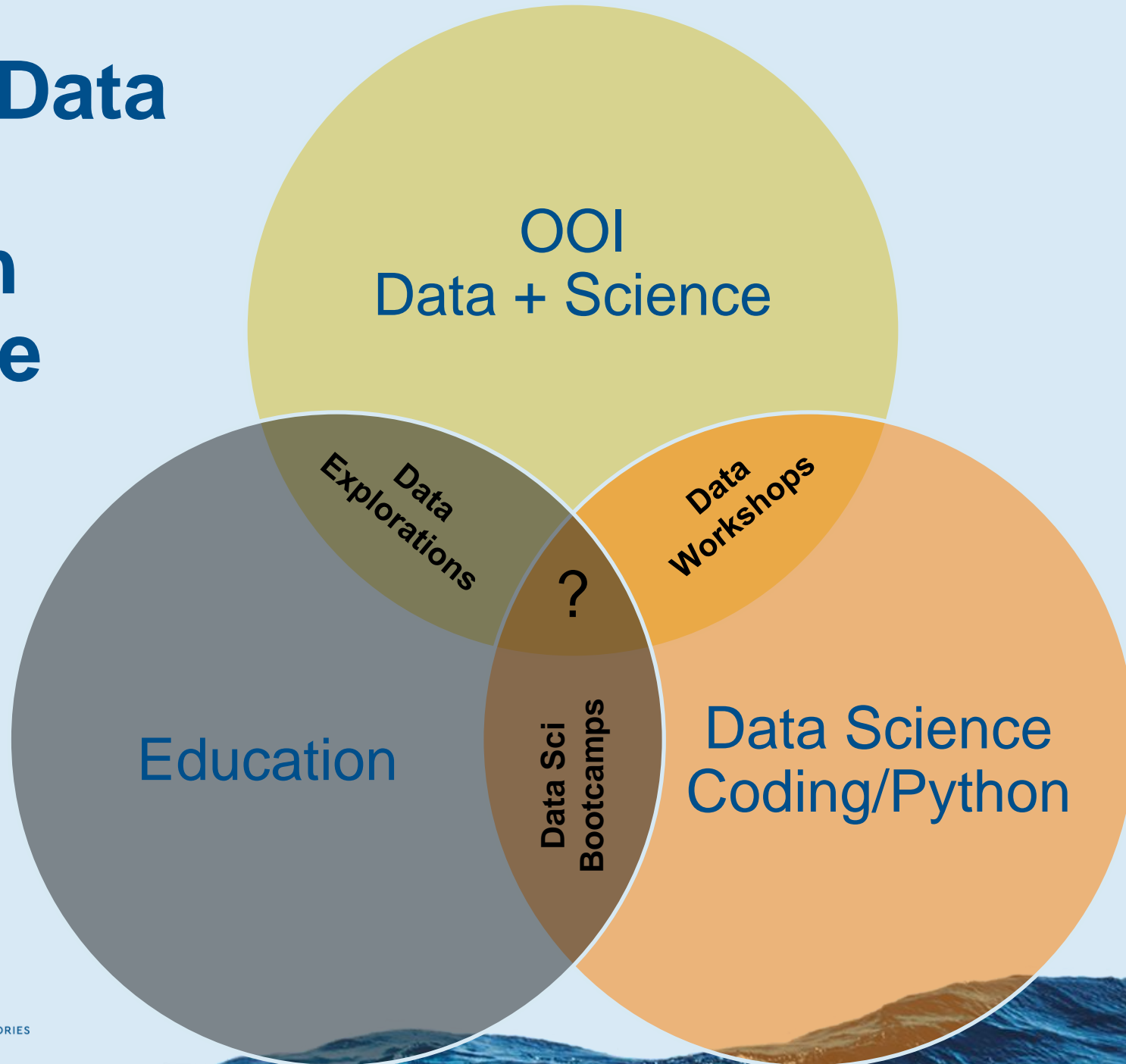


Meteorological and Oceanic Impacts of a Hurricane



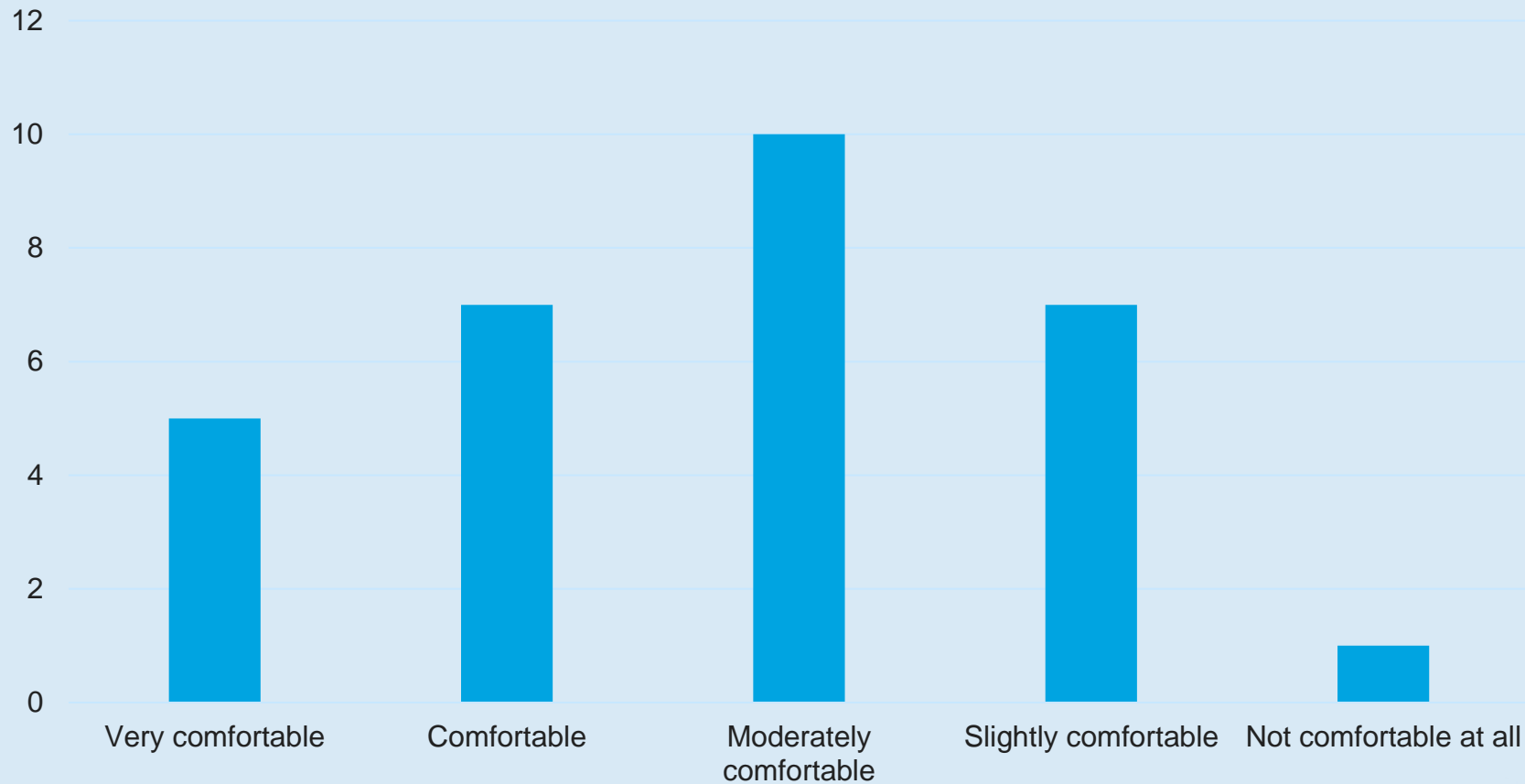


# The OOI Data Labs 2.0 Research Challenge



# Wilmington Workshop Participants...

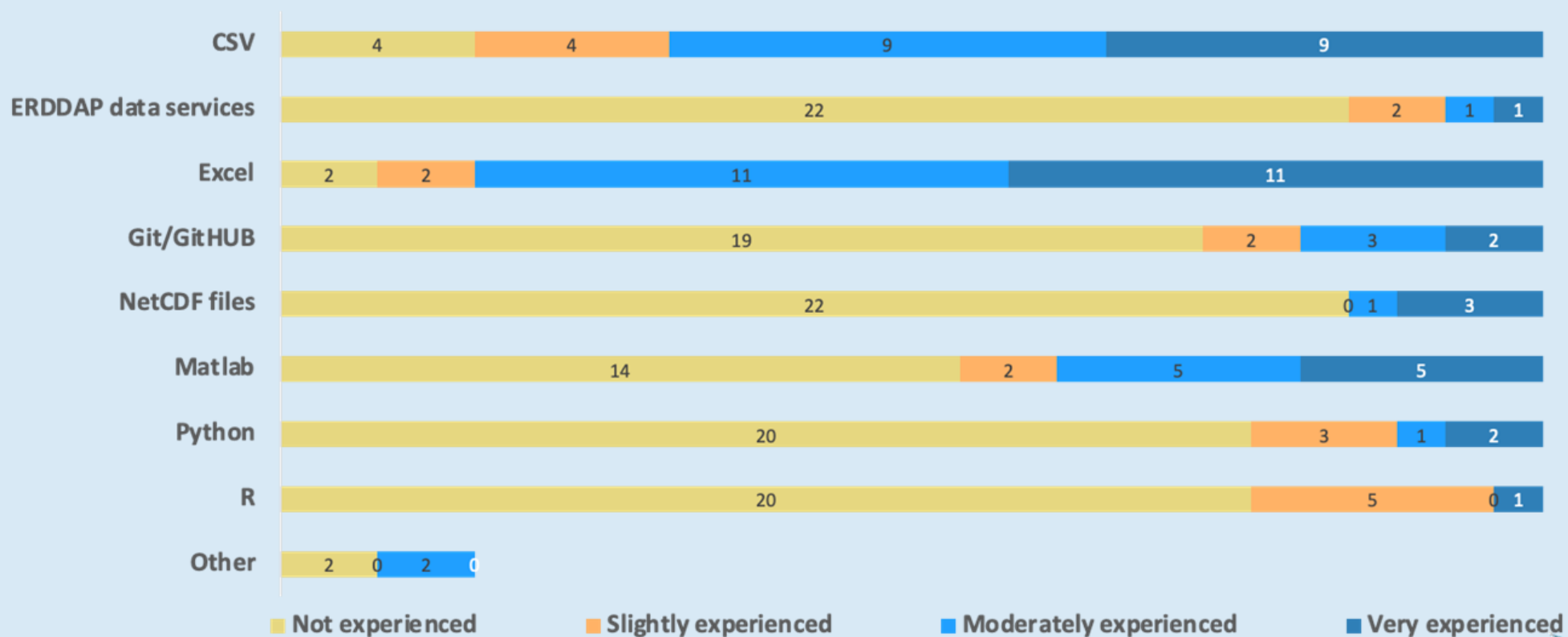
## How comfortable are you in incorporating oceanographic datasets into your teaching?





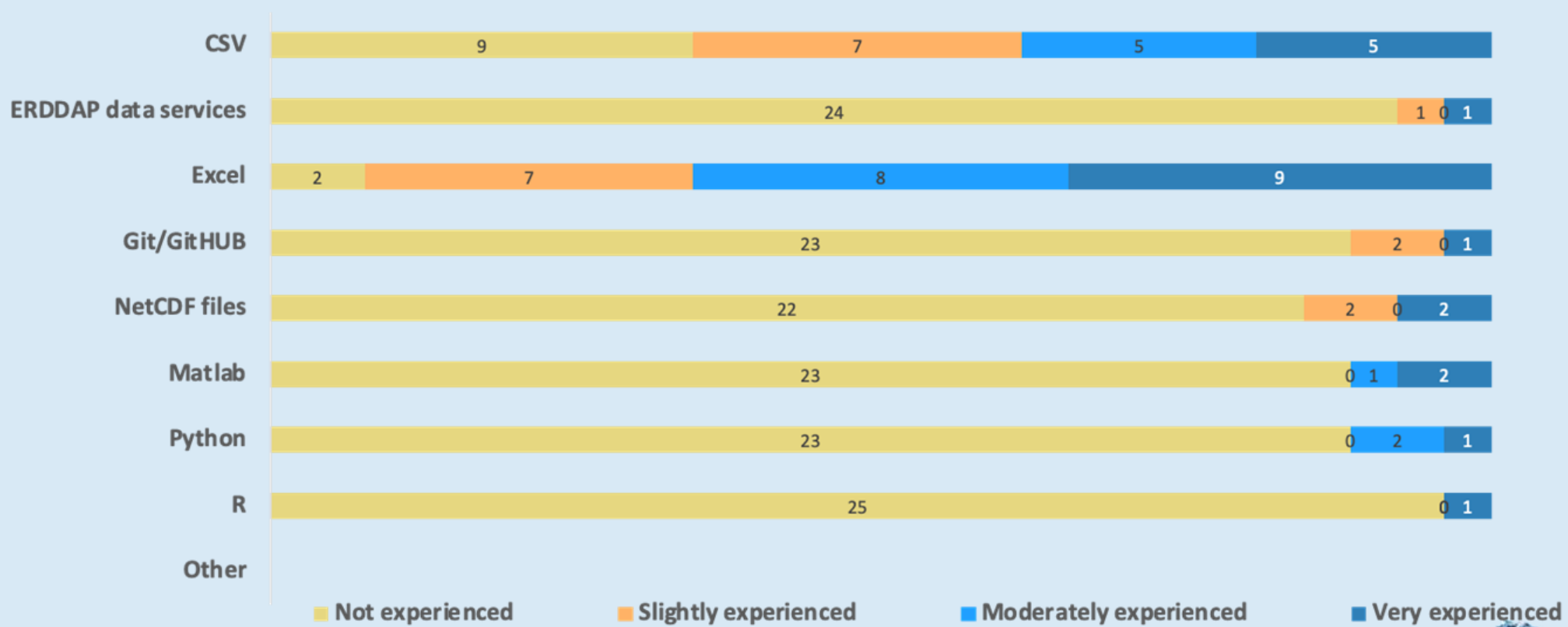
# Pre-Survey: Research Experience

What is your level of experience with the following file formats, software, and programming languages in your research?



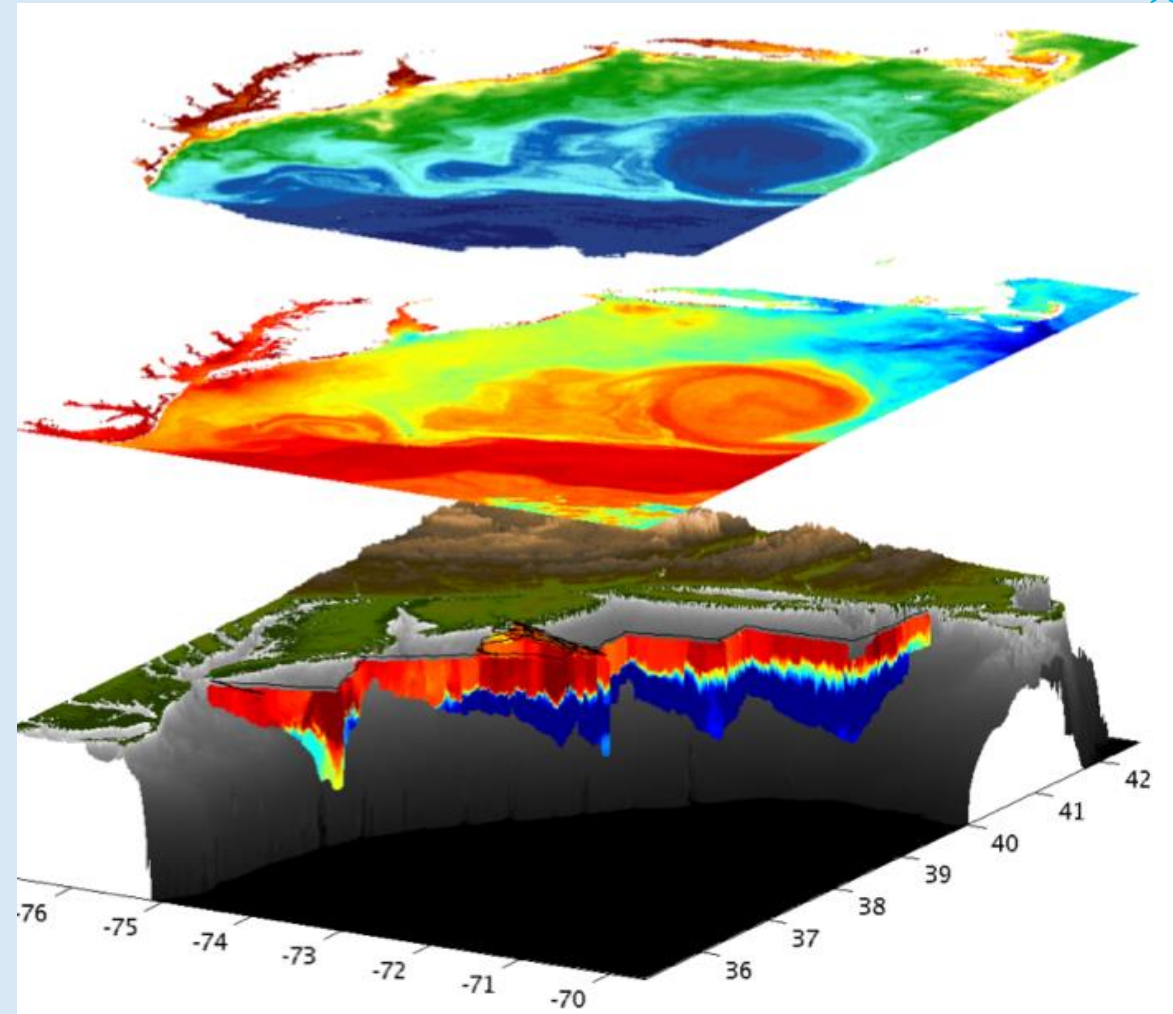
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What is your level of experience with the following file formats, software, and programming languages in your teaching?

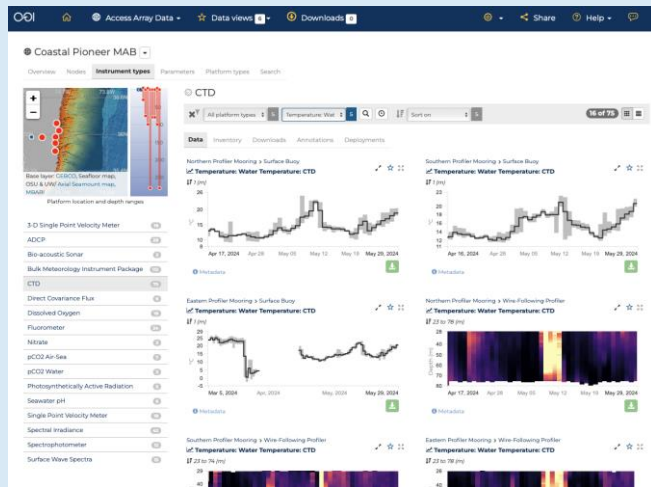


# Ocean Observing Systems Potential for Education

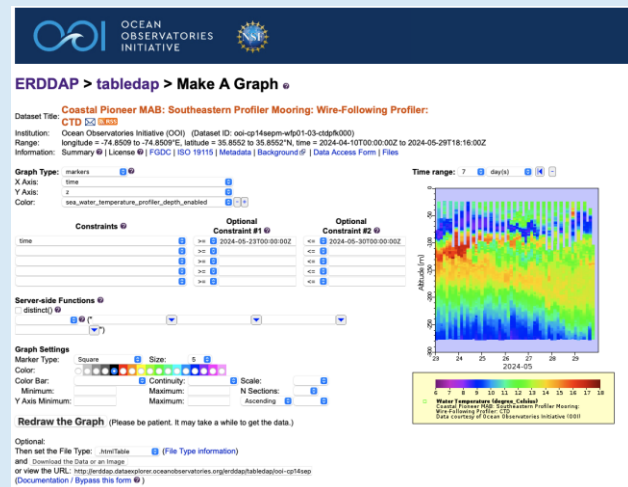
- Data already available “on the shelf”
- Supports a wide variety of research questions, locations & instruments
- Provides an opportunity to focus on programming, data analysis, and data visualization skills
- Helps build data literacy and critical thinking skills using “real” data



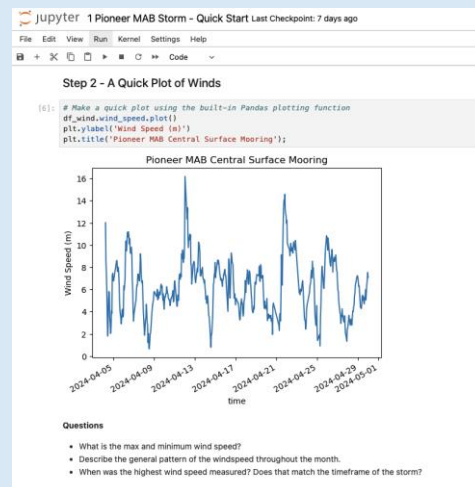
# OOI's Advanced Data Tools



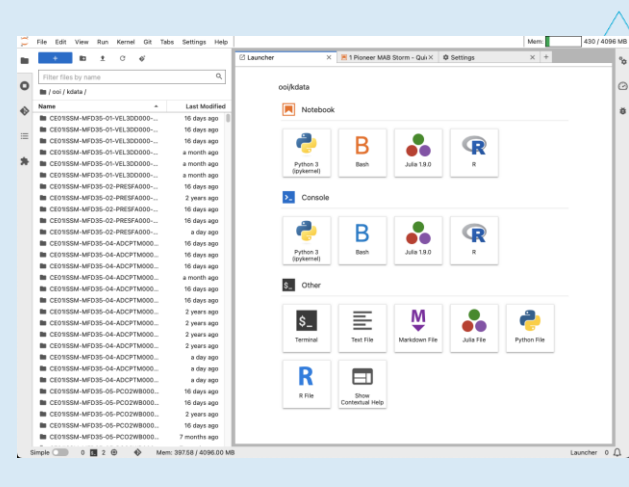
OOI Data Explorer



ERDDAP Data Servers



Coding Notebooks  
*(in development)*



OOI Jupyter Hub  
*New!*





# The Power of Coding Notebooks for Education

- Low-to-No setup
  - Thanks to Google Colab, OOI JupyterHub, and other tools
- Runs in your browser
- A “linear” development approach
  - Easy(ish) to understand
- Low bandwidth
  - No need to download data locally
- Lots of datasets readily available
  - Sometimes co-located with server
- Notebooks are Sharable
  - via GitHub
  - In real-time with Colab

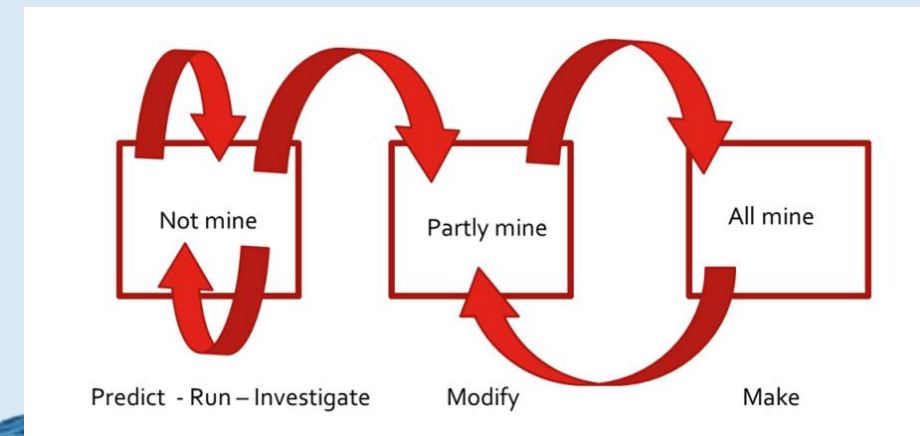
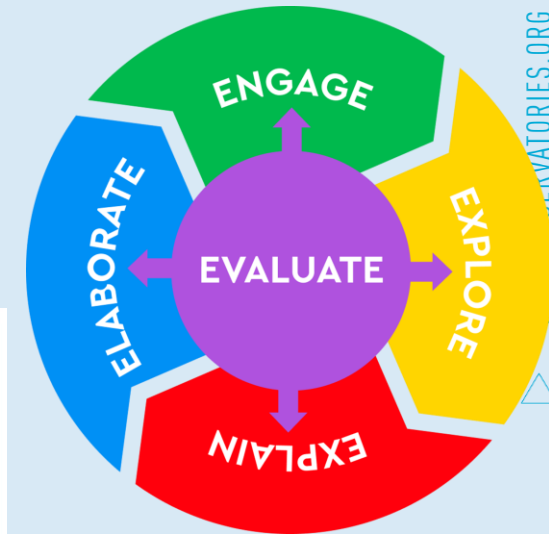
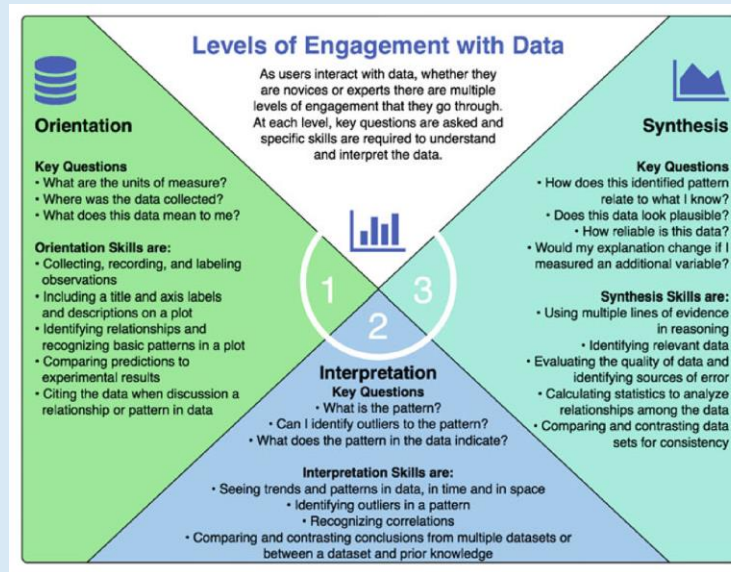
The screenshot shows a Jupyter Notebook interface. The title bar reads "Activity 1 OOI Data Quickstart.ipynb". The menu bar includes "File", "Edit", "View", "Insert", "Runtime", "Tools", and "Help". Below the menu bar are tabs for "CODE", "TEXT", "CELL", and "CELL". On the right side, there are buttons for "COMMENT" and "SHARE".

The main content area is titled "Activity 1 - A Quickstart to Playing with OOI Data". It includes a sub-header "Introduction" and a paragraph: "In this Python notebook, we will demonstrate how to quickly access and work with data from the Ocean Observatories Initiative (OOI). This example was designed to run on Google's Colaboratory platform, though it should also work on any Jupyter notebook platform, assuming the required libraries are installed. In this notebook, we will demonstrate the following **Data Discovery** steps: 3. Loading Data, 4. Exporting Datasets for use in other software tools, 5. Quick Plotting. We will use data from the 30m Dissolved Oxygen sensor on the [Global Irminger Sea Flanking Mooring A](#), also known as **GIO3FLMA-RIS01-03-DOSTAD000**. You can find out more information about this instrument on the [OOI Website](#), the [OOI Data Portal](#), or on the new [Rutgers OOI Data Review portal](#)." Below the text is a satellite map titled "GLOBAL IRMINGER SEA ARRAY" showing a circular area of interest in the ocean with a yellow circle and a coordinate marker "59°W 20°".



# Pedagogical Approaches for Coding-based Activities

- Structured/Guided Inquiry
- Constructivism / PBL
- Learning for Use (Edelson 2001)
  - Motivate, Construct, Apply/Refine
- Bybee 5E Instructional Model
  - Engage, Explore, Explain
- Levels of Engagement (Hoteling 2019)
  - Orientation, Interpretation, Synthesis
- PRIMM Teaching Model
- Paired Programming





# Potential Advantages of Notebook-based Educational Activities

## Educational Possibilities

- Develop your own activities
- Advanced activities allow students to gain experience
  - Working with data (Data Literacy)
  - Using data portals
  - Making their own graphs (Visualization Literacy)
- Student can conduct their own research projects (Scientific Literacy)

## OOI Tools for Skill Development

- Data Explorer
  - Quick graphs
  - Data Downloads for additional analysis
  - Share custom Data Views
- ERDDAP
  - Quick graphs & data downloads
- DIY Coding (R, Python, Matlab) Notebooks & JupyterHub
  - Custom graphs
  - Advanced data processing techniques (averaging, correlations, anomalies, etc.)





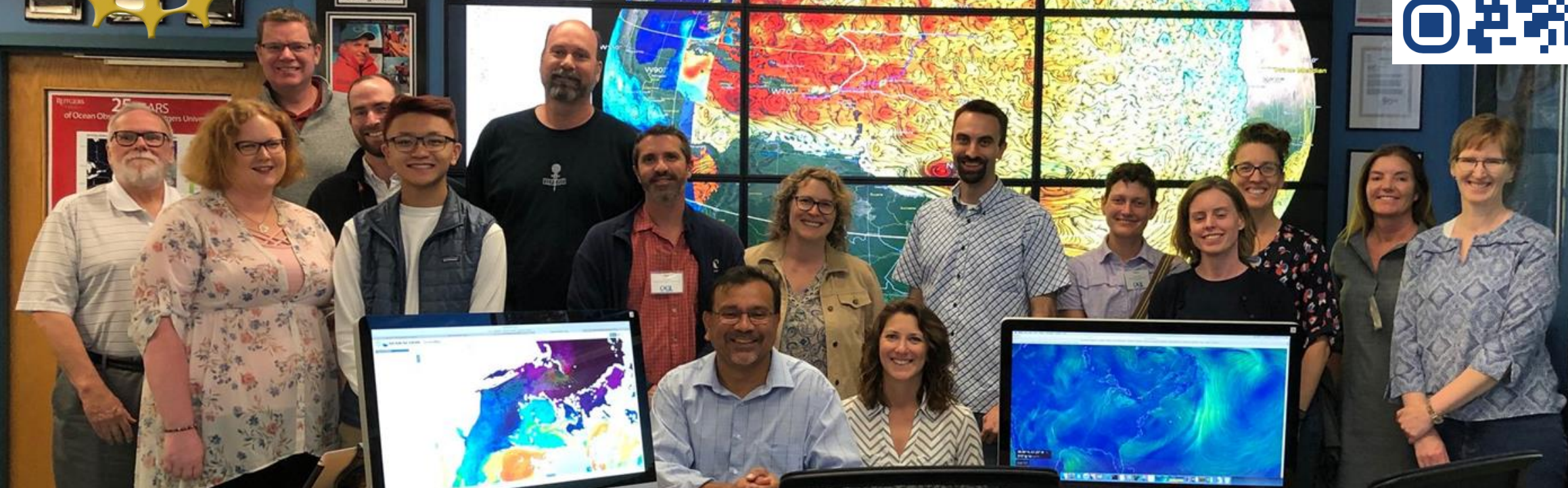
# Summary and Future Collaborations

- All OOI Data Labs activities are designed to develop students' **Data Literacy**, to engage them in the **scientific process** and help them develop a key **workforce** development skill.
- The OOI Lab Manual and Data Explorations, are targeted to introductory courses that include majors and non-majors, focusing on data **Orientation** and **Interpretation** skills.
- The Python notebook-based activities (in development) will guide students through the scientific process with OOI data to further support their data analysis skills.

## The Future

- Future Pioneer MAB scientific results can inspire future student activities!
- Broader Impacts: OOI Data Labs provides several models for engaging faculty and students (undergrad and grad) in using OOI data





**Thank you!**  
**[datalab.marine.rutgers.edu](http://datalab.marine.rutgers.edu)**