

What are our motivations for teaching with data?



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Presented at: Ocean Observatories Initiative (OOI) Teaching with Data Workshop
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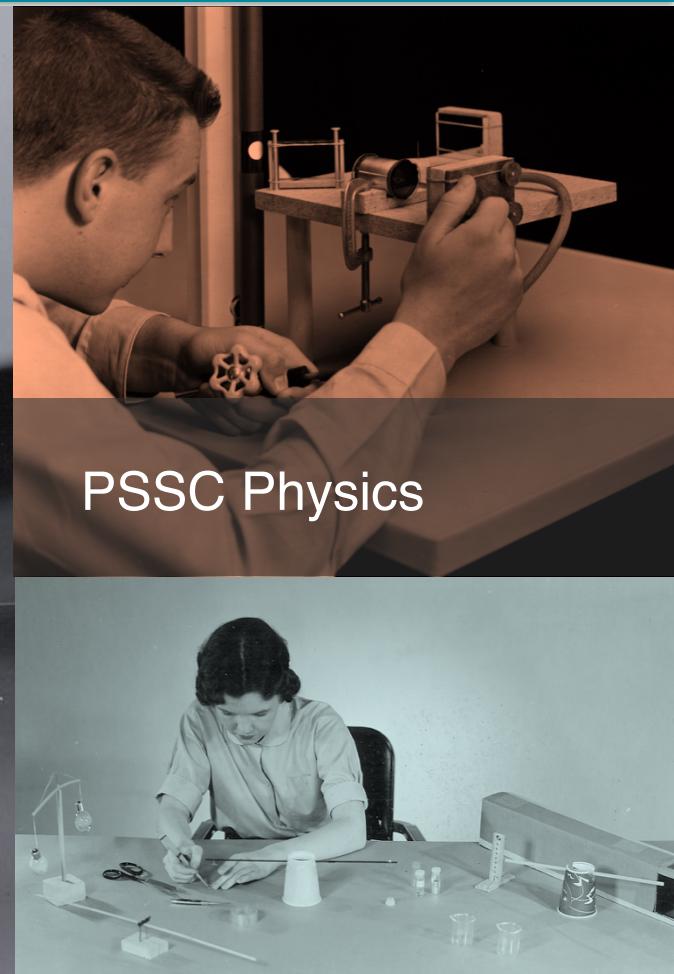


About EDC

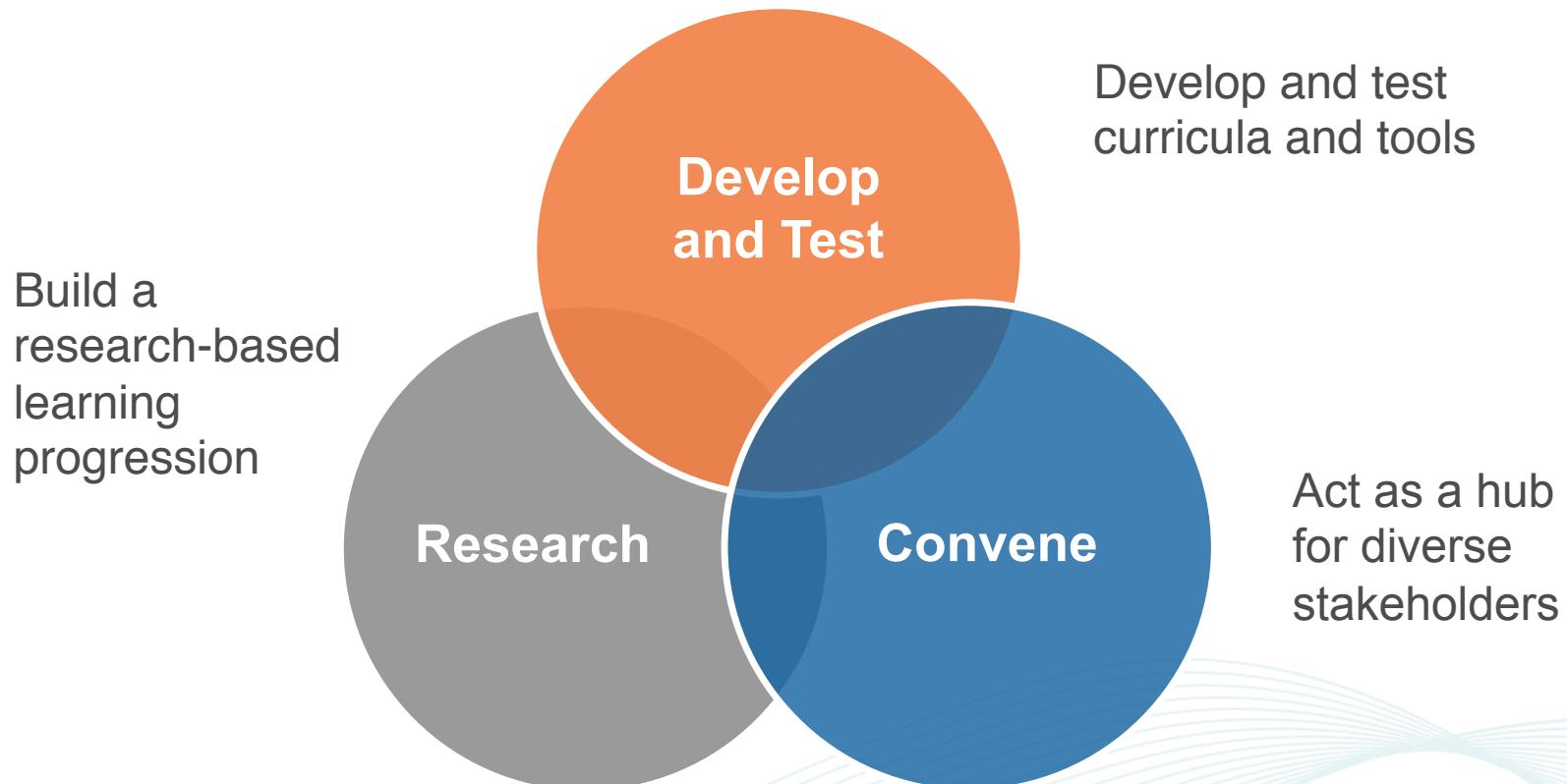


A global nonprofit organization that develops innovative programs to solve some of the world's most urgent challenges in education, health, and economic development

EDC's history in STEM education



Oceans of Data Institute: Promoting the data literacy of K-16 students

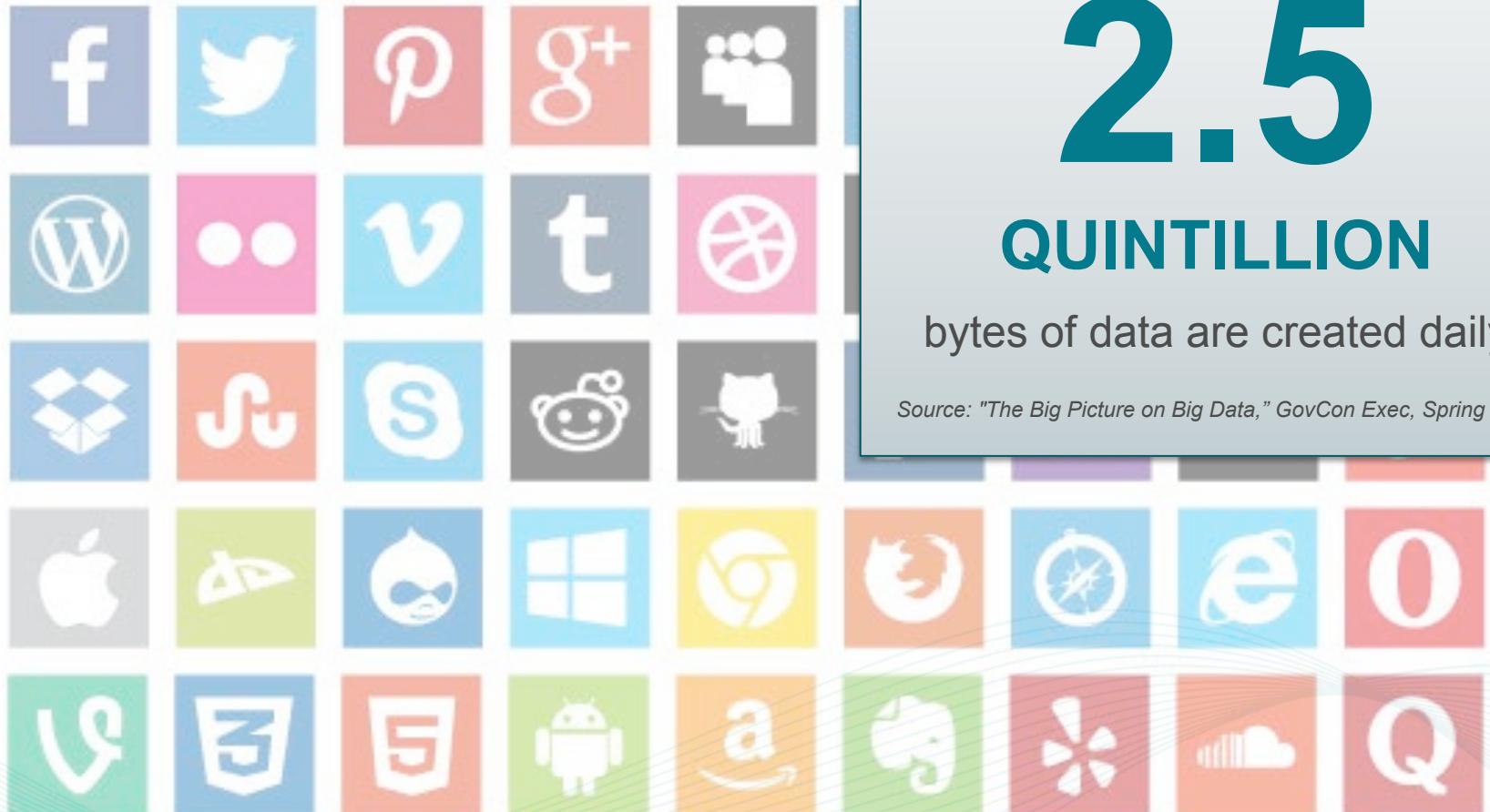


Why teach with data?

1. We live in a data-intensive world.
2. The job market demands it.
3. Data literacy is an integral part of learning science.
4. Because we can.



1. We live in a data-intensive world.



2. The job market demands it.

THE WALL
STREET
JOURNAL.

Get Familiar With Big Data Now—or Face 'Permanent Pink Slip'

Demand Rises for Analytics Professionals, Data Scientists (2014)

"Basic skills in working with data that every person should have are not being taught in K-16 schools. Thus, they are lacking at the highest levels in the broad array of professions that are becoming increasingly data-driven."

Juan LaVista, Principal Data Scientist at Microsoft

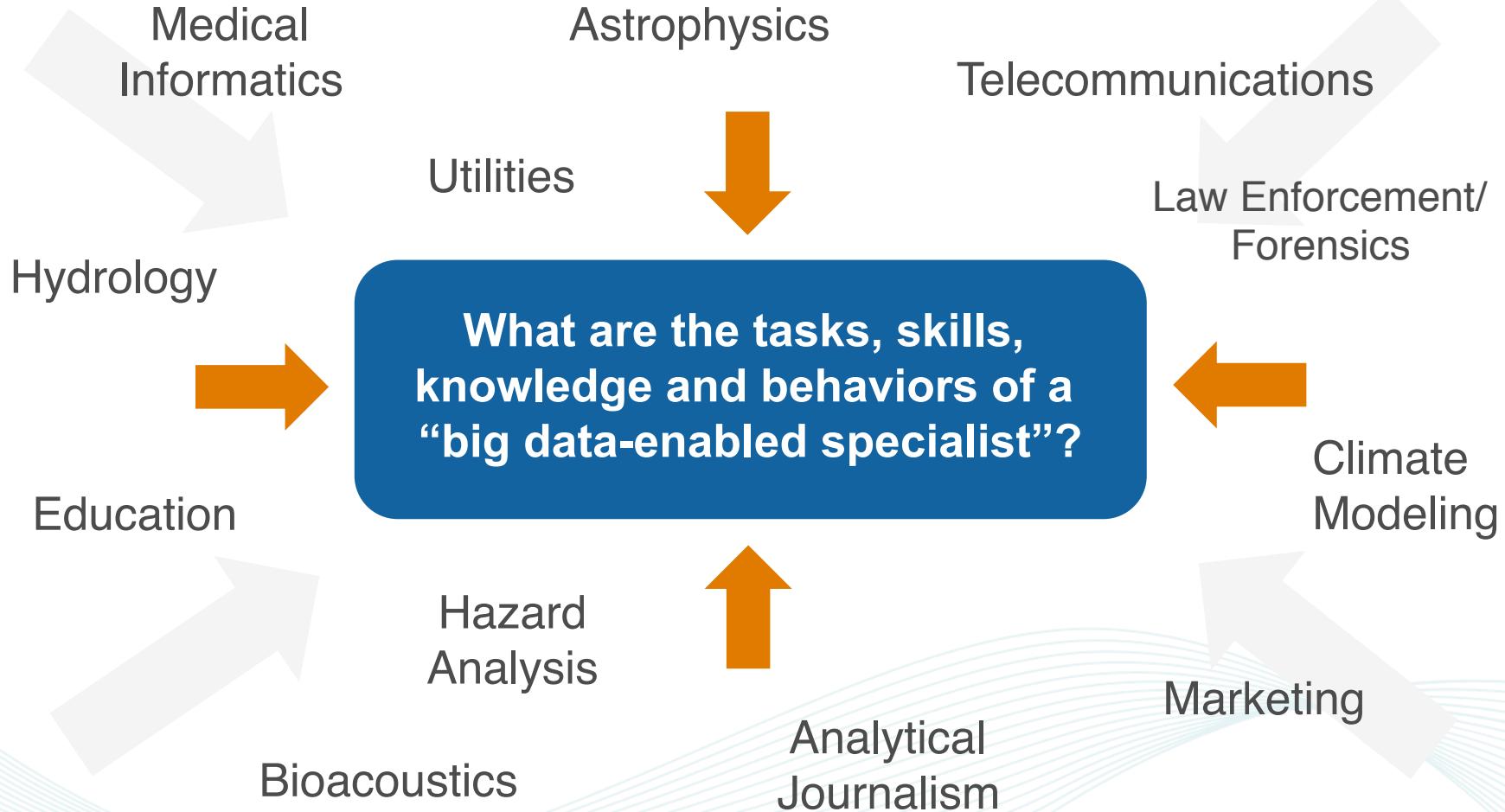
"By 2018, the United States alone could face a shortage of 140,000 to 190,000 people with deep analytical skills as well as 1.5 million managers and analysts with the know-how to use the analysis of big data to make effective decisions." (McKinsey Global Institute, 2011)

Students recognize the importance of data literacy

The Oceans of Data Institute surveyed 300+ students from community college and university settings:

- 85% of respondents agreed or strongly agreed that the ability to make sense of data is **important to get a good job and will help in their future careers.**
- 90% of respondents agreed or strongly agreed that learning to make sense of data will help them be **more effective and informed citizens.**

Developing an Occupational Profile



What are the knowledge, skills, and behaviors of a “big data-enabled specialist”?

As identified by an expert panel of big data users, and verified by ~150 big data users:

Knowledge:

- Analytic Thinking (89%)
- Algorithms (76%)
- Data Modeling (70%)
- Data Structures (70%)
- Best Practices (69%)
- Statistics (69%)

Skills:

- Analytical Thinking (96%)
- Critical Thinking (84%)
- Problem-solving (75%)
- Applying Statistical Methods (74%)
- Data Manipulation (70%)

Behaviors:

- A problem solver (89%)
- A lifelong learner (78%)
- Willing to question (78%)
- A seeker of patterns (67%)
- Open-minded (67%)

3. Data literacy is an integral part of learning science

“Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements—knowledge and practice—are essential.”

Next Generation Framework for K-12 Science Education, NRC 2011, p. 2-3



Using data helps develop key problem-solving skills and increase relevancy of science content.

Use of authentic scientific data in classrooms enables students to engage in learning activities that are more deeply inquiry-based and enable higher development of problem-solving skills, address more complex concepts, and offer greater relevance to students' lives than traditional learning activities.

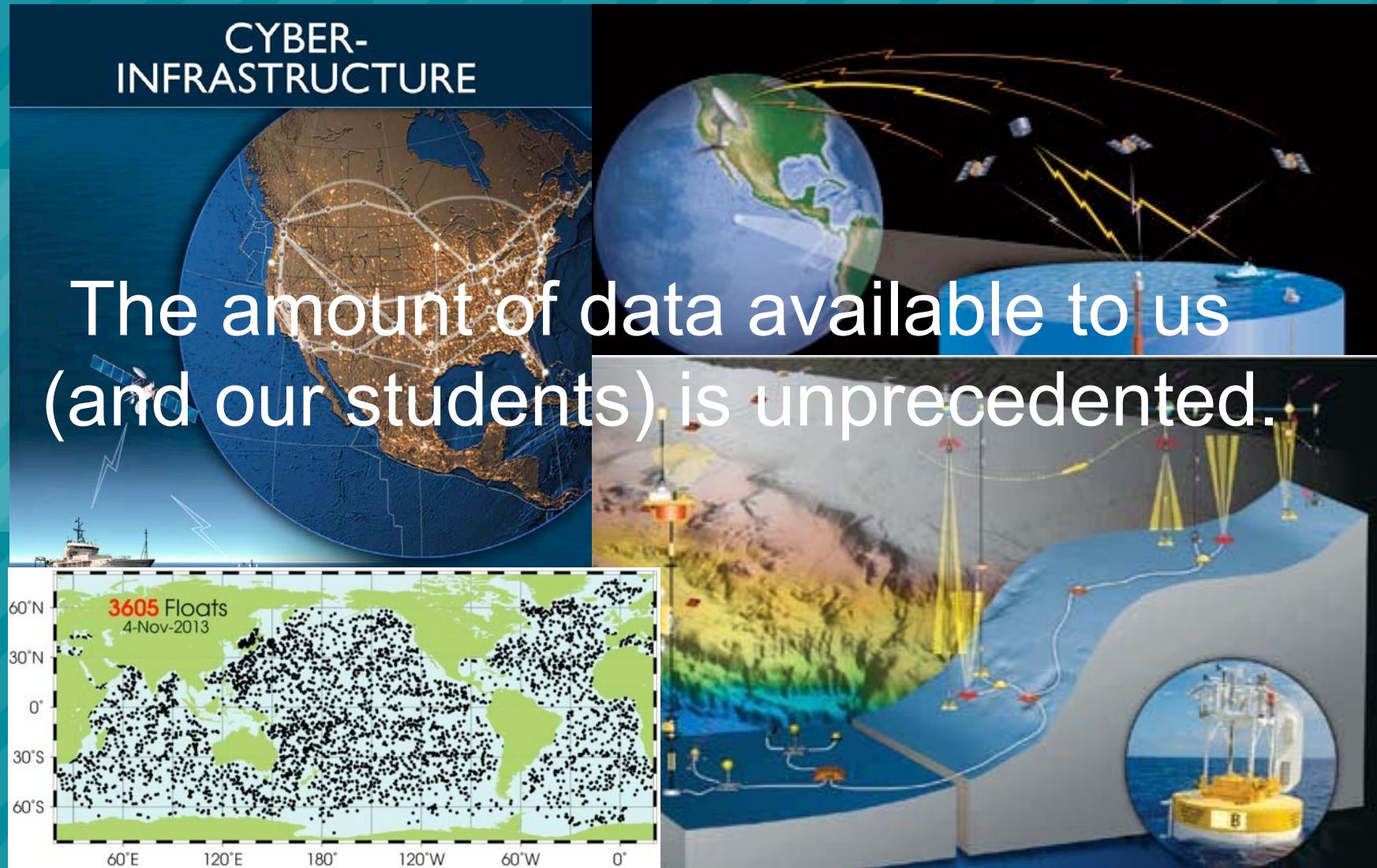
(Hotaling, 2005; Parsons, 2006, Simmons, Wu, Knight, & Lopez, 2008)

Using data will help students gain a deeper understanding of content.

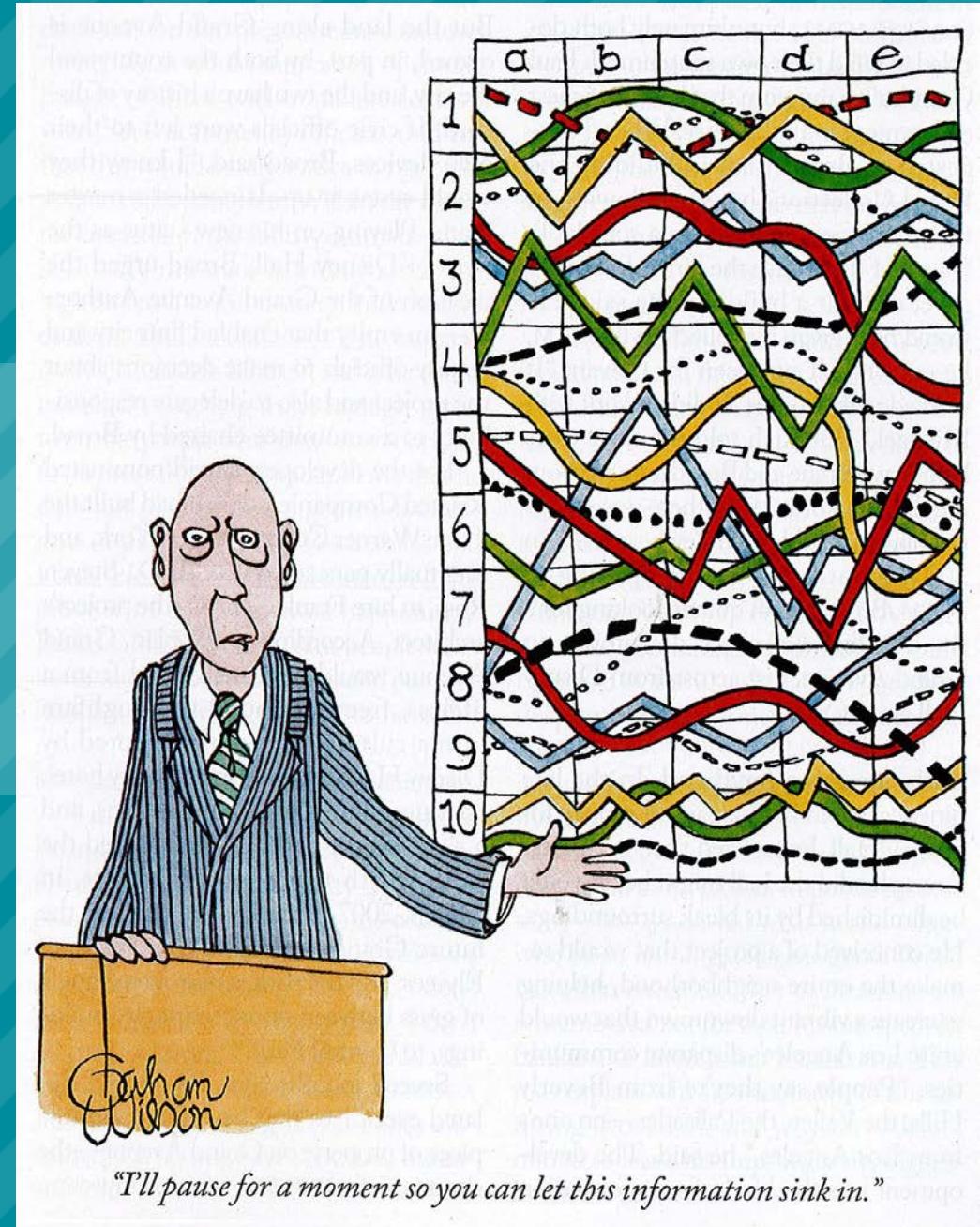
There is now considerable evidence that knowledge acquired by students via simply “taking in” or memorizing information is fragile and can be superficial. To build a more robust and enduring understanding of content, students in science classrooms need to actively engage with new information, connecting and applying concepts as they construct scientific explanations for observed phenomena.

(NRC, 2000, 2012)

4. Because we can.



**Building
students'
skills in
working with
large,
complex
datasets is
important,
but
challenging.**



What are some of those challenges?

- **Schools (K-16) aren't currently developing students' data-using skills**, particularly those skills necessary to work with large, complex data sets.
- **Very little research** has been done that tells us how to develop these skills.
- **Limited awareness** of the importance of ramping up the teaching of these skills.

What's different about “big” data sets?

Complex – include different types of data, collected different ways

Large – there are more data than you need to answer any particular question

Interactive – you are able to explore the data interactively, comparing different sets of data via a variety of data visualizations

Professionally-collected – it was collected by “others” (not the student)

Challenging transitions

Embodied, experiential
grasp of the natural setting
and data collection methods

Metadata

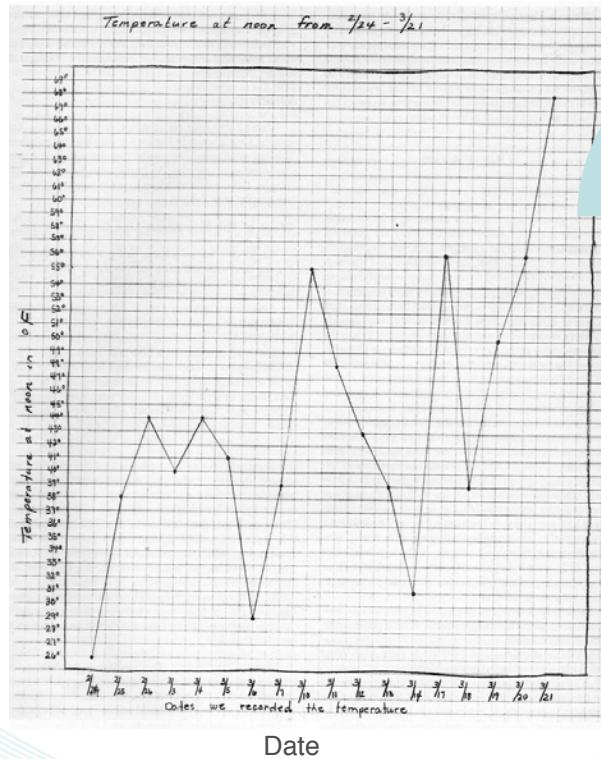


Photo credits: (left) School in the Forest powerpoint,
<http://www.blackrockforest.org/docs/about-the-forest/schoolintheforest>
(right) Using a Digital Library to Enhance Earth Science Education,
Rajul Pandya, Holly Devaul, and Mary Marlino)

Challenging transitions

Dozens of data points

Air temperature at noon



Petabytes

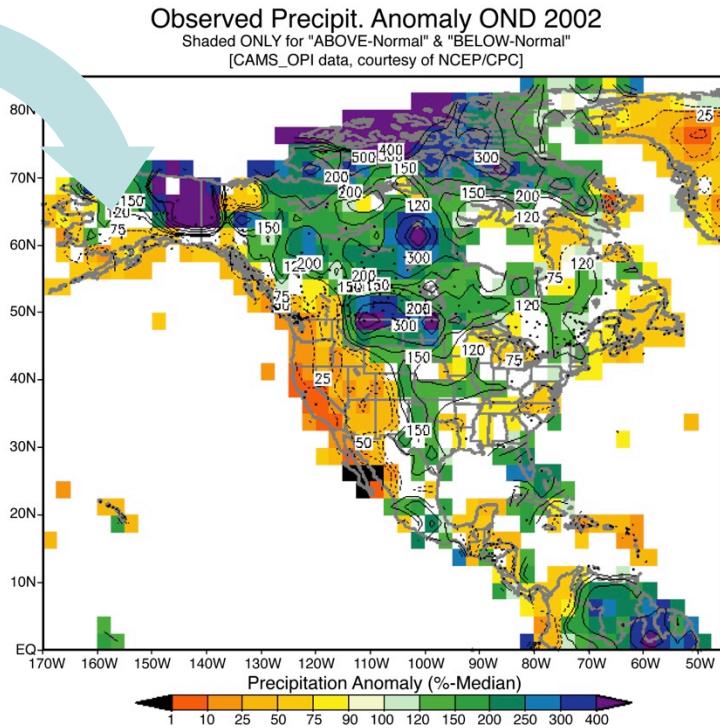
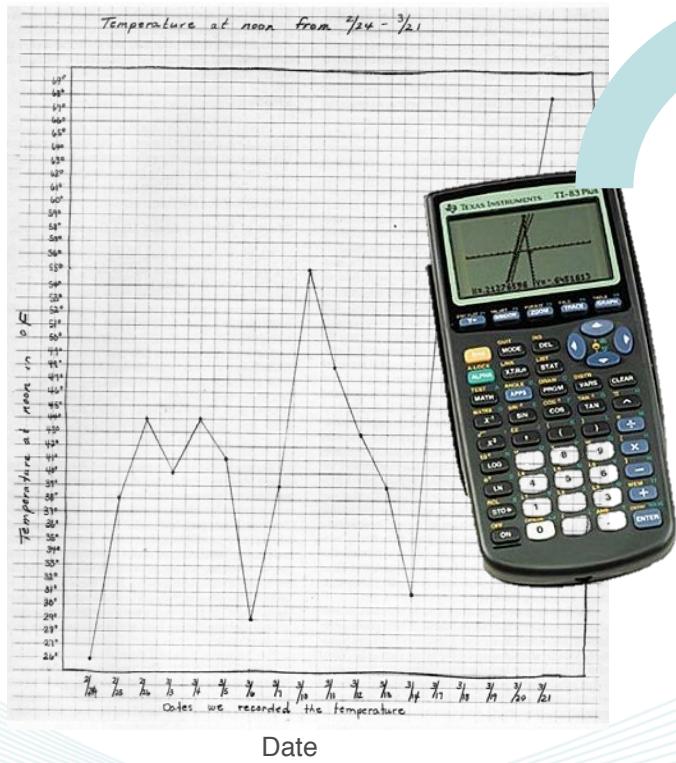


Image credits: (left) from Clement, 2002

Challenging transitions

Simple, transparent tools
and techniques

Air temperature at noon



Sophisticated tools and
techniques

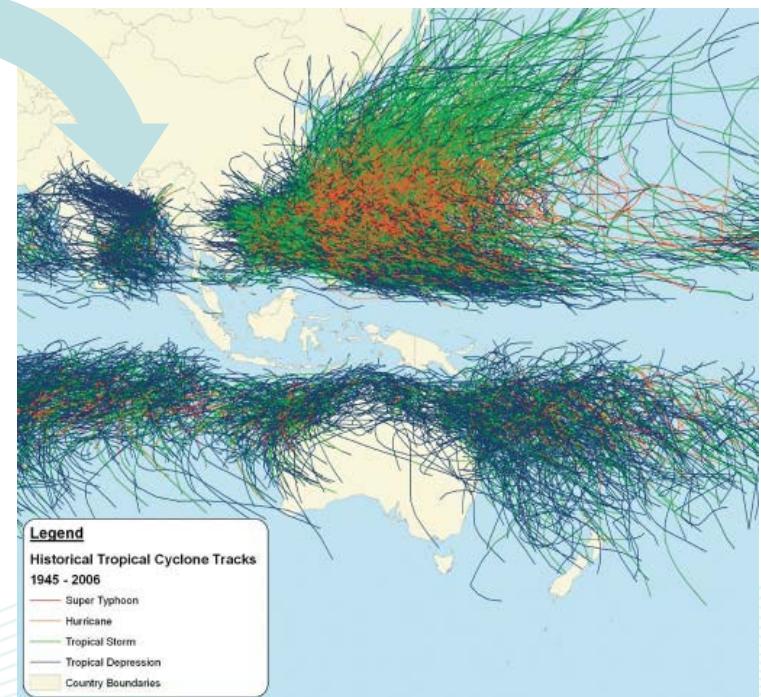


Image credits: (left) from Clement, 2002; (right) <http://www.esri.com/library/ebooks/climate-change.pdf>

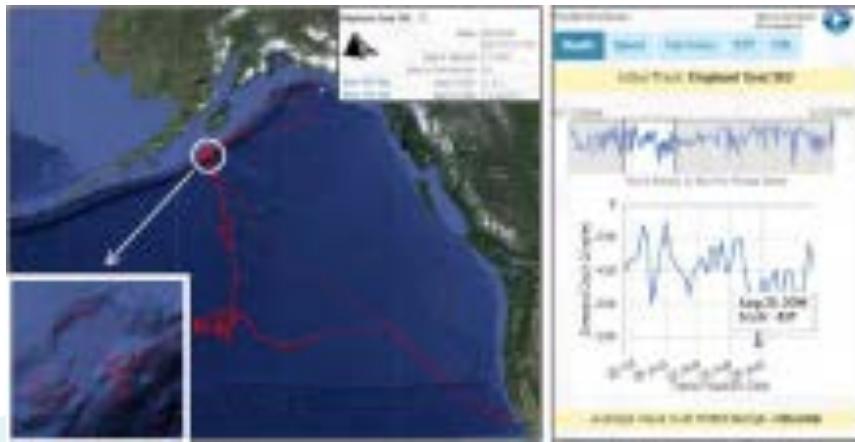
Other challenges

- Expert data access and data representations may be baffling to students.
- Working with real data can be messy and without clear answers.

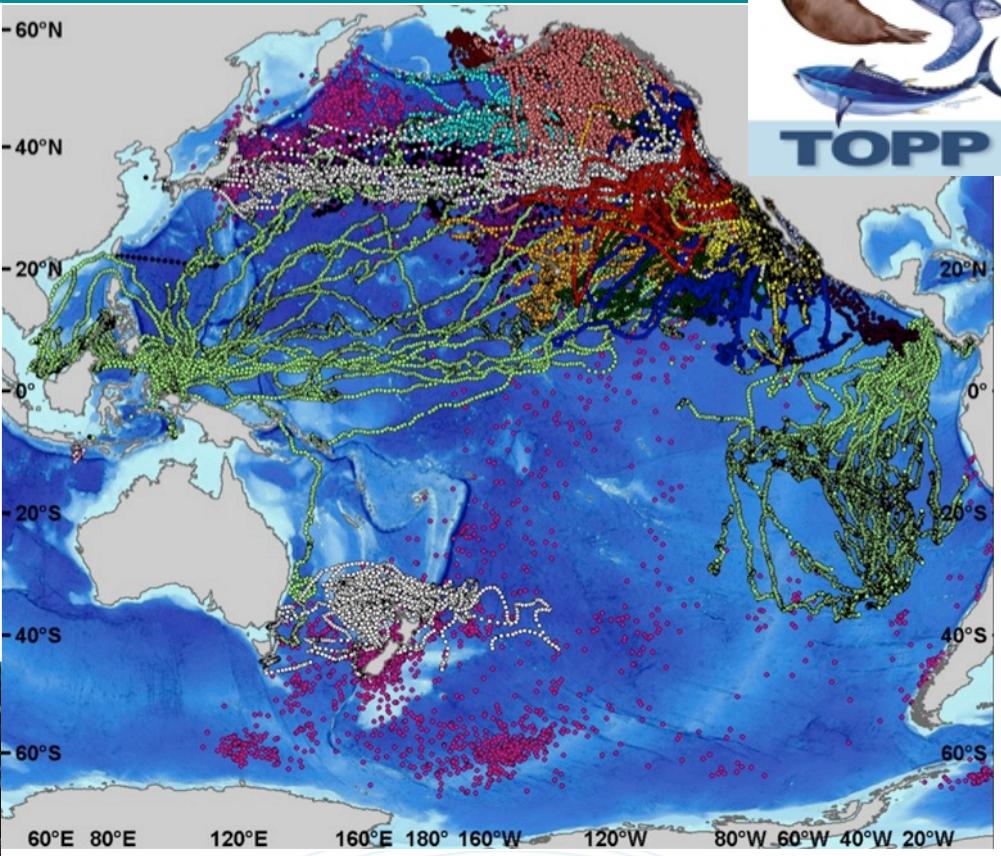
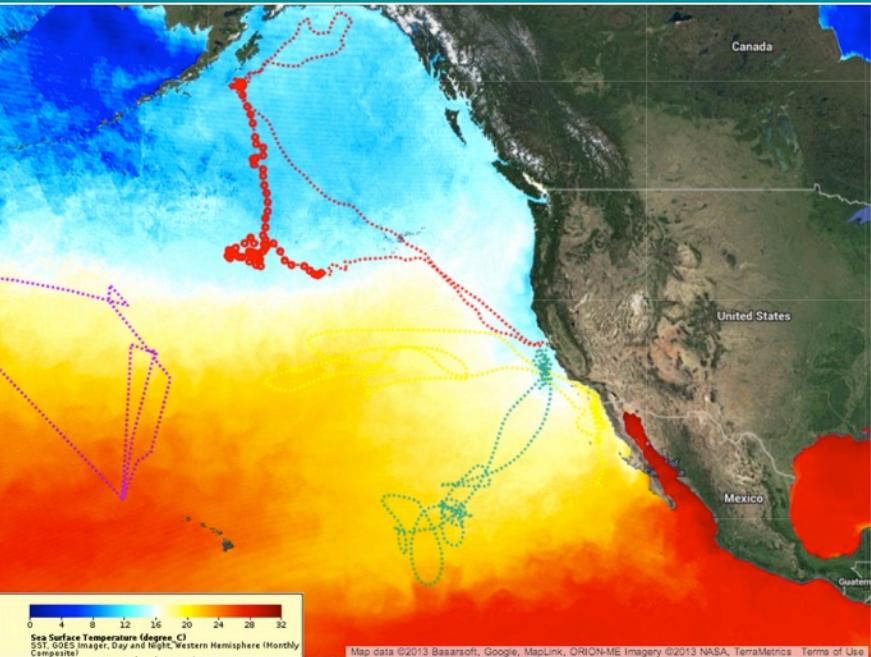
How ODI Approaches Teaching with Data

OCEAN TRACKS—COLLEGE EDITION

The project is creating an interactive Web-based learning resource to help students at different types of undergraduate institutions develop valuable skills in analyzing and learning from large, authentic scientific datasets. This project is investigating how a learning resource that includes a data interface, set of analysis tools, and curricula can be used to motivate diverse populations of college students to learn and do science with real data, bringing opportunities to engage broad student populations in scientific practice.



The Data



OT-CE Curriculum Modules

Tag – You're It!
Exploring Ocean Tracks Data

How do you gather and display data about the travels and behaviors of real, live marine animals? Electronic tagging technology lets us track marine animals' migration, feeding, and breeding patterns, as well as information about the variety of environmental conditions they experience as they traverse the oceans. Dive in! Hit the beach in Hawaii with a white shark. Play "tag" with an elephant seal. Learn how marine animals are tagged and tracked across the Pacific.

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OCEANTRACKS

What is UP with the California Coast?
The making of productive habitat

What makes the California Coast so inviting for marine species? There's just something about the California Coast. Is it the sunshine? The long sandy beaches? The palm trees? Not only are people drawn to this beautiful coastline, many marine animals are too. In this module, you'll investigate sea surface temperature, chlorophyll concentration, and migration data on the Ocean Tracks website to explore some of what makes the California coast such a popular ocean destination.

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OCEANTRACKS

The Need for Speed
Exploring Adaptations for Migration

What adaptations make animals suited for long distance ocean travel? "Swim" along with elephant seals, bluefin tuna, Laysan albatrosses, and white sharks to find out who travels fastest, farthest, and deepest. Research the adaptations that make these animals suited for long distance ocean travel and how their migration tracks relate to known behaviors.

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OCEANTRACKS

Do You Come Here Often?
The Making of a Biological Hotspot

What attracts predators to hotspot regions in the North Pacific Ocean? Use Ocean Tracks to discover where top predators congregate in the North Pacific Ocean. Research behaviors of these animals at their hotspots, examine overlap between species hotspots, and draw conclusions about the oceanographic conditions that define these hotspots over space and time. Finally, consider how a better understanding of the characteristics and locations of these important habitats help us conserve and manage species more effectively.

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OCEANTRACKS

Battle of the Sexes
Determining the sex of elephant seal 302

Is Elephant Seal 302 male or female? Some species exhibit physical and behavioral differences between the sexes. Use migration track points, measurements, and background information about elephant seal behaviors as clues to solve the mystery of whether Elephant Seal 302 is male or female. Defend your claim in a lively debate with your classmates. Determine who has the most sufficient evidence to knock out the competition in this "battle of the sexes."

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OCEANTRACKS

TLC in an MPA
Establishing a New Marine Protected Area

Where in the North Pacific Basin could you create the most effective Marine Protected Area? If you could protect the sea life and environment of any part of the North Pacific Basin, which region would you choose? What factors would influence your decision? Use Ocean Tracks to explore the extent of human impacts in areas of the North Pacific Ocean that are heavily used by albatrosses, elephant seals, white sharks, and bluefin tuna. Determine some of the most important characteristics of Marine Protected Areas (MPAs) and how they can improve the overall health of the ocean. Using what you've learned, propose the establishment of a new MPA that has the greatest potential for protecting marine species in the future.

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OCEANTRACKS

OT-CE Data Skills

- Decoding and describing data patterns
- Explaining why a data pattern occurs using background info/content knowledge
- Providing appropriate or relevant data to support a claim or hypothesis
- Providing multiple sources of evidence to support a claim or hypothesis
- Providing reasoning for how data measurements or patterns support a hypothesis or claim, referring to scientific principles or processes
- Generating a hypothesis or claim that addresses a given research question

Goals for students

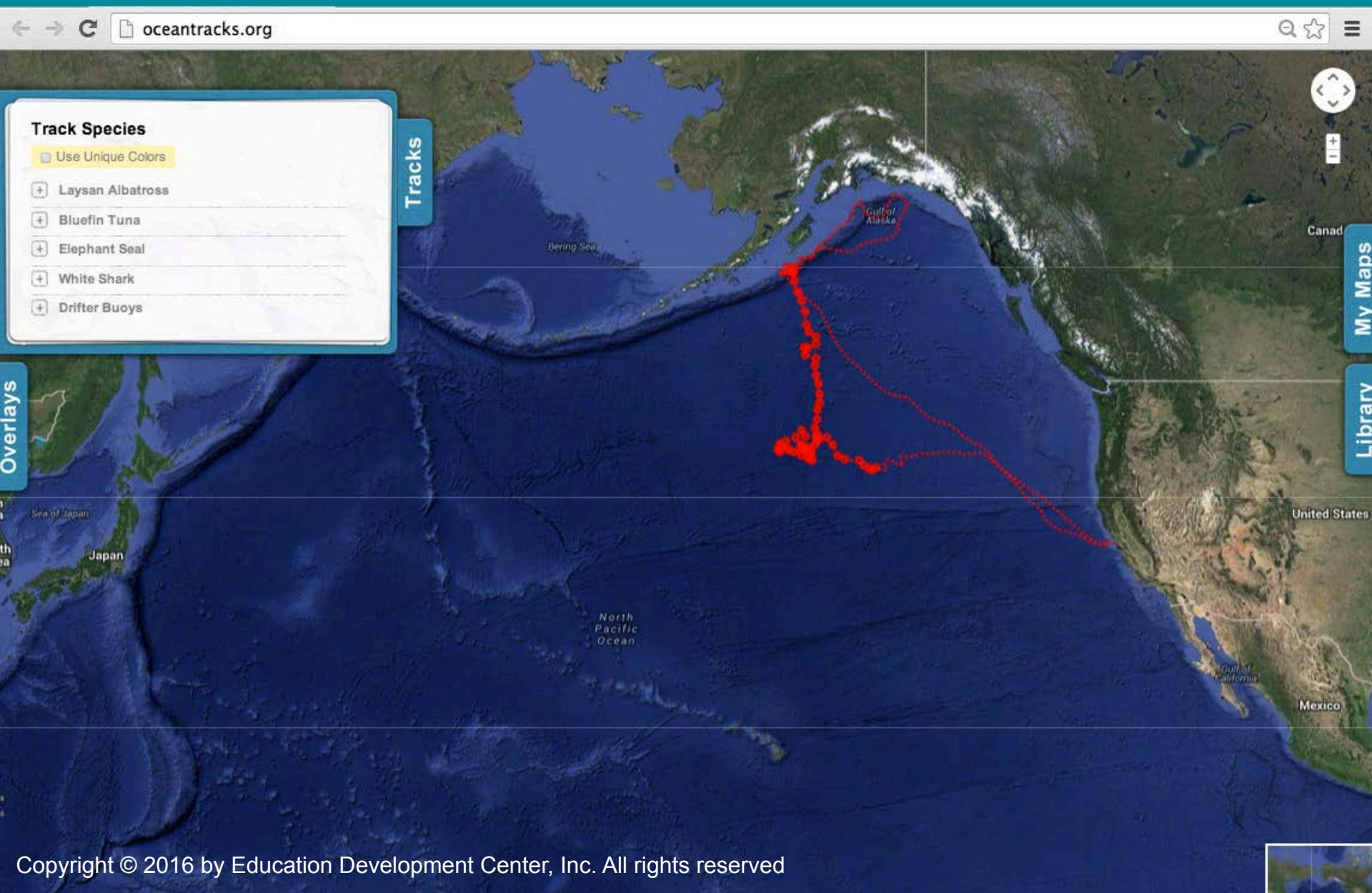
Explore questions of current scientific interest using compelling data sets.

- What might influence the movement of marine species?
- Why might movement be affected by oceanographic factors?
- How does the importance of these factors differ across species?
- Can we predict where marine species will congregate in the future, to target for protection?

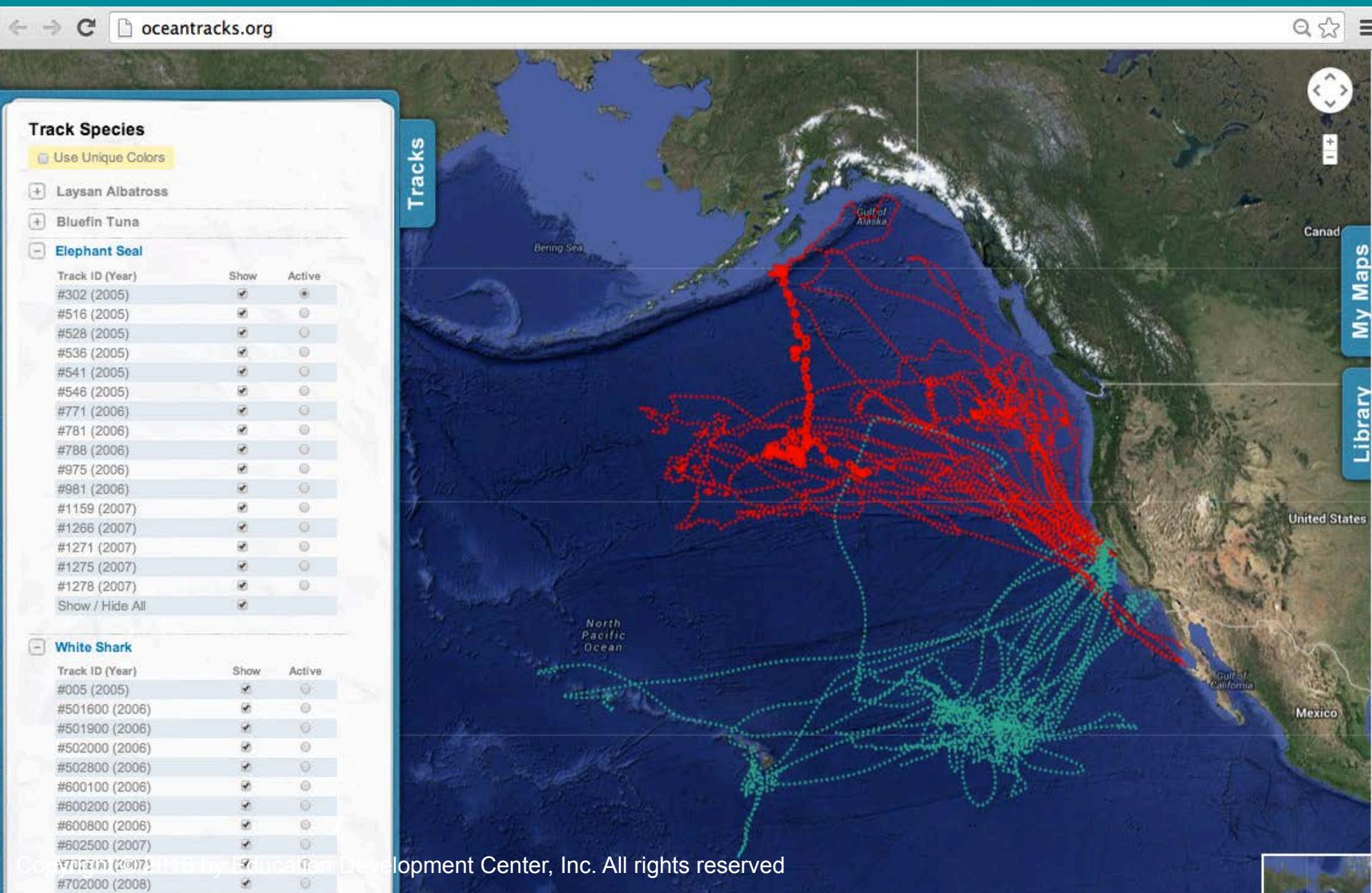
The Interface

This screenshot shows the oceantracks.org interface. The main view is a satellite map of the North Pacific Ocean, centered around the Bering Sea and the Gulf of Alaska. A prominent red dotted line represents a tracking path, starting near the coast of Russia, crossing the Bering Sea, and then heading west through the North Pacific towards the coast of North America. The map also shows the Sea of Okhotsk, Sea of Japan, and parts of Canada, the United States, and Mexico. Several regions are labeled: "Bering Sea", "Sea of Okhotsk", "Sea of Japan", "Japan", "North Pacific Ocean", "Gulf of Alaska", "Canada", "United States", "Mexico", and "Gulf of California". The top navigation bar includes a back/forward button, a search icon, and a star icon. The bottom left corner features a vertical sidebar with buttons for "Tracks", "Tools", "Overlays", and "Library". The bottom right corner contains a small inset map.

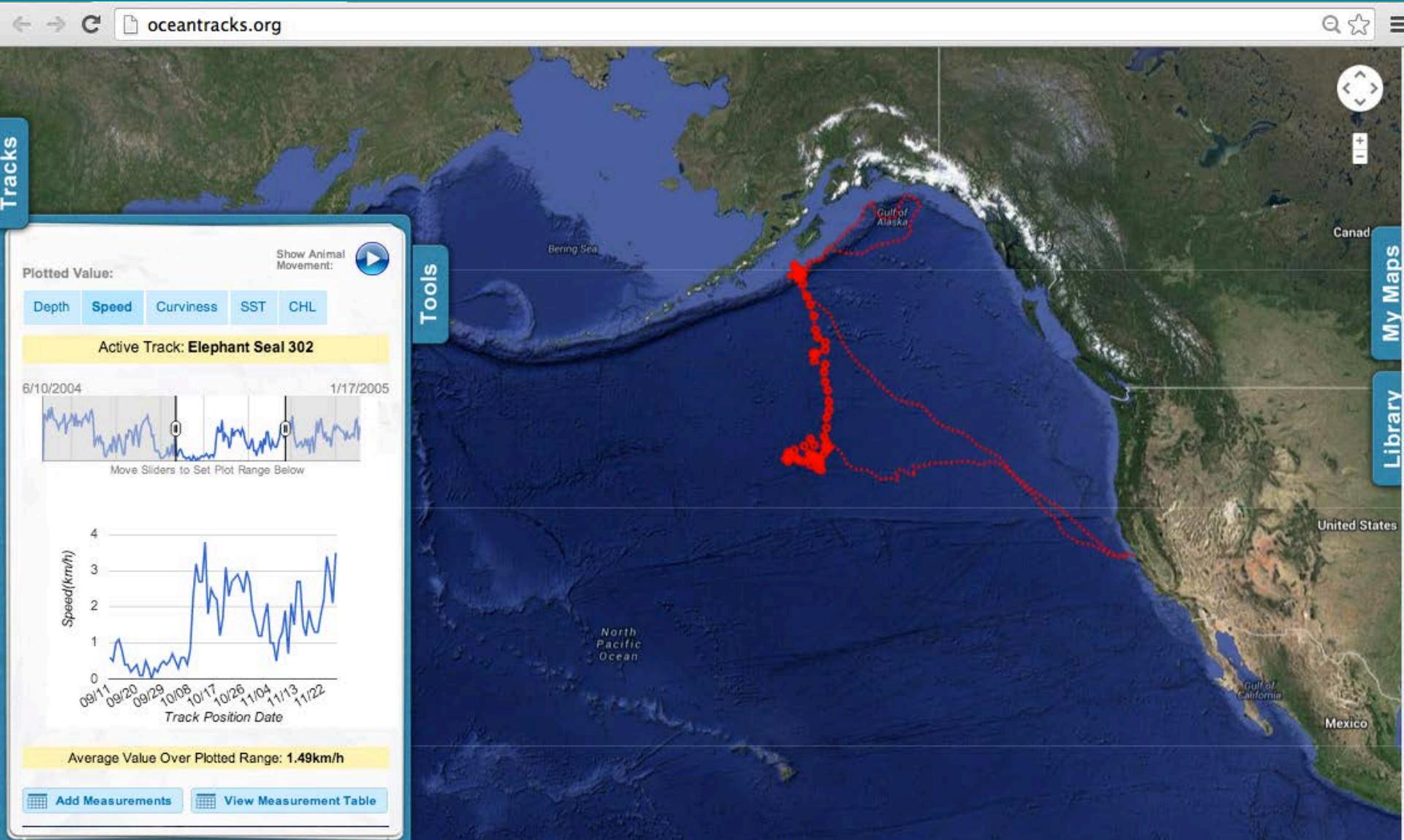
Get students quickly to the data



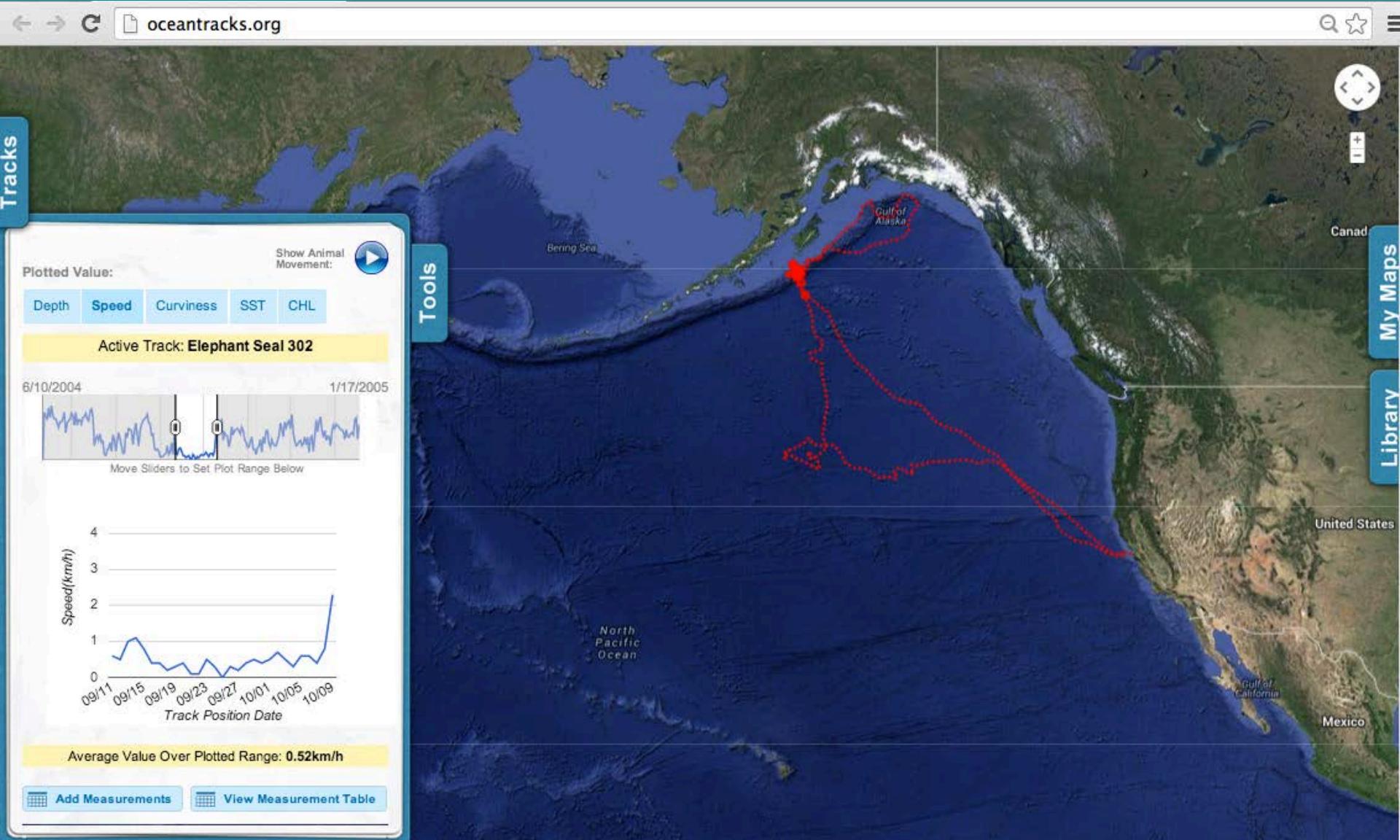
Get students quickly to the data



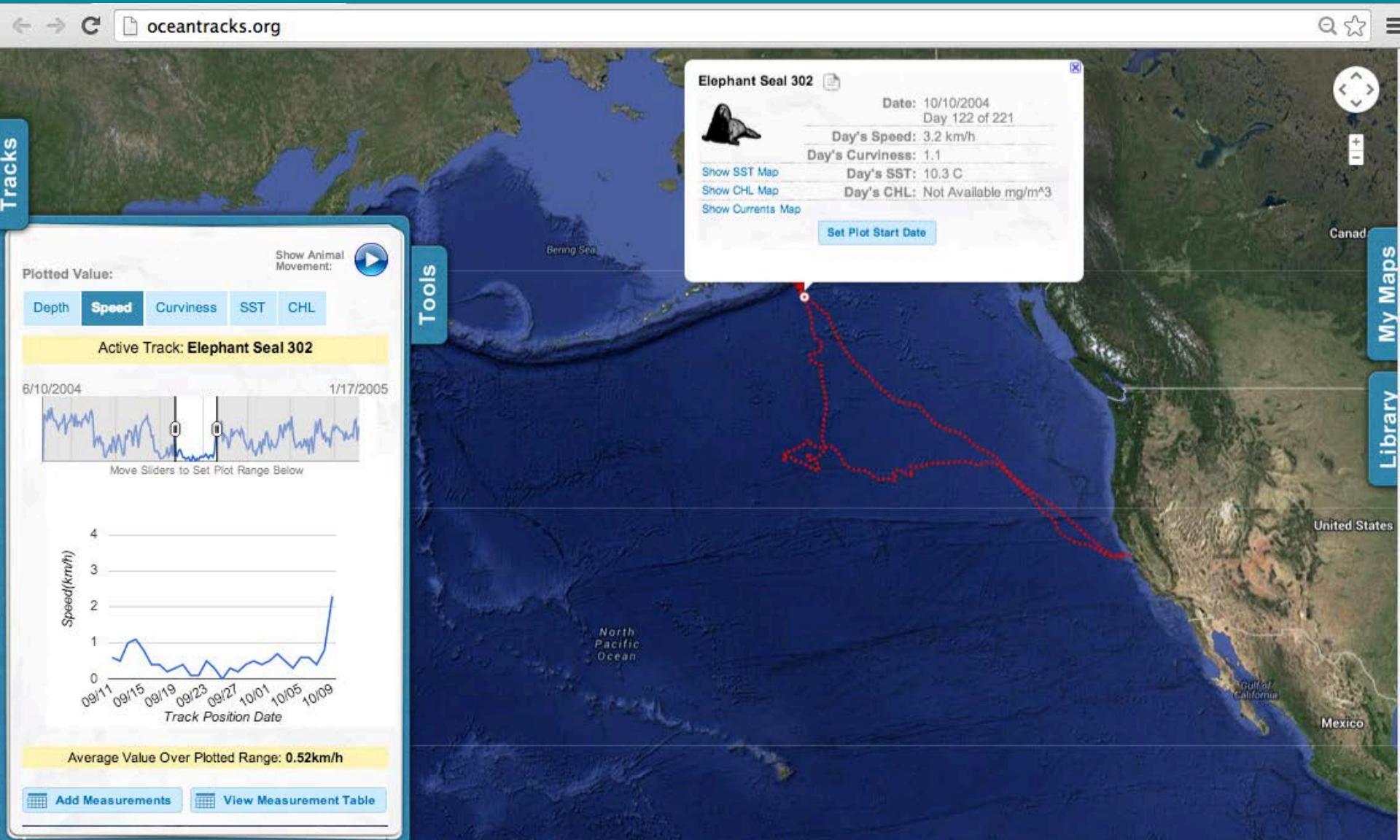
Allow them to easily create and interact with data displays



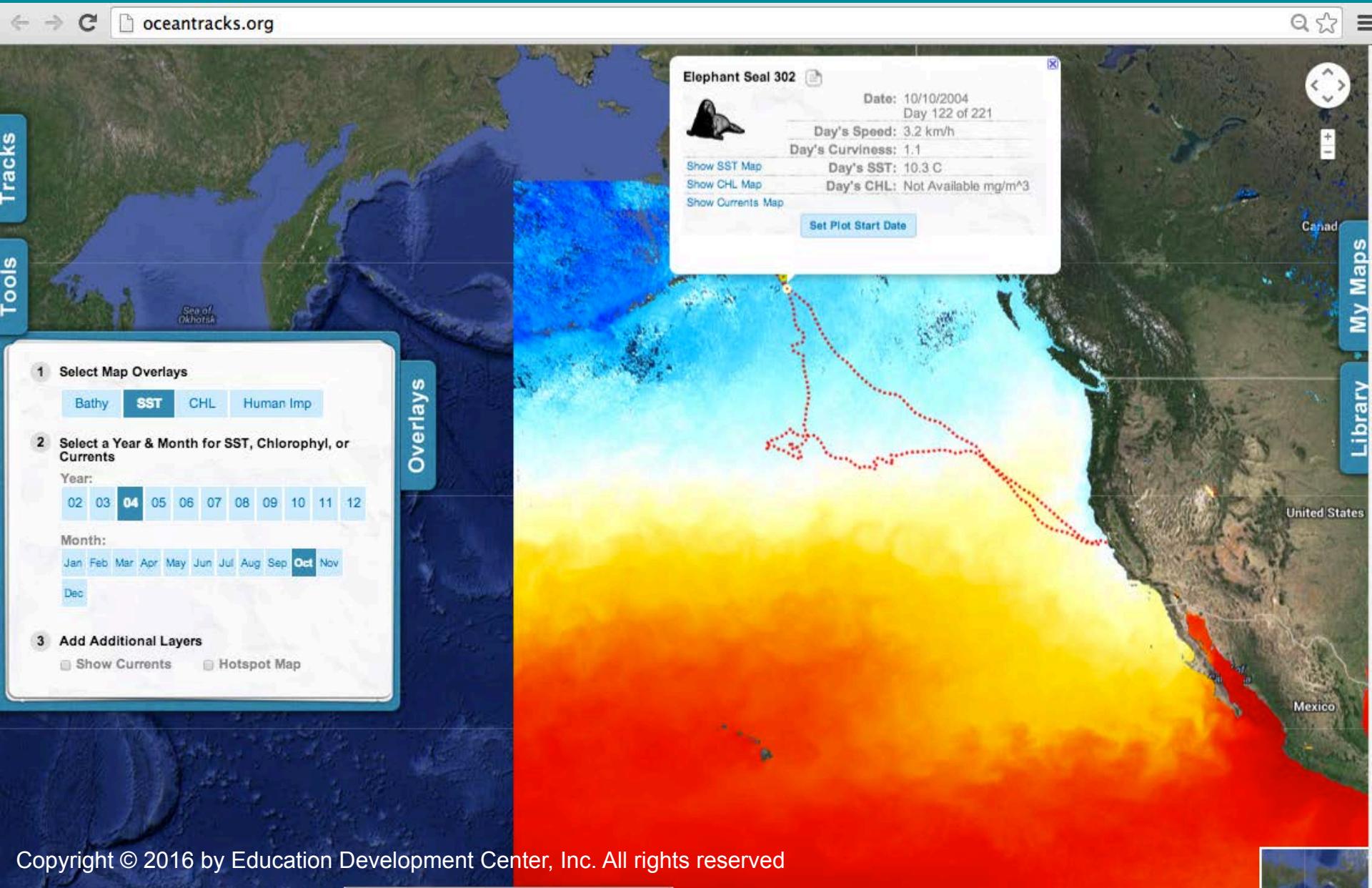
Allow them to easily create and interact with data displays



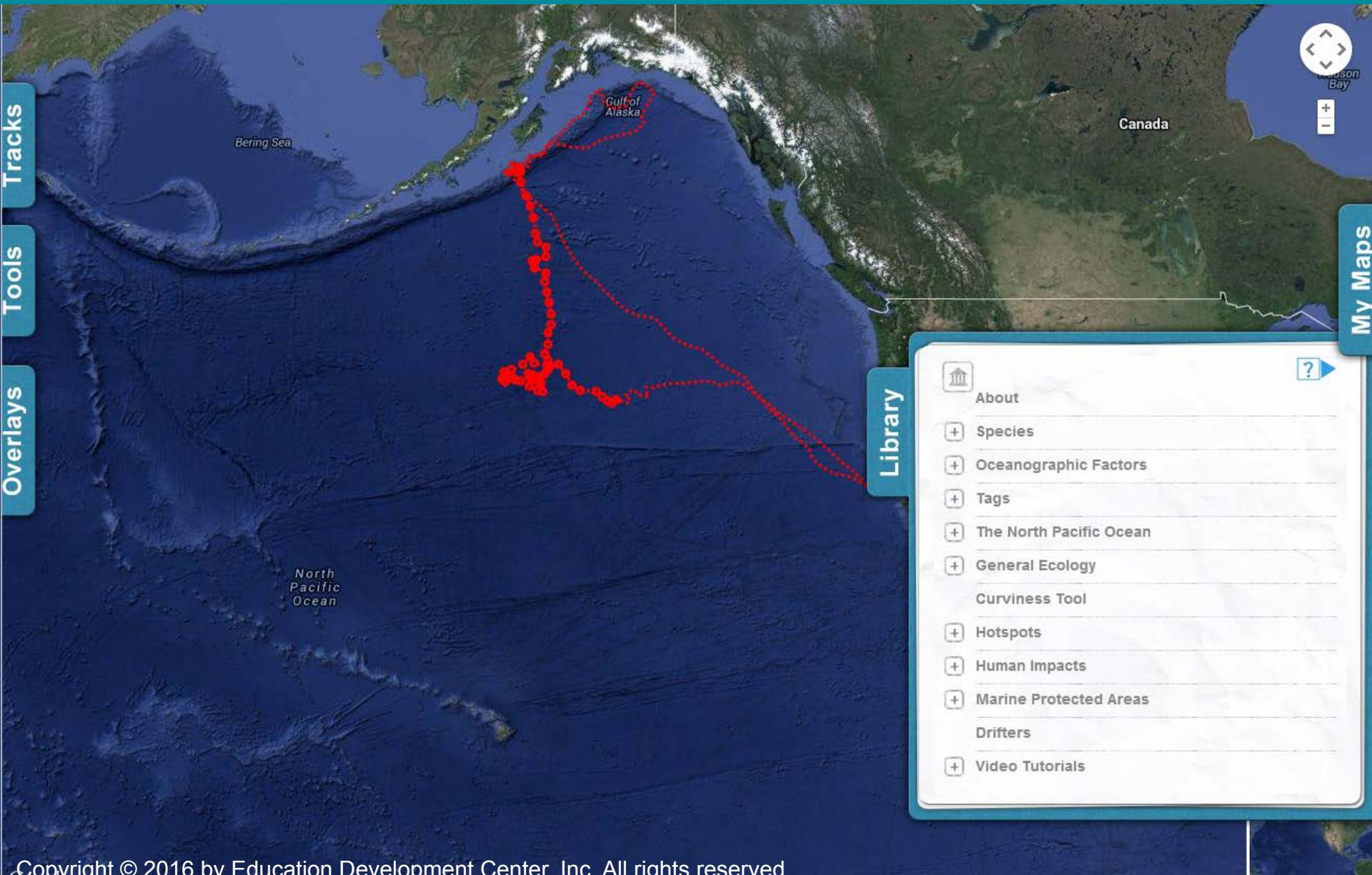
Allow them to easily create and interact with data displays



Allow them to easily create and interact with data displays



Provide supports that can be accessed on-demand



Customized content supports

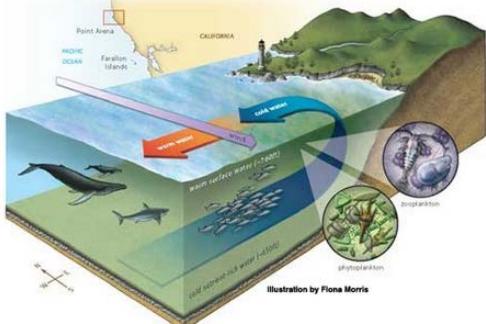
Ocean Tracks Library

Categories

- [About](#)
- [Species](#)
- [Oceanographic Factors](#)
- [Tags](#)
- [The North Pacific Ocean](#)
 - [Major Currents](#)
 - [The North Pacific Transition Zone and Transition Zone Chlorophyll Front](#)
 - [Upwelling and the California Current](#)
- [General Ecology](#)
 - [The Curviness Tool](#)
 - [Hotspots](#)
 - [The Hotspot Tool](#)
 - [Human Impacts](#)
 - [Marine Protected Areas](#)
 - [Drifters](#)
 - [Video Tutorials](#)

Upwelling and the California Current

- The California current is the **eastern boundary current** of the North Pacific Gyre, running southward from British Columbia, Canada to Baja California, Mexico. This current draws cool, nutrient rich waters from the Alaska current down along the western coast of North America.
- Western boundary currents flow deeper and stronger than eastern boundary currents. This means that cool, nutrient-rich water is closer to the surface in eastern boundary currents than western boundary currents. This results in the creation of **rich upwelling zones** in areas with eastern boundary currents, such as the California Current.
- The intensity of the California current is influenced by strong northwesterly winds. These winds predominantly blow along shore, which because of the earth's rotation (see [Eckman transport](#)) cause water to be transported in an offshore direction. This movement of water offshore causes cooler, nutrient rich water to be upwelled over the narrow continental shelf to the surface.



1. To access the map, [click here](#).

2. The map works like other Google maps interfaces, with zoom and pan functions on the upper right hand side of the screen. You can also click and drag the map to get to a different location.

3. A small map on the bottom right hand side of the screen shows you a zoomed out view to help you orient yourself.

4. The map interface has a set of menus that expand from tabs on the left and right hand sides of the screen. Click the tab to expand the menu.

5. The track you see on the map was made by an Elephant Seal (#302). Watch the tutorial videos below to learn how to interact with this track and others.

THIS IS WHERE YOU CAN ANNOTATE AND SAVE MAPS WHILE YOU ARE WORKING.

The Library - This video shows you how to access and use the Library, where you'll find more information about the animals and the ocean, as well as the technologies used to explore them.

Overview - This video is a compilation of all the videos above. It takes you through all the elements of the Ocean Tracks map interface, just as they are listed here.

Implementation Research Questions

- How do students and faculty at different undergraduate institutions engage in and interact with OT-CE?
- What changes in science attitudes and interests do students show after completing OT-CE modules?
- What changes in data inquiry skills do students show after completing OT-CE modules?
- How might changes in students' science attitudes and interests and data inquiry skills be related to the ways in which faculty implement OT-CE modules?

For more info, visit us at:

A decorative graphic at the bottom of the slide features several sets of thin, light blue lines forming a series of overlapping, undulating waves. Some lines are solid, while others are dashed. Small dark blue 'x' marks are placed along some of the lines, particularly on the left side.

oceansofdata.org

Discussion

Why do you think it's important to teach with data?

How do you incorporate data into your teaching?