Using Multiple Real-world Datasets to Build Data Literacy Among Undergraduate Students in Asynchronous Online Intro to Oceanography Labs

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Outline

- **Science**, and ***Data***, and ***Math*** (Oh My!)
- Structuring Labs for Student Learning
- Student Perceptions & Reflections
  - "Static" labs & Calculations
- Student Perceptions & Reflections
  - "Cool" Data Visualization Methods
    - OOI Data Lab Exercises
    - earth.nullschool.net
    - Google Earth
- Wrap-up

Science, Data, and Math

- Introductory science lecture classes typically cover a wide range of content
- "Survey courses" introduce concepts to a diverse group of students:
  - Future majors/minors
  - Other majors (General Ed. Credit)
  - Undecided students
- 100+ student course resources: lecture, static figures, textbook, animations & short videos, real-world examples (topics in the news)
- Often lecture focuses on the conceptual and avoids the **data** and calculations (the **math**)
- Data (how it is measured, displayed, interpreted) and calculations happen in **LAB**

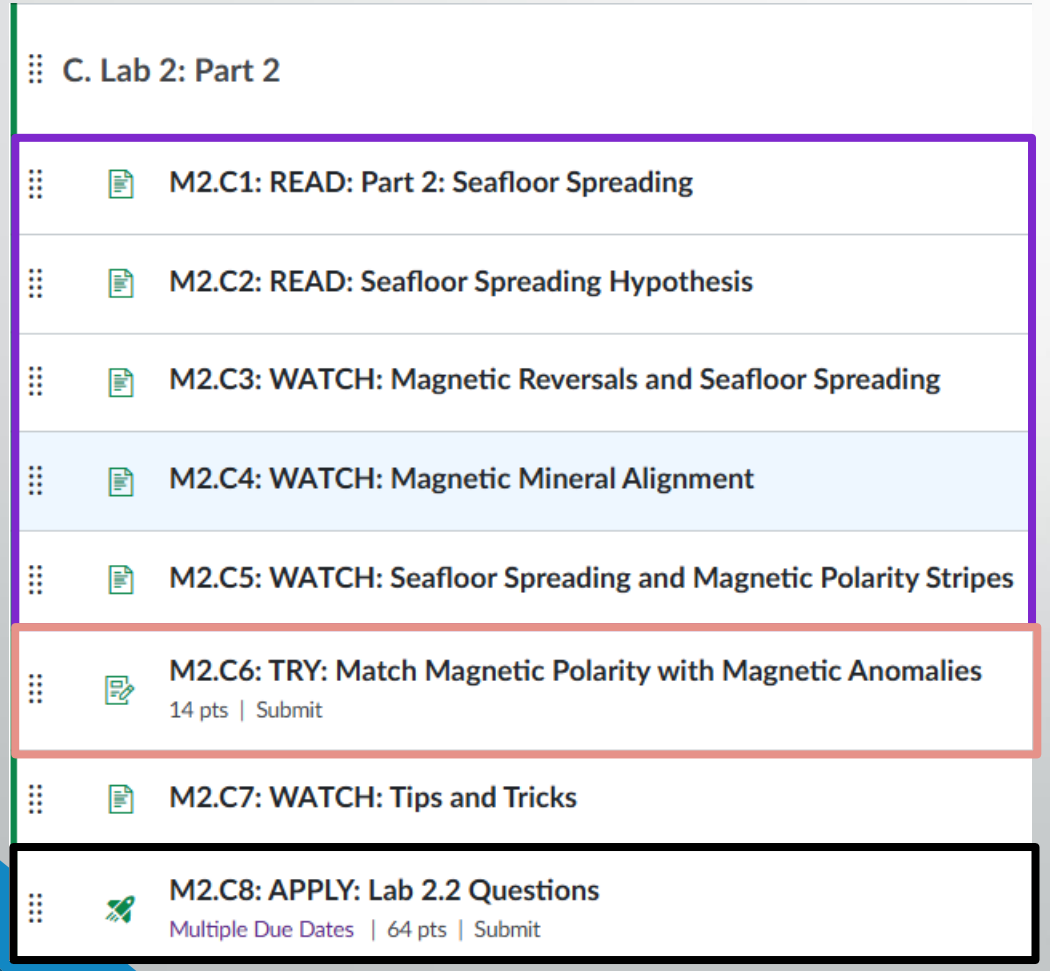
Science, Data, and Math

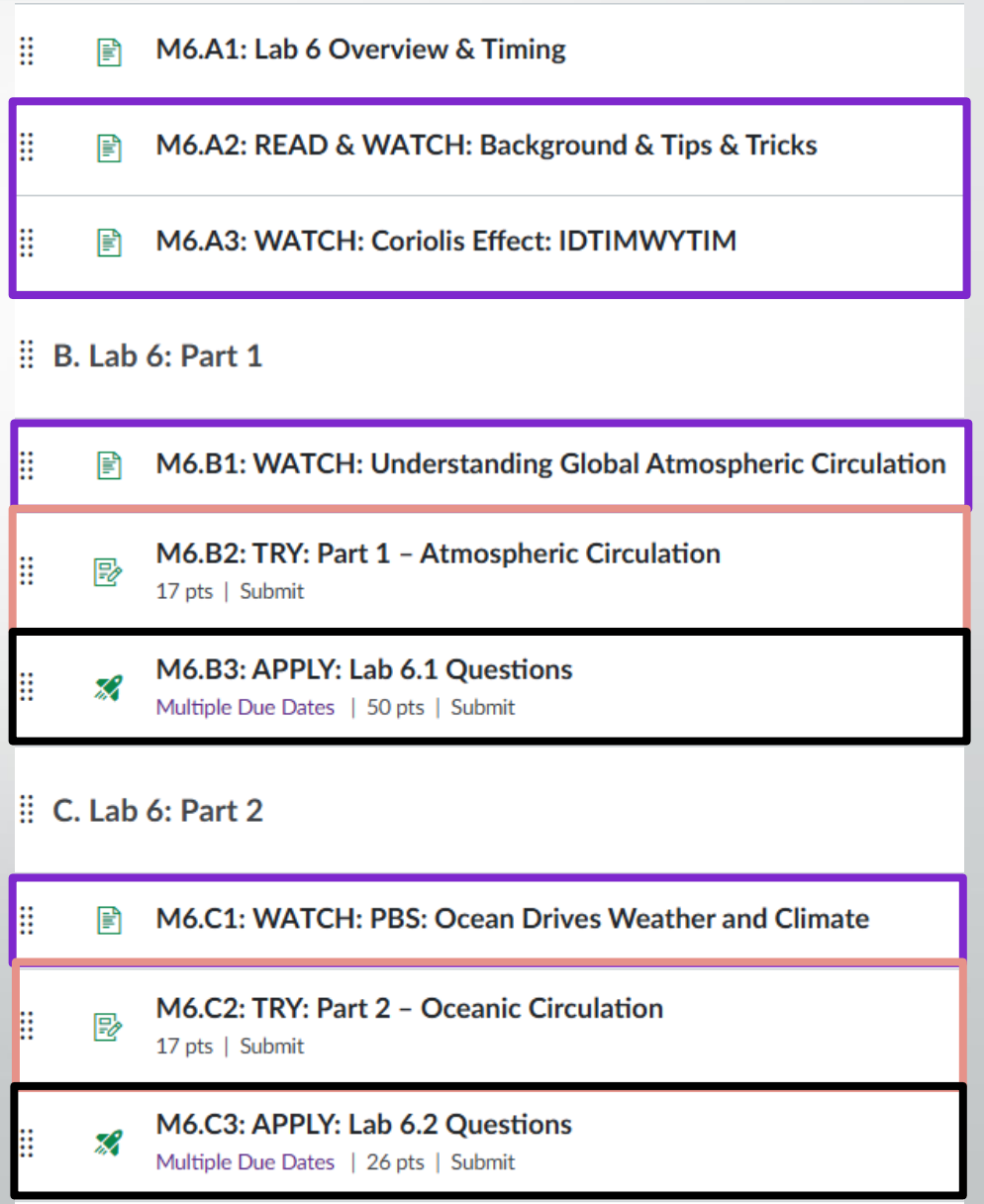
- Examples and reflections from the following Lab Assignments:
  - Lab 2: Plate tectonics and seafloor spreading → Paleomagnetic time scale, spreading rate calculations
  - Lab 3: Marine provinces and bathymetry → OOI Data Lab 3, Google Earth
  - Lab 5: Seawater properties → OOI Data Lab 2
  - Lab 6: Atmospheric and oceanic circulation → earth.nullschool.net

Lab Structure for Learning:

1. Instructional Materials (READ/WATCH)
2. Quick Check, instant feedback (TRY)
3. Scaffolded open-ended Q's (APPLY)
4. REFLECT – Learnings? Struggles? Favorites?

Instructional Materials
TRY exercises
APPLY questions



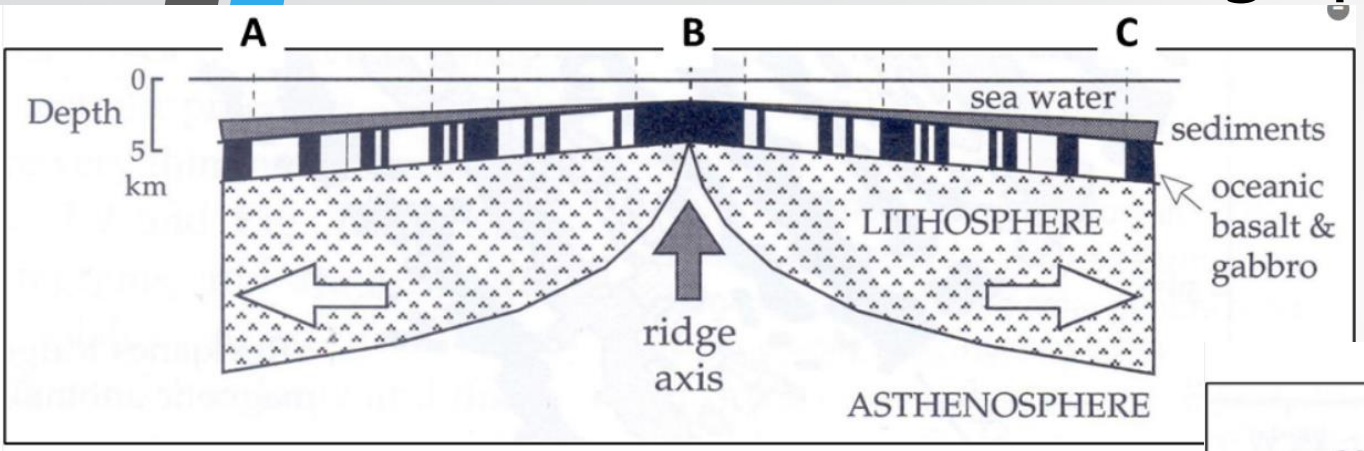


Student Perceptions (oh my!)

Early labs: Seafloor spreading rates & paleomagnetism

- "I did struggle with understanding what exactly paleomagnetism was, but I figured it out more towards the end, as well as calculating MOR spreading rates, **I am not the best at math**"
- "I did struggle when it came to reading ridge distances and calculating. **Math isn't my strong suit**, so this may be a reason I struggled with that section specifically"
- "During the lab, **I mostly struggled with calculating** MOR spreading rates using distance in time."
- "My **least favorite part** was definitely the calculations and conversions from km to inches to see how far the seafloor spreads."
- "Even though my initial calculations showed unrealistically high spreading rates, the method itself makes sense: dividing the distance by age and converting to cm/yr helps measure how fast the ocean floor is expanding. **I enjoyed calculating the spreading rates** because it made the process feel more tangible and seeing real numbers helped me connect theory to actual data."

“Static” Lab 2 – Example: Calculating spreading rates

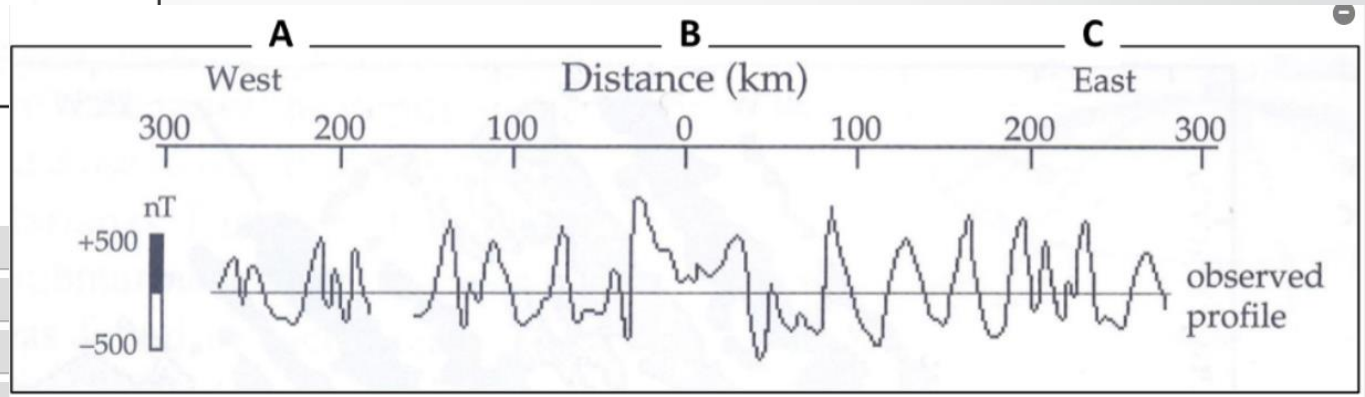


See the cross-section (side) view of a mid-ocean ridge above.

Where is new crust being created?

- A
- B
- C
- A&B
- B&C
- A&C

Check



This is a magnetic anomaly profile recovered from a ship that pulled a magnetometer over a mid-ocean ridge. The distance is measured in kilometers from the ridge axis and the magnetic signal is measured in nano-teslas (nT).

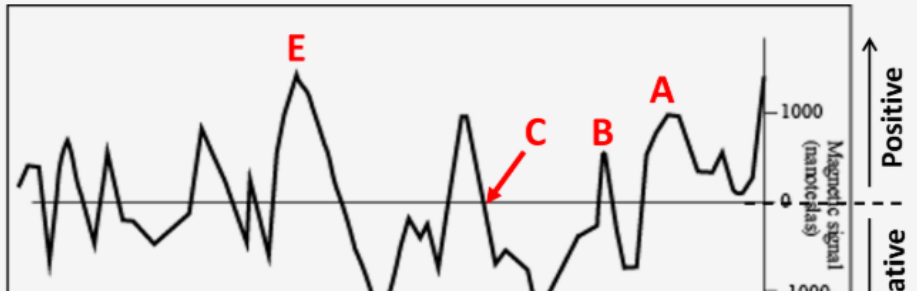
From the readings and the video, what does it mean if the magnetic anomaly is POSITIVE?

- The ocean crust rock recorded normal polarity
- The ocean crust rock recorded reversed polarity
- The ocean crust rock recorded a magnetic reversal

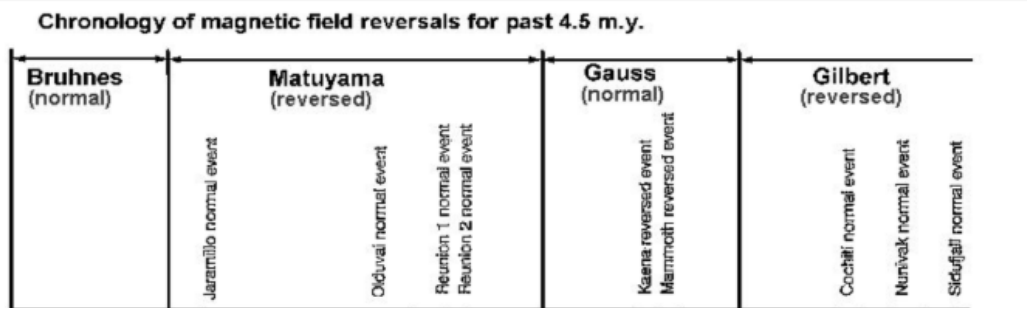
Check

"Static" Lab 2 – Example: Calculating spreading rates

Magnetic profiles from two locations along the Central-Indian ridge are graphed in the figures below. Well-defined magnetic anomaly features A-E have been noted for you on these figures as well. You will use these figures to answer questions 1-4 below.



The magnetic reversal time scale.



6 Essay 10 points

Columns 7-8: Calculate Spreading Rates!

You will need your data from questions 1 and 3 (columns 1, 2, and 6) to do the calculations.

Now estimate the spreading rates. **Divide your distances (in km) for both Profile 1 and 2 by the age of the event (A-E) in years** (NOT m.y. or million years), and then multiply by 100,000 to convert km/yr to to cm/year and put those numbers into the columns of the table below.

Note - If you've entered the date of an event as 1.87 ***million years*** (in column 6), that is equal to 1,870,000 ***years*** - For the conversion above to work, you must use the date in YEARS.

Copy the chart above and paste into your answer area, filling in the appropriate blanks for the last two columns. (1pt each blank = 10pts total)

Edit View Insert Format Tools Table

Student Perceptions (oh my!)

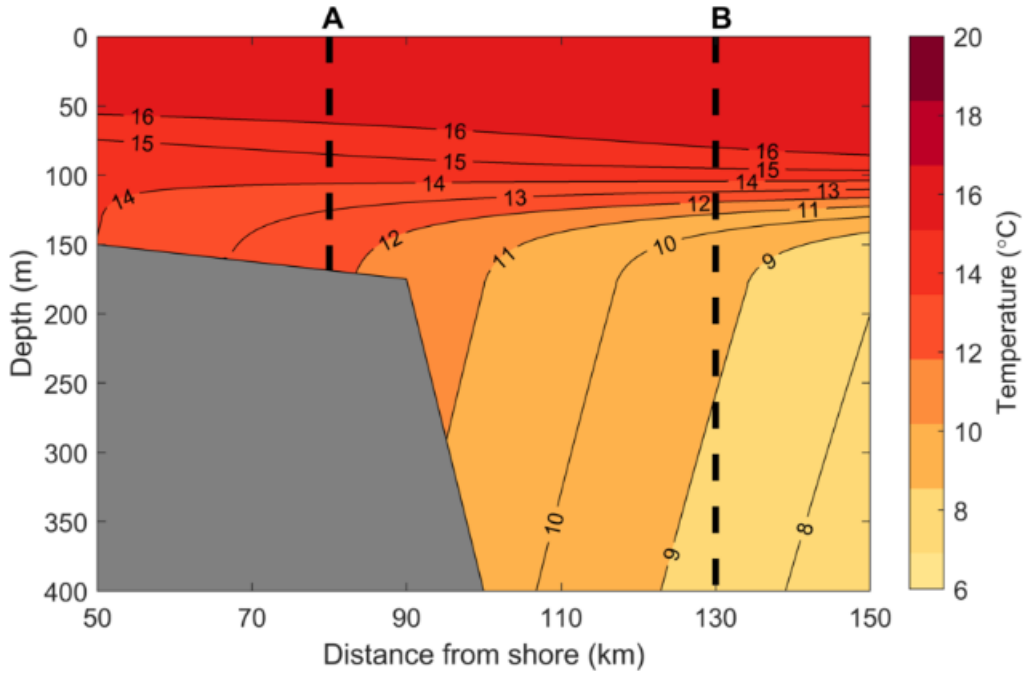
"Cool" Interactive labs:

- "I had a general idea that the seafloor wasn't flat, but **I didn't fully understand how much detail you could get from bathymetry maps and Google Earth**. Now, I see how seafloor slope and texture vary based on tectonic activity…" Lab 3
- "My favorite part of the lab was using Google Earth to explore underwater terrain **it felt like virtual scuba diving**! I was surprised by how varied the seafloor texture can be and how much it tells us about geological activity." Lab 3
- "When I looked at real-time data with the textbook it was very exciting. While the common patterns were similar, I noticed a difference when looking at the seasonal changes and localized weather events." Lab 6

OOI Data Labs & "quick checks", earth.nullschool.net, Google Earth

M5.C2: APPLY: Lab 5.2 Questions

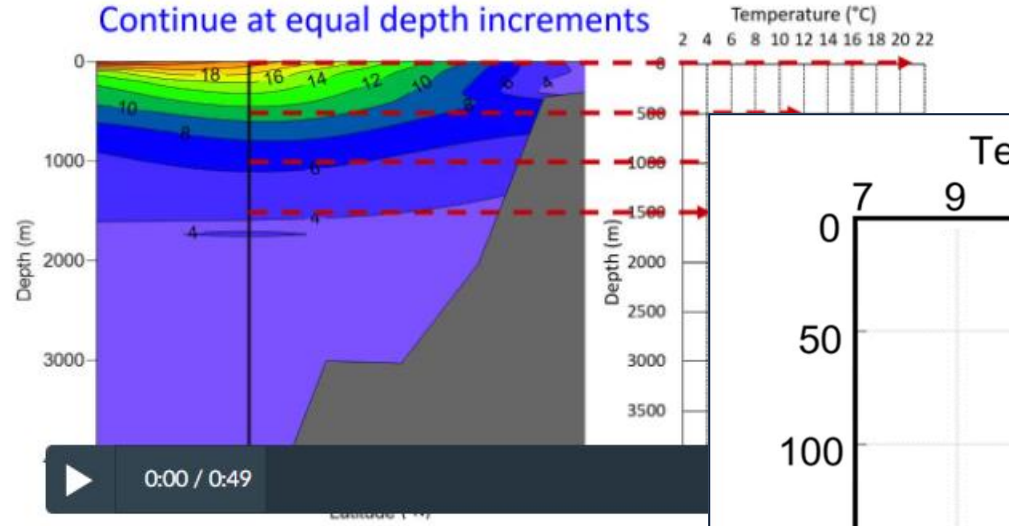
Next, we will make a more precise assessment of the variation in temperature with depth in the vertical section. The figure below is a copy of the temperature vertical section, with two station profile locations (A and B) marked.

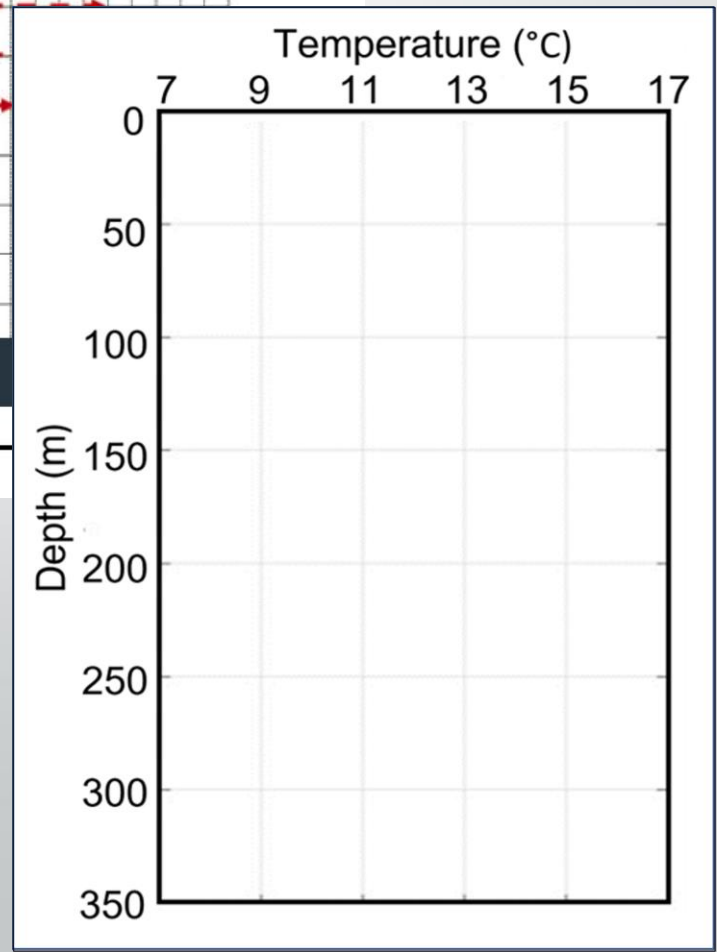


Practice: Imagine that we collected a station profile at location A. Draw a station profile graph with depth on the y-axis and temperature on the x-axis. If you need assistance with plotting this graph, see the animation below. **When you are done, scroll to the bottom to check your answer.**

WATCH: How to Draw a Station Profile from a Vertical Section

I recommend making this full screen while you watch! Note, there is no sound in this video.





"My favorite part was getting to make another graph with the data from the vertical station profile in one of the earlier "APPLY" sections." Lab 2(5)

M5.C2: APPLY: Lab 5.2 Questions

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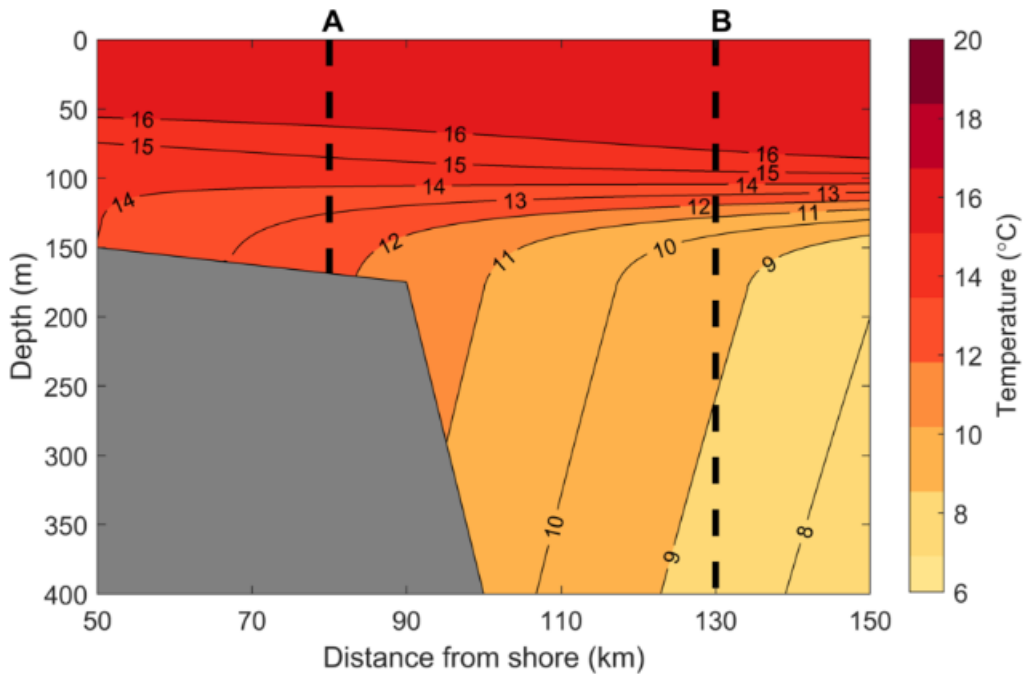

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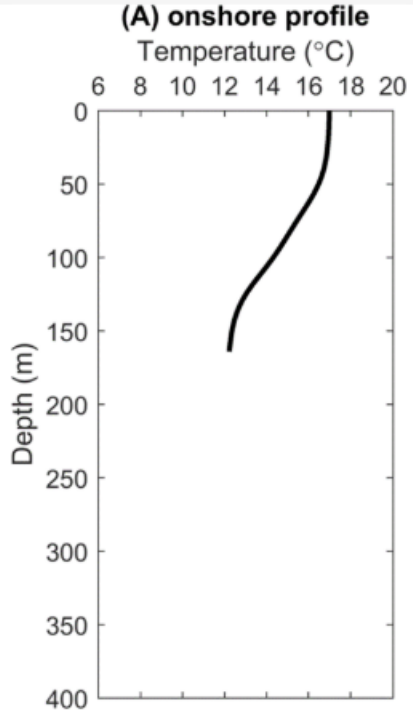
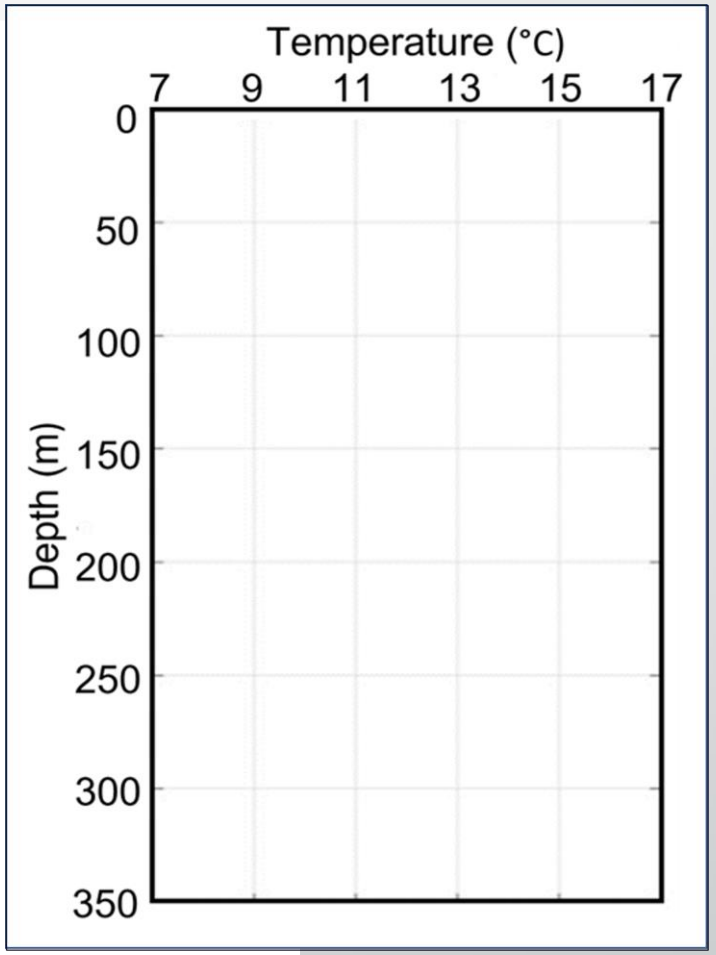
Profile A

Instructions

Check to see if your practice Profile for location A looks like this!



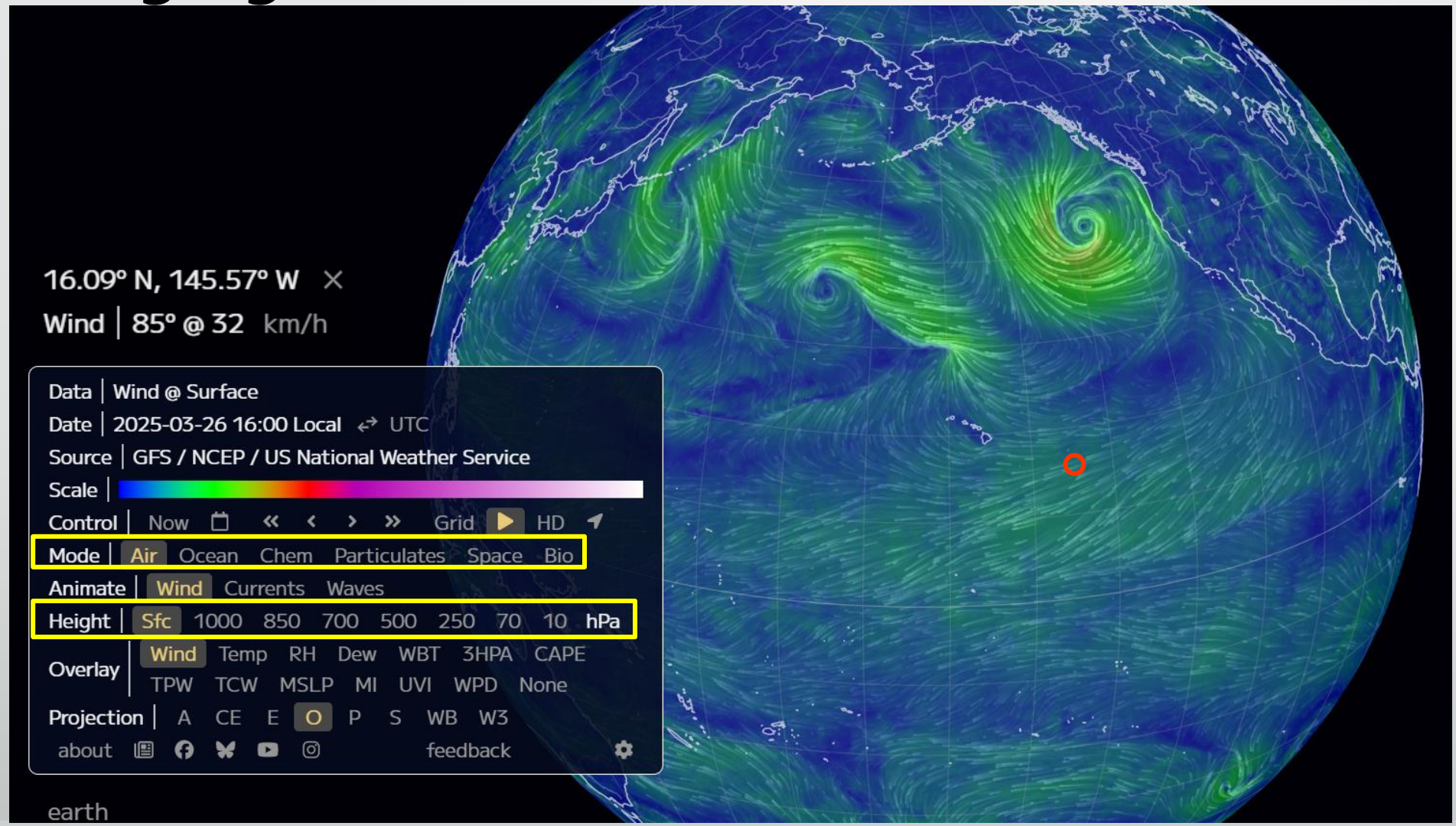


8 Multiple Choice 1 point

Does your Practice Profile A look like the example above? Yes or no?

- (●) Yes - Great job!
- ( ) No - Then try again before you attempt drawing Profile B!

Bringing the Data to Life: earth.nullschool.net



- "Before this lab, I had a general understanding of atmospheric and oceanic circulation patterns from textbooks and lectures, **but seeing real-time data helped me make stronger connections between theory and reality**. One key takeaway was **how high- and low-pressure systems interact with surface winds**."

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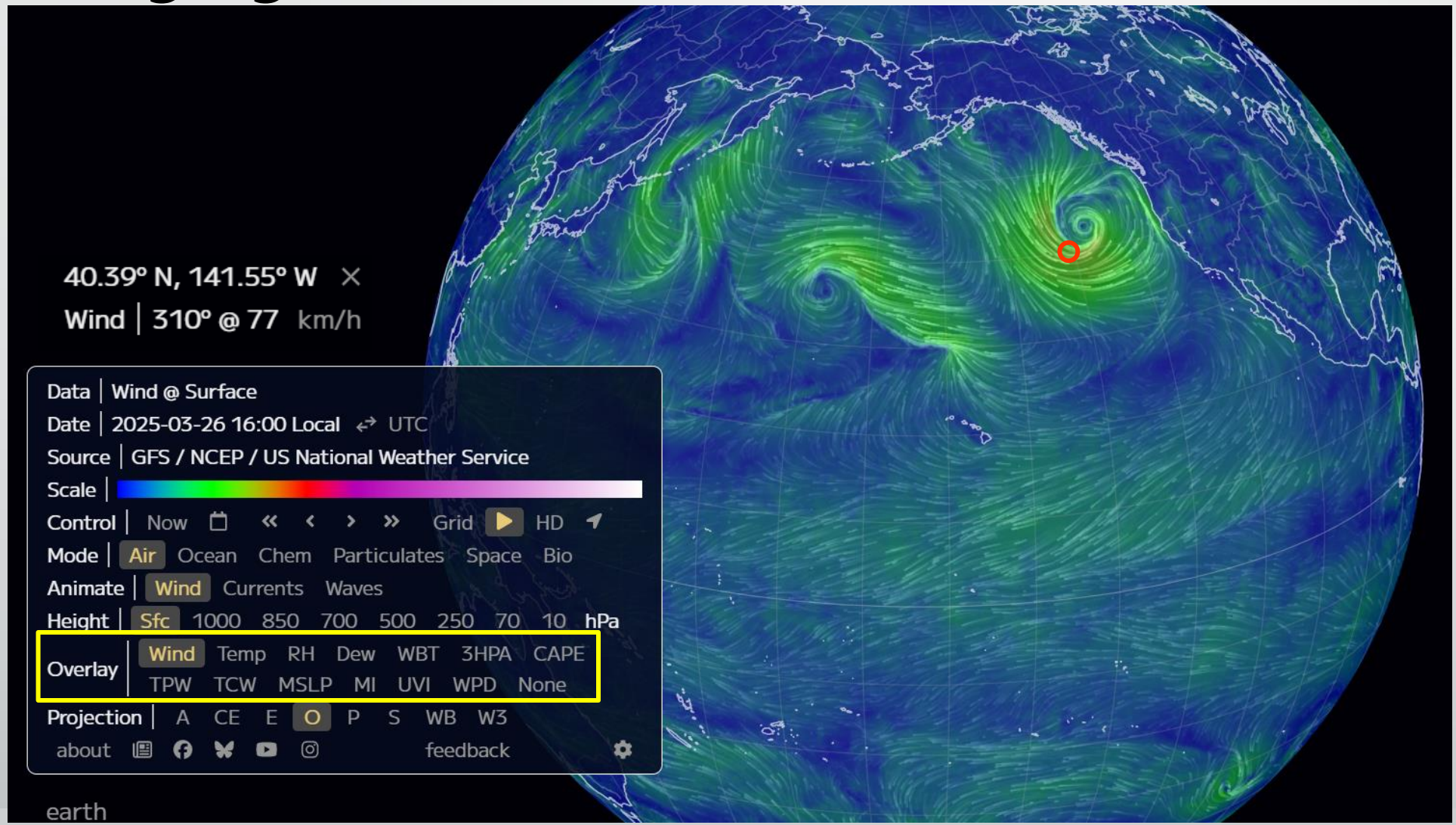

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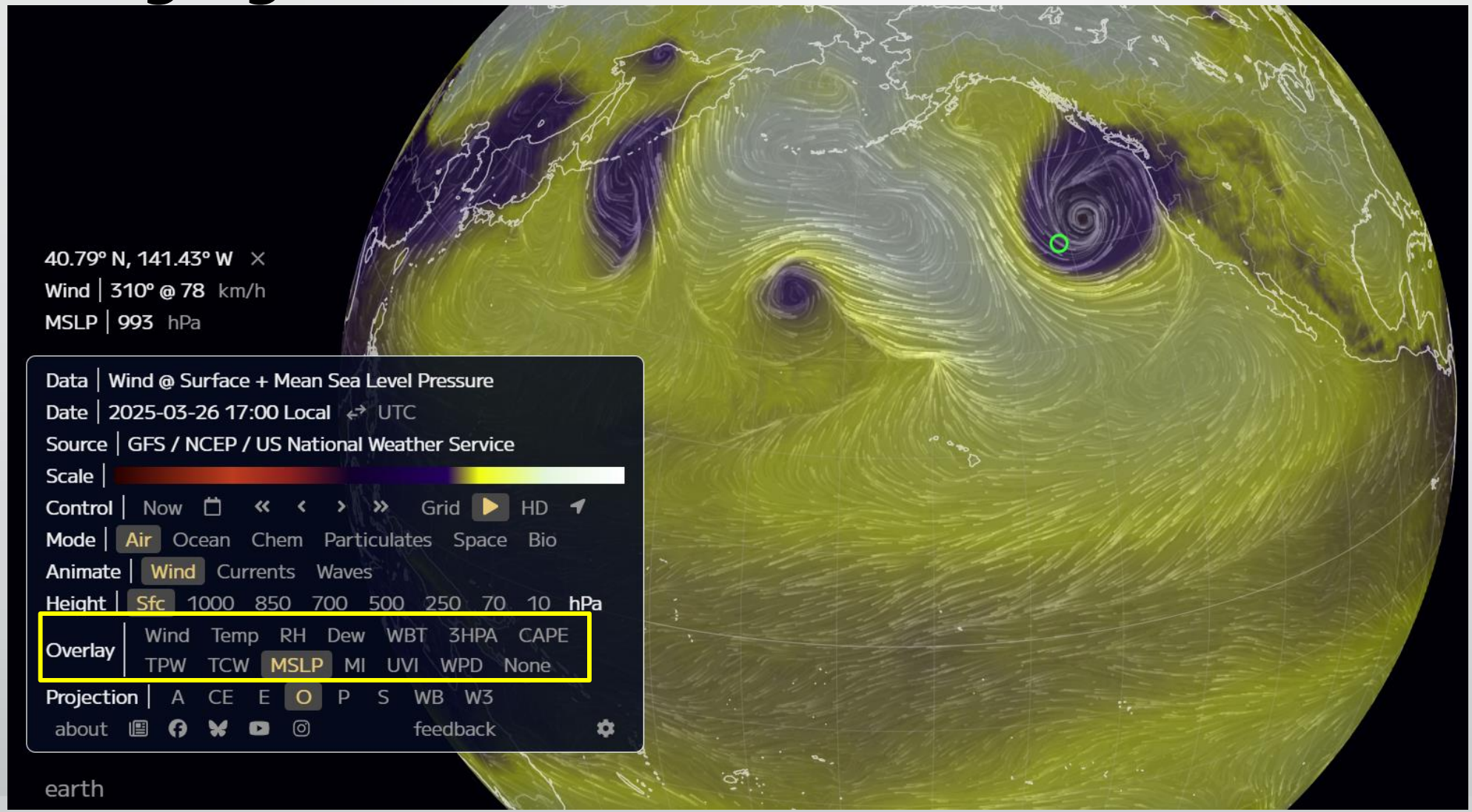

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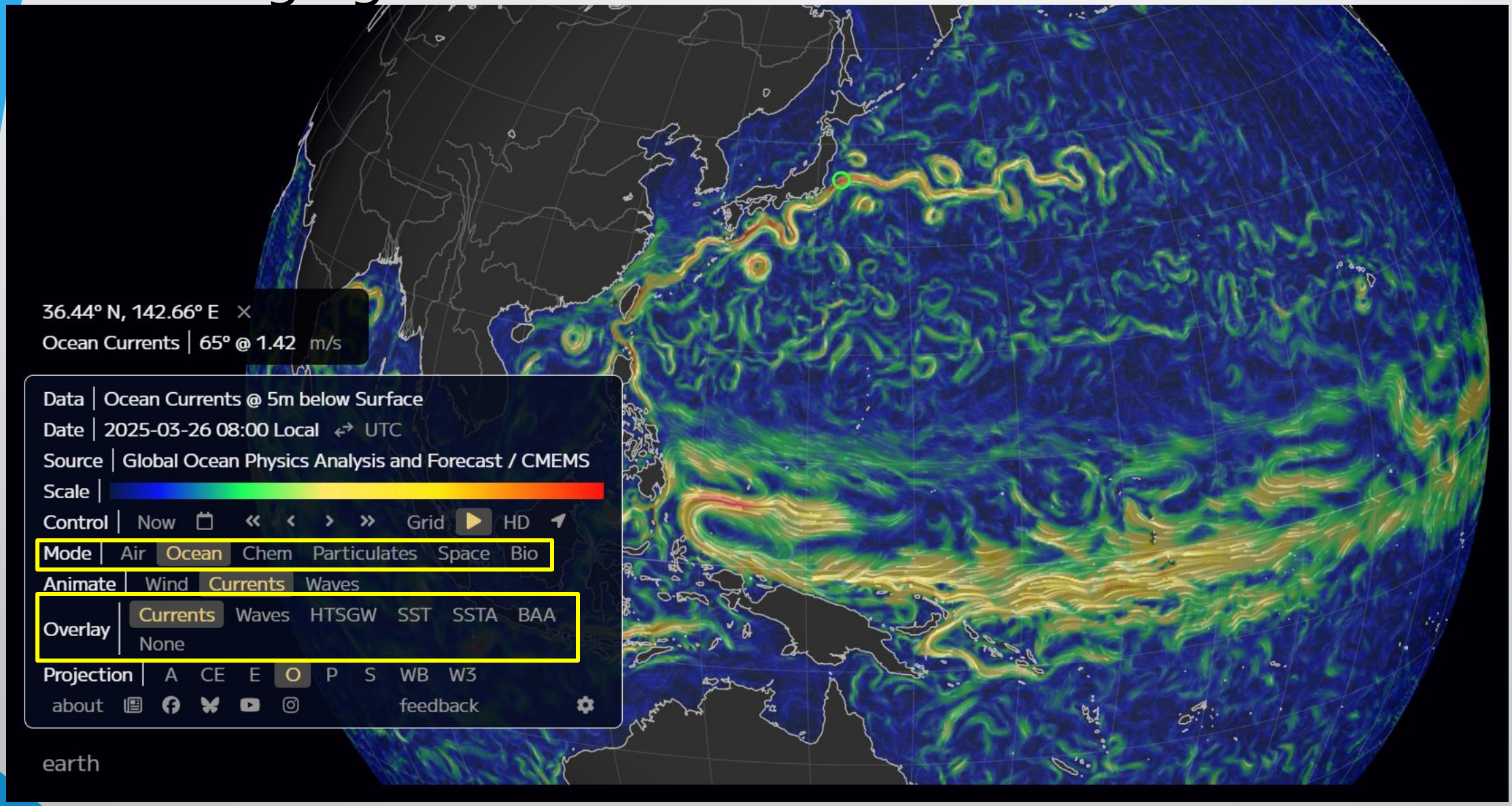
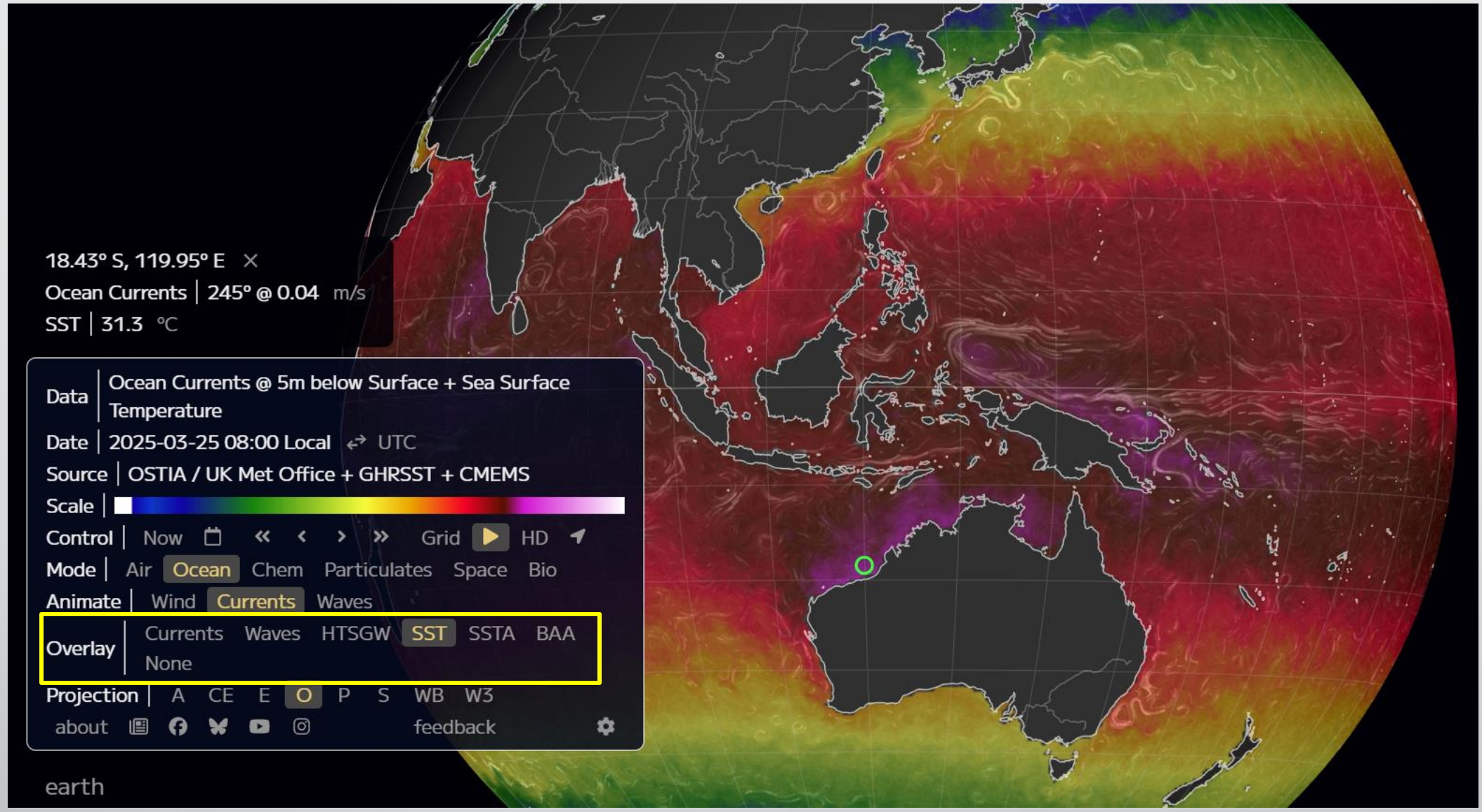
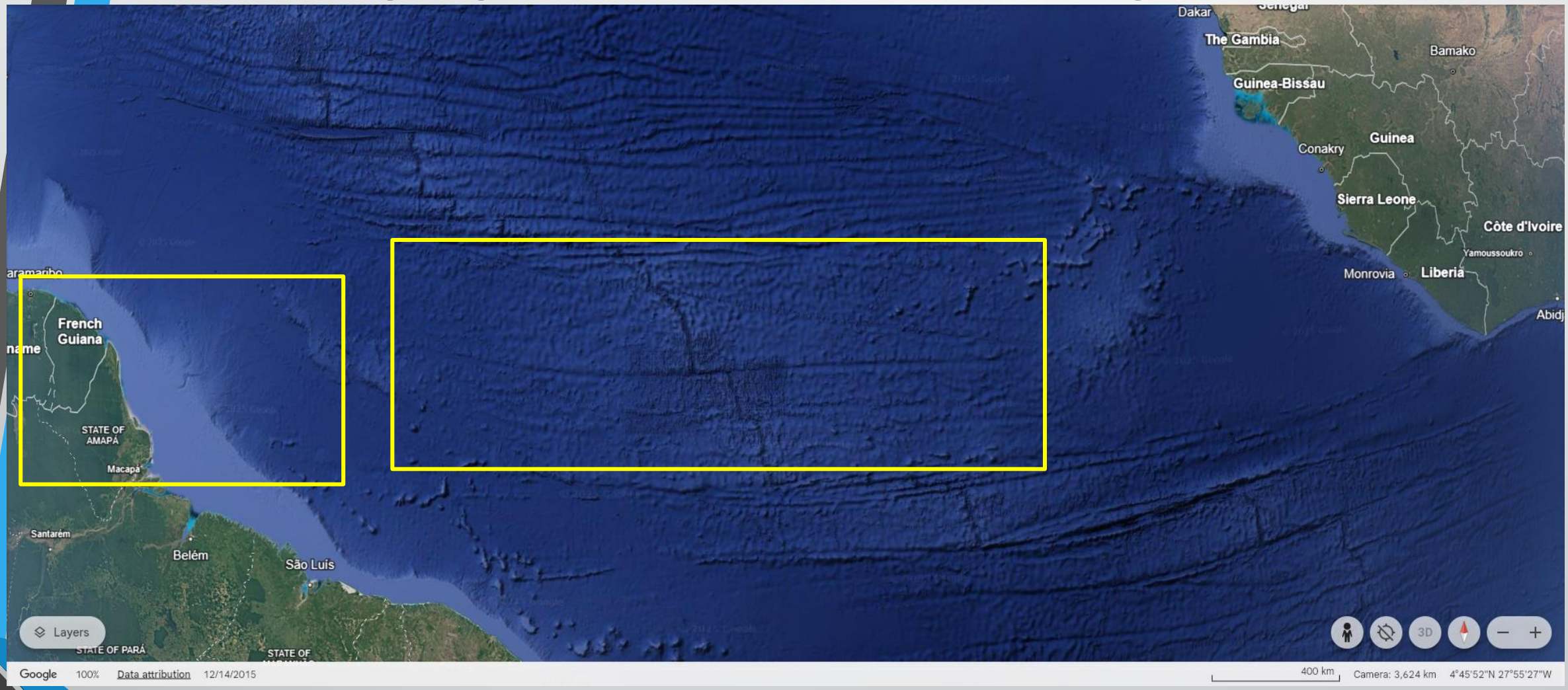


- "During this section of the course, studying the real time data map of oceanic and air circulation **has been my favorite lab so far**." Lab 6



- "Lab 6.2 (ocean circulation) was easier for me to understand compared to Lab 6.1 (atmospheric circulation), likely because I had become more familiar with the website through practice. I was most surprised by how much ocean temperatures can vary. **I didn't expect to see temperatures over 30°C in some regions.** My favorite part of the lab was exploring the website and seeing how wind and current patterns changed with altitude, location, and direction." Lab 6

Bringing the Data to Life: Google Earth



- "One of the most interesting parts was using Google Earth to see the seafloor features and their connection to tectonic activity. It was cool to see how **mid-ocean ridges**, trenches, and **continental shelves** align with plate boundaries."

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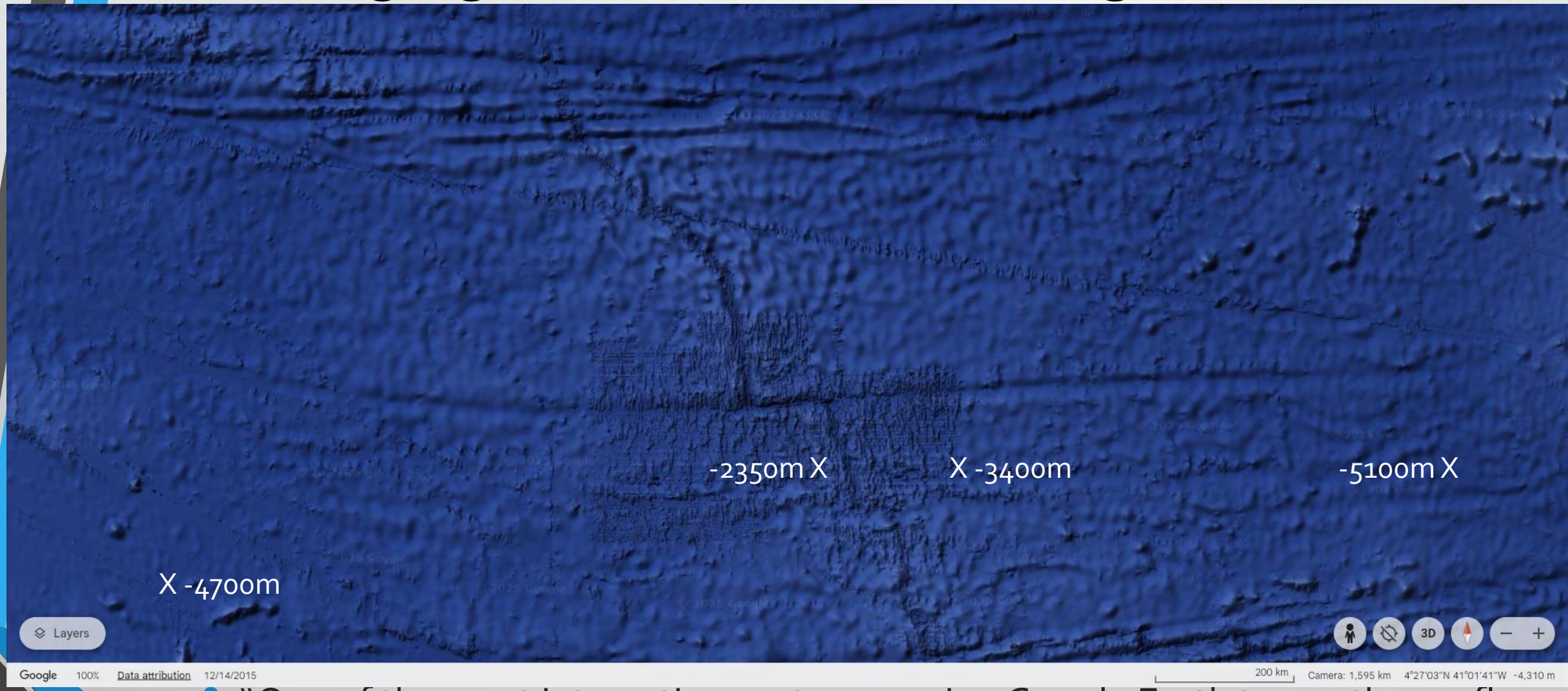

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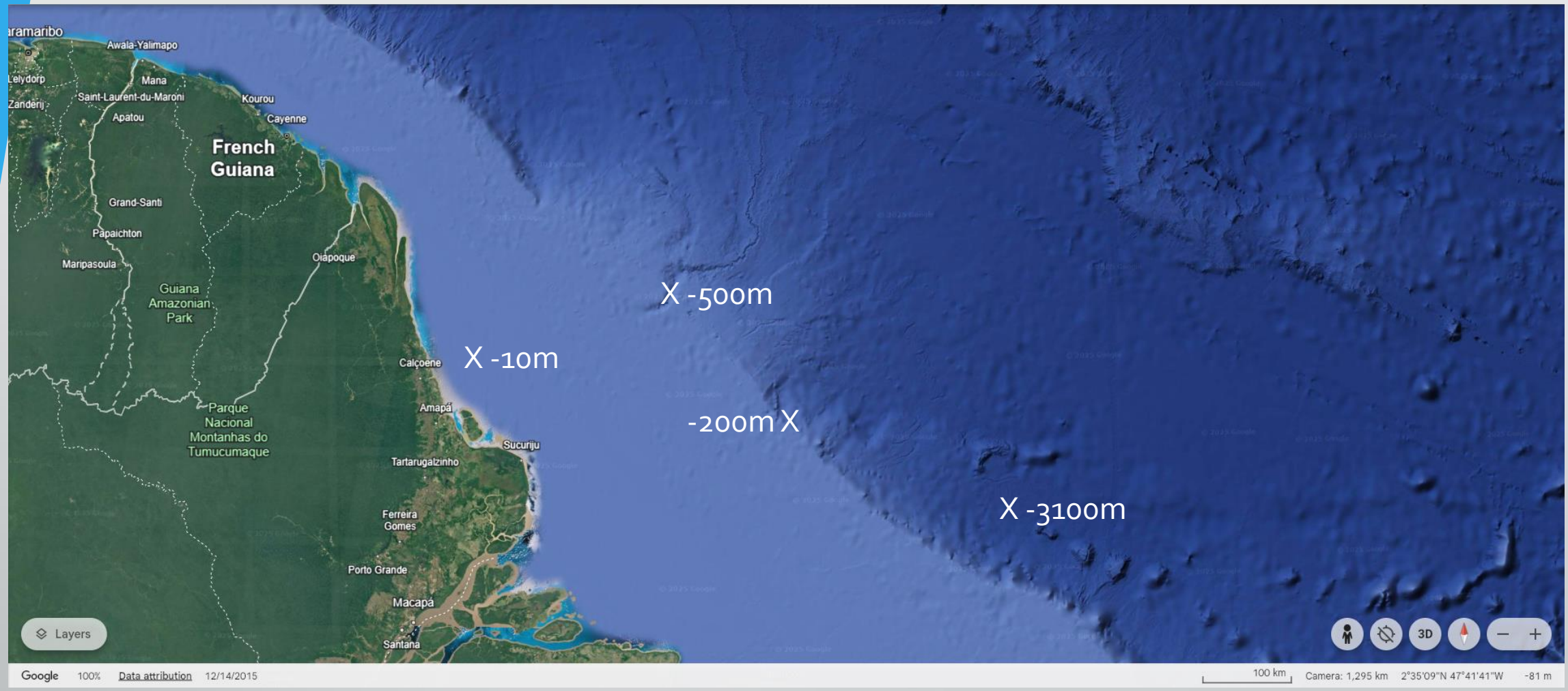

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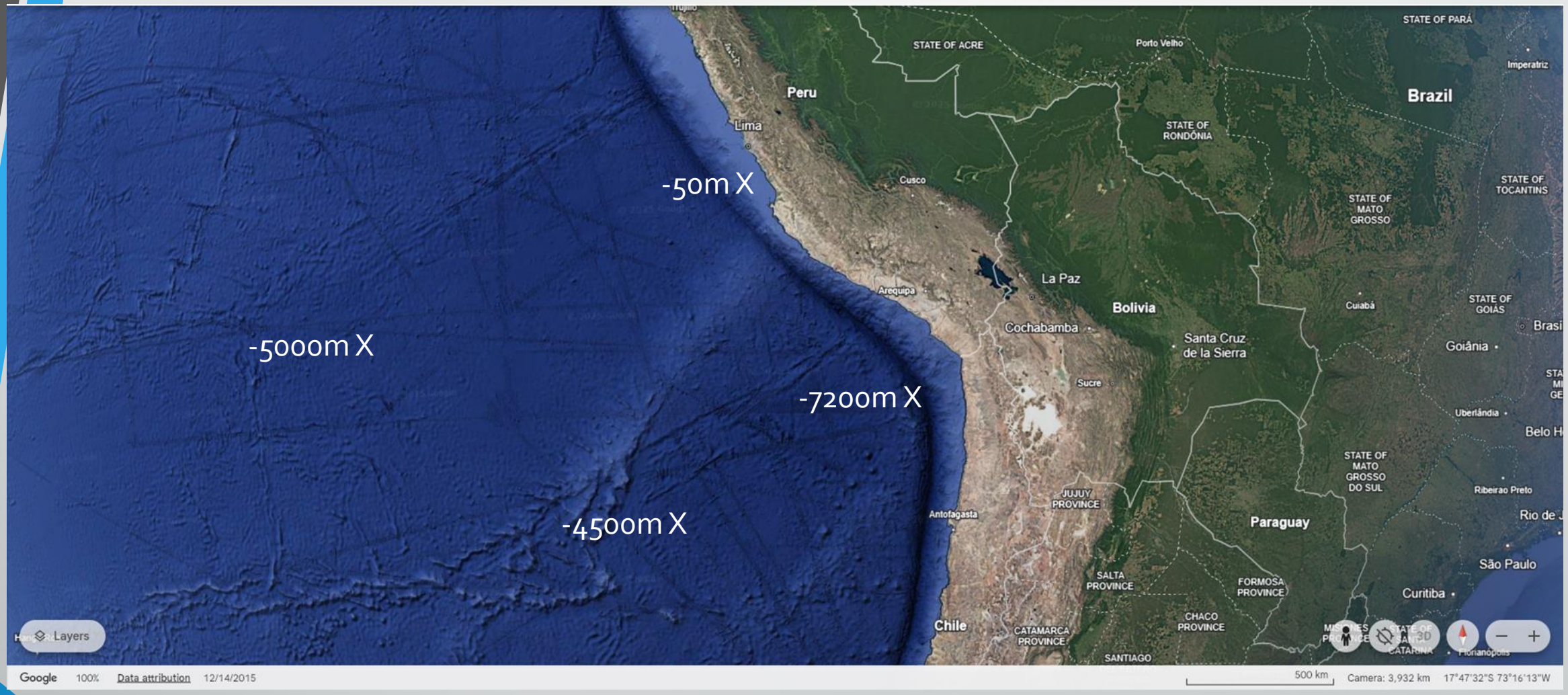

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Summary

- Bring in real-time data through interactive means where you can
- Have students reflect on their learning – It's useful for them to see they are not "alone" in their struggles, and it helps to tweak future assignments in response to their discussions!
- OOI Data Labs, earth.nullschool.net, and Google Earth bring the oceans to life through data exploration!

Thank you – Questions?

References

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- Sahl, L., Pfeiffer-Herbert, A., Bristol, D., and Lichtenwalner, S. (2021). Lab 2 – Building Data Skills – The display of oceanographic data. In Bristol, D.L. and Pfeiffer-Herbert, A. (Eds.), *Ocean Data Labs: Exploring the Ocean with OOI Data – Online Laboratory Manual*. 2nd edition. Rutgers, The State University of New Jersey. Originally Accessed [1/10/23] https://datalab.marine.rutgers.edu/ooi-lab-exercises