Lesson Plan, Oceanography Spring 2020 – Natasha Gownaris, 2020 OOI Data Labs Fellow
OOI 2: Ocean Structure (Salinity, Temperature, Density)

Audience:
100-level Oceanography class, 35 non-major students (mostly juniors and seniors); Gettysburg College, PA

Time Allotted:
~45 minutes, in-class activity (with student laptops)

Learning Goals:
- Explore processes that drive variation in ocean salinity
- Identify features of depth profiles (e.g. thermocline)
- Become comfortable with reading oceanographic plots of various types (depth profiles, transects, time series)
- Acknowledge that real data are complicated and messy (as compared to textbook salinity profiles, for example).

Prior Knowledge:
Before completing this activity, students will have learned about the global patterns of sea surface temperature and salinity and how temperature, salinity, and density change with depth. They will have gained experience in drawing salinity profiles of their own. The OOI observing system was discussed during the first week of class, while covering the history of ocean exploration. Prior to this activity, a salinity transect from SERC (link below) was used and students were broken up into 12 groups (~3 students per group; station created for every 10° latitude) to draw their salinity profile at an assigned location. I use mini whiteboards for these types of activities. A representative from each group came to the front of the room with their diagram and students were organized from station 1 through station 12.

Figure 5 from SERC website:
https://serc.carleton.edu/integrate/teaching_materials/earth_modeling/student_materials/unit8_article1.html

Useful link for showing salinity trends globally:
https://salinity.oceansciences.org/

Useful link for showing temperature trends globally (I show both land and water when discussing the heat capacity of water):
https://earthobservatory.nasa.gov/global-maps/MYD28M/MOD_LSTD_M

Invitation:
Show students video of temperature and water density and tell them that salinity plays a similar role. Ask students to come up with hypothesis on whether ice cubes will melt faster in salty water or in fresh water.

Video:
https://www.youtube.com/watch?v=Ak9CBB1bTcc

Ice Cube Activity:
https://datalab.marine.rutgers.edu/explorations/chemistry/documents/Ice%20Cubes%20Explanation.pdf

Exploration:
Students will answer basic questions regarding trends in surface salinity measured inshore in the North Pacific Ocean (at the coastal endurance array).

Data Lab:
https://datalab.marine.rutgers.edu/explorations/chemistry/activity2.php?level=exploration

Concept Invention
Students will form hypotheses regarding the processes that control salinity at this site and will then test these hypotheses by adding air temperature and salinity data to their plots.

Application:
Students will examine depth profiles of salinity data across a summer in the North Atlantic Ocean, comparing inshore and offshore sites.

Data Lab:
https://datalab.marine.rutgers.edu/explorations/chemistry/activity6.php?level=application

Reflection
Discussion of activities and how the data they saw compared to the plots we examined in class in readings + ASPECT Survey.

Aspect Survey: https://www.ncbi.nlm.nih.gov/pubmed/28495936

Oceanography (ES 128)
Spring 2020

Name:

Salinity Trends from Two Ocean Basins

Today we will be exploring oceanographic data collected at two sites off the coast of the United States, one in the Pacific Ocean and one in the Atlantic Ocean. We will explore both time series data and depth profiles of salinity through these exercises.

Part I – Inshore Pacific Ocean
(Coastal Endurance Array)

https://datalab.marine.rutgers.edu/explorations/chemistry/activity2.php?level=exploration

The first site is located off the coast of the Pacific Ocean at a depth of 80 meters. First, let's answer a couple of questions regarding this site and the data collected here.

1. **Is this mooring locating on a passive or active margin?**

2. **Scroll down to the bottom of the page and read the section titled "Dataset Information". How frequently were these data collected?**

Now go to the top of the page and examine the time series data. Make sure that the "Salinity" box is checked and that you have selected "None" for the second parameter to start.

3. **What is the time frame over which these data were collected? Remember that you can scroll over a point to find the exact day and time of data collection.**
4. **Are these data continuous? If not, what is the time frame(s) during which data are missing?**

5. **What is the range of salinities in the graph?**

6. **When during the time period does salinity show a decreasing trend? An increasing trend?**

7. **Based on what you know about the factors influencing salinity, highlight either increasing or decreasing for the following:**

Increasing air temperatures will lead to ______________ surface salinities.

Increasing/Decreasing

High rain rates will lead to ______________ surface salinities.

Increasing/Decreasing

After you have completed the previous section, click "Air Temperature" and then "Rain Rate". You can use the scroll bar under the plot to zoom into the graph at shorter time periods and to more closely examine these variables and their relationship with salinity.

8. **Based on these data, which has a stronger control on sea surface salinity in the North Pacific Ocean, air temperature or rain rate?**

Part II – Inshore, Offshore, and Polar North Atlantic Sites
(Pioneer Array and Irminger Sea)

https://datalab.marine.rutgers.edu/explorations/chemistry/activity6.php?level=application

Now it's time to explore some data collected at three locations in the North Atlantic Ocean. The Central Inshore (127 meters deep) and Central Offshore (453 meters deep) sites of the Pioneer Array and a polar site in the Irminger Sea (2,600 m deep) from June through September of 2015.

First, scroll use your scroll bar to explore how the salinity profile changes over time.

9. When you have finished exploring, scroll to June 8. Data are not available for the Irminger Sea for this time period, so the Polar Deep Basin plot will be empty. Briefly describe the salinity profiles at the inshore and offshore shelf sites. Note the depth of the thermocline if there is one.

Temperate Inshore Shelf:

Temperate Offshore Shelf:

10. Next, scroll to June 23. Data are not available for the Irminger Sea for this time period, so the Polar Deep Basin plot will be empty. Describe the salinity profiles at the inshore and offshore shelf sites on these two dates. Note the depth of the thermocline if there is one. If the salinity profile looks different than it did on June 8, provide a possible cause.

Temperate Inshore Shelf:

Temperate Offshore Shelf:

You can see the entire time series of depth profiles at once by clicking on "Show Context". Click this box before answering the following questions. You will now see Irminger Sea data.

11. **What is the salinity range at the shallowest locations (surface) for each site?**

    Temperate Inshore Shelf:
    Temperate Offshore Shelf:
    Polar Deep Basin:

12. **What is the salinity range for the deepest locations at each site?**

    Temperate Inshore Shelf:
    Temperate Offshore Shelf:
    Polar Deep Basin:

13. **What is the general shape of the Polar Deep Basin salinity profile with depth? Does this shape vary more or vary less than at the other two sites?**

14. **To finish, click "Match salinity limits". What is the general shape of your Polar Deep Basin salinity profile as compared to the other two sites? Is there a noticeable thermocline using these wider salinity limits?**