POLAR TREC
Learning Resources

Details


Completion Time: Less than a week

Permission: Download, Share, and Remix

Investigating Earth's Hydrosphere: Ocean Currents and Temperature

Overview

In part two of this two-part lesson students work in pairs to explore the effects of temperature on ocean stratification using a simple plastic shoebox-sized container in which they create a mini-ocean environment. Students will apply what they learn in the lab setting along with information gained in several online articles to a basic understanding of the Global Conveyor Belt and it's effect on Global Climate.

Objectives

This lesson will answer the following essential questions:

- How does temperature affect ocean density?
- How do differences in ocean temperature affect ocean stratification?
- How do differences in ocean temperature contribute to the Global Ocean Conveyor Belt System?

Lesson Preparation

1. Students should have had prior lessons on density concepts.
2. Before completing the lab students should read the article, "Temperature of Ocean Water" developed by Windows On The Universe. This article can be accessed at three different reading levels and in Spanish. In this lesson students will create a mini-ocean system in a clear box to determine how salinity can affect ocean density and stratification. Students will add various amounts of salt to three different water samples, color each sample with food coloring, pour them one by one into a clear box and finally observe the profile of the overall system.
3. Students should read the journal and watch the movie "Mooring Anticipation", by PolarTREC educator Lisa Seff to get an overview of how ocean salinity and temperature data are collected by researchers in the field using long-term moorings.

Materials

- 1-500mL beaker
- 2-300 mL beakers
- Ice water in a cooler
- Hot water in a coffee urn
- Room temperature water in beakers
- Red and blue food coloring
- Clear plastic shoebox-sized-box
- Thermometer
- 2-2.5cm side length wooden blocks
- Red, blue and standard pencils

POLAR TREC Learning Resources

Procedure

Procedure 1: Preparing the ocean water

1. Label the large beaker "Water #1".
2. Add 500 mL of room temperature water to this beaker.
3. Use a thermometer to determine the temperature of Water #1.
4. Write the temperature of Water #1 into the data table.
5. Write "clear" in the color of Water #1 in the data table.
6. Add 50 mL of ice water from the cooler to one of the small beakers.
7. Label this beaker "Water #2".
8. Use a thermometer to determine the temperature of Water #2.
9. Write the temperature of Water #2 in the data table.
10. Add 3 drops of blue food coloring to Water #2 and swirl gently until mixed.
11. Write the color of Water #2 in the data table.
12. Add 50 mL of hot water from the coffee urn to the other small beaker.
13. Label this beaker "Water #3".
14. Use a thermometer to determine the temperature of Water #3.
15. Write the temperature of Water #3 in the data table.
16. Add 3 drops of red food coloring to Water #3 and swirl gently until mixed.

Procedure 2: Creating your ocean environment

1. Place 2 blocks under the corners at one end of your clear box so that the box is stable but tilted as shown in Diagram #1 (see 'Procedure 2' attached).
2. Carefully pour Water # 1 into the box. You should have several inches of the box bottom that are not covered with water as shown with the arrow in the profile view Diagram #2 (see 'Procedure 2' attached).
3. Let the water rest for a minute.
4. Carefully and slowly pour Water # 2 into the box in the area not covered with water just above the wooden blocks.
5. Let the water rest for a minute then move so your eyes are level with the water in the container and draw the profile view you see into Diagram #3 (see 'Procedure 2' attached).
6. Carefully and slowly pour Water # 3 into the box in the area not covered with water just above the wooden blocks.
7. Let the water rest for a minute then move so your eyes are level with the water in the container and draw the profile view you see into Diagram #4 (see 'Procedure 2' attached).

Extension

1. Complete the lesson Investigating Earth's Hydrosphere: Ocean Stratification, Currents and Temperature
2. Read the articles "Ocean Water Properties" by the University of Rhode Island and "Salinity" by NASA Science Earth and the "Global Conveyor Belt" by NOAA Ocean Service Education. The NOAA article also includes several animations the students should watch.
3. If alternatively educators would like to access articles on salinity available in different reading levels and in Spanish they should go to "Salinity, Density of Ocean Water and Thermoha-

line Circulation" by Windows To The Universe. Use the links at the top of each webpage to change the reading level or language.
4. Complete the corresponding survey: "Ocean Water Properties and the Global Conveyor Belt".

Resources

- Center For Microbial Oceanographic Research & Education Ocean Conveyor Belt (http://cmore.soest.hawaii.edu/education/teachers/science_kits/ocean_conveyor_kit.htm)
- Mooring Anticipation PolarTREC Journal and Video by Lisa Seff (http://www.polartrec.com/expeditions/oceanographic-conditions-of- bowhead-whale-habitat/journals/2012-09-09)
- Ocean Water Properties by University of Rhode Island (http://www.hurricanescience.org/science/basic/water/)
- Salinity by NASA Science Earth (http://science.nasa.gov/earth-science/oceanography/physical-ocean/salinity/)
- Global Conveyor Belt by NOAA Ocean Education (http://oceanservice.noaa.gov/education/kits/currents/06conveyor2.html)
- Salinity by Windows To The Universe (advanced level-the level and language of this article can be changed by clicking on the appropriate link at the top of the page) (http://www.windows2universe.org/earth/Water/salinity.html&edu=high)
- Density of Ocean Water by Windows To The Universe (advanced level-the level and language of this article can be changed by clicking on the appropriate link at the top of the page) (http://www.windows2universe.org/earth/Water/density.html&edu=high)
- Thermohaline Circulation: Global Ocean Conveyor by Windows To The Universe (advanced level-the level and language of this article can be changed by clicking on the appropriate link at the top of the page) (http://www.windows2universe.org/earth/Water/circulation1.html&edu=high)

Assessment

Student will be evaluated through the use of the lab questions and extension survey: Ocean Water Properties and the Global Conveyor Belt.

Credits

This lesson was adapted by PolarTREC and Springs School Educator Lisa Seff from lesson materials originally developed by the Center for Microbial Oceanographic Research and Education. For the original lesson plan "Ocean Conveyor Belt" and additional resources such as PowerPoints, lesson extensions and self-contained lesson plan kits that educators may borrow for classwork. Go to the following link: C-MORE Ocean Conveyor Belt (http://cmore.soest.hawaii.edu/education/teachers/science_kits/ocean_conveyor_kit.htm)

Learning Resources

National Science Education Standards (NSES)

Content Standards, Grades 5-8

Content Standard A: Science As Inquiry
a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry

Content Standard B: Physical Science
a. Properties and changes of properties in matter

Content Standard D: Earth and Space Science
a. Structure of the earth system

Content Standard E: Science and Technology
a. Abilities of technological design
b. Understandings about science and technology

Content Standards, Grades 9-12

Content Standard A: Science As Inquiry
a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry

Content Standard B: Physical Science
b. Structure and properties of matter

Content Standard E: Science and Technology
a. Abilities of technological design
b. Understandings about science and technology

Other Standards

New York State Regents Common Core Learning Standard(s) Addressed:
WHST.6-8.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
WHST.6-8.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
WHST.6-8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

DATA TABLE #1

	Volume (mL)	Temperature (degrees C)	Color
Water #1			
Water #2			
Water #3			

DATA TABLE #1

Procedure 2: Creating your ocean environment

1. Place 2 blocks under the corners at one end of your clear box so that the box is stable but tilted as shown in Diagram #1 below.

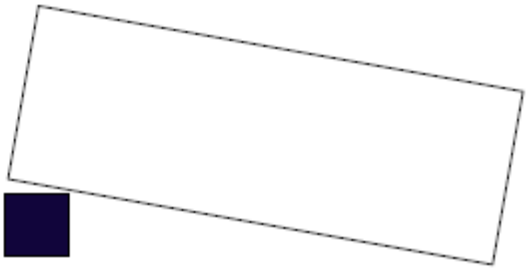

Diagram #1

2. Carefully pour Water # 1 into the box. You should have several inches of the box bottom that are not covered with water as shown with the arrow in the profile view Diagram 2 below

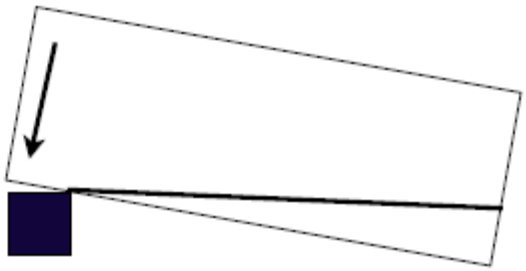

Diagram #2

3. Let the water rest for a minute.
4. Carefully and slowly pour Water # 2 into the box in the area not covered with water just above the wooden blocks.
5. Let the water rest for a minute then move so your eyes are level with the water in the container and draw the profile view you see into Diagram #3 below:

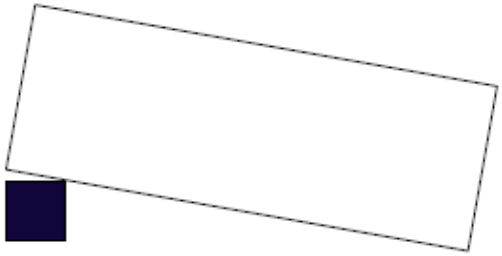

Diagram #3

6. Carefully and slowly pour Water # 3 into the box in the area not covered with water just above the wooden blocks.
7. Let the water rest for a minute then move so your eyes are level with the water in the container and draw the profile view you see into Diagram #4 below:

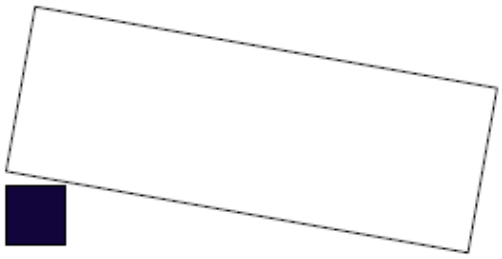

Diagram #4

Lab Work Discussion Questions

1. What happened when you added Water #2 to the ocean environment?

2. Why do you think this occurred? What were the properties of Water #2 and Water #1 that you think caused this to occur? (discuss the temperature and inferred densities based on the positions of each water layer in the box)

3. What happened when you added Water #3 to the ocean environment?

4. Why do you think this occurred? What were the properties of Water #1, #2 and #3 that you think caused this to occur? (discuss the temperature and inferred density based on the positions of water layers in the box)