POLAR TREC
Learning Resources

Details

Completion Time: About a week

Permission: Download, Share, and Remix

Investigating Earth's Hydrosphere: Ocean Currents and Salinity

Overview

In part one of this two-part lesson students work in pairs to explore the effects of salinity 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 its effect on global climate.

Objectives

The objective of this lesson is to answer the following essential questions:

- How does salinity affect ocean density?
- How do differences in ocean salinity affect ocean
- stratification?
- How do differences in ocean salinity 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, "Salinity" developed by Windows On The Universe (see Resources section). 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 "Going On A Sea Cruise", by PolarTREC educator Lisa Seff (see Resources section) to get an overview of how ocean salinity and temperature data are collected by researchers in the field.

Materials

- 1-1000 mL beaker
- 1-500mL beaker
- 2-300 mL beakers
- 1.75 teaspoons of salt
- 600 mL of room temperature water
- red and blue food coloring
- clear plastic shoebox-sized plastic box
- salinity probe
- thermometer
- 2-2.5cm side length wooden blocks
- red, blue and standard pencils

Learning Resources

Procedure

Procedure 1: Preparing the ocean water

1. Label the large beaker "Water #1"
2. Pour 500 mL of room temperature water into this beaker.
3. Add 1.5 teaspoons of salt and gently stir/swirl until all of the salt dissolves.
4. Use the salinity probe as directed by your instructor to determine the salinity of Water #1.
5. Write the salinity of Water #1 into the data table.
6. Add 50 mL of room temperature water to one of the small beakers.
7. Label this beaker "Water #2"
11. Add .25 teaspoons of salt and gently stir/swirl until all of the salt dissolves.
12. Use the salinity probe as directed by your instructor to determine the salinity of Water #2.
13. Write the salinity of Water #2 in the data table.
14. Add 3 drops of blue food coloring to Water #2 and swirl gently until mixed throughout.
15. Add 50 mL of room temperature water to the other small beaker.
16. Label this beaker "Water #3"
17. Do not add any salt to this beaker. The salinity will be 0ppt. Write the salinity into the data table.
18. 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. Take the temperature of Water #1 and write the temperature in the Data Table. 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. Take the temperature of Water #2 and write the temperature in the Data Table. 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. Take the temperature of Water #3 and write the temperature in the Data Table. 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 complementary lesson 'Investigating Earth's Hydrosphere: Ocean Stratification, Currents and Temperature' (available through the PolarTREC website: www.polartrec.com)

2. Read the articles 'Ocean Water Properties' by the University of Rhode Island and 'Salinity' by NASA Science Earth, 'A Chilling Possibility' by NASA Science News and 'Global Conveyor Belt' by NOAA Ocean Service Education. The NOAA article also includes several animations the students should watch.
3. Alternatively, if 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 Thermohaline Circulation' by Windows To The Universe. Use the links at the top of each webpage to change the reading level or language. 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)
- 'Going On A Sea Cruise' PolarTREC Journal and Video (http://www.polartrec.com/expeditions/oceanographic-conditions-of-bowhead-whale-habitat/journals/2012-09-02)
- '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/)
- 'A Chilling Possibility' by NASA Science News (http://science.nasa.gov/science-news/science-at-nasa/2004/05mar_arctic/)
- '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

Students will be evaluated through the use of the accompanying lab questions and student worksheet.

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
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 D: Earth and Space Science
b. Geochemical cycles

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.

Name _____ Date _____

Student Worksheet
Ocean Water Properties, the Global Conveyor Belt and Climate

1.How is salt delivered into the ocean system? Where does the salt originate?

2. How is sea surface salinity globally distributed? Where are the areas with higher and lower salinity?

3. How does salinity affect ocean density? How did your lab results support this conclusion?

4. How does temperature affect ocean density? How did your lab results support this conclusion?

5. How do differences in salinity and temperature drive the thermohaline circulation known as the Global Conveyor Belt?

6. Where does the Global Conveyor Belt begin?

7. How does the Global Conveyor Belt affect our global climate?

8. How can present and future climate changes affect the Global Conveyor Belt?

9. How could these possible changes in the Global Conveyor Belt further affect the global climate?

Ocean Current and Salinity

DATA TABLE #1

	Volume (mL)	Amount of Salt added (teaspoon)	Temperature (degrees C)	Salinity (ppt)	Color
Water #1					Clear
Water #2					Blue
Water #3					Red

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 #1 and Water #2 that you think caused this to occur? (discuss the salinity 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 salinity and inferred density based on the positions of water layers in the box)

DATA TABLE #1

	Volume (mL)	Amount of Salt added (teaspoon)	Temperature (degrees C)	Salinity (ppt)	Color
Water #1					Clear
Water #2					Blue
Water #3					Red

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.

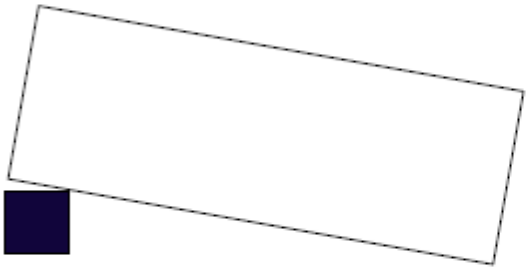

Diagram #1

2. Take the temperature of Water #1 and write the temperature in the Data Table. 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

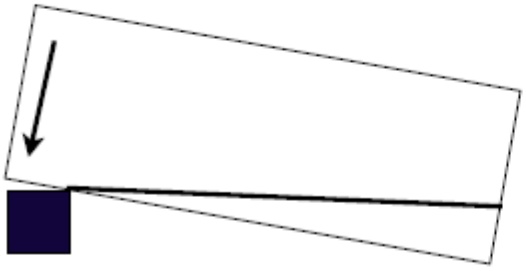

Diagram #2

3. Let the water rest for a minute.
4. Take the temperature of Water #2 and write the temperature in the Data Table. 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:

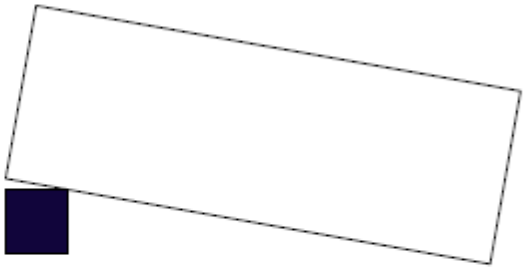

Diagram #3

6. Take the temperature of Water #3 and write the temperature in the Data Table. 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:

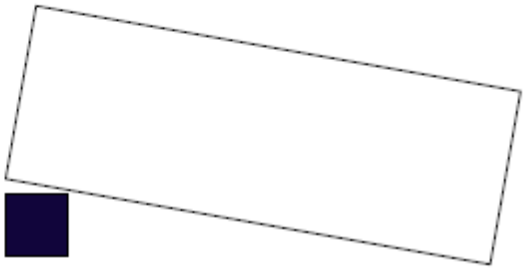

Diagram #4