Studying the Ocean Using Live Data

Overview

The Argo buoy project is a major oceanographic study that harnesses the power of automated unmanned buoys traveling the world's oceans (http://www.argo.ucsd.edu/). These floats gather data on the salinity, temperature and, in some cases, pH of the ocean from depths of 2,000 meters to the surface. The data collected by these buoys is sent automatically from the ocean via satellite to numerous data centers worldwide. These data are free to the public and researchers.

Ocean First Education has developed a map-based visualization platform for students to be scientists and explore these data. The Data Portal allows students to visually explore the physical properties of the world's oceans with just a few simple clicks, and analyze and interpret for themselves how the ocean's physical properties change across time, space, and depth.

The following lessons are designed to allow students to explore the data by visualizing it on a map and using observation to ask questions such as why? and how? Each lesson plan progressively builds on understanding, allowing students to formalize concepts, ideas, and mechanisms of the ocean and elements that affect it. Students can click and observe changes in physical properties of the world's ocean represented by colors on the map. They can also explore the cyclical nature of data across seasons.

Before getting started on the lessons, please review the Argo data user guide, which can be found here (http://oceanfirsteducation.com/research/live-ocean-data).

NGSS

5, MS, HS-ESS2 Earth's Systems
5, MS, HS-ESS3 Earth and Human Activity
Science and Engineering Practice: Analyzing and interpreting data
Crosscutting Concept: Patterns

Learning Goals

- The temperature at the ocean surface varies from north to south based on the sun's heat.
- The salinity at the ocean surface remains fairly constant across the globe.
- The range of temperature varies at different ocean depths and in different regions.

Part I

Focus Questions

What patterns do you see when you explore temperature and salinity at the surface of the ocean? What oceanic features do you see?

Background Knowledge

Since 2000, the Argo Project and buoys have provided an unprecedented and publically available data set on ocean salinity and temperature (and some dissolved oxygen) from the oceans' surface to 2,000 meters below. Argo floats are deployed at sea. More than 3,600 floats are present in the world's ocean, collecting data. The floats are autonomous – they require no human input, moving passively with the ocean currents. Each float works in a 10-day cycle, during which time it descends to approximately 2,000 meters below the surface and collecting data while ascending. As it reaches the surface, the float sends that data to an array of satellites. Once the data is sent, it once again descends to 2,000 meters and begins the process again. This process, occurring across the globe, amounts to over 130,000 cycles per year. As each float samples the water over 200 times on each cycle, the amount of data is unprecedented.

Materials

Access the internet and the Data Portal
http://oceanfirsteducation.com/research/live-ocean-data
Science notebook

Advance Preparation

Visit the Data Portal at http://oceanfirsteducation.com/research/live-ocean-data to familiarize yourself with the functionality of the portal. Review the user's guide.

Potential Misconceptions

- Ocean data (pH, temperature, dissolved oxygen) is the same at all depths and locations around the globe.
- Ocean data is the same at all times throughout the year and across time.

Eliciting Prior Knowledge

Ask students to write down what kind of "data" they can get from the ocean. Ask them to share with a partner and then add to their own list. On the board, create a student-generated list of potential data that can be collected from the ocean.

Process and Procedure

1. Direct students to the Data Portal and have them load the pop-up page. Given the amount of data, the students will need to wait about 15-20 seconds before interacting with the page. Acknowledge this with the students, sharing with them the amount of data gathered across the globe. Make sure students have their science notebooks ready.

2. First, ask students to display the *Salinity* data by clicking the second layer box on the right-hand side and selecting *Salinity*.

3. Ask students to take notes in their science notebooks, answering the following questions:

    a. Where are the highest salinities on the map? Where are the lowest salinities? *Hint: Students should refer to the scale in the bottom right of the map.* Note: Some green dots will appear among orange and red dots. These are data anomalies and can be ignored. Discuss with students, asking them what they think a data anomaly is.
    b. Ask students to quickly sketch salinity patterns in their notebook.

4. Next, have students change the layer from *Salinity* to *Temperature* and examine what happens to the map. Ask students to write down features and sketch patterns in ocean temperature across the surface of the world's ocean.

5. Put students in small groups to share and identify the main ideas, observations, and patterns agreed upon by the group. Ask one person from each group to write down their group's main ideas on the board. Come to a whole-class consensus on the main ideas, patterns, and observations shared.
   Hint: Students should have observed that for salinity, there is some change across the world's oceans but not a lot. For temperature, there should be greater contrast in what they observed from north to south. Students should have observed that temperature was lower near the poles and higher across the equator.

6. After a class discussion, ask students to describe their thinking about the following questions in their notebook:
    a. Why do you think the temperature pattern in the ocean is the way it is?
    b. Why is salinity the way it is?

7. Discuss student ideas as a class. Ask students to add to their thinking in their notebooks. *Hint: Students should identify that the sun's heat is responsible for the temperature difference from north to south. For salinity, students should identify that it is largely uniform across the ocean and down to deeper depths. However, they may find areas of high salinity and low salinity. These can be related to areas of high rainfall, such as off of Alaska, and areas of high evaporation by the sun, such as in the Mediterranean.*

Dive Deeper

Students may have observed that some areas have extremely high salinities. This is typically observed in the Mediterranean, Red Sea, and Dead Sea. (The Red Sea and the Dead Sea may not have buoys, depending on when your class is observing the data). This activity helps students understand the interplay between the oceans and sun, beyond just as a source of heat.

Process and Procedure

1. Direct students to the Mediterranean Sea. Remind them to check that they are still displaying *Salinity* on the map.

2. From the colors of the dots and using the key, have the students identify the range of salinities within the Mediterranean.

3. Have students move west on the map and explore the Eastern Atlantic. What are the similarities and differences in the range of salinities in the Eastern Atlantic compared with the Mediterranean? Direct students to discuss their observations in small groups and write their ideas in their notebook.

4. Ask students to think about their observations and discussion. Ask students, "What else, besides increasing the temperature, can the sun do to water?" *Hint: The discussion should focus on the impact of the sun on evaporation of water from the sea surface. In the Mediterranean, especially the eastern half, evaporation causes the water to become saltier. The narrow Straight of Gibraltar that limits tidal flow in and out of the Mediterranean enhances the effect of evaporation by limiting the amount of new water entering the sea. Go here (www.ocean-sci.net/10/693/2014/os-10-693-2014.pdf) for an in-depth scientific look at the Mediterranean and how it might be getting even saltier.*

Part 2

Focus Question

- What happens to the temperature, from the ocean surface to the darkest depths, and from the poles to the equator?

Background Knowledge

As the depth of the ocean increases, the amount of sunlight penetrating decreases. The only source of heat for the ocean is that from the sun. As you progress into deeper depths, the ocean becomes cooler. Similarly, as you go across the surface of the ocean towards the poles, the amount of sunlight reaching the surface water also decreases, and thus you get seawater that is almost at a freezing point at the poles.

Process and Procedures

1. Direct students to the Data Portal and have them load the pop-up page. Using the radio buttons on the bottom left, ask students to click through different depths sequentially from 0, 400, 800 and 1200 meters. In their science notebooks, have them take notes on the change in colors (temperature) across the world and answer the following question:
    a. What does depth do to temperature? Explain your thinking.

2. Ask students to compare the temperatures at the ocean surface and the deepest depths. Suggest that they explore tropical areas, such as the Caribbean, and Polar regions, such as Antarctica and the Arctic. Ask students to develop a table in their notebooks comparing temperatures in different regions and depths. Have them answer, using their data, and develop an explanation for the following question:
    a. Where is greatest temperature change between the ocean surface and 1,200 meters?

Dive Deeper

1. Direct student to use the Data Portal plotting feature to examine data across the globe. Students will discover changes in temperature at different depths and in different regions by visualizing the data on a standard x- and y-axis.

2. Have students select individual buoys by clicking on a buoy in a region, such as a tropical equatorial area. Now have them click on another buoy in a contrasting region, such as a temperate region (west coast of North America or Alaska).

Questions

1. Which variables would you select and on what axis should each be placed to generate a graph showing temperature changing with depth? Sketch the graph by hand and compare it with what you see on the Data Portal.

2. What are the differences in temperature and salinity when comparing equatorial waters with Polar-regions? Compare and contrast the patterns observed with temperature and the patterns seen with salinity?