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? 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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Analyzing and Interpreting Data	• ESS2.A: Earth's Materials and Systems	• Stability and Change • 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?

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 to a World Map
Access the internet and the Data Portal
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. Prior to viewing the video, ask students to predict locations where salinity values are higher compared to other areas of the ocean.

2. Direct students to the Ocean First Education Data Portal and have them load the pop-up page by selecting "Click to Interact with Current Ocean Data". 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.

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

4. Based on their initial predictions, ask students to investigate their prediction by collecting salinity data in their science notebooks. They can also investigate 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 and possible explanations for it.
    b. What patterns in salinity data did you observe?

5. Next, have students change the layer from *Salinity* to *Temperature* and examine what happens to the map. Ask students to write down data and patterns in ocean temperature across the surface of the world's ocean. Have students generate an illustration (map), graph, or model depicting the relationships of temperature and salinity.

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. Ask students to explain their models to the class. Ask students to reflect on the reasons for the relationship among the variables. 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 Sea.*

Part 2

Focus Question

- How are the physical characteristics of the Caribbean Sea and the Indo-Pacific region alike? How are they different?

Background Knowledge

The Indo-Pacific

The Indo-Pacific is a body of water that spans the western region of the equatorial Pacific to the Indian Ocean. The Western Indo-Pacific includes the western and central portion of the Indian Ocean. Water along Africa's east coast, the Red Sea, the Persian Gulf, and the Arabian Sea, plus the coastal waters of Madagascar and the Seychelles are also part of this region. The Central Indo-Pacific is made up of the many seas and straits that connect the Indian Ocean to the Pacific. The Central Pacific Ocean, which surrounds numerous volcanic islands like Hawaii, makes up the Eastern Indo-Pacific region.

The Indo-Pacific holds the world's warmest ocean water in what is known as the Indo-Pacific warm pool. Here, average daytime water temperatures oscillate roughly every other decade from warm to warmer and back again, or between 84°F (29°C) and 86°F (30°C). Although scientists do not yet understand this periodicity in temperature, they are examining mechanisms that would cause the pattern, such as warm underwater currents that bring heat across the Pacific Ocean to the waters of the Indo-Pacific.

The Caribbean Sea

The Caribbean Sea lies west of the Atlantic Ocean in five submarine basins that are separated by broad ridges. The water in the Caribbean is clear and warm (75°F/24°C); even deep water in the Caribbean Sea is warmer than that of the Atlantic because the submarine ridges between basins block the influx of cold water from the Antarctic. Daytime air temperatures near the shore, which average around 85°F (30°C), stay steady year-round. Because of its large size (1,063,000 square miles or 2,753,000 square kilometers), some characteristics of the Caribbean Sea's tropical climate can vary from region to region. For example, rainfall can range from 10 inches (25 cm) on the arid island of Bonaire off the coast of Venezuela to 350 inches (900 cm) on the island of Dominica in the eastern Caribbean. Tropical storms of hurricane strength often originate over the Atlantic and visit the northern parts of the Caribbean Sea, most frequently in September, but these storms rarely disrupt the sea in the far south. Surface currents and trade winds mix water of high and low salinity until the average salinity of the Caribbean Sea is lower than that of the Atlantic Ocean.

Process and Procedures

1. Review the location of the Caribbean Sea and the Indo-Pacific region with students.

2. Direct students to the Data Portal and have them load the pop-up page

3. From the map, have students select an individual buoy in the Caribbean Sea by clicking on a data point. Once selected the data collected by that buoy will populate a graph. Students can click directly on the graph to obtain the exact data values.
    a. Record the data provided by the buoy, including:
        i. Current latitude and longitude
        ii. Salinity and temperature by date
        iii. Dissolved oxygen by date, if available
4. Now have students click on another buoy in the Indo-Pacific.
    a. Record the data provided by the buoy

5. Ask students to compare the data recorded by each pair of buoys. If students are working in pairs or small groups, have each group share the data they collected.
    a. Are the temperatures the same over time throughout both regions?
    b. Is the salinity the same throughout both regions?
    c. Which region showed the greatest fluctuation in temperature? In salinity?
    d. Did any of the buoys measure dissolved oxygen? How do the regions compare?

6. Direct student to use the Data Portal plotting feature to examine data collected from each geographical area. Students will discover changes in temperature at different depths and in different regions by visualizing the data on a standard x- and y-axis.

Questions

1. Why is it important for scientists to collect ocean data?
2. What other applications could this data to be useful?
3. How are coral reefs around the world changing today? How could this data be used to observe and measure those changes?
4. What can you do to become a champion for the coral reefs and a steward for a healthy ocean?