Investigating 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 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 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 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. As a class, access the Data Portal and load the pop-up page by selecting "Click to Interact with Live Ocean Data". Given the amount of data, it will take 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.

2. Display the *Temperature* data by clicking the second layer box near the top right-hand side and selecting *Temperature*.

3. As a class, review the data displayed. Note the color-coded temperature scale found in the bottom right of the map. Review the location of the North and South poles and the Equator before asking students to analyze the data presented. Ask students to take notes in their science notebooks, answering the following questions:
    a. Where are the highest temperatures on the map? Where are the lowest temperatures?
    Note: Some blue dots will appear among orange and yellow 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 (i.e. broken buoy, buoy that was hit by a boat, or caught in a net).
    b. Ask students to draw a model of the map in their notebook and identify where the ocean water is: cold (blue-purple), cool (green-yellow), and warm (orange-red).

4. 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 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.

5. 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, with the poles receiving less direct sunlight than the water near the Equator.*

Part 2

Focus Questions

- How does the water temperature of the Caribbean Sea and the Indo-Pacific fluctuate over time?
- Is the water temperature different in the Caribbean Sea than it is in the Indo-Pacific?

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. As a class, access the Data Portal and load the pop-up page.

3. From the map, 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. Click directly on the graph to obtain the exact data values by date. Be sure to select the temperature line, the thinner of the two, to obtain the proper data.
    a. In their notebook, have each student record the data provided by the buoy, including:
        i. Current latitude and longitude
        ii. Temperature by date
4. Time permitting; select 1-2 additional buoys in the same location in the Caribbean Sea and have students record the data collected by each.
5. Now select another buoy, this time from the Indo-Pacific.
    a. Have students record the latitude and longitude of the buoy and the temperature data over time.
6. Time permitting; select 1-2 additional buoys in the same location and have students record the data collected by each.

7. Ask students to compare the data recorded by each pair of buoys.
    a. Did any of the buoys collect data at the same time of year?
    b. Are the temperatures recorded at each location the same during the same time of year? (i.e. What is the temperature in the month of December from both locations?)
    c. Are the temperatures different during the same time of year?
    d. How much of a temperature difference is there between locations?

Questions

1. Why is it important for scientists to collect ocean data related to temperature and biodiversity?
2. How can this type of data help scientists track changes to specific ocean environments?
3. What other technologies exist that can help maintain a healthy ocean? Can you think of an invention that might help solve some of the issues facing the oceans today?