liberty science center

Ships, Ocean, and Satellites (S.O.S)

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Topic: Using data to exploring spatial changes in seawater properties in the surface ocean.

Audience: Grades 6 – 8 (Expandable to 12th)

Length: 45 minutes

NJ State Standards:

- 5.1.8.B – Generate scientific evidence through active investigations.
- 5.1.8.D – Participate productively in science.
- 5.4.8.E – Energy in Earth Systems.
- 5.4.8.F – Climate and weather.

Objectives: Students will be able to:

- Interpret data and describe the pattern of sea surface temperature in a given area
- Explain the advantages and limitations of in-situ sampling.
- Gain a basic understanding of data resolution, and associated limitations of random sampling.
- Discuss the benefits, disadvantages, and applications of in-situ and remote sampling

Introduction:

This lesson introduces students to sea surface temperature data, as well as the concept of spatial resolution. Students work in groups to collect a limited number of "sea surface temperatures" from a simulated ocean. They discover patterns of sea surface temperature, along with challenges related to spatial resolution. Throughout the lesson, students are asked to collect and interpret data from their activity boards and from real time sources.

The introductory activity is designed to limit the data students have to work with and interpret. They are visually able to see the low spatial resolution that results. Students use the data they have to describe the patterns of sea surface temperatures. The activity progresses towards the introduction of real time data from sources like satellites, shore or bottom mounted stations, buoys, and autonomous submersibles like gliders. Throughout the activity, discussions of the advantages and disadvantages of different sampling techniques are discussed, as well as the resulting resolutions different technologies can produce.

Background:

Resolution is a concept many students are familiar with in terms of technology like digital cameras. The more pixels per square inch the camera can take, the better the pictures. The same idea is also true for ocean data. The more data points obtained over a specific area or period of study, the better the picture. In the field of oceanography spatial and/or temporal resolution is important to understand for data interpretation and discussion.

Historically Oceanography has been limited to discrete, in-situ sampling, a method that takes 1 sample from 1 location at 1 time. The sheer size of the ocean poses challenges to when and where scientists can sample. The resulting data can be low resolution.

The hostile nature of the ocean environment imposes many design challenges to technology. With these physical limitations, scientists have looked at ways to remotely study the ocean, in addition to ocean based observing. There are now many satellites in Earth orbit to measure a variety of ocean properties, as well as shore based stations monitoring coastal processes. As more of these systems come online, scientists have gained a better understanding of the interconnected systems within ocean basins, combining remote data with in-situ buoy, remote glider, or bottom mounted stations and traditional sampling methods shipboard. Many people are unaware of the new ways these scientists are sampling and studying the ocean.

Introducing students to real time data, and the potential uses it has in their own lives demystifies some of the processes of research science, and increases awareness of ocean observing systems. Students are highly receptive to the real time data streams and feel involved in the scientific process. Students are excited to learn that concepts they've been taught already about heat transfer and hydrologic cycle are directly related to the marine science concepts examined in this lesson. This activity expands on students' prior knowledge to make the science they've already studied relevant to ocean science.

Materials:

- Data/Map Worksheet to record sampling observations (1 per student, plus 1 to compile class data)
- Pipettes (4 per group of students)
- 50 mL beaker (1 per group)
- Test Tubes (30 per board)
- Water
- Food Coloring
- Colored markers, pencils, or crayons
- Teacher computer with projector
- Foam Board for Test tubes, with map (See related Construction Guide)

Procedure:

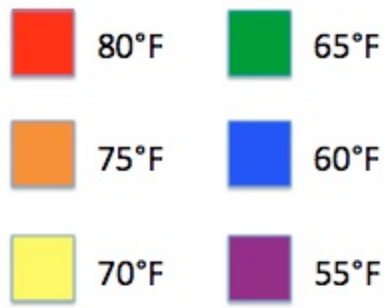
This lesson is facilitated by a teacher, and relies on student group work. Students work in groups of four or five, and are guided through the activity step by step by the teacher. Careful questioning techniques are used to direct the activities and students' thinking. These questions focus on getting students to think of ways to improve their spatial resolution, and interpret the data they have collected. The differences between observations and interpretations are stressed.

The introductory activity simulates ocean data at a low resolution using the constructed foam boards. These boards are prepared ahead of time so during class they only need to be distributed to each student group.

I. Preparation

A. Create a coded map of what color test tube should be in which hole. The map code we use was simplified from average SST data for the East coast of the United States in Late September. (Available on slide #9 in the Construction Guide on the website), if you wish to use the same geographic area and data.)

B. Fill test tubes with colored water to represent different temperatures. We specifically chose to use the Fahrenheit scale rather than metric Celsius for this age range so the numbers are meaningful to students.



1. Use the coded map to place these test tubes in the grid.

2. Place map "lid" on top and secure.

Note: Do not tip foam boards while filled test tubes are inside; ensure students leave their boards flat on their table.

C. Student Materials

1. Each student will have a map data sheet (matches lid), and colored pencils/markers/crayons to fill in the map.

2. Each group will also have four pipettes, and a small beaker for sample waste.

II. Activity

A. A brief introduction to the lesson assesses students' prior knowledge and gets them thinking about the connections this has to ocean science. If the students are not already, divide them into groups of four or five.

(Italic text throughout the activity offers suggested script sections you can use, if you wish.)

"Have you ever been to the shore at different times of year? Why does water temperature change? Many things can change the temperature of the surface ocean. In

order to try to figure out why ocean temperatures are different from one time and place to another, it is first helpful to sample the ocean and try to see what temperature the water is where at one time of year. We are just going to sample the surface ocean. The water in the deep ocean, below about 100 meters, is constantly cold; sunlight can never reach it and warm it up. The most solar energy is absorbed around the equator year round, so the warmest ocean water should form in the tropics. The poles get cold in winter, and have almost no sunlight then, so we should find the coldest ocean water near there."

B. Simulated ocean data activity

1. Explain that the students are to conduct a study of ocean surface water temperatures, each student group represents one research vessel and the group as a whole may only take four samples. The student groups may decide which holes in the board they will use a pipette to sample.

"Scientific sampling of the oceans has always been a difficult and expensive study. Traditionally scientists went to sea and took samples directly, which you are about to do on our model ocean here. These studies are limited mostly by the money you have available. It costs to charter a research vessel, and pay for a crew and fuel to operate it. You are to conduct a study of ocean surface water temperatures, but each group only has enough money to sample four locations total. You must decide, as a group, where you want to sample. Remember your table only gets four samples. We will be using a model ocean (show box) and something called 'false color' information. The different colors of the water samples represent different temperatures: red for the warmest water and purple for the coldest. You will use the colors to show where the surface water is different temperatures on your map –like a weather map, but for the ocean."

2. Pass out worksheets, and orient students on the map. Show a map from one of the boards to the whole class (which should match the map on their worksheets) and point out what is land, what is water, and what part of the world they are looking at (on our map, shown in the Construction Guide, we point out the east coast of the United States, and where New Jersey is.).

3. Clear instructions must be given before handing out the boards, or pipettes.

4. Rules:

a. No one may lift or tilt the foam board once it is placed on the table. No one may lift up the map or look under it.

b. Each group is given four pipettes, no pipette may be reused. (Be explicit that the groups will only have 4 data points total, not four per group member. Ensure students do not try to cheat and obtain more than 4 samples per group.)

c. Insert a pipette into the hole in the map you wish to sample. Do not remove the map if you have trouble, ask for help. Squeeze the pipette bulb, then let go to draw up a water sample. ***Do not remove*** *the pipette from the hole in the map.*

d. Record the water data (color) you obtained on the corresponding square on your worksheet. Each person should record all four of their group's samples on their worksheet. Also look at the color key on your worksheet and remind yourself what temperature each color represents.

e. Do not return sample water to the board. If you removed your pipettes, place them in the provided beaker. (Students are not to return sample water to a test tube, even the one they drew it out of. Watch students to ensure there is no cross contamination of colors.)

5. Never tell students how to record or color in their sheets, they should decide this for themselves. Often they choose to color the whole quadrant box, and this isn't necessarily correct. This common mistake can be pointed out after the exercise is complete: for example, explain that you only know the temperature of the exact point you sampled at (the center of the square). Coloring the whole box is making a broad assumption.

6. Have the students try to interpret their data. Even with only 4 points, they may be able to make some observations such as "water is warmer in the south".

"With the data points you've collected, what can you say about sea surface temperature along the east coast (or change this to the location you are using, if different)*? Can you discuss, accurately and with detail, what is happening in the ocean regarding*

temperature? Why not? If you can't afford to go back to sea, what would be another way to fill in the gaps?"

7. Collaboration is an important part of science. Scientists frequently share data so everyone has more information to work with. Allow students to share their data between groups, and discuss whether this collaboration improves their resolution. There are frequently duplicate samples between groups and the class will rarely end up with more than half of all the possible data points.

a. Can the students make any better interpretations of the data?

b. Are the previous observations and interpretations from four data points still correct?

8. Finally give students all the possible data for the map and see if their observations and interpretations still hold. Allow them a chance to "connect the dots" and create a false color map of their sea surface temperature data before showing the false color map created by the teacher.

a. Discuss the patterns that are seen in temperature and what students think is responsible for each. For example: *"There is a narrow band of warm water there. I wonder if that is a current of some kind. If it is a current, which direction is it flowing?"* (Warm water from the tropics traveling north.)

b. Some patterns to look for: currents (narrow bands of temperature very different from the water around it), upwelling (cold water right at the shoreline), warmer water near the continent (deeper water columns change temperature slower than shallow water, heat capacity).

9. Lead a discussion about the assumptions students use to create their maps.

a. Did they mark only the location they sampled (the center of the quadrant) or did they just color an entire quadrant the same color?

b. Did they mark two neighboring quadrants with a 5 or 10 degree temperature difference as sitting right up against each other, or did they try to develop temperature gradients between sample locations?

c. What rules did the teacher use in the creation of their false color map? How does it differ from students'?

10. Before continuing to the second half of the lesson ensure that students understand that scientists make a list of rules based on prior data interpretations for creating different data maps, and these rules are codified in computer programs when technology is used to generate the map. The resulting visualizations can be altered if the program parameters are changed.

C. Real Time Data Interpretation

1. Use the teacher computer to project a real time sea surface temperature map of the same region used in the previous activity boards. (See Resources section at the end of this lesson for links to places to find data maps.)

"Let me show you a map of the ocean surface temperatures taken from satellite. Is this map better than the one you completed? Why do you think so? (Show more than one example, if you like and if you have time.)

These maps are examples of remote sensing data. Scientists can measure the surface ocean temperature using a satellite and never have to go there. When you went to sea to sample, you were limited to a few data points, and each sample you gathered scientists would call an in-situ sample. You took your samples directly from that location. The satellite takes data in wide swaths, and transmits lots of data in real-time (the ocean looks like this right now). Scientists call this remote sensing. This satellite isn't going to each location in the ocean it measures; it gets its data from Earth orbit."

Have students discuss whether this map is better resolution than their own, and why they think so. Show an older map with cloud obscurities and anomalies, and again discuss the quality of the data.

2. Introduce the idea of real time data, and some of the technologies used to obtain it. Have students brainstorm the limitations each kind of technology might have, like clouds obscuring a satellite's view. (See the Resources section for some good references on satellites.)

3. Also ask students to brainstorm what kinds of information about the ocean can NOT be measured remotely. Can you think of something you might want to know about the ocean that you can't measure with a satellite? Some great examples are most chemistry measurements like salinity and dissolved oxygen, biological information such as types or amount of bacteria, types and numbers of animals, and especially anything below the surface. We can't measure the temperature of the bottom water, or the amount of carbon in the sediment at the bottom of the ocean. Satellites can only "see" the very top.

Evaluation:

Conclude the lesson with a discussion of integrating data from different sources to provide maximum information. Scientists can use remote data to plan in-situ sampling trips or to supplement previously obtained field data. Ensure students realize that ocean data has interdisciplinary uses from biologists mapping plankton blooms or predicting fish spawns, to meteorologist, to the physical oceanographers modeling ocean water movement. How can students use this kind of data? Let the students decide the relevance of ocean data to their lives, for any or all of the following activities: weather prediction, fish location, planning a beach day, kayaking or sailing, storm tracking and flood prediction, etc.

Resources:

Data

How to read a sea surface temperature map (for your reference, or have your students read).

http://rucool.marine.rutgers.edu/index.php/COOL-Data/how-to-read-sea-surface-temperature-map.html

Sea Surface Temperature data from the Coastal Ocean Observation Lab (COOL Room) at Rutgers University's Institute of Marine and Coastal Sciences.

http://marine.rutgers.edu/cool/sat_data/?product=sst&nothumbs=0 – use the boxes on the map to select what part of the east coast you want to look at.

See all the types of data they have available here:

http://rucool.marine.rutgers.edu/index.php/COOL-Data/

Satellites

See where satellites are now at http://climate.jpl.nasa.gov/Eyes/eyes.html select a satellite, then click "real time" at the bottom of the screen showing the earth.

Science Education Gateway, Center for Science Education at Space Sciences Laboratory, UC Berkeley.

Lessons on How Satellites See (3rd – 8th grade, multi day unit)

http://cse.ssl.berkeley.edu/lessons/indiv/wilder/summary.html

General Ocean Resources

The ocean is an important part of the Earth's climate system – water, especially ocean currents, carries a lot of heat from one place to another around the world.

To learn more, go to this link, and then click on "The Ocean's Impact on Weather and Climate"

http://coseenow.net/2008/11/ocean-literacy-interactive-animation/