Activity 1.5 Ocean Currents, Jet Streams and El Niño
- 1.5.1 Ocean Currents and Jet Streams
- 1.5.2 A Hands-On El Niño

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1.5.1 Ocean Currents and Jet Streams

Teacher Background

In the 1700s when the American colonies were dependent on sailing ships to receive mail from England the constant complatint was that it took 2 weeks longer for the mail to travel from Falmouth, England, to New York than it did to travel from London to Providence, Rhode Island. Benjamin Franklin, deputy Postmaster General at the time, was asked to investigate. Franklin spoke with his cousin, a Nanucket whaling captain, and found the canny New Englanders knew all about (and also how to avoid!) a current that delayed the colonies-bound mail by 70 miles a day, and sometimes even carried ships back towards England when the winds were light. Franklin has a map printed showing the Gulf Stream, but the Falmouth captains apparently ignored the information. As sagacious Ben said in another context, "Some are weather wise and some are otherwise."

Wind is one of the main forces behind surface currents. (See Activity 1.4 for more on pressure, temperature and wind.) The Coriolis effect causes currents in the open ocean north of the equator to move in a clockwise direction while currents south of the equator move in a counterclockwise direction. Surface currents which originate near the equator are warm currents and those that originate closer to the poles are cold currents. (See Activity 1.1, Sun and Seasons.) Continents are another factor which influence currents by causing the currents to be deflected from their original path.

Surface currents have a considerable effect on the climate of areas along their path. England and Iceland have much warmer and more moderate climates than would be expected just by looking at their location. Their latitude is similar to that of northern Canada, Labrador and Alaska, which experience a very different climate. It's all due to the warm Gulf Stream.

Objectives

Students will become familiar with ocean currents and wind patterns.
Students will make comparisons between wind patterns and ocean currents.

Vocabulary

current
Gulf Stream
jet stream
latitude
longitude

Materials (for each team of students)
9 x 12 inch aluminum pan
clay
flexible straw (the kind that's bendable)
water
small piece of aluminum foil
tracing paper
Worksheet 1.5.1.1 Ocean Currents
Worksheet 1.5.1.2 Wind Patterns
WEATHERlogs (for each student)

LFSTORM Standards Correlation sheet (for teacher reference)

Engage
Distribute Worksheets 1.5.1.1 and 1.5.1.2, the Ocean Currents and Wind diagrams. Explain to students that surface currents originating near the equator are warm while currents originating at the cooler latitudes are cold. Have students color the warm currents red and the cold currents blue. Instruct students to trace the wind diagram and place the tracing on top of the ocean current diagram. Ask students to record their observations in their WEATHERlogs. (Students should notice a correlation between ocean currents and wind patterns.) Discuss their observations as a class. Point out that wind is only one factor that influences ocean currents and discuss the other factors. (Coriolis effect, deflection by continents, location from which they originate.)

Explain/Explore
1. Using the clay have students make continents along both sides (lengthwise) of the aluminum pan.
2. Fill the middle section of the pan with water. Do not fill the pan so much that the continents are submerged.
3. Make 3 or 4 small rafts approximately 1 cm square out of the piece of aluminum foil.
4. Place your rafts in the "ocean."
5. Bend the straw and place the long end of the straw (end furthest from the bend) in your mouth. Aim the short end of the straw at your "ocean" and blow gently causing a breeze. You do not need to blow hard enough to have a visible movement of the water. A current should begin to form.
6. Observe the path of the rafts and record your observations.
7. Repeat the process blowing in different directions. Record your observations in WEATHERlogs. What factors influenced the path of the rafts? How did the path differ when the winds blew in different directions? Make a general statement about the connection between wind patterns and ocean currents based on your observations.

1.5.2 A HANDS-ON EL NIÑO
PTK thanks Carol McLaren, et al., and UCAR for permission to adapt the El Niño activity developed for Project LEARN, supported by NSF grant ESI-9153756.

Teacher Background

The term “El Niño” (Spanish for “the little boy” or “the Christ Child”) was originally used by fishermen along the coasts of Ecuador and Peru to refer to above-normal sea surface temperatures that typically appear around Christmas in the eastern Pacific Ocean and last for several months. But El Niño’s effects are not limited to Peru and Ecuador. They can impact weather patterns around the world and the disruption of the normal climate can have profound and even tragic consequences.

How does El Niño work? In normal years, winds tend to blow from east to west across the waters of the tropical Pacific. The easterly winds push the surface waters westward across the ocean. In turn, this causes deeper, colder waters to rise to the surface. This “upwelling” of deep ocean waters brings with it nutrients that otherwise would remain near the bottom. Fish populations living in the upper waters are dependent on these nutrients for survival. During El Niño years, the winds weaken, reducing or even choking off the upwelling of deep water. The consequent warming of the ocean surface further weakens the winds and strengthens El Niño. As the Pacific continues to heat up, the warmer waters shift eastward, and so do the clouds and thunderstorms that produce heavy rainfall along the equator. This results in changes in jet streams (the winds high aloft), which lead to dry conditions in Indonesia and Australia and floods in Peru and Ecuador. El Niño events occur on average every 3 to 5 years, though there can be periods of up to a decade without an El Niño. The cycle is called “ENSO”, which stands for the “El Niño Southern Oscillation.” The winter of 1997-1998 was marked by a record-breaking El Niño. The result was unusual weather in parts of the world, including the U.S. Severe weather events included flooding in the southeastern United States, major storms in the Northeast, and flooding in California.

El Niño’s twin sister is “La Niña” (“the little girl” in Spanish). Her effects are, as any siblings would expect, the exact opposite of El Niño’s: for instance, precipitation is below normal in California and the southeastern U.S. La Niña is characterized by below normal sea surface temperatures in the eastern equatorial Pacific. There are large variations in weather for many U.S. locations from warm spells to cold waves during a La Niña winter.
(Adapted, with permission, from the EPA/NASA/NOAA Climate Change Presentation Kit CD-ROM.)

Objectives

Students will make simulate ocean currents and cold water upwelling typical of El Niño.
Students will research connections between El Niño and global and local weather and climate.

Vocabulary

El Niño
ENSO
La Niña
upwelling

Materials (for each team of students)
glass baking dish or clear plastic shoebox
cooking oil
food coloring (green seems to work best)
bendable straw
apron
goggles
WEATHERlogs (for each student)

LFSTORM Standards Correlation sheet (for teacher reference)

Engage
Ask students what the terms El Niño and La Niña mean. Discuss weather conditions you are currently experiencing due to an El Niño or La Niña. Show the El Niño/La Niña segment from LIVE FROM THE STORM program 1, "The Who, What, Where, When and Why of Weather", or use the LFSTORM website (WHY section) and the El Niño animation to be found there to introduce key concepts.

Explain/Explore
To minimize the chance for flying ocean water (which made one teacher-reviewer note he'd not try this Activity with his current set of students!) this is suggested as a teacher supervised, student implemented Activity rather than as something for students to undertake independently.) Accordingly there is no Student Worksheet and the procedure appears only here in the Guide.

Procedure
Guide students through the implementation of this Activity.
1. Fill the baking dish or shoebox about 3/4 full with water.
2. Place a few drops of food coloring in the water and let it mix thoroughly.
3. Very slowly pour cooking oil on top of the water until there is the thinnest coating possible on top of the water. The entire surface of the water should be covered.
4. Place the long end of the straw (the end furthest away from the bend) in your mouth and gently blow across the top of the oil. There should be some visible movement, but not enough to spray the oil out of the pan.
5. Stop blowing and record your observations in WEATHERlogs. (Students should notice a hole in the layer of oil which quickly closes up when you stop blowing. The hole is easier to observe after you stop blowing.) Describe the circulation pattern of the oil. Compare your model to what happens in the Pacific Ocean during an El Niño. Compare your model to what happens during a La Niña.

Expand/Adapt/Connect
Experiment with different depths of water and oil and different wind speeds. Does the warm pool creep back over the surface if the winds only blow for a short while?
Visit the El Niño and La Niña sections of the LIVE FROM THE STORM website to learn more about the impact they have on weather in the United States and follow links to check out the latest information about the consequences of ENSO.
Research the effect El Niño and La Niña have on the climate of your area.

Suggested URLs
http://www.coe.usouthal.edu/oar/html/ocean_currents.html
NOAA OAR web page for students on ocean currents: good background, activities and links to additional resources.

http://www.pmel.noaa.gov/toga-tao/el-nino/nino-home.html
NOAA's El Niño Theme Page: background information, including current ENSO status.

http://www.dir.ucar.edu/esig/la_nina_home/
La Niña Home page, explaining the human impact, forecasts and links to additional resources.

http://airsea-www.jpl.nasa.gov/ENSO/welcome.html
El Niño from NASA's satellite resources: the oceanographic, meteorological and biological viewpoint, plus animations and links.