Oceanography in the Formal and Informal Classroom

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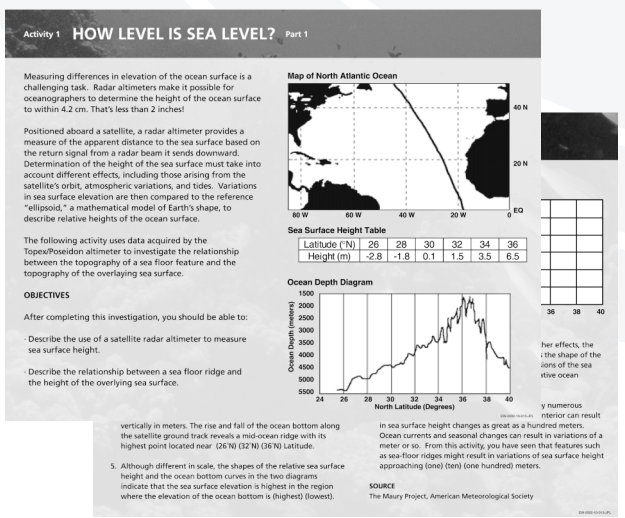
The TOPEX/Poseidon and Jason-1 ocean altimeter missions offer the educator in the middle school or informal education venue a unique opportunity for reinforcing ocean science studies. An educational poster from NASA's Jet Propulsion Laboratory and France's Centre National d'Études Spatiales provides teachers and students a tool to examine topics such as the dynamics of ocean circulation, ocean research, and the oceans' role in climate.

"Oceans' Music: Climate's Dance" is a joint JPL/CNES effort. It highlights the ocean–climate link and provides educational activities that can be used in the classroom. The eye-catching poster should stimulate conversation about the ocean and provide a point of entry into inquiry-based learning about the connections between ocean circulation and global climate.

Highlights

- Joint product published in French and English
- Ocean–climate–life connection
- Hands-on activities
- Electronic resources


Activity 1 HOW LEVEL IS SEA LEVEL? Part 1

Measuring differences in elevation of the ocean surface is a challenging task. Radar altimeters make it possible for oceanographers to determine the height of the ocean surface to within 4.2 cm. That's less than 2 inches!

Positioned aboard a satellite, a radar altimeter provides a measure of the apparent distance to the sea surface based on the return signal from a radar beam it sends downward. Determination of the height of the sea surface must take into account different effects, including those arising from the satellite's orbit, atmospheric variations, and tides. Variations in sea surface elevation are then compared to the reference "ellipsoid," a mathematical model of Earth's shape, to describe relative heights of the ocean surface.

The following activity uses data acquired by the Topex/Poseidon altimeter to investigate the relationship between the topography of a sea floor feature and the topography of the overlaying sea surface.

OBJECTIVES

After completing this investigation, you should be able to:

- Describe the use of a satellite radar altimeter to measure sea surface height.
- Describe the relationship between a sea floor ridge and the height of the overlying sea surface.

Map of North Atlantic Ocean

Sea Surface Height Table

Latitude (°N)	26	28	30	32	34	36
Height (m)	-2.8	-1.8	0.1	1.5	3.5	6.5

Ocean Depth Diagram

vertically in meters. The rise and fall of the ocean bottom along the satellite ground track reveals a mid-ocean ridge with its highest point located near (26°N) (32°N) (36°N) Latitude.

5. Although different in scale, the shapes of the relative sea surface height and the ocean bottom curves in the two diagrams indicate that the sea surface elevation is highest in the region where the elevation of the ocean bottom is (highest) (lowest).

in sea surface height changes as great as a hundred meters. Ocean currents and seasonal changes can result in variations of a meter or so. From this activity, you have seen that features such as sea-floor ridges might result in variations of sea surface height approaching (one) (ten) (one hundred) meters.

SOURCE
The Maury Project, American Meteorological Society

Electronic Resources

Visit the Ocean Altimetry Websites:

Topex/Poseidon and Jason-1 Website
http://sealevel.jpl.nasa.gov (NASA/PL)

AVISO Website
http://www.aviso.oceanobs.com (CNES/CLS)

Altimetry

University of Colorado, Colorado Center for Astrodynamics Research (CCAR) Altimeter Pages
http://www-ccar.colorado.edu/research/topex/html/topex.html
http://www-ccar.colorado.edu/~altimetry/applications/index.html

National Oceanic and Atmospheric Administration (NOAA) Topex/Poseidon page
http://ibis.grdl.noaa.gov/SAT/SAT.html

University of Texas, Center for Space Research (UTCSR) Topex/Poseidon page
http://www.tsgc.utexas.edu/topex/

Delft University of Technology (TUDelft) Altimetry Atlas
http://www.deos.tudelft.nl/

Ocean Altimeter PATHFINDER
http://iliad.gsfc.nasa.gov/ocean.html

GASBAG: Altimetry in Action
http://www.soc.soton.ac.uk/Gasbag/

General

NASA/JPL - Home Page - http://www.jpl.nasa.gov/
Thursday's Classroom - http://www.thursdaysclassroom.com/
Earth Observatory - http://earthobservatory.nasa.gov/
Space Place - http://spaceplace.nasa.gov

Oceanography and Climatology

Jet Propulsion Laboratory's Ocean Research Element
http://oceans-www.jpl.nasa.gov/

Physical Oceanography Distributed Active Archive Center
http://podaac.jpl.nasa.gov/

NASA Oceanography Homepage
http://oceans.nasa.gov/

Bigelow Laboratory for Ocean Sciences
http://www.bigelow.org/

Ocean Planet Exhibit at the Smithsonian
http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/ocean_planet_overview.html

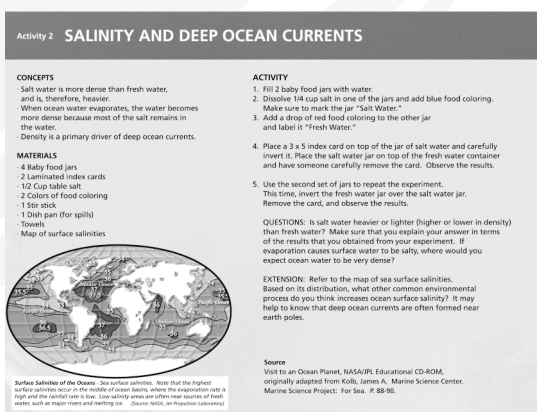
Oceanography Education

Texas A&M University "Ocean World"
http://oceanworld.tamu.edu

Climate

U.S. Global Change Research Information Office
http://www.gcrio.org/index.shtml

NOAA's Climate Research site
http://www.oar.noaa.gov/climate/


Activity 2 SALINITY AND DEEP OCEAN CURRENTS

CONCEPTS

Salt water is more dense than fresh water, and is, therefore, heavier.
- When ocean water evaporates, the water becomes more dense because most of the salt remains in the water.
- Density is a primary driver of deep ocean currents.

MATERIALS

- 4 Baby food jars
- 2 Laminated index cards
- 1/2 Cup table salt
- 2 Colors of food coloring
- 1 Stir stick
- 1 Dish pan (for spills)
- Towels
- Map of surface salinities

ACTIVITY

1. Fill 2 baby food jars with water.
2. Dissolve 1/4 cup salt in one of the jars and add blue food coloring. Make sure to mark the jar "Salt Water."
3. Add a drop of red food coloring to the other jar and label it "Fresh Water."
4. Place a 3 x 5 index card on top of the jar of salt water and carefully invert it. Place the salt water jar on top of the fresh water container and have someone carefully remove the card. Observe the results.
5. Use the second set of jars to repeat the experiment. This time, invert the fresh water jar over the salt water jar. Remove the card, and observe the results.

QUESTIONS: Is salt water heavier or lighter (higher or lower in density) than fresh water? Make sure that you explain your answer in terms of the results that you obtained from your experiment. If evaporation causes surface water to be salty, where would you expect ocean water to be very dense?

EXTENSION: Refer to the map of sea surface salinities. Based on its distribution, what other common environmental process do you think increases ocean surface salinity? It may help to know that deep ocean currents are often formed near earth poles.

Source
Visit to an Ocean Planet, NASA/JPL Educational CD-ROM, originally adapted from Kolb, James A. Marine Science Center. Marine Science Project: For Sea. P. 88-90.

Surface Salinities of the Oceans - Sea surface salinities. Note that the highest surface salinities occur in the middle of ocean basins, where the evaporation rate is high and the rainfall rate is low. Low salinity areas are often near sources of fresh water, such as major rivers and melting ice. (Source: NASA, Jet Propulsion Laboratory)

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