My NASA Data - Lesson Plans

How Level Is Sea Level?

Grade Band

- 3-5
- 6-8
- 9-12

Time

- 50 minutes

Overview

This learning activity uses data acquired by the TOPEX/Poseidon altimeter, a joint project of NASA and the French Space Agency, to investigate the relationship between the topography of a sea-floor feature and the topography of the overlying sea surface.

Materials Required

- Student Data Sheet

Procedure

1. Examine the accompanying map of the North Atlantic Ocean which shows part of the ground track of one orbit of the satellite carrying the TOPEX/Poseidon altimeter. The part of the ground track of interest for this activity is about 1,800 km in length between 26°N and 40°N Latitude. Mark with an (x) each end of this ground-track segment directly on the map.

2. Turn to the Sea Surface Height Table. The sea-surface heights appearing in the table are in meters above (positive numbers) or below (negative numbers) the reference ellipsoidal shape of Earth's sea surface. The heights are listed at regular intervals (and at the location of maximum elevation) measured along the ground track of the altimeter. In the table, the highest sea surface is located near (27°N) (32°N) (37°N) Latitude.

3. Plot the sea-surface heights as reported in the table on the Sea Surface Height Diagram. Connect adjacent plotted points with solid straight lines.

4. On the Ocean Depth Diagram, the depth of water to the ocean bottom measured by direct soundings from ships is plotted 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 (27°N) (32°N) (37°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).

6. Research indicates that, in the absence of all other effects, the topography of the sea surface generally mimics the shape of the underlying ocean bottom. Hence, over depressions of the sea bottom such as trenches, the height of the relative ocean surface is (lowered) (elevated).

7. Variations in sea surface height are governed by numerous factors. Density differences within Earth's interior can result 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. And, 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.

Credit: NASA Visit to an Ocean Planet

NGSS Three Dimensional Learning

NGSS Disciplinary Core Ideas

- ESS2A: Earth Materials and Systems
- ESS2B: Plate Tectonics and Large-Scale Systems
- ESS2C: The Role of Water in Earth's Surface Processes
- ESS3A: Natural Resources

NGSS Crosscutting Concepts

- Scale, Proportion, and Quantity
- Systems and System Models

NGSS Science and Engineering Practices

- Asking Questions and Defining Problems
- Developing and Using Models
- Planning and Carrying out Investigations
- Analyzing and Interpreting Data
- Engaging in Argument from Evidence

Learning Objectives

- Examine a map of the features of the North Atlantic Ocean
- Describe the use of a satellite radar altimeter to measure sea surface height.
- Graph sea surface height data.

- Describe the relationship between a sea-floor ridge and the height of the overlying sea surface.

Essential Questions

- What ocean measurements can be made?
- What are some of Earth's major ocean systems?
- What structures can be found in Earth's oceans?
- How do Earth's oceans change and cause change?

Why Does NASA Study This Phenomenon?

NASA keeps track of sea level change and its causes from space. Since 1992 NASA, NOAA and European partners have been tracking global ocean surface topography with joint ocean altimeter satellite missions from an orbit 1,336 km above the ocean surface. The spacecrafts' radar altimeters measure the precise distance between the satellite and sea surface. This record began with TOPEX/Poseidon, followed by Jason-1 and the Ocean Surface Topography Mission on Jason-2, and will be continued by Jason-3.

Radar altimetry from orbit revolutionized global sea-level observations, capturing variations across most of the planet’s oceans every 10 days, as well as at other time intervals. The first measurements precise enough to track changes in global mean sea level began with the launch of the NASA-CNES TOPEX/Poseidon satellite in 1992 (CNES is the French space agency). The spacecraft was equipped with two altimeters and a microwave radiometer, which corrected for the effects of water vapor on radar signal transmission; other instruments ensured precision tracking of the satellite’s orbital position.

Teacher Background Information

Why do we care about sea levels?

Video: NASA's Earth Minute: Sea Level Rise

NASA's Earth Minute: Sea Level Rise | https://www.youtube.com/watch?v=msnOHuPep9I | Source: NASA's Earth Minute

Measuring differences in elevation of the ocean surface is a challenging task. A radar altimeter now makes it possible for oceanographers to determine the height of the ocean surface to within 4.5 cm. Positioned aboard an orbiting satellite, the radar altimeter provides a measure of the apparent distance to the sea surface based on the returns of a radar beam it shoots downward. Determination of the height of the sea surface takes 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.

Video: ScienceCasts: Measuring the Rising Seas

ScienceCasts: Measuring the Rising Seas | https://www.youtube.com/watch?v=n2q6VYD8Pyg&t=1s | Source: Science at NASA

Teacher Resources

- How Level is Sea Level?