How Is Earth Heated?

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Summary

Students conduct an investigation of how the Sun heats Earth.

Grade level

Second Grade

Time required

Three 60-minute class periods

Materials

Plastic cups with a hole in bottom
Thermometers
Small bowls or trays
Sand and soil
Science journals
Okanogan Salish words for Earth
Satellite image of the Colville Reservation – see Resources

Goals

By completing this lesson, students will

1) learn that Earth and the air above it is heated by the Sun's energy in various ways,
2) discover that surfaces reflect and absorb light differently,
3) learn about the balance of Nature and
4) develop science inquiry skills.

Science standards addressed

National Science Standards

- Abilities necessary to do scientific inquiry
- Evolution and equilibrium
- Properties of Earth materials

American Indian Science Standards

- Observations and understandings of nature and ecological relationships traditionally formed an essential base of knowledge among American Indian cultures

Teacher tips

In this lesson children explore the effects of the Sun's energy on Earth through an investigation in which they compare the temperature of Sun-warmed sand and soil, and the temperature of the air that surrounds them. The experiment should be conducted on a sunny day in a location that will provide continuous sunlight. Differences in temperature in the soil and sand will be more obvious if there is a distinct color difference between the two. Since air temperatures within the cup can well exceed 100 degrees on warm sunny days, make sure the thermometers have an adequate upper range to measure the temperature.

To make the necessary equipment for the experiment, you will need a long glass rod thermometer and a 16 ounce clear plastic cup (A large clear plastic deli container also works.). Drill a hole in the bottom of the cup just large enough for the thermometer to fit through. Insert the thermometer into the hole from the bottom of the cup. If necessary to keep the thermometer from slipping, wrap a rubber band around the thermometer at the level you want it to be suspended. The tray or bowl should have about 1" of sand or soil in it. Invert the cup over the tray, burying its edges to seal it.

To measure the absorbed heat of the sand or soil in the first phase of the experiment, children should adjust the height of the thermometer so that the tip of the thermometer is completely submerged in the sand or soil. To measure the temperature of the air in the second phase of the experiment, they should move the thermometer up so that it suspends in the air in the inverted cup. To get accurate readings, students should make sure the tip of thermometer does not touch the cup or tray in either phase of the experiment. To allow the temperature to stabilize, have students wait ten to fifteen minutes before taking the measurements.

The experiment provides several easy opportunities for process skill development. For example, students can make predictions, measure the soil in the tray, take temperature readings, use a clock to time the experiment, record and graph their data, draw conclusions and from hypotheses.

Background information

Although there are fluctuations in the average temperature of a specific location on Earth over the years, Earth's overall yearly surface temperature remains relatively constant. This temperature stability occurs through a complex interaction of processes that balance the solar radiation received and given off by Earth's surface each year.

As solar energy moves through Earth's atmosphere toward Earth's surface, some of it is absorbed and some is reflected by clouds, air molecules and Earth's surfaces. The amount absorbed and reflected varies depending on the type of molecule the energy strikes. For example, light colored surfaces, like snow, reflect most of the Sun's energy. Darker surfaces, like asphalt, absorb much more of the energy. Water also absorbs most of the Sun's energy that strikes it, although much more slowly than most land surfaces do.

Most of the energy given off by the Sun is short wavelength, too small to be directly absorbed by the tiny air molecules in Earth's atmosphere. As Earth's surfaces are

warmed by the Sun's energy, however, it warms the air above it through two different means. Air that comes in direct contact with the surface is warmed by conduction of heat from Earth's surfaces to the air molecules. Earth also reradiates heat from its surface in a longer wavelength that is absorbed by the air molecules that it contacts. Many of these processes also work in reverse, creating a give and take system of several processes that generate a delicate balance of energy sometimes called Earth's *Radiative Budget*. Scientists are studying these complex interactions, in part to determine how human processes are affecting Earth's climate. For a more thorough explanation of the Radiative Budget, visit the NASA Goddard's *Institute on Climate and Planets* web page at icp.giss.nasa.gov/education/radforce/page2.html.

Similar to the ideas of the Radiative Budget, many Native American cultures, including the Colville bands, embrace a philosophy of the Circle of Life and the harmony and balance of Nature. Invite an elder to talk with students about these important ideas.

Procedure

Engagement

1) Ask students: "What are some surfaces you do not want to walk on in bare feet on a hot summer day?" Ask students why they think some surfaces are hotter than others. Use the words *absorb* and *reflect* in the discussion.
2) Take students outside on a sunny day. Have student pairs compare the warmth of surfaces by touching them with their hands: blacktop, cement, grass, dirt, etc.

Exploration

1) Show students the thermometer, tray set up, soil and sand. As a class, design an experiment for measuring the temperature of the sand and soil.
2) Allow student pairs to set up their experiments in a sunny location outside. While they are waiting for the temperature to stabilize, assist students in drawing the experiment in their journals, along with a data table. Ask them to write a prediction about which will absorb more energy, soil or sand. Have them record their temperatures after fifteen minutes.
3) Ask students to change their experiment to record the temperature of the air above the soil or sand. Have them draw and write up the changes and their predictions. Have them record the temperatures after fifteen minutes.

Explanation

1) Make a class chart and record as students share the results of their experiments. Discuss the results, including the patterns seen in

    - the color of the surface and its temperature
    - the soil or sand temperature and temperature of the air above it

    As a class, develop a hypothesis to explain the results. Use the words absorb and reflect in context.
2) Facilitate a class discussion about Earth's temperature balance. As a class, develop a simple diagram of the absorption and reflection of solar energy on Earth.

Elaboration

1) Show the satellite image of the Colville Reservation. Ask students to predict which areas would absorb the most solar energy, and which would reflect the most.
2) Ask students to predict how human impacts might affect the absorption and reflection, e.g., deforestation, covering forested areas with pavement, agricultural development, etc.
3) Invite an elder to talk with students about the Okanogan beliefs about balance and harmony in Nature and the Circle of Life.

Evaluation

1) Show a true color picture of Earth and ask student partners to predict the absorption and reflection for areas such as the polar caps, rain forests, deserts, etc.
2) Review student journals and observe students during the experiments to assess their proficiency with the process skills and understanding of content.

Vocabulary

reflection absorption

Resources

Web sites

NASA Goddard's Institute on Climate and Planets– Provides explanation and a diagram about Earth's Radiative Budget
http://icp.giss.nasa.gov/education/radforce/page2.html

Satellite image of the Colville Reservation
http://yoda.cec.umt.edu/sid/bin/show_newjava.plx?image=colville.sid&client=Native_Lands&section=Colville%20Reservation&title=Native%20Lands