ACTIVITY

EXPLORING REMOTE SENSING

This lesson simulates the process of remote sensing using surface materials of different colors to represent different ground coverings on Earth. Light meters are used as an analog for satellite instruments to record data from surfaces representing the different ground coverings. The lesson will help students understand the role of satellites in remote sensing. Instructors can introduce the concept of albedo, which is the percentage of the Sun's radiation that reflects from different surfaces on Earth. Albedo is an important component of Earth's radiation budget (see pp. 26–27).

LEVEL: Grades 5–9

CONNECTIONS TO THE NEXT GENERATION SCIENCE STANDARDS

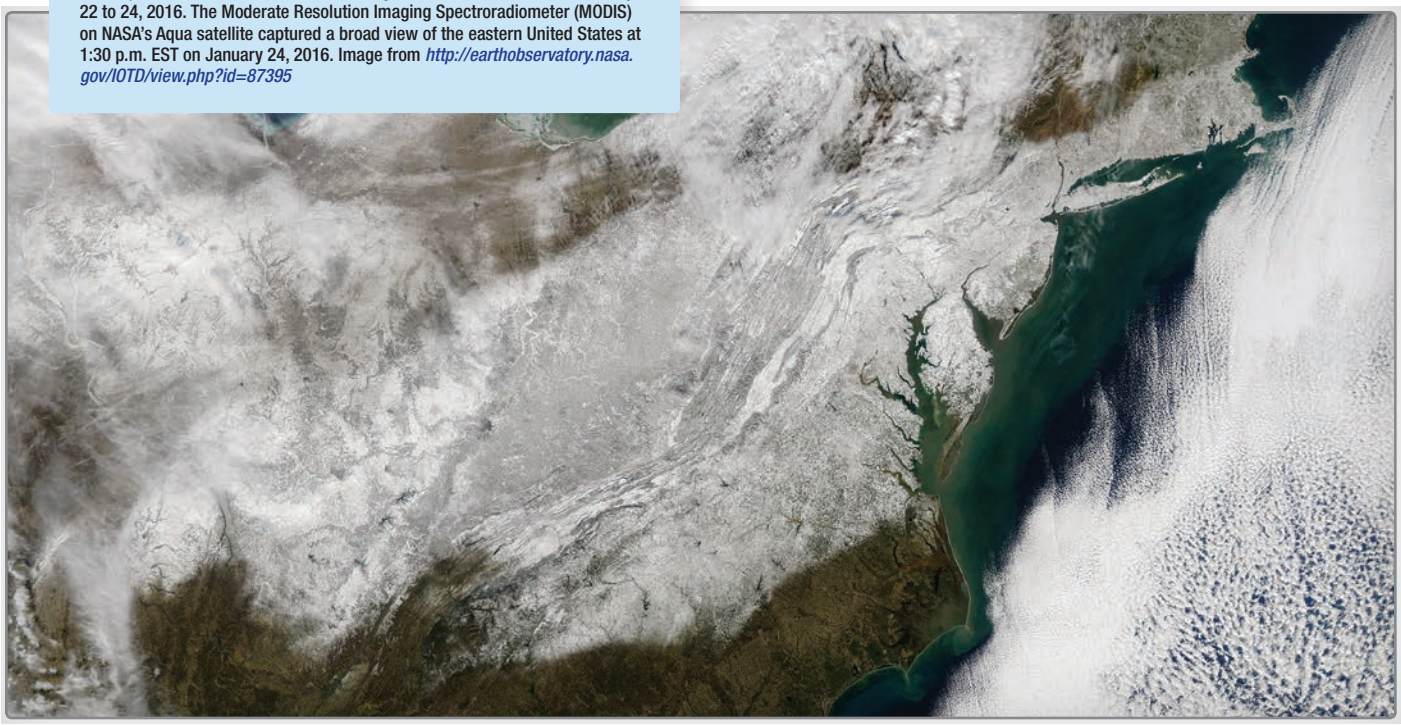
Disciplinary Core Idea PS4.B: Electromagnetic Radiation. When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.

MATERIALS

- **Paper or fabric** of different colors (about 6–10) to simulate ground coverings on Earth, including at least one each of a light-tone/white surface, a dark-tone/black surface, and a medium-tone/gray surface. Any patterns should be small and even across the surface, such as a calico print with small flowers.
- **Light meters** (or an iOS/Android device with a lux meter app).
- **Meter sticks**.
- **Copies of this booklet** printed for students, loaded onto a mobile device, or projected in the classroom. A PDF is available at *http://science.nasa.gov/ems*.
- **Access to an outdoor area** with several types of ground cover (e.g., asphalt, grass, bare dirt) (optional).

SET UP

- Place the surface materials in locations around the room. (If outdoors, identify a space that has several types of ground cover.)
- Divide the students into groups and provide each group with a light meter and a meter stick.



A MASSIVE WINTER STORM SYSTEM dropped 20 to 30 inches (50 to 70 centimeters) of snow from Tennessee and Georgia to Massachusetts from January 22 to 24, 2016. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite captured a broad view of the eastern United States at 1:30 p.m. EST on January 24, 2016. Image from *http://earthobservatory.nasa.gov/IOTD/view.php?id=87395*

This is a Landsat 8 image of a portion of the Southern Ocean and the northern Antarctic Peninsula. The dark open ocean (left) and exposed rock absorb a high percentage of the Sun's energy and have a low albedo. The flowing glaciers and other ice cover (bright and smooth areas) have high albedos, and the Larson B embayment (right) is covered with sea ice (mottled dull gray tone/texture), which has a slightly lower albedo than the adjacent ice shelf.

ENGAGE

Show students the satellite image of the eastern United States after a snowstorm. Ask them what they observe on the image (e.g., cloud cover, coastlines) and record their answers. Ask what can be inferred (e.g., lack of clouds over an area suggests a sunny sky there) or what they aren't sure of regarding what the image shows (e.g., whether white-colored areas are clouds or snow). Have students record their answers. Invite students to select one or two satellite images from this booklet and ask the same questions. Ask students to share their answers and discuss what kinds of information we get from these remotely sensed images.

EXPLORE

Demonstrate to students how to use the light meter with the meter stick as a guide for height. Have students design a method for collecting, analyzing, and communicating their data. Have them determine the parameters to include in their science journal entries (e.g., headings, data, methods, predictions, conclusions). They can include predictions on the reflectance of various materials and compare those to measurements.

EXPLAIN

Ask students to communicate group results. Did they notice any patterns? How did the values differ between surfaces? What happened to the light as it interacted with different surfaces? Can they explain any differences in the light measurements? How did they decide on the height at which they held the light meter to make measurements? This process will help make student thinking discernible so both they and the teacher can assess understanding.

Discuss how these measurements are like those of passive remote sensing instruments on satellites (e.g., the light meter collects light that reflects off the surface while some light is absorbed—see pp. 12–13). Discuss how light meters are unlike satellite instruments. For example, light meters used in this activity measure light in the entire visible range of the electromagnetic spectrum (see pp. 2–3), while most satellites collect data at specific regions—sometimes called bands—of the visible spectrum as well as parts of the spectrum beyond visible light (see the back cover).

EVALUATE

A simple rubric could be created from the steps above. Did students collect and record all the parameters that would influence their data (e.g., light source, height of measurement)? Did they recognize patterns? Did they collect enough data?

Gaining insight into students' thinking is a good way to scaffold student learning and monitor their progress. Have each student draw and label a diagram (visual model) of how satellites and/or the light meters detect electromagnetic energy. Encourage students to include on their diagrams features such as the radiation source, the interaction between the radiation and the surface (i.e., whether the radiation is reflected, absorbed, or scattered), and the detector (e.g., the light meter or a satellite instrument). Have students share their diagrams with others in order to refine their thinking.

EXTEND

The measurements in this activity correspond to the amount of visible light being reflected from the surface and detected by the meter. The percentage of how much of the Sun's radiation (light) that hits a surface is reflected without being absorbed is called albedo. Albedo is an important component of Earth's radiation budget (see pp. 26–27). Snow, for example, has a high albedo, meaning that it reflects a lot of the radiation that strikes it.

Observe the sea ice image on the top of page 13. In their science journals, ask students which has a higher albedo: ice or open ocean? (Ice.) As sea ice melts, what happens to the albedo of the Arctic? Will it increase or decrease? (Decrease.) What happens when the Sun's energy is absorbed by a surface? (It heats up.) What happens as sea ice melts? (The newly exposed water reflects less and absorbs more of the Sun's energy. This causes the water to warm and melt more ice.) This phenomenon is called the ice-albedo feedback effect. As the surface ice and the sea ice melt, the overall surface albedo lowers, causing more energy to be absorbed and continuing in a cycle, thus creating a positive feedback loop.

ADDITIONAL RESOURCES

"Ice Albedo: Bright White Reflects Light" is a short animation (~30 seconds) that illustrates the albedo concept: *http://go.usa.gov/cShKA*

"Daisy World" is a short video (~4 minutes) that demonstrates the albedo feedback loop using black and white daisies: *http://go.usa.gov/cShKm*