Heat Retention vs. Reflection

Driving Question: How does our landscape influence climate?
Synopsis: In this activity, students will collect data to determine how the amount of heat at a location changes, utilize mapping skills, and explore how the type of surface can impact heat retention (i.e. heat islands) and reflection (i.e. the albedo effect).
Rationale: This activity seeks to teach students how solar radiation impacts individual regions, including their local area. Using this knowledge, they will have a greater understanding of how to determine the amount of heat or warming that occurs in an area.
Materials: IR sensor
Clipboard with paper and pencil
Blackboard, whiteboard, or large easel paper
Source: Quoted and adapted from Feeling the Heat: A Windows to the Universe activity by Lisa Gardiner (Map the Radiation in your Neighborhood)
Transition Questions: Are there other local factors other that seasons that you think might influence the amount of heat there is in an area?

Procedure

EXPLORE

Task – Map the Radiation in your Neighborhood (quoted and adapted from Feeling the Heat: A Windows to the Universe activity by Lisa Gardiner)

1. Ask students: " Do you think that the temperature at all areas around the school are the same? If so, why? If not, which areas of the schoolyard are the warmest and which are the coolest?
2. Head outside into your schoolyard on a sunny, warm day. If you are in an area with deciduous trees, you may wish to do this activity at a time when the trees have leaves because of the shade they provide.
3. Provide each student group with data collection pages, clipboards, and an IR thermometer. Instruct students on how to use the thermometers.
    a. If using IR thermometers, remind students to point the thermometer directly at the ground surface they wish to measure (i.e., concrete, asphalt, grass, dirt, etc.)
4. Choose 6-8 areas of the schoolyard that students have identified. Students will collect temperature data in these areas. Make sure that there is a mix of sunny and shaded areas as well as a mix of paved and grass/natural areas.
5. Have student groups head to their locations, take 5 temperature measurements, and record descriptive information about their location on a data sheet.
6. In the classroom, create a chart or map of the locations. Have student groups fill in the data about their location including average temperature, sun/shade, and ground cover.
7. Discuss the results. Are the results what students predicted? Introduce the concept of microclimates (see Background Section below). Microclimates allow different locations to have different temperatures. Ask students what aspects of the environment affect temperature in these areas. (The most likely result is that areas in the sunshine were warmer than those in the shade, and areas that had a paved surface were warmer than grass or natural areas.)
8. Ask students, based on these results, which they think would be warmer: urban areas or rural areas. (In urban areas where surfaces like asphalt and concrete are

abundant, temperature will be higher.) Introduce the concept of urban heat islands (see Background Section below).

Background information for instructors

Copied from Feeling the Heat: A Windows to the Universe activity by Lisa Gardiner http://www.windows.ucar.edu/tour/link=/teacher_resources/teach_heat.html

The Urban Heat Island Effect
The air in urban areas can be 2 - 5°C (3.6 - 9°F) warmer than nearby rural areas. This is known as the heat island effect. It's most noticeable when there is little wind. An urban heat island can increase the magnitude and duration of a heat wave. It can also influence the weather, changing wind patterns, clouds, and precipitation.

What makes cities warmer? There are many factors that can influence the urban heat island effect. The modifications to the land surface that are made in urban areas have a large impact on whether a heat island forms. For example, many cities have fewer trees than surrounding rural areas. Trees shade the ground, preventing radiation from the Sun from being absorbed. Without them, the ground surface heats up. Dark rooftops and dark pavement absorb more radiation too. Tall buildings reflect and absorb sunlight. Automobiles, which make heat from their engines and exhaust, also contribute to the heat island effect. Fewer plants in urban settings mean that less evapotranspiration occurs, a process that cools the air.

Today, many cities are making an effort to combat the heat island effect. White or reflective materials are being used for roofing and roads. Trees are being planted along city streets. And, in many areas, green roofs - living plants on rooftops – are being installed.

Microclimates
In Part 1 of this activity, students investigate relatively small differences in temperature in their schoolyard. These differences reflect different microclimates. The term microclimate can be used to describe differences in small areas of just a few square meters or much larger areas a few kilometers apart.

Factors that contribute to microclimates in a small area like a school yard include the presence or absence of shade (from trees, buildings) and the type of material at the ground surface (dirt, grass, asphalt, concrete). Shaded areas are generally cooler since much solar radiation is unable to be absorbed by the Earth surface. Ground materials like asphalt and concrete absorb solar energy readily and dark paving will typically be warmer than light color paving because dark colors absorb more heat.

IR Thermometers
Infrared thermometers (IR thermometers) are recommended for Part 1 of this activity. IR thermometers measure temperature by assessing the amount of energy emitted from an object. When sunlight hits the Earth surface, some of that energy is absorbed and some is reflected. The energy that is absorbed heats and is radiated from the surface.