Exploring Weather Conditions

NS 696 V: Weather and Climate for Educators

Lesson was adapted using the following resources:
Weather and Climate Workshop for Teachers 2009
Textbook: Project-based Inquiry Science: Planetary Forecaster
Online resource: The Atmospheric Radiation Measurement (ARM) Program

Intended grade level: 7^{th}

Science Standards:
4.9 There are quantitative changes in weather conditions over time and space (humidity, temperature, air pressure, cloud cover, wind, precipitation)

Materials required:
Infrared (IR) thermometer (1 per group of three students)
World map that shows continents, equator, poles, lines of latitude (1 per student)
Colored pencils
Visual: World Map of surface temperatures for the month of July for any year (1 for the class)
http://www.mapsofworld.com/world-maps/averages-temperature-july-enlaged-map.html
World Map with eight different locations marked (1 per student)

Background information:
How did you choose what to wear to school today? I bet it had something to do with the **temperature** outside. Often we choose what to wear based on what we assume the weather will be like on a particular day. Weather describes what the atmosphere is like at a given time and place. It includes things like **temperature**, precipitation, wind, air pressure, and humidity. Over a long period of time, these factors determine the climate of an area. Though humans have figured how to survive in a variety of climates, some climates require more energy to survive than others. Today we will begin investigating how **temperature** differs across the Earth's surface. We will consider how **temperature** is affected by latitude and different surfaces of the Earth (land or water). Let's get started!

Objective: How does temperature differ across the Earth's surface?

Engage:
Brainstorm as a class, write ideas on the board:
1. What do we think we know about temperature?
2. How does temperature differ across the Earth's surface?

Divide students into groups of three and have them gather IR readings for different locations. Students will obtain an Infrared thermometer (one per group) and they will choose at least five different places to measure temperature. They will record the temperature readings and the following information:

1. The location the temperature was measured
2. The height (cm) in which you held your infrared thermometer while measuring the temperature.
3. The temperature (C)

When students return to the classroom have a class discussion about the results.

1. Were everyone's temperature readings the same? If not, how different were they?
2. What factors could have affected the temperature readings?
3. Does the temperature increase or decrease as we move further above the ground?
4. Compare and Contrast the temperatures of different materials that were measured

<u>Explore</u>:

Provide students with a blank world map. Ask students to make predictions of what surface temperatures are around the world. Have students color the map based on what they think the Earth's surface temperatures are in July. In some cases, they may know nothing about an area. Encourage them to make educated guesses. Students will need to make a color coded key for the temperature ranges they have chosen.

It would be a good idea to create temperature ranges on the board both F and C for the students to be able to make comparisons. Students could then choose which colors to correspond with the various temperature ranges. Once students have made predictions on their map, you can put up a visual of the same world map with the data for July of any given year. Lastly, have students make adjustments on their maps with the new data.

Brainstorm as a class:

1. Patterns between areas of similar latitude
2. Temperature changes over land and water

<u>Explain</u>:

There is a difference in the rate of heating of land and sea surfaces when exposed to solar radiation. As we know that land and water do not absorb energy in the same way, they heat and cool at different rates. Water takes longer to heat up than the land. Even though the same amount of sunlight hits both the land and water, the land becomes hot much faster than the water. However, the water does not cool as fast as the land areas.

During the day, the land becomes warmer than the sea. The warm air rises and air pressure becomes lower over the land than over the sea. Air then blows from sea to land as a Sea Breeze. Meanwhile warm air tends to descend on cooling over the sea.

The reverse system operates at night. In coastal regions at night, Land Breezes may develop. In general land breezes are not as strong as Sea Breezes. They are developed more markedly in tropical regions, where they may sometimes force moist unstable air to rise over the sea, leading to thunderstorms off the coast towards dawn.

During the night, the land cools more quickly than the sea. Higher pressure, therefore, develops over the land. Air blows from land to sea as a Land Breeze, and rises over the sea on warming.

On a global scale, this is what causes winds and atmospheric circulation in the lower troposphere. Let us first look at an idealized Earth that isn't spinning or tilted over on its axis, and try to understand what form the general circulation of the atmosphere would take. We have already noted that the equatorial regions of the world receive more solar energy than the polar regions. The warm air from the equatorial region will rise and spread out towards higher latitudes. As the air rises and spreads, it cools. When the air reaches the polar regions, it has cooled enough so that it sinks. The region where air is rising tends to result in a low pressure area, and the region where air is sinking is generally a relatively higher pressure. At the surface, air will move from an area of higher pressure to an area of lower pressure. That is, at the surface air will move from the poles towards the equator, but in the upper part of the atmosphere the movement is from equator towards the poles. This type of circulation has the name Hadley Cell circulation.

However, when we look at the winds of the world, we also have to remember that the Earth is a spinning planet. This spin results in an apparent deflection of the winds. This is known as the Coriolis Effect. Because of the Coriolis Effect, winds in the Southern hemisphere curve to the left and winds in the Northern hemisphere curve to the right. Although the wind system is very complex, one can briefly say that the spin also breaks the wind system down into a series of bands, so that instead of a large Hadley Cell in each hemisphere, there are now several cells in each hemisphere.

In short, air rises at the Equator because it is hot and less dense. This air moves outwards and sinks down at approximately 30? north and south of the Equator. Some of this air moves back to the surface as the Trade Winds, while the rest moves towards the poles as the Westerlies. Meanwhile, the cold air at the poles sinks downwards and moves outwards as the Polar winds, which meet the Westerlies along the Polar Front (approximately 60 degrees north and south of the Equator).

http://education.arm.gov/teacherslounge/background/cloudrain.stm

Evaluate/Extend:

Give students a world map with eight locations marked, vary the locations based on latitude and make sure to have some over water.

1. Ask students to arrange the numbers in order of temperature from warmest to coldest.

2. Students will need to provide the reasons they made the temperature predictions for the eight locations. In their explanation they should include the following: an explanation about how latitude affects temperature and how the rates at which land and water heat up affect temperature.
3. In what areas where you less confident about your temperature predictions? What information did you use to make your predictions in these areas?