CLIMATE CYCLES ACTIVITY

Title: Climate Cycles

Grade Range: Middle School

Time Required: About 1.5 hours of classroom time, no out-of-class time

Objective: The students will understand what climate is, and how climatologists use data to understand past climates and infer future climates.

Materials/supplies required

- Tall glass jar (a spaghetti jar will work very well)
- A multicolored, crushable material (small marshmallows or packing peanuts) sorted into cups of four different colors
- A dark-colored granular material (for example, peppercorns)
- Plots of the Vostok ice core temperature record with and without the Holocene portion
- Pictures of ice core drilling operations, ice cores, and core storage facilities

Vocabulary:

- Climate
- Climatologists
- Dendrochronology
- Ice age
- Ice core
- Layer
- Milankovich variations
- Paleoclimatology
- Time scale

Prerequisites: None

Procedure

a. Introduction

Write the word *climate* on the board and ask the students to describe what the word means to them. Write down the definitions provided by the students. Some of the definitions might be synonymous with weather. Explain that weather and climate both refer to processes in the atmosphere, but that weather is what happens on short *time scales* (seconds to years) and climate is what happens over scales from years to billions of years. Some student definitions might refer to the particular characteristics of a place (how hot it is or how much rain the place gets). Help refine this definition to "the average, range, and extreme states of the

earth-atmosphere-ocean system". Describe how temperature and precipitation are the most obvious climate elements, but that climate may also include cloudiness, wind, sunshine, and many other characteristics. Build a concept diagram on the board as you go along.

Now ask if climate changes, in other words if a particular place always has the same climate. Ask if the amount of rain received this year is different from last year (be prepared with the numbers in case the students don't know). Ask how someone can find out if this year and last year's rainfall are different. A student will likely suggest that records of rainfall are kept and can be looked up. Then ask how someone could find out if the rainfall 100 years ago was different. The students might not have any idea how to do this. Point out that records were kept then as well. Extend the question to 1,000, 10,000, or 100,000 years ago. The students might mention tree rings (*Dendrochronology*) or ice cores. Explain that in today's lesson you'll be looking at ice cores, what they tell us about past climates, and how *climatologists* (climate scientists) use them.

Carry out Activity 1 at this point.

Now show and describe the pictures of ice core operations. Mention that the ice in Antarctica is so deep (4 kilometers) that it contains hundreds of thousands of years of climate information. One of the best-known ice cores from Antarctica came from a Russian station at Vostok (which means "East" in Russian).

Carry out Activity 2 at this point.

b. Activities

1) Simulating an ice core

Seat the students around a table and give each student but one a cup of marshmallows, making sure that the marshmallow colors repeat in sequence around the table. . Explain that each of the colors represents the amount of snow that falls in a season. Give the remaining student a cup with the peppercorns and explain that that student will represent a volcano. Put the empty jar in the center of the table. Now, go around the table and have each student put in a handful or two of marshmallows in sequence. Tell the students to change the amount of marshmallows they put in, and sometimes to put in 3 or 4 handfuls. The students representing summer should put in the smallest amount of marshmallows. Every so often, tell the student with the peppercorns to dump some in the jar. When the jar fills up, squeeze the contents downward and continue putting marshmallows in. Repeat until the jar is extremely full and most of the air has been squeezed out of the spaces between the marshmallows. Now have the students pretend that they are climatologists and have just taken the core out of the ice. The top layer represents the current year and season. Have each student create a timeline describing how much precipitation fell in each season of each year (giving the years numerically). The students should also indicate on their timeline when volcanic eruptions occur. The students should then compare their timelines and see how different they are.

2) Using ice core data to understand climate cycles and predict future climate.

The students should sit at their desks for this portion. Pass out the copy of the Vostok temperature record without the latest portion. Have the students draw on the graph what they think the temperature record would look like up to the present. When all students are finished, post all of the graphs and ask each student to explain why they extended the curve the way they did. Most or all will note the clear 100,000 year cycles and describe that they continued the cycle up to the present. Now show the full graph, and praise the students for seeing the cycles. Mention that the Earth's climate shows three variations at time scales of tens of thousands of years, at 19,000, 26000, and 100,000 years, and that these cycles are caused by wobbles in the Earth's orbit (called *Milankovich variations*). Mention that it was ice core data just like the students used that enabled climatologists to discover how climate cycles repeat. This science is called *Paleoclimatology*.

c. Closure

Ask the students to discuss what kinds of things could make an ice core difficult to interpret and why. Answers could include poor handling of the ice core (melting or contamination), movement of the ice, and local variations in snowfall. Have the students retrieve their Vostok graphs and use them to predict the climate of the Earth for the next 10,000 years. Then ask the students to discuss their predictions and why they made them.

Assessment

Have each student write an essay describing:

- How climate is different from weather
- How ice cores are used to estimate past climates
- How past climate cycles can be used to predict future climates

Additional resources

a. Web sites on Paleoclimatology
   http://deschutes.gso.uri.edu/~rutherfo/milankovitch.html
   http://www.ngdc.noaa.gov/paleo/milankovitch.html
   http://www.museum.state.il.us/exhibits/ice_ages/
   http://www.secretsoftheice.org/icecore/cores.html
   http://nicl.usgs.gov/
   http://www.arm.gov/docs/education/globwarm/icexpert.html
   http://www.ngdc.noaa.gov/paleo/paleo.html