Phenomena to Help Middle School Students Understand Seasonal Changes in Temperature Patterns on the Earth

Ted Willard and Jo Ellen Roseman, AAAS Project 2061 ♦ Tim Eichler, NOAA

Abstract

Much of science involves finding patterns in observations and explaining them in terms of a small number of principles or ideas. In order to do this, students need to have a sense of the range of observations (phenomena) that are used to form the patterns. They also need to see how the principles can help summarize or explain the patterns.

Project 2061's evaluations of science textbooks revealed that textbooks rarely engaged students with phenomena relevant to important science ideas, rarely included phenomena that directly address the often incorrect ideas that students may already have, and rarely guided students in reconciling phenomena with scientifically accepted ideas (Kesidou & Roseman, 2002; Stern & Roseman, 2004; American Association for the Advancement of Science [AAAS], 2002, 2005).

In response to these deficiencies, Project 2061 and other CCMS researchers are identifying phenomena that could be used to support the teaching and learning of ideas recommended in *Benchmarks for Science Literacy* (AAAS, 1993) and in *National Science Education Standards* (National Research Council, 1996). This poster describes how to present students with data that show how the temperatures in one place vary over the course of the year and with patterns that show how temperatures vary across the surface of the Earth.

Key Idea #1 (Yearly Temperature Cycles)

The temperature in any location on the Earth's surface tends to rise and fall in a somewhat predictable cycle over the course of a year.

What Students are Expected to Know

- Students should know that the temperature in any one place tends to be higher during some parts of the year and lower during other parts of the year. They should know that the daily high and low temperatures in any one place tend to rise and fall in a fairly predictable yearly cycle.
- Students should also know that while no two years follow the exact same cycle of rising and falling, most years follow a similar pattern of having the lowest daily temperature in the winter and the highest daily temperature in the summer.
- Students are not expected to know why this pattern takes place. They are only expected to know what the pattern is.

Key Idea #2 (Geographic Factors Influence Temperature Cycles)

The yearly temperature cycle of a location depends on how far north or south of the equator it is, how high it is, and how near to oceans it is.

What Students are Expected to Know

- Students should know that there are several factors that contribute to differences in yearly temperature patterns from one location to another. They should know that at a certain time of year one place may be experiencing higher temperatures while another place is experiencing lower temperatures. They should know that places in the northern hemisphere tend to experience higher temperatures in June, July, and August and lower temperatures in December, January, and February. They should know that the pattern is reversed in places in the southern hemisphere. These places experience lower temperatures in June, July, and August and higher temperatures in December, January, and February.
- Students should know that places nearer to the equator are in general warmer than places farther from the equator. They should also know that the range of higher and lower temperatures is in general less extreme near the equator and more extreme farther from the equator.
- Students should know that place near large bodies of water, in particular the oceans, also tend to have a smaller range of high and low temperatures. They should also know that places at higher elevations, such as high in the mountains, have temperatures that are cooler than places at lower elevations.
- Students do not need to know the mechanism that explains why these various factors influence the temperature, or even that there is a causal relationship. At this stage, they are only expected to know that these factors can be used to make predictions of the variations in temperatures in a certain place, or to make predictions about the relative variations in temperature in two different places.

This work is funded by the National Science Foundation grant "Supporting the Next Generation of Curriculum Materials" (NSF ESI-0103678).

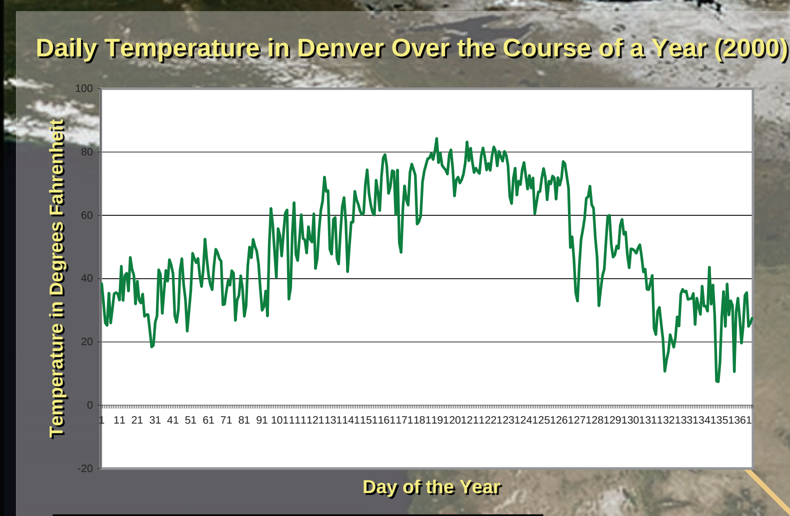
This poster shows a sequence of phenomena that could help students understand seasonal changes in temperature patterns on the Earth. For each phenomenon, students may need considerable help in

a) understanding what was measured,

b) describing the temperature patterns, and

c) relating the temperature patterns to information about the different locations (in this case, their distances from the equator).

Similar instructional sequences would be needed to develop students' understanding of the relationship between mean monthly temperature patterns and altitude and between mean monthly temperature patterns and proximity to an ocean.



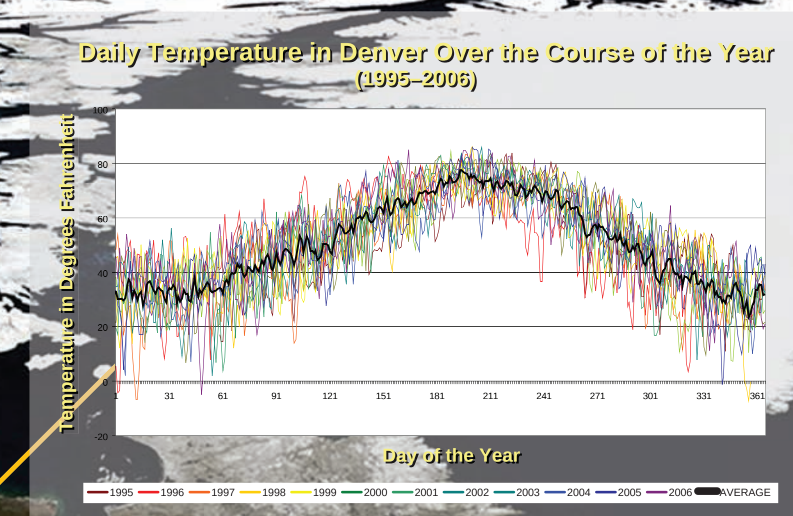
Students should observe from the graph that the daily temperature in Denver, Colorado, was higher during the middle of the year 2000 than it was during the beginning or the end of that year.

Students should also observe that the daily temperature in Denver increased during the first 200 or so days of the year 2000 and then declined during the rest of that year.

To help students form the generalization that there is a temperature pattern for any given location (Key Idea #1), students should examine corresponding graphs for several different places.

If students have difficulty seeing a pattern amidst the fluctuations from day to day, it may be helpful to start with a simpler graph, such as one that shows mean monthly temperature for each of the twelve months. However, this would require that students understand what a mean tells you about a set of data (based on benchmark 9D/M3).

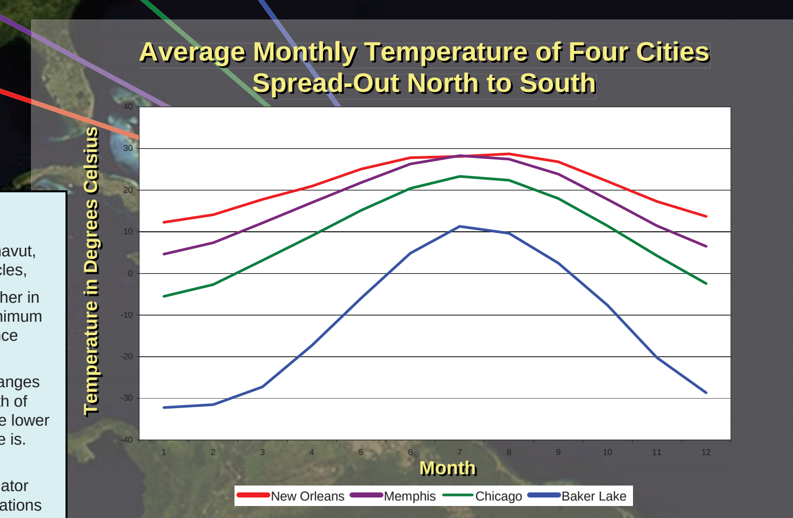
If students have difficulty reading and interpreting the graph (benchmark 12D/E4**), it may be helpful to start by having them first construct a graph from a table of mean monthly temperatures over a 12-month period.



Students should observe from the set of superimposed graphs of daily temperature over twelve consecutive years that the temperature of Denver, Colorado, rises and falls in a fairly consistent pattern over all twelve years.

To help students form the generalization that the temperature pattern of any given location is somewhat predictable (Key Idea #1), students should examine corresponding sets of graphs for several different places.

If students have difficulty seeing a pattern amidst the fluctuations from day to day, it may be helpful to start with a set of simpler graphs, such as a set showing mean monthly temperature for each of the twelve months over several consecutive years. However, this would require that students understand what a mean tells you about a set of data (based on benchmark 9D/M3).



Students should observe that

- the yearly temperature cycles of four locations (Baker Lake in Nunavut, Canada, Chicago, Memphis, and New Orleans) rise and fall in cycles,
- the temperature cycles of these four locations differ from one another in terms of their temperature maximum temperature for the year, minimum temperature for the year, and in their temperature ranges (difference between maximum temperature and minimum temperature), and
- the maximum and minimum temperatures and their temperature ranges correlate with their distances from the equator-i.e., the farther north of the equator a location is, the lower its minimum temperature is, the lower its maximum temperature is, and the greater its temperature range is.

To help students form the generalization that the yearly temperature pattern of any location depends on how far north or south of the equator the location, students will need to examine graphs of a variety of locations that differ only in their distances from the equator (not their altitude or proximity to an ocean).

A table might be useful for presenting a wider range of locations, as long as students understand what quantity each number in the table is representing.

References:

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy*. New York: Oxford University Press.

American Association for the Advancement of Science. (2002). *Middle grades science textbooks: A benchmarks-based evaluation*. Retrieved June 19, 2007 from http://www.project2061.org/publications/textbook/mgsci/report/index.htm.

American Association for the Advancement of Science. (2005). *High school biology textbooks:A benchmarks-based evaluation*. Retrieved June 19, 2007 from http://www.project2061.org/publications/textbook/mgsci/report/index.htm.

Kesidou, S. & Roseman, J. E. (2002). How well do middle school science programs measure Up? Findings from Project 2061's curriculum review. *Journal of Research in Science Teaching*, *39* (6). 522-549.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

Stern, L., & Roseman, J. E. (2004). Can middle-school science textbooks help students learn important ideas? Findings from Project 2061's curriculum evaluation study: Life science. *Journal of Research in Science Teaching*, *41*(6), 538-568.