



Historical Climate Statistics

Grades 3-5

Lesson Summary

Students will be introduced to the concept of climate change at a sample locality where the historical temperature records are available. They will then graph the temperature records and interpret what their plots mean.

Prior Knowledge & Skills

- Knowledge of the difference between weather and climate

AAAS Science Benchmarks

The Nature of Mathematics

Patterns and Relationships

The Mathematical World

Symbolic Relationships

Shapes

NSES Science Standards

Life Science

Regulation and Behavior

Teaching Time: 45 – 60 minutes

Materials

- Graph paper
- Ruler
- Pen and pencil

Advanced Planning

Preparation Time: ~10 minutes

1. Review the instructions
2. Gather the necessary supplies.

Recommended Reading: (attached)

- Background Information on Climate Change

The Atmospheric Radiation Measurement Program – North Slope, Alaska
Bringing Climate Change Into The Classroom

<http://www.arm.gov/>

Bringing Climate Into The Classroom

Key Ideas

Students will:

- Understand the greenhouse effect and how it works.
- Understand the concept of “climate change”.



Background Information on Climate Change

What is Climate Change?

The surface temperature of our earth depends on a process called the heat budget. This budget, like any other type of budget, remains balanced if the amount of energy coming in equals the amount going out. If the energy balance is disrupted, then the result would be a change in temperature. Ice ages occur when the energy going out exceeds incoming solar energy; global warming occurs when the incoming solar energy is greater than the energy going out. Clouds play a major role in the heat budget. Clouds act as both a block to solar energy coming in as well as an insulator trapping heat below.

An indication of climate change would be a gradual shift in the earth's average surface temperature. Locally, annual temperatures might fluctuate due to differences in weather systems from one year to the next. On a global scale, however, those local fluctuations are canceled out and the earth's average temperature should remain the same. But global average temperature, currently 57° F (14° C), has risen almost 1 degree over the last century. Some scientists predict that temperatures will rise another 2 to 6 degrees over the next century!

The Greenhouse Effect

Greenhouse gases are atmospheric gases (including CO₂, water vapor and aerosols) that trap heat given off by the Earth. As a result they enhance global warming much like a greenhouse gardeners use to shield their plants from the outside weather. Greenhouses trap solar energy and keep the inside warm. Many of these gases occur naturally on our earth and are essential to life on earth by providing a blanket of warmth for marine and terrestrial organisms.

Without them, temperatures on earth would be too cold. However, when the concentrations of these gases become too high, they may make the earth much too hot and contribute to global warming. Many scientists believe that human activities have been changing the concentrations of these gases since the start of the industrial revolution, around 1850.



Causes of Climate Change

Since the start of the industrial revolution, human activities have caused a steady increase in the concentration of some greenhouse gases to unprecedented levels in our Earth's recent history. Human activities release large amounts of carbon dioxide, methane, and nitrous oxide from the burning of fossil fuels (e.g., oil, gas and coal) from industrial activities, landfills, agricultural practices, and many other processes. By adding more greenhouse gases to the atmosphere, we increase the atmosphere's capacity to trap heat, therefore making the whole planet warmer. Human activities that contribute to climate change include disruptions to natural ecosystems, such as deforestation, overuse of water, burning of fossil fuels, and increased pollution.

Greenhouse Gases

Greenhouse gases may be described as

Long-lived which means they are stable, and last many years in the atmosphere.

Well-mixed which means they are evenly distributed in the atmosphere.

Most greenhouse gases are both long-lived and well-mixed. They include carbon dioxide, methane gas, oxides of nitrogen, and halocarbons. Ozone is long-lived but is found in higher concentrations in cities, especially in the northern hemisphere. Therefore, it is not well-mixed. Water vapor is actually the most dominant greenhouse gas, but it is neither well-mixed nor long-lived. Because of this, its overall effect on global warming is the least understood. Water vapor is important because it is necessary for the formation of clouds. Water vapor is one of the greenhouse gases we need to learn more about to study its impact on global warming. The ARM Program is designed to gather data from our three field research sites is providing us with some important information about how water vapor affects climate change.

Activity 2: Historical Climate Statistics

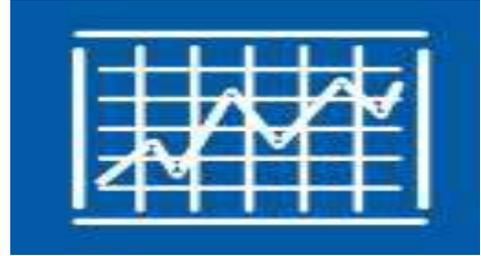
Objective: The object of this activity is to demonstrate the concept of climate change at a sample locality where the historical temperature records are available.

Materials:

Graph paper

Ruler

Pen and pencil



Important Points to Understand:

- Scientists have evidence that the global climate has changed in the past and is subject to natural changes even before the idea of enhanced greenhouse gases.
- Global temperature is gradually changing according to the long-term temperature records.
- There are no accurate predictions of what will happen to the Earth's climate with an increase in greenhouse gases.

Preparation:

Before the activity, try to explain that the climate system is very complex. Scientists have been using a combination of mathematical models, the geological record of past climates, meteorological records and theories on the global atmospheric and oceanic circulation to provide an estimate for past, current, and future values.

The information in the following table shows the average winter temperature in central England from 900-1900 AD.

Year	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1400
Temp (° C)	3.45	3.55	3.62	3.69	3.58	3.69	4.12	4.09	4.05	3.81	3.63
Year	1450	1500	1550	1600	1630	1700	1750	1800	1850	1900	
Temp (° C)	3.46	3.65	3.5	3.21	3.18	3.38	3.55	3.47	3.66	3.97	

Procedure:

1. Plot on graph paper, time on the x axis and temperature on the y axis.
2. The period 1550-1700 in Europe is known as the Little Ice Age. Can you see evidence for this?
3. What can you say in general from the whole plot?
4. Can you explain why the temperatures in the plot are much warmer than the temperatures on the North Slope?

Extension for older students:

How far back is there recorded average temperature data for the North Slope of Alaska? A good student research project would be to try to find this out. Have students talk to their community members, the National Weather Service, NOAA, or do research on the web.



**To find out more about climate change,
visit these web sites:**

- Atmospheric Radiation Measurement (ARM) Project: www.arm.gov
- EPA Global Warming site: <http://www.epa.gov/globalwarming/>
- Institute of Global Environment and Society: <http://grads.iges.org/>
- NSF Polar Reserch: <http://www.nsf.gov/home/polar/start.html>

**For climate change teaching resources,
visit these websites:**

- ARM Education Program's Education Center:
www.arm.gov/docs/education
- ARM Education Lessons: <http://www.arm.gov/docs/education/tlessons.html>
- Oklahoma Climatological Survey Weather Series Lessons:
<http://k12.ocs.ou.edu/teachers/lessons/default.html>
- Atmospheric Visualization Collection lessons:
http://avc.comm.nsdlib.org/cgi-bin/wiki.pl?Atmospheric_Visualization_Collection

References:

Atmospheric Radiation Program: <http://www.arm.gov>
National Science Foundation: <http://www.nsf.gov/od/lpa/news/publicat/nsf0050/arctic/seaice.htm>
Center for Global Change and Arctic System Research: <http://www.cgc.uaf.edu/>
Arctic Climate System Study: <http://acsys.npolar.no/implan/sea%20ice.htm>
National Snow and Ice Data Center: http://nsidc.org/sotc/sea_ice.html