

A Short Introduction to Paleoclimatology

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Subject Area: History/Global Studies

Grade Level: High School

Time Frame for Unit: 1 50-minute class period

Introduction: This lesson prepares students to understand climate change by introducing them to the proxies from which the early climatic record is reconstructed

Geographic Connections: Climate Change

Vocabulary: weather, climate, paleoclimatology, proxy data, dendroclimatology, core sample (ice, sedimentary, oceanic), speliotherm

Stage 1-Desired Results	
<p>Content Standards:</p> <p><u>CCSS.ELA-LITERACY.RH.9-10.7</u> Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.</p> <p><u>CCSS.ELA-LITERACY.RST.9-10.1</u> Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</p> <p><u>CCSS.ELA-LITERACY.RST.11-12.7</u> Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.</p>	
<p>Understanding Goals:</p> <p>Students will understand: *the difference between weather & climate and the relationship of the two *what the field of paleoclimatology is *various proxies for determining climate before modern instrumentation *how scientists use these proxies to create models of climate change over time</p>	<p>Essential Question:</p> <p>How do we determine the climates of the past to predict climates of the future?</p>

Student Objectives (Outcomes):

- *Describe the various proxies for climate in the era before widespread scientific instrumentation
- *Compare various proxies in writing and consider the work that goes into obtaining these

Stage 2-Assessment Evidence

Performance Task:

Students will write independent journal entry comparing four different climate proxies. They will also discuss which proxy method they would most likely engage in if they were a paleoclimatologist and why.

Other Evidence:

Discussion Performance

Stage 3- Learning Plan

Learning Activities:

- I. What is the difference between weather and climate?
 - A. Begin with a discussion of how one defines these terms. Distribute scratch paper and have students write definitions of “weather.” Then have them compare their definitions with that of a classmate and from these two, create an ideal definition. Have students pass their new (paired) definition in and read all of these aloud. Hold a discussion about these different definitions. Next, ask students to define “climate.” Discuss examples of climate and from these decide on what might be good definitions. Speculate about how weather is different from climate.
 - B. Follow this discussion by viewing a 6-minute animated film from Colorado State University on the difference between weather and climate.

<https://www.youtube.com/watch?v=VHgyOa70Q7Y>
 - C. Following the film, have students number off into groups of four and join together for a short discussion on the video they just watched. First they should discuss parts of the video that they didn’t understand and then focus on specific points made in it.
 - D. Review with the class all the different measurements that are taken in developing a full and complete picture of the weather at any given point in time. (To make this more meaningful, students could be shown images of barometers, thermometers, rain gauges, meter sticks, etc)
- II. How is climate determined?
 - A. Show a graph of the climate for the last 150 years or so.

Go to either of the following links and analyze the diagram at the bottom of the page which shows changes in the earth’s temperature since the 19th century. Points to note include the fact that the graphs show trends from the 19th century

(when these sorts of precise measurements began to be taken systematically), that there was a marked cooling in the 1940s and 1950s, that the graphs aren't up-to-date and thus don't show the continued upward movement in the last few years, etc. This discussion should be relatively brief (~ 2 minutes).

<http://www.ecy.wa.gov/climatechange/whatis.htm>

OR

http://know.climateofconcern.org/index.php?option=com_content&task=article&id=73

B. Continue this discussion about the trend in climate by asking students to brainstorm answers to the following question:

How can we develop an understanding of the climate in earlier eras (when there was less formal, standardized measurement)?

[Emphasize that today our understanding of climatic issues is based on a complex set of measurements using a wide variety of instruments barometers, meter sticks, thermometers, gauges –but that because these measurements, did not exist in the past, we must rely on other means to develop an understanding of the climate.]

Have students brainstorm about how climate in earlier (pre-instrumentation) eras could be measured. After students have offered ideas for a couple of minutes, explain that they will be shown several images that will give them hints related to the ways scientists draw conclusions about the climate from the past.

These images (Appendix 1) are from the website of NOAA National Centers for Environmental Education at the following link:

<ftp://ftp.ncdc.noaa.gov/pub/data/paleo/about/what-is-paleo.txt>

(Creating a six-slide Powerpoint presentation of these images would be ideal.)

III. What is paleoclimatology* (the study of past climates) and what are the proxies that are used to research climate in the era before instrumentation?

A. Distribute to six students the descriptions of different proxies for measuring the climate of earlier eras. (Appendix B) These short descriptions are from the same source as the images, the NOAA National Centers for Environmental Education. Explain to them that paleoclimatologists gather data from human and

natural records of climate variability and that by analyzing these records, they help develop our understanding of climate beyond the 100+ year instrumental record. Also mention that these are referred to as proxy climate data types.

[For a simple visual explanation of this concept, use the following link:

<http://serc.carleton.edu/microbelife/topics/proxies/paleoclimate.html>

C. After hearing each description, have students connect it with one of the images. Re-emphasize that it is through these proxy climate data types that scientists have developed an understanding of climate for a much longer span of time.

D. Show students a graph of climate that extends over a much longer time span than the ones shown earlier in the class. The two graphs on this PBS website show a shorter timespan and a longer one.

<http://www.pbs.org/wgbh/warming/etc/graphs.html>

Ask the class to state what they now understand about the different methods that were used to create the two graphs of temperature rise that they are seeing.

Follow-up Assignment, Lesson, or Homework:

Have students watch the National Geographic film, *Baked Alaska*, which includes a discussion of measuring ice depth on a glacier, depicts ice cores, etc

<http://www.pbs.org/newshour/bb/scientists-read-layers-alaskas-ice-snow-track-climate-change/>

Resource List/Bibliography

1. Film on Weather versus Climate from Colorado State University

<https://www.youtube.com/watch?v=VHgyOa70Q7Y>

2. Sources That Contain Graphs of Climate Change from the 19th to the 20th Centuries

<http://www.ecy.wa.gov/climatechange/whatis.html/>

http://know.climateofconcern.org/index.php?option=com_content&task=article&id=73

3. Overview of Paleoclimatology from Carleton

<http://serc.carleton.edu/microbelife/topics/proxies/paleoclimate.html>

4. List of Climate Proxies from NOAA National Centers for Environmental Information

<ftp://ftp.ncdc.noaa.gov/pub/data/paleo/about/what-is-paleo.txt>

5. Video on Climate Change in Alaska (shows ice cores): “Baked Alaska”:
(measures ice depth on a glacier, discussion of layers as evidence of climate, depiction of ice cores)

<http://www.pbs.org/newshour/bb/scientists-read-layers-alaskas-ice-snow-track-climate-change/>

6. PBS Graphs of Temperature Rise

<http://www.pbs.org/wgbh/warming/etc/graphs.html>

7. Using Speliotherms as Dating Proxies

<http://www.ncdc.noaa.gov/data-access/paleoclimatology-data/datasets/speleothem>

Use of This Lesson: This lesson is for use in a ninth-grade World Cultures class as part of a short introduction to Climate Change early in the school year. It will give students insight into the rich and varied scientific contributions to creating climate models, giving them a greater appreciation of the foundations on which climate change theory is based. In addition, by introducing the concept of climate change early in the year, students will be attuned to considering the environmental aspects, if any, related to various global issues.

Materials Needed for this Lesson:

Audio-Visual Technology for showing video and images from websites

Copies of Appendix 1: Paleoclimatology Images (alternatively, create a power point from the original source of the images)

One Copy of Appendix B, cut into 6 separate readings

APPENDIX 1: PROXIES FOR DETERMINING CLIMATE



<ftp://ftp.ncdc.noaa.gov/pub/data/paleo/about/what-is-paleo.txt>

APPENDIX B

<p>1) Historical documents contain a wealth of information about past climates. Observations of weather and climatic conditions can be found in ship and farmers' logs, travelers' diaries, newspaper accounts, and other written records. When properly evaluated, historical data can yield both qualitative and quantitative information about past climate.</p>
<p>2) Corals build their hard skeletons from calcium carbonate, a mineral extracted from sea water. The carbonate contains isotopes of oxygen, as well as trace metals, that can be used to determine the temperature of the water in which the coral grew. These temperature recordings can then be used to reconstruct climate when the coral lived.</p>
<p>3) All flowering plants produce pollen grains. Their distinctive shapes can be used to identify the type of plant from which they came. Since pollen grains are well preserved in the sediment layers in the bottom of a pond, lake or ocean, an analysis of the pollen grains in each layer tell us what kinds of plants were growing at the time the sediment was deposited. Inferences can then be made about the climate based on the types of plants found in each layer.</p>
<p>4) Since tree growth is influenced by climatic conditions, patterns in tree-ring widths, density, and isotopic composition reflect variations in climate. In temperate regions where there is a distinct growing season, trees generally produce one ring a year, and thus record the climatic conditions of each year. Trees can grow to be hundreds to thousands of years old and can contain annually-resolved records of climate for centuries to millennia. [The science of determining past climates from trees is called dendroclimatology.]</p>
<p>5) Located high in mountains and in polar ice caps, ice has accumulated from snowfall over many millennia. Scientists drill through the deep ice to collect ice cores. These cores contain dust, air bubbles, and isotopes of oxygen, that can be used to interpret the past climate of that area.</p>
<p>6) Billions of tons of sediment accumulate in the ocean and lake basins each year. Scientist drill cores of sediment from the basin floors. Ocean and lake sediments include tiny fossils and chemicals that are used to interpret past climates.</p>

<ftp://ftp.ncdc.noaa.gov/pub/data/paleo/about/what-is-paleo.txt>