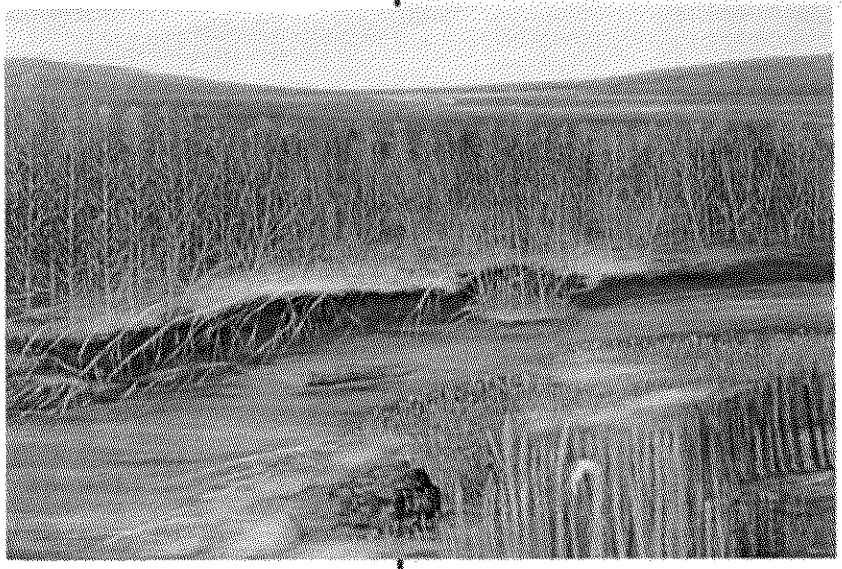
ACTIVITY 2

OBJECTIVES

Students will be able to:

1. Explain what has caused climate changes hundreds of thousands of years ago.
2. Describe how climate changes occurring today are the same or different from past changes to Earth's climate.
3. Describe how scientists perform research on past climates.



The Archean Eon
(Four to 2.5 billion years ago)
Illustration by Peter Sawyer, modified by Mary Parrish © Smithsonian Institution

Background

In the 4.6 billion years of Earth's history, the composition of the atmosphere has changed from a hazy, unfamiliar mix to today's mostly blue skies. As the atmosphere developed, life began and evolved. The evolution of living things changed the atmosphere, and those changes in turn altered life.

To deduce what the atmosphere has been like for billions of years, paleontologists, geologists, and paleoclimatologists study rocks, ancient soils, and fossils. With every new find, they improve and refine their understanding of ancient atmospheres.

Three billion years ago, the sun was only about 70 percent as bright as it is today. Earth should have frozen over, but it didn't. Why not? Because greenhouse gases in the atmosphere, mainly methane and carbon dioxide, retained enough of the sun's heat to keep temperatures above freezing.

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The Late Carboniferous Period
(Pennsylvanian)
(318–299 million years ago)

Illustration by Mary Parrish © Smithsonian Institution

During most of the past 290 million years, Earth was much warmer than it is now. Between 200 and 45 million years ago polar ice caps were small or absent, and winters were warmer around the globe. Many scientists think that high levels of CO_2 in the atmosphere contributed to keeping the climate warm. High-latitude forests may also have raised temperatures by absorbing heat from the sun. Regardless of the cause, warm climates enabled many types of plants and animals to live in the Polar Regions.

Decreases in atmospheric CO_2 have been linked to ice ages over the past million years, when ice sheets periodically blanketed much of the Northern Hemisphere. Scientists studying air bubbles trapped in cores of ancient ice from Greenland and Antarctica found that continental ice sheets advanced while CO_2 in the atmosphere decreased. As the ice sheets advanced and retreated and the climate changed, many species vastly changed their geographic ranges.

At the start of the Eocene Epoch, about 55.5 million years ago, Earth experienced perhaps the most sudden and extreme warming at any time in its history. This planetary heat wave is called the Paleocene-Eocene Thermal Maximum, or PETM. Scientists have found evidence that the PETM was associated with a major release of CO_2 into the environment, much as is happening with burning fossil fuels today. What we learn from studying the PETM may help us understand our own future.

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Activity

1. Explain the activity and provide background information on the Earth's changing atmosphere.
2. If the classroom has enough computers for students to work independently, assign each student to a computer. If the classroom does not have enough computers for individual work, divide the class up into groups.
3. Provide students with the following list of web sites that contain historical atmospheric data and have students spend up to fifteen minutes reviewing the sites.

   The Mauna Loa curve (atmospheric carbon dioxide measurements since 1958) http://maps.grida.no/go/graphic/co2_concentration_in_the_atmosphere_mauna_loa_curve

   Vostok ice cores (carbon dioxide and temperature data from ice cores for the past 460,000 years) http://gcmd.nasa.gov/records/GCMD_CDIAC_CO2_VOSTOK_ICECORE.html

   Temperature changes over the past 1,000 years http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewclimate.htm

Questions

Students should write down answers to the following questions:

1. Is a correlation between Earth's average temperature and carbon dioxide levels? What is the correlation?
2. How rapidly did carbon dioxide and temperature fluctuate hundreds of thousands of years ago. How rapidly have they fluctuated in the past 1,000 years?
3. What causes the fluctuations?
4. Are the fluctuations in the past 1,000 years in keeping with natural variation or not?
5. What do you noticed about changes in the fluctuations since the 19th century when the Industrial Revolution increased emissions of carbon dioxide into the atmosphere?