

- Increasing the use of biomass fuels can potentially decrease human dependence on greenhouse gas-emitting fossil fuels. One potential concern in using biomass fuels is the harvesting of the materials needed to make the fuels. Ask students to research this topic and then write an essay on the potential environmental benefits and limitations of using biomass fuels. Possible questions to consider are: How can the harvesting of crops for biomass fuels and the use of biomass fuels affect greenhouse gas concentrations? How can the harvesting of crops for biomass fuels affect living organisms? How can the use of biomass fuels affect global climate?
- There have been numerous international efforts to increase awareness of global climate change and help countries reduce greenhouse gas emissions, such as the establishment of the Intergovernmental Panel on Climate Change and the United Nations Framework Convention on Climate Change, as well as the creation of the Kyoto Protocol and the Bali roadmap. Create a time line that highlights these and other key events related to global climate change. For each time line entry, write the name and date of the event and a one-sentence summary that explains the importance of the event.
- Through the Clean Development Mechanism, projects are underway around the world to cut or reduce emissions in developing countries. Visit cdm.unfccc.int/Projects/MapApp/index.html for an interactive map of CDM projects. Have students select and report on a CDM project. Their descriptions should include the location of the project, the project's objectives and the countries involved in making the project possible. Students can also include their personal assessment of the project's effectiveness.

Suggested Internet Resources

Periodically, Internet Resources are updated on our website at www.LibraryVideo.com.

- www.ngdc.noaa.gov/paleo/ctl/index.html
The National Climatic Data Center Paleoclimatology Program's "Climate TimeLine" explores weather events and climate change on Earth over the past 100,000 years.
- www.reachoutmichigan.org/funexperiments/agesubject/lessons/greenhouse.html
The Michigan Reach Out! program presents an experiment that will help students understand the greenhouse effect. The website includes

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background information, experiment objectives and a complete list of materials and procedures.

- www.enviroliteracy.org/article.php/1340.html
This website from the Environmental Literacy Council describes the use of climate modeling to predict global climate change. Click the "Climate" link under "Related Pages" for more information about Earth's climate.
- www.exploratorium.edu/climate/index.html
The National Science Foundation and the Exploratorium present this website for students on global climate change. Scientific data related to the atmosphere, hydrosphere, cryosphere and biosphere is available for exploration.

Suggested Print Resources

- Revkin, Andrew. *The North Pole Was Here: Puzzles and Perils at the Top of the World*. Houghton Mifflin, New York, NY; 2006.
- Stille, Darlene. *The Greenhouse Effect: Warming the Planet*. Coughlan Publishing, Mankato, MN; 2006.
- Wyman, Bruce and L. Harold Stevenson. *The Facts On File Dictionary of Environmental Science (Third Edition)*. Facts On File, Inc., New York, NY; 2007.

TEACHER'S GUIDE

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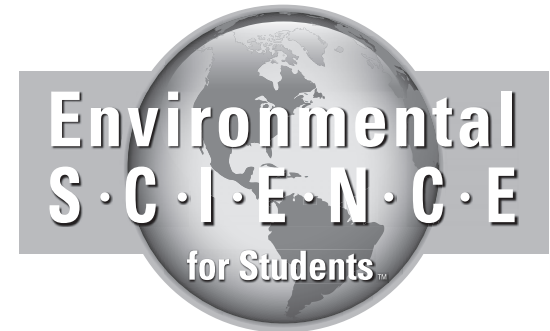
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GLOBAL CLIMATE CHANGE

Grades 5–12

An understanding of the environment and the relationship that humans, plants and animals have with it is instrumental in developing environmental literacy. Such awareness can help to shape future understandings of the Earth and our actions as informed citizens. For this reason, as students engage in a study of the environment, it is important to present them with accurate explanations, global examples and balanced viewpoints. In addition, the environment's link to human health, the economy and society should also be examined to make clear the interconnected nature of these components. *Environmental Science for Students* will help viewers to understand the science behind their changing world as well as consider multiple perspectives. This six-part series explores the causes and effects of issues facing our environment in the 21st century and explores the short- and long-term potential of possible solutions.



Program Overview

Earth's climate is constantly changing, and throughout its history, the planet has gone through numerous cycles of warmer and cooler temperatures. By the end of the 20th and beginning of the 21st centuries, temperatures were higher than at any period of comparable length in the past 600 years. A growing number of scientists agree that this most recent global warming trend cannot be explained by natural events and is in fact due to human activity, specifically an increase in the amount of carbon dioxide, methane and certain other gases in the atmosphere.

When discussing temperature changes on Earth, it is essential to consider the greenhouse effect, which traps some of the Sun's heat energy near the Earth's surface and prevents the planet from becoming too cold to support life. As the concentration of greenhouse gases like carbon dioxide, nitrous oxide and methane increases in the atmosphere, the greenhouse effect also increases, and as more of the Sun's heat energy is trapped near the Earth's surface, temperatures increase.

Potential effects of global warming include the melting of Earth's polar ice caps, changes in the temperatures of Earth's oceans and worldwide changes in weather and climate. International efforts such as the United Nations Framework Convention on Climate Change, the Kyoto Protocol and the Clean Development Mechanism are increasing awareness of global climate change and helping countries reduce greenhouse gas emissions. Another way people are reducing greenhouse gas emissions is through the use of hybrid vehicles and other low-emission forms of transportation, such as biking, walking or public transit.

Vocabulary

climate change — Variations in weather patterns over a long period of time. Climate change can be caused by naturally occurring events and by human activity.

global warming — An increase in Earth's average surface temperature.

Little Ice Age — A period from about the 15th century to the 19th century that is believed to have had an average global temperature that was a few degrees cooler than today's. During this period, glaciers advanced and different regions of the world (Europe in particular) experienced bitterly cold winters, shortened growing seasons and the deaths of large numbers of livestock.

greenhouse effect — The trapping of heat near the Earth's surface by certain gases in the atmosphere.

greenhouse gas — A gas in the atmosphere that acts like the glass of a greenhouse and traps some of the incoming heat from the Sun, keeping it close to the Earth's surface. Examples of greenhouse gases include carbon dioxide, nitrous oxide and methane.

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carbon dioxide (CO₂) — A colorless, odorless greenhouse gas that is formed during combustion of carbon-based substances like fossil fuels and is also produced by many organisms, including humans, during respiration and exhaled on a continual basis.

nitrous oxide (N₂O) — A colorless, sweet-smelling greenhouse gas that enters the atmosphere from nitrogen-based fertilizers, sewage treatment plants and the burning of fossil fuels. Nitrous oxide molecules are very stable, and can remain in the atmosphere for over a century.

methane (CH₄) — A colorless, odorless gas formed during the decomposition of organic matter that is used as a fossil fuel. Methane is a greenhouse gas that is produced by many types of livestock as a by-product of digestion and is also released into the atmosphere during oil drilling and coal mining.

Gulf Stream — A warm water current that originates in the Gulf of Mexico and flows north in the Atlantic Ocean along the eastern coastline of the United States and Newfoundland, Canada towards Europe. The Gulf Stream influences the climate of the eastern United States, Newfoundland and western Europe.

Kyoto Protocol — An international agreement to reduce global greenhouse gas emissions that was adopted at the United Nations Framework Convention on Climate Change in Kyoto, Japan in 1997.

Clean Development Mechanism (CDM) — An arrangement under the Kyoto Protocol that allows a developed country to invest in projects that cut or avoid greenhouse gas emissions in developing countries and receive credits that can be applied to meeting its own emissions targets.

Environmental Protection Agency (EPA) — The United States agency created in 1970 that is responsible for protecting human health and the quality of the natural environment.

hybrid vehicle — A vehicle that combines an efficient gasoline engine with an electric motor.

Pre-viewing Discussion

- The climate of an area is influenced by several factors. Give students three different locations in the world and have them discuss how elevation, latitude, topography and distance from water affect the climate of each location.
- Divide the class into six groups and give each group one of the following locations: Anchorage, Alaska; Honolulu, Hawaii; Miami, Florida; Omaha, Nebraska; Phoenix, Arizona; Seattle, Washington. Ask each group to make a list that summarizes how the climate of the location affects the people living there (e.g., kinds of clothing needed during the year, relative amount of money spent per year on energy for heating and cooling, availability of resources, etc.). The groups can share their lists and then discuss the possible benefits and limitations of living in each location.

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- Using a world map, ask students to locate the three major climate zones on Earth: tropical zones, temperate zones and polar zones. Write a brief summary of each climate zone that includes descriptions of temperature and amount of precipitation in the zone.

Focus Questions

1. What is climate change? How has Earth's climate changed throughout history?
2. What is global warming? What factors do many scientists believe contribute to global warming?
3. What was the Little Ice Age and what were some of its effects?
4. What is the greenhouse effect? What are some examples of greenhouse gas?
5. How have levels of carbon dioxide in the atmosphere changed over the past few hundred years?
6. What are some sources of nitrous oxide and methane?
7. What are some of the potential effects of global warming?
8. What is the United Nations Framework Convention on Climate Change? What is the Kyoto Protocol?
9. What are hybrid vehicles? Why are hybrid vehicles more environmentally friendly than vehicles that use only fossil fuels?

Follow-up Discussion & Activities

- While discussions about global warming often bring out strong opinions, the ability to support those opinions with accurate scientific evidence and facts is an essential skill. Ask students to conduct a global warming debate by separating the class into two groups, the "believers" and the "skeptics," and have the students in each group research their position. Remind students that regardless of their personal opinions on the subject, they should attempt to find accurate scientific evidence that supports the position of their group. Set rules for the debate and select a debate format that is appropriate for the class. Following the debate, encourage students to discuss their views on global warming and how the evidence presented during the debate affected their views.
- The impact of climate change can be considered in many ways. One overarching concern is its impact on human health. It has been argued that global warming could increase the transmission of infectious diseases, such as malaria. It has also been argued that an increase in Earth's average surface temperature could reduce the number of cold-related deaths. Engage students in an investigation of other potential health effects of global warming and ask them to assess their impact.

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