

Lesson 3

Global Climate Change: Understanding the Greenhouse Effect

Lesson Overview

Grade Level and Subject: 6-8 , 9-12

Length: 2 class periods

Objectives

- Understand what global climate change is and how it affects our lives
- Learn about greenhouse gases and begin to consider what events are causing an increase in the amount of greenhouse gases in the atmosphere

Introduction

Changes to Earth's global climate have had and will have major consequences for life on Earth. Using evidence preserved in ice for tens of thousands of years, scientists are searching for an understanding of the history of Earth's climate changes in order to better predict what the future holds for life on the planet. In this lesson, students learn about ways in which we study past climate change, and reflect on the present condition of Earth's climate. They explore the effect of greenhouse gases on Earth's atmosphere, and begin to consider the human impact on global warming.

(Note: This is the first of two global climate change lesson plans. You may want to follow this lesson with [Global Climate Change: The Effects of Global Warming Lesson Plan](#) .)

Multimedia Resources

- [Climate Change QuickTime Video](#)
- [Greenland Ice Sheet Project 2: A Record of Climate Change Flash Interactive](#)
- [Natural Climate Change in Djibouti, Africa QuickTime Video](#)
- [Global Warming: The Physics of the Greenhouse Effect QuickTime Video](#)
- [Global Warming: Carbon Dioxide and the Greenhouse Effect QuickTime Video](#)

Materials

For each pair or small group of students:

- three thermometers
- two clear glass jars that will fit over the thermometers
- sun lamp or sunny windowsill
- paper towels
- Scientific notebooks or journals for recording data and observations
- Graph paper

One clock to be used by the entire class

Before the Lesson

If possible, arrange computer access for all students to work individually or in pairs. Prepare thermometers, jars, and sun lamps for each pair or small group of students.

The Lesson

Part I: What Is Global Climate Change?

1. Write the word *climate* on the board and ask students to try to define it. Write down their suggestions on the board. Once the list is complete, help students synthesize their ideas into a class definition. For example, one definition might be: "Climate is how weather acts over a large area over many years." Then have students discuss different types of climate areas on Earth: for example, polar, temperate, mountain, etc.
2. Ask students to think about the term *global climate*. Ask them how global climate might differ from regional or local climate. Discuss with students that the term global climate describes Earth's overall climate variability — such as average temperature, average precipitation, average intensity of winds, and other conditions of Earth's overall atmosphere and at its surface — separate from any specific weather events or local climate conditions. Show the [Climate Change QuickTime Video](#) and discuss the following questions:
 - a. What is the difference between weather and climate?
 - b. How do scientists measure the average world temperature in past eons?
 - c. Before 8000 B.C., dramatic changes in average temperature occurred over just a few years' time. What was happening to the global climate before 8000 B.C.?
3. Ice cores are critical to understanding the conditions on Earth over the past 40,000 years, but obtaining them is no easy task. Have students work in pairs or small groups to

explore the [Greenland Ice Sheet Project 2: A Record of Climate Change](#) Flash Interactive to learn about the difficulties scientists face as they drill for ice cores in Greenland, and to find out what the scientists are learning about global climate change from the ice. Have students answer the following questions in their journals: Why do you think this project was so difficult to mount and took as long as it did?

- a. Analyze the Greenland Summit Temperature graph. Describe the two variables shown on this graph (temperature and time). During what time period did the largest change in temperature occur? Have we seen world average temperature changes occur this rapidly in the past century?
 - b. Analyze the Methane Concentration graph. When did the largest change in methane gas concentration occur?
 - c. Look at the Methane graph with the temperature overlay showing. What is the general relationship between methane concentration and temperature?
 - d. Analyze the Calcium (Dust) graph. How does calcium dust get into the glacial ice? When did the largest change in calcium dust concentration occur?
 - e. Look at the Calcium graph with the temperature overlay showing. What is the general relationship between calcium dust concentration and temperature? Why does this relationship even exist? (Hint: Think about reflected light.)
 - f. Analyze the Insolation graph. When did the largest change in insolation occur?
 - g. Look at the Insolation graph with the temperature overlay showing. What is the general relationship between insolation and temperature? What else besides the chemicals in the atmosphere affects the temperature on Earth?
 - h. How might any of these variables (temperature, methane concentration, calcium dust concentration, and insolation) be used to determine past or future climatic conditions?
4. Dramatic global climate change is evident in many places on Earth. For example, Djibouti, which lies east of the Sahara is one of the hottest and most arid countries in the world. However, it wasn't always this way. Show students the [Natural Climate Change in Djibouti, Africa](#) QuickTime Video and discuss these questions:
- a. Explain how the tilt of Earth on its axis is related to our changing seasons.
 - b. What evidence do the shells provide to scientists?

- c. What is the most recent scientific explanation for the dramatic climate change that caused the Sahara's massive lakes to dry up?

Part II: The Greenhouse Gases

5. Divide the class into small groups to begin exploring the effects of greenhouse gases on our atmosphere. Distribute the prepared materials to each group. Have each group place three thermometers within a few inches of each other on a sunny windowsill or under a sun lamp. Be sure that all three thermometers receive the same amount of light for the entire class period. Have students move on to the next activity, but ask them to periodically check the thermometers until they are at exactly the same temperature. Ask students to record this temperature and the time.

6. Now cover two thermometers with glass jars, leaving one thermometer uncovered. Students should place a wet paper towel inside one of the two jars. Use water at room temperature to wet the paper towel. (In this experiment, the water vapor will act like a greenhouse gas and increase the temperature in the jar with the wet paper towel even more than the temperature in the dry jar.) Continue with the next activity, but have students periodically check all three thermometers and record the temperature and time.

7. The presence of greenhouse gases, compounds in the atmosphere that trap heat, maintains Earth's temperature. Human activities, however, are increasing greenhouse gas concentrations and affecting global temperatures. Show students the video [Global Warming: The Physics of the Greenhouse Effect](#) QuickTime Video to introduce them to these concepts, and have them answer these questions:

- a. What is the greenhouse effect?
- b. What are four naturally occurring greenhouse gases?
- c. What would Earth be like without the greenhouse effect?
- d. What are some manmade sources of greenhouse gases other than power plants and automobiles?
- e. What natural phenomena produce greenhouse gases?

8. If they have not already done so, have students take temperature readings of the thermometers inside the jars and compare them to the temperature of the thermometer

outside the jars. Then show the video Global Warming: Carbon Dioxide and the Greenhouse Effect QuickTime Video and discuss the following:

- a. Why does the image of the scientist fade after carbon dioxide has been turned on?
How does this explain the greenhouse effect?
 - b. What would the scientist feel like if he were inside the tube? How does this explain the effect of carbon dioxide on the temperature of the atmosphere?
 - c. How long does it take for carbon dioxide to spread throughout Earth's atmosphere?
How long does it take to be absorbed into the oceans?
9. In small groups, have students take their final temperature measurements and analyze the data that they have collected. Students should graph the data to show how the temperature of the thermometers under the "dry" glass jar and the "moist" glass jar changed throughout the day, and how these temperatures compared with the temperature of the thermometer outside the jars. Finally, ask students to write a summary of their findings and how these results compare to the greenhouse effect of our atmosphere.

Check for Understanding

Have students discuss the following:

1. What tools/methods are used to study climate change in the history of Earth?
2. What is the general climatic trend on Earth as revealed by the evidence gathered through these methods?
3. Distinguish between the greenhouse effect and global warming.
4. In what ways are humans having an effect on the concentration of greenhouse gases?

The Digital Library for Earth System Education (www.dlese.org) offers access to additional resources on this topic.

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Icelandic National Television Service

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Iowa Public Television

Instituto e Museo di Storia della Scienza, Florence

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