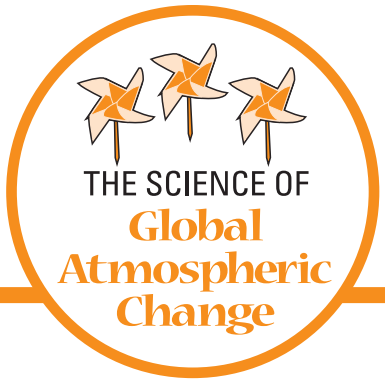

Greenhouse S'Mores

Activity from *The Science of Global Atmospheric Change Teacher's Guide* and for *Mr. Slaptail's Curious Contraption*

Written by
Nancy P. Moreno Ph.D.
Barbara Z. Tharp, M.S.
Judith Dresden, M.S.

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Teacher Resources from the Center for Educational Outreach at Baylor College of Medicine.

The activities described in this book are intended for school-age children under direct supervision of adults. The authors and Baylor College of Medicine cannot be responsible for any accidents or injuries that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text.

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Authors: Nancy P. Moreno, Ph.D., Barbara Z. Tharp, M.S., and Judith H. Dresden, M.S.
Editor: James P. Denk, M.A.
Designer and Illustrator: Martha S. Young, B.F.A.

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BCM
Baylor College of Medicine

Center for Educational Outreach
Baylor College of Medicine
One Baylor Plaza, BCM411
Houston, Texas 77030
713-798-8200 | 800-798-8244 | edoutreach@bcm.edu
www.bcm.edu/edoutreach | www.bioedonline.org | www.k8science.org

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ALAN E. WHEALS, PH.D., UNIVERSITY OF BATH
http://www.bath.ac.uk/bio-sci/research/profiles/wheals-a.html

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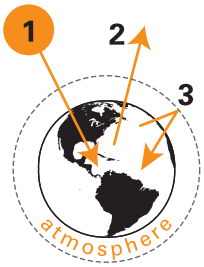
People and Climate Changes

Environment and Health Basics

WHAT IS THE GREENHOUSE EFFECT?



1. Sunlight passes through the clear atmosphere and warms the Earth's surface.
2. The warm surface reflects heat back into the atmosphere.
3. Greenhouse gases and water vapor trap some of the heat and send it back toward the Earth.

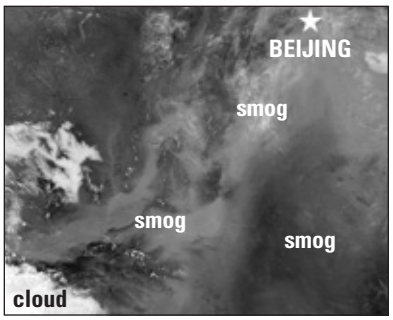
CFSs AND OZONE

The release of chemicals known as CFCs (chlorofluorocarbons) is contributing to changes in the atmosphere that will affect climate and human health and well-being. Freon and other CFCs are greenhouse gases that increase the amount of heat trapped near the surface of Earth. In addition, chlorine molecules released by these chemicals in the stratosphere break apart the ozone molecules responsible for shielding Earth from ultraviolet radiation.

Over the last decade, the amount of ozone in the stratosphere has decreased (especially in the polar regions)—leading to greater risks of skin cancer for people and also damaging vital populations of plants, animals and marine life.

Life on Earth has been possible because of the very special characteristics of our atmosphere. The planet is warm enough to support life, thanks to the presence of certain gases in the lower atmosphere. The atmosphere also absorbs almost all of the potentially damaging radiation produced by the sun before it reaches the surface. Our atmosphere contains elements necessary for life—nitrogen, carbon and oxygen—as well as abundant water vapor to maintain the water cycle.

Human actions, particularly during the last several decades, are changing the composition of Earth's atmosphere. Since the industrial revolution, people have been removing stored carbon from Earth in the forms of coal, crude oil and natural gas, and burning it to make heat. In the process, water vapor, carbon dioxide and small amounts of other substances are produced. Other activities, such as clearing land (by burning) for agriculture, also have added CO_2 to the atmosphere. As a result, levels of carbon dioxide in the lower atmosphere have increased from around 260 parts per million (ppm) by weight to more than 350 ppm.



The dense smog over China in the above image likely results from pollution held in place by a temperature inversion. Air high in the atmosphere is usually cooler than the air near the ground. As warm air rises through the atmosphere, it disperses its pollutants, but when cold air is trapped under a layer of warm air, it cannot rise.

Winter temperature inversions are not uncommon as residents rely on coal for electricity and heat. These conditions lead to frequent build-ups of smog.

Photo courtesy of NASA Earth Observatory.

Carbon dioxide is one of the gases responsible for trapping heat near Earth's surface and lower atmosphere. Many scientists believe that increases in the amounts of CO_2 and other greenhouse gases, such as methane (CH_4), will lead to warmer temperatures on Earth. Even minor increases in the surface temperature of the planet could have far-reaching effects. Major climactic patterns of winds, temperature and rainfall could change drastically. This would impact water resources, coastlines, agriculture, forests, energy production and patterns of disease.

Climate, the characteristics of weather in a particular region over long periods of time, determines which kinds of plant and animal life are present, which crops can be grown, how people construct their houses and, to a great extent, people's clothing and diet. The climate of any given region depends on its distance from the equator, altitude and rainfall patterns.

Even slight changes in the world's climate affect human health and well-being in countless ways.

Greenhouse S'Mores

Environment and Health

Several transparent gases in the lower layer of the atmosphere (troposphere) have an important role in determining the temperature of Earth's surface. These gases, which act like glass windows in a greenhouse or automobile, let light and other forms of radiation from the sun pass through the atmosphere. Much of this energy is absorbed into Earth's surface, which becomes warmer (just like the seats in a car parked in the sun). Some heat, however, is radiated back into the atmosphere. There, gases like carbon dioxide, methane, ozone and water vapor (the so-called "greenhouse gases") absorb some of the heat and sent it out again in all directions, including back toward the surface. This warms Earth's surface and the lower atmosphere.

Unit Links

Mr. Slaptail's Curious Contraption
Story, pp. 24–27, 30–31

Explorations
Not Such a New Issue, p. 6; Lief Sigren, p. 7

Without the warming effect of greenhouse gases, Earth's average surface temperature would be around –18°C (0°F), instead of the actual temperature of about 15°C (59°F). Much of the planet would be frozen. On the other hand, if there were more of the greenhouse gases, Earth's surface would be too hot to support life.

Scientists around the world are concerned that increased levels of greenhouse gases (especially carbon dioxide), resulting from human activities, are causing additional warming of the planet's surface. Levels of carbon dioxide in the atmosphere have increased more than 30% since the industrial revolution. This increase is due primarily to the burning of fossil fuels and changes in land use (burning forests to clear land for farming, for example).

Even minor increases in the surface temperature can have far-reaching effects. Major climactic patterns of winds, temperature and rainfall could change drastically, impacting water resources, coastlines, agriculture, forests and energy production, as well as patterns of disease.

This activity is designed to provide a simple introduction to the concepts underlying the greenhouse effect and to provide background information for thinking about climate change.

SETUP

Place all materials in a central area for Materials Managers to collect for their groups. Have students work in groups of 4.

If you are teaching this lesson during the winter, you will need to conduct it indoors with a heat lamp or use a sunny window. When the weather is warm, students may conduct the experiment outside in an area that is protected from the wind.

CONCEPTS

- Different materials absorb and trap heat differently.
- Some materials allow light to pass through, but do not let heat escape.

OVERVIEW

Students will observe how some transparent materials allow light to pass through, but do not let heat escape. This will provide background for understanding the role of heat-trapping gases in the atmosphere ("greenhouse effect").

SCIENCE, HEALTH & MATH SKILLS

- Predicting
- Observing
- Modeling
- Drawing conclusions

TIME

Preparation: 10 minutes
Class: 30–60 minutes

MATERIALS

Each group will need:

- 4 chocolate candies ("kisses" or squares)
- 4 cups, 9-oz clear plastic
- 4 plain round cookies
- 4 toothpicks
- 1/4 cup of marshmallow creme (or frosting)
- Plastic knife or spreader
- Sheet of aluminum foil (approx. 12-in. sq. or 30-cm sq.)
- Sheet of black construction paper, 9 in. x 12 in.
- Sheet of white construction paper, 9 in. x 12 in.
- Tape or a stapler
- Tray or paper plate

S'MORES

S'Mores are traditional campfire treats made by roasting a marshmallow and a square of chocolate between two graham crackers. This activity challenges students to use solar energy to cook smaller versions of S'Mores.

GREENHOUSE S'MORES

Students will create covers of different materials for cups containing their "Greenhouse S'Mores." One way to make a cover is to roll a sheet of paper into a tube that will fit around the cup. Fold and tape (or staple) the top of the tube and place it over a cup.

	TREATMENT			
	Clear	Foil	Black	White
Group 1	4	1	3	2
Group 2	4	1	2	3
Group 3	3	2	4	1
Group 4				
Group 5				
Group 6				
TOTAL				

The windows of an automobile let sunlight through, but do not allow heated air to escape.

PROCEDURE

1. Ask students, *Have you ever noticed how warm a car can become when it is parked in the sun? Where do you think the heat inside the car comes from? How do you think we can learn more about light and heat?*
2. Tell students that they will investigate the heat-trapping qualities of different materials by using the sun to make a treat (see "Greenhouse S'Mores," left sidebar). Have Materials Managers collect 4 cups and 1 sheet of each of the 3 coverings for their groups. Have students make the following covers for three of the cups: white construction paper, black construction paper and aluminum foil. All covers should be about the same size and shape. Have students follow the instructions described at left OR challenge students to create their own cover designs. One cup will not have a cover.
3. After students have made covers for three cups, have each Materials Manager pick up four round cookies, four chocolate candies, a spreader and a small container of marshmallow creme or frosting.
4. Ask students if they have ever made S'Mores using marshmallows and chocolate squares. Tell students they will be using solar energy to make S'Mores in class. Each student will create one S'More by placing a small amount of marshmallow creme or frosting on the cookie, followed by a chocolate candy.
5. Direct students to place the cookies on a plate or tray and to cover each cookie with one of the cups. (If the experiment will be conducted outside, have students tape the cups to the plate.)
6. Within their groups, have students discuss the cover treatments and predict which treatment will result in the most softened or melted chocolate. Have students rank their predictions using a scale of 1 to 4, in which 1 = least softened and 4 = most softened.
7. Have students place the plates and cups in a sunny spot near a window, or outside in direct sunlight, preferably on a lawn. (Do not place the plates on hot pavement in the sun. The heat from the already warm surface will affect the results.)
8. Let students make their first observations after about 15 minutes. They should use a toothpick to test the candies. Depending on the air temperature, some of the chocolate candies may begin to soften by this time. Continue observing at 10–15 minute intervals, until at least one of the candies has become very soft. (Note: some chocolate candies may retain their shape even when they are very soft.)
9. Have students bring their plates indoors and observe the condition of each of the four chocolate candies. Ask students to rank the candies from least melted to most melted—giving a score of "1" to the least softened or melted and a score of "4" to the most softened or melted.

10. Make a chart on the board (see example, sidebar, p. 3) and have each group report its results.
11. Add (or have students add) all of the points received by each treatment. Usually, the clear /uncovered cup treatment will end up with the most points (clear cups result in the most melted chocolate, followed by the white cover and the black cover). The foil cover will have the fewest points (least melted chocolate). Because the observations are subjective, there usually will be some discrepancies among the results reported by each group. Use this as an opportunity to point out the importance of conducting an experiment more than once.
12. Discuss the results with the class. Ask, *Which treatment melted the chocolate the most? The least? Why do you think so?* Help students understand that more light energy was able to pass into the clear cup than into the others. Much of this energy was transformed into heat. The cup covered with foil reflected more light energy away. The white paper reflected some of the light energy away. The black paper absorbed more energy than the white cup.
13. Let each student eat his or her S'More, while you lead a discussion connecting their observations to what happens inside a car parked in the sun. You also may want to refer to page 9 in the story, *Mr. Slaptail's Curious Contraption*. Help students understand that certain gases in the atmosphere, especially carbon dioxide, act like the clear cups in their experiments. These gases keep the surface of the planet warmer than it would be otherwise.

VARIATIONS

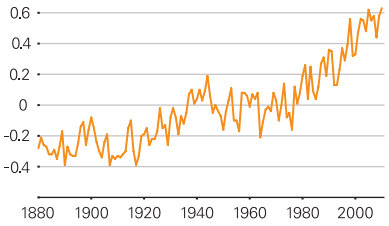
Before beginning, have students create a class chart of their predictions about the results of the investigation. Compare the predictions to the results and discuss the differences with students.

QUESTIONS FOR STUDENTS TO THINK ABOUT

The levels of some heat-trapping gases (especially carbon dioxide, methane and ozone) have increased in the atmosphere during the last several decades. Many scientists believe that these increases in greenhouse gases will cause additional warming of Earth's surface. Ask students, *Based on what you have observed, do you think that this is a reasonable prediction? What other information can you find about this topic in the library or on the Internet?*

Ask, *Based on what you have learned in this activity, how do you think Mr. Slaptail might have improved upon the design of his water-heating contraption?*

GLOBAL TEMPERATURE RECORDS



Global Temperature Anomalies (°C)

An analysis from the Goddard Institute for Space Studies shows that 2010 tied with 2005 as the warmest year on record, and was part of the warmest decade on record. Measures of temperature anomalies combine data representative of much larger regions than would be possible with absolute temperature, which varies markedly in short distances.

Source: NASA Earth Observatory.

VARIABLES

Experiment results often vary due to factors, known and unknown, that cannot be controlled by the investigator. Because of this variability, scientists use several to many experimental groups and repeat their experiments. This makes it possible to estimate the amount of variability present and to predict the consistency of the results.

This activity demonstrates the importance of conducting an experiment multiple times. It also shows how qualitative data can be handled using quantitative methods.