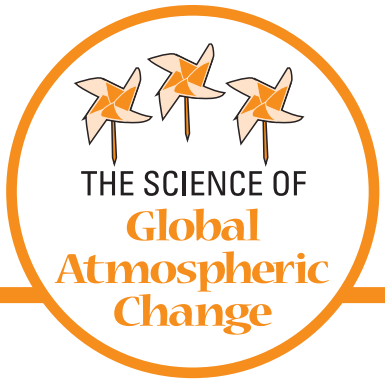

Modeling Earth's Atmosphere

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

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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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WORLD HEALTH ORGANIZATION who.int/global-change/environment

Energy and the Atmosphere

Physical Science Basics

THE SPECTRUM

Radiation travels in waves. The wavelengths that we see as visible light represent a small portion of the entire electromagnetic spectrum.

Light usually is measured in nanometers (one nanometer equals 0.000,000,001 meters). Wavelengths that we can see fall between 400 and 700 nm. During photosynthesis, green plants capture energy from wavelengths in this range.

Some kinds of radiation are listed below, from longest to shortest wavelengths.

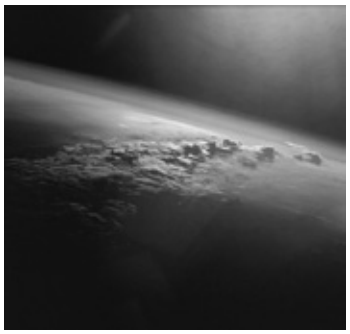
- Long wave radio
- Short wave radio
- Radar
- Microwave
- Infrared
- Visible light
- Ultraviolet light
- X-ray
- Gamma ray
- Cosmic ray

FOSSIL FUELS

Fossil fuels — coal, oil and natural gas — consist of the remains of ancient plants, animals and one-celled organisms that have been buried under intense pressures and high temperatures for millions of years. The resulting substances deliver much more useful energy than raw plant materials, such as wood.

The sun is the source of Earth's energy. Every second, approximately five million tons of matter within this relatively small star are converted into energy, which is sent outward into space. We feel part of this energy as heat and see another part as light. Heat and light that we can detect, however, represent only a small portion of the radiation emitted by the sun.

Radiation travels in waves, similar in some ways to waves on the surface of a lake. The distance between the peaks, or crests, of two successive waves is known as the wavelength. The longest wavelengths—between 1 and 1,000 meters—correspond to television and radio signals. The shortest wavelengths, those of cosmic rays, are only 0.000,000,000,000,01 meters long!



Radiation traveling toward Earth passes through a thin layer of gases called the atmosphere. Without this protective layer, life on Earth would be impossible. Earth's atmosphere consists primarily of nitrogen and oxygen, along with other argon, carbon dioxide and water vapor. The atmosphere keeps the planet warmer than it would be otherwise; provides oxygen, moisture and carbon dioxide; and prevents most harmful radiation from reaching the surface.

Green plants and algae (related plant-like organisms that usually grow in water) are able to absorb energy from the sun and use it to combine carbon dioxide (CO_2) from the atmosphere with water to make energy-rich molecules, such as sugars and carbohydrates. Green plants and their products form the base of almost all food webs on Earth. They also are the source of our most common fuels.

Fuels such as wood, coal, oil and natural gas all are composed of matter originally produced by plants and other organisms. Each holds energy, originally trapped during photosynthesis, in the chemical bonds of carbon-containing molecules. When these substances are burned, they release heat energy that can be used for many purposes.

Our use of fossil fuels has grown dramatically since the 1800s. During the Industrial Revolution, coal was used to power steam engines in mines, factories, locomotives and ships. Later, it was used to generate electrical power. The discovery of large deposits of petroleum led to widespread use of fuels for transportation, heating and production of electricity. When fossil fuels are burned, carbon-containing molecules combine rapidly with oxygen. This chemical reaction releases energy in the form of heat. It also releases CO_2 into the air. Many other chemical substances also are produced by the burning or incomplete burning of fossil fuels.

Photo courtesy of NASA.

Modeling Earth's Atmosphere

Physical Science

The air surrounding Earth is known as the atmosphere. Gas molecules in the atmosphere are held relatively close to Earth's surface by gravity. The atmosphere is mostly nitrogen (78%) and oxygen (20%). The amount of water vapor in the atmosphere varies, but can be as much as 5% by volume. Other gases, present in much smaller amounts, also are extremely important parts of the atmosphere. Carbon dioxide (CO_2), methane (CH_4) and other gases, including water vapor, help radiate heat back toward Earth's surface, thus keeping it much warmer than it would be otherwise. Ozone, which is present in tiny amounts in part of the atmosphere, filters out most of the harmful ultraviolet radiation from the sun.

Life on Earth would not be possible without the atmosphere, which protects the planet's surface from extremes of temperature and harmful radiation, and also provides essential water, carbon dioxide, oxygen and nitrogen. This activity helps students learn about Earth's atmosphere by creating a scale model.

Unit Links

Mr. Slaptail's Curious Contraption
Story, pp. 6–9

Explorations
Swirled World, p. 4

SETUP

Divide the class into six groups of four students. Each group will be responsible for creating a different part of the model, which should be assembled and displayed on the floor or the wall. Copy and cut out the Job cards prior to class.

PROCEDURE

1. Ask students if they ever have seen pictures of astronauts in space. Ask, *Why do the astronauts wear special suits?* Mention that the space suits keep astronauts warm, provide them with air to breathe and protect them from harmful rays from the sun. Follow by asking if we need to wear space suits on Earth. Help students recognize that the thin layer of gases surrounding Earth—the atmosphere—provides protection for all of the planet, as space suits protect the astronauts.
2. Mention that, as a class, the students will create a scale model of Earth's protective layer of gases. Lay a sheet of brown or white paper (at least 2.5 m long) on the floor where students can work on it. Discuss the scale of the model with students (1 cm = 1/2 km; 2 cm = 1 km).
3. Distribute the Job cards to student groups. Each group will create and decorate a different part of the atmosphere model. Older students should measure and draw their own lines on the model. To facilitate work in groups, you may want students to cut off their sections of the model to complete in separate

CONCEPTS

- The atmosphere consists of layers of gases surrounding Earth.
- The layers have different characteristics.

OVERVIEW

By creating a scale model of the atmosphere, students learn about its composition and structure.

SCIENCE, HEALTH & MATH SKILLS

- Measuring
- Modeling
- Inferring

TIME

Preparation: 10 minutes
Class: One or two sessions of approximately 30 minutes

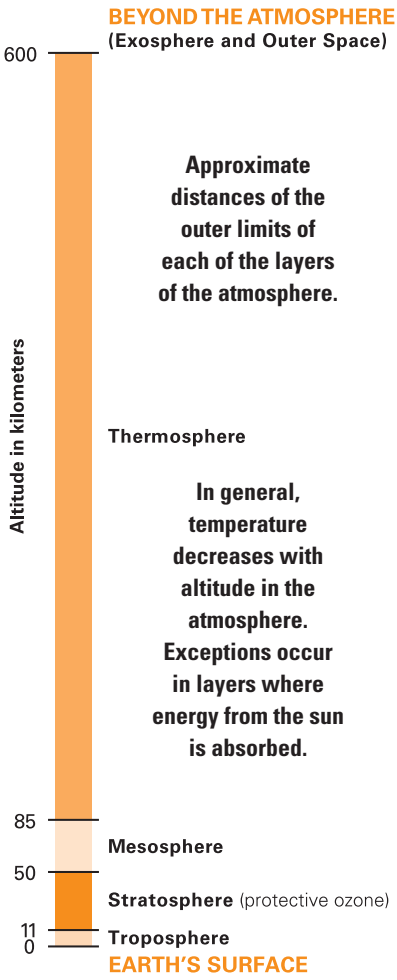
MATERIALS

- Large sheet of white or brown wrapping or banner paper, 1 m x 3 m (approx.)

Each group will need:

- 6 sheets of construction paper, asst. colors, 9 in. x 12 in.
- Crayons or markers
- Glue stick or roll of tape
- Pair of scissors
- Job cards from "Atmosphere Model" student sheets

The word "atmosphere" comes from the Greek word *atmos* (vapor) and the Latin *sphaera* or Greek *sphaira* (ball). The names of the layers are based on *tropos* (to turn), *stratum* (layer), *mesos* (middle) and *therme* (heat).



Ozone, a highly reactive gas molecule made of three oxygen atoms, is found naturally in the stratosphere. Even though it is present only in tiny amounts, ozone is vital to the planet. It absorbs most of the harmful ultraviolet radiation emitted by the sun and prevents it from reaching Earth's surface.

Near the ground, ozone often is produced as a byproduct of burning fossil fuels. Unfortunately, in this instance, ozone is very harmful. It can damage lungs and is harmful to other living things, such as plants.

In the atmosphere model created by students, 1 cm represents 0.5 km. Based on these proportions, the diameter of the Earth would have to be drawn as approximately 25,000 cm. The sun would be positioned 300,000,000 cm away!

locations. (Groups 1 and 2 work on the same section.) Once completed, the sections can be taped together.

Group 1–Planet Earth. Draws a vertical line about 15 cm from the bottom of the sheet of paper (this line represents the Earth's surface); creates figures (mountains, forests, cities, etc.), using construction paper or other materials and adds them to the model. Remind students that the figures they create should be no more than 5 cm tall.

Group 2–First layer of the atmosphere (troposphere). Draws a line about 22 cm from the line designating Earth's surface (represents the upper limit of the first layer); adds figures of weather phenomena (clouds, rain, lightning, etc.), as well as low-flying aircraft and hot air balloons. Point out to students that much of the pollution produced by burning wood and fossil fuels remains in the troposphere. The gases responsible for keeping Earth warm (greenhouse gases) are found in this layer. Temperatures within the troposphere decrease with altitude.

Group 3–Second layer of the atmosphere (stratosphere). Draws a line about 100 cm from the line for the Earth's surface (represents the upper limit of the second layer); adds figures of storm clouds, jet aircraft, wind, and a representation of the protection provided by ozone molecules in this layer. The stratosphere is warmer due to absorption of UV light by ozone.

Group 4–Third layer of the atmosphere (mesosphere). Draws a line about 170 cm from the line for the Earth's surface (represents the upper limit of the third layer); adds figures of feathery ice clouds and weather balloons. The mesosphere is very cold.

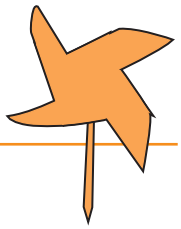
Group 5–Fourth layer of the atmosphere (thermosphere). Adds figures of spacecraft, satellites and meteors (shooting stars) to the model. If students were to draw a line, the upper limit of the thermosphere would be 1,200 cm (12 m) from the baseline of the model. This group may use the remainder of the space on the sheet. This layer is very hot in some parts—up to 1,700°C or more—due to absorption of radiation by different atoms and molecules.

Group 6–Space outside Earth. Creates figures representing other components of the solar system and universe, and places them around the room. The exosphere contains very small amounts of hydrogen and helium, and continues until it merges with space.

4. Have each group label its layer on the model. Display the model somewhere in the classroom. Encourage students to note that most activities involving the atmosphere occur very close to Earth's surface. Leave the model available for students to refer to throughout the unit.

Atmosphere Model

Job Cards



Group 1 Surface of Planet Earth

1. Draw a line across one end of the sheet of paper, about 15 cm from the bottom. This line represents Earth's surface.

2. Make figures that show different things found on the surface of Earth (like mountains, oceans, forests and buildings). The figures should be no taller than 5 cm. Glue or tape your figures onto the model.

Group 2 First Layer of the Atmosphere: The Troposphere

1. Draw a line about 22 cm above the line for Earth's surface. This line represents the top of the first layer of the atmosphere.

2. Make figures to represent weather (like clouds, rain, lightning and wind), as well as low-flying aircraft and hot air balloons. Glue or tape your figures onto the model within the troposphere.

Group 3 Second Layer of the Atmosphere: The Stratosphere

1. Draw a line about 100 cm above the line for Earth's surface. This line represents the top of the second layer of the atmosphere.

2. Make figures of storm clouds, jet aircraft, winds, and the protection provided by ozone. Glue or tape your figures onto the model within the stratosphere.

Group 4 Third Layer of the Atmosphere: The Mesophere

1. Draw a line about 170 cm above the line for Earth's surface. This line represents the top of the third layer of the atmosphere.

2. Make figures of feathery ice clouds and weather balloons. (Temperatures in this layer are very cold.) Glue or tape your figures onto the model within the mesophere.

Group 5 Fourth Layer of the Atmosphere: The Thermosphere

1. Use the remaining portion of the sheet to represent the thermosphere.

2. Make figures of spacecraft, satellites and meteors. (This layer is very hot.) Glue or tape your figures onto the model.

Group 6 Space Outside Earth's Atmosphere

1. Make figures representing other parts of the solar system and universe.

2. Place your figures anywhere around the room.

Modelo de la Atmósfera

Tarjetas de Trabajo

Grupo 1 Superficie de la Tierra

1. Dibujen una línea a lo largo de uno de los extremos del papel. Esta línea representa la superficie de la Tierra.

2. Hagan figuras de diferentes cosas que se encuentran sobre la Tierra (por ejemplo, montañas, océanos, bosques y edificios). Las figuras no deben de tener más de 5 cm de alto. Usen pegamento o cinta para colocar las figuras en el modelo.

Grupo 2 Primera Zona de la Atmósfera: La Tropósfera

1. Dibujen una línea aproximadamente 22 cm de la línea que representa la superficie. La nueva línea representa el límite superior de la primera zona.

2. Hagan figuras de aviones, globos y que corresponden al tiempo (por ejemplo, nubes, lluvia y rayos). Usen pegamento o cinta para colocar las figuras en el modelo.

Grupo 3 Segunda Zona de la Atmósfera: La Estratósfera

1. Dibujen una línea aproximadamente 100 cm de la línea que representa la superficie. La nueva línea representa el límite superior de la segunda zona.

2. Hagan figuras de cosas como nubes de tormentas, aviones de reacción, viento y la capa de ozono. Usen pegamento o cinta para colocar las figuras en el modelo.

Grupo 4 Tercera Zona de la Atmósfera: La Mesósfera

1. Dibujen una línea aproximadamente 170 cm de la línea que representa la superficie. La nueva línea representa el límite superior de la tercera zona.

2. Hagan figuras de cosas como nubes de hielo y globos meteorológicos. (La mesófera es muy fría.) Usen pegamento o cinta para colocar las figuras en el modelo.

Grupo 5 Cuarta Zona de la Atmósfera: La Termósfera

1. Su grupo puede usar el resto del papel para sus figuras.

2. Hagan figuras de cosas como naves espaciales, satelites y meteoros. Usen pegamento o cinta para colocar las figuras en el modelo.

Grupo 6 El Espacio Fuera de la Atmósfera:

1. Hagan figuras que representan otras partes del sistema solar y del universo.

2. Coloquen sus figuras dondequiera en el salon.