

# 14

## KEY CONCEPT

# Human activities affect the atmosphere.

### BEFORE, you learned

- The atmosphere has gases that absorb and give off radiation
- The ozone layer absorbs ultraviolet radiation
- The greenhouse effect keeps Earth warm

### NOW, you will learn

- What the types and effects of pollution are
- About the effect of human activities on greenhouse gases
- How the ozone layer is changing

## VOCABULARY

air pollution p. 27  
particulate p. 28  
fossil fuel p. 28  
smog p. 28

## EXPLORE Air Pollution

### Where does smoke go?

#### PROCEDURE

- 1 Light the candle and let it burn for a minute or two. Observe the air around the candle.
- 2 Blow out the candle and observe the smoke until you cannot see it anymore.

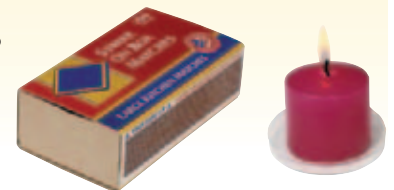
#### MATERIALS

- candle in holder
- matches



#### WHAT DO YOU THINK?

- How far did the smoke from the candle travel?
- A burning candle produces invisible gases. Where do you think they went?



## Human activity can cause air pollution.

If someone in your kitchen burns a piece of toast, and if a fan is blowing in the hallway, everyone in your home will smell the smoke. That means that everyone will breathe some air containing smoke. Smoke and other harmful materials that are added to the air are called **air pollution**. Outdoors, wind can spread air pollution from place to place the way a fan does within your home.

When toast burns, you may be able to see smoke. If smoke drifts in from another room, it may be too thin to see, but you may be able to smell it. There are other types of air pollution that you cannot see or smell. Like smoke, they can be spread around by wind. Air pollution from one place can affect a wide area. However, most types of pollution leave the air or become thin enough to be harmless after a time.

### CHECK YOUR READING

How is air pollution moved around?

**SUPPORTING MAIN IDEAS**  
Remember to start a new chart for each main idea.

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graph TD; A[ ] --- B[ ]; A --- C[ ]; A --- D[ ]
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## Types of Pollution

### READING TIP

*Pollution and pollutant have the same root, pollute—"to make unfit."*

Scientists classify the separate types of air pollution, called pollutants, as either gases or particles. Gas pollutants include carbon monoxide, methane, ozone, sulfur oxides, and nitrogen oxides. Some of these gases occur naturally in the atmosphere. These gases are considered pollutants only when they are likely to cause harm. For example, ozone gas is good in the stratosphere but is harmful to breathe. When ozone is in the troposphere, it is a pollutant.

Particle pollutants can be easier to see than gas pollutants.

**Particulates** are tiny particles or droplets that are mixed in with air. Smoke contains particulates. The wind can pick up other particulates, such as dust and dirt, pollen, and tiny bits of salt from the oceans. Some sources of pollutants are listed below.



### CHECK YOUR READING

What are the two types of pollutants? Give an example of each.

In cities and suburbs, most air pollution comes from the burning of fossil fuels such as oil, gasoline, and coal. **Fossil fuels** are fuels formed from the remains of prehistoric animals and plants. In London in the 1800s, burning coal provided much of the heat and energy for homes and factories. The resulting smoke and local weather conditions often produced a thick fog or cloud. The word **smog** describes this combination of smoke and fog. A newer type of air pollution is also called smog. Sunlight causes the fumes from gasoline, car exhaust, and other gases to react chemically. The reactions form new pollutants, such as ozone, which together are called smog. In cities, there can be enough smog to make a brownish haze.

## Sources of Pollution

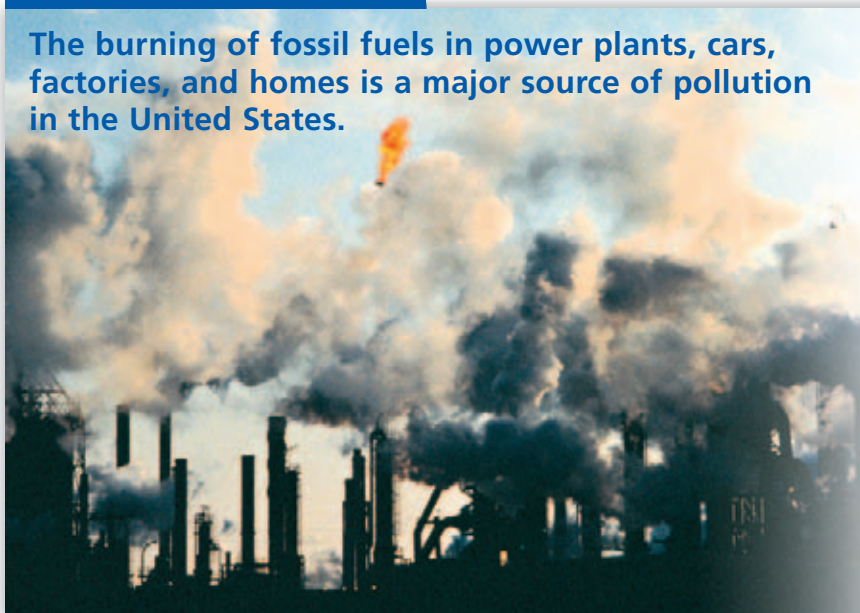
The burning of fossil fuels in power plants, cars, factories, and homes is a major source of pollution in the United States.

### Human Activities

- fossil fuels: gases and particles
- unburned fuels: smog
- manufacturing: gases and particles
- tractors/construction equipment: dust and soil
- farming: fertilizers and pesticides

### Natural Sources

- dust, pollen, soil, salt
- volcanoes and forest fires: gases and particles



## Effects of Pollution

Air pollution can cause health problems. Polluted air may irritate your eyes, nose, throat, and lungs. It can smell bad or make it hard to breathe. Gases or chemicals from particulates can move from your lungs to other parts of your body. Exercising in polluted air can be dangerous because you take more air into your lungs when you exercise. Over time, people who breathe polluted air can develop lung disease and other health problems. Air pollution can cause extra problems for young children, older adults, and people who suffer from asthma.



### CHECK YOUR READING

Describe three of the ways in which pollution can affect people.

A man in Mexico City wears a gas mask while he sells newspapers. The green sign behind him warns people of a high ozone level.

Particulates can stick to surfaces and damage plants, buildings, and other objects outdoors. Dusty air or a dust storm can darken the day and make it difficult to see. Particulates can be carried high into the atmosphere, where they can reflect or absorb sunlight and even affect the weather. Rain clears the air by removing particles and some polluting gases from the air. However, some pollutants are still harmful when rain moves them from the air to the ground, lakes, and oceans.

## Controlling Pollution

You may have experienced a smog or ozone alert. In some cities, smog becomes so bad that it is dangerous to exercise outdoors. Weather reports may include smog alerts so that people will know when to be careful. Cities may ask people not to drive cars when the weather conditions are likely to produce smog.

National, state, and local governments work together to reduce air pollution and protect people from its effects. Countries may come to agreements when the air pollution from one country affects another. Within the United States, Congress has passed laws to reduce air pollution. The Clean Air Act limits the amount of air pollution that factories and power plants are allowed to release. The act also sets rules for making car exhaust cleaner. The Environmental Protection Agency measures air pollution and works to enforce the laws passed by Congress.



## Human activities are increasing greenhouse gases.

A source of air pollution usually affects areas close to it. In contrast, some natural processes and human activities change the amounts of gases throughout Earth's atmosphere.

### Sources of Greenhouse Gases

You read in Section 1.1 how natural cycles move gases into and out of the atmosphere. Plant growth, forest fires, volcanoes, and other natural processes affect the amounts of carbon dioxide and other greenhouse gases in the atmosphere. The amounts of greenhouse gases then affect temperatures on Earth. In turn, the temperatures affect plant growth and other processes that produce or reduce greenhouse gases.

#### REMINDER

Plants remove carbon dioxide from the air and store the carbon in solid forms.

#### CHECK YOUR READING

How do life and the atmosphere affect each other?

Most greenhouse gases occur naturally. They have helped keep temperatures within a range suitable for the plants and animals that live on Earth. However, human activities are producing greenhouse gases faster than natural processes can remove these gases from the

### Greenhouse Gases from Human Activities

#### Carbon dioxide (CO<sub>2</sub>)

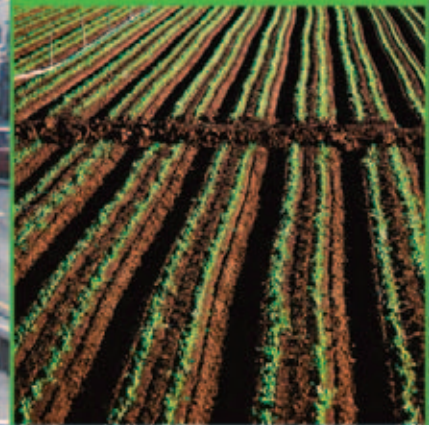
Carbon dioxide comes largely from the use of fossil fuels in power plants, cars, factories, and homes.

#### Methane (CH<sub>4</sub>)



Methane comes from cattle and other livestock, bacteria in rice fields, and landfills (waste disposal).

#### Nitrous oxide (N<sub>2</sub>O)



Nitrous oxide comes from fertilizers and chemical factories.

atmosphere. Some activities that produce greenhouse gases are shown on page 30. Water vapor is also a greenhouse gas, but the amount of water vapor in the air depends more on weather than on human activity.

## Global Warming

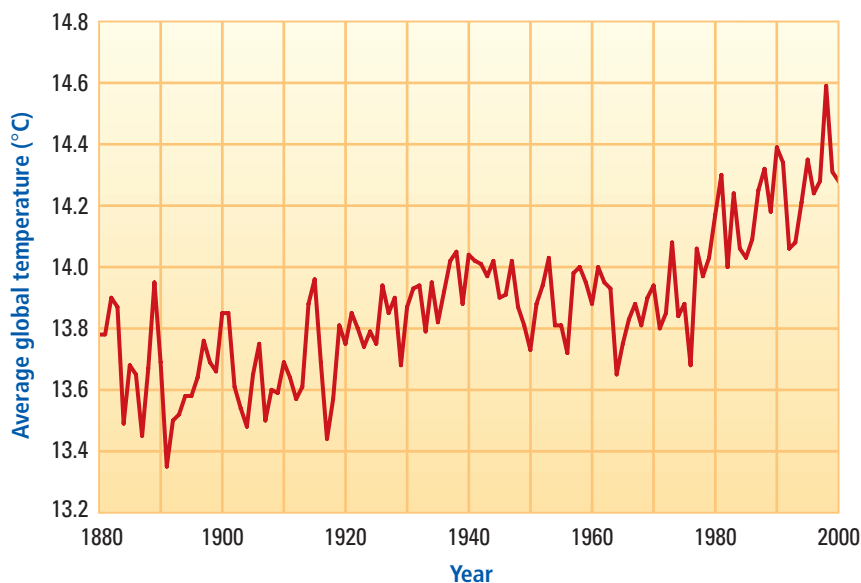
Many people are concerned about the amounts of greenhouse gases that humans are adding to the air. Carbon dioxide, for example, can stay in the atmosphere for more than 100 years, so the amounts keep adding up. The air contains about 30 percent more carbon dioxide than it did in the mid-1700s, and the level of carbon dioxide is now increasing about 0.4 percent per year.

### CHECK YOUR READING

How are carbon dioxide levels changing?

As the graph below shows, temperatures have risen in recent decades. Earth's atmosphere, water, and other systems work together in complex ways, so it is hard to know exactly how much greenhouse gases change the temperature. Scientists make computer models to understand the effects of greenhouse gases and explore what might happen in the future. The models predict that the average global temperature will continue to rise another 1.4–5.8°C (2.5–10.4°F) by the year 2100. This may not seem like a big change in temperature, but it can have big effects. Global warming can affect sources of food, the amount of water and other resources available, and even human health. You will read more about the possible effects of global warming in Chapter 4.

Global Surface Temperature Change



SOURCE: NASA Goddard Institute for Space Studies

Earth's average temperature has risen over the last century.



This commuter is traveling to work without burning fossil fuels.

## Reducing Greenhouse Gases

Global warming is not a local issue. It affects the atmosphere around the entire planet. An international agreement to limit the amounts of greenhouse gases, called the Kyoto Protocol, would require developed nations to release no more greenhouse gases each year than they did in 1990. The Kyoto Protocol could take effect only if the nations releasing the most greenhouse gases accept the agreement. In 1990, more than one-third of the amount of greenhouse gases released came from the United States, which has not accepted the agreement.

New technologies may help fight the problem of global warming. Scientists are developing ways to heat and cool buildings, transport people and goods, and make products using less energy. Using less energy saves resources and money and it also reduces greenhouse gases. Scientists are also developing ways to produce energy without using any fossil fuels at all.



How can technology help reduce global warming?

## Human activities produce chemicals that destroy the ozone layer.



Examine the current state of the ozone layer.

At ground level, ozone is a pollutant, but at higher altitudes it benefits life. The ozone layer in the stratosphere protects living things by absorbing harmful ultraviolet radiation. You read in Section 1.3 that ozone is constantly being formed and broken apart in a natural cycle.

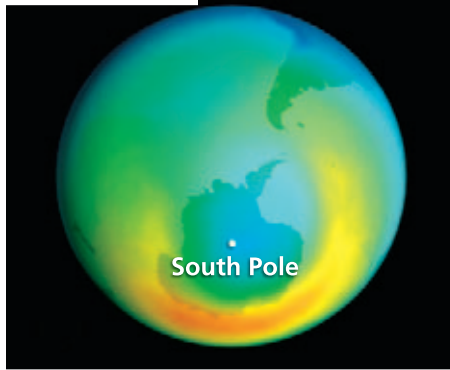
In the 1970s, scientists found that certain chemicals were disrupting this cycle. An atom of chlorine (Cl), for example, can start a series of chemical reactions that break apart ozone ( $O_3$ ) and form regular oxygen gas ( $O_2$ ). The same atom of chlorine can repeat this process thousands of times. No new ozone is formed to balance the loss.



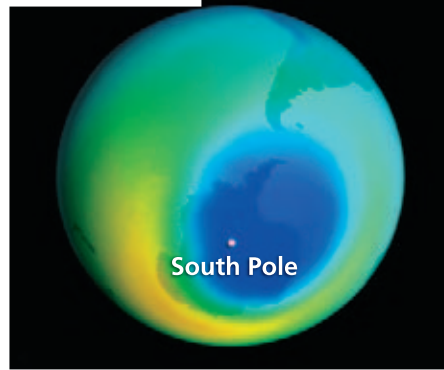
What does chlorine do to the amount of ozone in the stratosphere?

Some natural processes put chlorine into the stratosphere, but about 85 percent of the chlorine there comes from human activity. Chemicals called chlorofluorocarbons (KLAWR-oh-FLUR-oh-KAHR-buhnZ) have been manufactured for use in cooling systems, spray cans, and foam for packaging. These chemicals break down in the stratosphere and release chlorine and other ozone-destroying chemicals.

October 1979



October 2000



The size of the dark blue area of little ozone increased from 1979 to 2000.



SOURCE: Goddard Space Flight Center/NASA

**READING VISUALS** Compare the color at one location on both maps. How has the amount of ozone changed?

The amount of ozone in the stratosphere varies from place to place and changes with the seasons. Cold temperatures and sunshine make the ozone over Antarctica—the South Pole—especially sensitive to the chemicals that destroy ozone. The amount of ozone over Antarctica decreased by half from the 1970s to the mid-1990s. The maps above show the loss of ozone over Antarctica. Smaller but important changes were measured in other regions.

The ozone layer affects the whole world. Since 1987, more than 180 nations have signed an agreement called the Montreal Protocol. They have agreed on a plan to stop making and using chemicals that harm the ozone layer. Experts study the ozone layer and recommend changes to the agreement. The Montreal Protocol has been updated several times. Less harmful chemicals are now used instead of chlorofluorocarbons, but gases from past human activities are still in the ozone layer. If countries continue to follow the Montreal Protocol, ozone levels will return to normal in about 50 years.

## 1.4 Review

### KEY CONCEPTS

1. Describe two of the sources of air pollution.
2. What are three human activities that increase the levels of greenhouse gases?
3. How do human activities affect the ozone layer?

### CRITICAL THINKING

4. **Classify** List the following pollutants as either gases or particles: dust, ozone, pollen, carbon monoxide, methane.
5. **Predict** How might global warming affect the way you live in the future?

### CHALLENGE

6. **Synthesize** In North America, winds typically blow from west to east. Where might pollution from your community end up? Use a map to help you answer the question.