

SECTION 1 **What Is Climate?**

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What is climate?
- What factors affect climate?
- How do climates differ around the world?

National Science Education Standards
ES 1f, 1j, 3d

What Is Climate?

How is weather different from climate? **Weather** is the condition of the atmosphere at a certain time. The weather can change from day to day. In contrast, **climate** describes the average weather conditions in a region over a long period of time. The climate of an area includes the area's average temperature and amount of precipitation. Different parts of the world have different climates.

STUDY TIP

Ask Questions As you read this section, write down any questions that you have. When you finish reading, talk about your questions in a small group.

What Factors Affect Climate?

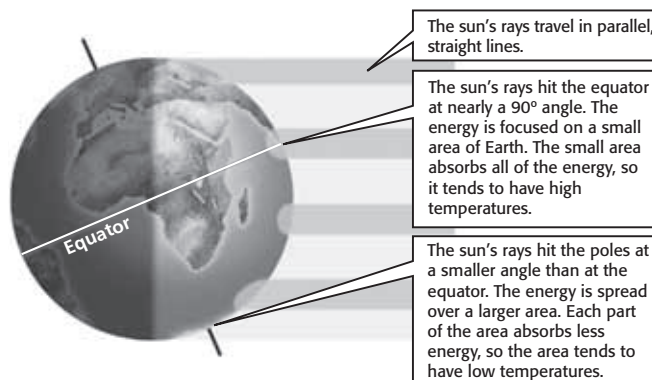
Climate is mainly determined by temperature and precipitation. Many factors affect temperature and precipitation, including latitude, wind patterns, landforms, and ocean currents. ✓

READING CHECK

1. List What are the two main things that determine climate?

SOLAR ENERGY AND LATITUDE

Remember that the **latitude** of an area is its distance north or south of the equator. In general, the temperature of an area depends on its latitude. Latitudes closer to the poles tend to have colder climates. Latitude affects temperature because latitude determines how much direct solar energy an area gets, as shown in the figure below.



TAKE A LOOK

2. Explain Why do areas near the equator tend to have high temperatures?

SECTION 1 What Is Climate? *continued*

STANDARDS CHECK

ES 3d The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day.

Word Help: major
of great importance or large scale

Word Help: energy
the ability to make things happen

Word Help: phenomenon
any fact or event that can be sensed or described scientifically (plural, *phenomena*)

3. Explain Why don't areas near the equator have large seasonal changes in weather?

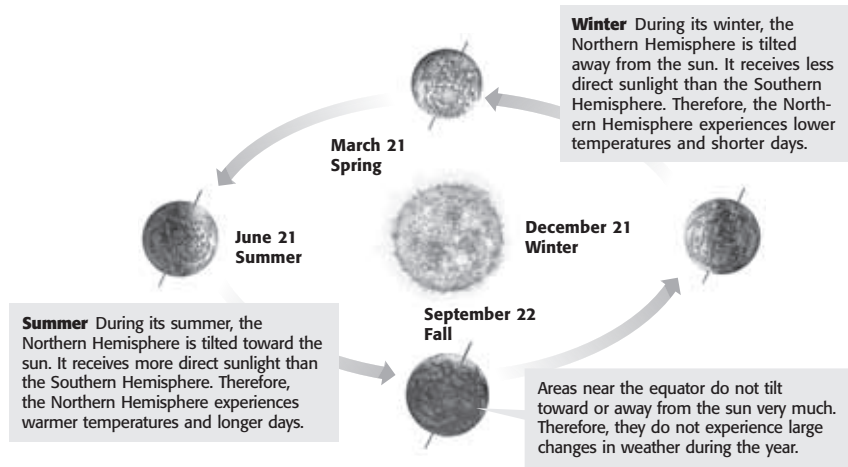
READING CHECK

4. Identify What causes wind to form?

LATITUDE AND SEASONS

Most places in the United States have four seasons during the year. However, some places in the world do not have such large seasonal changes. For example, places near the equator have about the same temperatures and amounts of daylight all year.

Seasons happen because Earth is tilted on its axis by about 23.5°. This tilt affects how much solar energy an area gets as Earth orbits the sun. The figure below shows how Earth's tilt affects the seasons.



PREVAILING WINDS

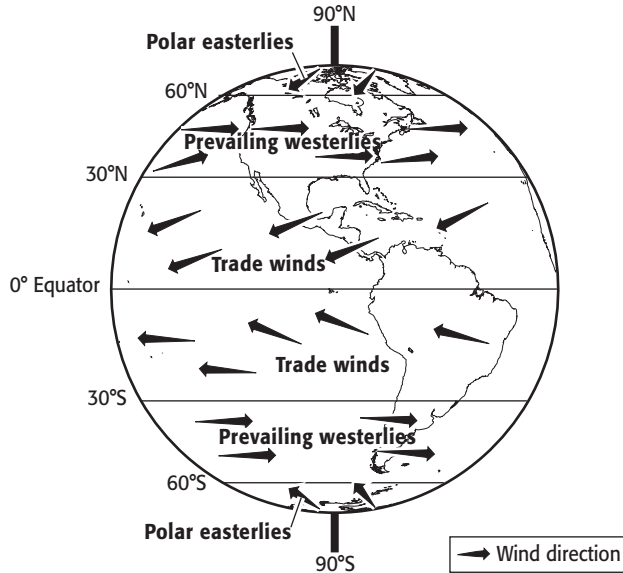
Prevailing winds are winds that blow mainly in one direction. The wind patterns on Earth are caused by the uneven heating of Earth's surface. This uneven heating forms areas with different air pressures. *Wind* forms when air moves from areas of high pressure to areas of low pressure. ✓

Prevailing winds affect climate and weather because they move solar energy from one place to another. This can cause the temperature in one place to decrease and the temperature in another place to increase.

Prevailing winds also affect the amount of precipitation an area gets. They can carry water vapor away from the oceans. The water vapor can condense and fall to the land somewhere far from the ocean.

The figure on top of the next page shows the major prevailing winds on Earth. Notice that most prevailing winds blow from west to east or from east to west.

SECTION 1 What Is Climate? *continued*



TAKE A LOOK

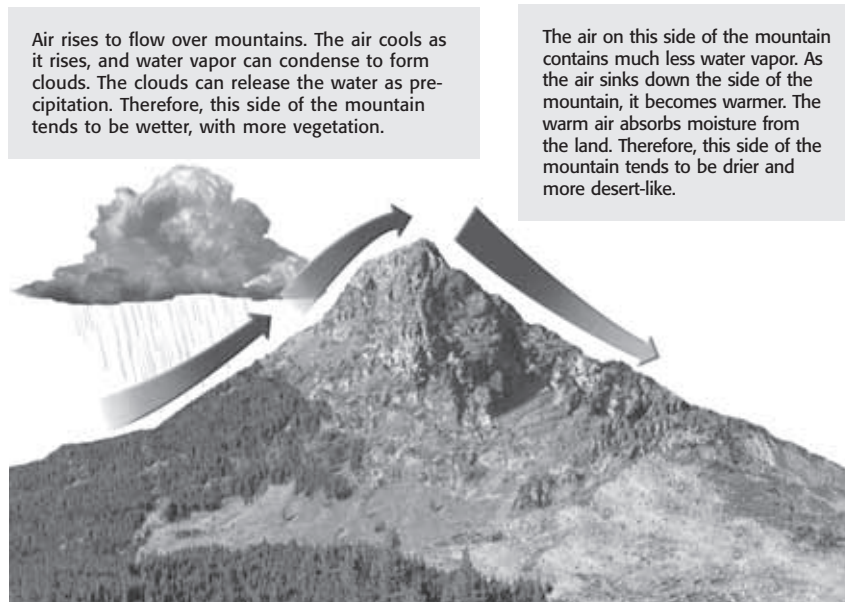
5. Read a Map In which direction do the Prevailing Westerlies blow?

TOPOGRAPHY

The sizes and shapes of the land-surface features of a region form its *topography*. The topography of an area affects its climate because topography can affect temperature and precipitation. For example, elevation is a feature of topography that can have a large impact on temperature.

Elevation is the height of an area above sea level. As elevation increases, temperature tends to decrease. ✓

Mountains can also affect precipitation. As air rises to move over a mountain, it cools. The cool air condenses, forming clouds. Precipitation may fall. This process causes the *rain-shadow effect*, which is illustrated in the figure below.



READING CHECK

6. Describe In general, how does elevation affect temperature?

TAKE A LOOK

7. Explain Why do clouds form as air moves over a mountain?

SECTION 1 What Is Climate? *continued*

LARGE WATER BODIES

Large bodies of water can affect an area’s climate. Water absorbs and releases heat more slowly than land. This quality helps regulate the air temperature over the land nearby. This is why sudden temperature changes are not very common in areas near large bodies of water. ✓

An example of this effect is the climate of Michigan. Michigan is surrounded by the Great Lakes. It has more-moderate temperatures than other places at the same latitude. However, the lakes also increase the humidity of the air. This can cause heavy snowfalls in the winter.

READING CHECK

8. Explain Why aren’t sudden temperature changes common near large bodies of water?

OCEAN CURRENTS

Surface currents can have a big effect on a region’s climate. **Surface currents** are paths of flowing water found near the surface of the ocean. As surface currents move, they carry warm or cool water to different places. The temperature of the water affects the temperature of the air above it. For example, warm currents can heat the surrounding air.

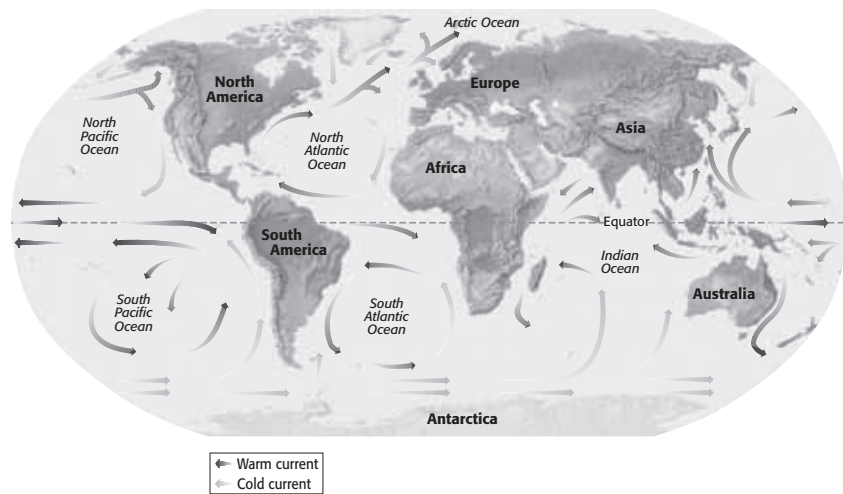
An example of the effects of ocean currents on climate can be seen in Iceland. Iceland is an island near the Arctic Circle. The Gulf Stream, a warm surface current, flows past Iceland. The warm water in the Gulf Stream causes Iceland’s climate to be fairly mild. In contrast, the island of Greenland is at a similar latitude but is not affected by the Gulf Stream. Greenland’s climate is much colder than Iceland’s.

Critical Thinking

9. Describe Processes
Cool surface currents can cause the air above them to become cooler. Explain how this happens.

TAKE A LOOK

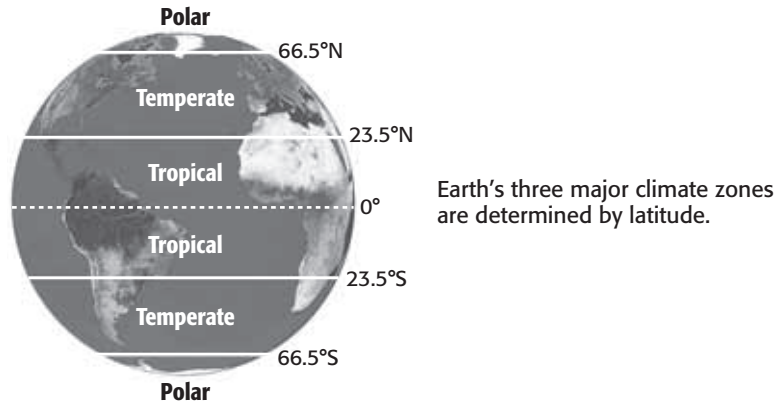
10. Identify What kind of surface current is found off the East Coast of the United States?



SECTION 1 What Is Climate? *continued*

What Are the Different Climates Around the World?

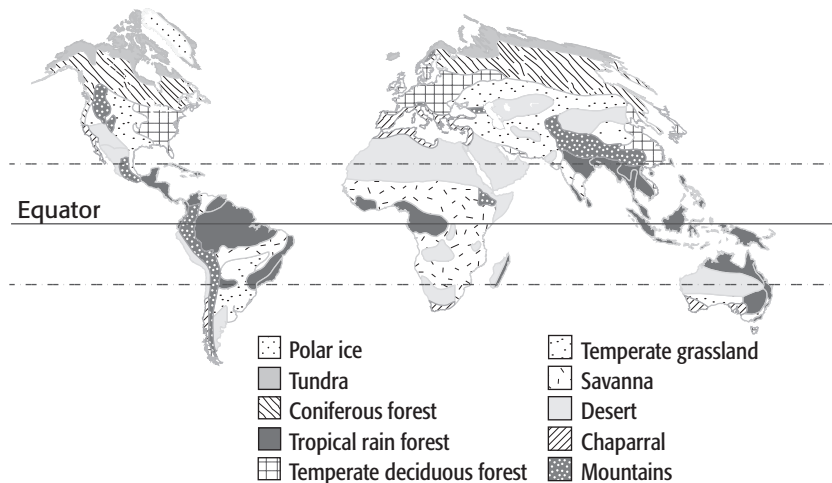
Earth has three major climate zones: tropical, temperate, and polar. The figure below shows where these zones are found.



Each climate zone has a certain range of temperatures. The tropical zone, near the equator, has the highest temperatures. The polar zones, located at latitudes above 66.5°, have the lowest temperatures. ✓

BIOMES

Each climate zone contains several different kinds of climates. The different climates are the result of topography, winds, and ocean currents. The different climates affect the organisms that live in an area. A large area with a certain climate and types of organisms is called a **biome**. ✓



This map shows some of the major land biomes on Earth.

TAKE A LOOK

11. Identify What determines Earth's major climate zones?

READING CHECK

12. Describe Which climate zone has the highest temperatures?

READING CHECK

13. Identify Relationships How are biomes and climate related?

TAKE A LOOK

14. Explain Where are most tropical rain forest biomes located?

Section 1 Review

NSES ES 1f, 1j, 3d

SECTION VOCABULARY

biome a large region characterized by a specific type of climate and certain types of plant and animal communities

climate the average weather conditions in an area over a long period of time

elevation the height of an object above sea level

latitude the distance north or south from the equator; expressed in degrees

prevailing winds winds that blow mainly from one direction during a given period

surface current a horizontal movement of ocean water that is caused by wind and that occurs at or near the ocean's surface

weather the short-term state of the atmosphere, including temperature, humidity, precipitation, wind, and visibility

1. Compare How is climate different from weather?

2. Apply Concepts Nome, Alaska, lies at 64°N latitude. San Diego, California, lies at 32°N latitude. Which city receives more sunlight? Explain your answer.

3. Explain What causes some places on Earth to have seasons?

4. Identify What are four things that can affect climate?

5. Explain Describe how the rain-shadow effect works.

BEFORE YOU READ

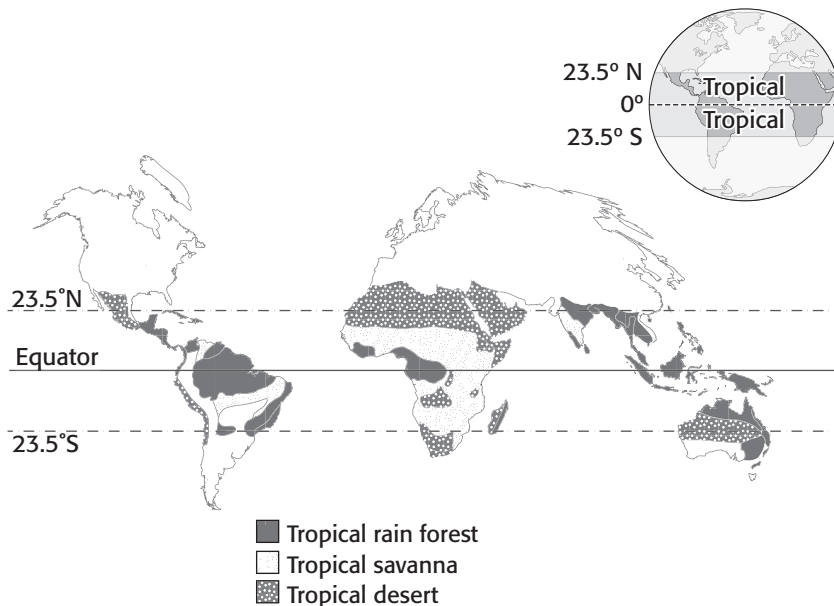
After you read this section, you should be able to answer these questions:

- Where is the tropical zone?
- What are three biomes found in the tropical zone?

What Is the Tropical Zone?

Remember that latitudes near the equator receive more solar energy than other areas. The area between 23.5°N latitude and 23.5°S latitude receives the most solar energy. This region is called the **tropical zone**. It is also known as the *Tropics*. Because areas in the Tropics receive so much solar energy, they tend to have high temperatures.

There are three main biomes in the Tropics: tropical rain forest, tropical savanna, and tropical desert. All the tropical biomes have high temperatures. However, they receive different amounts of rain and have different types of soil. Therefore, different organisms live in each biome. The figure below shows where each of these biomes is found. ✓



STUDY TIP

Compare After you read this section, make a chart comparing the three kinds of tropical biomes.

READING CHECK

1. Explain Why do the different tropical biomes have different organisms living in them, even though they all have high temperatures?

TAKE A LOOK

2. Identify Where are the Tropics?

SECTION 2 The Tropics *continued*

TROPICAL RAIN FORESTS

Tropical rain forests are warm and wet. They are located close to the equator, so they receive about the same amount of solar energy all year long. Therefore, there is little difference between the seasons. ✓

Tropical rain forests are homes to many different kinds of living things. Animals that live in tropical rain forests include monkeys, parrots, frogs, tigers, and leopards. Plants include mahogany trees, vines, ferns, and bamboo.

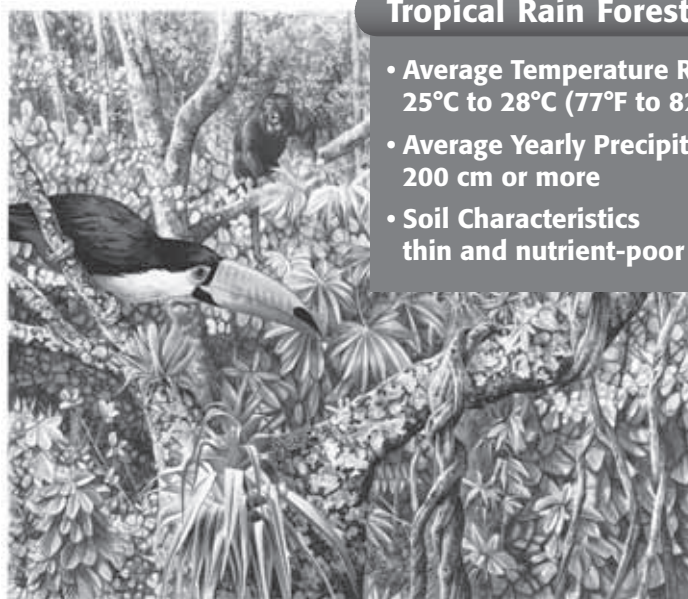
Many organisms live in tropical rain forests. When dead organisms decay, nutrients return to the soil. However, the nutrients are quickly used up by plants or washed away by rain. As a result, the soil is thin and poor in nutrients.

READING CHECK

3. Explain Why is there little difference between the seasons in a tropical rain forest?

TAKE A LOOK

4. Explain Why is the soil in tropical rainforests thin and nutrient-poor?



Tropical Rain Forest

- Average Temperature Range 25°C to 28°C (77°F to 82°F)
- Average Yearly Precipitation 200 cm or more
- Soil Characteristics thin and nutrient-poor

TROPICAL SAVANNAS

Tropical savannas, or grasslands, contain tall grasses and a few trees. The climate is usually very warm. Tropical savannas have two main seasons. The dry season lasts four to eight months. It is followed by a wet season that contains short periods of rain.

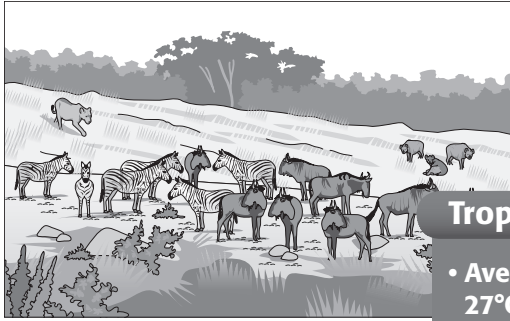
Because savannas are often dry, fires are common. These fires can help to enrich the soil in the savanna. Many plants in the savanna have adapted to yearly fires and rely on them for growth. For example, some plants need fire to break open their seeds' outer skin.

Animals that live in tropical savannas include giraffes, lions, crocodiles, and elephants. The figure on the top of the next page shows a tropical savanna.

Critical Thinking

5. Predict Consequences What could happen to a tropical savanna if people stopped all fires from spreading? Explain your answer.

SECTION 2 The Tropics *continued*



Tropical Savanna

- Average Temperature Range 27°C to 32°C (80°F to 90°F)
- Average Yearly Precipitation 100 cm
- Soil Characteristics generally nutrient-poor

Math Focus

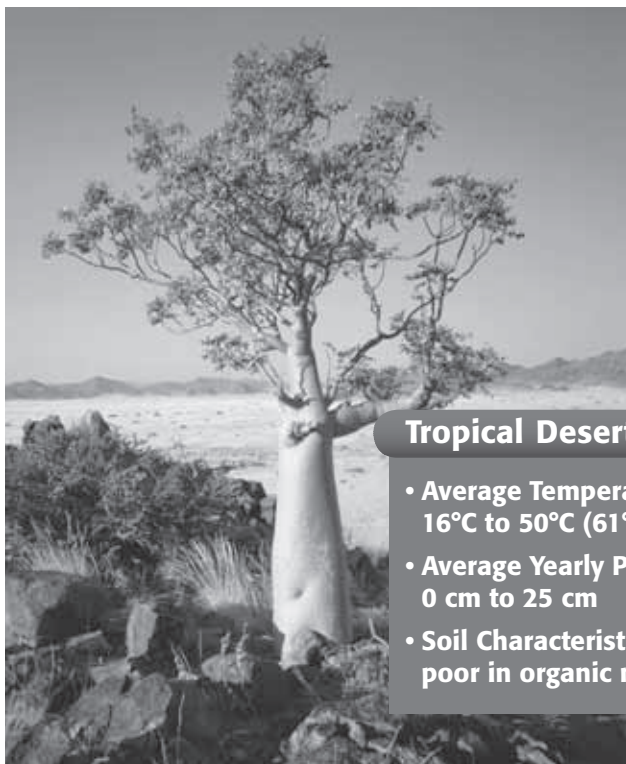
6. Convert About how many feet of rain does a tropical savanna get in a year?

1 in. = 2.54 cm

TROPICAL DESERTS

A desert is an area that receives less than 25 cm of rainfall per year. Deserts are the driest places on Earth. Tropical desert plants, such as shrubs, are adapted to living in places with little water. Animals such as camels, lizards, snakes, and scorpions also have adaptations for living in the desert.

Most tropical deserts are very hot in the daytime. They can be up to 50°C (120°F) during the day. However, the temperatures at night may be much lower. Therefore, organisms that live in deserts are also adapted to changing temperatures. ✓



Tropical Desert

- Average Temperature Range 16°C to 50°C (61°F to 120°F)
- Average Yearly Precipitation 0 cm to 25 cm
- Soil Characteristics poor in organic matter

READING CHECK

7. Explain Why do tropical desert organisms have to be adapted to changing temperatures?

Section 2 Review

SECTION VOCABULARY

tropical zone the region that surrounds the equator and that extends from about 23° north latitude to 23° south latitude	
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1. **List** What are the three biomes found in the Tropics?

2. **Identify** What is one thing that all the biomes in the Tropics have in common?

3. **Compare** Fill in the missing information about the features of each tropical biome.

Biome	Rainfall	Soil	Example of an animal found here	Example of a plant found here
Tropical rain forest		poor	parrot	
	100 cm per year		giraffe	
		poor		palm tree

4. **Apply Concepts** An area is located at 30°N latitude. It receives less than 25 cm per year of rain and has temperatures as high as 50°C during the day. Is the area a tropical desert? Explain your answer.

5. **Identify** On which continent are most tropical savannas found?

6. **Identify** Which tropical biome has the largest range of temperatures? Which tropical biome has the smallest range of temperatures?

Temperate and Polar Zones

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What biomes are found in the temperate zone?
- What biomes are found in the polar zone?
- What are two examples of microclimates?

What Is the Temperate Zone?

The climate zone between the tropical and the polar zones is the **temperate zone**. This zone extends from about 23.5° to about 66.5° north or south latitudes. Most of the continental United States is in the temperate zone. The temperate zone receives less solar energy than the Tropics. Therefore, temperatures in the temperate zone tend to be lower than those in the Tropics.

The four main biomes in the temperate zone are temperate forests, temperate grasslands, chaparrals, and temperate deserts. All of these biomes show seasonal changes in weather. However, some biomes have more extreme weather changes than others. For example, some areas in the United States have similar temperatures all year long. Other areas have very low temperatures in the winter and very high temperatures in the summer. ✓



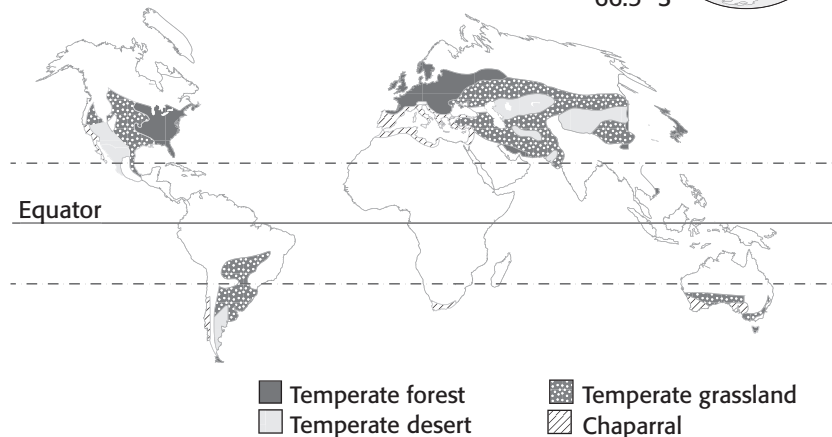
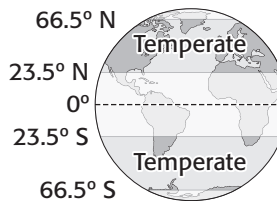
Compare After you read this section, make a table comparing the four main temperate biomes.



1. Identify What do the four main temperate biomes have in common?

TAKE A LOOK

2. Read a Map What kind of biome is found in northern and southern Africa?



SECTION 3 Temperate and Polar Zones *continued*

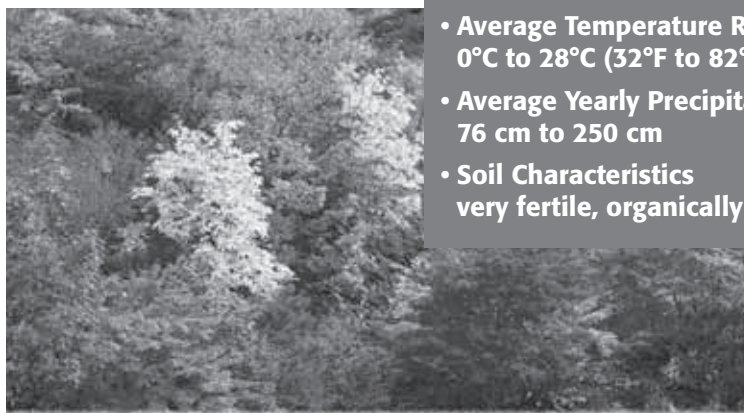
Critical Thinking

3. Infer A student visits a forest in Vermont in January. Most of the trees in the forest are covered with leaves. Are the trees probably deciduous trees or evergreens? Explain your answer.

TEMPERATE FORESTS

Temperate forests tend to have high amounts of rainfall and large seasonal temperature differences. The summers are warm, and the winters are cold. Animals that live in temperate forests include foxes, deer, and bears. Some trees in temperate forests lose their leaves each winter. These trees are called *deciduous* trees. Other trees, called *evergreens*, do not lose all of their leaves at once.

The soils in most temperate forests are very rich in nutrients. This is because the deciduous trees drop their leaves every winter. As the leaves decay, nutrients are added to the soil.



Temperate Forest

- Average Temperature Range
0°C to 28°C (32°F to 82°F)
- Average Yearly Precipitation
76 cm to 250 cm
- Soil Characteristics
very fertile, organically rich

TEMPERATE GRASSLANDS

Temperate grasslands have warm summers and very cold winters. Few trees grow in temperate grasslands because they do not receive enough rain. Animals that live in temperate grasslands include bison and kangaroos.

Of all the land biomes, temperate grasslands have the most fertile soil. As a result, much of the grassland on Earth has been plowed up to make room for crops.



Temperate Grassland

- Average Temperature Range
-6°C to 26°C (21°F to 78°F)
- Average Yearly Precipitation
38 cm to 76 cm
- Soil Characteristics
most-fertile soils of all biomes

TAKE A LOOK

4. Identify What is the main kind of plant that grows in temperate grasslands?

SECTION 3 Temperate and Polar Zones *continued*

CHAPARRALS

Chaparral regions have cool, wet winters and hot, dry summers. Animals that live in the chaparral include mountain lions, coyotes, and quail.

Fires are common during the summers in chaparrals. Some chaparral plants are adapted to these fires. Chaparral plants also have adaptations that prevent water loss during dry conditions. For example, the main kinds of plants in the chaparral are evergreen shrubs. These shrubs have thick leaves with waxy coatings. The coatings help prevent the leaves from losing water. ✓



Chaparral

- Average Temperature Range
11°C to 26°C (51°F to 78°F)
- Average Yearly Precipitation
48 cm to 56 cm
- Soil Characteristics
rocky, nutrient-poor soils

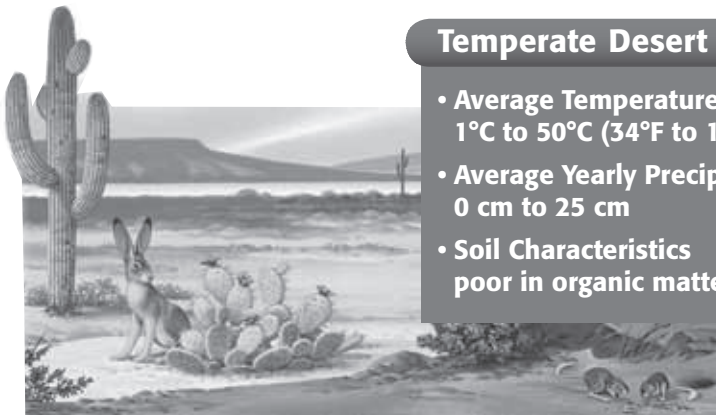
✓ **READING CHECK**

5 Describe What adaptation do evergreen shrubs in the chaparral have to survive dry conditions?

TEMPERATE DESERTS

Like tropical deserts, temperate deserts are hot in the daytime and receive little rainfall. However, temperate deserts tend to have much colder nights than tropical deserts. This is because temperate deserts tend to have low humidity and cloudless skies. These conditions allow solar energy to heat the surface a lot during the day. They also allow heat to move into the atmosphere at night. ✓

Plants that live in temperate deserts include cacti, shrubs, and thorny trees. Animals include lizards, snakes, bats, and toads.



Temperate Desert

- Average Temperature Range
1°C to 50°C (34°F to 120°F)
- Average Yearly Precipitation
0 cm to 25 cm
- Soil Characteristics
poor in organic matter

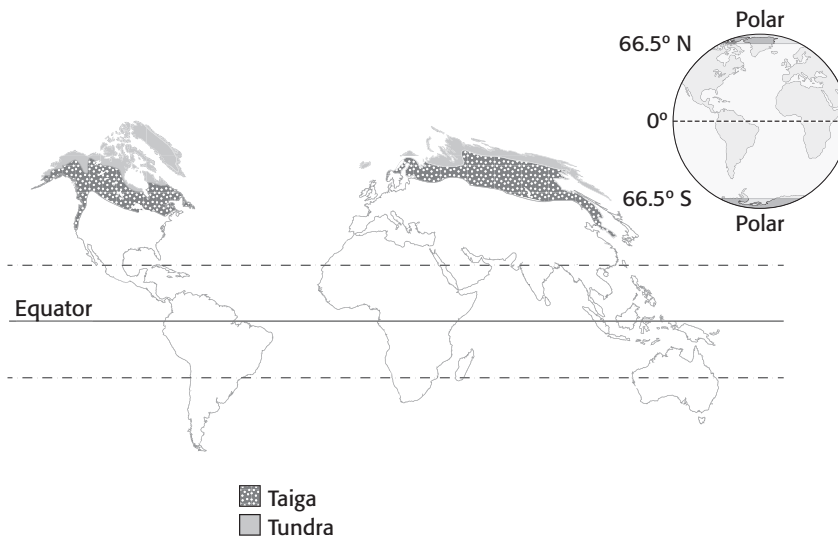
✓ **READING CHECK**

6. Compare How are temperate deserts different from tropical deserts? Give one way.

SECTION 3 Temperate and Polar Zones *continued*

What Is the Polar Zone?

The **polar zone** is located between 66.5° and 90° north and south latitudes, near the North and South Poles. This zone has the coldest temperatures of all climate zones. There are two biomes in the polar zone: tundra and taiga.



TAKE A LOOK

7. Identify On which continents is taiga found?

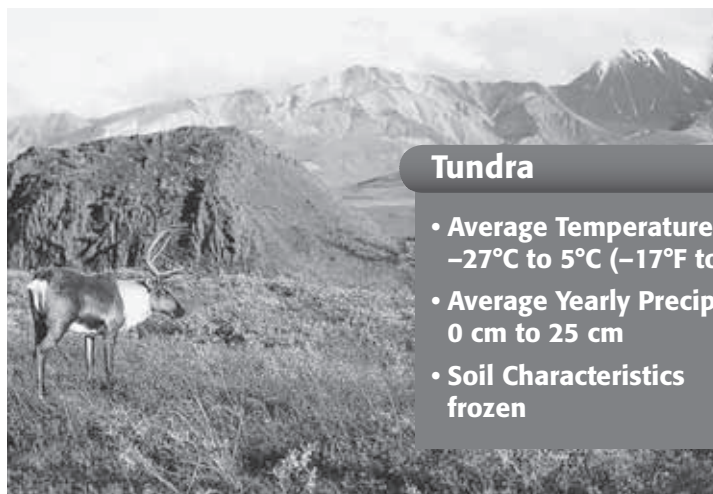
TUNDRA

The tundra has long, cold winters and short, cool summers. In the summer, only the top meter of soil thaws out. Below this depth is a permanently frozen layer called *permafrost*. It prevents water in the thawed soil from draining away. Therefore, the upper soil is muddy in the summer. Insects like mosquitoes thrive there. Birds migrate there in the summer to eat the insects. ✓

Other animals that live in the tundra include caribou, reindeer, and polar bears. Only small plants, such as mosses, live in the tundra.

READING CHECK

8. Explain Why is the upper soil in the tundra muddy during the summer?



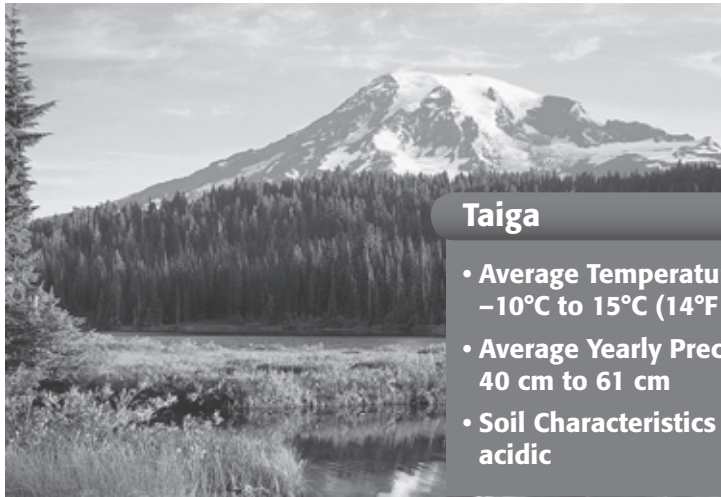
Tundra

- Average Temperature Range -27°C to 5°C (-17°F to 41°F)
- Average Yearly Precipitation 0 cm to 25 cm
- Soil Characteristics frozen

SECTION 3 Temperate and Polar Zones *continued***TAIGA**

Taiga biomes are found just south of tundra biomes in the Northern Hemisphere. The taiga has long, cold winters and short, warm summers. Animals that live in the taiga include moose, bears, and rabbits.

Evergreen trees called *conifers*, such as pine and spruce, are the main plants that grow in the taiga. The needle-like leaves from these trees contain acidic substances. When the needles die and decay on the ground, these substances make the soil acidic. Not very many plants can grow in acidic soils. Therefore, few plants grow on the forest floor of the taiga.

**Taiga**

- Average Temperature Range
-10°C to 15°C (14°F to 59°F)
- Average Yearly Precipitation
40 cm to 61 cm
- Soil Characteristics
acidic

What Are Microclimates?

Remember that latitude, topography, and water help determine the climate of an area. Local conditions can also affect the climate in smaller areas. A **microclimate** is the climate of a small area. Two examples of microclimates are alpine biomes and cities. ✓

Alpine biomes are cold microclimates found near the tops of mountains. In winter, the temperatures are below freezing. In summer, they range from 10°C to 15°C. It is the high elevations of alpine biomes that cause them to be so cold. Alpine biomes are even found on mountains in the Tropics.

Cities are also microclimates. Buildings and pavement are made of dark materials. They absorb solar energy and stay warm. City temperatures can be 1°C to 2°C warmer than temperatures in other areas.



Share Experiences In a small group, talk about different biomes that you or your classmates have visited.

Math Focus

9. Convert How much precipitation does the taiga get per year in inches?

1 in. = 2.54 cm



10. Define What is a microclimate?

Section 3 Review

SECTION VOCABULARY

microclimate the climate of a small area	temperate zone the climate zone between the Tropics and the polar zone
polar zone the North or South Pole and the surrounding region	

1. **List** What are the four biomes of the temperate zone?

2. **Identify** At what latitudes is the temperate zone found?

3. **Explain** Why are temperate deserts very hot during the day but very cold at night?

4. **Explain** Why do cities often have higher temperatures than surrounding rural areas?

5. **Explain** Why are most taiga soils acidic?

6. **Compare** How are temperate deserts and the tundra similar?

7. **Explain** Why do few trees grow in temperate grasslands?

Changes in Climate

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- How has Earth's climate changed over time?
- What factors can cause climates to change?

National Science Education Standards
ES 1k, 2a

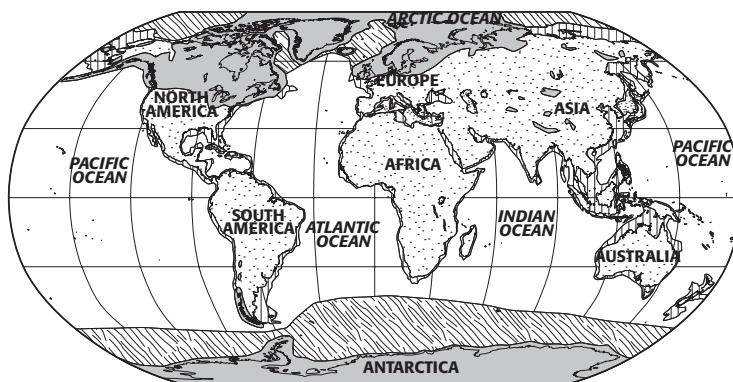
How Was Earth's Climate Different in the Past?

The geologic record shows that Earth's climate in the past was different from its climate today. During some periods in the past, Earth was much warmer. During other periods, Earth was much colder. In fact, much of Earth was covered by sheets of ice during some times in the past.

An **ice age** happens when ice at high latitudes expands toward lower latitudes. Scientists have found evidence of many major ice ages in Earth's history. The most recent one began about 2 million years ago. ✓

Many people think of an ice age as a time when the temperature is always very cold. However, during an ice age, there can be periods of colder or warmer weather. A period of colder weather is called a *glacial period*. A period of warmer weather is called an *interglacial period*.

During glacial periods, large sheets of ice grow. These ice sheets form when ocean water freezes. Therefore, sea level drops during glacial periods. The figure below shows the coastlines of the continents during the last glacial period. Notice that the continental coastlines extended further into the ocean than they do today.



Extent of land mass at glacial maximum	Extent of continental glaciation
Current land mass	Extent of sea ice

STUDY TIP

Learn New Words As you read, underline any words that you don't know. When you figure out what they mean, write the words and their definitions in your notebook.

READING CHECK

1. Define Write your own definition for *ice age*.

TAKE A LOOK

2. Explain Why is more land exposed during glacial periods than at other times?

SECTION 4 Changes in Climate *continued*

What Can Cause Climates to Change?

Scientists have several theories to explain ice ages and other forms of climate change. Factors that can cause climate change include Earth's orbit, plate tectonics, the sun's cycles, asteroid impacts, volcanoes, and human activities.

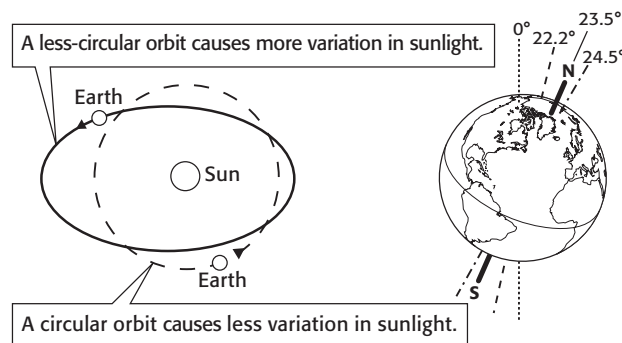
CHANGES IN EARTH'S ORBIT

A Serbian scientist, Milutin Milankovitch, found that changes in Earth's orbit and tilt can affect Earth's climate. He modeled the way Earth moves in space and found that Earth's movements change in a regular way. These changes happen over tens of thousands of years. For example, Earth's orbit around the sun is more circular at some times than others.

These variations in Earth's orbit and tilt affect how much sunlight Earth gets. Therefore, they can also affect climate. The figure below shows how these factors can change the amount of sunlight Earth gets.

Critical Thinking

3. Infer Could changes in climate over 100 years be caused by changes in Earth's orbit and tilt? Explain your answer.

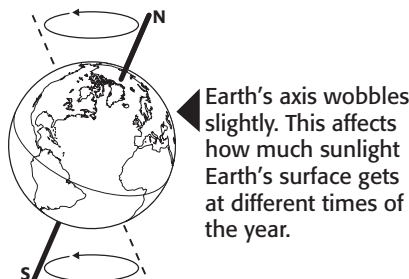


Earth's orbit is more circular at some times than at other times. The amount of solar energy that Earth gets from the sun varies more when Earth's orbit is less circular.

Earth's tilt on its axis can vary. When the tilt is greater, the poles get more solar energy.

TAKE A LOOK

4. Identify How does the shape of Earth's orbit change?



Earth's axis wobbles slightly. This affects how much sunlight Earth's surface gets at different times of the year.

SECTION 4 Changes in Climate *continued*

PLATE TECTONICS

Plate tectonics and continental drift also affect Earth’s climate. When a continent is closer to the equator, its climate is warmer than when it is near the poles. Also, remember that continents can deflect ocean currents and winds. When continents move, the flow of air and water around the globe changes. These changes can strongly affect Earth’s climate.



The locations of the continents can affect their climate. When India, Africa, South America, and Australia were part of Pangaea, they were covered with large ice sheets.

TAKE A LOOK

5. Identify How was the climate of India different when it was part of Pangaea?

THE SUN

Some changes in Earth’s climate are caused by changes in the sun. Many people think that the sun is always the same, but this is not true. In fact, the amount of energy that the sun gives off can change over time. The sun follows a regular cycle in how much energy it gives off. Because the sun’s energy drives most cycles on Earth, these changes can affect Earth’s climate.

READING CHECK

6. Explain Why do changes in the sun’s energy affect the climate on Earth?

IMPACTS

Sometimes, objects from outer space, such as asteroids, crash into Earth. An *asteroid* is a small, rocky object that orbits the sun. If a large asteroid crashed into Earth, the climate of the whole planet could change.

When a large object hits Earth, particles of dust and rock fly into the atmosphere. This material can block some sunlight from reaching Earth’s surface. This can cause temperatures on Earth to go down. In addition, plants may not be able to survive with less sunlight. Without plants, many animals would die off. Many scientists believe that an asteroid impact may have caused the dinosaurs to become extinct.

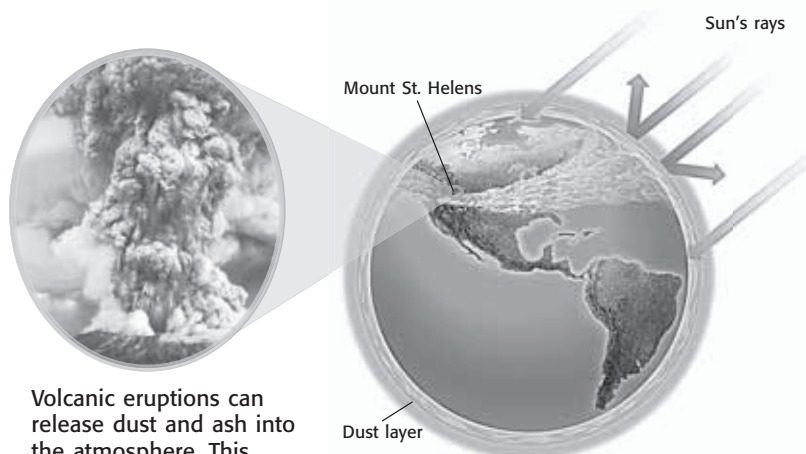
Critical Thinking

7. Identify Relationships Why may animals die off if there are fewer plants around?

SECTION 4 Changes in Climate *continued*

VOLCANIC ERUPTIONS

Volcanic eruptions can affect Earth’s climate for a short time. They send large amounts of dust and ash into the air. As with an asteroid impact, the dust and ash block sunlight from reaching Earth’s surface. The figure below shows how volcanic dust can affect sunlight.



TAKE A LOOK

8. Compare How are the effects on climate of volcanic eruptions and asteroid impacts similar?

Volcanic eruptions can release dust and ash into the atmosphere. This plume of dust and ash was produced by the eruption of Mount St. Helens, in Washington, in 1980.

The dust and ash from the volcano can spread throughout the atmosphere. Sunlight reflects off this dust and ash. Less sunlight reaches Earth’s surface.

What Is Global Warming?

A slow increase in global temperatures is called **global warming**. One thing that can cause global warming is an increase in the greenhouse effect. The **greenhouse effect** is Earth’s natural heating process. During this process, gases in the atmosphere absorb energy in sunlight. This energy is released as heat, which helps to keep Earth warm. Without the greenhouse effect, Earth’s surface would be covered in ice. ✓

READING CHECK

9. Define What is global warming?

One of the gases that absorbs sunlight in the atmosphere is carbon dioxide (CO₂). If there is more CO₂ in the atmosphere, the greenhouse effect can increase. This can cause global warming.

SECTION 4 Changes in Climate *continued***WHERE CO₂ COMES FROM**

Much of the CO₂ in the atmosphere comes from natural processes, such as volcanic eruptions and animals breathing. However, human activities can also increase the amount of CO₂ in the atmosphere. ✓

When people burn fossil fuels for energy, CO₂ is released into the atmosphere. When people burn trees to clear land for farming, CO₂ is released. In addition, plants use CO₂ for food. Therefore, when trees are destroyed, we lose a natural way of removing CO₂ from the atmosphere.

PROBLEMS WITH GLOBAL WARMING

Many scientists think that if global warming continues, the ice at Earth's poles could melt. This could cause sea levels to rise. Many low-lying areas could flood. Global warming could also affect areas far from the oceans. For example, the Midwestern part of the United States could become warmer and drier. Northern areas, such as Canada, may become warmer. ✓

WHAT PEOPLE CAN DO

Many countries are working together to reduce the effects of global warming. Treaties and laws have helped to reduce pollution and CO₂ production. Most CO₂ is produced when people burn fossil fuels for energy. Therefore, reducing how much energy you use can reduce the amount of CO₂ produced. Here are some ways you can reduce your energy use:

- Turn off electrical devices, such as lights and computers, when you are not using them.
- Ride a bike, walk, or take public transportation instead of using a car to travel.
- Turn the heater to a lower temperature in the winter.
- Turn the air conditioner to a higher temperature in the summer.

 **READING CHECK**

10. Identify What are two natural sources of carbon dioxide in the atmosphere?

 **READING CHECK**

11. Explain Why may sea level rise if global warming continues?

Section 4 Review

NSES ES 1k, 2a

SECTION VOCABULARY

global warming a gradual increase in average global temperature

greenhouse effect the warming of the surface and lower atmosphere of Earth that occurs when water vapor, carbon dioxide, and other gases absorb and reradiate thermal energy

ice age a long period of climatic cooling during which the continents are glaciated repeatedly

1. Identify Relationships How is global warming related to the greenhouse effect?

2. Describe What did Milutin Milankovitch's research show can affect Earth's climate?

3. Identify Give two ways that plate tectonics can affect an area's climate.

4. Predict Consequences How could global warming affect cities near the oceans? Explain your answer.

5. List Give three ways that human activities can affect the amount of CO₂ in the atmosphere.
