

## Why It Matters

Climate affects where and how people live. An understanding of Earth's climates and the factors, both physical and human, that influence them adds to a more complete view of life on Earth.

### BIG Ideas

#### Section 1: Earth-Sun Relationships

The physical environment affects people and their activities. Earth's position in relation to the sun affects temperatures, day and night, and seasons on Earth, which in turn influence when and how people perform certain activities.

#### Section 2: Factors Affecting Climate

Physical processes shape Earth's surface. Latitude, elevation, wind patterns, and ocean currents affect Earth's climates.

#### Section 3: World Climate Patterns

Geographers organize Earth into regions that share common characteristics. Geographers classify Earth's climate and vegetation into regions.

### Geography ONLINE

**Chapter Overview** Visit the *World Geography and Cultures* Web site at [glencoe.com](http://glencoe.com) and click on Chapter Overviews—Chapter 3 to preview information about planet Earth.

# Climates of the Earth



Monaco Glacier, Svalbard, Norway, is a popular hunting ground for polar bears.




**FOLDABLES™**  
**Study Organizer**

**Identifying** Make a Vocabulary Book to help you organize and learn the content vocabulary terms introduced as you read about the climates of the Earth. You may need to make more than one Vocabulary Book.

equinox	Content Vocabulary
solstice	
greenhouse effect	
global warming	
prevailing wind	
doldrums	
windward	
leeward	
natural vegetation	
permafrost	

**Reading and Writing** As you read the chapter, write a term on each tab and its definition underneath. You may want to illustrate visual terms such as *rain shadow*.

# Earth-Sun Relationships

## Guide to Reading

### Section Preview

Earth's position in relation to the sun affects temperatures, day and night, and seasons on Earth.

### Content Vocabulary

- weather (p. 51)
- climate (p. 51)
- axis (p. 51)
- temperature (p. 51)
- revolution (p. 51)
- equinox (p. 51)
- solstice (p. 51)
- greenhouse effect (p. 52)
- global warming (p. 53)

### Academic Vocabulary

- contrast (p. 51)
- affects (p. 51)
- regulated (p. 52)

### Places to Locate

- Tropic of Cancer (p. 51)
- Tropic of Capricorn (p. 52)

### Reading Strategy

**Categorizing** Complete a graphic organizer similar to the one below by listing the major characteristics of the summer and winter solstices.

Northern Hemisphere	
Summer solstice	Winter solstice
<ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>

**From the Alps** in the heart of Europe, scientists gather data about melting glaciers and changes in the snow line. Their research reveals information about the Earth's atmosphere and the warming effects of the sun. Such dynamic relationships between the Earth and the sun influence all life on Earth.

### NATIONAL GEOGRAPHIC VOICES AROUND THE WORLD

*"We marvel at the mountains, but it's the water that everything depends on. . . . Snow, glaciers, permafrost, surging hot springs, aquamarine ramparts of ice—the very capillaries of the rock itself are permeated with water. It comes sneaking down black rock faces, it drips into hidden cavern pools. If the Alps had a voice, it would be the musical notes of water. Water is what is literally holding the high mountains together, and if the ice and permafrost begin to lose their grip, as is already happening, the mountains start to crumble."*

—Erla Zwingle, "Meltdown: The Alps Under Pressure,"  
*National Geographic*, February 2006

Hikers in the Alps



# Climate and Weather

**MAIN Idea** The relationship between the Earth and the sun affects climate, which influences life on Earth in dramatic ways.

**GEOGRAPHY AND YOU** Did you know that as you are sitting in geography class it is nighttime in some parts of the world? Read to learn how the Earth-sun relationship causes night and day.

Climate is often confused with weather, which is a short-term aspect of climate. **Weather** is the condition of the atmosphere in one place during a limited period of time. When people look out the window or watch the news to see whether they need umbrellas or sunscreen, they are checking the weather.

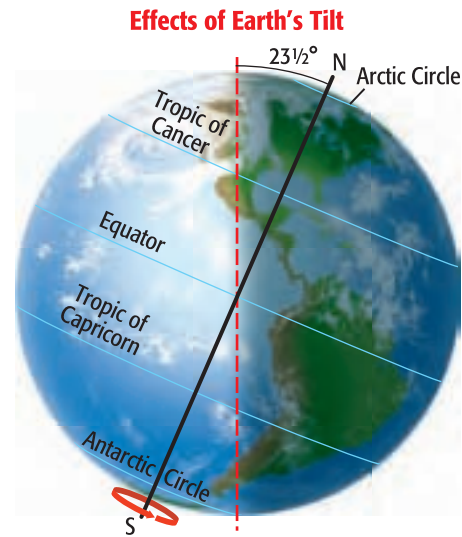
**Climate** is the term for the weather patterns that an area typically experiences over a long period of time. People in Seattle, Washington, for example, frequently use umbrellas because of the rainy, wet climate. In contrast, people in the dry, desert climate of Phoenix, Arizona, must use sunscreen to protect themselves from the sun.

## Earth's Tilt and Rotation

Earth's tilt is one reason for variations in sunlight. As the diagram above shows, the Earth's **axis**—an imaginary line running from the North Pole to the South Pole through the planet's center—is currently tilted at an angle of about  $23\frac{1}{2}^{\circ}$ . Because of the tilt of this axis, not all places on the planet receive the same amount of direct sunlight at the same time.

For this reason, the angle of tilt **affects** the **temperature**—the measure of how hot or cold a place is. Areas that receive a large amount of direct sunlight have warmer temperatures than places that receive little direct sunlight. Temperature is usually measured in degrees on a set scale. The most common scales for measuring temperature are Fahrenheit ( $^{\circ}\text{F}$ ) and Celsius ( $^{\circ}\text{C}$ ).

Whether or not a particular place on Earth receives light also depends on the side of the planet that is facing the sun. Earth rotates on its axis, making one complete rotation every 24 hours. Rotating from west to east, the Earth turns first one hemisphere and then the other toward the sun, alternating between the light of day and the darkness of night.



## Earth's Revolution

While planet Earth is rotating on its axis, it is also traveling in an orbit around the sun, our nearest star. It takes the Earth a few hours more than 365 days—one year—to complete one **revolution**, or trip around the sun.

The Earth's revolution and its tilt cause changes in the angle and amount of sunlight that reach different locations on the planet. These changes follow a regular progression known as the seasons. During the course of a year, people on most parts of the Earth experience distinct differences in the length of days and the daily temperature as the seasons change.

The seasons are reversed north and south of the Equator. When it is spring in the Northern Hemisphere, it is fall in the Southern Hemisphere. When it is winter in the Southern Hemisphere, it is summer in the Northern Hemisphere. Around March 21, the sun's rays fall directly on the Equator. This day is called an **equinox** (meaning "equal night") because daylight and nighttime hours are equal.

**The Tropics of Cancer and Capricorn** As the Earth continues its revolution around the sun, it moves so that eventually the sun's rays directly strike the **Tropic of Cancer** at  $23\frac{1}{2}^{\circ}$  N, the northernmost point on the Earth to receive the direct rays of the sun. These direct rays reach the Tropic of Cancer about June 21, bringing the Northern Hemisphere its longest day of sunlight. This date, known as the summer **solstice**, marks the beginning of summer in the Northern Hemisphere.

By about September 23, the Earth has revolved so that the sun's rays directly strike the Equator again. This equinox marks the beginning of fall in the Northern Hemisphere. Gradually the sun's direct rays strike farther south, reaching their southernmost latitude of  $23\frac{1}{2}^{\circ}$  S, at the **Tropic of Capricorn** about December 22. The winter solstice is the day of shortest daylight in the Northern Hemisphere, beginning the season of winter.

**The Poles** The most dramatic variation in the amount of sunlight occurs at the Poles. For six months of the year, one Pole is tilted toward the sun and receives continuous sunlight, while the other Pole is tilted away from the sun and receives little to no sunlight.

At the North Pole, the sun never sets from about March 20 to September 23. At the South Pole, continuous daylight lasts from about September 23 to March 20. The tilt of the Earth's axis as it revolves around the sun causes this natural phenomenon, known as the midnight sun. The occurrence of the midnight sun goes almost unnoticed in sparsely populated Antarctica. Parts of northern North America (including Alaska) and northern Europe in the Arctic, however, have become popular tourist destinations as lands of the midnight sun.

**READING Check Regions** What factor distinguishes weather from climate?

## The Greenhouse Effect

**MAIN Idea** The natural process of the greenhouse effect has been influenced by human activity.

**GEOGRAPHY AND YOU** Have you heard news accounts of the dangers of global warming? Read to learn how global warming can affect Earth.

Even on the sunniest days in the warmest climates, only part of the sun's radiation passes through the Earth's atmosphere. The atmosphere reflects some radiation back into space. Enough radiation, however, reaches the Earth to warm the land, water, and air.

Because the atmosphere traps some heat and keeps it from escaping back into space too quickly, Earth's atmosphere is like the glass in a greenhouse—it traps the sun's energy for growing plants even in cold weather. Without this **greenhouse effect**, the Earth would be too cold for most living things.

In order to support plant growth, conditions in a greenhouse must be **regulated**. If too much

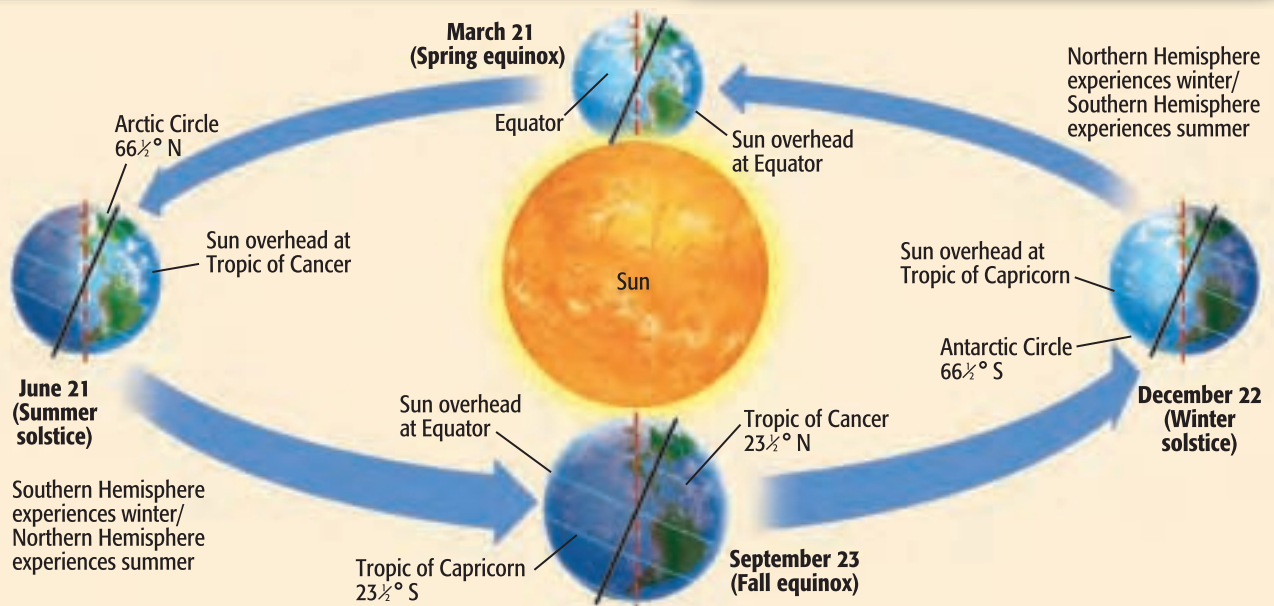
### DIAGRAM STUDY

- Regions** Why are the seasons reversed in the Northern and Southern Hemispheres?
- Place** Explain the difference between the equinoxes and the solstices.



## The Earth's Seasons

Use **StudentWorks™ Plus** or [glencoe.com](http://glencoe.com).



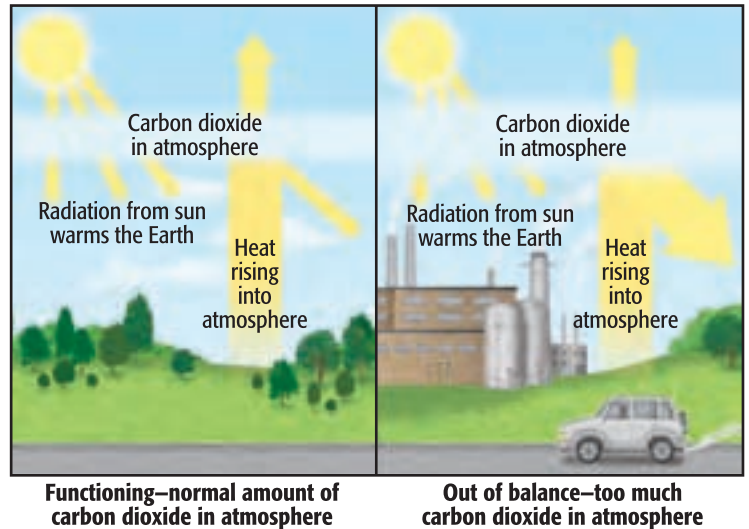
heat escapes, the plants will freeze. If too much heat is trapped, the plants will wilt or dry out.

The greenhouse effect of Earth's atmosphere follows some of the same general rules. Normally, the atmosphere provides just the right amount of insulation to promote life on the planet. The 50 percent of the sun's radiation that reaches the Earth is converted into infrared radiation, or heat. Clouds and greenhouse gases—atmospheric components such as water vapor and carbon dioxide (CO<sub>2</sub>)—absorb the heat reflected by the Earth and radiate it back again so that a balance is created.

Many scientists, however, claim that in recent decades a rise in atmospheric CO<sub>2</sub> levels has coincided with a general rise in global temperatures. This trend—known as **global warming**—is believed to be caused in part by human activities, such as the burning of coal, oil, and natural gas. These fossil fuels release carbon dioxide, a greenhouse gas, in the atmosphere that traps more heat.

Some scientists report that global warming will make weather patterns more extreme. Water, for example, will evaporate more rapidly from oceans, increasing humidity and rainfall generally. Rapid water evaporation from soil, however, will cause land to dry out more quickly between rains. Some areas may even become drier than before.

### The Greenhouse Effect



Scientists do not all agree on the nature of global warming and its effects. Some claim that a natural cycle, not human activity, is causing rising temperatures. Others claim that the evidence for global warming is inconclusive and that it is too early to forecast future effects.

**READING Check** **Human-Environment Interaction**  
How has human activity contributed to global warming?

## SECTION 1 REVIEW

### Vocabulary

1. Explain the significance of: weather, climate, axis, temperature, revolution, equinox, solstice, greenhouse effect, global warming.

### Main Ideas

2. Explain the greenhouse effect. Then describe how this natural process has been influenced by human activity.
3. Use a chart like the one below to describe how the relationship between the Earth and the sun affects climate. List characteristics of the Earth-sun relationship and describe their effects on climate.

Earth-Sun Relationship	Effects on Climate
Tilt	
Rotation	
Revolution	

### Critical Thinking

4. **Big Idea** What effects does the Earth's tilt on its axis have on your daily life?
5. **Comparing and Contrasting** Explain the differences in the weather you would expect in Alaska and in Florida.
6. **Analyzing Information** What would you pack if you were visiting Argentina in December?
7. **Analyzing Visuals** Study the diagram of the Earth's seasons on page 52. In what months do the sun's rays directly strike the Equator? The Tropics of Cancer and Capricorn?

### Writing About Geography

8. **Expository Writing** Review the text in Section 1 about global warming. Then write a paragraph explaining the ways in which agriculture may be affected.

### Geography ONLINE

**Study Central™** To review this section, go to [glencoe.com](http://glencoe.com) and click on Study Central.



# Factors Affecting Climate

## Guide to Reading

### Section Preview

Factors such as latitude, elevation, wind patterns, and ocean currents affect Earth's climates.

### Content Vocabulary

- prevailing wind (p. 56)
- Coriolis effect (p. 56)
- doldrums (p. 57)
- current (p. 57)
- El Niño (p. 58)
- windward (p. 59)
- leeward (p. 59)
- rain shadow (p. 59)

### Academic Vocabulary

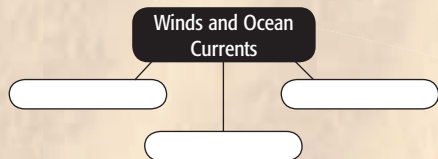
- retains (p. 55)
- creates (p. 56)
- factors (p. 57)

### Places to Locate

- low latitudes (p. 55)
- high latitudes (p. 55)
- Arctic Circle (p. 55)
- Antarctic Circle (p. 55)
- midlatitudes (p. 55)

### Reading Strategy

**Organizing** As you read about factors affecting Earth's climate, create a web diagram like the one below by listing factors that cause both winds and ocean currents.



**Latitude**, wind patterns, ocean currents, and landforms create extremely cold temperatures and climate conditions in Antarctica. Only a few brave researchers and scientists spend months at a time in one of the last wilderness places on Earth. Antarctica provides them with a wonderful natural laboratory in which to study Earth.

## NATIONAL GEOGRAPHIC VOICES AROUND THE WORLD

*“There are no places left like Antarctica: a wilderness continent that offers scientists unique views of the workings of the Earth. . . . [W]inds roll down the polar plateau at speeds up to 180 miles an hour. Some of the world’s most violent squalls and mountainous seas batter the lonely archipelagoes off the Antarctic Peninsula. . . . Antarctica influences weather patterns across the Southern Hemisphere, shapes ocean currents throughout the world, and acts as a sobering litmus for humanity’s use and abuse of the planet.”*

—Roff Smith,  
“Frozen Under,”  
*National Geographic*,  
December 2001



*Adélie penguin, Antarctica*

# Latitude, Elevation, and Climate

**MAIN Idea** Latitude and elevation affect the angle of the sun's rays and temperatures on Earth.

**GEOGRAPHY AND YOU** Did you know that some parts of the Earth experience daylight nearly 24 hours a day for six months? Read to learn how latitude affects the amount of sun a place receives.

During the Earth's annual revolution around the sun, the sun's direct rays fall upon the planet in a regular pattern. This pattern can be correlated with bands, or zones, of latitude to describe climate regions. Within each latitude zone, climate follows general patterns.

## Low Latitudes

Between 30° S and 30° N latitude is a zone known as the **low latitudes**. This zone includes the Tropic of Capricorn, the Equator, and the Tropic of Cancer. Portions of the low latitudes receive the direct rays of the sun year-round. Places located in the low latitudes have warm to hot climates.

## High Latitudes

The Earth's polar areas, which stretch from 60° N to 90° N and from 60° S to 90° S, are called the **high latitudes**. When either the Northern or the Southern Hemisphere is tilted toward the sun, its polar area receives nearly continuous, but indirect, sunlight. From about March 21 to about September 23, the polar area from north of the **Arctic Circle** (latitude 66½° N) experiences continuous daylight or twilight. The polar area south of the **Antarctic Circle** (latitude 66½° S) experiences continuous daylight or twilight for the other six months of the year.

## Midlatitudes

The most variable weather on Earth is found in the **midlatitudes**, between 30° N and 60° N in the Northern Hemisphere and between 30° S and 60° S in the Southern Hemisphere. The midlatitudes generally have a temperate climate—one that ranges from fairly hot to fairly cold—with dramatic seasonal weather changes.

Warm/hot and cool/cold air masses affect mid-latitude weather throughout the year. Although warm, tropical, wet air masses from near the Equator predominate in summer, they are still present in winter. In fact, they are the source of the rain and snow the midlatitudes receive during winter. Cool/cold air masses bring this part of the world its relief from the hot, humid weather in summer, as well as the cold of winter.

## Elevation

At all latitudes, elevation influences climate because of the relationship between the elevation of a place and its temperature. The table below shows how elevation can influence temperature regardless of latitude. The Earth's atmosphere thins as altitude increases. Thinner air is less dense and **retains** less heat. As elevation increases, temperatures decrease by about 3.5°F (1.9°C) for each 1,000 feet (305 m). This effect occurs at all latitudes. For example, in Ecuador, the city of Quito (KEE•toh) is nearly on the Equator. However, Quito lies in the Andes at an elevation of more than 9,000 feet (2,743 m), so average temperatures there are about 32°F (18°C) cooler than in the coastal lowlands.

**The Influence of Elevation on Temperature**

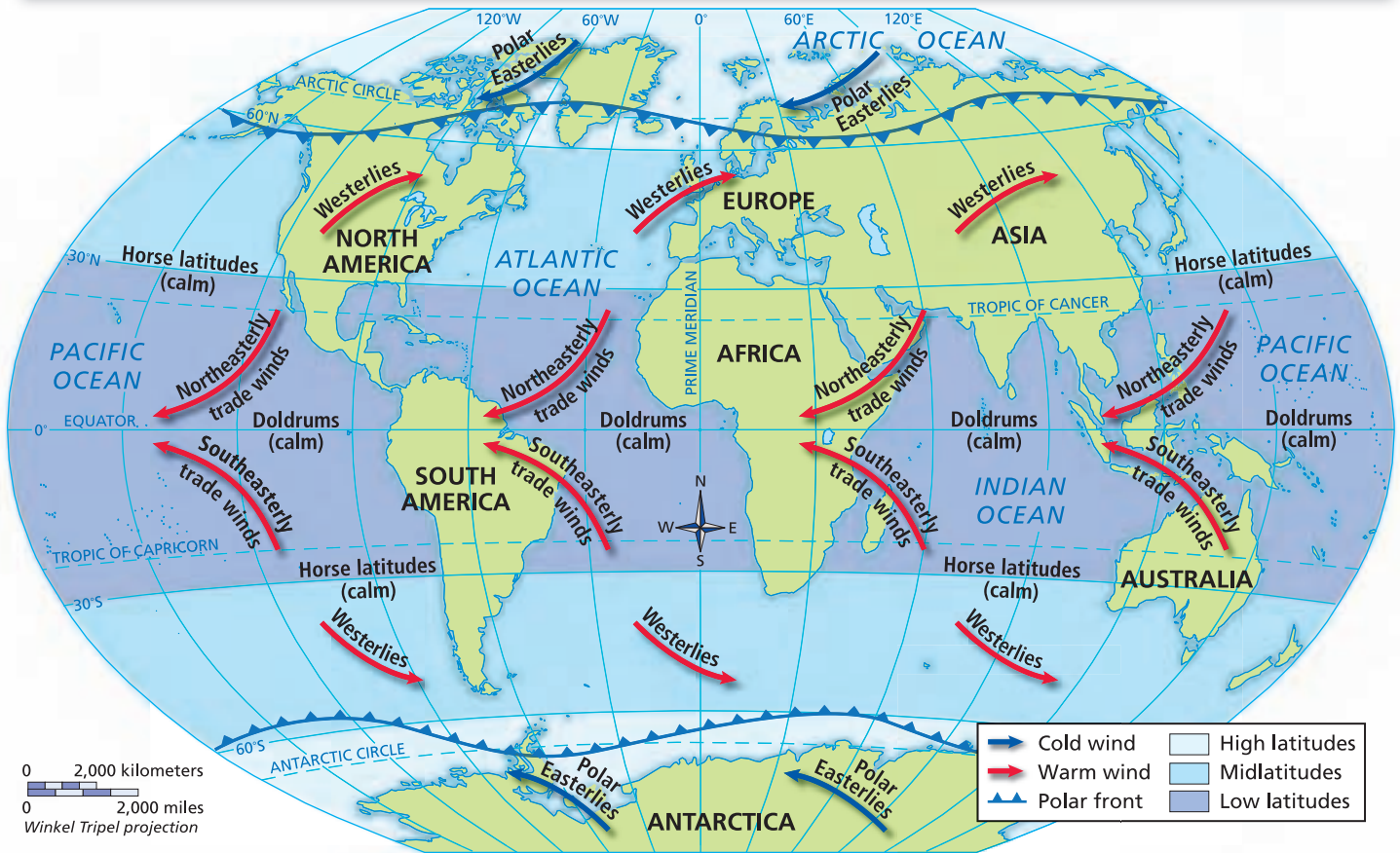
	Elevation	Latitude & Longitude	Average Temperature
Quito, Ecuador	9,223 ft. (2,811 m)	0°09' S 78°29' W	58°F (14°C)
Nairobi, Kenya	5,327 ft. (1,623 m)	1°19' S 36°55' E	67°F (19°C)
Bujumbura, Burundi	2,568 ft. (782 m)	3°19' S 29°19' E	77°F (25°C)
Manaus, Brazil	276 ft. (84 m)	3°09' S 59°59' W	81°F (27°C)
Telluride, Colorado	8,760 ft. (2,670 m)	37°57' N 107°49' W	39°F (3°C)

Source: [www.weatherbase.com](http://www.weatherbase.com)

Sunlight is bright in Quito and other places with high elevation because the thinner atmosphere filters fewer rays of the sun. Even in bright sunlight, the world's highest mountains—the Andes and the Alps, for example—are cold, snowy places year-round.

**READING Check** **Regions** What happens to temperature as elevation increases?





## Winds and Ocean Currents

**MAIN Idea** Wind and water combine with the effects of the sun to influence Earth’s weather and climate.

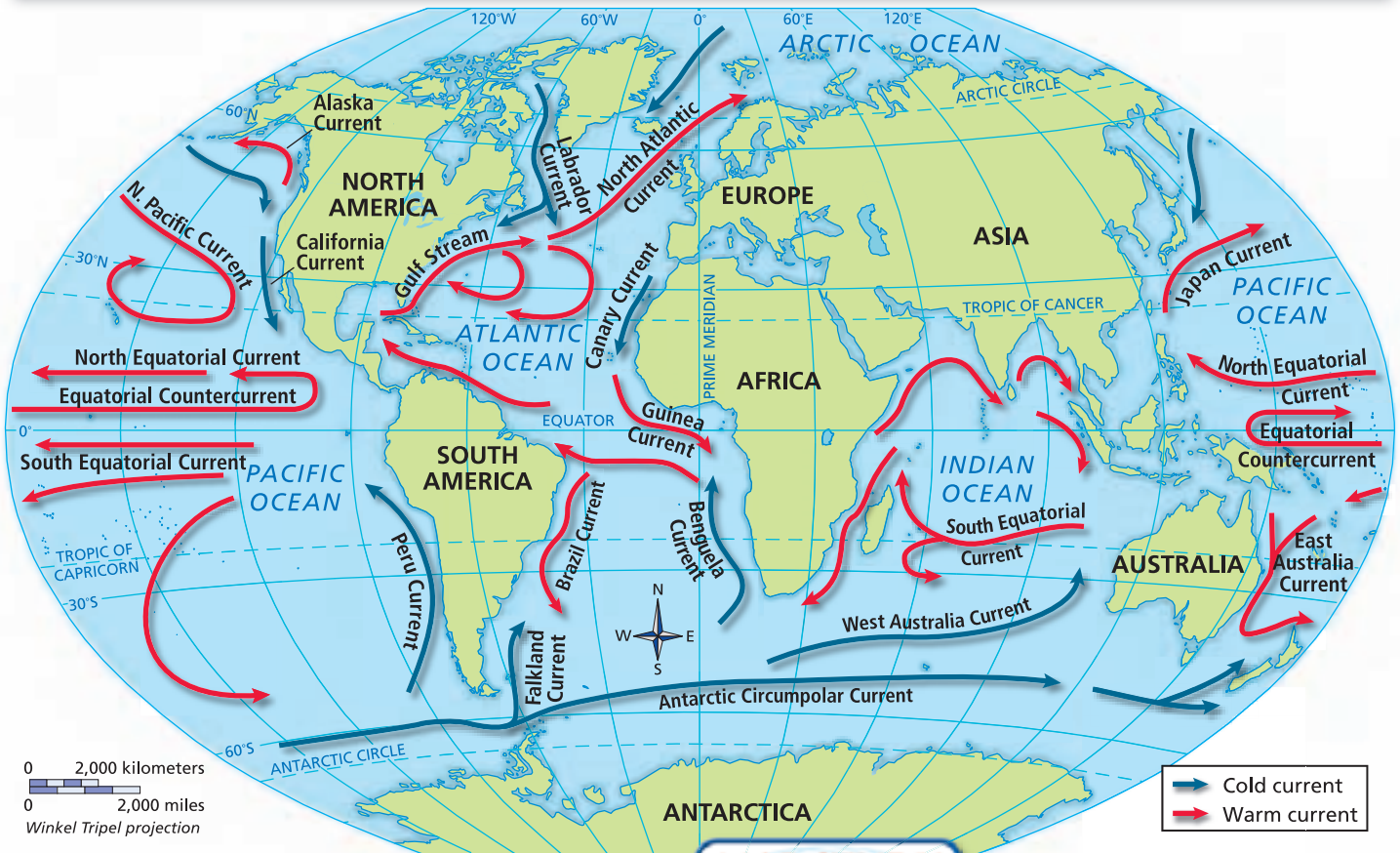
**GEOGRAPHY AND YOU** How does wind affect the weather in your community? Does it bring cold air or warm air? Read to learn about the patterns of global winds and ocean currents that affect climate.

Air moving across the surface of the Earth is called wind. Winds occur because sunlight heats the Earth’s atmosphere and surface unevenly. Rising warm air creates areas of low pressure, and sinking cool air causes areas of high pressure. The cool air then flows in to replace the warm rising air. These movements over the Earth’s surface cause winds, which distribute the sun’s energy around the planet.

## Wind Patterns

Winds blow because of temperature differences on Earth’s surface, with tropical air moving toward the Poles and polar air moving toward the Equator. Global winds blow in fairly constant patterns called **prevailing winds**, as shown on the map above. The direction of prevailing winds is determined by latitude and is affected by the Earth’s movement. Because Earth rotates to the east, the global winds are displaced clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. This phenomenon, called the **Coriolis effect**, causes prevailing winds to blow diagonally rather than along strict north-south or east-west directions.

Winds are often named for the direction from which they blow, but they sometimes were given names from the early days of sailing. Named for their ability to move trading ships through the region, the prevailing winds of the low latitudes are called *trade winds*. They blow from the north-



**MAP STUDY**

- Regions** What air currents flow over the midlatitudes?
- Movement** How do ocean currents develop? How is this process similar to the development of wind patterns?

maps in **MOtion** Use **StudentWorks™ Plus** or **glencoe.com**.

east toward the Equator from about latitude 30° N and from the southeast toward the Equator from about latitude 30° S. *Westerlies* are the prevailing winds in the midlatitudes, blowing diagonally west to east between about 30° N and 60° N and between about 30° S and 60° S. In the high latitudes, the *polar easterlies* blow diagonally east to west, pushing cold air toward the midlatitudes.

**The Horse Latitudes**

At the Equator, global winds are diverted north and south, leaving a narrow, generally windless band called the **doldrums**. Two other narrow bands of calm air encircle the globe just north of the Tropic of Cancer and just south of the Tropic of Capricorn. In the days of wind-powered sailing ships, crews feared being stranded in these windless areas. With no moving air to lift the sails, ships were stranded for weeks in the hot, still weather. Food supplies dwindled, and perishable cargoes spoiled as the ships sat.

To lighten the load so the ships could take advantage of the slightest breeze, sailors would toss excess cargo and supplies overboard, including livestock being carried to colonial settlements. This practice gave rise to the name by which the calm areas at the edges of the Tropics are known—the *horse latitudes*.

**Ocean Currents**

Just as winds move in patterns, cold and warm streams of water, known as **currents**, move through the oceans. Ocean currents are caused by many of the same **factors** that cause winds, including the Earth’s rotation, changes in air pressure, and differences in water temperature. The Coriolis effect is also observed in ocean currents.



As ocean currents circulate, cold water from the polar areas moves slowly toward the Equator, warming as it moves toward the low latitudes. This water forms the warm ocean currents. The warm water, in turn, moves away from the Equator, cooling as it nears the polar areas.

Ocean currents affect climate in the coastal lands along which they flow. Cold ocean currents cool the lands they pass. Warm ocean currents bring warmer temperatures. For example, the North Atlantic Current flows near western Europe. This current gives western Europe a relatively mild climate in spite of its northern latitude.

## Weather and the Water Cycle

Wind and water work together to affect weather in another important way. Driven by temperature, condensation creates *precipitation*—moisture falling to the Earth in the form of rain, sleet, hail, or snow. The sudden cloudburst that cools a steamy summer day is an example of how precipitation both affects and is affected by temperature. Water vapor forms in the atmosphere from evaporated surface water. As rising air cools when elevation increases, the water vapor condenses into liquid droplets, forming clouds. Further cooling causes rain to fall, which can help lower the temperature on warm days.

## El Niño

Climate is also affected by recurring phenomena, or events, that alter weather patterns. The most famous of these recurring climatic events is

**El Niño** (ehl NEE•nyoh). It is a periodic change in the pattern of ocean currents, water temperatures, and weather in the mid-Pacific region.

El Niño does not occur every year, but its frequency appears to have increased over the last 25 years. In an El Niño year, the normally low atmospheric pressure over the western Pacific rises, and the normally high pressure over the eastern Pacific drops. This reversal causes the trade winds to diminish or even to reverse direction. The change in wind pattern reverses the equatorial ocean currents, drawing warm water from near Indonesia east to Ecuador, where it spreads along the coasts of Peru and Chile.

Changing air pressures resulting from El Niño influence climates around the world. Precipitation increases along the coasts of North and South America, warming winters and increasing the risk of floods. In Southeast Asia and Australia, drought and occasional massive forest fires occur.

Scientists are not sure what causes El Niño or why it appears to be occurring more frequently. Preliminary studies have linked it to global warming. The costs in human and economic terms of the weather catastrophes associated with El Niño make learning more about this climatic event vitally important.

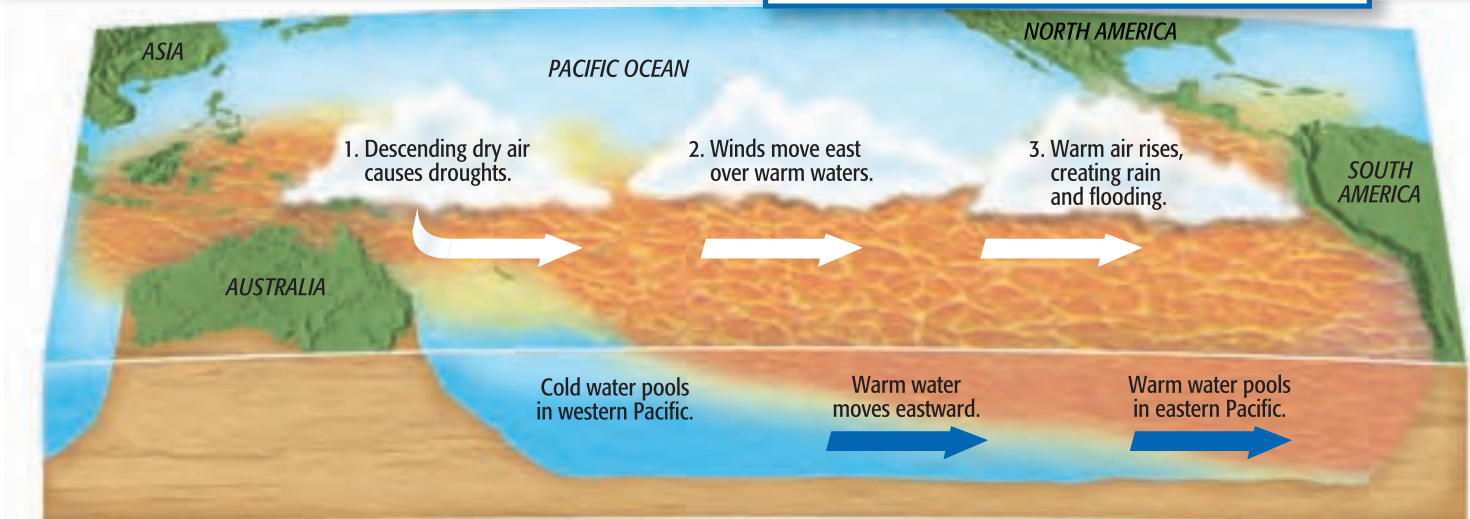
**READING Check** **Place** What happens to global winds at the Equator?

### DIAGRAM STUDY

- Human-Environment Interaction** How might El Niño impact the lives of people in North America?
- Place** What happens to the water temperatures and wind patterns in an El Niño year?



## The Influence of El Niño



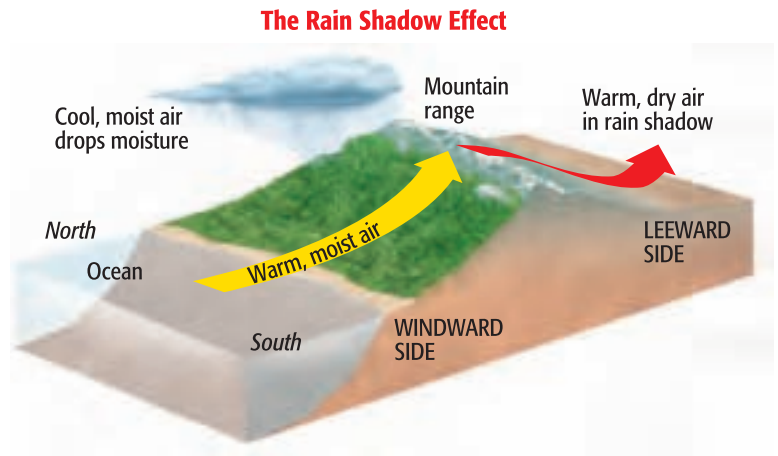
# Landforms and Climate

**MAIN Idea** Landforms and bodies of water influence Earth's climate patterns.

**GEOGRAPHY AND YOU** Do you live near mountains? A large body of water? Read to find out how these features can affect climate.

The climates of places located at the same latitude can be very different, depending on the presence or absence of certain physical features. Large bodies of water, for example, are slower to heat and to cool than land. As a result, water temperatures are more uniform and constant than land temperatures. Coastal lands receive the benefit of this moderating influence and experience less changeable weather than do inland areas.

Mountain ranges, too, influence precipitation and affect climate. As the diagram shows, winds are pushed upward when they meet a mountain range. The rising air cools and releases most of its moisture in the form of precipitation on the



**windward** side—the side of the mountain range facing the wind. After the precipitation is released, winds become warmer and drier as they descend on the opposite, or **leeward**, side of the mountains. The hot, dry air produces little precipitation in an effect known as a **rain shadow**. The rain shadow effect often causes dry areas—and even deserts—to develop on the leeward sides of mountain ranges.

**READING Check Movement** What happens to winds after they release precipitation?

## SECTION 2 REVIEW

### Vocabulary

1. Explain the significance of: prevailing wind, Coriolis effect, doldrums, current, El Niño, windward, leeward, rain shadow.

### Main Ideas

2. How do wind and water combine with the effects of the sun to influence Earth's weather and climate?
3. Explain how landforms and bodies of water influence Earth's climate patterns.
4. Use a table like the one below to explain how latitude and elevation affect the angle of the sun's rays and temperatures on Earth.

Location	Effect
Low latitudes	
High latitudes	
Midlatitudes	
Elevation	

### Critical Thinking

5. **Big Idea** Describe the general differences in climate between the low latitudes and the midlatitudes.
6. **Analyzing Information** Both Quito, Ecuador, and Singapore, Singapore, are located near the Equator. What factor may contribute to Quito's lower average annual temperature?
7. **Identifying Cause and Effect** How does the presence of mountain ranges influence climate?
8. **Analyzing Visuals** Study the maps of wind patterns and ocean currents on pages 56–57. Describe the patterns of warm currents and cold currents on both maps. Are they similar or different?

### Writing About Geography

9. **Expository Writing** Study the map of wind currents on page 56. Suppose you are on a ship sailing in the low latitudes. Write a paragraph explaining what might happen as you drift near the Equator.

### Geography ONLINE

**Study Central™** To review this section, go to [glencoe.com](http://glencoe.com) and click on Study Central.



# World Climate Patterns

## Guide to Reading

### Section Preview

Geographers classify Earth's climate and vegetation into regions. Recurring climate phenomena influence climate patterns.

### Content Vocabulary

- natural vegetation (p. 61)
- oasis (p. 61)
- coniferous (p. 62)
- deciduous (p. 62)
- mixed forest (p. 62)
- prairie (p. 62)
- permafrost (p. 63)
- hypothesis (p. 64)
- smog (p. 64)

### Academic Vocabulary

- widespread (p. 61)
- exceeds (p. 61)
- consists (p. 61)

### Places to Locate

- Tropics (p. 61)
- Sahara (p. 61)

### Reading Strategy

**Organizing** Complete a graphic organizer similar to the one below by filling in a brief description of each climate region.

Climate	Description
Tropical	
Dry	
Midlatitude	
High latitude	
Highland	

**Ordinary climate patterns** vary from region to region. However, factors such as winds and air pressure can create pockets of dramatic climate. For example, most of Australia has a dry climate, but during the summer the trade winds meet, creating intense thunderstorms and bringing monsoons to the continent's northern coast.

### NATIONAL GEOGRAPHIC VOICES AROUND THE WORLD

*"Here at last, in Weipa, was the wet I'd been looking for—the lush growth along the shore, the brooding thundery skies, the heavy curtains of rain. Nearly three feet of rain had fallen here in the past month, and more drenchings were on the way. 'All this can get to be really depressing,' a woman named Lorisa Morgan told me one morning when I dropped by the community center and thrift shop. 'You get so tired after a while of mold growing on everything. You want to go out for a nice dinner? First you have to clean the mold off your belt and shoes. We have to store our videos and computer disks in the refrigerator to keep the mold from ruining them.'"*

—Roff Smith, "The Wet Down Under,"  
*National Geographic*, November 2004

*Flooding in New South Wales, Australia*



# Climate Regions

**MAIN Idea** Geographers divide the Earth into regions that have similar climates.

**GEOGRAPHY AND YOU** Does it rain much where you live? Or is it very cold with lots of snow? Read to learn about the climate region where you live.

Climates are organized into regions—tropical, dry, midlatitude, high latitude, and highland. But since climates can vary within these broad regions, geographers further divide the major regions into smaller ones. Each of these divisions has its own characteristic soils and **natural vegetation**—the plant life that grows in an area where the natural environment is unchanged by human activity.

## Tropical Climates

Tropical climates are found in or near the low latitudes—the **Tropics**. The two most **widespread** kinds of tropical climate regions are tropical wet and tropical dry.

Hot and wet throughout the year, *tropical wet* climates have an average temperature of 80°F (27°C). The warm, humid air is saturated with moisture, producing rain almost daily. Yearly rainfall averages about 80 inches (203 cm). This continual rain tends to leach, or draw out, nutrients from the soil in these climates. Wildlife is also abundant.

Tropical rain forest vegetation grows thickly in layers. Tall trees form a canopy over shorter trees and bushes. Shade-loving plants grow on the trees. The world's largest tropical rain forest is in the Amazon River basin. Similar climate and vegetation exist in other parts of South America, the Caribbean, Asia, and Africa.

*Tropical dry* climates have dry winters and wet summers, accompanied by high year-round temperatures. In the dry season, the ground is covered with clumps of coarse grass. Fewer trees exist in these regions, also called savannas, than in the rain forests. Tropical savannas are found in Africa, Central and South America, Asia, and Australia.

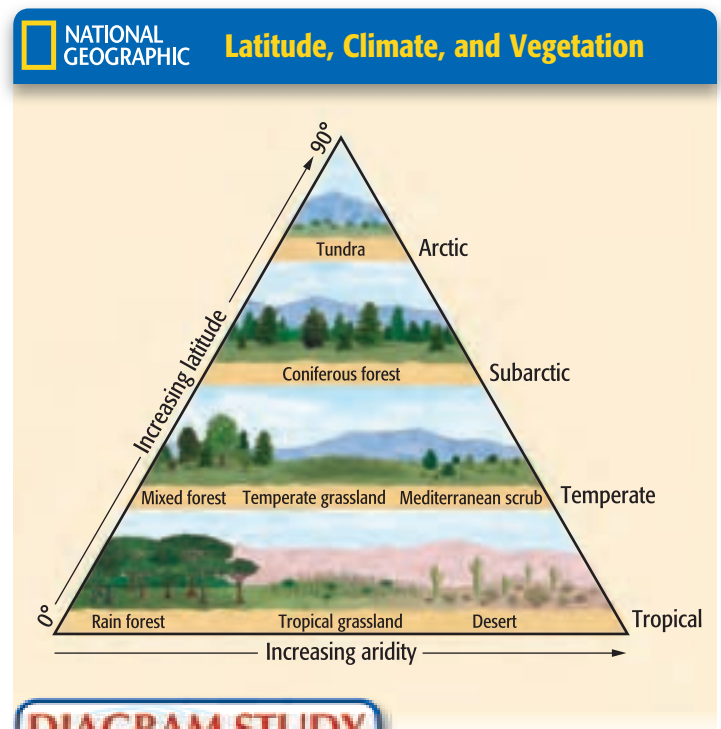
## Dry Climates

Geographers have identified two types of dry climates, based on the vegetation in each. Both *desert* and *steppe* climates occur in low latitudes and midlatitudes.

Dry areas with sparse plant life are called deserts. Yearly rainfall in deserts seldom **exceeds** 10 inches (about 25 cm), and temperatures vary widely from the heat of day to the cool of night and from season to season. Desert climates occur in just under one-third of the Earth's total land area. The **Sahara** alone extends over almost the entire northern one-third of the African continent.

The natural vegetation of deserts **consists** of scrub and cactus, plants that tolerate low and unreliable precipitation, low humidity, and wide temperature ranges. In some desert areas, underground springs may support an **oasis**, an area of lush vegetation. Some deserts have dunes or rocky surfaces, and others have fertile soil that can yield crops through irrigation.

Often bordering deserts are dry, largely treeless grasslands called steppes. Yearly rainfall in steppe areas averages 10 to 20 inches (25 to 51 cm). The world's largest steppe stretches across eastern Europe and western and central Asia. Steppes are also found in North America, South America, Africa, and Australia.



### DIAGRAM STUDY

- Regions** How do changes in temperature and moisture affect vegetation?
- Place** What sort of temperatures would you expect to find in a temperate grassland? A rain forest?



## Midlatitude Climates

The midlatitudes include four temperate climate regions. Midlatitude climates experience variable weather patterns and seasonal changes that give rise to a variety of natural vegetation.

Along western coastlines, between the latitudes of 30° N and 60° N and 30° S and 60° S, are regions with a *marine west coast* climate. For example, the Pacific coast of North America has a marine west coast climate. Ocean winds bring cool summers and cool, damp winters. Abundant rainfall supports the growth of both coniferous and deciduous trees. **Coniferous** trees, most of which are evergreens, have cones. **Deciduous** trees, most of which have broad leaves, change color and drop their leaves in autumn. Typical of marine west coast climates are **mixed forests** with both kinds of trees.

Lands surrounding the Mediterranean Sea have mild, rainy winters and hot, sunny summers. The natural vegetation includes thickets of woody bushes and short trees known as Mediterranean scrub. Geographers classify as *Mediterranean* any coastal midlatitude areas

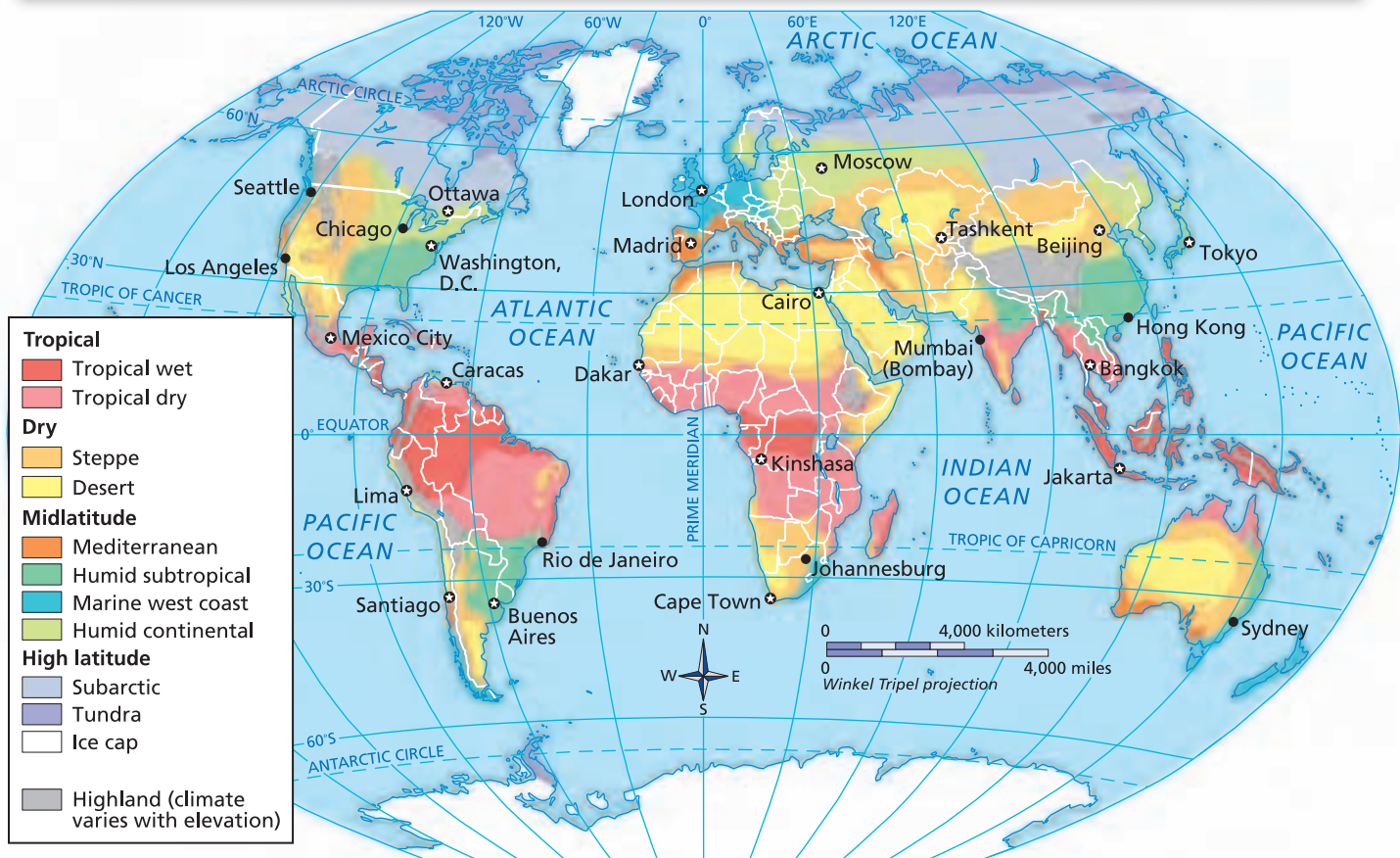
with similar climate and vegetation. Such areas include southwest Australia.

In the southeastern United States, a *humid subtropical* climate brings short, mild winters and nearly year-round rain. The wind patterns and high pressure related to nearby oceans keep humidity levels high in these areas. Vegetation consists of **prairies**, or inland grasslands, and forests of evergreen and deciduous trees.

In some midlatitude regions of the Northern Hemisphere, landforms influence climate more than winds, precipitation, or ocean temperatures do. *Humid continental* climate regions do not experience the moderating effect of ocean winds because of their northerly continental, or inland, locations. The farther north one travels in these humid continental areas, the longer and more severe are the snowy winters, and the shorter and cooler are the summers. Vegetation in humid continental regions is similar to that found in marine west coast areas, with evergreens outnumbering deciduous trees in the northernmost areas.



### World Climate Regions



## High-Latitude Climates

In high-latitude climates, freezing temperatures are common throughout the year because of the lack of direct sunlight. As a result, the amount and variety of vegetation is limited.

Just south of the Arctic Circle lie the *subarctic* climate regions. Winters here are bitterly cold, and summers are short and cool. Subarctic regions have the world's widest temperature ranges, varying from winter to summer by as much as 120°F (49°C). In parts of the subarctic, only a thin layer of surface soil thaws each summer. Below it is permanently frozen subsoil, or **permafrost**. Brief summer growing seasons may support needled evergreens.

Closer to the Poles are *tundra* climate regions. Winter darkness and bitter cold last for several months and the sun's indirect rays during long summer days have limited warming effects. The layer of thawed soil is even thinner than in the subarctic. Trees cannot establish roots, so vegetation is limited to low bushes, very short grasses, mosses, and lichens (LY• kuhns).

Snow and ice, often more than 2 miles (3 km) thick, constantly cover the surfaces of *ice cap* regions. Lichens are the only form of vegetation that can survive in these areas, where monthly temperatures average below freezing.

## Highland Climates

High mountain areas, even along the Equator, share some of the same characteristics of high-latitude climates because of the thinning of the atmosphere at high altitudes. The higher the elevation, the cooler the temperatures. Natural vegetation also varies with elevation. Mixed forests lie at the bases of mountain ranges. Higher up are meadows with small trees, shrubs, and wildflowers.

**READING Check** **Regions** What happens as you move north through humid continental regions?

### MAP STUDY

- Regions** Why does the amount of vegetation decrease as you move toward higher latitudes?
- Location** Which type of climate and vegetation is found only along coastal areas?



## World Natural Vegetation Regions



Use StudentWorks™ Plus or [glencoe.com](http://glencoe.com).





# Climate Changes

**MAIN Idea** Climate changes over time. Although the causes of change are unclear, evidence suggests that human activity has influenced some of the changes.

**GEOGRAPHY AND YOU** Does your community have problems with smog? Read to learn how human activity can influence climate change.

Climates change gradually over time, although the causes of these changes are unclear. Scientists search for answers by studying the interrelationships among ocean temperatures, greenhouse gases, wind patterns, and cloud cover.

During the last 1 to 2 million years, for example, the Earth passed through four ice ages, eras when glaciers covered large areas of the planet's surface. One **hypothesis**, or scientific explanation, for these ice ages is that the Earth absorbed less solar energy because of variations in the sun's output of energy or because of variations in the Earth's orbit. Another hypothesis suggests that dust clouds from volcanic activity reflected

sunlight back into space, cooling the atmosphere and lowering surface temperatures.

Human interaction with the environment also affects climate. Burning fossil fuels releases gases that mix with water in the air, forming acids that fall in rain and snow. Acid rain can destroy forests. Fewer forests may result in climatic change. The exhaust released from burning fossil fuels in automobile engines and factories is heated in the atmosphere by the sun's ultraviolet rays, forming **smog**, a visible chemical haze in the atmosphere that endangers people's health. Other human-driven changes result from dams and river diversions. These projects, intended to supply water to dry areas, may cause new areas to flood or to dry out and may affect climate over time.

**READING Check** **Human-Environment Interaction** How does the burning of fossil fuels create smog?

## Geography ONLINE

**Student Web Activity** Visit the *World Geography and Cultures* Web site at [glencoe.com](http://glencoe.com) and click on Student Web Activities—Chapter 3 for an activity about global climate change.

## SECTION 3 REVIEW

### Vocabulary


1. Explain the significance of: natural vegetation, oasis, coniferous, deciduous, mixed forest, prairie, permafrost, hypothesis, smog.

### Main Ideas

2. Describe one hypothesis for climate change. Then list examples of human activities that affect climate.
3. Create a table like the one below to show how geographers divide the Earth into regions with similar climates. Add information and a brief description about each of the world's climate regions.

Earth's Climates	
Climate Region	Features

### Critical Thinking

4.  How are the five major climate regions related to the three zones of latitude?
5. **Comparing and Contrasting** What factors account for the similarities and differences between the subdivisions in tropical climate zones?
6. **Drawing Conclusions** What are the two main categories of factors causing climate change?
7. **Analyzing Visuals** Study the map of world natural vegetation regions on page 63. What vegetation type dominates Russia? Canada?

### Writing About Geography

8. **Summary Writing** On the map of world climate regions on page 62, locate the climate regions for Tashkent, Cape Town, Lima, Chicago, London, and Jakarta. Then write a paragraph summarizing the relationship between climate and settlement.

## Geography ONLINE

**Study Central™** To review this section, go to [glencoe.com](http://glencoe.com) and click on Study Central.



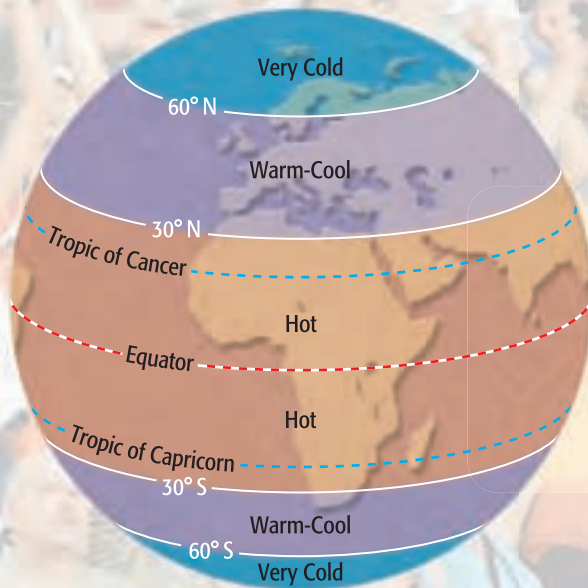
## EARTH-SUN RELATIONSHIPS

- The relationship of the Earth to the sun affects climate patterns around the world.
- The Earth's tilt and revolution cause the seasons by changing the relationship of the Earth's surface to the sun.
- When the sun is directly over the Tropic of Cancer it is summer in the Northern Hemisphere. When it is directly over the Tropic of Capricorn, it is winter in the Northern Hemisphere.



*Inuit boy with sled dogs during midnight sun, Canada*

## Latitude and Temperature



## FACTORS AFFECTING CLIMATE

- Latitude plays a major role in climate. The farther one gets from the Equator, the cooler the climate.
- High elevations are generally cooler than the surrounding landscape.
- Other factors that help determine climate are wind and water currents, recurring phenomena such as El Nino, and large landforms.

## WORLD CLIMATE PATTERNS

- Geographers divide the world into major climate regions.
- The major climate regions are tropical, dry, midlatitude, high latitude and highland climates. Each of these can be broken down into smaller categories.
- Each climate region has its own characteristic natural vegetation.
- Climate patterns change over time as a result of both natural processes and human activity.



*Viedma glacier breaking into lake, Argentina*



# CHAPTER 3

## STANDARDIZED TEST PRACTICE

### TEST-TAKING TIP

If you find a question that is more difficult for you, skip it and go on to answer the other questions. Then return to the more difficult question.

### Reviewing Vocabulary

Directions: Choose the word or words that best complete the sentence.

- Day-to-day conditions of the atmosphere make up \_\_\_\_\_.
  - weather
  - climate
  - axis
  - equinox
- Long-term atmospheric conditions that people can expect to be generally true make up \_\_\_\_\_.
  - weather
  - climate
  - solstice
  - tilt
- Because of \_\_\_\_\_, winds tend to blow diagonally rather than from due north, south, east, or west.
  - weather
  - rain shadow
  - the Coriolis effect
  - El Niño
- Grasslands in midlatitude climates are called \_\_\_\_\_.
  - savannas
  - mixed vegetation
  - prairies
  - tundras

### Reviewing Main Ideas

Directions: Choose the best answers to the following questions.

#### Section 1 (pp. 50–53)

- Why is the greenhouse effect necessary to life?
  - People's activities increase the greenhouse effect.
  - Without the greenhouse effect, Earth would be too cold for life.
  - Farmers grow crops in greenhouses.
  - Scientists are afraid that climate change will harm society.

#### Section 2 (pp. 54–59)

- During El Niño years, weather in western South America becomes \_\_\_\_\_.
  - hotter and drier
  - warmer and rainier
  - colder and rainier
  - colder and drier

#### Section 3 (pp. 60–64)

- Each climate region has its own kind of \_\_\_\_\_.
  - rock structure
  - tectonic plate
  - natural vegetation
  - Coriolis effect

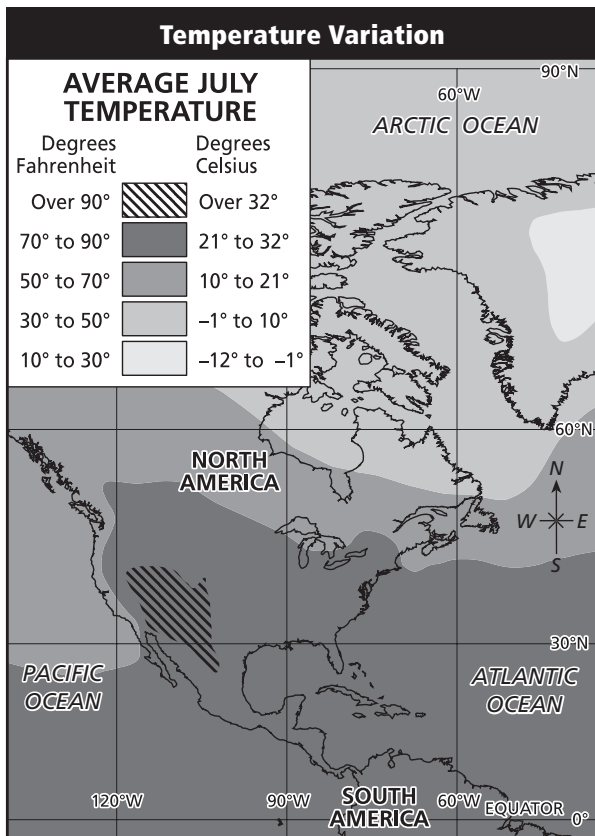
**GO ON** 

## Critical Thinking

Directions: Choose the best answers to the following questions.

8. How do human activities impact climate?
- A The sun may give off varying amounts of solar energy.
  - B Volcanic eruptions may increase cloud cover.
  - C People add gases to the atmosphere by burning fossil fuels.
  - D Scientists do research to learn what causes climate change.

Base your answer to question 9 on the map and on your knowledge of Chapter 3.



9. Going from the Equator to the North Pole, average temperatures \_\_\_\_\_.
- A become progressively warmer
  - B become warmer, then colder
  - C become colder, then warmer
  - D become progressively colder

## Document-Based Questions

Directions: Analyze the document and answer the short-answer questions that follow the document.

The United Nations Framework Convention on Climate Change went into force in 1994. The excerpt below explains why its framers believed it was necessary.

*The Parties to this Convention,*

*Acknowledging that change in the Earth's climate and its adverse effects are a common concern of humankind,*

*Concerned that human activities have been substantially increasing the atmospheric concentrations of greenhouse gases, that these increases enhance the natural greenhouse effect, and that this will result on average in an additional warming of the Earth's surface and atmosphere and may adversely affect natural ecosystems and humankind, . . .*

*Acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions, . . .*

*Affirming that responses to climate change should be coordinated with social and economic development in an integrated manner with a view to avoiding adverse impacts on the latter, taking into full account the legitimate priority needs of developing countries for the achievement of sustained economic growth and the eradication of poverty. . . .*

10. Why were the writers of the framework concerned about climate?
11. What attitude does the framework take regarding social and economic development?

## Extended Response

12. Describe the influence humans have upon climate change?

**STOP**

**Geography ONLINE**

For additional test practice, use Self-Check Quizzes—Chapter 3 on [glencoe.com](http://glencoe.com).

### Need Extra Help?

If you missed questions . . .	1	2	3	4	5	6	7	8	9	10	11	12
Go to page . . .	51	51	56	62	52	58	61	64	55	64	64	64