# Chapter 3 Planning Guide

## Key to Ability Levels
- **BL**: Below Level
- **OL**: On Level
- **AL**: Above Level
- **ELL**: English Language Learners

## Key to Teaching Resources
- Print Material
- Transparency
- CD-ROM or DVD

## Levels

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✓ Chapter- or unit-based activities applicable to all sections in this chapter.

*Also available in Spanish*
### Teacher Resources

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✓ Chapter- or unit-based activities applicable to all sections in this chapter.  
*Also available in Spanish
Chapter 3 Integrating Technology

Teach With Technology

**What is a widget?**
The McGraw-Hill widget is a program for any computer with Internet access that acts as a one-stop launching pad for both software- and online-based programs.

**How can the widget help my students and me?**
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- recognition of, and compatibility with, Glencoe DVD and CD-ROM programs
- QuickPass entry for fast access to chapter content and activities

Visit glencoe.com to download the free student and teacher versions for the McGraw-Hill widget.

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Visit glencoe.com and enter QuickPass™ code WGC2630C3T for Chapter 3 resources.

You can easily launch a wide range of digital products from your computer’s desktop with the McGraw-Hill widget.

### World Geography and Cultures Online Learning Center (Web Site)

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The following articles relate to this chapter:

- “Nary a Drop to Spare,” by Chris Carroll, July 2005.

**National Geographic Society Products** To order the following, call National Geographic at 1-800-368-2728:


Access National Geographic’s new dynamic MapMachine Web site and other geography resources at:

- [www.nationalgeographic.com](http://www.nationalgeographic.com)
- [www.nationalgeographic.com/maps](http://www.nationalgeographic.com/maps)

**Biography**

The following videotape program is available from Glencoe as a supplement to Chapter 3:

- Valley Forge (ISBN 0-76-704671-4)

To order, call Glencoe at 1-800-334-7344. To find classroom resources to accompany many of these videos, check the following pages:

- A&E Television: [www.aetv.com](http://www.aetv.com)
- The History Channel: [www.historychannel.com](http://www.historychannel.com)

**Reading List Generator CD-ROM**

Use this database to search more than 30,000 titles to create a customized reading list for your students.

- Reading lists can be organized by students’ reading level, author, genre, theme, or area of interest.
- The database provides Degrees of Reading Power™ (DRP) and Lexile™ readability scores for all selections.
- A brief summary of each selection is included.

**Leveled reading suggestions for this chapter:**

For students at a Grade 7 reading level:

- Exploring Arctic Ice, by Jane Ellen Stevens

For students at a Grade 8 reading level:

- A Reef Comes to Life: Creating an Undersea Exhibit, by Carolyn Meyer

For students at a Grade 9 reading level:

- Global Warming, by Jenny Tesar

For students at a Grade 10 reading level:

Geographers study how people, places, and environments are distributed on Earth’s surface. Climate affects where and how people live. An understanding of Earth’s climates and the factors that influence them adds to a more complete view of life on Earth.

**Focus**

**More About the Photo**

**Visual Literacy** Glaciers form in regions of high snowfall in winter and cool temperatures in summer. This ensures that the accumulating snow does not melt. As the snow builds up over time, it turns to ice. Then, under the pressure of its own weight, it flows outward and downward, sometimes carrying rocks, silt, and other debris along with it. Huge chunks of ice that break off of glaciers where they meet the sea become icebergs.

**Teach**

As you begin teaching this chapter, read the Big Idea out loud to students. Explain that the Big Idea is a broad, or high-level, concept that will help them understand what they are about to learn. Use the Essential Question for each section to help students focus on the Big Idea.

**Section 1: Earth-Sun Relationships**

**Essential Question** How does Earth’s position in relation to the sun affect life on Earth?

(Energy from the sun warms the Earth. Different areas on Earth have different climates based on when and how much of the sun’s energy reaches them.) Point out that in Section 1, students will learn about the relationship between the sun and Earth’s climates.

**Section 2: Factors Affecting Climate**

**Essential Question** What factors can affect how climates are distributed on Earth’s surface?

(Distribution of climates on Earth’s surface can be influenced by latitude, elevation, landforms, winds, and proximity to oceans.) Point out that in Section 2, students will learn about these factors that affect climates.
Section 3

World Climate Patterns

**Essential Question** How do geographers classify Earth’s climate and vegetation? (Climates are usually classified into regions based on temperature and precipitation. Vegetation is classified by type and the conditions necessary for growth.) Point out to students that in Section 3, they will learn about Earth’s climate patterns. **OL**
Earth-Sun Relationships

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.

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 sleeking 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.”

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 23½°. 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 (°F) and Celsius (°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 23½° 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.
**Writing Support**

**Expository Writing** Ask students to research cities, towns, or people living in the “land of the midnight sun” and write a few paragraphs about what life is like in such a place.

**DIAGRAM STUDY**

**Answers**

1. When the sun’s rays hit the Tropic of Cancer, the Southern Hemisphere receives less direct sunlight than the Northern Hemisphere and is therefore cooler. When the sun’s rays hit the Tropic of Capricorn, the situation is reversed.

2. During the equinoxes the Northern and Southern Hemispheres have similar temperatures because the sun’s rays fall directly on the Equator. During the solstices one hemisphere experiences cooler temperatures while the other experiences warmer temperatures.

**Hands-On Chapter Project**

**Step 1**

**Holding a Climate Fair**

**Step 1: Model the Greenhouse Effect**

The greenhouse effect is essential to all of Earth’s climates. Have students work in groups to design miniature greenhouses to help them explore the greenhouse effect.

**Essential Question:** How does the sun affect climate and weather?

Directions: Write the Essential Question on the board and ask students to read it. Provide materials such as egg cartons, plastic wrap, clear plastic boxes, wooden pallets, thermometers, and sheets of glass, but allow each group to construct its own greenhouse. Students may research greenhouses in gardening books or on the Internet. Have each group fill its completed greenhouse with potting soil. Next, have them plant lima beans in their greenhouses, place them in direct sunlight, and monitor the progress of their plants. After a designated time, have the class evaluate the success of each greenhouse design.

**Summarizing** Have each group explain what they learned about the Essential Question by building and using their greenhouses. Students will use what they learned about climate and weather to study wardrobes around the world in Section 2.

(Chapter project continued on page 57.)

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**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.

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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 23½° 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.

**Diagram Study**

**DIAGRAM STUDY**

**The Earth’s Seasons**

Use StudentWorks™ Plus or 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 (CO₂)—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 CO₂ 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.

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.

Critical Thinking
Comparing and Contrasting
Ask students to read the passage.

Ask: What is the difference between the greenhouse effect and global warming? (The greenhouse effect is a natural phenomenon in which our atmosphere insulates Earth. Global warming is a trend of rising global temperatures.)

READING Check Answer: by burning fossil fuels

Answers

1. Definitions for the vocabulary terms are found in the section and the Glossary.
2. The greenhouse effect occurs when radiation from the sun warms the Earth and carbon dioxide in the atmosphere traps the rising heat and radiates it back towards Earth. Burning fossil fuels releases carbon dioxide, adding more to the atmosphere so more heat is trapped and radiated back to Earth.
3. tilt: areas receive differing amounts of direct sunlight, which affects temperature; rotation: alternates the Eastern and Western Hemispheres between night and day; revolution: affects the angle and amount of sunlight reaching different locations on the planet, which causes seasons
4. Answers will vary depending on location.
5. Because of Florida’s location, the state receives more direct sunlight than Alaska year-round, so it will have warmer weather.
6. summer clothes
7. March 21, September 23; June 21 and December 22
8. Paragraphs should demonstrate an understanding of global warming and its effect on climate and weather.
Factors Affecting Climate

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 an excellent natural laboratory in which to study Earth.

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. . . . Winds 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.”

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 66 2/3° N) experiences continuous daylight or twilight. The polar area south of the Antarctic Circle (latitude 66 2/3° 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 midlatitude 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-tow) 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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Elevation</th>
<th>Latitude &amp; Longitude</th>
<th>Average Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quito, Ecuador</td>
<td>9,223 ft.</td>
<td>0°09’ S / 78°29’ W</td>
<td>58°F (14°C)</td>
</tr>
<tr>
<td>Nairobi, Kenya</td>
<td>5,327 ft.</td>
<td>1°18’ S / 36°55’ E</td>
<td>67°F (19°C)</td>
</tr>
<tr>
<td>Bujumbura, Burundi</td>
<td>2,568 ft.</td>
<td>3°19’ S / 29°19’ E</td>
<td>77°F (25°C)</td>
</tr>
<tr>
<td>Manaus, Brazil</td>
<td>276 ft.</td>
<td>3°09’ S / 59°59’ W</td>
<td>81°F (27°C)</td>
</tr>
<tr>
<td>Telluride, Colorado</td>
<td>8,760 ft.</td>
<td>107°49’ W / 37°57’ N</td>
<td>39°F (3°C)</td>
</tr>
</tbody>
</table>

Source: 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.

**Critical Thinking**

**Analyzing Information**
Tell students that Mount Everest is 29,028 feet (8,848 m) tall. Tell them also that Mauna Kea, Hawaii’s tallest mountain, is 13,796 feet (4,205 m) tall. Ask: Given what you know about the effect of elevation, where would it be colder and the air thinner? (Students may say that the taller mountain has the thinner air and colder environment.) Ask: Why? (Mount Everest has a much higher elevation above sea level.)

Additional Support

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

**Differentiated Instruction**

**Reading Essentials/Note-Taking Guide, p. 19**

**Reinforcing Skills Activity, URB, p. 39**

**Vocabulary Activity 3, URB, p. 35**
Determining Cause and Effect Explain to students that Earth receives the sun’s energy through a chain of causes and effects. Direct students to determine this chain, ending with the sun’s energy being distributed around the planet. (The sun heats the Earth’s atmosphere and surface unevenly, causing warm and cool air masses. The warm air rises and the cool air flows in to replace the warm air. These movements cause winds, which distribute some of the sun’s thermal energy around Earth.)

For additional practice on this skill, see the Skills Handbook.

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-

Activity: Interdisciplinary Connection

**Music** Ask: How can wind create music? Have students create wind chimes to help them investigate this question. Students may work independently or in groups to research the kinds of materials and forms of construction used around the world to make wind chimes. Have students hang their completed wind chimes outdoors and listen for the differences in tone that accompany various wind speeds and patterns. OL
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.

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.

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.

Holding a Climate Fair

Step 2: Climate and Clothes Have the teams of students from Step 1 investigate how climate affects how people live and how they dress.

Directions Assign each group a region of the world. Have each group research the climate of the region and plan a year-round wardrobe for people living there. Students can create an illustrated poster that shows the different items of clothing worn at different times of the year. Have groups explain why each item of clothing represents a response to the regional climate.

Summarizing After each group has researched a region and made a poster, have the class compare wardrobes and determine which region requires the greatest variety of clothing. (Chapter Project continues on page 61.)
Differentiated Instruction

Verbal/Linguistic  Pair a struggling student (Student A) with an on-level student (Student B). Have both students read the passage. Then, Student A will listen as Student B explains El Niño. Student A can then ask clarifying questions of Student B. Next, Student A explains El Niño to Student B. Finally, Student B asks clarifying questions of Student A.  BL

Answers

1. El Niño brings increased rain, warming winters and causing flooding.
2. As cold water pools in the western Pacific, warm water moves east and pools in the eastern Pacific. Dry air descends over the western Pacific. The winds move east over warm waters, and the warm air rises in the eastern Pacific, creating rain.

\[\text{Reading Check} \quad \text{Answer: Winds are diverted north and south, leaving a narrow windless band.}\]

**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 NE•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 beginning in the 1970s. 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**

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

**Did You Know?**

**Astronomy** The Tropic of Cancer and the Tropic of Capricorn are named for the constellations through which the sun appears to be traveling when its rays strike these lines of latitude directly.

**Treacherous Waters** The Maelstrom is a swift current in the Norwegian Sea off the coast of Norway. Strong winds cause this dangerous current to form huge whirlpools that can destroy small ships. After American author Edgar Allan Poe wrote about the Maelstrom, its name came to mean any whirlpool or any kind of severe turmoil.
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 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 extreme temperatures. Large bodies of water take longer to heat and cool than land so the water temperature is cooler than land year-round; warm all year-round; so cold/cool year-round; cooler the higher the elevation.

### 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.

<table>
<thead>
<tr>
<th>Location</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low latitudes</td>
<td></td>
</tr>
<tr>
<td>High latitudes</td>
<td></td>
</tr>
<tr>
<td>Midlatitudes</td>
<td></td>
</tr>
<tr>
<td>Elevation</td>
<td></td>
</tr>
</tbody>
</table>

### Critical Thinking

5. Answering the Essential Question Describe the general differences in climate between the low latitudes and the midlatitudes. What factors account for these differences?
6. Identifying Cause and Effect How does the presence of mountain ranges influence climate?
7. 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?
8. 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.

### Assess

**Geography ONLINE**

Study Central™ provides summaries, interactive games, and online graphic organizers to help students review content.

### Close

**Compare and Contrast** Ask: What is the difference in climate between the high latitudes and the midlatitudes? (The high latitudes are cold, dry polar regions. The midlatitudes are variable and can be hot or cold with a wide range of seasonal changes.)

### Answers

1. Definitions for the vocabulary terms are found in the section and the Glossary.
2. The sun heats the Earth unevenly, which causes ocean and wind currents. Those currents, combined with the sun shining on the Earth at certain times of year, combine to influence a region’s climate and weather.
3. Large bodies of water take longer to heat and cool than land so the water temperatures are more uniform and moderate the weather of coastal lands.
4. **Low latitudes:** receive more direct sunlight all year, so warm all year-round; **High latitudes:** receive less direct sunlight all year, so cold/cool year-round; **Midlatitudes:** amount of direct sunlight varies; seasonal climate patterns; **Elevation:** cooler the higher the elevation.
5. The low latitudes are warm to hot all year. The midlatitudes have a temperate climate and experience dramatic seasonal changes. Proximity to the direct rays of the sun causes these differences.
6. Mountains located near large bodies of water block rain clouds from reaching inland, resulting in one side being cooler and wetter, the other warmer and drier.
7. They are different. Wind currents are more uniform than ocean currents. Cold winds and cold currents originate close to the high latitudes, but only cold currents make their way into the mid- and low latitudes.
8. Paragraphs should address what would happen as the ship approaches the doldrums.
World Climate Patterns

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.

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.’"


Guide to Reading

Essential Question
How do geographers classify Earth’s climate and vegetation?

Content Vocabulary
- natural vegetation (p. 61)
- oasis (p. 61)
- coniferous (p. 62)
- deciduous (p. 62)

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: low latitudes, hot and wet year-round or hot with wet summers and dry winters
- Dry: little precipitation, desert or steppe (grassland)
- Midlatitude: variable weather patterns and seasonal changes
- High latitude: bitterly cold winters, and short, cool summers
- Highland: varies by elevation

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, midlatitudes, high latitude, and highland. But since climates can vary within these broad regions, they are further divided into smaller ones. Each of these divisions has its own characteristic soils and natural vegetation—the original plant life growing in an area. Together with animal life, these elements form biomes.

**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.

**Holding a Climate Fair**

**Step 3: The World Café** Groups of students create menus of foods native to particular climate regions.

**Directions** Write the Essential Question on the board. Divide students into groups and assign a major climate region to each.

Have each group compile a list of dishes made from plant products common to its assigned climate region. Students may then use encyclopedias, cookbooks, or Internet resources for research.

**Synthesizing** Have all the groups work together to create the menu for a world café that includes dishes for each climate region. Ask students how this exercise helped them answer the Essential Question and understand the relationships between Earth’s climate regions. 

(Chapter Project continues on the Visual Summary page.)
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 climates 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.
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 are 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 winter darkness and bitter cold last for several months, and the sun’s indirect rays during long winter days have limited warming effects. The months, and the sun’s indirect rays during long

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. With highland climates, 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.

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.

Activity: Interdisciplinary Connection

Science Ask: How acidic is your rain? Have students use library or Internet resources to research the level at which acid precipitation (acid rain) begins to affect the environment. Ask students to hypothesize about the acidity of their local precipitation. Students will then collect samples of local rain or snow and use a pH meter or litmus strips to determine acidity levels. Invite students to make predictions about the effects of acid precipitation on the local environment based on their findings.
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** How does the burning of fossil fuels create smog?

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**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.

<table>
<thead>
<tr>
<th>Earth's Climates</th>
<th>Climate Region</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Critical Thinking**

4. **Answering the Essential Question** 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 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.

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**Answers**

1. Definitions for the vocabulary terms are found in the section and the Glossary.
2. Answers should have one of the following: variations in the sun’s energy output, changes in the Earth’s orbit, or volcanic activity; burning fossil fuels, damming and diverting rivers
3. **Highland**: varies based on elevation; **Desert**: hot, dry, sparse vegetation; **Mediterranean**: coastal midlatitude with thickets of woody bushes and short trees; **Humid subtropical**: short, mild winters, rain nearly all year; **Steppe**: dry, treeless grasslands; **Tropical wet**: hot and wet all year, near low latitudes; **Tropical dry**: hot all year, rainy summers, dry winters; **Marine west coast**: cool summers, cool damp winters, abundant rainfall, western coastlines in midlatitudes; **Humid continental**: more severe winters and shorter, cooler summers as you move north; **Subarctic**: bitterly cold winters, short and cool summers; **Tundra**: cold summers, bitterly cold winters, no trees; **Ice cap**: permanent ice
4. Three are directly related to latitude (tropics, midlatitudes and high latitudes), two are based on landforms or rainfall (dry, highland).
5. Both are in the low latitudes. Tropical wet is wet year-round. Tropical dry is wet during the summer.
6. Natural and human causes
7. Coniferous forest; coniferous and mixed forests
8. Paragraphs should address that many of the world’s cities are in the midlatitudes because people tend to settle in climates favorable to survival.
**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.

**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 Niño, 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.

**Did You Know?**
The hottest temperatures ever recorded in the world were in Death Valley, California, and El Azizia, Libya, where temperatures reached 134°F (56.6°C) and 136°F (57.7°C), respectively. Both areas are found in mid- or low-latitudes, which get far more direct sun than higher latitudes. Vostok, Antarctica, has been recorded as the coldest place on Earth. The temperature there has dropped as low as −129°F (−89.4°C).

**Hands-On Project**
**Step 4: Wrap-Up**
Allow students to present their Climate Fair to other students in the school.

**Visual Summary**
- Ask: What is the “midnight sun” referenced in the photo at the top? (At the high latitudes, there are times of the year that the sun is always shining.)

**Organizing Information**
Ask the students to use the information on the Visual Summary page to help them create their own study guide. Some ideas students can use:
- Make note cards of each bullet point;
- Write questions based on the information on the page and use them to quiz each other; or
- Create a graphic organizer, such as a concept map or outline.
Answers, Analyses, and Tips

Reviewing Vocabulary

1. A Students struggling with this question will probably choose between answers A and B. In the question, the phrase “day-to-day” implies a short-term occurrence. The correct answer is A.

2. B As with the question above, students will probably choose between A and B. Since weather occurs over the short term, students may conclude that long-term conditions make up climate.

3. C The Coriolis effect is covered extensively in the chapter, and is illustrated on the World Zones of Latitude and Wind Patterns map.

4. C Mixed vegetation implies that more than grassland is found in the region. Students should know that savannas are found in the tropics and tundra is found in high-latitude climates close to the Poles.

Reviewing Main Ideas

5. B Students may be confused because all the answer options are true statements. The question asks for an explanation of why life depends on the greenhouse effect. Only answer B addresses that question.

6. B Answers B and C are possible answers since precipitation increases along the coast of South America during El Niño years. El Niño also causes warmer winters, so the combination of warmer and rainier makes choice B correct.

7. C Answers A and B are terms for geologic structures, and are not specific to climate regions. Students struggling to choose between C and D should remember that different climates support very different vegetation.
Critical Thinking

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 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. Students’ answers will vary but should include the terminology used to discuss climate regions in this chapter. Answers should also reflect an understanding of the factors that affect climate.