

CHAPTER 22 Climate

SECTION 1

Factors That Affect Climate

KEY IDEAS

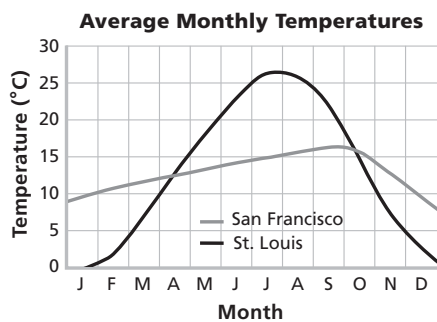
As you read this section, keep these questions in mind:

- What are the two main characteristics of an area’s climate?
- How does latitude determine the amount of solar energy that Earth receives?
- How do the different rates at which water and land are heated affect climate?
- What are the effects of topography on climate?

What Is Climate?

Weather and climate are not the same thing. *Weather* is the condition of the atmosphere at a particular time. **Climate** is the pattern of weather conditions for an area over a long period of time.

An area’s climate has two main characteristics: temperature and precipitation. An area’s average yearly temperature and precipitation can give you important information about the area’s climate. However, the yearly range of temperatures and precipitation in an area is also important, as shown in the photo below.



St. Louis and San Francisco have the same average yearly temperature. However, they have very different yearly temperature ranges.

The *yearly temperature range* of an area is the difference between the area’s highest and lowest monthly average temperatures. Similarly, the *yearly precipitation range* of an area is the difference between the area’s highest and lowest monthly average precipitation.

Several factors influence the temperature and precipitation levels of an area. The three factors that have the greatest influence on climate are latitude, heat absorption and release, and topography.

READING TOOLBOX

Ask Questions As you read this section, underline any ideas that you don’t understand. When you finish reading, write several questions about the underlined ideas. Work in pairs to try to figure out the answers.

LOOKING CLOSER

1. Describe How are the yearly temperature ranges of St. Louis and San Francisco different from one another?

SECTION 1 Factors That Affect Climate *continued*

How Does Latitude Affect Climate?

The most important factor that determines a region's climate is the region's latitude. Different latitudes on Earth receive different amounts of solar energy. ✓

READING CHECK

2. Identify What is the most important factor that determines a region's climate?

SOLAR ENERGY

The more solar energy an area receives, the higher the average temperatures in the area will be. The angle at which the sun's rays hit Earth determines how much solar energy an area receives.

At the equator, the sun's rays hit Earth at a 90° angle. The sun's rays are concentrated on a small area. Therefore, temperatures at the equator are high. At higher latitudes, the sun's rays hit Earth at a smaller angle. Therefore, the sun's rays are spread out over a larger area. As a result, temperatures at higher latitudes are low. ✓

READING CHECK

3. Explain Why are temperatures high at the equator?

Earth's axis is tilted. Thus, the angle at which the sun's rays hit Earth changes as Earth orbits the sun. During winter in the Northern Hemisphere, the northern half of Earth tilts away from the sun. Therefore, the Northern Hemisphere receives less solar radiation, and temperatures are lower. At the same time, the Southern Hemisphere is tilted toward the sun, so its temperatures are higher.

During winter, Earth's tilt also causes areas at higher latitudes to face the sun for less time each day. As a result, the days are shorter during the winter months.

Effects of Latitude on Climate

Region	Latitude Range	Description	Examples
Polar regions	60°N–90°N and 60°S–90°S	daylight ranges from 24 h in summer to 0 h in winter; annual temperature range is very large; daily temperature range is very small	Greenland, Antarctica
Middle latitudes	about 20°N–60°N and about 20°S–60°S	daylight changes during the year, but less than in polar regions; yearly temperature range is smaller than in polar regions	most of North America and Europe
Equator	0° to about 20°N and 0° to about 20°S	daylight changes little during the year; yearly temperature range is smaller than in middle latitudes	parts of Africa and South America

LOOKING CLOSER

4. Interpret Which region has the smallest yearly temperature range?

SECTION 1 Factors That Affect Climate *continued*

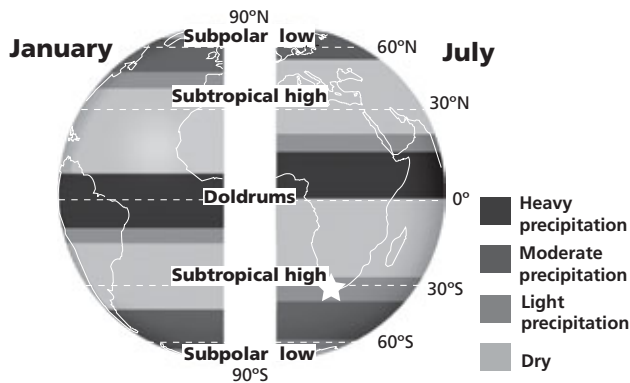
GLOBAL WIND PATTERNS

Solar energy heats the air above Earth’s surface. The warmer the surface is, the warmer the air above it is. Therefore, belts of cool, high-pressure air form near the poles. Belts of warm, low-pressure air form near the equator. These differences in air pressure produce global winds.

Global winds affect precipitation and temperature. Areas in different wind belts often have different climates. For example, the equatorial region is located in the *doldrums*. Within the doldrums, air rises and cools, making water vapor condense. Therefore, the equatorial region receives large amounts of precipitation.

In contrast, the *subtropical highs* exist between 20° and 30° latitude. Within the subtropical highs, air sinks. As it sinks, it becomes warmer and less humid. Therefore, the subtropical highs generally receive little precipitation.

In the middle latitudes, at 45° to 60° latitude, warm tropical air meets cold polar air. This produces large amounts of precipitation. In high-pressure areas above 60° latitude, air is cold and dry. Therefore, precipitation in these regions is low.



As seasons change, global wind belts shift in either a northern or southern direction. At the same time, the associated belts of precipitation also shift.

Critical Thinking

5. Apply Concepts Weather maps typically show areas of high pressure and low pressure. Why might a low-pressure area be more likely to have storms?

LOOKING CLOSER

6. Interpret South Africa (shown on the map with a star) is a country on the southern tip of the African continent. During which season will this country receive the most precipitation?

How Does Heat Absorption Affect Climate?

The amount of heat that air absorbs or releases depends on the temperature of the land or water beneath it. Land and water absorb and release heat differently.

Land is opaque and unmoving, so it heats more quickly than water. Surface water, on the other hand, is transparent and moves continuously. Waves and currents replace warm surface water with cooler water. This action prevents the surface temperature from increasing rapidly.

SECTION 1 Factors That Affect Climate *continued*

SPECIFIC HEAT AND EVAPORATION

Even when it is not in motion, water warms more slowly than land. It also releases heat energy more slowly. This is because the specific heat of water is higher than that of land. **Specific heat** is the amount of energy needed to change the temperature of 1 g of a substance by 1 °C. ✓

 **READING CHECK**

7. Explain Why does land heat more quickly than water?

The temperatures of land and water at the same latitude also vary because of differences in heat loss through evaporation. Evaporation affects water surfaces more than land surfaces, because water surfaces contain more water.

OCEAN CURRENTS

Warm and cold ocean currents can heat or cool the air above them. Therefore, ocean currents can affect an area’s climate. For example, wind can blow warm air above a warm ocean current onto the nearby land. The warm air can make the land’s climate warmer.

SEASONAL WINDS

In some areas, temperature differences between land and water cause winds to shift seasonally. During the summer, the land warms more quickly than the ocean. The warm air rises. Cooler air from over the ocean moves in to replace the warm air, producing wind. During the winter, the land loses heat more quickly than the ocean does. The cool air above the land flows toward the ocean and produces wind. These seasonal winds are called **monsoons**. ✓

 **READING CHECK**

8. Define What is a monsoon?

Monsoon winds are caused by seasonal heating and cooling. In the winter, winds blowing toward the oceans can cause dry weather and droughts. In the summer, winds blowing toward the land bring moisture from the ocean. These summer winds can cause heavy rainfall and flooding.

Effects of Seasonal Winds on Climate

Season	Direction the Monsoon Blows	Effects on Climate
Winter		Winter monsoon winds bring dry weather and droughts.
Summer	from ocean toward the land	

LOOKING CLOSER

9. Identify Complete the table to describe summer and winter monsoon winds.

SECTION 1 Factors That Affect Climate *continued*

EL NIÑO–SOUTHERN OSCILLATION

The *El Niño–Southern Oscillation*, or *ENSO*, is a cycle of changing wind and water-current patterns. Every 3 to 10 years, **El Niño**, the warm-water phase of the ENSO, makes surface-water temperatures in some areas rise. The event changes the interaction of ocean and air. This change can alter global weather patterns.

During El Niño, some areas have more typhoons, cyclones, and floods. Droughts may strike other areas. The ENSO also has a cool-water phase called *La Niña*. La Niña can also affect weather patterns. For example, during La Niña, some areas experience more hurricanes. ✓

READING CHECK

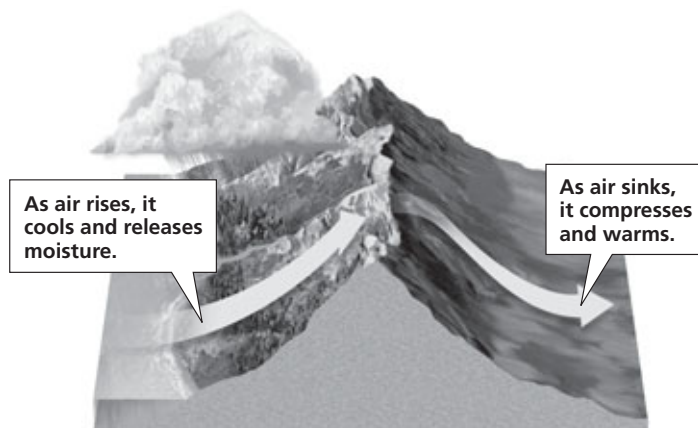
10. Explain What is La Niña?

What Effect Does Topography Have on Climate?

The surface features of land, or *topography*, also influence climate. Topographical features, such as mountains, can control air flow through a region.

Changes in *elevation*, or height above sea level, can cause temperature changes. Temperature generally decreases as elevation increases. Even along the equator, high mountain peaks can be cold enough to be covered with snow.

Mountains can also influence climate by creating an effect called a *rain shadow*, as shown below. When a moving air mass comes into contact with a mountain range, the air rises and cools. The rising and cooling produces precipitation. The precipitation falls mainly on one side of the mountain. As a result, the air that flows down the other side is warmer and drier.



Mountains cause air to rise, cool, and lose moisture as air passes over them. This process creates the rain shadow effect.

LOOKING CLOSER

11. Infer Which side of the mountain would you expect to have more vegetation? Why?

Section 1 Review

SECTION VOCABULARY

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

El Niño the warm-water phase of the El Niño–Southern Oscillation; a periodic occurrence in the eastern Pacific Ocean in which the surface-water temperature becomes unusually warm

monsoon a seasonal wind that blows toward the land in the summer, bringing heavy rains, and that blows away from the land in the winter, bringing dry weather

specific heat the quantity of heat required to raise a unit mass of homogenous material 1 K or 1 °C in a specified way, given constant pressure and volume

1. Identify What are the two main characteristics that describe the climate of an area?

2. Explain How does the latitude of an area on Earth determine the amount of sunlight the area receives?

3. Explain Why do areas near the poles receive little to no daylight during the winter?

4. Compare What is the difference between El Niño and La Niña?

5. Describe How do monsoons form?

6. Define What is a rain shadow?
