Section 12.2

Objectives

- **Compare and contrast** the three major wind systems.
- **Identify** four types of fronts.
- **Distinguish** between high- and low-pressure systems.

Review Vocabulary

convection: the transfer of thermal energy by the flow of a heated substance

New Vocabulary

Coriolis effect
polar easterlies
prevailing westerlies
trade winds
jet stream
front

Weather Systems

MAIN Idea Weather results when air masses with different pressures and temperatures move, change, and collide.

Real-World Reading Link On a summer day, you might enjoy cool breezes. However, on a winter day, you might avoid the cold wind. Winds are part of a global air circulation system that balances thermal energy around the world.

Global Wind Systems

If Earth did not rotate on its axis, two large air convection currents would cover Earth, as shown in **Figure 12.4.** The colder and more dense air at the poles would sink to the surface and flow toward the tropics. There, the cold air would force warm, equatorial air to rise. This air would cool as it gained altitude and flowed back toward the poles. However, Earth rotates from west to east, which prevents this situation.

The directions of Earth's winds are influenced by Earth's rotation. This **Coriolis effect** results in fluids and objects moving in an apparent curved path rather than a straight line. Thus, as illustrated in **Figure 12.5,** moving air curves to the right in the northern hemisphere and curves to the left in the southern hemisphere. Together, the Coriolis effect and the heat imbalance on Earth create distinct global wind systems. They transport colder air to warmer areas near the equator and warmer air to colder areas near the poles. Global wind systems help to equalize the thermal energy on Earth.

There are three basic zones, or wind systems, at Earth's surface in each hemisphere. They are polar easterlies, prevailing westerlies, and trade winds.

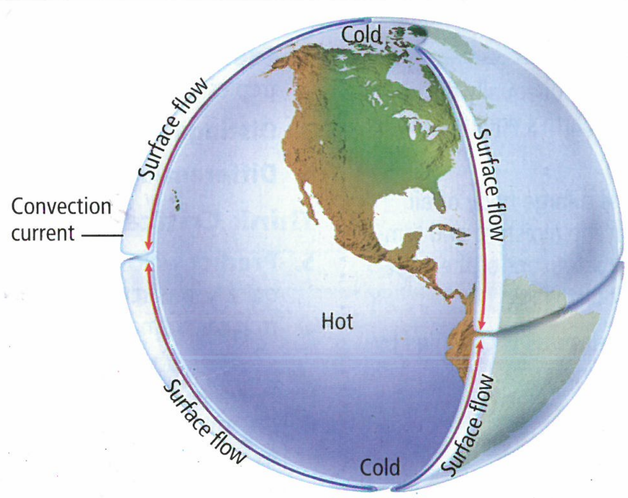


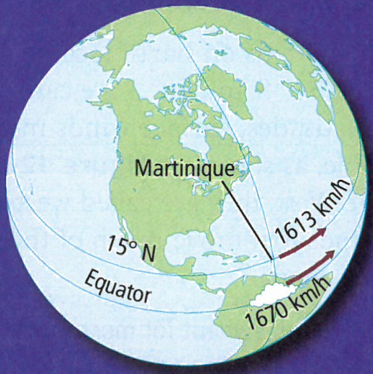
Figure 12.4 If Earth did not rotate, two large convection currents would form as denser polar air moved toward the equator. These currents would warm and rise as they approached the equator, and cool as they moved toward each pole.

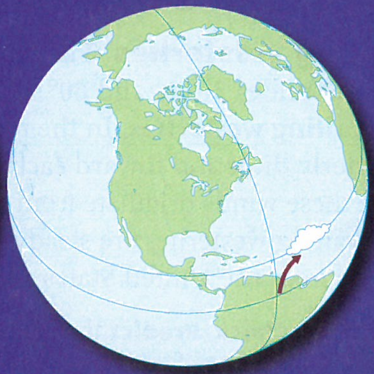
Visualizing the Coriolis Effect

Figure 12.5 The Coriolis effect results in fluids and objects moving in an apparent curved path rather than a straight line.

Recall that distance divided by time equals speed. The equator has a length of about 40,000 km—Earth's circumference—and Earth rotates west to east once about every 24 hours. This means that things on the equator, including the air above it, move eastward at a speed of about 1670 km/h.

However, not every location on Earth moves eastward at this speed. Latitudes north and south of the equator have smaller circumferences than the equator. Those objects not on the equator move less distance during the same amount of time. Therefore, their eastward speeds are slower than objects on the equator.



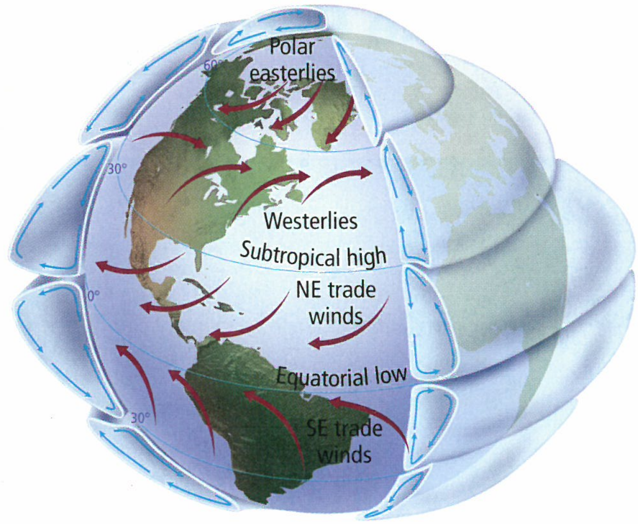


The island of Martinique is located at approximately 15°N latitude. Suppose that rising equatorial air is on the same line of longitude as Martinique. When this air arrives at 15°N latitude a day later, it will be east of Martinique because the air was moving to the east faster than the island was moving to the east.

The result is that air moving toward the poles appears to curve to the right, or east. The opposite is true for air moving from the poles to the equator because the eastward speed of polar air is slower than the eastward speed of the land over which it is moving.

Concepts In Motion To explore more about the Coriolis effect, visit glencoe.com.

Earth Science Online



■ **Figure 12.6** The directions of Earth's wind systems, such as the polar easterlies and the trade winds, vary with the latitudes in which they occur. Note that a wind is named for the direction from which it blows. A north wind blows from the north.

Polar easterlies The wind zones between 60° N latitude and the north pole, and 60° S latitude and the south pole are called the **polar easterlies,** also shown in **Figure 12.6.** Polar easterlies begin as dense polar air that sinks. As Earth spins, this cold, descending air is deflected in an easterly direction away from each pole. The polar easterlies are typically cold winds. Unlike the prevailing westerlies, these polar easterlies are often weak and sporadic.

Between polar easterlies and prevailing westerlies is an area called a polar front. Earth has two polar fronts located near latitudes 60° N and 60° S. Polar fronts are areas of stormy weather.

Vocabulary

Science usage v. Common usage

Circulation

Science usage: movement in a circle or circuit

Common usage: condition of being passed about and widely known; distribution

Prevailing westerlies The wind systems on Earth located between latitudes 30° N and 60° N, and 30° S and 60° S are called the **prevailing westerlies.** In the midlatitudes, surface winds move in a westerly direction toward each pole, as shown in **Figure 12.6.** Because these winds originate from the West, they are called westerlies. Prevailing westerlies are steady winds that move much of the weather across the United States and Canada.

Reading Check **Predict** the direction of movement for most tornadoes in the United States.

Trade winds Between latitudes 30° N and 30° S are two circulation belts of wind known as the **trade winds,** which are shown in **Figure 12.6.** Air in these regions sinks, warms, and moves toward the equator in an easterly direction. When the air reaches the equator, it rises and moves back toward latitudes 30° N and 30° S, where it sinks and the process repeats.

Horse latitudes Near latitudes 30° N and 30° S, the sinking air associated with the trade winds creates an area of high pressure. This results in a belt of weak surface winds called the horse latitudes. Earth's major deserts, such as the Sahara, are under these high-pressure areas.

Intertropical convergence zone Near the equator, trade winds from the North and the South meet and join, as shown in **Figure 12.6.** The air is forced upward, which creates an area of low pressure. This process, called convergence, can occur on a small or large scale. Near the equator, it occurs over a large area called the intertropical convergence zone (ITCZ). The ITCZ drifts south and north of the equator as seasons change. In general, it follows the positions of the Sun in relation to the equator. In March and September it is directly over the equator. Because the ITCZ is a region of rising air, it has bands of cloudiness and thunderstorms, which deliver moisture to many of the world's tropical rain forests.

VOCABULARY

ACADEMIC VOCABULARY

Generate (JE nuh rayt)
to bring into existence
Wind is generated as air moves from an area of high pressure to an area of low pressure.

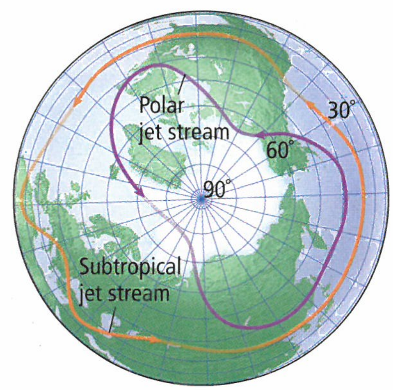
Jet Streams

Atmospheric conditions and events that occur at the boundaries between wind zones strongly influence Earth's weather. On either side of these boundaries, both surface air and upper-level air differ greatly in temperature and pressure. Recall from Chapter 11 that warmer air has higher pressure than cooler air, and that the difference in air pressure causes wind. Wind is the movement of air from an area of high pressure to an area of low pressure.

A large temperature gradient in upper-level air combined with the Coriolis effect results in strong westerly winds called jet streams. A **jet stream,** shown in **Figure 12.7,** is a narrow band of fast wind. Its speed varies with the temperature differences between the air masses at the wind zone boundaries. A jet stream can have a speed up to 185 km/h at altitudes of 10.7 km to 12.2 km.

The position of a jet stream varies with the season. It generally is located in the region of strongest temperature differences on a line from the equator to a pole. The jet stream can move almost due south or north, instead of following its normal westerly direction. It can also split into branches and re-form later. Whatever form or position it takes, the jet stream represents the strongest core of winds.

Figure 12.7 Weather in the middle latitudes is strongly influenced by fast-moving, high-altitude jet streams.

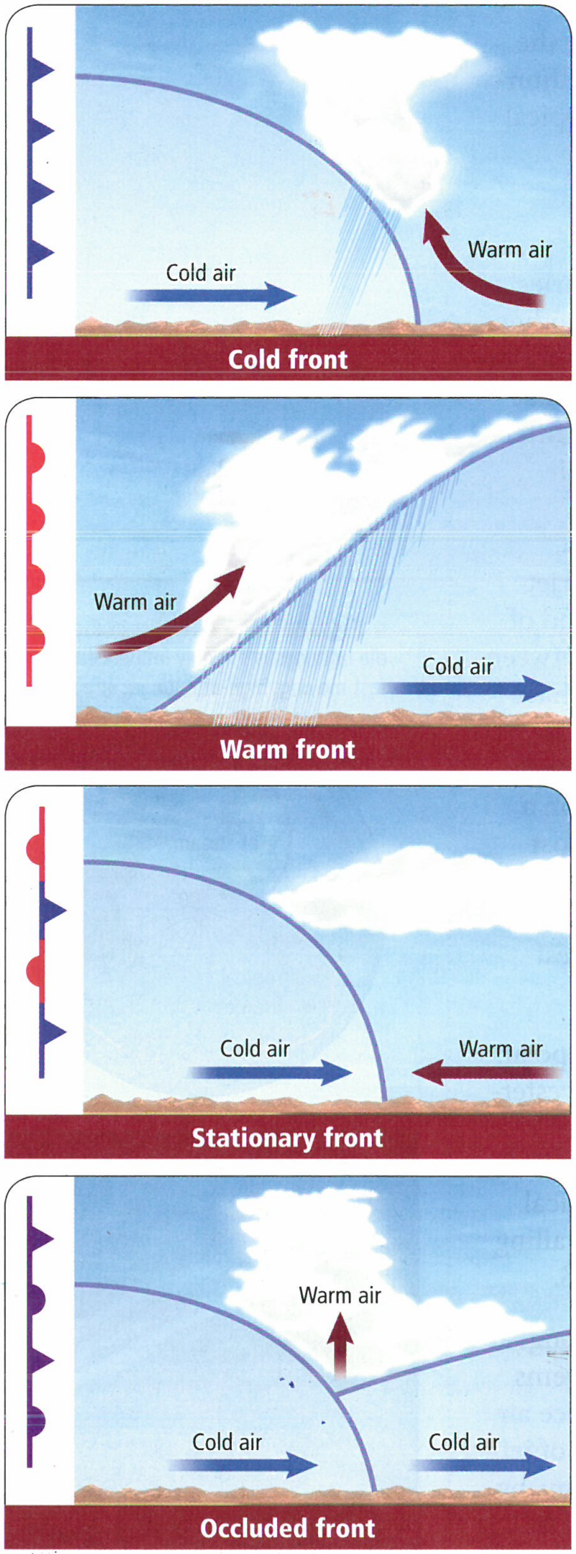


Types of jet streams The major jet streams, called the polar jet streams, separate the polar easterlies from the prevailing westerlies in the northern and southern hemispheres. The polar jet streams occur at about latitudes 40° N to 60° N and 40° S to 60° S, and move west to east. The minor jet streams are the subtropical jet streams. They occur where the trade winds meet the prevailing westerlies, at about latitudes 20° N to 30° N and 20° S to 30° S.

Jet streams and weather systems Storms form along jet streams and generate large-scale weather systems. These systems transport cold surface air toward the tropics and warm surface air toward the poles. Weather systems generally follow the path of jet streams. Jet streams also affect the intensity of weather systems by moving air of different temperatures from one region of Earth to another.

■ **Figure 12.8** The type of front formed depends on the types of air masses that collide.
Identify ***the front associated with high cirrus clouds.***

Concepts In Motion
Interactive Figure To see an animation of fronts, visit glencoe.com.



Fronts

Air masses with different characteristics can collide and result in dramatic weather changes. A collision of two air masses forms a **front**—a narrow region between two air masses of different densities. Recall that the density of an air mass results from its temperature, pressure, and humidity. Fronts can cover thousands of kilometers of Earth's surface.

Cold front When cold, dense air displaces warm air, it forces the warm air, which is less dense, up along a steep slope, as shown in **Figure 12.8.** This type of collision is called a cold front. As the warm air rises, it cools and condenses. Intense precipitation and sometimes thunderstorms are common with cold fronts. A blue line with evenly spaced blue triangles represents a cold front on a weather map. The triangles point in the direction of the front's movement.

Warm front Advancing warm air displaces cold air along a warm front. A warm front develops a gradual boundary slope, as illustrated in **Figure 12.8.** A warm front can cause widespread light precipitation. On a weather map, a red line with evenly spaced, red semicircles pointing in the direction of the front's movement indicates a warm front.

Stationary front When two air masses meet but neither advances, the boundary between them stalls. This front—a stationary front, as shown in **Figure 12.8**—frequently occurs between two modified air masses that have small temperature and pressure gradients between them. The air masses can continue moving parallel to the front. Stationary fronts sometimes have light winds and precipitation. A line of evenly spaced, alternating cold- and warm-front symbols pointing in opposite directions represents a stationary front on a weather map.

Occluded front Sometimes, a cold air mass moves so rapidly that it overtakes a warm front and forces the warm air upward, as shown in **Figure 12.8.** As the warm air is lifted, the advancing cold air mass collides with the cold air mass in front of the warm front. This is called an occluded front. Strong winds and heavy precipitation are common along an occluded front. An occluded front is shown on a weather map as a line of evenly spaced, alternating purple triangles and semicircles pointing in the direction of the occluded front's movement.

Pressure Systems

In Chapter 11, you learned that at Earth's surface, sinking air is associated with high pressure and rising air is associated with low pressure. Air always flows from an area of high pressure to an area of low pressure. Sinking or rising air, combined with the Coriolis effect, results in the formation of rotating high- and low-pressure systems in the atmosphere. Air in these systems moves in a circular motion around either a high- or low-pressure center.

Low-pressure systems In surface low-pressure systems, air rises. When air from outside the system replaces the rising air, this air spirals inward toward the center and then upward. Air in a low-pressure system in the northern hemisphere moves in a counterclockwise direction, as shown in **Figure 12.9.** The opposite occurs in the southern hemisphere for a low-pressure system. As air rises, it cools and often condenses into clouds and precipitation. Therefore, a low-pressure system, whether in the northern or southern hemisphere, is often associated with cloudy weather and precipitation.

High-pressure systems In a surface high-pressure system, sinking air moves away from the system's center when it reaches Earth's surface. The Coriolis effect causes the sinking air to move to the right, making the air circulate in a clockwise direction in the northern hemisphere and in a counter clockwise direction in the southern hemisphere. High-pressure systems are usually associated with fair weather. They dominate most of Earth's subtropical oceans and provide generally pleasant weather.

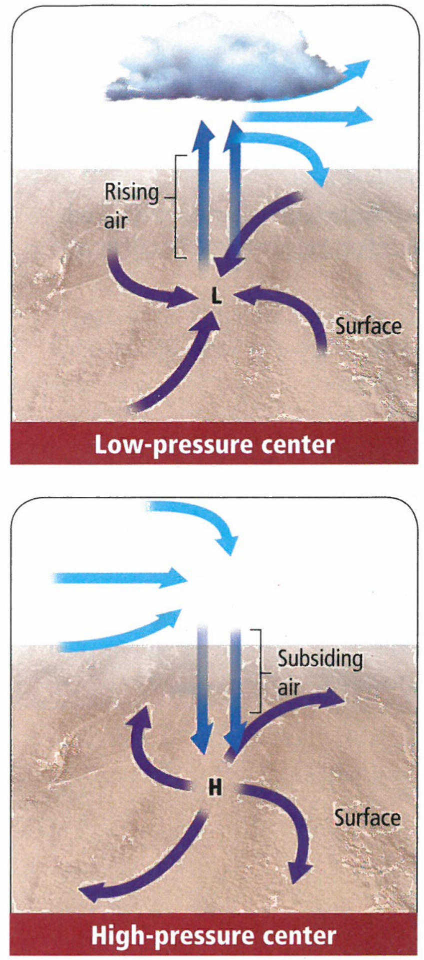


Figure 12.9 In the northern hemisphere, winds move counterclockwise around a low-pressure center, and clockwise around a high-pressure center.

Section 12.2 Assessment

Section Summary

- The three major wind systems are the polar easterlies, the prevailing westerlies, and the trade winds.
- Fast-moving, high-altitude jet streams greatly influence weather in the middle latitudes.
- The four types of fronts are cold fronts, warm fronts, occluded fronts, and stationary fronts.
- Air moves in a generally circular motion around either a high- or low-pressure center.

Understand Main Ideas

1. MAIN Idea **Summarize** information about the four types of fronts. Explain how they form and lead to changes in weather.
2. **Distinguish** among the three main wind systems.
3. **Describe** the Coriolis effect.
4. **Explain** why most tropical rain forests are located near the equator.
5. **Describe** how a jet stream affects the movement of air masses.
6. **Compare and contrast** high-pressure and low-pressure systems.

Think Critically

7. **Analyze** why most of the world's deserts are located between latitudes 10°N to 30°N and 10°S to 30°S.

WRITING in Earth Science

8. Write a summary about how the major wind systems form.