SECTION 3 READING WARM-UP

Terms to Learn

wind
Coriolis effect
trade winds
westerlies
polar easterlies
jet streams

What You'll Do

- Explain the relationship between air pressure and wind direction.
- Describe the global patterns of wind.
- Explain the causes of local wind patterns.

Atmospheric Pressure and Winds

Sometimes it cools you. Other times it scatters tidy piles of newly swept trash. Still other times it uproots trees and flattens buildings, as shown in **Figure 12.** **Wind** is moving air. In this section you will learn about air movement and about the similarities and differences between different kinds of winds.

Figure 12 *In 1998, the winds from Hurricane Mitch reached speeds of 288 km/h, destroying entire towns in Honduras.*

Why Air Moves

Wind is created by differences in air pressure. The greater the pressure difference is, the faster the wind moves. This difference in air pressure is generally caused by the unequal heating of the Earth. For example, the air at the equator is warmer and less dense. This warm, less-dense air rises. As it rises it creates an area of low pressure. At the poles, however, the air is colder and more dense. Colder, more-dense air is heavier and sinks. This cold, sinking air creates areas of high pressure. Pressure differences in the atmosphere at the equator and at the poles cause air to move. Because air moves from areas of high pressure to areas of low pressure, winds generally move from the poles to the equator, as shown in **Figure 13.**

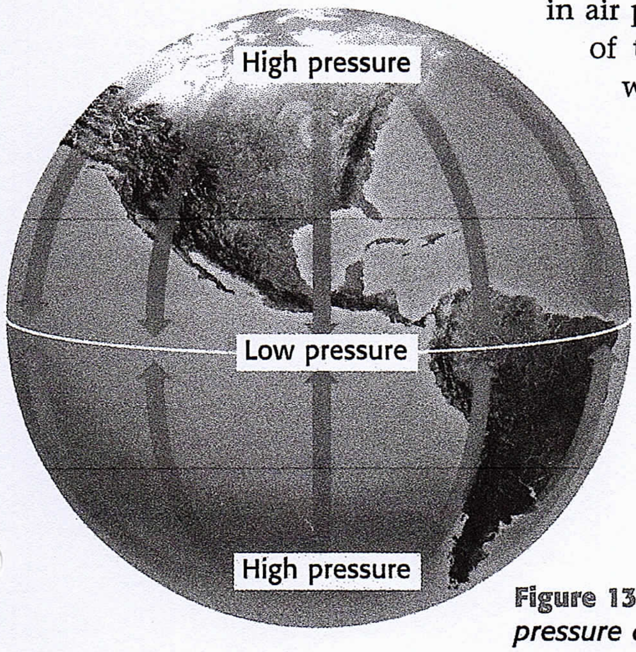


Figure 13 *Surface winds blow from polar high-pressure areas to equatorial low-pressure areas.*

Pressure Belts You may be imagining wind moving in one huge, circular pattern, from the poles to the equator. In fact, the pattern is much more complex. As warm air rises over the equator, it begins to cool. Eventually, it stops rising and moves toward the poles. At about 30° north and 30° south latitude, some of the cool air begins to sink. This cool, sinking air causes a high pressure belt near 30° north and 30° south latitude.

At the poles, cold air sinks. As this air moves away from the poles and along the Earth's surface, it begins to warm. As the air warms, the pressure drops, creating a low-pressure belt around 60° north and 60° south latitude. The circular patterns caused by the rising and sinking of air are called *convection cells,* as shown in **Figure 14.**

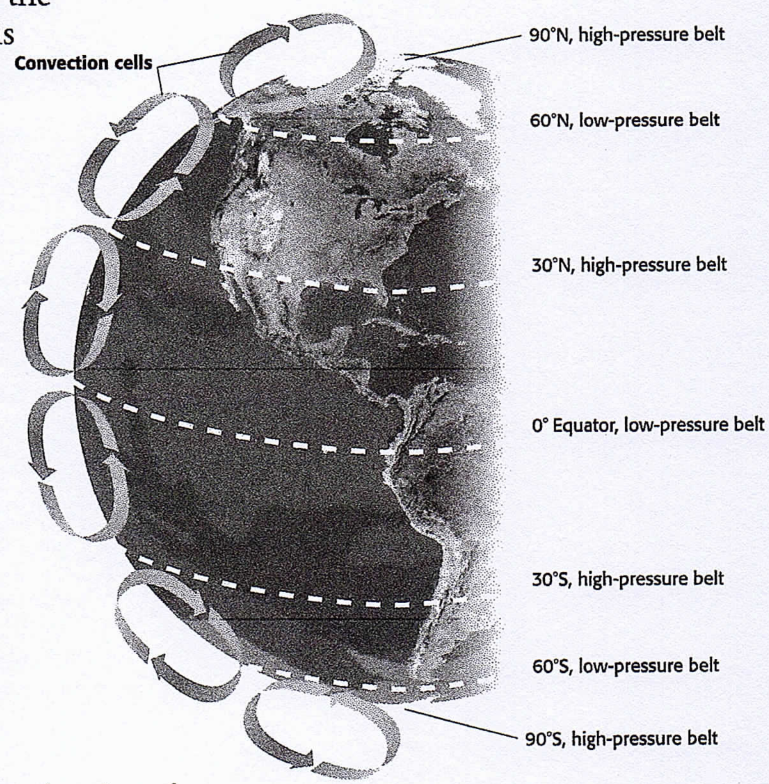


Figure 14 *The uneven heating of the Earth produces pressure belts. These belts occur at about every 30° of latitude.*

Coriolis Effect Winds don't blow directly north or south. The movement of wind is affected by the rotation of the Earth. The Earth's rotation causes wind to travel in a curved path rather than in a straight line. The curving of moving objects, such as wind, by the Earth's rotation is called the **Coriolis effect.** Because of the Coriolis effect, the winds in the Northern Hemisphere curve to the right, and those in the Southern Hemisphere curve to the left.

To better understand how the Coriolis effect works, imagine rolling a marble across a Lazy Susan while it is spinning. What you might observe is shown in **Figure 15.**

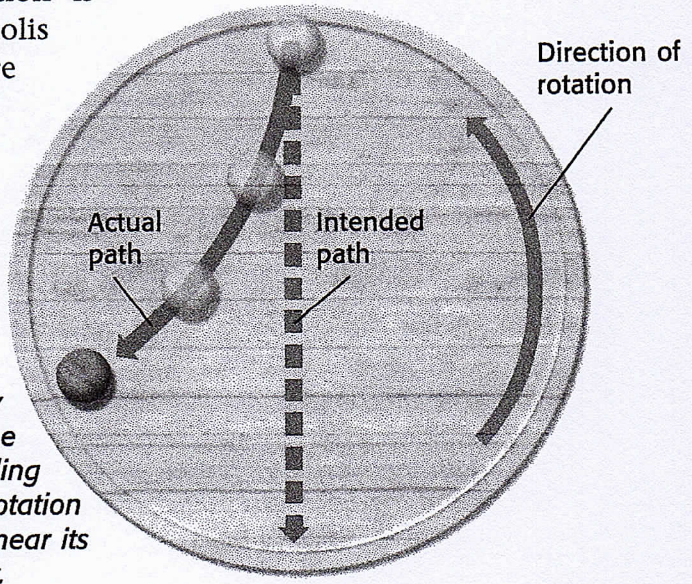


Figure 15 *Because of the Lazy Susan's rotation, the path of the marble curves instead of traveling in a straight line. The Earth's rotation affects objects traveling on or near its surface in much the same way.*

QuickLab

Full of "Hot Air"

1. Fill a **large clear-plastic container** with **cold water.**
2. Tie the end of a **string** around the neck of a **small bottle.**
3. Fill the small bottle with **hot water,** and add a few drops of **red food coloring** until the water has changed color.
4. Without tipping the small bottle, lower it into the plastic container until it rests on the bottom.
5. Observe what happens.
6. What process does this activity model? What do you think will happen if you fill the small bottle with cold water instead? Try it!

TRY at HOME

Types of Winds

There are two main types of winds: local winds and global winds. Both types are caused by the uneven heating of the Earth's surface and by pressure differences. *Local winds* generally move short distances and can blow from any direction. *Global winds* are part of a pattern of air circulation that moves across the Earth. These winds travel longer distances than local winds, and they each travel in a specific direction. **Figure 16** shows the location and movement of major global wind systems. First let's review the different types of global winds, and later in this section we will discuss local winds.

Trade Winds In both hemispheres, the winds that blow from 30° latitude to the equator are called **trade winds.** The Coriolis effect causes the trade winds to curve, as shown in Figure 16. Early traders used the trade winds to sail from Europe to the Americas. This is how they became known as "trade winds."

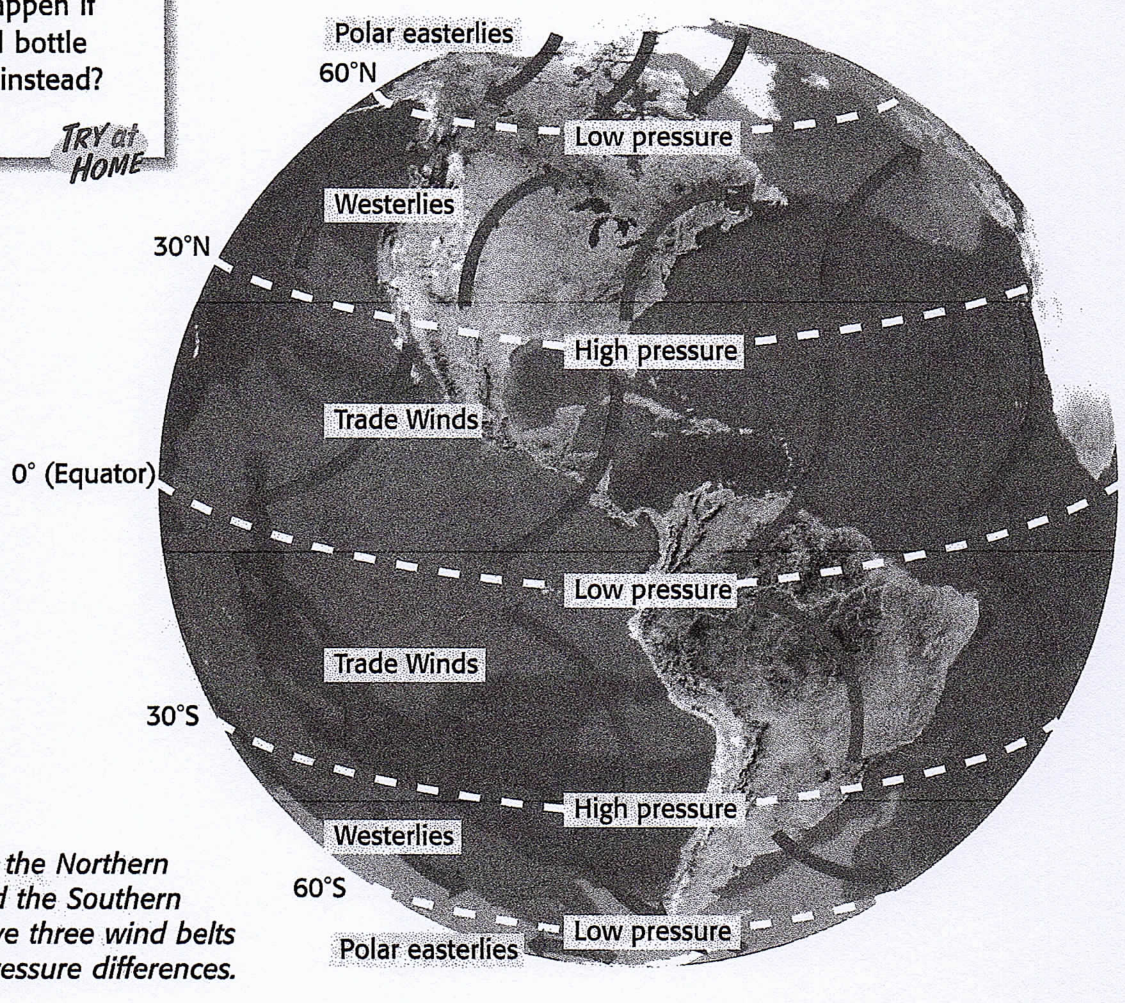


Figure 16 *Both the Northern Hemisphere and the Southern Hemisphere have three wind belts as a result of pressure differences.*

The Doldrums and Horse Latitudes The trade winds of the Northern and Southern Hemispheres meet in an area of low pressure around the equator called the *doldrums*. In the doldrums there is very little wind because of the warm rising air. *Doldrums* comes from an Old English word meaning "foolish." Sailors were considered foolish if they got their ship stuck in these areas of little wind.

At about 30° north and 30° south latitude, sinking air creates an area of high pressure. This area is called the *horse latitudes*. Here the winds are weak. Legend has it that the name horse latitudes was given to these areas when sailing ships carried horses from Europe to the Americas. When the ships were stuck in this area due to lack of wind, horses were sometimes thrown overboard to save drinking water for the sailors.

Westerlies The **westerlies** are wind belts found in both the Northern and Southern Hemispheres between 30° and 60° latitude. The westerlies flow toward the poles in the opposite direction of the trade winds. The westerlies helped early traders return to Europe. Sailing ships, like the one in **Figure 17**, were designed to best use the wind to move the ship forward.

Figure 17 *This ship is a replica of Columbus's Santa Maria. If it had not sunk, the Santa Maria would have used the westerlies to return to Europe.*

Polar Easterlies The **polar easterlies** are wind belts that extend from the poles to 60° latitude in both hemispheres. The polar easterlies are formed from cold, sinking air moving from the poles toward 60° north and 60° south latitude.

Environment CONNECTION

Humans have been using wind energy for thousands of years. Today wind energy is being tapped to produce electricity at wind farms. Wind farms are made up of hundreds of wind turbines that look like giant airplane propellers attached to towers. Together these wind turbines can produce enough electricity for an entire town.

LabBook

To find out how to build a device that measures wind speed, turn to page 102 of the LabBook.

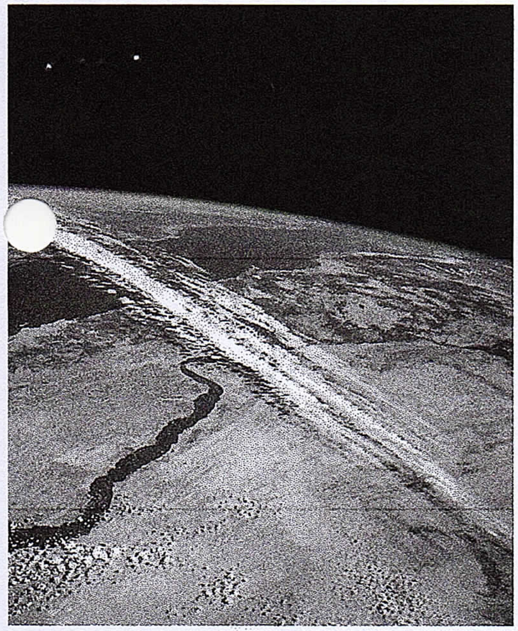


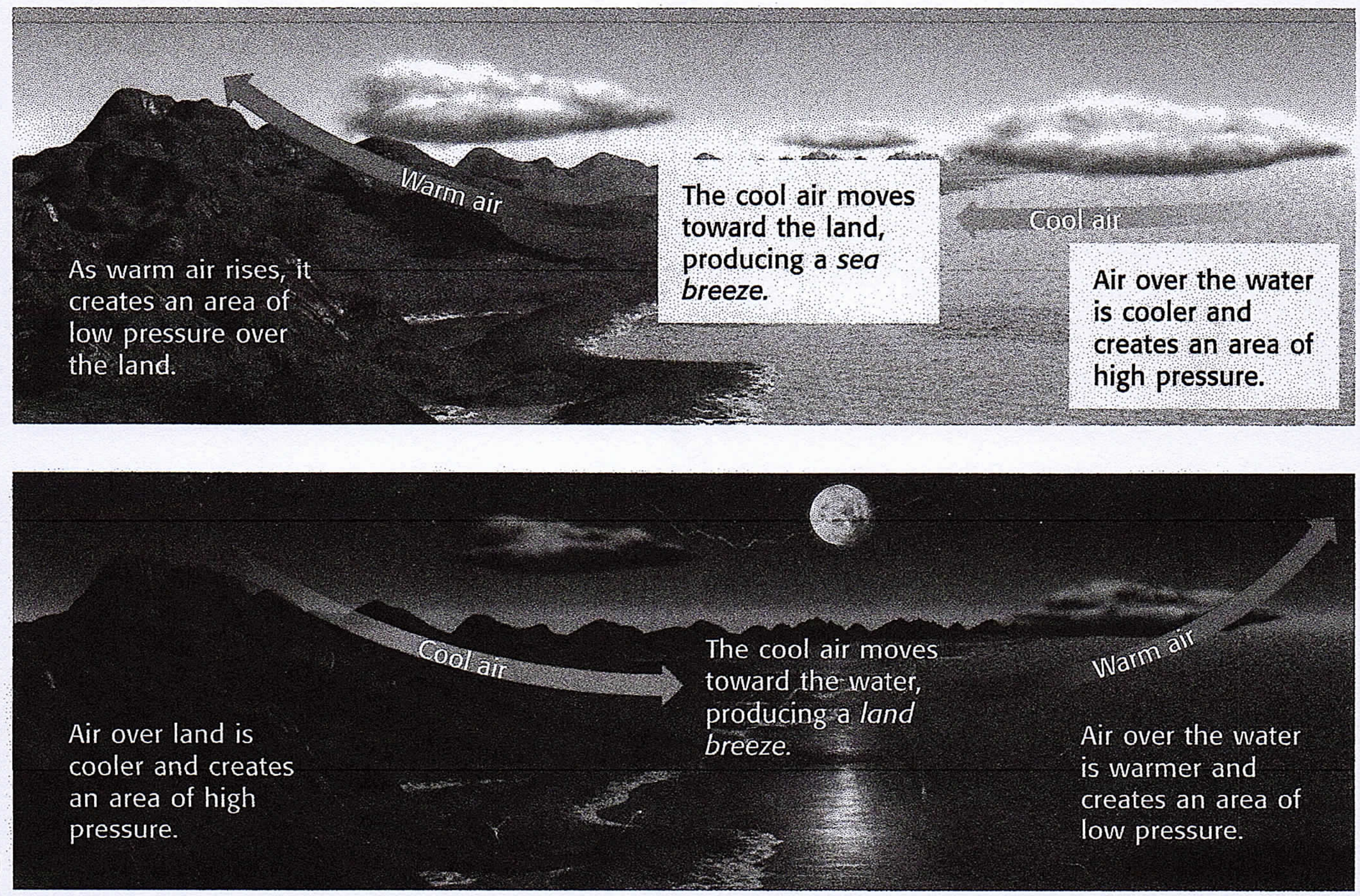
Figure 18 *The jet stream is the white stripe moving diagonally above the Earth.*

Jet Streams The **jet streams** are narrow belts of high-speed winds that blow in the upper troposphere and lower stratosphere, as shown in **Figure 18.** These winds often change speed and can reach maximum speeds of 500 km/h. Unlike other global winds, the jet streams do not follow regular paths around the Earth.

Knowing the position of the jet stream is important to both meteorologists and airline pilots. Because the jet stream controls the movement of storms, meteorologists can track a storm if they know the location of the jet stream. By flying in the direction of the jet stream, pilots can save time and fuel.

Local Winds Local winds are influenced by the geography of an area. An area's geography, such as a shoreline or a mountain, sometimes produces temperature differences that cause local winds like land and sea breezes, as shown in **Figure 19.** During the day, land heats up faster than water. The land heats the air above it. At night, land cools faster than water, cooling the air above the land.

Figure 19 **Sea and Land Breezes**



Mountain and valley breezes are another example of local winds caused by an area's geography. Campers in mountain areas may feel a warm afternoon change into a cold night soon after the sun sets. The illustrations in **Figure 20** show you why.

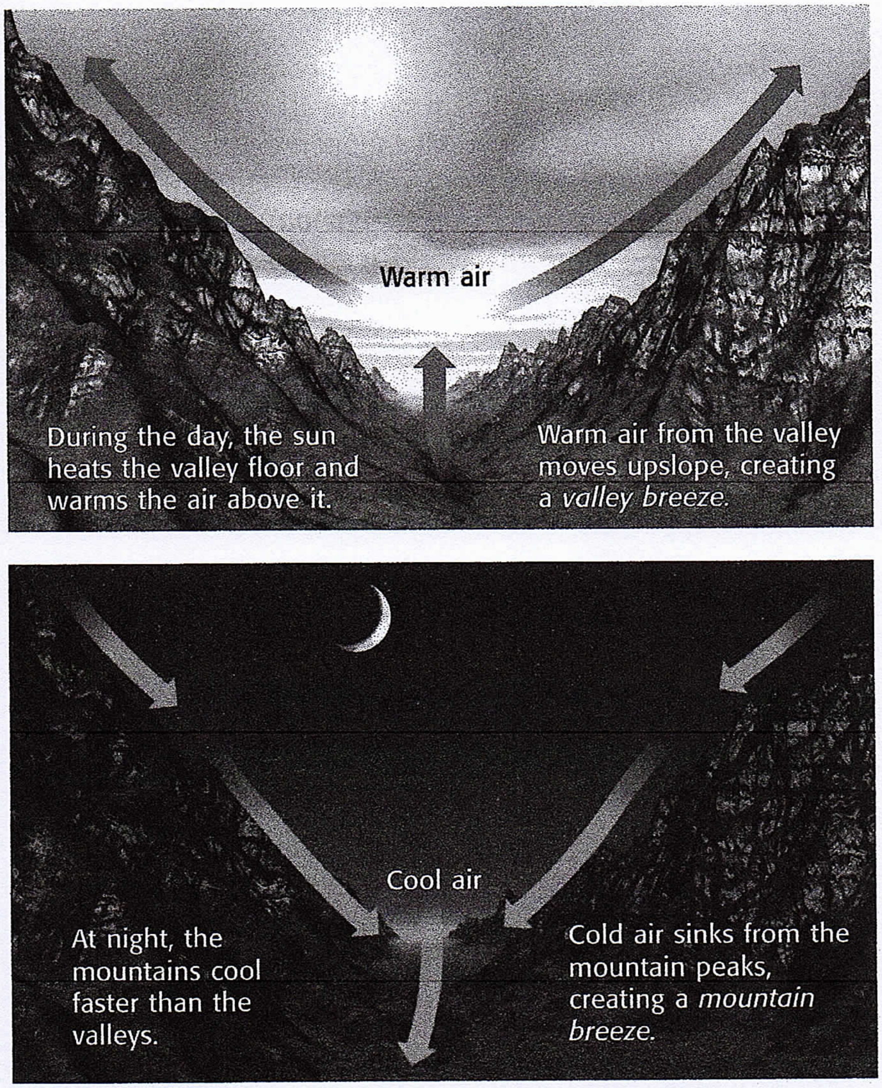


Figure 20 *During the day, a gentle breeze blows up the slopes. At night, cold air flows downslope and settles in the valley.*

MATH BREAK

Calculating Groundspeed
An airplane has an airspeed of 500 km/h and is moving into a 150 km/h head wind due to the jet stream. What is the actual groundspeed of the plane? Over a 3-hour flight, how far would the plane actually travel? (Hint: To calculate actual ground-speed, subtract head-wind speed from airspeed.)

SECTION REVIEW

1. How does the Coriolis effect affect wind movement?
2. What causes winds?
3. Compare and contrast global winds and local winds.
4. **Applying Concepts** Suppose you are vacationing at the beach. It is daytime and you want to go swimming in the ocean. You know the beach is near your hotel, but you don't know what direction it is in. How might the local wind help you find the ocean?

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