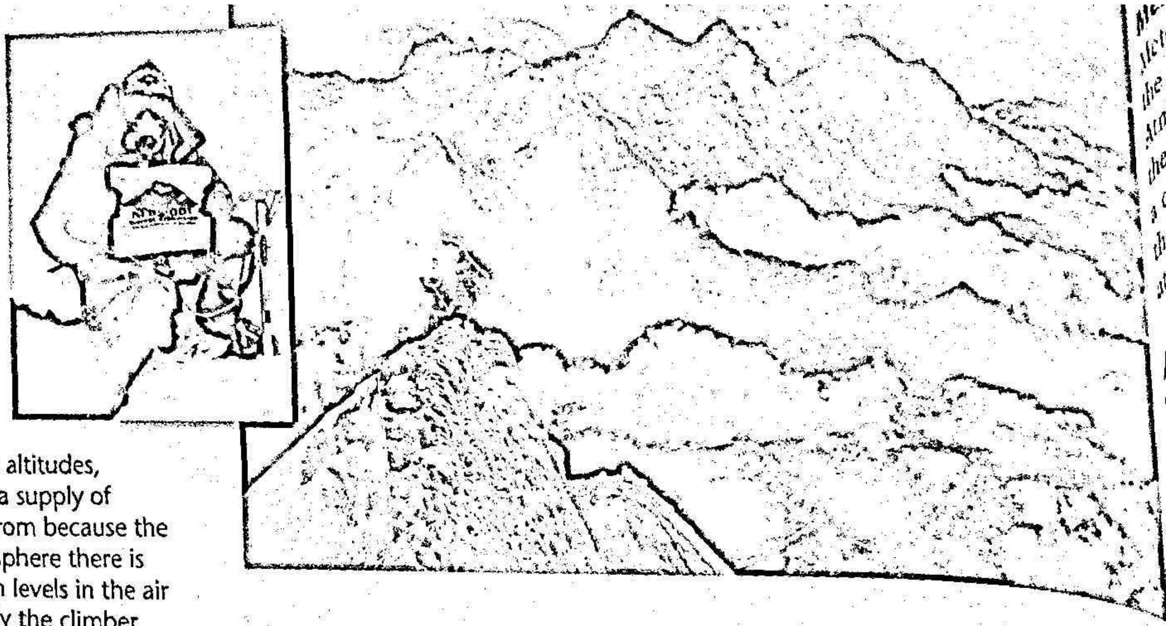


Figure 5 ▶ At high altitudes, climbers must carry a supply of oxygen to breathe from because the density of the atmosphere there is very low. So, oxygen levels in the air are too low to supply the climber. In 2001, Eric Weihenmeyer (shown above) was the first blind person to reach the summit of Mount Everest.

Atmospheric Pressure

Gravity holds the gases of the atmosphere near Earth's surface. As a result, the air molecules are compressed together and exert force on Earth's surface. The pressure exerted on a surface by the atmosphere is called **atmospheric pressure.** Atmospheric pressure is exerted equally in all directions—up, down, and sideways.

atmospheric pressure the force per unit area that is exerted on a surface by the weight of the atmosphere

Earth's gravity keeps 99% of the total mass of the atmosphere within 32 km of Earth's surface. The remaining 1% extends upward for hundreds of kilometers but gets increasingly thinner at high altitudes, as shown in **Figure 5.** Because the pull of gravity is not as strong at higher altitudes, the air molecules are farther apart and exert less pressure on each other at higher altitudes. Thus, atmospheric pressure decreases as altitude increases.

Atmospheric pressure also changes as a result of differences in temperature and in the amount of water vapor in the air. In general, as temperature increases, atmospheric pressure at sea level decreases. The reason is that molecules move farther apart when the air is heated. So, fewer particles exert pressure on a given area, and the pressure decreases. Similarly, air that contains a lot of water vapor is less dense than drier air because water vapor molecules have less mass than nitrogen or oxygen molecules do. The lighter water vapor molecules replace an equal number of heavier oxygen and nitrogen molecules, which makes the volume of air less dense.

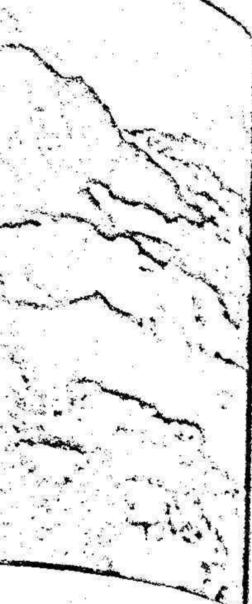
MATHPRACTICE

Force of the Air

On average, a column of air 1 m^2 at its base that reaches upward from sea level has a mass of 10,300 kg and exerts a force of 101,325 N (newtons) on the ground. So, at sea level, on every square meter of Earth's surface, the atmosphere presses down with an average force of 101,325 N. What would the average force of a column of air that has a 3 m^2 base be?

Measuring Atmospheric Pressure

Meteorologists use three units for atmospheric pressure: atmospheres (atm), millimeters or inches of mercury, and millibars (mb). *Standard atmospheric pressure*, or 1 atmosphere, is equal to 760 mm of mercury, or 1000 millibars. The average atmospheric pressure at sea level is 1 atm. Meteorologists measure atmospheric pressure by using an instrument called a *barometer.*



Mercurial Barometers

Meteorologists use two main types of barometers. One type is the *mercurial barometer,* a model of which is shown in **Figure 6.** Atmospheric pressure presses on the liquid mercury in a well at the base of the barometer. The pressure holds the mercury up to a certain height inside a tube. The height of the mercury inside the tube varies with the atmospheric pressure. The greater the atmospheric pressure is, the higher the mercury rises.

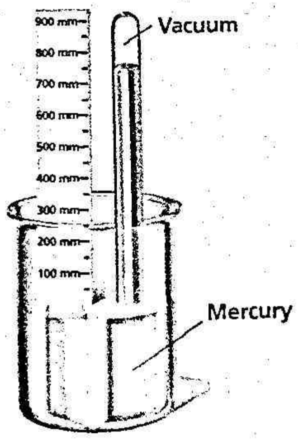


Figure 6 ▶ The height of the mercury in this mercurial barometer indicates barometric pressure. ***What is the barometric pressure shown?***

Aneroid Barometers

The type of barometer most commonly used today is called an *aneroid barometer.* Inside an aneroid barometer is a sealed metal container from which most of the air has been removed to form a partial vacuum. Changes in atmospheric pressure cause the sides of the container to bend inward or bulge out. These changes move a pointer on a scale. Aneroid barometers can be constructed to keep a continuous record of atmospheric pressure.

An aneroid barometer can also measure altitude above sea level. When used for this purpose, an aneroid barometer is called an *altimeter*. The scale on an altimeter registers altitude instead of pressure. At high altitudes, the atmosphere is less dense and exerts less pressure than at low altitudes. So, a lowered pressure reading can be interpreted as an increased altitude reading.

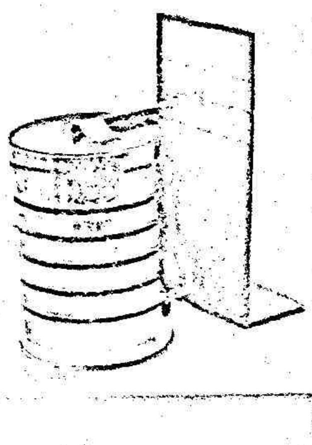
Reading Check **What is inside an aneroid barometer? (See the Appendix for answers to Reading Checks.)**

Quick LAB **25 min (over 5 days)**

Barometric Pressure

Procedure

1. Use a **rubber band** to secure **plastic wrap** tightly over the open end of a **coffee can.**
2. Use tape to secure one end of a **10 cm drinking straw** onto the plastic wrap near the center of the can.
3. Use **scissors** and a **metric ruler** to cut a piece of **cardboard** 10 cm wide. The cardboard should also be at least 13 cm taller than the can.
4. Fold the cardboard so that it stands upright and extends at least 3 cm above the top of the straw.
5. Place the cardboard near the can so that the free end of the straw just touches the front of the cardboard. Mark an *X* where the straw touches.
6. Draw three horizontal lines on the cardboard: one that is level with the *X*, one that is 2 cm above the *X*, and one that is 2 cm below the *X*.



7. Position the cardboard so that the straw touches the *X*. Tape the base of the cardboard in place.
8. Observe the level of the straw at least once per day over a 5-day period. Record any changes that you see.

Analysis

1. What factors affect how your model works? Explain.
2. What does an upward movement of the straw indicate? What does a downward movement indicate?
3. Compare your results with the barometric pressures listed in your local newspaper. What may have caused your results to differ from the newspaper's?

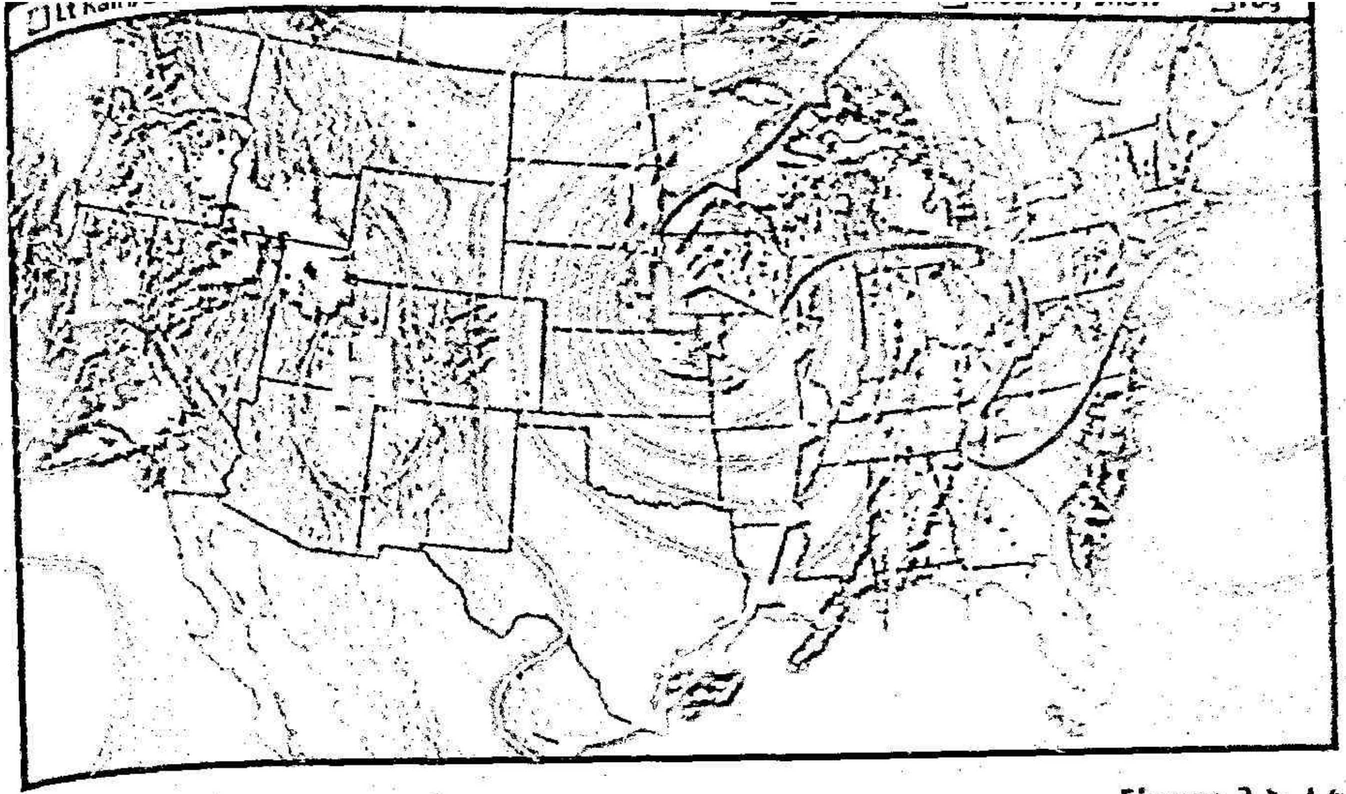


Figure 3 ▶ A typical weat[…] shows isobars, highs and lo[…] and precipitation. *In what […] the United States are low-[…] areas located?*

Plotting Temperature and Pressure

Scientists use lines on weather maps to connect points of equal measurement. Lines that connect points of equal temperature are called *isotherms*. Lines that connect points of equal atmospheric pressure are called *isobars*. The spacing and shape of the isobars help meteorologists interpret their observations about the speed and direction of the wind. Closely spaced isobars indicate a rapid change in pressure and high wind speeds. Widely spaced isobars generally indicate a gradual change in pressure and low wind speeds. Isobars that form circles indicate centers of high or low air pressure. Such centers that are marked with an *H* represent high pressure, as you can see in **Figure 3.** Centers that are marked with an *L* represent low pressure.

SCILINKS.

For a variety of links relat[…] subject, go to www.scil[…]

Topic: Weather Maps
SciLinks code: HQ61647
Topic: Weather Forecastin[…]
SciLinks code: HQ61645

Plotting Fronts and Precipitation

Most weather maps mark the locations of fronts and areas of precipitation. The weather map in **Figure 3** shows examples of a warm front, a cold front, an occluded front, and a stationary front. Fronts are identified by sharp changes in wind speed and direction, temperature, or humidity.

Areas of precipitation are commonly marked by using colors or symbols. Different forms of precipitation are represented by different colors or symbols. For example, the weather map in **Figure 3** indicates light rain by using light green, while snow is represented by gray and white. Some weather maps use colors to represent different amounts of precipitation so that the amount of precipitation that falls in different areas can be compared.

Reading Check How do meteorologists mark precipitation on a weather map? (See the Appendix for answers to Reading Checks.)

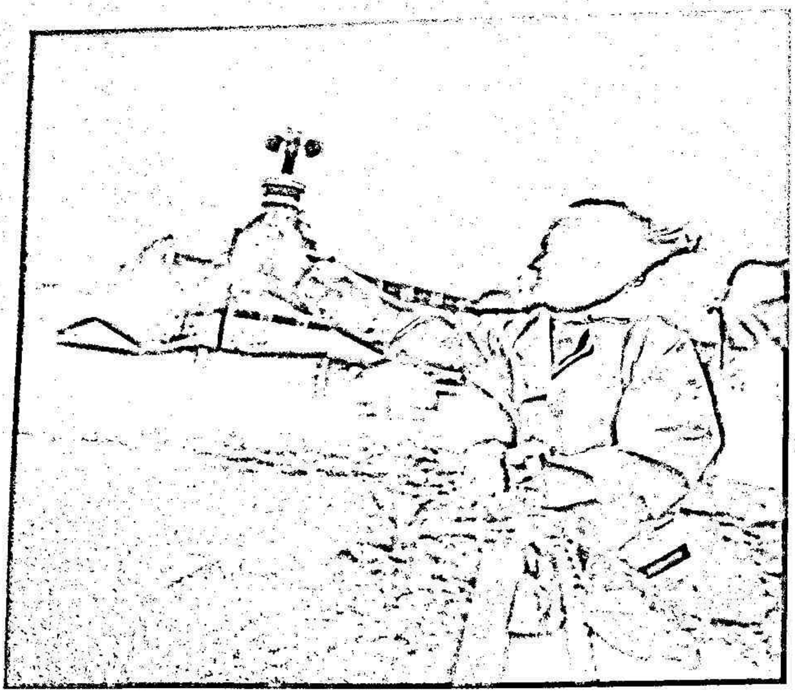


Figure 2 ▶ A meteorologist uses an anemometer during Hurricane Luis to measure wind speed.

Air Pressure

Changes in air pressure affect air masses. The approach of a front is usually indicated by a drop in air pressure. Scientists use instruments called **barometers** to measure atmospheric pressure.

Wind Speed

An instrument called an **anemometer** (AN uh MAHM uht uhr) measures wind speed. A typical anemometer consists of small cups that are attached by spokes to a shaft that rotates freely. The wind pushes against the cups and causes them to rotate, as shown in **Figure 2**. This rotation triggers an electrical signal that registers the wind speed in meters per second or in miles per hour.

Wind Direction

The direction of the wind is determined by using an instrument called a **wind vane**. The wind vane is commonly an arrow-shaped device that turns freely on a pole as the tail catches the wind. Wind direction may be described by using one of 16 compass directions, such as north-northeast. Wind direction also may be recorded in degrees by moving clockwise and beginning with 0° at the north. Thus, east is 90°, south is 180°, and west is 270°.

barometer an instrument that measures atmospheric pressure

anemometer an instrument used to measure wind speed

wind vane an instrument used to determine direction of the wind

Reading Check **Which instrument is used to measure air pressure? (See the Appendix for answers to Reading Checks.)**

Quick LAB 15 min

Wind Chill

Procedure

1. Place a **23 cm × 33 cm pan** on a level table. Fill the pan to a depth of 1 cm with **room temperature water.**
2. Lay a **thermometer** in the center of the pan with the bulb submerged. After 5 minutes, record the water temperature. Do not touch the thermometer.
3. Place an **electric fan** facing the pan and a few centimeters from the pan. Turn on the fan at a low speed. **CAUTION** Do not get the fan or cord wet.
4. Record the water temperature every minute until the temperature remains constant.

Analysis

1. How does the moving air affect the temperature of the water?

2. If the moving air is the same temperature as the still air in the room, what causes the water temperature to change?
3. How would you dress on a cool, windy day to stay comfortable? Explain your answer.

Section 3 Atmospheric Circulation

Pressure differences in the atmosphere cause the movement of air worldwide. The air near Earth's surface generally flows from the poles toward the equator. The reason for this flow is that air moves from high-pressure regions to low-pressure regions. High-pressure regions form where cold air sinks toward Earth's surface. Low-pressure regions form where warm air rises away from Earth's surface.

OBJECTIVES

- Explain the Coriolis effect.
- Describe the global patterns of air circulation, and name three global wind belts.
- Identify two factors that form local wind patterns.

KEY TERMS

Coriolis effect
trade winds
westerlies
polar easterlies
jet stream

The Coriolis Effect

The circulation of the atmosphere and of the oceans is affected by the rotation of Earth on its axis. Earth's rotation causes its diameter to be greatest through the equator and smallest through the poles. Because each point on Earth makes one complete rotation every day, points near the equator travel farther and faster in a day than points closer to the poles do. When air moves toward the poles, it travels east faster than the land beneath it does. As a result, the air follows a curved path. The tendency of a moving object to follow a curved path rather than a straight path because of the rotation of Earth is called the **Coriolis effect**, which is shown in **Figure 1.**

Coriolis effect the curving of the path of a moving object from an otherwise straight path due to Earth's rotation

Winds that blow from high-pressure areas to lower-pressure areas curve as a result of the Coriolis effect. The Coriolis effect deflects moving objects along a path that depends on the speed, latitude, and direction of the object. Objects are deflected to the right in the Northern Hemisphere and are deflected to the left in the Southern Hemisphere.

The faster an object travels, the greater the Coriolis effect on that object is. The Coriolis effect also noticeably changes the paths of large masses that travel long distances, such as air or ocean currents. In general, the Coriolis effect is detectable only on objects that move very fast or that travel over long distances.

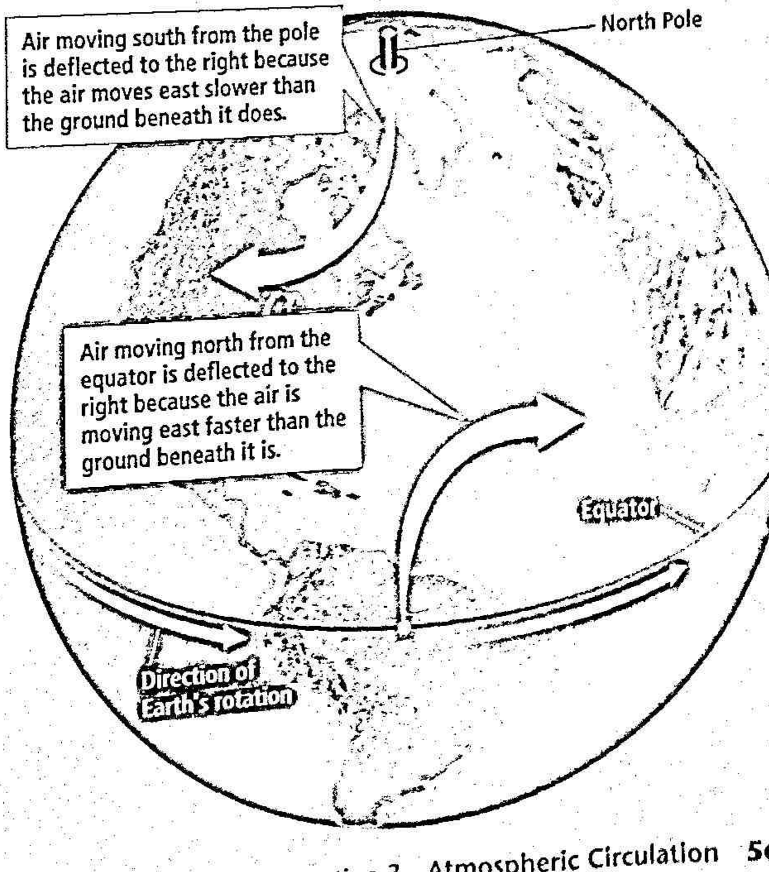


Figure 1 ▶ Because of Earth's rotation, an object that travels north from the equator will curve to the east. This curving is called the Coriolis effect.

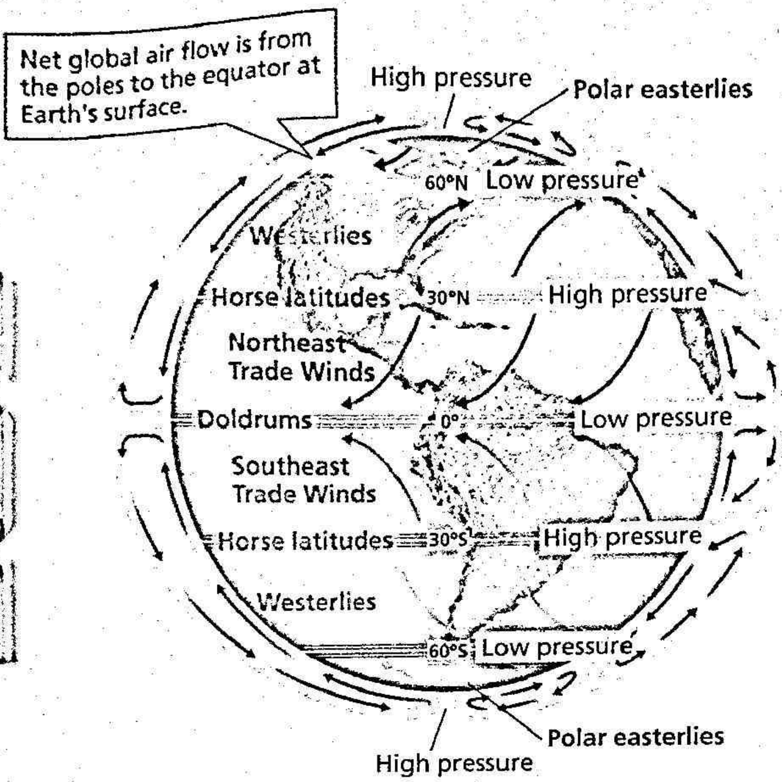


Figure 2 ▶ Each hemisphere has three wind belts. Wind belts are the result of pressure differences at the equator, the subtropics, the subpolar regions, and the poles. Winds in the belts curve because of the Coriolis effect. ***Do winds in the Northern Hemisphere curve clockwise or counterclockwise?***

Global Winds

The air that flows from the poles toward the equator does not flow in a single, straight line. Each hemisphere contains three looping patterns of flow called *convection cells*. Each of these convection cells correlates to an area of Earth's surface, called a *wind belt*, that is characterized by winds that flow in one main direction. These winds are called *prevailing winds*. All six wind belts are shown in **Figure 2.**

Trade Winds

In both hemispheres, the winds that flow toward the equator between 30° and 0° latitude are called **trade winds.** Like all winds, the trade winds are named according to the direction from which they flow. In the Northern Hemisphere, the trade winds flow from the northeast and are called the *northeast trade winds*. In the Southern Hemisphere, the trade winds are called the *southeast trade winds*. These wind belts are called *trade winds* because many trading ships sailed on these winds from Europe in the 18th and 19th centuries.

Westerlies

Between 30° and 60° latitude, some of the descending air moving toward the poles is deflected by the Coriolis effect. This flow creates the **westerlies,** which exist in another wind belt in each hemisphere. In the Northern Hemisphere, the westerlies are southwest winds. In the Southern Hemisphere, they are northwest winds. The westerlies blow throughout the contiguous United States.

Reading Check **Name two ways in which the trade winds of the Northern Hemisphere differ from the westerlies of the Northern Hemisphere. (See the Appendix for answers to Reading Checks.)**

Polar Easterlies

Toward the poles, or poleward, of the westerlies—at about 60° latitude—is a zone of low pressure. This zone of low pressure separates the westerlies from a third wind belt in each hemisphere. Over the polar regions themselves, descending cold air creates areas of high pressure. Surface winds created by the polar high pressure are deflected by the Coriolis effect and become the **polar easterlies.** The polar easterlies are strongest where they flow off Antarctica. Where the polar easterlies meet warm air from the westerlies, a stormy region known as a *front* forms.

trade winds prevailing winds that blow from east to west from 30° latitude to the equator in both hemispheres

westerlies prevailing winds that blow from west to east between 30° and 60° latitude in both hemispheres

polar easterlies prevailing winds that blow from east to west between 60° and 90° latitude in both hemispheres

The Doldrums and Horse Latitudes

As **Figure 2** shows, the trade wind systems of the Northern Hemisphere and Southern Hemisphere meet at the equator in a narrow zone called the *doldrums*. In this warm zone, most air movement is upward and surface winds are weak and variable. As the air approaches 30° latitude, it descends and a high-pressure zone forms. These subtropical high-pressure zones are called the *horse latitudes*. Here, too, surface winds are weak and variable.

Graphic Organizer **Comparison Table**

Create the **Graphic Organizer** entitled "Comparison Table" described in the Skills Handbook section of the Appendix. Label the columns with "Trade winds," "Westerlies," "Polar easterlies," and "Jet streams." Label the rows with "Latitude" and "Direction.". Then, fill in the table with details about each type of wind.

Wind and Pressure Shifts

As the sun's rays shift northward and southward during the changing seasons of the year, the positions of the pressure belts and wind belts shift. Although the area that receives direct sunlight can shift by up to 47° north and south of the equator, the average shift for the pressure belts and wind belts is only about 10° of latitude. However, even this small change causes some areas of Earth's surface to be in different wind belts during different times of the year. In southern Florida, for example, westerlies prevail in the winter, but trade winds dominate in the summer.

Jet Streams

Narrow bands of high-speed winds that blow in the upper troposphere and lower stratosphere are **jet streams**. These winds exist in the Northern Hemisphere and Southern Hemisphere.

jet stream a narrow band of strong winds that blow in the upper troposphere

One type of jet stream is a polar jet stream. Polar jet streams form as a result of density differences between cold polar air and the warmer air of the middle latitudes. These bands of winds, which are about 100 km wide and 2 to 3 km thick, are located at altitudes of 10 to 15 km. Polar jet streams can reach speeds of 500 km/h and can affect airline routes and the paths of storms.

Another type of jet stream is a subtropical jet stream. In the subtropical regions, very warm equatorial air meets the cooler air of the middle latitudes, and the *subtropical jet streams* form. Unlike the polar jet streams, the subtropical jet streams do not change much in speed or position. A subtropical jet stream is shown in **Figure 3**.

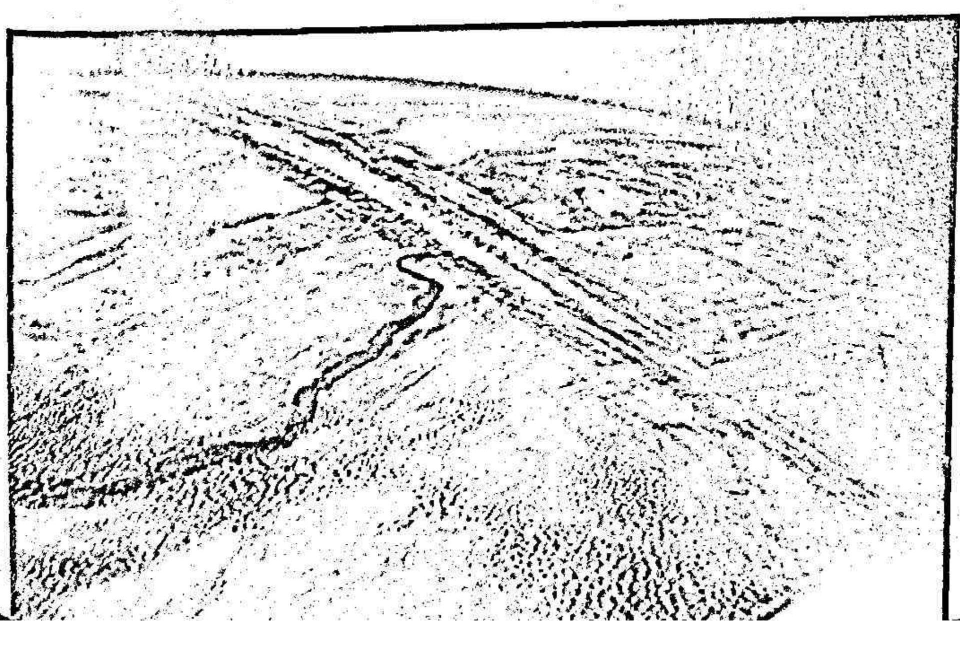
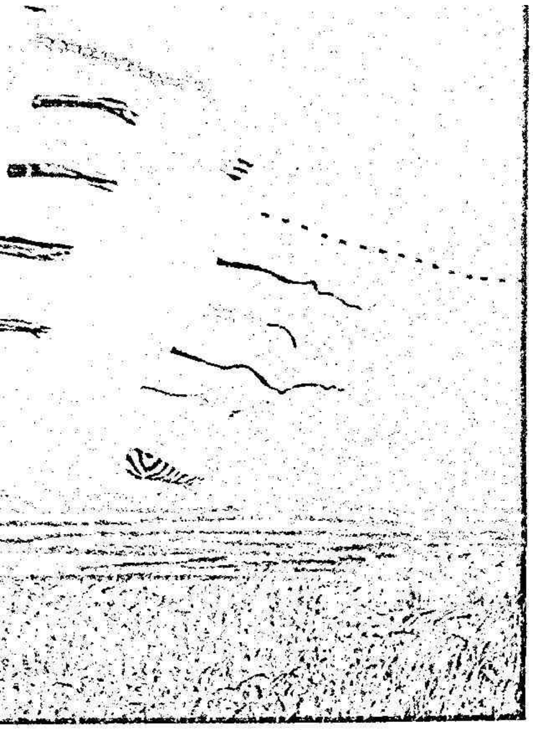


Figure 3 ▶ Clouds in this jet stream are traveling high over Egypt. This remarkable photograph was taken by *Gemini 12* astronauts.



a breezes keep these
g the afternoon.
breezes will blow the
ocean.

Local Winds

Winds also exist on a scale that is much smaller than a global scale. Movements of air are influenced by local conditions, and local temperature variations commonly cause local winds. Local winds are not part of the global wind belts. Gentle winds that extend over distances of less than 100 km are called *breezes*.

Land and Sea Breezes

Equal areas of land and water may receive the same amount of energy from the sun. However, land surfaces heat up faster than water surfaces do. Therefore, during daylight hours, a sharp temperature difference develops between a body of water and the land along the water's edge. This temperature difference is apparent in the air above the land and water. The warm air above the land rises as the cool air from above the water moves in to replace the warm air. A cool wind moving from water to land, called a *sea breeze*, generally forms in the afternoon, as shown in **Figure 4.** Overnight, the land cools more rapidly than the water does, and the sea breeze is replaced by a *land breeze*. A land breeze flows from the cool land toward the warmer water.

Mountain and Valley Breezes

During the daylight hours in mountainous regions, a gentle valley breeze blows upslope. This *valley breeze* forms when warm air from the valleys moves upslope. At night, the mountains cool more quickly than the valleys do. At that time, cool air descends from the mountain peaks to create a *mountain breeze*. Areas near mountains may experience a warm afternoon that turns to a cold evening soon after sunset. This evening cooling happens because cold air flows down mountain slopes and settles in valleys.

Review

e pattern of air circulation between an
pressure and an area of high pressure.

v the Coriolis effect affects wind flow.

describe Earth's three global wind belts.

the importance of the jet streams.

o factors that create local wind patterns.

7. **Inferring Relationships** Which has a lower pressure: the air in your lungs as you inhale or the air outside your body? Explain.
8. **Applying Ideas** While visiting the Oregon coast, you decide to hike toward the ocean, but you are not sure of the direction. The time is 4:00 P.M. How might the breeze help you find your way?

CONCEPT MAPPING

Global Wind Patterns

Because Earth receives different amounts of solar energy at different latitudes, belts of cool, dense air form at latitudes near the poles, while belts of warm, less dense air form near the equator. Because cool air is dense, it forms regions of high pressure, while warm air forms regions of low pressure. Differences in air pressure create wind. Because air pressure is affected by latitude, the atmosphere is made up of global wind belts that run parallel to lines of latitude. Winds affect many weather conditions, such as precipitation, temperature, and cloud cover. Thus, regions that have different global wind belts often have different climates.

In the equatorial belt of low pressure, called the *doldrums*, the air rises and cools, and water vapor condenses. Thus, this region generally has large amounts of precipitation. The amount of precipitation generally decreases as latitude increases. In the regions between about 20° and 30° latitude in both hemispheres, or the *subtropical highs*, the air sinks, warms, and dries. Thus, little precipitation occurs in these regions. Most of the world's deserts are located in these regions. In the middle latitudes, at about 45° to 60° latitude in both hemispheres, warm tropical air meets cold polar air, which leads to belts of greater precipitation. In the high-pressure areas, above 60° latitude, the air masses are cold and dry, and average precipitation is low.

As seasons change, global wind belts shift in a north or south direction, as shown in **Figure 3.** As the wind and pressure belts shift, the belts of precipitation associated with them also shift.

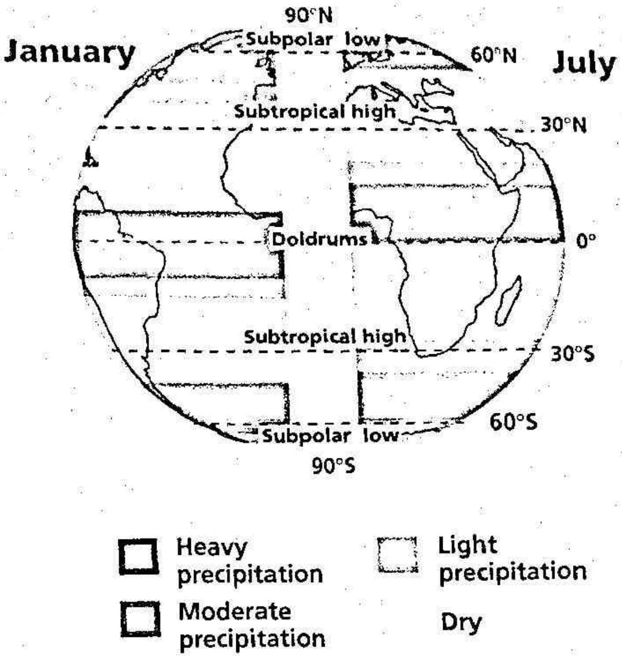


Figure 3 ▶ During winter in the Northern Hemisphere, global wind and precipitation belts shift to the south.

Heat Absorption and Release

Latitude and cloud cover affect the amount of solar energy that an area receives. However, different areas absorb and release heat differently. Land heats faster than water and thus can reach higher temperatures in the same amount of time. One reason for this difference is that the land surface is solid and unmoving. Surface ocean water, on the other hand, is liquid and moves continuously. Waves, currents, and other movements continuously replace warm surface water with cooler water from the ocean depths. This action prevents the surface temperature of the water from increasing rapidly. However, the surface temperature of the land can continue to increase as more solar energy is received. In turn, the temperature of the land or ocean influences the amount of heat that the air above the land or ocean absorbs or releases. The temperature of the air then affects the climate of the area.

✓ **Reading Check** How do wind and ocean currents affect the surface temperature of oceans? (See the Appendix for answers to Reading Checks.)

Specific Heat and Evaporation

Even if not in motion, water warms more slowly than land does. Water also releases heat energy more slowly than land does. 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. A given mass of water requires more energy than land of the same mass does to experience an increase in temperature of the same number of degrees.

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

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

MATHPRACTICE

Specific Heat

Use the following equation to calculate the amount of energy needed to heat 200 kg of water 6°C given that the specific heat of water is 4,186 J/kg • K.

energy = specific heat × mass × temperature change

Ocean Currents

The temperature of ocean currents that come in contact with the air influences the amount of heat absorbed or released by the air. If winds consistently blow toward shore, ocean currents have a strong effect on air masses over land. For example, the combination of a warm Atlantic current and steady westerly winds gives northwestern Europe a high average temperature for its latitude. In contrast, the warm Gulf Stream has little effect on the eastern coast of the United States. This is because westerly winds usually blow the Gulf Stream and its warm tropical air away from the coast.

Reading Check **Why does land heat faster than water does? (See the Appendix for answers to Reading Checks.)**

QuickLAB 15 min

Evaporation

Procedure

1. On a **piece of paper**, make a data table similar to the one shown here.
2. Assemble a **ring stand** on a **table**. Use a **meterstick** to place the support rings at heights of 20 cm and 40 cm above the base. Position a **portable clamp lamp that has an incandescent bulb** directly over the rings and at a height of 60 cm.
3. Place three **Petri dishes** or **watch glasses** as follows: one on the base of the stand and one on each of the two rings.
4. Take **three thermometers**, and lay one across each dish. Turn on the lamp. Use a **stopwatch** to record the temperature every 3 min for 9 min.
5. Remove the thermometers, and add **30 mL of water** to each of the three dishes.
6. Keep the lamp on and over the dishes for 24 h.

Dish	Temperature	Amount of water evaporated
1		
2		
3		

7. Turn off the lamp. Carefully pour the water from the first dish into a **graduated cylinder**, and record any change in volume. Repeat this process for the other two dishes.

Analysis

1. At what distance from the lamp did the most water evaporate? the least water evaporate?
2. Explain the relationship between temperature and the rate of evaporation.
3. Explain why puddles of water dry out much more quickly in summer than they do in fall or winter.

El Niño–Southern Oscillation

The *El Niño–Southern Oscillation*, or *ENSO*, is a cycle of changing wind and water-current patterns in the Pacific Ocean. Every 3 to 10 years, **El Niño**, which is the warm-water phase of the ENSO, causes surface-water temperatures along the west coast of South America to rise. The event changes the interaction of the ocean and the atmosphere, which can change global weather patterns. During El Niño, typhoons, cyclones, and floods may occur in the Pacific Ocean region and southeastern United States. Droughts may strike other areas around the world, such as Indonesia and Australia. The ENSO also has a cool-water phase called *La Niña*. La Niña also affects weather patterns.

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

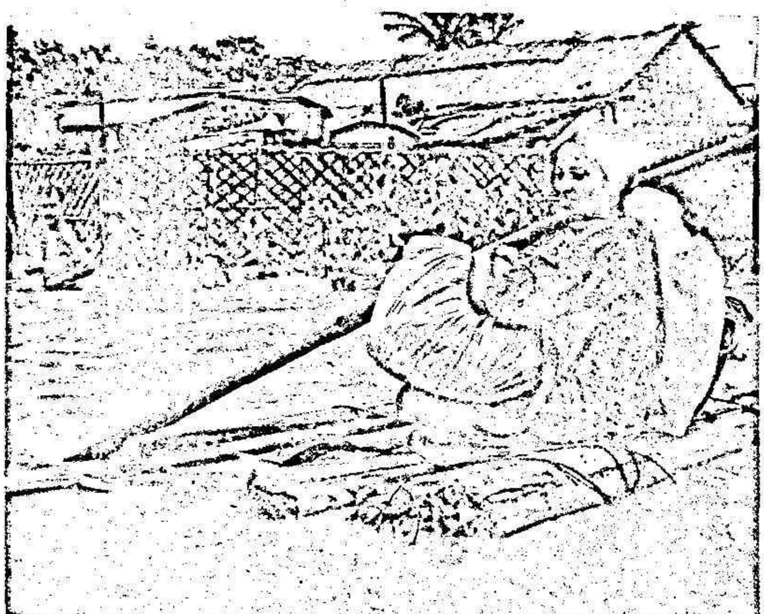
monsoon a seasonal wind that blows toward the land in the summer, bringing heavy rains, and that blows away from the land in the winter, bringing dry weather

Seasonal Winds

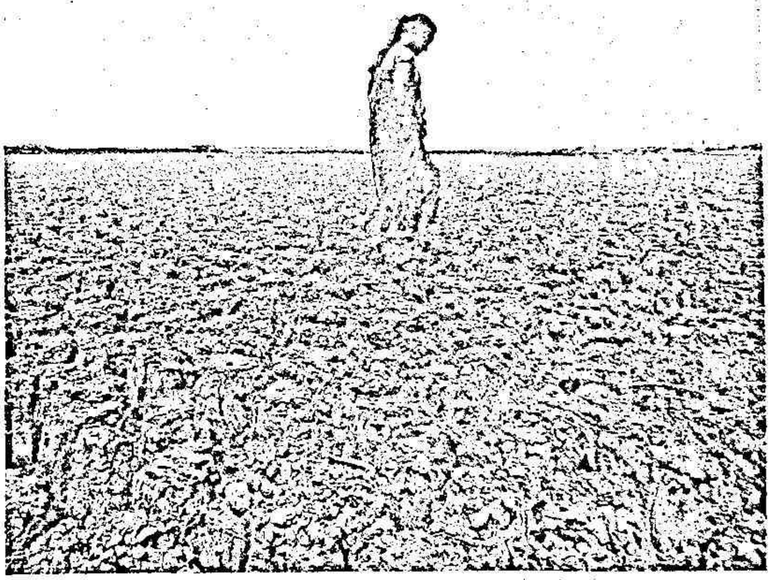
Temperature differences between the land and the oceans sometimes cause winds to shift seasonally in some regions. During the summer, the land warms more quickly than the ocean. The warm air rises and is replaced by cool air from the ocean. Thus, the wind moves toward the land. During the winter, the land loses heat more quickly than the ocean does, and the cool air flows away from the land. Thus, the wind moves seaward. Such seasonal winds are called **monsoons.**

Monsoon climates, such as that in southern Asia, are caused by heating and cooling of the northern Indian peninsula. In the winter, continental winds bring dry weather and sometimes drought. In the summer, winds carry moisture to the land from the ocean and cause heavy rainfall and flooding, as shown in **Figure 4.** Monsoon conditions also occur in eastern Asia and affect the tropical regions of Australia and East Africa.

Figure 4 ➤ **Effects of Monsoon Climates**



Because monsoon rains cause regular flooding, such as this flood in eastern India, people who live in monsoon regions have adapted to living in flood conditions.



People who live in monsoon climates must adjust to periodic droughts, such as the drought that affected this cropland in southern India.

Topography

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

Elevation

The elevation, or height of landforms above sea level, produces distinct temperature changes. Temperature generally decreases as elevation increases. For example, for every 100 m increase in elevation, the average temperature decreases by 0.7°C. Even along the equator, the peaks of high mountains can be cold enough to be covered with snow.

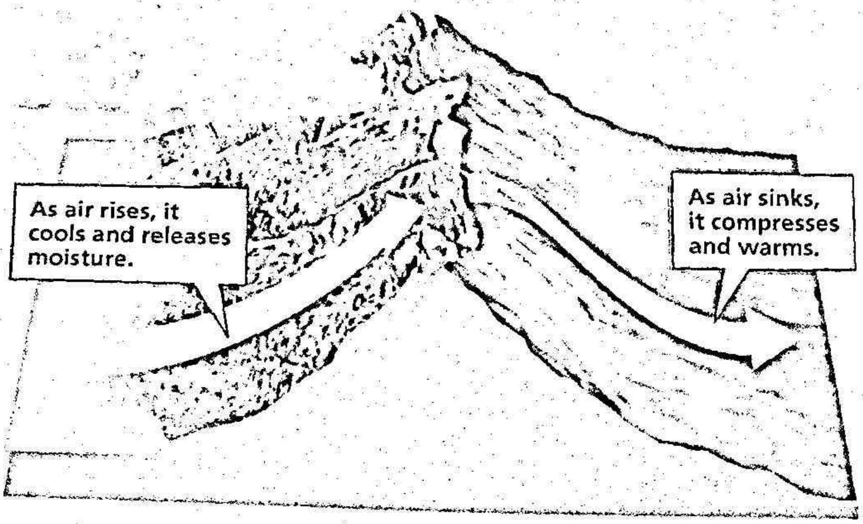


Figure 5 ▶ Mountains cause air to rise, cool, and lose moisture as the air passes over the mountains. This process affects the climate on both sides of the mountain.

Rain Shadows

When a moving air mass encounters a mountain range, the air mass rises, cools, and loses most of its moisture through precipitation, as shown in **Figure 5.** As a result, the air that flows down the other side of the range is usually warm and dry. This effect is called a *rain shadow*. One type of warm, dry wind that forms in this way is the *foehn* (FAYN), a dry wind that flows down the slopes of the Alps. Similar dry, warm winds that flow down the eastern slopes of the Rocky Mountains are called *chinooks*.

Section 1 Review

1. **Identify** two factors that are used to describe climate.
2. **Explain** how latitude determines the amount of solar energy received on Earth.
3. **Describe** how latitude determines wind patterns.
4. **Describe** how the different rates at which land and water are heated affect climate.
5. **Explain** the El Niño–Southern Oscillation cycle.
6. **Summarize** the conditions that cause monsoons.
7. **Explain** how elevation affects climate.
8. **Describe** a rain shadow and the resulting local winds.

CRITICAL THINKING

9. **Making Inferences** If land and water had the same specific heat, how might climate be different around the world?
10. **Analyzing Processes** On a mountain, are you likely to find more vegetation on the side facing prevailing winds or on the side facing away from them?
11. **Recognizing Relationships** Why might you find snow-capped mountains in Hawaii even though Hawaii is closer to the equator than Florida is?

CONCEPT MAPPING

12. Use the following terms to create a concept map: *climate, temperature range, wind, doldrums, subtropical high, monsoon, El Niño,* and *topography.*