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KEY CONCEPT

Weather changes as air masses move.

BEFORE, you learned

- Air pressure changes with location and altitude
- Water vapor in the atmosphere condenses when air rises

NOW, you will learn

- What air masses are
- What happens when air masses meet
- How pressure systems affect the weather

VOCABULARY

air mass p. 79

front p. 82

high-pressure system p. 84

low-pressure system p. 85

EXPLORE Air Masses

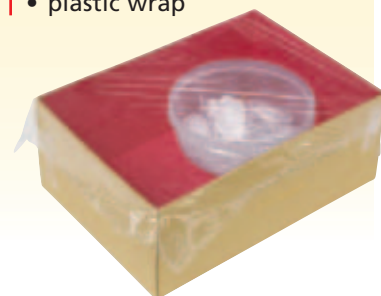
How does an air mass form?

PROCEDURE

- 1 Put ice into one bowl and warm water into a second bowl. Leave the third bowl empty.
- 2 Place each bowl in a different box and cover the box with plastic wrap. Wait a few minutes.
- 3 Put your hand into each box in turn.

MATERIALS

- 3 bowls
- ice
- warm water
- 3 shoe boxes
- plastic wrap



WHAT DO YOU THINK?

- How would you describe the air in each box?
- Which box's air feels the most humid? Why?

Air masses are large bodies of air.

You have probably experienced the effects of air masses—one day is hot and humid, and the next day is cool and pleasant. The weather changes when a new air mass moves into your area. An **air mass** is a large volume of air in which temperature and humidity are nearly the same in different locations at the same altitude. An air mass can cover many thousands of square kilometers.

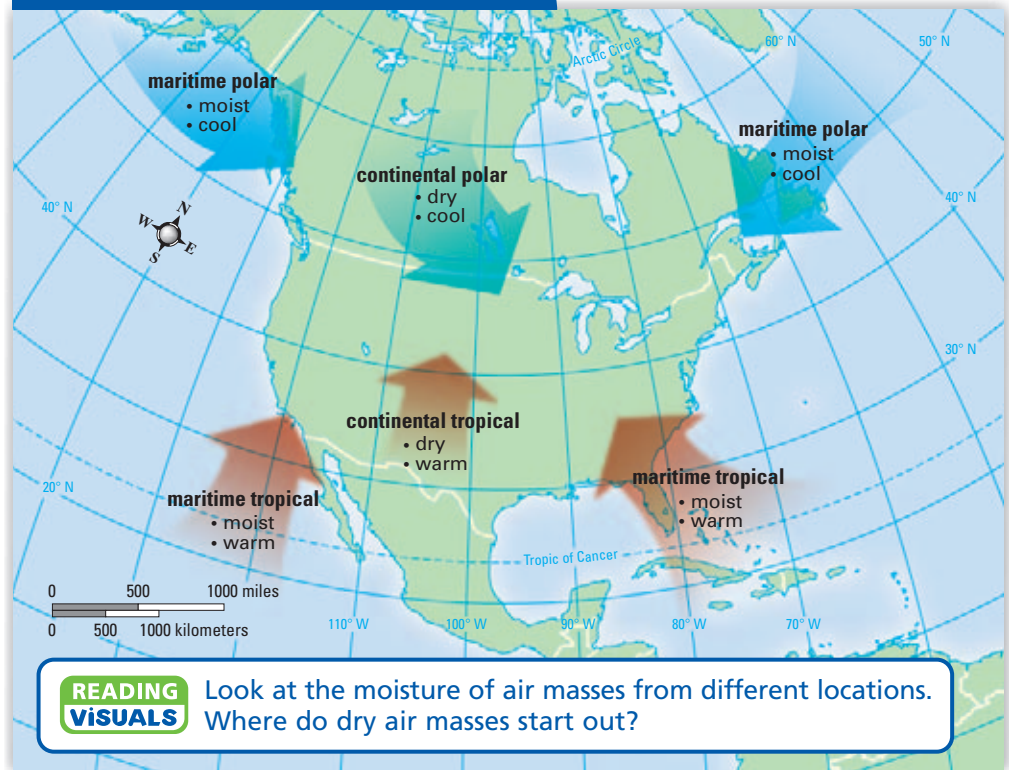
An air mass forms when the air over a large region of Earth sits in one place for many days. The air gradually takes on the characteristics of the land or water below it. Where Earth's surface is cold, the air becomes cold. Where Earth's surface is wet, the air becomes moist. As an air mass moves, it brings its temperature and moisture to new locations.

CHECK YOUR READING

Explain how the weather can change with the arrival of a new air mass. Your answer should include two ways that weather changes.



North American Air Masses



Characteristics of an Air Mass

Some regions of Earth's surface, such as those shown in the map above, produce air masses again and again. The characteristics of an air mass depend on the region where it forms. A hot desert produces dry, hot air masses, while cool ocean waters produce moist, cool air masses. Scientists classify air masses into categories according to the characteristics of regions. Each category name is made of two words—one for moisture, one for temperature.

The first word of an air mass's category name tells whether the air mass formed over water or dry land. It describes the moisture of the air mass.

- **Continental** air masses form over land. Air becomes dry as it loses its moisture to the dry land below it.
- **Maritime** (MAR-ih-TYM) air masses form over water. Air becomes moist as it gains water vapor from the water below it.

The second word of a category name tells whether an air mass formed close to the equator. It describes the air mass's temperature.

- **Tropical** air masses form near the equator. Air becomes warm as it gains energy from the warm land or water.
- **Polar** air masses form far from the equator. Air becomes cool as it loses energy to the cold land or water.

READING TIP

The word *maritime* has the same root as the word *marine*. Both come from the Latin word *mare*, which means "sea."

The combination of words gives the characteristics of the air mass. A maritime tropical air mass is moist and warm, while a continental polar air mass is dry and cold.

CHECK YOUR READING

What can you tell from each word of an air mass's name?

Movement of an Air Mass

Air masses can travel away from the regions where they form. They move with the global pattern of winds. In most of the United States, air masses generally move from west to east. They may move along with the jet stream in more complex and changing patterns.

When an air mass moves to a new region, it carries along its characteristic moisture and temperature. As the air moves over Earth's surface, the characteristics of the surface begin to change the air mass. For example, if a continental polar air mass moves over warm water, the air near the surface will become warmer and gain moisture. These changes begin where the air touches the surface. It may take days or weeks for the changes to spread upward through the entire air mass. An air mass that moves quickly may not change much. If it moves quickly enough, a continental polar air mass can move cold air from northern Canada all the way to the southern United States.

INVESTIGATE Air Masses

What happens when air masses collide?

PROCEDURE

- 1 Cut the cardboard to create a snug barrier that divides your beaker in half.
- 2 Mix about 5 mL of salt, 50 mL of water, and a drop of blue food coloring in one cup. This dense mixture represents a cold air mass.
- 3 Mix 50 mL of water with a drop of red food coloring in the other cup. This less-dense mixture represents a warm air mass.
- 4 Carefully pour the red water into one side of your divided beaker and the blue saltwater into the other side. As you look through the side of the beaker, quickly remove the barrier.

WHAT DO YOU THINK?

- What happened when the two liquids met?
- To what extent did the liquids mix together?

CHALLENGE How are the liquids like air masses?

SKILL FOCUS

Inferring



MATERIALS

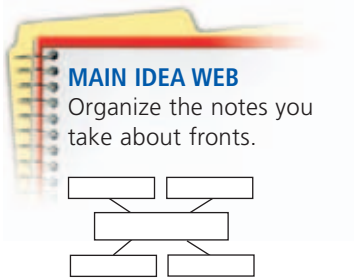
- 500 mL beaker
- stiff cardboard
- scissors
- 2 cups
- small beaker for measuring
- salt
- water
- food coloring

TIME
25 minutes



Weather changes where air masses meet.

When a new air mass moves over your area, you can expect the weather to change. Perhaps you have heard a weather forecaster talk about fronts. A **front** is a boundary between air masses. The weather near a front can differ from the weather inside the rest of an air mass. As one air mass pushes another, some of the air at the boundary will be pushed upward. Clouds can form in this rising air. The weather often becomes cloudy or stormy as a front passes. Afterward, you experience the temperature and humidity of the air mass that has moved in.



Fronts and Weather

Different types of fronts produce different patterns of weather. When a cold, dense air mass pushes warmer air, it produces a cold front. When a warm air mass pushes colder air, it produces a warm front. These names tell you which way the temperature will change but not how much it will change. A cold front can turn a heat wave into normal summer weather or turn cold winter air into very cold weather.



CHECK YOUR READING How would the weather change if a cold front moved into your area?

- 1 Cold fronts** can move into regions quickly. As you can see on page 83, a cold front is steeper than the other types of fronts. As a mass of cold, dense air moves forward, warmer air ahead of it is pushed upward. Water vapor in the warm air condenses as the air rises. Cold fronts often produce tall cumulonimbus clouds and precipitation. Brief, heavy storms are likely. After the storms, the air is cooler and often very clear.
- 2 Warm fronts** move more slowly than cold fronts. Warm air moves gradually up and over a mass of denser and colder air. Moisture in the warm air condenses all along the sloping front, producing cloud-covered skies. As a warm front approaches, you may first see high cirrus clouds, then high stratus clouds, then lower and lower stratus clouds. Often, a warm front brings many hours of steady rain or snow. After the front passes, the air is warmer.
- 3 Stationary fronts** occur when air masses first meet or when a cold or warm front stops moving. For a while, the boundary between the air masses stays in the same location—it stays stationary. The air in each air mass can still move sideways along the front or upward. The upward air motion may produce clouds that cover the sky, sometimes for days at a time. When the front starts moving, it becomes a warm front if the warm air advances and pushes the cold air. If the cold air moves forward instead, the front becomes a cold front.



See how the air moves in warm fronts and cold fronts.

Fronts and Weather

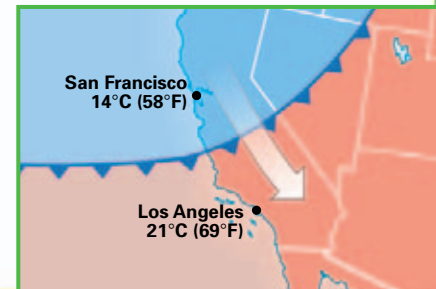
As fronts move across Earth's surface, they produce changes in the weather.

1 Cold Front



A **cold front** forms when a cold air mass pushes a warm air mass and forces the warm air to rise. As the warm air rises, its moisture condenses and forms tall clouds.

Triangles show the direction that a cold front moves.

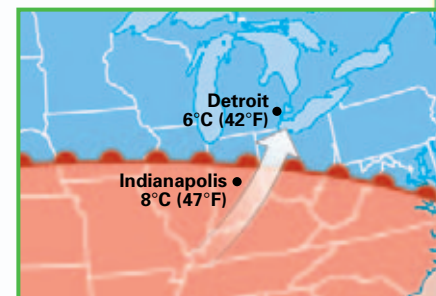


2 Warm Front



A **warm front** forms when a warm air mass pushes a cold air mass. The warm air rises slowly over the cold air and its moisture condenses into flat clouds.

Semicircles show the direction that a warm front moves.

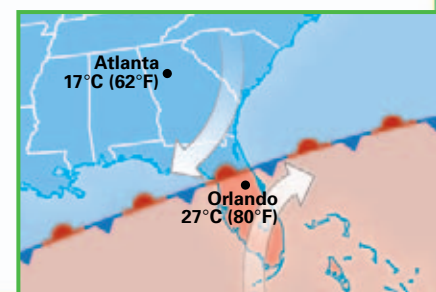


3 Stationary Front



A **stationary front** occurs when two air masses push against each other without moving. A stationary front becomes a warm or cold front when one air mass advances.

Alternating triangles and semicircles show a stationary front.



PREDICT Which city will the cold front affect next?

High-Pressure Systems

You may have seen the letters H and L on a weather map. These letters mark high-pressure centers and low-pressure centers, often simply called highs and lows. Each center is the location of the highest or lowest pressure in a region. The pressure differences cause air to move in ways that may make a high or low become the center of a whole system of weather.

READING TIP

A *system* includes different parts that work together.

At a high-pressure center, air sinks slowly down. As the air nears the ground, it spreads out toward areas of lower pressure. In the Northern Hemisphere, the Coriolis effect makes the air turn clockwise as it moves outward. A **high-pressure system** is formed when air moves all the way around a high-pressure center. Most high-pressure systems are large and change slowly. When a high-pressure system stays in one location for a long time, an air mass may form. The air—and resulting air mass—can be warm or cold, moist or dry.

A high-pressure system generally brings clear skies and calm air or gentle breezes. This is because as air sinks to lower altitudes, it warms up a little bit. Water droplets evaporate, so clouds often disappear.

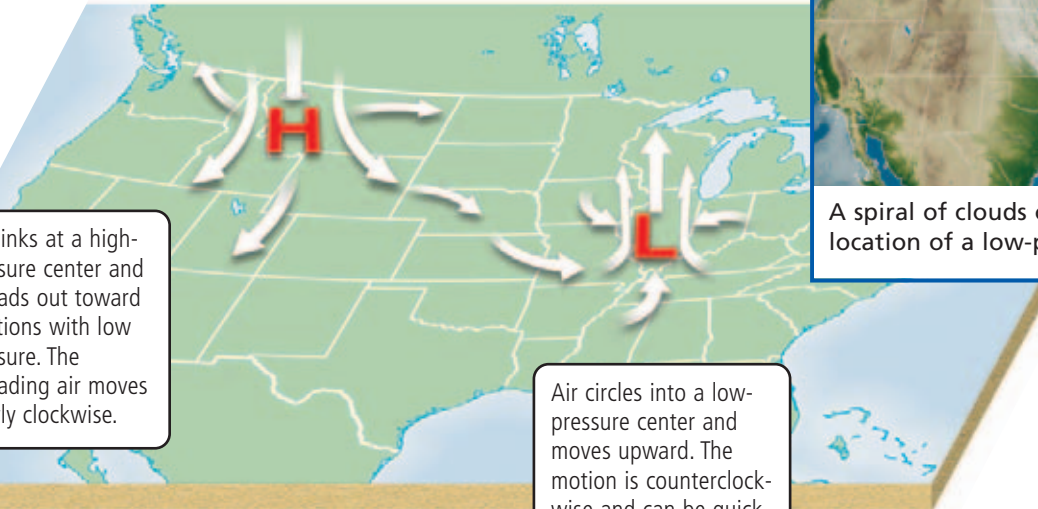


CHECK YOUR READING

What type of weather do you expect in a high-pressure system?

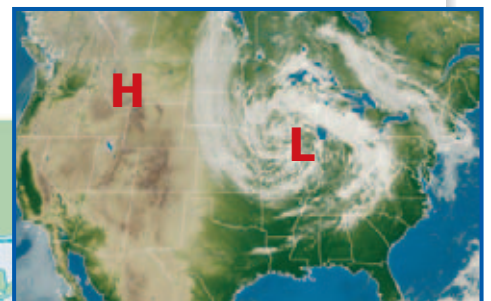
Weather Systems in the Northern Hemisphere

High-pressure systems and low-pressure systems produce patterns of weather across Earth's surface.



Air sinks at a high-pressure center and spreads out toward locations with low pressure. The spreading air moves slowly clockwise.

Air circles into a low-pressure center and moves upward. The motion is counterclockwise and can be quick.



A spiral of clouds often shows the location of a low-pressure system.

READING VISUALS

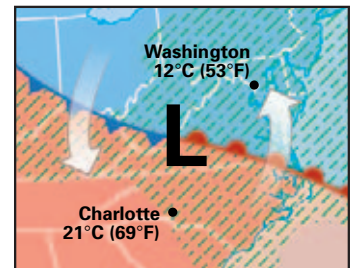
With your finger, trace the motion of air, starting above the high. Where have you seen similar patterns in earlier chapters?

Low-Pressure Systems

A small area of low pressure can also develop into a larger system. A **low-pressure system** is a large weather system that surrounds a center of low pressure. It begins as air moves around and inward toward the lowest pressure and then up to higher altitudes. The upward motion of the air lowers the air pressure further, and so the air moves faster. The pattern of motion strengthens into a low-pressure weather system. The rising air produces stormy weather. In the Northern Hemisphere, the air in a low-pressure system circles in a counterclockwise direction.

A low-pressure system can develop wherever there is a center of low pressure. One place this often happens is along a boundary between a warm air mass and a cold air mass. The diagram shows an example of this process.

- Part of the boundary between the air masses moves south and becomes a cold front.
- Part of the boundary moves north and becomes a warm front.
- A center of low pressure forms where the ends of the two fronts meet.



The low-pressure center and fronts become parts of a whole system of weather. Rising air at the fronts and at the low can cause very stormy weather.

The diagram on page 84 shows how air moves between pressure centers. Air moves down, out, and around a high-pressure center. Then it swirls around and into a low-pressure center and moves upward. Highs and lows affect each other as they move across the surface. Large weather systems generally move with the pattern of global winds—west to east over most of North America. But, within a weather system, winds can blow in different directions.

3.1 Review

KEY CONCEPTS

1. What are the two characteristics of an air mass that you need to know in order to classify it?
2. What happens when a warmer air mass pushes a cooler air mass?
3. What type of weather system brings calm, clear weather?

CRITICAL THINKING

4. **Compare and Contrast** Explain how air moves differently in low- and high-pressure systems.
5. **Apply** If the weather becomes stormy for a short time and then becomes colder, which type of front has passed?

CHALLENGE

6. **Synthesize** You check a barometer and observe that the air pressure has been dropping all day. Is tonight's weather more likely to be calm or stormy?