

Air Masses and Fronts

Reading Preview

Key Concepts

- What are the major types of air masses in North America, and how do they move?
- What are the main types of fronts?
- What type of weather is associated with cyclones and anticyclones?

Key Terms

- air mass • tropical • polar
- maritime • continental
- front • occluded • cyclone
- anticyclone

Target Reading Skill

Comparing and Contrasting As you read, compare and contrast the four types of fronts by completing a table like the one below.

Types of Fronts

Front	How Forms	Type of Weather
Cold front	A cold air mass overtakes a warm air mass.	
Warm front		
Occluded front		

FIGURE 1

Major Snowstorm

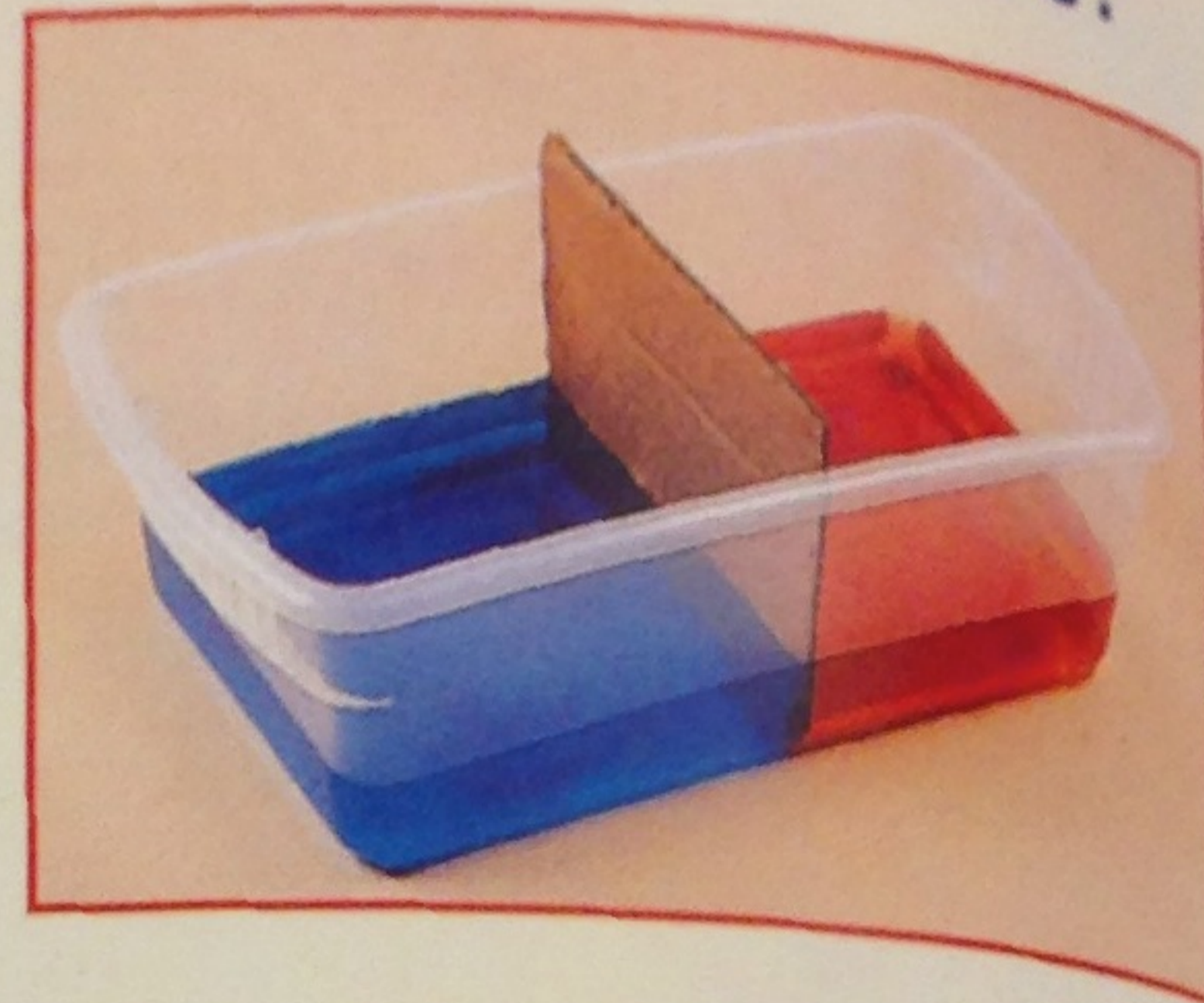
In winter, humid air masses bring heavy snowstorms to areas like New York City.

Lab
zone

Discover Activity

How Do Fluids of Different Densities Behave?

1. Put on your apron. Place a cardboard divider across the middle of a plastic shoe box.
2. Add a few drops of red food coloring to a liter of warm water. Pour the red liquid, which represents low-density warm air, into the shoe box on one side of the divider.

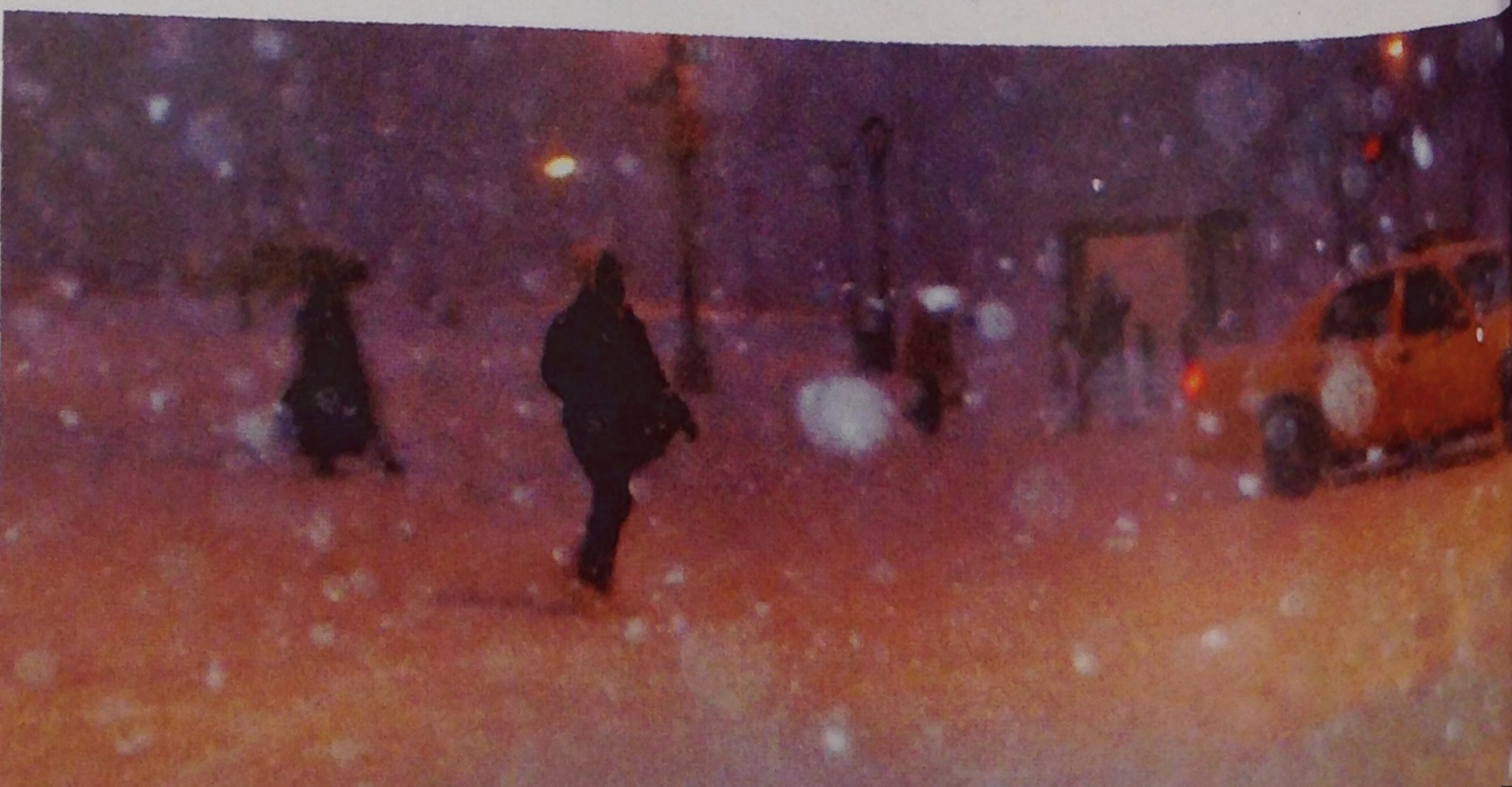


3. Add about 100 mL of table salt and a few drops of blue food coloring to a liter of cold water. Pour the blue liquid, which represents high-density cold air, into the shoe box on the other side of the divider.
4. What do you think will happen if you remove the divider?
5. Now quickly remove the divider. Watch carefully from the side. What happens?

Think It Over

Developing Hypotheses Based on this activity, write a hypothesis stating what would happen if a mass of cold air ran into a mass of warm air.

Listen to the evening news in the winter and you may hear a weather forecast like this: “A huge mass of Arctic air is moving our way, bringing freezing temperatures.” Today’s weather can be influenced by air from thousands of kilometers away—perhaps from Canada or the Pacific Ocean. A huge body of air that has similar temperature, humidity, and air pressure at any given height is called an **air mass**. A single air mass may spread over millions of square kilometers and be up to 10 kilometers deep.



Types of Air Masses

Scientists classify air masses according to two characteristics: temperature and humidity. Four major types of air masses influence the weather in North America: maritime tropical, continental tropical, maritime polar, and continental polar.

The characteristics of an air mass depend on the temperatures and moisture content of the region over which the air mass forms. Remember that temperature affects air pressure. Cold, dense air has a higher pressure, while warm, less dense air has a lower pressure. **Tropical**, or warm, air masses form in the tropics and have low air pressure. **Polar**, or cold, air masses form north of 50° north latitude and south of 50° south latitude. Polar air masses have high air pressure.

Whether an air mass is humid or dry depends on whether it forms over water or land. **Maritime** air masses form over oceans. Water evaporates from the oceans, so the air can become very humid. **Continental** air masses form over land. Continental air masses have less exposure to large amounts of moisture from bodies of water. Therefore, continental air masses are drier than maritime air masses.

Maritime Tropical Warm, humid air masses form over tropical oceans. Maritime tropical air masses that form over the Gulf of Mexico and the Atlantic Ocean move first into the southeastern United States. These air masses then move north and northeast, where they influence weather in the central and eastern United States. In the west, maritime tropical air masses form over the Pacific Ocean. They mainly affect the weather on the West Coast. As they cross the coastal mountain ranges, the Pacific air masses lose moisture.

In summer, maritime tropical air masses usually bring hot, humid weather. Many summer showers and thunderstorms in the eastern United States develop in air masses that have formed over the Gulf of Mexico. In winter, a humid air mass can bring heavy rain or snow.

Classifying Air Masses





	Wet	Dry
Warm	 Maritime tropical	 Continental tropical
Cold	 Maritime polar	 Continental polar

FIGURE 2

Air masses can be classified according to their temperature and humidity. **Identifying** What type of air mass consists of warm, moist air?

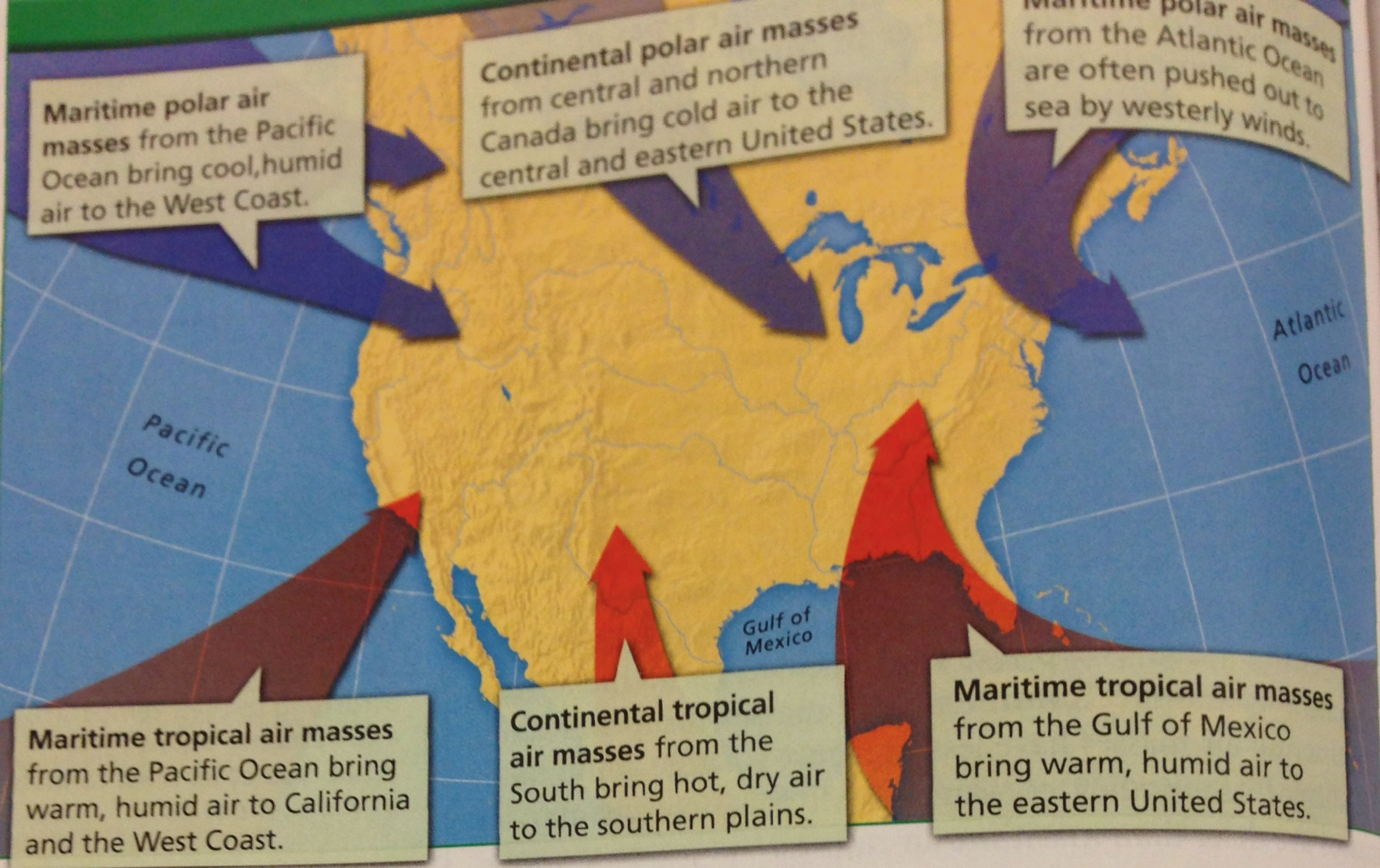


FIGURE 3

air masses can be warm or cold, and humid or dry. As an air mass moves into an area, the weather changes.

Maritime Polar Cool, humid air masses form over the icy cold North Pacific and North Atlantic oceans. Maritime polar air masses affect the West Coast more than the East Coast. Even in summer, these masses of cool, humid air often bring fog, rain, and cool temperatures to the West Coast.

Continental Tropical Hot, dry air masses form mostly in summer over dry areas of the Southwest and northern Mexico. Continental tropical air masses cover a smaller area than other air masses. They occasionally move northeast, bringing hot, dry weather to the southern Great Plains.

Continental Polar Large continental polar air masses form over central and northern Canada and Alaska, as shown in Figure 3. Air masses that form near the Arctic Circle can bring bitterly cold weather with very low humidity. In winter, continental polar air masses bring clear, cold, dry air to much of North America. In summer, the air mass is milder. Storms may occur when continental polar air masses move south and collide with maritime tropical air masses moving north.

Reading Checkpoint

Where do continental polar air masses come from?

How Air Masses Move

When an air mass moves into an area and interacts with other air masses, it causes the weather to change. In the continental United States, air masses are commonly moved by the prevailing westerlies and jet streams.

Prevailing Westerlies The prevailing westerlies, the major wind belts over the continental United States, generally push air masses from west to east. For example, maritime polar air masses from the Pacific Ocean are blown onto the West Coast, bringing low clouds and showers.

Jet Streams Embedded within the prevailing westerlies are jet streams. Recall that jet streams are bands of high-speed winds about 10 kilometers above Earth's surface. As jet streams blow from west to east, air masses are carried along their tracks.

Fronts As huge masses of air move across the land and the oceans, they collide with each other. But the air masses do not easily mix. Think about a bottle of oil and water. The less dense oil floats on top of the denser water. Something similar happens when two air masses with a different temperature and humidity collide. The air masses do not easily mix. The boundary where the air masses meet becomes a **front**. Storms and changeable weather often develop along fronts, as shown in Figure 4.

Reading Checkpoint

In what direction does the jet stream move storms?

Lab zone Skills Activity

Calculating

When planes fly from west to east, they fly with the jet stream, and therefore can fly faster. When traveling from east to west, planes fly against the jet stream, and travel slower. To calculate the rate at which the planes fly, divide the distance traveled by the time it takes.

$$\text{Rate} = \frac{\text{Distance}}{\text{Time}}$$

If a plane flies from Denver, Colorado, to New York City, a distance of about 2,618 kilometers, it takes about 3 hours and 30 minutes. The return flight takes about 4 hours. Calculate the rates of air travel, in km/h, in each direction. How much extra speed does the jet stream add to the west-to-east flight?

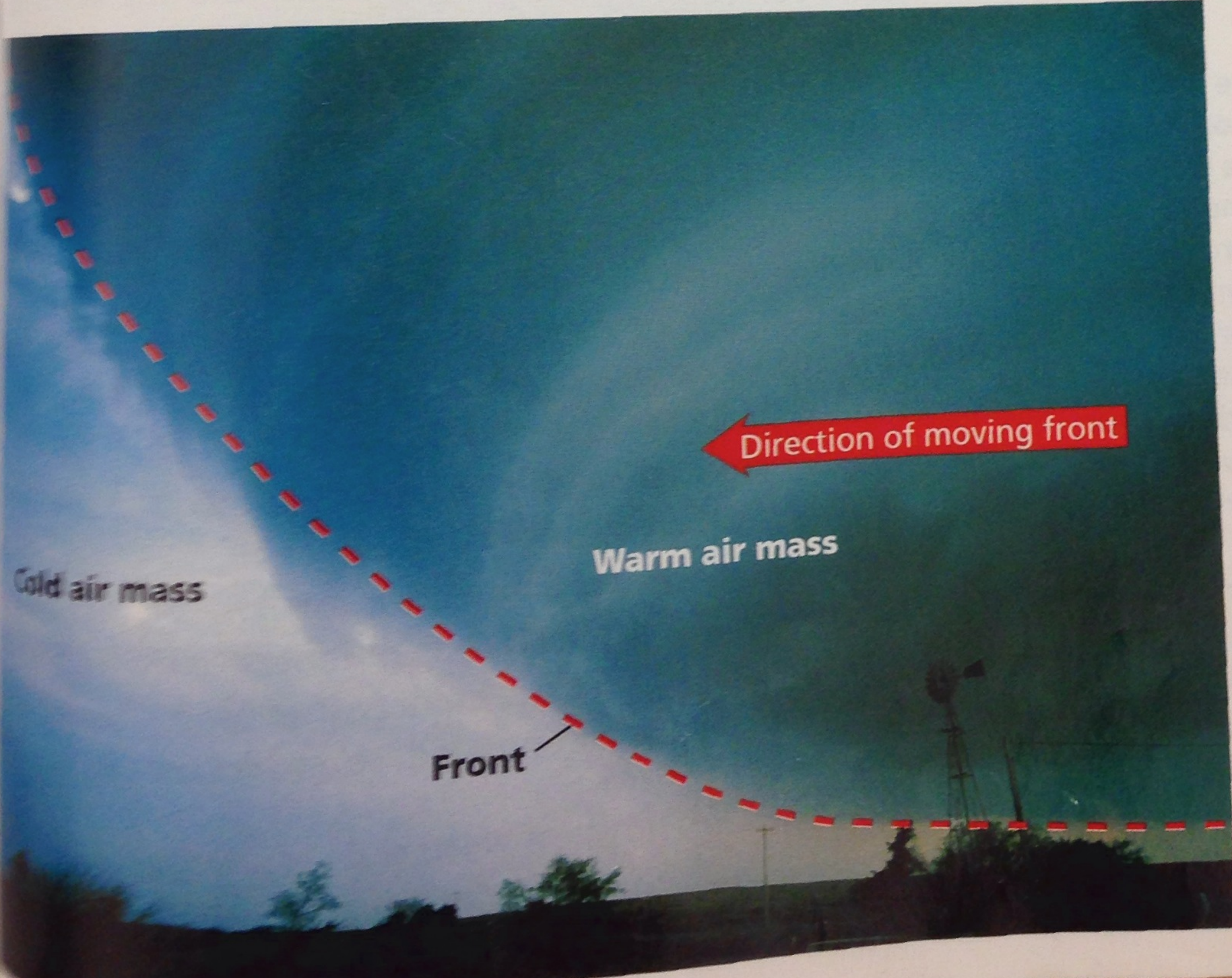


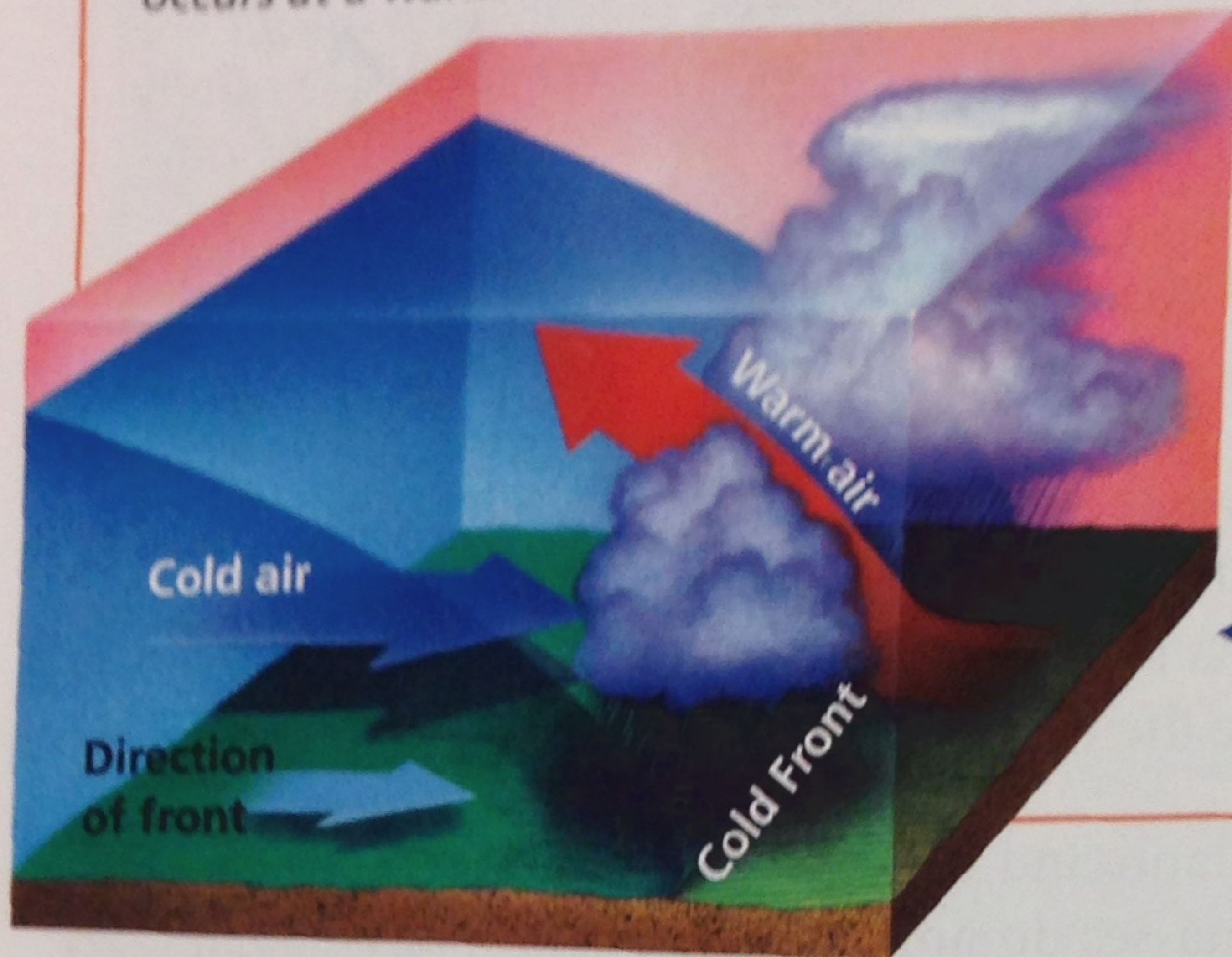
FIGURE 4
How a Front Forms
The boundary where unlike air masses meet is called a front. A front may be 15 to 600 kilometers wide and extend high into the troposphere.

FIGURE 5

Types of Fronts

There are four types of fronts: cold fronts, warm fronts, stationary fronts, and occluded fronts.

Interpreting Diagrams What kind of weather occurs at a warm front?



▲ Warm Front

A warm air mass overtakes a slow-moving cold air mass.

◀ Cold Front

A fast-moving cold air mass overtakes a warm air mass.

Types of Fronts

Colliding air masses can form four types of fronts: cold fronts, warm fronts, stationary fronts, and occluded fronts. The kind of front that develops depends on the characteristics of the air masses and how they are moving.

Cold Fronts As you have learned, cold air is dense and tends to sink. Warm air is less dense and tends to rise. When a rapidly moving cold air mass runs into a slowly moving warm air mass, the denser cold air slides under the lighter warm air. The warm air is pushed upward along the leading edge of the colder air, as shown in Figure 5. A cold front forms.

As the warm air rises, it expands and cools. Remember that warm air can hold more water vapor than cool air. The rising air soon reaches the dew point, the temperature at which the water vapor in the air condenses into droplets of liquid water or forms tiny ice crystals. Clouds form. If there is a lot of water vapor in the warm air, heavy rain or snow may fall. If the warm air mass contains only a little water vapor, then the cold front may be accompanied by only cloudy skies.

Since cold fronts tend to move quickly, they can cause abrupt weather changes, including thunderstorms. After a cold front passes through an area, colder, drier air moves in, often bringing clear skies, a shift in wind, and lower temperatures.

Lab zone Skills Activity

Classifying

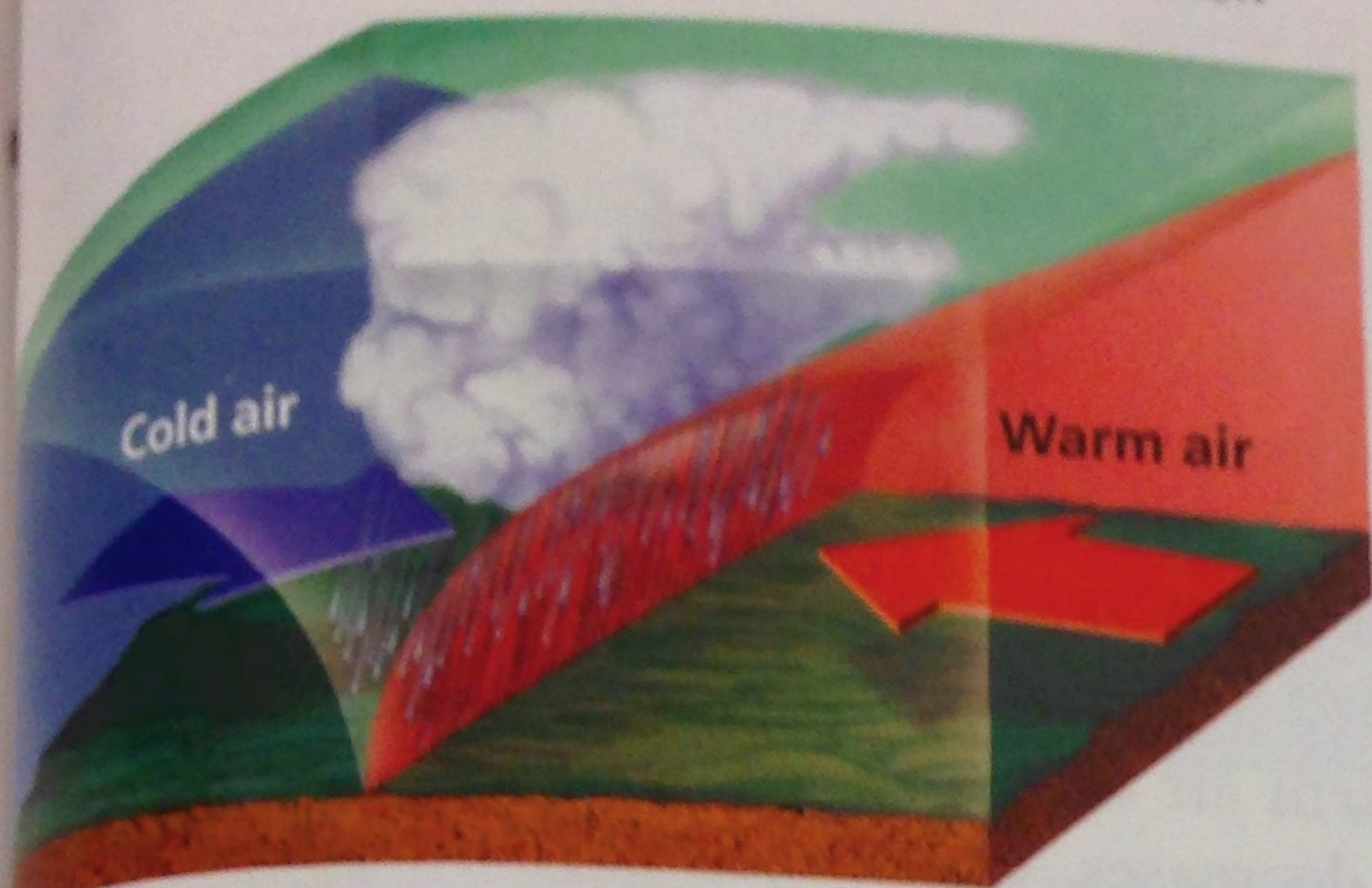
At home, watch the weather forecast on television. Make a note of each time the weather reporter mentions a front. Classify the fronts mentioned or shown as cold, warm, stationary, or occluded. What type of weather is predicted to occur when the front arrives? Note the specific weather conditions, such as temperature and air pressure, associated with the front. Is each type of front always associated with the same type of weather?

Reading Checkpoint

What type of weather do cold fronts bring?

▼ Stationary Front

Cold and warm air masses meet, but neither can move the other.





▲ Occluded Front

A warm air mass is caught between two cooler air masses.

Warm Fronts Clouds and precipitation also accompany warm fronts. At a warm front, a fast-moving warm air mass overtakes a slowly moving cold air mass. Because cold air is denser than warm air, the warm air moves over the cold air. If the warm air is humid, light rain or snow falls along the front. If the warm air is dry, scattered clouds form. Because warm fronts move slowly, the weather may be rainy or cloudy for several days. After a warm front passes through an area, the weather is likely to be warm and humid.

Stationary Fronts Sometimes cold and warm air masses meet, but neither one can move the other. The two air masses face each other in a “standoff.” In this case, the front is called a stationary front. Where the warm and cool air meet, water vapor in the warm air condenses into rain, snow, fog, or clouds. If a stationary front remains stalled over an area, it may bring many days of clouds and precipitation.

Occluded Fronts The most complex weather situation occurs at an occluded front, where a warm air mass is caught between two cooler air masses. The denser cool air masses move underneath the less dense warm air mass and push the warm air upward. The two cooler air masses meet in the middle and may mix. The temperature near the ground becomes cooler. The warm air mass is cut off, or **occluded**, from the ground. As the warm air cools and its water vapor condenses, the weather may turn cloudy and rain or snow may fall.

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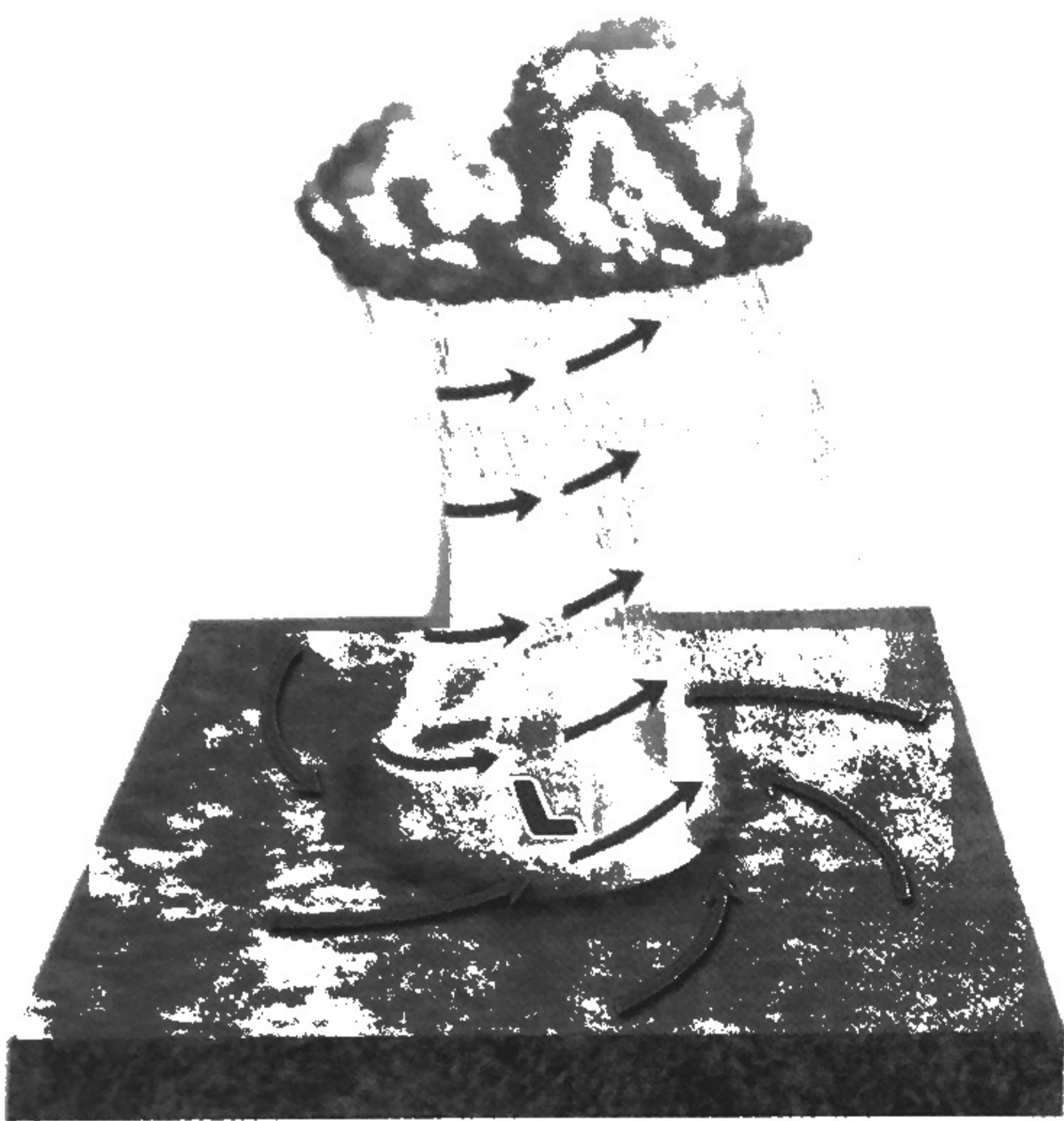
FIGURE 6

Structure of Cyclones and Anticyclones

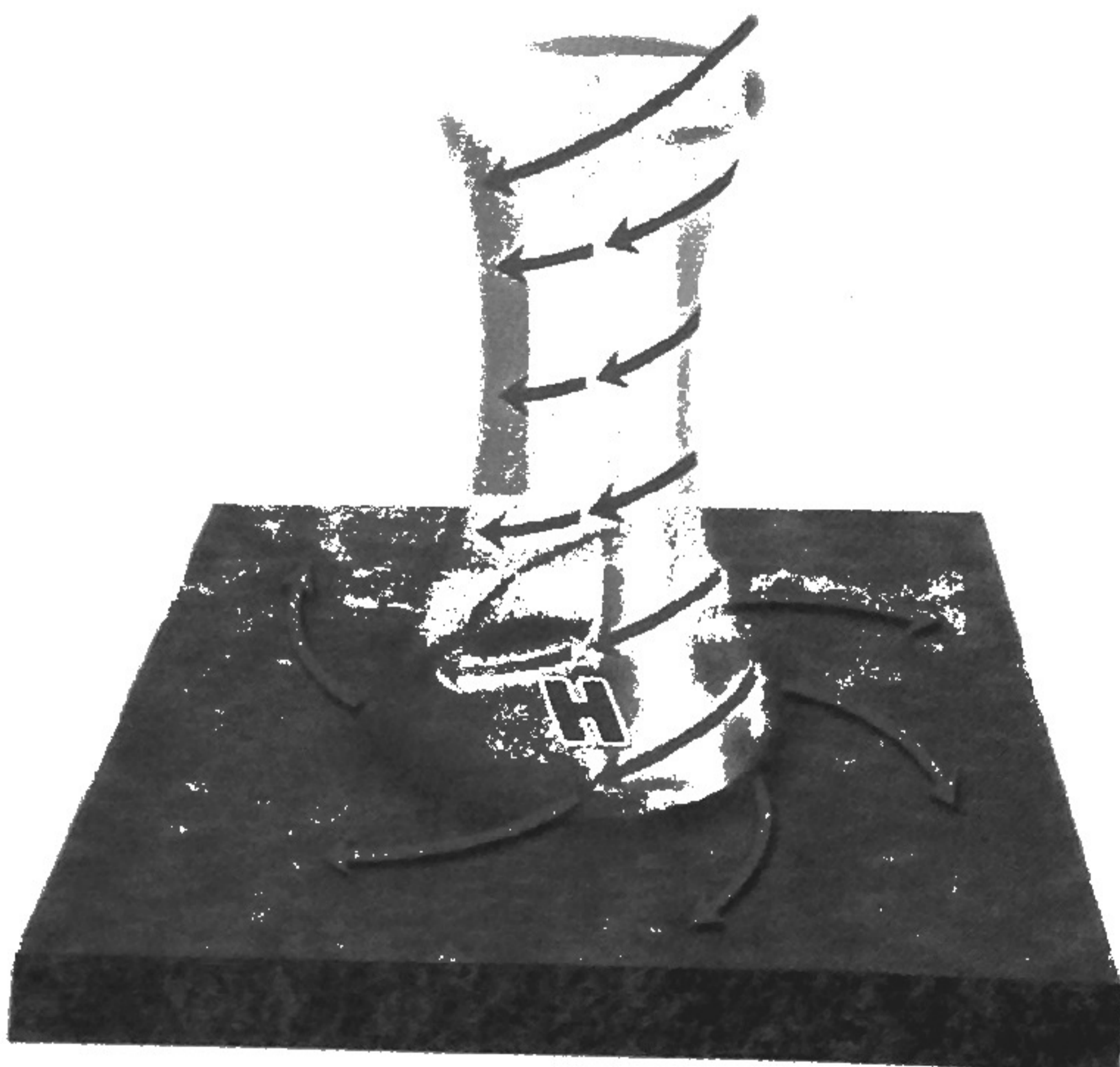
Winds spiral inward towards the low-pressure center of a cyclone. Winds spiral outward from the high-pressure center of an anticyclone.

Interpreting Diagrams Do cyclone winds spin clockwise or counter-clockwise in the Northern Hemisphere?

Cyclone (Low)



Anticyclone (High)



Cyclones and Anticyclones

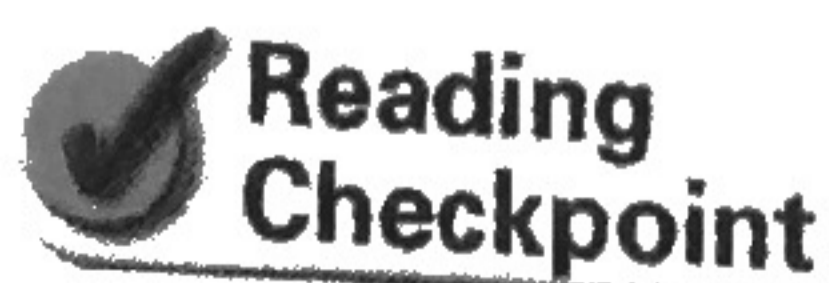
As air masses collide to form fronts, the boundaries between the fronts sometimes become distorted. The distortion can be caused by surface features, such as mountains, or strong winds, such as the jet stream. When this happens, bends can develop along the front. The air begins to swirl. The swirling air can cause a low-pressure center to form.

Cyclones If you look at a weather map, you will see areas marked with an *L*. The *L* stands for “low,” and indicates an area of relatively low air pressure. A swirling center of low air pressure is called a **cyclone**, from a Greek word meaning “wheel.”

As warm air at the center of a cyclone rises, the air pressure decreases. Cooler air blows toward this low-pressure area from nearby areas where the air pressure is higher. As shown in Figure 6, winds spiral inward toward the center of the system. Recall that, in the Northern Hemisphere, the Coriolis effect deflects winds to the right. Because of this deflection, winds in a cyclone spin counterclockwise in the Northern Hemisphere when viewed from above.

Cyclones play a large part in the weather of the United States. As air rises in a cyclone, the air cools, forming clouds and precipitation. **Cyclones and decreasing air pressure are associated with clouds, wind, and precipitation.**

Anticyclones As its name suggests, an anticyclone is the opposite of a cyclone. **Anticyclones** are high-pressure centers of dry air. Anticyclones are usually called “highs”—*H* on a weather map. Winds spiral outward from the center of an anticyclone, moving toward areas of lower pressure. Because of the Coriolis effect, winds in an anticyclone spin clockwise in the Northern Hemisphere. Because air moves out from the center of the anticyclone, cool air moves downward from higher in the troposphere. As the cool air falls, it warms up, so its relative humidity drops. **The descending air in an anticyclone generally causes dry, clear weather.**



Reading
Checkpoint

What is an anticyclone?



FIGURE 7

Highs and Lows

The satellite image shows a low-pressure area (cyclone) over the Northeast and high-pressure areas (anticyclones) over the South and West.



◀ High-pressure areas usually have clear skies.

Low-pressure areas often bring precipitation. ▶



Section 1 Assessment

Target Reading Skill Comparing and Contrasting Use the information in your table about fronts to help you answer Question 2 below.

Reviewing Key Concepts

1. a. **Reviewing** What two characteristics are used to classify air masses?
- b. **Classifying** Classify the four major types of air masses according to whether they are dry or humid.
- c. **Applying Concepts** What type of air mass would form over the northern Atlantic Ocean?
2. a. **Defining** What is a front?
- b. **Describing** Name the four types of fronts and describe the type of weather each brings.
- c. **Classifying** What type of front would most likely be responsible for several days of rain and clouds?

3. a. **Identifying** What is a cyclone?
- b. **Relating Cause and Effect** How does air move in an anticyclone? How does this movement affect the weather?
- c. **Comparing and Contrasting** Compare cyclones and anticyclones. What type of weather is associated with each?

Writing in Science

News Report Suppose you are a television weather reporter covering a severe thunderstorm. Write a brief report to explain to viewers the conditions that caused the thunderstorm.