Table 1 Air Masses

Source region	Type of air	Symbol
Continental	dry	c
Maritime	moist	m
Tropical	warm	T
Polar	cold	P

Types of Air Masses

Air masses are classified according to their source regions. The source regions determine the temperature and the humidity of the air masses. The source regions for cold air masses are polar areas. The source regions for warm air masses are tropical areas. Air masses that form over oceans are called *maritime*. Air masses that form over land are called *continental*. Maritime air masses are moist, and continental air masses are dry. Air masses and the symbols used to designate them are listed in **Table 1.** The combination of tropical or polar air and continental or maritime air results in air masses that have distinct characteristics.

Continental Air Masses

Continental air masses form over large landmasses, such as northern Canada, northern Asia, and the southwestern United States. Because these air masses form over land, the level of humidity is very low. An air mass may remain over its source region for days or weeks. However, the air mass will eventually move into other regions because of global wind patterns. In general, continental air masses bring dry weather conditions when they move into another region. There are two types of continental air masses: *continental polar* (cP) and *continental tropical* (cT). Continental polar air masses are cold and dry. Continental tropical air masses are warm and dry.

READING TOOLBOX

Generalizations

As you read Section 1, look for sentences that contain generalizations. List them in a table like the one shown at the beginning of this chapter. Remember that some generalizations are not signaled by a word or phrase.

Maritime Air Masses

Maritime air masses form over oceans and other large bodies of water. These air masses take on the characteristics of the water over which they form. The humidity in these air masses tends to be higher than that of continental air masses. When these very moist air masses travel to a new location, they commonly bring precipitation and fog, as shown in **Figure 2.**

The two types of maritime air masses are *maritime polar* (mP) and *maritime tropical* (mT). Maritime polar air masses are moist and cold. Maritime tropical air masses are moist and warm.

Figure 2 A maritime air mass brings fog that rolls in off the coast of California.

North American Air Masses

The four types of air masses that affect the weather of North America come from six locations. These air masses, their source locations, their movements, and the weather they bring are summarized in **Table 2.** The general directions of the air masses' movements are shown in **Figure 3.** An air mass usually brings the weather of its source location, but an air mass may change as it moves away from its source location. For example, cold, dry air may become warmer and more moist as it moves from land to a warm ocean. As the lower layers of the air are warmed, the air rises. This warmed air may then create clouds and precipitation.

Table 2 Air Masses of North America

Air mass	Source location	Movement	Weather
cP	polar regions in Canada	south-southeast	cold and dry
mP	polar Pacific; polar Atlantic	southeast; southwest-south	cold and moist
cT	U.S. southwest	north-northeast	warm and dry
mT	tropical Pacific; tropical Atlantic	northeast; north-northwest	warm and moist

Academic Vocabulary
summarize (SUHM uh RIEZ) explain in a brief way

Tropical Air Masses

Continental tropical air masses form over the deserts of the southwestern United States. These air masses bring dry, hot weather in the summer. They do not form in the winter. Maritime tropical air masses form over the warm water of the tropical Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. They bring mild, often cloudy weather to the eastern United States in the winter. In the summer, they bring hot, humid weather and thunderstorms. Maritime tropical air masses also form over warm areas of the Pacific Ocean. But these air masses do not usually reach the Pacific coast. In the winter, maritime tropical air masses bring moderate precipitation to the coast and the southwestern deserts.

SCILINKS
www.scilinks.org
Topic: Air Masses
Code: HQX0031

Reading Check **Which air mass brings dry, hot weather in the summer?** (See Appendix G for answers to Reading Checks.)

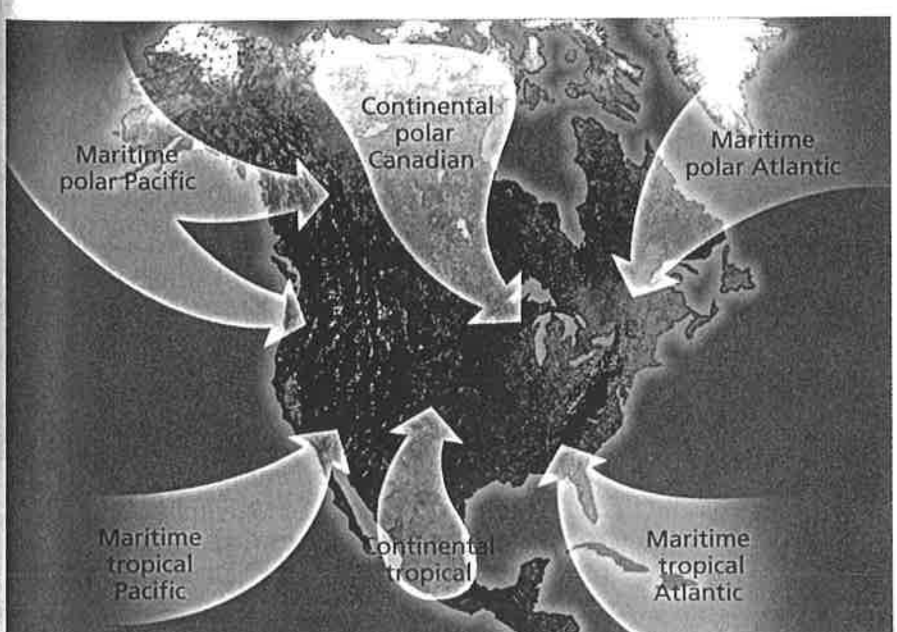


Figure 3 The four types of air masses that influence the weather in North America come from six locations and are named according to their source locations.

Figure 4 Maritime polar Atlantic air masses can bring heavy snowfall, such as this snowstorm that hit New York City in 2003.

Polar Air Masses

Polar air masses from three regions—northern Canada and the northern Pacific and Atlantic Oceans—influence weather in North America. Continental polar air masses form over ice- and snow-covered land. These air masses move into the northern United States and can occasionally reach as far south as the Gulf Coast of the United States. In summer, these air masses usually bring cool, dry weather. In winter, they bring very cold weather to the northern United States.

Maritime polar air masses form over the North Pacific Ocean and are very moist, but they are not as cold as continental polar Canadian air masses. In winter, maritime polar Pacific air masses bring rain and snow to the Pacific Coast. In summer, they bring cool, often foggy weather. As they move inland and eastward over the Cascades, the Sierra Nevada, and the Rocky Mountains, these cold air masses lose much of their moisture and warm slightly. Thus, they may bring cool and dry weather by the time they reach the central United States.

Maritime polar Atlantic air masses generally move eastward toward Europe, but they sometimes move westward over New England and eastern Canada. In winter, they can bring cold, cloudy weather and snow, as shown in **Figure 4.** In summer, these air masses can produce cool weather, low clouds, and fog.

Section 1 Review

Key Ideas

1. **Define** *air mass.*
2. **Explain** how an air mass forms.
3. **Identify** the location where a cold, dry air mass would form.
4. **List** the four main types of air masses.
5. **Describe** how the four main types of air masses affect the weather of North America.
6. **Describe** the air mass that forms over the warm water of the Atlantic Ocean. What letters designate the source region of this air mass?

Critical Thinking

7. **Making Predictions** How do temperature and humidity change when a maritime tropical air mass is replaced by a continental polar air mass?
8. **Recognizing Relationships** In which direction would you expect a tropical air mass near the coast of Europe to travel? Explain your answer.

Concept Mapping

9. Use the following terms to create a concept map: *maritime polar Pacific, maritime polar, continental polar Canadian, air mass, continental polar,* and *maritime polar Atlantic.*

SECTION 2

Fronts

Key Ideas

- Compare the characteristic weather patterns of cold fronts with those of warm fronts.
- Describe how a midlatitude cyclone forms.
- Describe the development of hurricanes, thunderstorms, and tornadoes.

Key Terms

cold front
warm front
stationary front
occluded front
midlatitude cyclone
thunderstorm
hurricane
tornado

Why It Matters

You've probably heard a weather forecaster use the term *front* and perhaps say that a cold front would pass through your area. Tracking the movement of fronts helps us forecast the weather.

When two unlike air masses meet, density differences usually keep the air masses separate. A cool air mass is dense and does not mix with the less-dense air of a warm air mass. Thus, a boundary, called a *front*, forms between air masses. A typical front is several hundred kilometers long. However, some fronts may be several thousand kilometers long. Changes in middle-latitude weather usually take place along the various types of fronts. Fronts do not exist in the tropics because no air masses that have significant temperature differences exist there.

Types of Fronts

For a front to form, one air mass must collide with another air mass. The kind of front that forms is determined by how the air masses move in relationship to each other.

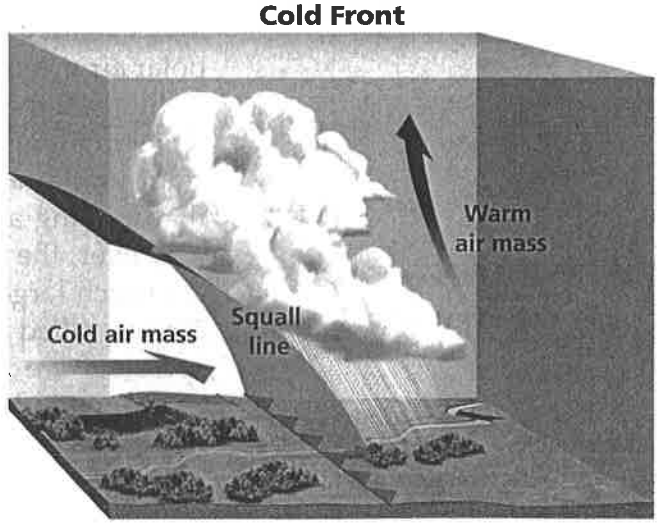
cold front the front edge of a moving mass of cold air that pushes beneath a warmer air mass like a wedge

Cold Fronts

When a cold air mass overtakes a warm air mass, a **cold front** forms. The moving cold air lifts the warm air. If the warm air is moist, clouds will form. Large cumulus and cumulonimbus clouds typically form along fast-moving cold fronts, as shown in **Figure 1.** Storms that form along cold fronts are usually short-lived and are sometimes violent. A long line of heavy thunderstorms, called a *squall line,* may occur in the warm, moist air just ahead of a fast-moving cold front. A slow-moving cold front lifts the warm air ahead of it more slowly than a fast-moving cold front does. A slow-moving cold front typically produces weaker storms and lighter precipitation than a fast-moving cold front does.

Figure 1 As a cold air mass overtakes a warm air mass, a line of thunderstorms called a *squall line* forms.

Cold Front



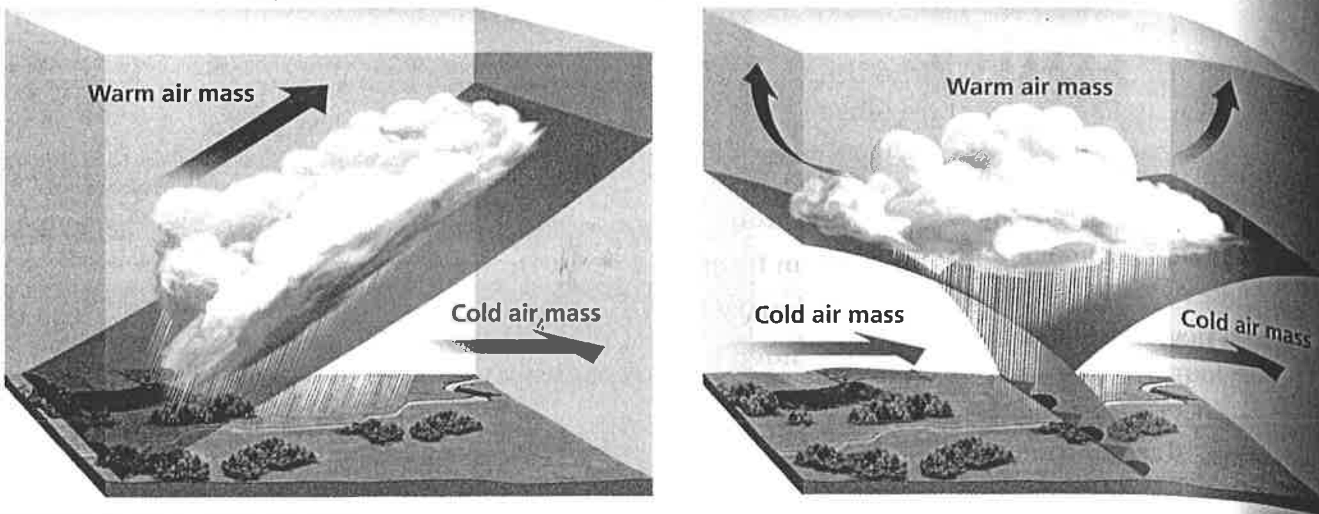


Figure 2 As a warm air mass rises over a cold air mass (left), a warm front forms at the boundary of the two air masses. An occluded front (right) forms when a cold air mass lifts a warm air mass off the ground.

Warm Fronts

When a warm air mass overtakes a cold air mass, a **warm front** forms. The less dense warm air rises over the cooler air. The slope of a warm front is gradual, as shown in **Figure 2.** Because of this gentle slope, clouds may extend far ahead of the surface location, or *base,* of the front. A warm front generally produces precipitation over a large area and may occasionally cause violent weather.

warm front the front edge of an advancing warm air mass that replaces colder air with warmer air

stationary front a front of air masses that moves either very slowly or not at all

occluded front a front that forms when a cold air mass overtakes a warm air mass and lifts the warm air mass off the ground and over another air mass

midlatitude cyclone an area of low pressure that is characterized by rotating wind that moves toward the rising air of the central low-pressure region

Stationary and Occluded Fronts

Sometimes, when two air masses meet, the air moves parallel to the front and neither air mass is displaced. A front at which air masses move either very slowly or not at all is called a **stationary front.** The weather produced by a stationary front is similar to the weather produced by a warm front. An **occluded front** usually forms when a fast-moving cold front overtakes a warm front and lifts the warm air off the ground completely, as shown in **Figure 2.**

Polar Fronts and Midlatitude Cyclones

Over each of Earth's polar regions is a dome of cold air that may extend as far as 60° latitude. The boundary where this cold polar air meets the tropical air mass of the middle latitudes, especially over the ocean, is called the *polar front*. Waves commonly develop along the polar front. A *wave* is a bend that forms in a cold front or a stationary front. This wave is similar to the waves that moving air produces when it passes over a body of water. However, the waves that form in a cold front or stationary front are much larger. They are the beginnings of low-pressure storm centers called midlatitude cyclones or *wave cyclones*. **Midlatitude cyclones** are areas of low pressure that are characterized by rotating wind, which moves toward the rising air of the central low-pressure region. These cyclones strongly influence weather patterns in the middle latitudes.

READING TOOLBOX

Two-Column Notes

Use the two-column table that you started at the beginning of the chapter as a model to review the main ideas about fronts in this section.

Stages of a Midlatitude Cyclone

A midlatitude cyclone usually lasts several days. The stages of formation and dissipation of a midlatitude cyclone are shown in **Figure 3.** In North America, midlatitude cyclones generally travel about 45 km/h in an easterly direction as they spin counterclockwise. They follow several storm tracks, or routes, as they move from the Pacific coast to the Atlantic coast. As they pass over the western mountains, they may lose their moisture and energy.

SciLinks
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Topic: Fronts and Severe Weather
Code: HQX0624

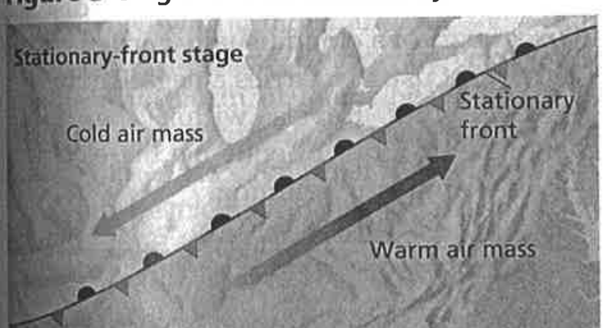
Anticyclones

Unlike the air in a midlatitude cyclone, the air in an *anticyclone* sinks and flows outward from a center of high pressure. Because of the Coriolis effect, the circulation of air around an anticyclone is clockwise in the Northern Hemisphere. Anticyclones bring dry weather, because their sinking air does not promote cloud formation. If an anticyclone stagnates over a region for a few days, it may cause air pollution problems. After being stationary for a few weeks, an anticyclone may cause a drought.

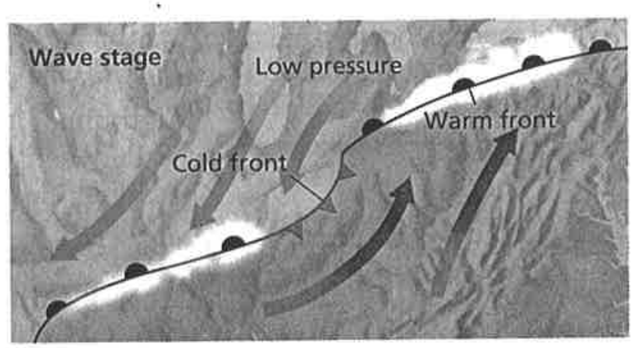
Reading Check **How is the air of an anticyclone different from the air of a midlatitude cyclone?**

THINK central
INTERACT ONLINE
(Keyword: HQXWTHF3)

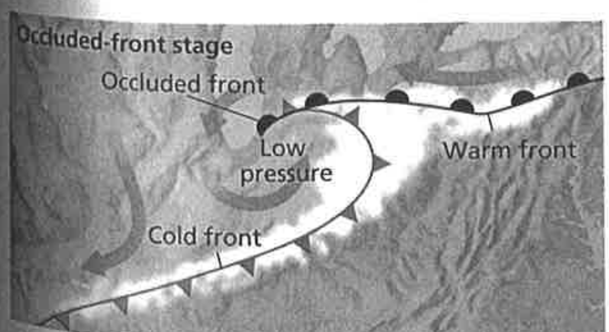
Figure 3 Stages of a Midlatitude Cyclone



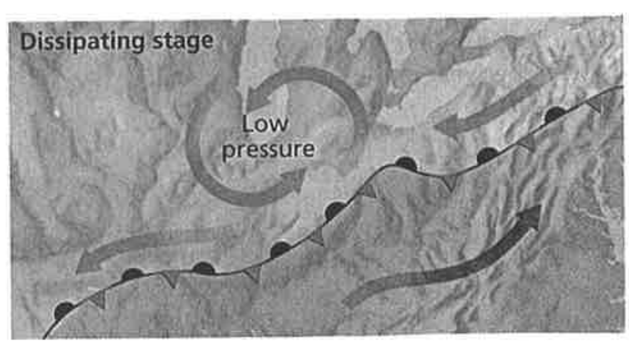
1 Midlatitude cyclones occur along a stationary front. Winds move parallel to the front but in opposite directions on the two sides of the front.



2 A wave forms when a bulge of cold air develops and advances slightly ahead of the rest of the front.



3 As the fast-moving part of the cold front overtakes the warm front, an occluded front forms and the storm reaches its highest intensity.



4 Eventually, the system loses most of its energy and the midlatitude cyclone dissipates.

Tornadoes

The smallest, most violent, and shortest-lived severe storm is a tornado. A **tornado** is a destructive, rotating column of air that has very high wind speeds and that is visible as a funnel-shaped cloud, as shown in **Figure 6.**

A tornado forms when a thunderstorm meets high-altitude, horizontal winds. These winds cause the rising air in the thunderstorm to rotate. A storm cloud may develop a narrow, funnel-shaped, rapidly spinning extension that reaches downward and may or may not touch the ground. If the funnel does touch the ground, it generally moves in a wandering, haphazard path. Frequently, the funnel rises and touches down again a short distance away. Tornadoes generally cover paths not more than 100 m wide. Usually, however, everything in that path is destroyed. Tornadoes occur in many locations, but they are most common in *Tornado Alley* in the late spring or early summer. Tornado Alley stretches from Texas up through the midwestern United States.

The destructive power of a tornado is due to mainly the speed of the wind in the funnel. This wind may reach speeds of more than 400 km/h. Most injuries and deaths caused by tornadoes occur when people are trapped in collapsing buildings or are struck by objects blown by the wind.

Figure 6 A powerful tornado in Texas embedded this bucket in a wooden door (inset).

tornado a destructive, rotating column of air that has very high wind speeds and that may be visible as a funnel-shaped cloud

Section 2 Review

Key Ideas

1. **Describe** the four main types of fronts.
2. **Compare** the characteristic weather patterns of cold fronts with those of warm fronts.
3. **Identify** the type of front that may form a squall line.
4. **Summarize** how a midlatitude cyclone forms.
5. **Describe** the stages in the development of a thunderstorm.
6. **Describe** the stages in the development of a hurricane.
7. **Explain** why tornadoes are so destructive.

Critical Thinking

8. **Evaluating Methods** What areas of Earth should meteorologists monitor to detect developing hurricanes? Explain your answer.
9. **Making Comparisons** Compare the destructive power of midlatitude cyclones, hurricanes, and tornadoes in terms of size, wind speed, and duration.

Concept Mapping

10. Use the following terms to create a concept map: *tornado, hurricane, warm front, squall line, cold front, severe weather, stationary front, front, midlatitude cyclone,* and *occluded front.*