Name _____ Class _____ Date _____

CHAPTER 21 Weather
SECTION 1

Air Masses

KEY IDEAS

As you read this section, keep these questions in mind:

- How does an air mass form?
- What are the four main types of air masses?
- How do air masses affect North America's weather?

How Does Air Move?

Remember that air moves from areas of high pressure to areas of low pressure. In general, surface air moves from the poles toward the equator. At high altitudes, warm air flows from the equator toward the poles. These motions happen because the equator is generally warmer than the poles. Because the air at the equator is warmer, air pressure there is low. Air pressure at the poles is higher, because the air there is colder.

The movements of air in the atmosphere create global wind belts. The Northern Hemisphere and the Southern Hemisphere each have three wind belts. Earth's rotation can influence the direction of these wind belts through the *Coriolis effect.*

READING TOOLBOX

Summarize As you read this section, underline or circle the vocabulary words and other important terms. After you read the section, create a concept map using the terms you underlined or circled.

What Is an Air Mass?

Air does not move much when air pressure differences are small. The air may stay in one place or move very slowly over an area. If this happens, the air takes on the temperature and humidity of that region. A large body of air with similar temperature and moisture is an **air mass**.

Scientists classify air masses by their *source regions*, or the areas in which they form. Scientists use two-letter symbols to describe air masses. The first letter in the symbol indicates whether the air mass is dry or moist. The second letter indicates whether the air mass is warm or cold.

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

Critical Thinking

1. Explain How does pressure affect the movement of surface air?

_____

_____

_____

_____

_____

LOOKING CLOSER

2. Identify Where do warm air masses form?

_____

CONTINENTAL AIR MASSES

Continental air masses form over large bodies of land, such as northern Asia and the southwestern United States. Continental air masses have very low humidity because they form over land. In general, continental air masses bring dry weather when they move into other regions. ☑

READING CHECK

3. Explain How do continental air masses affect the weather of a region?

_____

_____

There are two types of continental air masses: *continental polar* (cP) and *continental tropical* (cT). Continental polar air masses are dry and cold. Continental tropical air masses are dry and warm.

MARITIME AIR MASSES

Maritime air masses form over large bodies of water, such as the Atlantic and Pacific Oceans. These air masses usually have higher humidity than continental air masses do. Maritime air masses bring precipitation and fog when they move to a new region.

Critical Thinking

4. Draw Conclusions Which type of maritime air mass forms over the Arctic Ocean? Why?

_____

_____

_____

_____

_____

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

What Air Masses Affect North America?

An air mass usually brings the weather of its source location. However, an air mass may change as it moves away from its source location. For example, cold dry air may become warm and moist as it moves from land to a warm ocean. The lower layers of the air become warm and rise. As the air rises, clouds and precipitation may form.

The air masses that affect the weather of North America come from six places. The table below shows the sources, movements, and weather of these air masses.

Air Masses in North America

Air Mass	Source Region	Movement	Weather
cP	polar regions in Canada	south-southeast	cold and dry
mP	polar Pacific; polar Atlantic	southeast; south-southwest	cold and moist
cT	southwestern United States	north-northeast	warm and dry
mT	tropical Pacific; tropical Atlantic	northeast; north-northwest	warm and moist

LOOKING CLOSER

5. Describe What type of weather does the continental polar air mass bring?

_____

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 winter.

Maritime tropical air masses form over the Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. These air masses bring mild, cloudy weather to the eastern United States in winter. In summer, they bring hot, humid weather and storms.

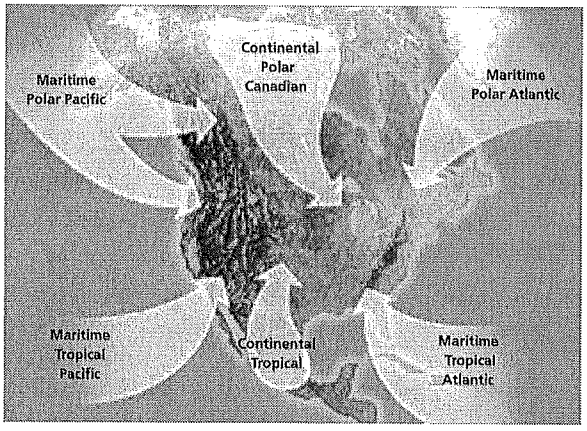
Maritime tropical air masses also form over the Pacific Ocean. During summer, they do not usually reach the Pacific coast. In winter, maritime tropical air masses bring precipitation to the coast and the Southwest.

POLAR AIR MASSES

Continental polar air masses form over ice and snow in northern Canada. These air masses move into the northern United States. In summer, they bring cool, dry weather. In winter, they bring very cold weather.

Maritime polar air masses form over the North Pacific Ocean and reach the Pacific coast. In winter, they bring rain and snow. In summer, they bring cool, often foggy weather. These air masses lose their moisture as they move over the Rocky Mountains. As a result, they can bring cool and dry weather to the central United States.

Maritime polar air masses also form over the Atlantic Ocean. These air masses usually move east toward Europe. Sometimes, they move west over eastern Canada and the United States. In winter, they bring cold, cloudy weather and snow. In summer, they bring cool weather and fog.



The air masses that affect the weather in North America are named according to their source regions.

Critical Thinking

6. Infer How is summer in the southwestern United States different from summer in the southeastern United States?

_____

_____

_____

_____

Talk About It

Apply Concepts Look at the map below. Which air masses affect the weather where you live? How do they affect the weather? Discuss your ideas with a partner.

LOOKING CLOSER

7. Identify Which air mass brings dry, hot weather in the summer?

_____

_____

Name _____ Class _____ Date _____

Section 1 Review

SECTION VOCABULARY

air mass a large body of air throughout which temperature and moisture content are similar	

1. **Explain** How does an air mass form?

_____

_____

2. **List** What are the four main types of air masses?

_____

3. **Compare** Use the charts below to compare the types of maritime and continental air masses.

	Continental Polar	**Continental Tropical**
Symbol	cP	
Weather		

	Maritime Polar	**Maritime Tropical**
Symbol		
Weather	moist and cold	

4. **Describe** How do tropical air masses affect North America?

_____

_____

5. **Describe** How do polar air masses affect North America?

_____

_____

6. **Make Predictions** Suppose a continental polar air mass replaced a maritime tropical air mass. How would temperature and humidity change? Explain your answer.

_____

_____

_____

Name _____ Class _____ Date _____

CHAPTER 21 Weather
SECTION 2

Fronts

KEY IDEAS

As you read this section, keep these questions in mind:

- What weather patterns do warm and cold fronts bring?
- How does a midlatitude cyclone form?
- How do hurricanes, thunderstorms, and tornadoes form?

What Is a Front?

Air masses have different densities. Cool air masses are denser than warm air masses. These density differences keep the air masses separate. As a result, a boundary forms between the air masses. This boundary is a *front*. A typical front is several hundred kilometers long. Some fronts may be several thousand kilometers long. ☑

In the middle latitudes, changes in weather happen along fronts. The middle latitudes are the regions between the tropical and polar regions. Tropical regions do not have fronts because tropical air masses do not have large differences in temperature.

READING TOOLBOX

Make Comparisons As you read this section, make a chart to compare midlatitude cyclones, hurricanes, and tornadoes. Include information about size, wind speed, and duration for each event.

READING CHECK

1. Define What is a front?

_____

_____

_____

What Are the Types of Fronts?

One air mass must collide with another air mass to form a front. The type of front that forms depends on how the air masses move.

COLD FRONTS

A **cold front** forms when a cold air mass pushes under a warm air mass. The moving cold air lifts the warm air. If the warm air is moist, clouds will form. The front moves in the direction the cold air mass was moving.

Cold fronts can move at different speeds. Fast-moving cold fronts lift warm air more quickly than slow-moving cold fronts do. The speed of a cold front affects the weather conditions along the front, as shown below.

Types of Cold Fronts

Speed of Front	Resulting Weather Conditions
Fast	large clouds; short, violent storms; chance of a long line of heavy thunderstorms called a *squall line*
Slow	weaker storms; lighter precipitation

LOOKING CLOSER

2. Identify Which type of cold front may form a squall line?

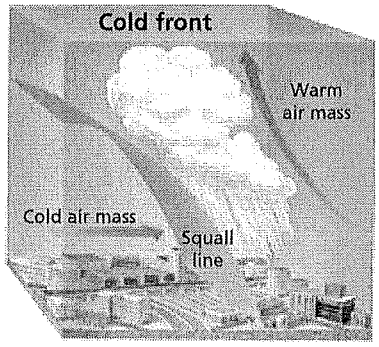
_____

LOOKING CLOSER

3. Describe What type of weather commonly forms along cold fronts?

_____

_____



Large cumulus and cumulonimbus clouds usually form along fast-moving cold fronts.

WARM FRONTS

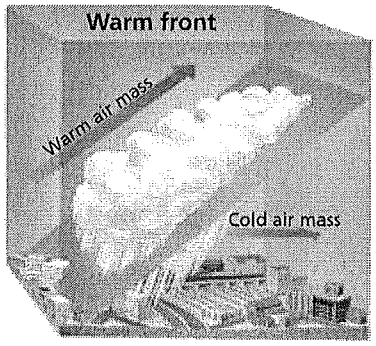
A **warm front** forms when a warm air mass pushes a cold air mass. The less dense warm air rises over the cooler air. The front moves in the direction the warm air mass was moving. A warm front has a gentle slope. As a result, clouds may stretch ahead of the surface location, or *base*, of the front. A warm front causes precipitation over a large area. It sometimes causes violent weather.

LOOKING CLOSER

4. Compare How is the slope of a warm front different from the slope of a cold front?

_____

_____



Clouds may extend ahead of the base of a warm front.

STATIONARY AND OCCLUDED FRONTS

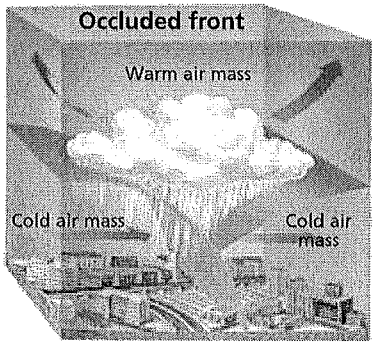
A **stationary front** forms when air masses move slowly or not at all. A stationary front causes weather similar to the weather of a warm front. An **occluded front** forms when a fast-moving cold front lifts a warm air mass completely off the ground.

LOOKING CLOSER

5. Explain What happens to warm air as an occluded front forms?

_____

_____



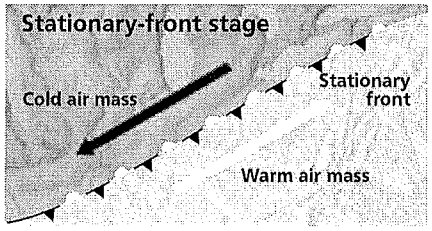
An occluded front forms when a cold air mass lifts a warm air mass off the ground.

How Do Cyclones Form?

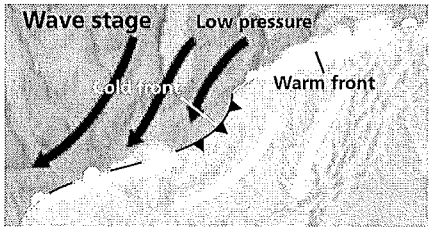
A dome of cold air covers each of Earth's polar regions. This cold air meets the tropical air mass of the middle latitudes at the *polar front.*

Waves often form along the polar front, as shown below. A *wave* is a bend that forms in a cold front or a stationary front. This wave is the beginning of a low-pressure storm center called a midlatitude cyclone, or *wave cyclone.* **Midlatitude cyclones** are areas of low pressure that have rotating wind. The wind moves toward the rising air in the center.

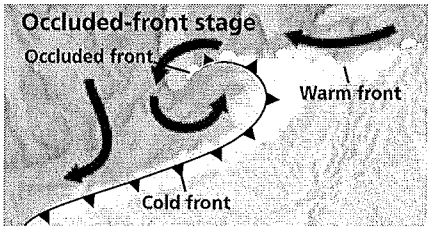
Midlatitude cyclones strongly affect weather patterns in the middle latitudes. They usually last for several days. In North America, they usually travel east at about 45 km/h as they spin counterclockwise. The cyclones may lose energy as they pass over mountains.



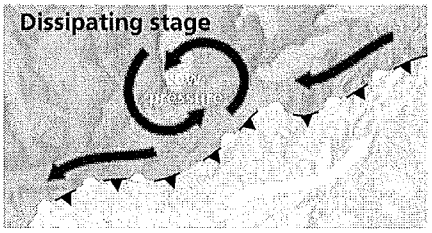
Midlatitude cyclones start to form along a stationary front. Winds blow in opposite directions along the front.



A *wave* forms when a bulge of cold air forms and moves slightly ahead of the rest of the front.



The fast-moving part of the front moves up until it reaches the warm front. An occluded front forms.



Eventually, the system loses most of its energy. The cyclone breaks apart.

Critical Thinking

6. Understand Relationships Would a wave form along the equator? Why or why not?

_____

_____

_____

_____

Talk About It

Discuss Images With a partner, talk about what these images show. Work together to describe in your own words how a midlatitude cyclone forms.

LOOKING CLOSER

7. Identify Name three types of fronts shown in this midlatitude cyclone.

_____

_____

_____

ANTICYCLONES

Fronts can also cause anticyclones. The air in an *anticyclone* sinks and flows outward from a high-pressure center. In the Northern Hemisphere, air flows clockwise around an anticyclone. Anticyclones bring dry weather. If an anticyclone stays in one place, it may cause air pollution problems and drought. ☑

READING CHECK

8. Compare How are anticyclones different from midlatitude cyclones?

_____

_____

_____

_____

What Are Some Types of Severe Weather?

Severe weather is weather that can cause property damage and death. Severe weather includes thunderstorms, tornadoes, and hurricanes.

THUNDERSTORMS

A **thunderstorm** is a heavy storm with rain, thunder, lightning, and strong winds. Thunderstorms develop in three stages, as shown below.

LOOKING CLOSER

9. Describe What causes a thunderstorm to break apart?

_____

_____

_____

_____

Stage	Weather Conditions
Cumulus	Warm, moist air rises. The water vapor in the air condenses to form cumulus clouds.
Mature	The water vapor continues to condense. The clouds rise and become dark cumulonimbus clouds. Heavy rain or hail may fall from the clouds. Downdrafts form as precipitation drags air downward.
Dissipating	Strong downdrafts stop air from rising. The supply of water vapor decreases. The thunderstorm breaks apart.

Parts of a cloud can have different electrical charges. To make the charges equal, clouds may release electricity as *lightning*. Lightning can travel within a cloud, or between a cloud and the ground. The lightning heats the air, and the air quickly expands. The expanding air produces the loud noise called *thunder*.

TORNADOES

A **tornado** is a spinning column of air that has very high winds. A tornado appears as a funnel-shaped cloud. Tornadoes last a short time, but they are very violent.

READING CHECK

10. Explain How do tornadoes form?

_____

_____

_____

_____

A tornado forms when a thunderstorm meets high-altitude, horizontal winds. These winds spin the rising air in the thunderstorm. Part of the storm cloud may reach down in a narrow funnel shape. This funnel may or may not touch the ground. If the funnel does touch the ground, it generally moves in an irregular path. ☑

HURRICANES

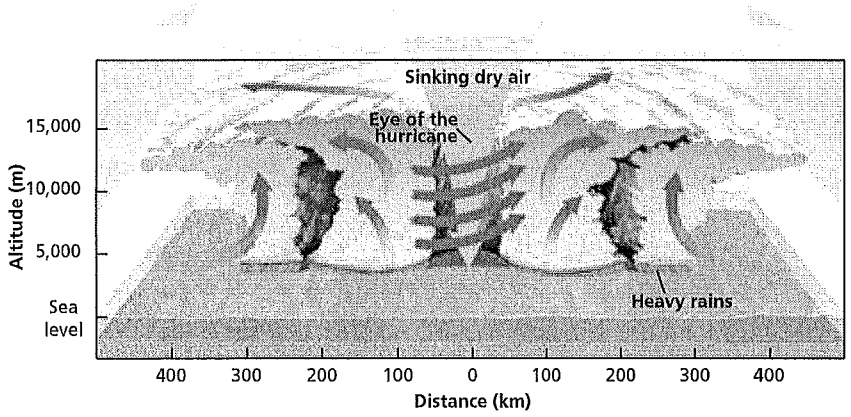
Tropical storms are intense storms that usually form in the tropics. Tropical storms are different from midlatitude cyclones in many ways. Tropical storms cover a smaller area. They do not have warm or cold fronts. Also, they are usually more violent than midlatitude cyclones. A tropical storm with winds that spiral in toward a low-pressure center is called a **hurricane**. A hurricane has wind speeds of 120 km/h or more.

Hurricanes develop over warm, tropical oceans. A hurricane starts when warm, moist air over the ocean quickly rises. The moisture condenses and releases a large amount of energy as *latent heat.* Latent heat is heat energy that is absorbed or released during a phase change.

A fully developed hurricane has thick bands of clouds. These clouds spin upward around the center, or eye, of the storm. Winds increase near the eye. However, the eye itself is a region of calm, sinking air.

Hurricanes are the most destructive storms on Earth. The most dangerous part of a hurricane is a storm surge. A *storm surge* is a rise in sea level with large waves. A storm surge can flood low coastal areas and cause people to drown. ☑

Scientists classify hurricanes using many factors. These factors include central pressure, wind speed, and storm surge. Scientists use these factors to rank hurricanes on the *Saffir-Simpson scale,* which has five categories. Category 1 storms cause the least damage. Category 5 storms cause the worst damage.



The arrows in this picture represent the movement of moist air. Air moves the fastest near the center of the hurricane.

Critical Thinking

11. Draw Conclusions Why are hurricanes more likely to hit states along the Gulf of Mexico than states in the Northeast?

_____

_____

_____

_____

READING CHECK

12. Explain Why is a storm surge so dangerous?

_____

_____

_____

LOOKING CLOSER

13. Identify How wide is the hurricane in this picture?

_____

Name _____ Class _____ Date _____

Section 2 Review

SECTION VOCABULARY

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

hurricane a severe storm that develops over tropical oceans and whose strong winds of more than 120 km/h spiral in toward the intensely low-pressure storm center

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

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

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

thunderstorm a usually brief, heavy storm that consists of rain, strong winds, lightning, and thunder

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

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

1. **Compare** How are the weather patterns produced by cold fronts and warm fronts similar? How are they different?

2. **Summarize** How does a midlatitude cyclone form?

3. **List** What are the three stages in the development of a thunderstorm?

4. **Explain** What causes thunder during a thunderstorm?

5. **Explain** How are tornadoes and thunderstorms related?

6. **Evaluate Methods** A meteorologist wants to study developing hurricanes. What areas of Earth should the meteorologist observe? Explain your answer.