

Section 2

Fronts and Weather

Key Concept Weather results from the movement of air masses that differ in temperature and humidity.

What You Will Learn

- Differences in pressure, temperature, air movement, and humidity cause changes in weather, including severe weather.
- Severe weather and floods can cause property damage and death.

Why It Matters

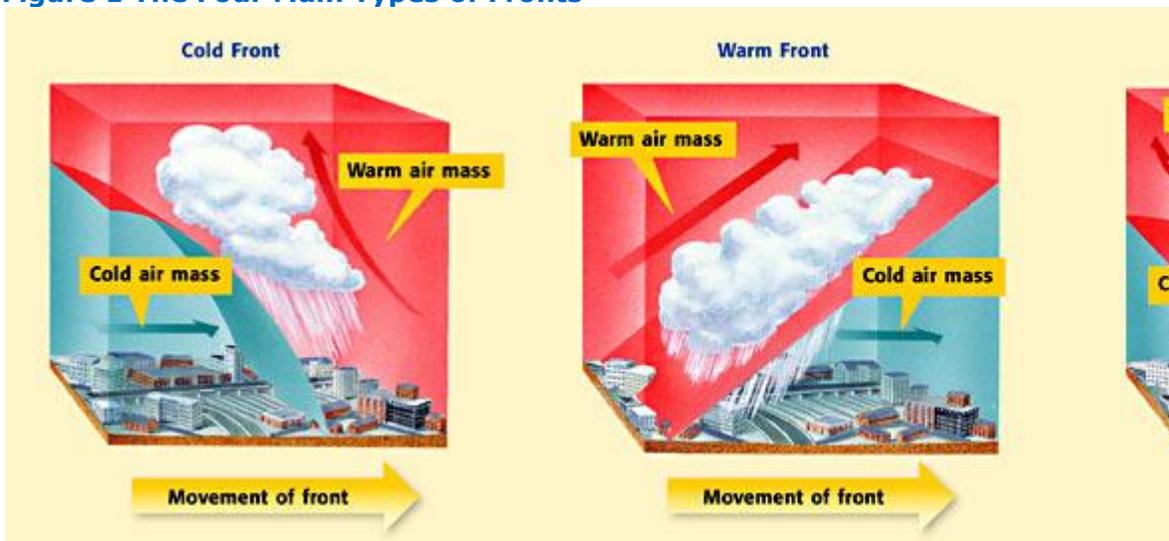
Severe weather can cause property damage, injury, and death.

Have you ever wondered how the weather can change so quickly? Changes in weather are caused by the interaction of air masses. An **air mass** is a large body of air that has similar temperature and moisture content throughout.

Fronts

When different air masses meet, the less dense air mass rises over the denser air mass. Warm air is less dense than cold air is. So, when a warm air mass and a cold air mass meet, warm air generally rises. The area in which two or more air masses meet is called a **front**. **Figure 1** shows the four different kinds of fronts.

Figure 1 The Four Main Types of Fronts



Cold Fronts

A cold front forms where cold air moves under warm air. Because the warm air is less dense, the cold air pushes the warm air up. Cold fronts can move quickly and bring heavy rain or snow. Cooler weather follows a cold front. The cooler weather is brought by the cold, dry air mass behind the cold front that pushed up the warm air mass.



Warm Fronts

A warm front forms where warm air moves over cold, denser air that is leaving an area. The warm air replaces the cold air as the cold air moves away. Warm fronts generally bring drizzly rain. They also are followed by clear, warm weather.

Occluded Fronts

An occluded front forms when a warm air mass is caught between two colder air masses. One cold air mass moves under and pushes up the warm air mass. The cold air mass then moves forward until it meets the other cold air mass. The advancing cold air mass moves under and pushes up the other cold air mass. Sometimes, though, the two colder air masses mix. An occluded front brings cool temperatures and large amounts of rain and snow.

Standards Check What kind of weather would you expect an occluded front to produce?



Stationary Fronts

A stationary front forms when a cold air mass and a warm air mass move toward each other. The warm air mass is commonly forced over the cold air mass. However, there is not enough force for either air mass to advance relative to the other. So, the two air masses remain separated. Stationary fronts happen when there is not enough wind to keep the air masses pushing against each other. A stationary front generally causes many days of cloudy, wet weather.



Air Pressure and Weather

You may have heard a weather reporter talking about areas of low pressure and high pressure. These areas of different pressure cause changes in the weather. An area that has lower air pressure than the areas around it do is called a **cyclone**. Cyclones are areas where air rises. As the air in the center of a cyclone rises, the air cools. Clouds form and may cause rainy and stormy weather.

Areas of high air pressure are called *anticyclones*. Anticyclones are areas where air sinks. As the air sinks, it gets warmer and its relative humidity decreases. As a result, the sinking air in an anticyclone brings dry, clear weather. **Figure 2** shows how an anticyclone can form a cyclone.

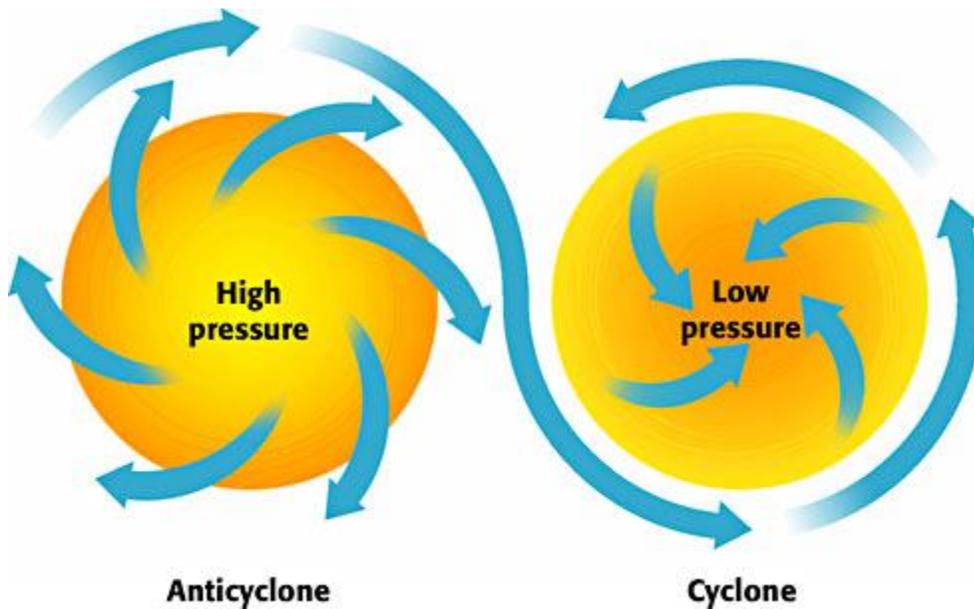


Figure 2 As the colder, denser air spirals out of the anticyclone, the air may spiral in toward areas of low pressure called cyclones.

Standards Check Describe the different kinds of weather that cyclones and anticyclones can form.

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Thunderstorms

A *thunderstorm* is an intense local storm that forms strong winds, heavy rain, lightning, and thunder. Two atmospheric conditions are needed to form thunderstorms: warm and moist air near Earth's surface and an unstable atmosphere. The atmosphere is unstable when cold air is over warm air. When the rising warm air reaches its dew point, the water vapor in the air forms cumulus clouds. If the warm air continues to rise, the cloud may grow into a dark, cumulonimbus cloud. One such cloud is shown in **Figure 3**.



Figure 3 A typical thunderstorm, such as this one over Los Angeles, California, generates an enormous amount of electrical energy.

Lightning

Have you ever touched someone after scuffing your feet on the carpet and received a mild shock? If so, you have experienced how lightning forms. While you walk around, friction between the floor and your shoes builds up an electric charge in your body. When you touch someone else, the charge is released. Lightning forms in a similar way. **Lightning** is an electric discharge that happens between a positively charged area and a negatively charged area. This process is shown in **Figure 4**.

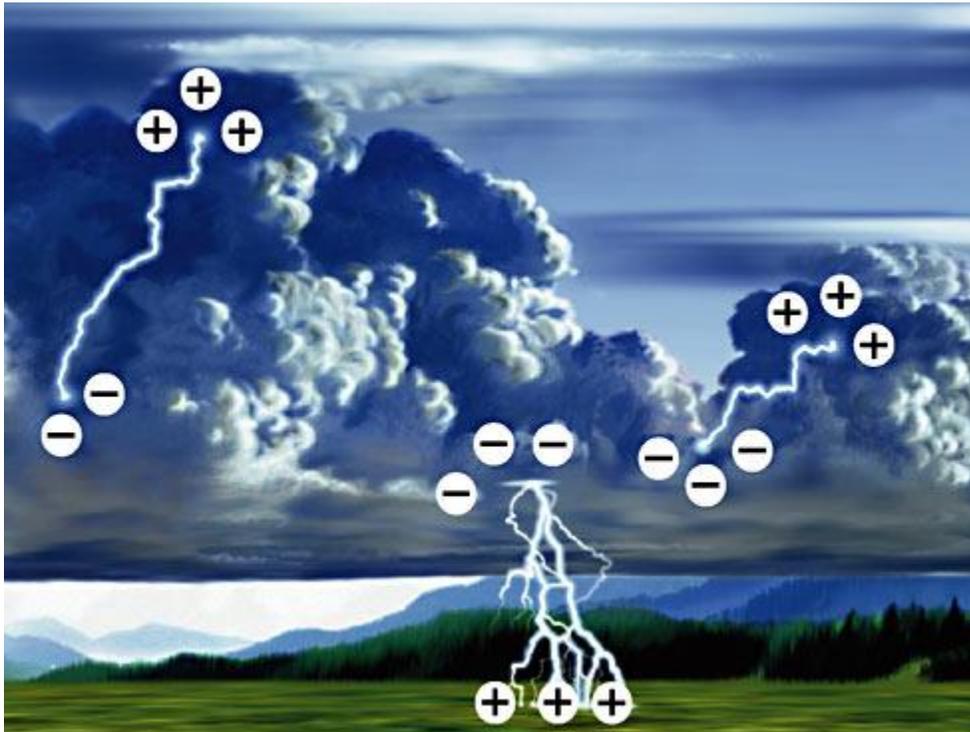


Figure 4 The upper part of a cloud usually carries a positive electric charge. The lower part of the cloud carries mainly negative charges.

Thunder

When lightning strikes, the air along its path is superheated. The superheated air expands rapidly. The rapidly expanding air causes the air to vibrate and release energy as sound waves. The result is **thunder**, which is the sound caused by the fast expansion of air along the lightning strike.

Tornadoes

Tornadoes happen in less than 1% of all thunderstorms. A **tornado** is a rapidly, spinning column of air with high wind speeds and low central pressure and that touches the ground. The beginning of a tornado can be seen as a funnel cloud that

pokes through the bottom of a cumulonimbus cloud. The funnel cloud becomes a tornado when it touches down on Earth's surface, as shown in **Figure 5**.

Figure 5 How a Tornado Forms



1 Wind moving in two directions causes a layer of air in the middle to begin to spin like a roll of toilet paper.



2 The spinning column of a vertical position by strong drafts of air located next to a cumulonimbus cloud.



3 The spinning column of air moves to the bottom of the cumulonimbus cloud and forms a funnel cloud.



4 A funnel cloud becomes a tornado as it touches the ground.



Hurricanes

A large, rotating tropical weather system that has wind speeds of at least 120 km/h is called a *hurricane*. A hurricane is shown in **Figure 6**. Hurricanes are the most powerful storms on Earth. Hurricanes range in size from 160 km to 1,500 km in diameter. They can travel for thousands of kilometers.

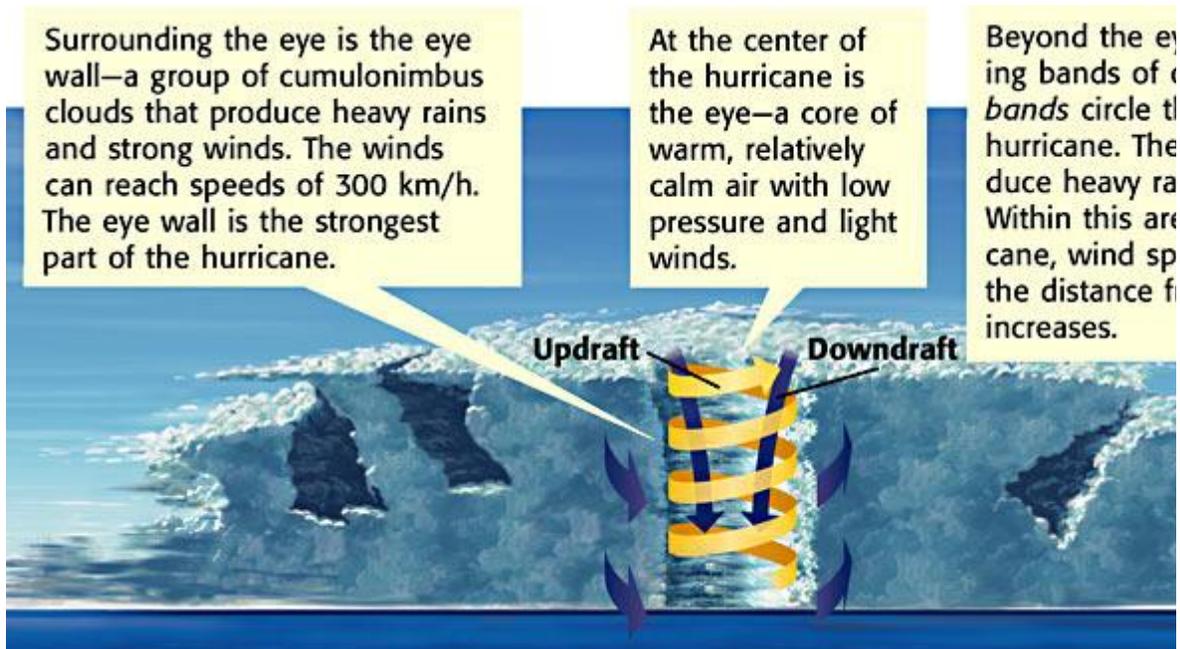


Figure 6 Although hurricanes are very destructive storms, the eye at the center of the tropical storm is relatively calm.

Where Hurricanes Form

Most hurricanes form in the areas between 5° and 20° north latitude and between 5° and 20° south latitude. These storms form over warm, tropical oceans. At higher latitudes, the water is too cold for hurricanes to form.

How Hurricanes Form

A hurricane gets its energy from the evaporation and condensation of water vapor. Once formed, the hurricane is fueled through contact with the warm ocean water. Heat from the sun causes ocean water to evaporate. The evaporation adds moisture to the warm air. As the warm, moist air rises, the water vapor condenses and releases large amounts of energy. A group of thunderstorms forms and moves over tropical ocean waters. The thunderstorms produce a large vortex, or whirl of air.

The hurricane continues to grow as long as it is over warm ocean water. When the hurricane moves over colder waters or over land, the storm loses energy. This loss of energy is the reason that California does not experience hurricanes. Hurricanes approaching California quickly die out over the cold California coastal waters.

Standards Check How does the sun's energy power hurricanes?

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Effects of Severe Weather

Severe weather is weather that can cause property damage, injury, and sometimes death. Hail, lightning, high winds, tornadoes, and flash floods are all part of severe weather. Hailstorms can damage crops and cars and can break windows. Lightning starts thousands of forest fires and kills or injures hundreds of people and animals each year. Winds and tornadoes can uproot trees and destroy homes.

Floods caused by heavy rains cause millions of dollars in property damage every year. Flash flooding is also a leading cause of weather-related deaths. Most damage from hurricanes results from flooding caused by heavy rains and storm surges. A *storm surge* is a rise in sea level that forms in the ocean during a storm. The storm surge crashes onto shore, endangering lives and causing property damage. Hurricane Katrina in 2005 caused more damage and deaths to the southeastern coast of the United States from flooding than from high-speed winds.

Standards Check How do floods affect humans?

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Severe-Weather Safety

During severe weather, one of the most important things to do is to listen to your local radio or TV stations. Severe-weather announcements will let you know a storm's location. They also tell you if the storm is getting worse. During most kinds of severe weather, it is safest to stay indoors away from windows. However, in some situations, you may need to evacuate. During a flood warning, if you are in a low-lying place, such as the one shown in **Figure 7**, you should move to higher ground. Never enter

floodwaters. Even shallow floodwater can be dangerous if it is moving fast.



Figure 7 In 1998, heavy rains caused flooding in the town of Petaluma, California.



Section Summary

- Thunderstorms are weather systems that produce strong winds, heavy rain, lightning, and thunder.
- Lightning is a large electric discharge that occurs between two oppositely charged surfaces. Lightning releases a great deal of energy and can be very dangerous.
- Tornadoes are small, rapidly rotating columns of air that touch the ground and can cause

severe damage.

- A hurricane is a large, rotating tropical weather system that has high wind speeds.
- In the event of severe weather, it is important to stay safe. Listen to your local TV or radio stations for updates, and remain indoors and away from windows.

