



Tornadoes

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Background

Tornadoes is one of the topics in the series of *Masters of Disaster* materials created by the American Red Cross for schools, clubs, organizations and families across the country. The *Tornadoes* module leads young people to understand how tornadoes form, the impact a strike can have on a community and the safe actions to take if the National Weather Service issues a tornado WATCH or WARNING.

These activities are specifically tailored for reaching children in the lower elementary (K–2), upper elementary (3–5) and middle school (6–8) grades. *Tornadoes* is divided into two sections, Tornado Science and Tornado Safety.

Masters of Disaster Connections

Refer to the following modules in the *Masters of Disaster* series to learn more about a particular topic and to reinforce the objectives of the lesson.

- Tornadoes are extremely powerful storms that generate destructive winds, often causing incredible damage and death. The *Hurricanes* and *Floods* modules in *Masters of Disaster* offer comprehensive lessons that complete a student’s understanding of tornadoes.
- An essential part of preparing for any disaster is to be ready with plans, supplies and practice. *Masters of Disaster’s Be Disaster Safe* inspires young people by teaching them to prepare for all hazards.
- The lessons of *In the Aftermath* focus on recovery after a disaster—for the individual, the school and the community.

Why Talk About Tornadoes?

Tornadoes have been reported in every state and, although they generally occur during spring and summer, they can happen at any time of the year. They can occur also at any time of the day or night, but are most likely to happen between 3:00 p.m. and 9:00 p.m. No areas are immune—tornadoes have been reported in mountains and valleys, over deserts and swamps, from the Gulf Coast into Canada, in Hawaii and even in Alaska. The word “tornado” comes from the Spanish word *tronada*, which means “thunderstorm.” In Japan, tornadoes are called *tatsumaki*, which means “dragon whirls.”

Tornado Science

A tornado is a violently rotating column of air extending from a thunderstorm to the ground. The most violent tornadoes have rotating winds of 250 miles (402 kilometers) per hour or more. In the Northern Hemisphere, tornado winds usually spin counterclockwise; in the



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Southern Hemispheres, they usually spin clockwise.

Although tornadoes can cause great destruction, they are an important part of the earth's weather patterns. A tornado releases pressure that builds up in the atmosphere, and the storms that produce them often bring much-needed rain.

Tornado Types

There are three types of tornadoes: weak, strong and violent. See the Enhanced Fujita Scale (EF Scale) on page 5.

Weak Tornadoes (EF0, EF1)

Scientists consider a tornado weak if its winds spin at 110 miles (177 kilometers) per hour or less. Weak tornadoes usually leave behind a path of damage less than 3 miles (5 kilometers) long and 50 yards (46 meters) wide and are the most common of the three tornado types.

Strong Tornadoes (EF2, EF3)

The winds of strong tornadoes range from 111 to 165 miles (178 to 266 kilometers) per hour. These tornadoes average a path about 9 miles (14 kilometers) long and 200 yards (183 meters) wide.

Violent Tornadoes (EF4, EF5)

Violent tornadoes are the least common type of tornado. Only 1 in 50 tornadoes in the United States is classified as violent. Their winds range from 166 to more than 200 miles (267 to 322 kilometers) per hour and may last several hours. A typical violent tornado leaves a path of destruction about 26 miles (42 kilometers) long and 425 yards (389 meters) wide. A few violent tornadoes have left paths that were more than 100 miles (161 kilometers) long and 1 mile (1.6 kilometers) wide.

Waterspouts

Waterspouts are weak tornadoes that form over warm water. They are most common along the Gulf Coast and southeastern states. In the western United States, they occur with cold, late-fall or late-winter storms, during a time when tornado development is least expected. Occasionally, they move inland, becoming tornadoes that cause damage and injury.

Tornado Formation

Tornadoes form in the following sequence:

Fronts

Cool air pushes against warm air in the atmosphere. The place where the two meet is called a front, which can stretch over 100 miles (161 kilometers). As the cool air presses forward, it slides underneath the warm air. The warm air is pushed upward, and water droplets form. Fast-growing clouds, called thunderheads, take shape. A line of thunderheads 100 miles (161 kilometers) or more in length may grow along a front.

Thunderheads

Thunderheads, or cumulonimbus (kyu-mya-lo-NIM-buhs) clouds, are the giant clouds that produce storms with lightning and thunder. When you see a thunderhead, you are looking at a place in the sky where warm, moist air is



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rising quickly through cool air. This can happen along and ahead of fronts, as well as on hot, sunny days.

When the sun heats the ground, the air near it grows warm, too. The warm air rises, but it sometimes becomes trapped by a layer of cooler air above it. As the day progresses, the sun keeps shining, and more heated air pushes skyward. Finally, it breaks through. The warm air blasts high into the sky, like water shooting up from a fountain, and a thunderhead grows.

The thunderheads most likely to cause tornadoes are those that form along and ahead of fronts because strong winds often blow high above fronts. The power of these winds, along with slower winds closer to the ground, can make the rising air in a thunderhead start rotating.

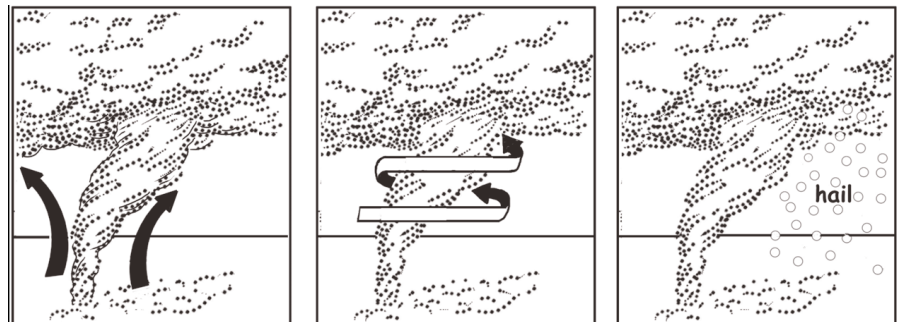
A supercell is a thunderstorm with a persistent rotating updraft. Supercells are rare but are responsible for a remarkably high percentage of severe weather events, especially tornadoes, extremely large hail and damaging straight-line winds. Supercells frequently travel to the right of the main environmental winds, that is, they are “right movers.”

Mesocyclones

If the rising air in a thunderhead begins to rotate, the column of spinning winds is called a mesocyclone (mez-uh-SY-klon). As it rotates, it stretches toward warm air near the ground. The lower part of the mesocyclone narrows. The more it narrows, the faster it spins.

The mesocyclone acts like a giant vacuum-cleaner hose. Warm air is drawn in through its lower end and pulled upward through the thunderhead. The air swirls higher and higher. The spinning air may soar all the way to the top of a thunderhead, 10 miles (16 kilometers) above the ground.

Some mesocyclones spin like this for a few minutes and then just disappear. In others, however, a smaller column of faster-spinning air forms inside the bottom of the mesocyclone. This column is usually less than a half-mile (800 meters) wide. As it spins, it reaches toward the ground.



Funnel Clouds

When the column of tightly spinning winds descends from the mesocyclone, it draws in warm, moist air. The air cools as it is pulled up into the column. Tiny droplets of water form and a whirling cloud appears. This cloud is called a “funnel cloud.”



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Funnel clouds are named for their shape—tubes that are wide at the top and narrow at the bottom. Some funnel clouds hang straight down from the storm cloud. Others stretch sideways through the sky. A funnel cloud may descend and then retract into the mesocyclone, or it may touch the ground. If it does, the funnel cloud is called a tornado.

Sometimes when a tornado is forming, no funnel cloud can be seen. The air near the ground is so dry that, when it is sucked into the whirling column, no water droplets form. Then the fast-spinning air stays invisible until it becomes a tornado, stirring up dust and soil.

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If you see a funnel cloud dip down from a thunderhead, usually it is a sign that a tornado is on its way. But not all tornadoes look like funnels. They can be shaped more like jars—with the same width from top to bottom—or they may have more than one funnel. Large tornadoes may have several narrow, twisting funnels circling around.

Some of the largest, most dangerous tornadoes do not look like funnels at all. These tornadoes appear to be big clouds moving along the ground. Tornadoes also change shape with time. Many funnels become thin, like pieces of rope, as they lose power. They look like giant elephant trunks snaking through the sky.

Tornado winds can be so strong that they can blow large objects, such as parts of buildings, trees and cars, for miles.







The Enhanced Fujita Scale Used to Measure Tornado Intensity

The Enhanced Fujita Scale is a measurement of observed damage caused by tornadoes. The scale includes estimated wind speeds based on damage. Tornado intensity can be measured only after a tornado has happened.



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	EF Scale Number	Wind Speed (3-second gusts)	Description of Damage
	EF0 Light damage	65 to 85 mph (105–137 km/h)	Causes some damage to siding, shingles and gutters; breaks branches from trees and overturns trees with shallow roots
	EF1 Moderate damage	86 to 110 mph (138–177 km/h)	Causes considerable roof damage; can uproot trees, bend flagpoles and large signs; may overturn single-wide mobile homes, tear off exterior doors and break windows and other glass
	EF2 Considerable damage	111 to 135 mph (178–217 km/h)	Destroys most single-wide mobile homes; tears roofs off well-constructed homes and shifts these homes from their foundations; uproots or breaks large trees in half; debarks soft-wood trees; tosses and overturns cars; collapses flagpoles and large signs
	EF3 Severe damage	136 to 165 mph (218–266 km/h)	Tears the bark from hardwood trees; destroys all but small portions of houses; causes severe damage to office buildings or shopping malls; overturns trains and throws cars; blows away structures with weak foundations
	EF4 Devastating damage	166 to 200 mph (267–322 km/h)	Completely destroys well-built residences, large sections of school buildings and large office buildings; throws about cars and other large objects; tosses small objects like missiles
	EF5 Incredible damage	More than 200 mph (more than 322 km/h)	Causes significant structural deformation of mid- and high-rise buildings; throws automobile-size missiles through the air 100 yards (91 meters) or more. To date, no EF5 tornadoes have been recorded.



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Tornado Safety

Tornadoes can change direction, intensity and speed very quickly. Because they accompany severe thunderstorms, weather conditions can change rapidly. Often, there is no time to issue a tornado WARNING. To ensure their own and their family's safety, it is extremely important that people take steps before a tornado occurs and know what to do in the event one does strike.

Be Ready for Tornadoes

Tornadoes will descend from the clouds whenever weather conditions are right. Nothing we can do will turn a tornado in a different direction, make it a single minute shorter or lessen its power. Students and families need to know how to prepare for and respond to a tornado.

Before a Tornado

Be prepared before the possibility of a tornado.

- Listen to National Oceanic and Atmospheric Administration (NOAA) Weather Radio on a radio equipped with a tone-alert feature to keep you informed of WATCHES and WARNINGS issued in your area or have a battery-powered radio or television to listen to local weather information.
- Watch for tornado danger signs. For example:
 - **Dark, often greenish sky.** Sometimes one or more of the clouds turns greenish (a phenomenon caused by hail) indicating a tornado may develop.
 - **Wall cloud.** An isolated lowering of the base of a thunderstorm, it is especially threatening if it is rotating.
 - **Large hail.** Tornadoes are spawned from powerful thunderstorms and the most powerful thunderstorms produce large hail. Tornadoes frequently emerge near the hail-producing portion of the storm.
 - **Cloud of debris.** An approaching cloud of debris can mark the location of a tornado even if a funnel is not visible.
 - **Funnel cloud.** A visible rotating extension of the cloud base is a sign that a tornado may develop.
 - **Roaring noise.** The high winds of a tornado can cause a roar that is often likened to the sound of a freight train.
 - **Visibility.** Tornadoes may occur near the trailing edge of a thunderstorm and be quite visible. It is not uncommon to see clear, sunlit skies behind a tornado. Tornadoes may also be embedded in rain and not visible at all.

Tornado WATCH

If a tornado WATCH is issued for your area, it means that a tornado is possible.

- Listen to NOAA Weather Radio or a local radio or television station for updated information.
- Be alert to changing weather conditions. Large hail, blowing debris or the sound of an approaching tornado may alert you. Many people say an approaching tornado sounds like a freight train.



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- Check to make sure your family disaster supplies kit is ready. (See the *Be Disaster Safe* lesson plans.)

Tornado WARNING

If a tornado WARNING is issued, it means that a tornado has actually been spotted, or is strongly indicated on radar; go to a safe place immediately. Remember, there is often no time to issue a tornado WARNING. If the signs are there and a WATCH is in effect, move to safety.

- Listen to a battery-powered NOAA Weather Radio or a local radio or television station for updated information.
- If you are inside, go to your safe place. The safest place to take shelter during a tornado is in a basement. If your home does not have a basement, go to the lowest floor and take shelter in a hallway, closet, or small room toward the inside of the building, away from windows.
- Get under a piece of sturdy furniture, such as a workbench or heavy table, and hold onto it. Use your other arm and hand to protect your head and neck from falling or flying objects.
- Stay away from windows. Don't open windows.
- If you are in a car, a mobile home or transportable classroom, go immediately to the basement of a nearby sturdy building. If there is no nearby building, lie flat in a low spot. Use your arms and hands to protect your head.
- Do *not* go under highway bridges and overpasses.
- Avoid places with wide-span roofs, such as auditoriums, cafeterias, gymnasiums, large hallways or shopping malls.

What to Do After a Tornado

- Continue listening to an NOAA Weather Radio or a local radio or television station for updated information and instructions.
- Help neighbors who may require special assistance—infants, elderly people and people with disabilities.
- Help any injured or trapped person. Give first aid when appropriate.
- Watch out for fallen power lines or broken gas lines and report them to the utility company immediately.
- If you are away from home, return only when authorities say it is safe.
- When reentering damaged buildings, use extreme caution: wear sturdy shoes and use battery-powered lanterns or flashlights when examining buildings.