Module 11: Meteorology
Topic 6 Content: Severe Weather Notes

Severe weather can pose a risk to you and your property. Meteorologists monitor extreme weather to inform the public about dangerous atmospheric conditions. Thunderstorms, hurricanes, and tornadoes are all types of severe weather. In this activity, follow meteorologist Dr. Benjamin Perez as he explores some of these types of severe weather. Click the weather signs to learn about each type.

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Thunderstorms can range from quick bursts of rain, thunder, and lightning to huge storms that bring high winds, heavy rain, and even hail. Thunderstorms form when warm, moist air rises rapidly. This can occur at a frontal boundary or inside a warm moist air mass. As the warm, moist air rises, it cools and the water vapor condenses into a cumulonimbus clouds. As the air reaches its dew point, or the temperature of saturation, precipitation begins to fall. Thunderstorms are commonly short weather events, lasting about 30 minutes, but can last longer in some cases.

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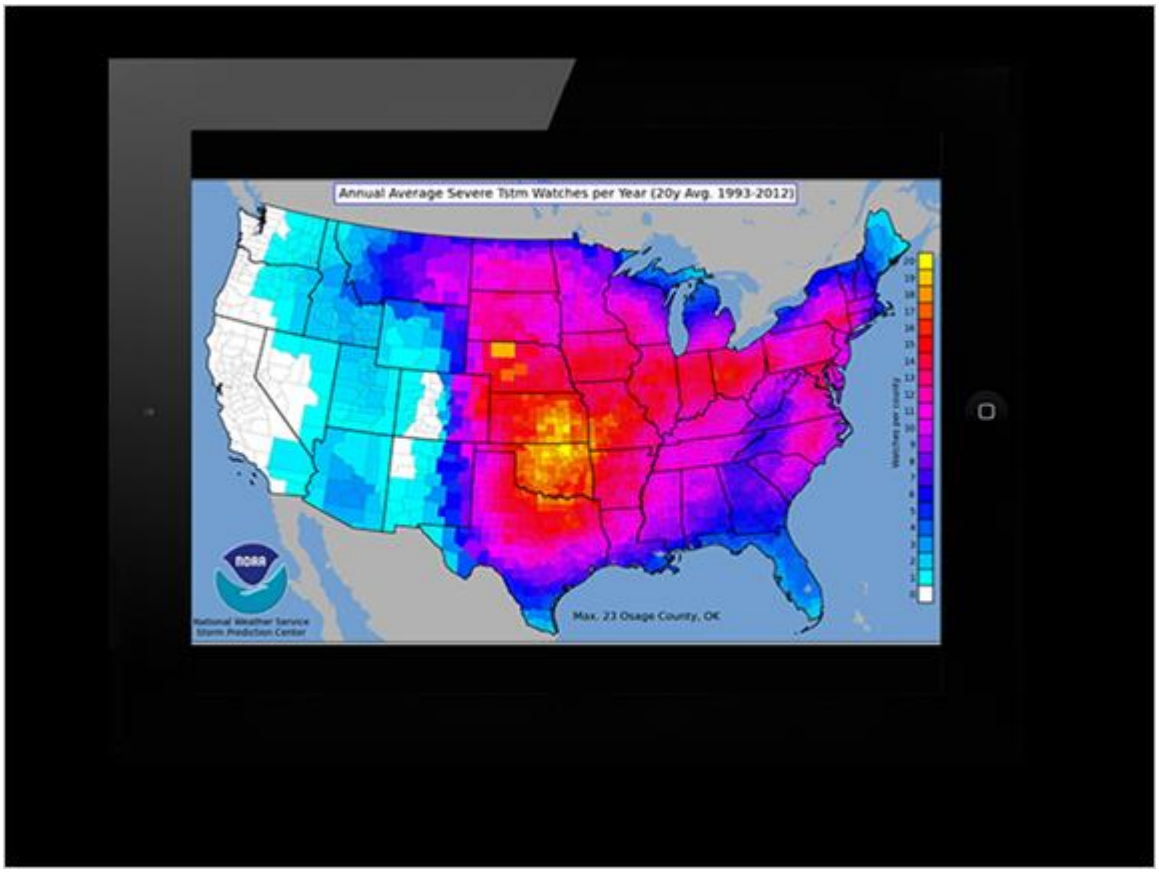

At any given moment, there could be thousands of thunderstorms on Earth. The majority of these storms occur in the tropics because of the constant warm, moist air. In the United States, areas in the central part of the country experience the most severe thunderstorms. The map shows the annual average severe storm watches from 1993 to 2012. As you can see from the image, the states of Texas, Oklahoma, Kansas, Arkansas, and Missouri experience the largest amounts of severe weather watches. In this area, opposite air masses meet and create atmospheric instability. A colder continental polar air mass meets a warmer maritime tropical air mass. The areas of red and yellow make up what is known as tornado alley. You can also see that states on the eastern coast also experience a high number of severe weather watches.

Thunderstorms form when warm, humid air is allowed to rise. Thunderstorms go through three phases of development. The first stage, called the cumulus stage, is when the rising warm air cools and condenses, forming a cumulus cloud. In the mature stage, updrafts and downdrafts of wind created by the temperature changes, form a convection cell and produce wind gusts characteristic of thunderstorms. This is also when precipitation is strongest. The original cumulus cloud has developed vertically into a cumulonimbus cloud. In the dissipation stage, the storm runs out of warm, moist air to fuel the updrafts. Without enough warm, moist air, the thunderstorm runs out of precipitation and the storm ends.

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Severe thunderstorms are most common when a cold front and low-pressure system overtake a warmer air mass. Supercells are a type of severe thunderstorm that can last for several hours and cause very intense weather conditions. Supercells are fueled by continuous rotating updrafts of warm air and can produce extremely high wind gusts and heavy precipitation. This type of thunderstorm is also called a mesocyclone and is associated with tornado development.

Click the Home button to learn more about the different types of severe weather.

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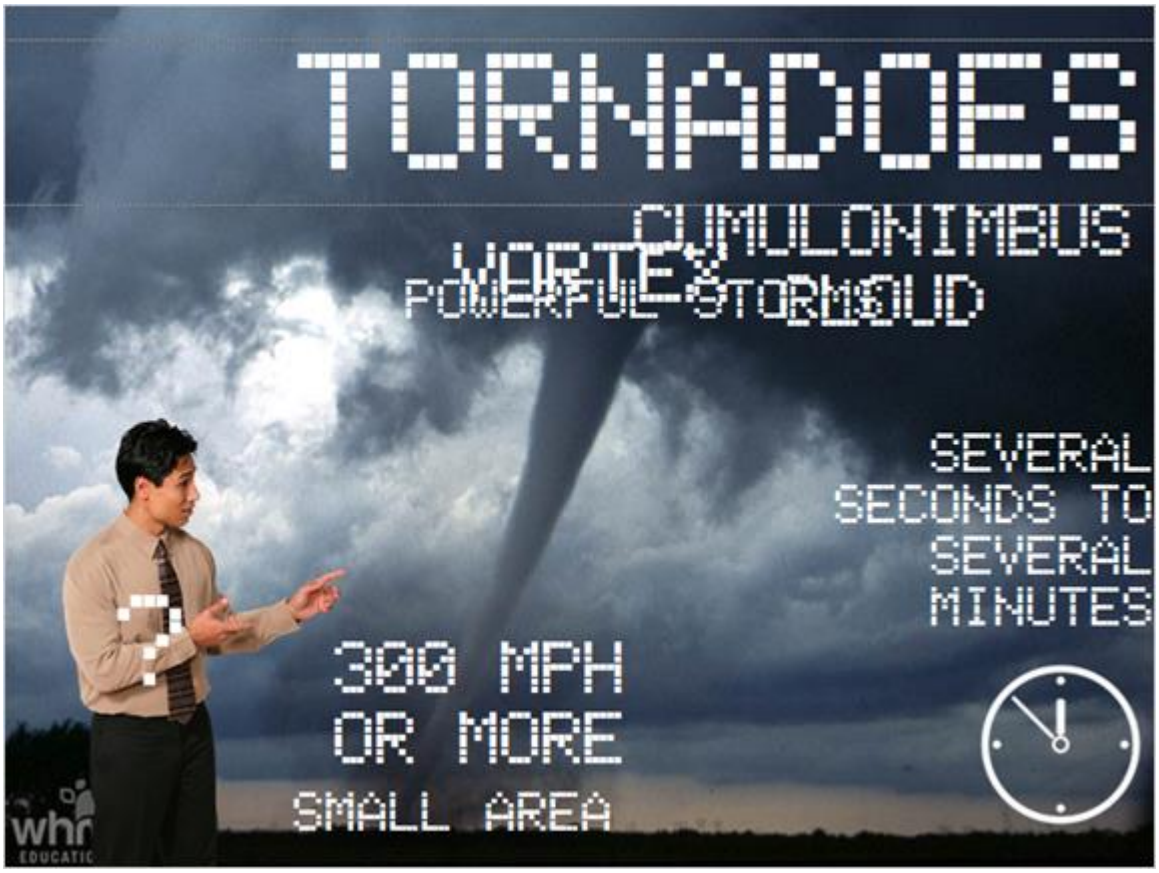
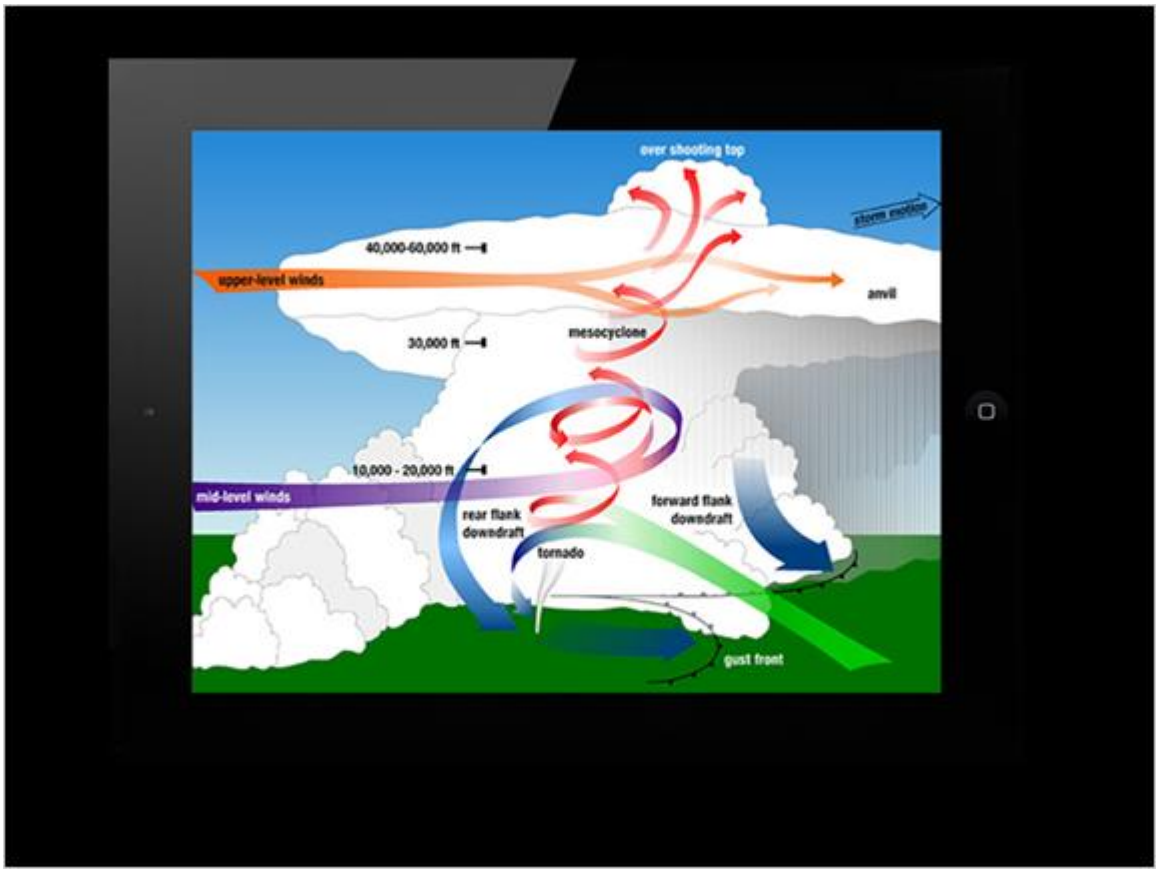


Tornadoes are unique in that they are extremely powerful storms that take place in a very small area. Some of the highest winds on Earth, 300 mph or higher, are found in swirling tornado clouds. It is difficult for meteorologists to study exactly what happens inside a tornado because they are violent and have relatively short lifespans. Tornadoes take the form of a rotating column of air called a vortex. The vortex extends downward from a cumulonimbus cloud. The vortex rotates very quickly and begins to collect debris. The debris that enters the vortex allows it to be observed. Tornadoes can last for several seconds to several minutes.



Tornadoes often form within supercell thunderstorm systems. As a supercell rotates, the updrafts within the cell can create a powerful spiraling wind current. This current, called a vortex, can travel upwards in the cloud. Like the water going down the drain in the tub, the rising air spirals as it meets the resistance of the downdrafts. The narrower section at the bottom of the spiral concentrates a huge amount of energy. While it is a very small area, it contains the strongest winds of the tornado.

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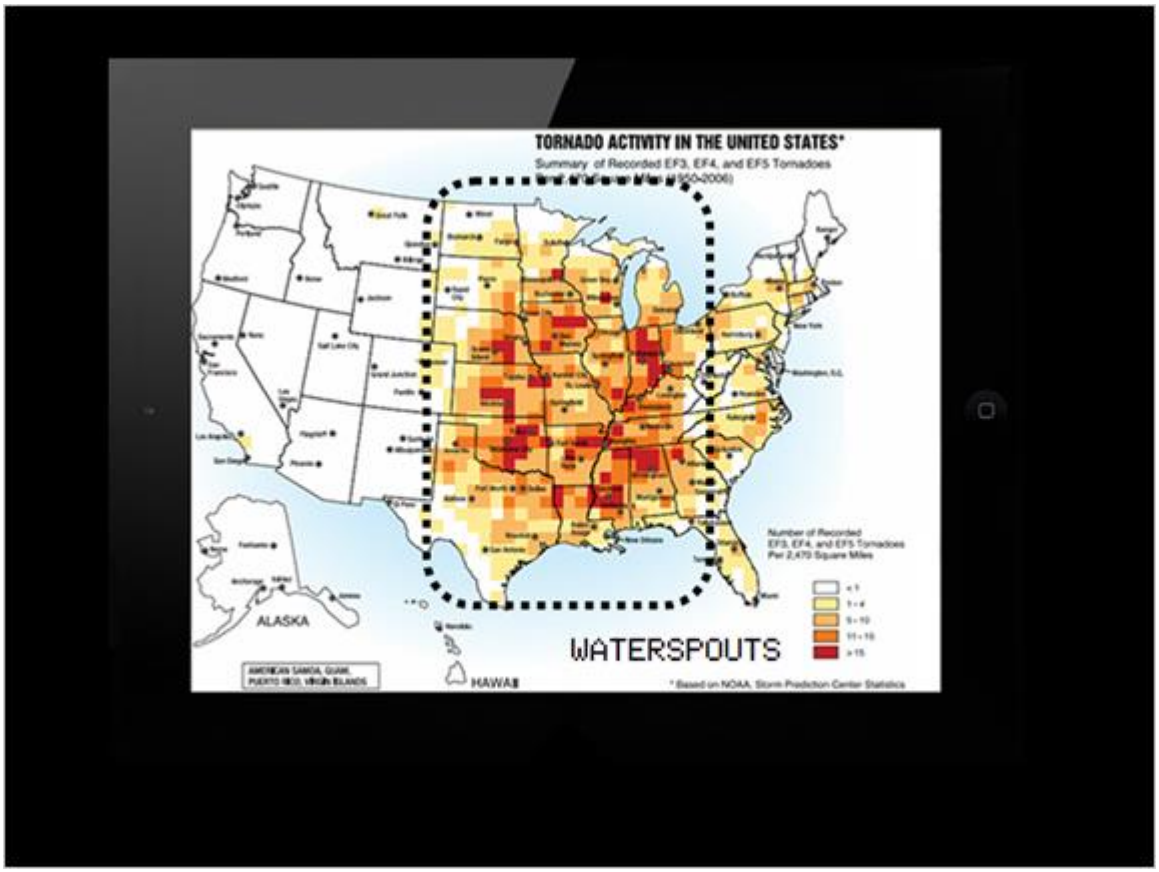
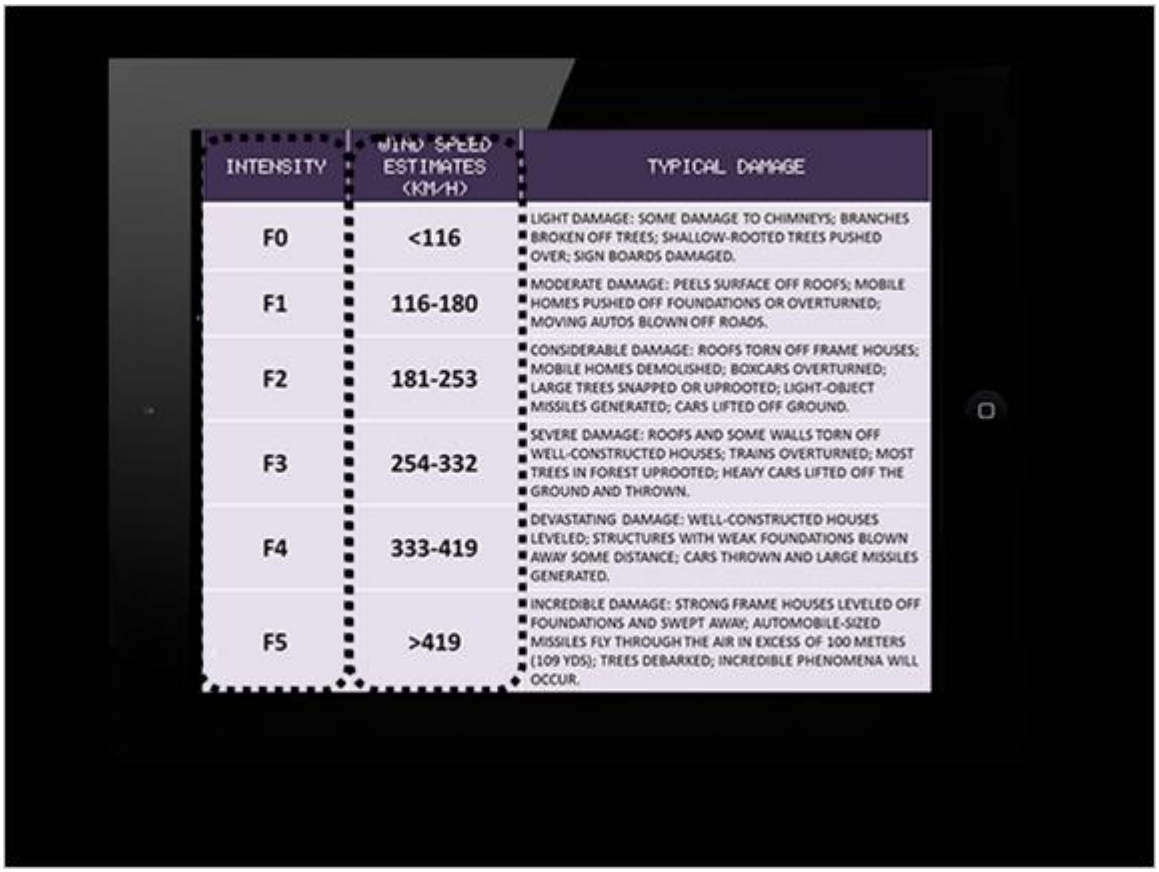


Tornadoes are most likely to occur between the Rocky Mountains and the Appalachian Mountains, in a region of the United States known as Tornado Alley. This area is particularly susceptible to tornadoes because the land is relatively flat and warm, and moist air from the Gulf of Mexico rises as the drier colder air from Canada sinks. Tornadoes can, and have, formed in every state in the United States. They are known as waterspouts when they form over bodies of water.



INTENSITY	WIND SPEED ESTIMATES (KM/H)	TYPICAL DAMAGE
F0	<116	LIGHT DAMAGE: SOME DAMAGE TO CHIMNEYS; BRANCHES BROKEN OFF TREES; SHALLOW-ROOTED TREES PUSHED OVER; SIGN BOARDS DAMAGED.
F1	116-180	MODERATE DAMAGE: PEELS SURFACE OFF ROOFS; MOBILE HOMES PUSHED OFF FOUNDATIONS OR OVERTURNED; MOVING AUTOS BLOWN OFF ROADS.
F2	181-253	CONSIDERABLE DAMAGE: ROOFS TORN OFF FRAME HOUSES; MOBILE HOMES DEMOLISHED; BOXCARS OVERTURNED; LARGE TREES SNAPPED OR UPROOTED; LIGHT-OBJECT MISSILES GENERATED; CARS LIFTED OFF GROUND.
F3	254-332	SEVERE DAMAGE: ROOFS AND SOME WALLS TORN OFF WELL-CONSTRUCTED HOUSES; TRAINS OVERTURNED; MOST TREES IN FOREST UPROOTED; HEAVY CARS LIFTED OFF THE GROUND AND THROWN.
F4	333-419	DEVASTATING DAMAGE: WELL-CONSTRUCTED HOUSES LEVELED; STRUCTURES WITH WEAK FOUNDATIONS BLOWN AWAY SOME DISTANCE; CARS THROWN AND LARGE MISSILES GENERATED.
F5	>419	INCREDIBLE DAMAGE: STRONG FRAME HOUSES LEVELED OFF FOUNDATIONS AND SWEPT AWAY; AUTOMOBILE-SIZED MISSILES FLY THROUGH THE AIR IN EXCESS OF 100 METERS (109 YDS); TREES DEBARKED; INCREDIBLE PHENOMENA WILL OCCUR.

Tornados are classified based on their wind speed and damage, rather than by the size of the funnel cloud. Even small tornadoes can cause serious damage to life and property. The classification system for tornadoes is the Fujita Tornado Intensity Scale, which ranges from F0 to F5. The type and amount of damage a tornado leaves behind gives meteorologists a very good estimate of the actual wind speeds, since it is difficult to monitor the wind speeds inside a tornado as it is happening. Take a moment to review the Fujita Scale and make note of the different levels of damage that each classification of tornado can cause.

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Tornado warning systems have greatly improved in recent years; however, one hurdle to tornado preparation is the short amount of time to prepare for a tornado's arrival. On average, warning times are between ten and fifteen minutes, but can be even less. Sirens, radios, television, and mobile device warning systems have all helped increase the amount of warning time by getting the information out to people quickly and efficiently. All storm warnings are produced from the Storm Prediction Center in Norman, Oklahoma. The Storm Prediction Center is part of the National Oceanographic Atmospheric Administration.

Click the Home button to learn more about the different types of severe weather.

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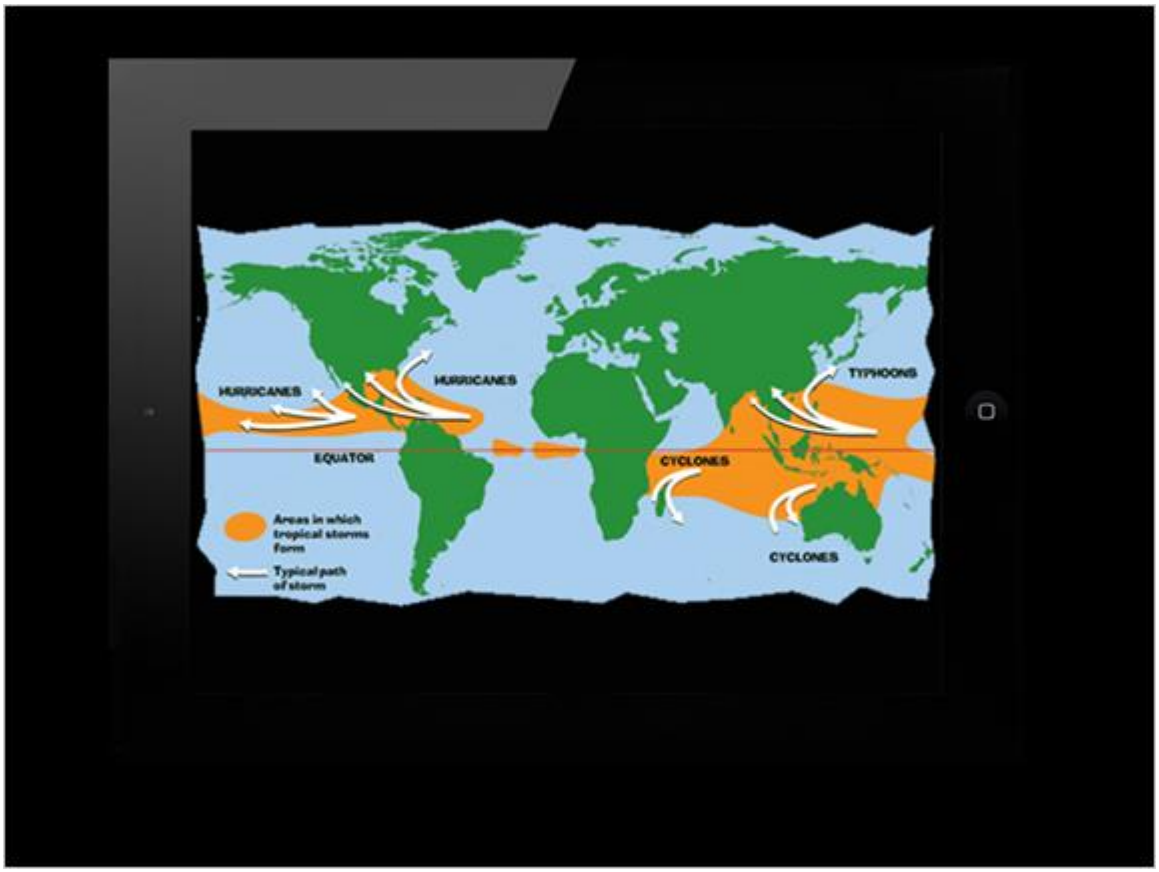
Hurricanes are one of the most powerful storms in nature. A hurricane is a specific type of rotating storm in the Atlantic Ocean with wind speeds that exceed 74 miles per hour. Hurricanes are somewhat unpredictable as to where they will make landfall, but meteorologists track the storms closely and pay close attention to warm water temperatures that would increase a hurricane's strength, as well as other weather systems and fronts that could impact its direction of travel. Once a hurricane hits land, it loses power quickly. Without warm water to fuel the storm, hurricanes lose their strength and their source of precipitation. While hurricanes can be disastrous to humans, they do play an important role in redistributing heat from the tropics toward the poles. This image shows Hurricane Isabel, a storm that struck the eastern coast of the United States in 2003.



Hurricanes are called tropical cyclones in the Southern Pacific Ocean and Indian Ocean, and they are called typhoons in the Northern Pacific Ocean. Hurricanes, tropical cyclones, and typhoons cause serious damage from their strong winds, flooding from their precipitation, as well as storm surges. This image shows that most of these storms originate in the tropics.

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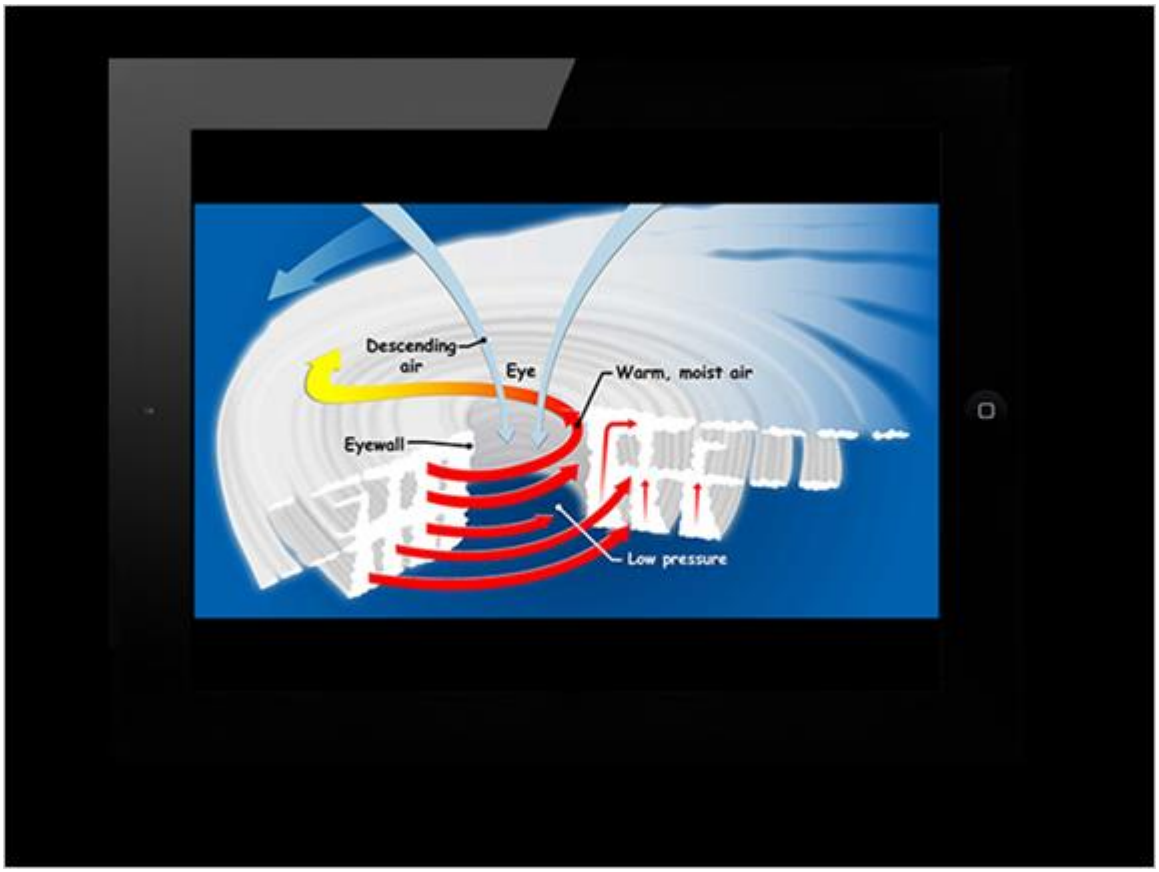

Hurricanes form in warm tropical water just above or below the equator when ocean temperatures have reached a minimum of 81°F. Typically, hurricane season lasts from June through November. It is the warm ocean water that provides the energy needed for the storm formation. The warm air over the warm ocean water rises and meets warm winds. This creates a thunderstorm. If the atmospheric pressure drops low enough as the storm forms, the air will begin to move in a spiral motion. The air pressure in the center of the spiral is the lowest pressure in the storm system, and the storm rotates counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. The storm is classified as a tropical storm when wind speeds reach anywhere from 39 to 73 miles per hour, and the storm is upgraded to hurricane status when winds exceed 74 miles per hour. A well-developed hurricane has a circular eye of low pressure in the center with much milder conditions such as light wind and some cloud cover. The strongest winds spiral around the eye. Surrounding the eye wall are several rain bands. The rain bands are areas of heavy rain and wind. As you move away from the eye wall, the rain bands spread out and lose energy.

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INTENSITY	WIND SPEED ESTIMATES (KM/H)	TYPICAL DAMAGE
1	119-153	NO REAL DAMAGE TO BUILDING STRUCTURES. DAMAGE PRIMARILY TO UNANCHORED MOBILE HOMES, SHRUBBERY, AND TREES. ALSO, SOME COASTAL ROAD FLOODING AND MINOR PIER DAMAGE.
2	154-177	SOME ROOFING MATERIAL, DOOR, AND WINDOW DAMAGE TO BUILDINGS. CONSIDERABLE DAMAGE TO VEGETATION, MOBILE HOMES, AND PIERS. COASTAL AND LOW-LYING ESCAPE ROUTES FLOOD 2-4 HOURS BEFORE ARRIVAL OF CENTER. SMALL CRAFT IN UNPROTECTED ANCHORAGES BREAK MOORINGS.
3	178-209	SOME STRUCTURAL DAMAGE TO SMALL RESIDENCES AND UTILITY BUILDINGS. MOBILE HOMES ARE DESTROYED. FLOODING NEAR THE COAST DESTROYS SMALLER STRUCTURES WITH LARGER STRUCTURES DAMAGED BY FLOATING DEBRIS. TERRAIN CONTINUOUSLY LOWER THAN 5 FEET ASL MAY BE FLOODED INLAND 8 MILES OR MORE.
4	210-249	SOME COMPLETE ROOF STRUCTURE FAILURE ON SMALL RESIDENCES. MAJOR EROSION OF BEACH. MAJOR DAMAGE TO LOWER FLOORS OF STRUCTURES NEAR THE SHORE. REQUIRING MASSIVE EVACUATION OF RESIDENTIAL AREAS INLAND AS FAR AS 6 MILES.
5	>249	COMPLETE ROOF FAILURE ON MANY BUILDINGS. SOME COMPLETE BUILDING FAILURES WITH SMALL UTILITY BUILDINGS BLOWN OVER OR AWAY. MASSIVE EVACUATION OF RESIDENTIAL AREAS ON LOW GROUND WITHIN 5 TO 10 MILES OF THE SHORELINE MAY BE REQUIRED.

Hurricanes are classified by their wind strength using the Saffir-Simpson Scale. A Category 1 hurricane is the weakest, while a Category 5 hurricane is strongest. Depending on local weather conditions and tidal patterns, even a Category 1 hurricane can cause serious damage. The most damaging aspect of a hurricane is storm surge. Hurricanes create a large dome of water that travels ashore when the hurricane strikes land. Storm surge can cause flooding and water damage to coastal areas. Take a moment to review the Saffir-Simpson Hurricane scale and the damage that each classification of hurricane can cause.

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