

# Severe Weather



# Thunderstorm

A thunderstorm (aka an *electrical storm*, a *lightning storm*, or a *thundershower*) is a type of storm characterized by the presence of **lightning** and its acoustic effect, **thunder**.

Thunderstorms result from the rapid upward movement of warm, moist air.

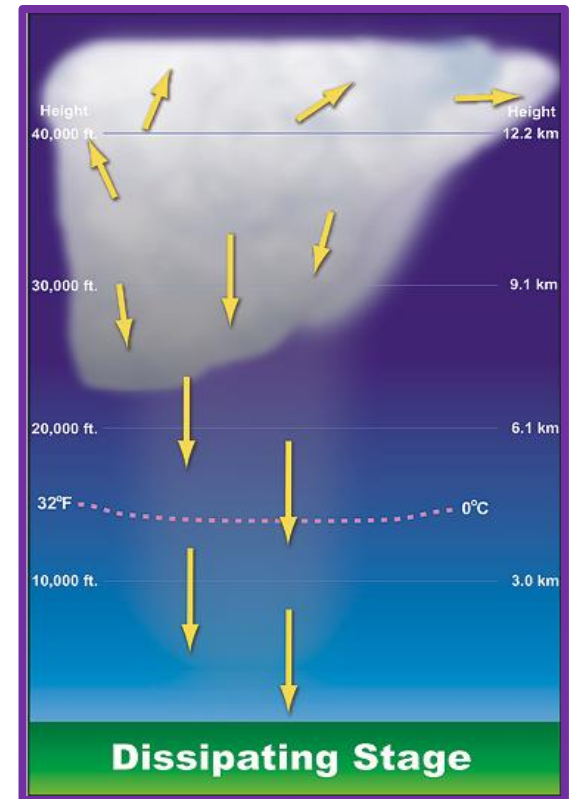
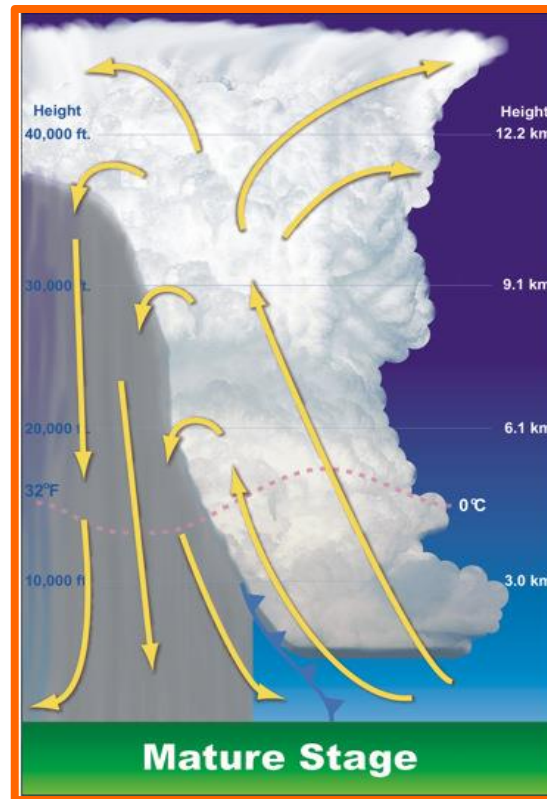
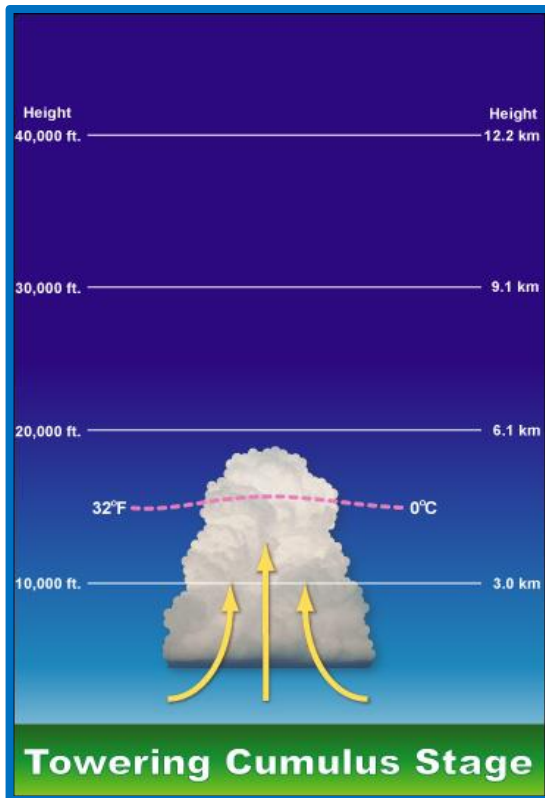


- In the Northern hemisphere, especially in North America, thunderstorms occur most often **between the months of March and September**.
- In a typical thunderstorm, approximately **500,000,000 kg** (~1.1 billion lb) of **water vapor** are **lifted** into the Earth's atmosphere.
- Thunderstorms have also been observed on **Jupiter** and **Venus**.

# Thunderstorm Lifecycle

All thunderstorms go through the following three stages:

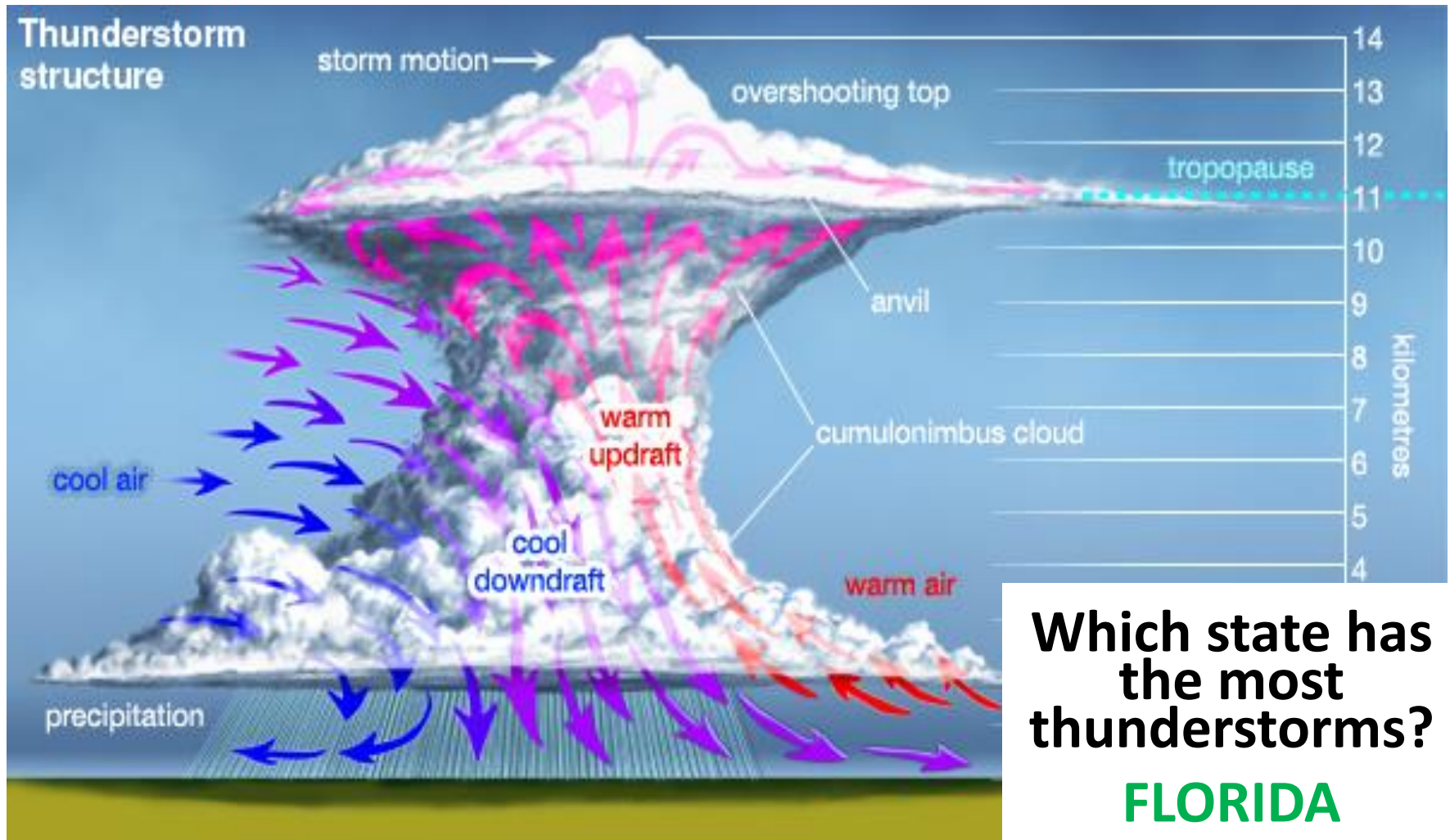
- **developing** stage aka **cumulus** stage
- **mature** stage
- **dissipation** stage



Depending on the atmospheric conditions, the **full cycle** takes an average of 30-60 minutes to go through.

# Thunderstorm Structure

The height of a thunderstorm is controlled/limited by the **depth of the troposphere** (the stratosphere above is too stable to support a thunderstorm); the average diameter is about 24 km (15 mi).



Which state has the most thunderstorms?

**FLORIDA**

# Mature Stage

Most mature thunderstorms are **so high** that **airplanes do not fly over them but instead fly around.**

- During mature stage, considerable **internal turbulence** can occur in the storm system, which manifests itself as *strong winds*, *severe lightning*, and even *tornadoes*.
- If there is sufficient wind shear, the downdraft will be separated from the updraft.
- Such storm may become a **supercell**, and its mature stage can sustain itself for several hours.



# Thunderstorm Hazards

Thunderstorms are responsible for the development and formation of many **severe weather phenomena**.

- Damage from an average thunderstorm is mainly due to:

- downburst **winds**
- large **hailstones**
- **flash flooding** caused by heavy precipitation.

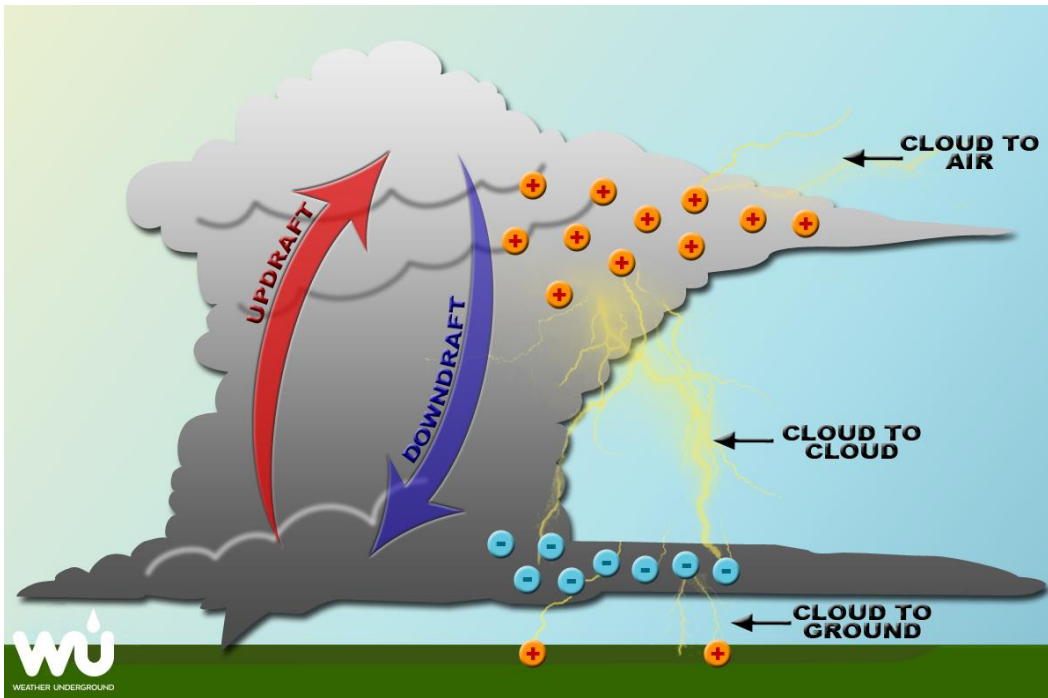
- Stronger thunderstorms are capable of producing **tornadoes** and **waterspouts**.



- Dry thunderstorms (with *no precipitation*) can cause **wildfires** with the heat generated from the **cloud-to-ground lightning**.
- A storm is considered **severe** if winds reach at least 93 km/h (58 mph), hail is 1 inch (25 mm) in diameter or larger, or if funnel clouds or tornadoes are reported.

# Lightning and Thunder

- **Lightning** occurs when an electrical charge is built up within a cloud, due to static electricity generated by super cooled (liquid below freezing temperature) water droplets colliding with ice crystals near the freezing level.
- The temperature of a lightning bolt can be **five times hotter than the surface of the Sun**.

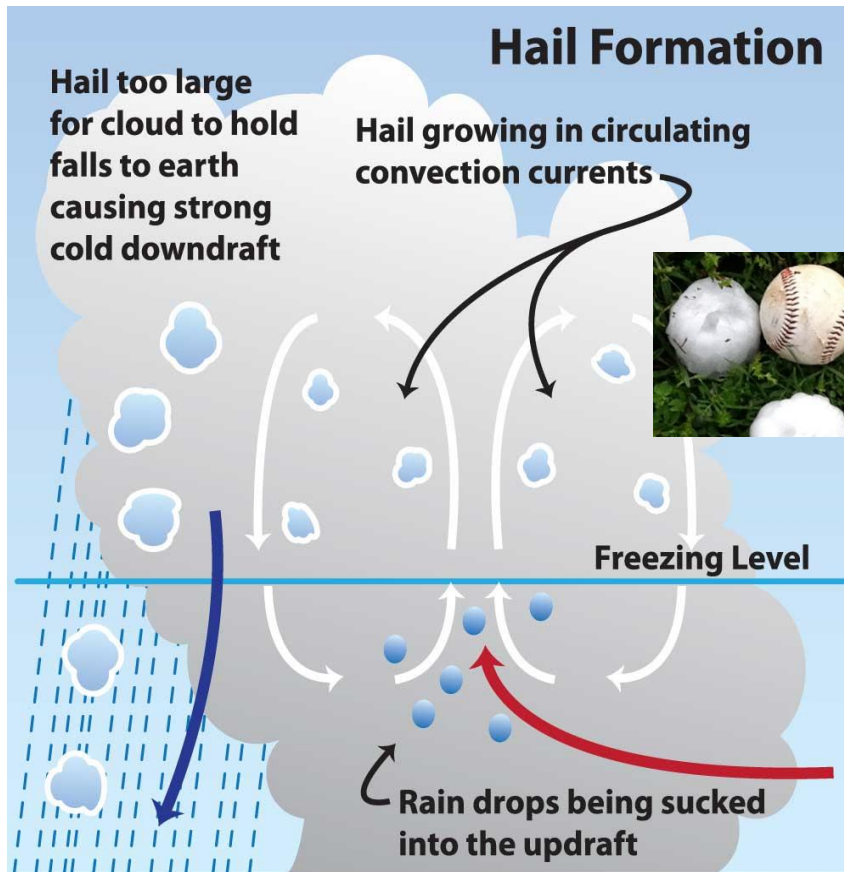


- The sudden increase in pressure and temperature from lightning produces rapid expansion of the air surrounding and within a bolt of lightning.
- In turn, this expansion of air creates a sonic shock wave, which produces the sound of **thunder**.

# Hail Formation

Hail consists of **balls or irregular lumps of ice**, called **hailstones**.

- Hailstones measure between 5 mm (0.2 in) and 15 cm (6 in) in diameter; largest can weigh more than 0.5 kg (1.1 lb).
- Hailstones generally fall at higher speeds as they grow in size.



In North America, hail is most common in the area where Colorado, Nebraska, and Wyoming meet, known as **“Hail Alley”**.



# Tornado

A tornado (aka twister) is a **violently rotating column of air** (*wind vortex*) that is in contact with both the Earth surface and a cumulonimbus cloud or, in rare cases, the base of a cumulus cloud.



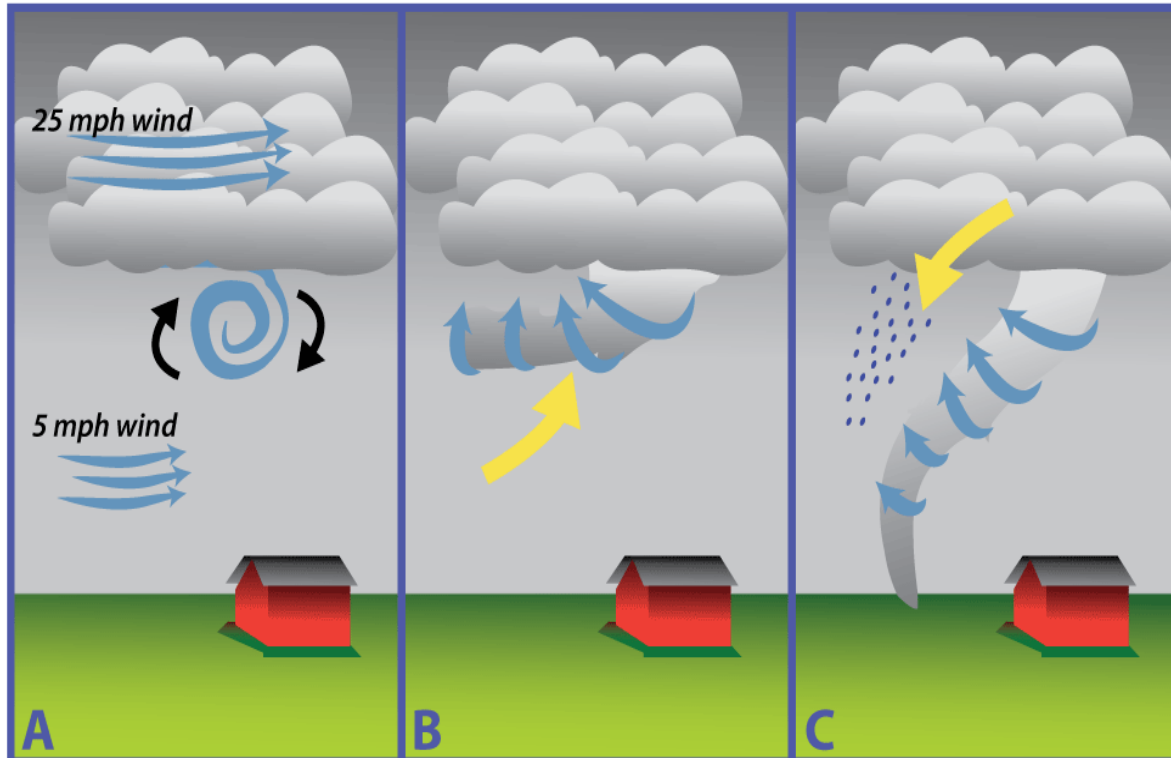
A tornado is **usually, but not necessarily, visible** (*funnel cloud*): condensation is due to intense low pressure caused by the high wind speeds and rapid rotation.

# Tornado Formation

Tornadoes form from thunderstorms which contain one or more updrafts (upward moving air which is warm and moist):

A. Rising **updrafts begin to rotate** as wind speed changes with direction and height in the thunderstorm...

...at some point this **rotation becomes very intense.**



B. A rotating wall cloud descends from the thunderstorm eventually forming a **vortex** known as a funnel.

C. Steered by the cold downdraft, funnel then extends downward to the ground.

**Possibly the first ever tornado photograph...**



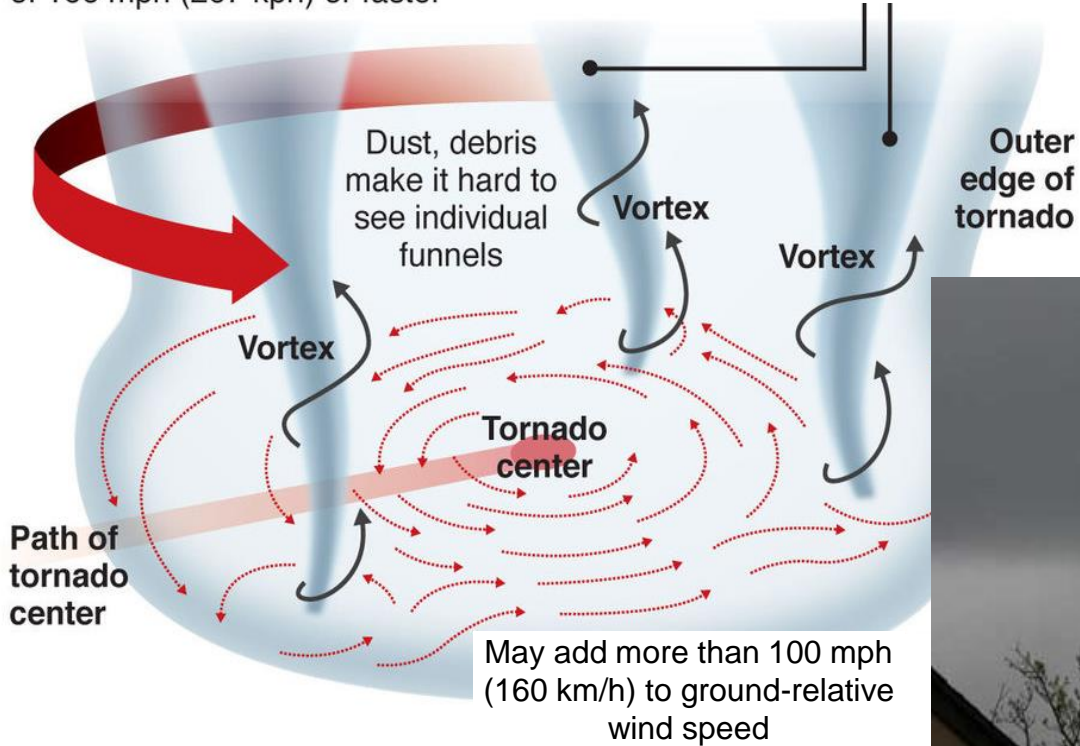
**...was taken on August 28, 1884**

# Multiple-Vortex Tornado

A multiple-vortex tornado is a type of tornado in which **two or more columns of spinning air rotate around a common center.**

Most common in tornados with wind speeds of 166 mph (267 kph) or faster

Individual vortices usually last less than one minutes each



**A multi-vortex structure can occur in almost any circulation...**



**...but is very often observed in intense tornadoes.**

# Tornado Facts

- Tornadoes can occur almost **anywhere in the world**.
- Most form during the months of **April and May**.
- 99% of all tornadoes in **Northern Hemisphere** rotate **counterclockwise**.
- Duration: **a few minutes**.
- Average diameter 250 feet (80 m), average travel length 4 miles (6 km).
- Funnel can travel with speeds ranging from zero up to ~70 mph, ~30 mph on average.
- Wind speeds within vortex are *usually* less than 110 mph (180 km/h).
- The **most extreme tornadoes**: wind speeds of more than **300 mph (480 km/h)**, stretch more than **2 miles (3 km) across**, and stay on the ground for dozens of miles (more than 100 km).
- Which state has highest frequency of tornadoes?



**TEXAS!**