

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.

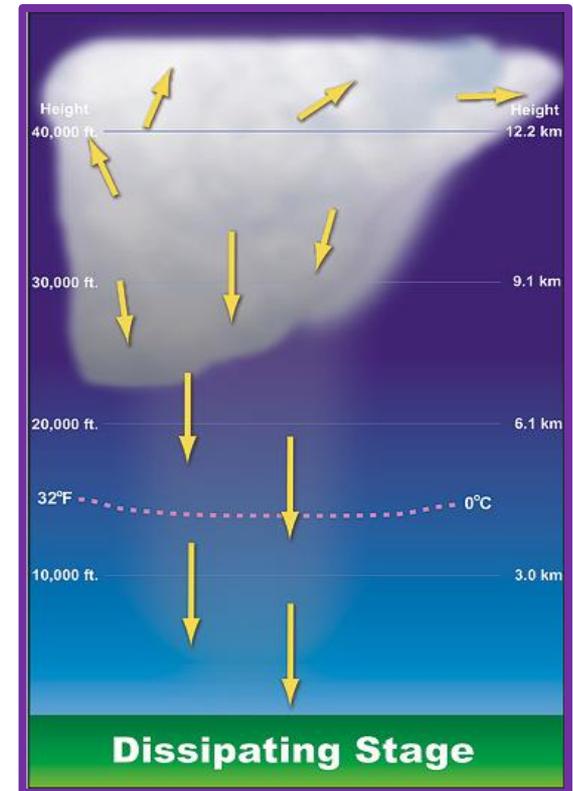
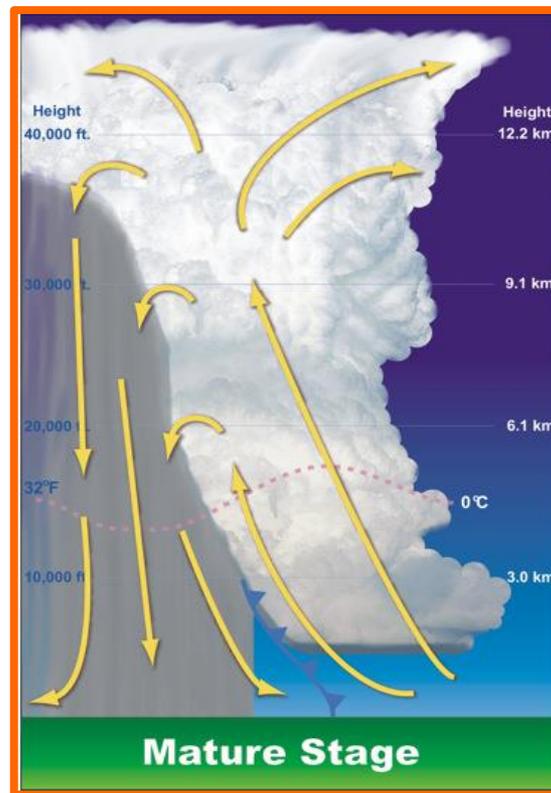
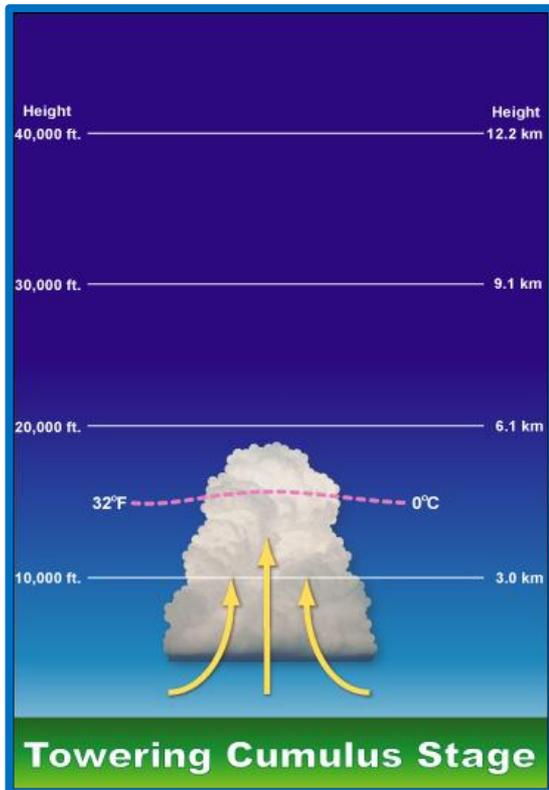


- In the Northern hemisphere, especially in North America, thunderstorms occur most often **between the months of March and September**.
- In a typical thunderstorm, approximately **500,000,000 kg** (~1.1 billion lb) of **water vapor** are **lifted** into the Earth's atmosphere.
- Thunderstorms have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

Thunderstorm Lifecycle

All thunderstorms go through the following three stages:

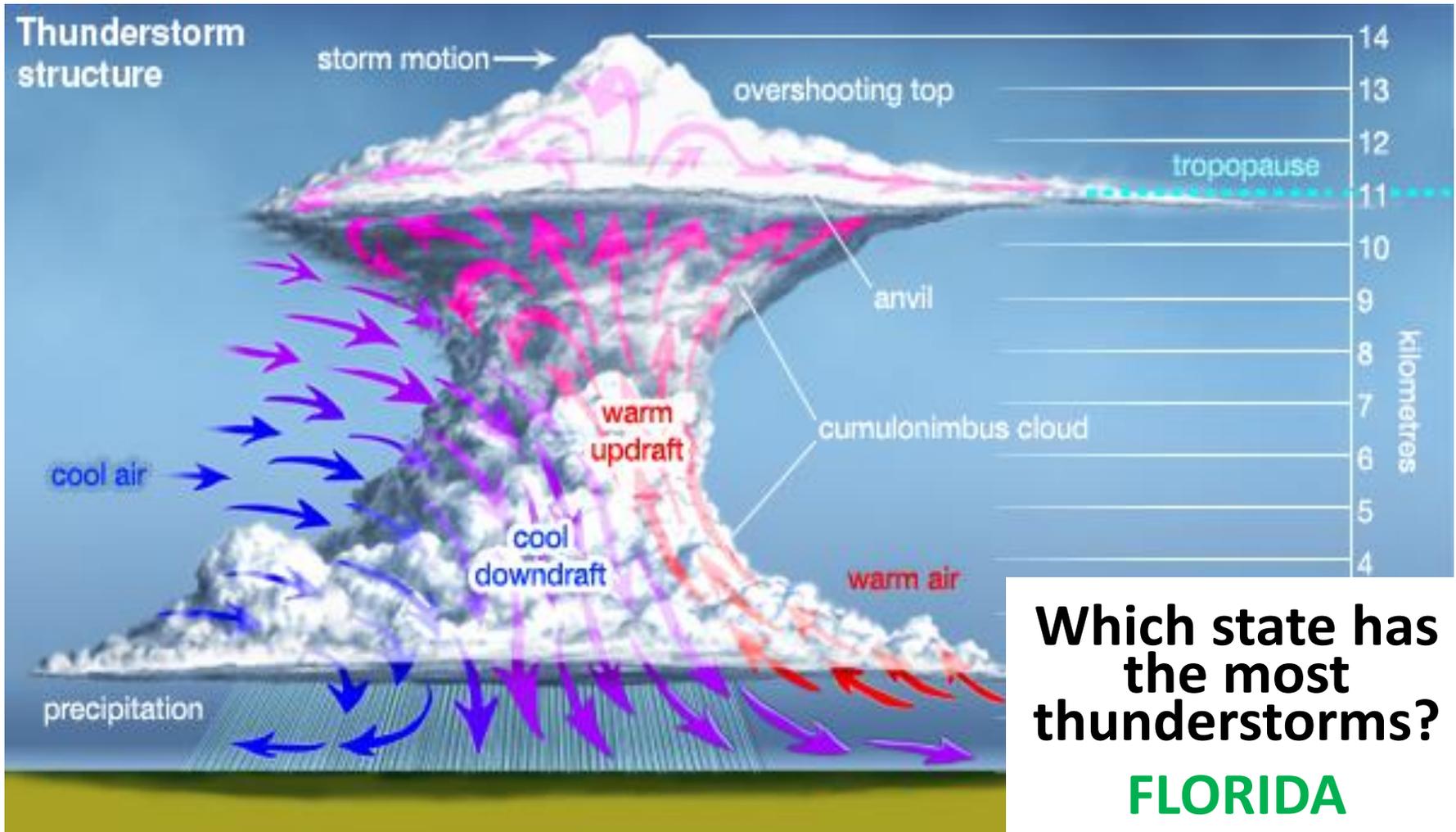
- **developing** stage aka **cumulus** stage
- **mature** stage
- **dissipation** stage



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.

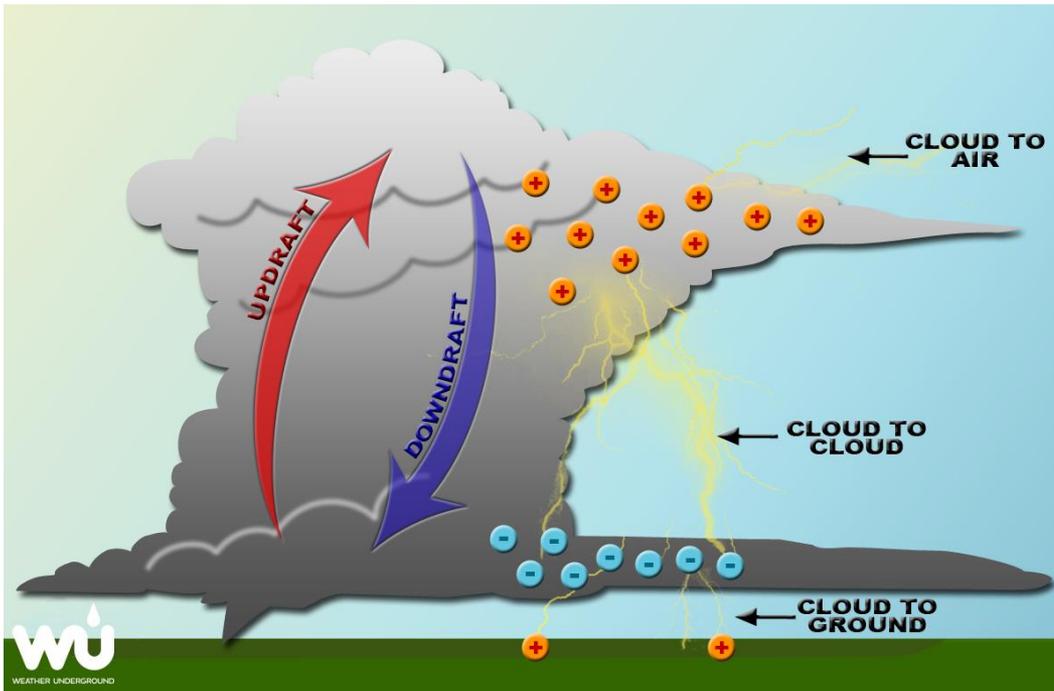
- Stronger thunderstorms are capable of producing **tornadoes** and **waterspouts**.



- 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**.

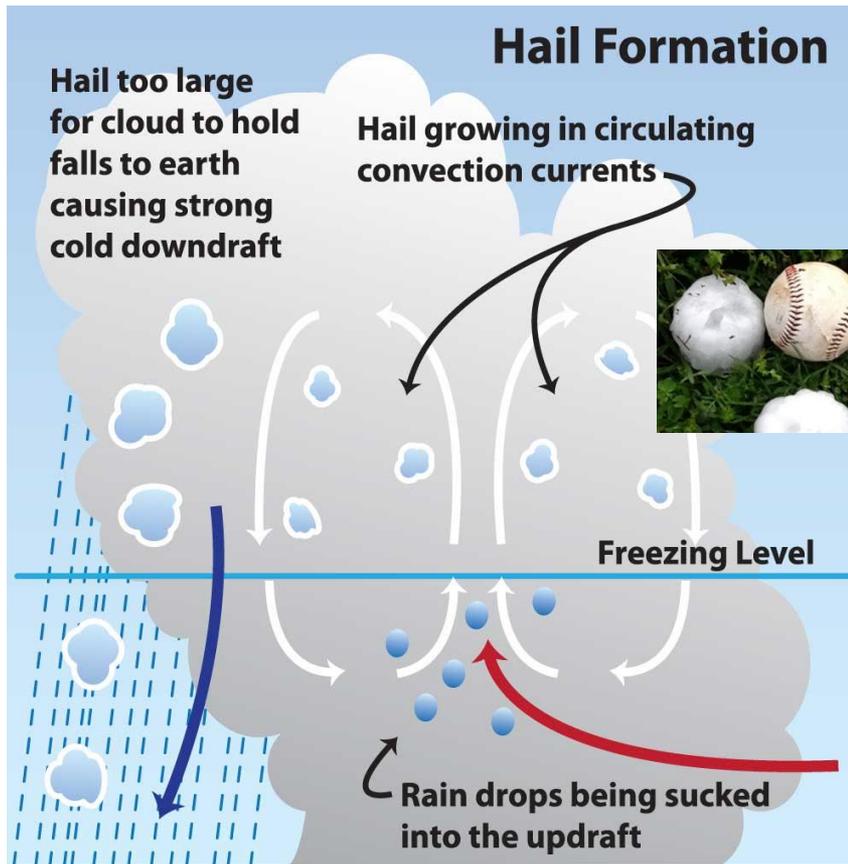


- The sudden increase in pressure and temperature from lightning produces rapid expansion of the air surrounding and within a bolt of lightning.
- In turn, this expansion of air creates a sonic shock wave, which produces the sound of **thunder**.

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.



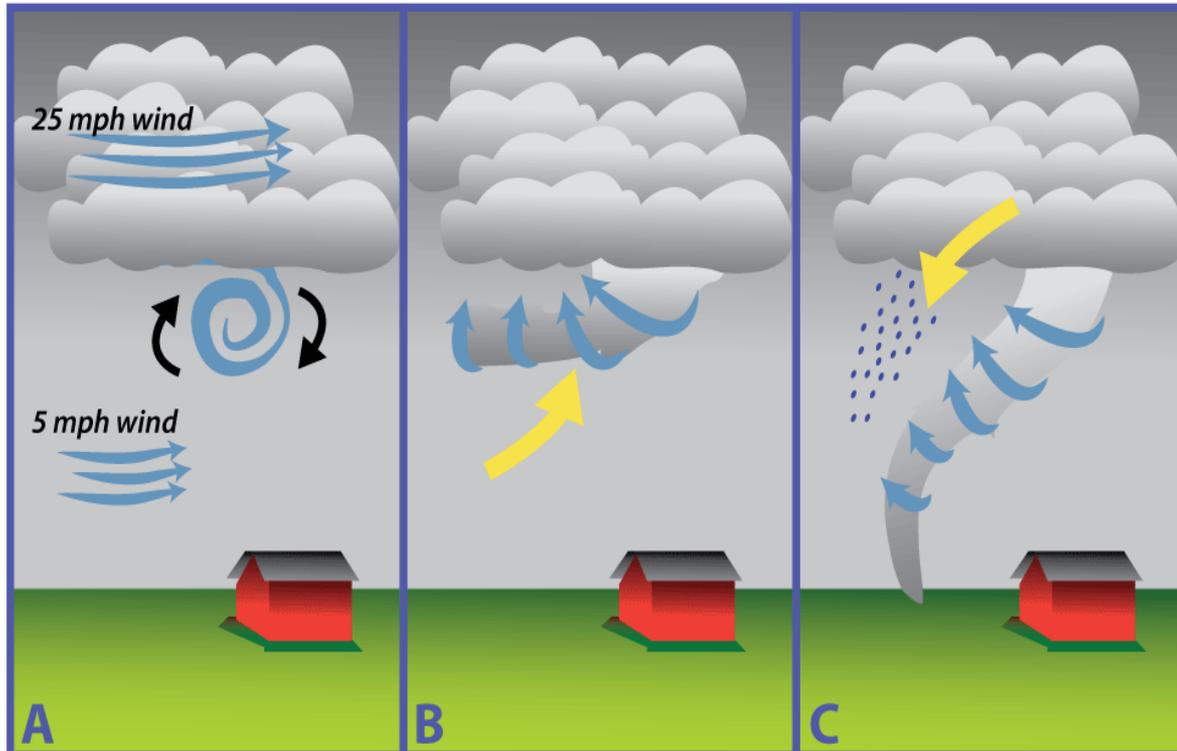
A tornado is **usually, but not necessarily, visible** (*funnel cloud*): condensation is due to intense low pressure caused by the high wind speeds and rapid rotation.

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...



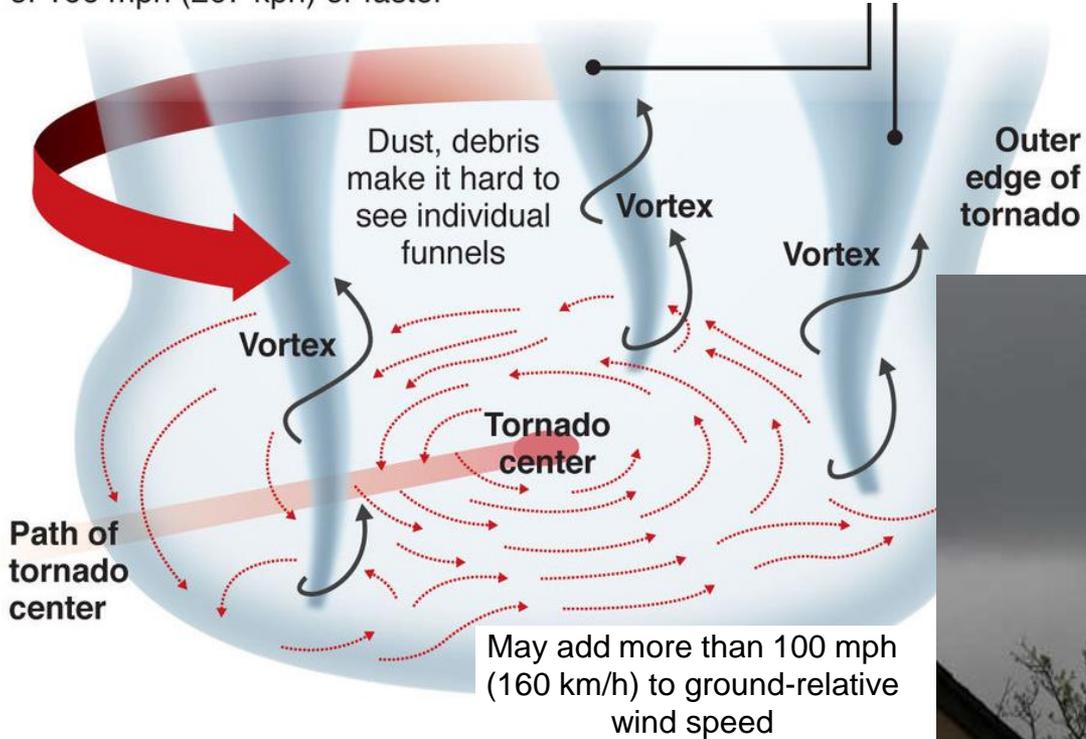
...was taken on August 28, 1884

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!