

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.



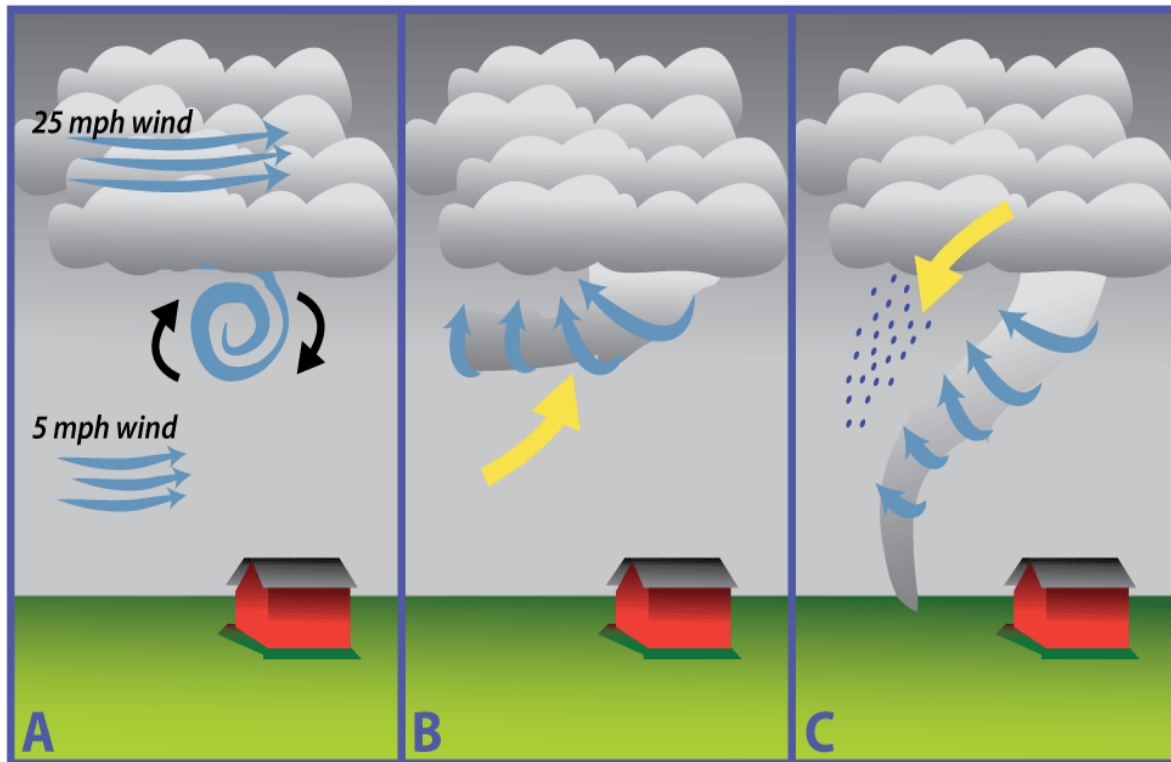
A tornado is **usually, but not necessarily, visible** (*funnel cloud*): condensation is due to intense low pressure caused by the high wind speeds and rapid rotation.

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.

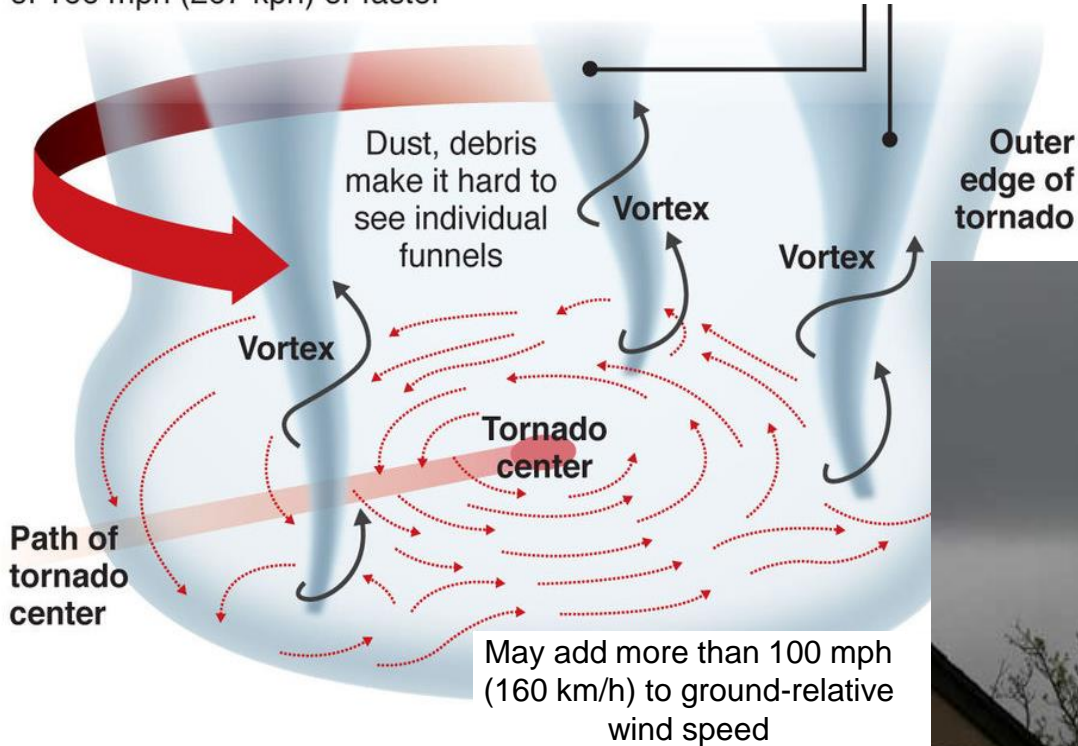
C. Steered by the cold downdraft, funnel then extends downward to the ground.

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.**

Waterspout

A waterspout is an intense vortex, usually appearing as a funnel-shaped cloud, that **occurs over a body of water**.



Frequently seen in tropical and sub-tropical climates, they occur most commonly in the Florida Keys (up to 400 per year!) and in the northern Adriatic Sea.

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: most tornadoes last **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?

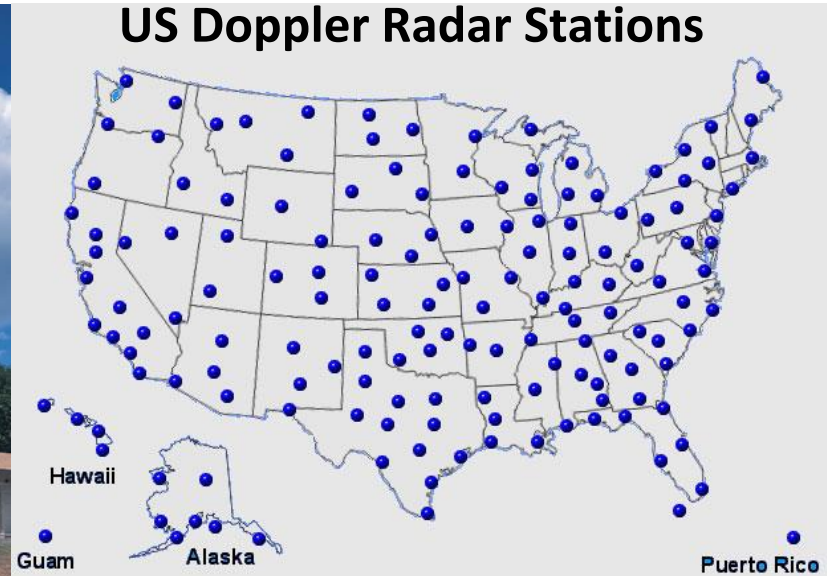


TEXAS!

Measuring Tornado Wind Speed

Direct measurement of the most violent tornado wind speeds is **nearly impossible**: conventional **anemometers** **would be destroyed** by the intense winds and flying debris.

- Most developed countries have a **network of weather radars**: these devices can **spot evidence of rotation in storms** from more than a hundred miles (160 km) away.









- The **highest wind speed ever measured in a tornado**, which is also the highest wind speed ever recorded on the planet, is **301 ± 20 mph** (484 ± 32 km/h) in the infamous 1999 Bridge Creek-Moore, Oklahoma twister which killed 36 people.

Tornado Classification

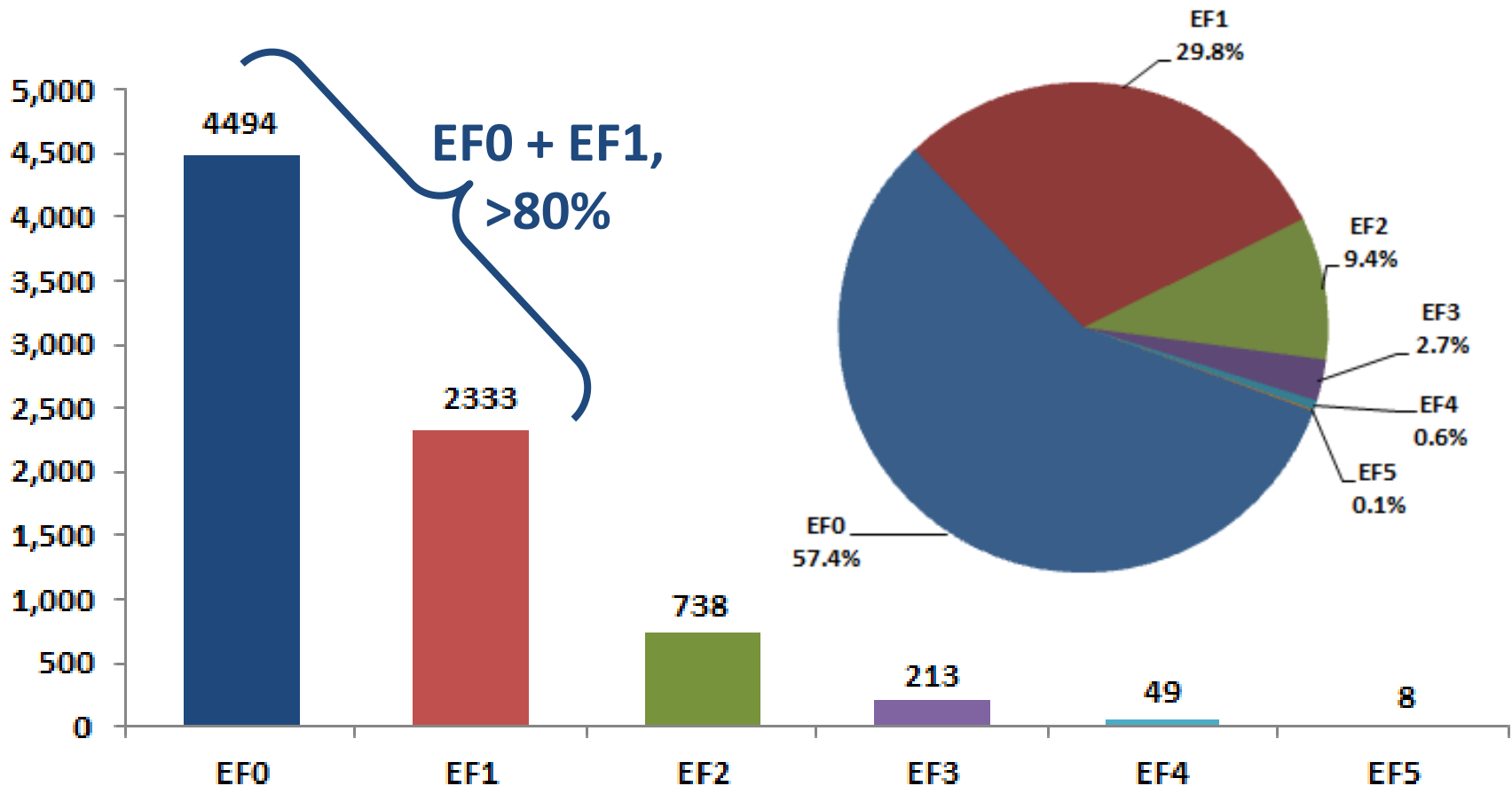
Tornadoes are classified into 6 categories **F0** – **F5** using the (Enhanced) Fujita scale.

- In rating tornadoes, only surface wind speeds, or the wind speeds indicated by the damage resulting from the tornado, are taken into account.
- Rating is based on the **amount of damage**, ranging from “**weak**” **F0** to “**violent**” **F5**.
- Outside Tornado Alley, and North America in general, **violent tornadoes are extremely rare**.

	Damage: Incredible	EF5
	Windspeeds: Greater than 322km/h (200mph)	
	Damage: Devastating	EF4
	Windspeeds: 267-322km/h (166-200mph)	
	Damage: Severe	EF3
	Windspeeds: 218-266km/h (136-165mph)	
	Damage: Considerable	EF2
	Windspeeds: 178-217km/h (111-135mph)	
	Damage: Moderate	EF1
	Windspeeds: 138-177km/h (86-110 mph)	
	Damage: Light	EF0
	Windspeeds: 105-137km/h (65-85mph)	

US Tornado Frequency

Number of Reported U.S. Tornadoes by EF Rating for the time period between 2/2007 and 12/2012



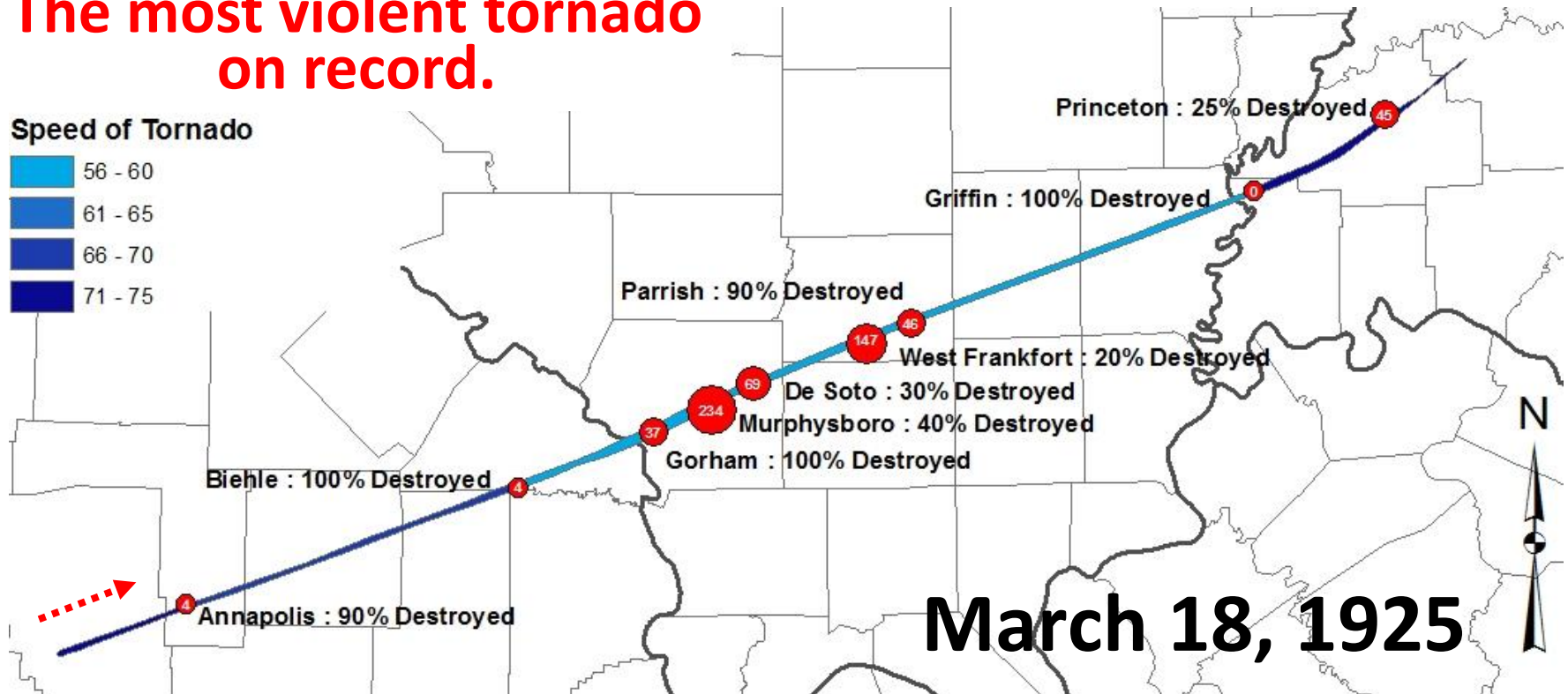
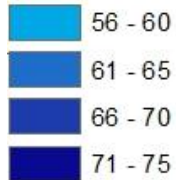
Tri-State Tornado



- Formed in **Missouri** and traveled **219 miles (352 km)** across **Illinois** into **Indiana**.
- It lasted **~3.5 hours** and **killed 695 people**.
- The funnel was up to **0.75 miles across** and traveled as fast as **73 mph (117 km/h)**.

The most violent tornado on record.

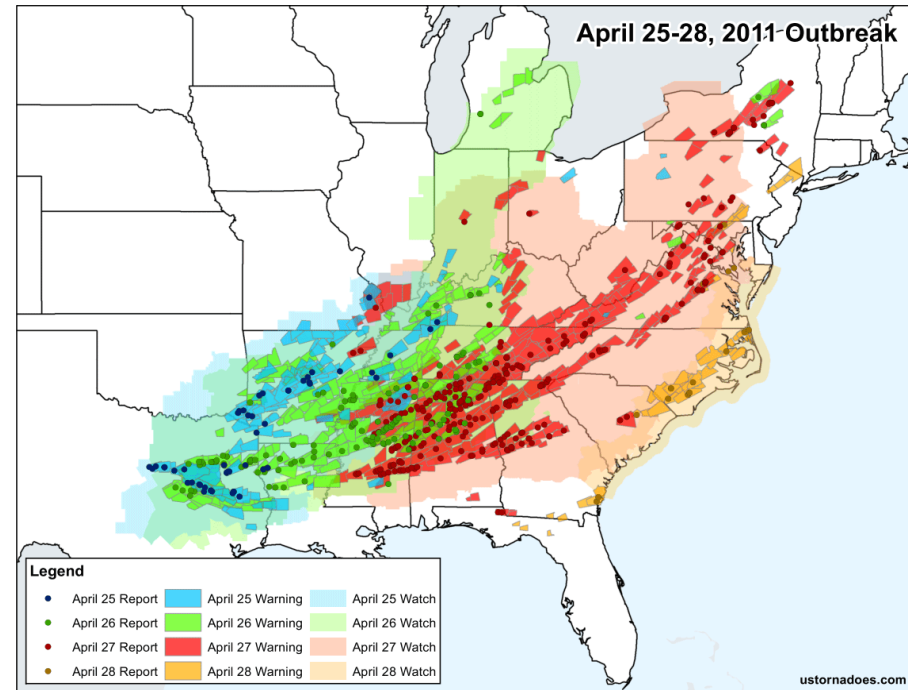
Speed of Tornado



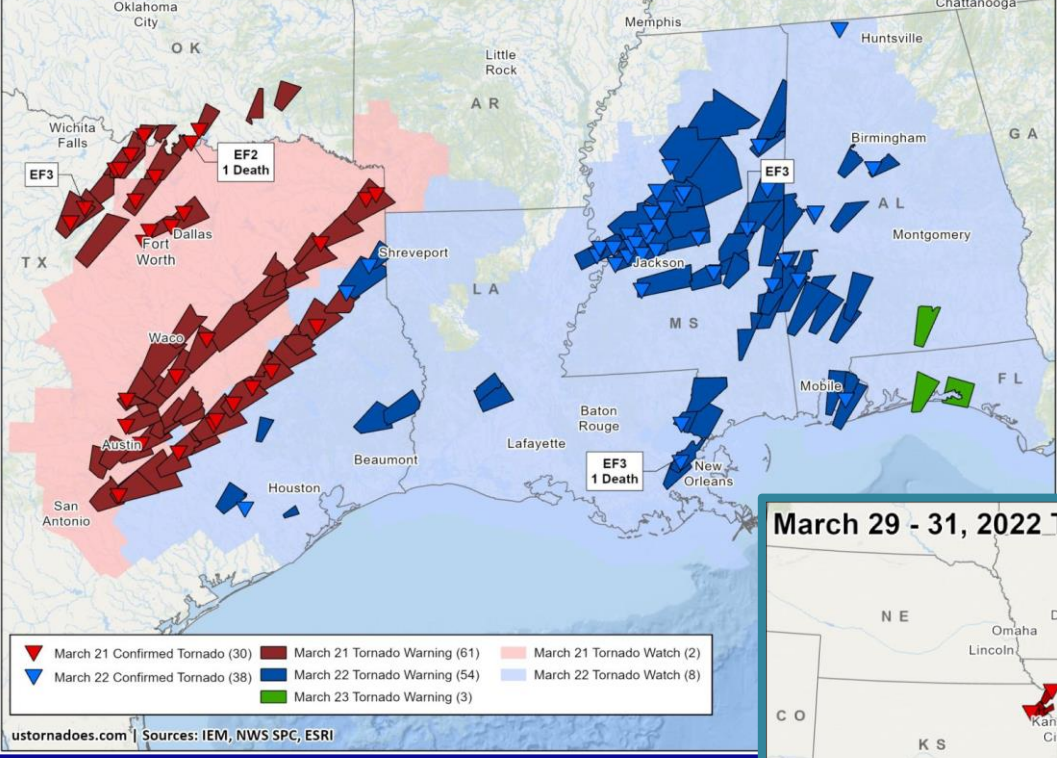
2011 Tornado Outbreak

The **largest, costliest** and **one of the deadliest** tornado outbreaks ever recorded occurred between **April 25–28, 2011** affecting the Southern, Midwestern, and Northeastern United States and even southern Canada.

- Originating from a huge frontal storm system, roughly **90% of the supercell thunderstorms that day produced tornadoes** (“normal” rate is about 25%).
- **355 tornadoes** were confirmed (**37** of them **rated EF3 or higher**).
- April 27, the most active day: record of **211 tornadoes** (four rated EF5).
- **324 deaths** across six states.
- One of the costliest natural disasters in United States history, with total damages of approximately **\$11 billion**.



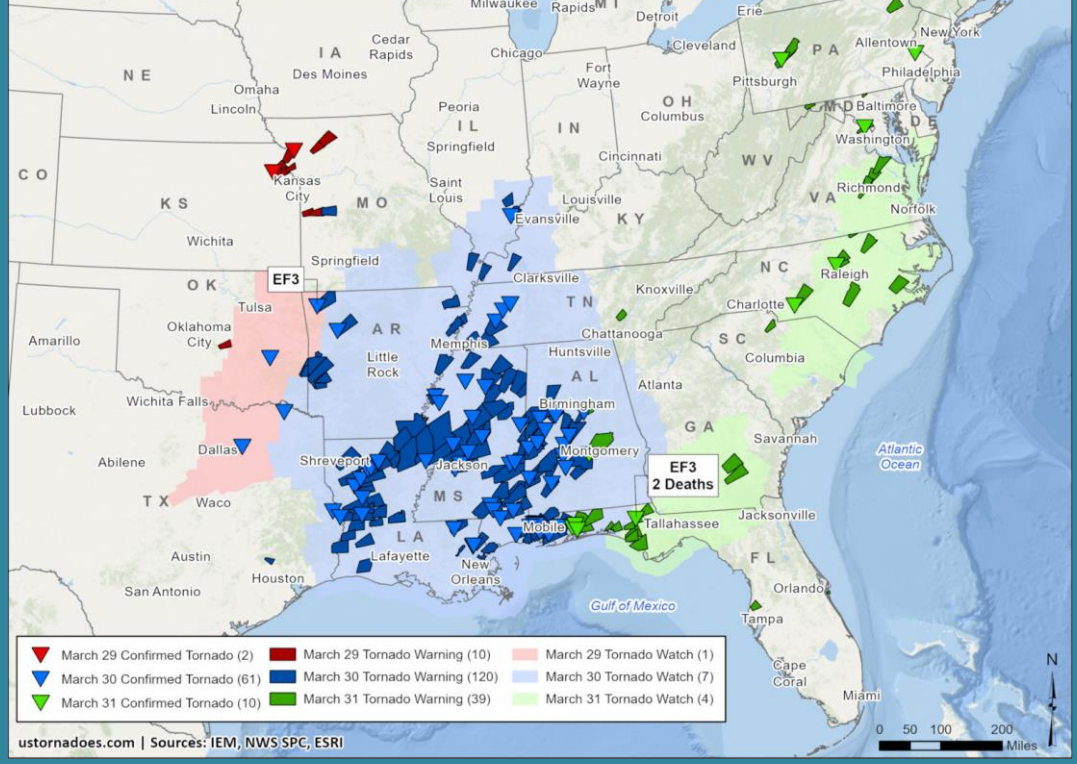
March 21 - 23, 2022 Tornadoes



March 2022

a record March for tornado numbers

March 29 - 31, 2022 Tornadoes



79 tornadoes including 3 EF3

90 tornadoes including 3 EF3