

# 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.



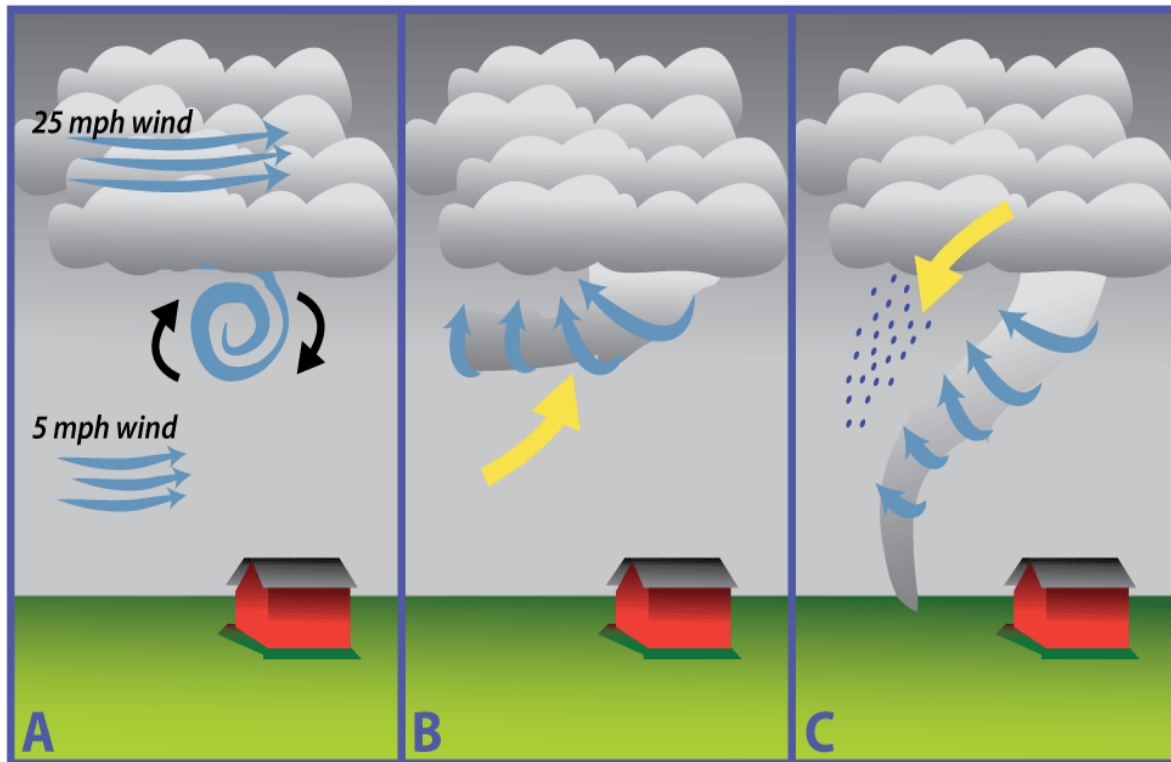
A tornado is **usually, but not necessarily, visible** (*funnel cloud*): condensation is due to intense low pressure caused by the high wind speeds and rapid rotation.

# 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.

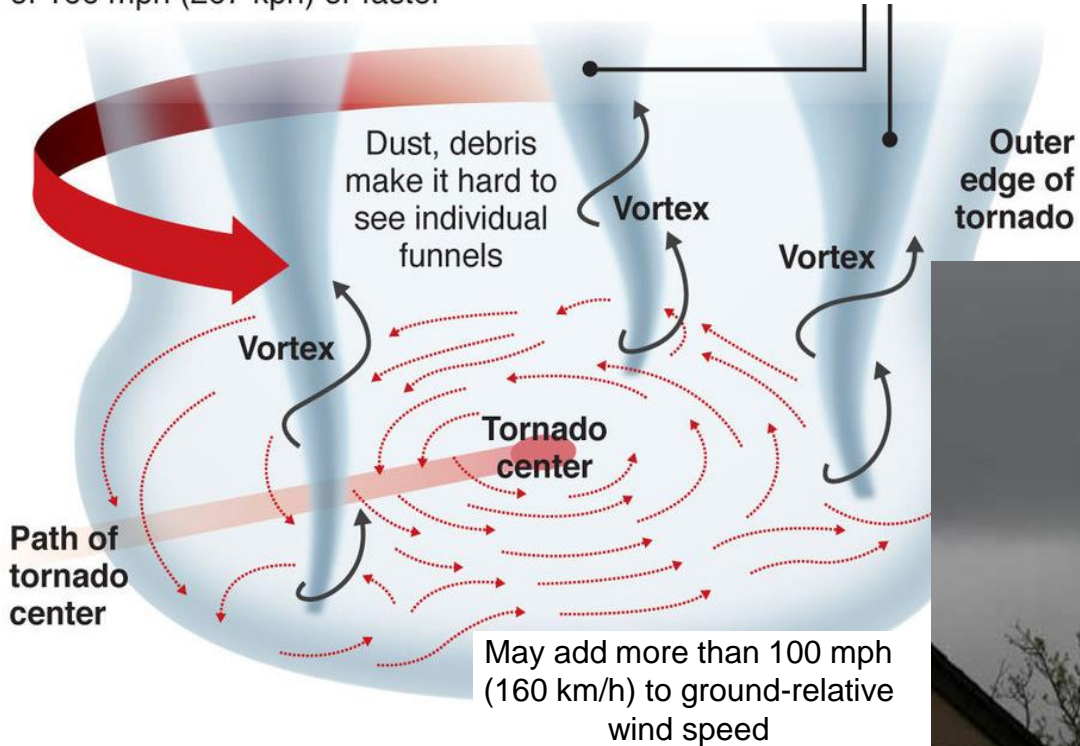
C. Steered by the cold downdraft, funnel then extends downward to the ground.

# 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 tornados.**

# 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?

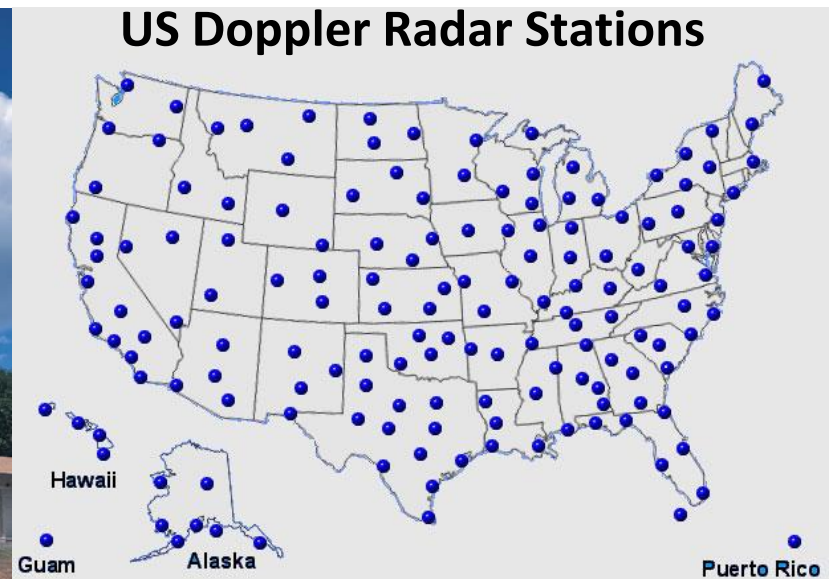


**TEXAS!**

# 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

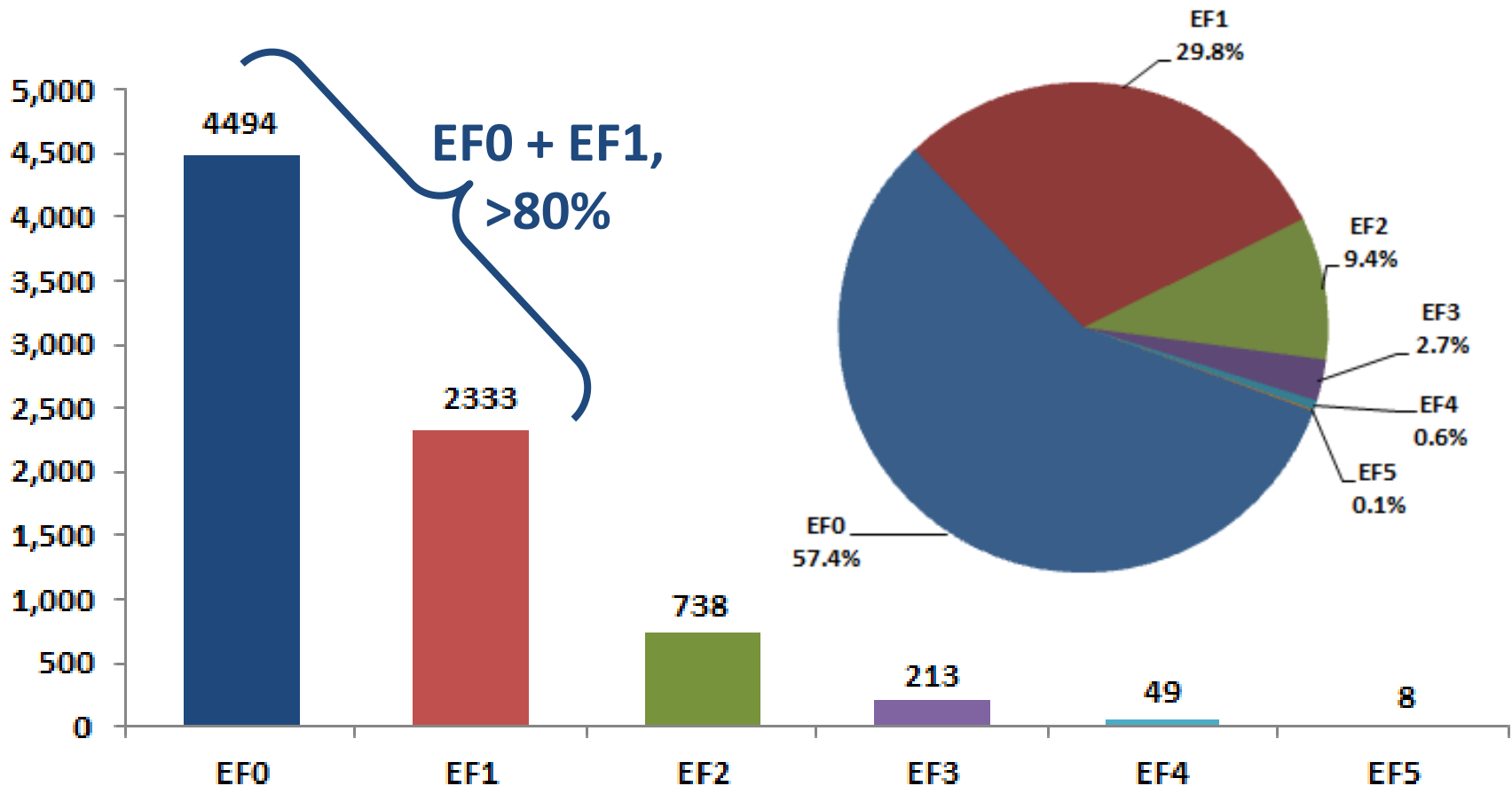
Tornadoes are classified into 6 categories **F0** – **F5** using the (Enhanced) Fujita scale.

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





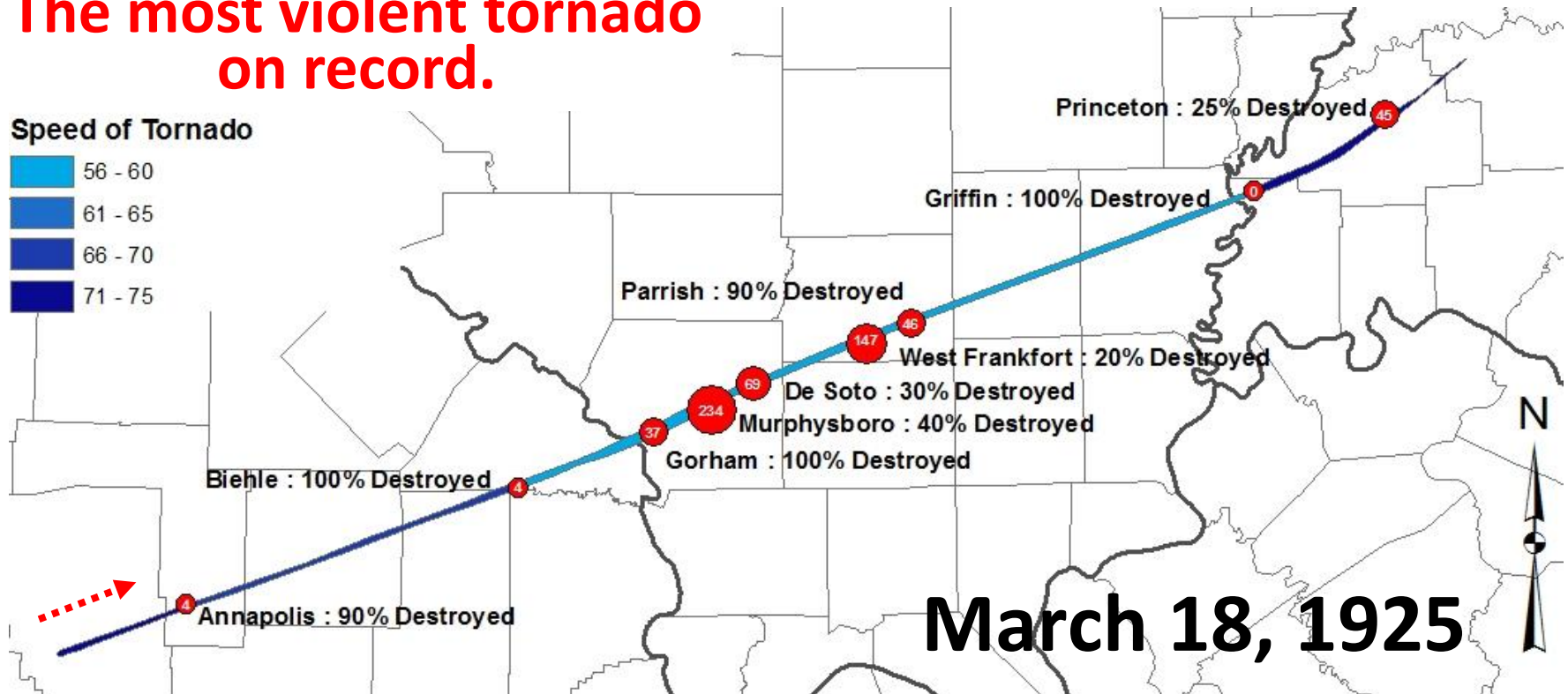
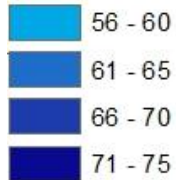
# Tri-State Tornado



- 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.**

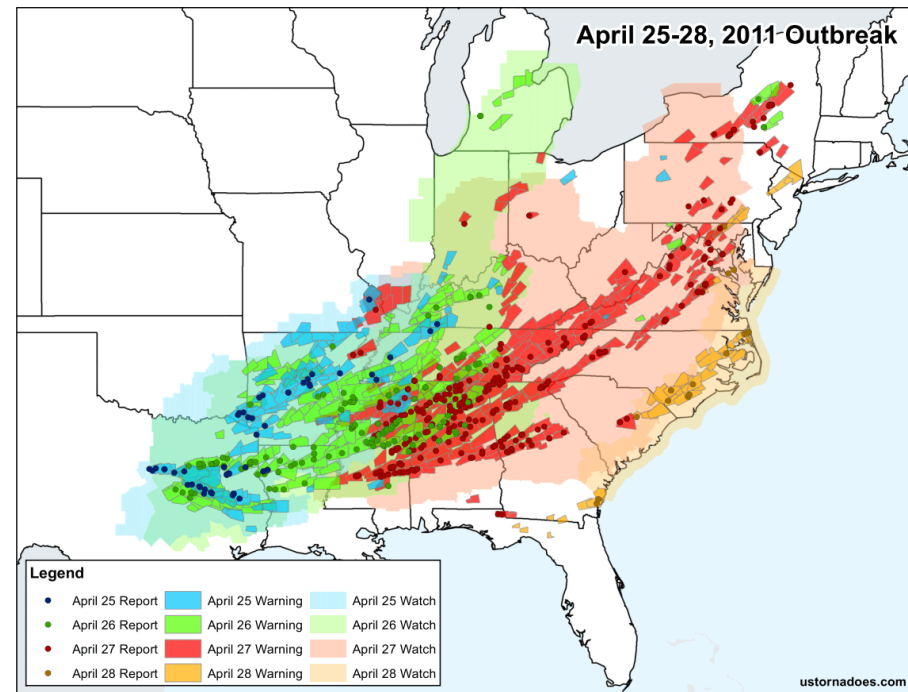
## Speed of Tornado



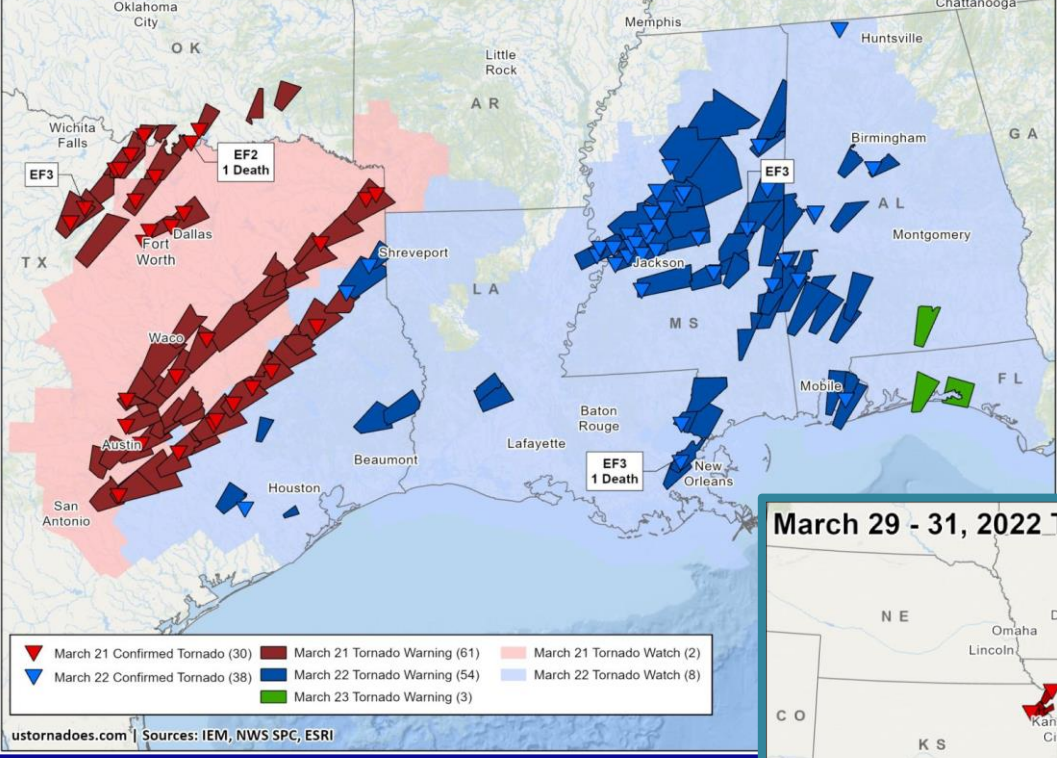
# 2011 Tornado Outbreak

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**.



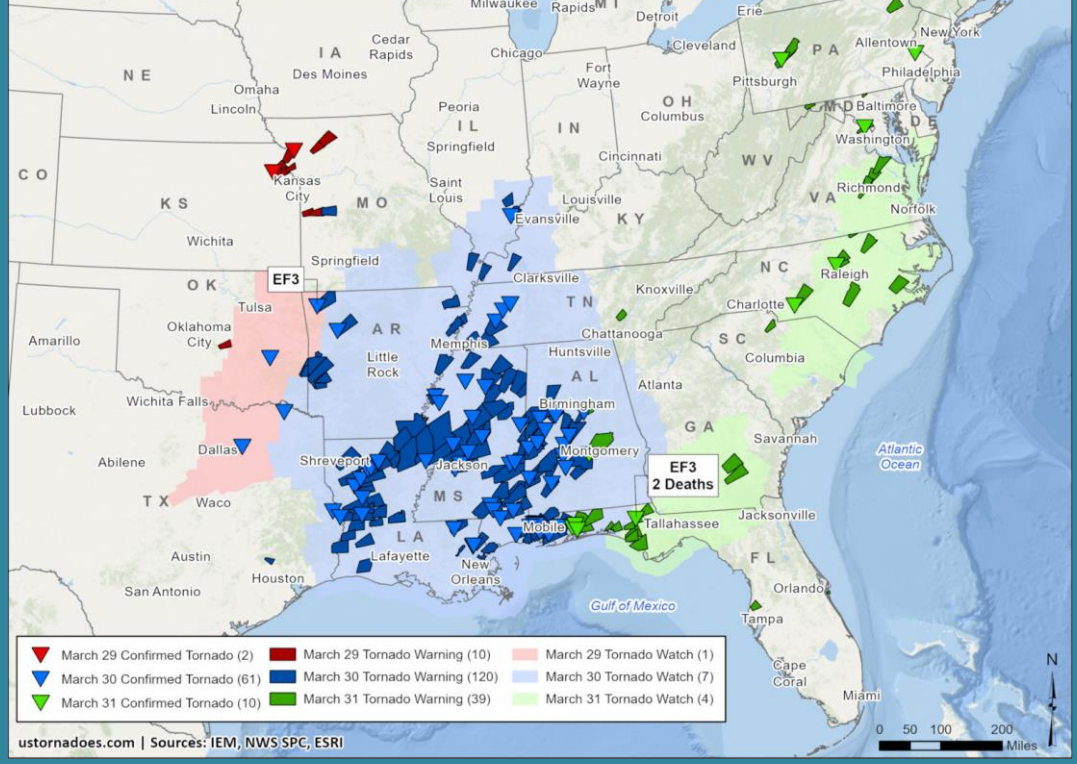
### March 21 - 23, 2022 Tornadoes



# March 2022

a record March for tornado numbers

### March 29 - 31, 2022 Tornadoes



79 tornadoes including 3 EF3

90 tornadoes including 3 EF3