

Natural Disasters

Lecture 8

Ch 10 –Tornadoes, Lightning, Heat, and Cold

Text Source Today:

Chapter 10 (p. 264-274)

10.3: Ch. 10 – Tornadoes, Lightning, Heat, and Cold

♦ **Tornadoes:** are rapidly **rotating columns of air** which extend downward from the base of a **thunderstorm**. Almost always smaller than 1 km (0.6 mi) in diameter, tornadoes can cause massive damage due to winds of up to **500 km/hr (300 mph)**! Most common in **spring and early summer**.

♦ **“Tornado Alley”:**

Tornadoes are most prevalent in the **central Plains of the U.S.**, as the necessary ingredients for deep convection are most often met in that region.

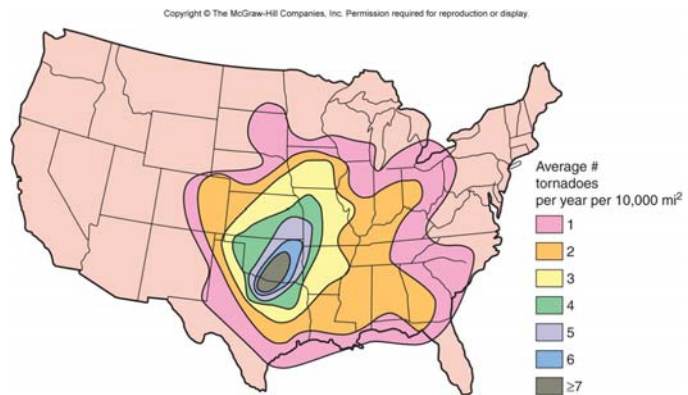
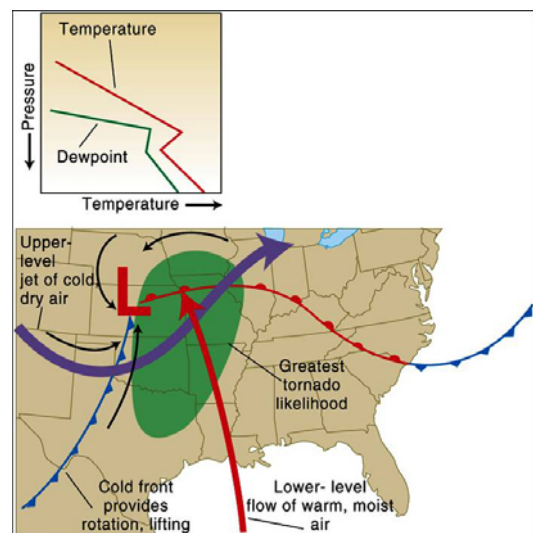


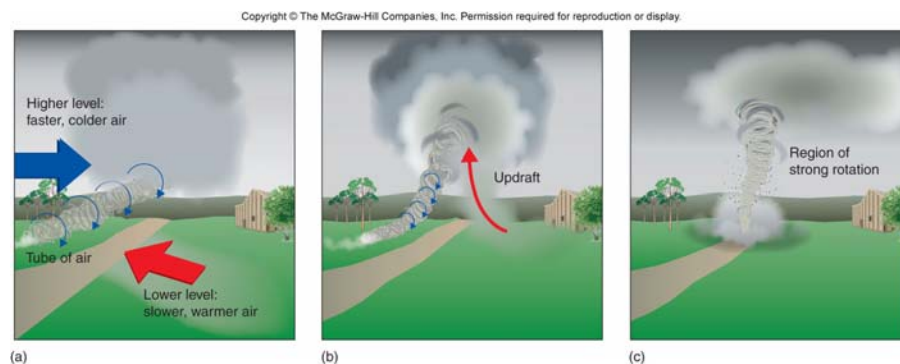
Fig. 10.28

● Though most prevalent over the U.S., tornadoes form in **Europe, Australia, Argentina, China and Bangladesh**, and other regions of Earth that experience **severe thunderstorms**.

♦ Tornadoes most often form within a **supercell**. Thus, the best conditions for tornado development are basically the same as those for an intense **supercell**: a low-level jet flow of **warm, moist air**, an upper-level jet flow of **colder, dry air** to create instability, and a triggering mechanism (**warm or cold front, dry line, etc.**) to get the warm air to rise. About **98%** of all tornadoes spin cyclonically.



♦ Tornadoes usually form in the **late afternoon and early evening**, again similar to **supercells**, at the time of max heating. A tornado actually forms within a **mesocyclone** in the larger convective cell. The **mesocyclone** forms from the combination of low-level **rotation** about a horizontal axis and an **intense updraft**. With time, the **rotation tilts upward** into the vertical, imparting rotation to the **intense updraft**. Scientists are still not certain why some **mesocyclones** develop tornadoes while others do not.



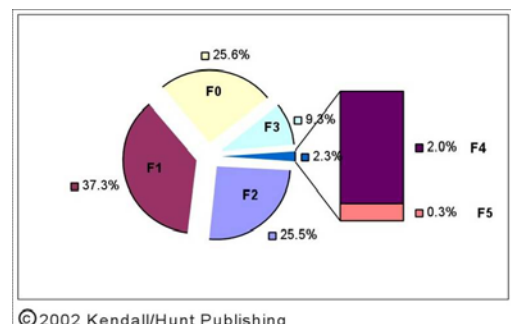
● Fig. 10.26 (above) from the text details an alternate hypothesis of a three-stage sequence of how some tornadoes may form.

♦ Tornadoes are rated by their maximum damage and **wind speed**. The **Fujita Scale** (and updated **Enhanced Fujita Scale**) are shown in Table 11.6 below. Extreme tornadoes (**EF4, EF5**) are fairly **rare**, only occurring on average **once or twice a year**. The U.S. averages around **1200** tornadoes per year.

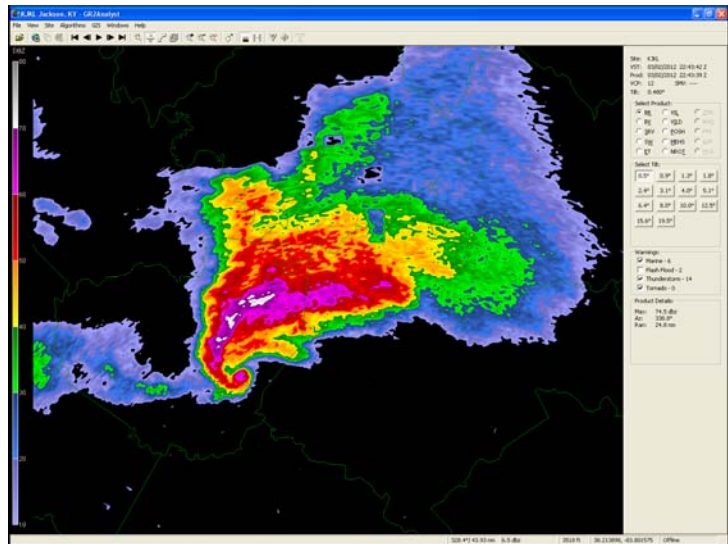
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TABLE 10.2
Fujita Wind Damage Scales

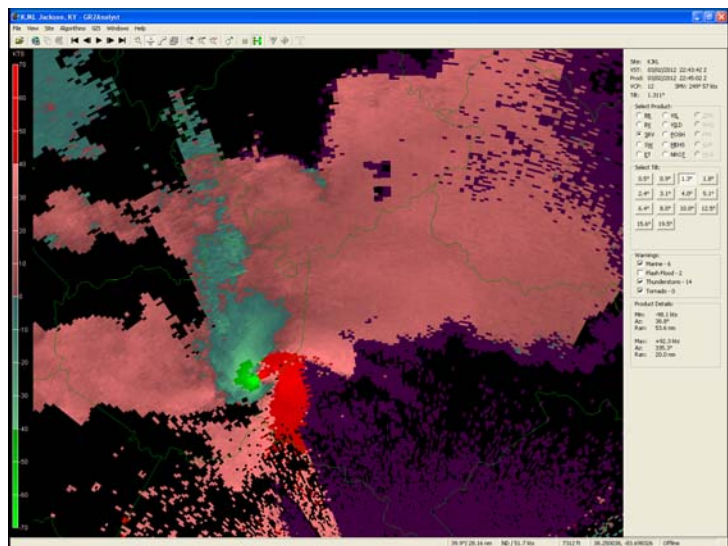
Fujita Scale	mph	(m/sec)	Enhanced Fujita Scale	mph	(m/sec)
F0	Under 72	(32)	EF0	65–85	(29–38)
Little damage			EF1	86–110	(38–49)
F1	73–112	(33–50)	EF2	111–135	(50–60)
Roof damage			EF3	136–165	(61–74)
F2	113–157	(51–70)	EF4	166–200	(74–89)
Roof gone			EF5	Over 200	(89+)
F3	158–206	(71–92)			
Wall collapse					
F4	207–260	(93–116)			
House blown down					
F5	261–318	(117–142)			
House blown away					



♦ The signature of a tornado/mesocyclone can be picked up on radar. A **hook echo** often appears in the **reflectivity** (top image at right) when a mesocyclone forms. Large precipitation particles do not have time to form within the strong updraft at the core of the mesocyclone, so the mesocyclone appears as a relative **minimum** in the **reflectivity**, creating the **hook shape**.



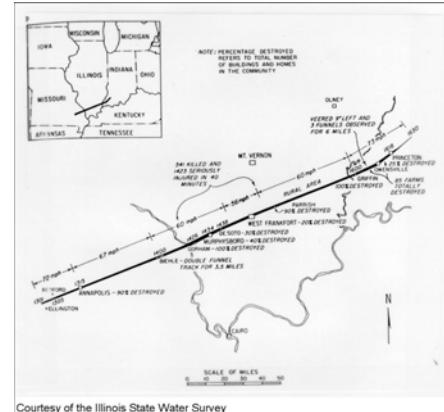
♦ The intense rotation of a mesocyclone/ tornado can also be found using **radial velocity** (bottom image at right), as a region of **intense winds moving toward** the radar (**green colors**) adjacent to a region of strong winds moving away from the radar (**red colors**).



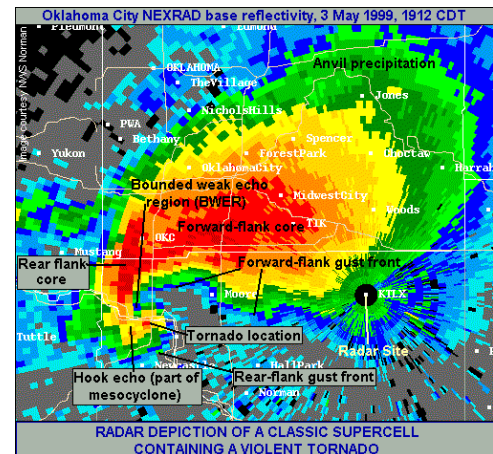
● Most tornadoes track from **southwest to northeast**, dragged along in the direction of the **supercell**, which is itself “steered” by the winds in the **middle troposphere (~500 mb)**, not by the polar jet stream as stated in the text (p. 313). However, steering-level winds can push supercells in any direction.

♦ **Tri-State Tornado, 1925:**

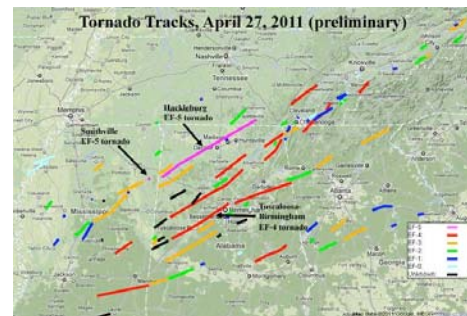
a bit before 1 PM on 18 March, a huge tornado touched down near Annapolis, MO and tracked across southern IL & IN, making this **longest tornado track** in recorded history. It traveled **353 km** (nearly **220 miles**) and was over **1.6 km** (**>1 mile**) in diameter for much of its lifetime. This tornado lasted **3.5 hours**, devastated 23 cities, and killed 689 people.



♦ **Moore, OK, 1999:** shortly after 7:12 PM on 3 May, the **strongest tornado** ever recorded passed through Moore, OK (a suburb of Oklahoma City). Winds in that tornado were recorded at **318 mph** using Doppler radial velocity. Damage from the Moore tornado was **catastrophic** – as we'll see in an upcoming video.



♦ **Super Outbreak, 2011:** on 25-28 April, a total of **358** tornadoes killed 348 people and over \$11 billion in damage! The **most tornadoes in a 24 hour** period for the U.S. occurred on the 27th, when **205** tornadoes were confirmed, of which 4 of the tornadoes were rated **EF5**.



♦ **Joplin, MO, 2011:** on 22 May, the costliest single tornado in U.S. history (~\$3 billion) killed 160 people and injured ~1000.

♦ **Tornado Safety:** The first step in tornado safety is **being aware** of the weather situation. Devices such as **NOAA Weather Radios** or **cell phone text alerts** will help keep you informed.

♦ The best place to be when a tornado is nearby is not nearby. If you can safely travel out of the way of the tornado, do so. The two main risks from tornado damage are **collapsing structures** and **flying debris**, so any location that minimizes both risks is the best shelter.

- However, if you cannot move out of the path, the next safest place to be is the **place least susceptible to damage**. The best option is a **storm cellar (underground)** or a **“safe room”** (a room with 12-inch-thick concrete walls, a steel door and a concrete roof). If neither are available, go to a basement, an interior room with no windows, or under a **sturdy desk or workbench**. **“Get in, get down, cover up!”**

- An **interior concrete stairwell, with no windows** in a high-rise building or a skyscraper is a safe place.

- **Do not waste time opening windows** in the attempt to equalize pressure. It does no good! You are better off using that time to seek shelter.

- If outside, **do not seek shelter under an overpass**. This can prove **deadly**, as wind speeds increase due to funneling. In the worst case scenario, **get into a ditch** to minimize being hit by debris.

◆ **Storm Prediction Center (SPC) Convective Outlooks:**
<http://www.spc.noaa.gov/>

