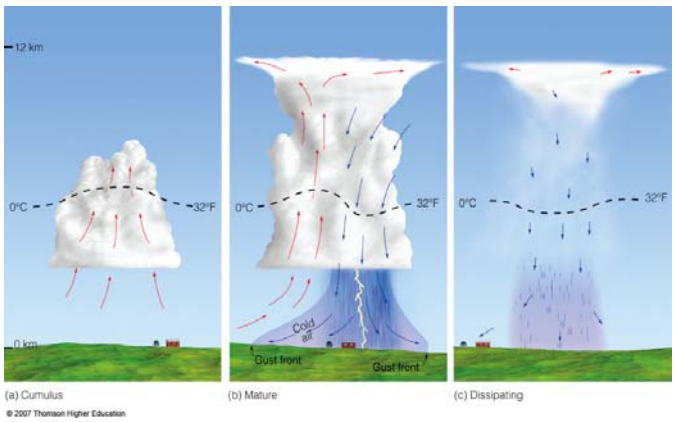
Thunderstorms and Tornadoes

- Ordinary Air Mass Thunderstorms
- Severe Thunderstorms
- Lightning
- Tornadoes

Thunderstorms and Tornadoes

- Ordinary Air Mass Thunderstorms
  - Need
    - Lift
    - low level moisture
    - conditionally unstable atmosphere
  - The life cycle
- Severe Thunderstorms
- Lightning
- Tornadoes

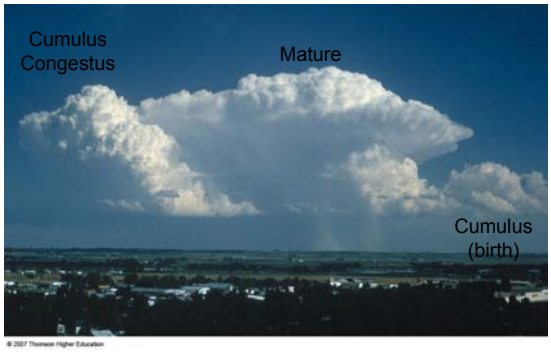
Simplified life cycle of an ordinary air mass thunderstorm



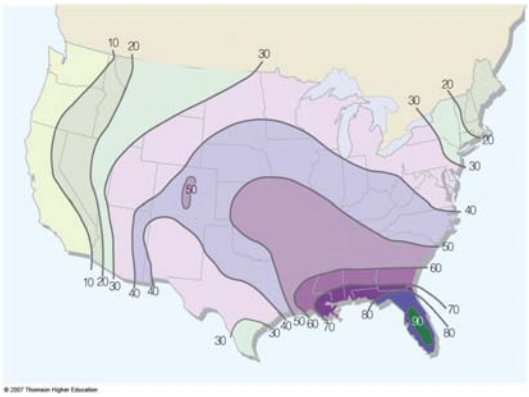
Ordinary Thunderstorms form in low wind shear and live only 1-2 hours

A Mature Ordinary (Air Mass) Thunderstorm

Air Mass Thunderstorms



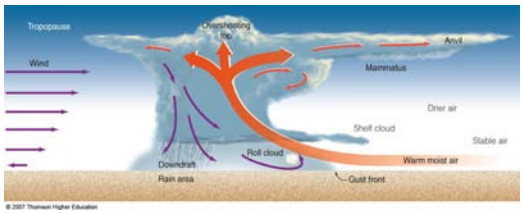
Average No. of Days per year with thunderstorms



Thunderstorms and Tornadoes

- Ordinary Air Mass Thunderstorms
- Severe Thunderstorms
  - Need
    - Lift
    - low level moisture
    - conditionally unstable atmosphere
    - *and strong vertical wind shear*
  - *Examples*
    - *Intense, long lived individual storms*
    - *Mesoscale Convective Complex (MCC)*
    - *Dry line severe storms (squall line)*
- Lightning
- Tornadoes

Anatomy of a Severe Thunderstorm



Wind shear helps keeps the updrafts and downdrafts separated. Gust front associated with cold downdraft can help fuel storm.

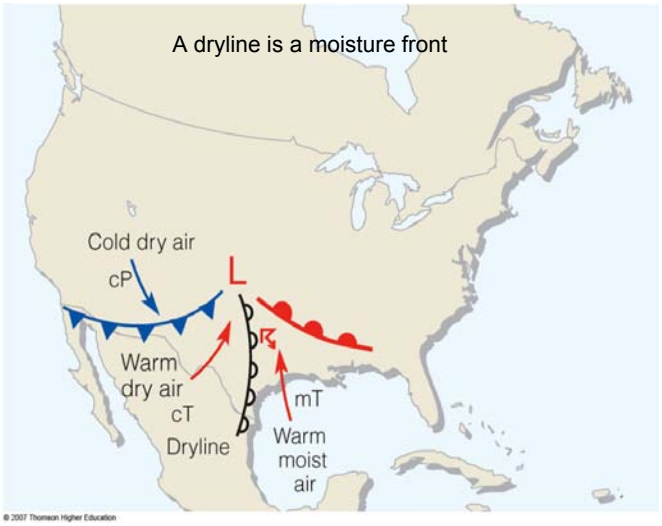
Extreme wind, precip and large Hail can form in this situation

A shelf cloud (or arcus cloud) associated with an intense thunderstorm

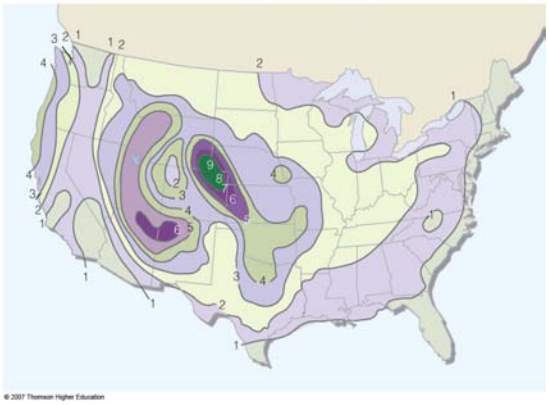
Mesoscale Convective Complex

… a huge area of heavy rainfall, thunderstorms severe downdrafts and hail

A dryline is a moisture front



Average No. of days per year with hail



Movie of hail in woodson tx: http://www.youtube.com/watch?v=wZr8jXo1Uso

Thunderstorms and Tornadoes

- Ordinary Air Mass Thunderstorms
- Severe Thunderstorms
- Lightning
  - A large voltage potential is produced by charge separation
    - ice crystals form from super cooled water
    - Super cooled water freezes on contact with warmer graupel
- Tornadoes

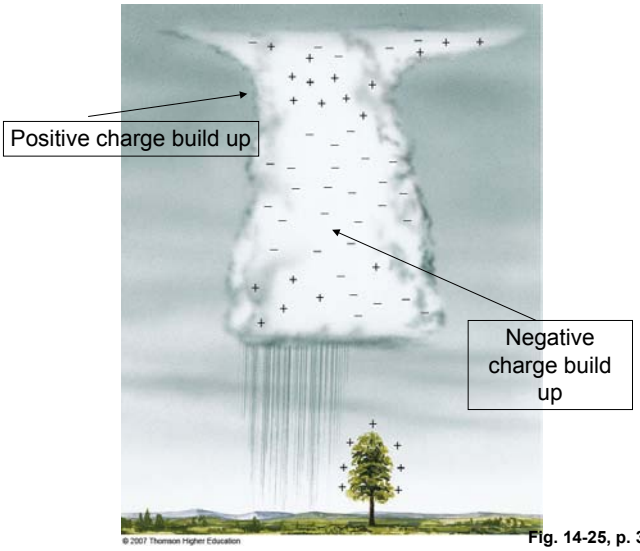
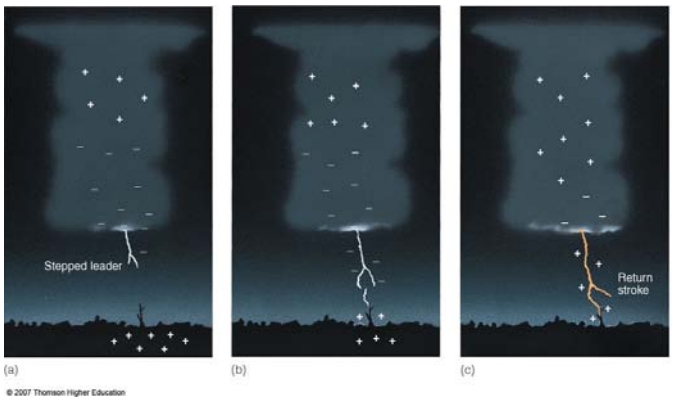


Fig. 14-25, p. 385

Anatomy of a cloud-to-ground lightning strike

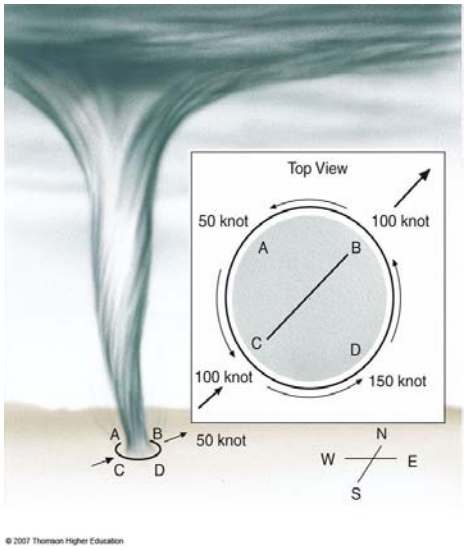


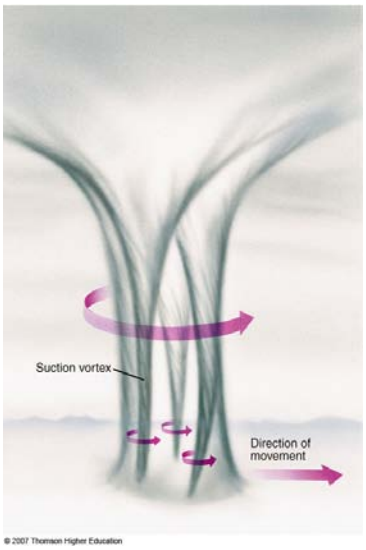
Thunderstorms and Tornadoes

- Ordinary Air Mass Thunderstorms
- Severe Thunderstorms
- Lightning
- Tornadoes
  - Form in a supercell: a very large (200km in diameter) isolated rotating thunderstorm in which is embedded an intense small scale (several km in diameter) mesocyclone

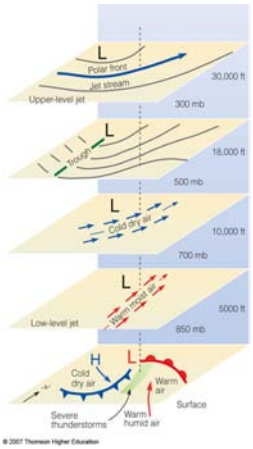
Elie, Manitoba F5 tornado on June 22, 2007

Movie of Tornadoes http://www.youtube.com/watch?v=43VoMesUd2Q



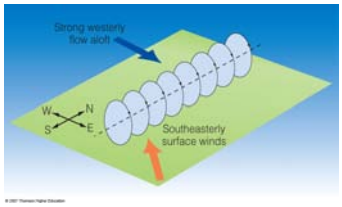


Conditions leading to the formation of some severe thunderstorms (especially supercells)



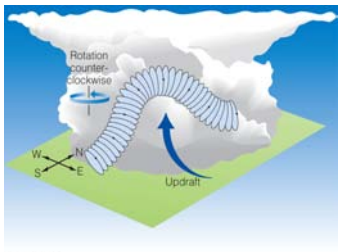
Energy for a tornado comes from spin (vorticity)

When the ambient wind has strong vertical shear and is caught in a convective updraft …



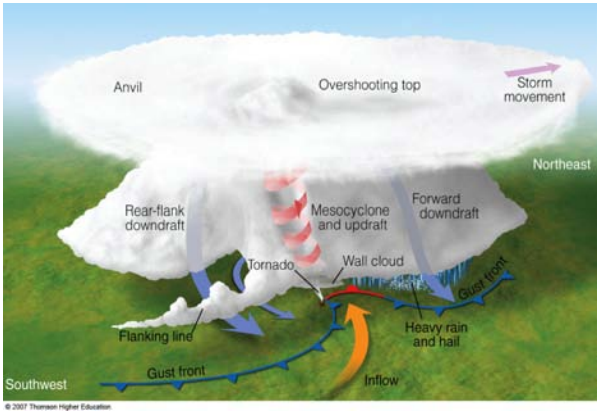
Vorticity dynamics (or trailer parks?) cause a small scale, intense vortex to form: a tornado

Tornadoes usually rotate cyclonical

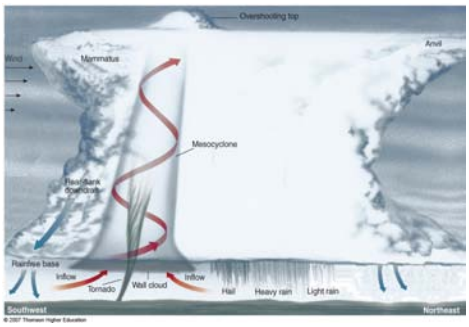


anatomy of a tornado movie
http://esminfo.prenhall.com/science/geoanimations/animations/Tornadoes.html

The Classic Tornadic Supercell



Anatomy of a Tornado



Some of the features associated with a tornado-breeding supercell thunderstorm as viewed from the southeast. The storm is moving to the northeast

Tornado incidence by state.

The upper number shows the number of tornadoes reported by each state during a 25-year period. The lower number is the average annual number of tornadoes per 10,000 square miles

Fig. 14-33, p. 391

Average number of tornadoes during each month in the United States.

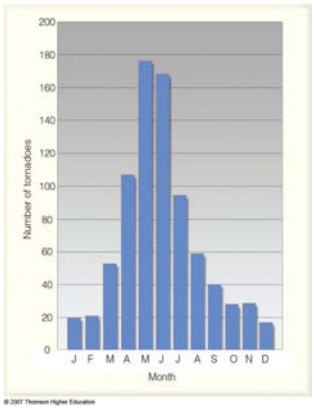


Fig. 14-34, p. 392

• TABLE 14.2

Fujita Scale for Damaging Wind

SCALE	CATEGORY	MI/HR	KNOTS	EXPECTED DAMAGE
F0	Weak	40–72	35–62	Light: tree branches broken, sign boards damaged
F1		73–112	63–97	Moderate: trees snapped, windows broken
F2	Strong	113–157	98–136	Considerable: large trees uprooted, weak structures destroyed
F3		158–206	137–179	Severe: trees leveled, cars overturned, walls removed from buildings
F4	Violent	207–260	180–226	Devastating: frame houses destroyed
F5*		261–318	227–276	Incredible: structures the size of autos moved over 100 meters, steel-reinforced structures highly damaged

*The scale continues up to a theoretical F12. Very few (if any) tornadoes have wind speeds in excess of 318 mi/hr.

• TABLE 14.1

Average Annual Number of Tornadoes and Tornado Deaths by Decade

DECADE	TORNADOES/YEAR	DEATHS/YEAR
1950–59	480	148
1960–69	681	94
1970–79	858	100
1980–89	819	52
1990–99	1,220*	56

*More tornadoes are being reported as populations increase and tornado-spotting technology improves.