

Natural Disasters

Lecture 6

Ch 10 – Tornadoes, Lightning, Heat, and Cold

Text Source Today:

Chapter 10 (p. 251-252, 256-261)

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

♦ **Thunderstorm:** the ONLY requirement to get a thunderstorm is a **cloud with lightning (and thunder)**. There is **no minimum** wind speed or amount of rain needed to qualify as a **thunderstorm**.

● **Thunderstorms** are relatively small columns in the atmosphere where **moist air ascends** very rapidly. **Severe weather** is usually associated with thunderstorms.

♦ U.S. thunderstorms are most prevalent in **Florida and along the Gulf Coast**, but have a secondary maximum near the **Front Range of the Rockies**. Florida thunderstorms happen throughout the **summer**, but are most prevalent in the central and southern Plains in **late spring and early summer**.

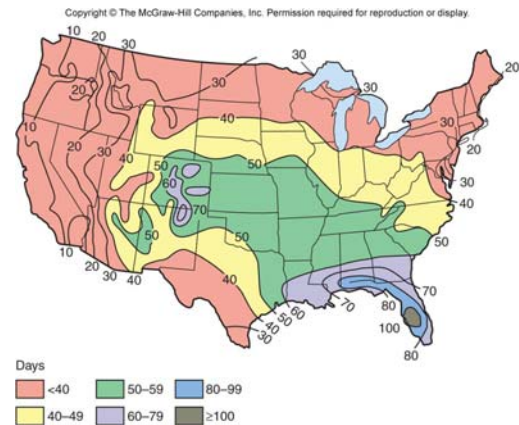
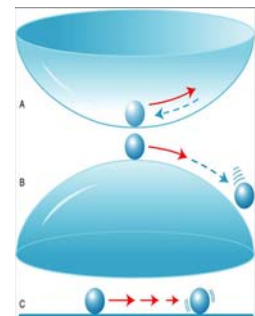


Fig. 10.17

♦ The main determining factor in thunderstorm development is **stability**: (a) **Stable** air refers to air that tends to **return to** its initial position after being perturbed. (b) **Unstable** air accelerates **away from** its initial position after being perturbed. (c) **Neutral** air will remain in its **new position** after being perturbed.



♦ If a parcel rises slightly (or is perturbed upward) and remains **warmer** than its neighbors, it will continue to **rise** on its own. This is an example of air that is **unstable**.

- Moist, unsaturated air can become **saturated** when lifted a sufficient distance. The level where a parcel reaches **saturation** is called the **lifted condensation level (LCL)**. Up to this point, the air has risen **dry** adiabatically, but it will rise **moist** adiabatically after saturation and thus **cool more slowly**.

- The **warmer** a parcel is than the surrounding air, the **faster** it will **rise**. Thus, an environment primed for thunderstorms would have **warm, moist air near the surface, and cooler air aloft**.

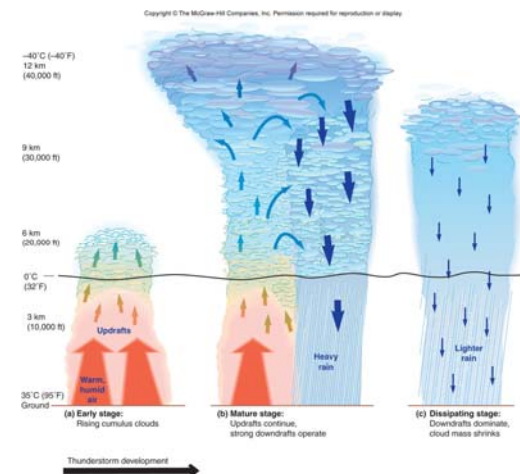
- An **updraft** is comprised of many parcels all rising in the same column. **Strong updrafts** in thunderstorms often stretch from near the surface up to **the tropopause**!

- Three major types of thunderstorms: **single-cell, multicell, and supercell**.

♦ Single-cell thunderstorm:

(a) begins with a **weak updraft** and cloud formation as warm, moist air rises. This is known as the **towering cumulus** or **developing stage**.

Fig. 10.13



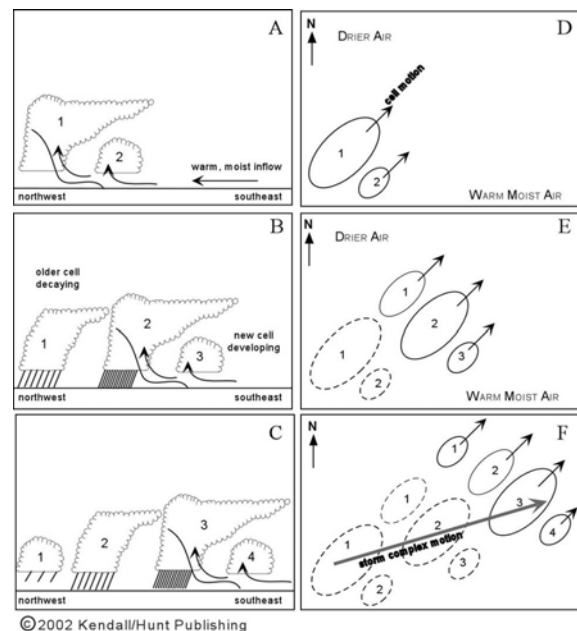
(b) With time, the **updraft** strengthens and **precipitation** starts to form. When the precipitation gets large (heavy) enough, it starts to fall through the cloud and **drag air down** with it. As it sinks, the precipitation can **evaporate** into the sinking air, leading to relative **cooling**. This cooler region of sinking air is called a

downdraft. The cell is in the **mature stage** when both **updrafts** and **downdrafts** are present and of roughly similar strength.

(c) Eventually, the cool air sinking from the cloud reaches the surface and **expands as outflow**, which cuts off the supply of **warm, moist air** at the surface. Precipitation also begins to fall **into the core of the updraft**, slowing it down, eventually causing the **updraft** to disappear completely. This process is the **dissipating stage**. (This whole process takes less than one hour, usually just 30 to 45 minutes.)

◆ **Multicell thunderstorm:**

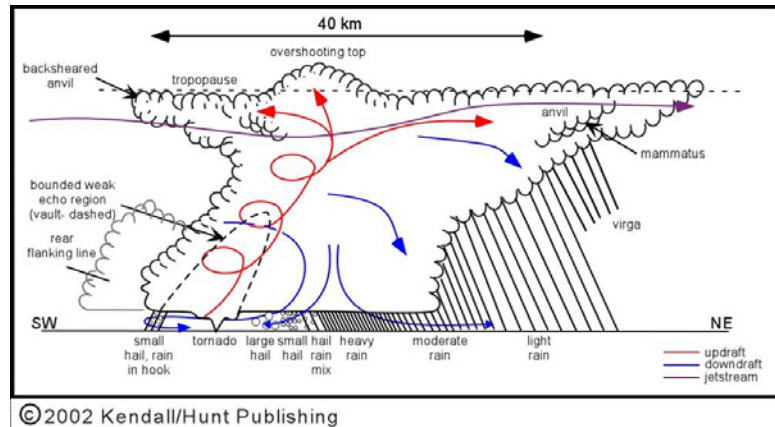
a collection of **single-cell** storms. The **cool outflow** from a mature or decaying cell helps to **lift warm, moist surface air** (outside the existing cell) to its LCL and to the point where it can rise on its own. Then, the **second cell** grows and becomes **dominant**, while the **first cell dissipates**. This constant process of **regeneration** defines multicells.



- A **squall line** is very long line (~100 km) of **multicells**. Often found at the leading edge or in advance of **cold fronts**, the outflow from the storms helps to **lift the warm, moist air** directly ahead of the **cold front**.

♦ Supercell thunderstorm:

the **most intense** and **longest-lasting** type of thunderstorms. Some **supercells** can last for more than 6 hours and travel over 300 miles!



♦ The key to the longevity of a supercell is the **tilt and rotation** of the **intense updraft**. The **tilt and rotation** arise from the ambient **wind shear** – the **change** in **wind direction and speed with height**.

♦ Unlike a single-cell or multicell thunderstorm, where precipitation eventually falls **into and weakens** the updraft, the **updraft tilt** means precipitation will fall **outside of the core of rising air** in the **forward flank** downdraft. The rotation of the **updraft** also helps it maintain structure; strong mid- and upper-level **winds are less able to** shear apart the **rotating updraft**.

♦ As the mid-latitude jet stream forces **dry air** into the **back** side of the supercell, the **mixing of air** (**entrainment**) causes **evaporation** and subsequent **cooling**. The resulting **second** downdraft is called the **rear flank downdraft (RFD)** and is believed to be **crucial** in the development of a **mesocyclone**, which can lead to the formation of a **tornado**!

● **Supercell** thunderstorms are frequently associated with **severe weather**: torrential downpours (flash floods), strong, damaging winds, large hail, and the most violent **tornadoes**!

- **The Geostationary Operational Environmental Satellite (GOES) Weather Satellites:** are parked in orbit about 23,000 miles above a fixed point on the equator.

- They use a **radiometer** to “see” the clouds, such as an **imager** (which provides better resolution, down to 1 nm) and a **sounder** (which gives a more accurate profile of temperature and moisture at different levels in the atmosphere). There are three primary types of weather satellite imagery:

- ◆ **Visible:** the **radiometer** is set to “see” reflected sunlight in the **visible** spectrum, such that **clouds** appear to be **WHITE**; any object with a low albedo will appear **DARK**, such as oceans and forests; other objects with a high albedo, such as snowcover, will give the appearance of being **“clouds.”**

- ◆ **Infrared:** the **radiometer** is set to “see” outgoing infrared radiation, such that warm clouds, land and oceans will appear **DARK** and the colder cloud tops will appear **WHITE**, resulting in a “gray scale” for in-between temperatures. (The “gray scale” can be “color-enhanced” to increase contrast between features and their backgrounds.)

- ◆ **Water Vapor:** the **radiometer** is set to “see” just **6.7 micro-meters**, which is a unique absorptivity wavelength of **water vapor**, such that areas of high moisture will appear **WHITE** and dry areas **DARK**.

