




Objectives

- **Identify** the processes that form thunderstorms.
- **Compare** and **contrast** different types of thunderstorms.
- **Describe** the life cycle of a thunderstorm.

Vocabulary

-  – air-mass thunderstorm
-  – sea-breeze thunderstorm
-  – frontal thunderstorm

Thunderstorms

- At any given moment, nearly 2000 thunderstorms are occurring around the world.
- Some are capable of producing hail the size of baseballs, swirling tornadoes, and surface winds of more than 160 km/h.
- **All thunderstorms**, regardless of intensity, **have certain characteristics in common.**

How Thunderstorms Form

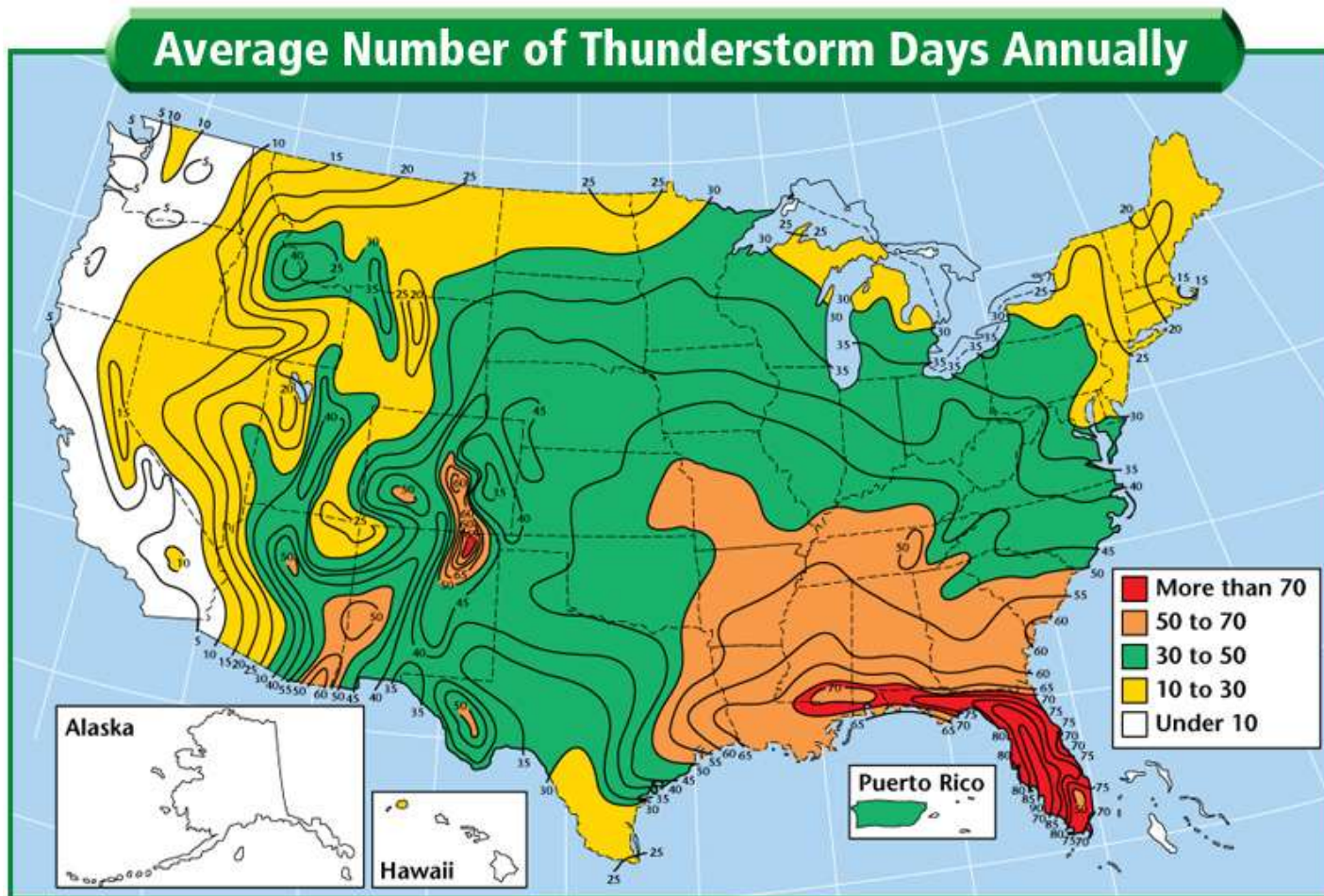
- For a thunderstorm to form, **three conditions must exist**.
 1. There must be an **abundant source of moisture** in the lower levels of the atmosphere.
 2. Some mechanism must **lift the air** so that the **moisture can condense and release latent heat**.
 3. The portion of the **atmosphere** through which the cloud grows **must be unstable**.

How Thunderstorms Form

Limits to Growth

- The air in a thunderstorm will keep rising until:
 1. It meets a layer of stable air that it cannot overcome
 2. The rate of condensation, which diminishes with height, is insufficient to generate enough latent heat to keep the cloud warmer than the surrounding air
- Typical thunderstorms last only about 30 minutes and individual storms are only about 24 km in diameter.

How Thunderstorms Form

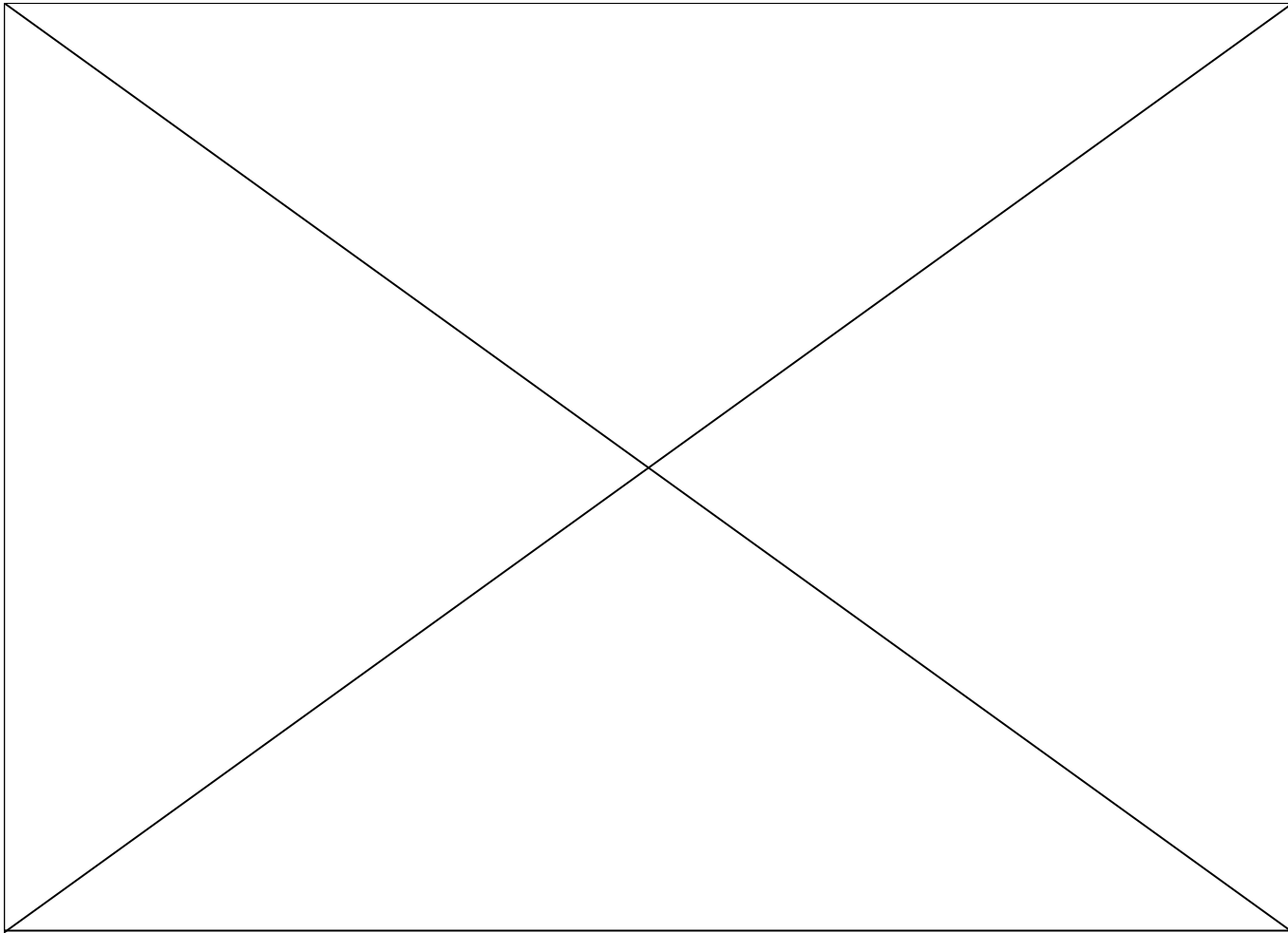


National Climatic Data Center, NOAA

Air-Mass Thunderstorms

- Thunderstorms are often classified according to the mechanism that caused the air to rise.
- 🔊 An air-mass thunderstorm is a thunderstorm that results from the air rising because of unequal heating of Earth's surface within one air mass.
 - Mountain thunderstorms occur when an air mass rises as a result of orographic lifting, which involves air moving up the side of a mountain.
 - 🔊 – Sea-breeze thunderstorms are local air-mass thunderstorms caused, in part, by extreme temperature differences between the air over land and the air over water.

Air-Mass Thunderstorms



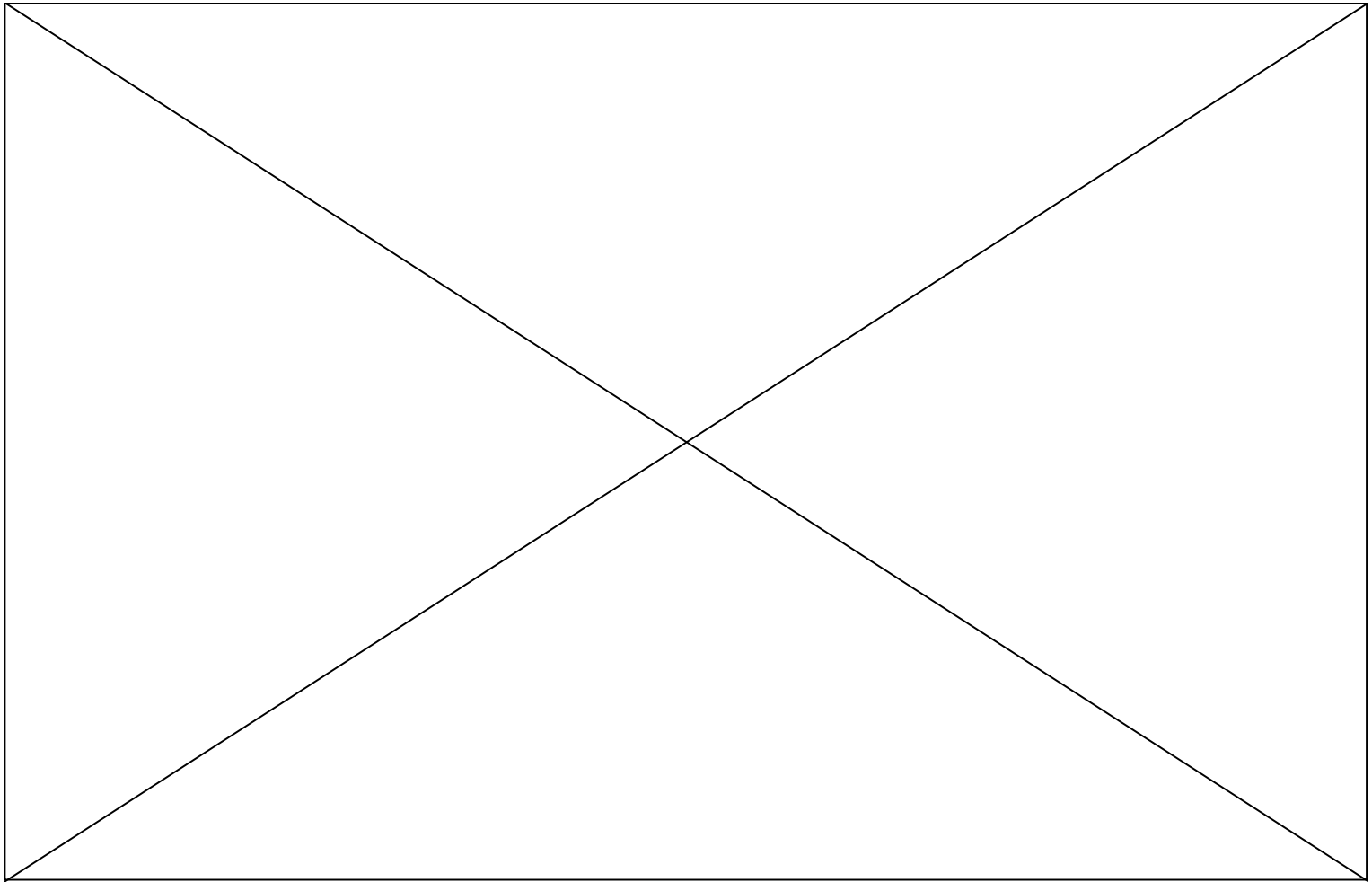
Frontal Thunderstorms

- **Frontal thunderstorms** are thunderstorms that are produced by advancing cold fronts and, more rarely, warm fronts.
- **Cold-front thunderstorms** get their initial lift from the push of the cold air which can produce a line of thunderstorms **along the leading edge of the cold front.**
- Because they are not dependent on daytime heating for their initial lift, cold-front thunderstorms **can persist long into the night.**

Stages of Development

- A thunderstorm usually has **three stages: the cumulus stage, the mature stage, and the dissipation stage.**
- The stages are classified according to the direction in which the air is moving.

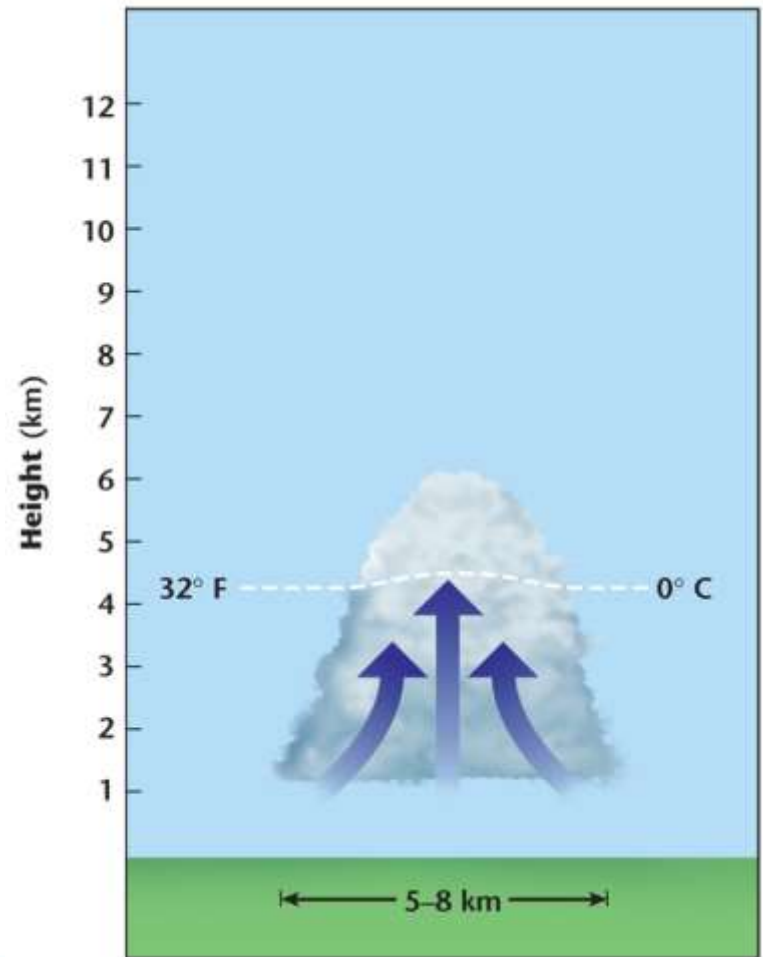
Stages of Development



Stages of Development

Cumulus Stage

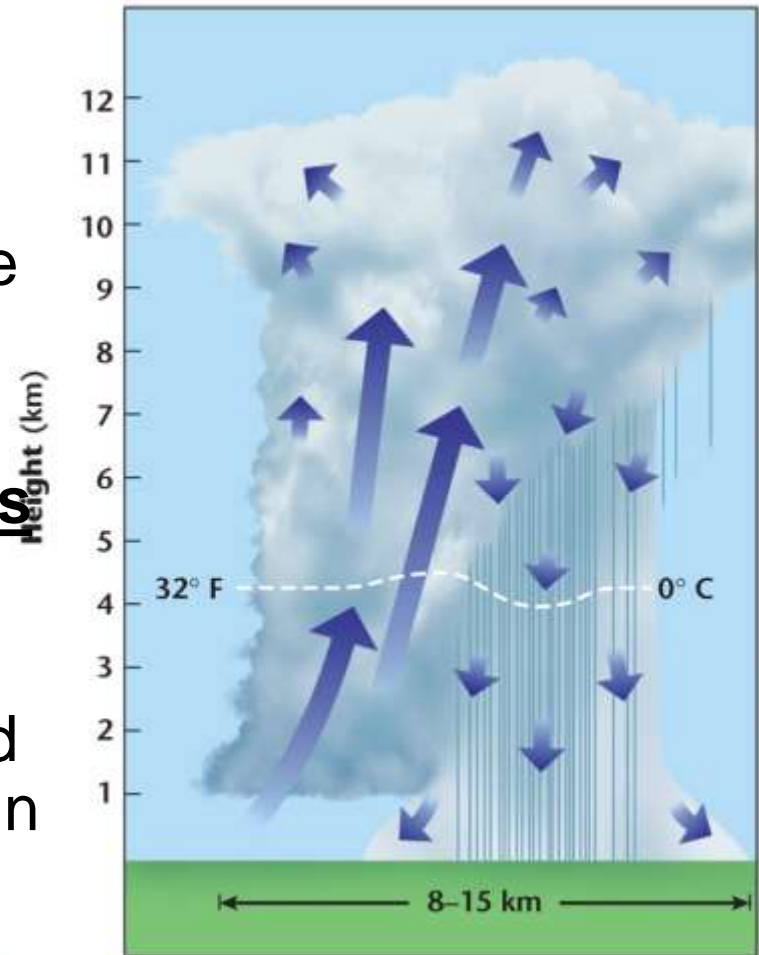
- In the **cumulus stage**, **air starts to rise** nearly vertically upward.
- Transported moisture **condenses into a visible cloud** and **releases latent heat**.
- As the cloud droplets coalesce, they form larger droplets, which eventually fall to Earth as precipitation.



Stages of Development

Mature Stage

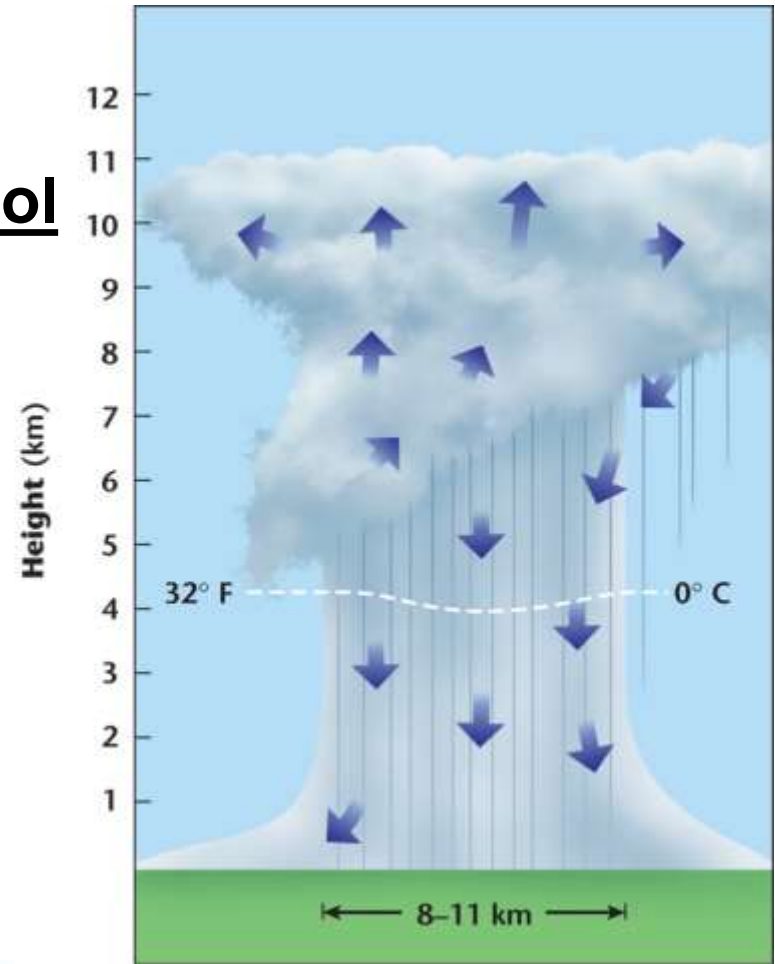
- As precipitation falls, it cools the air around it which becomes more dense than the surrounding air, so it sinks **creating downdrafts.**
- The **updrafts and downdrafts** form a convection cell.
- In the mature stage, nearly equal amounts of updrafts and downdrafts exist side by side in the cumulonimbus cloud.



Stages of Development

Dissipation Stage

- The supply of warm, moist air runs out because the cool downdrafts cool the area from which the storm draws energy.
- Without the warm air, the updrafts cease and precipitation can no longer form.
- The dissipation stage is characterized primarily by lingering downdrafts.



Section Assessment

1. Why does there need to be an abundant source of moisture in the lower levels of the atmosphere for thunderstorms to form?

The moisture feeds into a thunderstorm's updrafts, releasing latent heat when it condenses.

Section Assessment

2. What is the main cause of thunderstorm dissipation?

The downdrafts created by a thunderstorm eventually cut off the flow of warm, moist air into the storm. Without the warm updrafts, precipitation can no longer form and the convection stops.

Section Assessment

3. Identify whether the following statements are true or false.

true

Latent heat is crucial in maintaining the upward motion of a cloud.

false

Thunderstorms are more likely to develop along a warm front instead of a cold front.

true

A mountain thunderstorm is an example of an air-mass thunderstorm.

true

In the mature stage of a thunderstorm, updrafts are roughly equal to downdrafts.

End of the Section





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Objectives

- **Explain** why some thunderstorms are more severe than others.
- **Recognize** the dangers of severe thunderstorms, including lightning, hail, high winds, and floods.
- **Describe** how tornadoes form.

Vocabulary

-  – supercell
-  – downburst
-  – tornado
-  – Fujita tornado intensity scale

Severe Weather

- Occasionally, weather events come together in such a way that there is a continuous supply of surface moisture.
- This happens along a cold front that moves into warmer territory and can lift and condense a continuous supply of warm air.

Severe Thunderstorms

- Other factors also play a role in causing some storms to be more severe than others.
- Cold fronts are usually accompanied by upper-level, low-pressure systems that are marked by pools of cold air, which cause the air to become more unstable.
- When the strength of the storm's updrafts and downdrafts intensifies, the storm is considered to be severe.

Severe Thunderstorms

- **Supercells** are self-sustaining, extremely powerful severe thunderstorms, which are characterized by intense, rotating updrafts.
- Only about ten percent of the roughly 100 000 thunderstorms that occur each year in the United States are considered to be severe; even fewer become supercells.



Lightning

- Lightning is an electrical discharge caused by the friction of falling and rising ice crystals within strong drafts of a cumulonimbus cloud.
- Some atoms lose electrons and become positively charged ions, while other atoms receive the extra electrons and become negatively charged ions.
- This creates regions of air with opposite charges.
- To relieve the electrical imbalance, an invisible channel of negatively charged air, called a stepped leader, moves from the cloud toward the ground.



Lightning

- When the stepped leader nears the ground, a channel of positively charged ions, called the return stroke, rushes upward to meet it.
- The return stroke surges from the ground to the cloud, illuminating the channel with about 100 million V of electricity.

