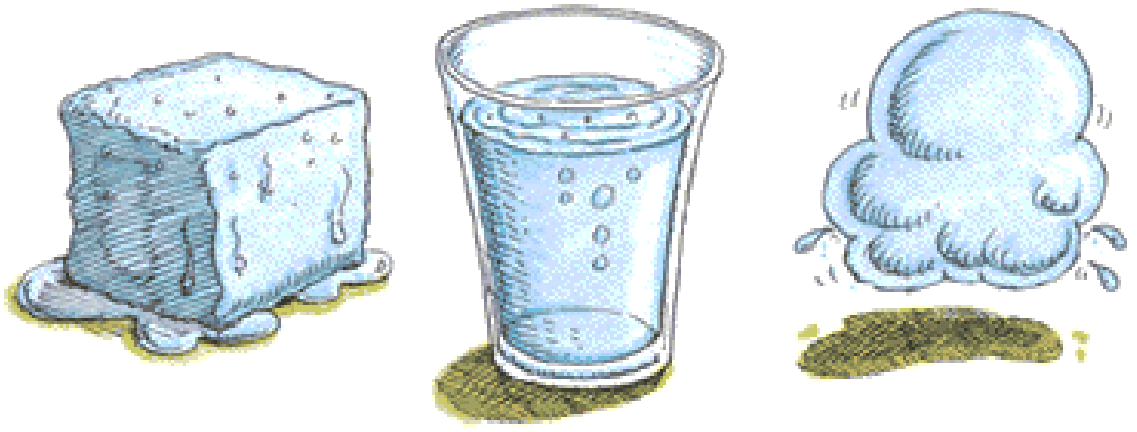
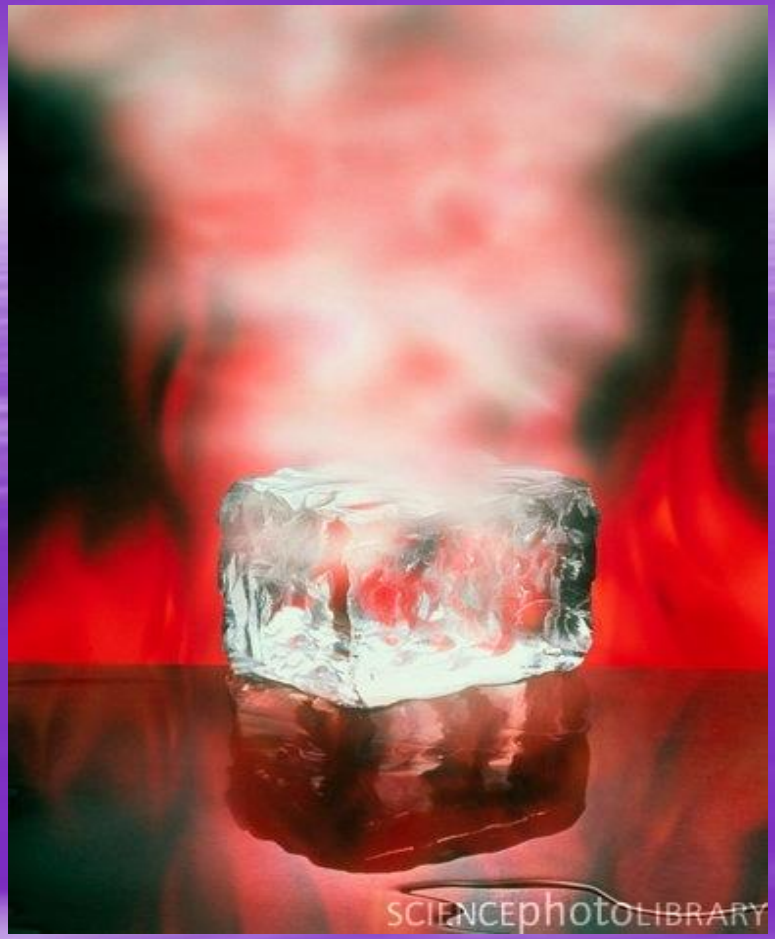
Lesson 1 - Changing Forms of Water



- Molecules of liquid water are always in motion.
- Water is unique because it is the only substance that commonly exist in all three states of matter:
- 1) Ice (Solid)
- 2) Water (Liquid)
- 3) Vapor (Gas)

Chapter menu
Resources
End Of Slide



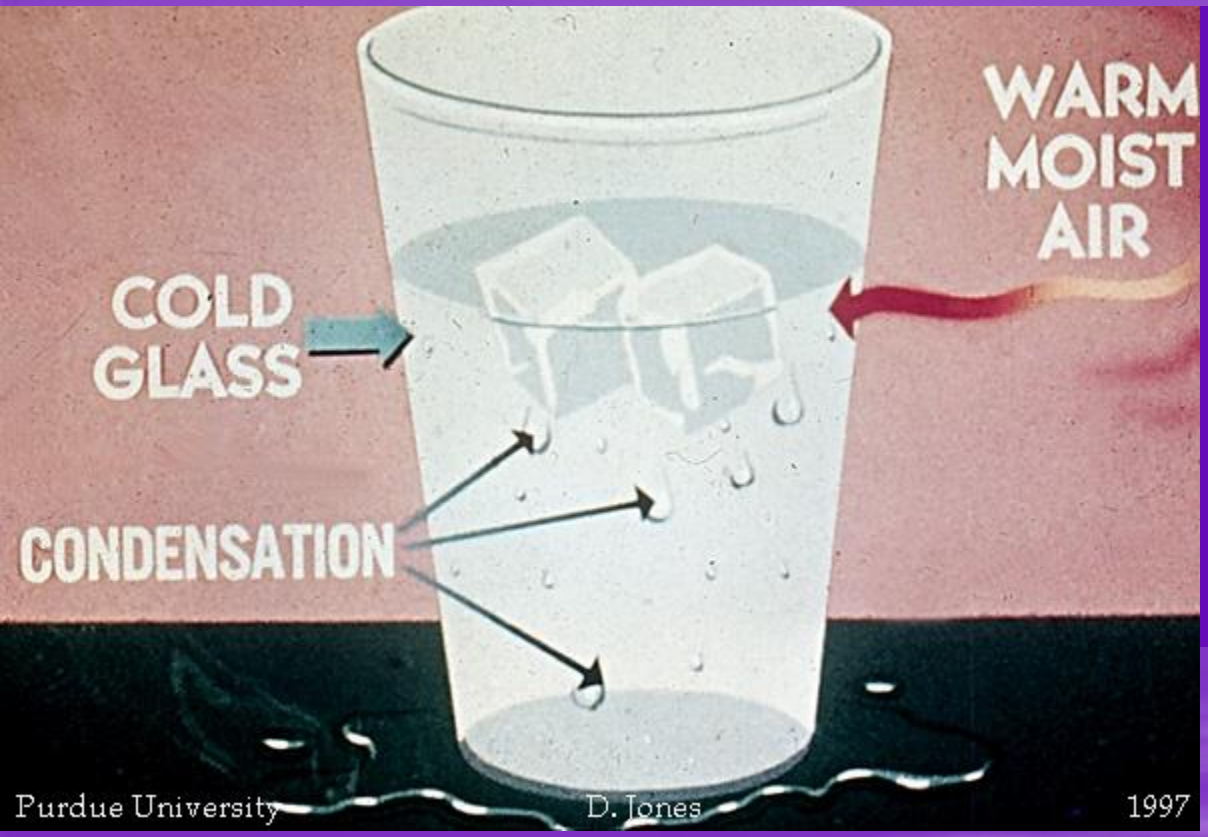
Changing Forms of Water

- Water changes from one phase to another when heat energy is absorbed or released.

- There are 4 ways to do this:
- 1) Condensation
- 2) Evaporation,
- 3) Transpiration
- 4) Sublimation.

End Of Slide

Chapter menu | Resources

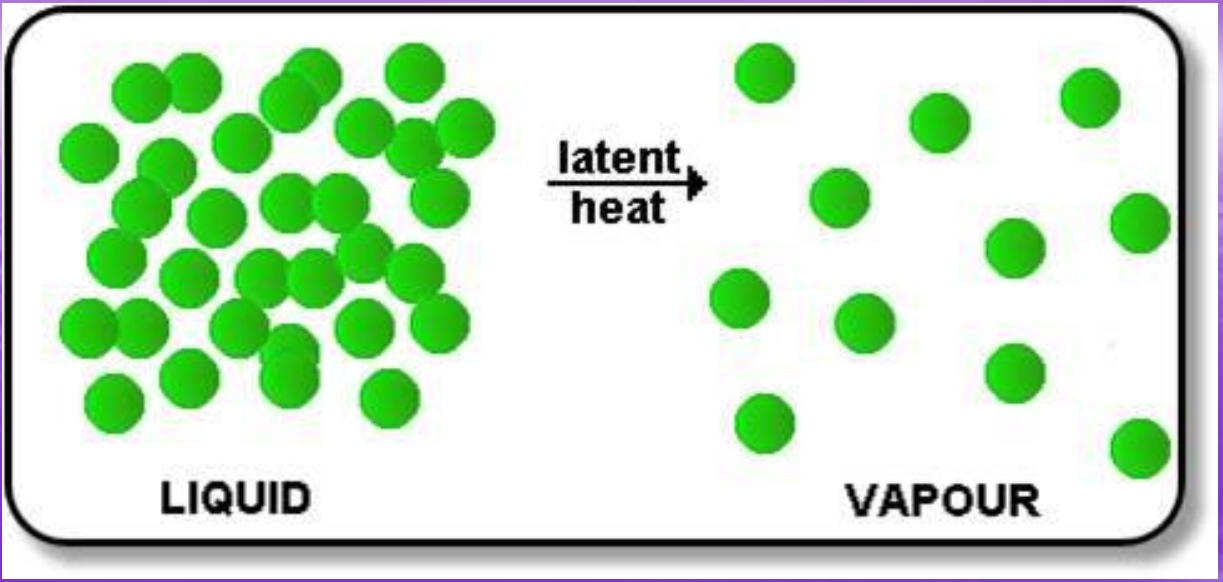


The change from water vapor to liquid water is called condensation.

It also releases a heat called latent heat because it is energy that is hidden.

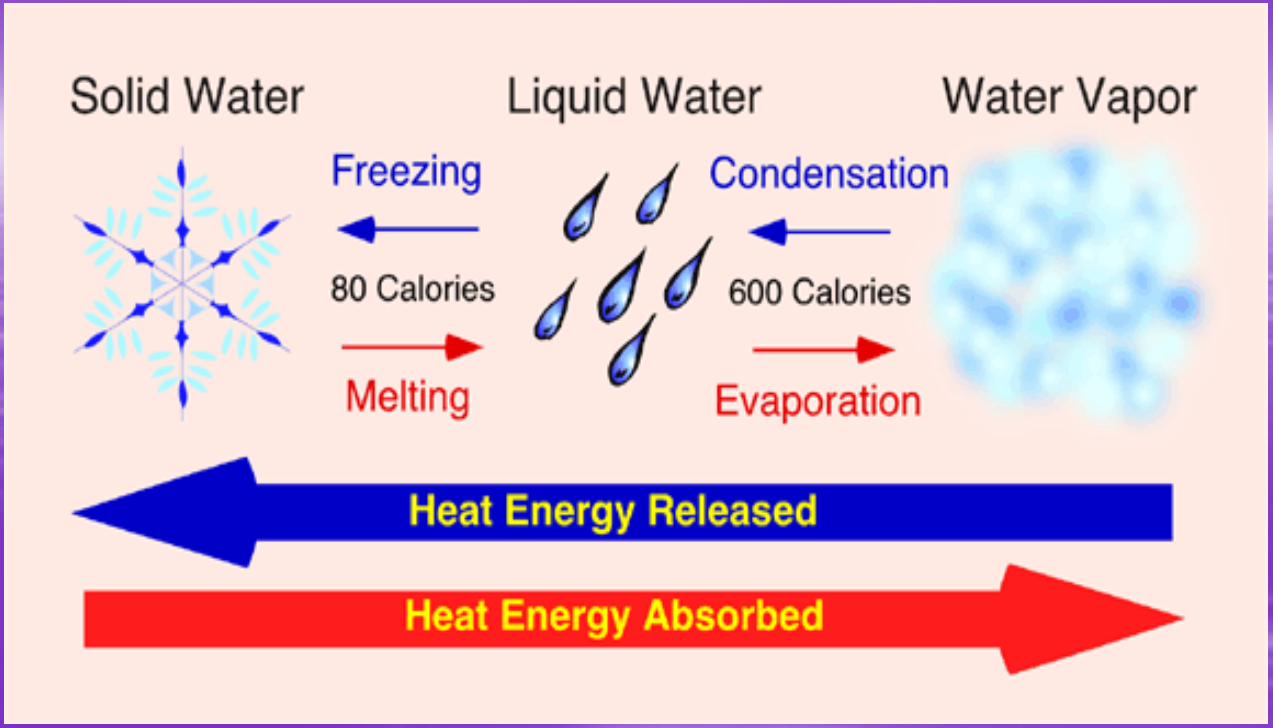
Condensation

Latent Heat



- Latent heat is the heat released or absorbed by a body of water during a change of state without change of temperature.

Latent Heat



- If water molecules are moving further apart (water vapor) heat energy is being absorbed.
- If water molecules are moving closer together (liquid water) heat energy is being released.

Understanding Latent Heat

- If you heat/boil water into a vapor– that energy is being absorbed.
- Turn that same vapor back into water – the heat absorbed (earlier) is now released (latent).
- This will play a huge factor in the formation of a hurricane.

- 90% of the moisture in the atmosphere occurs via evaporation.
- The remaining 10% is contributed by plant *transpiration*.

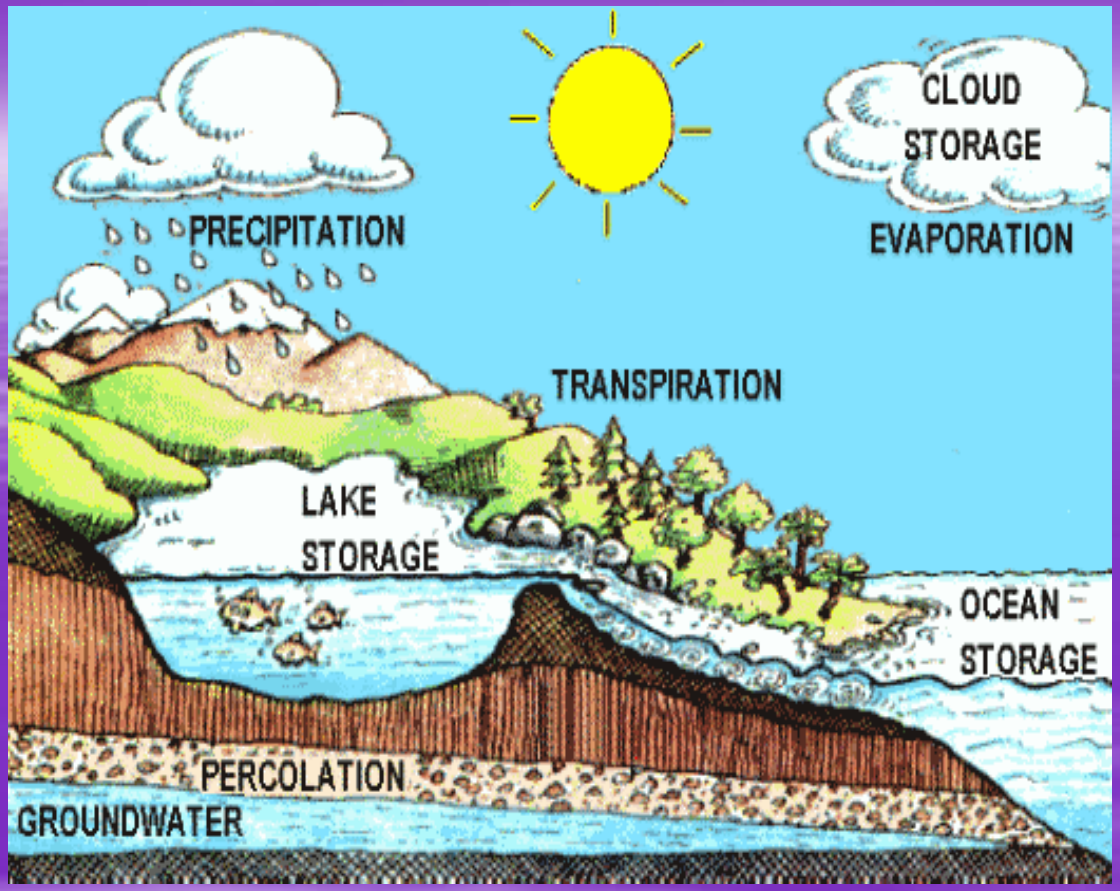
Evaporation

Evaporation

- The change from liquid water to water vapor absorbs heat is called evaporation.
- So while condensation gives off heat energy, evaporation will absorb heat energy.

- Take for example getting out of a swimming pool, you may feel chilly , but this is because the water molecules on your skin are absorbing your body heat as they evaporate.

Example of Evaporation

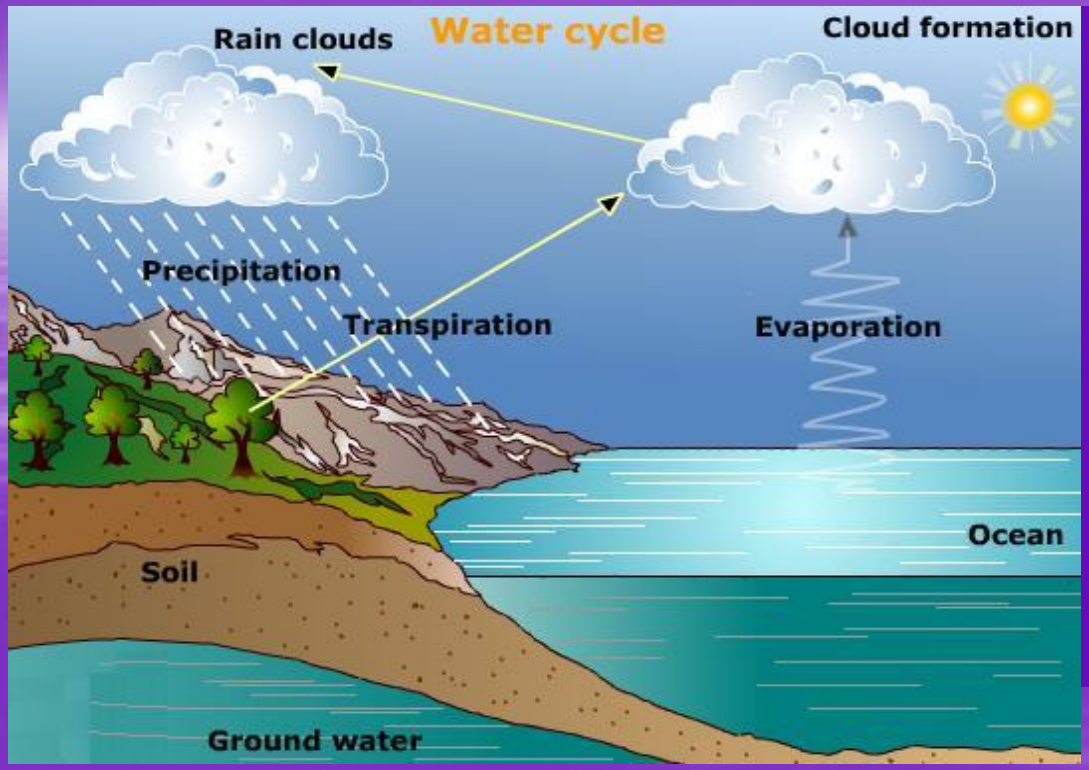


- The evaporation of liquid water is important to meteorology since the amount of moisture that evaporates into the air leads to changes in the weather.

The Rate of Evaporation

Check for Understanding

- What is latent heat and what is its role with evaporation and condensation?



- The five factors that determine the rate of evaporation are:

- (1) Water Temperature
- (2) Air Temperature
- (3) Wind Speed
- (4) Dryness of the Air
- (5) Direct Sunlight

The Rate of Evaporation

1. Temperature of the Water

- The water molecules move faster as water warms.
- The faster the molecules move the more easily they can escape the water surface.
- A warm lake or ocean will evaporate a large amount of moisture.

2. Temperature of Air

- As the air above the water warms it has greater capacity to hold more evaporated moisture.
- If the air is cold, because it is more dense, it is difficult to evaporate a large amount of moisture into the air.
- A combination of warm water and warm air will evaporate the most water.

- A higher wind helps remove moisture that has evaporated from the water.
- When the air is saturated the amount of moisture that evaporates into the air is minimized.

3. Wind Speed

- Higher winds will continue to supply drier air (like a conveyer belt) to the water surface allowing for a greater amount of evaporation to take place.

3. Wind Speed

4. Dryness of Air

- Dry air will help generate more evaporation especially if the air is warm and dry.
- There is a higher capacity to evaporate moisture into the air as the air dries.
- Once the air is saturated then the evaporation rate is minimized.

- Direct sunlight will lead to more evaporation.
- The direct photons of light increase the motion of the water molecules it strikes giving them a better chance to evaporate.

5. Sunlight

- The process by which water changes from a solid (ice or snow) to a gas, bypassing the liquid phase, is called sublimation and less than 1% of water vapor enter our atmosphere this way.

Sublimation

- This often happens in the Rocky Mountains as dry and warm winds blow in from the Pacific in late winter and early spring raising temperatures dramatically in a matter of hours and changes the snow directly into water vapor.

Sublimation

- This also occurs when frost develops on plants.
- When plants transpire they release water through their pores which becomes dew and turns into frost in cold weather.

Sublimation

Clouds
Cloud Seeding
Chapter menu
Resources
End of Slide

Check for Understanding

- List and explain the 5 factors that are involved with evaporation rates.
- Given what you just learned, where in the world would have the highest rate of evaporation? Justify your response.

Write using complete sentences and in your own words.

Lesson 2 – Why do Clouds Form

- In order for clouds to form they need three things:
- (1) Water Vapor
- (2) Condensation Nuclei
- (3) A Mechanism for Cooling the Air

(1) Water Vapor and Relative Humidity

- Humidity refers how near the air is to its maximum capacity for holding water vapor.

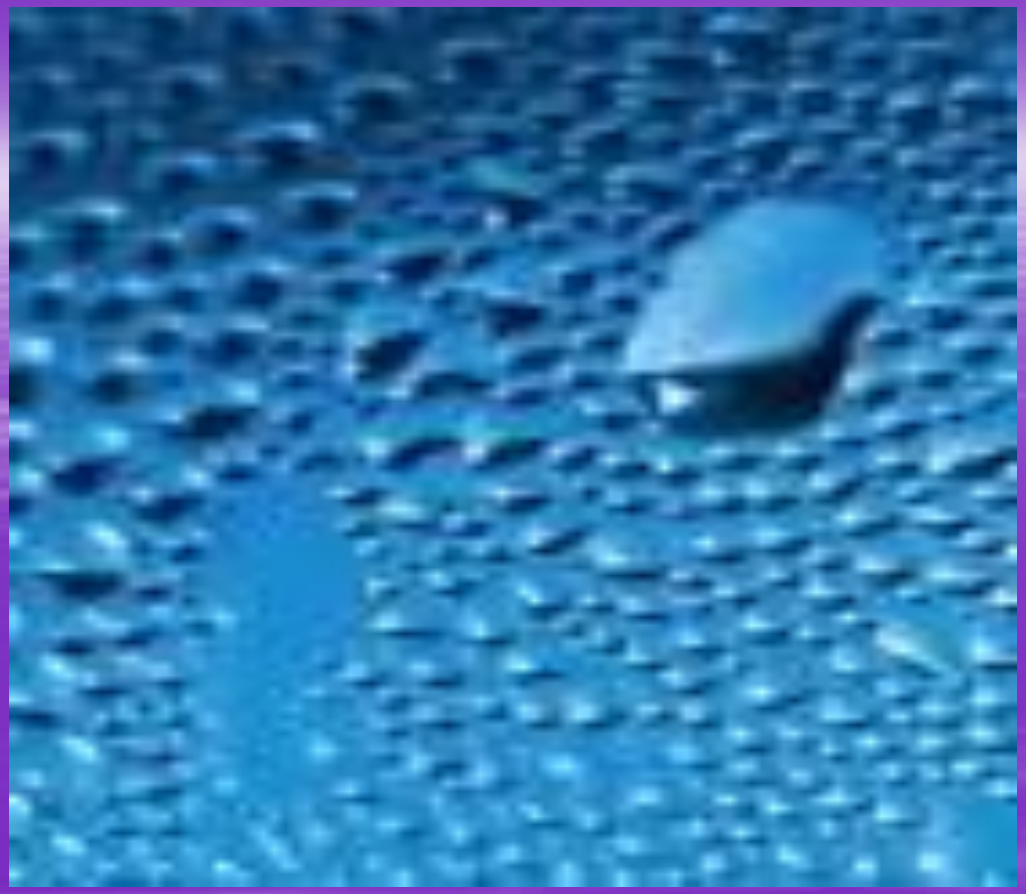
- Relative humidity compares the actual amount of water vapor in the air to the maximum amount of water that can be present in the air at the given temperature and pressure.

- When air cools, its capacity to contain water vapor diminishes.
- Which means as night falls the air becomes saturated and if the air continues to cool past the point of saturation, condensation occurs.

Condensation in the Air

Dew Point

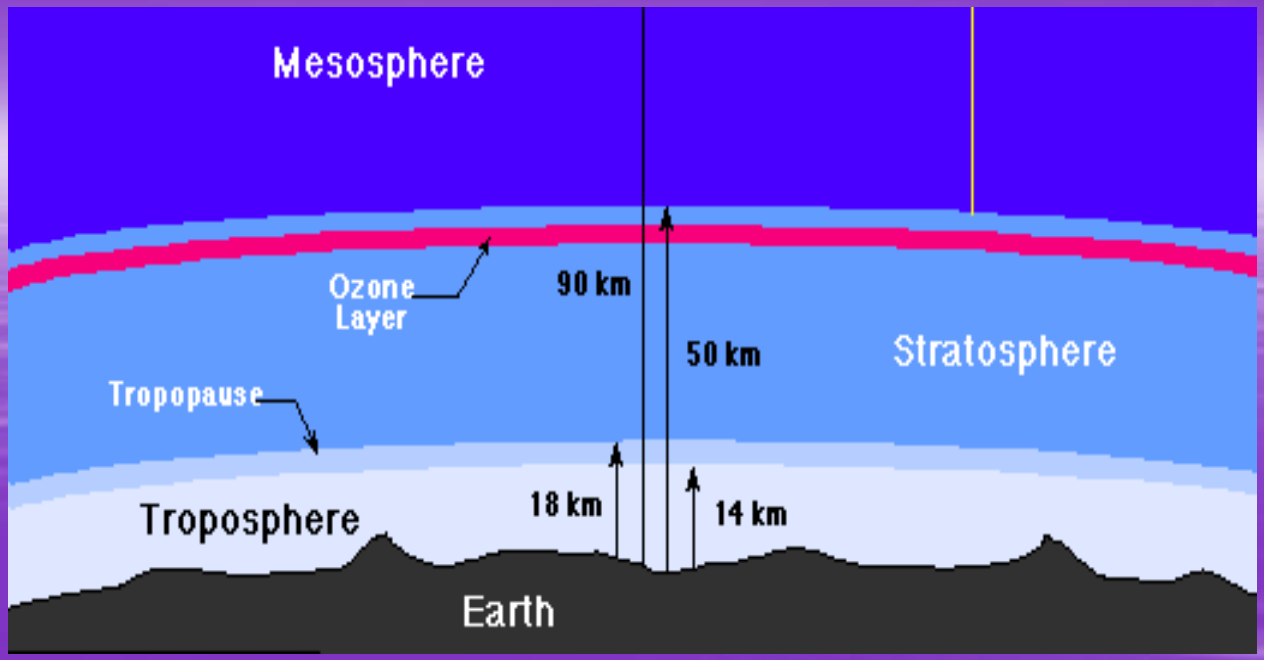
- The water vapor may condense into droplets, forming a cloud.
- If the water vapor condenses on the surface, such as grass, it is called dew.
- The temperature at which saturation occurs and condensation begins is called the Dew Point.



- For water vapor to condense and form a cloud, a solid surface must be available.
- This surface is referred to as the condensation nucleus.

2. Condensation Nuclei

Cloud Formation



- The troposphere contains millions of suspended particles of ice, salt, dust, and other materials.

End Of Slide

Chapter menu

Resources

- Because the particles (especially dust) are so small they remain suspended in the atmosphere for a long time.

Sahara dust

End Of Slide

Chapter menu

Resources

- Next time you are in your room look closely and you will see the dust.

Room Dust

End Of Slide

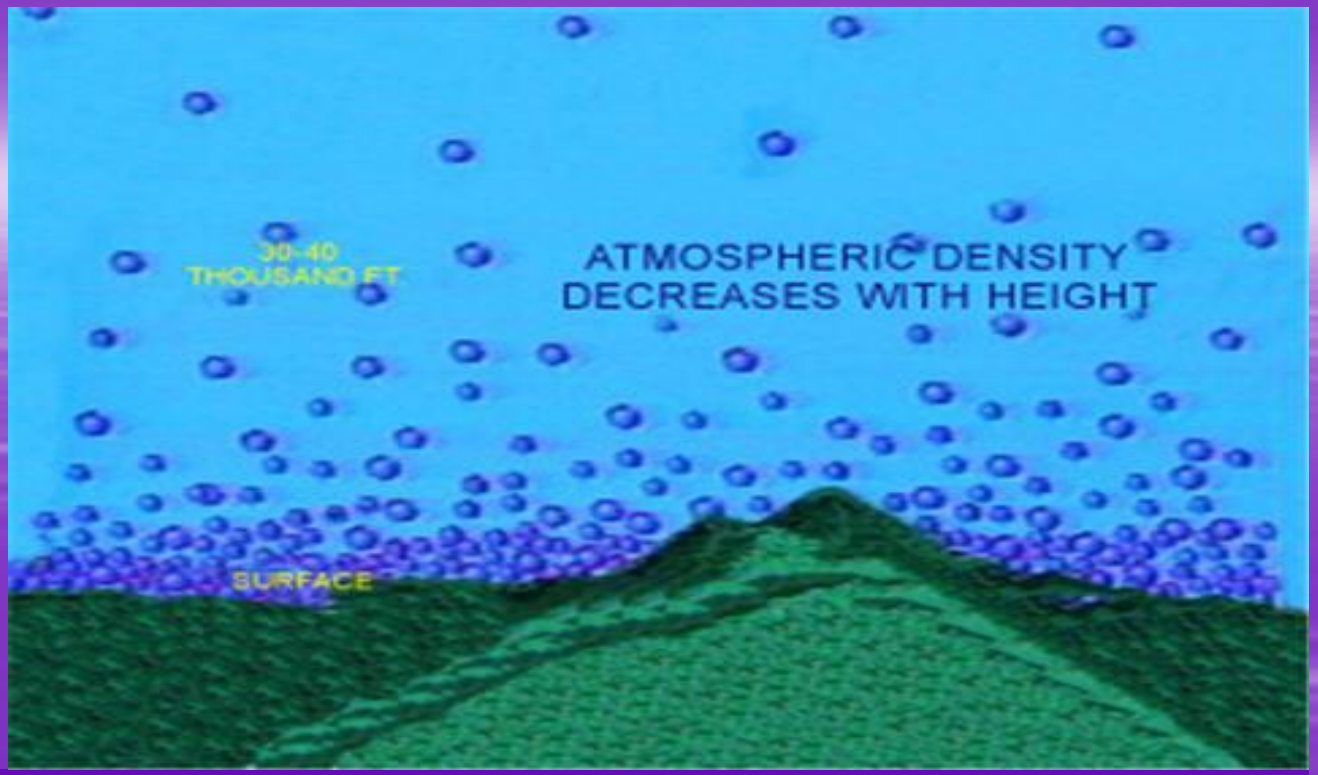
Chapter menu

Resources

- Adiabatic cooling is the process by which the temperature of an air mass decreases as the air mass rises and expands.
- As a mass of air rises, the surrounding atmospheric pressure decreases.

3. The Mechanism for Cooling- Adiabatic Cooling

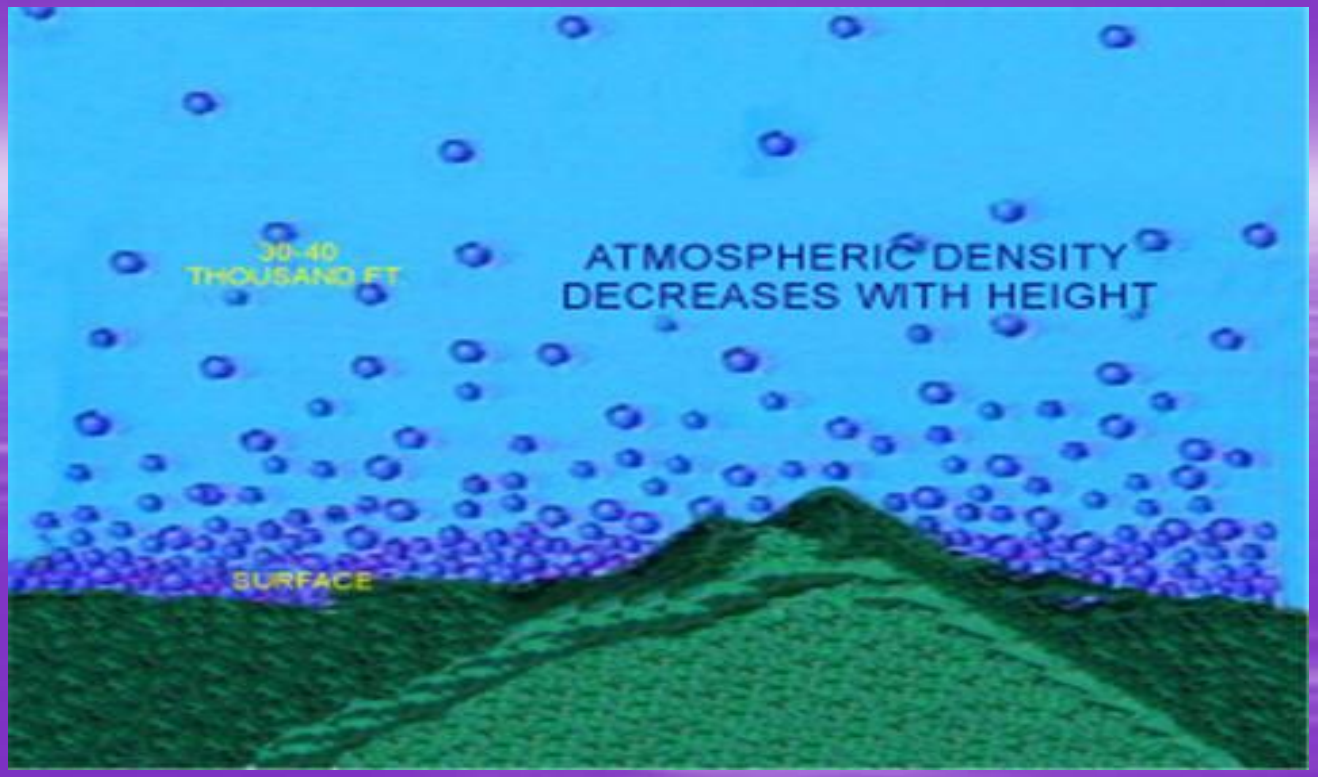
3. The Mechanism for Cooling- Adiabatic Cooling



- Thus, fewer collisions between the molecules happen.
- The resulting decrease in the amount of energy that transfers between molecules decreases the temperature of the air.

Chapter menu
Resources
End Of Slide

3. The Mechanism for Cooling- Adiabatic Cooling



- As the molecules slow down, some are not able to maintain their vapor form so they cluster (condense) in the air to form tiny liquid droplets.

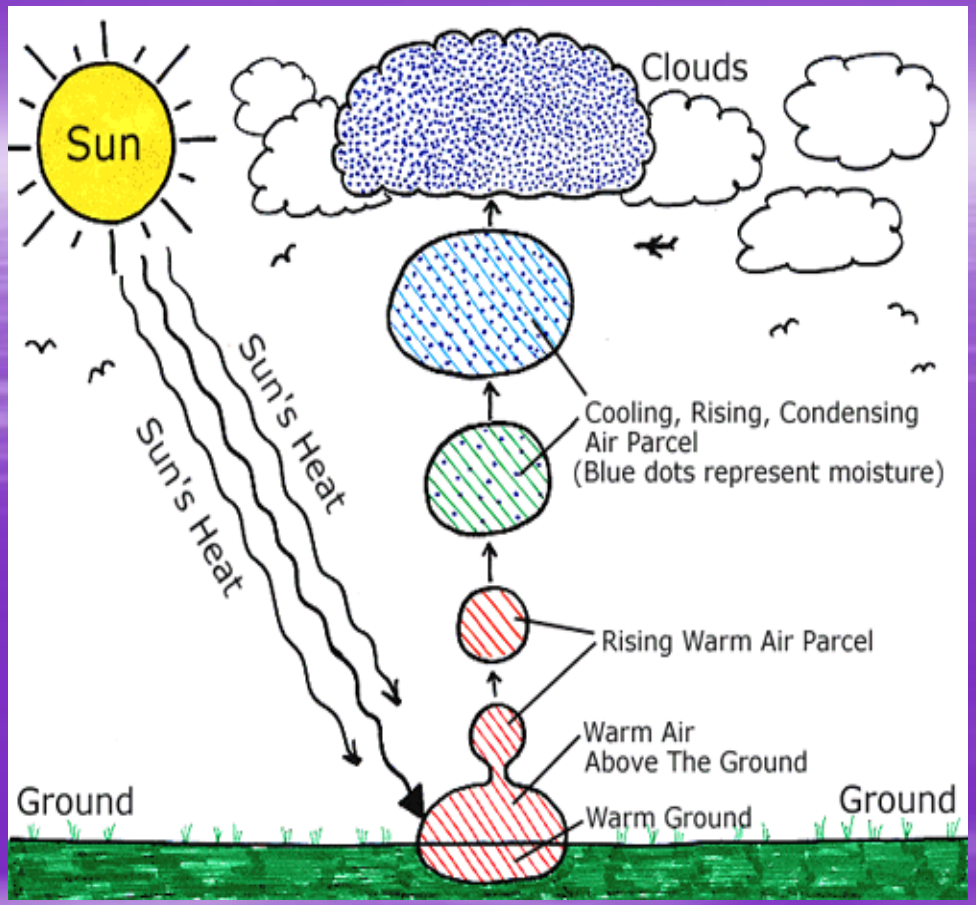
Chapter menu
Resources
End Of Slide

Check for Understanding

- What three things do clouds need to form?
- Describe what atmospheric saturation means?
- What is the Dew Point?
- *Complete questions using complete sentences and in your own words.*

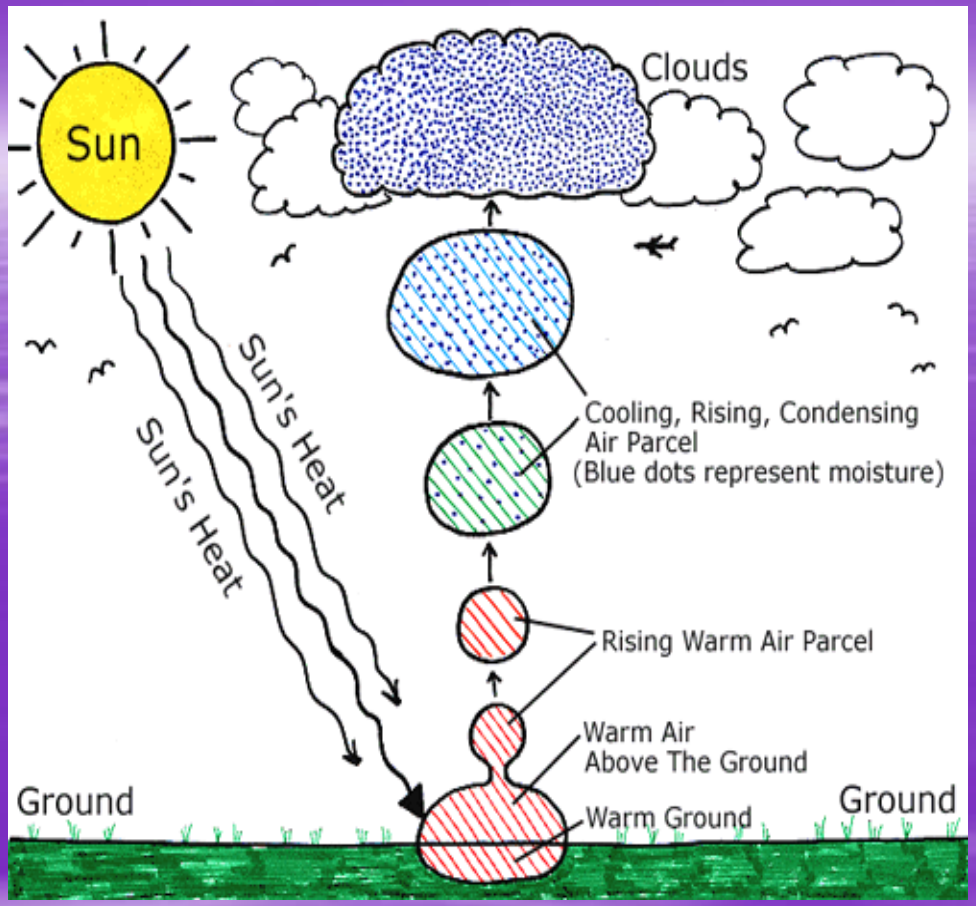
Cloud Formation

- While there are several factors that influence and affect the formation of clouds, it is the sun that plays the primary role.



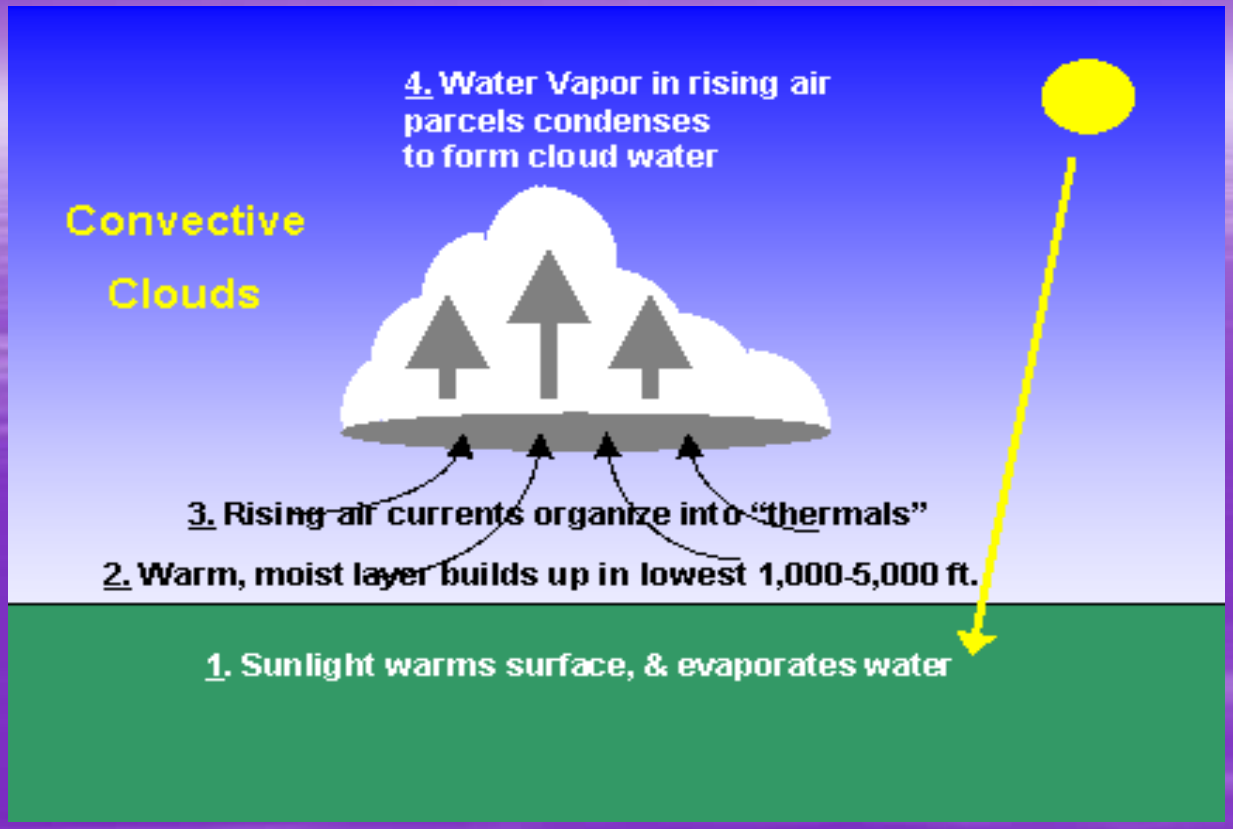
- The Sun creates a thermal which can be thought of as a rising "blob" of warm air due to unequal heating of the earth's surface.
- When the thermal forms at the surface, it is warmer than the surrounding air.

How Clouds Form



How Clouds Form

- Since the thermal is warmer than the air around it, the air in the thermal will rise (convection).
- As it rises, it will begin to expand and cool (adiabatic cooling), and will continue to do so until its temperature is the same as the surrounding air temperature.



- Clouds are the result of a simple process: when the air is cooled down below the temperature at which it can sustain water as a gas, air condensation occurs and clouds form.

How Clouds Form

Cloud Size and Height

- Cloud height is often related to the intensity of precipitation generated by a cloud:
- Thicker clouds tend to produce more intense rainfall.
- Thinner clouds do not generate any precipitation at the surface.

Condensation Level of a Cloud

- The altitude at which this net condensation begins is called the *condensation level and* is marked by the base of the clouds.
- Further condensation allows clouds to rise and expand above the condensation level.

Check for Understanding

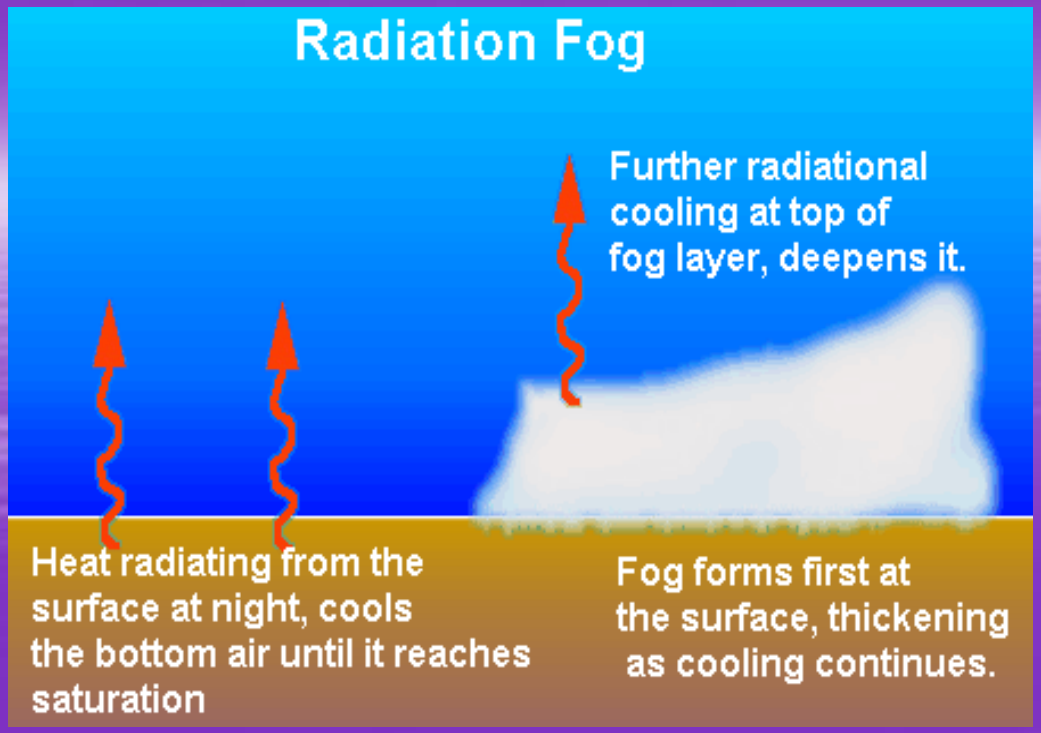
Draw a picture of the cloud formation process.

Explain your drawing?

- *Complete questions using complete sentences and in your own words.*

- There is no difference between fog and clouds other than altitude.
- Fog is defined as a visible moisture that begins at a height lower than 50 feet.
- Two common types of fog are called radiation fog and advection fog.

Lesson 3 - Fog and Cloud Types



1. Radiation Fog (Ground Fog)

- Radiation fog is also known as ground fog.
- The prime time ingredients for radiation fog are saturated soil, light wind, initially clear skies.
- This fog is formed by the cooling of land after sunset by thermal (infrared) radiation.

Radiation Fog (Ground Fog)

Dense Tule fog in Bakersfield, California. Visibility in this photo is less than 500 feet

- The cool ground produces condensation in the nearby air by heat conduction.
- This type of fog can reduce visibility to near zero at times and make driving very hazardous.

Radiation Fog (Ground Fog)

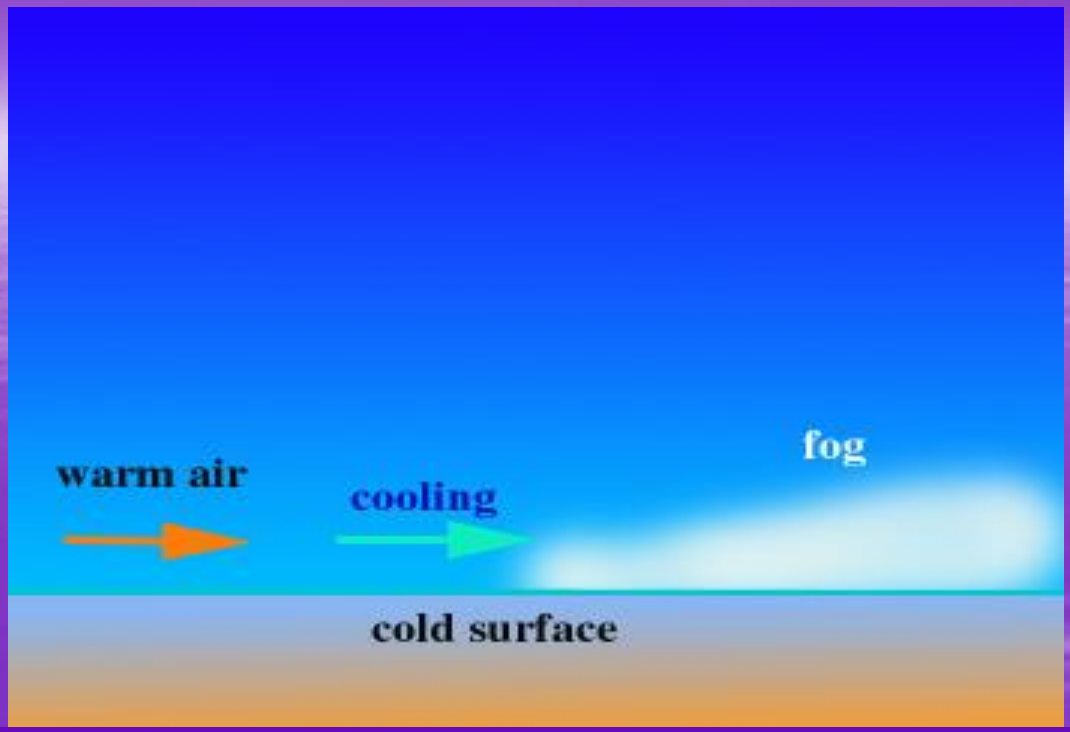
- This type of fog tends to dissipate very quickly once the sun comes up and starts to evaporate the fog layer.

End Of Slide

Chapter menu

Resources

2. Advection Fog (Sea Fog)



- Advection fog forms when warm, moist air moves across a cold surface.

Chapter menu
Resources
End of Slide

Advection Fog (Sea Fog)

- A very common advection fog is that caused by moist air over a cold body of water (sea fog), which occurs up north in cities like San Francisco.

- In San Francisco, the fog is created when warm, moist air blows from the central Pacific Ocean across the cold water of the California Current, which flows just off the coast. This creates cool moist wind along the coast.

Check for Understanding

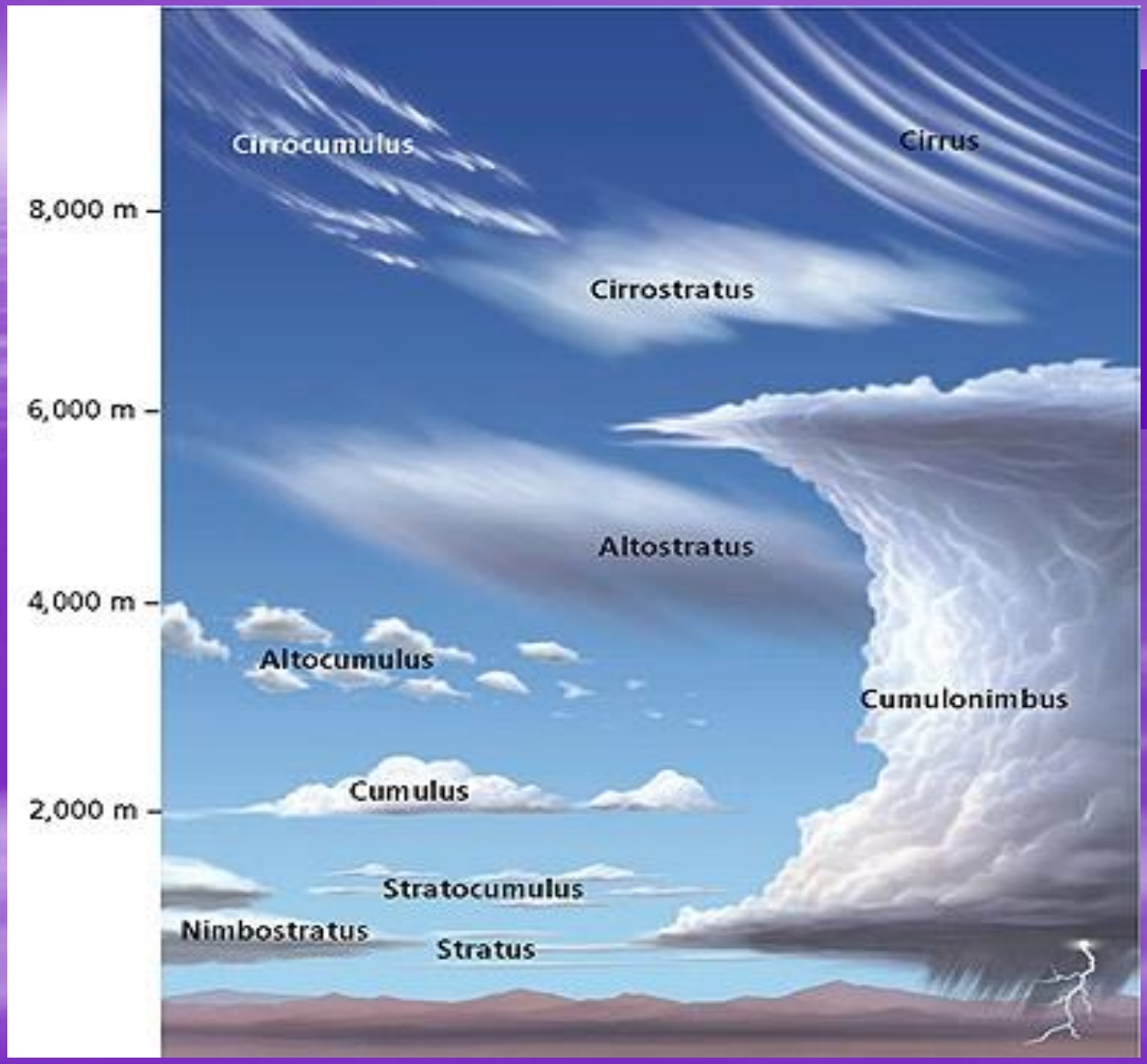
- Explain the main differences between advection fog and radiation fog. (Focus on how they form).

- Explain why fog and clouds are similar and explain why they are different.

Write using complete sentences and in your own words.

- The three basic cloud forms:
- (1) Stratus clouds – lowest level clouds about 0 – 1 mile above.
- (2) Cumulus clouds – middle to high – about 1 to 4 miles above
- (3) Cirrus clouds – highest of clouds about 4 miles – 8 miles above.

Classification of Cloud Types



The diagram below shows the different types of clouds in the atmosphere.

End Of Slide

Chapter menu

Resources

Chapter 23

Stratus Clouds

- Stratus cloud a gray cloud that has a flat uniform base and that commonly forms at very low altitudes
- Stratus clouds can look like a fog that doesn't reach the ground.
- *Stratus* means “sheet-like” or “layered.”

Stratus Clouds

- Two variations of stratus clouds:
- Nimbostratus is low level rain clouds.
- Altostratus thin clouds found at the middle levels and produce very little precipitation.

- Cumulus cloud a mid-level, billowy cloud that commonly has a top that resembles cotton balls and can have a dark bottom
- *Cumulus* means "piled" or "heaped."

Cumulus Cloud

End Of Slide

- The flat base that is characteristic of most cumulus clouds represents the condensation level.

Cumulus Clouds

End Of Slide

Chapter menu

Resources

Cumulonimbus Clouds

- Cumulonimbus clouds are high, dark storm clouds known as *cumulonimbus clouds*, or thunderheads, are often accompanied by rain, lightning, and thunder.

End Of Slide

Chapter menu

Resources

Altocumulus

- Two variations of cumulous clouds:
- Cumulonimbus clouds are mid level rain storm clouds.
- Altocumulus clouds are part of the Middle Cloud group (1 – 4 miles).

End Of Slide

- (3) Cirrus clouds – highest of clouds about 4 miles – 8 miles above.
- Classifications of clouds can also include the prefix nimbo / nimbus = rain
- Alto = Latin for high up (ex. also with instruments alto saxophone)

Cloud Prefix's

End Of Slide

Chapter menu

Resources

Cirrus Clouds

- Cirrus cloud are thin, wispy clouds blown by high winds into long streamers.
- They are considered "high clouds" forming above 4 miles.
- *Cirro*– and *cirrus* mean “curly.”

Cirrus Clouds

- Because these clouds are thin, light can easily pass through them.
- They generally represent fair to pleasant weather.

Cirrus Clouds

- There are two variations of cirrus clouds worth mentioning:
- Cirrocumulus clouds
- Cirrostratus clouds

Cirrocumulus clouds

- *Cirrocumulus clouds* are rare, high-altitude, billowy clouds composed entirely of ice crystals.
- Cirrocumulus clouds commonly appear just before a snowfall or a rain fall.

- Long, thin clouds called *cirrostratus clouds* form a high, transparent veil across the sky.

Cirrostratus

- A halo may appear around the sun or moon when either is viewed through a cirrostratus cloud.

Cirrostratus

- Lenticular clouds are stationary lens-shaped clouds that form at high altitudes, normally aligned perpendicular to the wind direction.
- You may mistake them for an unidentified flying object.

The Unique Lenticular Clouds

Chapter menu

Resources

End of Slide

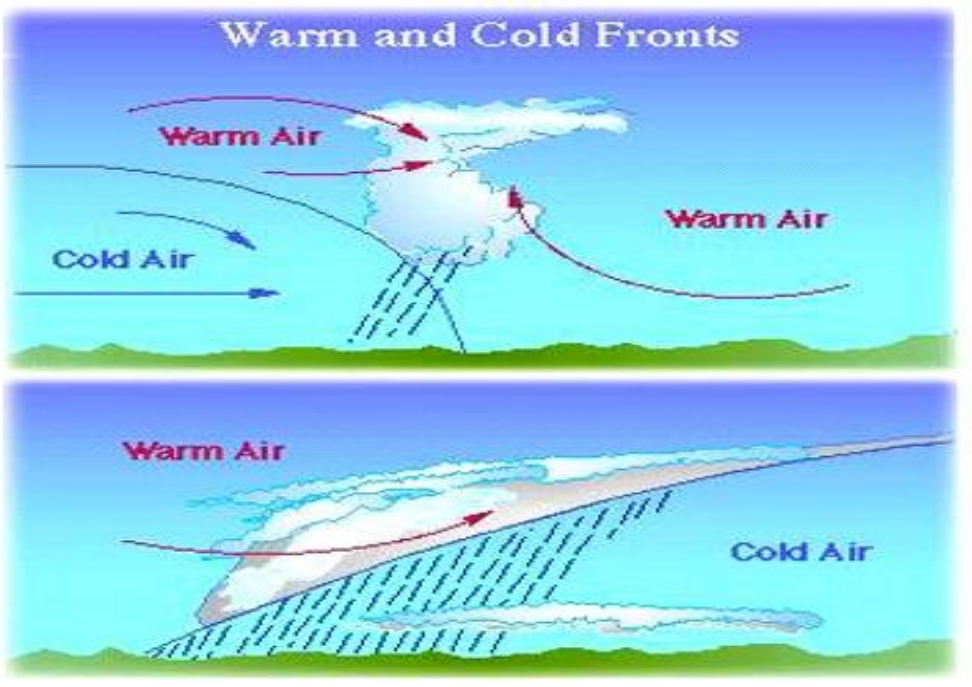
Check for Understanding

- Explain the main three different types of clouds?

Write using complete sentences and in your own words.

Chapter 24
Lesson 4 - Fronts

- Online Visual
http://www.classzone.com/books/earth_science/terc/content/visualizations/es2002/es2002page01.cfm?chapter_no=visualization

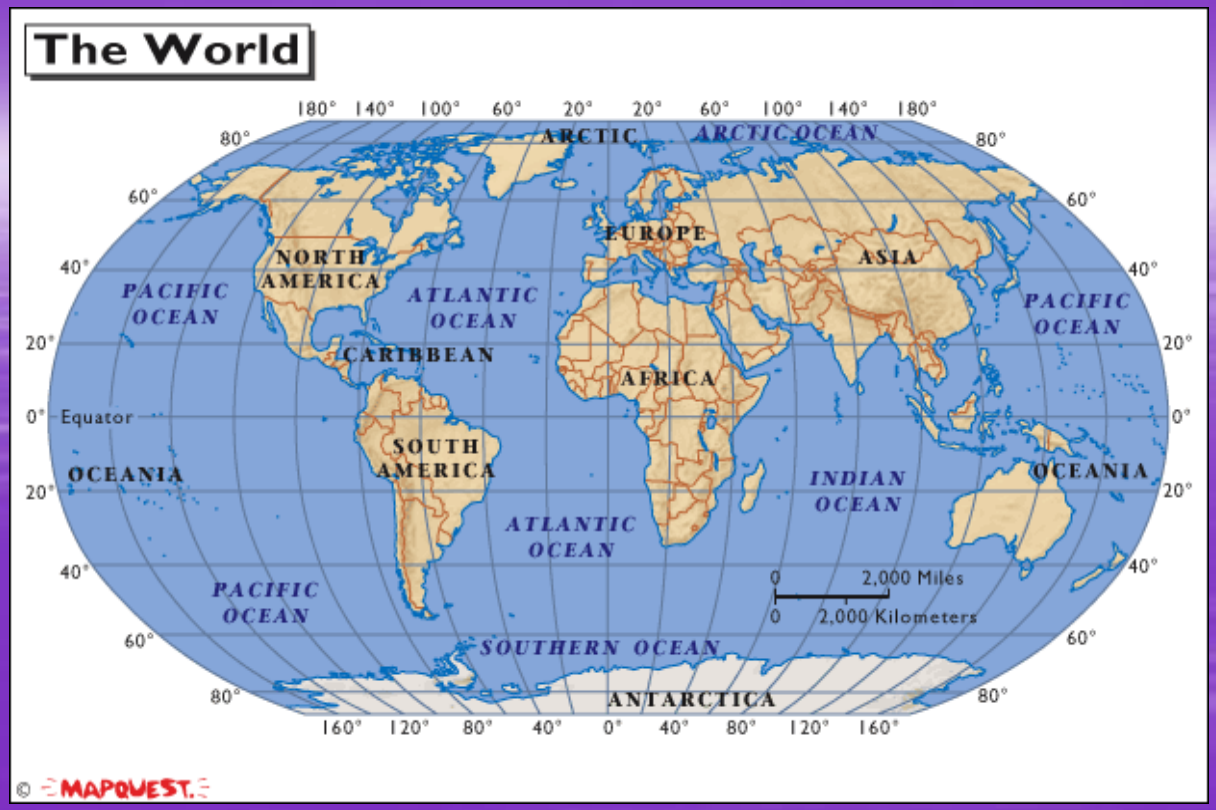


- A front is defined as the transition zone between two air masses of different density.

- A cool air mass is dense and does not mix with the less-dense air of a warm air mass, therefore there are two major fronts:
- (1) Cold Fronts
- (2) Warm Fronts.

Chapter menu
Resources
End of Slide

Where on Earth Do Fronts Compete Mid-Latitude

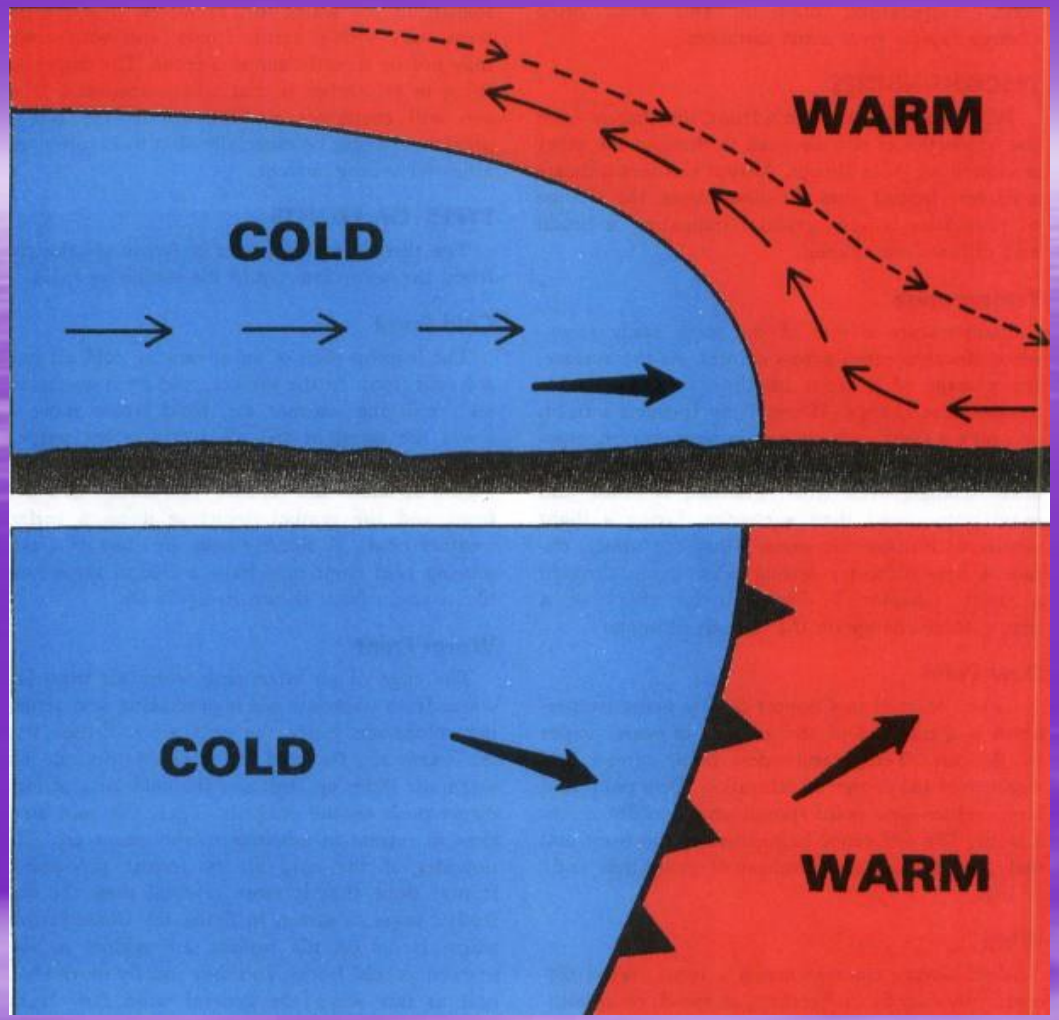


- Middle Latitudes: Their is constant competition between the warm air fronts of the tropics and colder air fronts of the Earth's Poles.

Chapter menu
Resources
End of Slide

- Equatorial or tropics: there are no distinguishable difference between competing air masses, so the weather is consistently nice with a chance of rain.

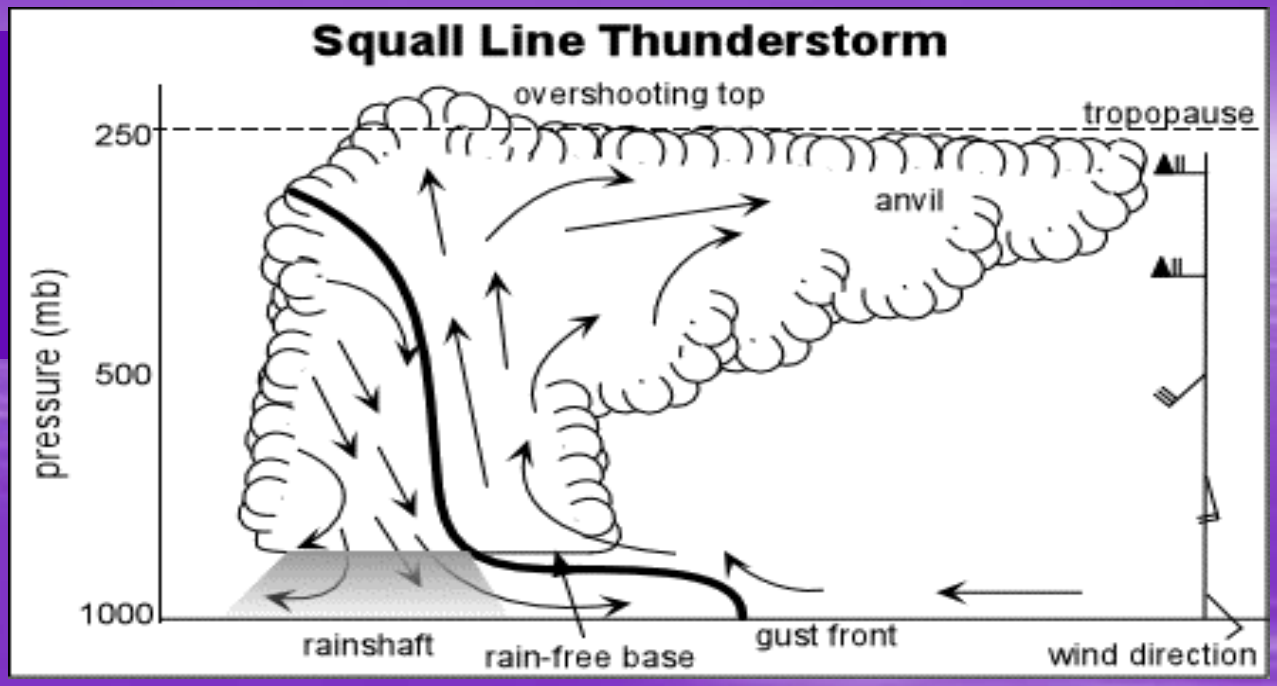
Tropical Weather Fronts



- A slow-moving cloud front (warm or cold) typically produces weaker storms and lighter precipitation than a fast-moving cold front does.

Speed of the New Front Matters

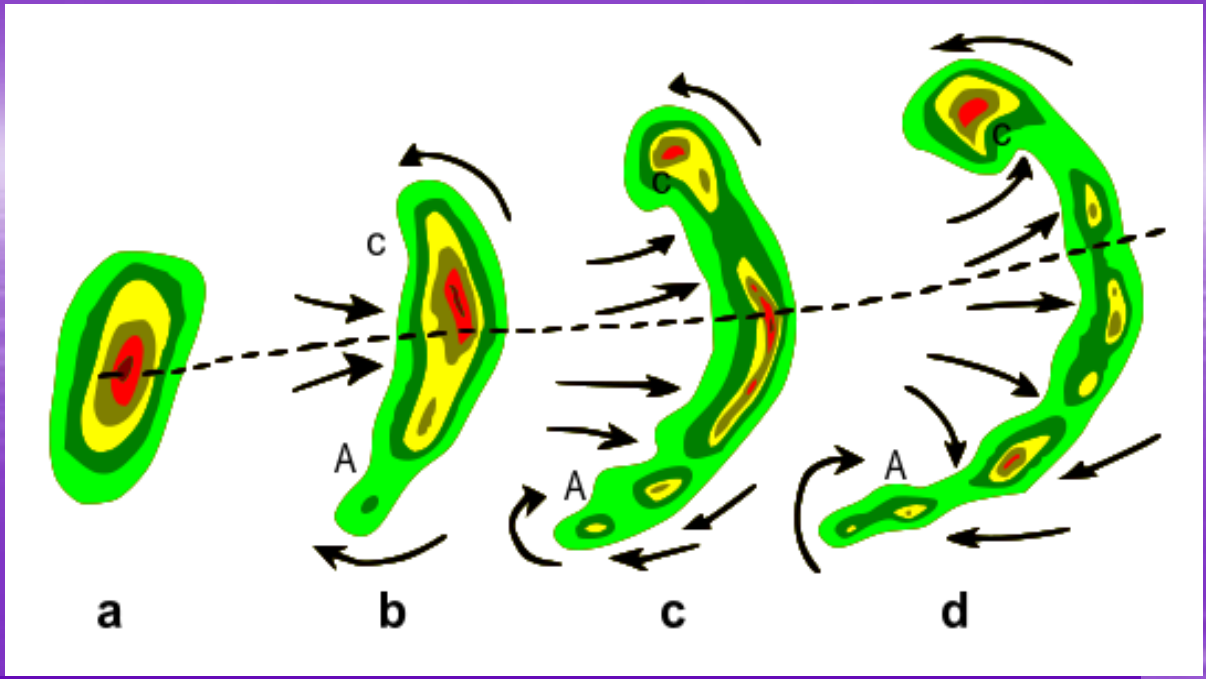
Fast Moving Front



- If the cold front is a fast moving front then large cumulus and cumulonimbus clouds typically will form.

Chapter menu
Resources
End Of Slide

Fast Moving Front



- Weather may be brief but can become unpredictable and downright violent with wind, rain, hail and thunderstorms and if you live east of the Rockies there is a chance of tornadoes.

Chapter menu
Resources
End Of Slide

Fast Moving Front

- Back east where weather can get severe this fast moving cold front is referred to as a squall line.

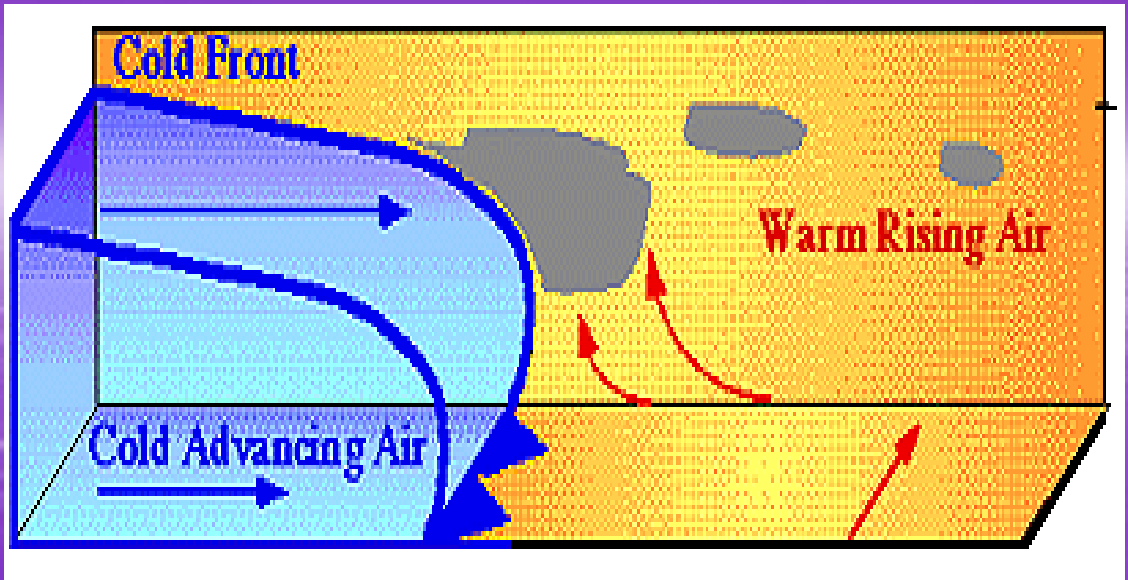
Chapter menu Resources End Of Slide

Check for Understanding

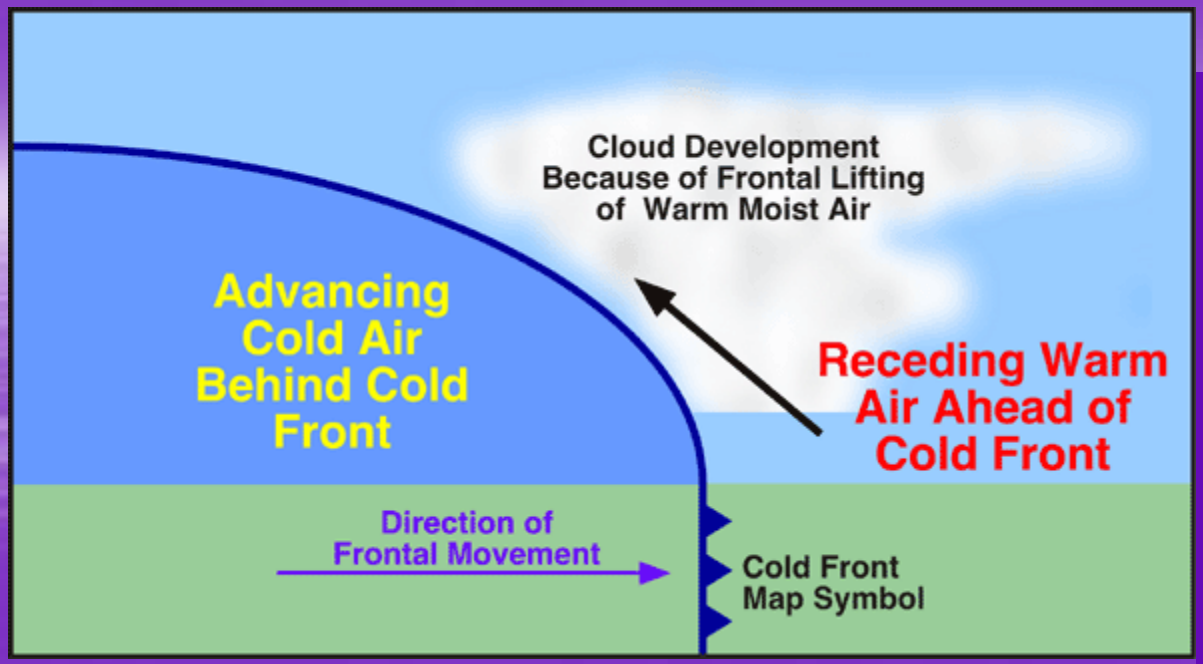
- What are weather fronts?

Write using complete sentences and in your own words.

Cold Fronts

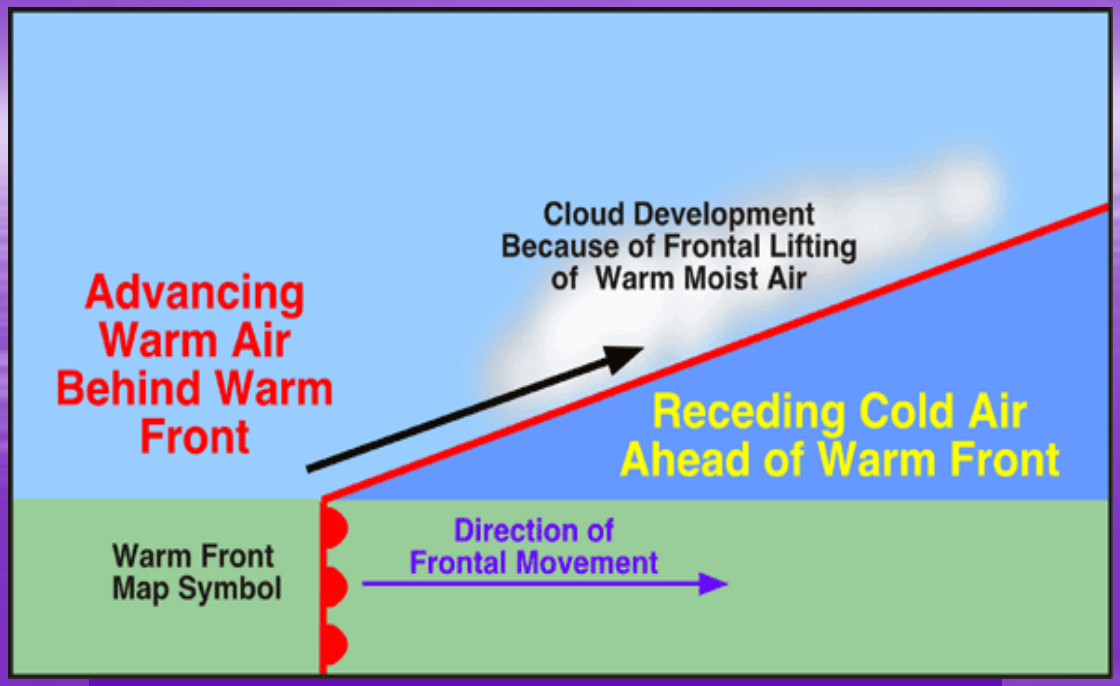


- A cold front is defined as the leading edge of a cooler mass of air, replacing (at ground level) a warmer mass of air, which lies within a fairly sharp surface trough of low pressure.
- Cold fronts will push warmer air mass up into the air because the edge of the cold front is more dense and if there is any moisture in the warm air then clouds will form.



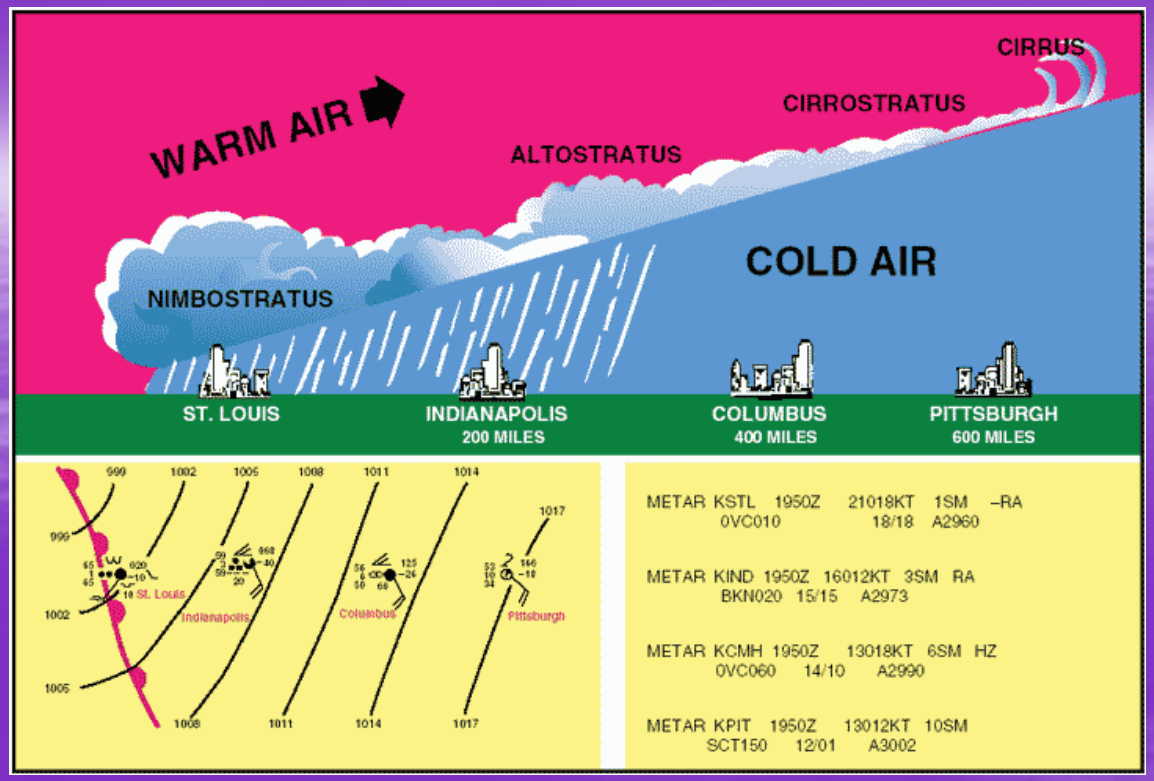
Characteristics of a Cold Front

- They tend to move fast
- Associated with the most violent weather
- Associated with cirrus well ahead of the front and a broad area of clouds immediately behind the front



Warm Fronts

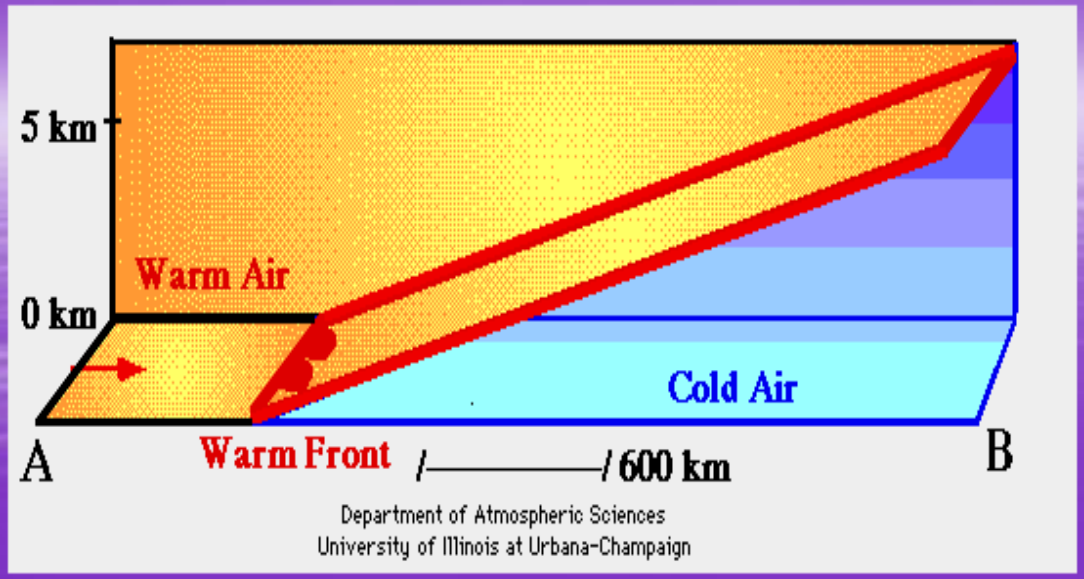
- A warm front is defined as the transition zone where a warm air mass is replacing a cold air mass.
- The slope of a warm front is gradual because of density differences.



Warm Fronts

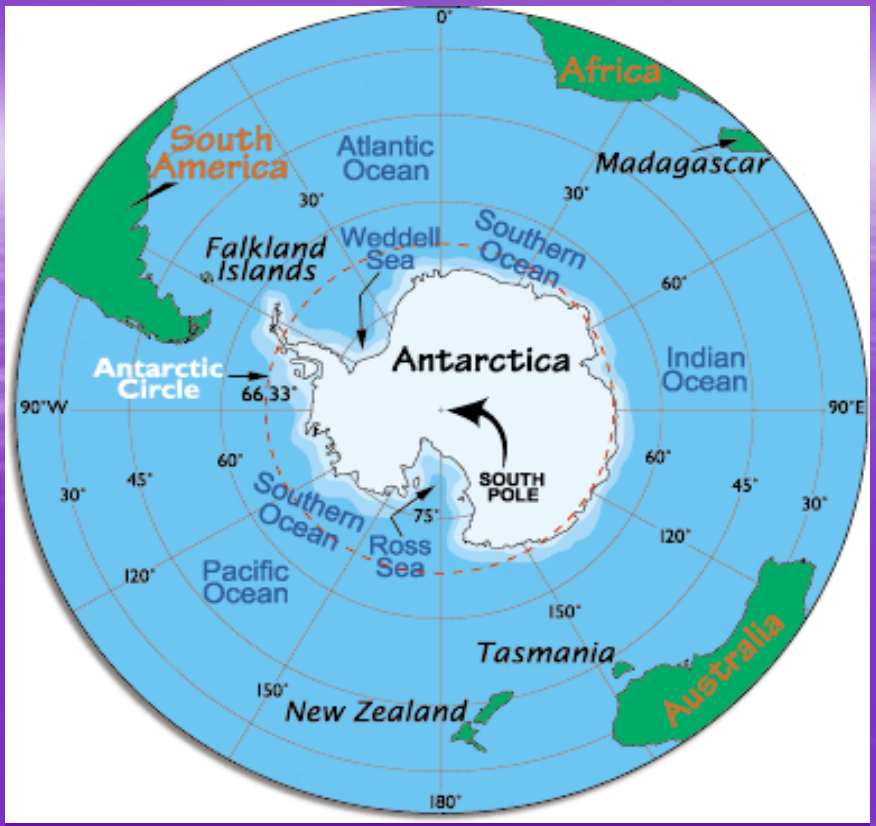
- Because of this gentle slope, clouds may extend far ahead of the surface location, or *base*, of the front.
- A warm front generally produces precipitation over a large area.
- It is like throwing a blanket over the car.

Chapter menu
Resources
End of Slide



Warm Fronts Characteristics

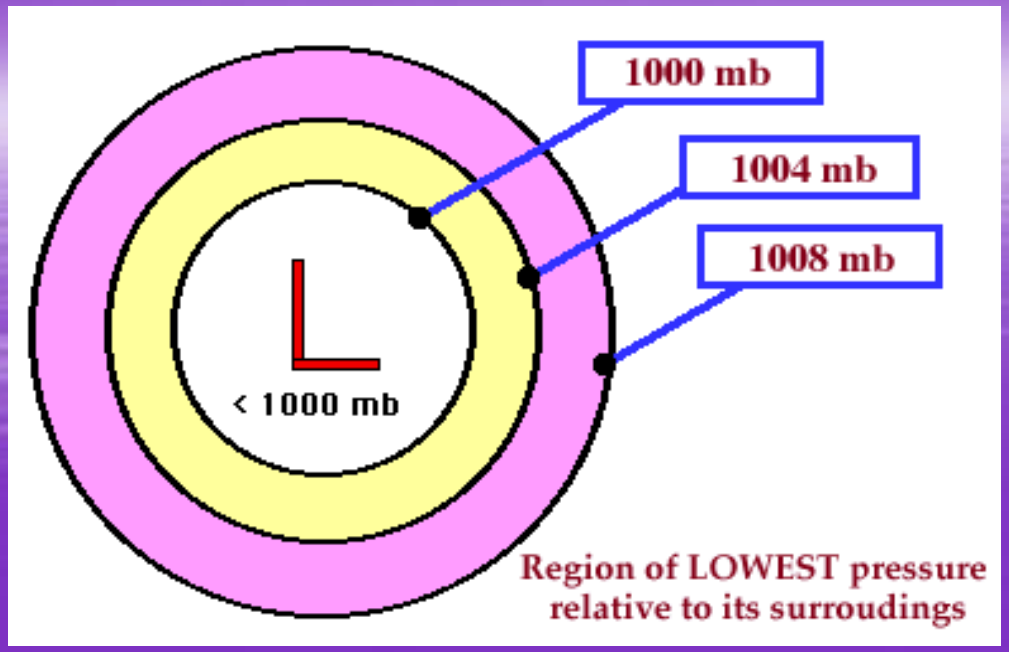
- Tend to move slowly
- Typically less violent than cold fronts with light to moderate continuous rainfall.
- Behind warm front, skies are relatively clear (but change gradually)



Polar Weather Fronts

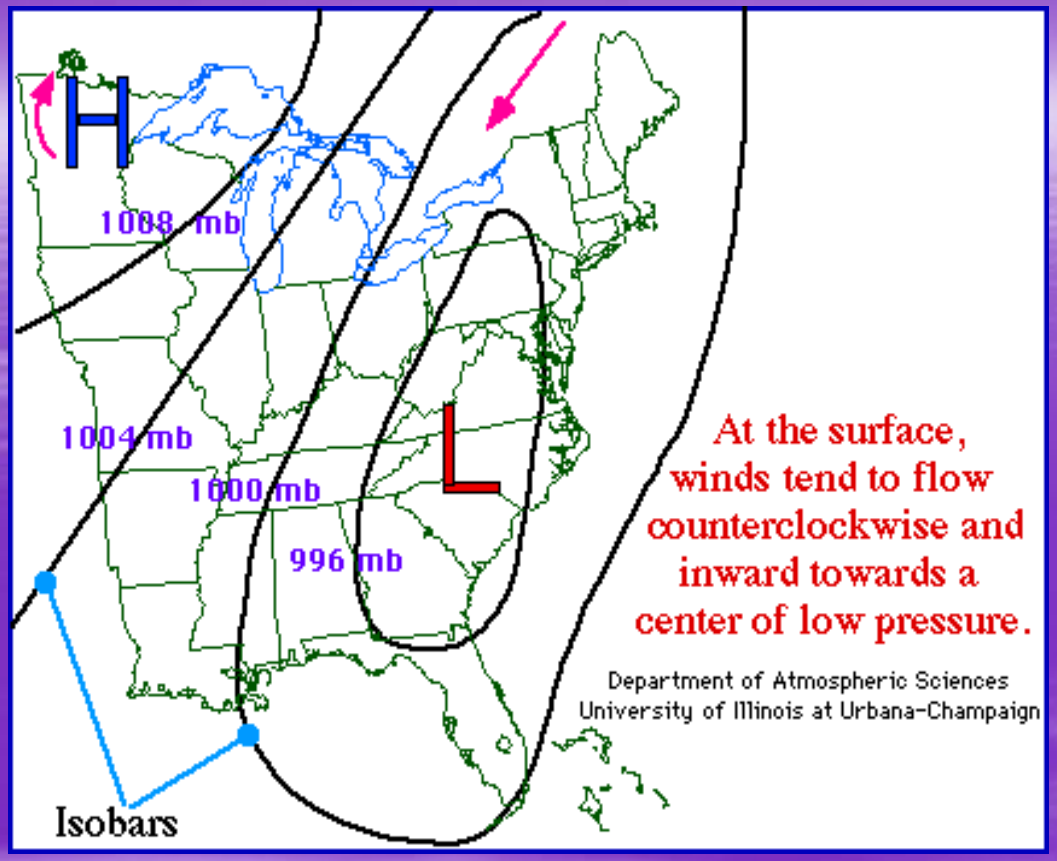
- The continent's extreme cold makes it the driest continent because very cold air contains hardly any water vapor to create snow.
- This is why the interior of Antarctica is the world's biggest desert, with the precipitation (if the snow were melted) averaging under 2 inches of water a year.

Chapter menu
Resources
End of Slide



Low Pressure Cyclone

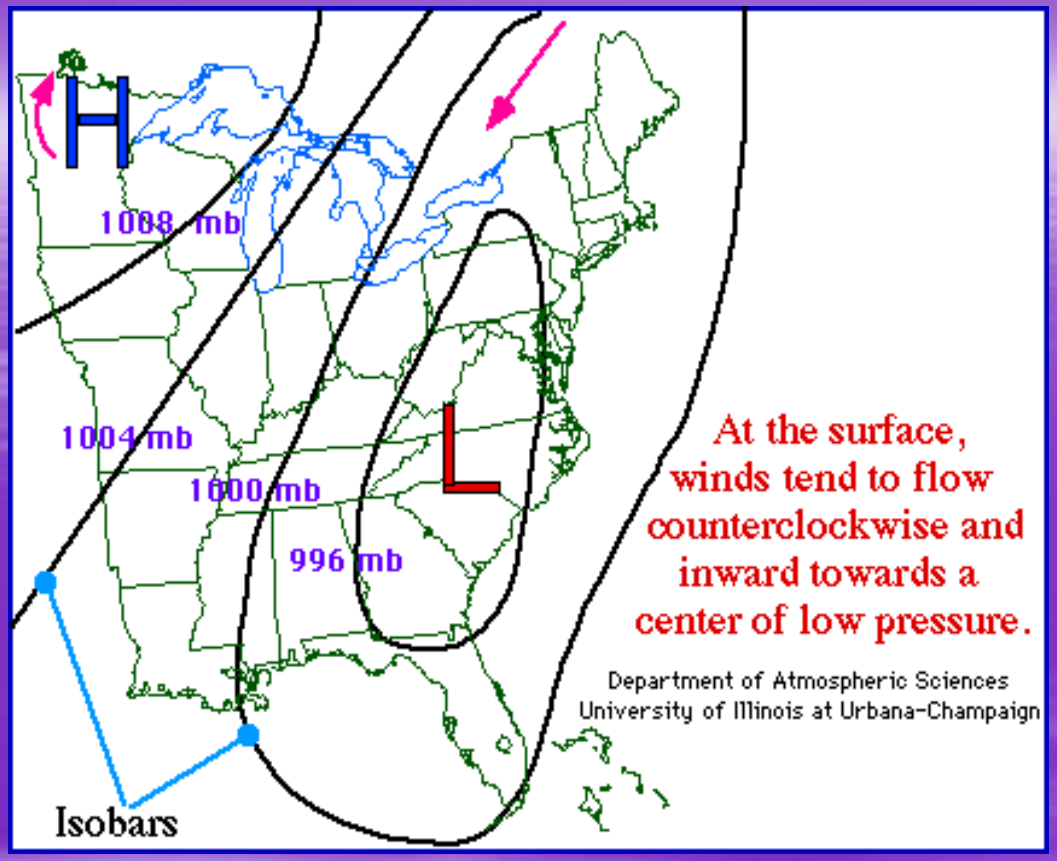
- A low pressure center is where the air pressure has been measured to be the lowest relative to its surroundings.
- At the surface winds flow counter-clockwise and inward toward the center of low pressure.



- Rising air favors the development of clouds and precipitation, which is why cloudy weather (and likely precipitation) are commonly associated.

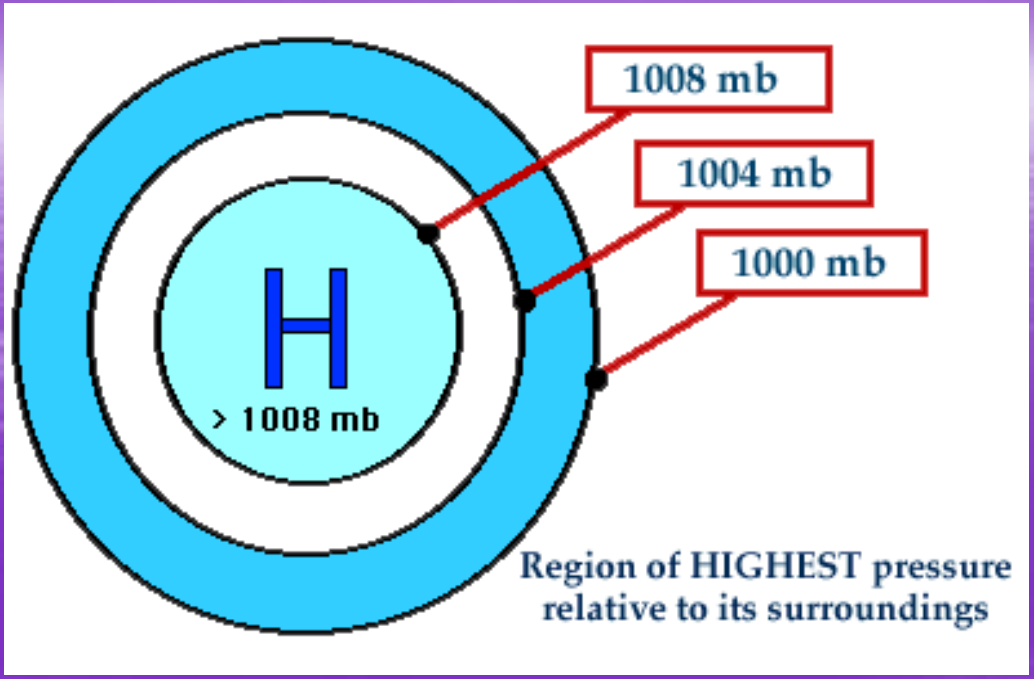
Low Pressure Cyclone

Chapter menu
Resources
End of Slide



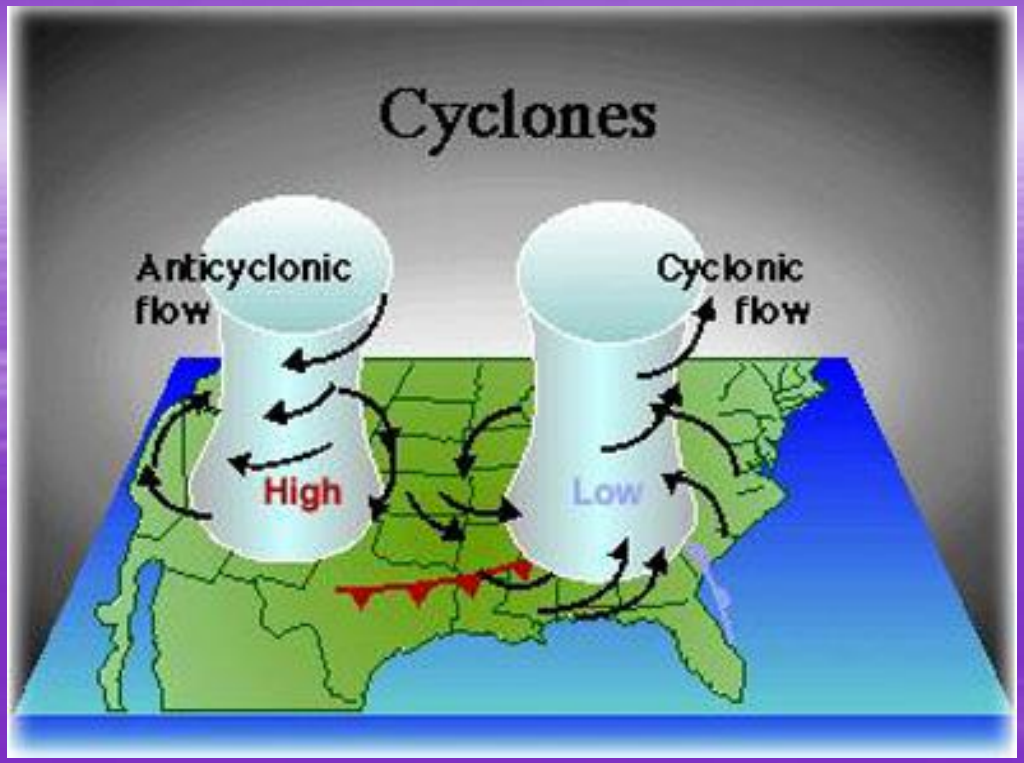
- The counterclockwise winds associated also play a significant role in the movement air masses, typically transporting warm moist air northward ahead of a low while dragging colder and drier air southward behind it.

Low Pressure Cyclone



High Pressure Anticyclone

- A high pressure center is where the air pressure has been measured to be the highest relative to its surroundings.
- At the surface winds flow clockwise and outward away from the center of high pressure.



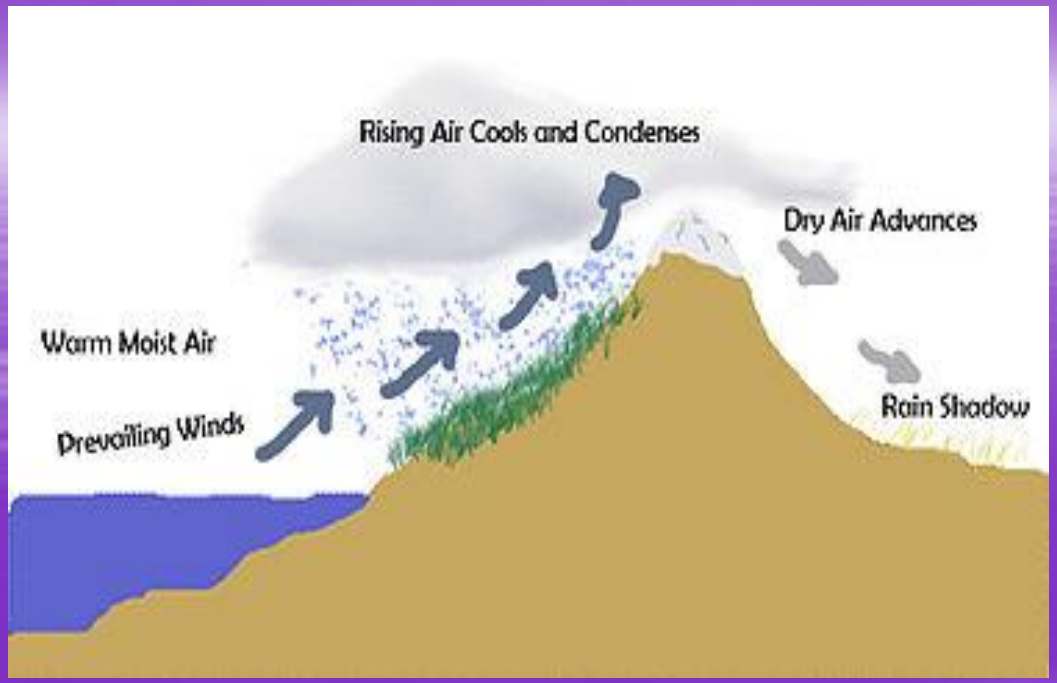
High Pressure Anticyclone

- The air inside an anti-cyclone is pushed away from the high pressure inside the center.
- The air that moved downward is compressed and warmed, reducing the humidity of the descending air; as a result there are fewer clouds and lower humidity.

Check for Understanding

- What is the difference between a low pressure cyclone and high pressure anticyclone?

Write using complete sentences and in your own words.



Extreme Weather of California - Rain Shadows

- Rain Shadows are areas that lie in the shadow of mountain ranges and receive little precipitation
- Rainfall is heavy along the western side of the Coastal Ranges and the Sierra Nevada's of California.

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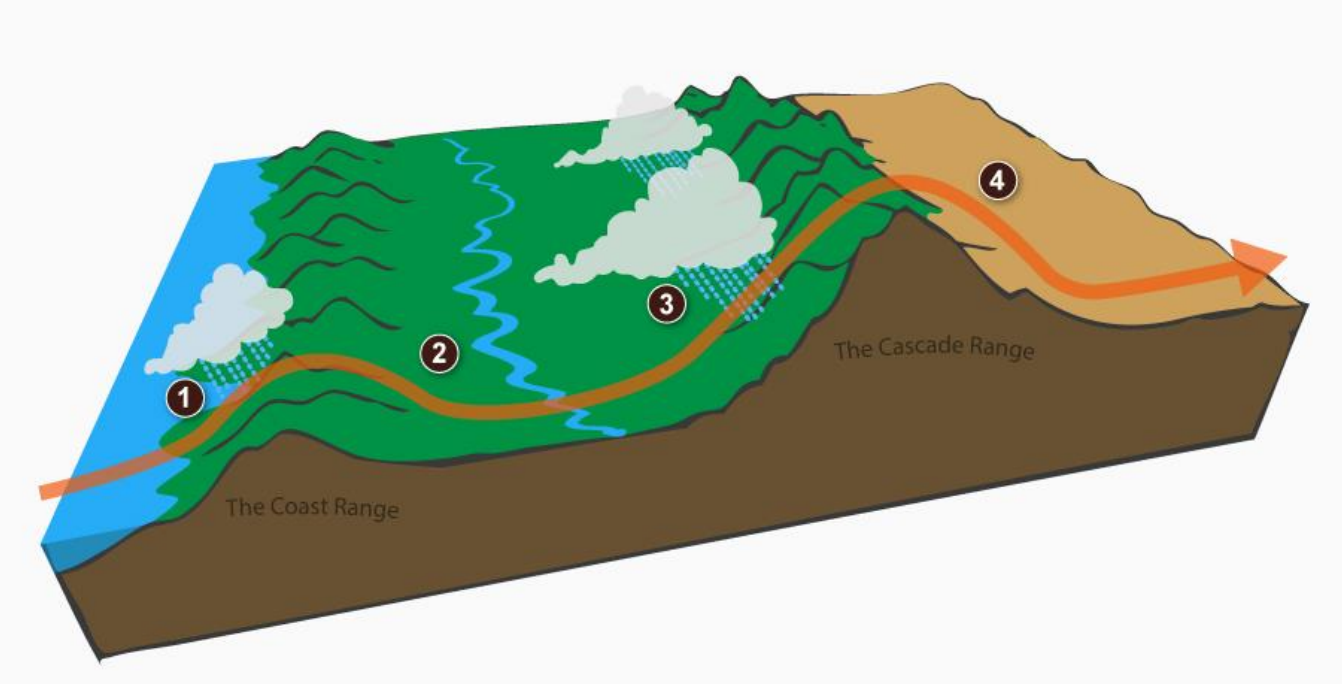
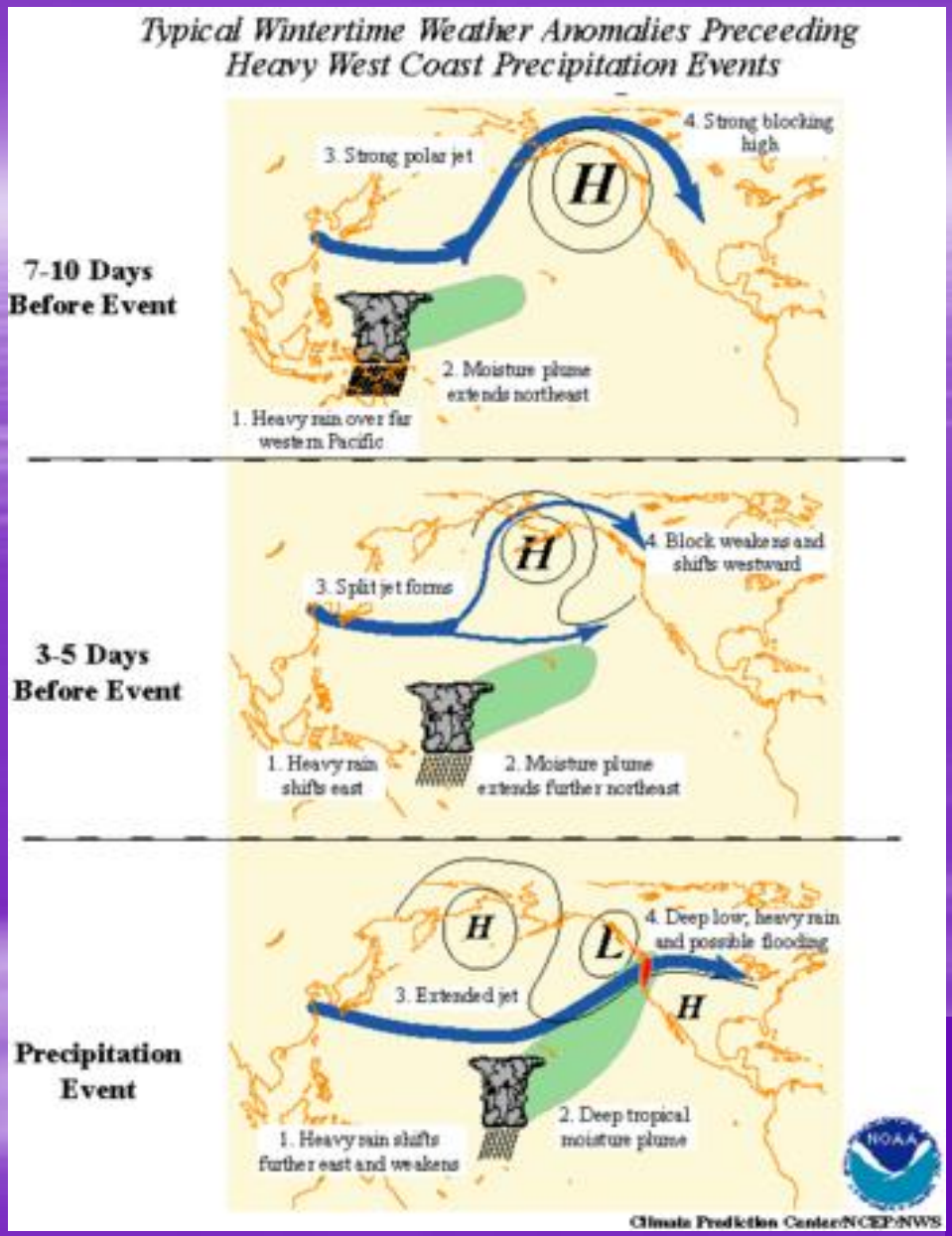
California Rain Shadows



- Much less rain occurs on the eastern side of these mountains.
- Semi-arid (Dry) valleys and deserts have formed on the eastern side of the mountains.



- The Pineapple Express refers to a warm tropical rain in southern California that usually coincides with the El Nino.
- The name refers to the air that comes from the Hawaiian tropics.

Extreme Weather of California -The Pineapple Express

The Pineapple Express

- The Pineapple express occurs when circulation pattern produces southwesterly winds pulling air from the tropical pacific into southern CA.

The Pineapple Express

- In 2010, a Pineapple Express system ravaged much of California from Dec.17 through Dec. 22, bringing with it as much as 14 inches of rain in some areas (La Verne had 9.84 inches).

Check for Understanding

- Explain a rain shadow.
- What is the Pineapple Express?

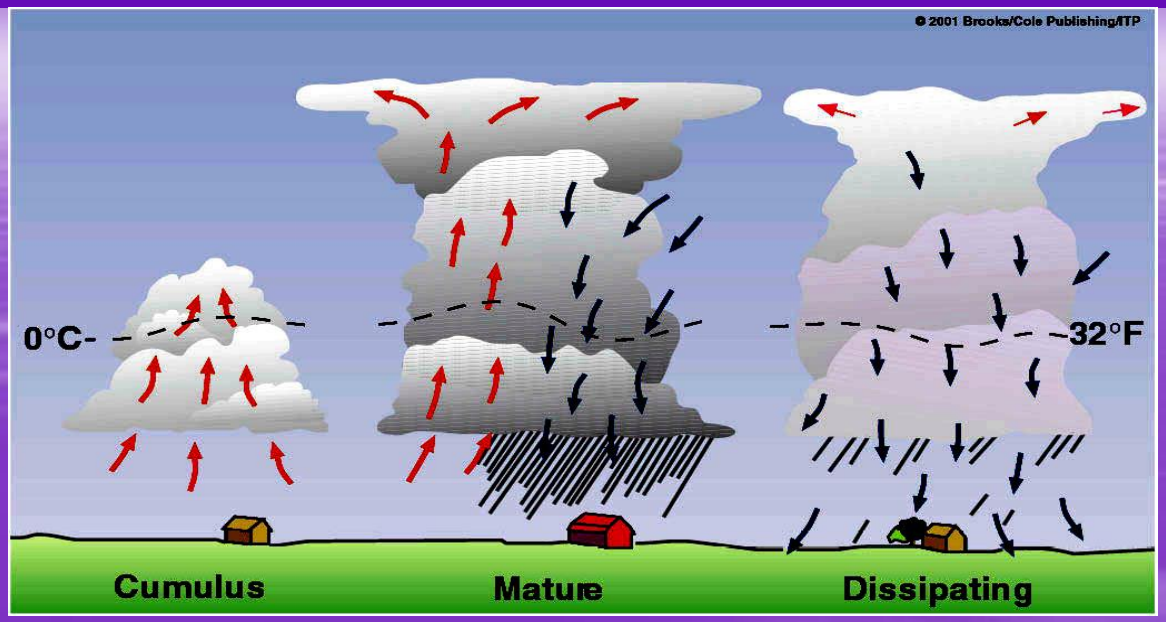
Write using complete sentences and in your own words.

Chapter 24 Lesson 5 – Thunder Storms

- Thunderstorms are usually brief, heavy storm that consists of rain, strong winds, lightning, and thunder.

Chapter menu Resources End of Slide

Thunderstorms develop in three distinct stages.

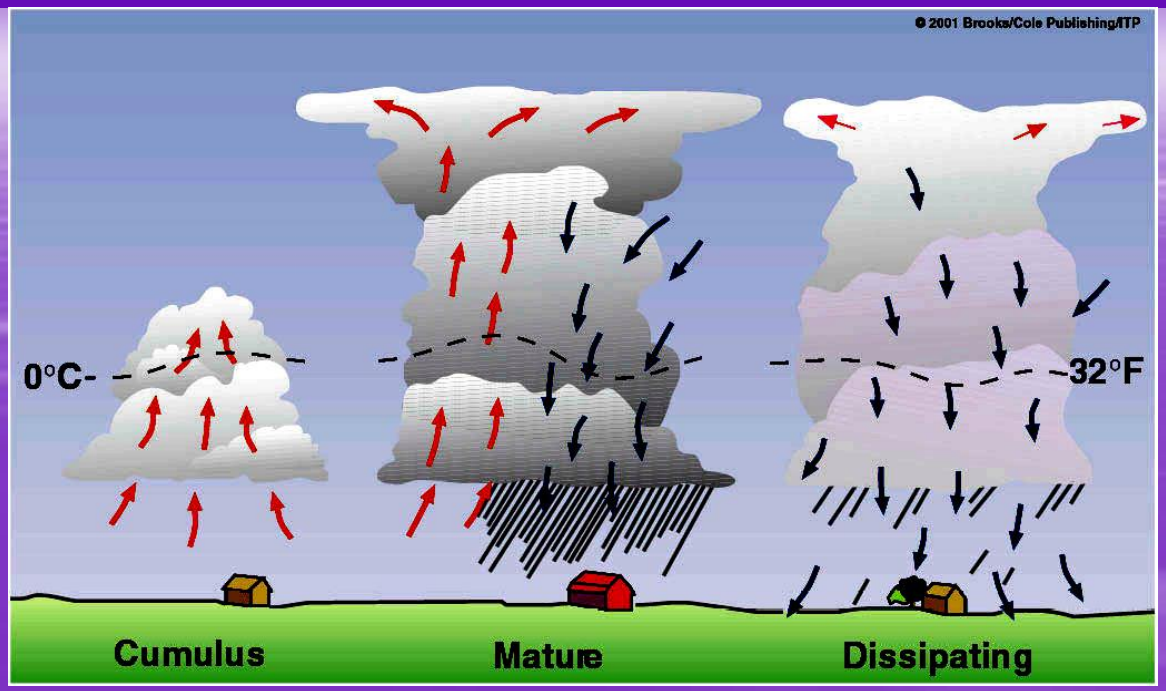


weather

- (1) Cumulus stage – cloud forms because of clashing fronts
- (2) Mature stage – cumulonimbus cloud forms an updraft & downdrafts create a cloud of lightning & thunder, hail and heavy rainfall

Chapter menu
Resources
End of Slide

Thunderstorms develop in three distinct stages.



- (3) Dissipating stage – strong downdraft takes over eliminating updraft and lighter rainfall.

Check for Understanding

- Explain the 3 stages of thunderstorm development.

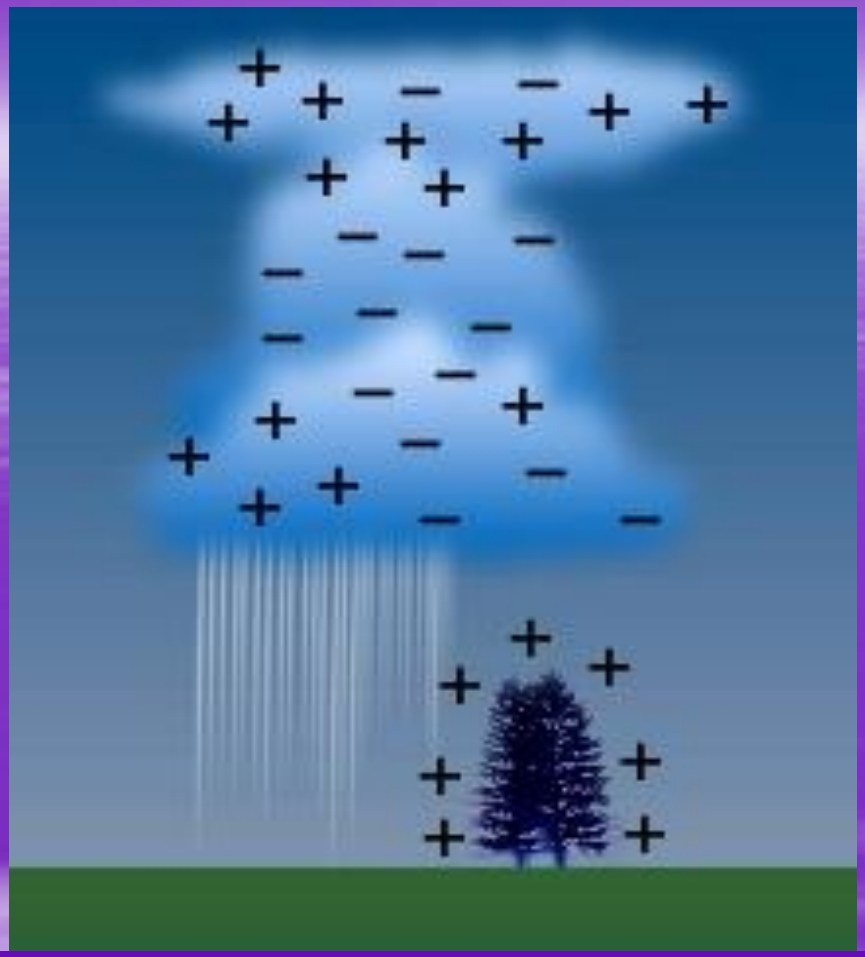
Thunder (10 feet away)

- Lightning is very hot and heats up the air around it.
- Hot air gets bigger: it expands.
- What you hear is air pushing against air and these vibrations (sound) bouncing off the ground and the clouds.

Chapter menu Resources End Of Slide

Lightning

- Lightning is like static electricity: when two materials come in contact with each other, one material will take some of the electrons from the other and this charge imbalance is where static electricity is created.



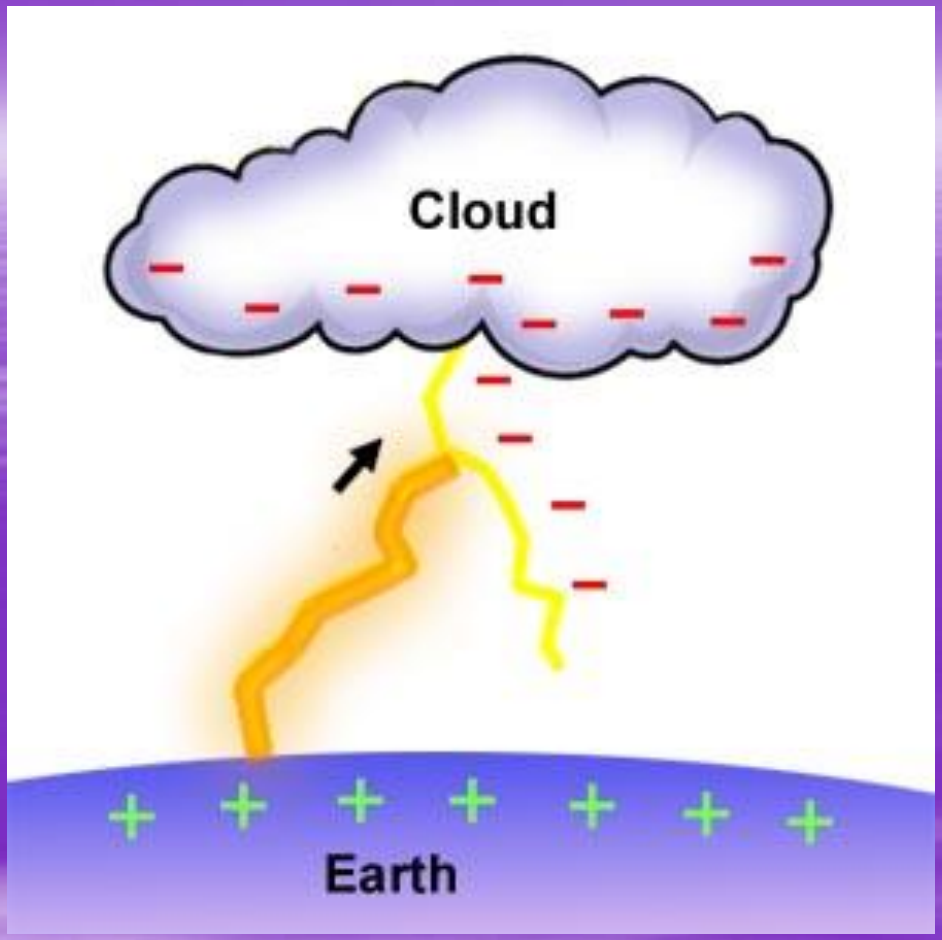
- Cloud-to-Ground (CG) lightning occurs during a thunderstorm turbulence in the cloud causes the charges to separate in such a way that the negative charges concentrate in the base of the cloud.

Why do we have Lightning

End Of Slide

Chapter menu

Resources

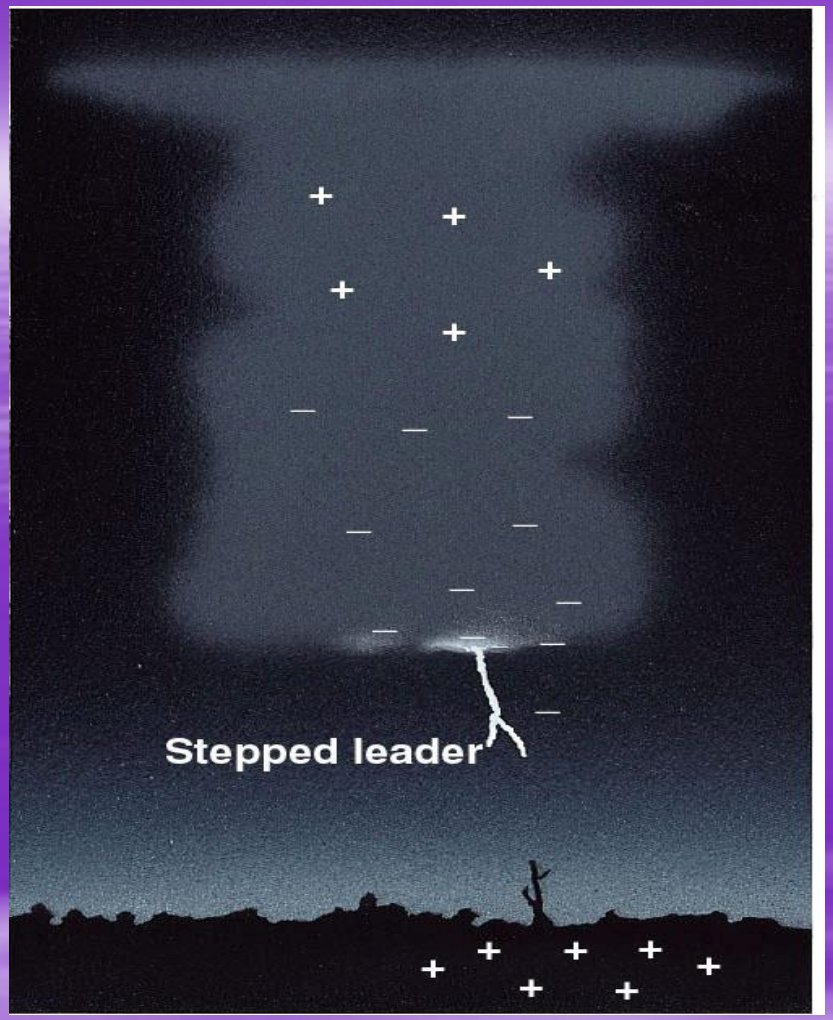


- Since like charges repel, some of the negative charges on the ground are pushed away from the surface.
- This leaves a net positive charge on the surface.

Why do we have Lightning

End Of Slide

Chapter menu | Resources



- At this point since opposites attract, the positive and negative charges are pulled toward each other.
- This attraction creates invisible strokes called a stepped leader.

Lightning's Invisible Stroke

Chapter menu
Resources
End of Slide

Visible Lightning

- As soon as the negative and positive parts connect there is a conductive path.
- From cloud to the ground (CG) the negative charges rush down it causing the visible stroke we call lightning.

- The visible stroke actually travels upwards, even though the charges are moving downward.

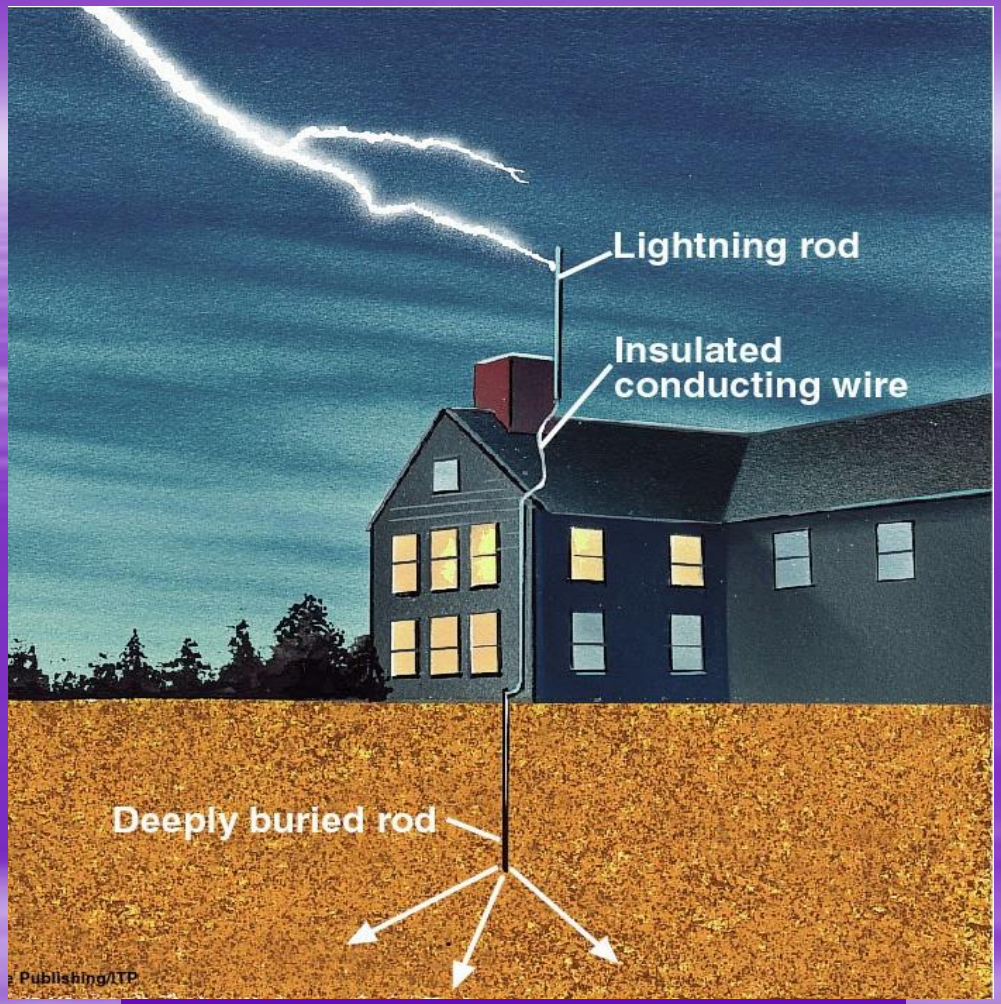
Visible (CG) Lightning

Cloud-to-Cloud Lightning

- True cloud-to-cloud (CC) lightning is rare.
- Most lightning flashes occur in the cloud or what is referred to as intra-cloud lightning.
- As with ground to cloud lightning (CG) discharge is initiated by the attraction of opposite charges within the clouds.

- Lightning rods were originally developed by Benjamin Franklin to protect structures.
- In the 1700's building materials, like wood, would easily catch fire creating havoc for towns.

Lightning Rod



- The lighting rod works by providing a low-resistance path for lightning strikes then safely passing their high voltage currents to “ground".

Lightning Rod

Lightning Rod

Chapter menu

Resources

End Of Slide

Lightning Rod

Chapter menu

Resources

End Of Slide

Lightning Rod

Top 10

Chapter menu

Resources

End Of Slide

Check for Understanding

- Explain how differing charges create lightning.

Write using complete sentences and in your own words.

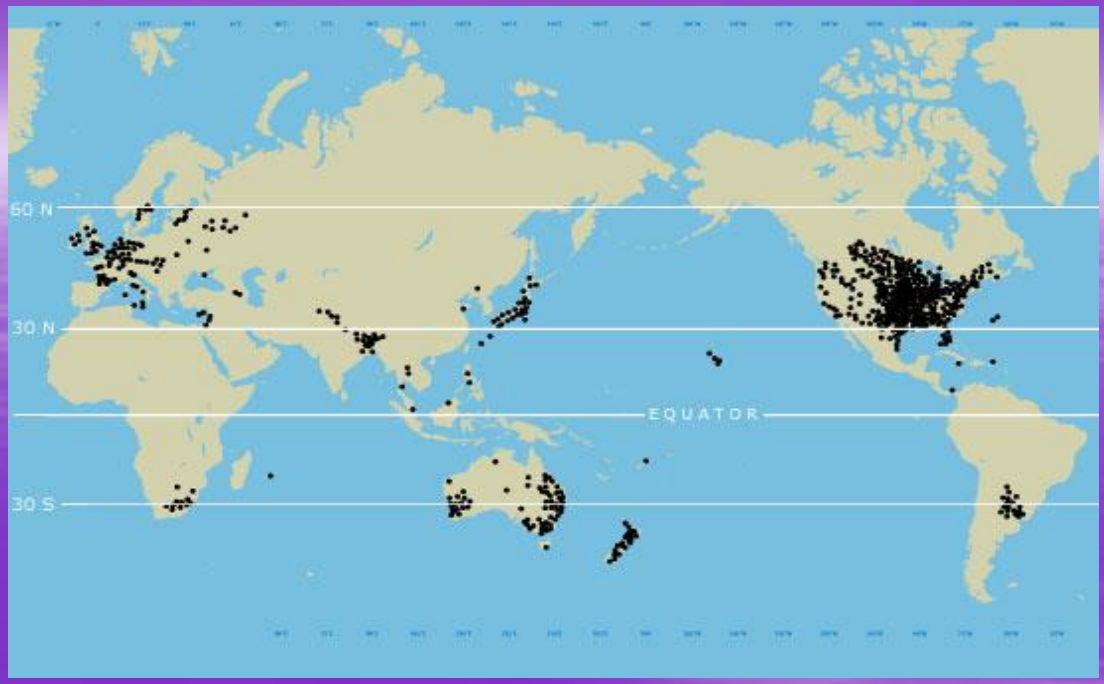
- Most are 110 mph and travel a few miles before dissipating.
- Extreme tornadoes - more than 300 mph, stretch more than two miles across, and stay on the ground for dozens of miles.

Lesson 6- Tornadoes

ABC storm chaser

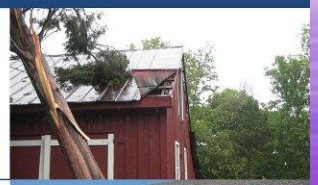
Chapter menu | Resources | End Of Slide

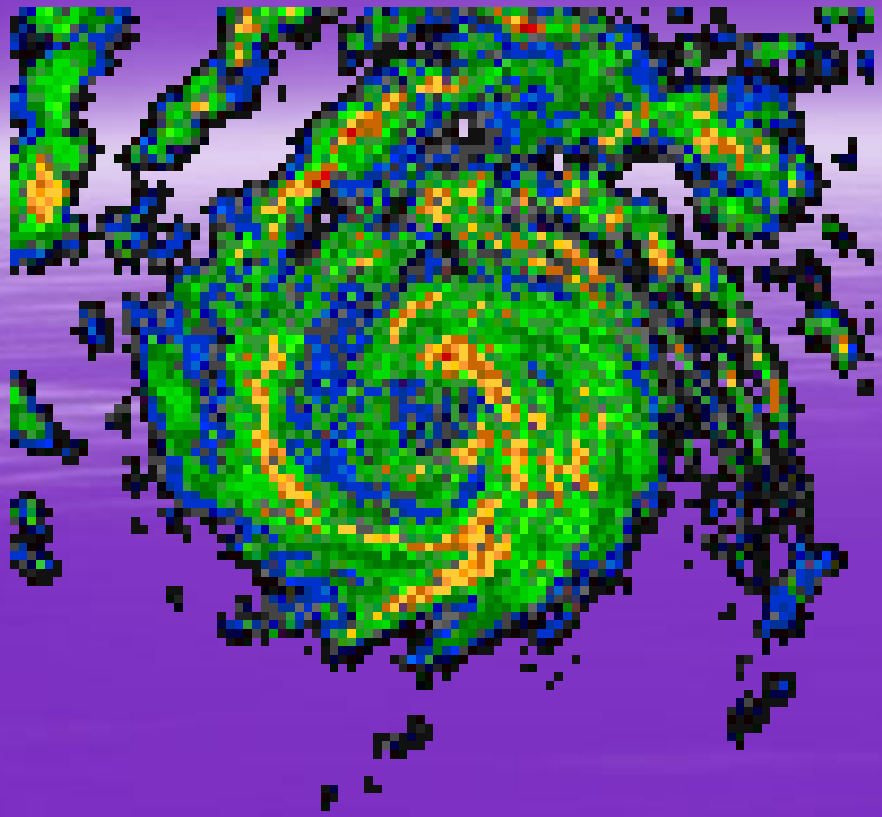
Tornadoes



- Have been observed on every continent except Antarctica.
- The strength of a tornado is measured by the Enhanced Fujita Scale EF0 – EF5 (5 being strongest).

EF Scale

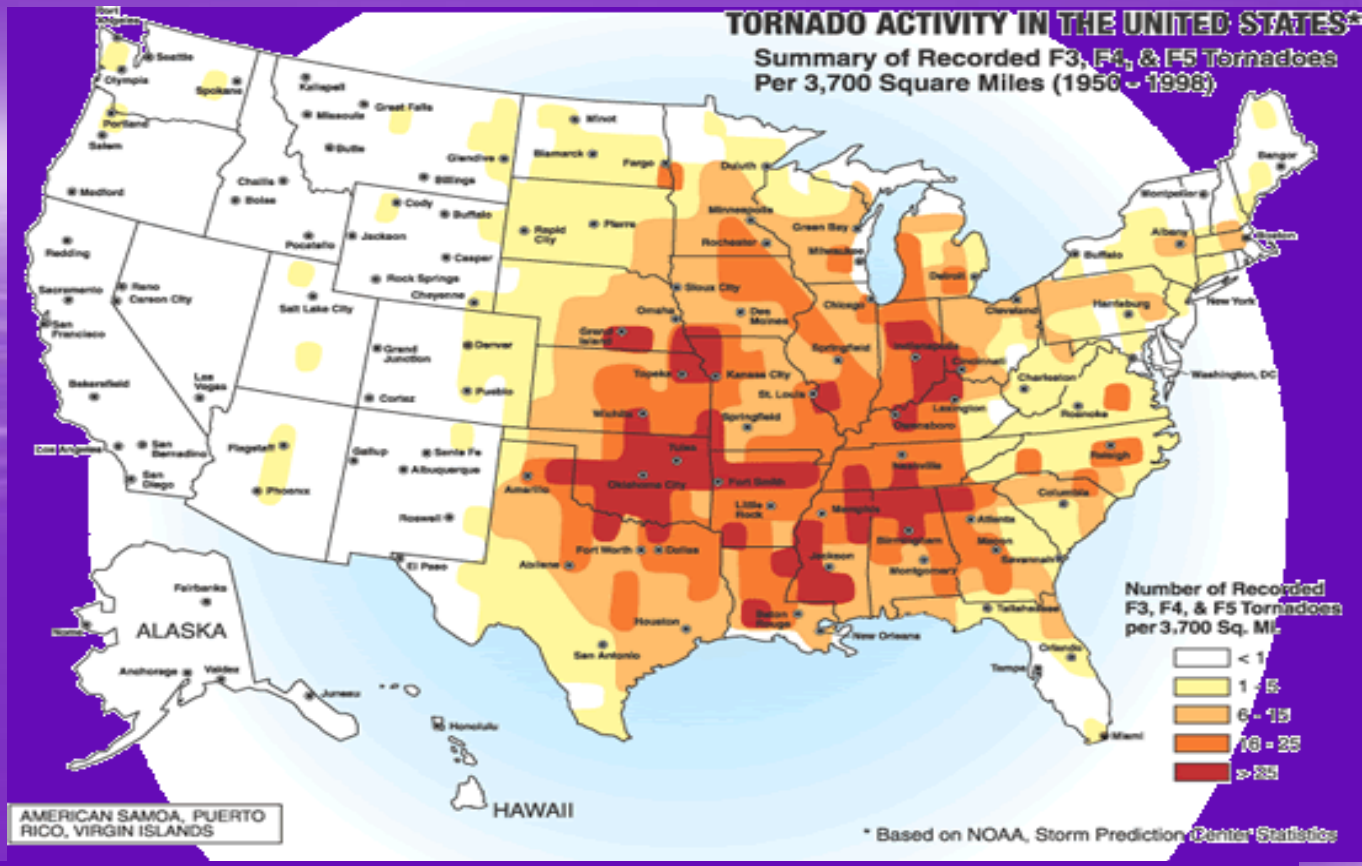
EF Rating	Wind Speeds	Expected Damage		
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.		
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.		
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.		
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.		
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.		
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.		



Tornadoes

- The North American continent (United States) averages the most recorded tornadoes – about a 1,000 a year.

Tornado Alley



- The Central Plains are most susceptible to tornadoes because atmospheric conditions are correct for severe thunderstorms.

- The peak "tornado season" is during May into early June, but tornadoes can happen at any time of year.

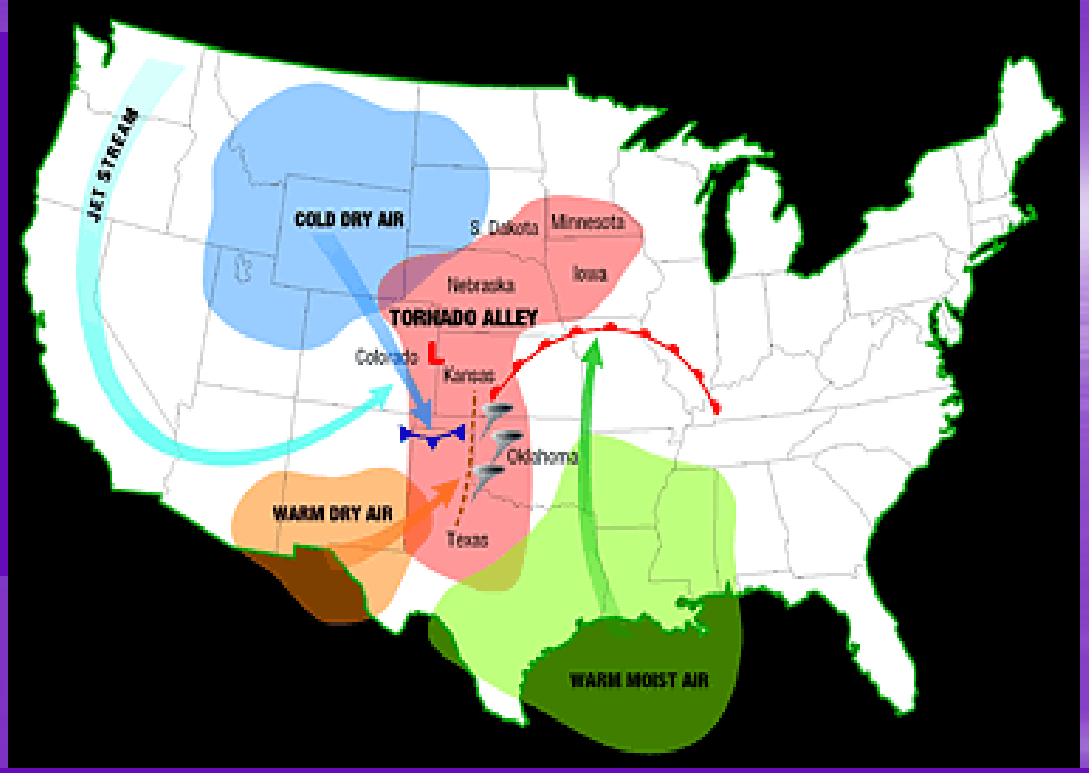
Tornadoes

Tornadoes

- We will be focusing on four aspects of Tornados.

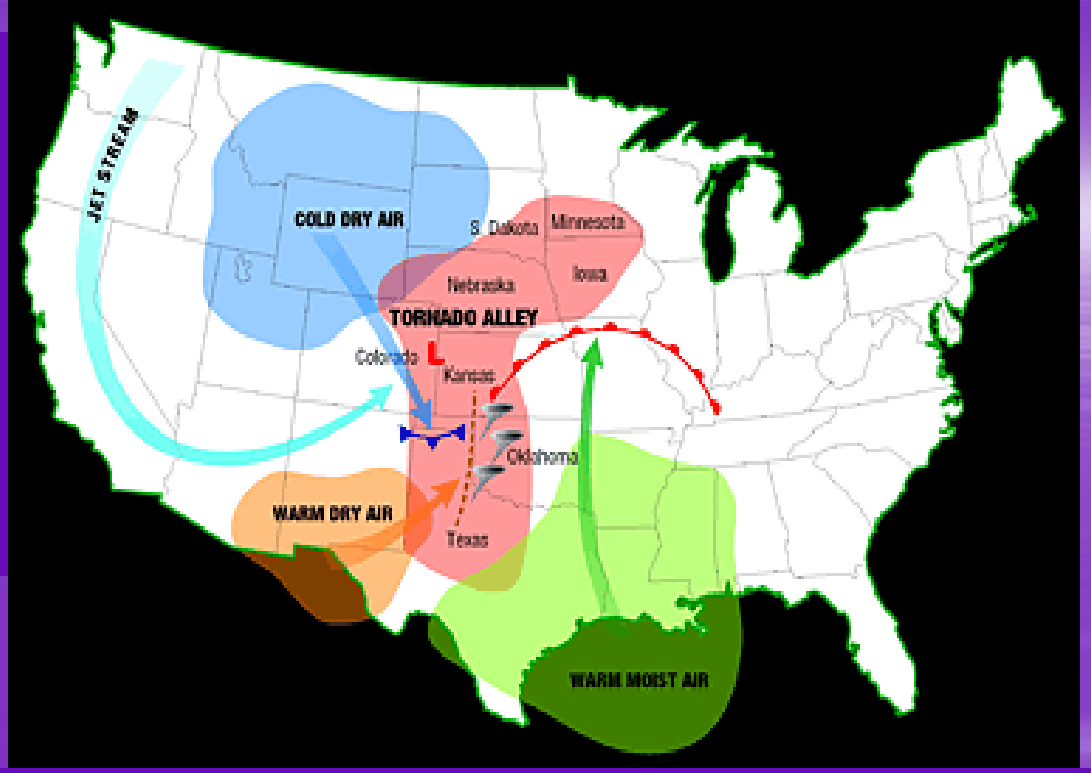
1. Mixing of Air
2. Unstable Atmosphere Conditions
3. Formation of

Recipe for a Tornado – (1) The Mixing of Dry and Warm Air



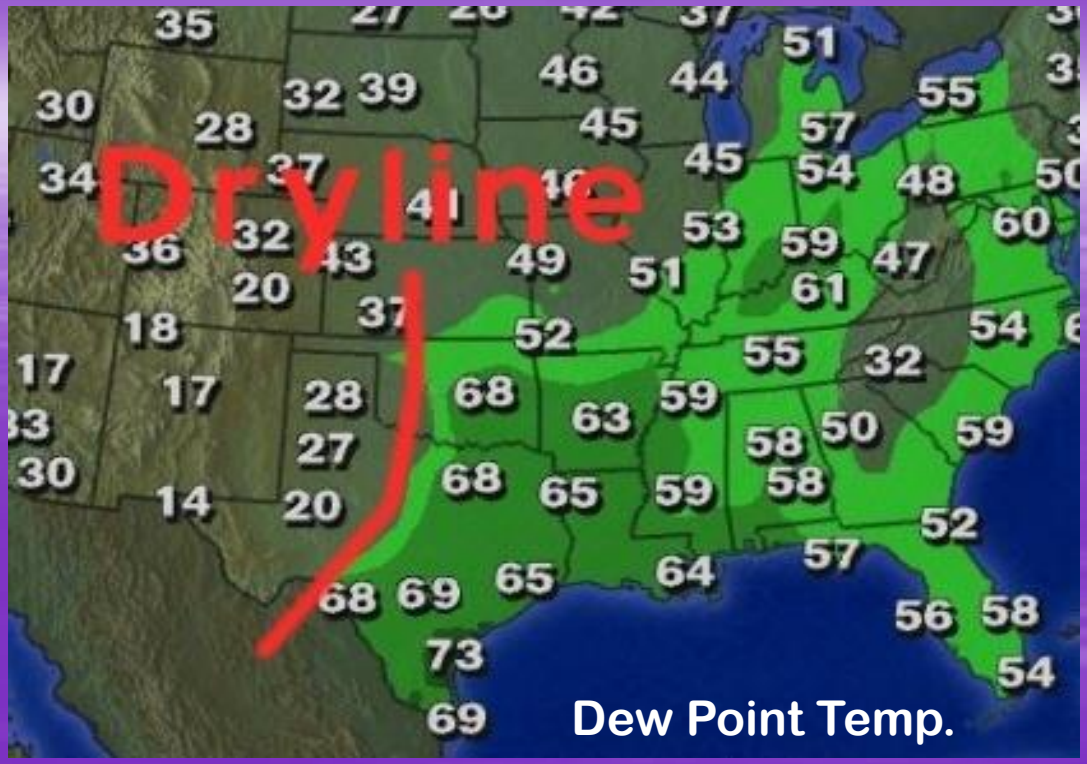
- Tornadoes are produced when two differing air masses meet.
- When cooler polar air masses meet warm and moist tropical air masses, the potential for severe weather is created.

Recipe for a Tornado – (1) The Mixing of Dry and Warm Air



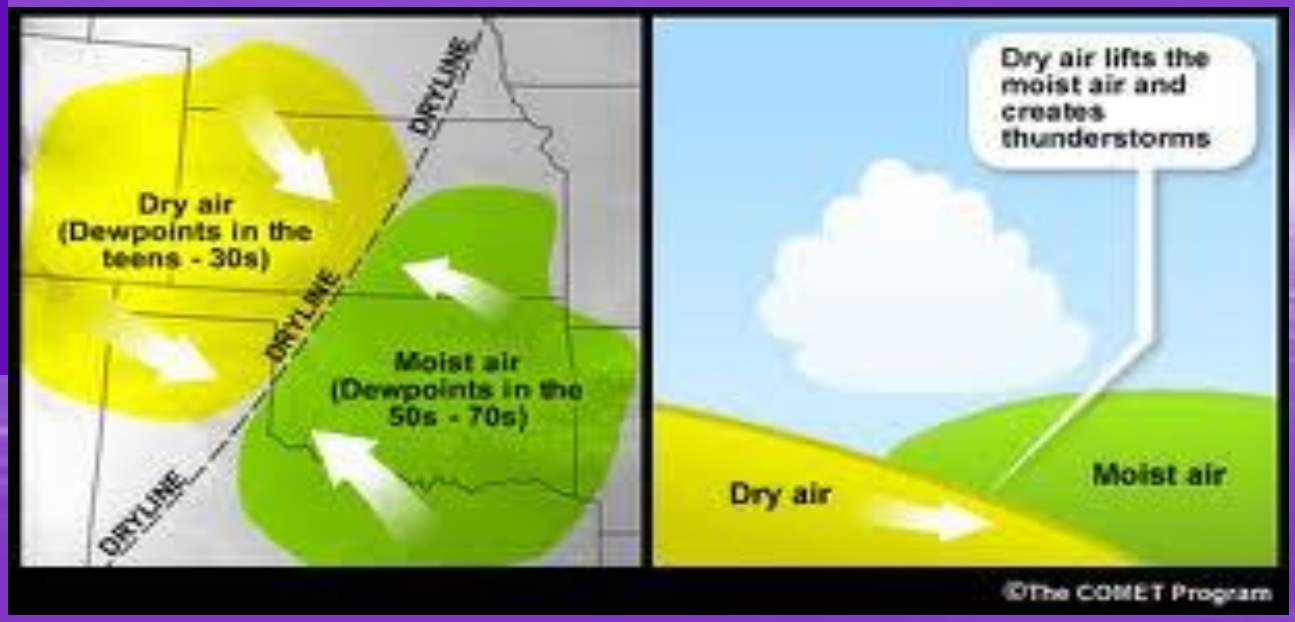
- Rocky Mountains to the west provide the cooler dry air.
- Gulf of Mexico to the south, provides the warm, humid air needed to fuel severe thunderstorms.

How Tornadoes Form – The Mixing of Dry and Warm Air



- A large number of tornadoes form when these two air masses meet, along a phenomenon known as a "dryline."

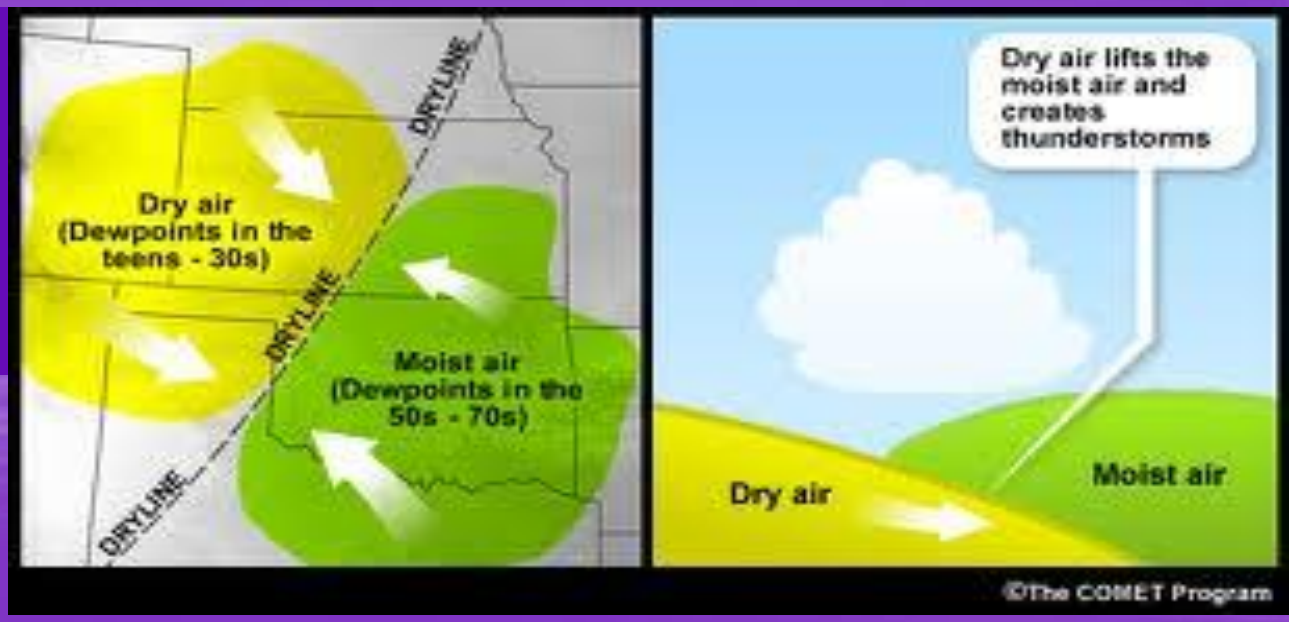
2) Unstable Air



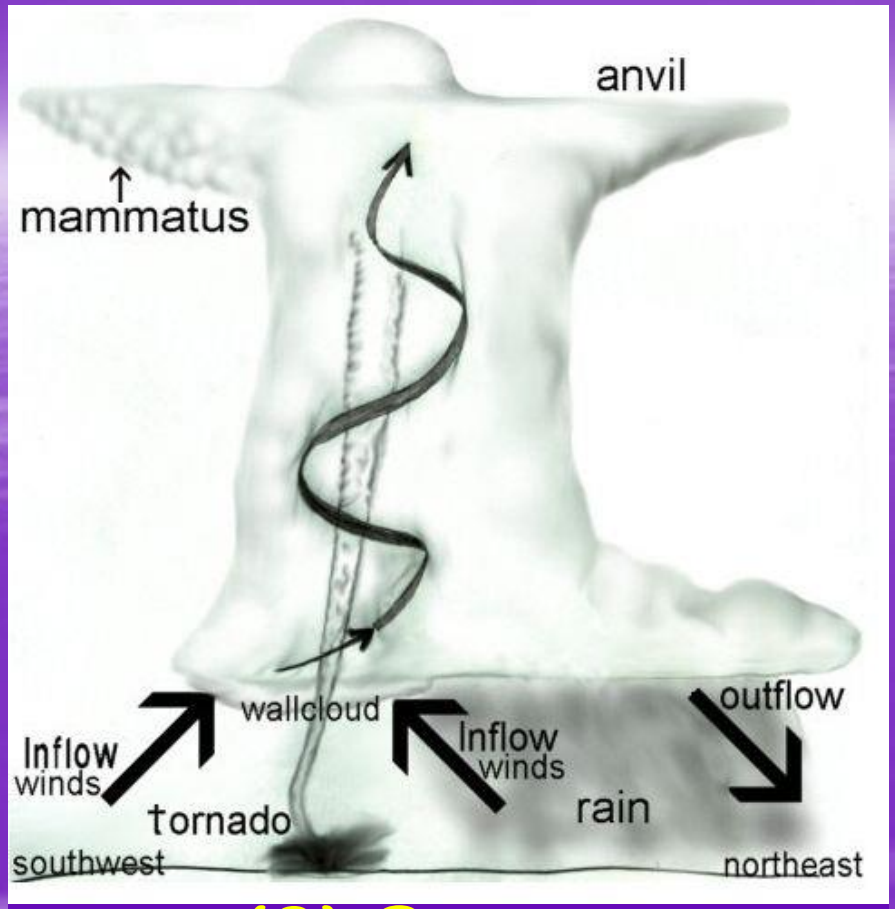
- The dryline is a boundary separating dry air to the west from warm, moist air to the east.

- During the day, it moves eastward mixing temperature and moisture differences between the surface and the upper levels to create the most important ingredient for tornado formation - air instability.

(3) Severe (Supercell) Thunderstorm



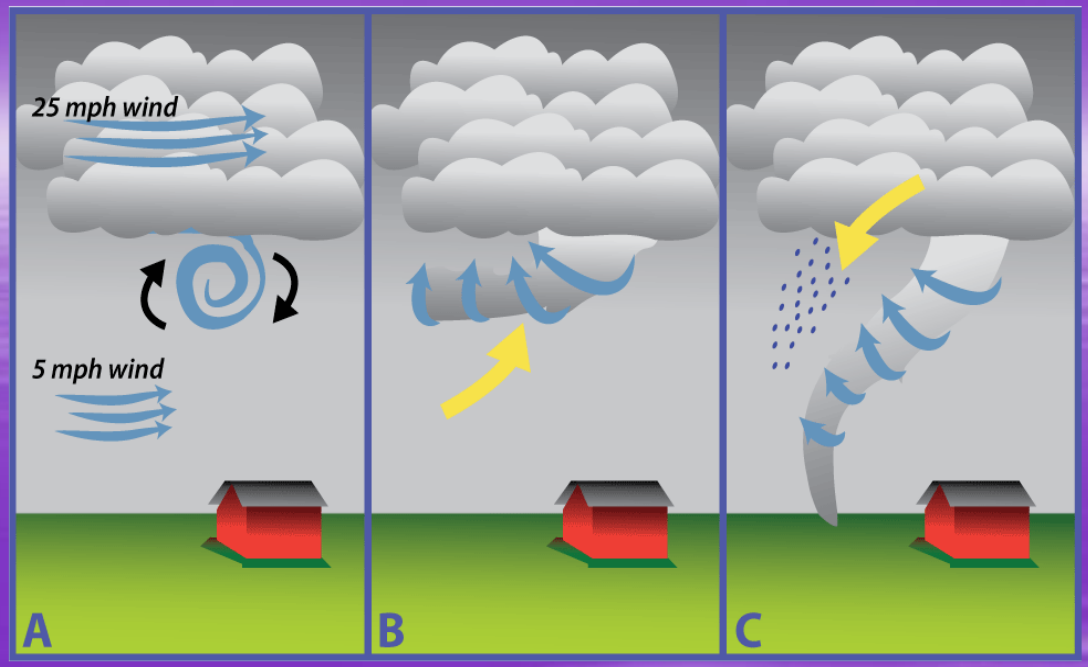
- As this air continues to mix severe thunderstorms and tornadoes can form along the dry line or in the moist air just ahead of it.



(3) Severe (Supercell) Thunderstorm

- A good deal of a thunderstorm's energy is a result of the condensation that forms the cloud known as latent heat.
- This change in physical state continues to feed more heat into the lower region of the thunderstorm creating “supercell” of more instability within the clouds.

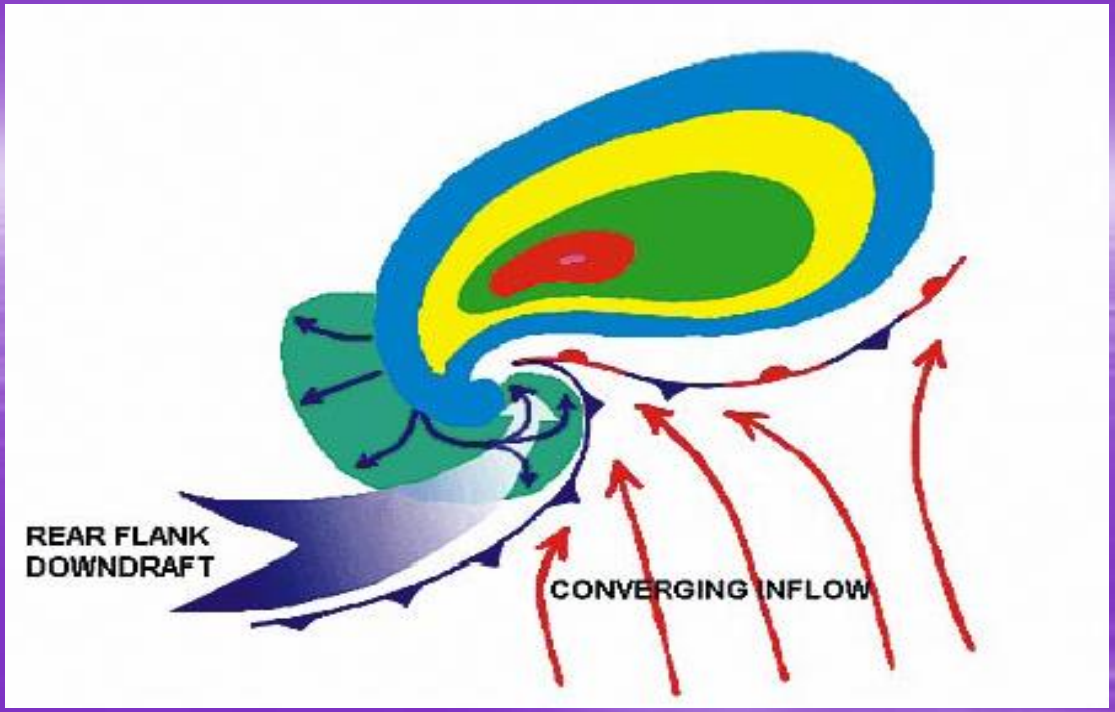
Formation of a Vortex



- Inside the clouds, increase in wind speed with increasing height (wind shear) creates an invisible, horizontal spinning effect in the lower atmosphere.

- Rising air within the thunderstorm updraft tilts the rotating air from horizontal to vertical.

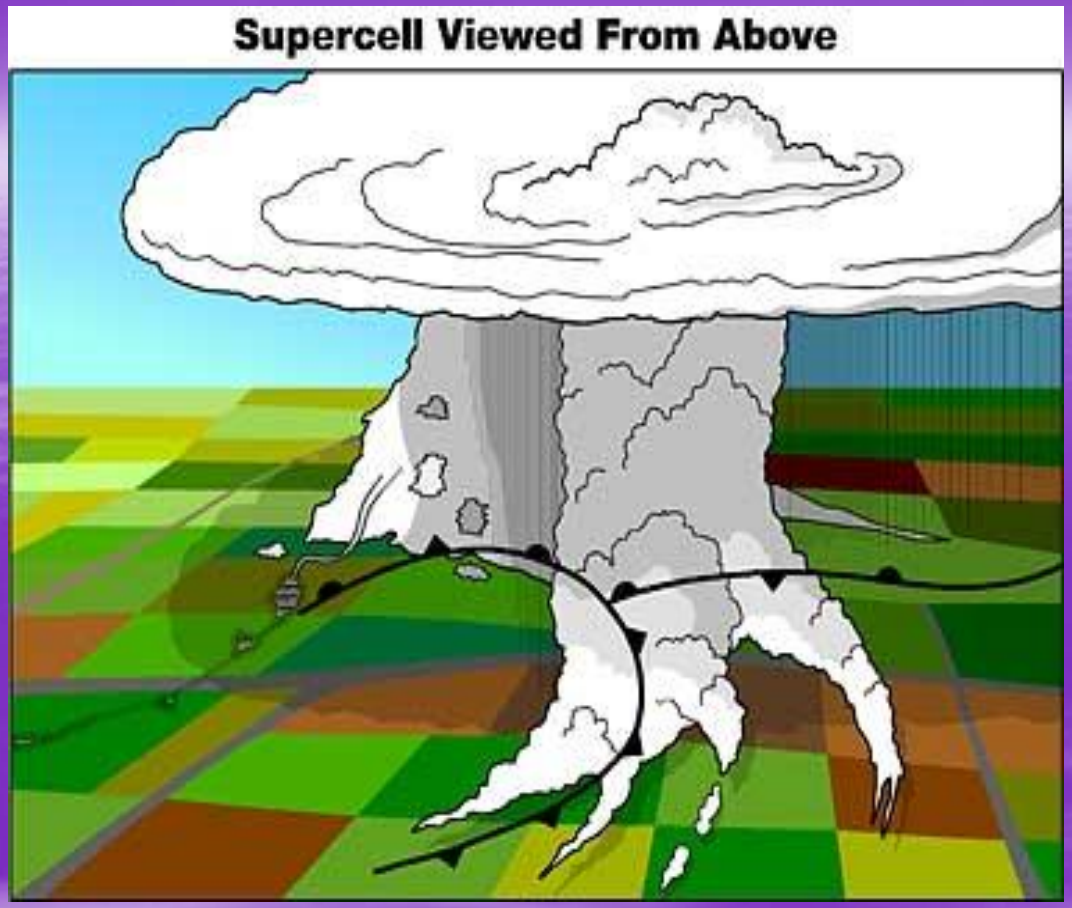
(4) - Rear Flank Downdraft (RFD)



- On the rear flank or backside of the thunderstorm a downdraft (RFD**)** of dry air wraps around the back of a super-cell thunderstorm.
- These areas of descending air (Hook Echo) are though to be essential in the production of many tornadoes.

- Once this connection is made an area of rotation typically spreads throughout the entire storm and it is from here that most tornadoes develop.

Rear Flank Downdraft (RFD)



- Tornado formation is more likely when certain features are spotted.
- Some of these are visual cues, include the rear-flank downdraft.

Forecasting Tornadoes

End Of Slide

Dangers of Tornados

- The air speeds can embed objects at over 200 mph.

Chapter menu

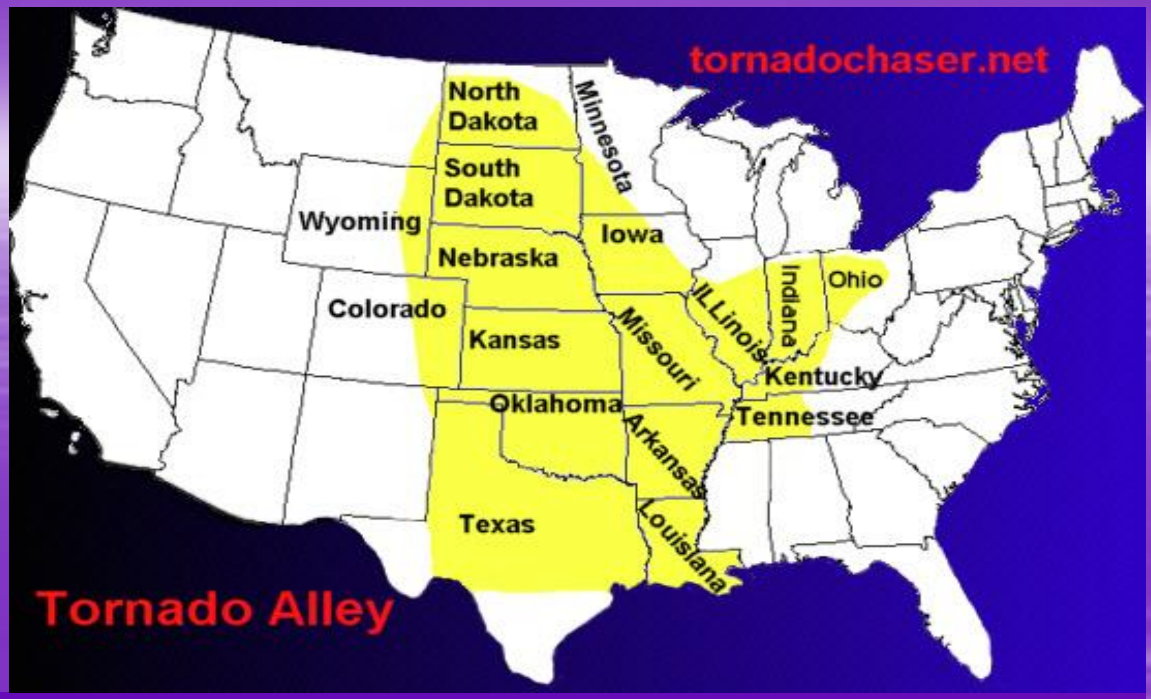
Resources

Tornado Hits

- Like hurricanes, a tornadoes path is hard to predict because it is haphazard (non-direct).
- A funnel may touch ground wander then rise and touch ground again a short distance away.

Tornado Hits

hardware
tuscloosanews
abc wrapup



- The state with the highest number of strong tornadoes per unit area is Oklahoma.

- Kansas holds the record the most F4 (166 mph – 200 mph) and F5 (above 200 mph) tornadoes in the country.

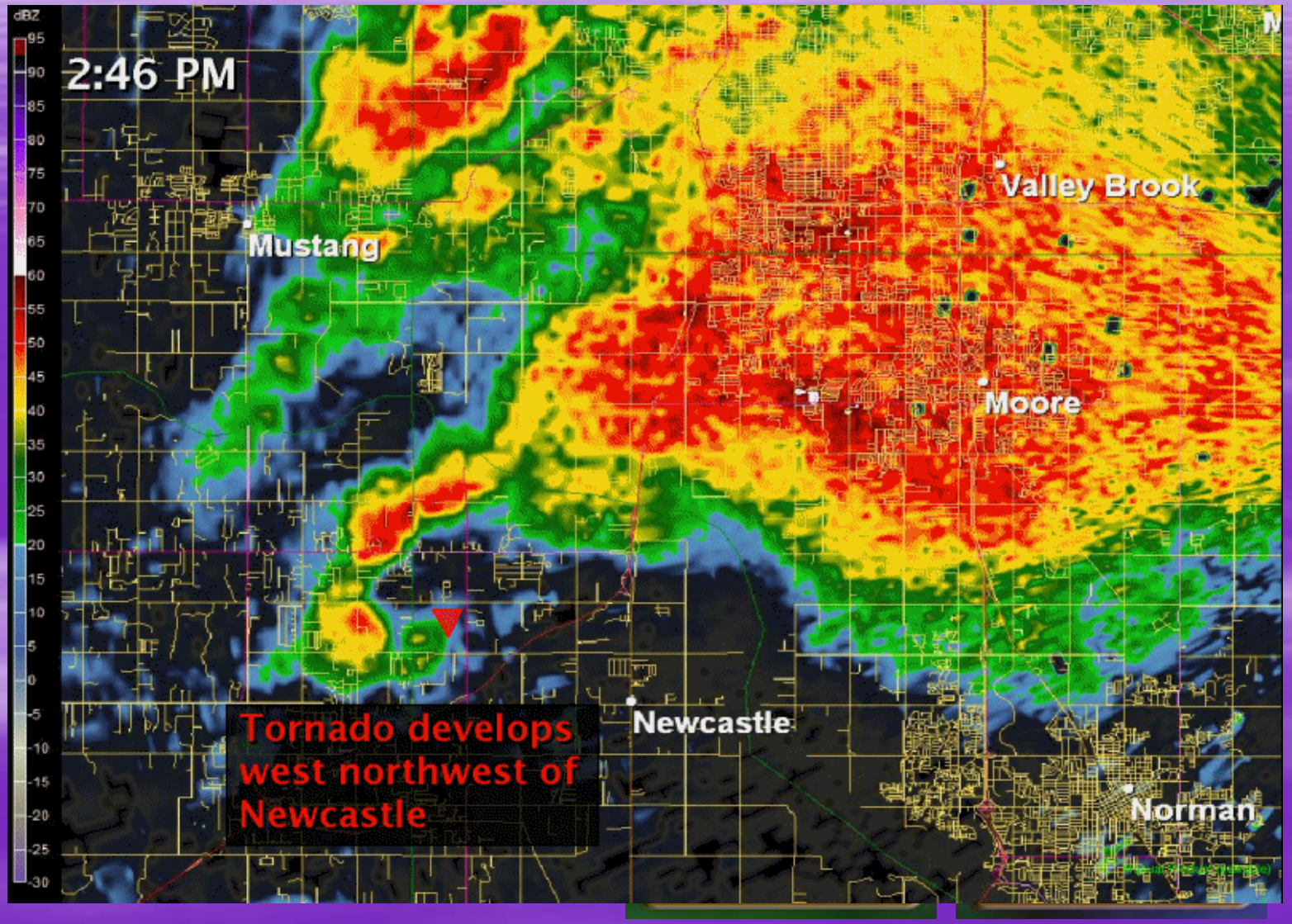
Resources

End Of Slide

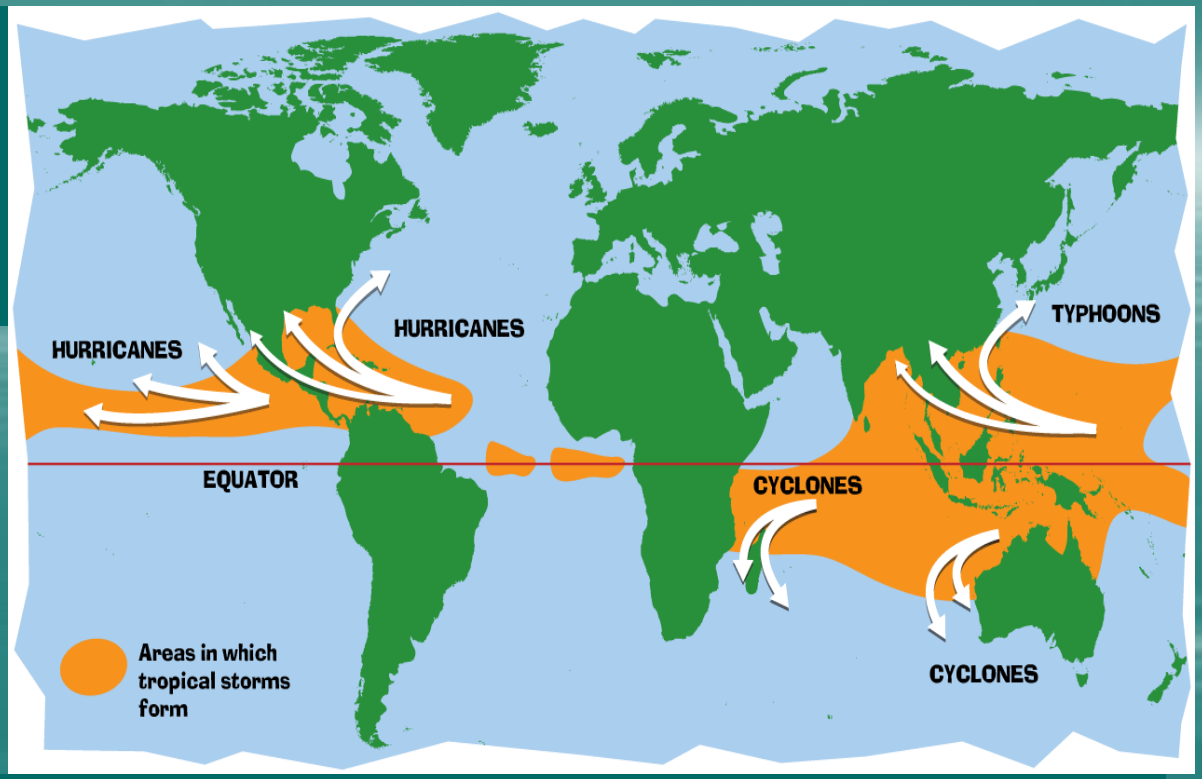
Studying Tornadoes

- National Severe Storms Laboratory participated in the Verification of the Origins of Rotation in Tornadoes EXperiment 2009-2010 (VORTEX2), the largest tornado research

Moore OK Tornado EF 5

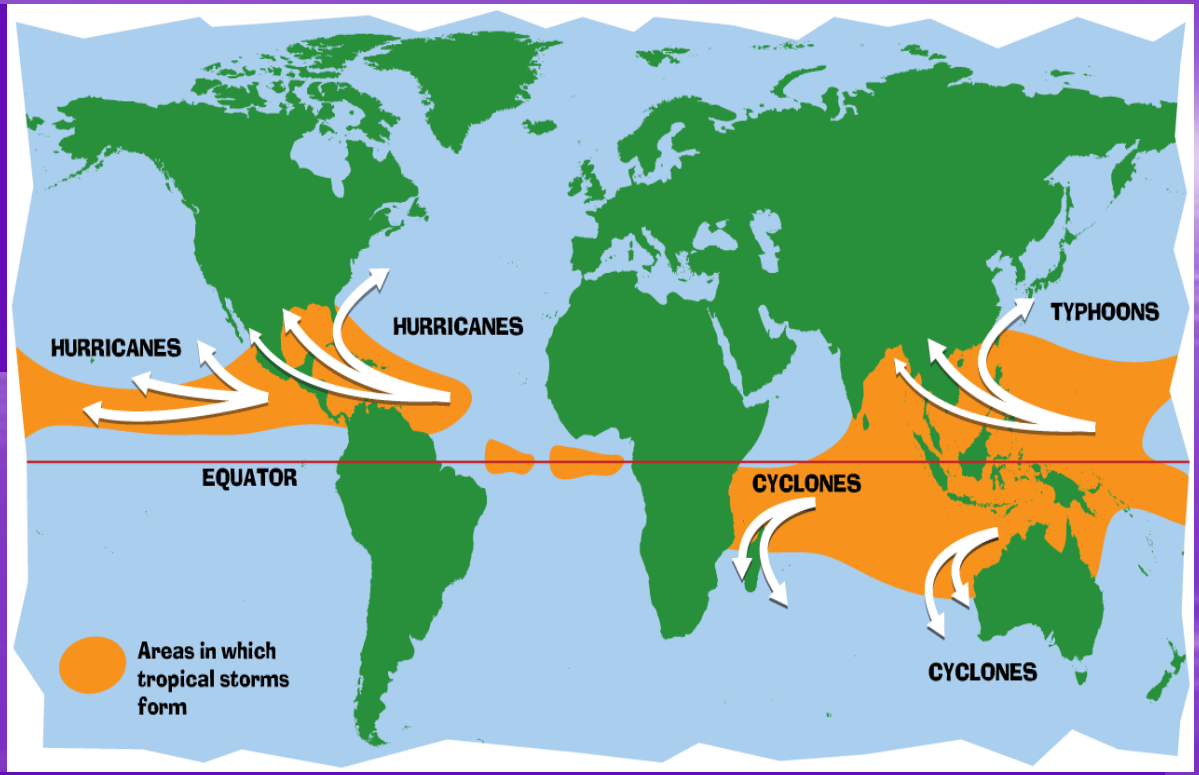


Lesson 7 - Hurricane Characteristics

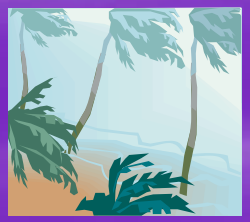


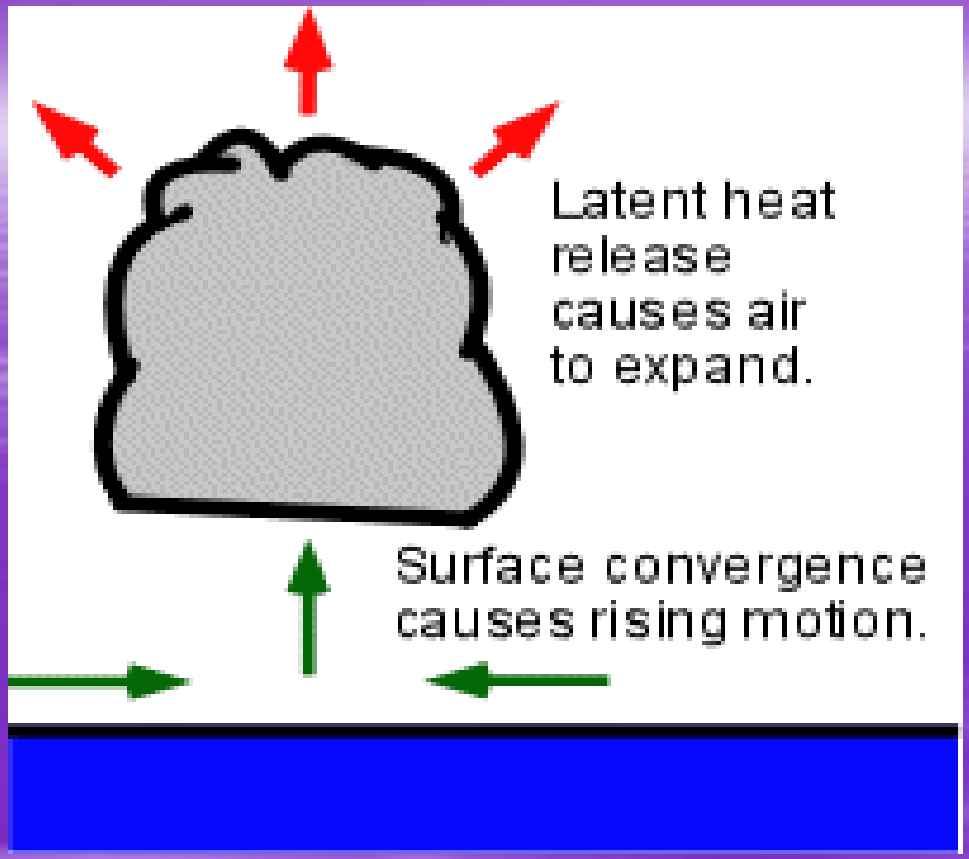
- A hurricane also called typhoons (in western Pacific) or cyclones (in Australia and Indian Ocean)
- They form over tropical oceans only (Summer and Fall)
- Have rotary circulation (counter-clockwise in the northern hemisphere)

Hurricane Characteristics



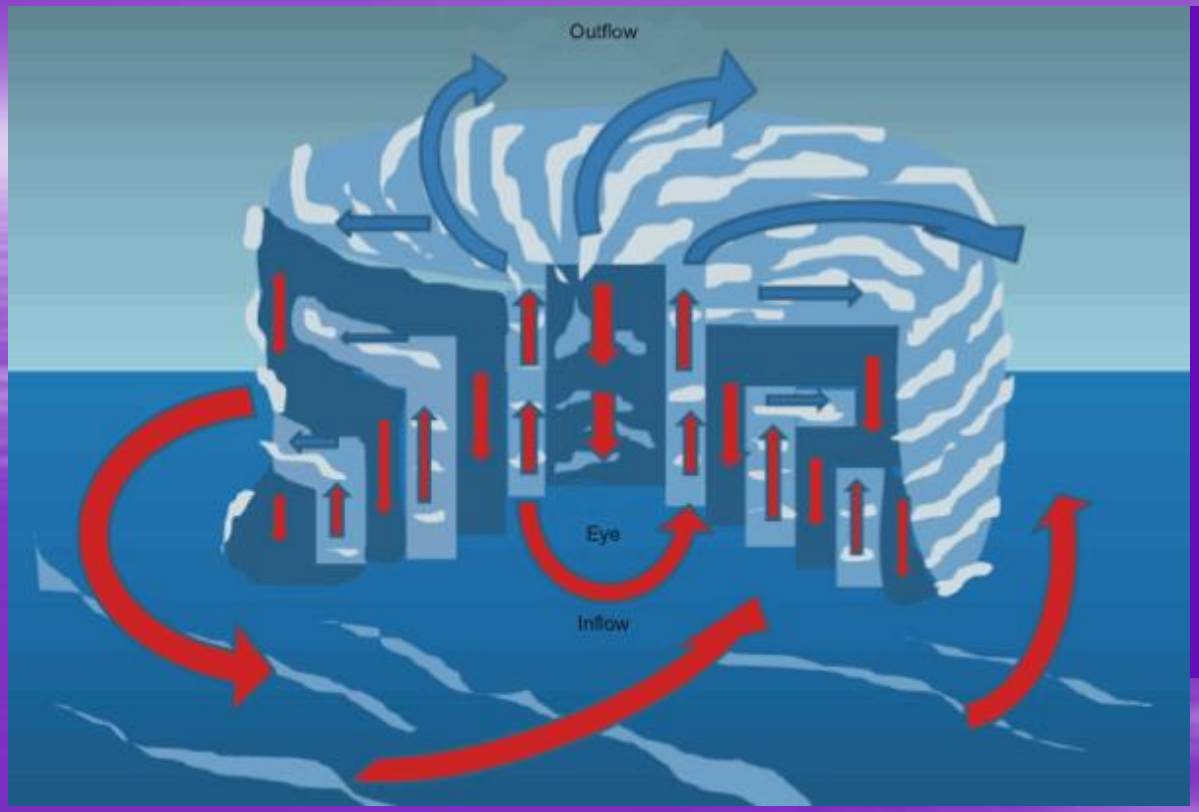
- Low pressure system powered by water vapor
- Strong winds of more than 75mph-170mph are powered by water vapor.





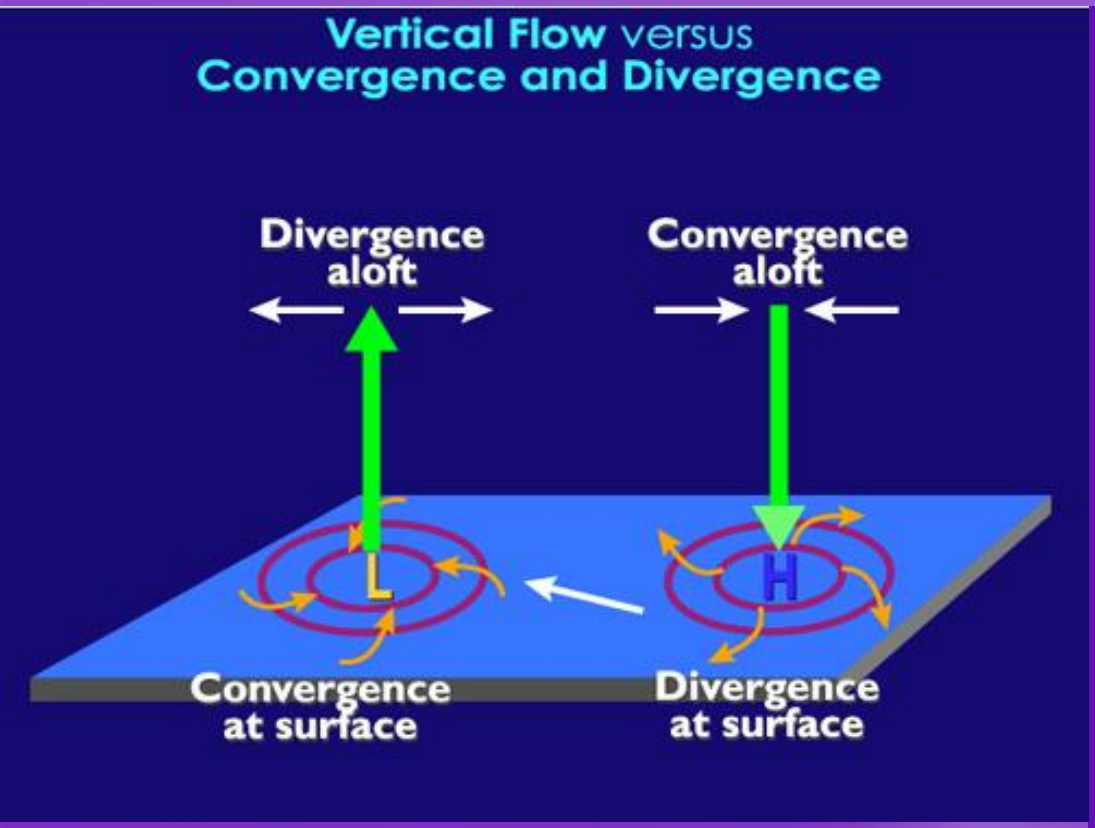
- Water vapor is the "fuel" for the hurricanes.
- Moisture that condenses forms clouds and rain but also releases latent heat warming the surrounding air.

What Fuels a Hurricane



- Usually, the heat released in tropical thunderstorms is carried away by wind shear, but if allowed to build up, a low pressure will form.

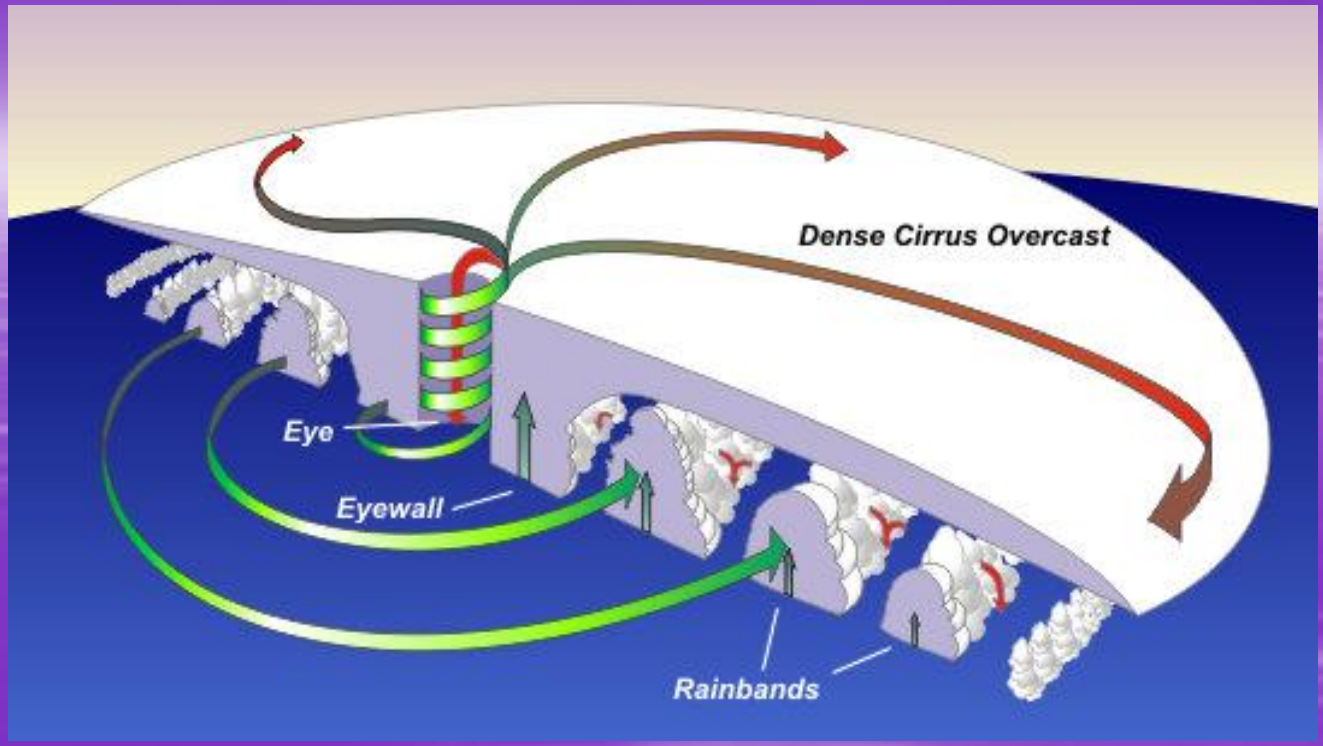
Low Pressure Forms



Low Pressure Forms

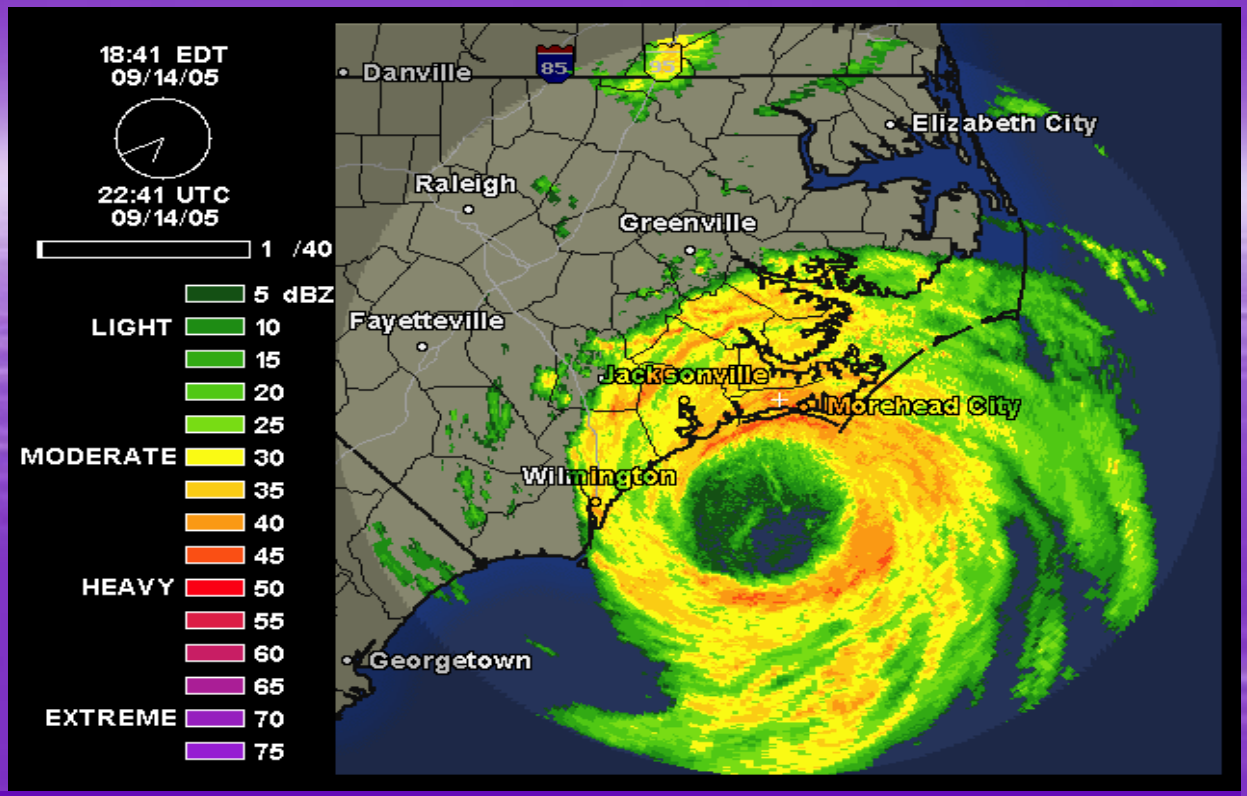
- Low pressure is like a vacuum it is an inward flow of air.
- The low pressure causes wind to begin to spiral inward toward the center of the low and the coriolis effect causes the winds to spiral in a counter-clockwise direction.

The Eye of a Hurricane



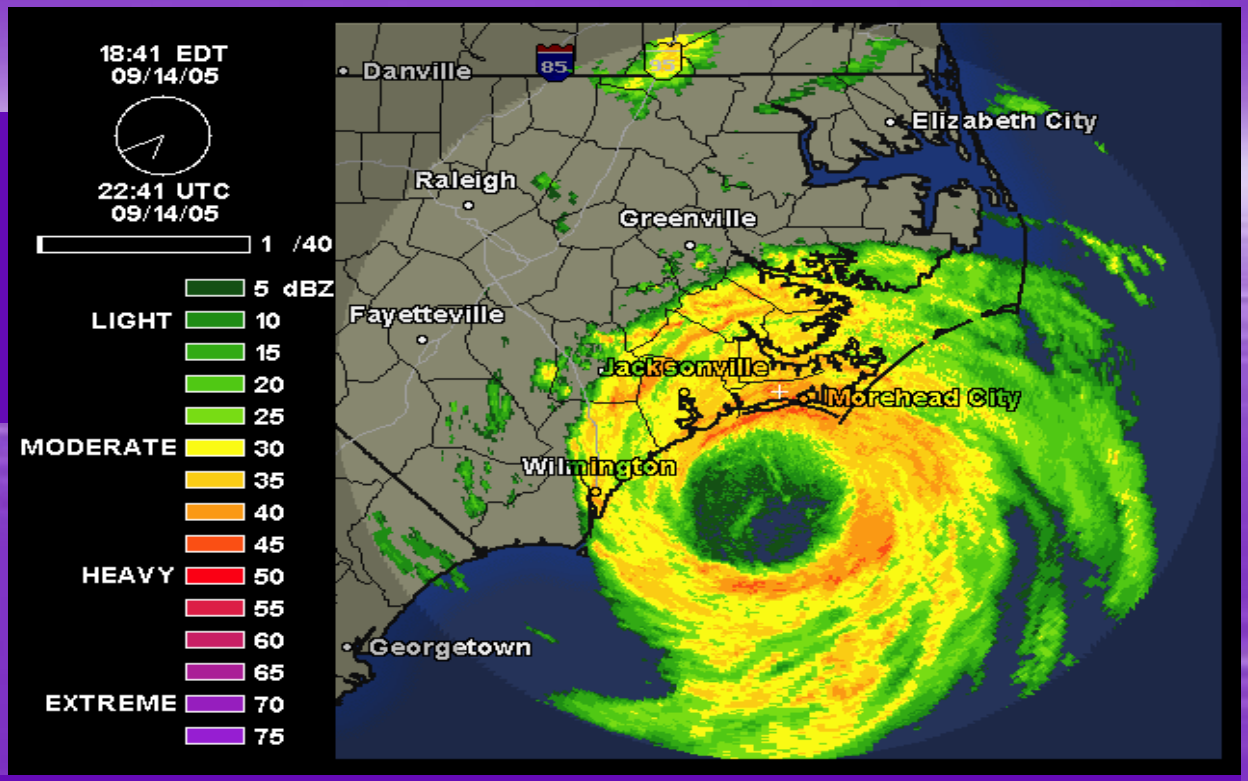
- The eyewall or core is where the strongest winds occur, which encircle the warmest air, in the eye of the hurricane.

Path of a Hurricane



- Hurricanes and tropical storms have highly erratic movements.
- The path is influenced by warm ocean currents and westerly wind paths.

The End of a Hurricane



- (1) Land will cause a hurricane to dissipate because a hurricane needs moisture and latent heat from warm ocean water to maintain themselves.
- (2) Movement North to cooler waters will also end a hurricane.

Categories of Hurricanes

CATEGORY	WINDS	DAMAGE
1	74-95 MPH	Minimal
2	96-110 MPH	Moderate
3	111-130 MPH	Major
4	131-155 MPH	Extensive
5	> 155 MPH	Catastrophic

- Category 1 74-95 MPH Damage Minimal
- Category 2 96-110 MPH Damage Moderate
- Category 3 111-130 MPH Damage Major
- Category 4 131-155 MPH Damage Extensive
- Category 5 > 155 MPH Damage Catastrophic

Chapter menu Resources

- High winds (over 75 mph) which can also lead to tornadoes.
- Heavy amounts of rain resulting in flooding.
- Storm Surge

What Causes the Destruction

End Of Slide

Chapter menu

Resources

Storm Surge

- Occurs in low-lying areas (New Orleans), because ocean water is blown onshore by the high winds.
- The storm surge usually ends up causing major flood damage to the beach communities.

End Of Slide

Chapter menu

Resources

Check for Understanding

- Explain how a storm surge builds momentum.
- Explain how a storm surge and a tsunami are different.

Write using complete sentences and in your own words.

- Worst case of storm surge was in New Orleans 2005 - Katrina.

Hurricane Katrina

Chapter menu | Resources | End of Slide

- Levees would break killing 1,836 people and making it the deadliest U.S. hurricane since the 1928.

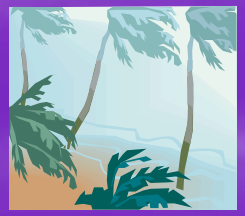
Hurricane Katrina

- Total property damage was estimated at $81 billion.

Hurricane Katrina

- Every hurricane is categorized 1 - 5.
- Katrina was a “5” with winds toping 175 mph.

Hurricane Katrina



Chapter menu

Resources

End of Slide

Hurricane Sandy 2012

- Classified as a Category 3 Hurricane.
- 2nd costliest Hurricane in the U.S. at $68 Billion in damages.
- Throughout 7 countries 286 people were killed

Hurricane Sandy Storm Path

- Many scientists predicted that Hurricane Sandy would follow the Gulf Stream

Hurricane Sandy Storm Path

- However the Jetstream helped to push the hurricane back into the east coast of the U.S.

- A hurricane is a tropical disturbance and gets its energy from latent heat by **condensation**.
- Tornadoes form when two fronts collide and also gets their energy from latent heat of condensation and **wind shear**.

Difference Between a Tornado and a Hurricane (18:00) (9:00)

Chapter menu
Resources
End Of Slide

How are Hurricanes Named

2014	2015	2016	2017	2018	2019
Arthur	Ana	Alex	Arlene	Alberto	Andrea
Bertha	Bill	Bonnie	Bret	Beryl	Barry
Cristobal	Claudette	Colin	Cindy	Chris	Chantal
Dolly	Danny	Danielle	Don	Debby	Dorian
Edouard	Erika	Earl	Emily	Ernesto	Erin
Fay	Fred	Fiona	Franklin	Florence	Fernand
Gonzalo	Grace	Gaston	Gert	Gordon	Gabrielle
Hanna	Henri	Hermine	Harvey	Helene	Humberto
Isaias	Ida	Ian	Irma	Isaac	Imelda
Josephine	Joaquin	Julia	Jose	Joyce	Jerry
Kyle	Kate	Karl	Katia	Kirk	Karen
Laura	Larry	Lisa	Lee	Leslie	Lorenzo
Marco	Mindy	Matthew	Maria	Michael	Melissa
Nana	Nicholas	Nicole	Nate	Nadine	Nestor
Omar	Odette	Otto	Ophelia	Oscar	Olga
Paulette	Peter	Paula	Philippe	Patty	Pablo
Rene	Rose	Richard	Rina	Rafael	Rebekah
Sally	Sam	Shary	Sean	Sara	Sebastien
Teddy	Teresa	Tobias	Tammy	Tony	Tanya
Vicky	Victor	Virginie	Vince	Valerie	Van
Wilfred	Wanda	Walter	Whitney	William	Wendy

Chapter menu Resources

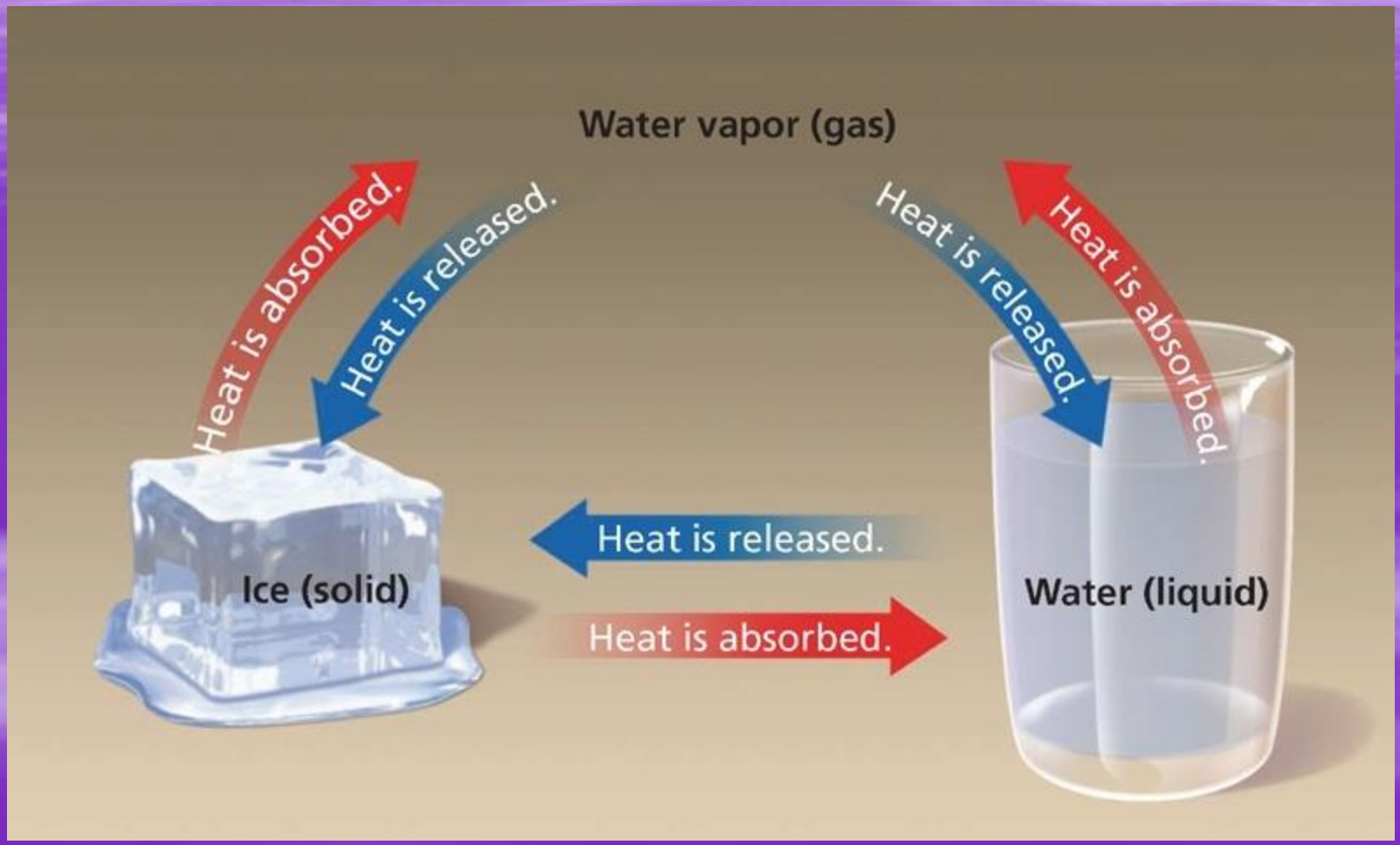
EF Rating	Wind Speeds
EF-0	65-85 mph
EF-1	86-110 mph
EF-2	111-135 mph
EF-3	136-165 mph
EF-4	166-200 mph
EF-5	> 200 mph

Saffir–Simpson Hurricane Scale

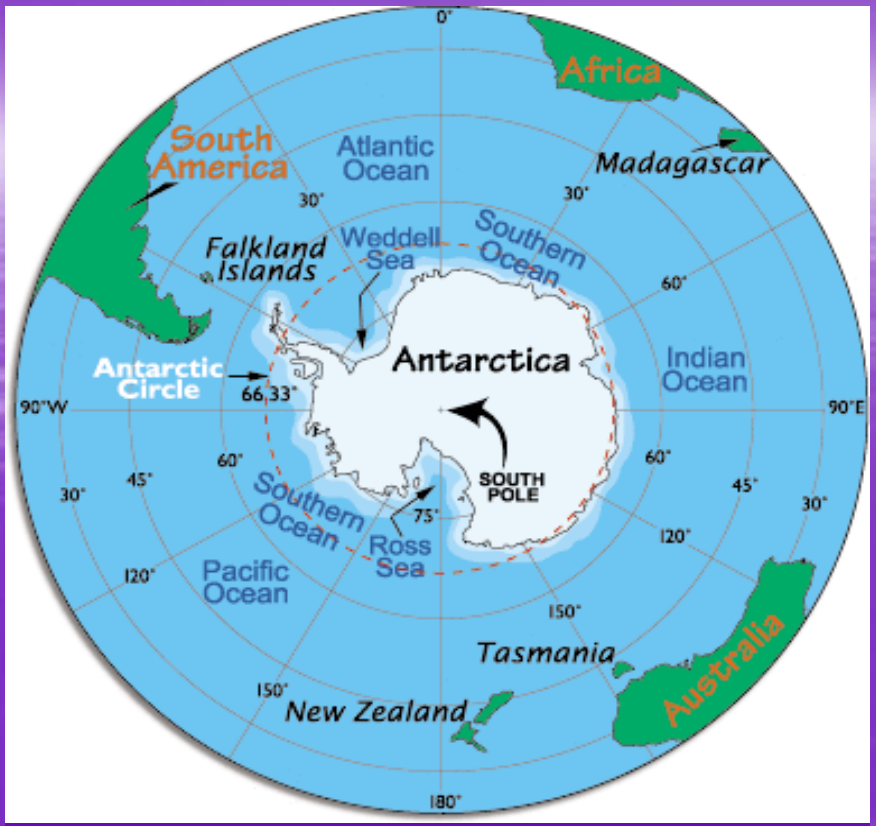
Category	Wind speed mph (km/h)	Storm surge ft (m)
Five	≥156 (≥250)	>18 (>5.5)
Four	131–155 (210–249)	13–18 (4.0–5.5)
Three	111–130 (178–209)	9–12 (2.7–3.7)
Two	96–110 (154–177)	6–8 (1.8–2.4)
One	74–95 (119–153)	4–5 (1.2–1.5)
Additional classifications		
Tropical storm	39–73 (63–117)	0–3 (0–0.9)
Tropical depression	0–38 (0–62)	0 (0)

Chapter 23

Phases of Water



Chapter menu
Resources



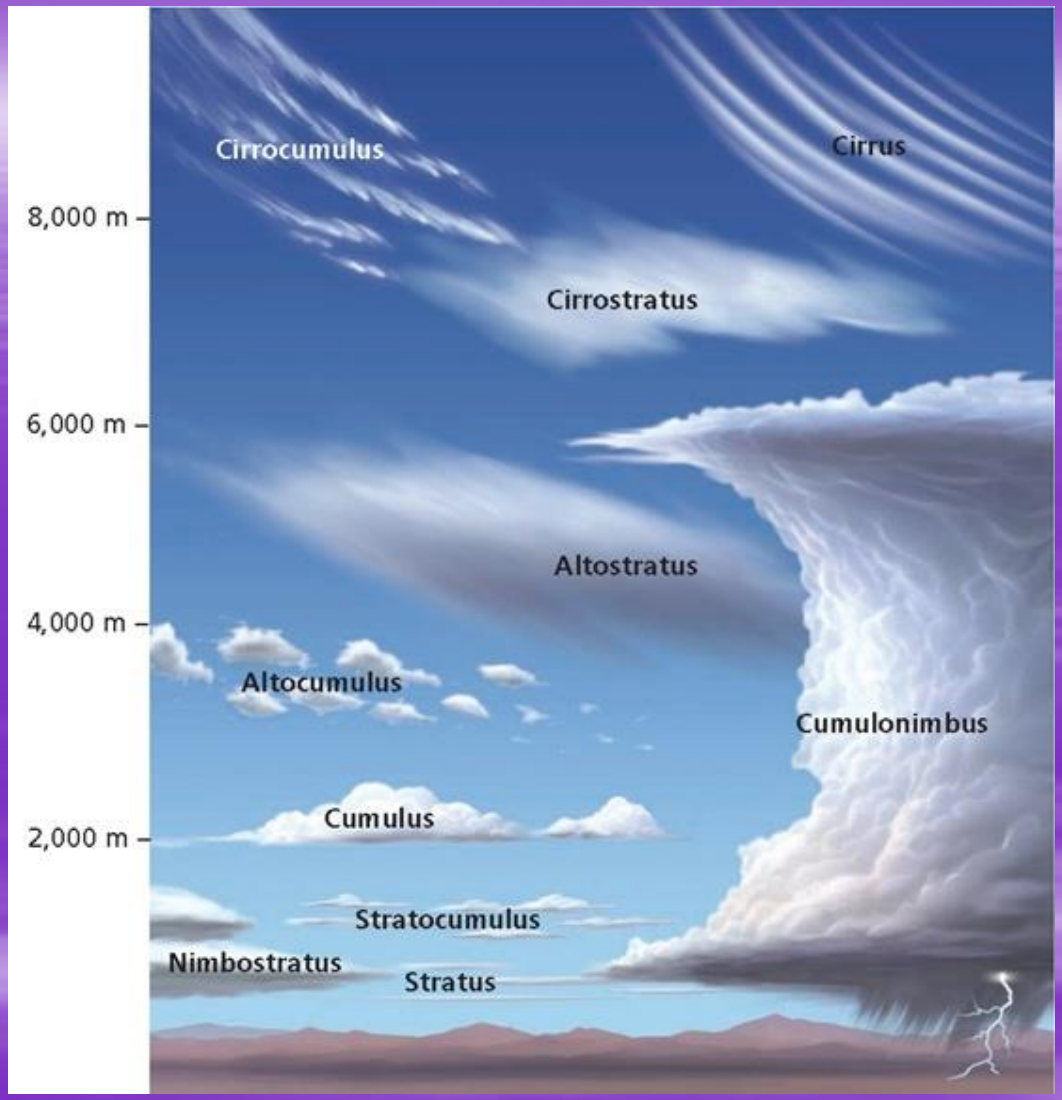
Polar Weather Fronts

- The continent's extreme cold makes it the driest continent because very cold air contains hardly any water vapor to create snow.
- This is why the interior of Antarctica is the world's biggest desert, with the precipitation (if the snow were melted) averaging under 2 inches of water a year.

Chapter menu
Resources
End of Slide

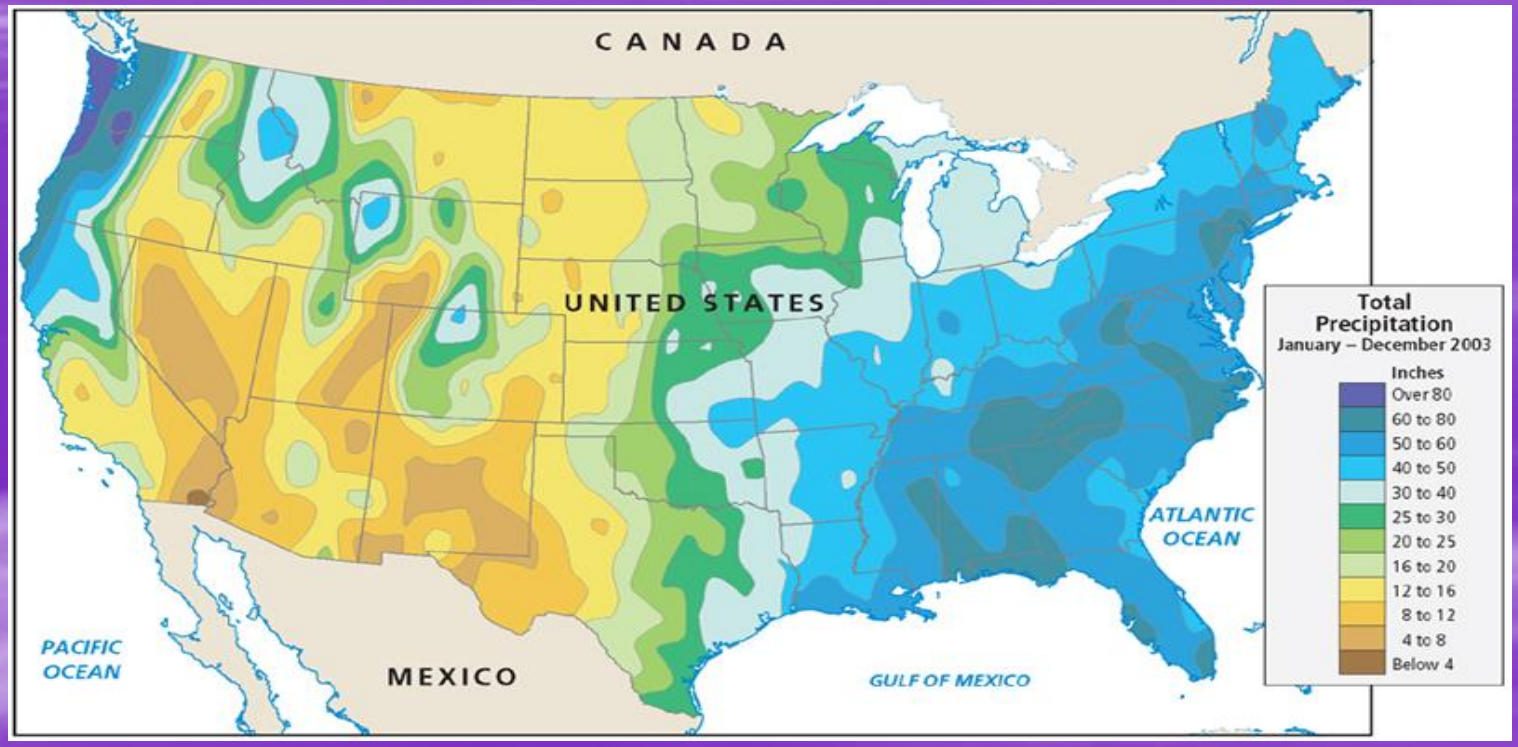
Chapter 23

Classification of Clouds



Chapter 23

Annual Precipitation in the United States



Chapter menu Resources