



Weather101

The North American Monsoon



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Poll #1

Have you ever experienced the North
American Monsoon?





01

What is the North American Monsoon (NAM)?

And what is it not?





Poll #2

True or False: The monsoon refers to an individual thunderstorm or a group of thunderstorms.



It's is a season!

- The North American Monsoon is simply a season
- Does not have a set and end date, but we typically define it being between June 15th and September 30th in the southwest US
 - Think of it like hurricane season!



“We had a lot of monsoons today!”

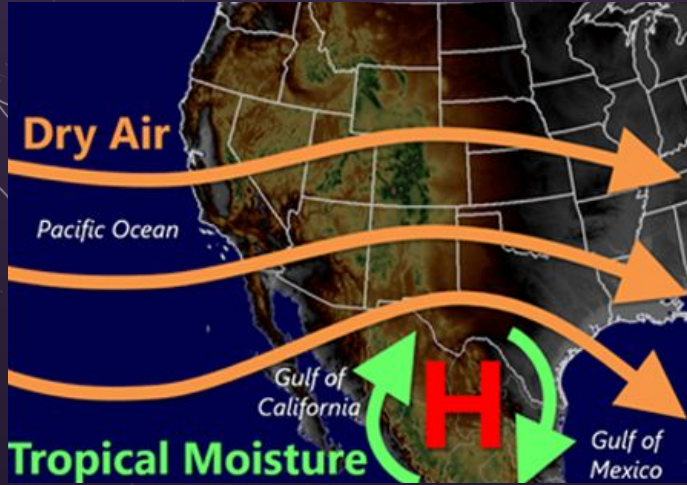


“The monsoon is my favorite time of the year!”

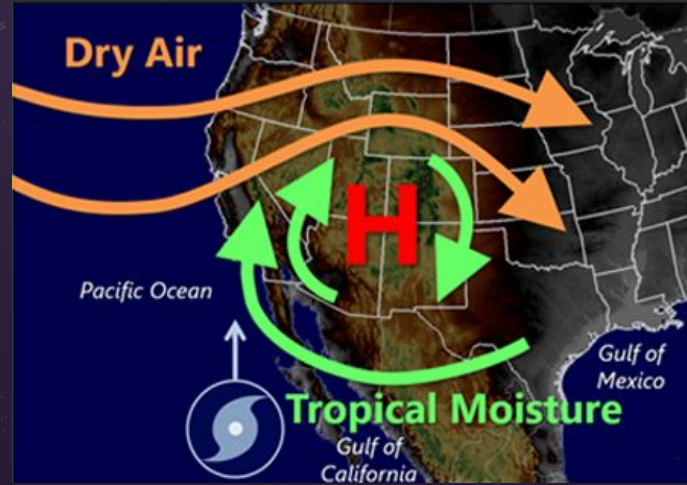


More specifically, it's a seasonal wind shift!

Typical Pattern

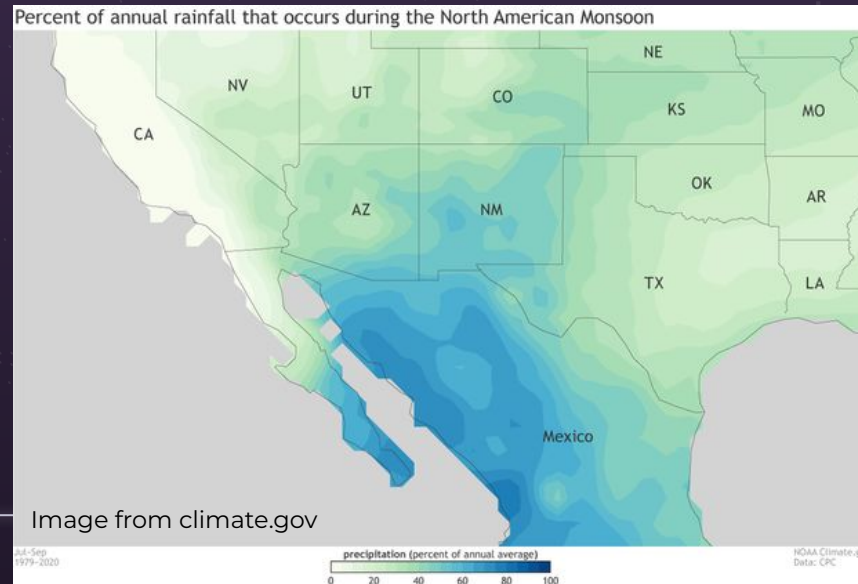


Summer Monsoon Pattern



Facts About Monsoon Season

- The season is responsible for a large percentage of the southwest's annual precipitation totals (~ 50-70%)
 - A bad monsoon season typically leads to worsening drought conditions and a bad fire weather season

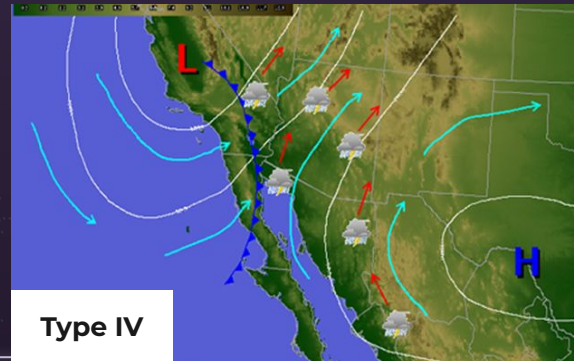
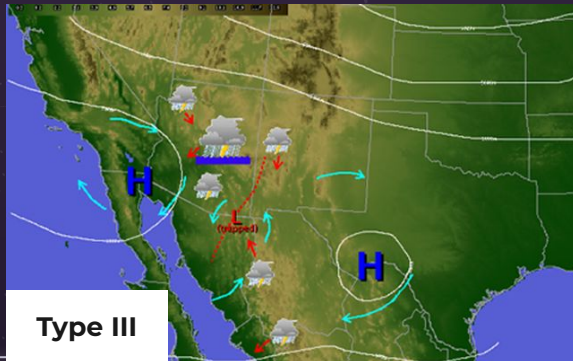
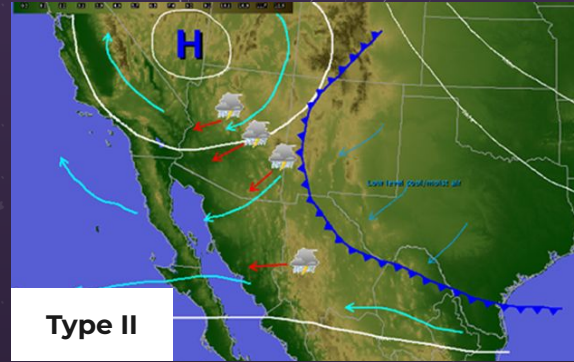
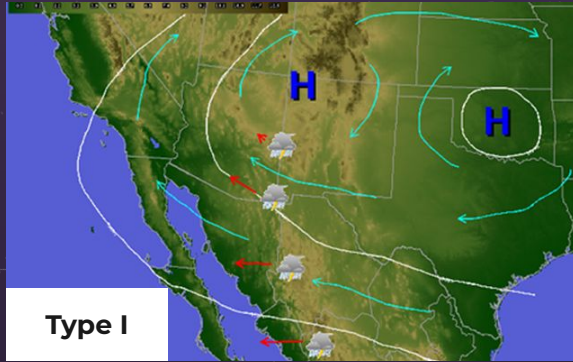


Facts About Monsoon Season

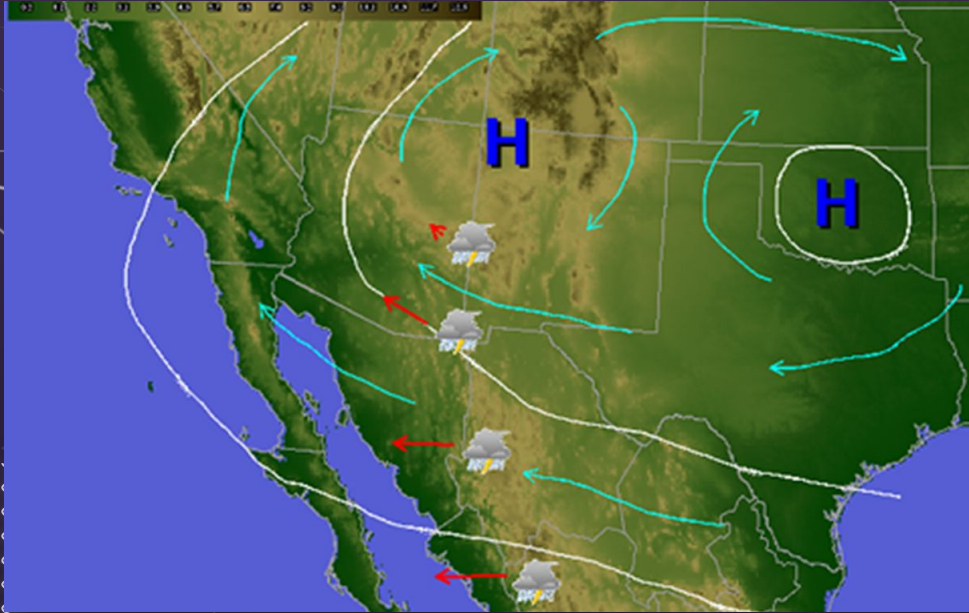
- The season is responsible for a large percentage of the southwest's annual precipitation totals (~ 50-70%)
 - A bad monsoon season typically leads to worsening drought conditions and a bad fire weather season
- The season ebbs and flows depending on the placement of the high pressure system
 - You are not guaranteed rain every day during the season
 - A very active pattern can quickly turn into a stretch with no rainfall
- Thunderstorms can be very hit and miss
 - Rainfall can be very localized and can vary over a short distance
- Everything is dependent on the different patterns!



Main Monsoon Patterns



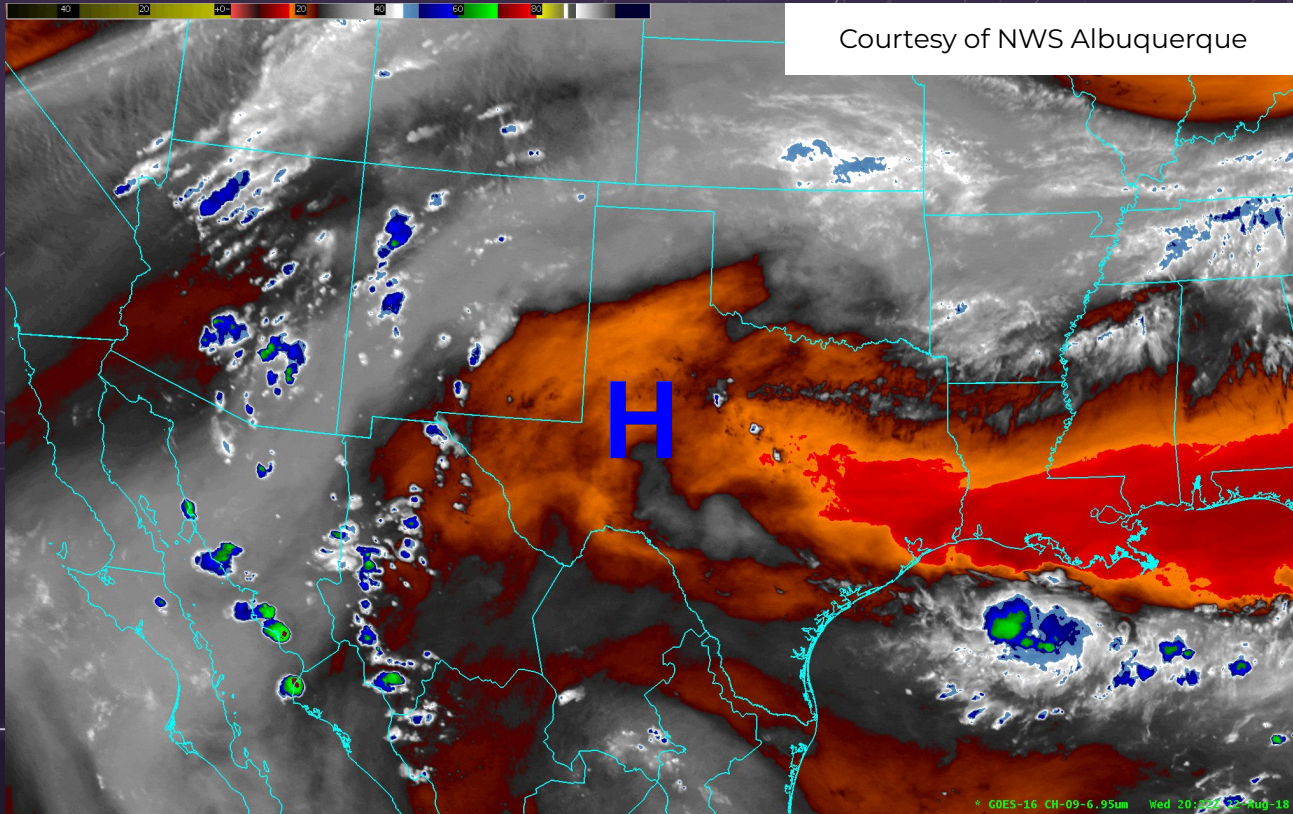
Monsoon Patterns: Type I



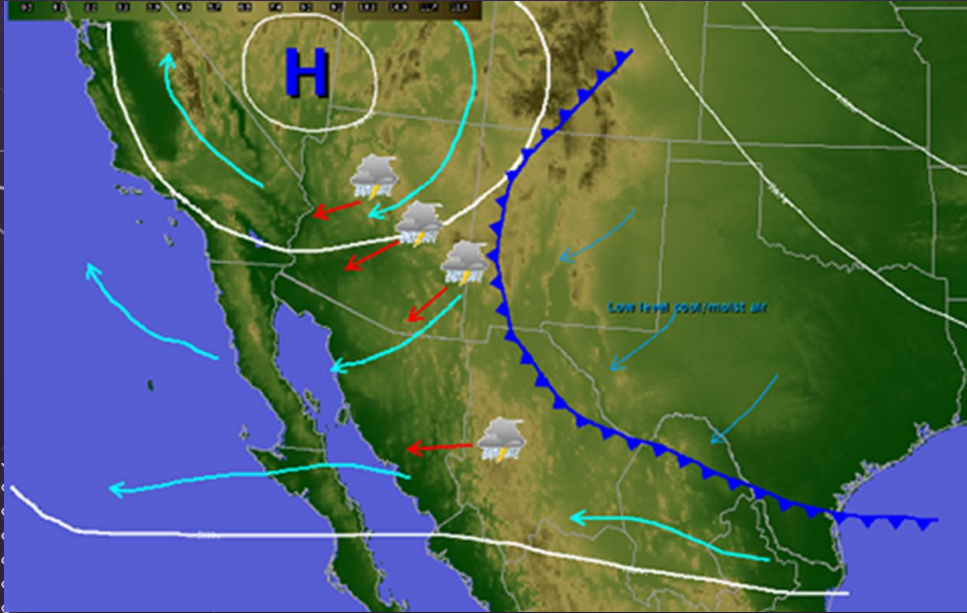
- Usually the most preferred monsoon pattern as it brings the most moisture
- The dominant high pressure to the east taps into moisture from the Gulf of Mexico
- Storms typically develop over the mountains and then propagate onto the lower elevations.



Monsoon Patterns: Type I



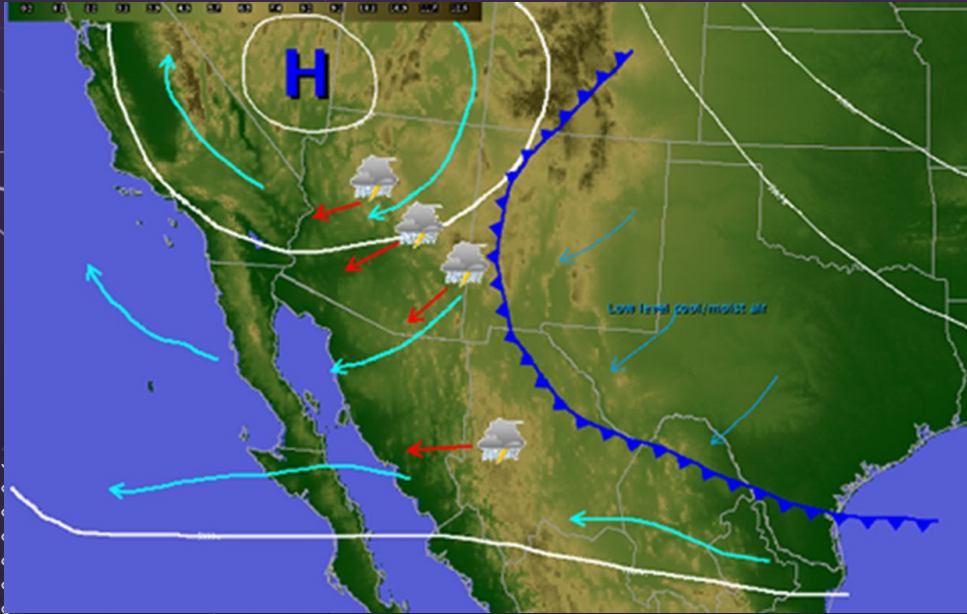
Monsoon Patterns: Type II



- Sometimes referred to as a “reverse monsoon” pattern
- The dominant high pressure centers itself near the Four Corners/Great Basin area
- Opens the door to backdoor cold fronts which provide the main source of moisture



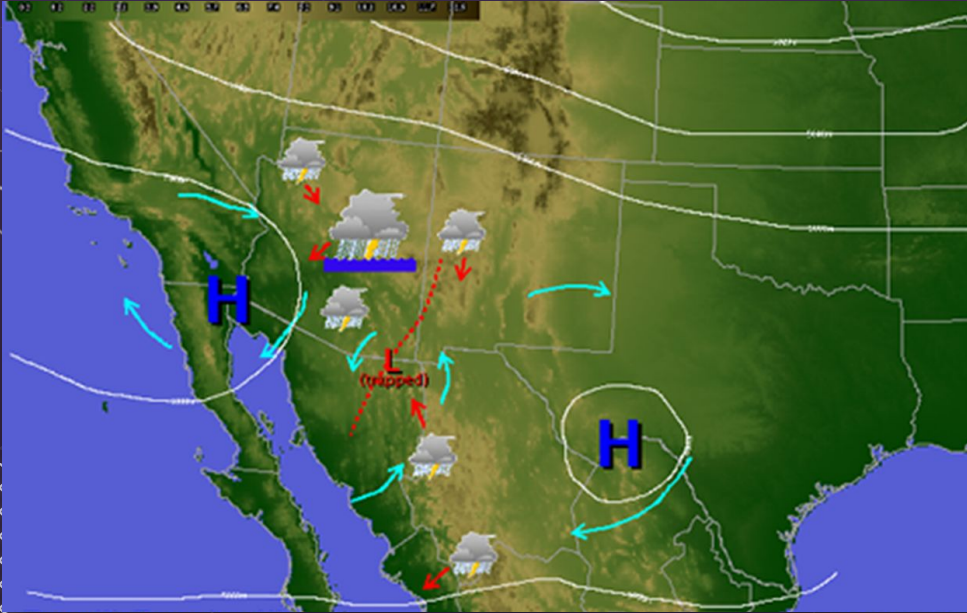
Monsoon Patterns: Type II



- If the high pressure gets too strong, it can actually result in suppressing thunderstorm development and lead to hot temperatures



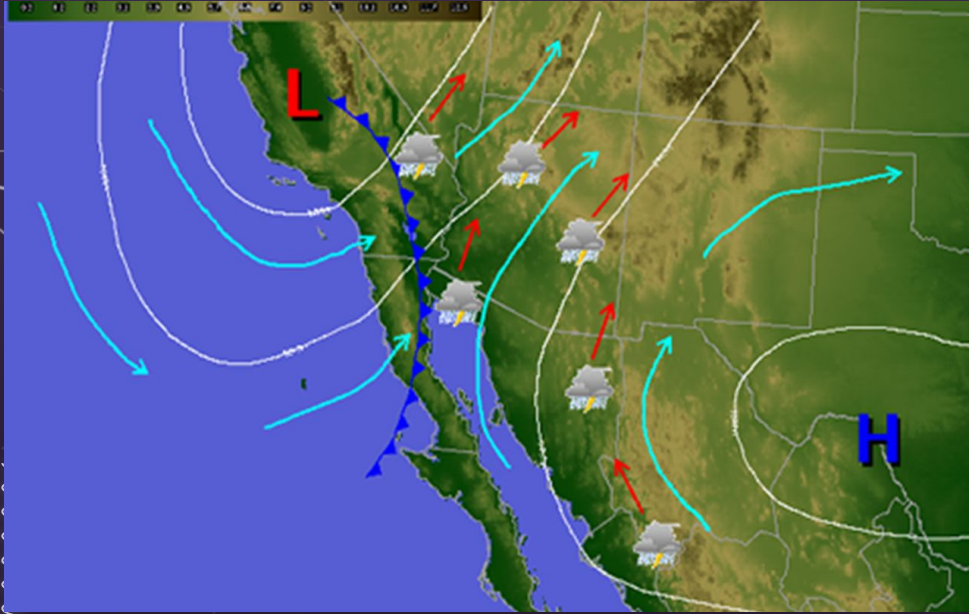
Monsoon Patterns: Type III



- The dominant area of high pressure shifts farther south
- Flow aloft turns more westerly, but recycled moisture still allows for thunderstorm development
- Light winds aloft will often lead to slower storm motions which present a flash flooding risk



Monsoon Patterns: Type IV



- Most likely pattern late in the season as we transition out of monsoon season
- The high pressure begins to build farther south, and traditional storm systems move in from the west
- Moisture sources are from the Pacific and Gulf of California





02



The Importance of El Niño & La Niña

Yep, it gets more complicated





Poll #3

Which do you think contributes in the most beneficial way to the North American Monsoon: El Niño or La Niña?



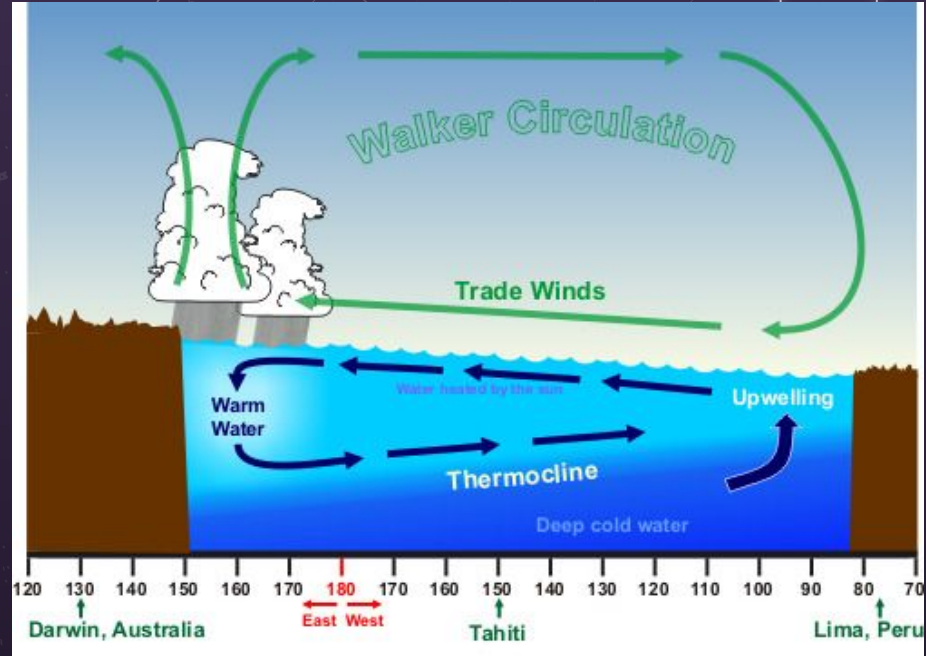
The El Niño Southern Oscillation (ENSO)

- Sea surface temperatures (SST) fluctuate dramatically in the tropical Pacific
- This variability in SST is referred to as the El Niño Southern Oscillation (ENSO)
- These warmer-than-normal or cooler-than-normal SST play a large role in the position of the jet stream and storm tracks across North America
- It's influence is much greater in winter & spring, but it can have a role during the monsoon season

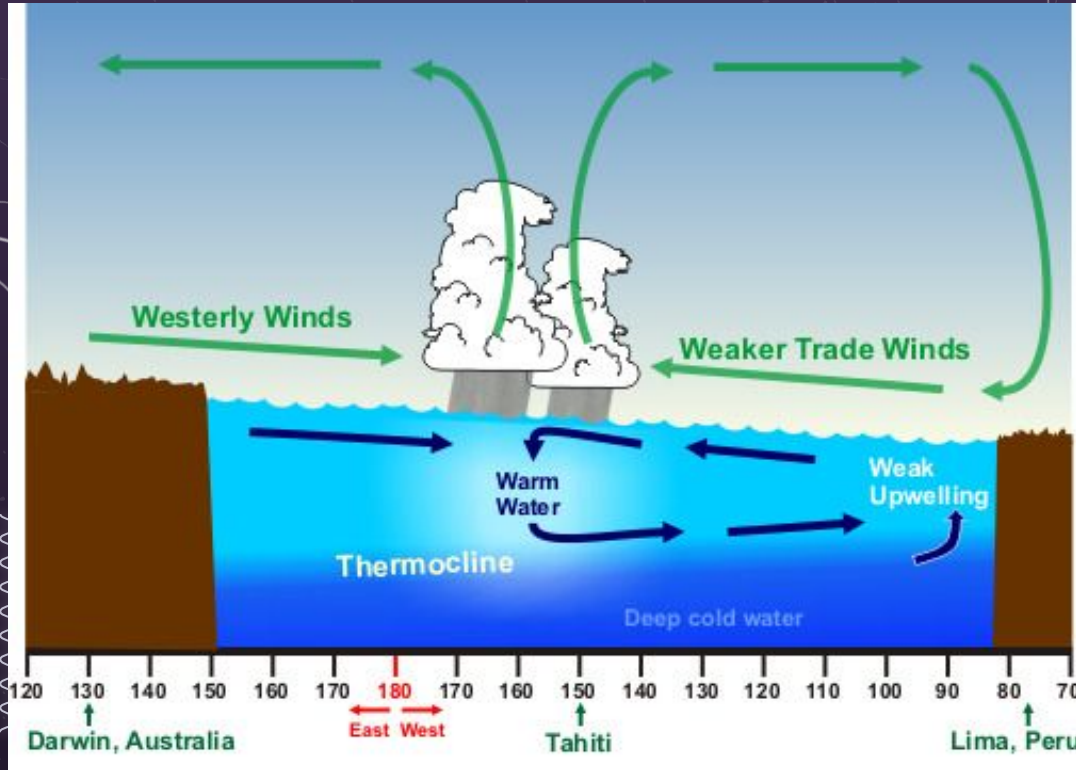


What Normally Happens in the Pacific?

- Typically in the Pacific Ocean, trade winds blow west along the equator
- This carries warm water from South America towards Asia
- This water has to be replaced so deeper, cold water rises
- When this normal process is interrupted, then we see El Niño or La Niña develop

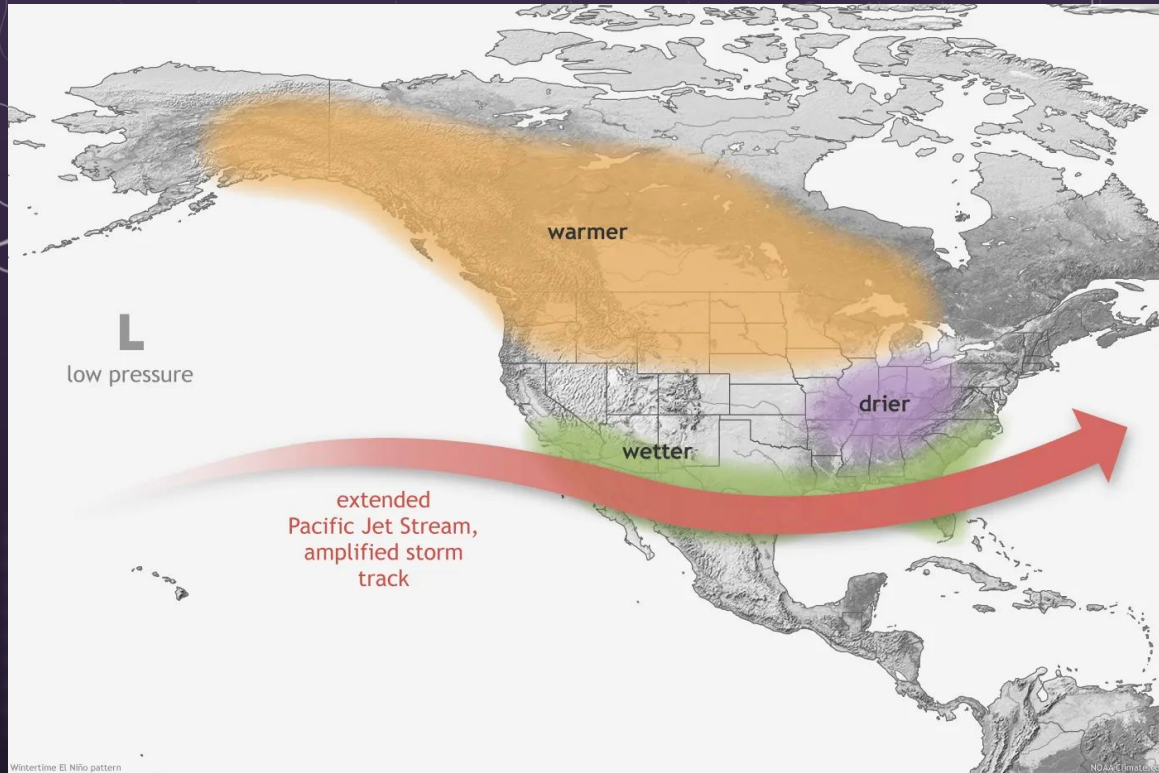


El Niño



- Trade winds weaken, and warm water is pushed back to the east towards the Americas
- Warmer-than-normal SST are then observed in the equatorial Pacific

El Niño



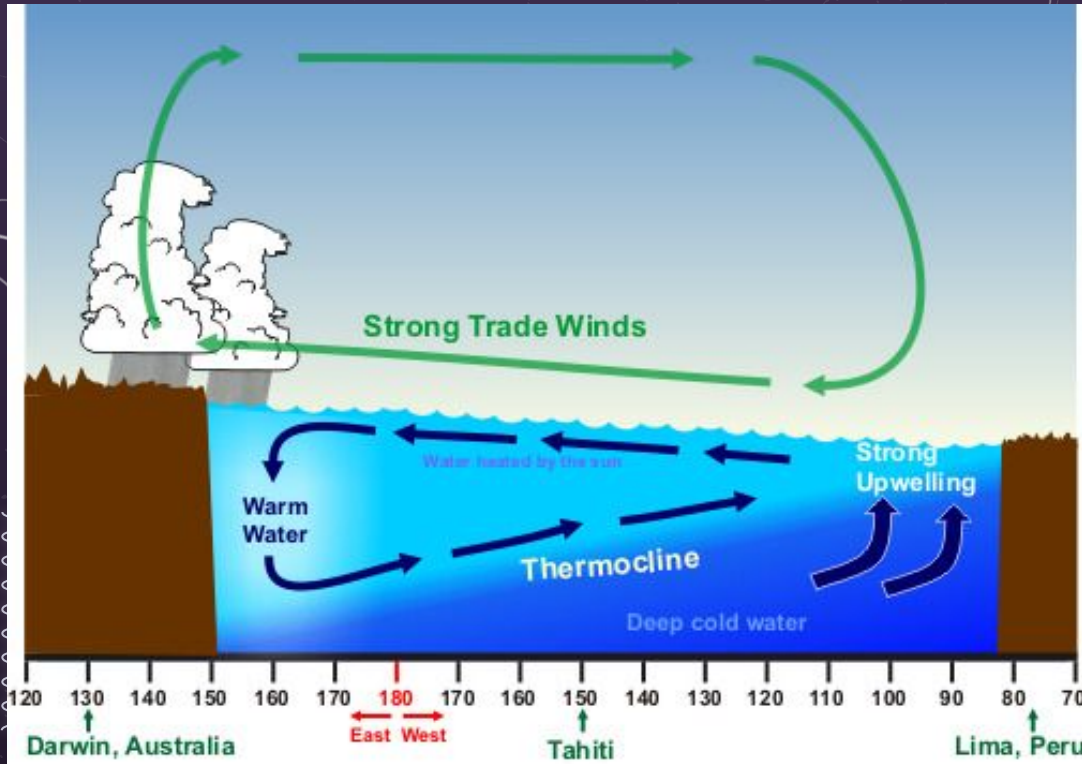
- Trade winds weaken, and warm water is pushed back to the east towards the Americas
- Warmer-than-normal SST are then observed in the equatorial Pacific
- This causes the jet stream to dip farther south, resulting in a more active storm track for the southern US

El Niño and Monsoon Season

- A strong, southern jet stream can weaken and reposition the important high pressure, delaying the onset of the monsoon season.
- But! El Niño events often leads to a more active Pacific hurricane season. This increased tropical activity can oftentimes be steered towards the southwest US
- **Above normal precipitation** totals can be favored during El Niño patterns

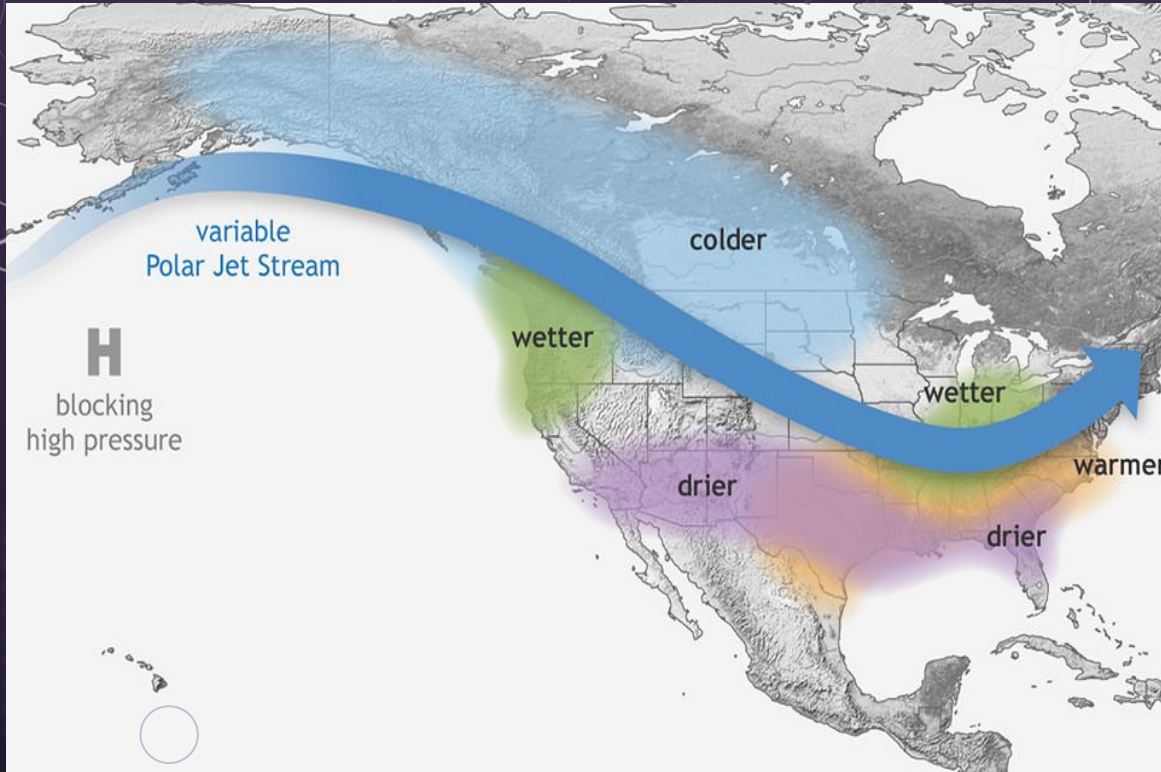


La Niña



- Trade winds are even stronger than normal, sending warm water towards Asia
- Cold water from the depths of the ocean is brought upward to replace the warm water, and cooler-than-normal SST are observed in the equatorial Pacific

La Niña



- Trade winds are even stronger than normal, sending warm water towards Asia
- Cold water from the depths of the ocean is brought upward to replace the warm water, and cooler-than-normal SST are observed in the equatorial Pacific
- This pushes the jet stream northward, oftentimes leading to drier conditions across the southern US



03



Hazards During the Monsoon

It's not just rain!





Poll #4

What do you think is the biggest hazard during monsoon season?



Flash Flooding

Turn Around, Don't Drown!

- Thunderstorms can produce heavy rainfall. Additionally, storm motions can be very slow at times which can also lead to flash flooding
- Flow can become dangerous in normally dry washes, arroyos, low-lying areas, and roadways
- Most flash flooding deaths occur in vehicles



Burn Scar Flash Flooding

Wildfires are a well-known hazard, particularly in the western US. But did you know that the burn scar they leave behind becomes especially dangerous? In fact, it doesn't even take that much rain for them to quickly turn dangerous!



FLOOD AFTER FIRE

Did you know that wildfires dramatically alter the terrain and increase the risk of floods?

Reduce your risk.
The time to buy flood insurance is now.

Contact your local insurance agent for more information or visit the National Flood Insurance Program at www.fema.gov/national-flood-insurance-program

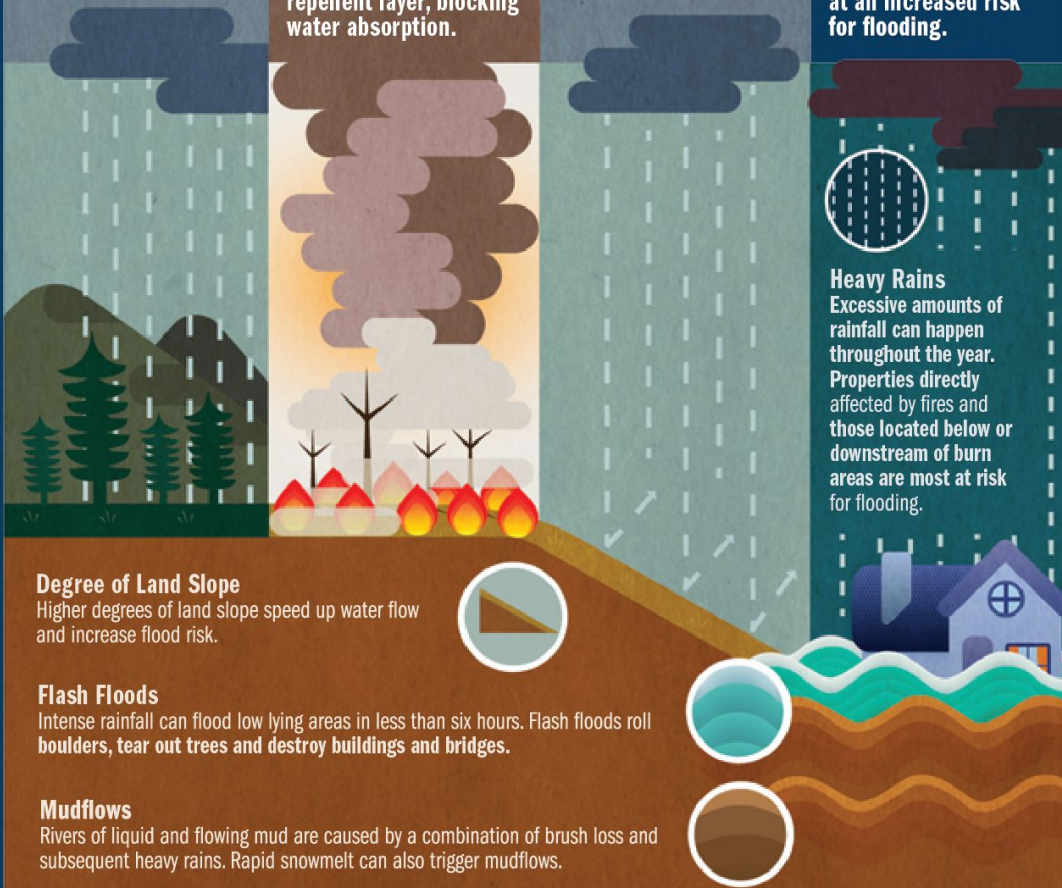


During normal conditions, vegetation helps absorb rainwater.

But after an intense wildfire, burned vegetation and charred soil form a water repellent layer, blocking water absorption.

During the next rainfall, water bounces off of the soil.

And as a result, properties located below or downstream of the burn areas are at an increased risk for flooding.



Degree of Land Slope

Higher degrees of land slope speed up water flow and increase flood risk.



Flash Floods

Intense rainfall can flood low lying areas in less than six hours. Flash floods roll boulders, tear out trees and destroy buildings and bridges.

Mudflows

Rivers of liquid and flowing mud are caused by a combination of brush loss and subsequent heavy rains. Rapid snowmelt can also trigger mudflows.

Heavy Rains

Excessive amounts of rainfall can happen throughout the year. Properties directly affected by fires and those located below or downstream of burn areas are most at risk for flooding.



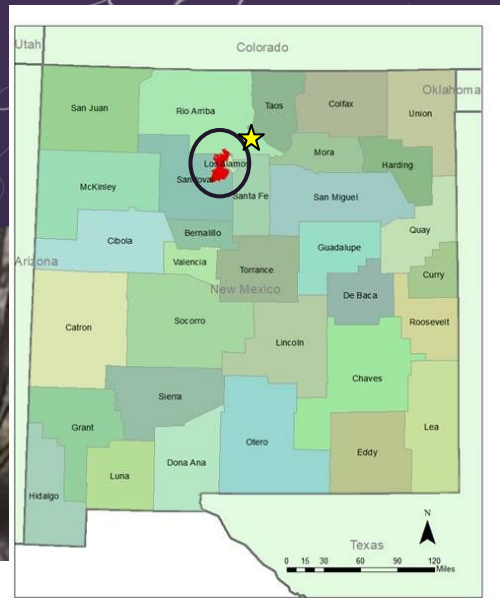
Burn Scar Flash Flooding



Did you ever see it rain in this video?



Dixon, NM Flash Flood - August 22, 2011

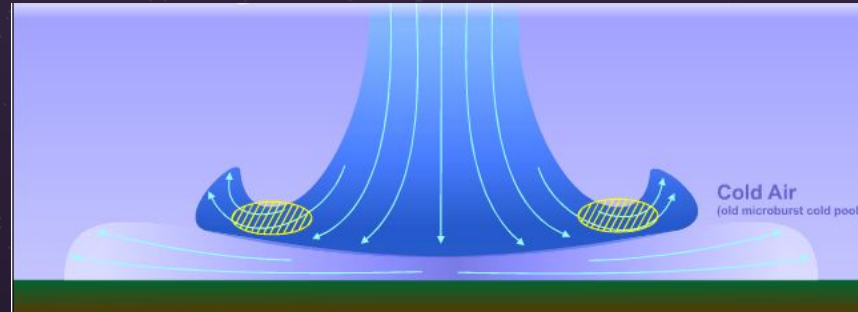
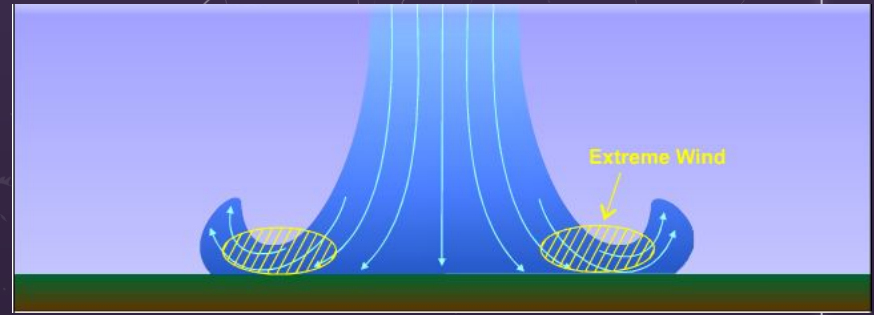
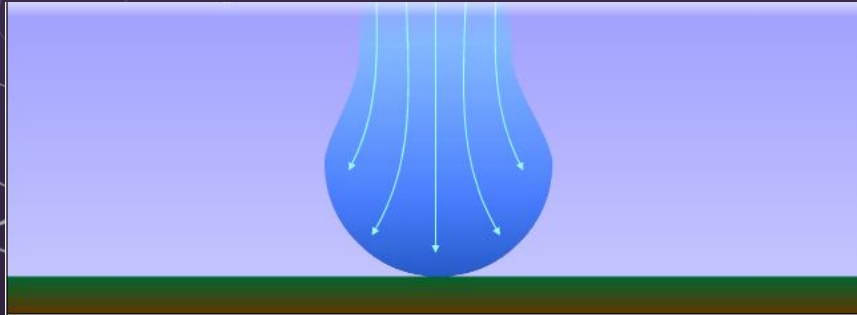


Downbursts

- Strong **downdraft** with an outrush of strong or damaging winds on or near the ground
 - **Macrobusts:** At least 2.5 miles in width and last anywhere between 5 to 30 minutes
 - **Microbursts:** Less than 2.5 miles in width and lasting on average between 2 to 5 minutes
- Can be wet or dry
 - Wet downdrafts will be accompanied by rain, making them easily seen
 - Dry downdrafts are difficult to see, but a raggedy appearance from the base of the cloud can give them away



Downbursts



- Wind gusts can be near or exceed 100 mph and this can do extensive damage!
 - Can also cause dust storms or haboobs

Dust Storms & Haboobs

Pull Aside, Stay Alive

- Are often formed from thunderstorm downdrafts, particularly the dry downdrafts
- Strong winds lift up the dust and loose dirt from the ground and this wall of dust then gains momentum and can move quickly
- Visibility can drop to near zero rapidly



Hail

- Hail may be more common during the early and late portions of the monsoon season
- Hail can get large with reports of hailstones larger than golf balls
- Small hail can be just as hazardous though, particularly a lot of small hail can turn roads into solid ice

Courtesy of Santa Rosa, NM FD - July 3, 2013



Lightning



Albuquerque, New Mexico, August 2, 2021 -
Courtesy of Jennifer Shoemake

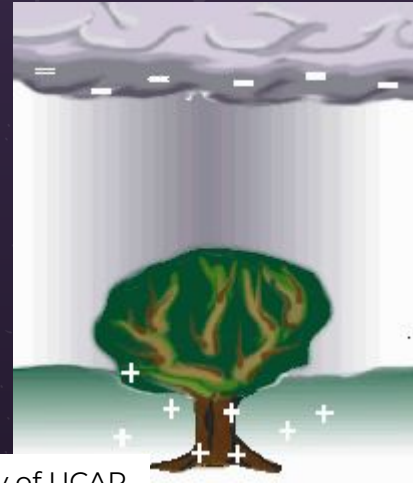
When Thunder Roars, Go Indoors

- Most victims are killed by the first or the last lightning strike
- Cloud bases are oftentimes very high across the west, allowing for a large part of a lightning bolt to be seen. Lightning can be seen for miles, and it makes for gorgeous photography!



Formation of Lightning

- There are multiple charges within the thunderstorm from ice crystals and water vapor
- The updraft within the thunderstorm separates these negative and positive charges
 - Top of the cloud becomes positively charged
 - Bottom of the cloud becomes negatively charged
 - The Earth's surface is positively charged

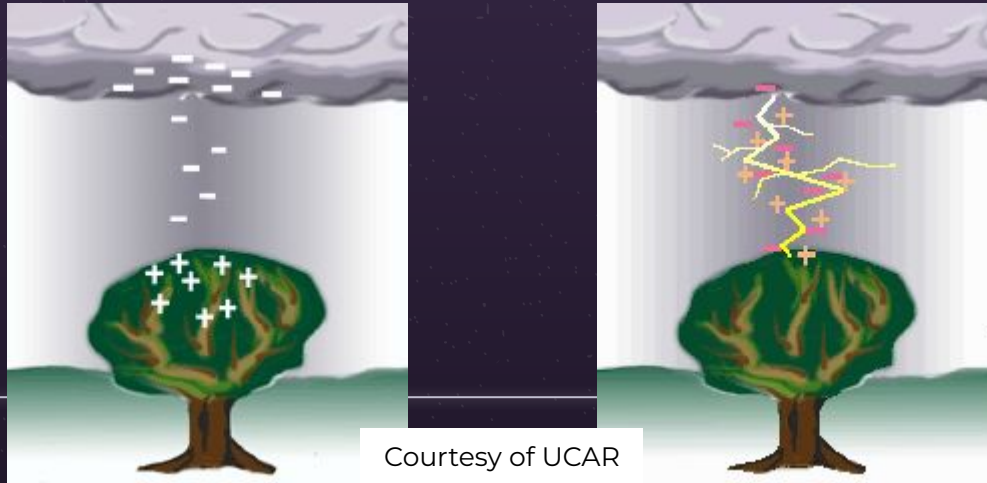


Courtesy of UCAR



Formation of Lightning

- Opposites attract
 - Once the negative charge at the bottom of the cloud gets large enough, it rushes toward the ground
 - The positive charge at the surface rushes upward to meet it
 - A connection is made, and we see the result in the form of a lightning bolt!



Courtesy of UCAR

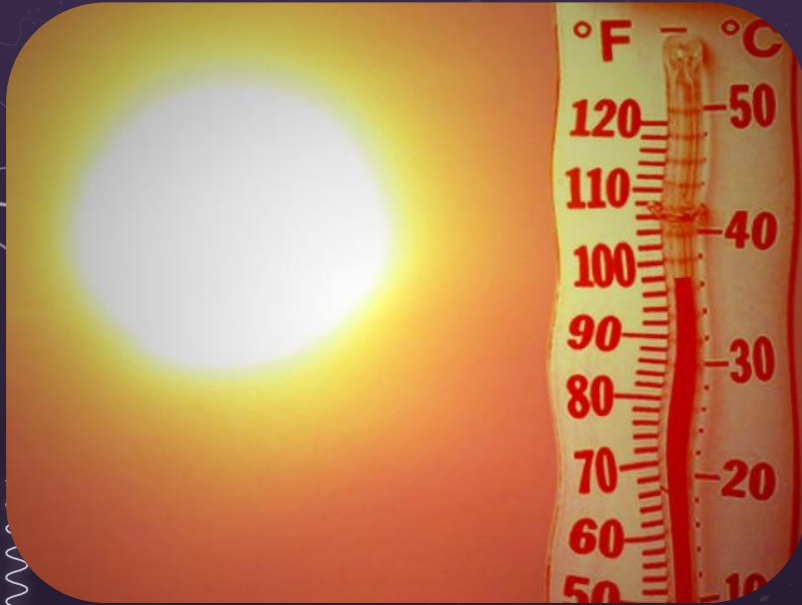


Formation of Lightning

- The lightning bolt heats the air to 18K - 20K degrees Fahrenheit in a few millionths of a second
- This extreme heating and expanding of the air creates a sound wave, AKA thunder
- Thunder and lightning actually occur at the same time. We see the lightning first because light travels faster than sound!



Heat



- The underrated monsoon hazard
- Remember, monsoon season ebbs & flows. A strengthening high pressure system in the wrong place can suppress thunderstorms and cause temperatures to soar!
- Temperatures in the 110-120 degrees Fahrenheit are common!





Thank You! Questions?

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