

Hazardous Weather Primer



CERT Basic Training Unit 0



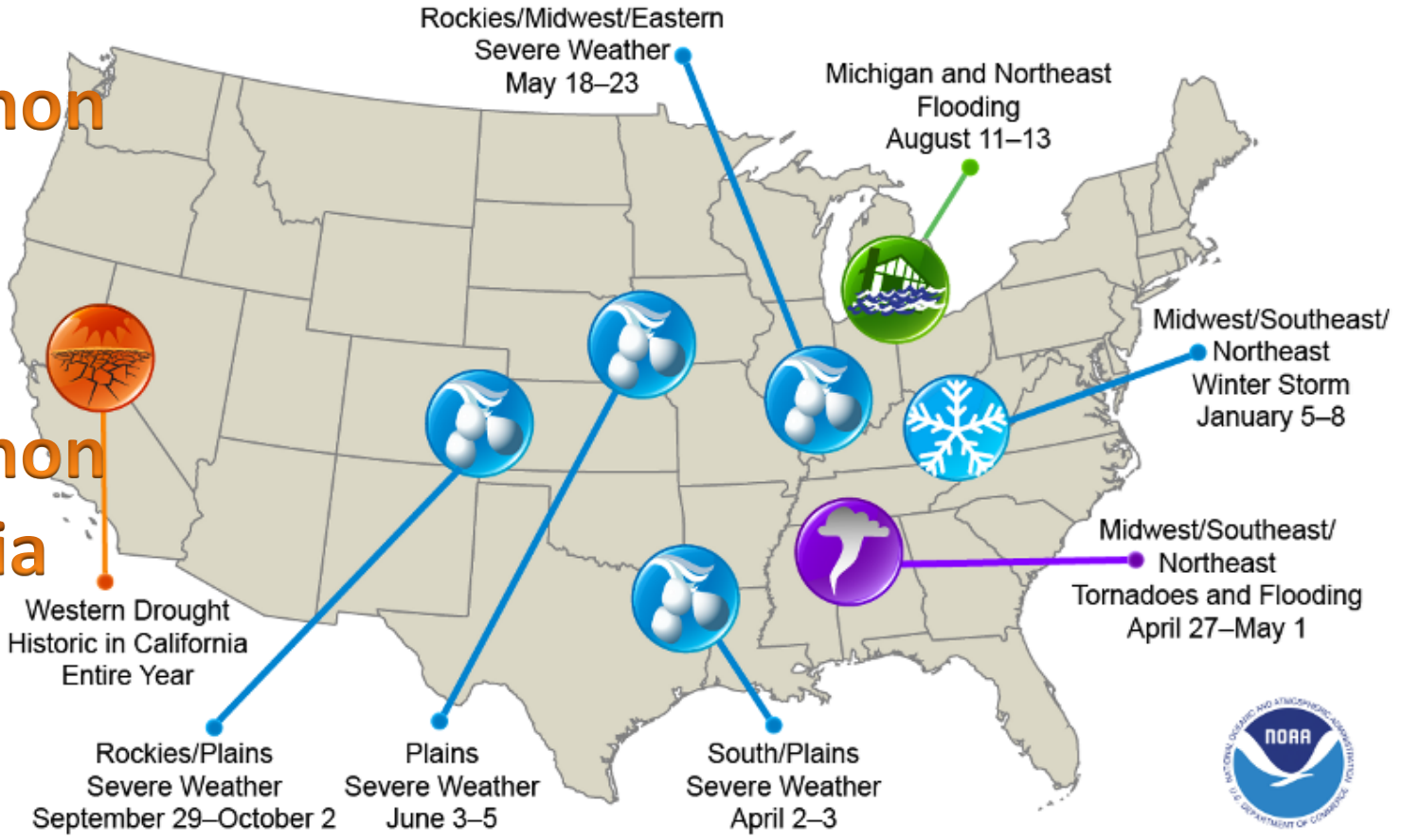
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citizen  *corps*

U.S. 2014 Billion-Dollar Weather and Climate Disasters

Most Common
Nationwide
Threat?

Most Common
Pennsylvania
Threat?



This map denotes the approximate location for each of the eight billion-dollar weather and climate disasters that impacted the United States during 2014.

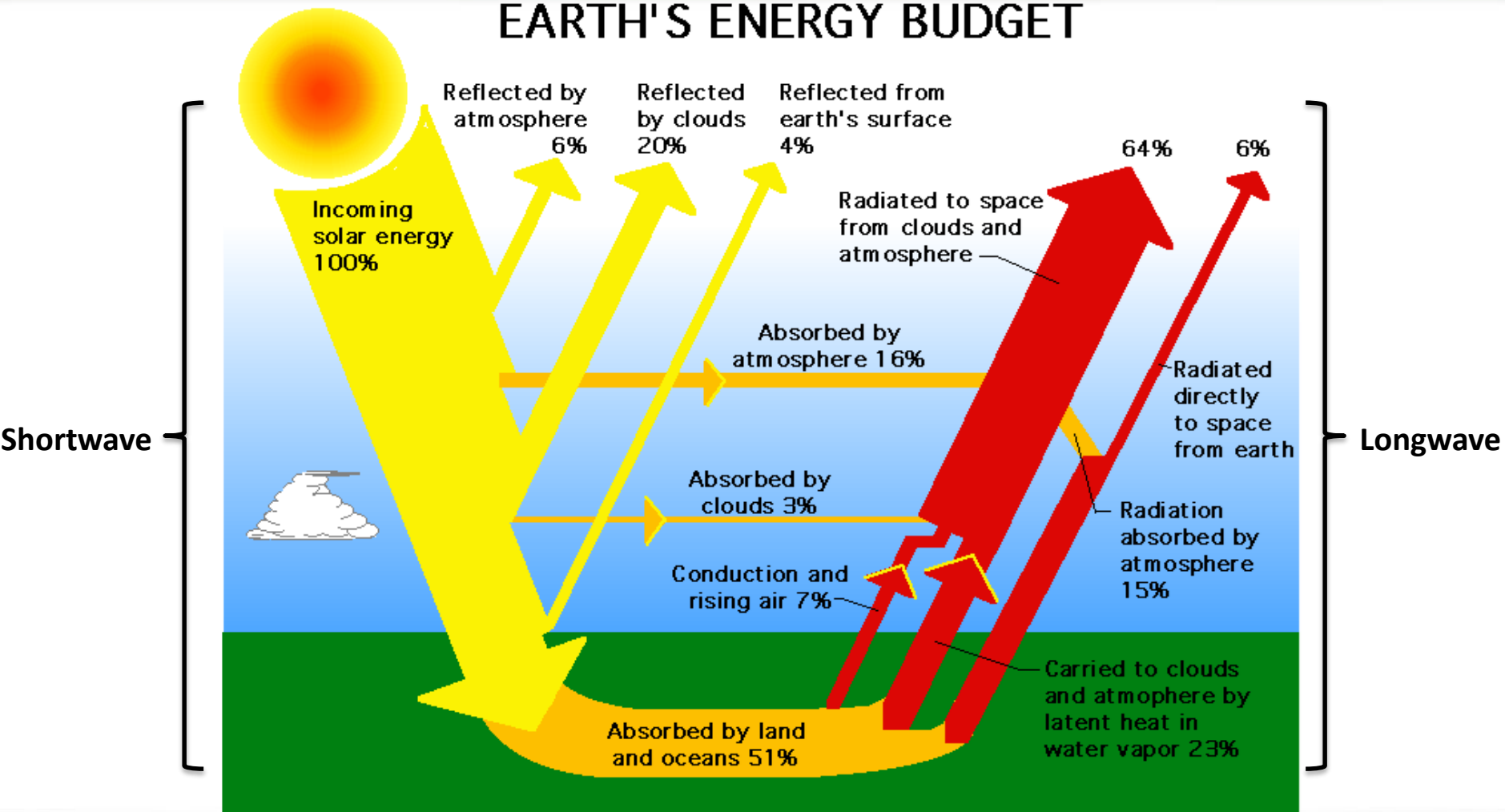




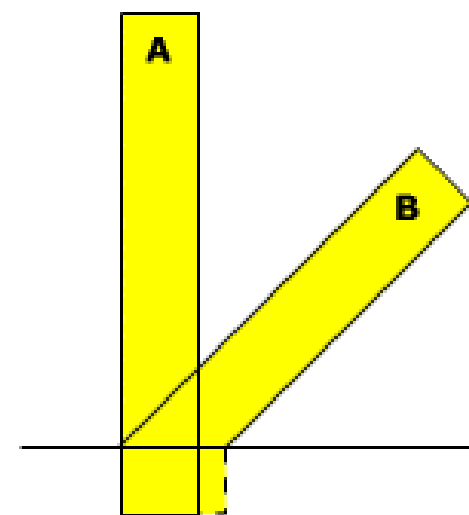
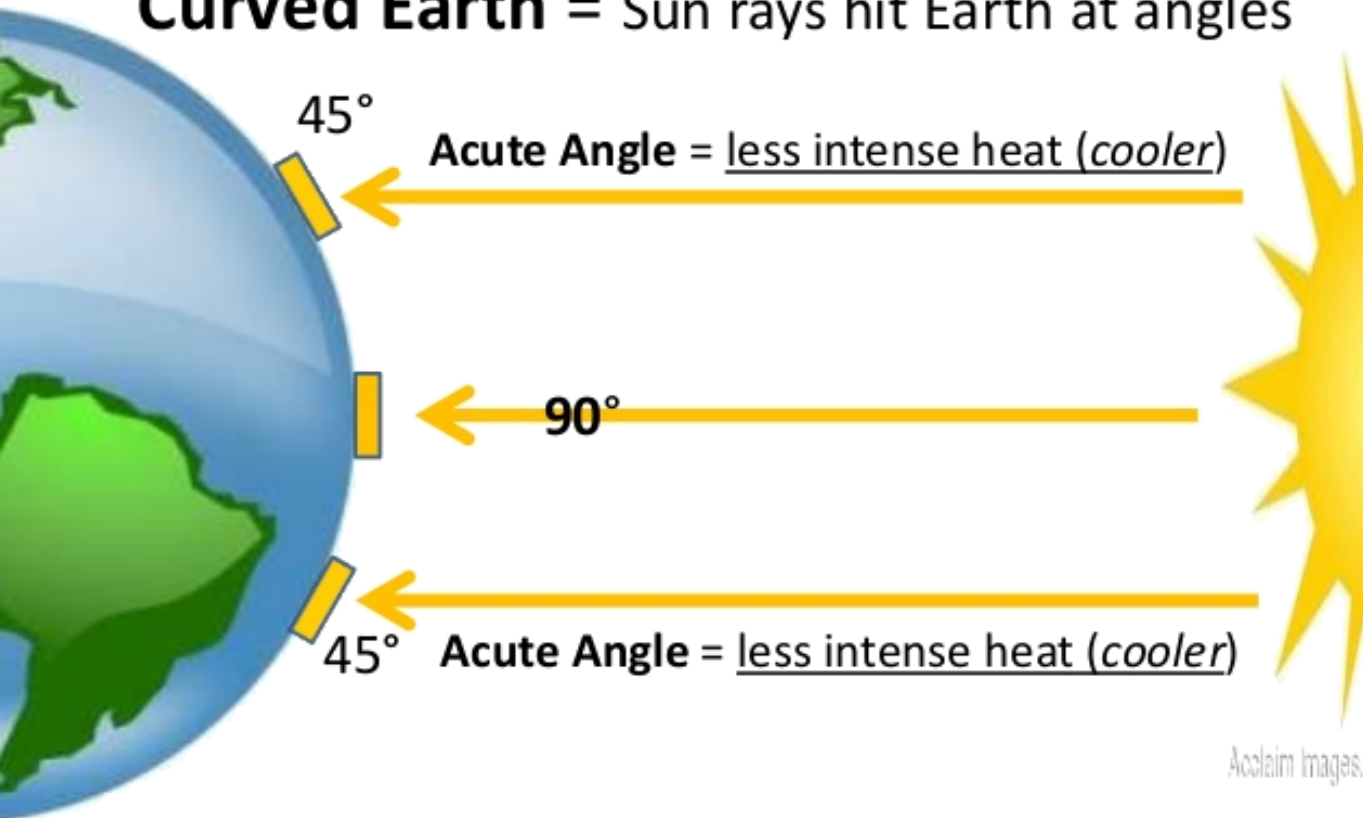
3 Basic Weather Elements:

1. Temperature

EARTH'S ENERGY BUDGET



Curved Earth = Sun rays hit Earth at angles



Area Illuminated

http://www.earthonlinemedia.com/ipg/images/atmosphere/energy/sun_angles.gif

<http://www.slideshare.net/jdlowe78/solar-energy-uneven-heating-of-earth-wind-and-ocean-currents>



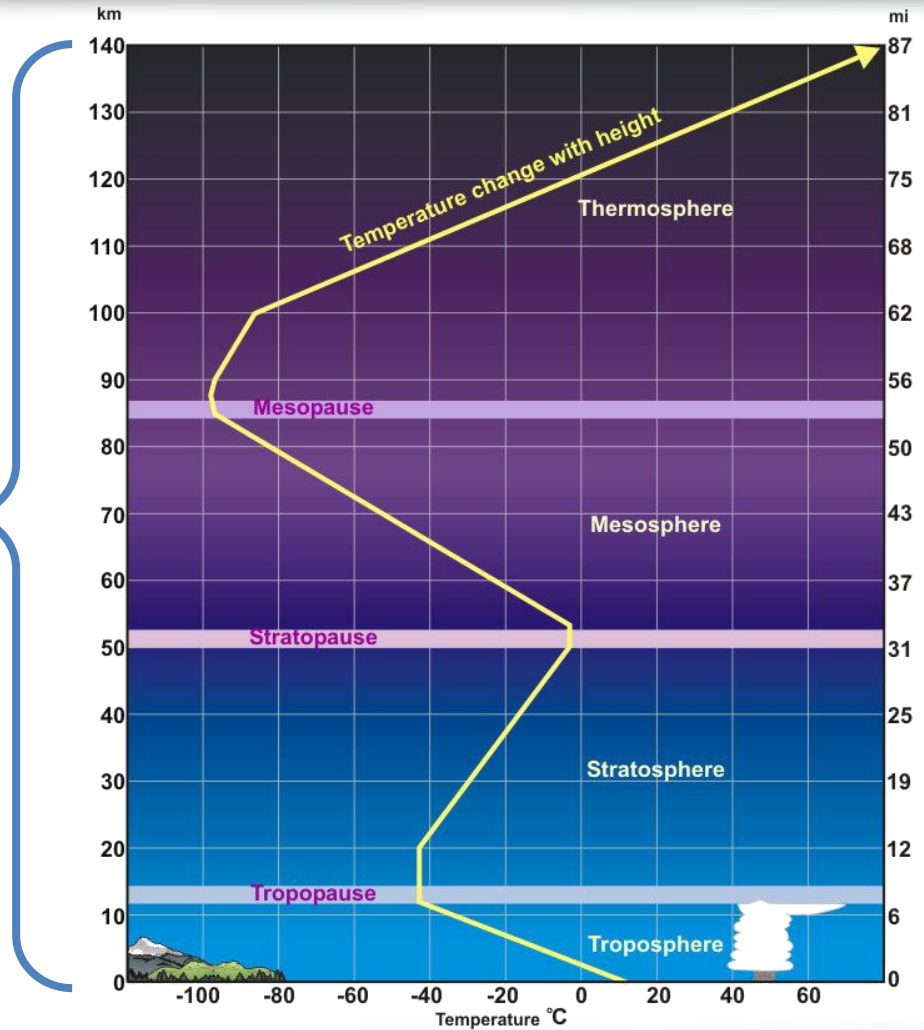
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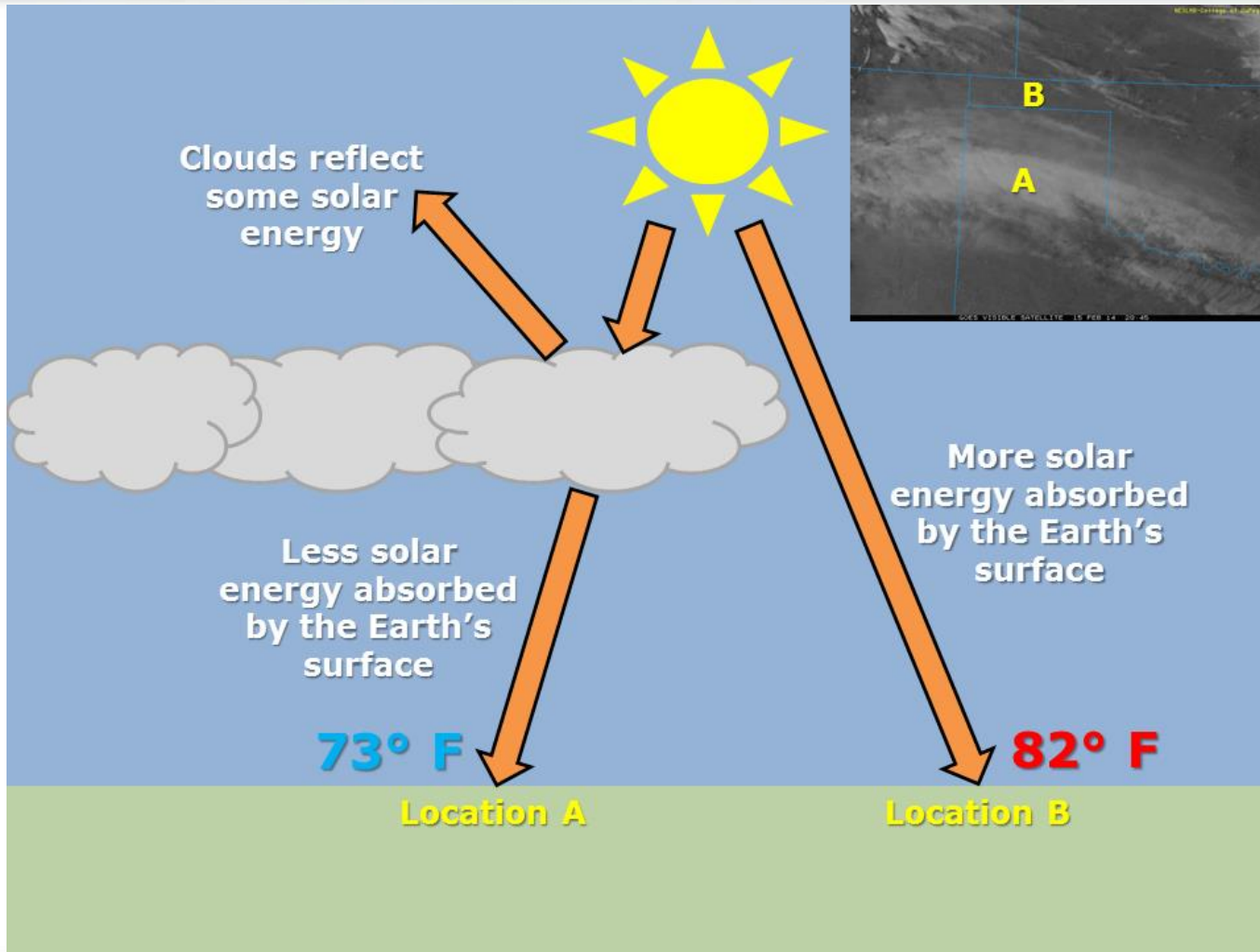


The Atmosphere's Layers:

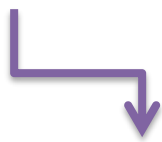
Nitrogen (N₂)
Oxygen (O₂)
Argon (Ar)
Carbon Dioxide (CO₂)

↓
99.998%





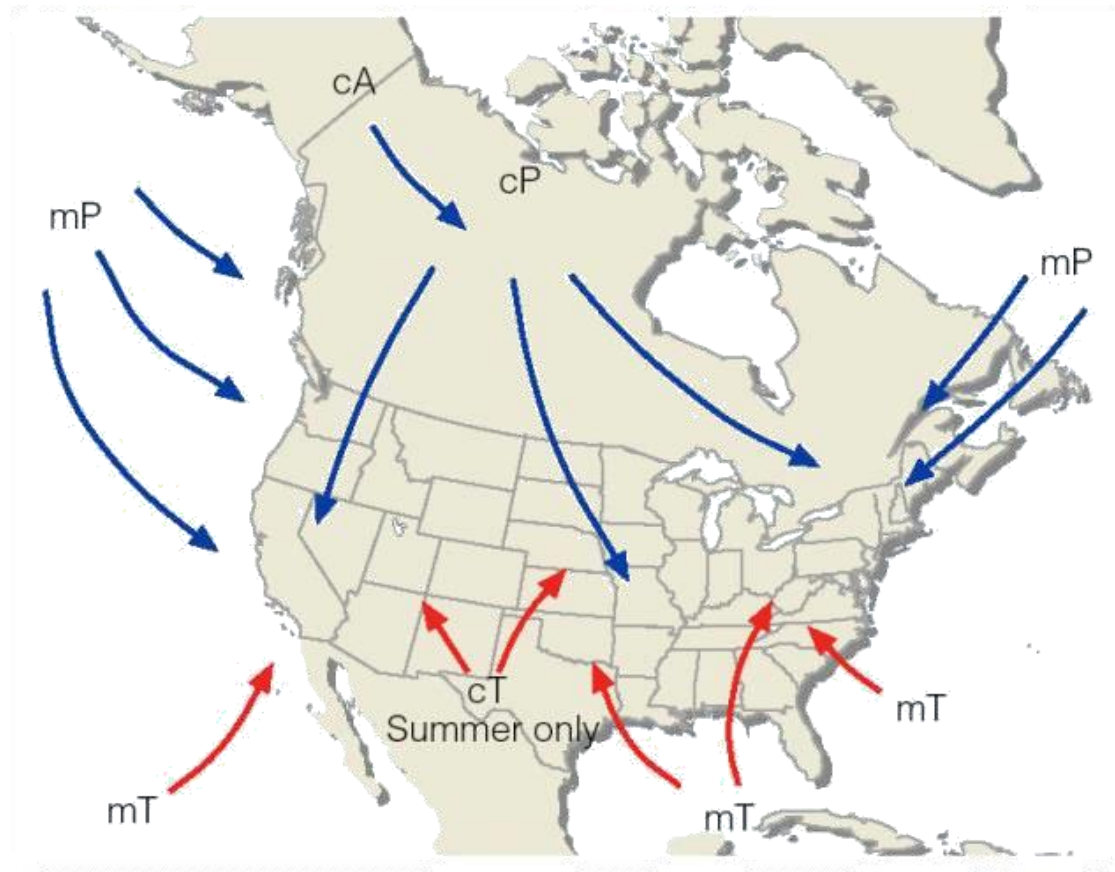
Air Mass: large body of air with generally uniform temperature and humidity. The area from which an air mass originates is called a "source region."



Source Region Decoder			
1		2	
m	Maritime	A	Arctic
c	Continental	P	Polar
		T	Tropical

EX: Maritime Tropical

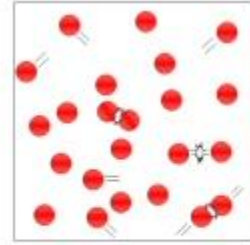
Air Masses



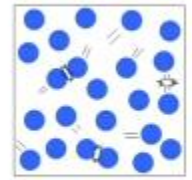
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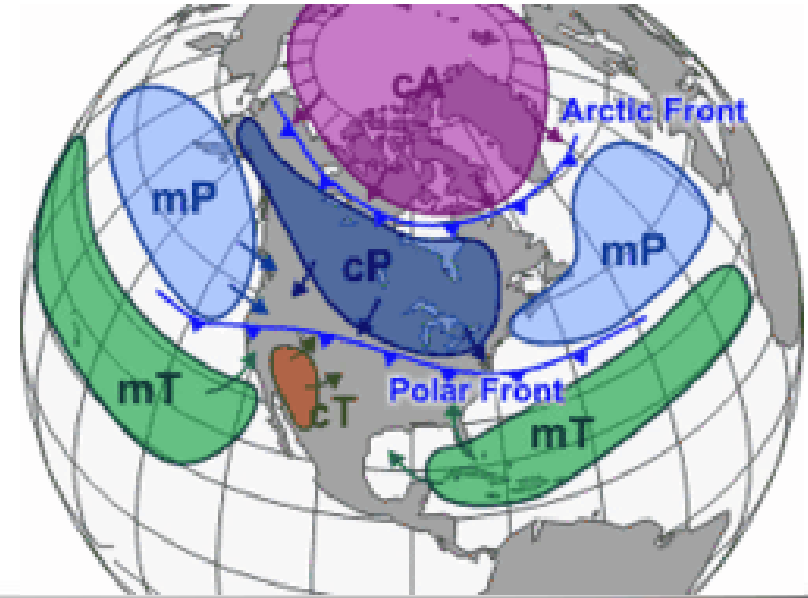
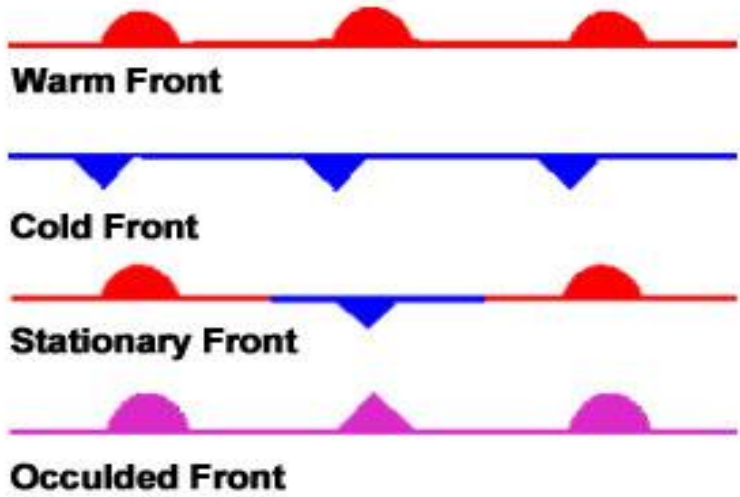
Front: Air mass leading edge



Warm molecules have more energy so move faster and take up more space



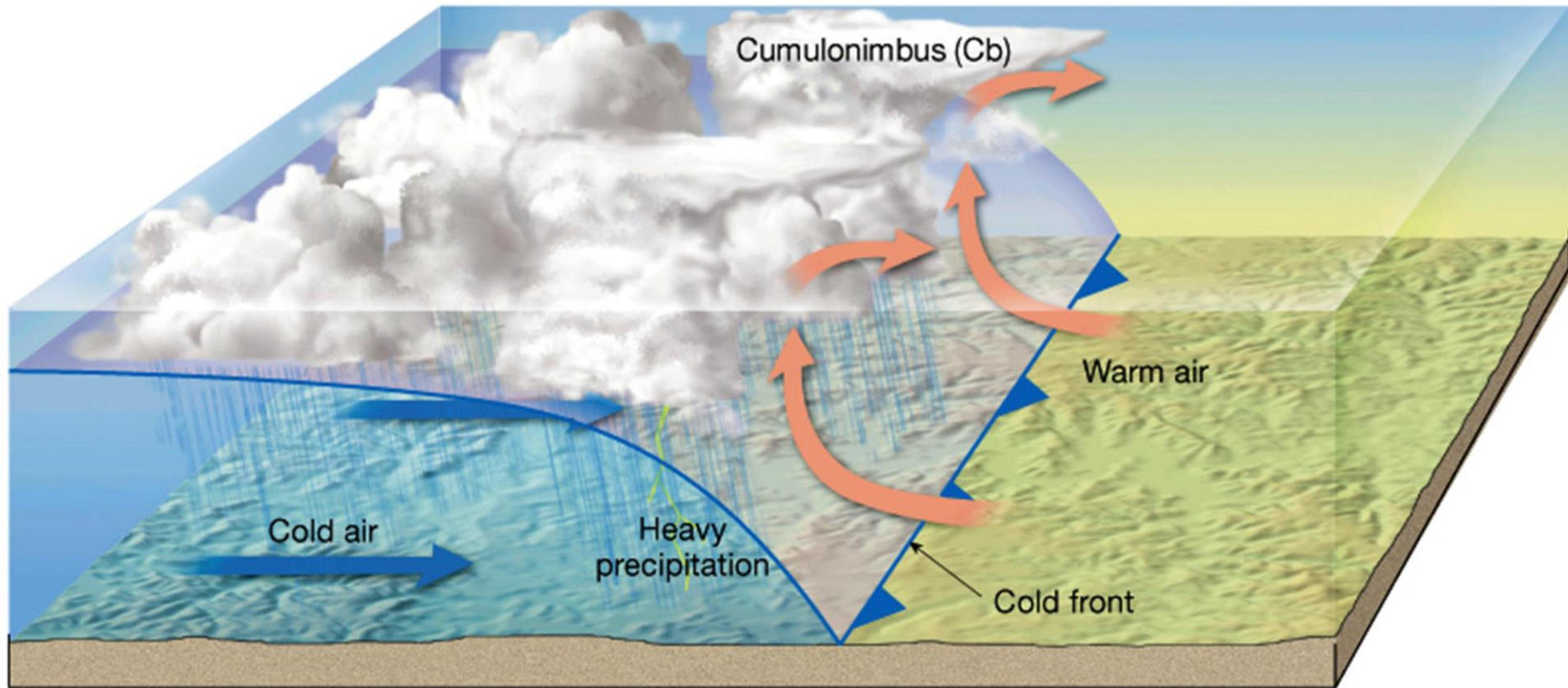
Cold molecules have less energy so move slower and take up less space



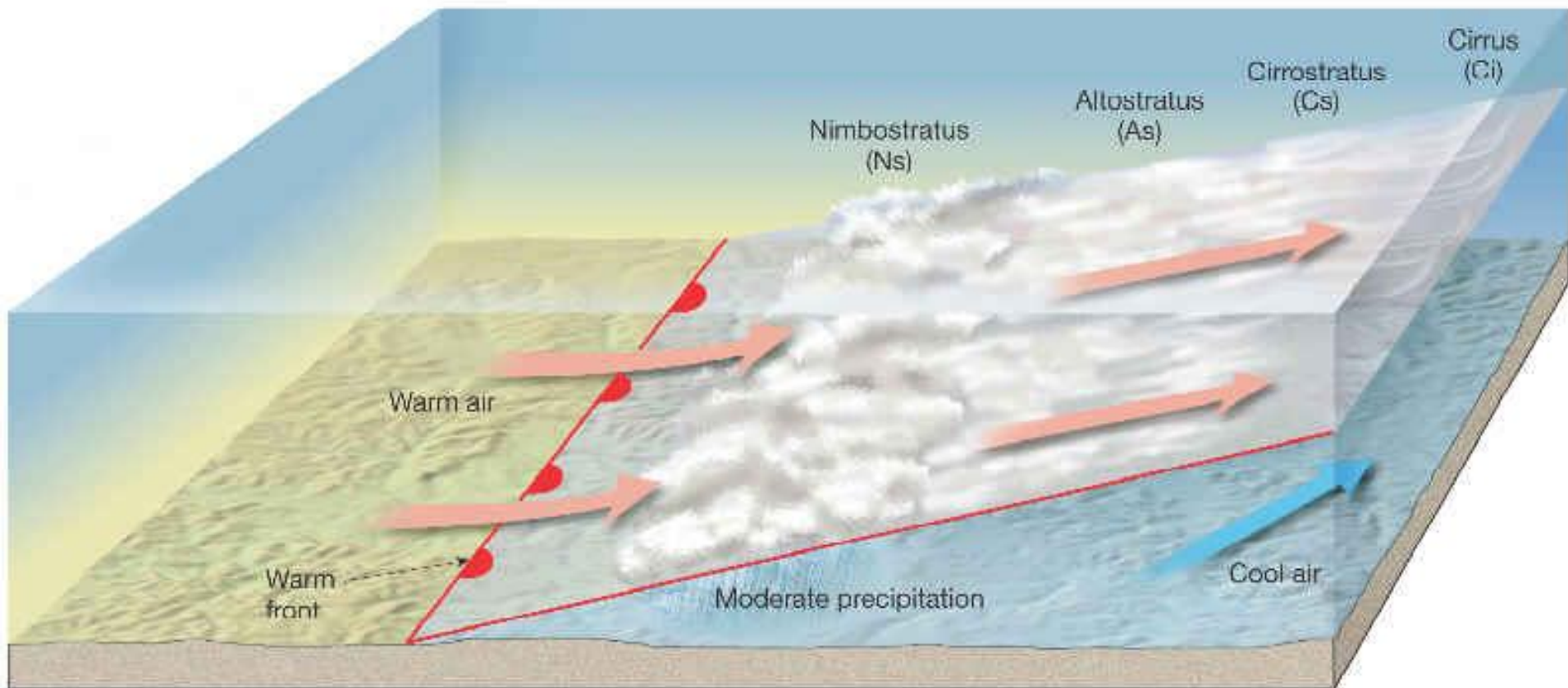


Cold front

Source: Lutgens and Tarbuck, 2004



Warm front



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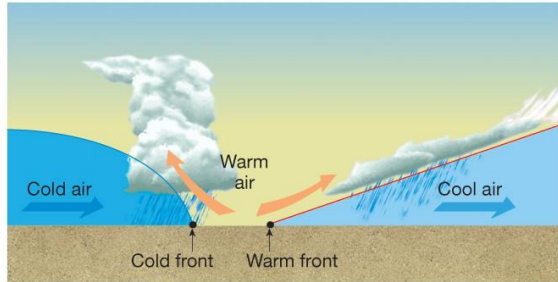




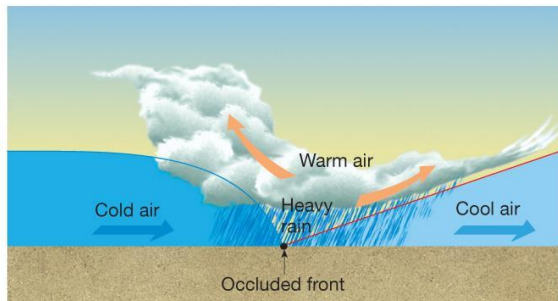
Occluded Front

- to close, shut, or stop up (a passage, opening, etc.).

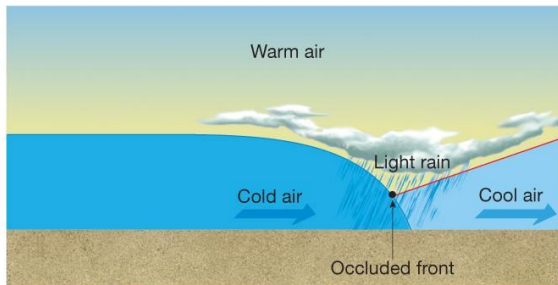
occlude. 2014. In *Merriam-Webster.com*. Retrieved April 14, 2014, from <http://www.merriam-webster.com/dictionary/occlude>



A.

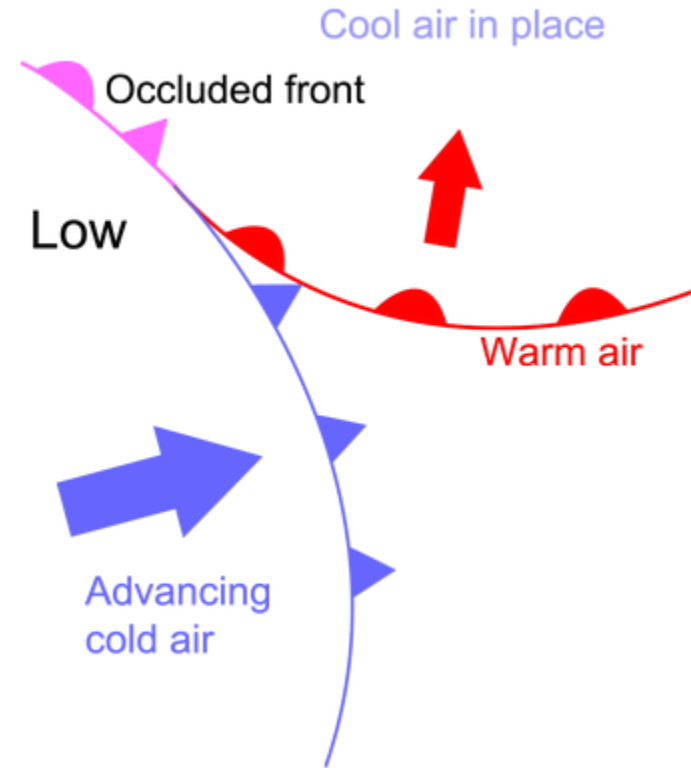


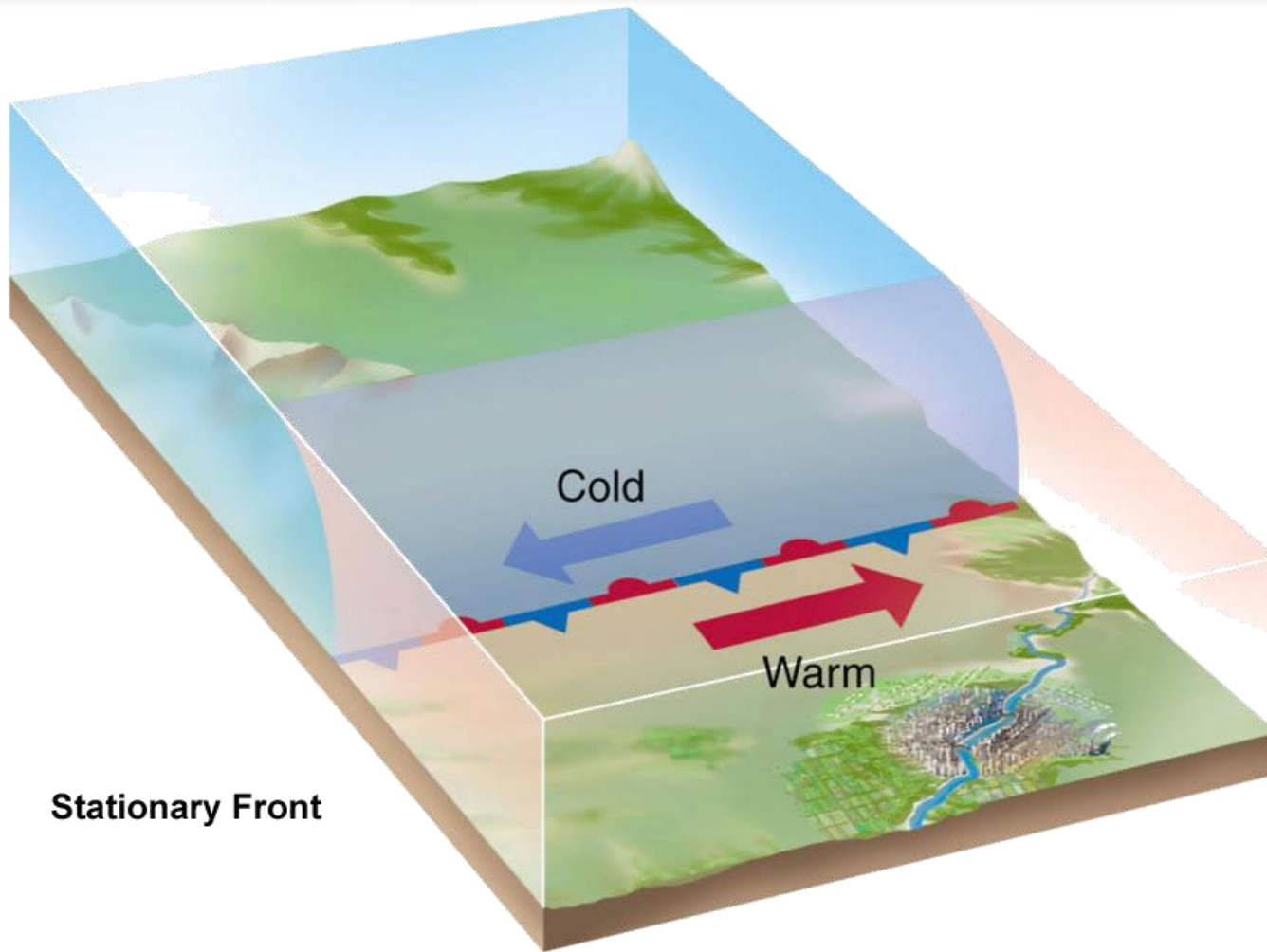
B.



C.

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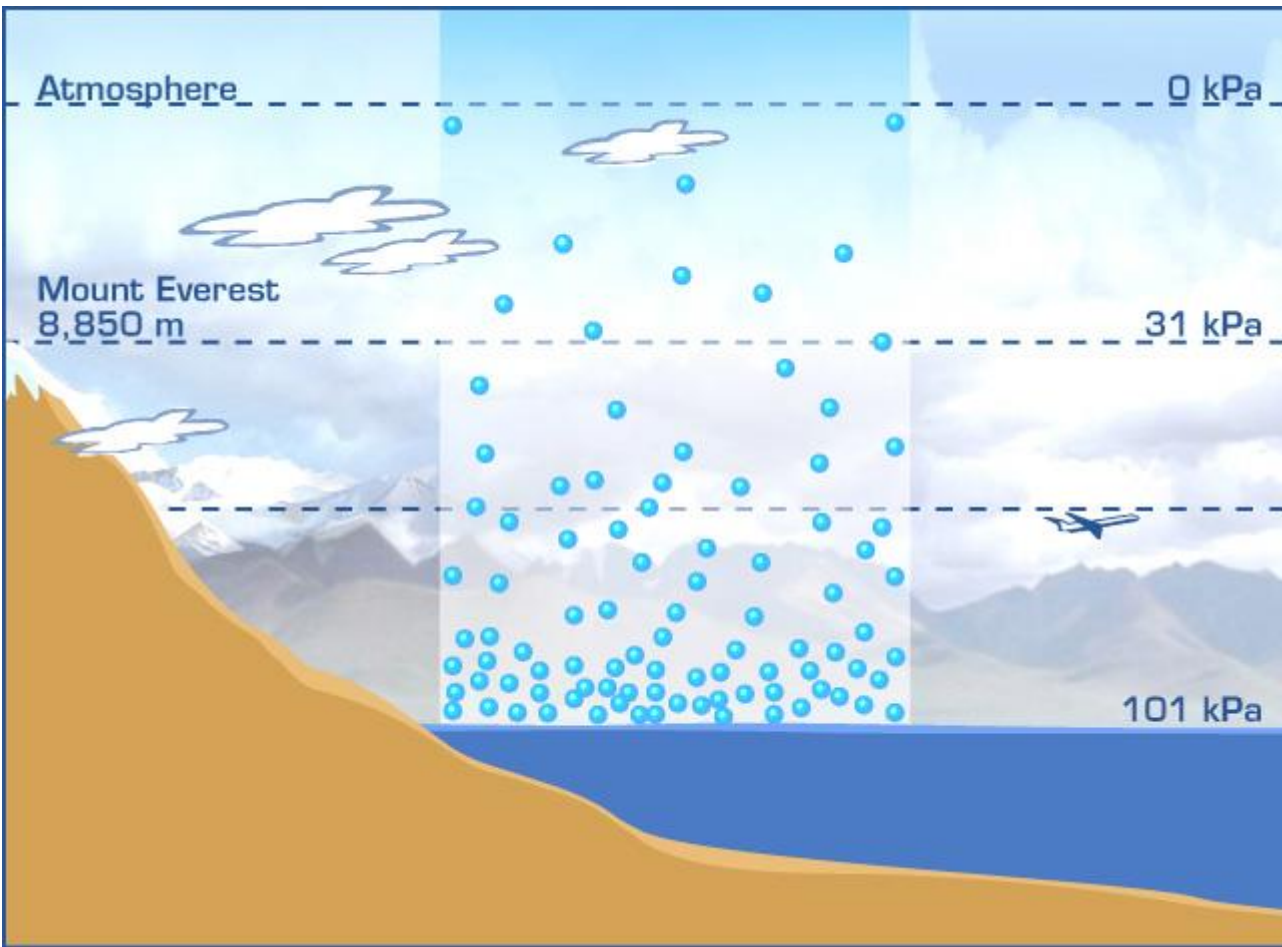
Stationary Front



3 Basic Weather Elements:

1. Temperature

2. Pressure & Wind

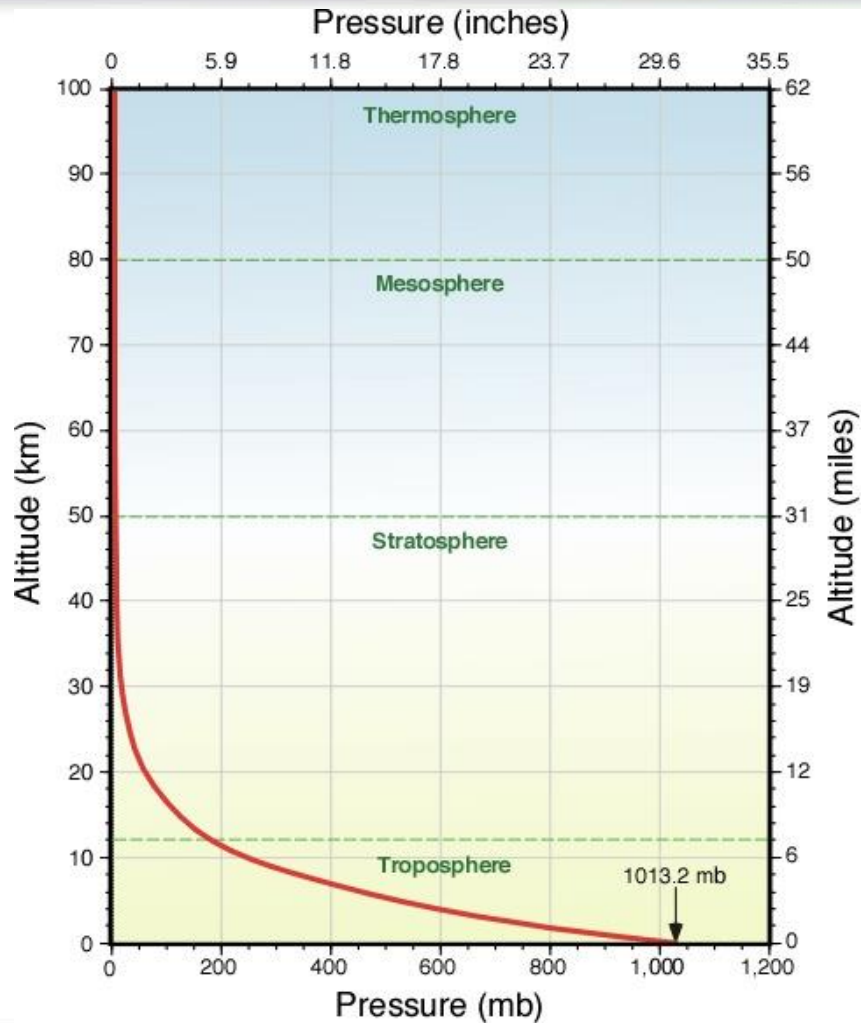


“Weight of the air”

Measured in Pascals, Atmospheres, millibars, or inches of mercury

One half of the air molecules in the atmosphere are contained within the first 18,000 feet (5.5 km).

Near sea level, a box one inch on each side contains around 400 sextillion air molecules (400 followed by 21 zeros).



1 atm = 1013.25 millibars (mb) = 29.92 in Hg

Barometer: used to measure atmospheric pressure

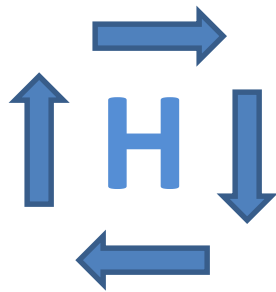
Altitude (ft)	Pressure (mb)
0	1013.2
400	1000
4,800	850
9,800	700
18,400	500
30,100	300
38,700	200

High Pressure – Areas of sinking air

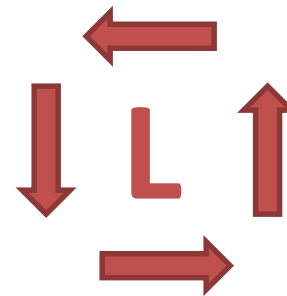
Low Pressure – Areas of rising air

} *Relative Pressure*

Isobars – Lines connecting points of equal pressure

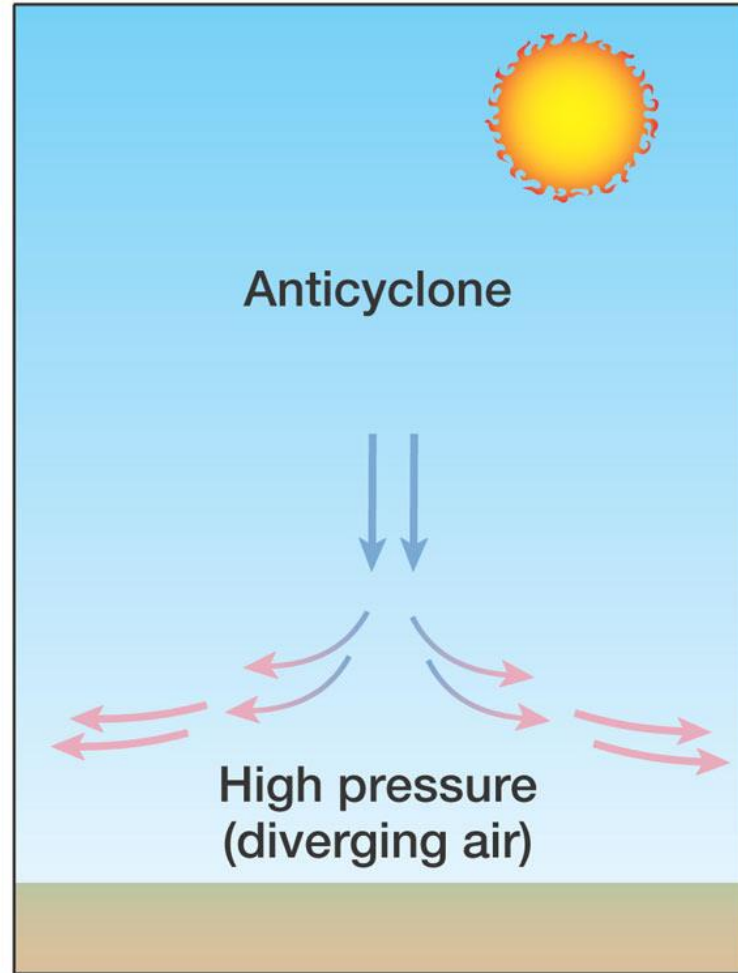
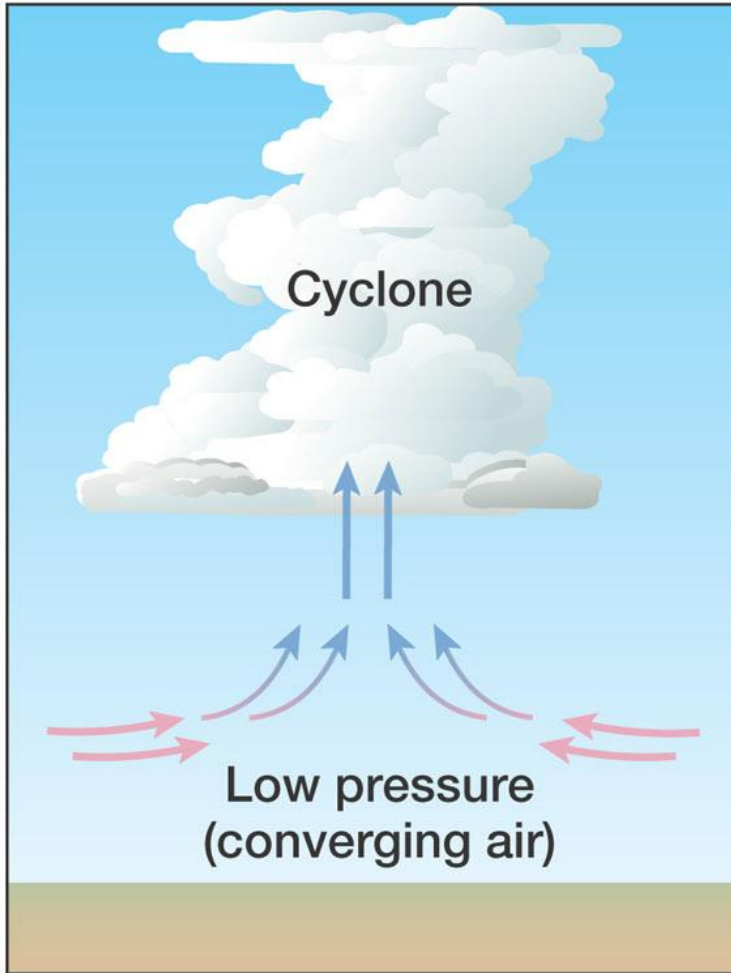


Clockwise = Anticyclonic Motion*



Counterclockwise = Cyclonic Motion*

* In Northern Hemisphere



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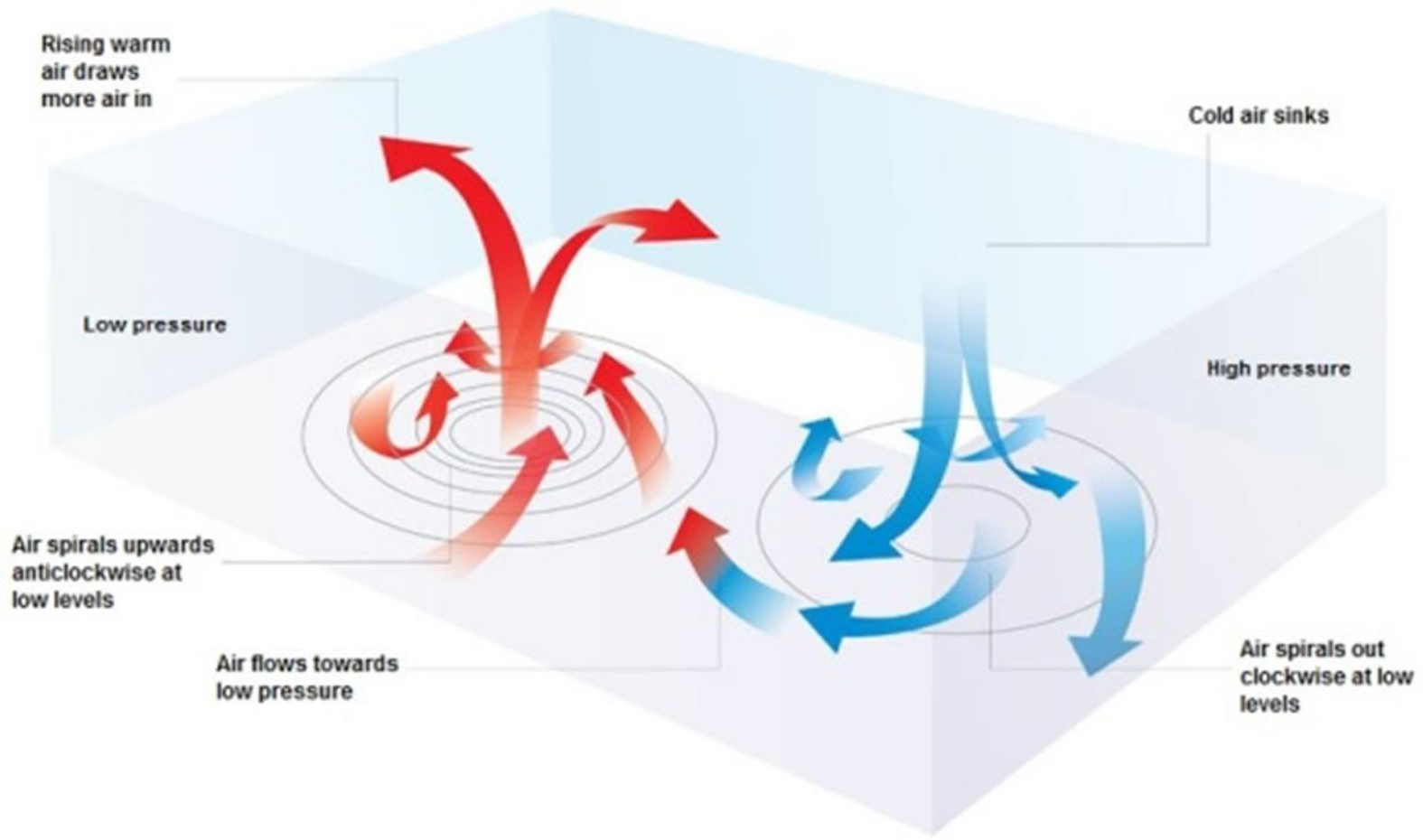


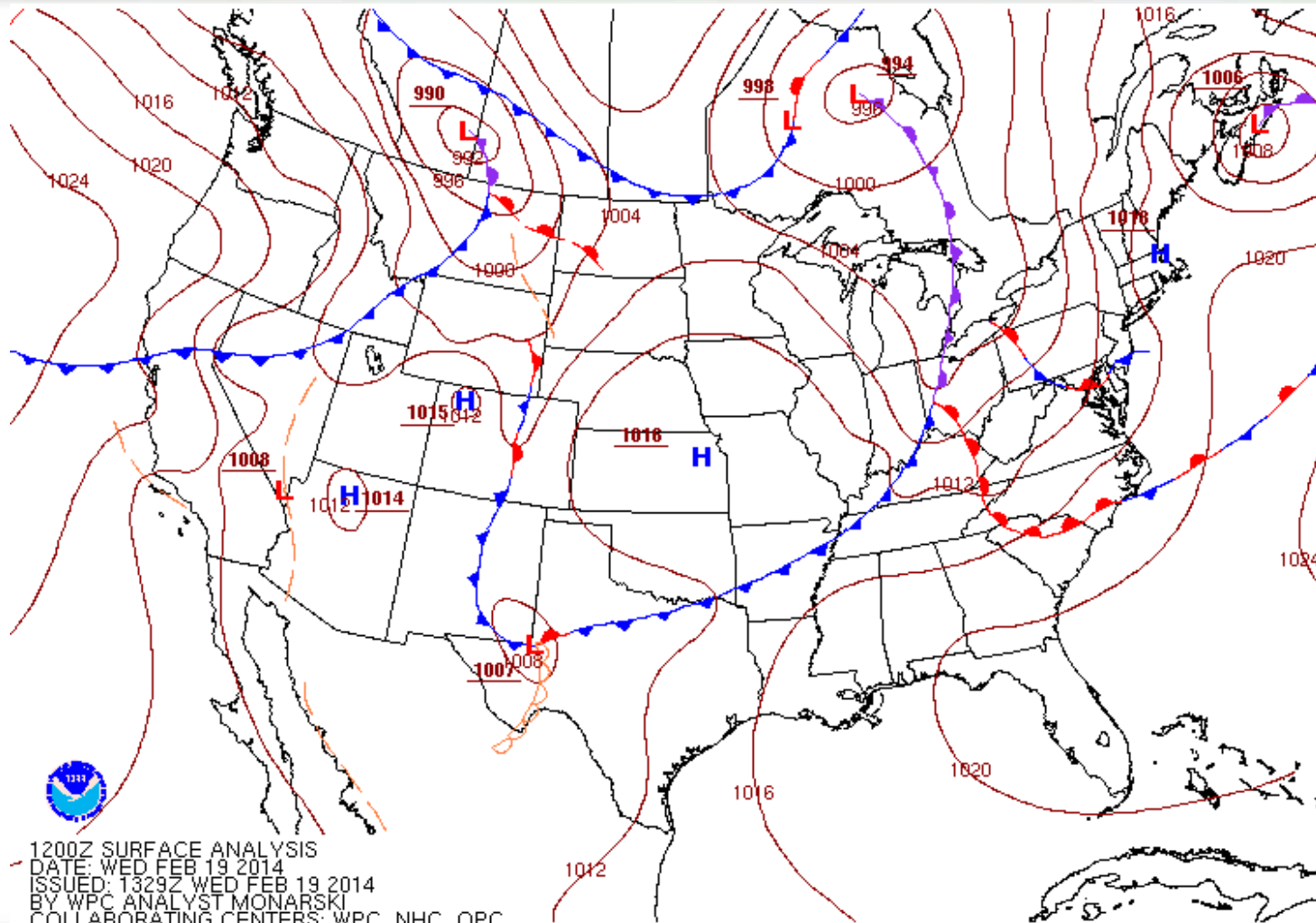
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Unit 0: Hazardous Weather Primer

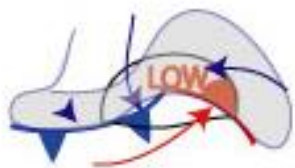
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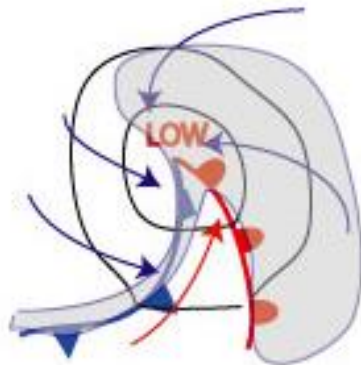




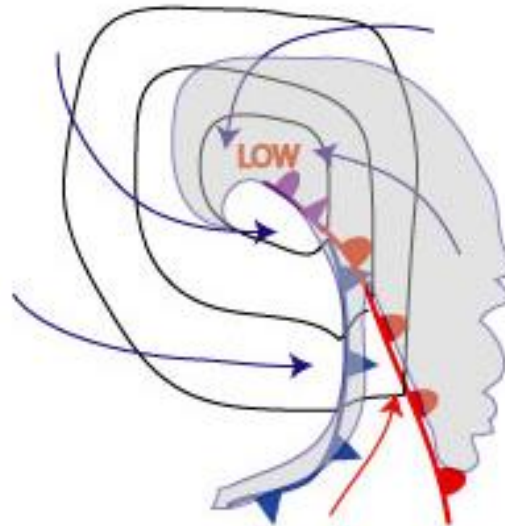
1200Z SURFACE ANALYSIS
 DATE: WED FEB 19 2014
 ISSUED: 1329Z WED FEB 19 2014
 BY WPC ANALYST MONARSKI
 COLLABORATING CENTERS: WPC, NHC, OPC



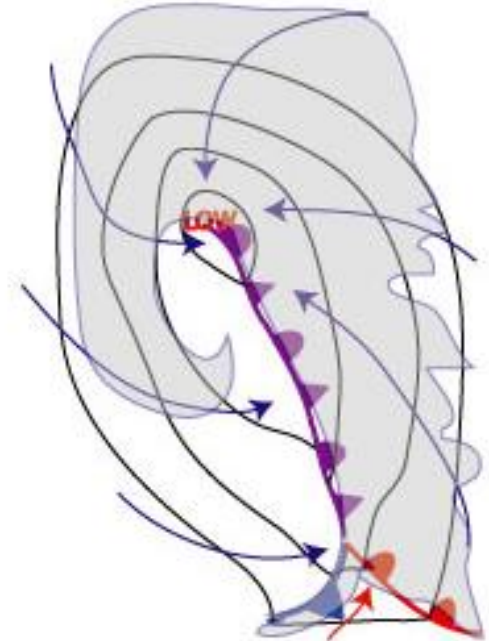
Day 1: Incipient Wave



Day 2: Mature Wave



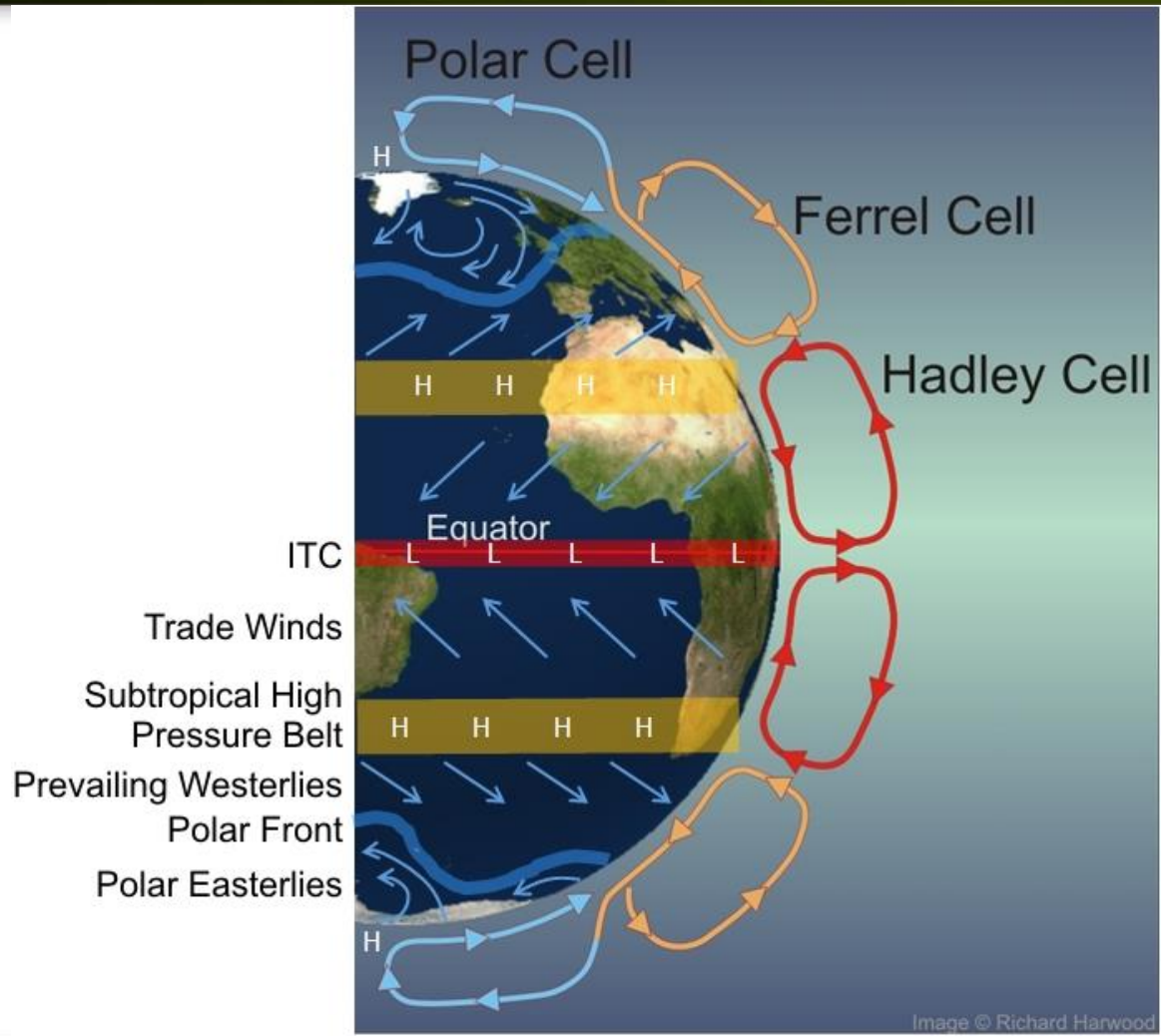
Day 3: Early Occlusion



Day 4: Late Occlusion

Stages in the Life Cycle of a Wave Cyclone

Grey Shading Indicates Cloudiness

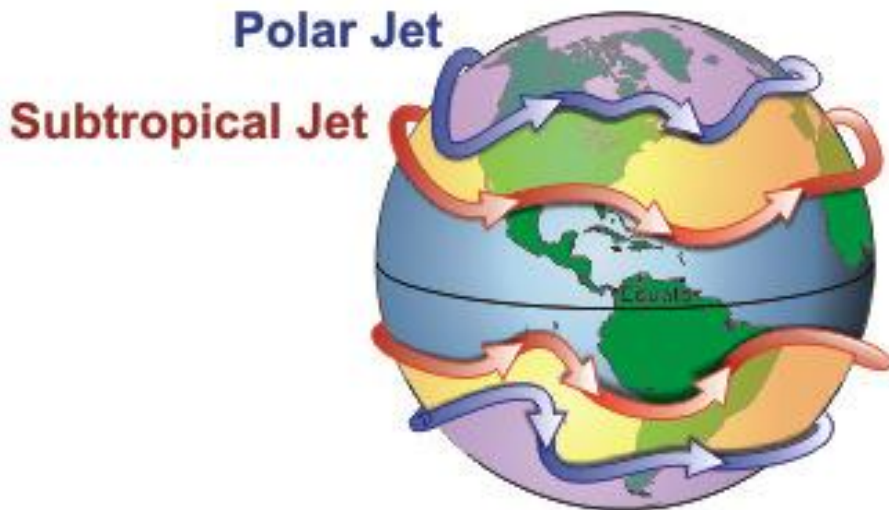


Jet Streams



Typically hundreds of miles wide but only a few miles in vertical thickness

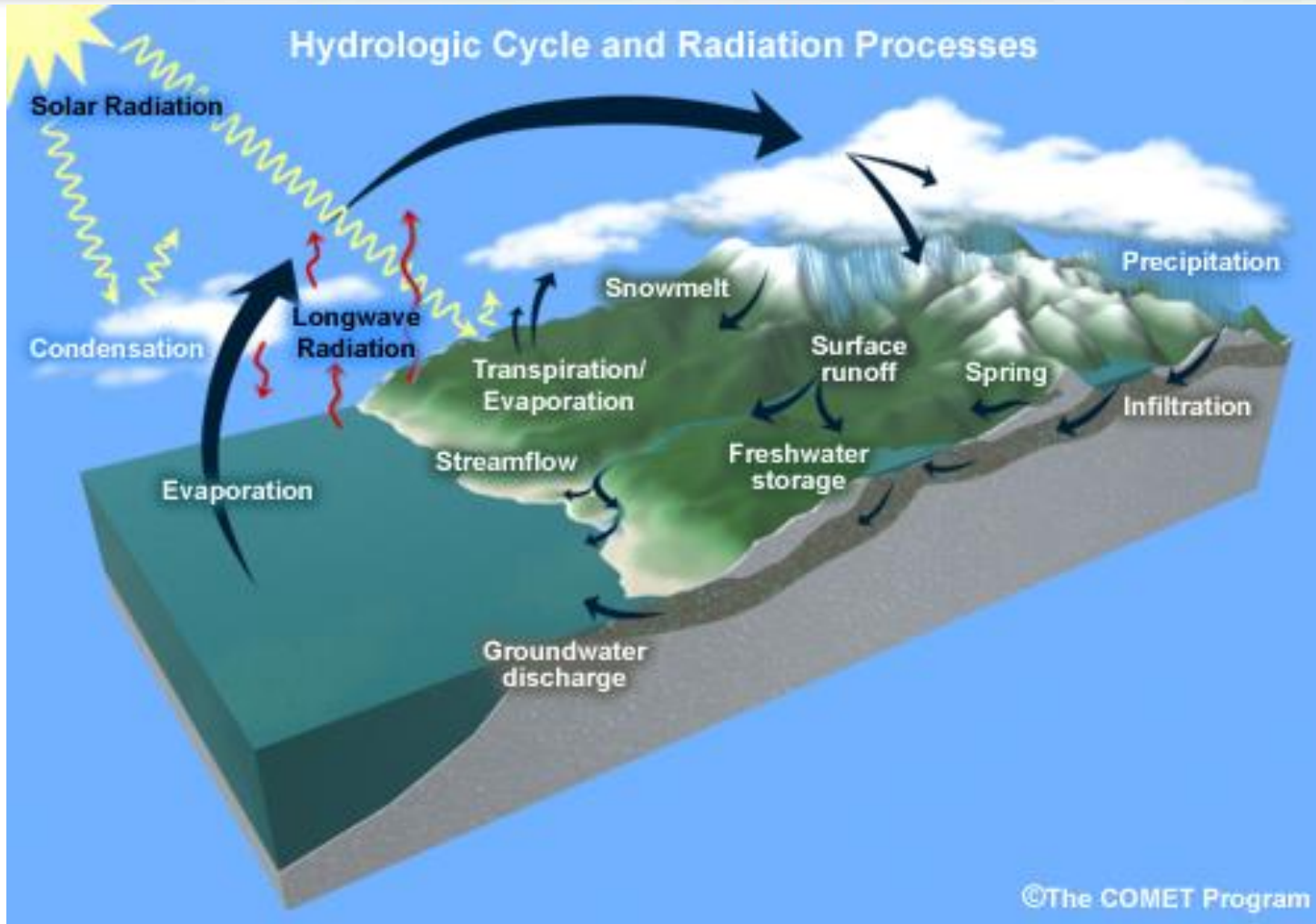
Polar jet streams are typically located near the 250 mb pressure level (4.3 to 7.5 mi.) while the weaker subtropical jet streams are much higher, between 6.2 and 9.9 miles above sea level.

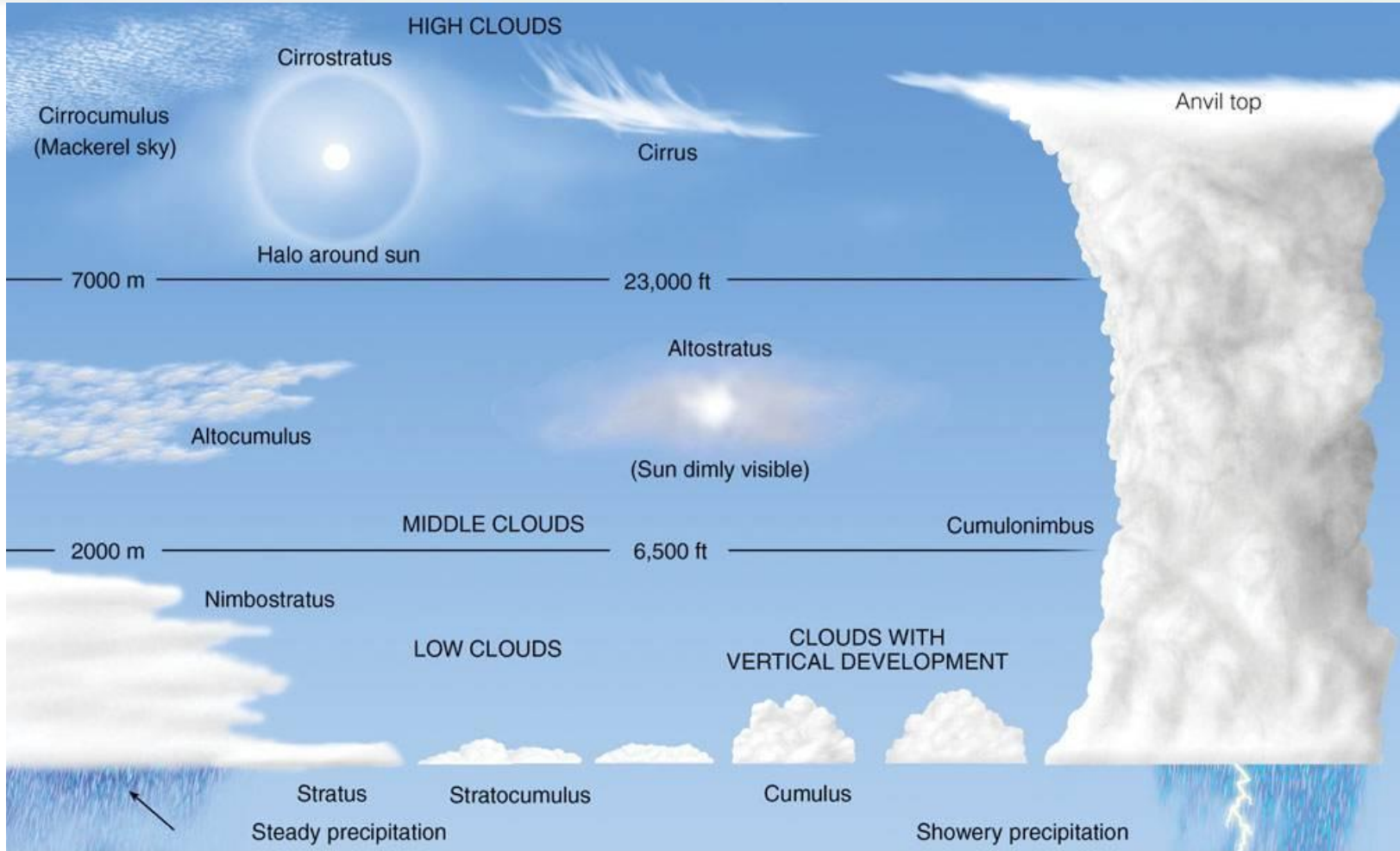




3 Basic Weather Elements:

1. Temperature
2. Pressure & Wind
3. Moisture





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High-Level Clouds

- Form above 20,000 ft
- Composed of ice crystals
- Thin and white in appearance
- Occur in fair weather
- Typically indicators of approaching cold fronts or low-pressure systems
- Types: Cirrus, Cirrostratus, Cirrocumulus



Mid-Level Clouds

- Form between 6,500 and 20,000 ft
- In the shape of rounded clumps
- Found in settled weather
- Usually composed of droplets, but may also contain ice crystals
- May produce virga
- Found ahead of warm fronts
- Types: Altocumulus, Altostratus



Low-Level Clouds

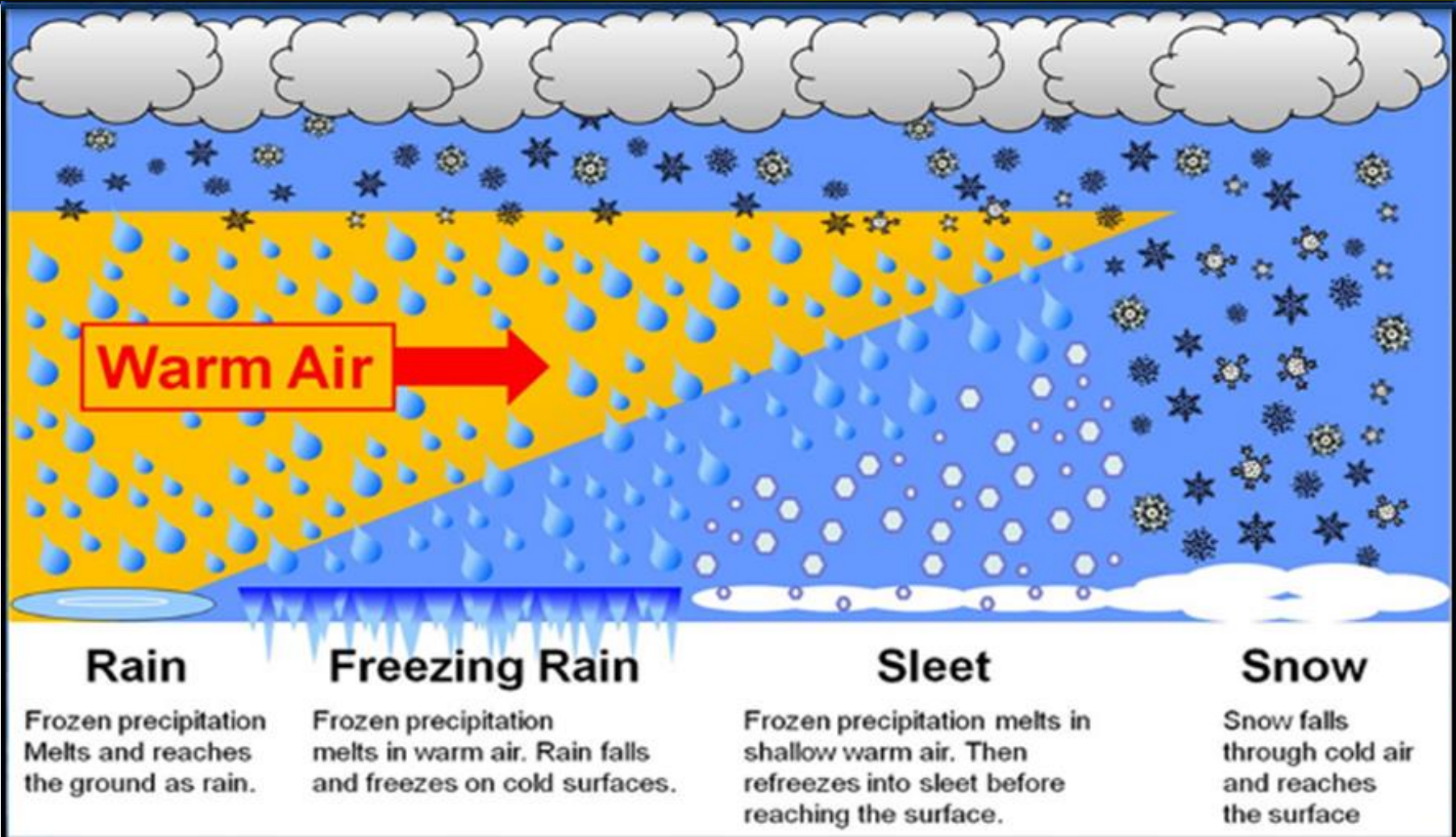
- Form lower than 7,000 ft
- Consist of a feature-less low layer that can cover the entire sky
- Indicate rain falling or about to fall
- Types: Stratus, Nimbostratus, Stratocumulus



Clouds of Vertical Development

- Variable in formation level (up to 60,000 feet tall)
- Look like cotton balls or cauliflower
- May produce hail, heavy rain, and tornadoes
- Types: Cumulus, Cumulonimbus





Warm Air →

Rain

Frozen precipitation melts and reaches the ground as rain.

Freezing Rain

Frozen precipitation melts in warm air. Rain falls and freezes on cold surfaces.

Sleet

Frozen precipitation melts in shallow warm air. Then refreezes into sleet before reaching the surface.

Snow

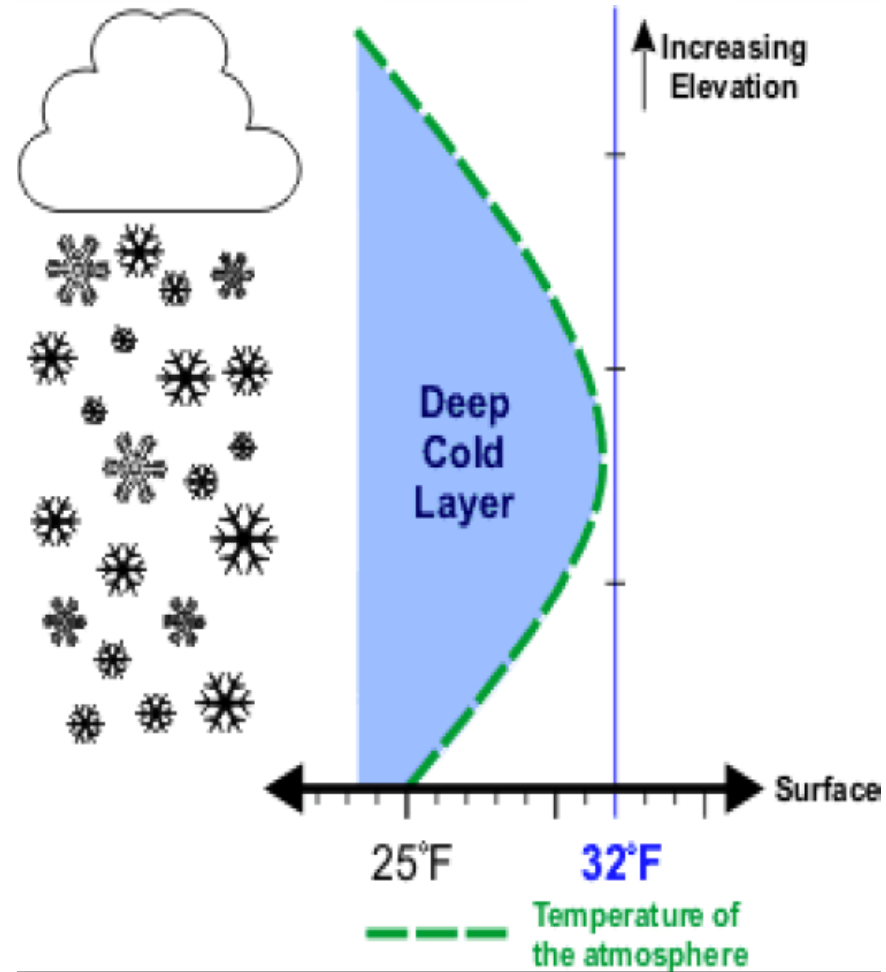
Snow falls through cold air and reaches the surface

Snow

In the image (right) the green dashed line is the temperature in respect to elevation.

The surface temperature is 25°F and increases with height before decreasing.

However, since the temperature remains below freezing any precipitation that falls will remain as snow.

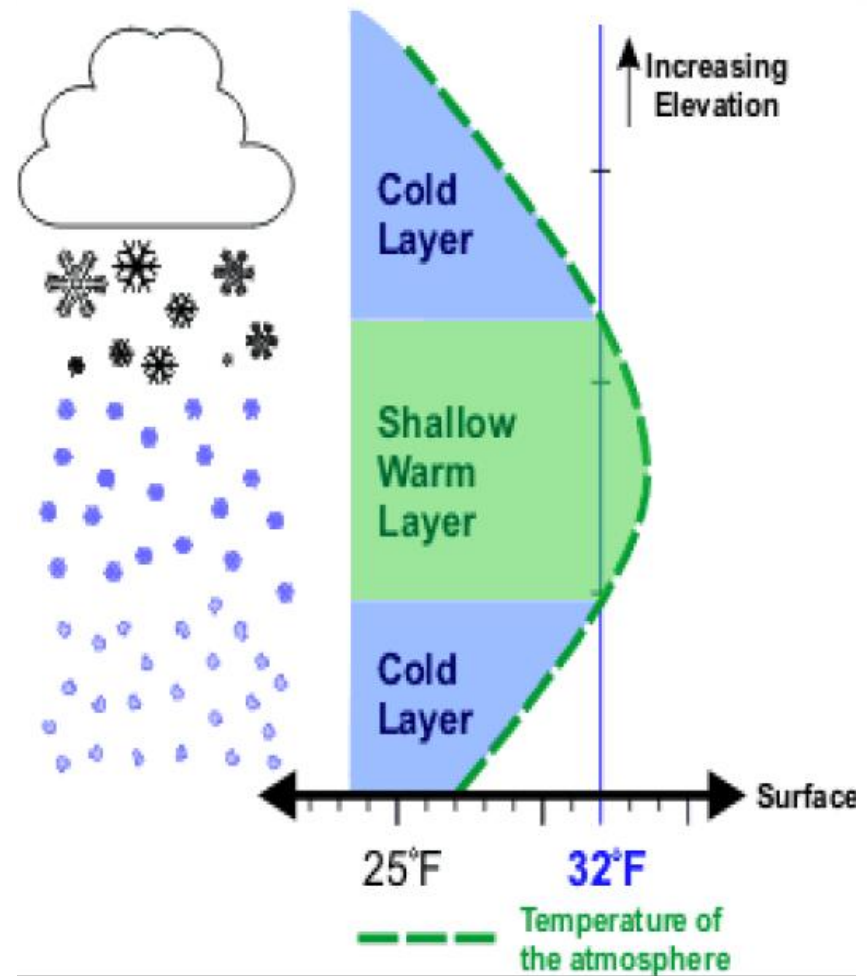


Sleet

As snow falls into the layer of air where the temperature is above freezing, the snow flakes partially melt.

As the precipitation reenters the air that is below freezing, the precipitation will re-freeze into ice pellets that bounce off the ground, commonly called sleet.

The most likely place for freezing rain and sleet is to the north of warm fronts.

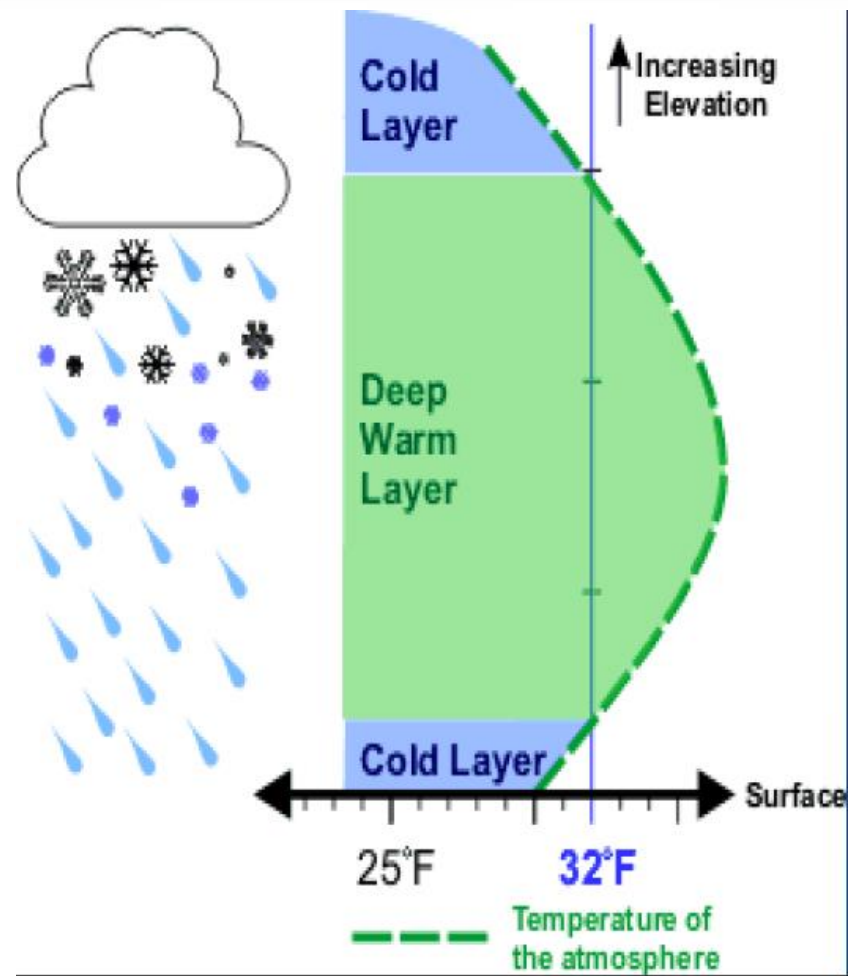


Freezing Rain

The precipitation can begin as either rain and/or snow but becomes all rain in the warm layer.

The rain falls back into the air that is below freezing but since the depth is shallow, the rain does not have time to freeze into sleet.

Upon hitting the ground or objects such as bridges and vehicles, the rain freezes on contact.





Severe Weather & Safety

- **Severe Thunderstorms**
- **Tornadoes**
- **Flooding/Tropical Storms**
- **Extreme Temperature**
- **Winter Weather**

Severe Thunderstorms

- Ingredients Needed:
 - Moisture
 - Instability or lifting mechanism
 - Heating
- Considered severe if:
 - winds >58 mph
 - hail >1" diameter
 - tornado

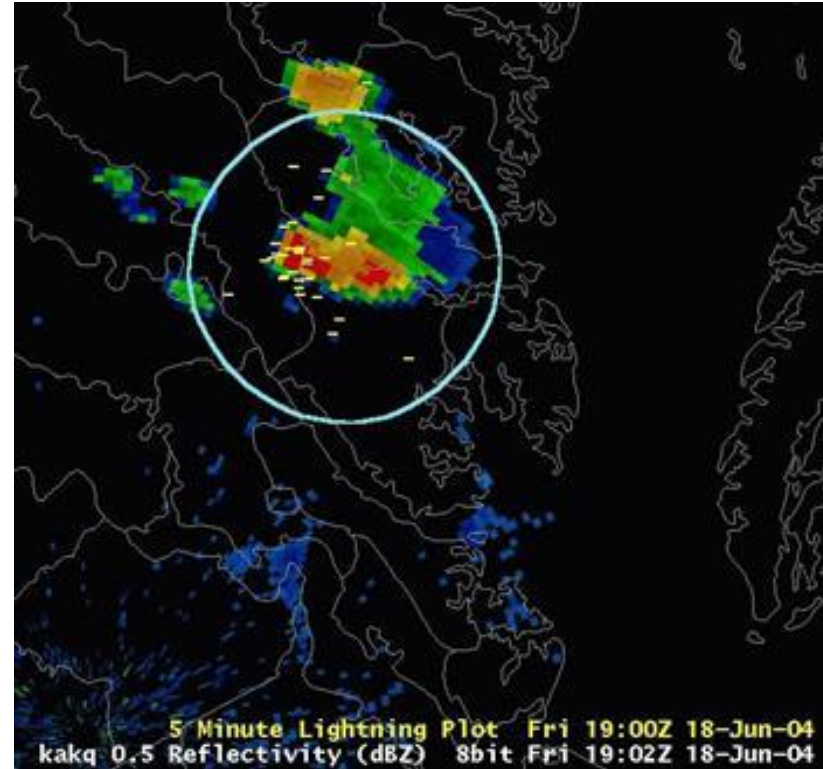


Lightning does not make a storm severe!

As lightning passes through air, it can heat the air to 50,000 degrees Fahrenheit (about 5 times hotter than the surface of the sun).

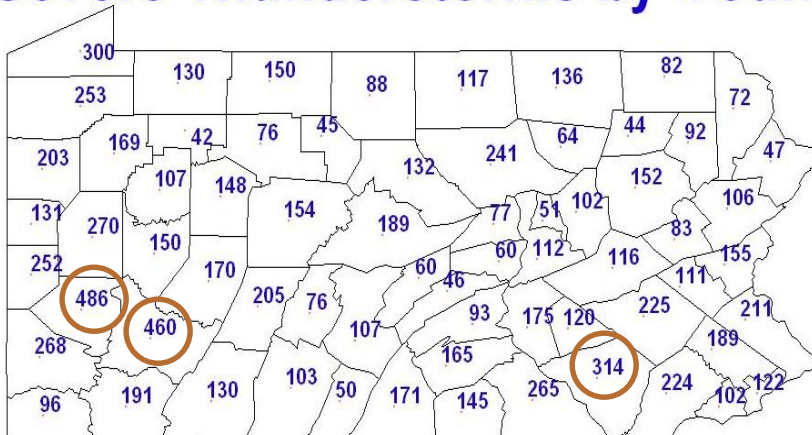


[C] Al Moller



Lightning Strikes can occur up to 20 miles away from the parent storm!

Severe Thunderstorms by County





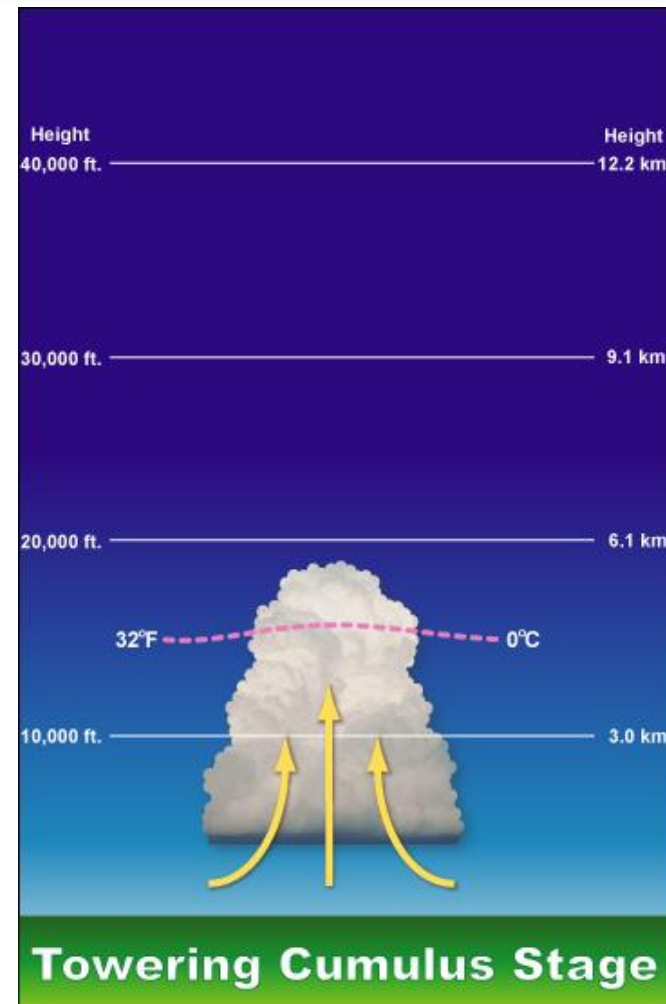
Lifecycle of a Thunderstorm:

• Towering Cumulus Stage

- Dominated by upward moving air
- Extends vertically >10,000 – 20,000 ft
- Noticeably taller than other cumulus



<http://severe-wx.pbworks.com/Thunderstorms>

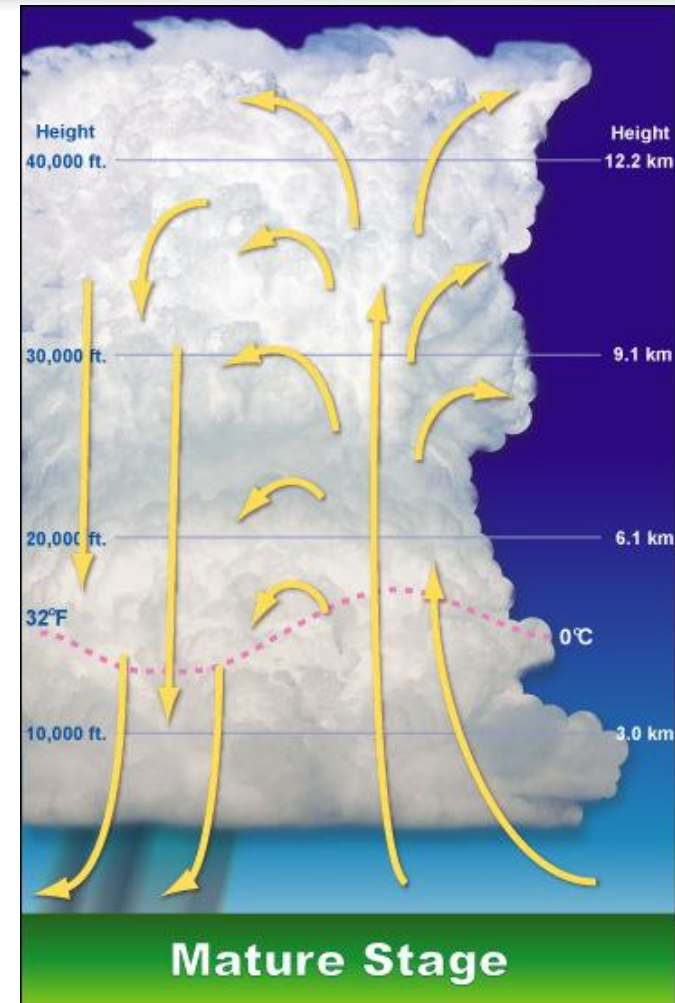
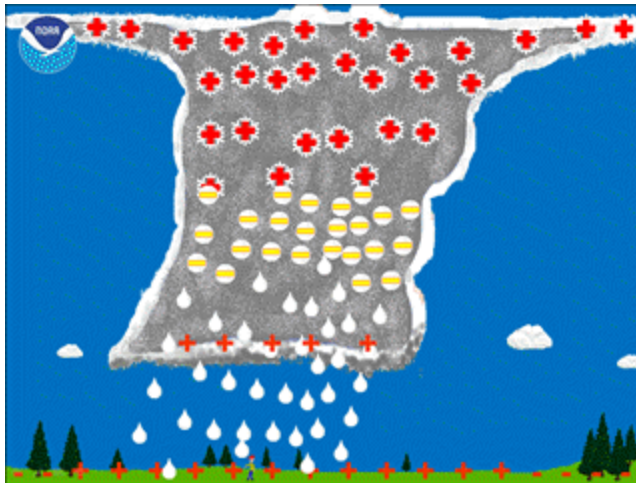




Lifecycle of a Thunderstorm:

• Mature Stage

- Storm contains UPWARD and DOWNWARD moving air
- Extends vertically to 40,000 to 60,000 ft.
- Best potential for severe weather including hail

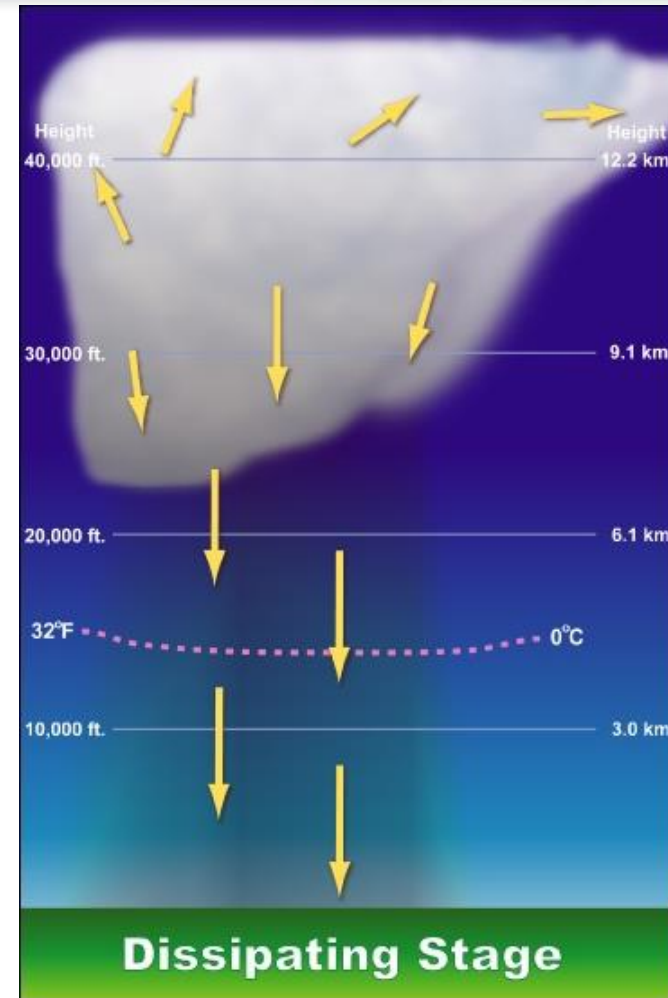


<http://severe-wx.pbworks.com/Thunderstorms>

Lifecycle of a Thunderstorm:

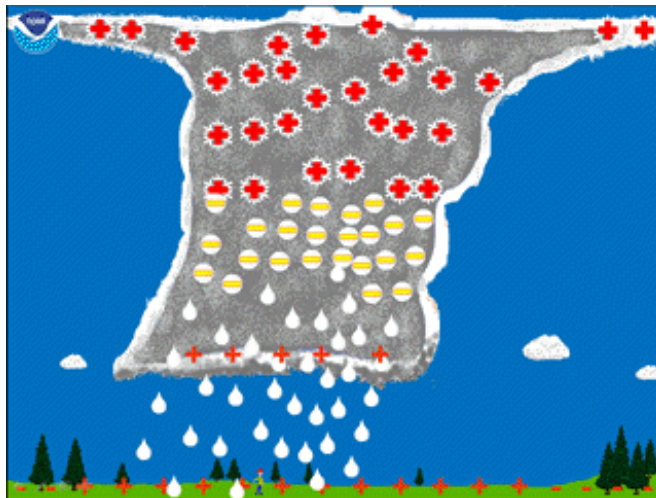
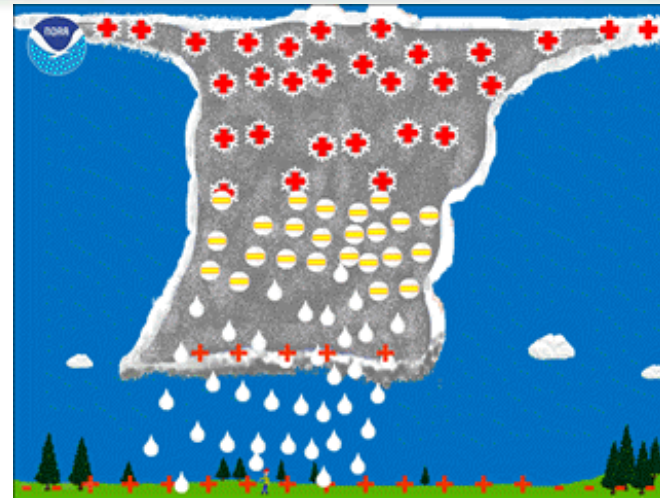
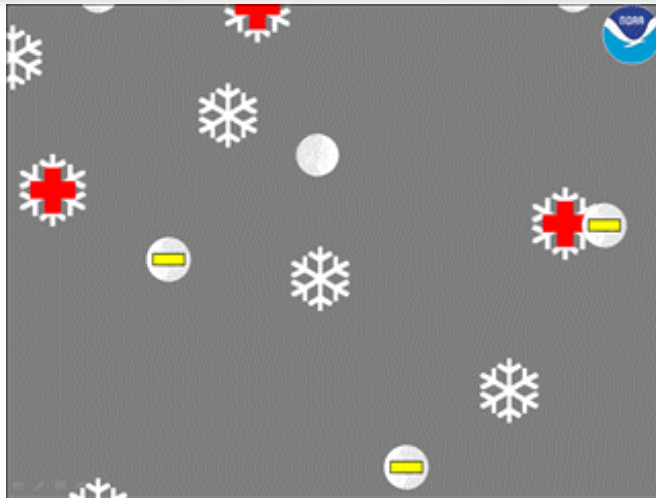
- **Dissipating Stage**

- Storm contains mostly **DOWNWARD** moving air
- Supply of warm moist air “fuel” has been exhausted or cut off
- Downburst winds can occur



<http://severe-wx.pbworks.com/Thunderstorms>





When Caught Outside in a Storm...

There is NO safe place outside when it is lightning but these actions may slightly reduce your risk of being struck.

- Avoid open fields, the top of a hill or a ridge top.
- Stay away from tall, isolated trees or other tall objects.
- Stay away from water, wet items, and metal objects.

Note: A tent or open air building will not protect you from lightning.

When you are Inside during a Thunder Storm...

- Don't touch electrical equipment or electronics plugged into the wall.
- Stay off corded phones and avoid plumbing.
- Stay away from windows and doors, and stay off porches. Do not lie on concrete floors or lean against concrete walls.

When you are Inside a car during a Storm...

You are safe from lightning inside a car as long as you do the following:

- Roll up the windows so that they are closed.
- Don't touch metal objects inside the car.
- Pull over on the side of the road and put your hazard lights on.



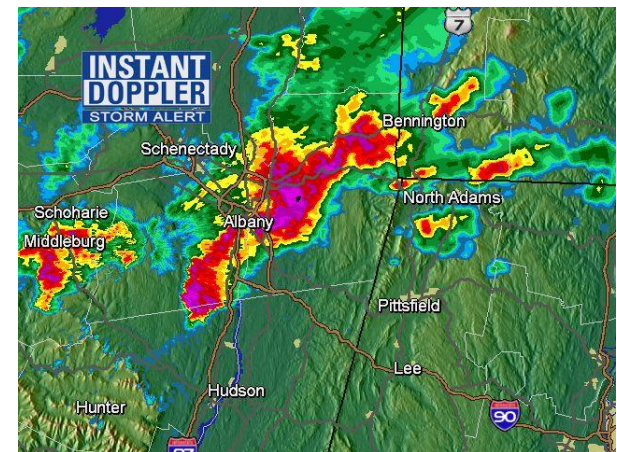
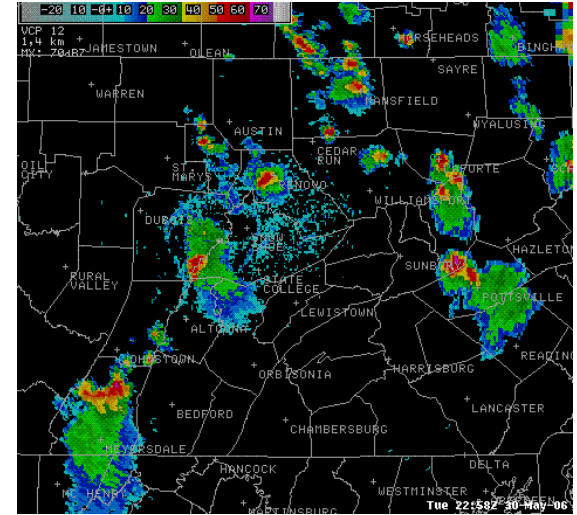
Types of Thunderstorms:

- **Single-Cell**

- Typical “garden variety” storm
- Low severe weather potential
- Average lifespan: ~30-60 minutes

- **Multi-Cell**

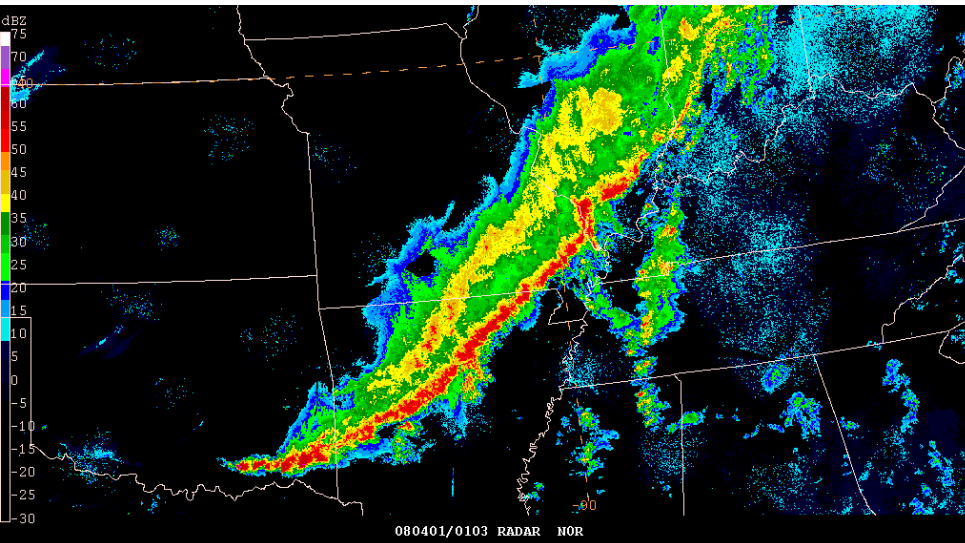
- Organized system of storms
- One lifecycle of a storm can trigger the next
- Organization can lead to higher severe weather potential
- Flooding a concern



Types of Thunderstorms:

- **Squall-line Thunderstorms**

- Linear in nature...usually associated with a cold front (typically moves west-east at 30 to 60 mph)
- Fast moving, with high straight-line wind potential



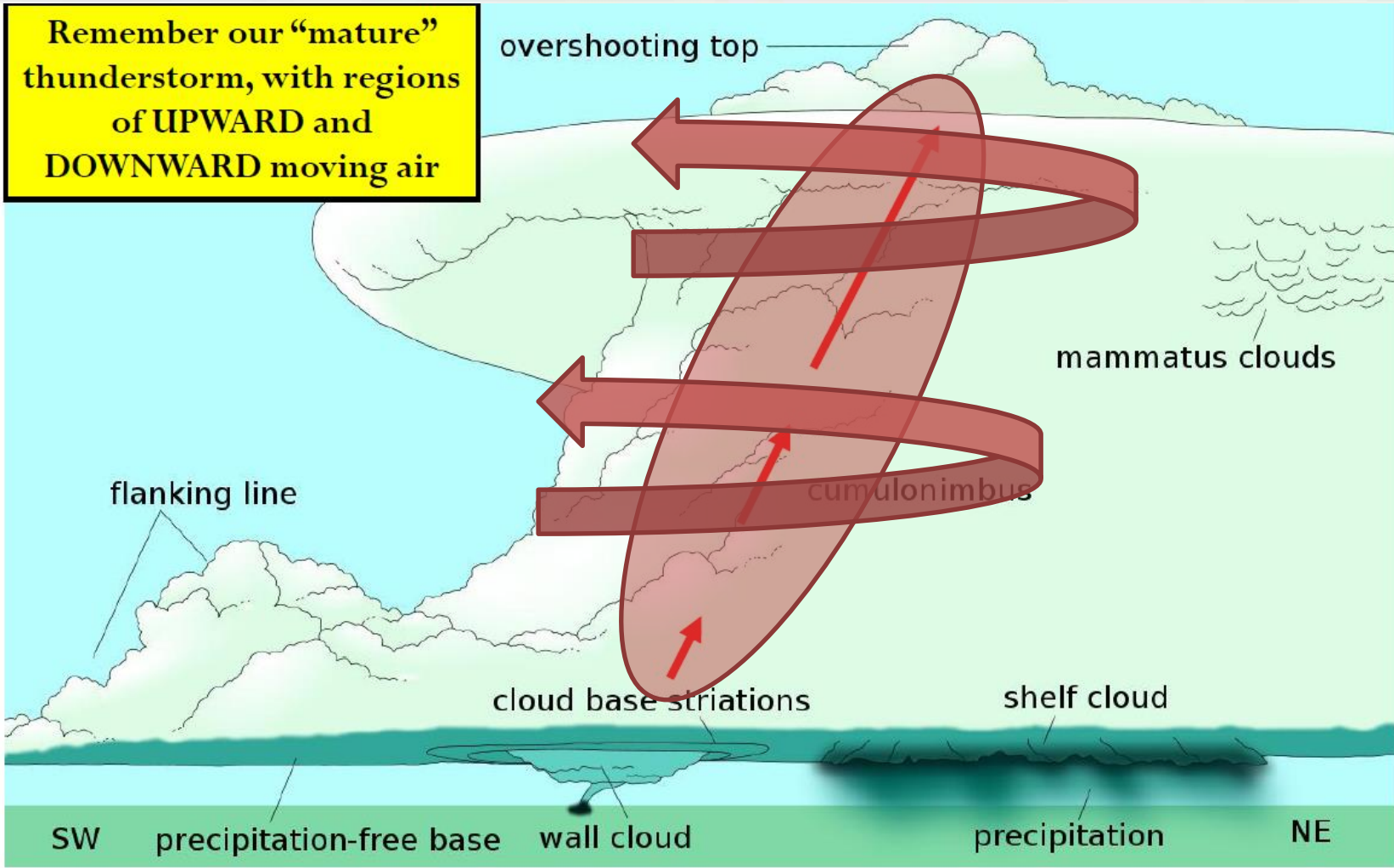
Types of Thunderstorms:

- **Supercell Thunderstorms**

- Storms possess rotation
- Highest severe weather potential
 - Best producer of tornadoes, hail, and downburst winds
- Long lifecycle in the 'mature' stage
 - Can last for hours, tracking across multiple states



Remember our “mature” thunderstorm, with regions of UPWARD and DOWNWARD moving air





Wall Cloud

- **Storm Rotating**
 - May lead to tornado formation
 - Thunderstorm severe at this point





Funnel Cloud

- **Tornado Forming**

- Circulation not reaching the ground
- May or may not develop into a tornado
- No damage = no tornado



Tornado

- “Rapidly rotating column of dirt, debris, wind reaching to the ground from the base of a thunderstorm”
- ~1% of thunderstorms produce tornadoes
- Can occur at any time of the year
- PA averages 15-20/year
- Most occur between 3 and 9pm
- Can be obscured by rain



MYTH: Windows should be opened before a tornado approaches to equalize pressure and minimize damage.

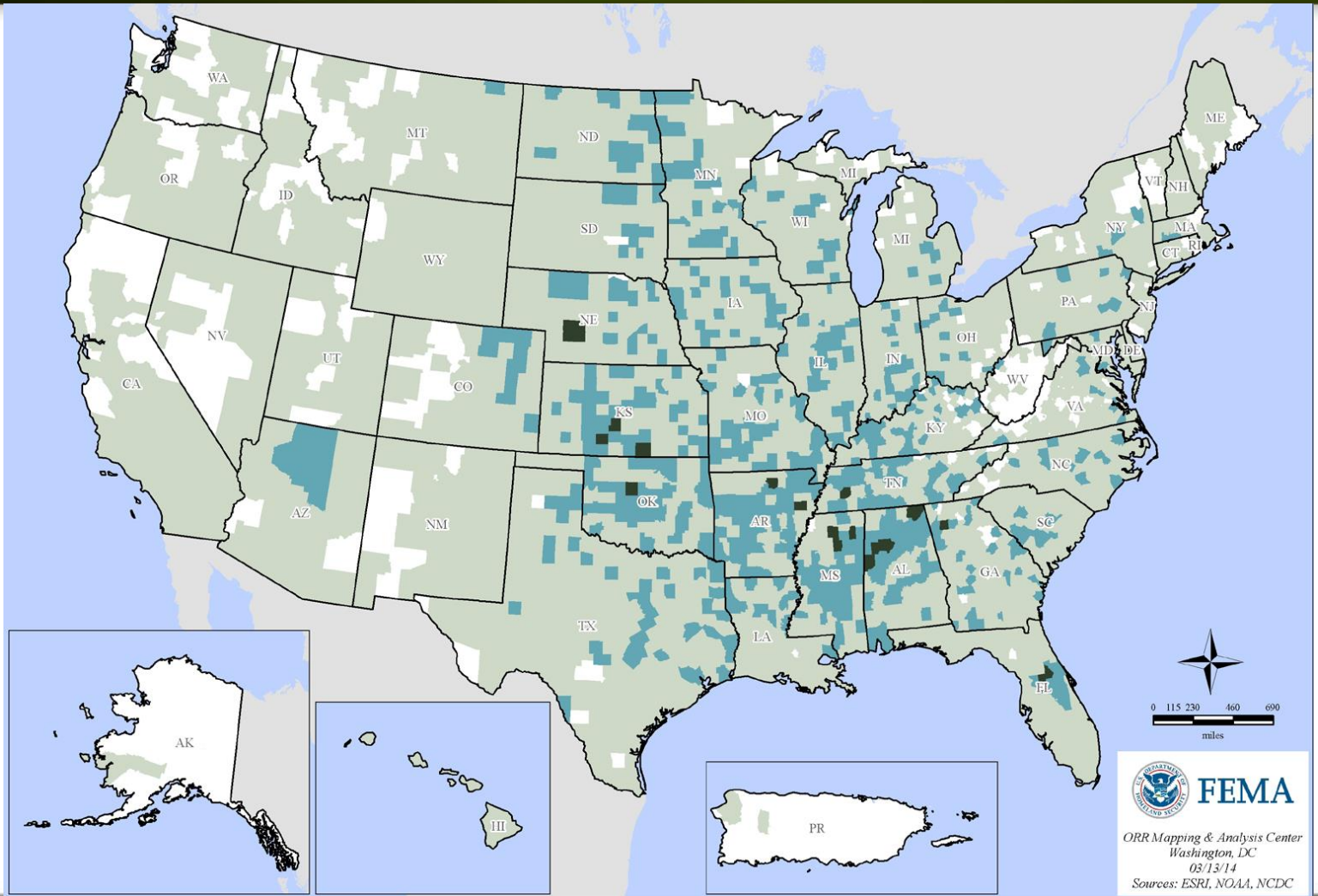
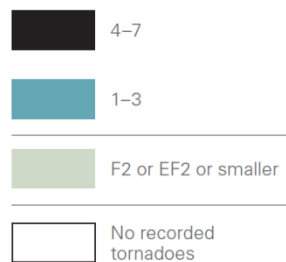
FACT: Opening windows allows damaging winds to enter the structure. Leave the windows alone; instead, immediately go to a safe place.




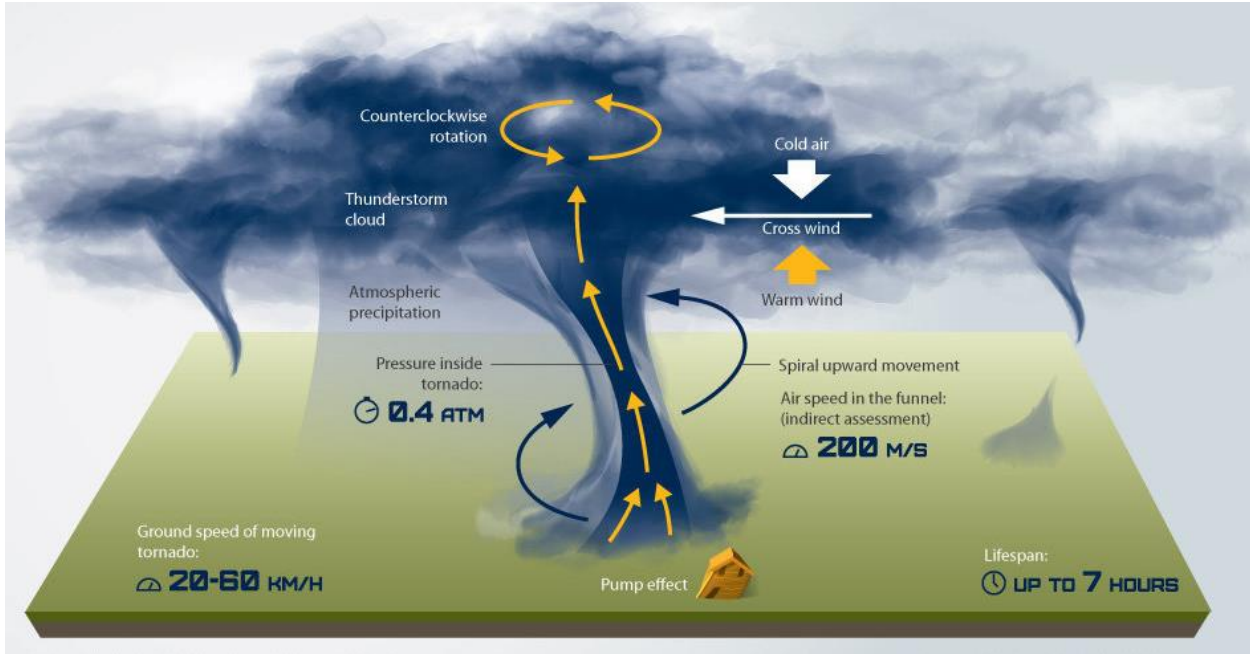
05/25/21



Frequency of F3* or EF3 or greater tornadoes



 **FEMA**
ORR Mapping & Analysis Center
Washington, DC
03/13/14
Sources: ESRI, NOAA, NCDC



Tornado Formation

1. Warm Moist and cool dry air collide – thunderstorm
2. Winds turn vertical
3. Funnel extends down to ground





EF SCALE	
EF Rating	3 Second Gust (mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

Tornado Watch – conditions are favorable for a tornado to form in developing storms

Tornado Warning – A tornado has been spotted on the ground or indicated by radar

Tornado Warning Signs

1

A rotating, funnel-shaped cloud that extends from a thunderstorm toward the ground may be visible.

2

An approaching cloud of debris, especially at ground level, can mark the location of a tornado even if a funnel is not visible.

3

A loud roar that sounds similar to a freight train.

4

A strange quiet occurring within or shortly after a thunderstorm. The wind may die down and the air may become very still.

5

Debris dropping from the sky.

6

A change in the color of the sky.

MYTH: Areas near rivers, lakes, and mountains are safe from tornadoes.

FACT: No place is safe from tornadoes. In the late 1980's, a tornado swept through Yellowstone National Park leaving a path of destruction up and down a 10,000 ft. mountain.



Chuck Doswell III

Weak Tornadoes

- 88% of all tornadoes
- Less than 5% of tornado deaths
- Lifetime 1 – 10+ minutes
- Winds less than 110 mph
- Produces EF0 or EF1 damage



Wikimedia/Justin Hobson

Strong Tornadoes

- 11% of all tornadoes
- Nearly 30% of all tornado deaths
- May last 20 minutes or longer
- Winds 111-165 mph
- Produces EF2 or EF3 damage



Wikimedia/Joshua Jans

Violent Tornadoes

- Less than 1% of all tornadoes
- 70% of all tornado deaths
- Can exceed 1 hour
- Winds greater than 166 mph
- Produces EF4 or EF5 damage



FEMA









Tornado Safety

Before a Tornado

- Make sure all family members know the tornado safe location in your home.
 - Store an emergency kit in your safe location.
 - Identify where to go if you are at work or school.
 - Make a family communications plan.

During a Tornado

- Go to a safe location away from windows on the lowest level of a sturdy building.
- If you are caught outside, get in a car, buckle up, and try to drive to the closest sturdy shelter.
- Go to a storm shelter if you are in a mobile home.

After a Tornado

- Beware of downed power lines, broken gas lines, and sharp/dangerous debris.
- Avoid damaged areas.
- Stay off the roads to allow rescue workers clear passage.
- Follow instructions from officials.



Tornado Lookalikes:





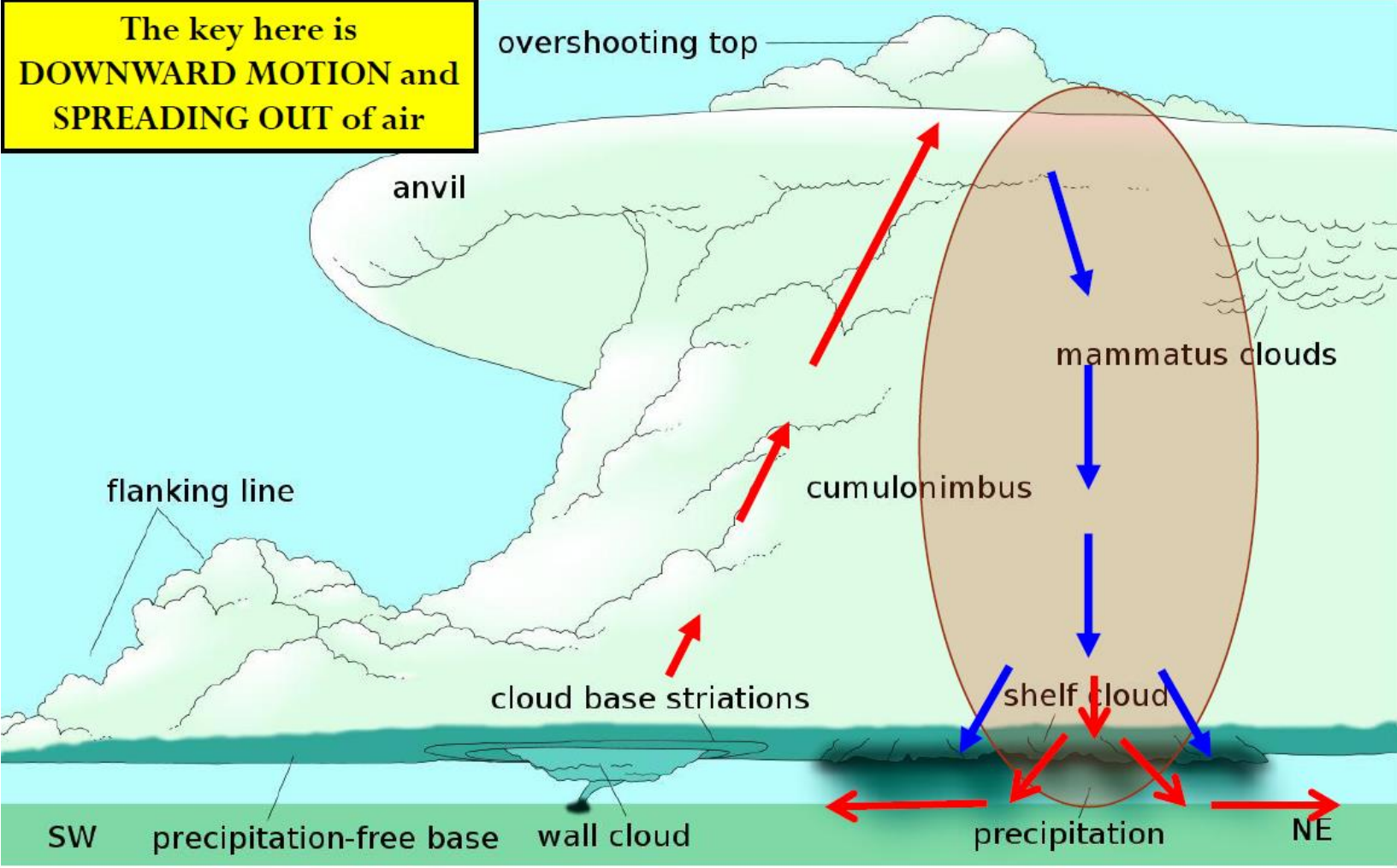
Non-Tornadic Winds

Much more common than tornadoes
Associated with thunderstorm outflow

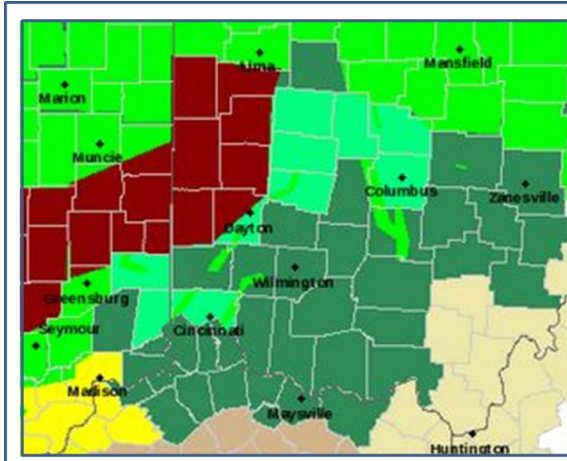
- **Downburst**
 - A strong downdraft with an outrush of damaging wind on or near the ground
- **Microburst**
 - Swath of damaging wind is more than 2.5 miles wide
- **Macroburst**
 - Swath of damaging winds is 2.5 miles wide or less.



The key here is
DOWNWARD MOTION and
SPREADING OUT of air



(Flash) Flooding



Flood Products on this Map

- Flash Flood Warning
- Flood Warning
- Flood Watch
- Flood Advisory

Wireless Emergency Alert 98%

18:27
Wednesday, January 30

Emergency Alert 18:26
Flash Flood Warning this area til 12:30 AM EST. Avoid flood areas. Check local media. - NWS

Main Causes in Pennsylvania

- Slow Moving Thunderstorms
- Tropical Systems
- Combination of Heavy Rain and Rapid Snowmelt

Other Causes

- Dam Breaks
- Ice Jams
- Fronts (Cold, Stationary, Warm)
- Snowmelt alone



Flood

Slower onset speed
Longer Lasting
Larger Rivers & bodies of water

Flash Flood

Faster onset speed
Shorter duration
Very Localized



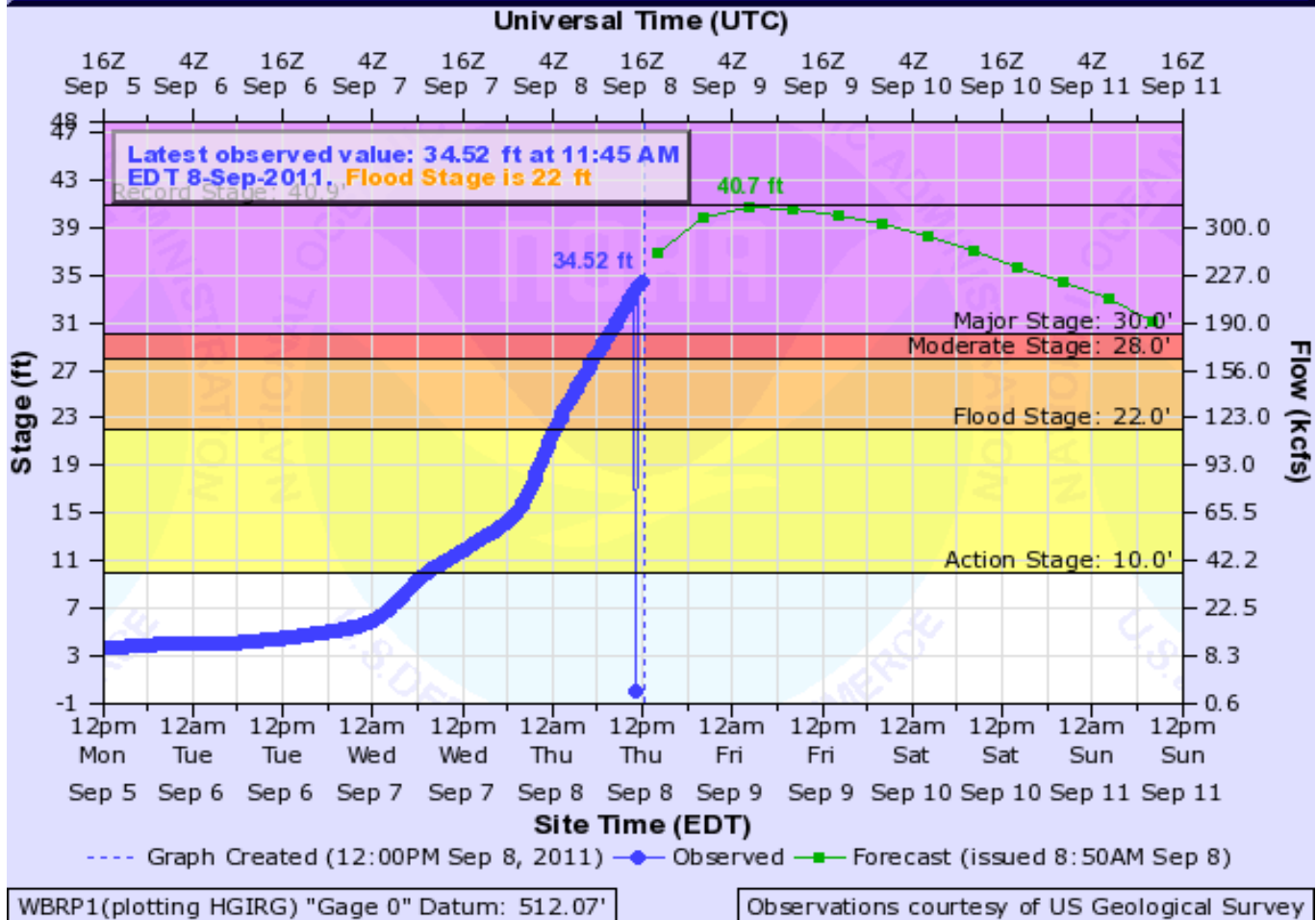
FEMA

CERT Basic Training
Unit 0: Hazardous Weather Primer

0-66



SUSQUEHANNA RIVER AT WILKES BARRE





Flood Safety

Before a Flood

- Learn whether your home, school or place of work is at risk of flooding.
- Find alternate routes to important locations.
- Make a family communications plan.
- If evacuation orders are issued in advance, follow them.

During a Flood

- Never drive or walk into flood waters.
- If told to evacuate, do so immediately.
- Get to higher ground.
- Get information from local tv/radio or your mobile phone.

After a Flood

- Avoid damaged areas and flood waters.
- Heed road closed and other cautionary signs.
- Wait for the “all clear” to enter a flood damaged structure.
- Contact your loved ones via text or social media to keep phone lines clear.

- Know the warning signs before an event
 - Dark clouds on the horizon, rivers starting to rise, etc.
- Ways of obtaining alerts & information
 - Best Source → *NOAA Weather Radio*
 - nationwide network of radio stations broadcasting continuous weather information directly from the nearest National Weather Service Office
 - broadcasts official Weather Service warnings, watches, forecasts and other hazard information 24 hours a day, 7 days a week.
 - **Do not rely on cellphone during an emergency**

*Any Weather **Watch** means *conditions are favorable* for the mentioned hazard to potentially occur.

*Any Weather **Warning** means the hazard mentioned is either *indicated or occurring*



FEMA



NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



- **Get a Kit**

- Collection of basic items your household may need in event of emergency
- Assemble kit well in advance of emergency
- Food, water and other supplies in sufficient quantity to last for at least 3 days


Recommended Supplies to Include in a Basic Kit:


- Water, one gallon of water per person per day, for drinking and sanitation
- Food, at least a three-day supply of non-perishable food
- Battery-powered radio and a NOAA Weather Radio with tone alert, and extra batteries for both
- Moist towelettes, garbage bags and plastic ties for personal sanitation
- Infant formula and diapers, if you have an infant
- Dust mask or cotton t-shirt, to help filter the air
- Plastic sheeting and duct tape to shelter-in-place
- Wrench or pliers to turn off utilities
- Flashlight and extra batteries
- First Aid kit
- Whistle to signal for help
- Can opener for food (if kit contains canned food)



Make a Plan


- Know where family members or coworkers will meet, before a disaster strikes
- Have important files and information adequately prepared and stored in a safe location.
- Don't forget about pets & grandparents





Ready.
Prepare. Plan. Stay Informed.

Family Emergency Plan



Make sure your family has a plan in case of an emergency. Before an emergency happens, sit down together and decide how you will get in contact with each other, where you will go and what you will do in an emergency. Keep a copy of this plan in your emergency supply kit or another safe place where you can access it in the event of a disaster.

Neighborhood Meeting Place: _____ Phone: _____
 Out-of-Neighborhood Meeting Place: _____ Phone: _____
 Out-of-Town Meeting Place: _____ Phone: _____

Fill out the following information for each family member and keep it up to date.

Name: _____	Social Security Number: _____
Date of Birth: _____	Important Medical Information: _____
Name: _____	Social Security Number: _____
Date of Birth: _____	Important Medical Information: _____
Name: _____	Social Security Number: _____
Date of Birth: _____	Important Medical Information: _____
Name: _____	Social Security Number: _____
Date of Birth: _____	Important Medical Information: _____
Name: _____	Social Security Number: _____
Date of Birth: _____	Important Medical Information: _____

Write down where your family spends the most time; work, school and other places you frequent. Schools, daycare providers, work places and apartment buildings should all have site-specific emergency plans that you and your family need to know about.

Work Location One Address: _____ Phone: _____ Evacuation Location: _____	School Location One Address: _____ Phone: _____ Evacuation Location: _____
Work Location Two Address: _____ Phone: _____ Evacuation Location: _____	School Location Two Address: _____ Phone: _____ Evacuation Location: _____
Work Location Three Address: _____ Phone: _____ Evacuation Location: _____	School Location Three Address: _____ Phone: _____ Evacuation Location: _____
Other place you frequent Address: _____ Phone: _____ Evacuation Location: _____	Other place you frequent Address: _____ Phone: _____ Evacuation Location: _____

Name	Telephone Number	Policy Number

Dial 911 for Emergencies

READY FOR A DISASTER?



GET A KIT.



MAKE A PLAN.



BE INFORMED.

WWW.READY.GOV



This completes the Hazardous Weather
Module

Any Questions?