Severe Weather Safety and Preparedness

National Weather Service
Bryce Williams

What is the National Weather Service?

- Federal government agency
  - NOAA / U. S. Dept. of Commerce
- Directive:
  - Protection of Life and Property
- Timely Weather Forecasts and Warnings
- Nationwide coverage
  - 122 Local Forecast Offices
  - 11 National Prediction Centers

What is the National Weather Service?
"Weather Behind the Scenes"

TV

Radio

Internet

Cell Phones

Newspapers

122 Weather Forecast Offices Issue
Local Forecasts & Warnings

National Centers for Environmental Prediction

Model Simulations
Climate & Seasonal Outlooks
Aviation & Marine Forecasts
Storm & Tornado Prediction
Hurricane Tracks

River Forecasts

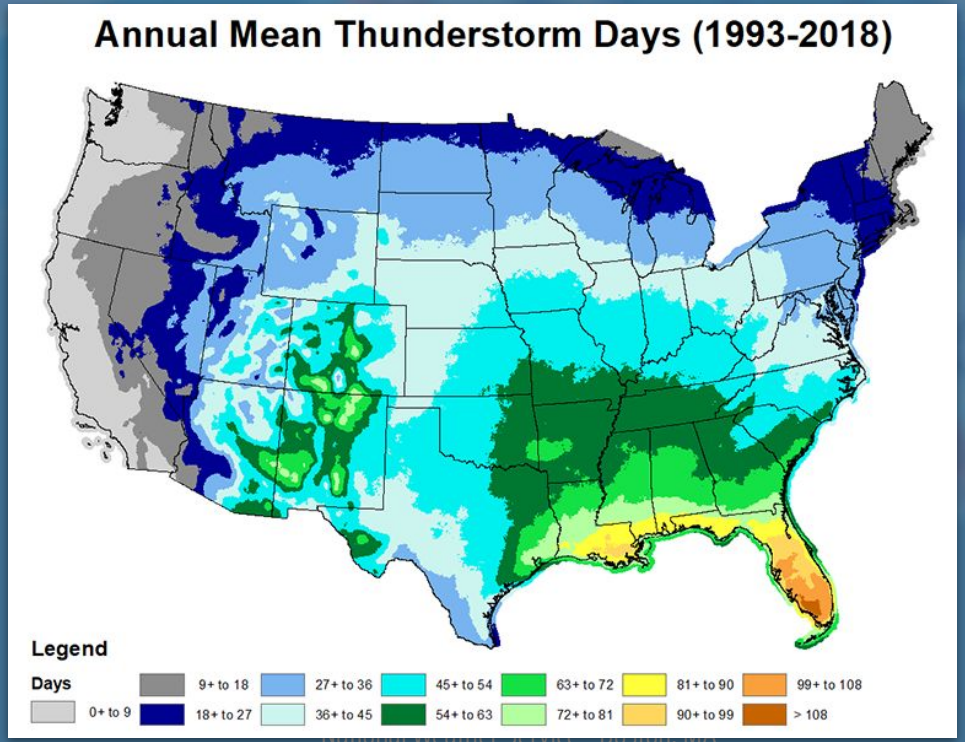
Hydropower, Flood warnings
Irrigation, River Navigation

Observations

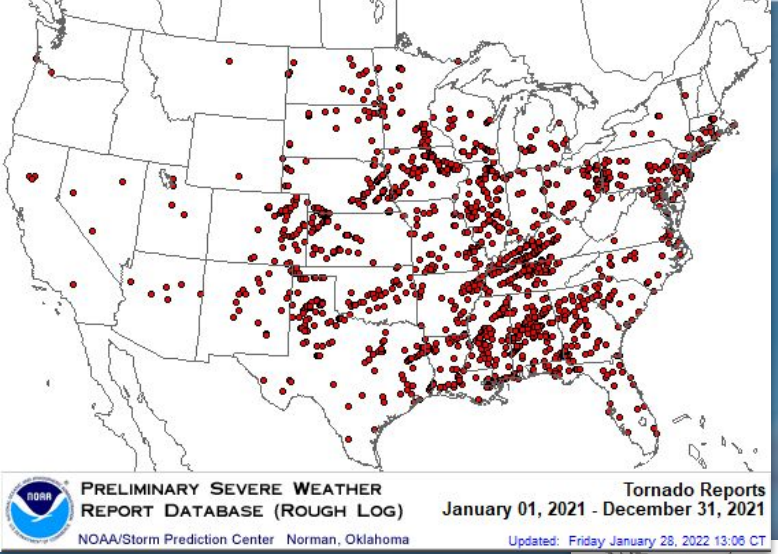
Radar Network, Satellites, Weather Balloons, Ground-level observations at airports, Aircraft, Lightning Network, Data Buoys, Stream Gauge Network, 11,000 Volunteer daily-data collectors,
Volunteer storm spotters

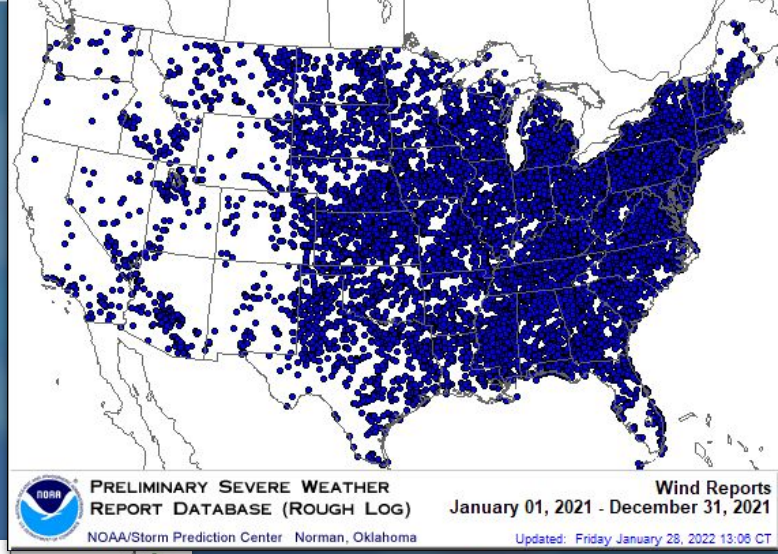
Thunderstorms Stats

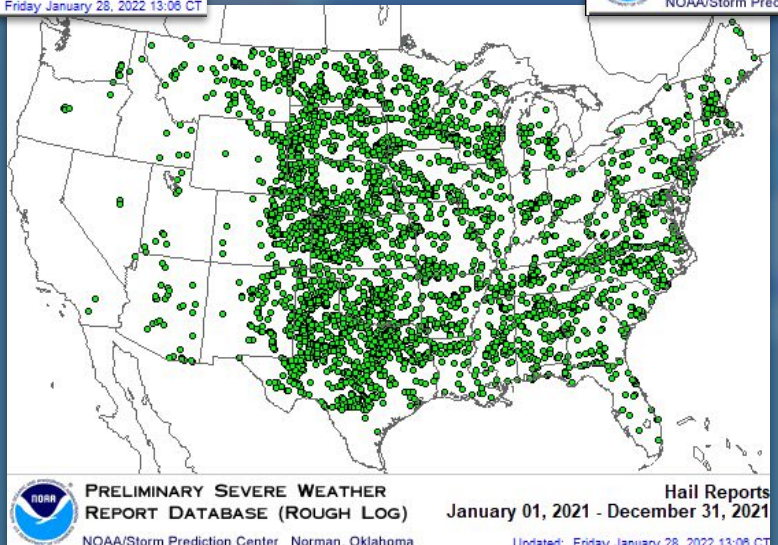
Worldwide, there are an estimated 16 million thunderstorms each year, and at any given moment, there are roughly 2,000 thunderstorms in progress.

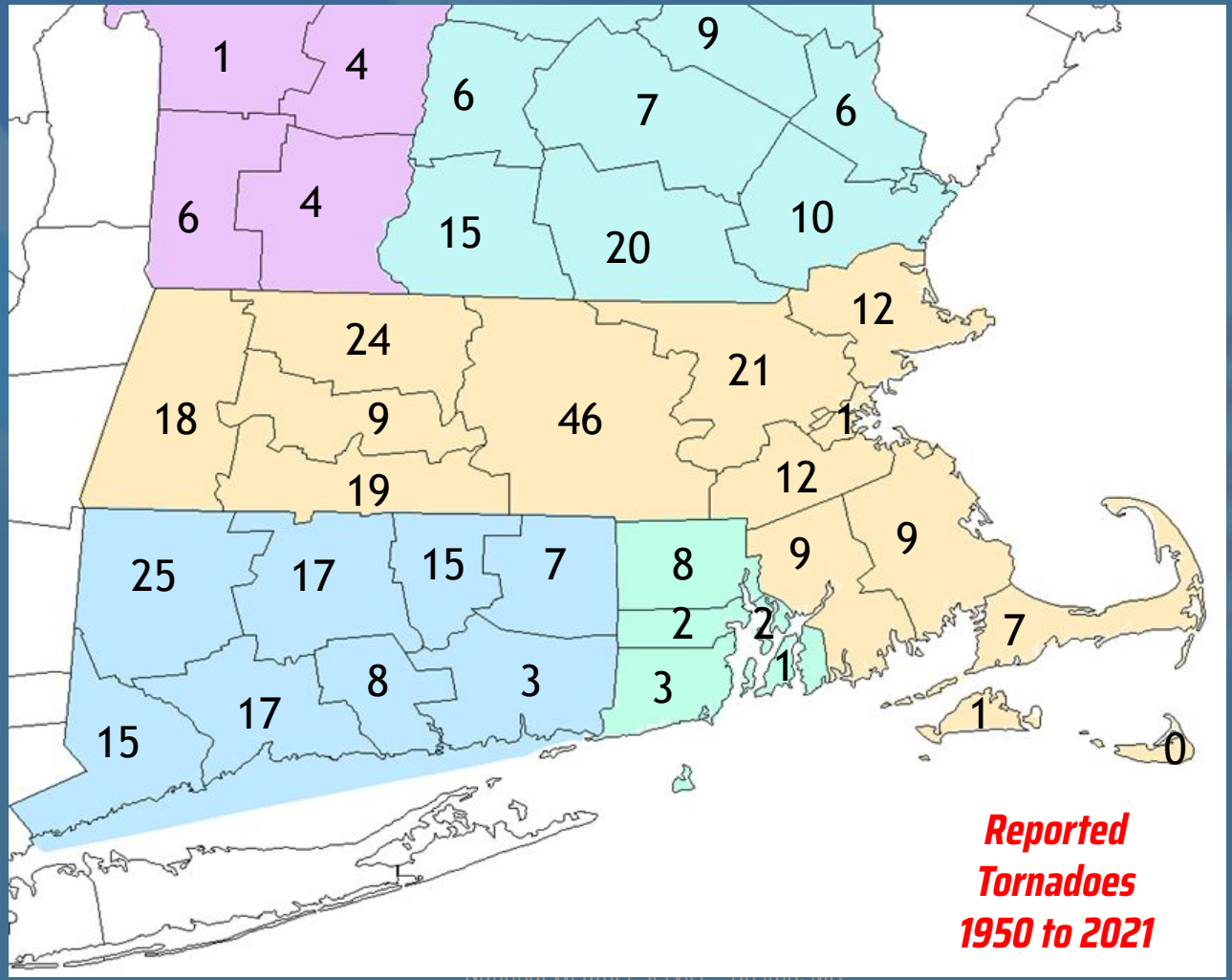


2021 Tornado, Wind, and Large Hail Reports





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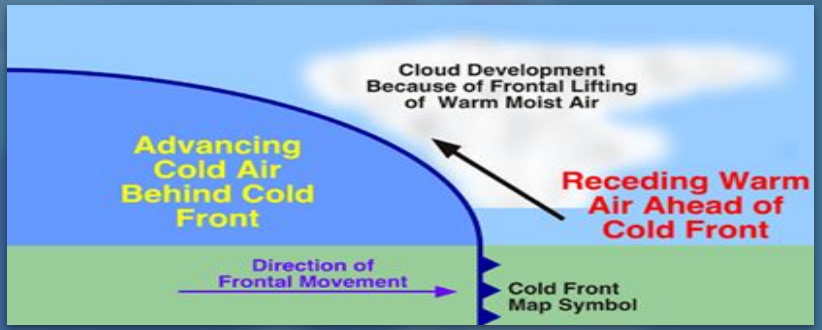
Reported
Tornadoes
1950 to 2021

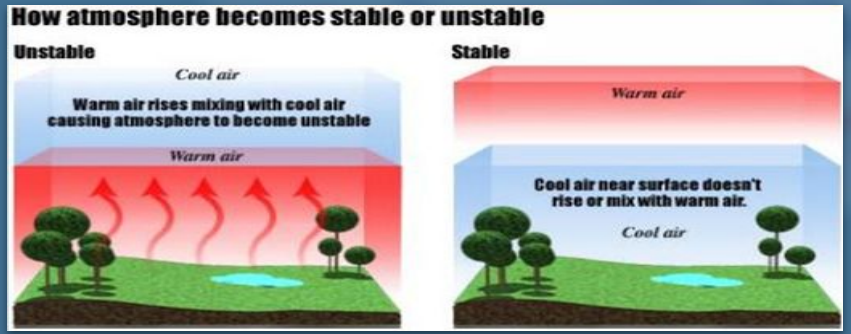
Basics of Severe Weather

Ingredients of a thunderstorm

Moisture

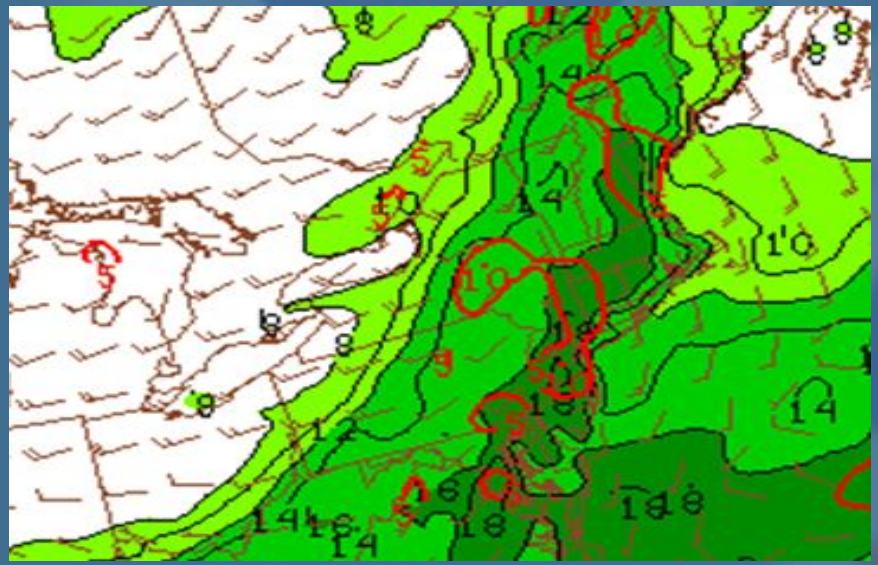


Lift



Instability

Moisture



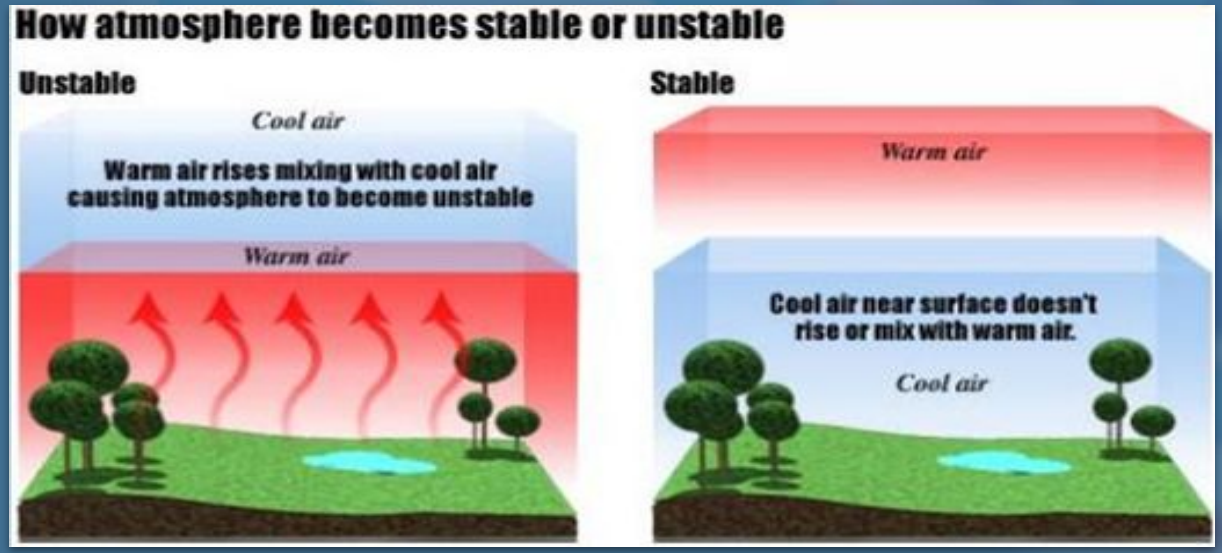
Primary Sources

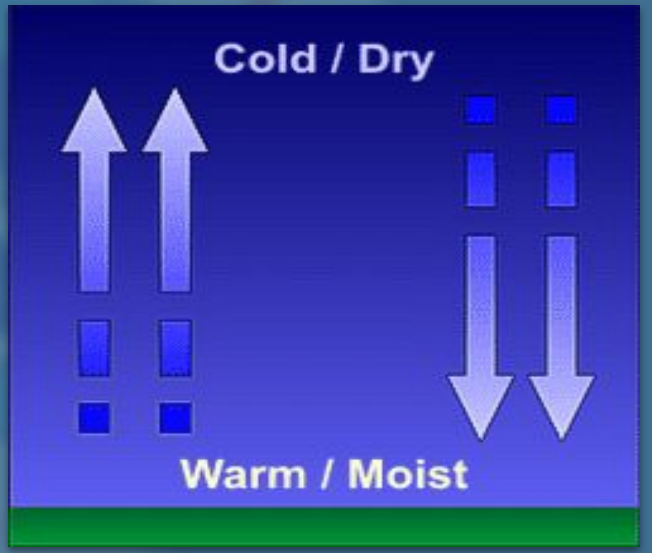
Atlantic/Pacific Ocean
Gulf of Mexico
Great Lakes (limited)

Forms the clouds and precipitation associated with thunderstorms

Instability

Warm, moist air near the ground with cold air above





The greater the instability the more favorable conditions are for thunderstorms

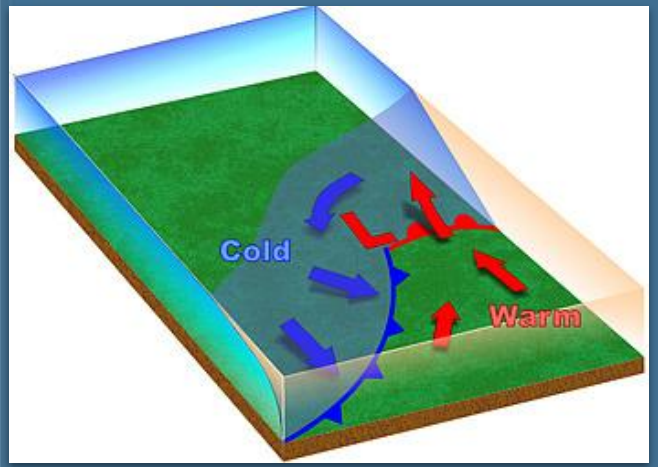
Sources of Lift

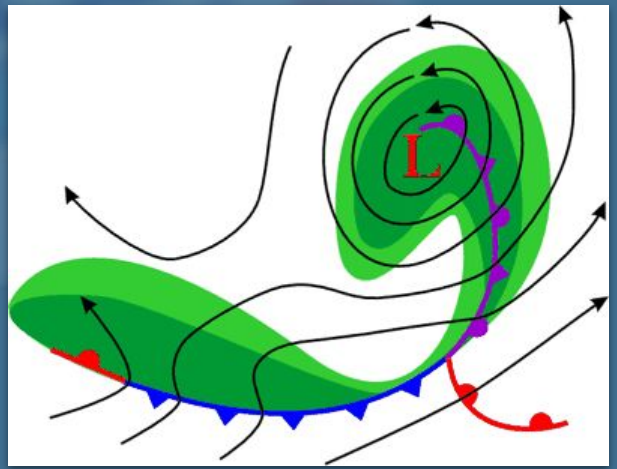
A forcing mechanism to cause air to rise, setting the thunderstorm process in motion

Fronts

A front is simply the boundary between two air masses.

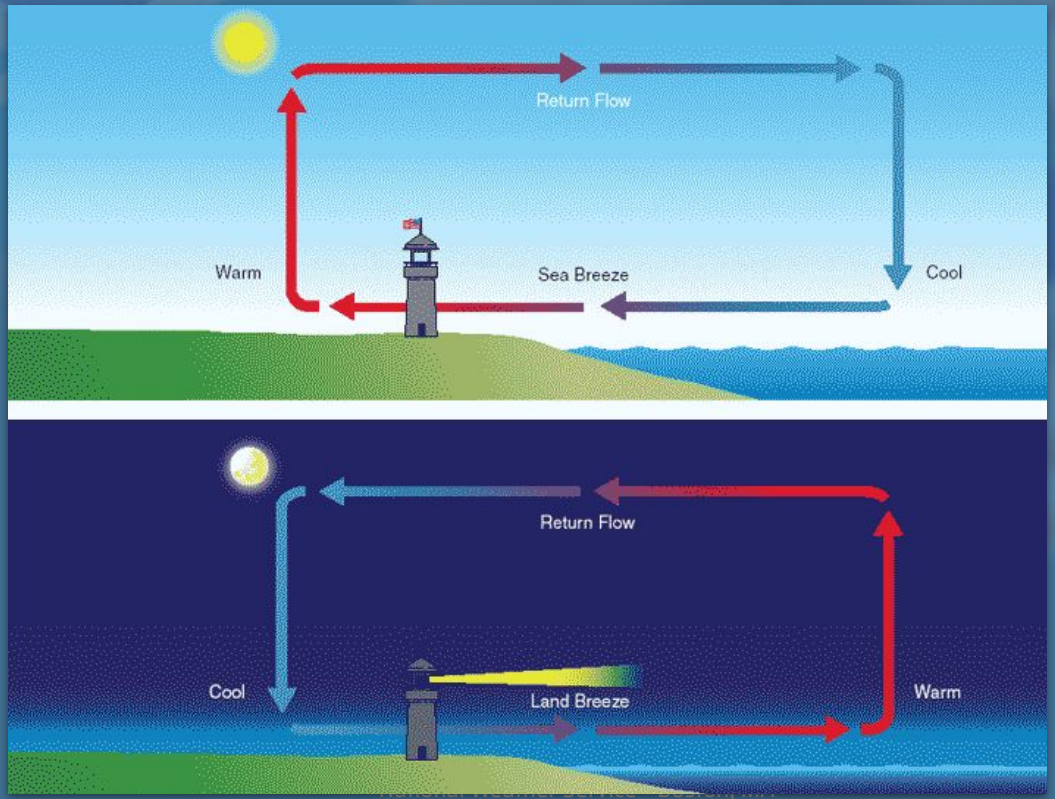
Fronts are classified by which type of air mass (cold or warm) is replacing the other.





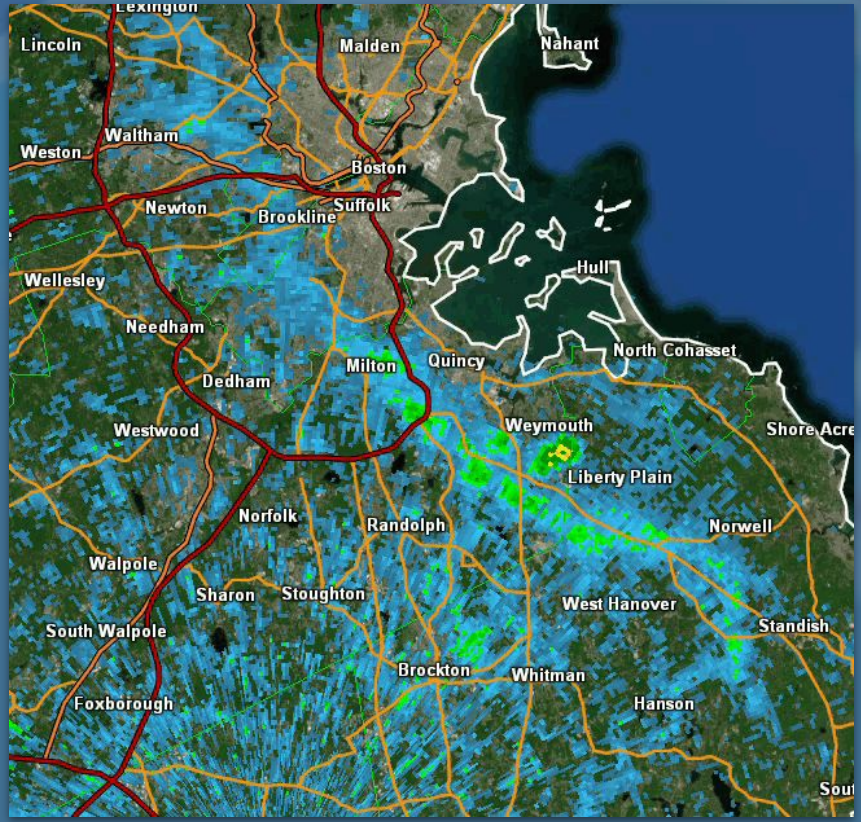
Sources of Lift

Sea Breeze



Sources of Lift

Sea Breeze

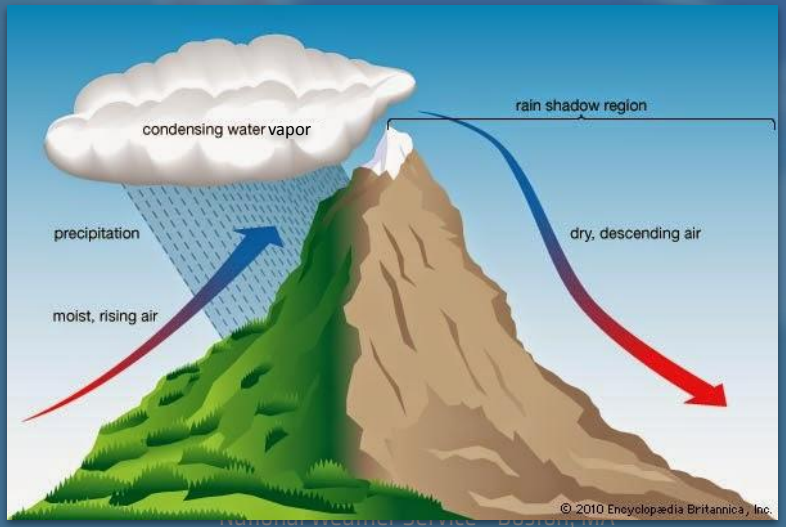


Sources of Lift

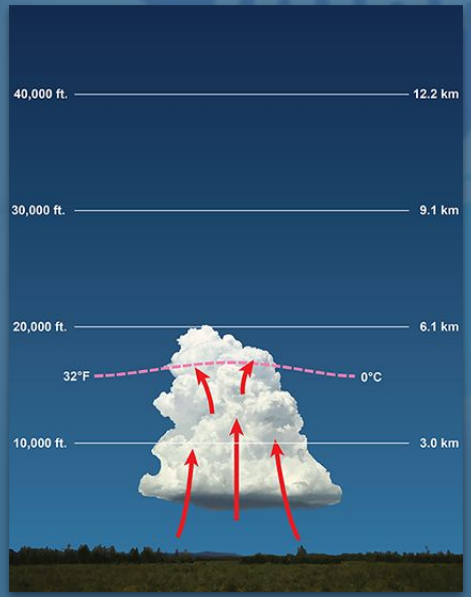
Orographic Lift

Air is forced to rise and cool due to terrain features such as hills or mountains.

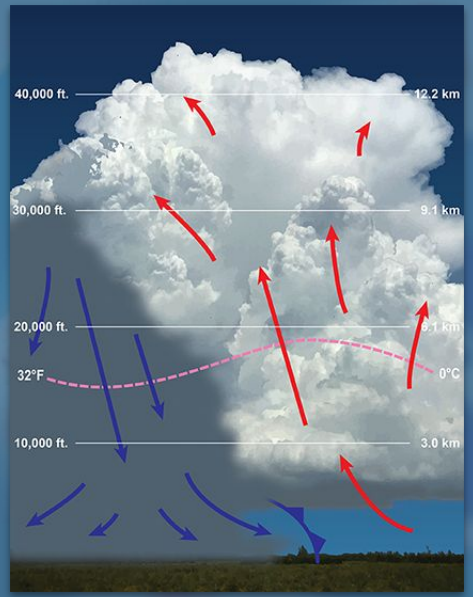
Ex. Berkshires, Worcester Hills



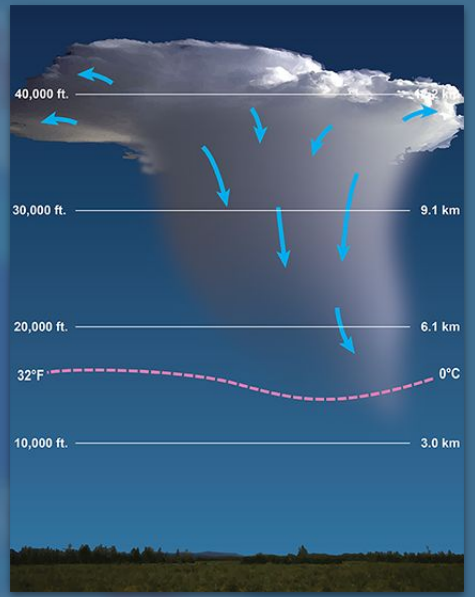
Thunderstorm Stages



Cumulus Stage



Mature Stage



Dissipating Stage

Types of Thunderstorms

Single Cell → Multicell Cluster → Multicell Line → Supercell

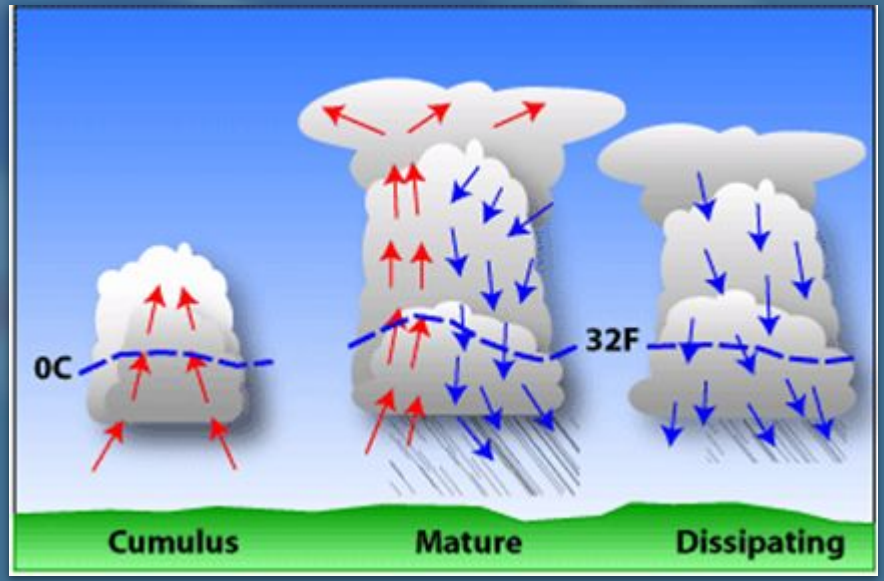



Occasional Severe Threat → Greater Severe Threat → Significant Severe Threat

Single Cell Thunderstorms

- Usually last about a half hour
- Occasionally severe

- Small Hail
- Gusty Winds
- Minor Flooding



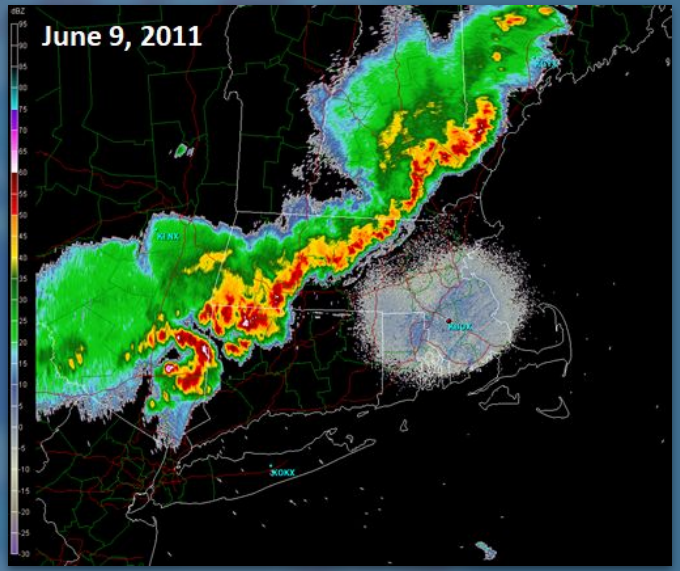
Multicell Clusters

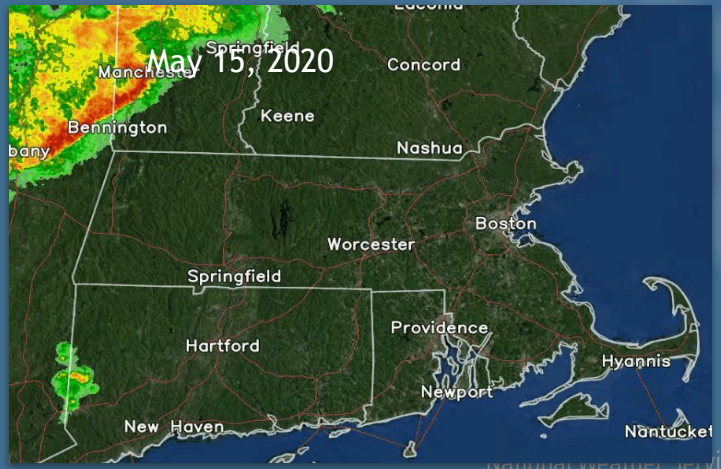
- Can last one to several hours
- May become severe

- Hail
- Strong Winds
- Flooding

Multicell Lines…also known as Squall Lines

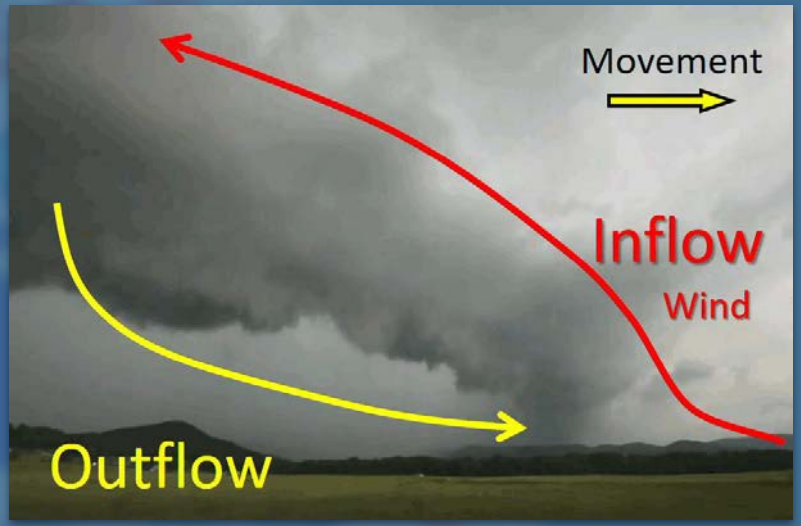
- A line of severe thunderstorms that can form along and/or ahead of a front or boundary
- Linear in structure and can be more than 100 miles long

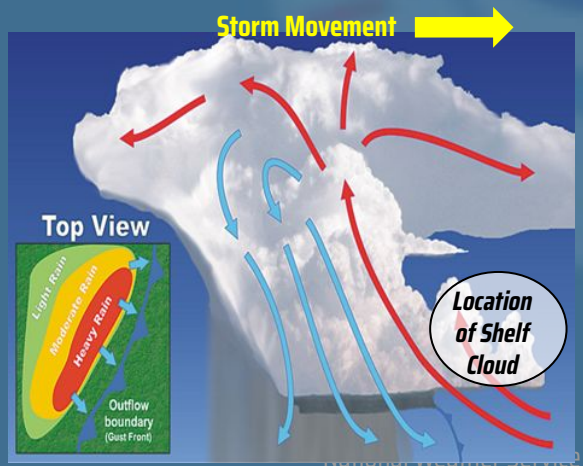




Things to Look For - Shelf Cloud

- Squall lines are often preceded by a shelf cloud, which usually extends from horizon to horizon
- Leading edge of the gust front - **means strong winds are imminent**
- Slopes down *<u>away</u>* from the rain





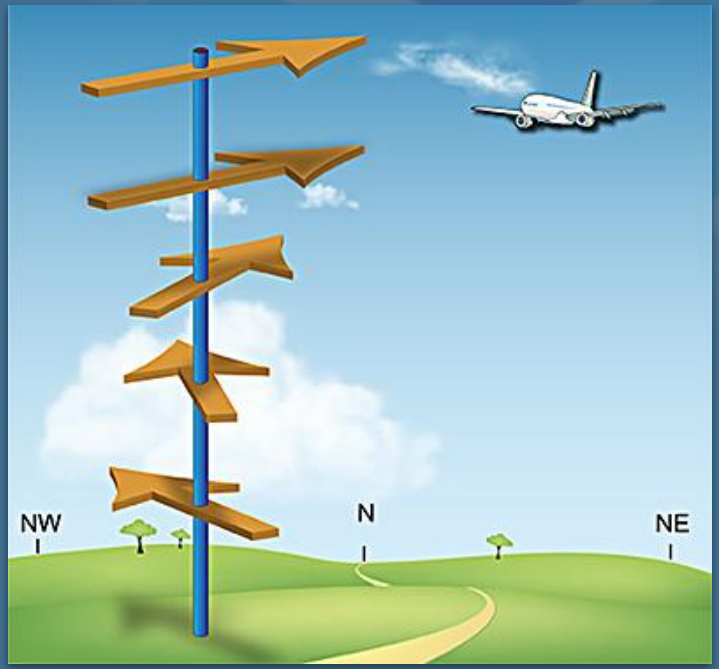
Things to Look For - Shelf Cloud

- Routinely have low hanging clouds on the underside of the shelf
- These are mistaken on a regular basis for funnel clouds or tornadoes
- Shelf clouds can be scary looking and often resemble
  - snow plows
  - big waves
  - spaceships??

Race Point Beach, Cape Cod

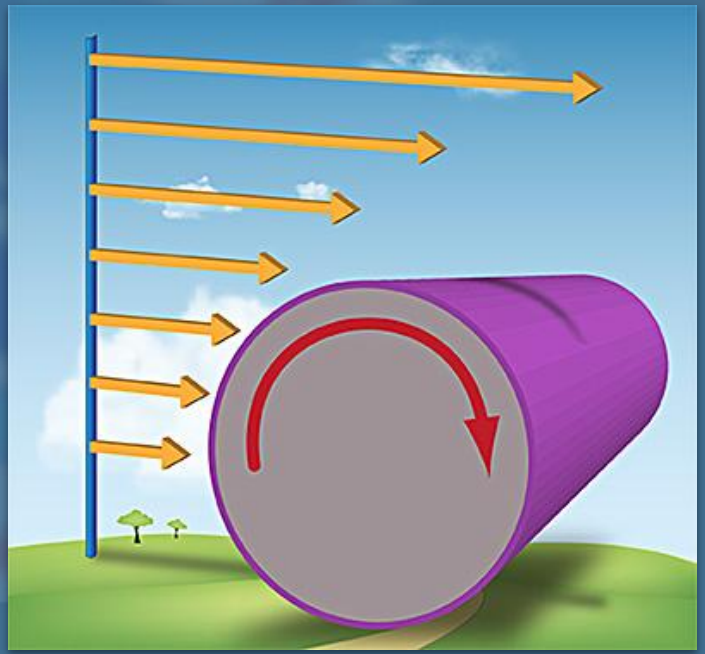
Supercell Thunderstorms

Additional Ingredient stronger storms: Wind Shear



Directional Shear

This wind profile allows horizontally oriented rolls to develop

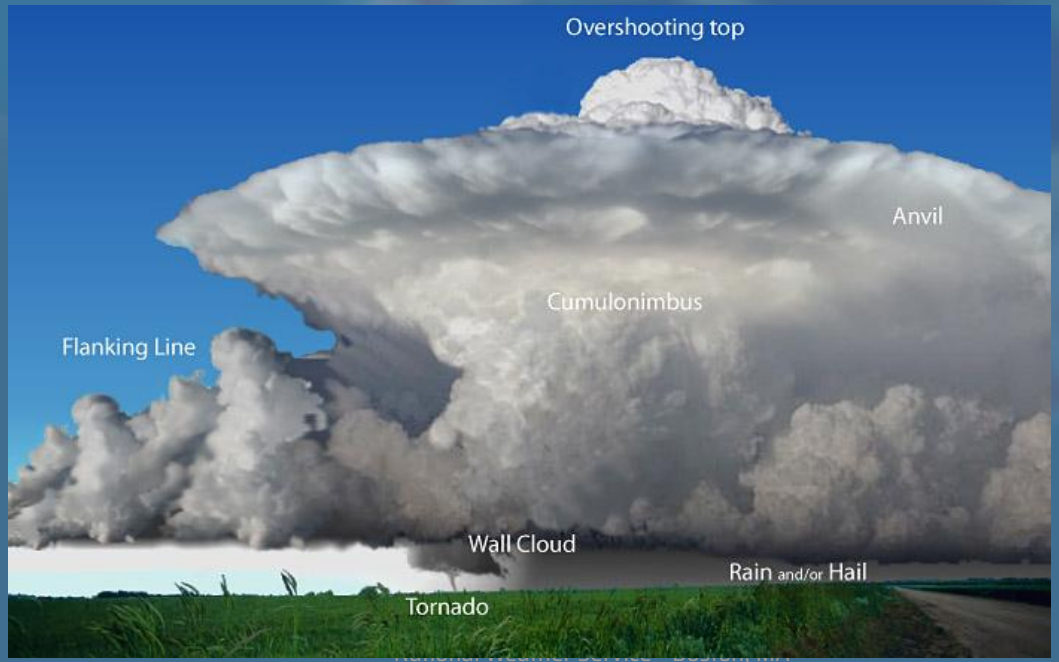


Speed Shear

Supercell Thunderstorms

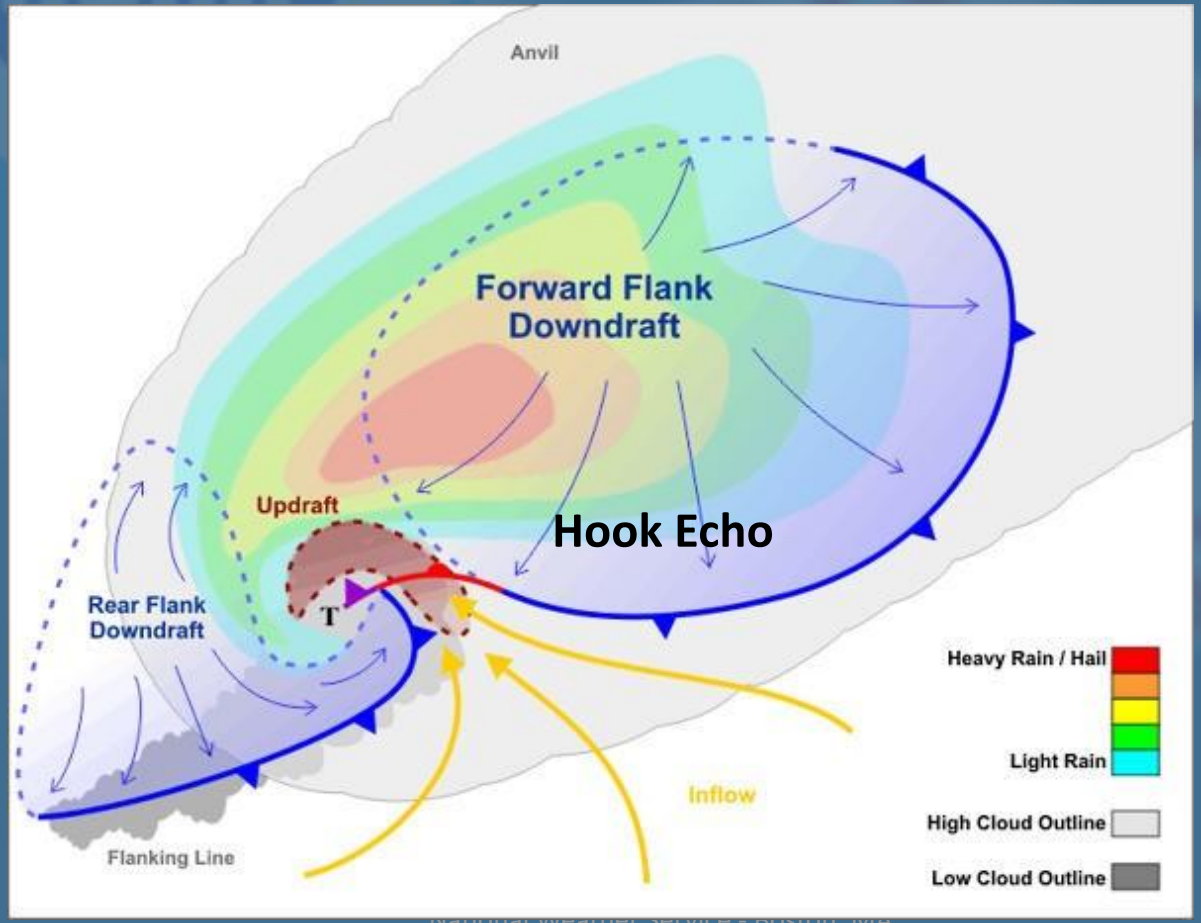
- Can last hours
- Most likely to become severe
- Least common in the Northeast

- Large Hail
- Damaging winds
- Tornadoes

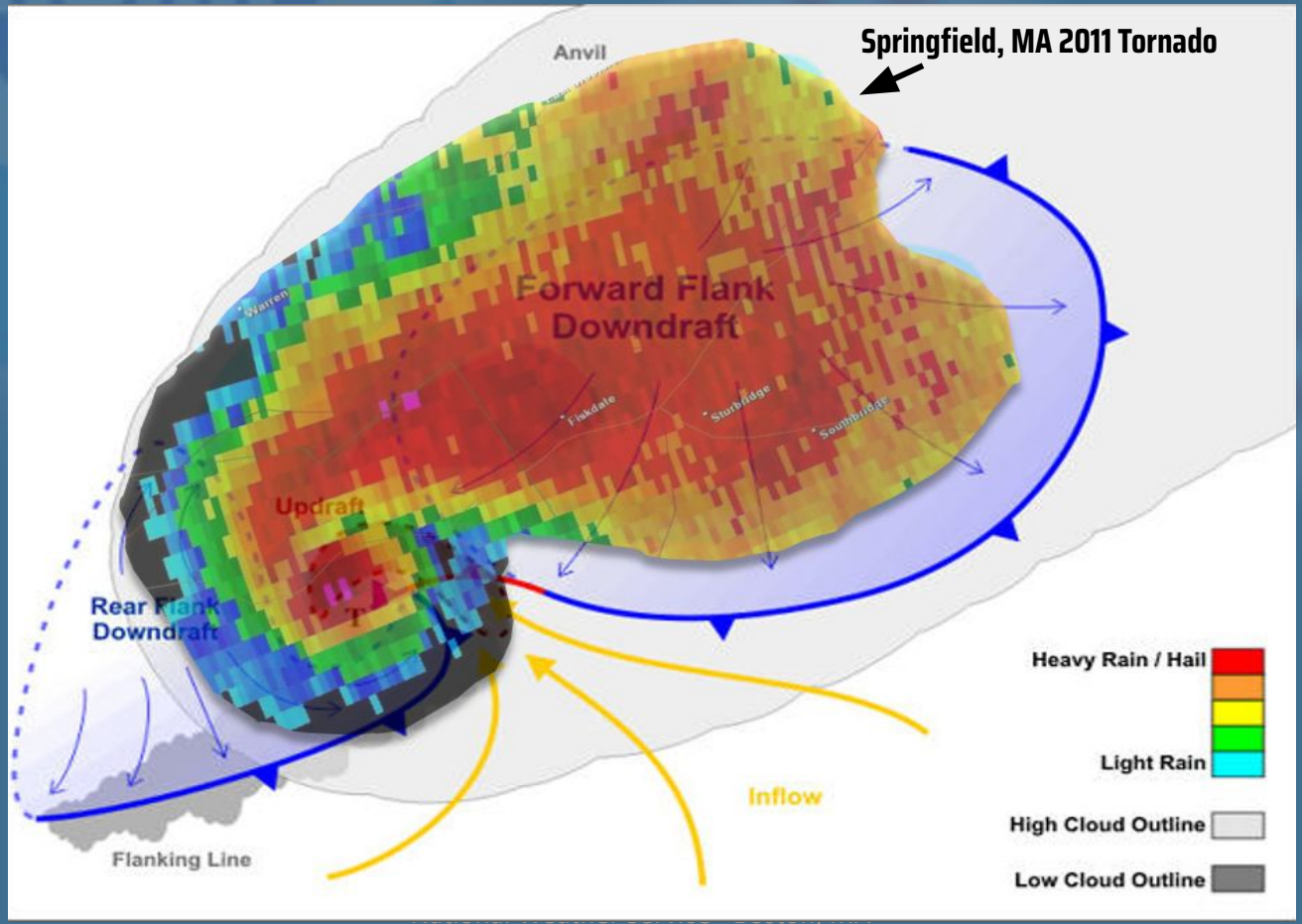



Overshooting Top
Anvil - Tropopause
Main
Storm
Tower
Creative Commons jslater316

Top - Down View



Top - Down View



Things to Look For - Wall Cloud

An abrupt lowering from a rain-free base

When seen up close, many wall clouds exhibit rapid upward motion and cyclonic rotation. However, not all wall clouds rotate

Supercell Feature - Rain Free Base

A dark horizontal cloud base with no visible precipitation beneath it. It typically marks the location of the thunderstorm updraft

Tornadoes may develop from wall clouds attached to the rain free base

Wall Cloud vs Shelf Cloud

Shelf Cloud

- slopes away from rain
- Associated with squall line
- At the leading edge of the storm

South Kingstown, RI July 2015

Wall Cloud

- Slopes toward the rain
- Associated with a supercell
- At the rear of the storm

Supercell Feature - Funnel Cloud

- Rotating column of air NOT in contact with the ground
- As the funnel descends the water vapor within it condenses into liquid droplets which makes the funnel visible
- Can be confused with SCUD (low hanging clouds)

Stoughton, MA - May 2013

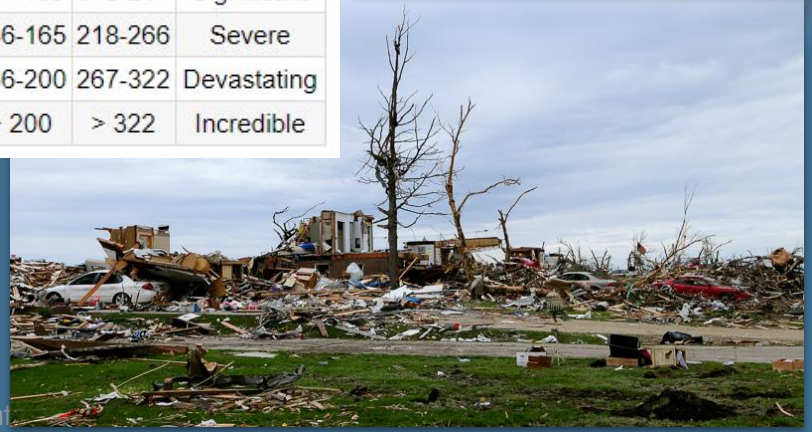
Tornadoes

Violently rotating column of air in contact with the ground

Tornadoes

Can cause extensive damage

EF scale	Class	Wind speed		Description
		mph	km/h	
EF0	weak	65-85	105-137	Minor
EF1	weak	86-110	138-177	Moderate
EF2	strong	111-135	178-217	Significant
EF3	strong	136-165	218-266	Severe
EF4	violent	166-200	267-322	Devastating
EF5	violent	> 200	> 322	Incredible

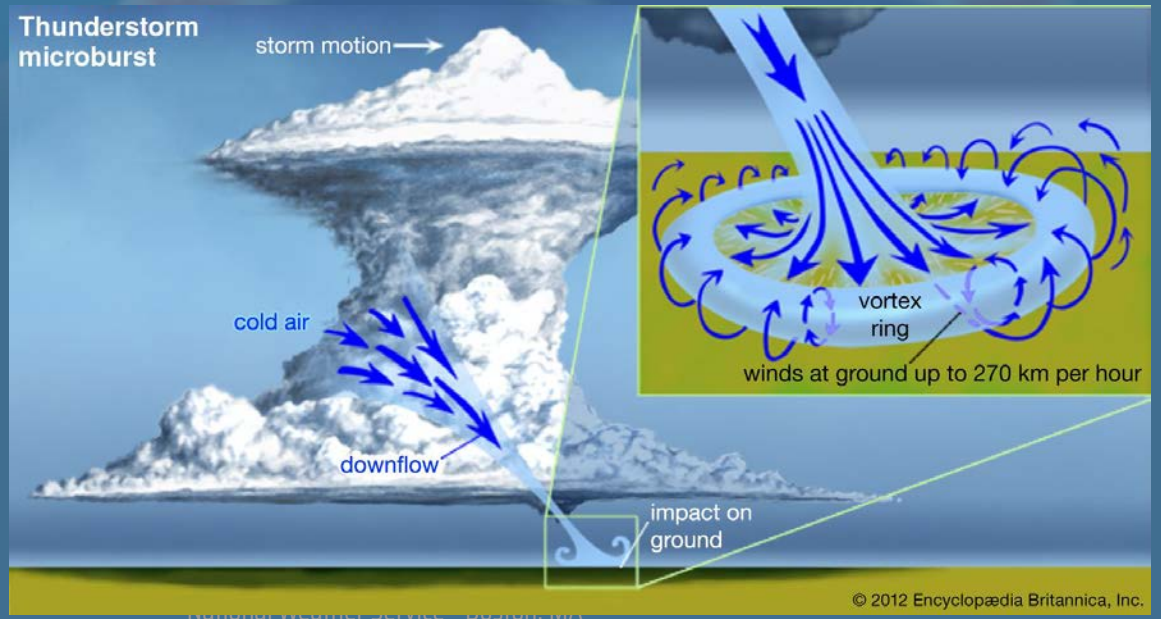


Rain Wrapped Tornado

- Common for New England tornadoes to be wrapped in rain
- Notice cars driving straight into the tornado, unaware

Microbursts & Straight Line Winds

- Evaporation can cool a parcel of air causing it to become heavier (more dense)
- Accelerates toward the ground then spreads out in all directions
- Can be the same magnitude of wind as a tornado



Microbursts

Last less than 5 minutes and affects and area less than 2.5 miles wide

Larger downbursts are called macrobursts

Damage from microburst in Groton, MA - May 15, 2020

Be Aware of Impending Hazardous Weather

St. Louis, MO - 2011

National Weather Service - Boston, MA

Preparedness Ahead of Severe Weather

National Weather Service - Boston, MA

Long Term: Preparedness Websites

www.weather.gov/boston

Storm Prediction Center
Norman, Oklahoma

www.spc.noaa.gov

Ready.
Prepare. Plan. Stay Informed.

Ready.gov

www.mass.gov/eopss/agencies/mema/

www.riema.ri.gov/

www.ct.gov/demhs/

SPC Outlooks

Understanding Severe Thunderstorm Risk Categories

THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
No severe* thunderstorms expected	**Isolated severe thunderstorms possible**	**Scattered severe storms possible**	**Numerous severe storms possible**	**Widespread severe storms likely**	**Widespread severe storms expected**
Lightning/flooding threats exist with all thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense

* NWS defines a severe thunderstorm as measured wind gusts to at least 58 mph, and/or hail to at least one inch in diameter, and/or a tornado. All thunderstorm categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.

National Weather Service

www.spc.noaa.gov

SPC Outlooks

COVERAGE

Understanding Severe Thunderstorm Risk Categories

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National Weather Service

www.spc.noaa.gov

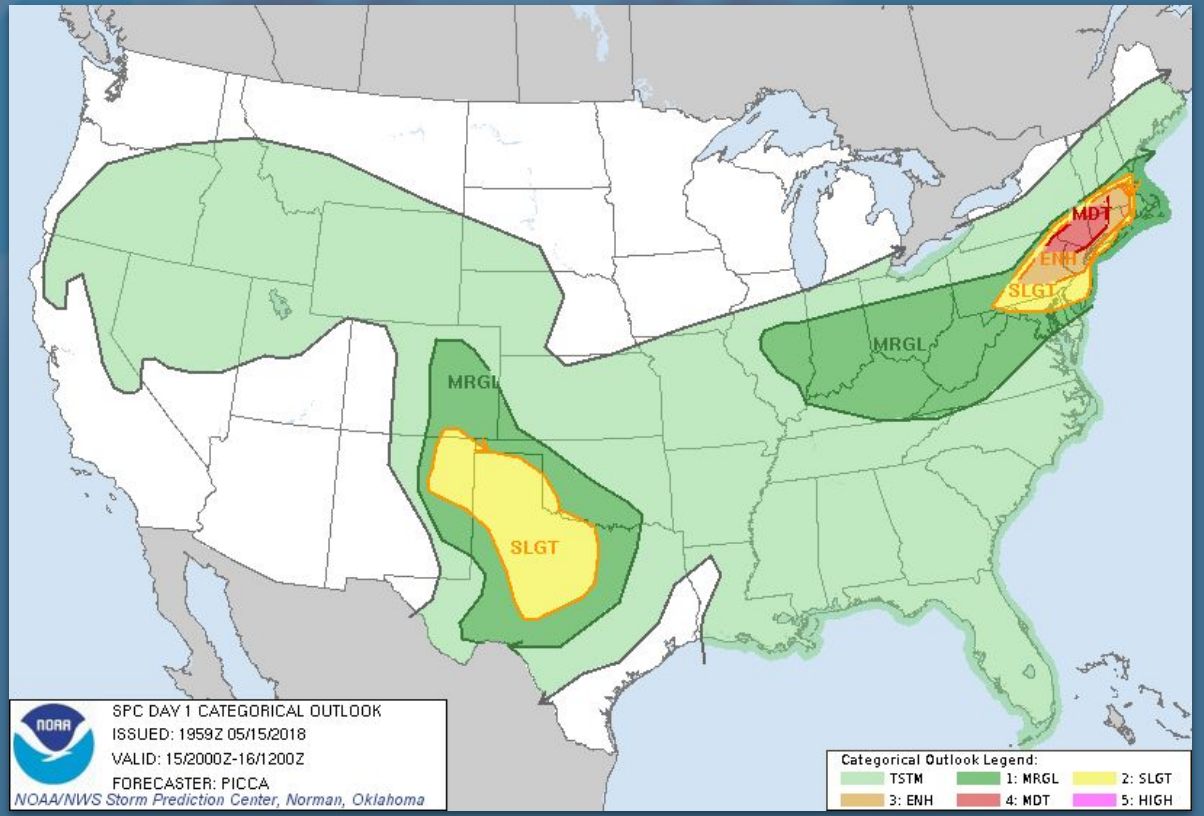
SPC Outlooks

This is an outlook over a broad area

The threat may occur in one area but not another

This is an outlook, not an observation.

Forecast is based on the state of the atmosphere

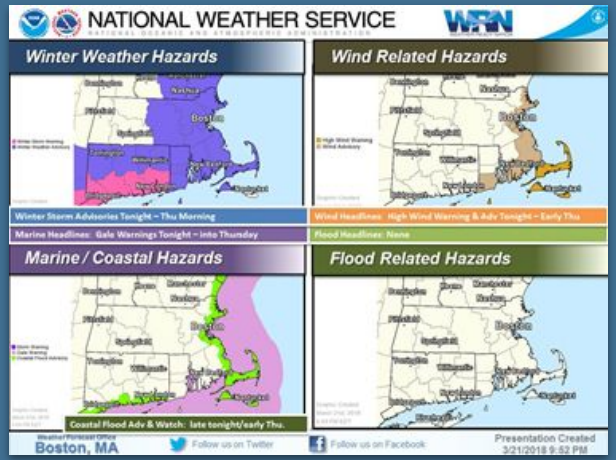


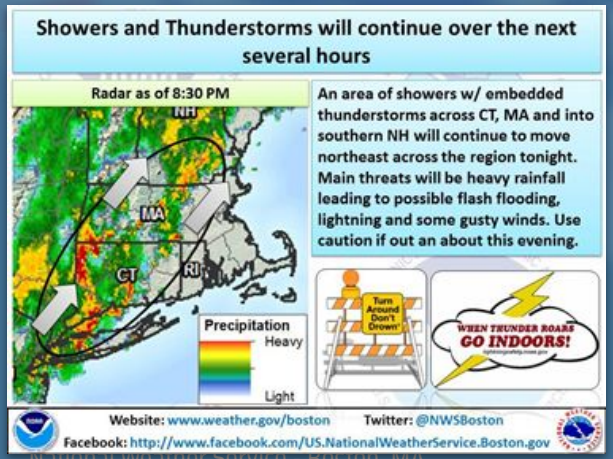
Preparedness : Social Media

NWS On Facebook & Twitter

@NWSBoston

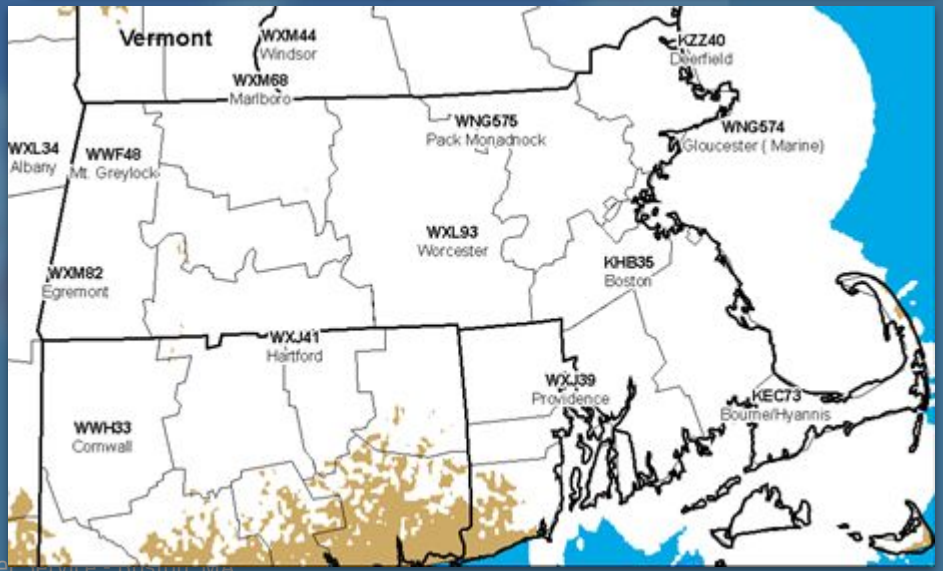
Preparedness Infographics





Preparedness: NOAA Weather Radio

- NOAA Weather Radio or NWR, is still one of the best ways to get up-to-the-minute watch and warning information.
- Comes directly from the NWS.
- Most radios will alert you when a certain warning is issued for your area by a tone, flashing light or both.



Severe Thunderstorm Watch vs Warning

Severe Thunderstorm Watch

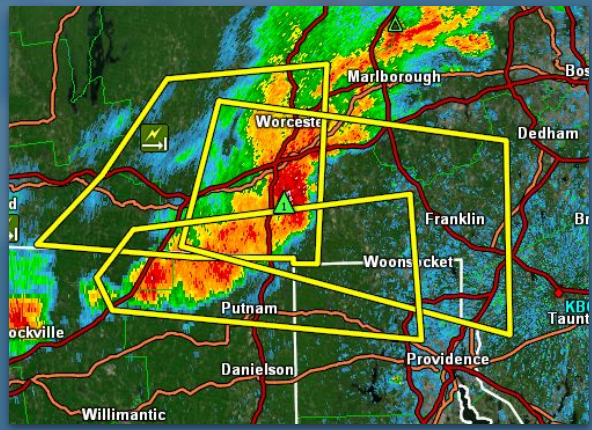
Conditions are favorable for severe thunderstorm development

Watch and **prepare** for severe weather & stay tuned to NOAA Weather Radio to know when warnings are issued.

Severe Thunderstorm Warning

There is a serious threat to life and property to those in the path of a specific storm.

ACT now to find safe shelter!



Weather Service - Boston, MA

Criteria for A *Severe* Thunderstorm

Hail 1” diameter
Quarter size

58+ mph wind gusts
Or downed trees/wires

Tornado

Tornado Watch vs Warning

Tornado Watch

Be Prepared….

a tornado is possible

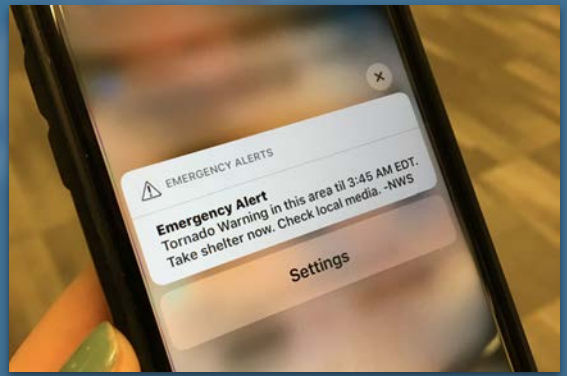
- Check for forecast updates
- Monitor sky conditions
- Know where to take shelter

Tornado Warning

Take Action!

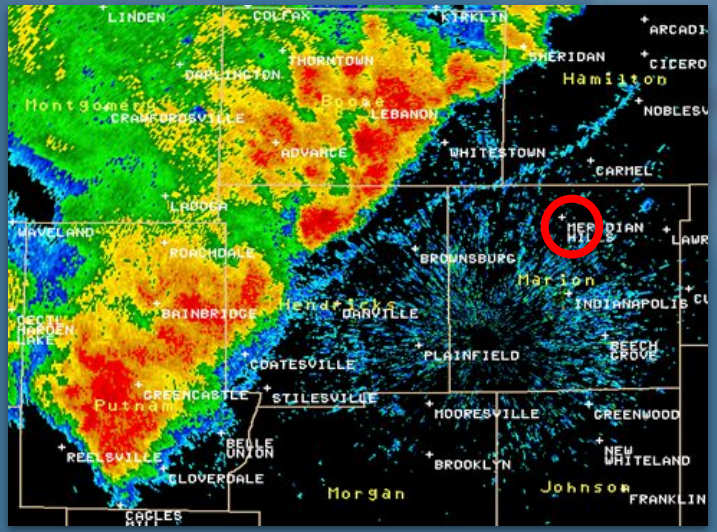
a tornado is imminent

- Take shelter immediately
- Check for forecast updates



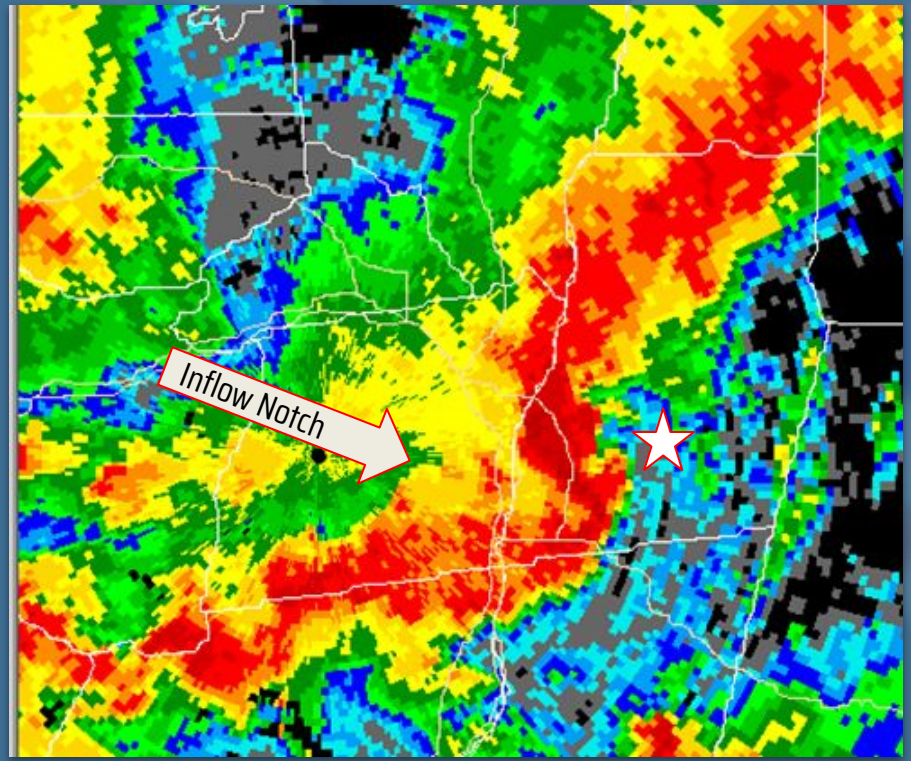
Short Term: Have a Radar App on Your Phone

- If you had a smart phone and saw this storm system coming at you on radar:
  - What would you do?
  - Where would you go?



Indianapolis, IN

Squall Line - Bow Echo



Notice the correlation of the actual shelf cloud to the radar image.

Both have an emphasized curvature.

Safety During Severe Weather

Lightning Safety

- 11 fatalities in 2021
  - Record low
- 23 fatalities per year on average 2011-2021
  - Record high: 432 Americans killed by lightning in 1943
- Most people struck by lightning live!
- Costs more than $1 billion in insured losses each year

Lightning is the #2 Weather Killer

- When thunder roars go indoors
- Remain in cover until 30 minutes after the final clap of thunder

Lightning Safety

- Indoors
  - Stay away from all electrical appliances, lighting, electric sockets, and plumbing
  - Do not lie on concrete floors or lean against concrete walls
    - Lightning can travel through any metal wires or bars in concrete walls or flooring.

- In A Car
  - Second best choice if no secure shelter is available
  - Avoid touching the steering wheel, ignition, or radio
  - The metal is what makes the car or truck safe, not the rubber tires
    - A Faraday cage is a conductive metal container that blocks electric fields.

Lightning Safety

- As a last resort, if you're trapped with no shelter option…
  - Avoid open fields and beaches, trees and light poles, metal fences, and unprotected open buildings such as pavilions.
- Get low
  - DON'T: lie on the ground. If lightning strikes the ground nearby, it will pass through your body as well.
  - DO: Crouch down on the balls of your feet with your heels touching.
  - DO: Put your hands over your ears
    - trying to avoid hearing loss/damaged ear drums

Helping Lightning Victims

- If someone is struck:
  - Most victims can survive a lightning strike
  - Victims do not carry an electrical charge
  - They need immediate medical attention - call 911
  - CPR or an AED may be needed to revive them
    - Cardiac arrest is the number one cause of death due to a lightning strike
  - Monitor the victim until medical help arrives
  - If possible, move the victim to a safer place away from the threat of lightning

Helping Lightning Victims

- Treat the burns
  - Treating burns is not as high priority as administering CPR, but if a person is conscious and has been burned it should get treatment. Cover the burn loosely with a dry, clean cloth. Remove clothing if necessary, but do not try to remove cloth that is stuck to a burn.

- Treat the person for shock
  - Lightning strikes can cause neurological damage, and if the victim is conscious, they might be disoriented—either from such damage or from shock. Either way, it's a good idea to get the victim to lie down and elevate their feet above their head if you suspect shock. Be sure to keep the victim warm with a blanket or jacket if possible.

Tornado Safety - Indoors

Every Tornado Should Be Seen As Life Threatening

- Winds from tornadoes can exceed 200 mph
- Flying debris is very dangerous, and most often the cause of death and injuries
- 60-65 fatalities from tornadoes per year on average
- ***Seek a sturdy shelter in a storm shelter, basement, or interior room away from windows on the lowest floor***
- Cover your head

Tornado Sheltering Guidelines

*Seek the best available refuge area **immediately** when a Tornado Warning is issued.*
Your chance of surviving a tornado is excellent if you follow these guidelines.

WORST OPTIONS

Mobile homes

Vehicles

Underneath a highway overpass

BAD OPTIONS

Large open rooms like gymnasiums

Manufactured housing

GOOD OPTIONS

Interior room of a well-constructed home or building

Basement

BEST OPTIONS

Above or below ground Tornado Storm Shelter (NSSA/ICC 500 compliant)*

Specifically-designed FEMA Safe Room*

Find another option → **Stay in place until all clear**

PHOTO: U.S. Air Force -Tech. Sgt. Bradley C. Church

*Recommended by FEMA

Tornado Safety - Indoors

Down to the lowest level

Under something sturdy

Cover your head

Keep in shelter until the storm has passed

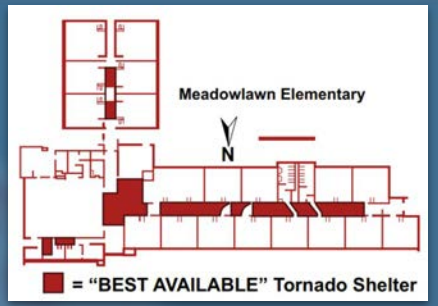

(Drone Base/Reuters)

Tornado Safety

Most Importantly:

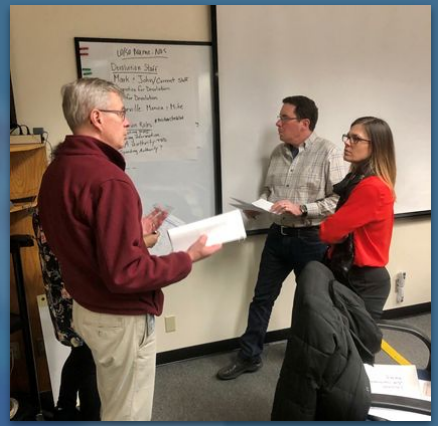
Develop and an Emergency Plan ahead of time

Emergency Plan - Planning



- **Identifying Shelter Locations**
  - An underground area, such as a basement or storm cellar, provides the best protection from a tornado. If an underground shelter is unavailable, consider the following:
    - Seek a small interior room or hallway on the lowest floor possible
    - Stay away from doors, windows, and outside walls
    - Stay in center of the room, & avoid corners because they attract debris
    - Rooms constructed with reinforced concrete, brick or block with no windows and a heavy concrete floor or roof system overhead
  - Avoid auditoriums, cafeterias, and gymnasiums that have flat, wide-span roofs.

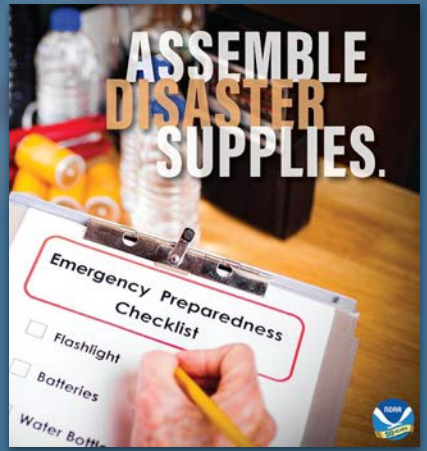
Emergency Plan - Planning



- **Accountability Procedures**
  - Develop a system for knowing who is in the building in the event of an emergency
  - Establish an alarm system to warn workers
    - Test systems frequently
    - Develop plans to communicate warnings to personnel with disabilities or who do not speak English
  - Account for workers, visitors, and customers as they arrive in the shelter
    - Use a prepared roster or checklist
    - Take a headcount
  - Assign specific duties to workers in advance; create checklists for each specific responsibility. Designate and train workers alternates in case the assigned person is not there or is injured

Emergency Plan - Equipping

- Get emergency supply kits and keep them in shelter locations
  - Food & Water
  - First Aid Kit
  - Whistle (to signal for help)
  - Battery Powered or hand crank radio and NOAA Weather Radio
- Ensure that all workers know what to do in case of an emergency.
- Practice shelter-in-place plans on a regular basis.
- Update plans and procedures based on lessons learned from exercises.



Tornado Safety - In Cars

- Get out of your vehicle and get into a ditch or ravine
- As a last resort, if a ditch isn't near, buckle in and lower your head below window level
- Find a reinforced shelter if possible

High Wind & Hail Safety

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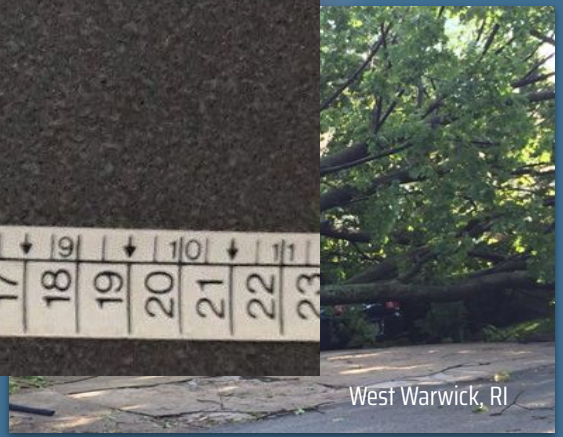
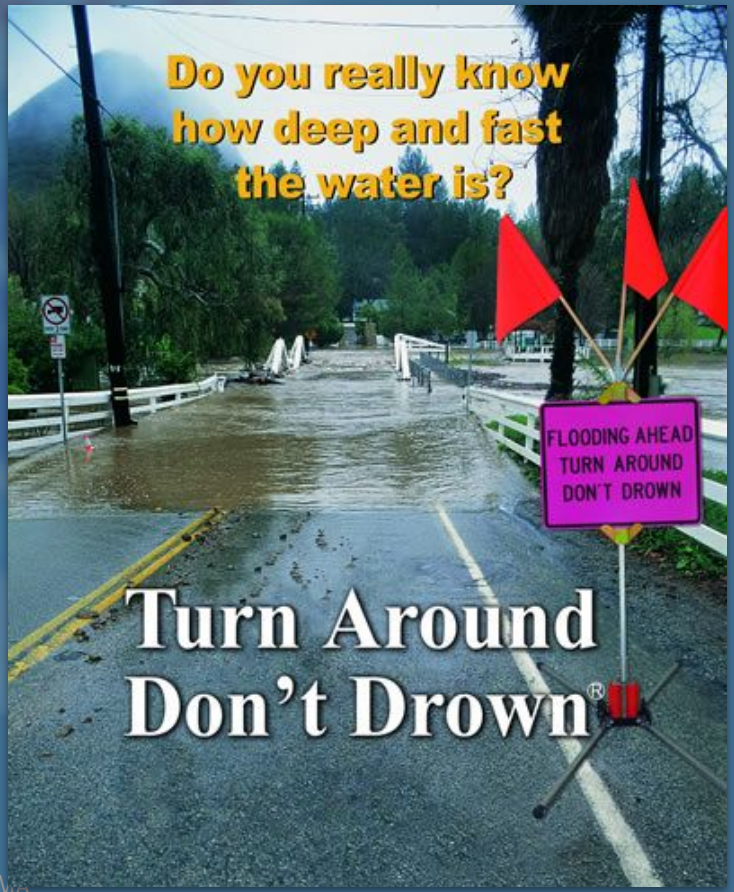


Flooding Safety

Turn Around Don't Drown

- **Six inches** of swiftly moving water can knock an adult off his/her feet.
- **Two feet** of water can make most cars and trucks float away

Tropical Storm Irene - Southern VT



Hurricane Safety

Rules of Thumb:

1. Any tropical system with a name in the Bahamas has the potential to quickly affect New England
2. Do not focus on when the eye is going to make landfall
3. Be aware of where you are with respect to the track of the eye
4. Run from the water and hide from the wind
5. Be Prepared! It is important to be able to be self-sufficient for 3+ days

Fairfield, Connecticut

Roy Carpenter's Beach, RI

Response and Recovery - Hazards

- **After the storm, recovery itself presents a new set of hazards**
  - Additional storms
  - Hazardous driving conditions due to blocked roadways
  - Falling and flying objects such as tree limbs and utility poles
  - Downed power lines
  - Fires caused by energized line contact or equipment failure
  - Heat and dehydration

(Nicolas Galindo - The News Star - via AP)

Response and Recovery - Precautions

- Continue to monitor your local radio or television stations for emergency information and the potential of additional storms.
- Be aware of possible structural, electrical, or gas-leak hazards.
  - If such hazards are identified, report them to the proper local authorities and/or utility.
- Do not touch downed power lines or objects in contact with downed power lines.
- Wear proper clothing when walking on or near debris, including boots and gloves.
- Be careful around sharp debris like nails and broken glass.
- Take steps to prevent heat illnesses and dehydration.

Wrap Up

- Be aware of upcoming weather hazards by monitoring your local forecast office and other resources so that you can plan ahead
- During severe weather stay situationally aware by keeping an eye on the latest updates and local radar
- Have an Emergency Plan ahead of time and practice that emergency plan
- Contact your local National Weather Service office if you have any questions or if we can be of any help at all!


Thank you for your time!
Questions?
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