

Severe Weather Safety

Mike Montefusco
National Weather Service
Wakefield, VA



Brief Introduction - Who We Are



NWS Weather Forecast Office Wakefield, VA

- 12 forecasters, 3 Electronic Technicians/IT Support, 1 Hydrologist, 1 Science & Operations Officer, 1 Observations Program Leader, 1 Warning Coordination Meteorologist, 1 Administrative Assistant, and a Meteorologist in Charge
- Open 24x7x365 to provide forecasts and warnings, as well as maintain the Doppler radar and other observation systems

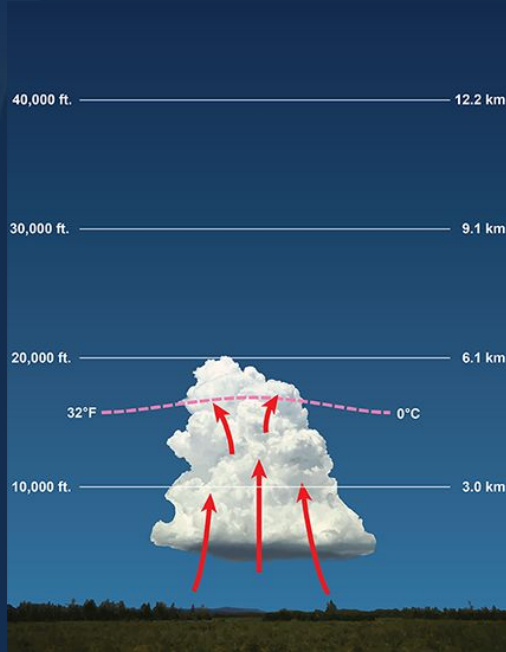
Thunderstorms

Types of Thunderstorms

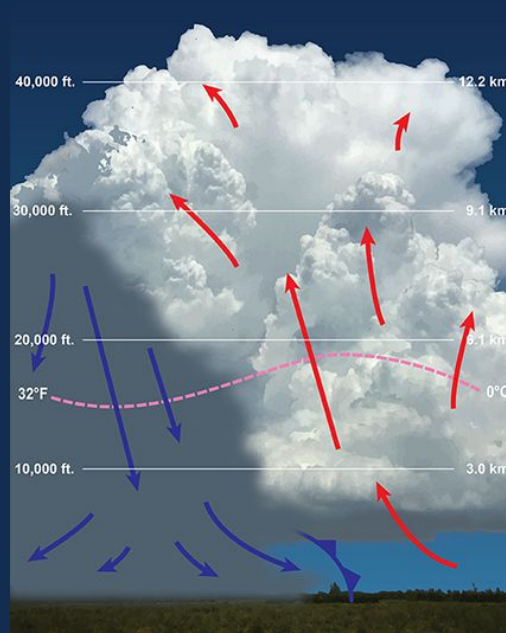
- Ordinary single-cell
- Multi-cell cluster/line
- Supercell



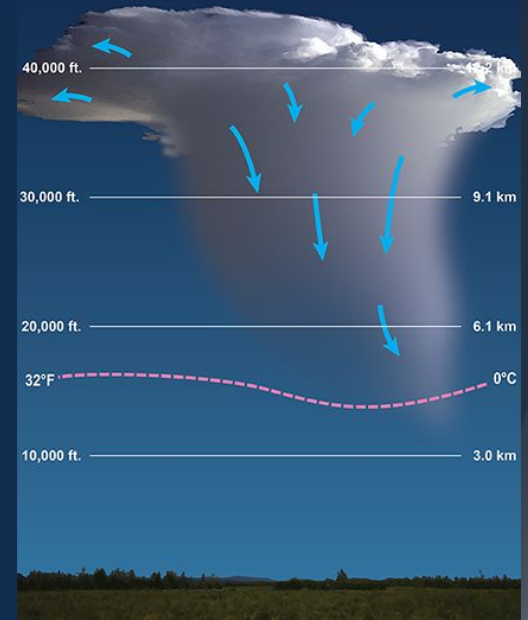
Life Cycle of an Ordinary Single-Cell Thunderstorm



Towering Cumulus

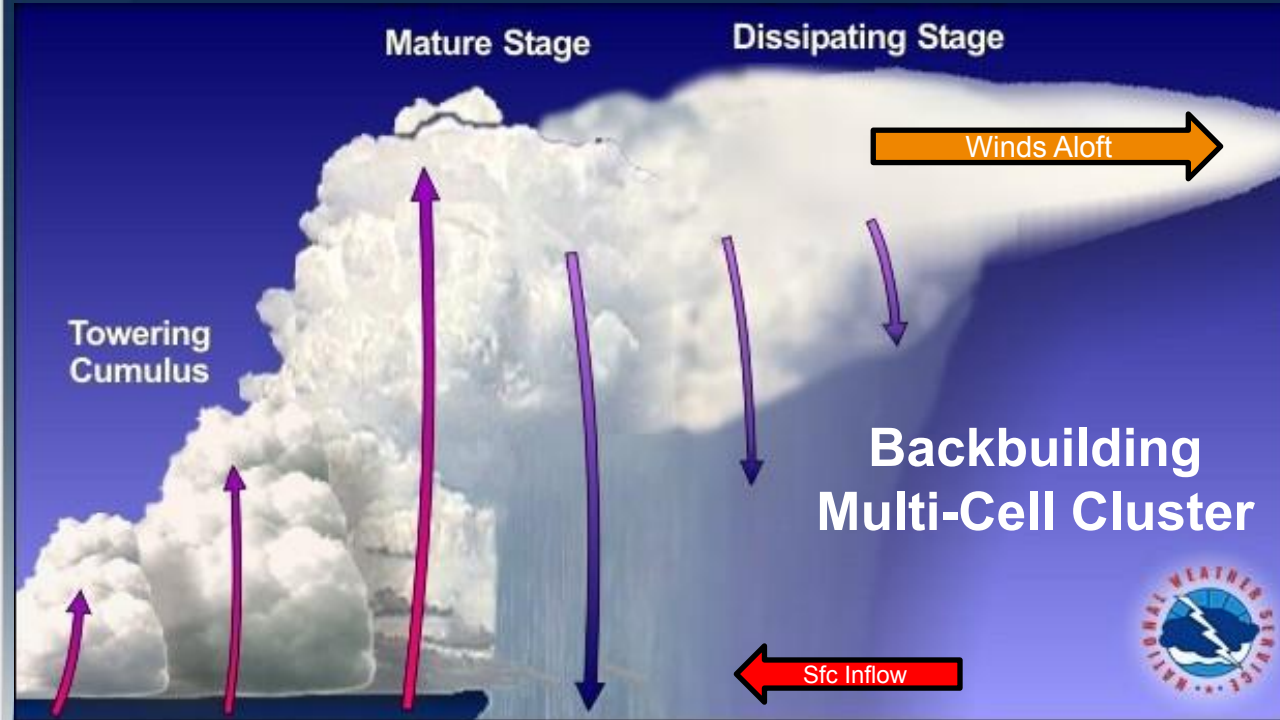


Mature Cumulus



Dissipation

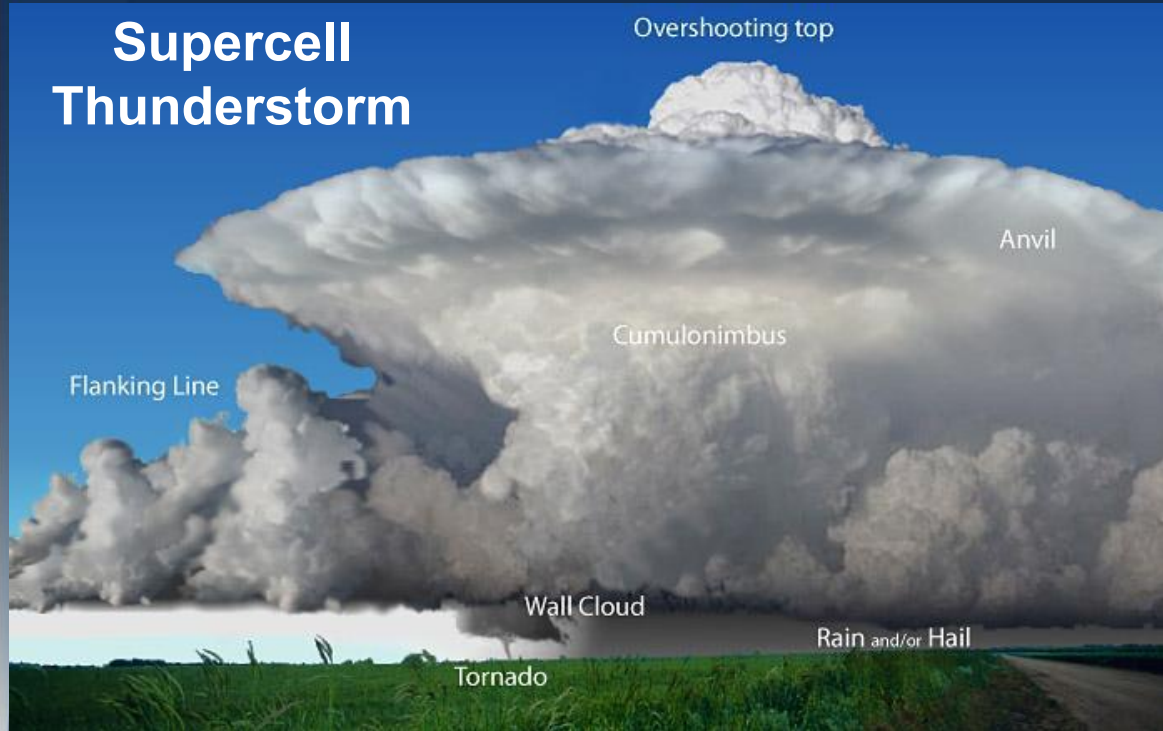
Multi-cell Cluster



- Upper-level winds carry the first cell downstream with a new cell forming upwind of the previous cell.
- If the upper-level wind is opposite of the low-level winds, **backbuilding** can develop – leading to flash flooding.
- A large, long-lived multi-cell cluster is known as a *mesoscale convective system*.
- A *linear* mesoscale convective system is called a squall line.

Supercell Thunderstorms

Supercell Thunderstorm



- Characterized by updrafts that can attain speeds over 100 mph and are able to produce giant hail with strong or even violent tornadoes.
- Downdrafts can produce downbursts/outflow winds in excess of 100 mph.
- Ideal conditions for supercells occur when winds turn clockwise with height (veering).

Types of Supercells



**Low-Precipitation (LP)
Supercell**



**High-Precipitation (HP)
Supercell**

Severe Thunderstorms

- What makes a thunderstorm **severe**?
 - Winds $\geq$ 58 mph (50 knots)
 - Hail $\geq$ 1 inch in maximum dimension
 - Tornado
- Other threats:
 - Lightning
 - Flooding



Severe Thunderstorms: Cloud Examples

Mesoscale Convective System

Shelf Cloud

- *Strong winds
- *Heavy rain
- *Small hail

Supercell

Wall Cloud

- *Large Hail
- *Tornadoes

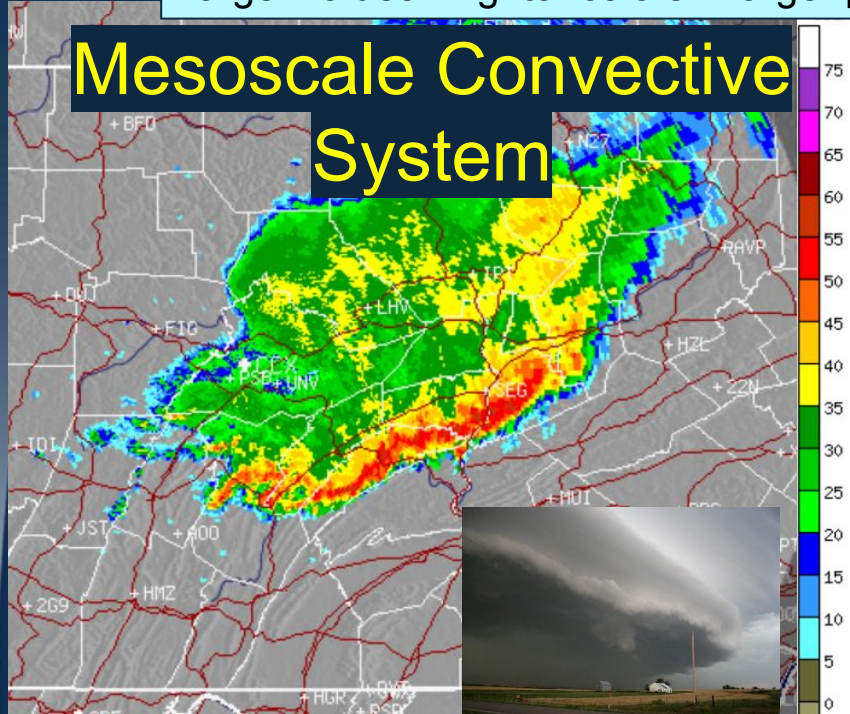


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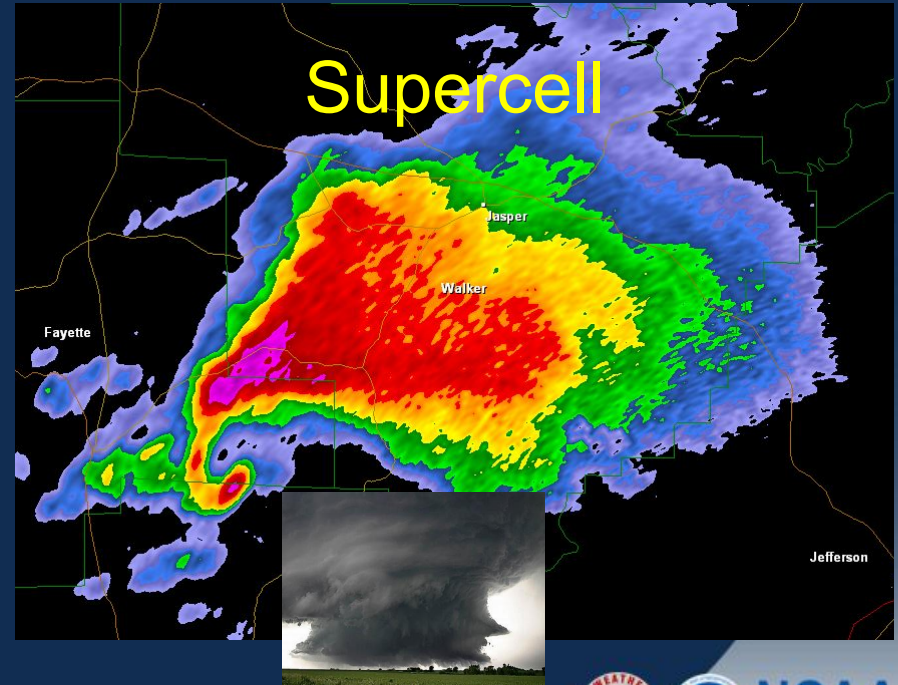
Severe Thunderstorms: Examples on Radar

Larger values/Brighter colors = larger particles and/or larger concentration of particles

Mesoscale Convective System



Supercell



Weather Hazards

1. Lightning
2. Hail
3. Wind
4. Tornadoes
5. Flooding
6. Extreme Heat





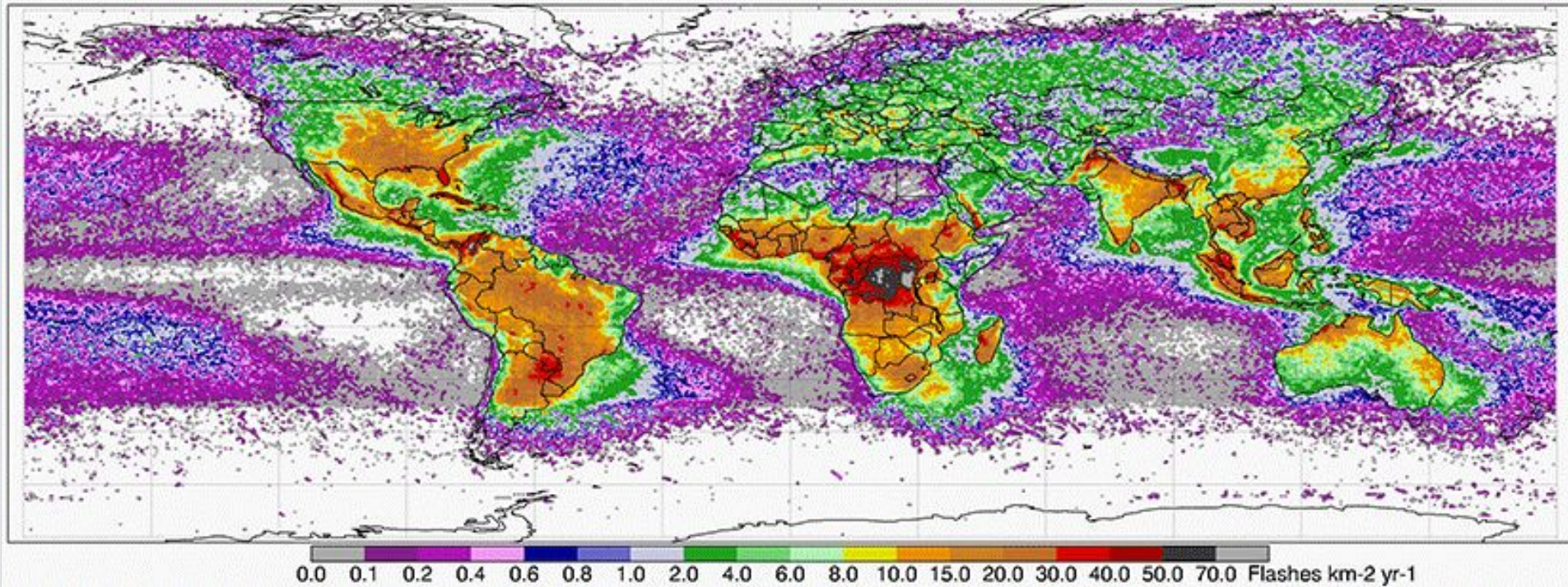
Lightning

Lightning

- Lightning is the **second most deadly** form of severe weather
- **First** hazard to arrive and **last** to leave
- In general, if you can *hear* thunder, you can be *struck* by lightning!
- The odds of getting struck by lightning are higher than the odds of winning the lottery!
- The average lightning strike carries **300 million volts**

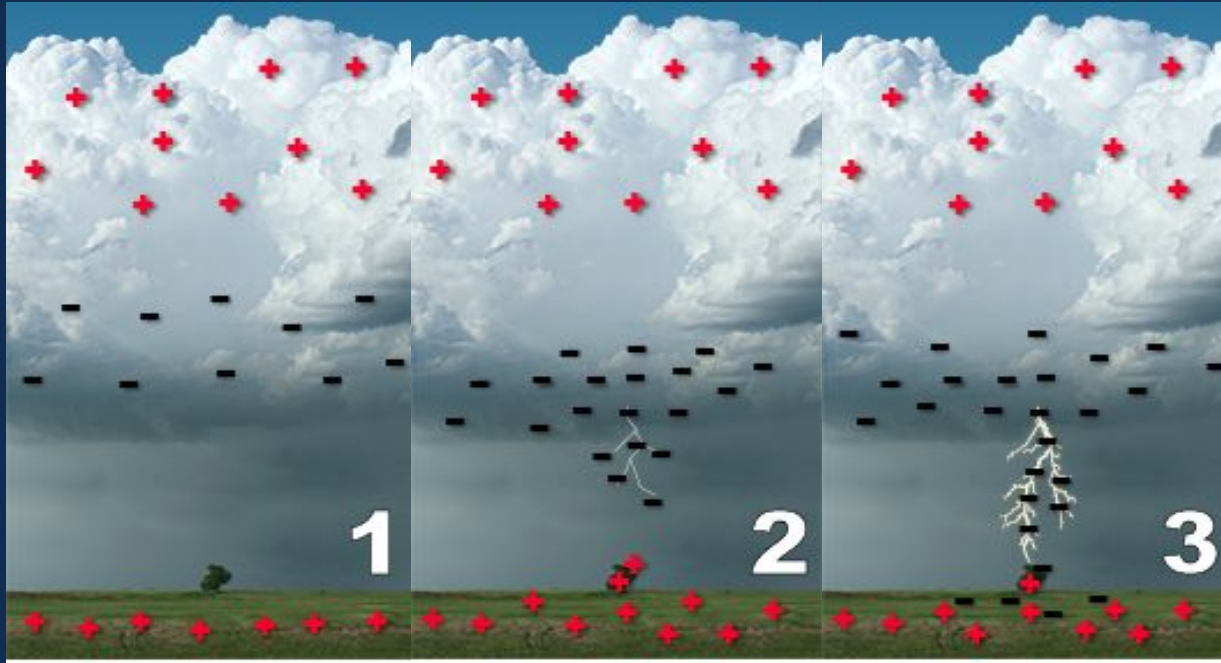


Where does lightning occur?



How do we get lightning?

- **“Negative lightning”**: transfer of negative charge from the cloud to the ground



Positive Lightning Strikes

- “**Positive lightning**”: transfer of positive charge from cloud to ground
- Rare, but **more dangerous!**
- Peak charge as much as **one billion volts!**
- Can strike more than **25 miles away!**
- Sometimes called “anvil crawlers”



Lightning Do's and Don'ts

Where to Go & What to Do

- Enclosed structures/buildings
- Enclosed vehicles
- Stay away from electrical appliances and plumbing
- Keep windows closed and do not touch metal (if inside a car)

Where NOT to Go & What NOT to DO

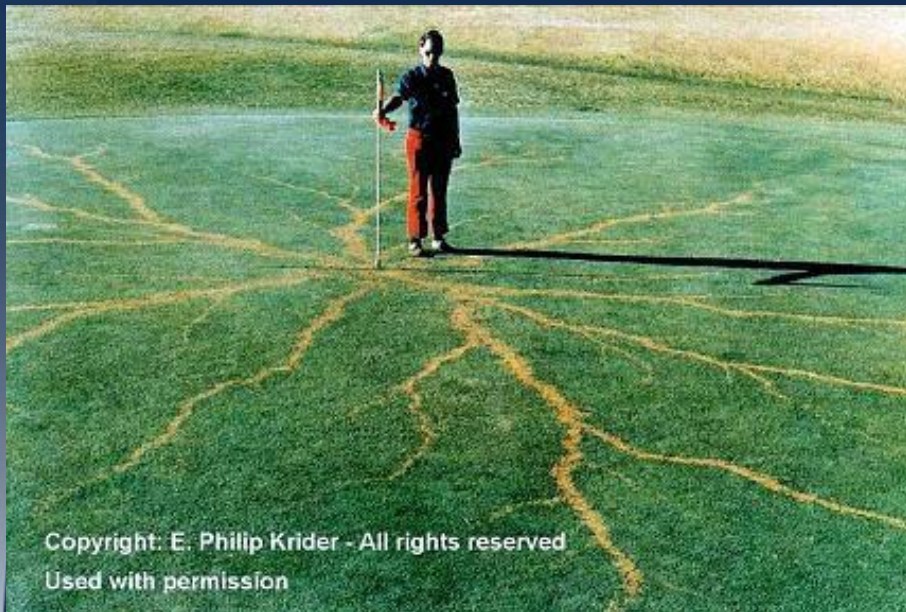
- Do not shelter in exposed buildings (pavilions, picnic shelters)
- Do not shelter in convertible vehicles
- Do not use electrical appliances
- Do not take a shower/bath
- *Rubber shoes will not protect you!*

Stuck Outside?

- Stay away from trees, cell phone towers, other tall objects
- Crouch while minimizing contact with the ground



Lightning: Why you should **never** stand under a tree!



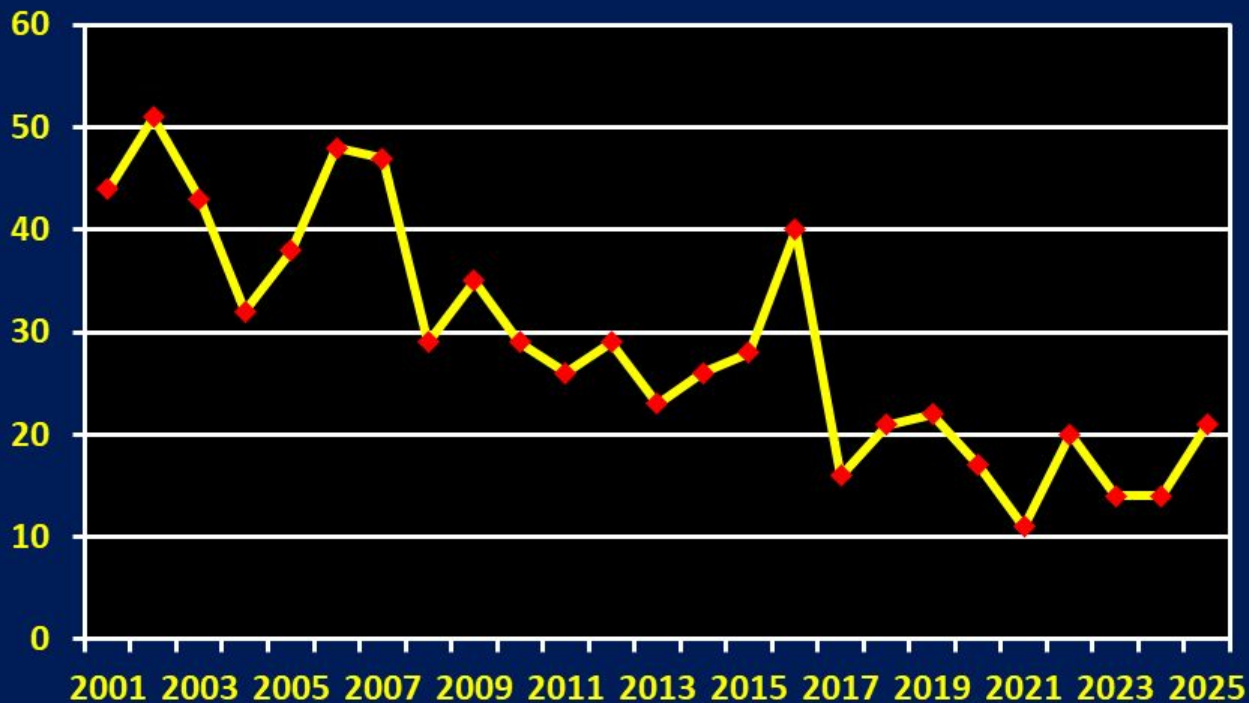
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Photo credit: Kelli Easterling | Richmond County Daily Journal
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Number of U.S. Lightning Fatalities 2001-2025



Compiled by John Jensenius
National Lightning Safety Council



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Hail

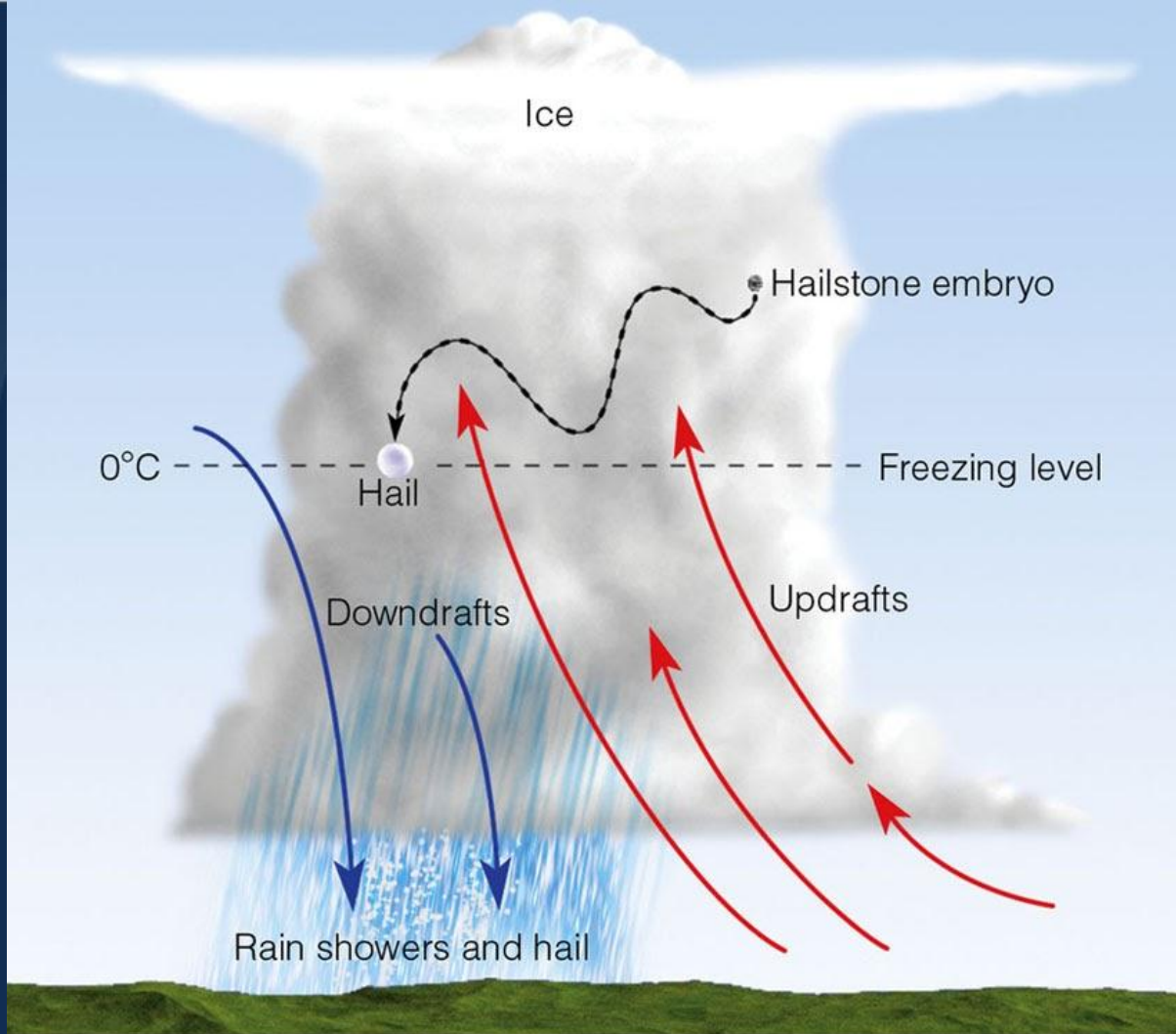
Hail

- Hail is the **costliest** form of severe weather
- Can be large and sporadic or small and accumulating

Ingredients for Hail Growth:

1. Embryos
2. Supercooled liquid water
3. Sufficiently strong updraft
4. Appropriate temperatures
5. Residence time
6. Optimal hail trajectories





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Hail Do's and Don'ts

Where to Go & What to Do

- Get inside a sturdy building
- Stay away from windows

Where NOT to Go & What NOT to DO

- Do not stand near windows
- Do not stay outside

Stuck Outside?

- Find shelter, cover your head

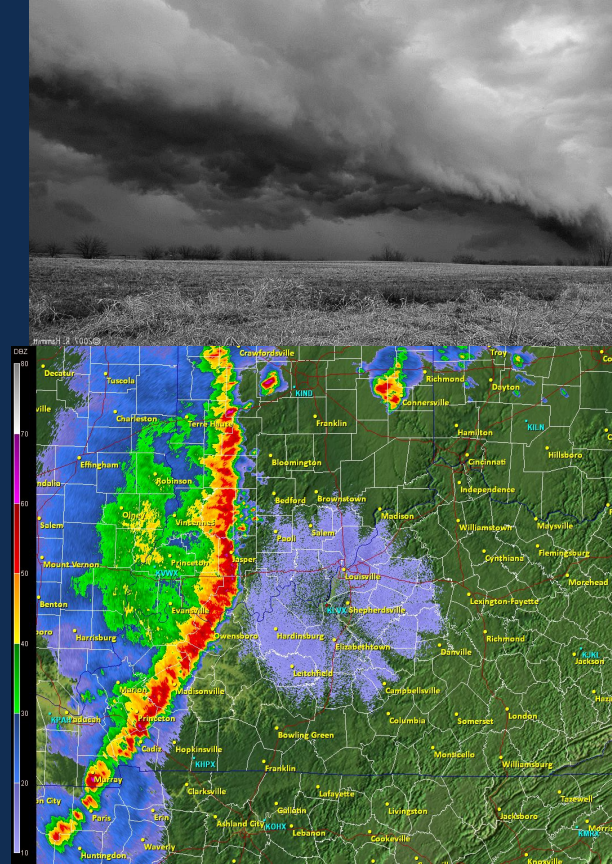




Wind

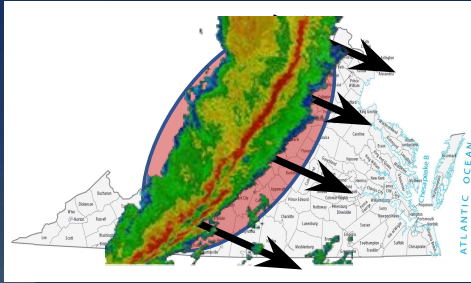
Straight Line Winds

- The most common type of wind damage we see here in the mid-Atlantic
- Result from a combination of the storm's forward motion, the transport of momentum from strong wind aloft, and the generation of storm-relative outflow as a downdraft descends to the ground
- Winds produce damage generally in a single direction, oriented parallel to the direction the storms were coming from
- Straight line winds may occur ahead of the actual "storm" at the leading edge (or gust front)



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Straight Line Winds



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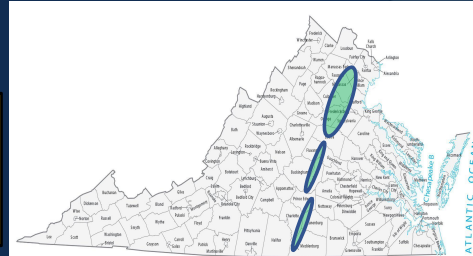


Storms moving at
35 mph due to
strong winds aloft

Downdraft-
Enhanced
Storm-Relative
Wind

=

Surface
wind gusts
of 65 mph



Straight Line Winds

Damage shows
a clear
**UNI-
DIRECTIONAL**
pattern



**STRAIGHT
LINE WIND
“footprint”**

Downbursts

Downburst

- Strong straight-line winds caused by an exceptionally strong downdraft, where cold, dense air descends from above, hits the ground, and spreads out at the surface
- Downburst winds can exceed 100 mph!
- **Microburst** – Downburst wind damage covering an area 2.5 miles or less
- **Macroburst** – Downburst wind damage covering an area more than 2.5 miles





Downburst

Damage shows
a clear
DIVERGING
pattern



DOWNBURST
“fingerprint”



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Wind

- **Straight-line** wind damage can be a result of a **microburst or macroburst** created by a very strong thunderstorm **downdraft**. These events can be **wet** or **dry**.
- **Microbursts** are small in size and only last 2 - 5 minutes
 - But, they can produce winds up to **168 mph!**
- **Macrobursts** are larger in size and can last 5 - 20 minutes
 - Can produce winds up to **130 mph**

This is equivalent to EF-3 scale tornado damage!



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Wind Do's and Don'ts

Where to Go & What to Do

- Seek shelter in a strong/stable building
- Stay away from windows and doors
- Stay to the interior of the building or go to the basement

Where NOT to Go & What NOT to DO

- Do not shelter in exposed buildings (pavilions, picnic shelters)
- Do not shelter in weak structures/buildings (barns/sheds)
- Do not stay near trees

Stuck Outside?

- Stay away from trees
- Seek shelter, but be cautious about unstable/exposed buildings
- Remain aware about the wind direction

A dramatic photograph of a tornado forming over a rural landscape. The sky is filled with dark, heavy storm clouds. A bright, white, funnel-shaped cloud descends from the center of the storm, tapering as it approaches the ground. In the foreground, there is a field of tall grass and a line of trees. A small house is visible among the trees. The word "Tornadoes" is written in large, white, serif font across the middle of the image.

Tornadoes

Tornadoes

- **Third most deadly** form of severe weather
- Most tornadoes are formed by **supercell thunderstorms**, but some can be formed by **mesoscale convective systems (MCSs)**
- Tornado formation requires that the **storm is rotating**

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

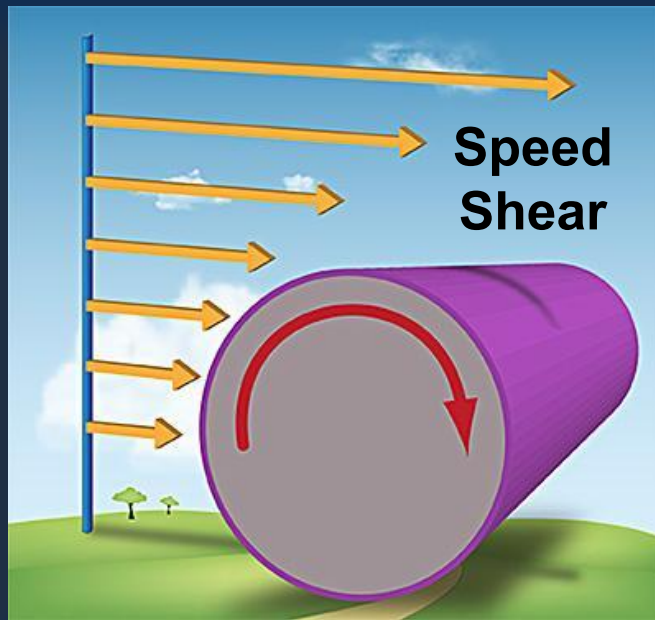


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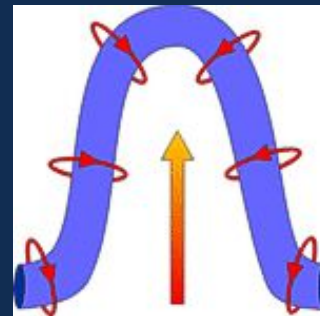
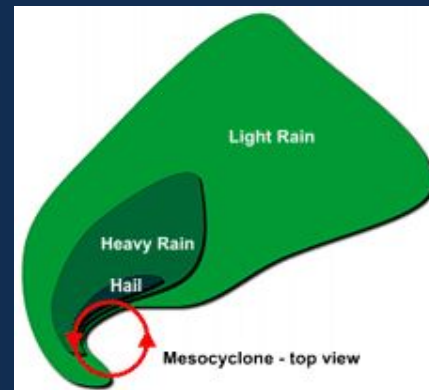
Tornado Formation



Wind **direction** changes with height



Wind **speed** changes with height



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Tornado

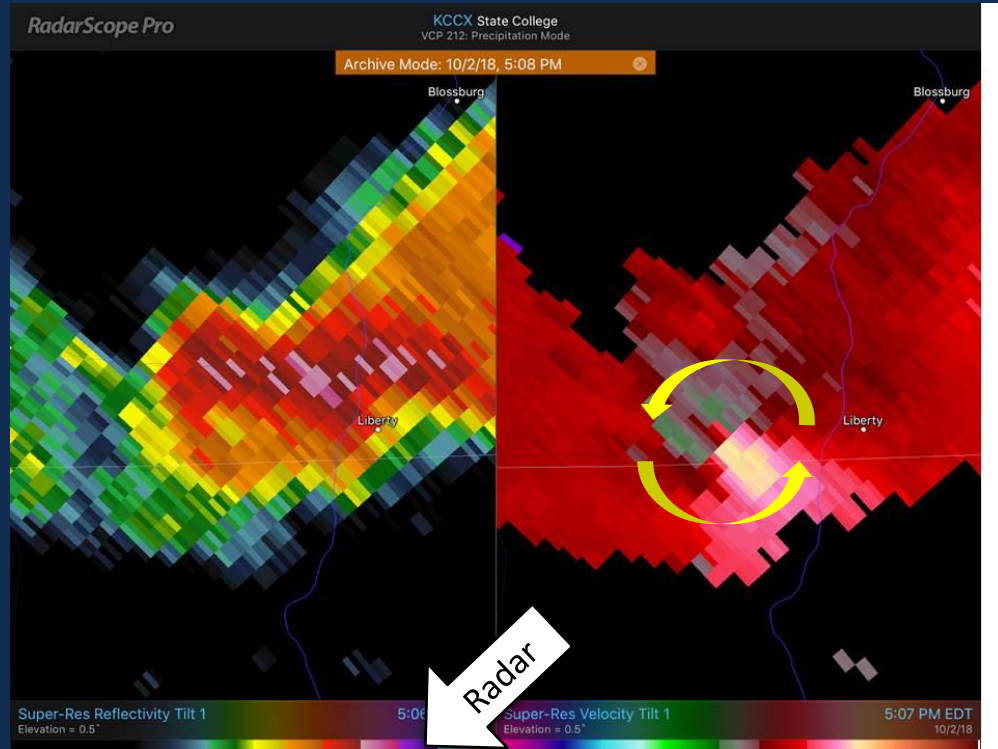
- A rapidly rotating column of air in contact with the ground, attached to the base of a thunderstorm or convective shower
- About 1 in 10,000 thunderstorms produce a tornado
 - Tornadoes usually produce a very small and defined area of damage (swath/path)
- **Remember:** The amount of damage does not indicate whether or not there was a tornado!



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A look at a Tornado on Doppler Radar

- When radar samples a tornadic thunderstorm, it typically samples a rapidly rotating mesocyclone, *not* the tornado vortex itself
- Rare exception: when a tornado passes very close to a radar



Tornado Damage



Damage shows a
clear
CRISS-CROSS
pattern of
convergence



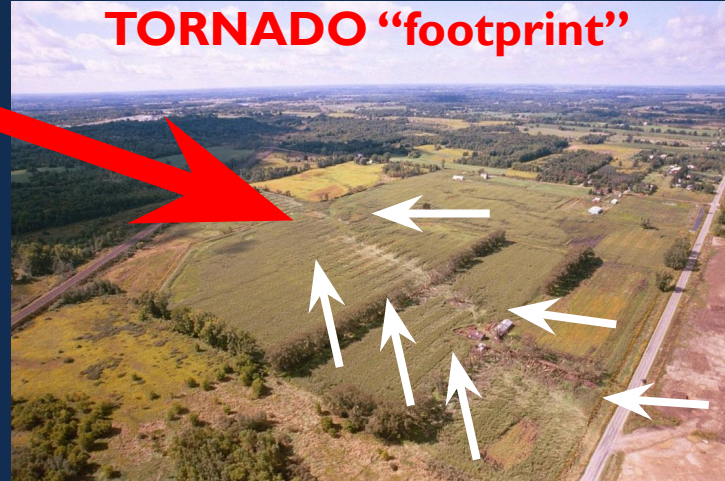
TORNADO
“footprint”

Tornado Damage

Damage shows a clear
CONVERGENT
pattern



TORNADO "footprint"



Damage shows a clear
CYCLONIC turning

TORNADO
"footprint"



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Tornado Do's and Don'ts

Where to Go & What to Do

- Always get to the lowest part of the building
- No basement? Get to an interior room such as a bathroom or closet
- Stay away from windows and doors
- Get under something sturdy or cover yourself with a mattress, blankets, or pillows

Where NOT to Go & What NOT to DO

- Do not hide under an overpass – they channel wind and debris
- Do not shelter near debris sources (cars, trees, etc.)
- Do not open the windows in your house
- Do not stand outside and watch the storm

Stuck Outside?

- If heavy rain and flooding is not a threat, lie in lowest spot available (ditch), face down, head covered
- Get away from debris sources





Flooding

August 2020 Chesterfield,
VA

Flooding

- Number one cause of death for severe weather

Turn Around, Don't Drown!

- As little as **6 inches** can sweep you off your feet
- As little as **1 foot** can sweep away a car
- If your car stalls, abandon it and head for higher ground
- Afterwards, avoid coming in contact with flood waters



Courtesy of Charles Rigdon

Flooding

- Severe thunderstorms that produce torrential downpours can cause flash flooding
- Slow moving, persistent rain showers over the span of several days can also cause flooding



Flooding Safety

Where to Go & What to Do

- Get to high ground, tall/stable building
- Turn around, don't drown if driving
- Avoid flood waters

Where NOT to Go & What NOT to DO

- Do not go towards floodwaters
- Do not drive on flooded pavement
- Do not drive over bridges





Extreme Heat

Extreme Heat

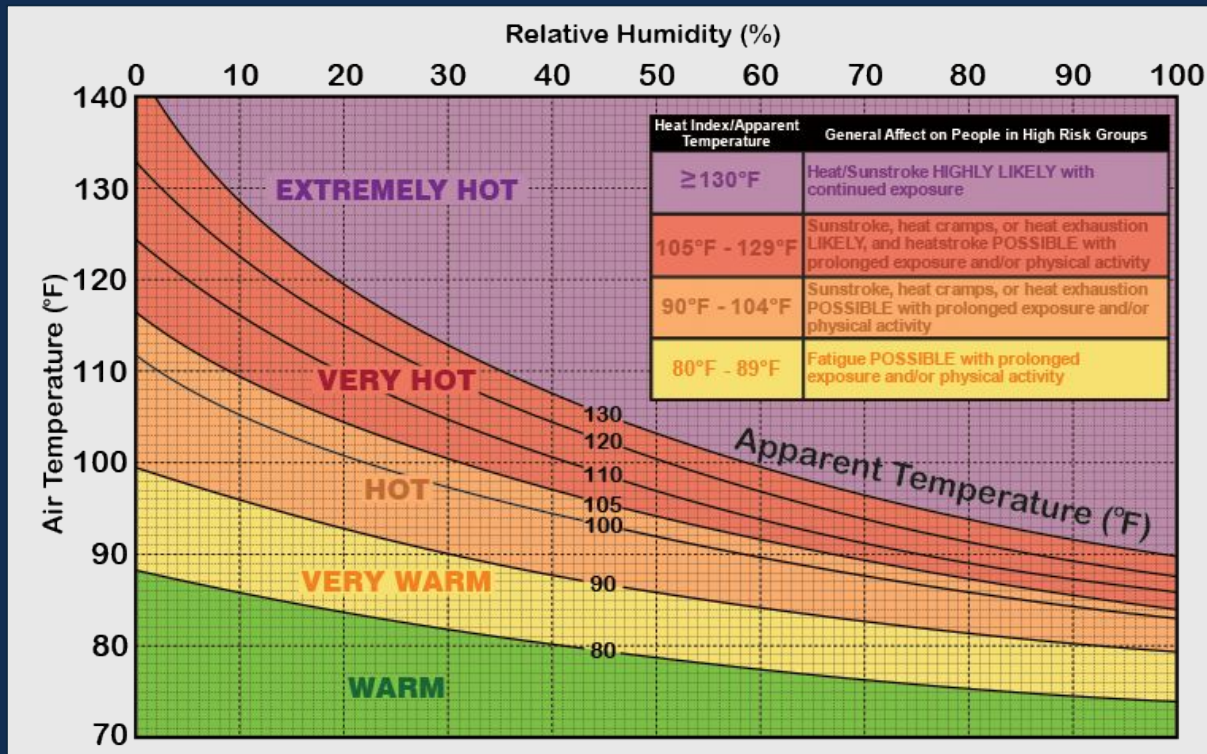
- Extreme heat is made worse by high humidity levels (heat index)
- High temperatures and high humidity combine to make uncomfortable and potentially dangerous heat indices

What to do in Extreme Heat

- Stay hydrated
- Wear sunscreen
- Dress in light-colored and loose clothing
- Seek shade
- Reduce physical activity



Extreme Heat: Heat Index



Extreme Heat: **W**et **B**ulb **G**lobe **T**emp (WBGT)

- Product that accounts for heat impacts when combining effects of the temperature + humidity + sun + wind

Suggested Actions and Impact Prevention		
WBGT(F)	Effects	Precautionary Actions
< 80		
80-85	Working or exercising in direct sunlight will stress your body after 45 minutes.	Take at least 15 minutes of breaks each hour if working or exercising in direct sunlight
85-88	Working or exercising in direct sunlight will stress your body after 30 minutes.	Take at least 30 minutes of breaks each hour if working or exercising in direct sunlight
88-90	Working or exercising in direct sunlight will stress your body after 20 minutes.	Take at least 40 minutes of breaks each hour if working or exercising in direct sunlight
>90	Working or exercising in direct sunlight will stress your body after 15 minutes.	Take at least 45 minutes of breaks each hour if working or exercising in direct sunlight

WBGT vs Heat Index



	WBGT	HEAT INDEX
Measured in the sun	●	●
Measured in the shade	●	●
Uses temperature	●	●
Uses relative humidity	●	●
Uses wind	●	●
Uses cloud cover	●	●
Uses sun angle	●	●



solar radiation



temperature



relative humidity



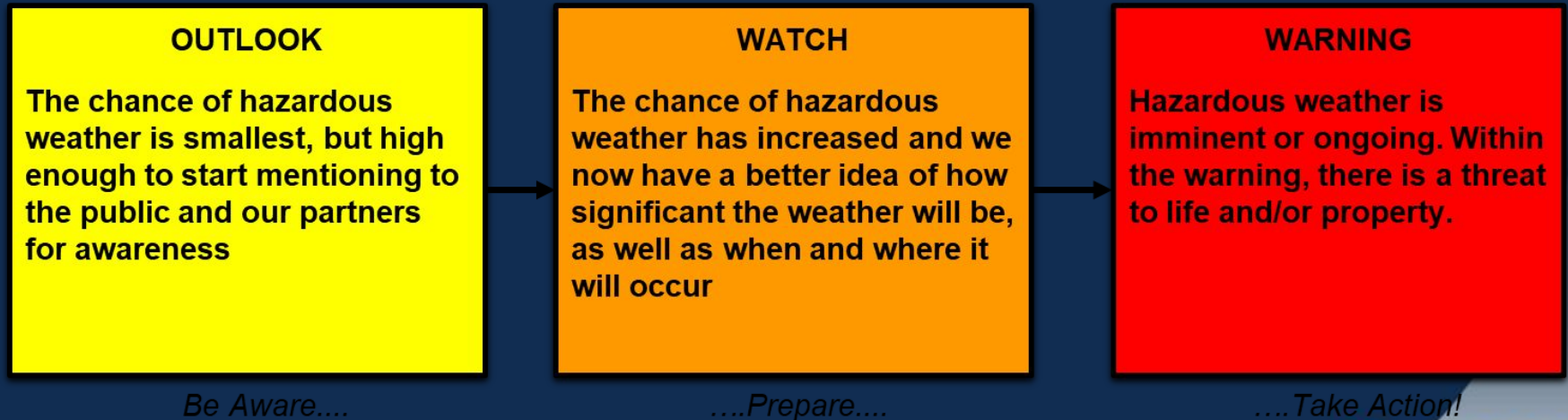
wind speed



Products and Services

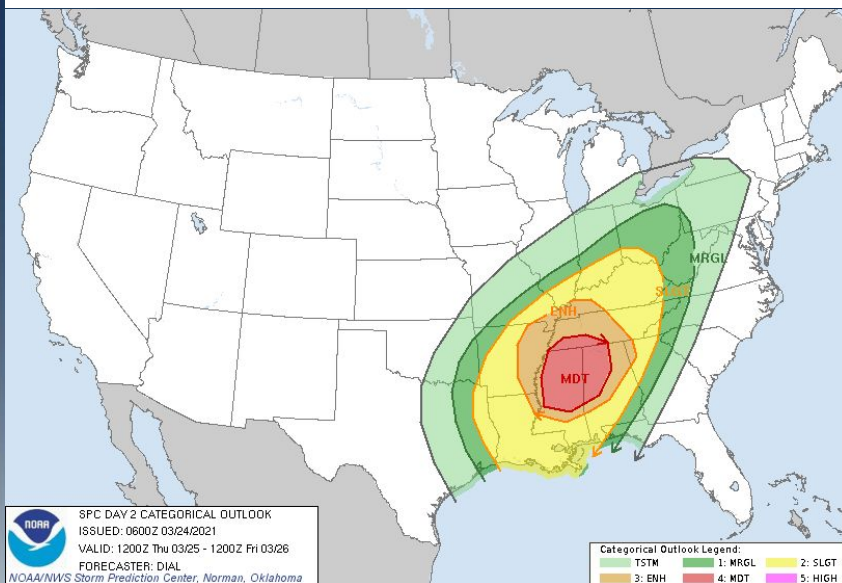
Severe Weather Outlooks

The NWS uses a variety of products to convey potential weather threats. As time passes and an event grows nearer and more certain, the type of NWS product changes



Severe Weather Outlooks

[SPC.NOAA.GOV](https://www.spc.noaa.gov) Convective Outlook



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 <u>all</u> 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
- Winds to 40 mph - Small hail	- Winds 40-60 mph - Hail up to 1" - Low tornado risk	- One or two tornadoes - Reports of strong winds/wind damage - Hail ~1", isolated 2"	- A few tornadoes - Several reports of wind damage - Damaging hail, 1 - 2"	- Strong tornadoes - Widespread wind damage - Destructive hail, 2" +	- Tornado outbreak - Derecho

* 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

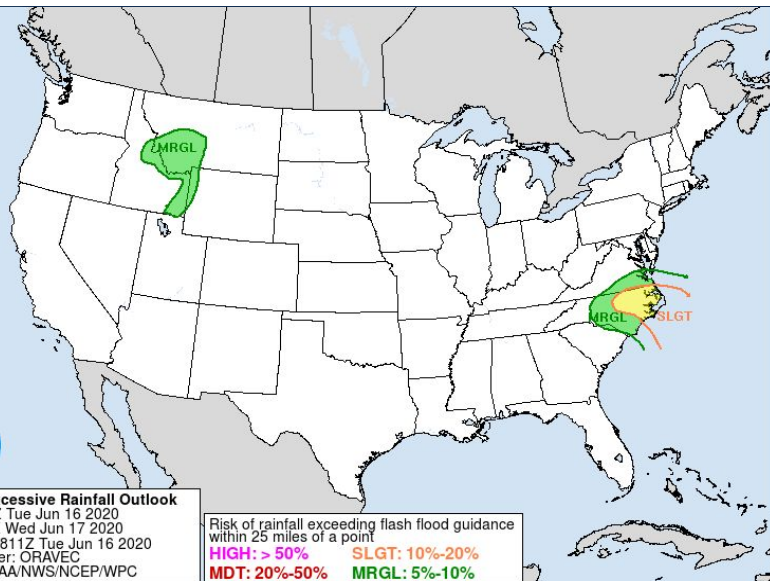
www.spc.noaa.gov



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Flash Flood Outlooks

WPC.NCEP.NOAA.GOV Excessive Rainfall Outlook

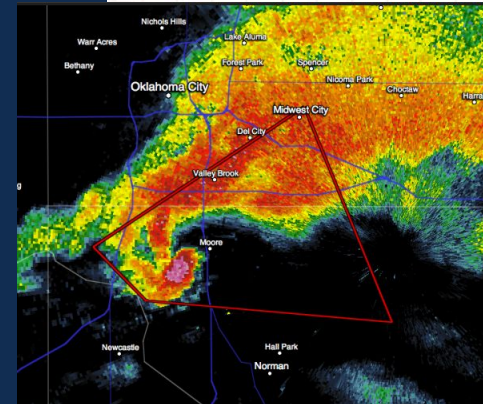
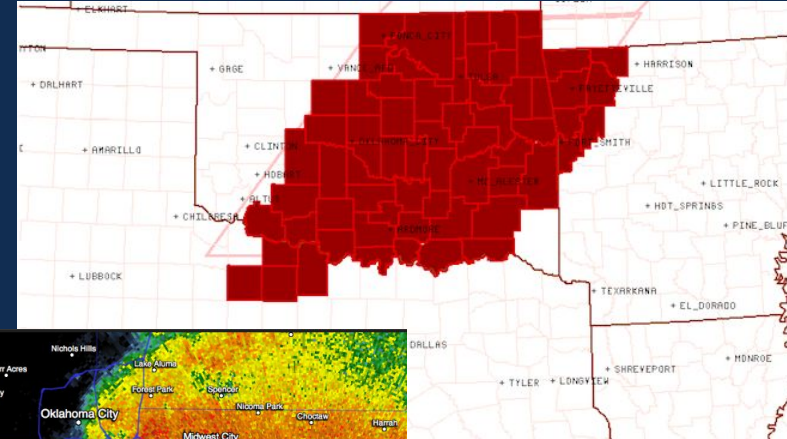


Understanding WPC Excessive Rainfall Risk Categories

No Area/Label	MARGINAL (MRGL)	SLIGHT (SLGT)	MODERATE (MDT)	HIGH (HIGH)
Flash floods are generally not expected.	Isolated flash floods possible	Scattered flash floods possible	Numerous flash floods likely	Widespread flash floods expected
www.wpc.ncep.noaa.gov @NWSWPC	Localized and primarily affecting places that can experience rapid runoff with heavy rainfall.	Mainly localized. Most vulnerable are urban areas, roads, small streams and washes. Isolated significant flash floods possible.	Numerous flash flooding events with significant events possible. Many streams may flood, potentially affecting larger rivers.	Severe, widespread flash flooding. Areas that don't normally experience flash flooding, could. Lives and property in greater danger.
Flash flooding near me?	Flash Flooding	Flash Flooding	Flash Flooding	Flash Flooding
NO Flash Flooding	Flash Flooding	Flash Flooding	Flash Flooding	Flash Flooding
 				
WEATHER PREDICTION CENTER				

Watches versus Warnings

- **Watch:** weather conditions are favorable for phenomenon to occur
 - Be alert to worsening conditions
 - Know how and where to take shelter
- **Warning:** phenomenon has been visually confirmed or indicated by weather radar
 - Act immediately



Product Guide - Watch

WATCH COUNTY NOTIFICATION FOR WATCH 653
NATIONAL WEATHER SERVICE WAKEFIELD VA
205 PM EDT FRI SEP 4 2026

VAC007-025-033-036-041-049-053-057-065-073-075-081-085-087-093-
095-097-101-103-109-111-115-117-119-127-133-135-145-147-149-159-
175-181-183-193-199-550-570-595-620-650-670-700-710-730-735-740-
760-800-810-830-050100-
/O.NEW.KAQ.SV.A.0653.260904T1805Z-260905T0100Z/

THE NATIONAL WEATHER SERVICE HAS ISSUED SEVERE THUNDERSTORM WATCH
653 IN EFFECT UNTIL 9 PM EDT THIS EVENING FOR THE FOLLOWING AREAS

IN VIRGINIA THIS WATCH INCLUDES 51 COUNTIES

IN CENTRAL VIRGINIA

AMELIA	CHESTERFIELD	
CITY OF COLONIAL HEIGHTS		CITY OF RICHMOND
CUMBERLAND	FLUVANNA	GOOCHLAND
HANOVER	HENRICO	LOUISA
POMHATAN	PRINCE EDWARD	

IN EAST CENTRAL VIRGINIA

CHARLES CITY	ESSEX	KING WILLIAM
KING AND QUEEN	NEW KENT	RICHMOND
WESTMORELAND		

IN EASTERN VIRGINIA

LANCASTER	MATHEWS	MIDDLESEX
NORTHUMBERLAND		

IN NORTH CENTRAL VIRGINIA

CAROLINE

IN SOUTH CENTRAL VIRGINIA

BRUNSWICK	CITY OF HOPEWELL	CITY OF PETERSBURG
DINKIDDIE	LUNENBURG	MECKLENBURG
NOTTOWAY	PRINCE GEORGE	

IN SOUTHEAST VIRGINIA

CITY OF CHESAPEAKE	CITY OF EMPORIA	CITY OF FRANKLIN
CITY OF HAMPTON	CITY OF NEWPORT NEWS	CITY OF NORFOLK
CITY OF POQUOSON	CITY OF PORTSMOUTH	CITY OF SUFFOLK
CITY OF VIRGINIA BEACH		CITY OF WILLIAMSBURG
GLOUCESTER	GREENSVILLE	ISLE OF WIGHT
JAMES CITY	SOUTHAMPTON	SURRY
SUSSEX	YORK	

Severe Thunderstorm Watch

Valid Until
9:00 PM EDT Friday
September 4, 2026

Threat Information



TORNADOES

A Couple Tornadoes
Possible



HAIL

Isolated Hail Up To
Ping Pong Size Possible



WIND

Scattered Gusts
Up To 70 MPH Likely

Potential Exposure



Population: 13,862,061
Schools: 3837
Hospitals: 230



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Product Guide - Warning

BULLETIN - IMMEDIATE BROADCAST REQUESTED

Severe Thunderstorm Warning
National Weather Service Wakefield VA
511 PM EDT Fri Sep 4 2026

The National Weather Service in Wakefield has issued a

* Severe Thunderstorm Warning for...
The City of Richmond in central Virginia...
Northern Henrico County in central Virginia...
Southern Hanover County in central Virginia...

* Until 600 PM EDT.

* At 510 PM EDT, a severe thunderstorm was located over Randolph
Macon College, moving southeast at 25 mph.

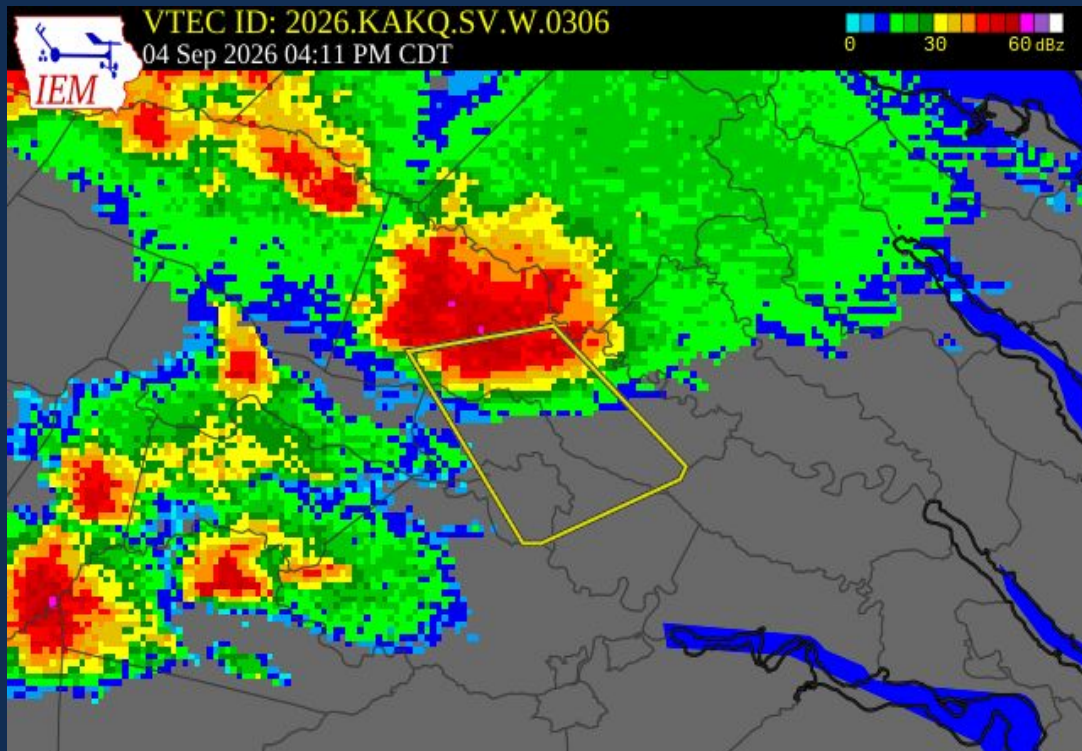
HAZARD...70 mph wind gusts and quarter size hail.

SOURCE...Radar indicated.

IMPACT...Minor damage to vehicles is possible. Expect considerable
tree damage. Wind damage is also likely to mobile homes,
roofs, and outbuildings.

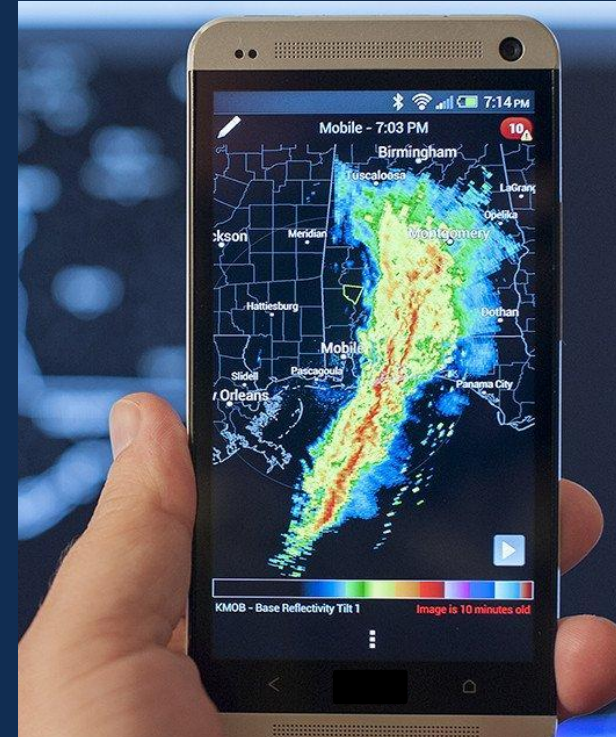
* This severe thunderstorm will be near...
Ashland, Laurel, and Glen Allen around 515 PM EDT.
Mechanicsville and Lakeside around 520 PM EDT.
Richmond and East Highland Park around 525 PM EDT.
Virginia Union University and Highland Springs around 535 PM EDT.

Other locations impacted by this severe thunderstorm include Fair
Oaks, Solomons Store, Chamberlayne, Atlee, Ashcake, Greendale,
Hanover Airport, Dumbarton, Elmont, and Montrose.



Severe Weather: Stay Weather-Aware!

- Have a way to receive warnings
 - NOAA weather radio
 - Phone/app/etc.
- Useful apps if you have a smartphone ...
 - FEMA
 - Put in your location to **receive automatic warnings** and important messages
 - mobile.weather.gov
 - Search your location for the weather forecast and other important updates
 - Radar apps
 - View real-time radar information and warnings



Be a Weather-Ready Nation Ambassador!

What is a Weather-Ready Nation Ambassador? An organization that ...

- Promotes Weather-Ready Nation messages and themes to their stakeholders
- Engage with NOAA personnel on potential collaboration opportunities
- Serves as an example by educating employees on workplace preparedness

How to become an Ambassador

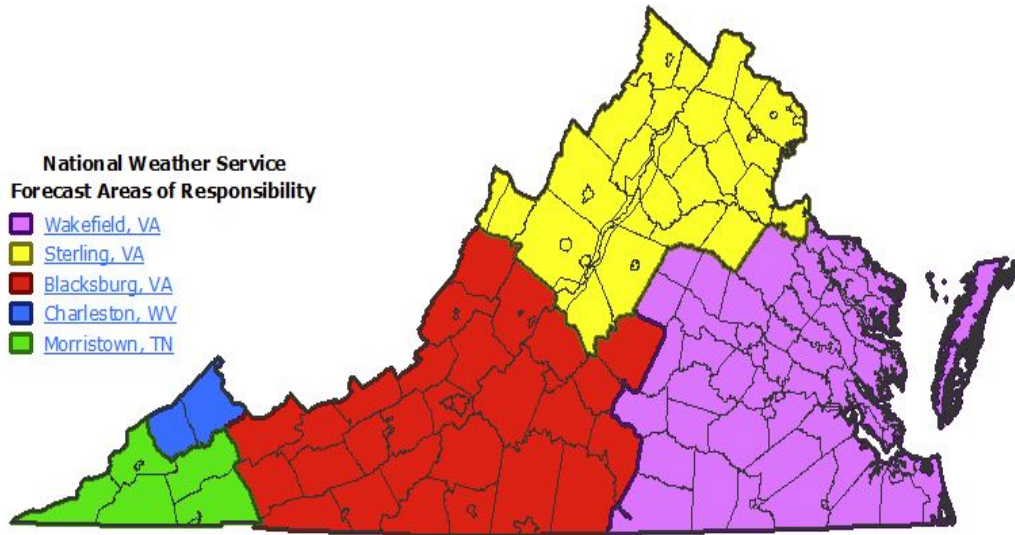
- Visit: <https://www.weather.gov/wrn/amb-tou>

What are the expectations if you are an Ambassador?

- Set an example by becoming “weather-ready” yourself (e.g., making employee preparedness a priority and having a disaster plan)
- Promote Weather-Ready Nation key messages in your outreach activities
- Provide incentives to your constituents and stakeholders to become more resilient
- Share success stories with NOAA



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