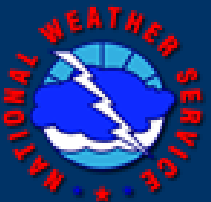




# Taking SKYWARN to the Next Level: An Advanced Weather & Storm Spotting Course

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National Weather Service – Columbia, SC  
[douglas.anderson@noaa.gov](mailto:douglas.anderson@noaa.gov)





# Course Information

## ☂ Purpose –

- ☂ To *expand* upon material presented in the basic SKYWARN course

## ☂ General Outline –

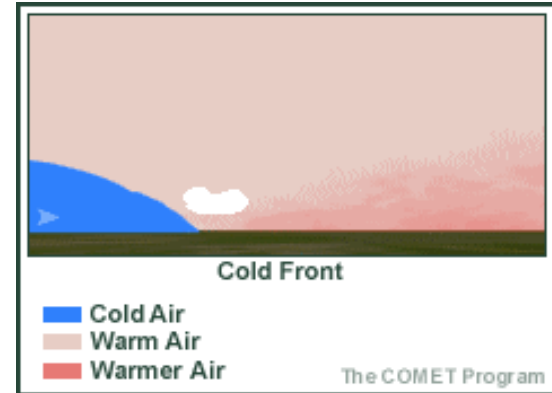
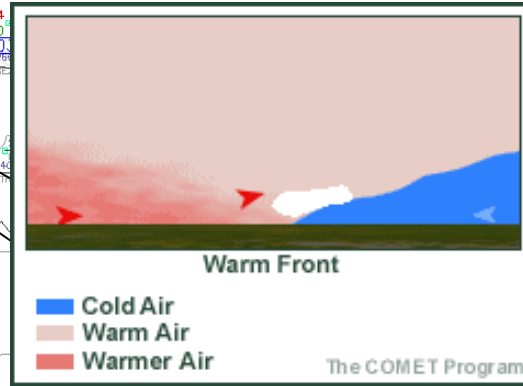
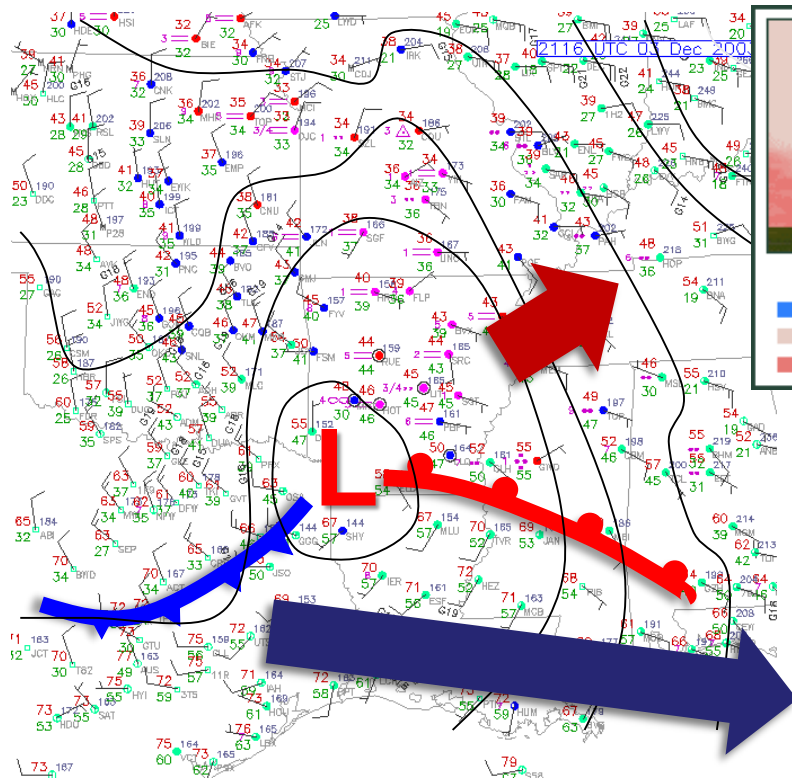
- ☂ Understanding the Atmosphere
- ☂ Severe Weather Ingredients
- ☂ Radar Principles, Advantages and Limitations
- ☂ Radar and Storm Structure
  - ☂ Review of Impact-Based Warnings
- ☂ Reporting Procedures



# Importance of Spotters

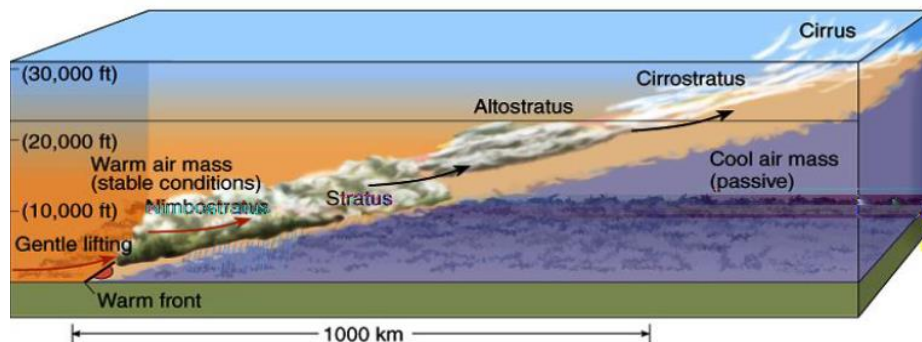
- ☀️ **Provide “Ground Truth”**
  - ☀️ Our “eyes” out there!
- ☀️ **Detailed storm reports can...**
  - ☀️ Add value to existing/new warnings
  - ☀️ Verify warnings
- ☀️ **Can assist with post-storm analysis, research and training**
- ☀️ **Can mitigate limitations with radar coverage**

# The 3-D Atmosphere

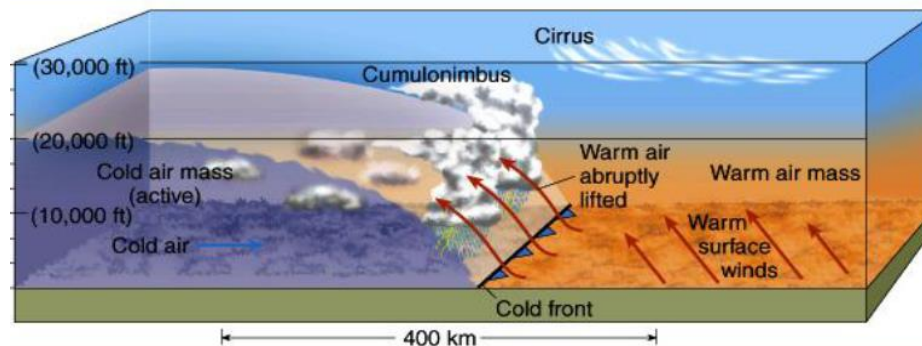




# The 3-D Atmosphere



Warm Front



Cold Front

# Ingredients

## Thunderstorm Development

- ☙ Moisture
- ☙ Trigger / Lift
- ☙ Instability

### Determining Factors:

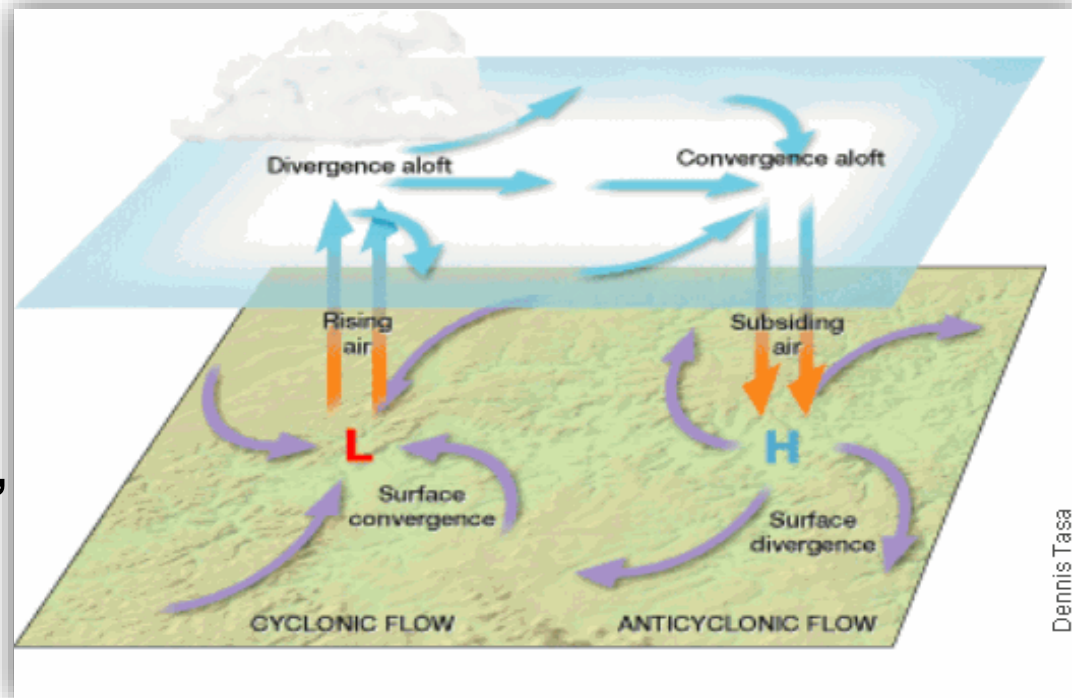
- ☙ **Instability**
- ☙ **Wind Shear**



# What is Stability?

☞ The degree to which vertical motion in the atmosphere is enhanced or suppressed

☞ Depending on the vertical temperature profile of the atmosphere, air will: rise, sink, remain at rest





# Three Types of Stability

## ✧ **Unstable Atmosphere**

- ✧ Enhances or encourages vertical movement of air

## ✧ **Stable Atmosphere**

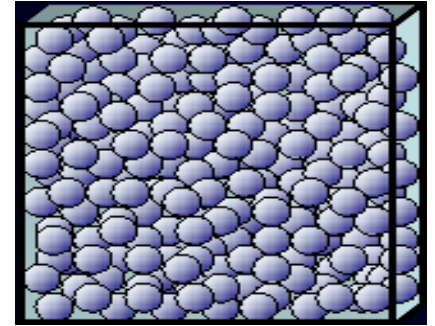
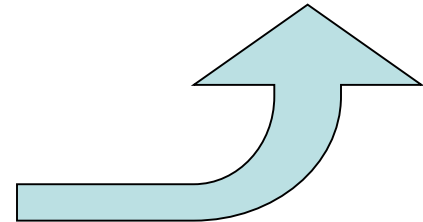
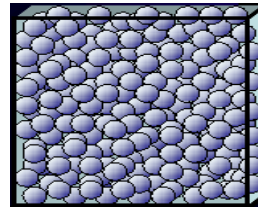
- ✧ Suppress or resists vertical movement of air

## ✧ **Neutral Atmosphere**

- ✧ Neither suppresses nor enhances vertical movement of air

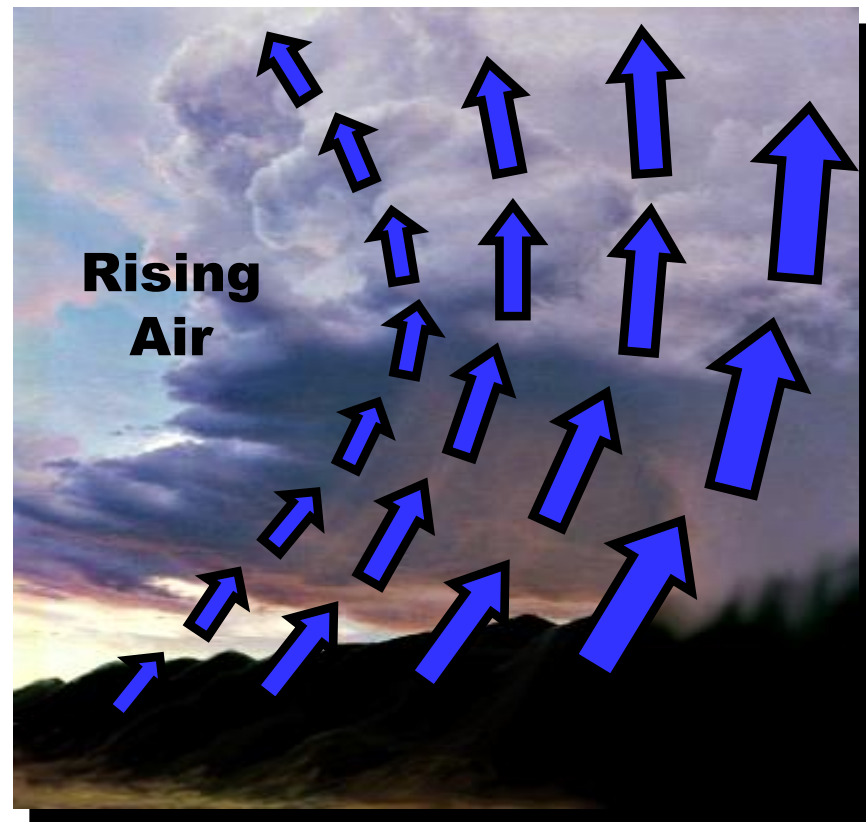
# Unstable Atmosphere

- ✧ Air parcels will continue to rise



# Unstable Atmosphere

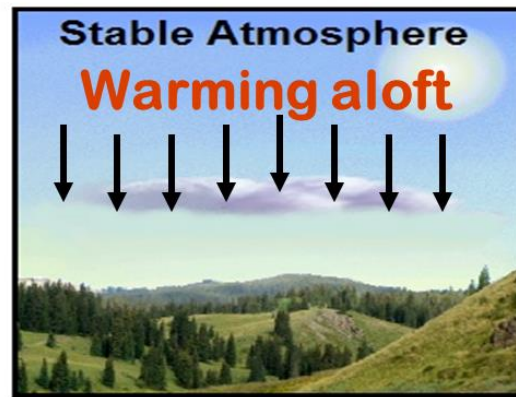
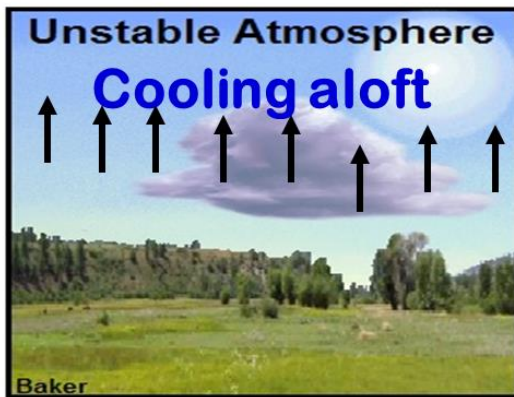
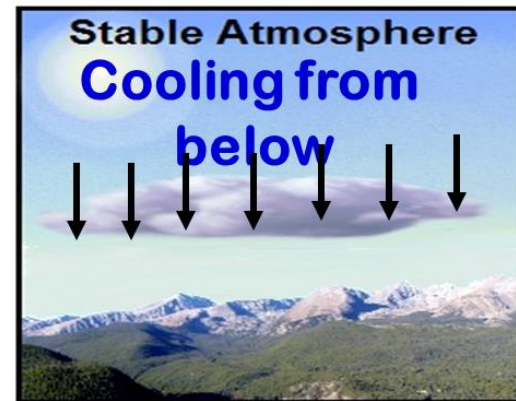
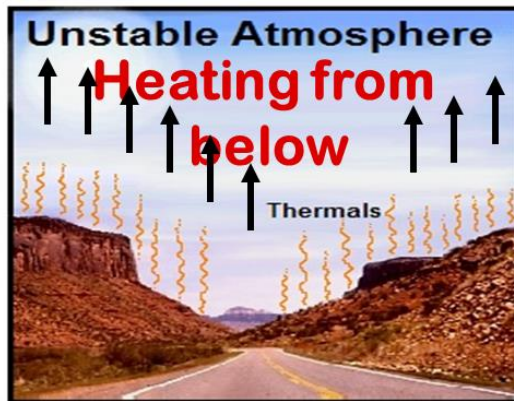
- ✧ Promotes the formation and growth of vertically developed clouds, thunderstorms and tall smoke columns





# Atmospheric Stability

- 4 ways to change atmospheric stability

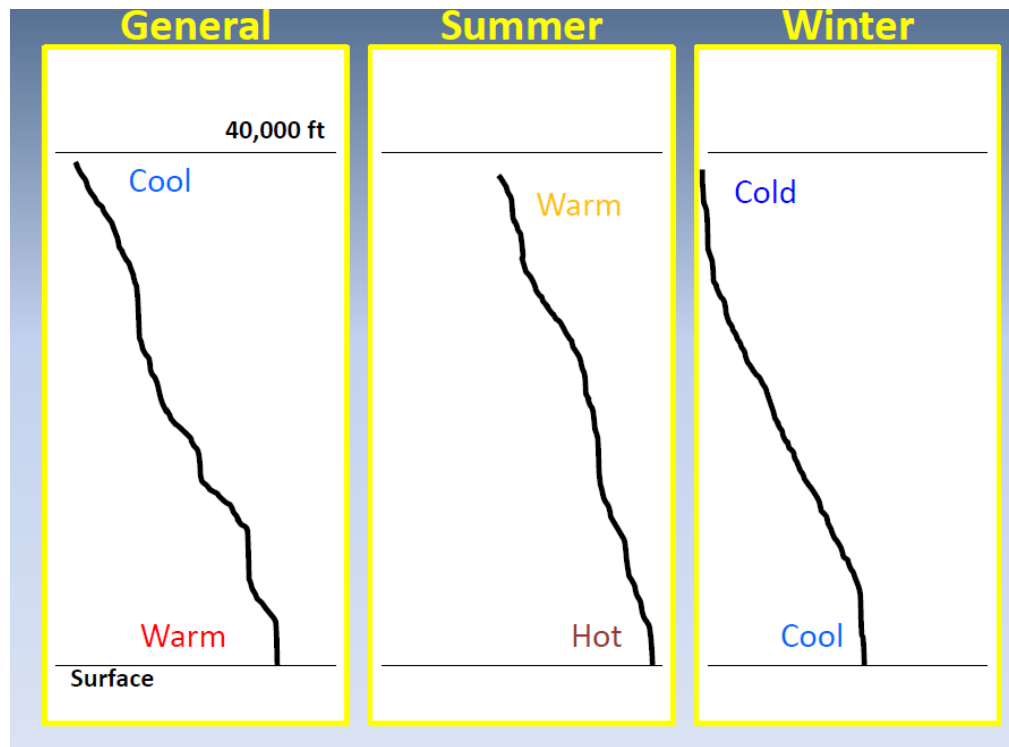




# Temperature Lapse Rates


## Change in Temperature Change in Altitude

✦ **Instability** is based upon how warm it is at the surface vs. how cold it is aloft



# Obtaining Sounding Data

<https://www.spc.noaa.gov/exper/soundings>



NOAA's National Weather Service

Storm Prediction Center

Site Map

News

Local forecast by "City, St" or "ZIP"  
City:  St:  ZIP:  Go

Facebook

SPC on Facebook

@NWS\_SPC

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Storm Reports

Storm Reports Dev.

NWS Hazards Map

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About the SPC

SPC FAQ

About Tornadoes

About Derechos

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Enh. Fujita Page

Our History

Public Tours

Observed Sounding Archive

This page shows current and recent observed radiosonde data in skew-T format. An archive of seven days of data will always be available. The images are created using a sounding analysis program called NSHARP. Sounding data will flow to this site as early as HH:30 after the hour, and will also re-run old hours to fill in late data.

NOTE: This data is experimental and may not always be available in a timely fashion.

Contacts for this resource: John Hart and Rich Thompson

NEW!! - Sounding Help Page Available

Today - Wednesday May 08, 2019

05/08/2019 1600 UTC

05/08/2019 1500 UTC

05/08/2019 1400 UTC

05/08/2019 1200 UTC

05/08/2019 1100 UTC

05/08/2019 1000 UTC

05/08/2019 0300 UTC

05/08/2019 0000 UTC

Tuesday May 07, 2019

05/07/2019 2200 UTC - OBS

05/07/2019 2100 UTC - OBS

05/07/2019 2000 UTC - OBS

05/07/2019 1800 UTC - OBS

05/07/2019 1700 UTC - OBS

05/07/2019 1600 UTC - OBS

05/07/2019 1500 UTC - OBS


05/07/2019 1400 UTC - OBS

National Weather Service • Since 1870

Sounding Analysis Page

NWS / Storm Prediction Center  
Norman, Oklahoma

Observed Radiosonde Data  
05/08/2019 12 UTC

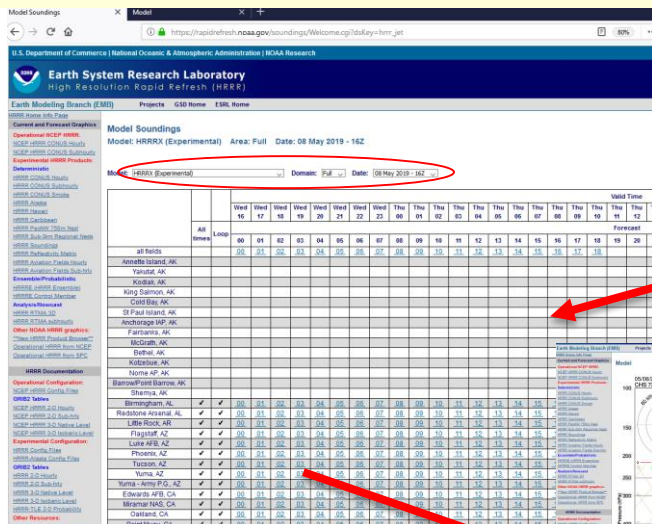


Choose another date/time period

NWS Columbia

# Forecast Model Soundings

<https://rapidrefresh.noaa.gov/hrrr/>



High-Resolution Rapid Refresh (HRRR) X

<https://rapidrefresh.noaa.gov/hrrr/>

U.S. Department of Commerce | National Oceanic & Atmospheric Administration | NOAA Research

**Earth System Research Laboratory**  
High Resolution Rapid Refresh (HRRR)

Earth Modeling Branch (EMB) Projects GSD Home ESRL Home

HRRR Home Info Page

**Current and Forecast Graphics**

- Operational HRRRv2
- NCEP HRRRv3
- NCEP HRRRv3 Subhourly
- Experimental HRRRv3 Products:
- Deterministic
- HRRR CONUS Hourly
- HRRR CONUS Subhourly
- HRRR CONUS Smoke
- HRRR Alaska
- HRRR Hawaii
- HRRR Caribbean
- HRRR PacNW 750m Nest
- HRRR Sub-3km RAS
- HRRR Reflectivity Matrix
- HRRR Aviation Fields Hourly
- Ensemble Probabilities
- HRRR (HRRR Ensemble)
- HRRR Control Member
- Analysis/Nowcast
- HRRR RTMA 3D
- HRRR RTMA subhourly
- Other NOAA HRRR graphics:
- "New HRRR Product Browser"
- Additional HRRR from NCEP
- Additional HRRR from SPC
- HRRR Documentation
- Additional Configuration:
- 3 HRRR Config Files
- 2 Tables
- 3 HRRR 2-D Hourly
- 3 HRRR 2-D Sub-hrly

**The High-Resolution Rapid Refresh (HRRR)**

The HRRR is a NOAA real-time 3-km resolution, hourly updated, cloud-resolving, convection-allowing atmospheric model, initialized by 3km grids with 3km radar data assimilation. The model is run at 3km resolution with 3km radar data assimilation. The model is run at 3km resolution with 3km radar data assimilation. The model is run at 3km resolution with 3km radar data assimilation.

HRRR implementations at NCEP

- HRRRv1 - 30 Sept 2014
- HRRRv2 - 23 Aug 2016
- HRRRv3 - 12 July 2018

HRRR Colorado Labs Award video - a 2-minute layperson-level description on the HRRR from late 2015 and why it is important. (October 2015)

The experimental version HRRRv3 of the HRRR model has been run in real-time at NOAA/ESRL since April 2017. HRRRv3/RAPv4 description and testing - June 2017.

Key features:

- improved mesoscale environment for convective storms and clouds.
- Less high precip bias for warm-season and cold-season precipitation
- Improved 2m temps in winter including over snow cover.
- Extension to 36h every 6h.
- Addition of Alaska domain for HRRR

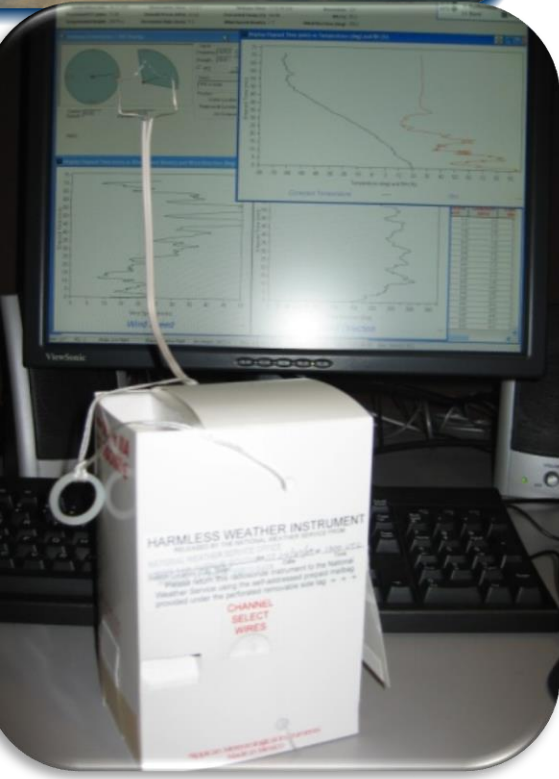
HRRR Ensemble (HRRRv3) prediction - documentation as of May 2018

The operational version of the HRRR (currently HRRRv2) was implemented at NCEP 23 Aug 2016. NOAA/NWS Technical Information Notice (TIN) on RAPv4

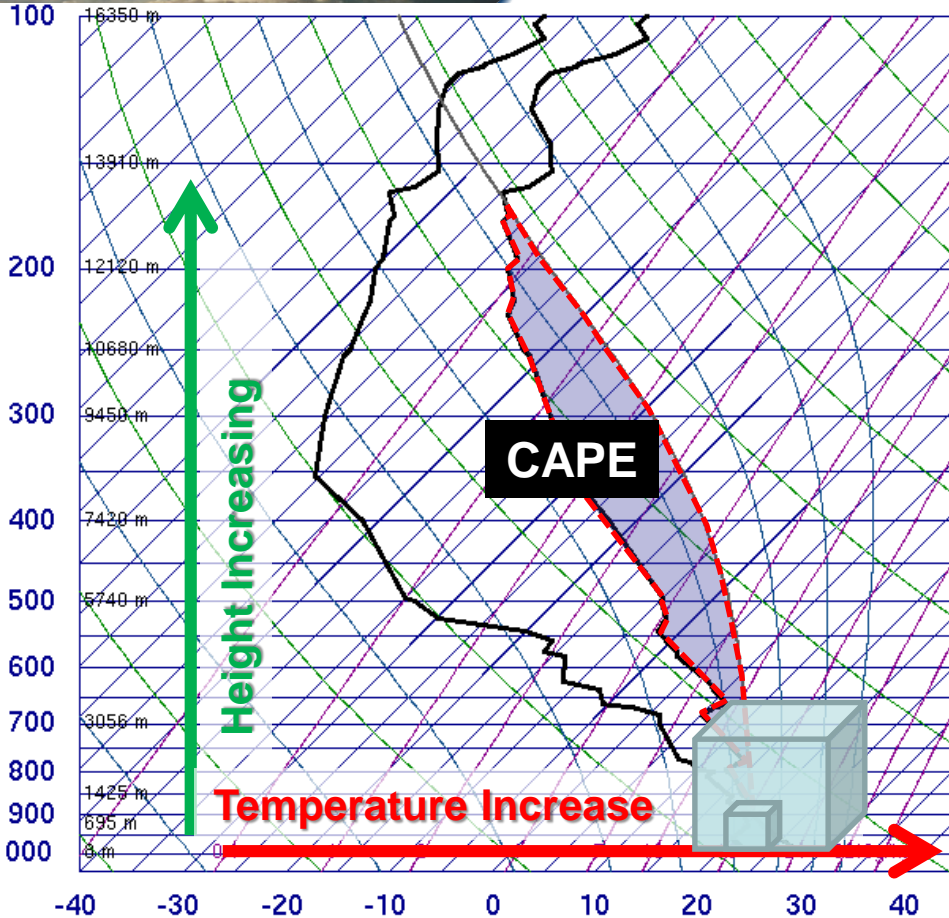
The experimental HRRR is run by NOAA/ESRL/GSD as a real-time demonstration of advanced versions of the HRRR, ahead of the NCEP operational version than the NCEP operational version but with slightly lower reliability. Usually yearly upgrades are made at ESRL.



# Measuring Stability



# Instability



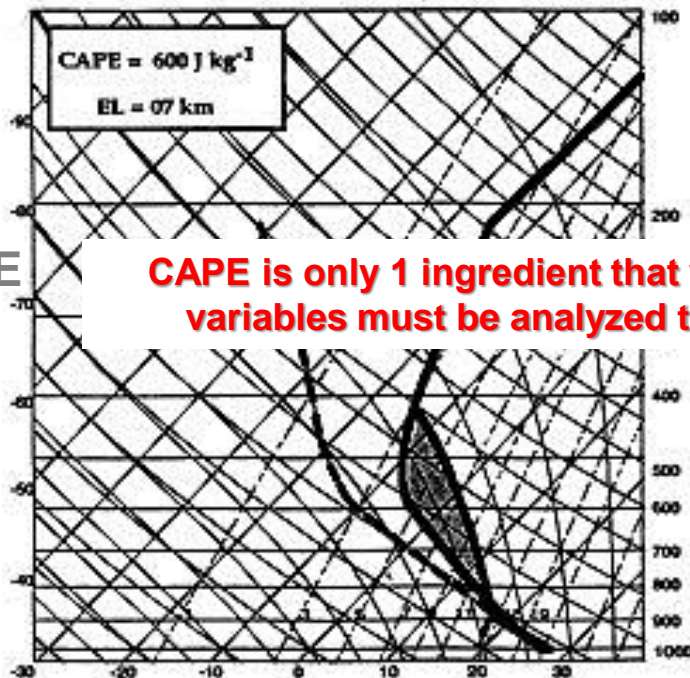
**CAPE** stands for the:  
**C**onvective  
**A**vailable  
**P**otential  
**E**nergy

- Depending on what type of CAPE exists (tall, short, skinny, fat) will determine the type and amount of thunderstorms that are possible (potential).



# High CAPE vs. Low CAPE

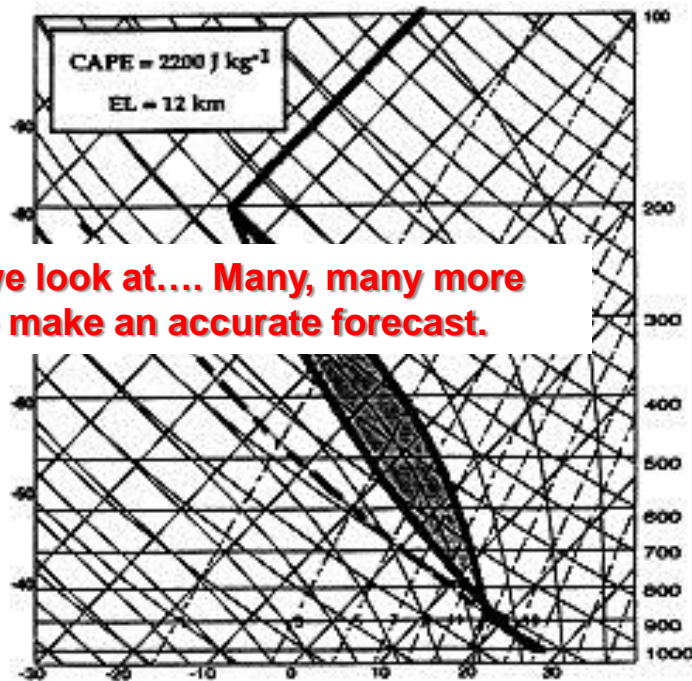
Low CAPE



**CAPE is only 1 ingredient that we look at.... Many, many more variables must be analyzed to make an accurate forecast.**

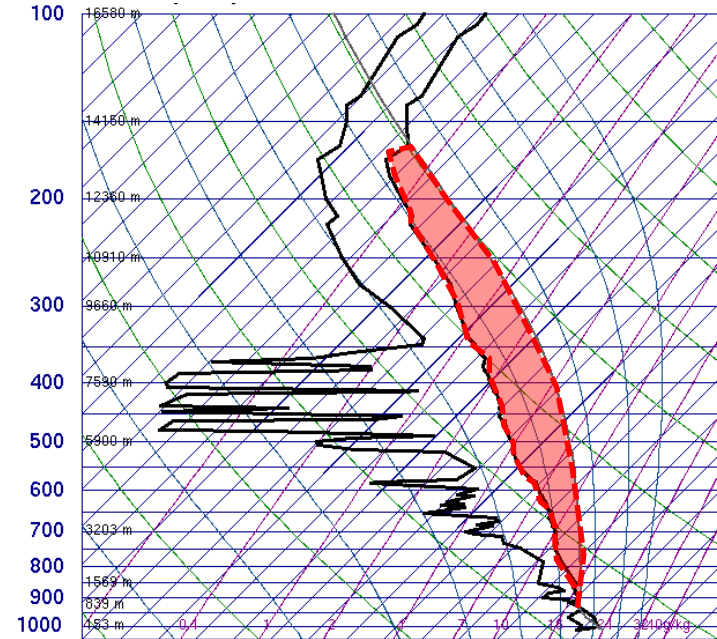
- Low storm potential
- Weak lapse rate

High CAPE



- Higher storm potential
- Steep lapse rate

# CAPE and Thunderstorms

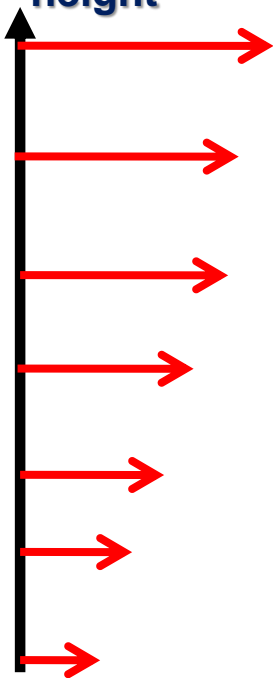




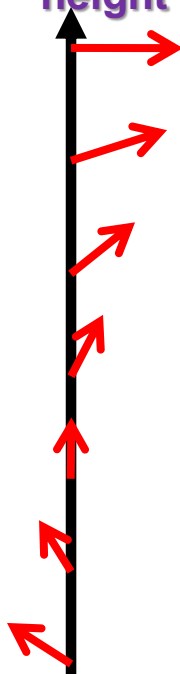
# Wind Shear: What is it?

Change in wind  
speed with  
height

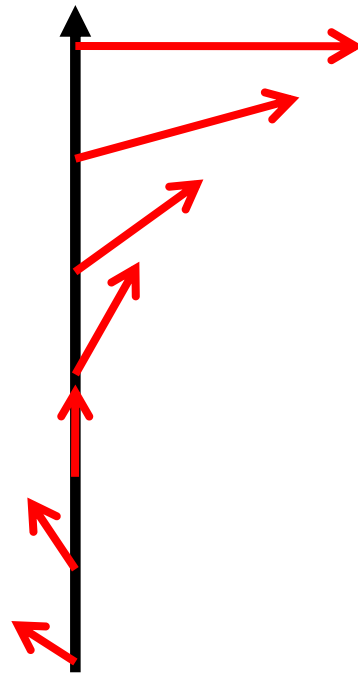
Increasing Height



Change in wind  
direction with  
height



Change in wind speed  
and direction with height

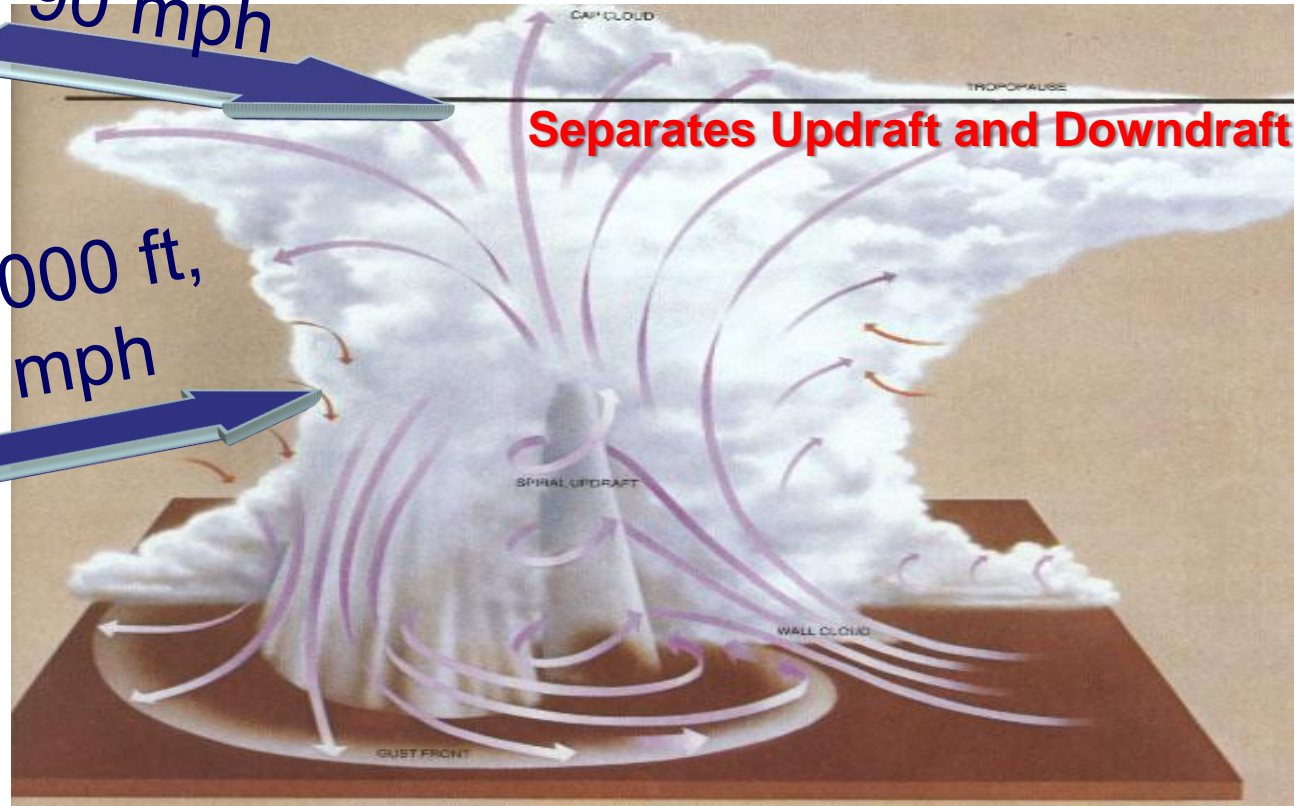


# Why Is Wind Shear So Important?

Separate  
Updrafts and  
downdrafts  
allow the  
storm to  
keep  
refueling.

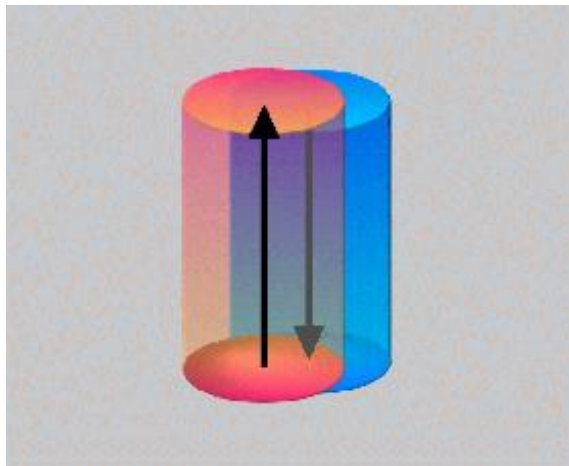
40,000 ft,  
90 mph

10,000 ft,  
60 mph



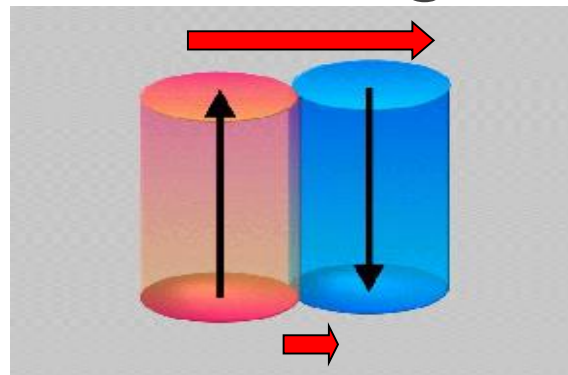


# Weak



**Downdraft chokes  
updraft causing storm  
be short-lived**

# Strong



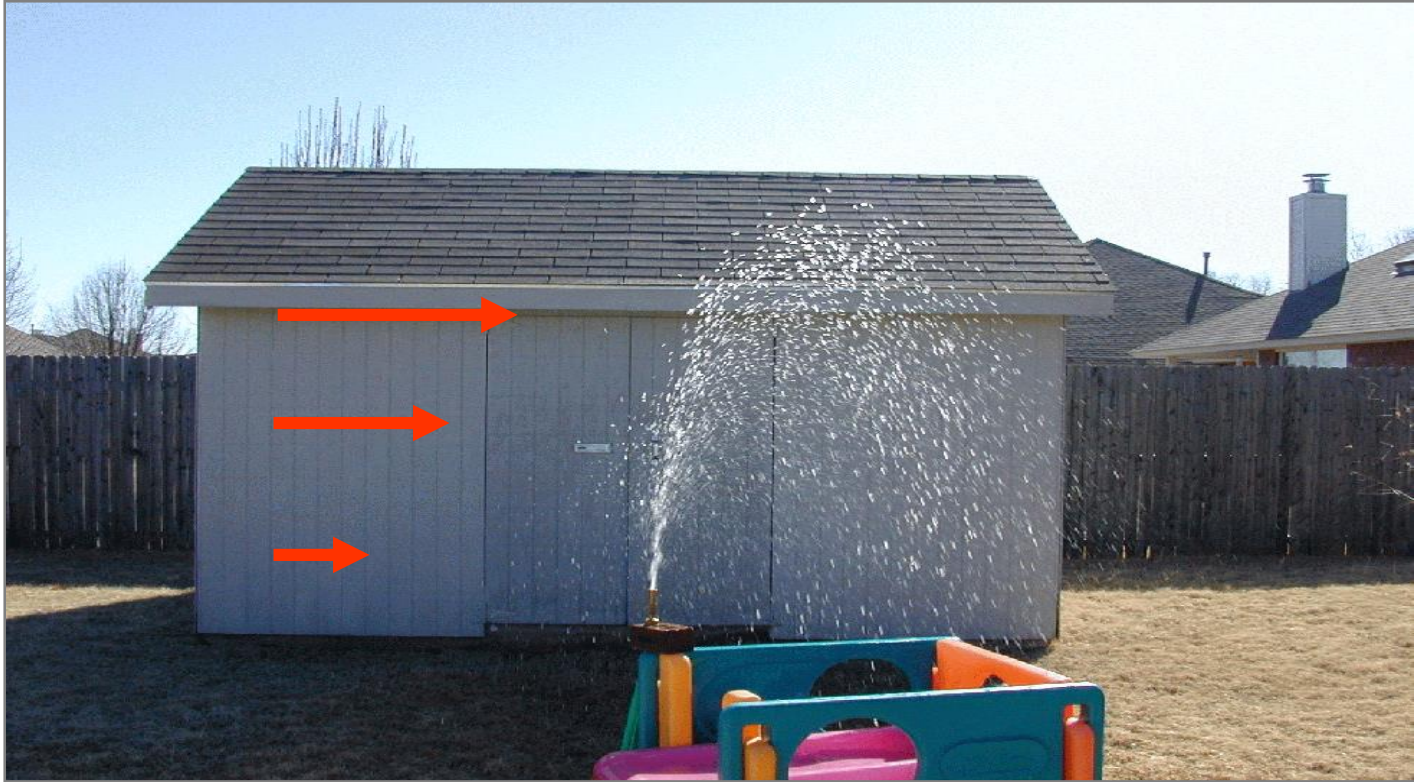
**Updraft &  
downdraft are  
separated, the  
storm lives longer**

# Updraft in Weak Wind SPEED Shear





# Updraft in Strong Wind SPEED Shear



# Wind Shear & Supercells

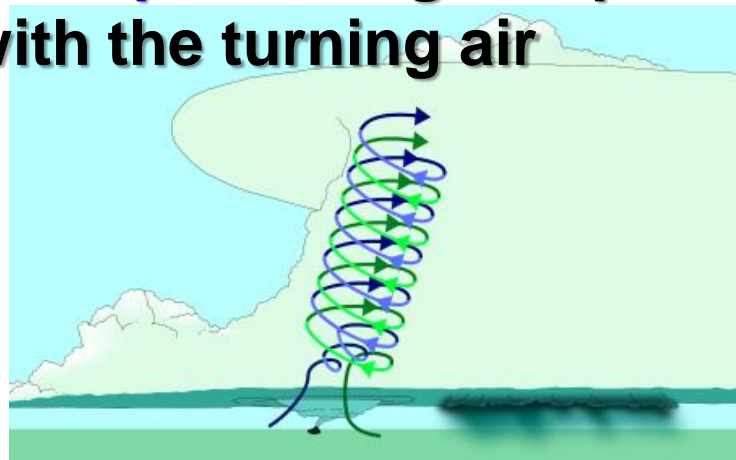
**Wind shear** gets the air turning



The **updraft** bends the turning air upward.



The **updraft** begins spinning with the turning air



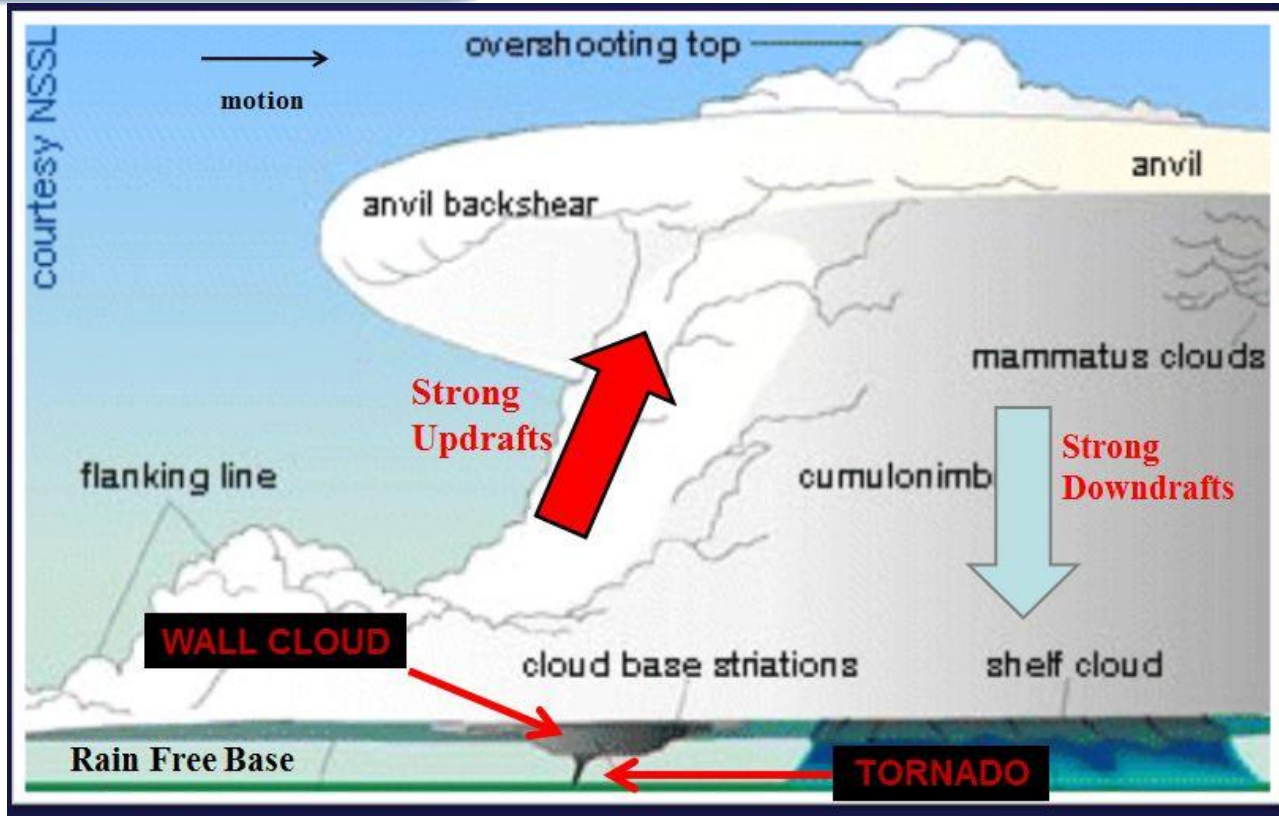
Wind shear is quantified using terms like **Helicity** and **Bulk Shear**

# Supercell – Rotating Updraft





# Supercell Thunderstorm

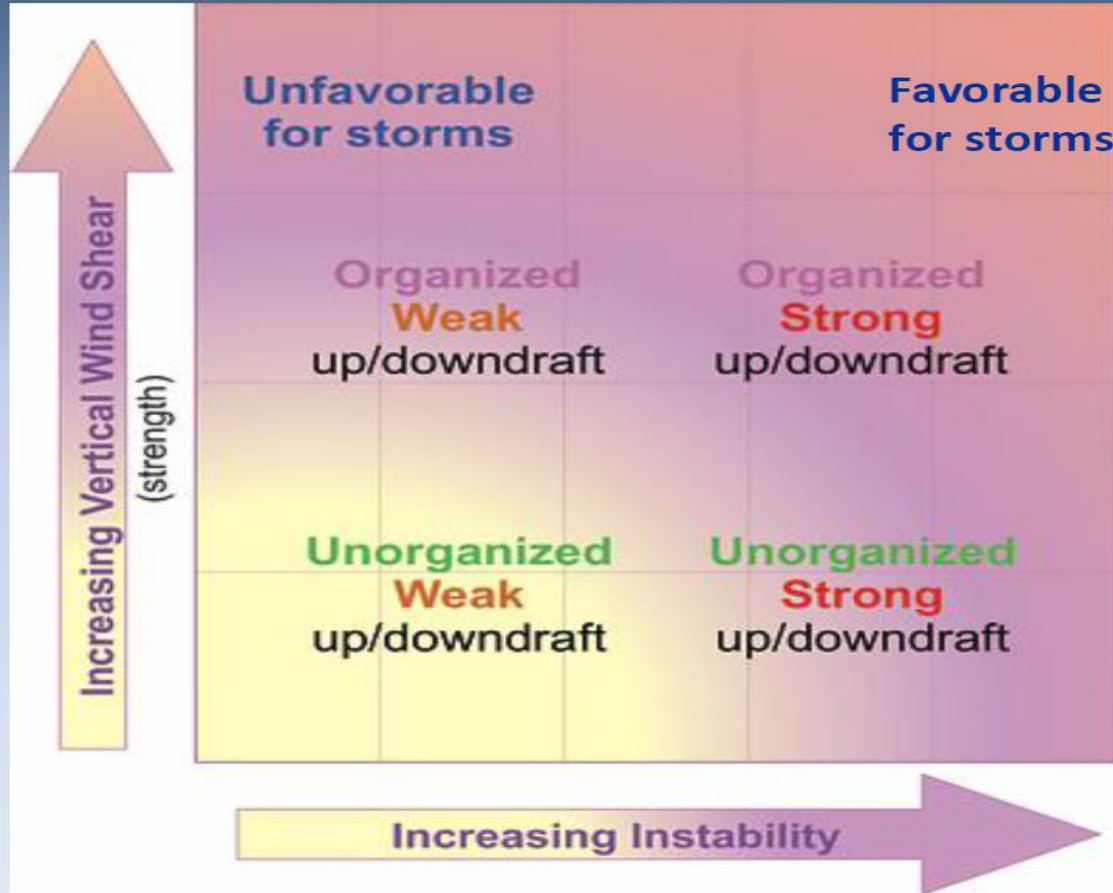


**Same Ingredients  
as a basic  
Thunderstorm.**

**But add  
significant  
amounts of speed  
and directional  
shear**

# Finding the Perfect Balance

## Instability versus Wind Shear

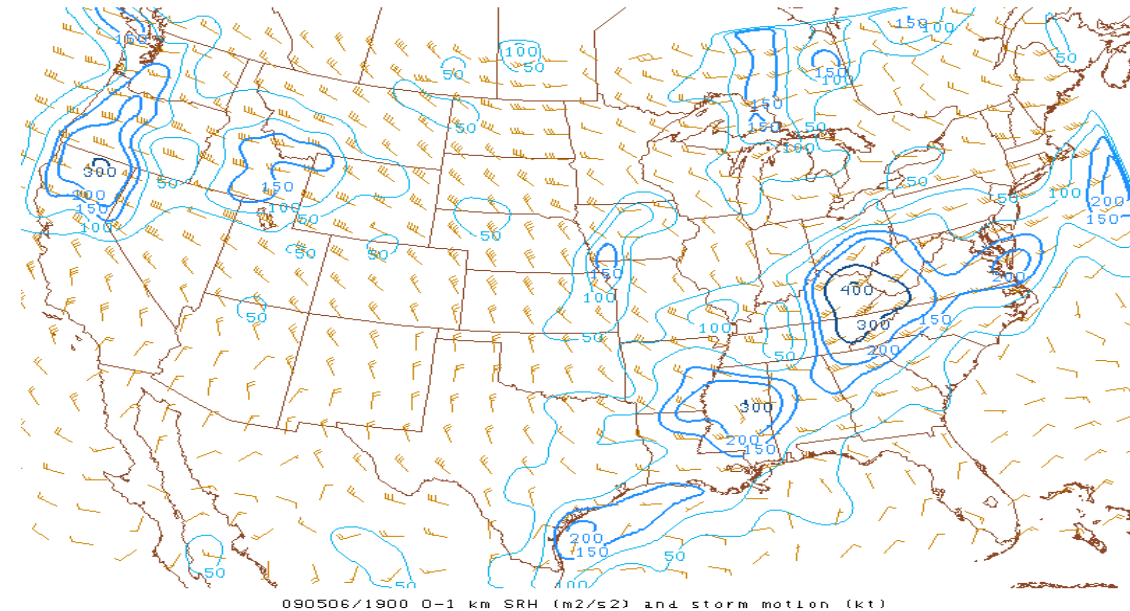


- Finding the perfect balance between instability and wind shear remains a forecast challenge.
- All about the favorable **mode of convection**.

# Measuring Wind Shear

## HELICITY FACTS:

- Measured at several height levels
- Aids in determining storm type and “convective mode”
- **0-6 km = Storm Motion**
- **0-3 km = Storm Type**
- **0-1 km = Tornadoes?**





[Soundings](#)
[Model](#)
[Storm Prediction Center](#)
[SPC Hourly Mesoscale Analysis](#)
[New!](#)

<https://www.spc.noaa.gov/expert/mesoscaleanalysis/new/>
120%

## SPC Mesoscale Analysis

Auto-refresh is set to every minute [\[OFF 1 min 5.1s\]](#)

[Change Area](#)
[Image Archive & Loops](#)
[SPC Homepage](#)
[Mobile Version](#)

**Operational EMC RAP**

[Observations](#)
[Surface](#)
[Upper Air](#)
[Thermodynamics](#)
[Wind Shear](#)
[Composite Indices](#)
[Multi-Parameter Fields](#)
[Heavy Rain](#)
[Winter Weather](#)
[Fire Weather](#)
[Classic](#)
[Data](#)

**NOAA/NWS/Storm Prediction Center**

**Mesoscale Analysis Data**

Bulk Shear - Effective  
 Bulk Shear - 30c-60m  
 Bulk Shear - 30c-30m  
 \*New\* Bulk Shear - 30c-30m  
 Bulk Shear - 30c-10m  
 BRN Shear  
 SR Helicity - Effective  
 SR Helicity - 30c-30m  
 SR Helicity - 30c-10m  
 SR Helicity - 30c-10m  
 SR Wind - 30c-20m  
 SR Wind - 4-6km  
 SR Wind - 5-10km  
 SR Wind - Anal Level  
 850-100mb Mean Wind  
 850 and 500mb Winds  
 3hr 30c-30m SR Helicity Change  
 3hr 30c-10m Bulk Shear Change  
 3hr 30c-60m Bulk Shear Change

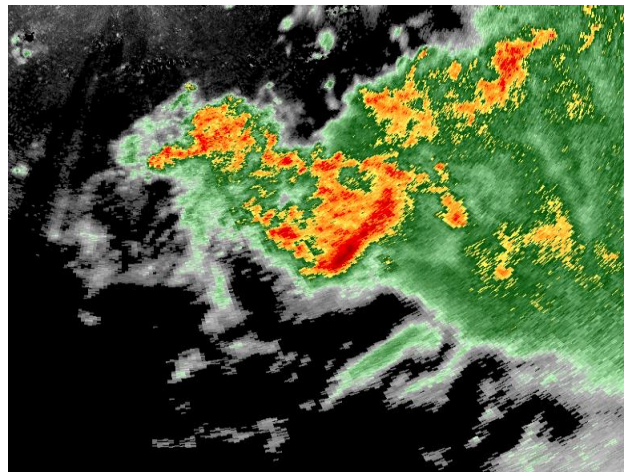
Image overlay:  
 County Boundaries  
 County Warning Areas  
 Highways & Cities  
 ARTCC Regions  
 NWS Watchers  
 SPC Daily Convective Outlook

Image under:  
 County  
 None  
 Radar  
 Terrain  
 Population  
 Surface Obs

**Current SPC**  
 Show current maps  
**Day1 Convective Outlook**  
 Issued at 1648 UTC  
 Private  
**Day1 National Outlook**  
 Issued at 1654 UTC  
**SVR TSTM VA**  
 Issued at 1755 UTC  
**Meso Discussion**  
 SEVERE POTENTIAL  
 Issued at 1807 UTC  
 The latest updates are...

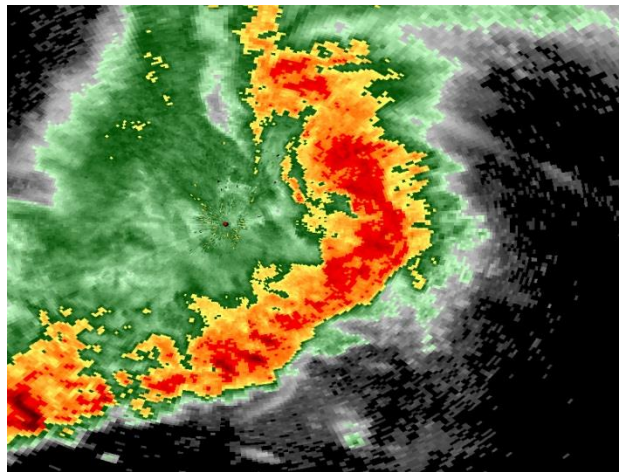
NWS Shreveport Advanced Spotters' Course – 2011

# Storm Type



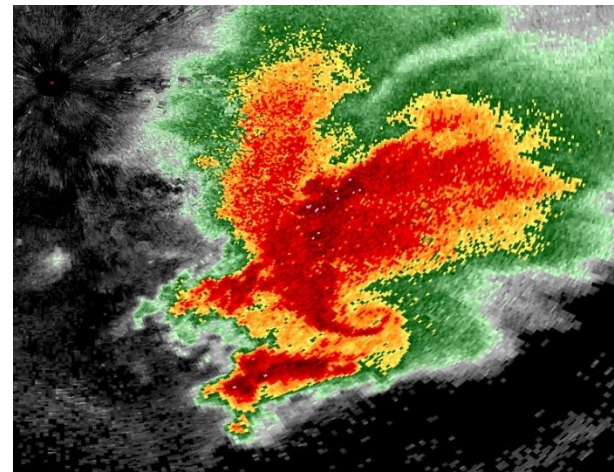
## Multi-Cell Cluster

- Downburst Winds
- Hail
- Flash Flooding
- Tornadoes (usually low)



## Multi-Cell Bow Echo

- Damaging Winds
- Isolated Tornadoes
- Flash Flooding
- Hail (usually low)



## Supercell

- Tornadoes
- Large Hail
- Damaging Winds
- Flash Flooding

**TIME  
FOR  
A**



**BREAK!**

# What is Radar?

## ☛ Radio Detection and Ranging

- ☛ Detects the distance to and power returned from a target

## ☛ Weather radar is designed to detect targets made of water



Raindrop, snowflake,  
hail, insect, dust, etc.

- ☛ Many brief microwave pulses per second are transmitted
- ☛ In between the pulses, the radar is “listening” for a reflected signal, or “echo”
- ☛ The amount of reflected signal received is called reflectivity



# What is Reflectivity?

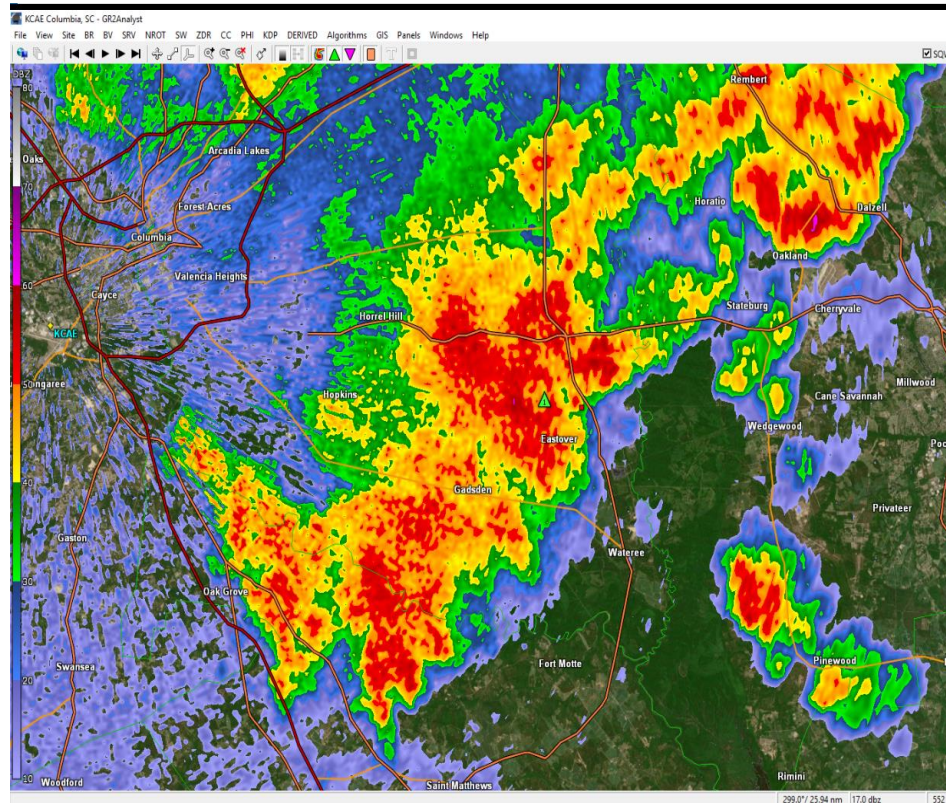
☁ The higher the reflectivity, the heavier the rainfall

☁ Colors are used to display low and high reflectivity

- ☁ Warm colors = high
- ☁ Cool colors = low
- ☁ Always use the color legend

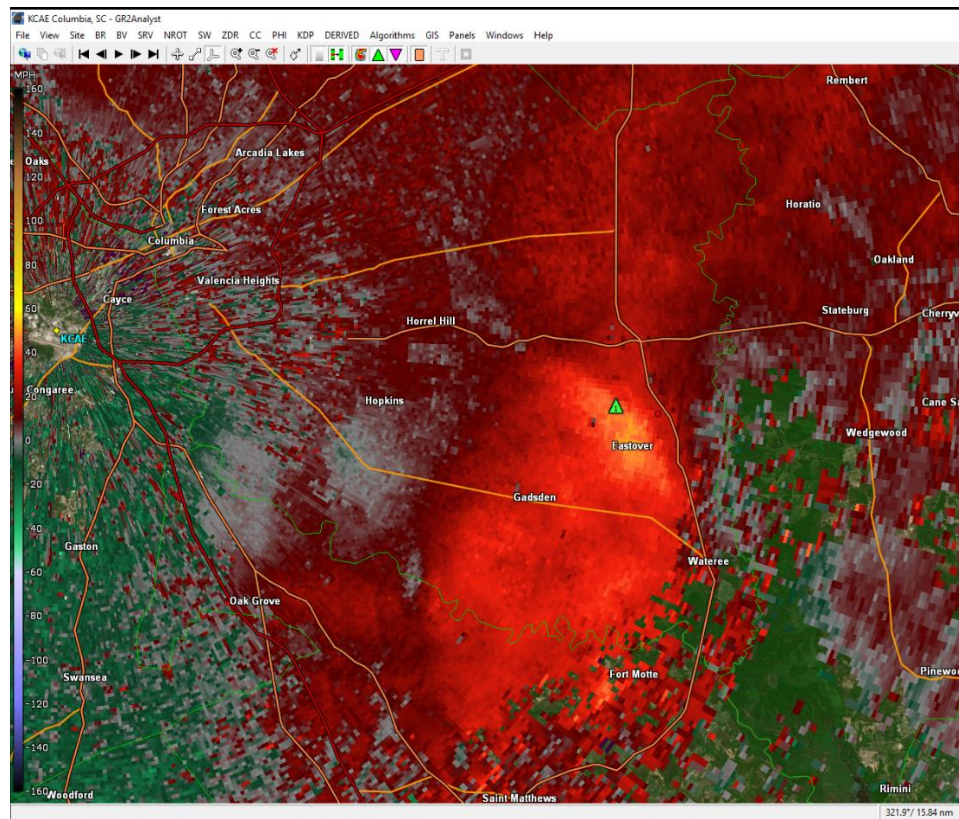
☁ Threats seen: Heavy rain, hail, snow

- ☁ Can also see birds, insects, leaves (tornado debris)



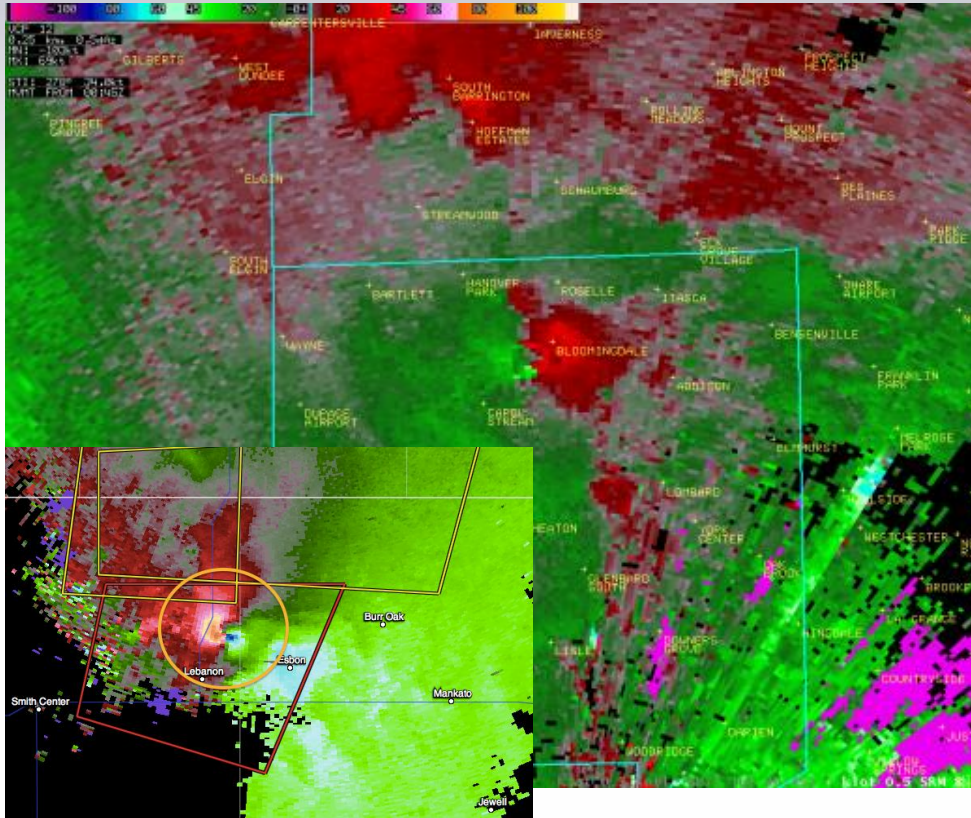
# The Doppler Effect

- ☛ Doppler effect is a change in frequency of a moving object
- ☛ Targets moving toward the radar are colored **green**
- ☛ Targets moving away from the radar are colored **red**
- ☛ The brighter the color, the stronger the wind
- ☛ Threats seen: Damaging wind, tornadoes





# Velocity



## Base Velocity and Storm Relative Velocity

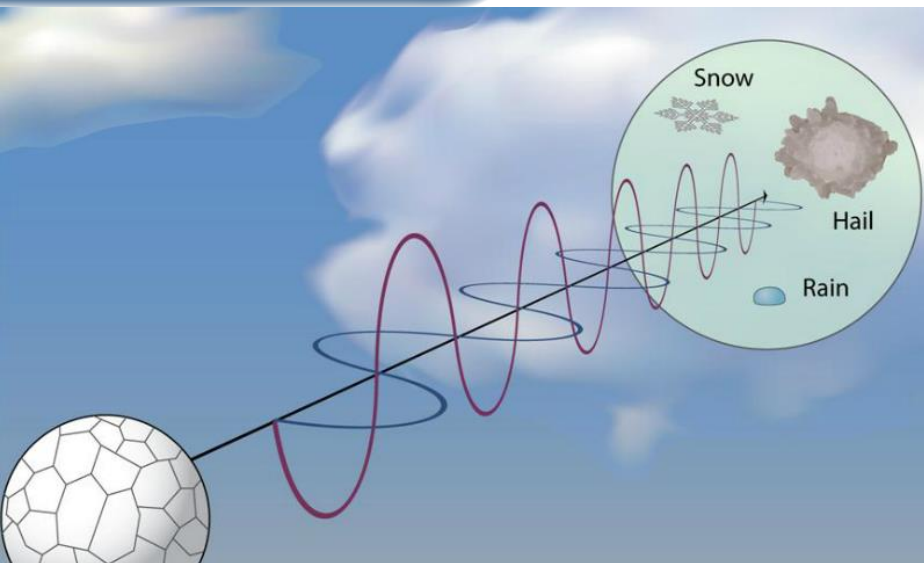
What separates storm relative motion from base velocity is the motion of storms are "subtracted" from the overall flow of the wind.

**Green** = Motion towards the radar

**Red** = Motion away from the radar

Couplet: Intense outbound winds next to intense inbound wind.

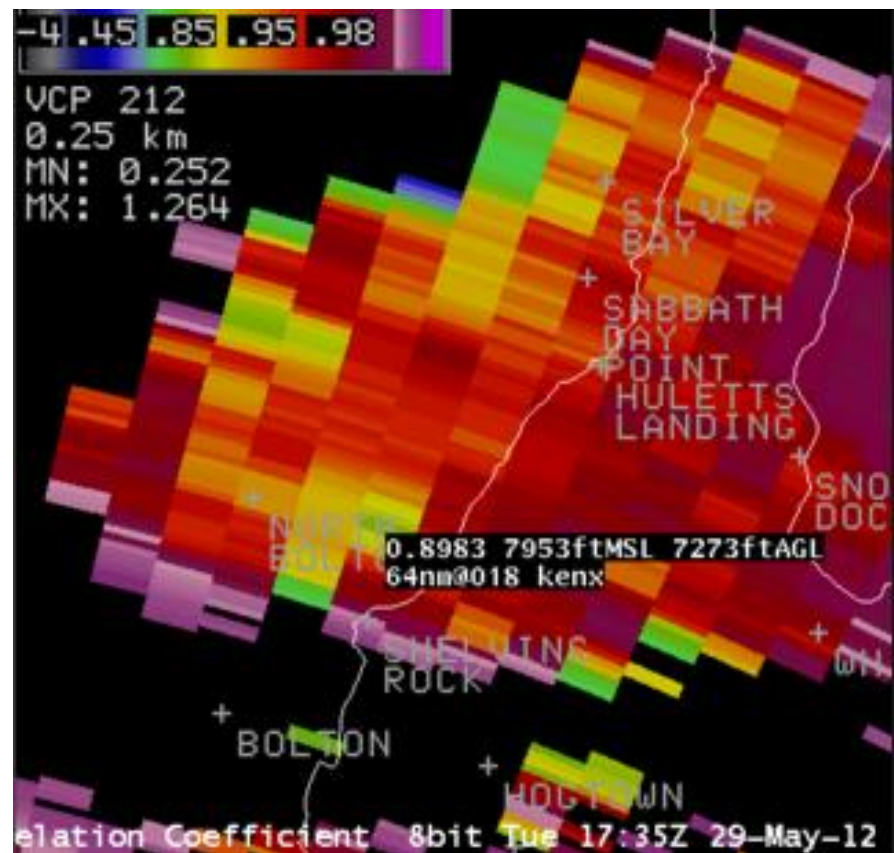
# Dual-Polarization Radar



- ⚡ Radar waves polarized horizontally *and* vertically
- ⚡ Can see the size and shape of weather and non-weather targets
- ⚡ Threats seen: Hail, heavy rainfall, tornado debris

# Correlation Coefficient

- ☛ A correlation between the reflected horizontal and vertical power returns
- ☛ Good indicator of hydrometeor diversity
- ☛ High values = Uniform targets (rain)
- ☛ Low values = Other targets mixed in (hail, debris, bugs, etc.)



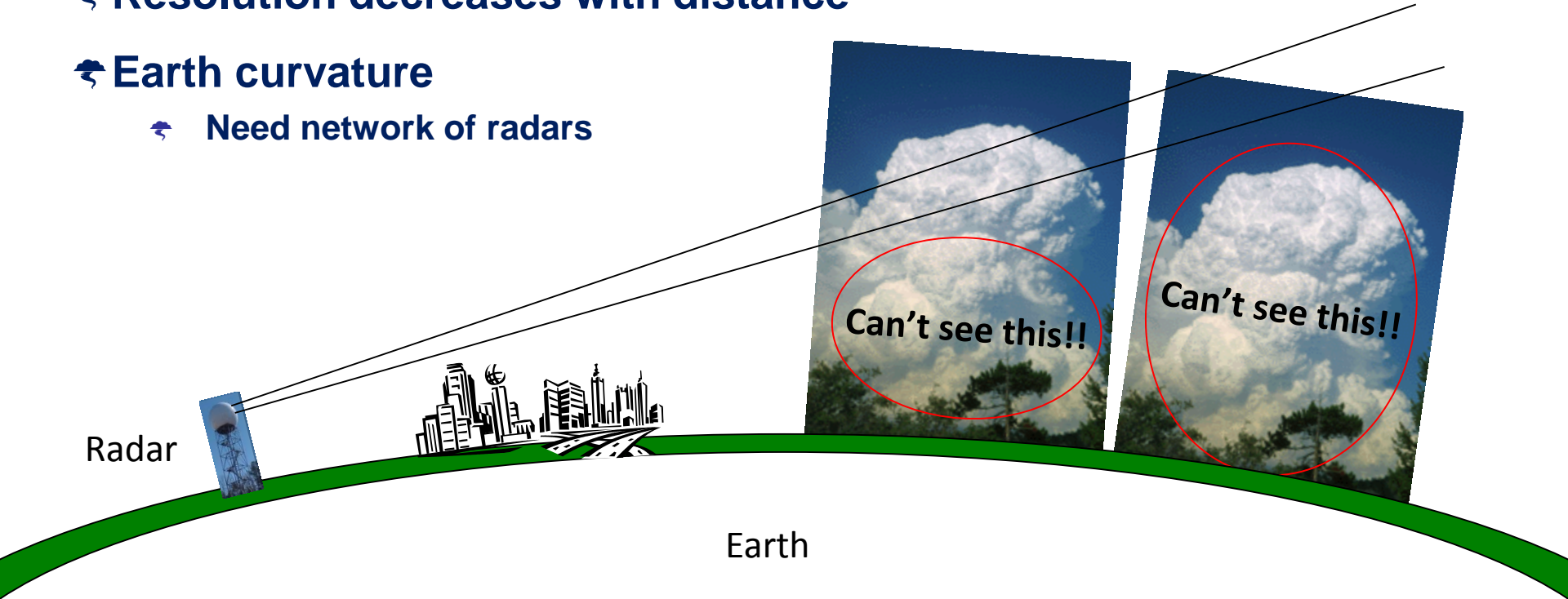


# Limitations of Radar

☼ Resolution decreases with distance

☼ Earth curvature

☼ Need network of radars



# Limitations of Radar

## Beam Spreading:



Beam spreads nearly 1,000 ft for every 10 miles of travel.

At 60 miles from the radar the beam is over 6,000 feet wide.

At 120 miles from the radar the beam is well over 2 miles wide.

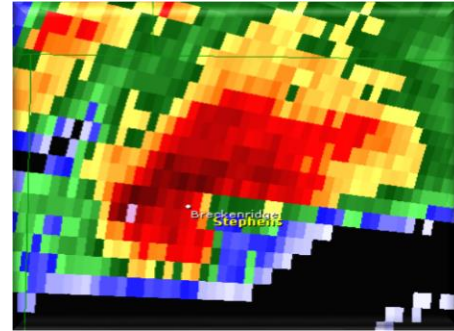
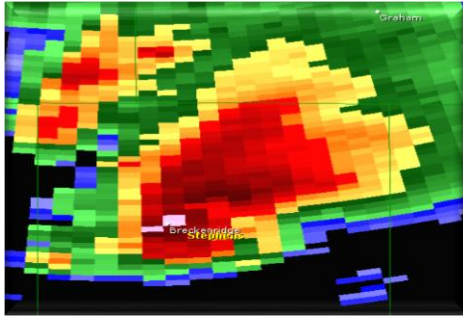
**Beam spreading affects resolution capability of the radar!**

Small scale features which can be easily discerned near the radar often become obscured at greater distances.

# Effects of Beam Spreading: *Same Storm w/ 4 different Radars*



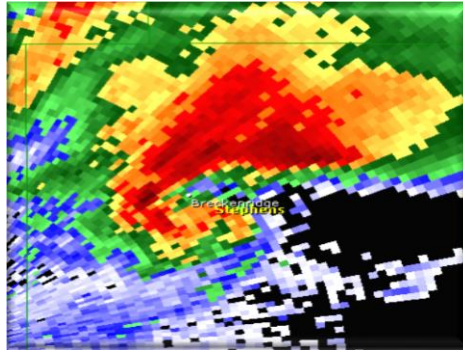
Frederick  
112 miles / 11,200 ft



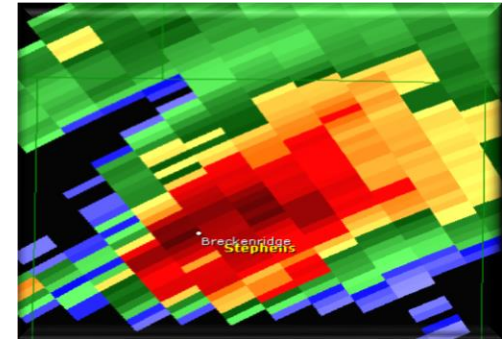
Fort Worth  
94 miles / 8,300 ft



Dyess AFB  
25 miles /  
1,700 ft

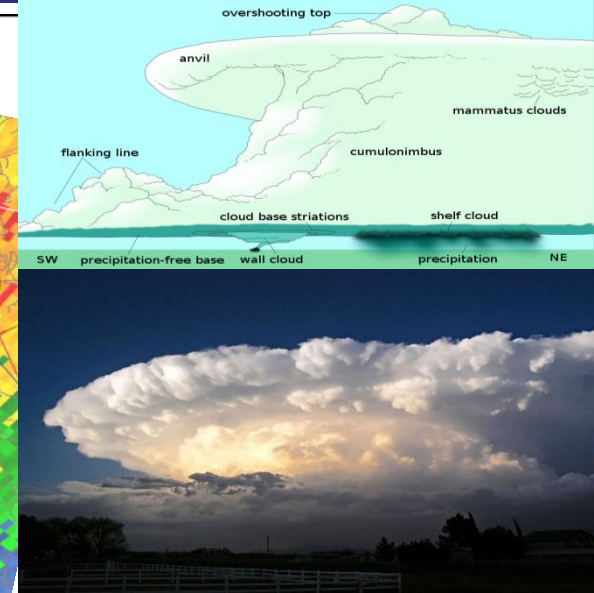
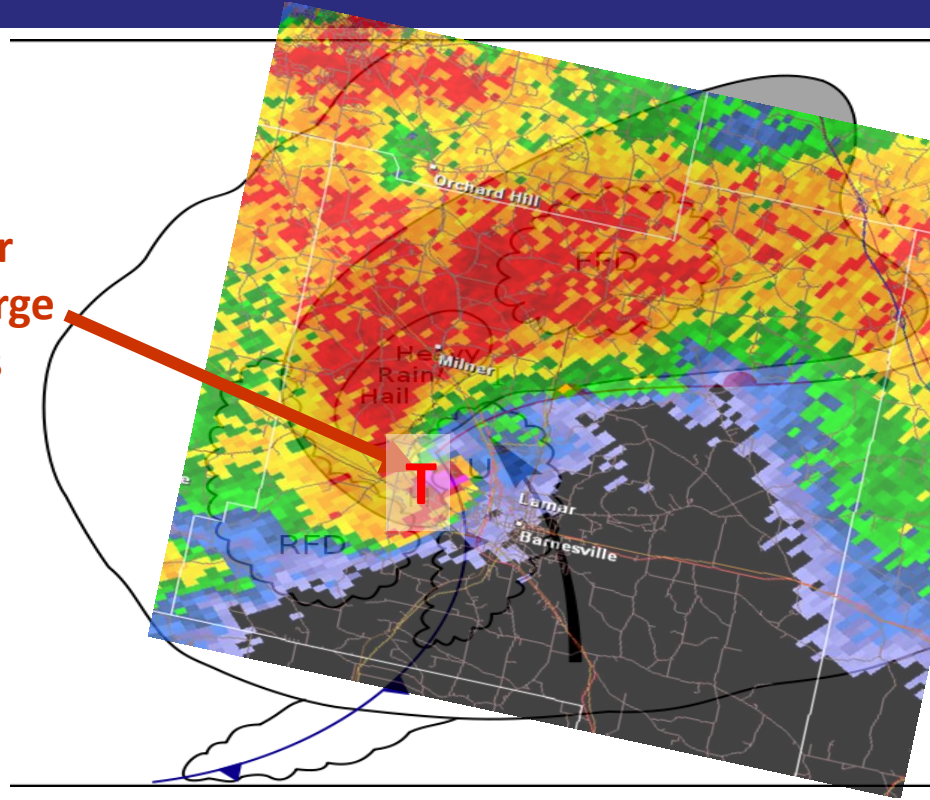


Granger  
167 miles /  
21,000 ft



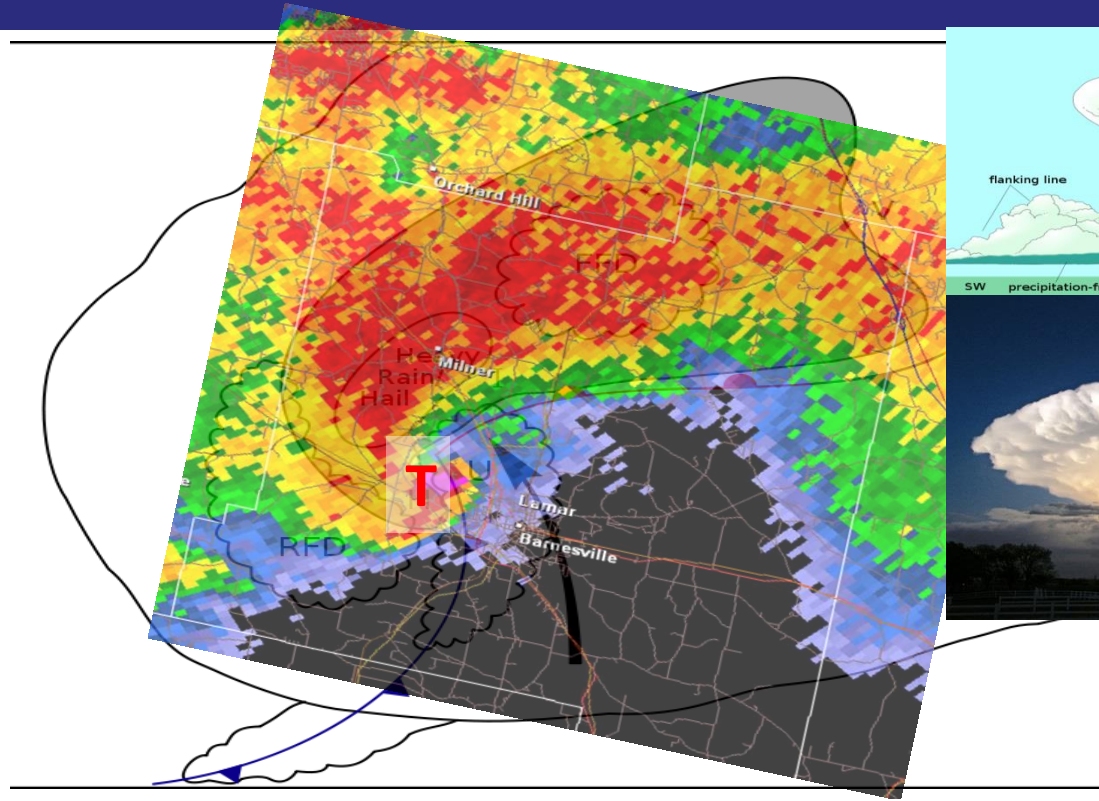
# Storm Structure - Reflectivity

Most likely area for  
damaging wind, large  
hail and tornadoes





# Storm Structure - Reflectivity

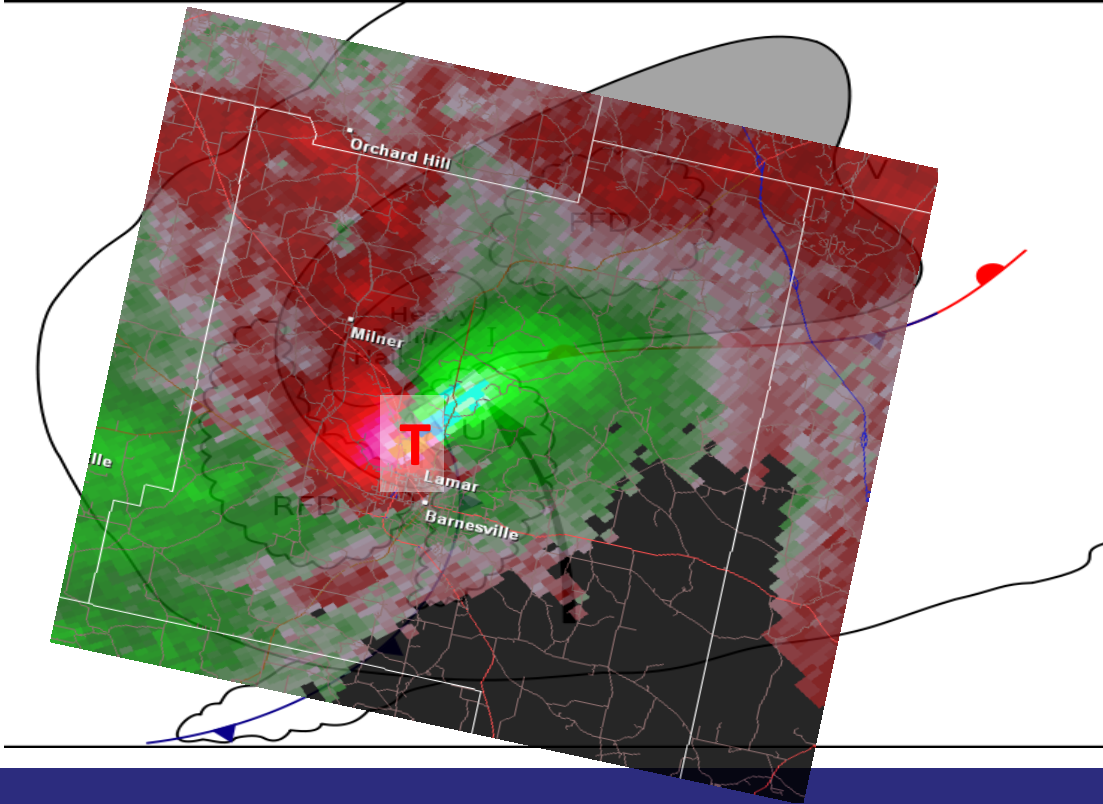




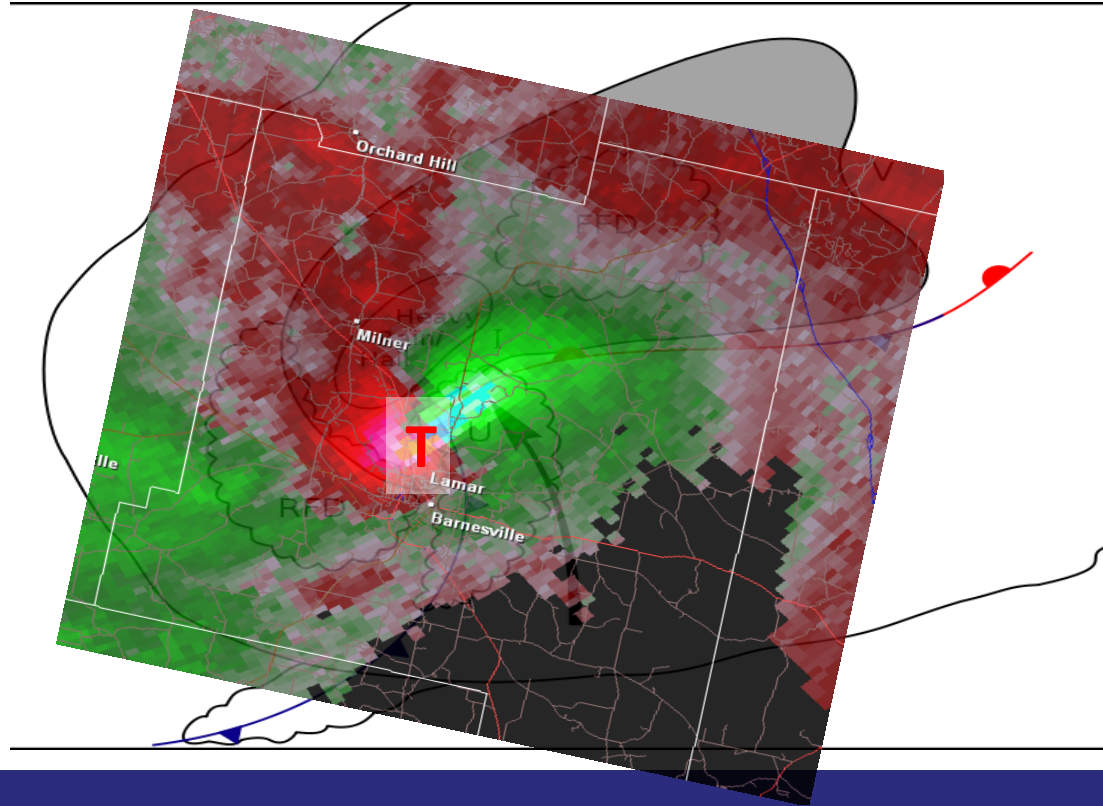
# HP Supercells: *Rain-Wrapped Tornado*



# Storm Structure - Velocity

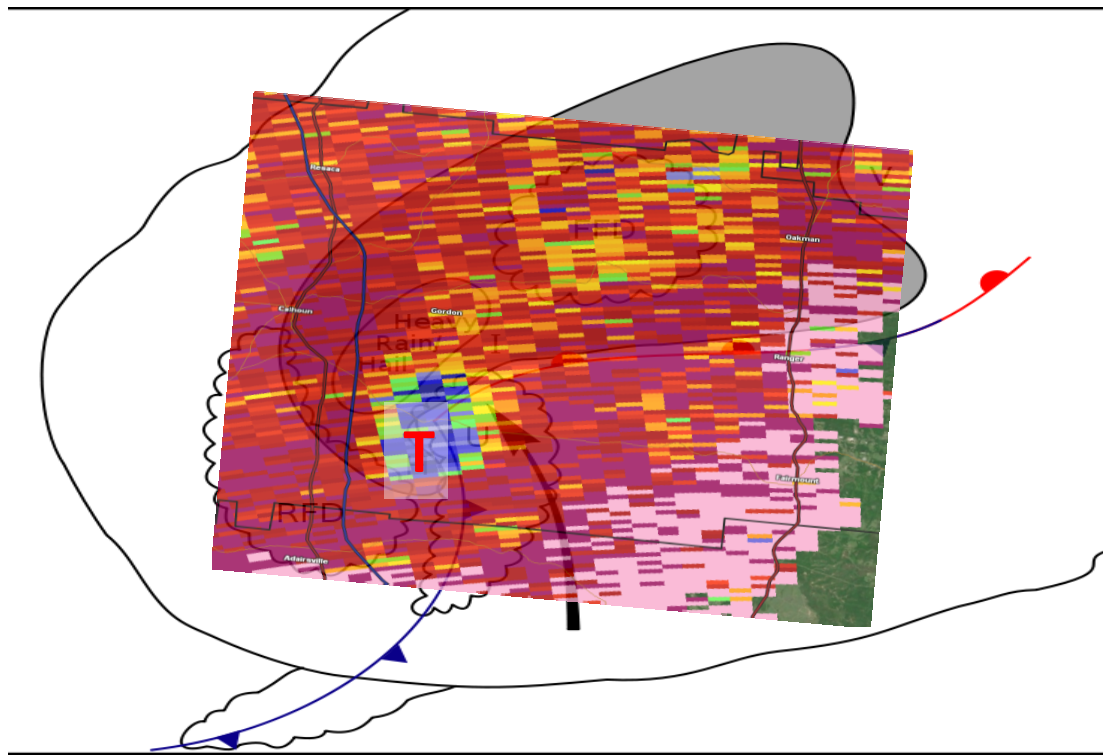


# Storm Structure - Velocity

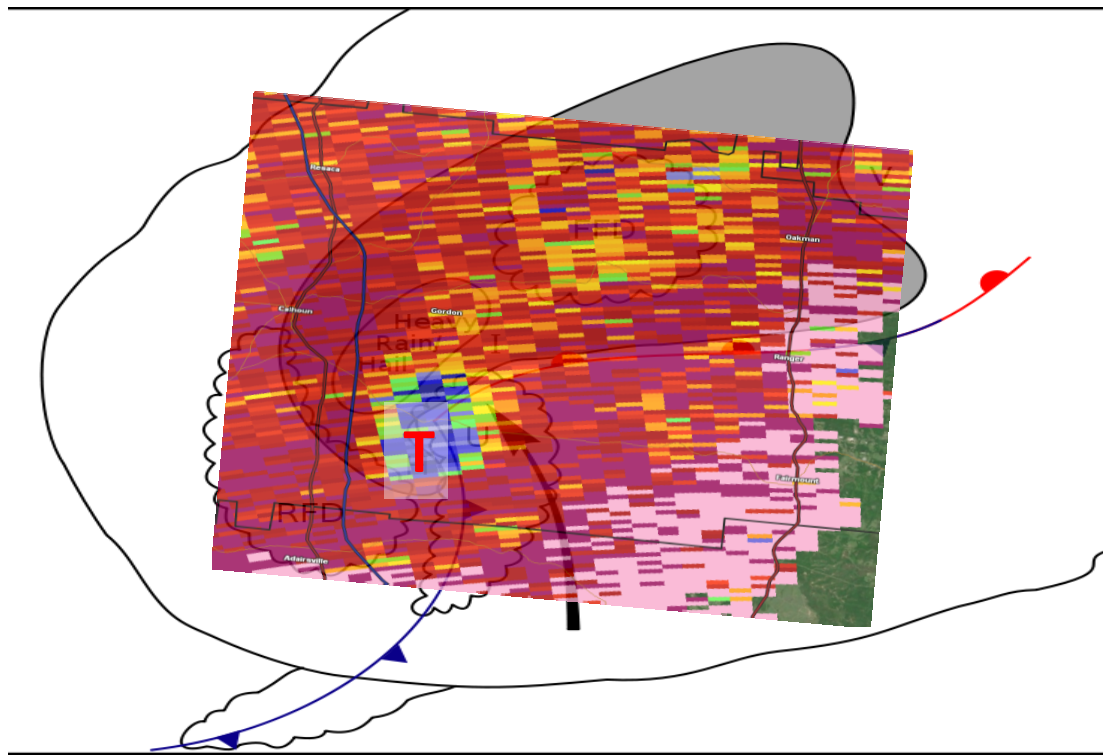




# Storm Structure – Dual-polarization



# Storm Structure – Dual-polarization



# Impact-Based Warnings

...TORNADO EMERGENCY FOR WASHTA...  
THE NATIONAL WEATHER SERVICE IN SIOUX FALLS HAS ISSUED A  
\* TORNADO WARNING FOR...  
CHEROKEE COUNTY IN NORTHWEST IOWA...  
\* UNTIL 800 PM CDT  
\* AT 720 PM CDT...A SEVERE THUNDERSTORM CAPABLE OF PRODUCING A  
LARGE AND EXTREMELY DANGEROUS TORNADO WAS LOCATED NEAR  
WASHTA...AND MOVING NORTHEAST AT 30 MPH.  
**THIS IS A TORNADO EMERGENCY FOR WASHTA. TAKE COVER NOW. THIS IS A  
PARTICULARLY DANGEROUS SITUATION.**  
**HAZARD...DAMAGING TORNADO.**  
SOURCE...RADAR INDICATED ROTATION.  
**IMPACT...YOU ARE IN A LIFE THREATENING SITUATION. FLYING DEBRIS  
MAY BE DEADLY TO THOSE CAUGHT WITHOUT SHELTER. MOBILE  
HOMES WILL BE DESTROYED. CONSIDERABLE DAMAGE TO  
HOMES...BUSINESSES AND VEHICLES IS LIKELY AND COMPLETE  
DESTRUCTION IS POSSIBLE.**  
\* THE TORNADO WILL BE NEAR...  
QUIMBY AROUND 730 PM CDT.  
CHEROKEE AROUND 745 PM CDT.  
AURELIA AROUND 750 PM CDT.  
PRECAUTIONARY/PREPAREDNESS ACTIONS...  
HEAVY RAINFALL MAY HIDE THIS TORNADO. DO NOT WAIT TO SEE OR HEAR THE TORNADO  
TAKE COVER NOW.  
44  
LAT...LON 4259 9585 4291 9565 4291 9550 4283 9538  
4269 9539 4256 9569 4256 9577  
TIME...MOT...LOC 0023Z 225DEG 27KT 4260 9567  
**TORNADO...OBSERVED  
TORNADO DAMAGE THREAT...CATASTROPHIC  
MAIL...1.50 IN**  
55

## Tornado Tag

TORNADO...RADAR INDICATED	Evidence on radar and near storm environment is supportive, but no confirmation.
TORNADO...OBSERVED	Tornado is confirmed by spotters, law enforcement, etc.

## Tornado Damage Threat Tag

No Tag	Use most of the time, when tornado damage possible within the warning polygon. Tornado duration generally expected to be short-lived
TORNADO DAMAGE THREAT...CONSIDERABLE	Use rarely, when there is credible evidence that a tornado, capable of producing considerable damage, is imminent or ongoing. Tornado duration generally expected to be long lived
TORNADO DAMAGE THREAT...CATASTROPHIC	Use exceedingly rarely, when a severe threat to human life and catastrophic damage from a tornado is occurring, and will only be used when reliable sources confirm a violent tornado.. Tornado duration generally expected to be long lived

## Tornado Tag In Severe Thunderstorm Warnings

TORNADO...POSSIBLE	A severe thunderstorm has some potential for producing a tornado although forecaster confidence is not high enough to issue a Tornado Warning.
--------------------	--

# IBW Case Study: November 18, 2015 QLCS Tornadoes







# Purpose:

## *Impact Based Warnings*

**Meteorology:** Newer (88D/Dual-Pol) Radar technology & products can affect NWS warning decision-making

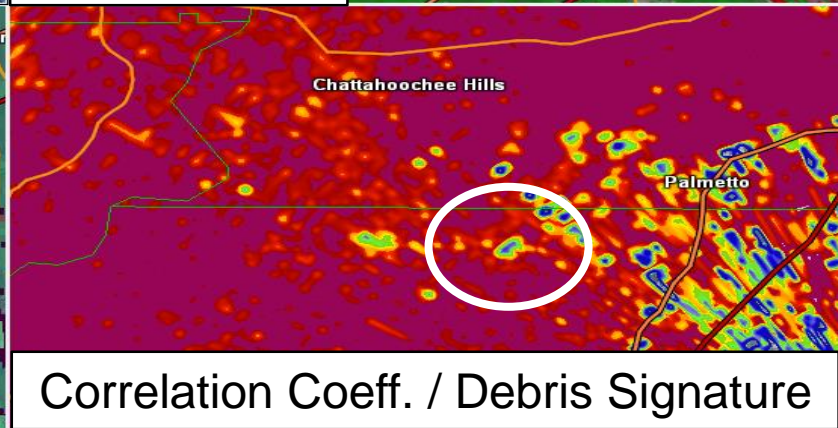
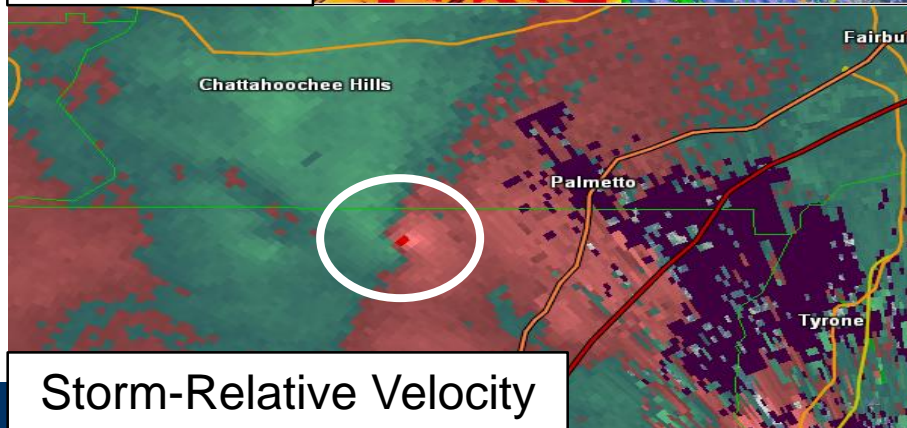
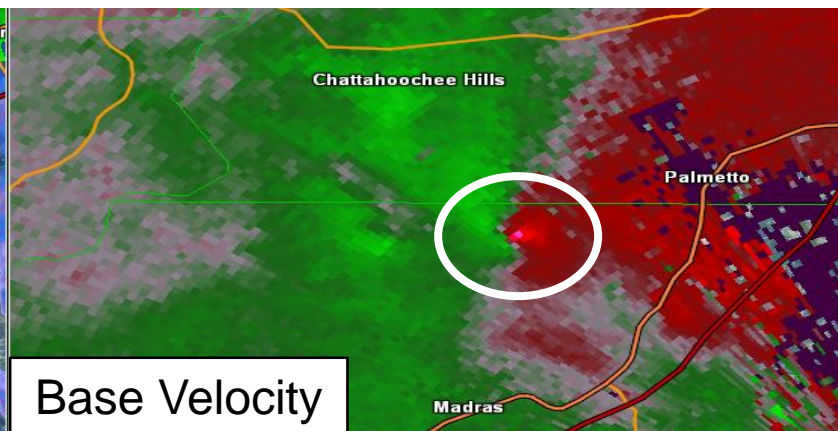
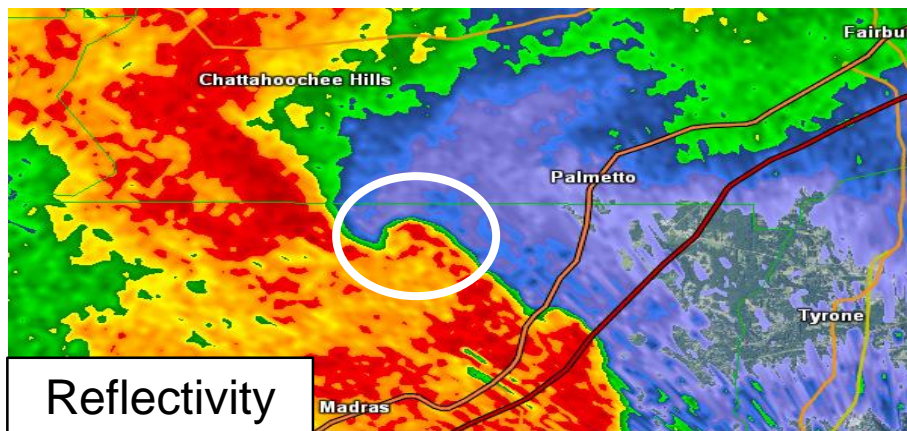
**Social Science:** Small, yet critical, wording changes in Warnings & Follow-up statements (SVS)

- ⚡ Hazard/Source/Impacts/Tags

**Media & Public:** easier to key in on the most important parts of warning (threats & impacts)

# 4-panel from FFC Radar:

## 4:45 PM EST



# Initial TORNADO Warning Issued at 4:47 PM EST

Confidence LOW  
with confirmation /  
HIGH tornado  
occurring

Source / Tag:

🔹 “Radar Indicated”

THE NATIONAL WEATHER SERVICE IN PEACHTREE CITY HAS ISSUED A

- \* TORNADO WARNING FOR...  
NORTHERN FAYETTE COUNTY IN NORTH CENTRAL GEORGIA...  
NORTH CENTRAL COWETA COUNTY IN WEST CENTRAL GEORGIA...  
SOUTH CENTRAL FULTON COUNTY IN NORTH CENTRAL GEORGIA...
- \* UNTIL 515 PM EST
- \* AT 447 PM EST...A SEVERE THUNDERSTORM CAPABLE OF PRODUCING A  
TORNADO WAS LOCATED OVER PALMETTO...OR 10 MILES NORTHEAST OF  
NEWNAN...MOVING NORTHEAST AT 30 MPH.

HAZARD...TORNADO.

SOURCE...RADAR INDICATED ROTATION.

IMPACT...FLYING DEBRIS WILL BE DANGEROUS TO THOSE CAUGHT WITHOUT  
SHELTER. MOBILE HOMES WILL BE DAMAGED OR DESTROYED.  
DAMAGE TO ROOFS...WINDOWS AND VEHICLES WILL OCCUR. TREE  
DAMAGE IS LIKELY.

- \* OTHER LOCATIONS IN THE WARNING INCLUDE BUT ARE NOT LIMITED TO  
FAYETTEVILLE...UNION CITY...FAIRBURN...TYRONE...PALMETTO...SANDY  
CREEK AND CANNONGATE.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

TAKE COVER NOW! MOVE TO A BASEMENT OR AN INTERIOR ROOM ON THE LOWEST  
FLOOR OF A STURDY BUILDING. AVOID WINDOWS. IF YOU ARE OUTDOORS...IN A  
MOBILE HOME...OR IN A VEHICLE...MOVE TO THE CLOSEST SUBSTANTIAL  
SHELTER AND PROTECT YOURSELF FROM FLYING DEBRIS.

IF YOU SEE WIND DAMAGE...HAIL OR FLOODING...WAIT UNTIL THE STORM HAS  
PASSED...AND THEN CALL THE NATIONAL WEATHER SERVICE TOLL FREE AT 1 8  
6 6 7 6 3 4 4 6 6 OR TWEET US YOUR REPORT AT NWSATLANTA.

&&

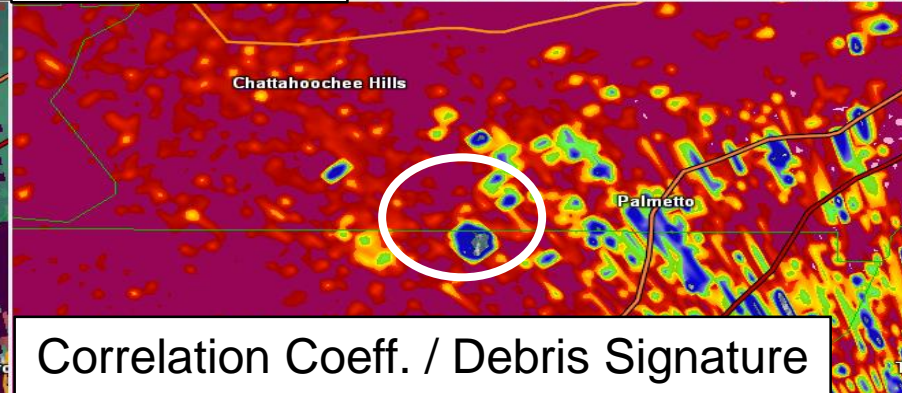
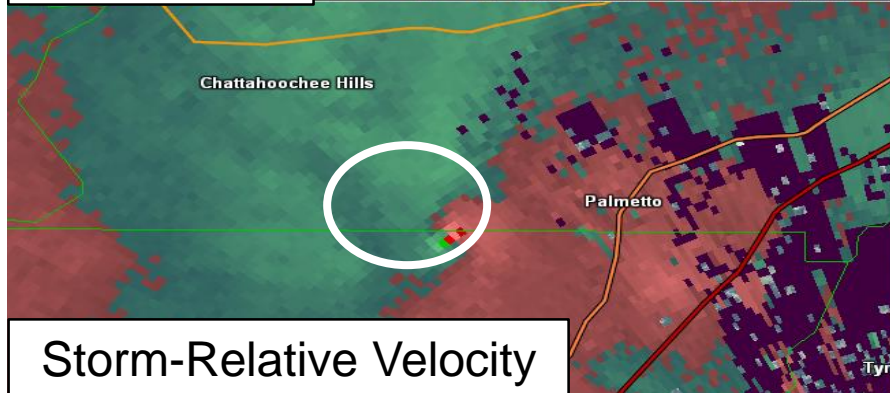
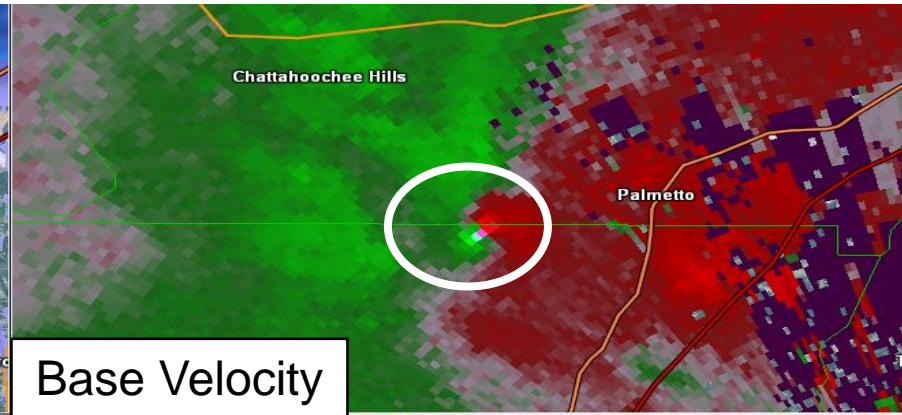
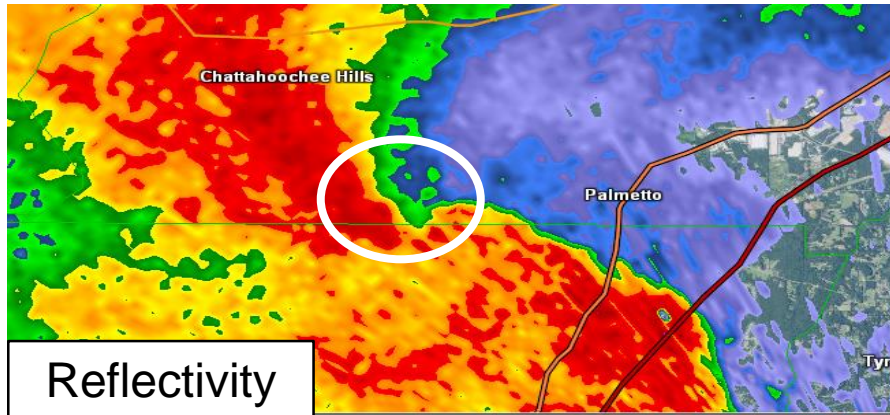
LAT...LON 3346 8472 3351 8476 3367 8456 3347 8442  
TIME...MOT...LOC 2147Z 244DEG 25KT 3351 8471

TORNADO...RADAR INDICATED  
HAIL...<.75IN



# 4-panel from FFC Radar:

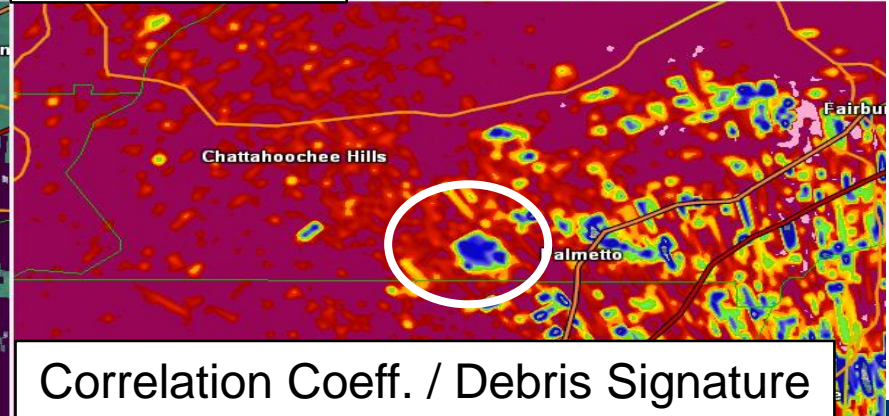
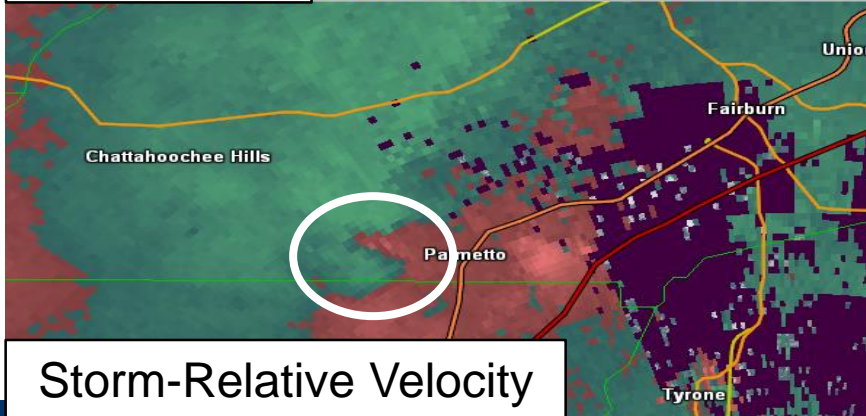
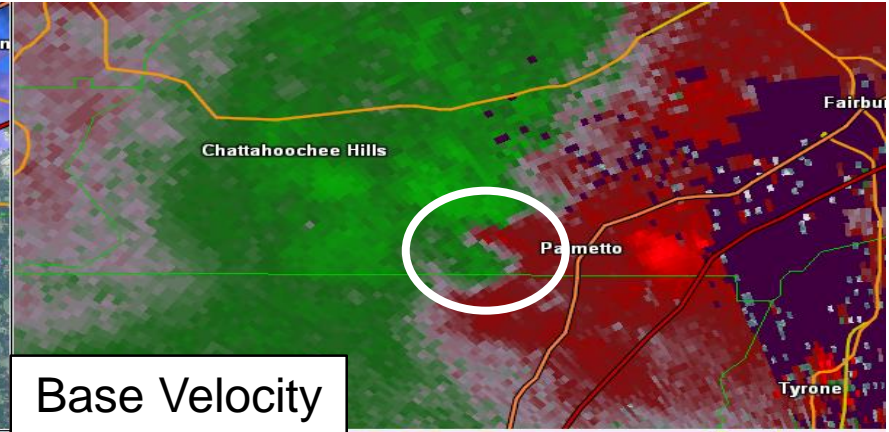
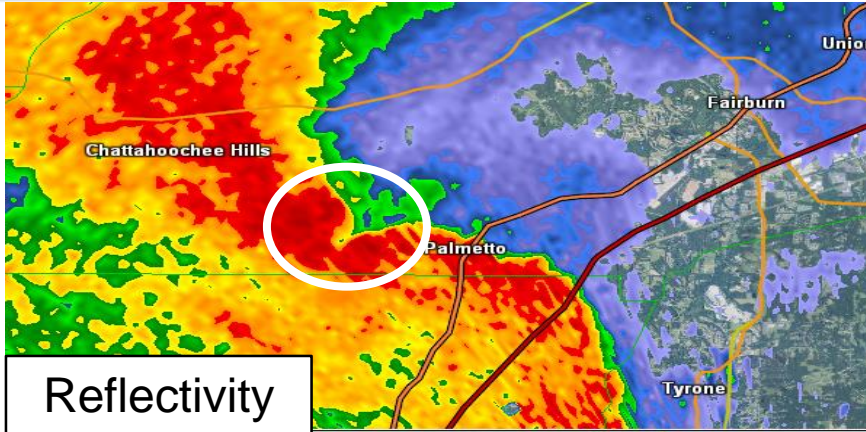
4:48 PM EST





# 4-panel from FFC Radar:

4:51 PM EST



# Follow-up Severe Weather Statement (SVS) -- continuing TOR Warning

Confidence HIGH confirmed  
tornado producing damage!

Based on Radar (TDS)

Source:

Radars Confirmed

Tag:

Observed

Hazard/PPA statements  
change

...A TORNADO WARNING REMAINS IN EFFECT UNTIL 515 PM EST FOR SOUTH CENTRAL FULTON COUNTY...

AT 458 PM EST...A CONFIRMED TORNADO WAS LOCATED OVER FAIRBURN...OR 12 MILES NORTHWEST OF FAYETTEVILLE...MOVING NORTHEAST AT 30 MPH.

HAZARD...**DAMAGING** TORNADO.

SOURCE...**RADAR CONFIRMED** TORNADO.

IMPACT...FLYING DEBRIS WILL BE DANGEROUS TO THOSE CAUGHT WITHOUT SHELTER. MOBILE HOMES WILL BE DAMAGED OR DESTROYED. DAMAGE TO ROOFS...WINDOWS AND VEHICLES WILL OCCUR. TREE DAMAGE IS LIKELY.

OTHER LOCATIONS IN THE WARNING INCLUDE BUT ARE NOT LIMITED TO UNION CITY...FAIRBURN AND PALMETTO.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

TO REPEAT...**A TORNADO IS ON THE GROUND.** TAKE COVER NOW! MOVE TO A BASEMENT OR AN INTERIOR ROOM ON THE LOWEST FLOOR OF A STURDY BUILDING. AVOID WINDOWS. IF YOU ARE OUTDOORS...IN A MOBILE HOME...OR IN A VEHICLE...MOVE TO THE CLOSEST SUBSTANTIAL SHELTER AND PROTECT YOURSELF FROM FLYING DEBRIS.

IF YOU SEE WIND DAMAGE...HAIL OR FLOODING...WAIT UNTIL THE STORM HAS PASSED...AND THEN CALL THE NATIONAL WEATHER SERVICE TOLL FREE AT 1 8

&&

LAT...LON 3367 8456 3355 8448 3353 8455 3351 8467  
3355 8470

TIME...MOT...LOC 2158Z 236DEG 28KT 3356 8462

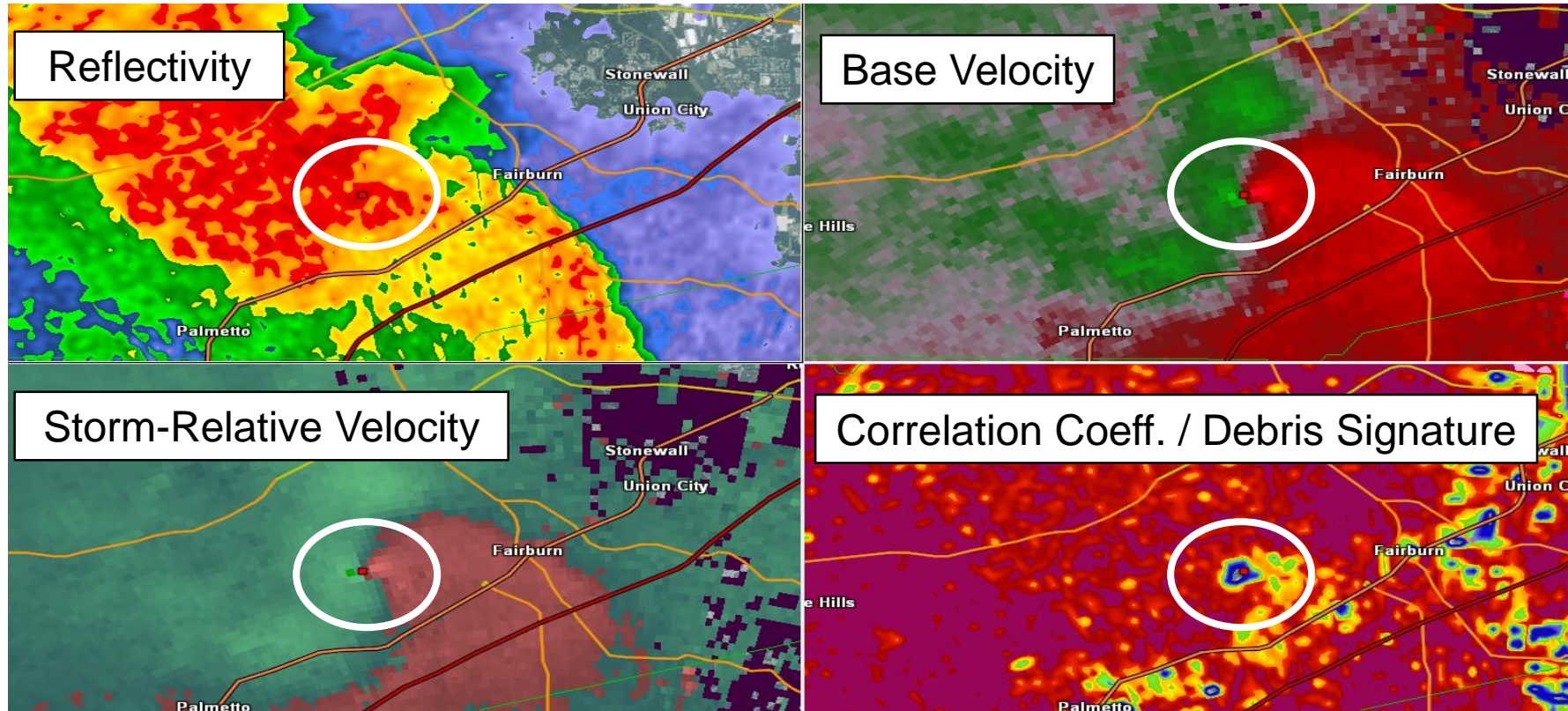
**TORNADO...OBSERVED**

HAIL...<.75IN



# 4-panel from FFC Radar:

4:58 PM EST – 2<sup>nd</sup> Tornado





# What to Report

- ⚡ **Measured or Estimated Winds 50+ mph**
- ⚡ **Wind Damage (downed trees/tree limbs, power lines, cars, etc.)**
- ⚡ **Tornadoes/Waterspouts**
- ⚡ **Funnel Clouds**
- ⚡ **Significant Flooding (roads impassable/closed, water into homes/businesses, etc.)**
- ⚡ **Hail (any size)...report largest piece**



# How to Report



**Web:**

<http://weather.gov/cae>

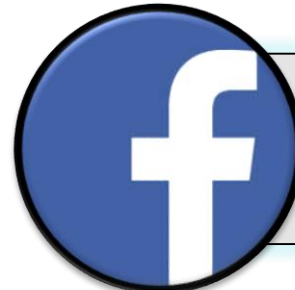


**Phone (unlisted):**



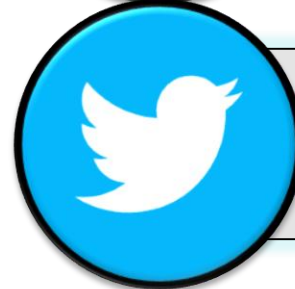
**E-mail:**

[NWS.Columbia@noaa.gov](mailto:NWS.Columbia@noaa.gov)



**Facebook:**

NWSColumbia



**Twitter:**

@NWSColumbia

# weather.gov/cae/register

- ☛ Register as a spotter to enter our database
- ☛ Receive your spotter certificate
- ☛ May infrequently be contacted for severe weather reports

