



# National Weather Service

## Newport/Morehead City

# Advanced SKYWARN

## Online Training

### 2020



By: Erik Heden  
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# Welcome To Our Third Year Of Online Classes



- You can download our presentation via our website if you have trouble. Visit:  
<https://www.weather.gov/mhx/MHXSkywarn>
- Both your audio and video will come through your PC/mobile device.
- We will send you a certificate of completion soon to the email you registered with. If you made a mistake with your email, you won't be getting a certificate!



# This is Advanced SKYWARN

- You should have already taken a Basic SKYWARN Class.
- This material is more in depth and is highly detailed.
- If you haven't taken a Basic Class yet, enjoy this class but PLEASE follow-up with our basic training afterwards.



# Future Classes



- We hold 4 SKYWARN classes throughout the year. **Basic Spring, Basic Winter, Flood/Tropical SKYWARN, Advanced SKYWARN.**
- We will **always** post future class information on our website **[weather.gov/newport](https://weather.gov/newport)** at the top of the page. Also, we will post it on Facebook.
- Our goal is that you report to us year round (snow, hail, high winds, etc).



# Keep Current

- **Bookmark [weather.gov/mhx/MHXSkywarn](http://weather.gov/mhx/MHXSkywarn)**
- **You can find YouTube training for both winter and spring skywarn**
- **You can also refresh yourself on when and how to report along with the current schedule**

Current Schedule | When To Report | How To Report | **YouTube Training**

### YouTube Training

**Basic SKYWARN (Parts 1 through 7)**  
Watch all 7 videos and instructions on how to receive your certificate.



# Asking Questions

- Throughout this class we will answer questions you have. If you raise your hand I will call on you and you can use your mic to ask a question. I will unmute your line.

- If you don't have a mic or don't want to ask in front of everyone, just send the questions through the webinar window (see right)



A screenshot of a webinar window. The top part shows the "Audio" settings, with "Computer audio" selected and "MUTED" in red. Below that is a "Questions" section with a text input field containing "[Enter a question for staff]" and a "Send" button. At the bottom, it says "Multi sessions different registrants", "Webinar ID: 980-960-603", and the "GoToWebinar" logo.



# Topics

- National Weather Service Overview
- SKYWARN Facts/Review Spotter Procedures
- Radar principles
- Radar velocity and reflectivity
- Dual pol radar
- CAPE and instability
- Precipitable water and wind shear
- Supercell Thunderstorms and Tornadoes
- Squall Lines and Bow Echoes



# National Weather Service - Nationwide

**Note: If you are not from Eastern North Carolina, we will forward your information to YOUR local office!**





# Our Local Office



Eastern part of North Carolina

Includes: Land areas, inland rivers, sounds, and adjacent ocean

Other parts of the state covered by other local offices (Raleigh, Wilmington, etc)





# Open 24/7/365



## Hurricane Florence

Staff here for 3 to 7 days



Our building is designed to withstand storms

We stay when the weather is bad



# Our Website

weather.gov/newport



Weather information from past events, current weather, and forecast

Explore the website and bookmark or save what you like

Go in depth as much as you need

**NATIONAL WEATHER SERVICE**  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

HOME FORECAST PAST WEATHER SAFETY INFORMATION EDUCATION NEWS SEARCH ABOUT

Local forecast by "City, St" or ZIP code  
Enter location ...   
[Location Help](#)

**News Headlines**

- [The Fall 2019 Edition Of Our Newsletter, Carolina Skywatcher, Is Now Online!](#)

**MY FORECAST**  
Morehead City NC

Overcast  
**49°F**  
9°C [Get Detailed info](#)

**Today**

Partly Sunny  
High: 55°F

**Tonight**

Mostly Cloudy  
Low: 43°F  
[change location](#)

**NWS Forecast Office Newport/Morehead City, Newport/Morehead City, NC**  
Weather Forecast Office

[Weather.gov](#) > Newport/Morehead City, NC

Current Hazards Current Conditions Radar Forecasts Rivers and Lakes Climate and Past Weather Local Programs

Click a location below for detailed forecast.

Watches, Warnings & Advisories

- Coastal Flood Advisory
- High Surf Advisory
- Small Craft Advisory
- Hazardous Weather Outlook

Last Map Update: Tue, Nov. 19, 2019 at 11:58:19 am EST

Tropical Local Radar Satellite

11/19/19 16:46Z GOES-East



# 7- Day Forecast

weather.gov/newport



Sky cover



High/low temperatures



Winds



Chance of precipitation

## Detailed Forecast

|                 |   |
|-----------------|---|
| Today           | Mostly cloudy, with a high near 54. Light northwest wind.                                 |
| Tonight         | Mostly cloudy, with a low around 38. West wind 5 to 7 mph.                                |
| Wednesday       | Sunny, with a high near 60. Northwest wind 7 to 9 mph.                                    |
| Wednesday Night | Mostly clear, with a low around 38. Light north wind.                                     |
| Thursday        | Sunny, with a high near 60. Light and variable wind becoming northwest around 5 mph.      |
| Thursday Night  | Partly cloudy, with a low around 44.  |
| Friday          | Mostly sunny, with a high near 67.  |
| Friday Night    | Mostly cloudy, with a low around 48.  |
| Saturday        | A chance of showers. Mostly cloudy, with a high near 64. Chance of precipitation is 50%.  |
| Saturday Night  | A chance of showers. Mostly cloudy, with a low around 44. Chance of precipitation is 50%. |
| Sunday          | Partly sunny, with a high near 58.  |
| Sunday Night    | Mostly clear, with a low around 39.   |
| Monday          | Sunny, with a high near 60.   |

## Extended Forecast for New Bern NC

| Today         | Tonight       | Wednesday   | Wednesday Night | Thursday    | Thursday Night | Friday       | Friday Night  | Saturday       |
|---------------|---------------|-------------|-----------------|-------------|----------------|--------------|---------------|----------------|
|               |               |             |                 |             |                |              |               |                |
| Mostly Cloudy | Mostly Cloudy | Sunny       | Mostly Clear    | Sunny       | Partly Cloudy  | Mostly Sunny | Mostly Cloudy | Chance Showers |
| High: 54 °F   | Low: 38 °F    | High: 60 °F | Low: 38 °F      | High: 60 °F | Low: 44 °F     | High: 67 °F  | Low: 48 °F    | High: 64 °F    |



# SKYWARN



- **SKYWARN** is a National volunteer program run by the National Weather Service
- **SKYWARN's** goal is to provide NWS with “Ground Truth Reports” of significant weather



Tree Damage  
Warsaw, NC 2/24/16



# How do Weather Spotters help the NWS?

- Real time reports **assist** the National Weather Service in our warning decisions.
- Helps forecasters **gauge** how severe a storm is.
- Your information may be the reason a warning is issued, and/or provides **credibility** to a warning.
- You could help provide the citizens of your community with potentially **life-saving** information.
- SKYWARN provides a backbone of emergency communications.
- **The trained eye of the storm spotter is still our greatest asset!**





# What to Report



***Tornadoes***

***Funnel Clouds***

***Flash Flooding***

***Storm Damage***

***Hail***

***Wind Speed***

***Rainfall Amt***



# How do I make my report?

Call the Spotter Hotline:

**REPORTS  
ONLY!**

**1-800-889-6889**

**REPORTS  
ONLY!**

**Note: This is specific to Eastern NC. Outside the area follow future info sent to you!**

This is a special number only for spotters and rings directly to us!

1. Who you are: Trained Skywarn Spotter
2. What you saw (funnel cloud etc.)
3. Where you saw it (Newport).
4. When you saw it (6:45 P.M.) or 5 minutes ago, etc.

# **REMEMBER... Spotters can help save lives by... Making their reports!**

**REPORTS  
ONLY!**

**Email US!!!**

**REPORTS  
ONLY!**

**Wxobs.mhx@noaa.gov**

**Note: This is specific to Eastern NC. Outside the area follow future info sent to you!**

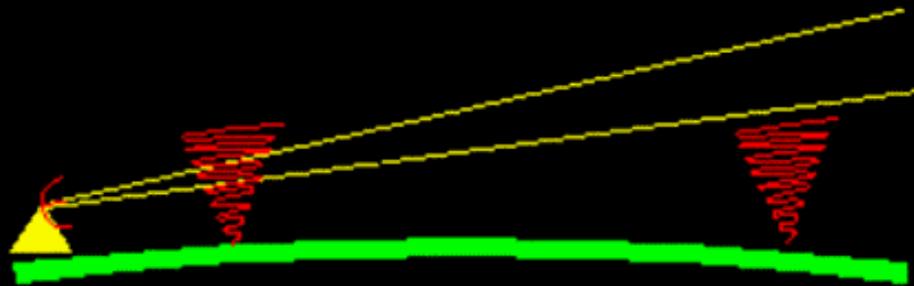
- 1. Who you are: Trained Skywarn Spotter.**
- 2. What you saw (large trees down. More than a few. 70 mph winds estimated)**
- 3. Where you saw it (1 mile east of Beaufort)**
- 4. When you Saw it (2:35 PM)**



# Basic Radar

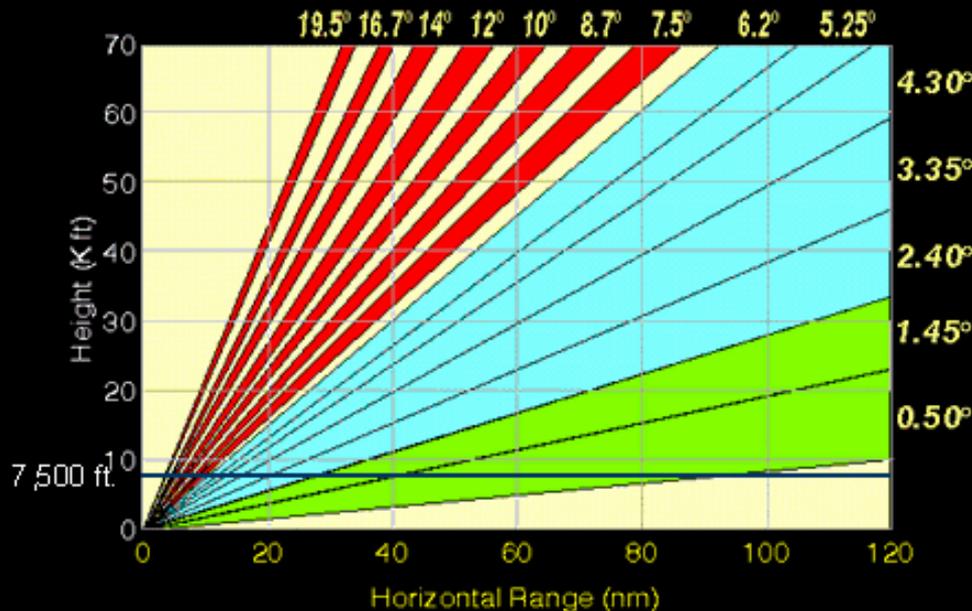


## Radar Horizon



**Volume Coverage Pattern 11**  
Number of Scans:14 Beam Width:0.95

Phenomena of similar sizes are not necessarily resolvable at near and far ranges.

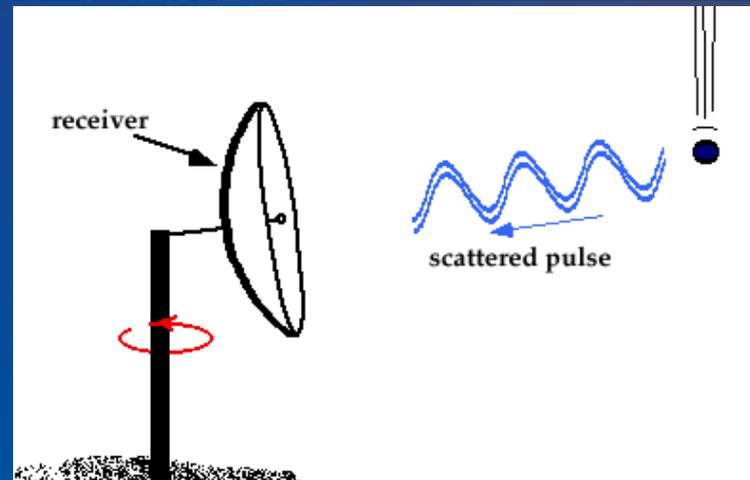
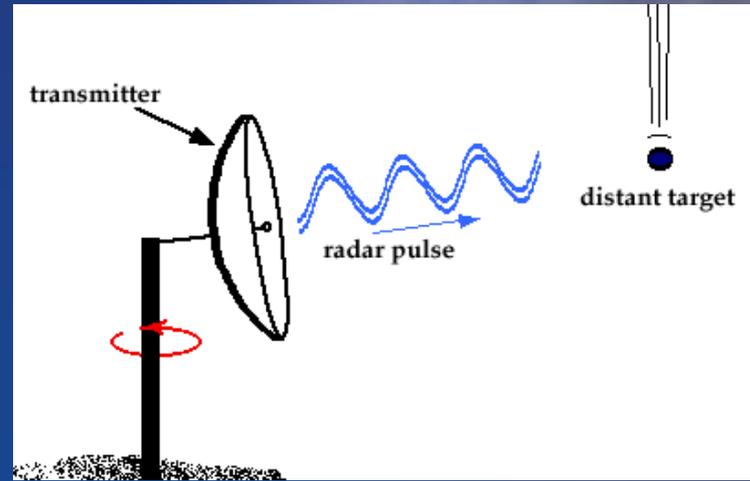
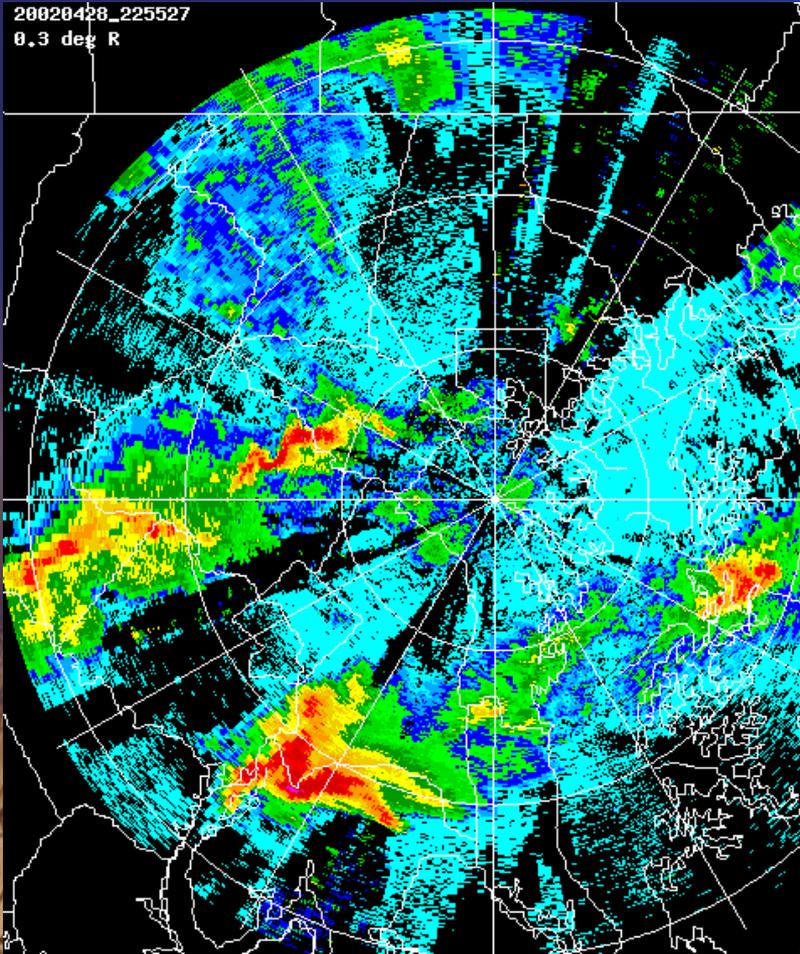


A 7,500 ft. circulation is easily resolved at 20 - 30 nautical miles, but the same circulation cannot be seen by the radar 100 nautical miles away.



# Radar Principles

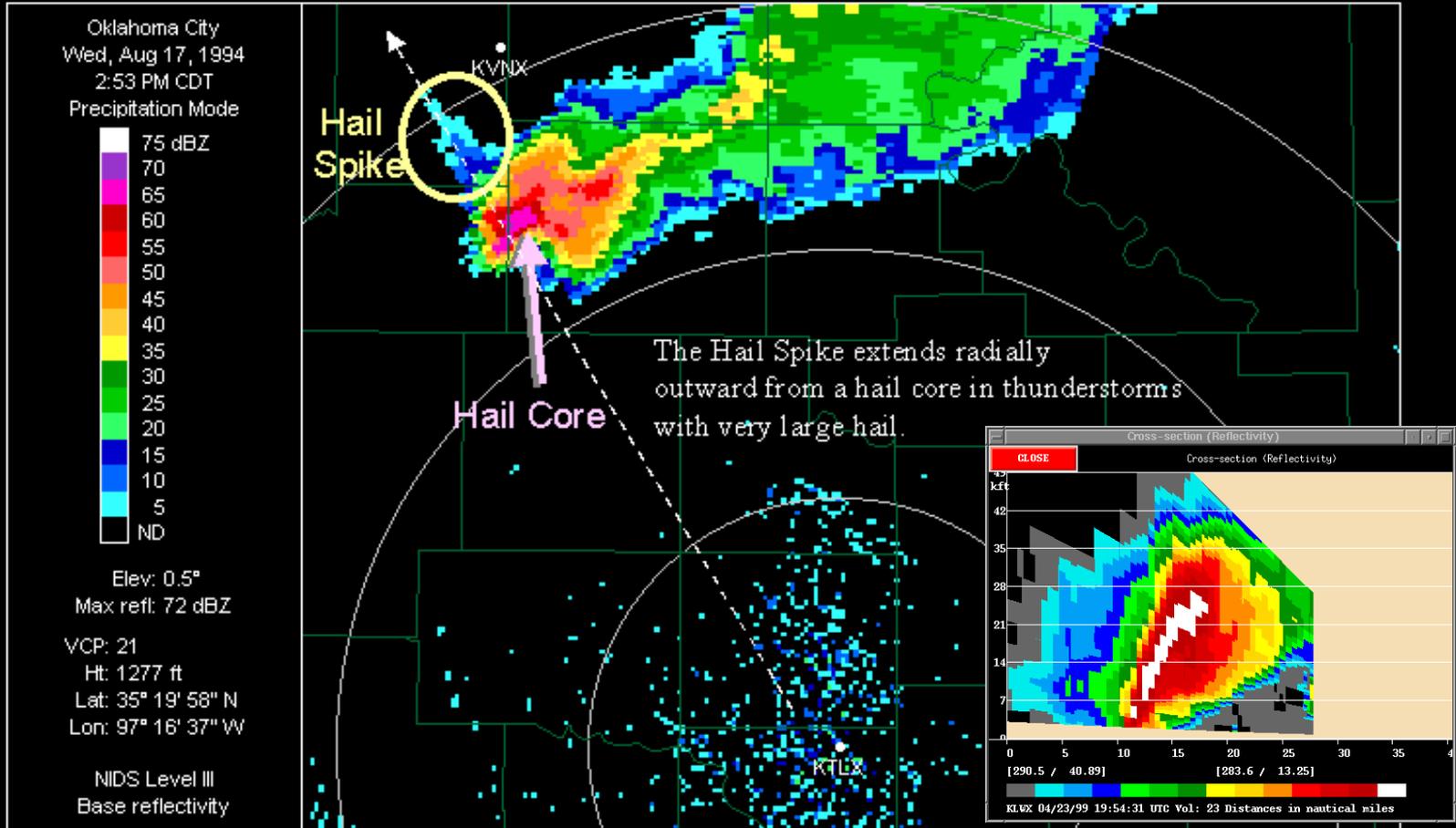
## Reflectivity





# Hail Indicators

## Three-Body Scatter Spike/Hail Spike Example



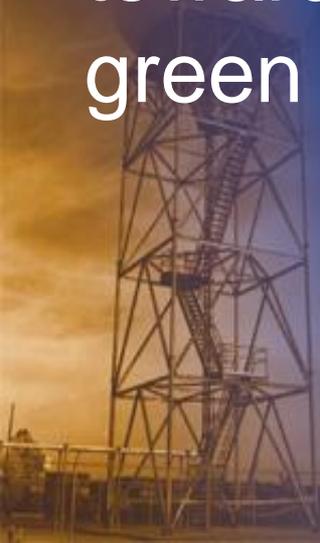
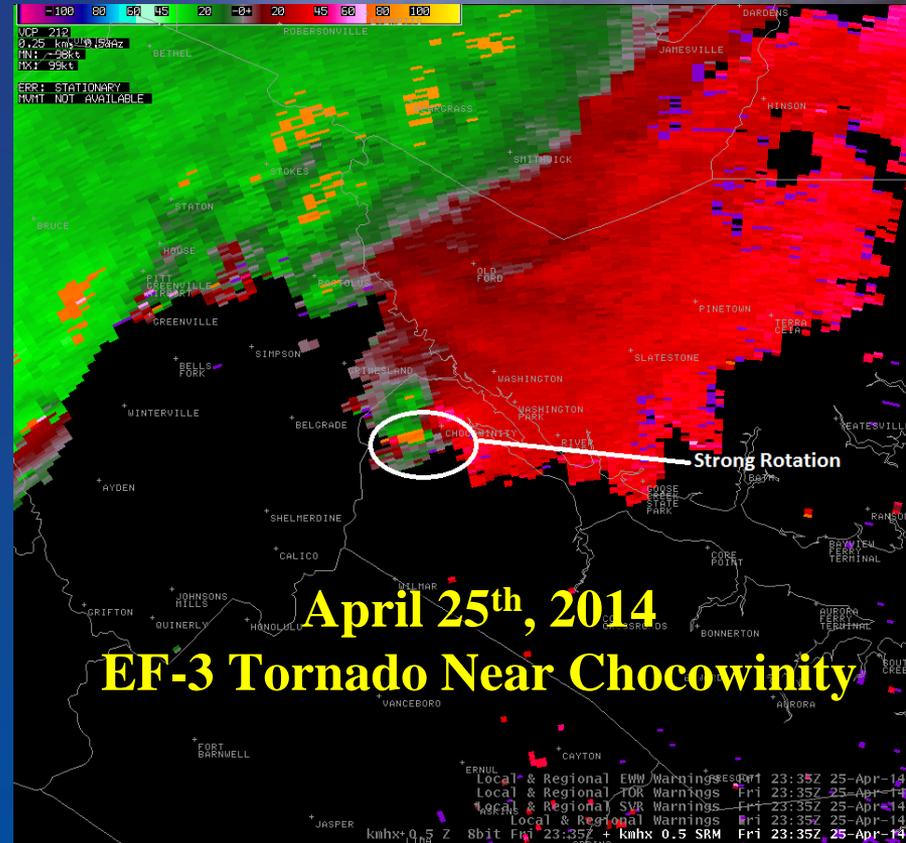
Cross-section of April 23, 1999 Hail Storm over Northern Virginia



# Doppler Winds

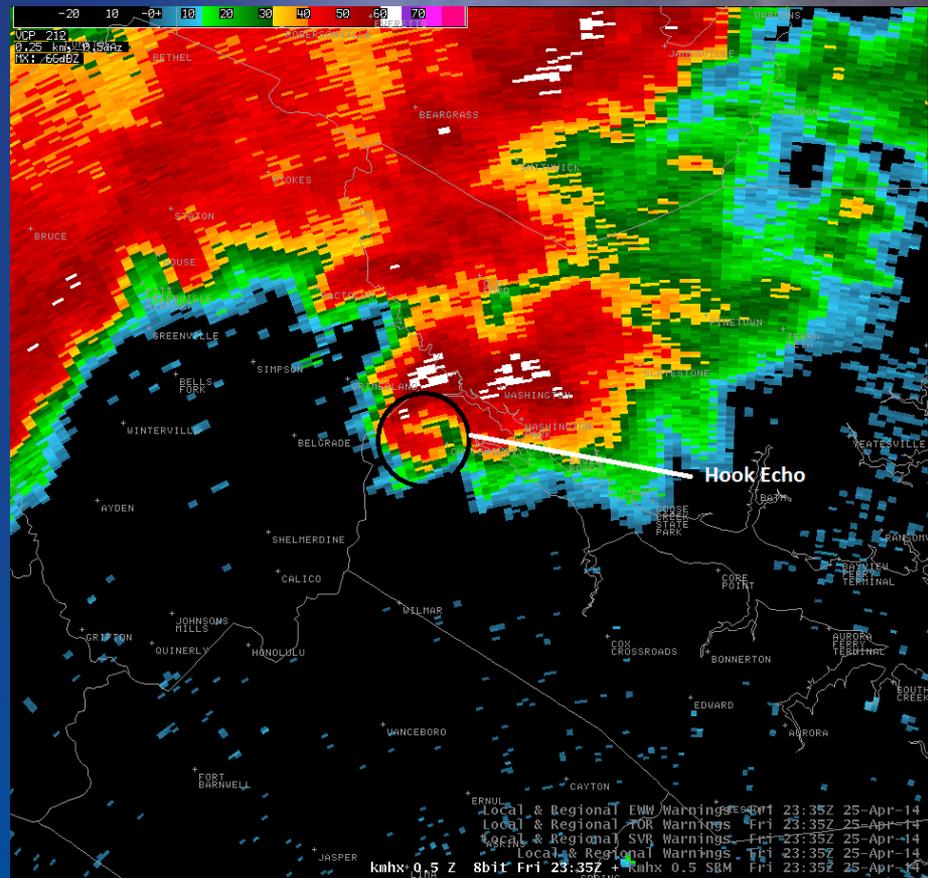
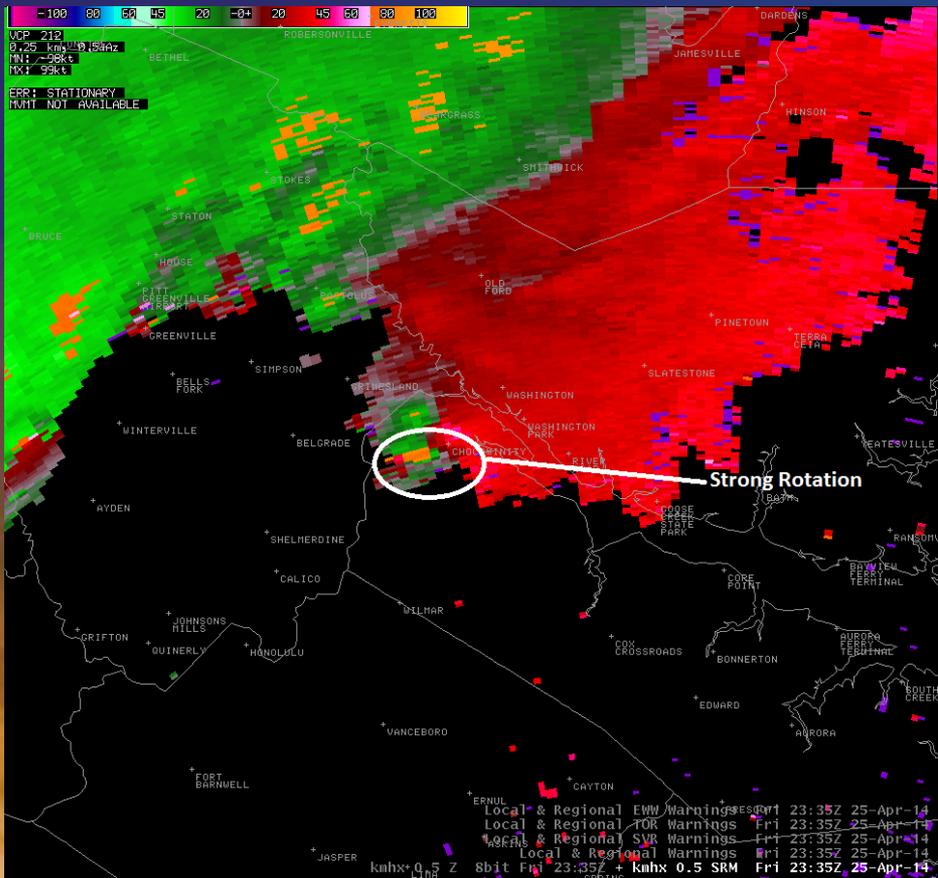


- Particles moving away from the radar appear red
- Particles moving toward the radar appear green





# Radar Velocity and Reflectivity

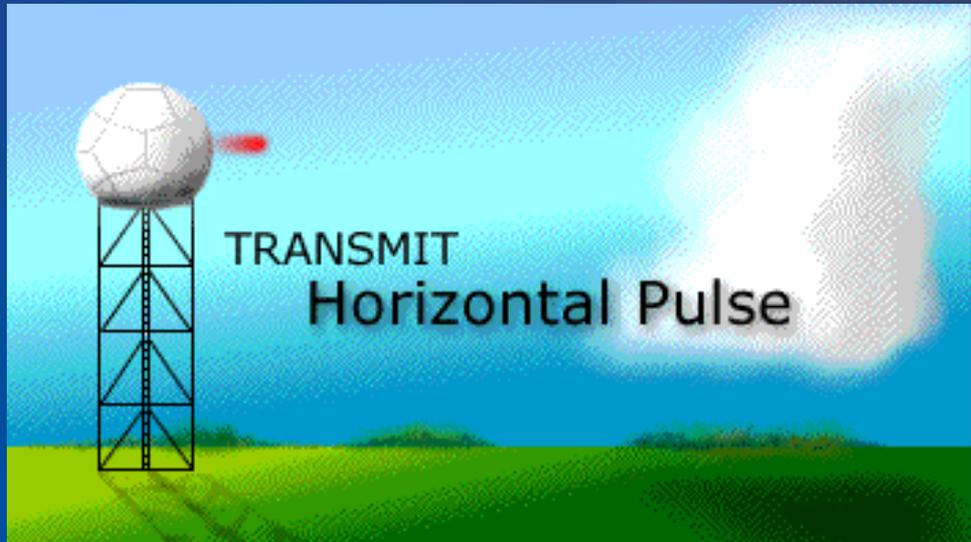
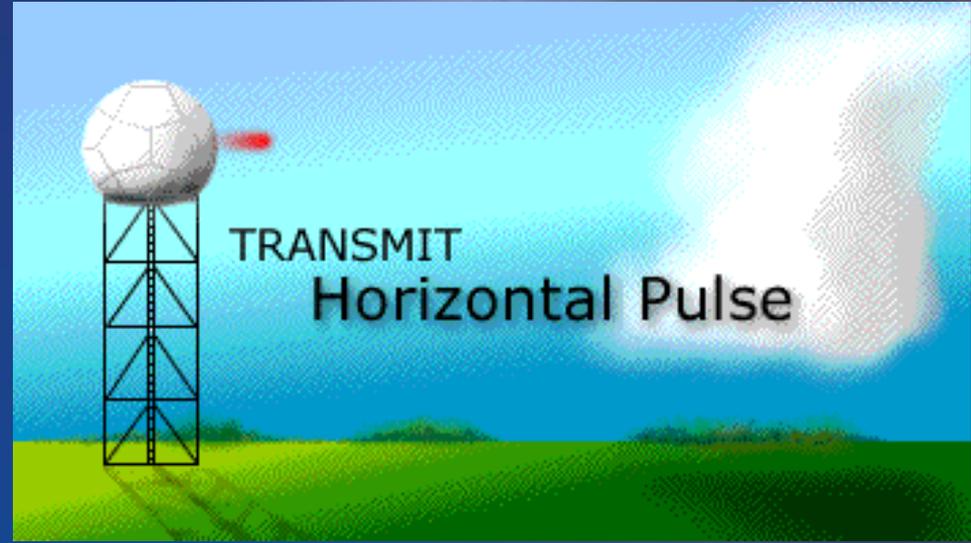
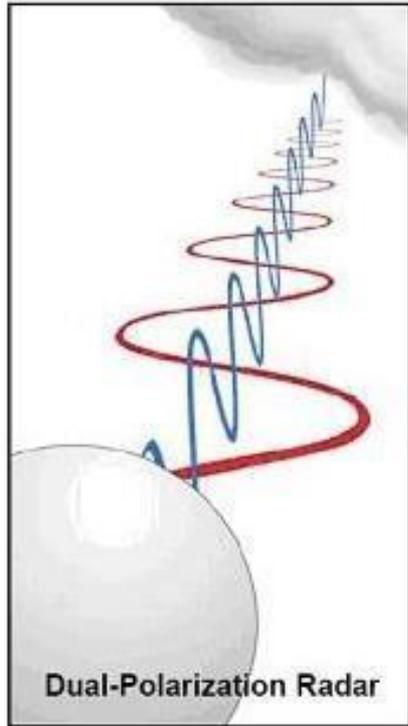
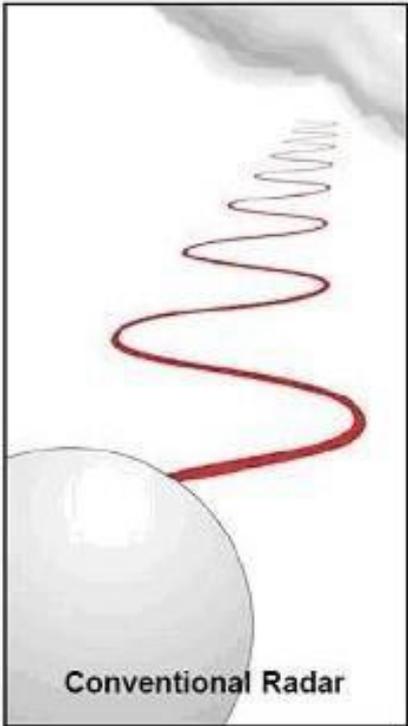


April 25<sup>th</sup>, 2014

EF-3 Tornado Near Chocowinity



# Dual Polarization





# New Products for Analysis

- **Differential Reflectivity ZDR**
  - *Difference between returned power from the horizontal and the vertical planes.*
- **Correlation Coefficient CC**
  - *Degree of “homogeneity” of the radar echoes.*
- **Specific Differential Phase KDP**
  - *Helps determine the amount of liquid water in storms and precipitation systems.*





# Biological Scatterers



- **Birds, insects, bats, anything else alive that flies...**
- **Complex, irregularly-shaped**
- **Often mixed types**
  - *What dominates signal?*





# Correlation Coefficient (CC)



$$0.0 < CC < 1.0$$

Fraction of "perfect" consistency between H & V

Non-Meteor  
(birds, insects...)

Meteor (Non-Uniform)  
(hail, melting snow...)

Meteor (Uniform)  
(rain, snow, etc.)



H & V not consistent

H & V sort of consistent

H & V nearly consistent

Low CC  
( $< 0.8$ )

Moderate CC  
( $0.80$  to  $0.97$ )

High CC  
( $> 0.97$ )



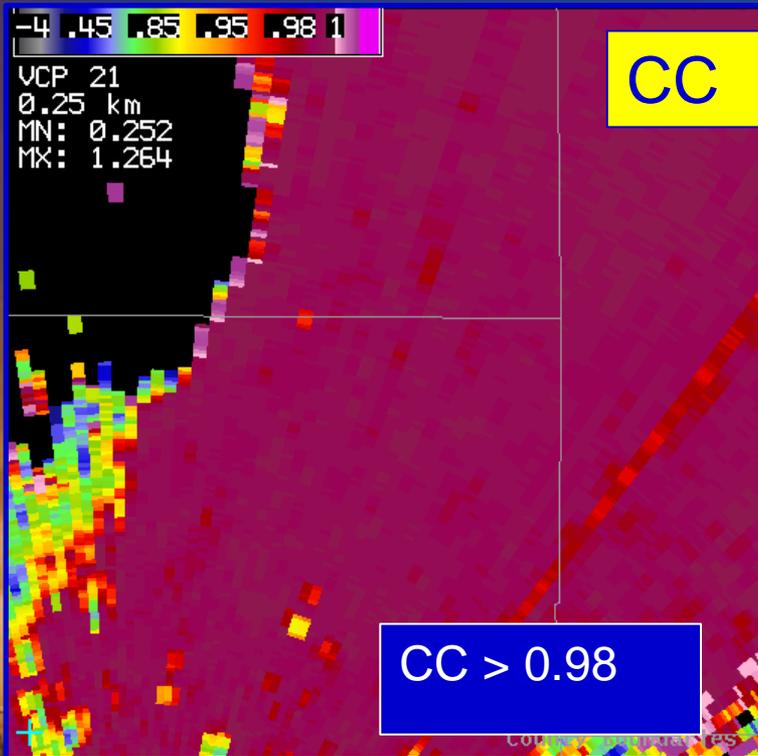
# Correlation Coefficient (CC)



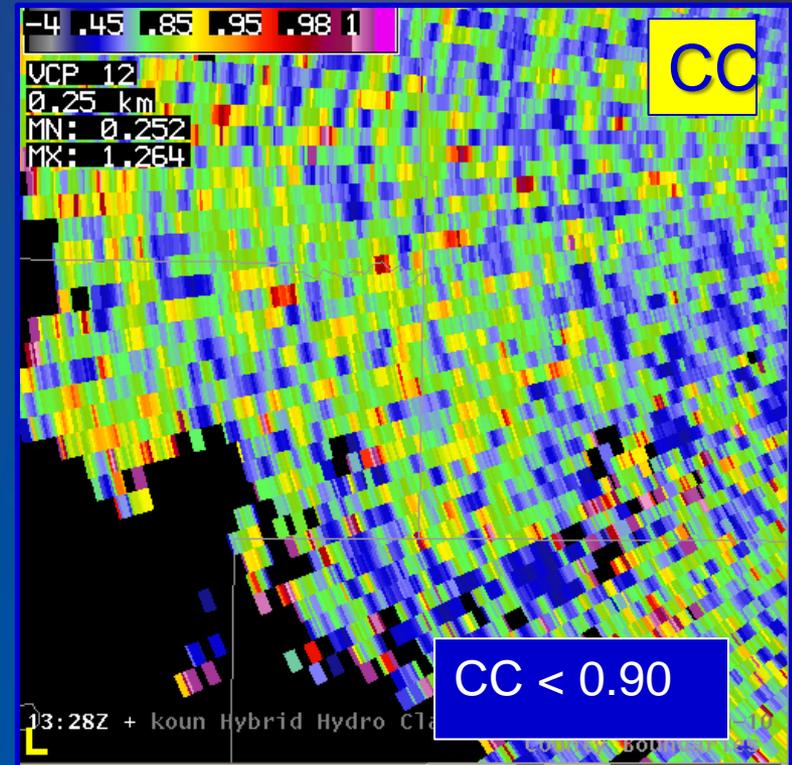
$$0.0 < CC < 1.0$$

Fraction of "perfect" consistency between H & V

How about this?

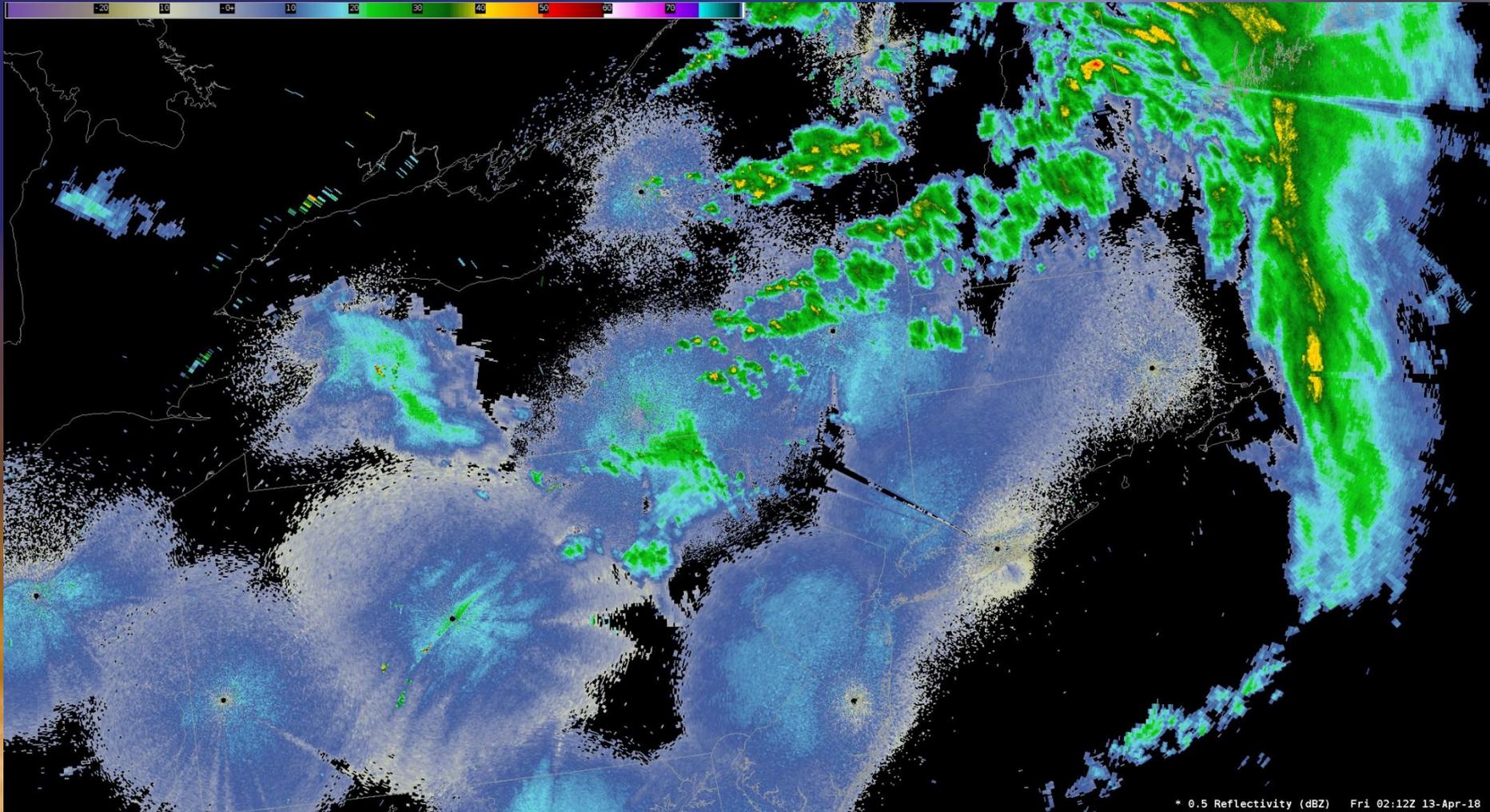


How about *this*??





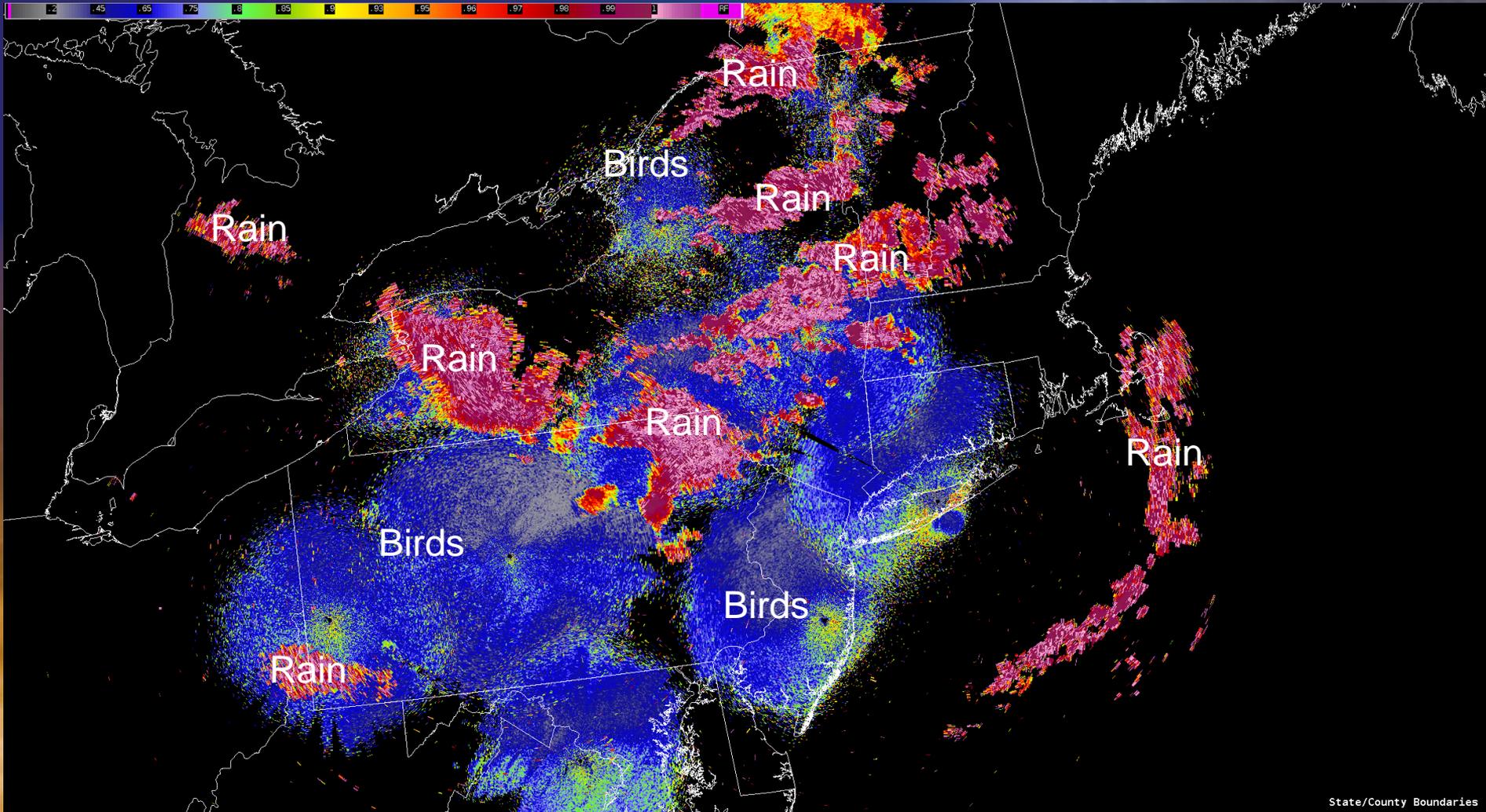
# Bird Migration and Rain



\* 0.5 Reflectivity (dBZ) Fri 02:12Z 13-Apr-18



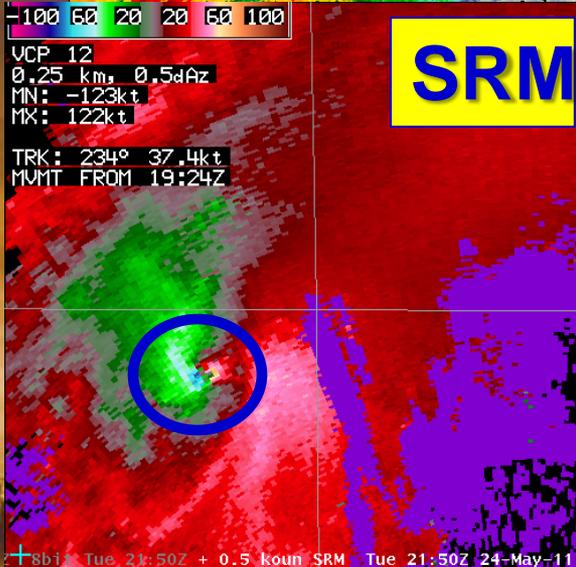
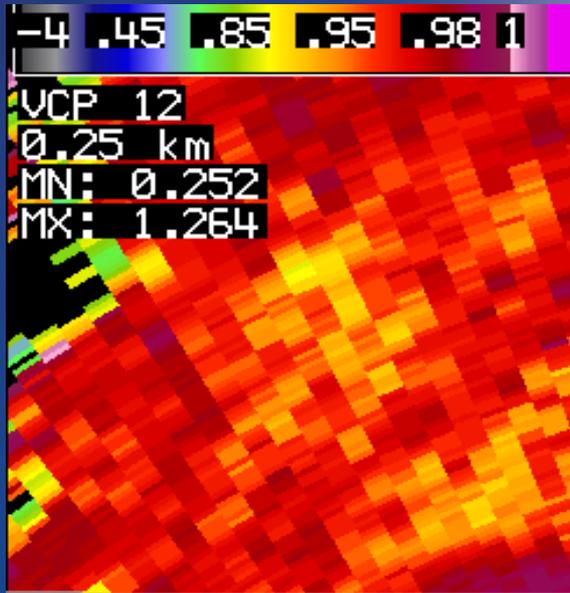
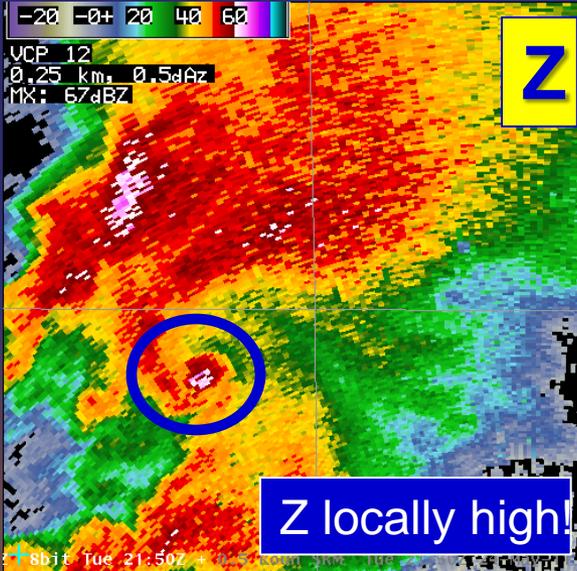
# Bird Migration and Rain CC



State/County Boundaries



# What Dual-Pol Base Data Does For Meteorologists



CC ~ < 0.80



# Why are we so concerned with Thunderstorms?



- Lightning
- High winds
- Heavy rain
- Hail
- Tornadoes
- Flash flooding





# What is a Severe Thunderstorm?



- A thunderstorm that produces
  - *Wind gusts of 58 mph or more and/or*
  - *Hail 1” in diameter or larger.*
  - *Statistically, structural damage begins with winds > 58 mph.*
  - *Keep in mind: all thunderstorms have lightning and are dangerous.*

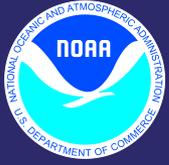


# Thunderstorm Ingredients



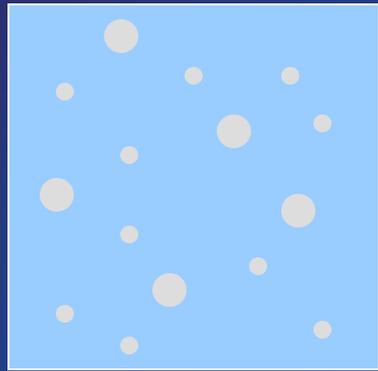
- **Instability**
- **Moisture**
- **Lifting Mechanism**
- **Wind Shear**



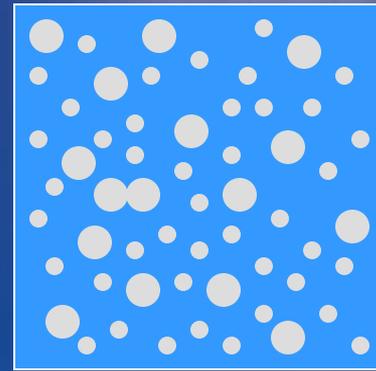


# Instability

## Cold air versus Warm air



Same size  
air parcels  
←→



Warm air molecules are actively moving around limiting the number of molecules that an air parcel can hold. With less molecules per area, it is lighter.

Cold air parcel packs in a lot of molecules. There is less movement. With more molecules per area, this air is heavier and denser.



# Instability



## Atmospheric Instability

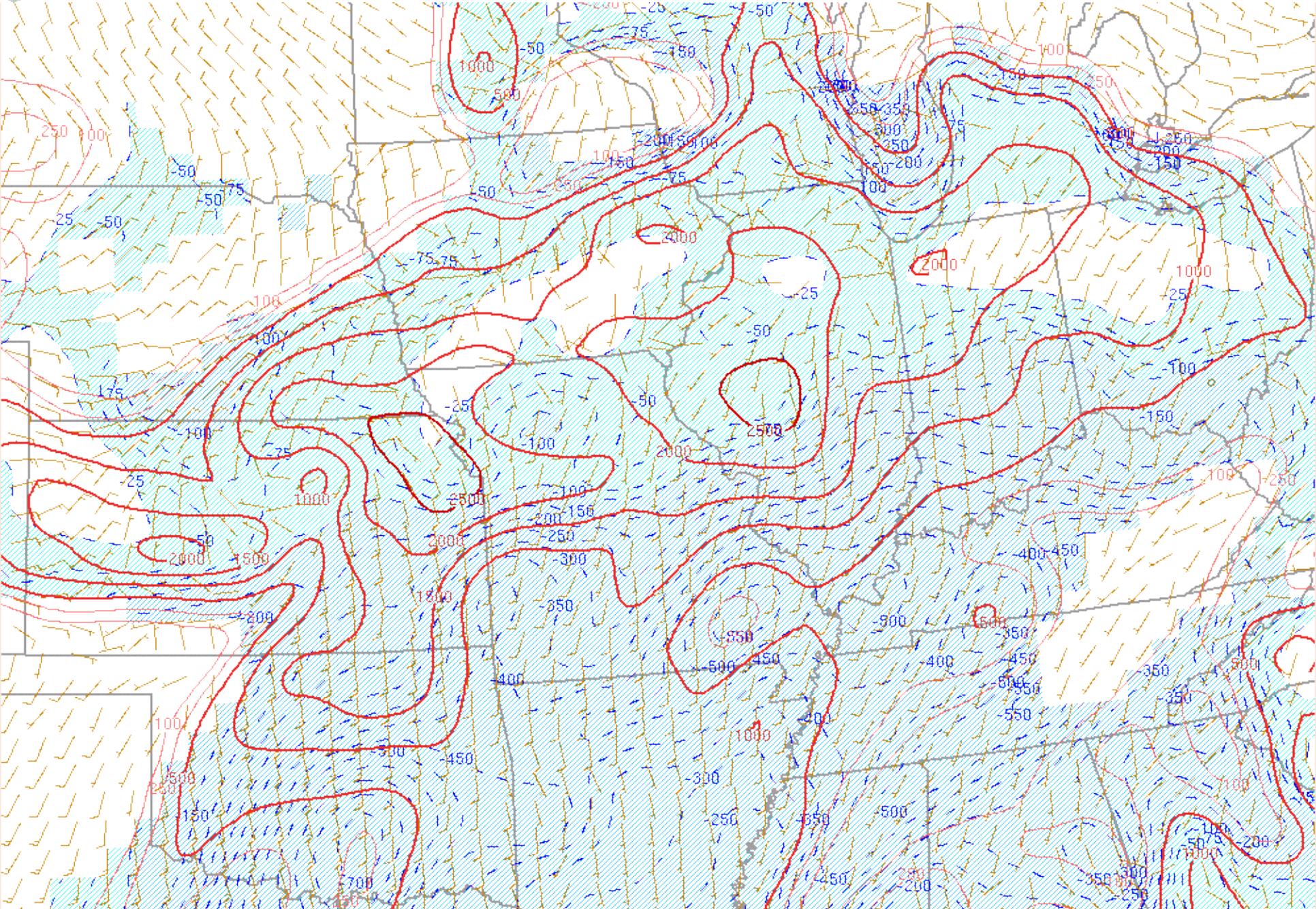




# A measure of instability: Convective Available Potential Energy (CAPE)



- A measure of potential energy available in the air because of buoyancy
- CAPE 500 to 1000 J/kg produces thunderstorms, perhaps severe.
- CAPE 1000 to 2500 J/kg More likely to produce severe thunderstorms and at times even tornadoes.
- CAPE  $>$  2500 J/kg major severe weather outbreaks, including tornadoes and major wind damage events.
- The higher value the more energy available and the higher potential for severe weather!



140521/0100 MLCAPE (contour) and MLCIN (J/kg, shaded)



# Instability = Updraft Strength = Strength of Storm



- Leads to Updraft in a storm
- Stronger the instability, the stronger the updraft.
- The stronger the updraft the more powerful the storm.
- Ordinary thunderstorms
  - *30-50 mph updrafts*
- Severe thunderstorms
  - *50-70 mph updrafts*
- Supercells
  - *> 100 mph!!!*



# Thunderstorm Ingredients



- **Instability**
- **Moisture**
- **Lifting Mechanism**
- **Wind Shear**



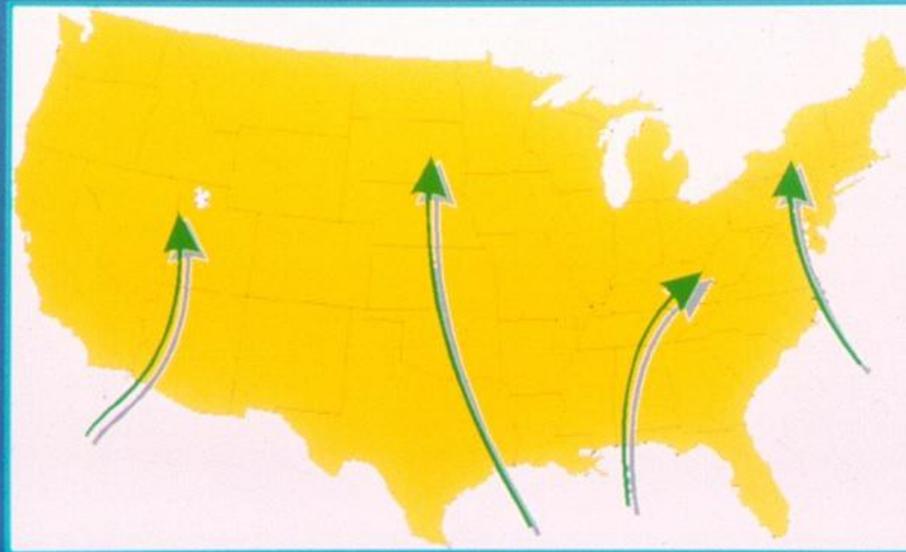


# Moisture- next ingredient



- Moisture
- Increases Instability
- Increases updraft strength

## Thunderstorm Moisture Sources





# How does Moisture Increase Instability?



## Dry air versus Moist air

| Molecule                   |                  | Weight |
|----------------------------|------------------|--------|
| Nitrogen (N <sub>2</sub> ) | 78% of air       | 28     |
| Oxygen (O <sub>2</sub> )   | 21% of air       | 32     |
| Water Vapor                | H <sub>2</sub> O | 18     |

Water vapor is lighter than air!



# How does moisture increase updraft strength?



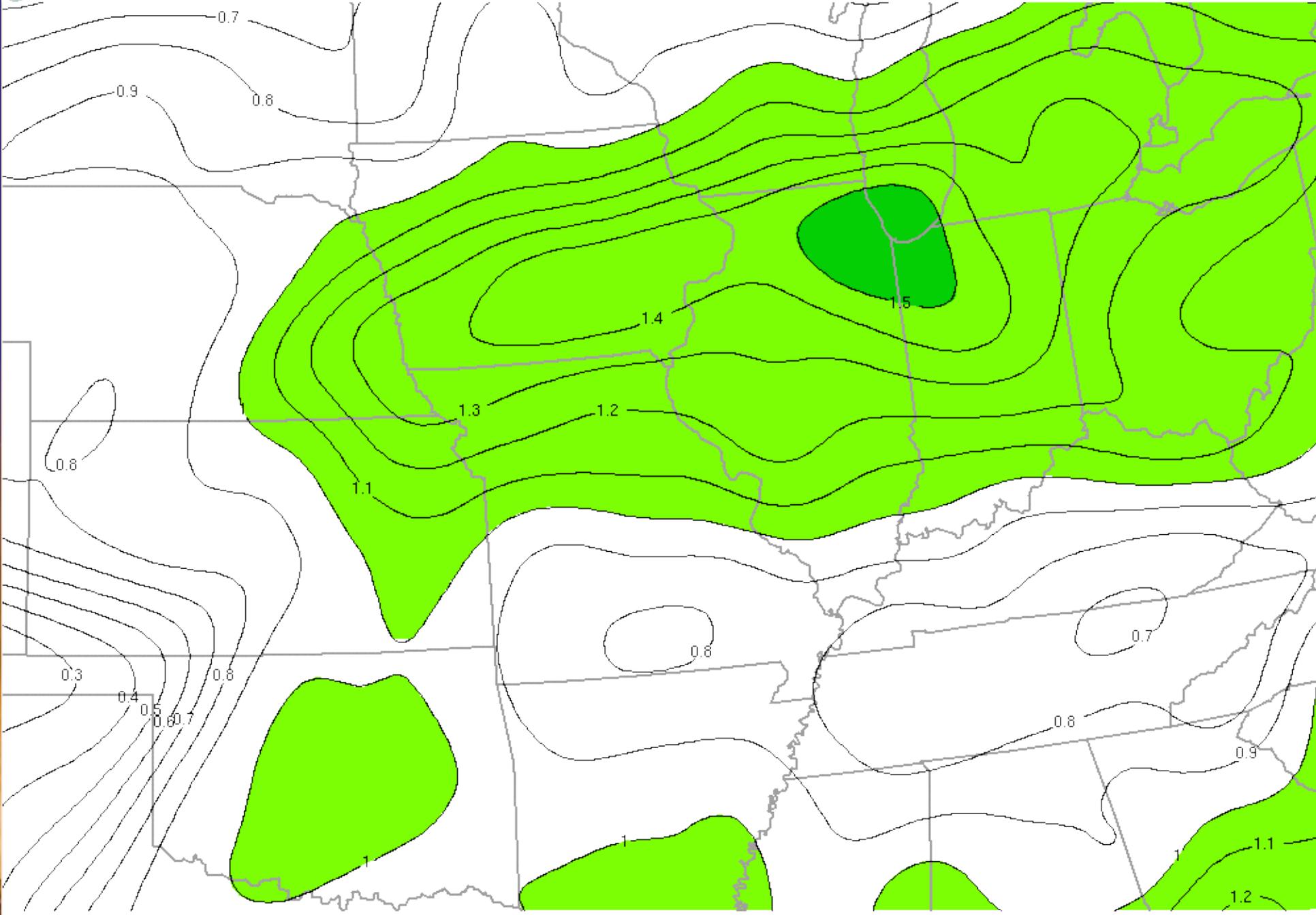
- When moisture condenses to form clouds heat is released.
- This heat also adds to the instability.





# Precipitable Water

- How much water is in the atmospheric column above you?
- Measured in inches.
- Generally 1-2 inches is needed for thunderstorms.
- > 2 inches could mean flash flooding.



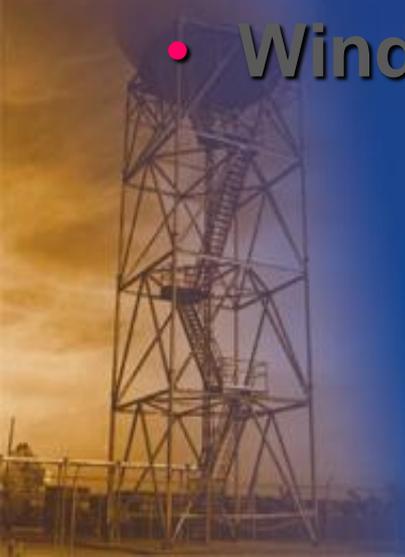
140521/0200 precipitable water (in) lowest 400 mb



# Thunderstorm Ingredients

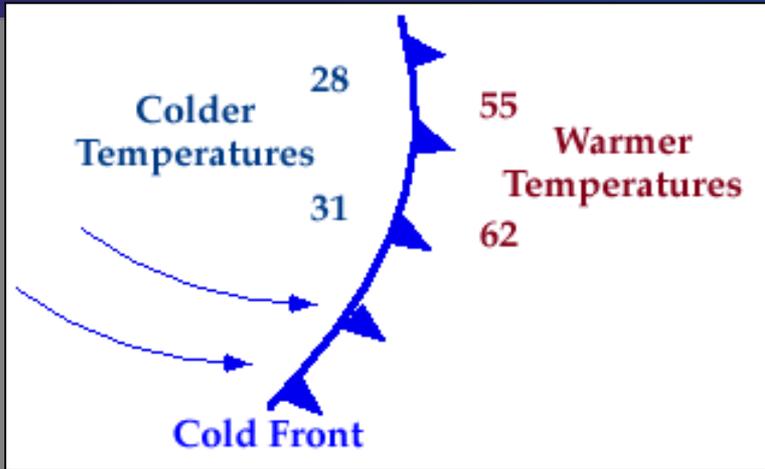


- **Instability**
- **Moisture**
- **Lifting Mechanism**
- **Wind Shear**

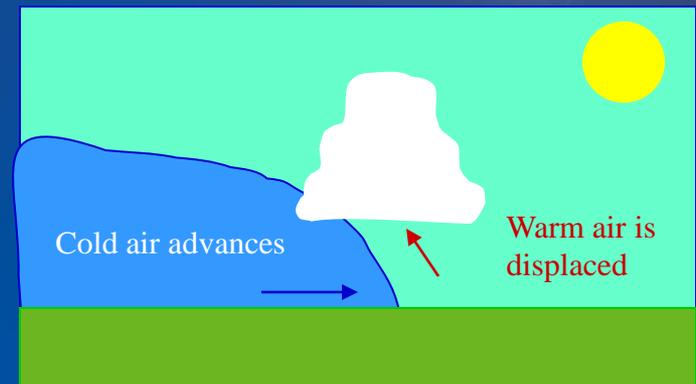
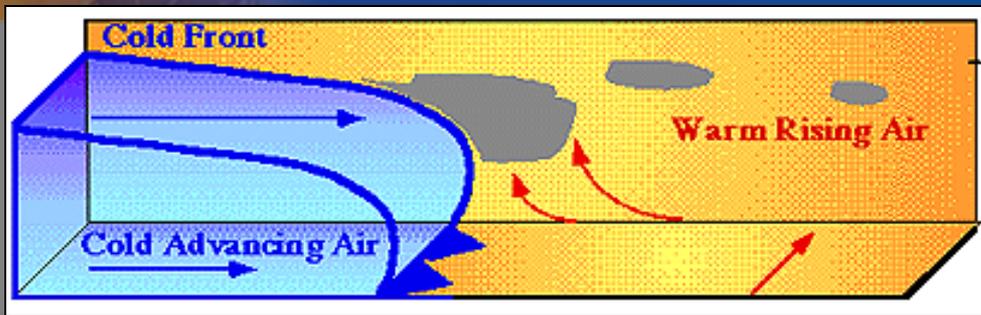




# Cold Front

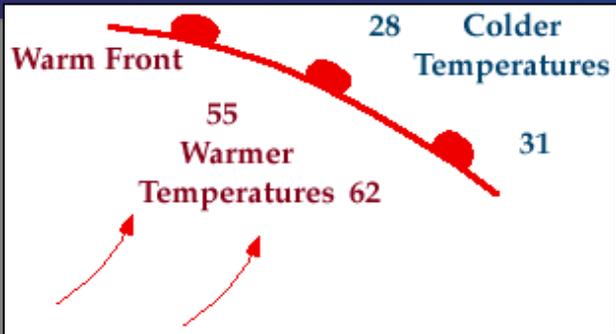


Colder air is denser than the warm air ahead of the front. The warmer air is forced to rise up. If the air is unstable, it will keep rising. Cold fronts often initiate lines of showers and thunderstorms.

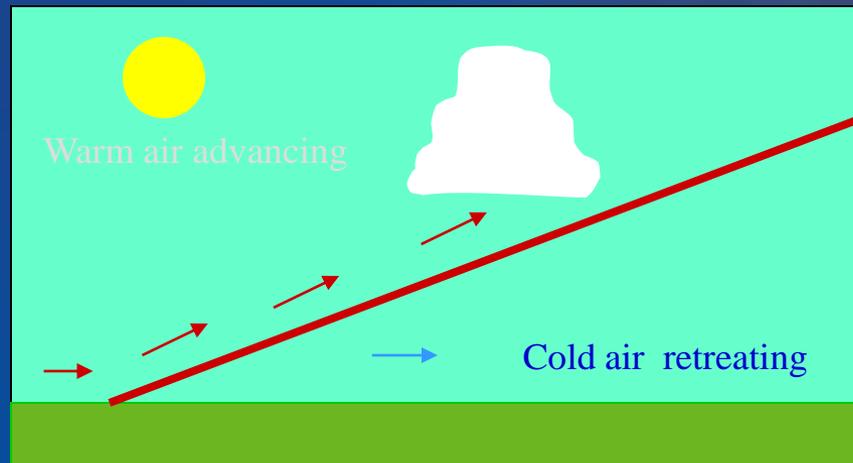
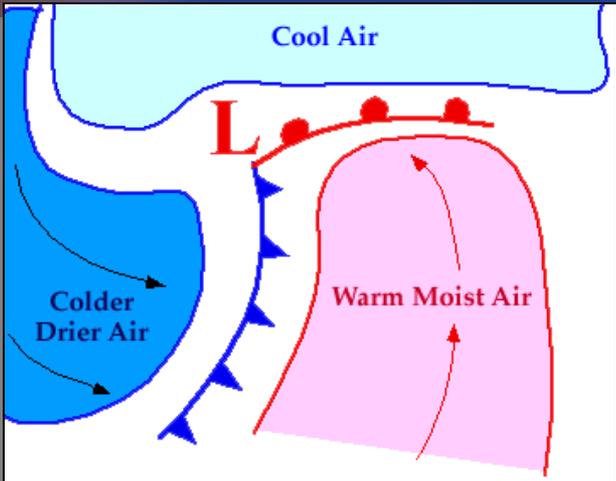




# Warm Front



Again, the colder air is denser than the warm air. As the warm air encounters the cold air, it is forced to rise up and over. If the air is unstable, showers and thunderstorms can form.



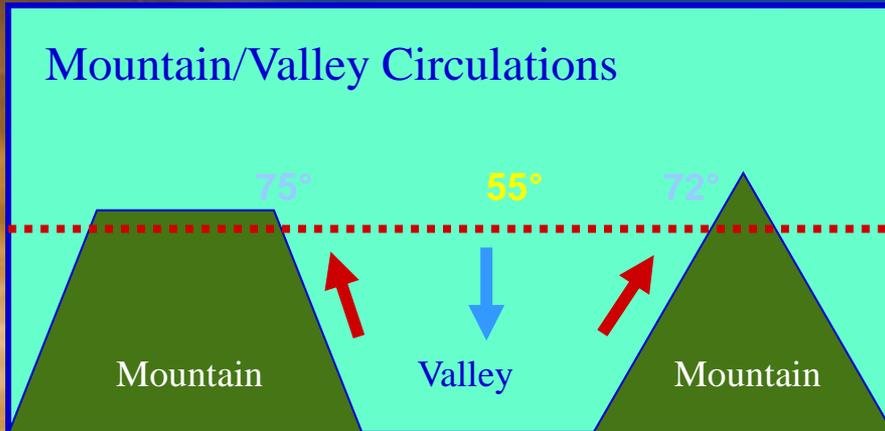


# Mountains



- **Lift**

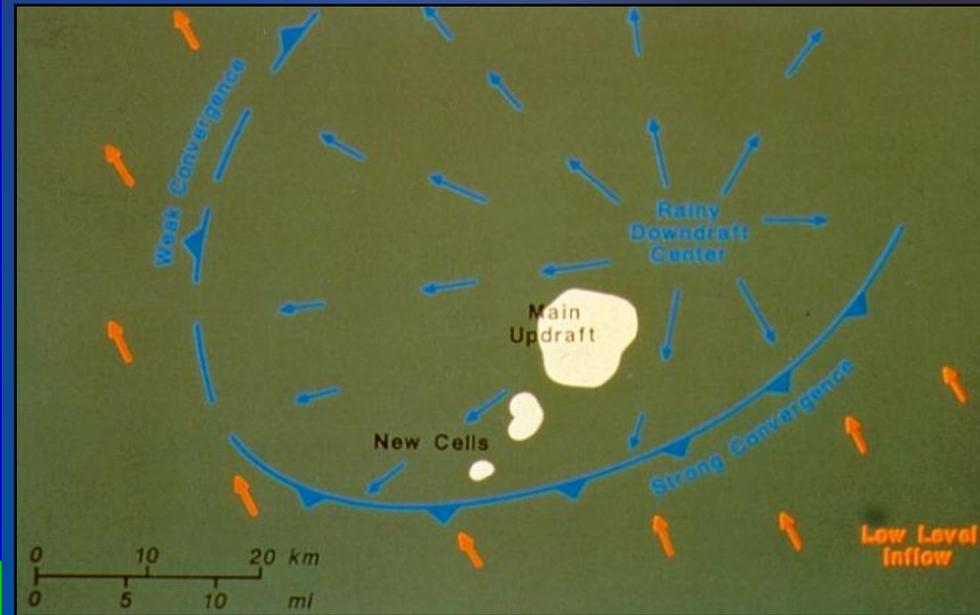
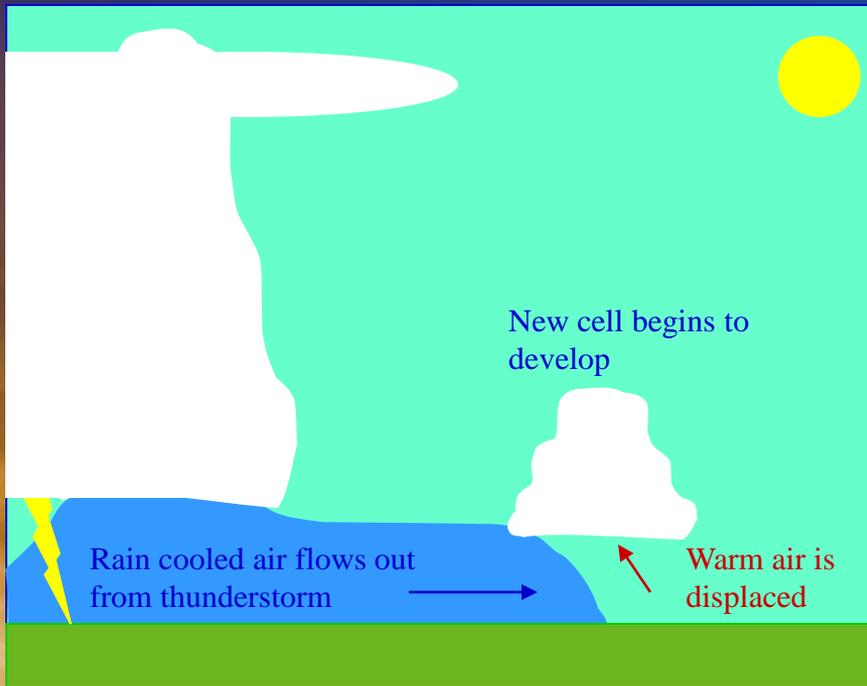
- *Mountains are a barrier*
- *Heat up more than air over valley*





# Thunderstorm Outflow

Cool air flowing out of a thunderstorm acts like a cold front. The rain cooled air displaces the warm air beginning the development of a new storm.





# Thunderstorm Ingredients



- **Instability**
- **Moisture**
- **Lifting Mechanism**
- **Wind Shear**

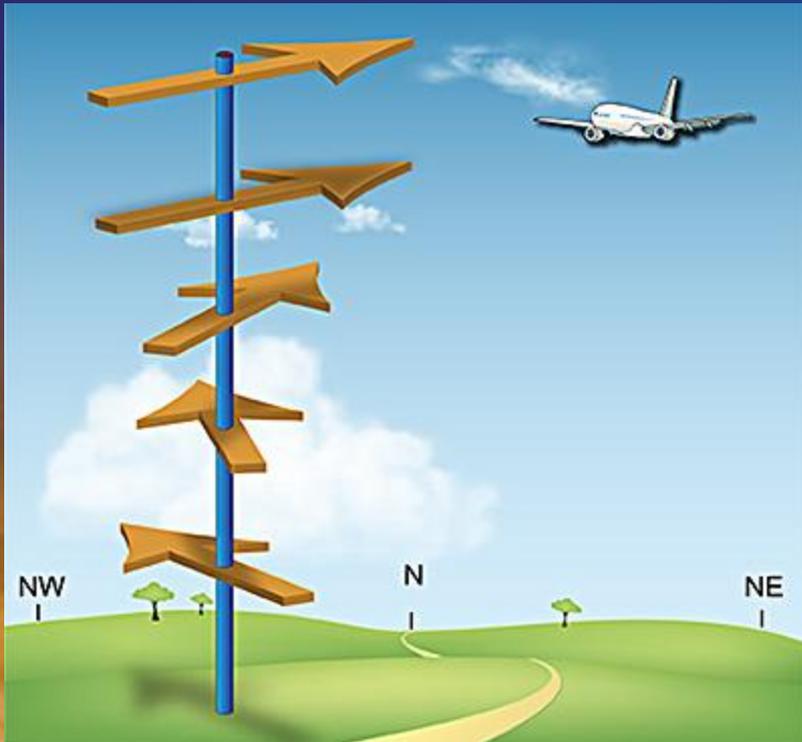




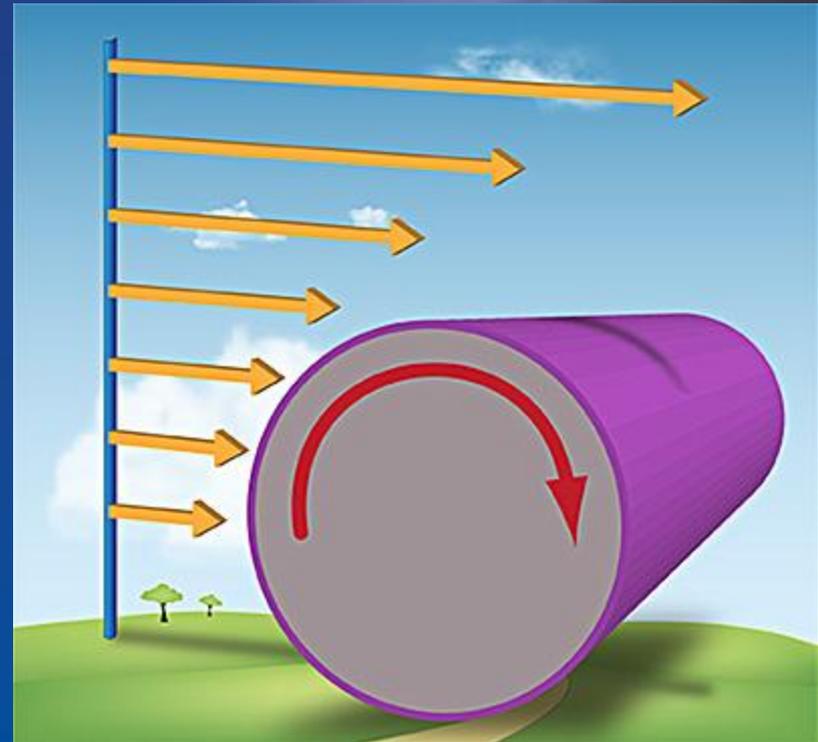
# Wind Shear



## Directional Shear



## Speed Shear

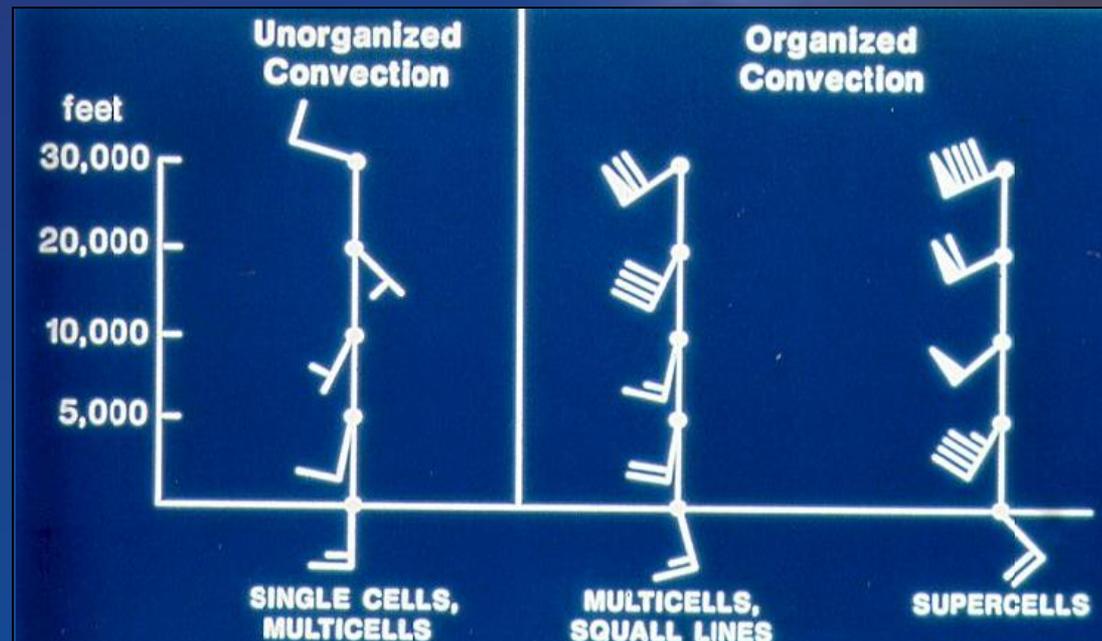




# Wind Shear



- **Instability** determines how strong the storm will be.
- **Wind shear** Determines the type of severe weather



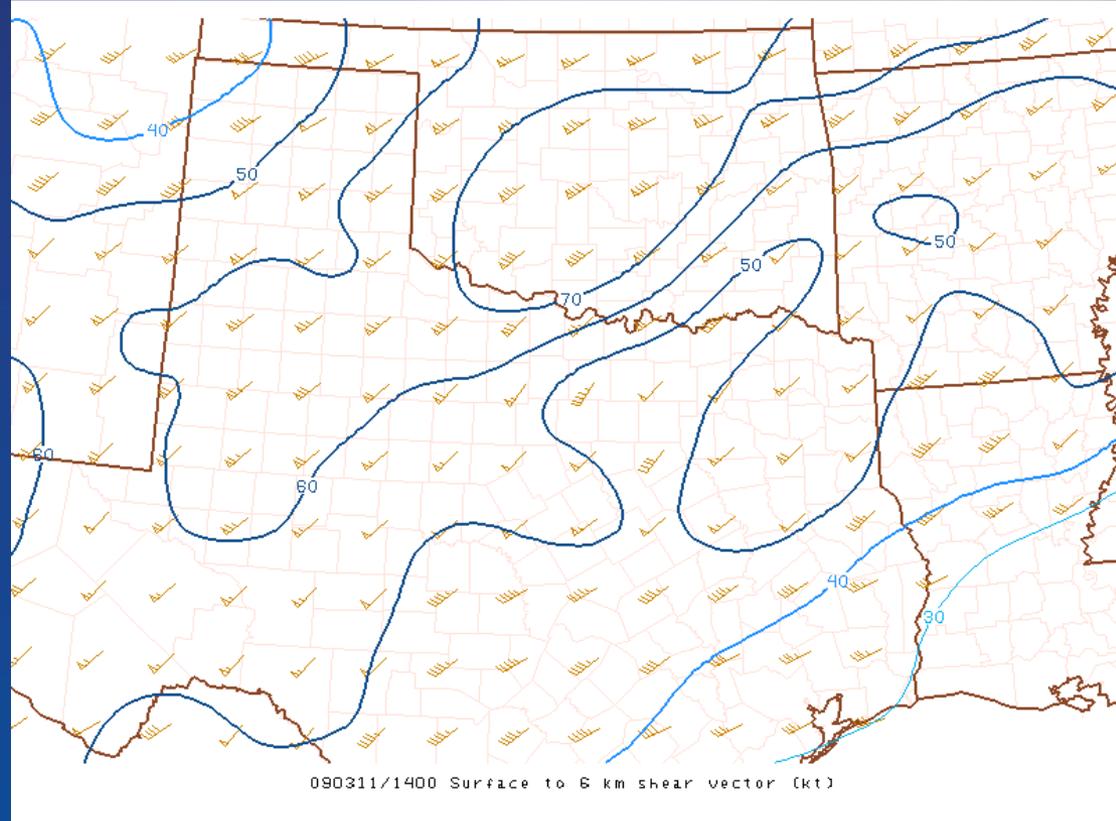
**High instability and high wind shear = trouble!!**



# Measurements of Shear



- Subtract wind speed and direction from 6 km to sfc
- 0-6 km shear commonly used
- Values greater than 35 knots favorable
- Values greater than 50 knots serious
- Values greater than 75 knots dangerous





Single Cell

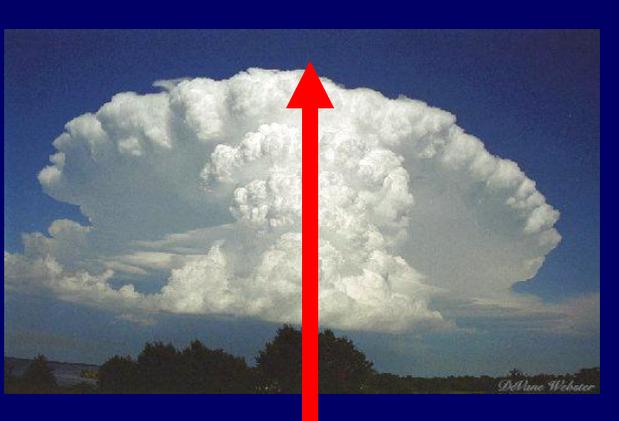
Multicell cluster or line

Supercell

Weak shear

Moderate shear

Strong shear



Copyright Alan Switzer

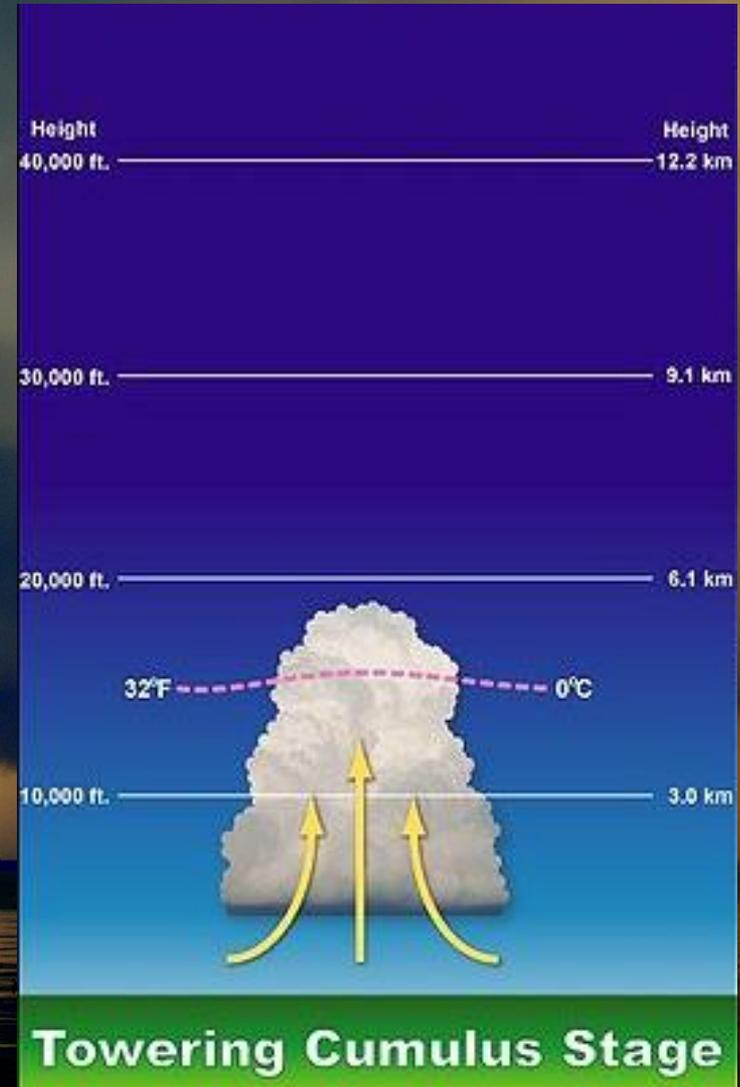


Steven Maciejewski

Updraft Strength or Instability determines how severe the storm is.  
Shear determines type and how long the storm survives.

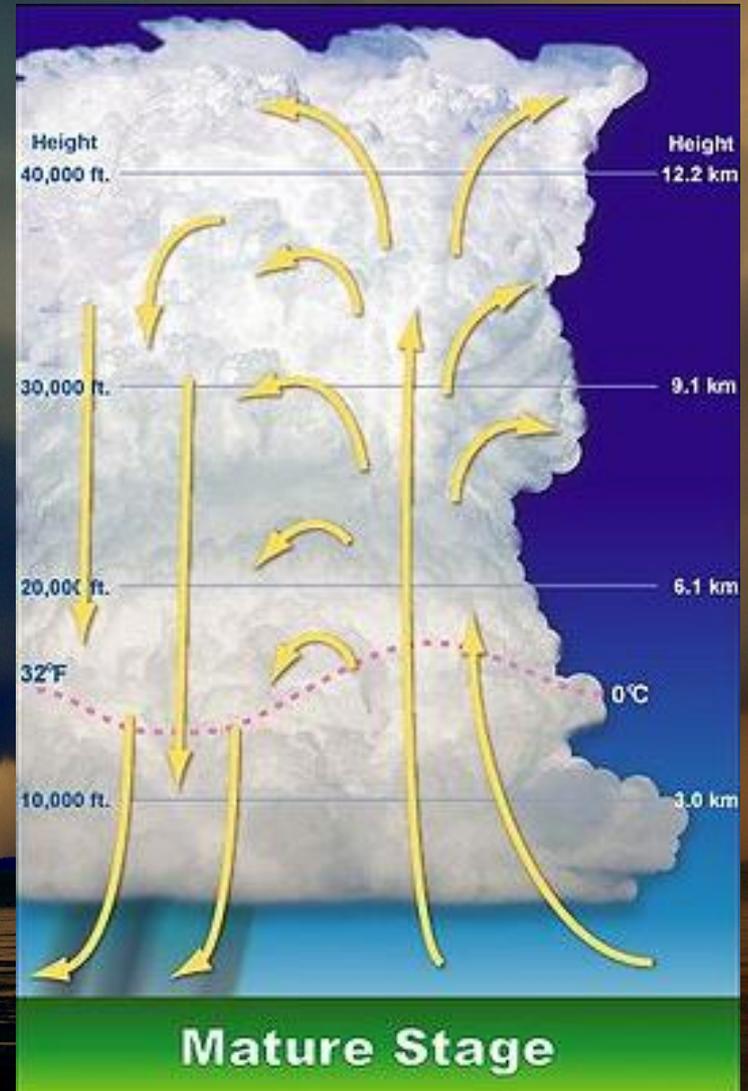
# Thunderstorm Life Cycle

- Developing Stage (towering cumulus).
- Updraft begins.
- Storm begins to produce precipitation in the upper portion of the cloud.
- Think of this as a “baby” storm.



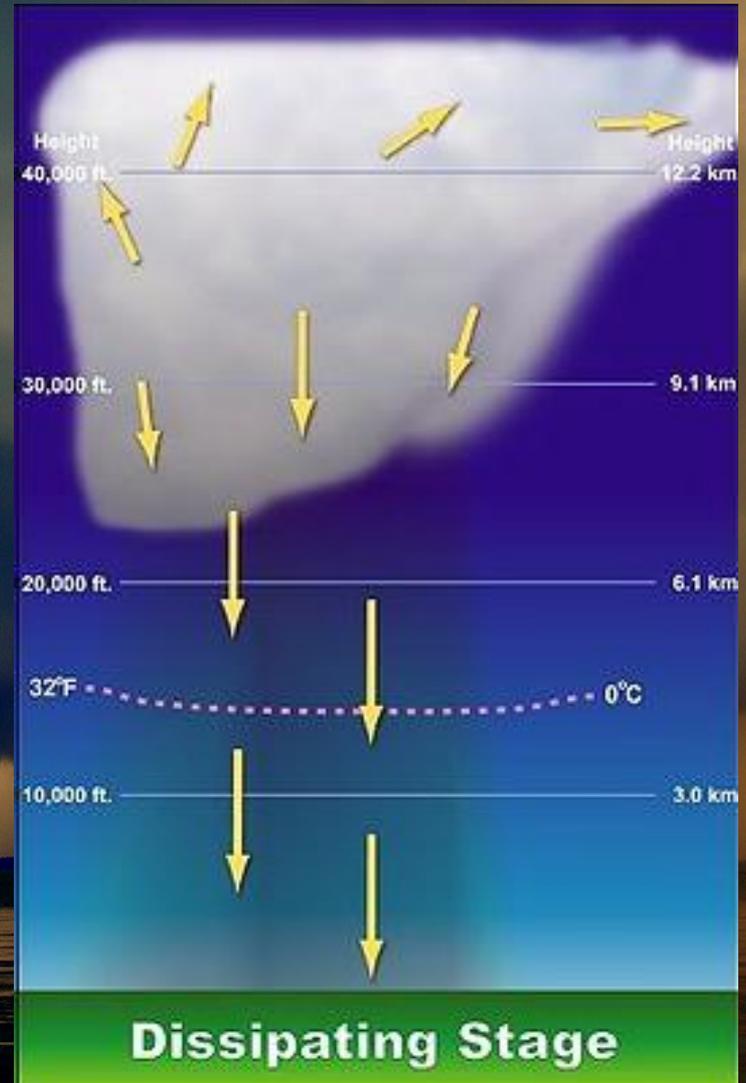
# Thunderstorm Life Cycle

- Mature Stage.
- Updraft/downdraft coexist.
- Downdraft reaches the ground (rain, wind, hail).
- Tornadoes possible (most likely rain free area far right).



# Thunderstorm Life Cycle

- Dissipating Stage.
- Downdraft is dominating.
- Lose favorable warm/moist inflow (fuel) for the storm to maintain itself.



# Intense Downdrafts: Downbursts



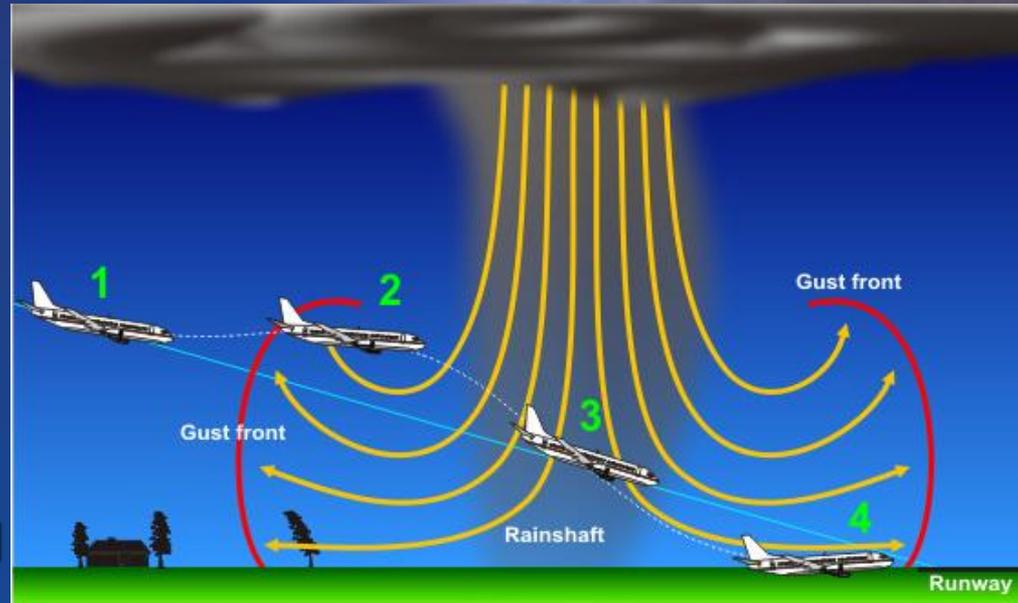
- Intense downdrafts lead to downbursts

  - *Macroburst* (>2.5 mi)

  - *Microburst* (< 2.5 mi)

- Drier air is entrained into the storm in the mid-levels

- Evaporation causes a cold ball air which then descends and accelerates to the ground



***Downburst damage can sometimes look very similar to tornado damage!***





**Single Cell**

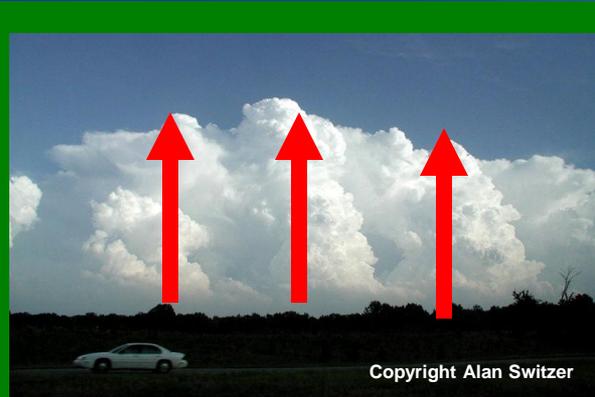
**Multicell cluster or line**

**Supercell**

Weak shear

Moderate shear

Strong shear



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Updraft Strength or Instability determines how severe the storm is.

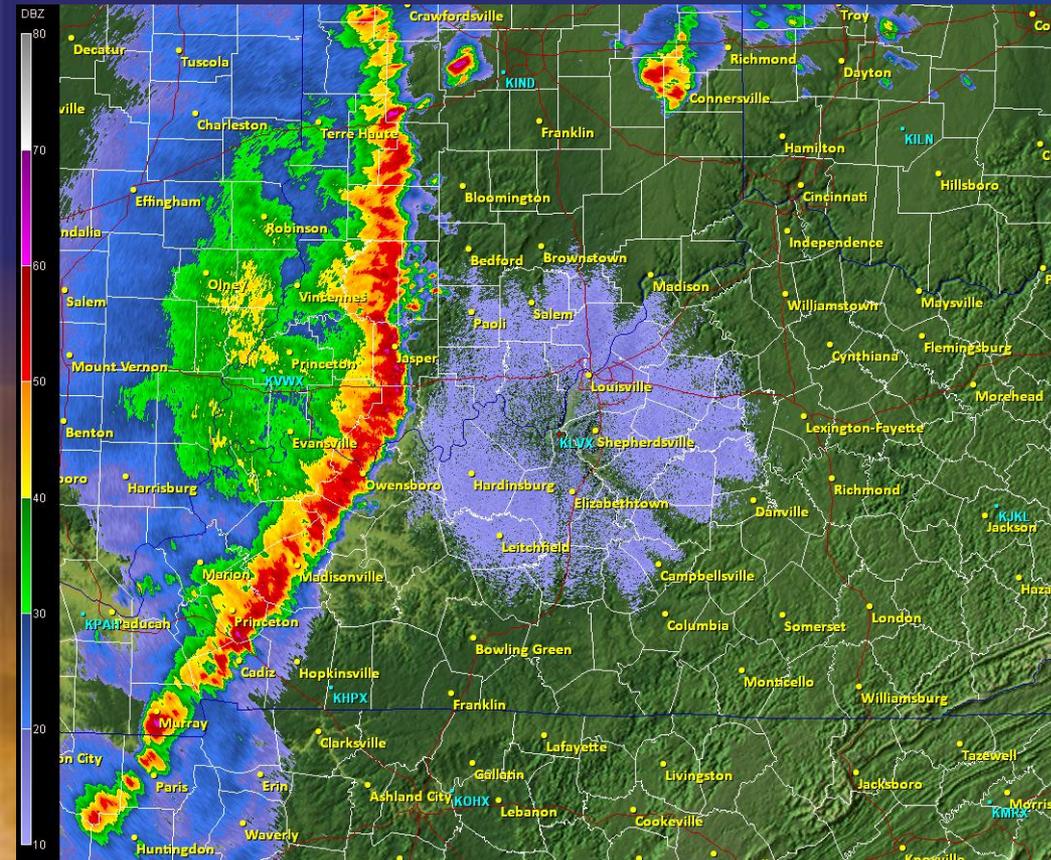
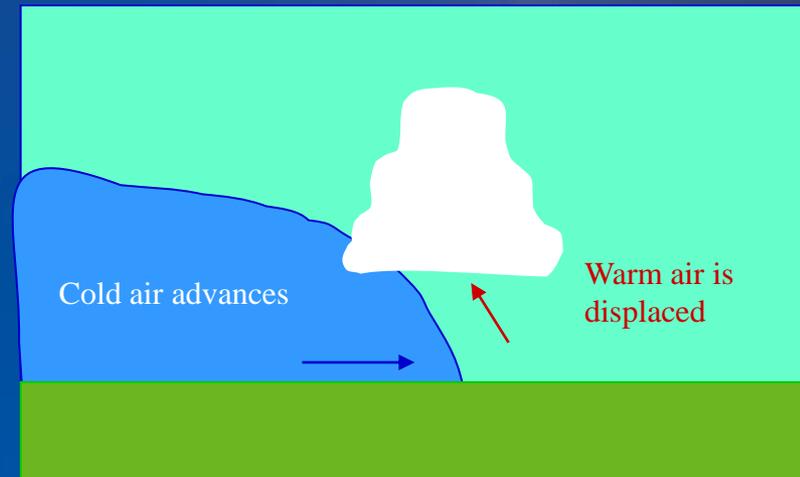
Shear determines type and how long the storm survives.



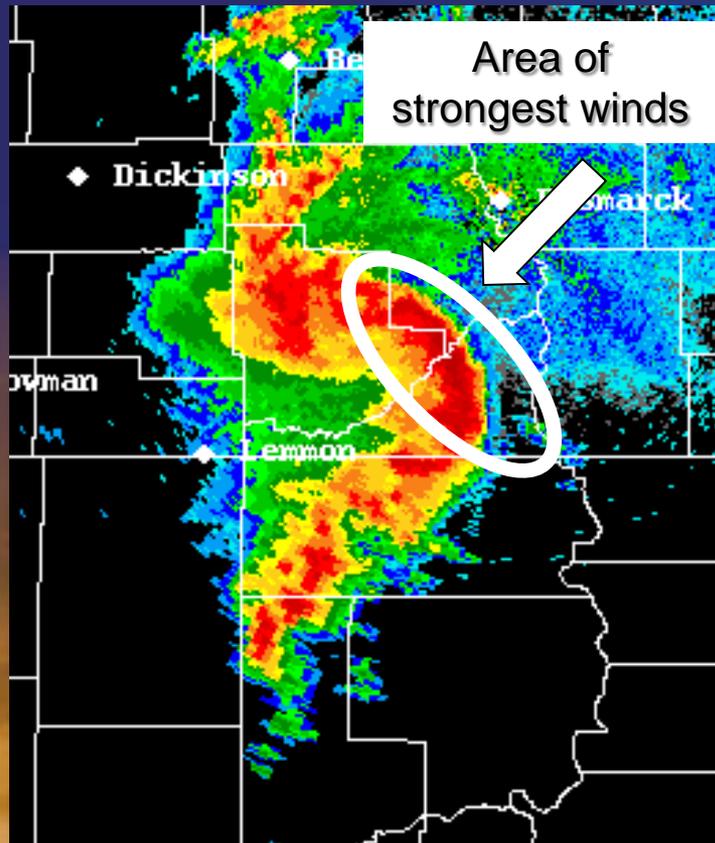
# Squall Lines or Multicell Lines



- Lift mechanism (such as a cold front) is usually the initiator
- Often have winds greater than 50 mph up at 5000 feet pushing the storms



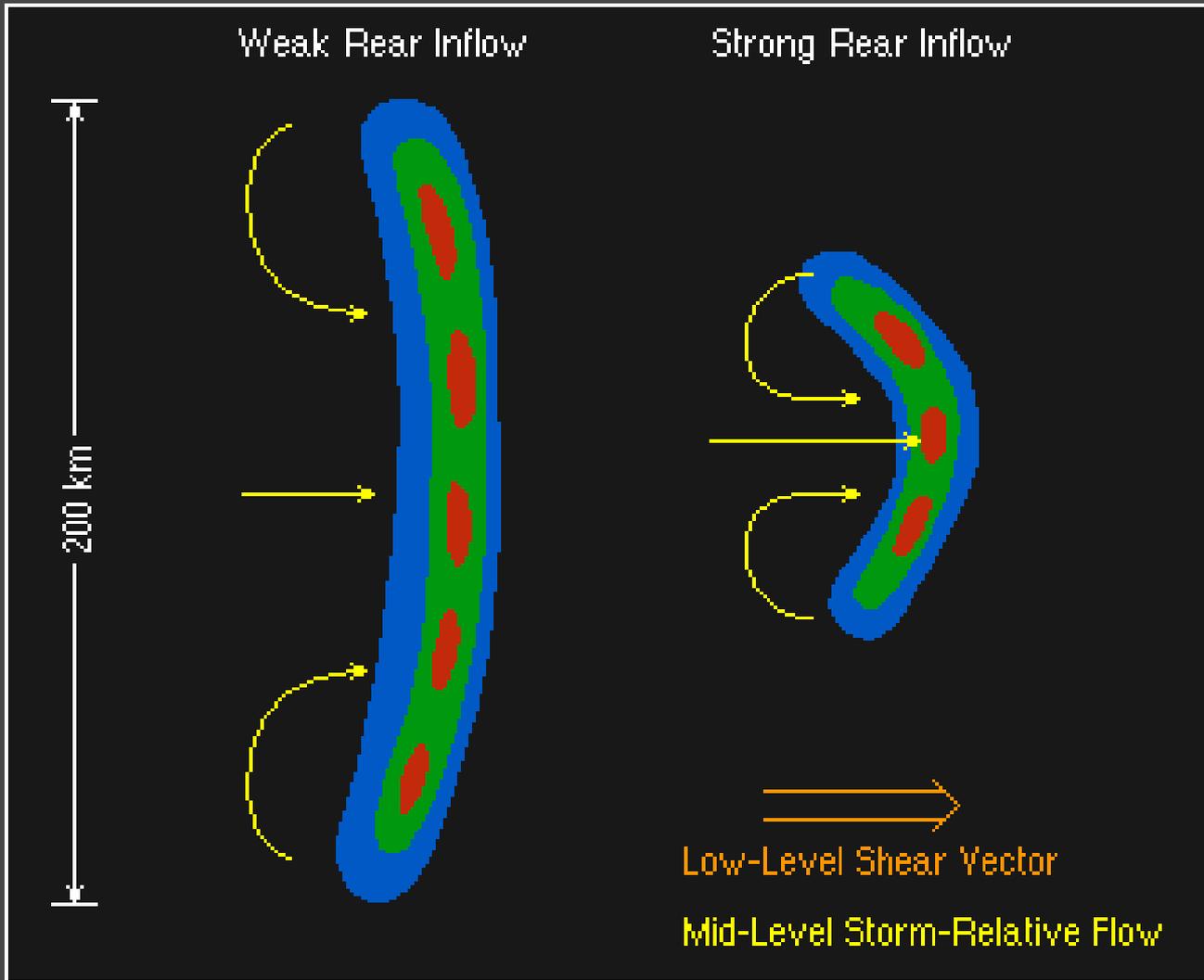
# Squall lines and multicell storms occasionally develop the appearance of a "bow echo."



Bow echoes are usually associated with an axis of enhanced winds that create straight-line wind damage at the surface.



# Effects of Line-End (Bookend) Vortices on Rear-Inflow Jet at $t \sim 3-5h$



The COMET Program



Single Cell

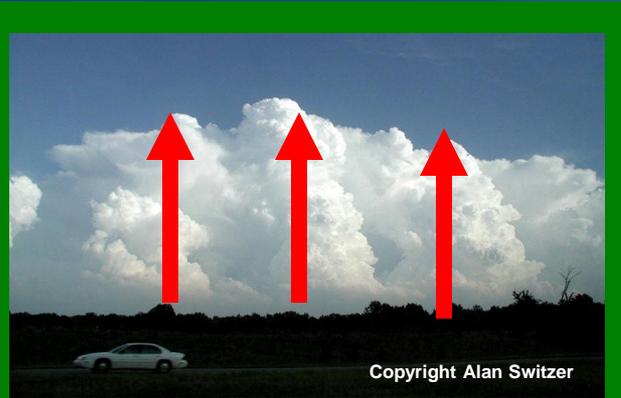
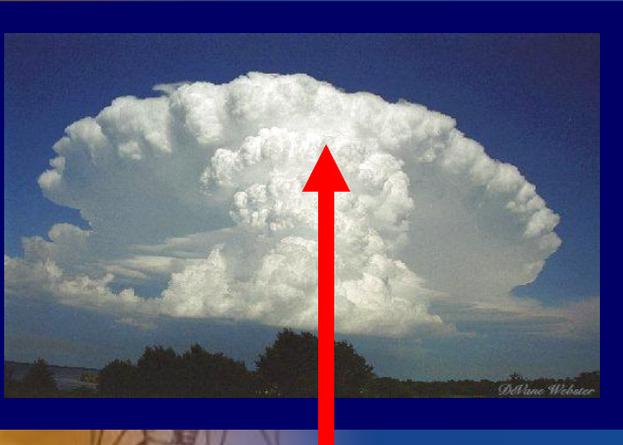
Multicell cluster or line

Supercell

Weak shear

Moderate shear

Strong shear



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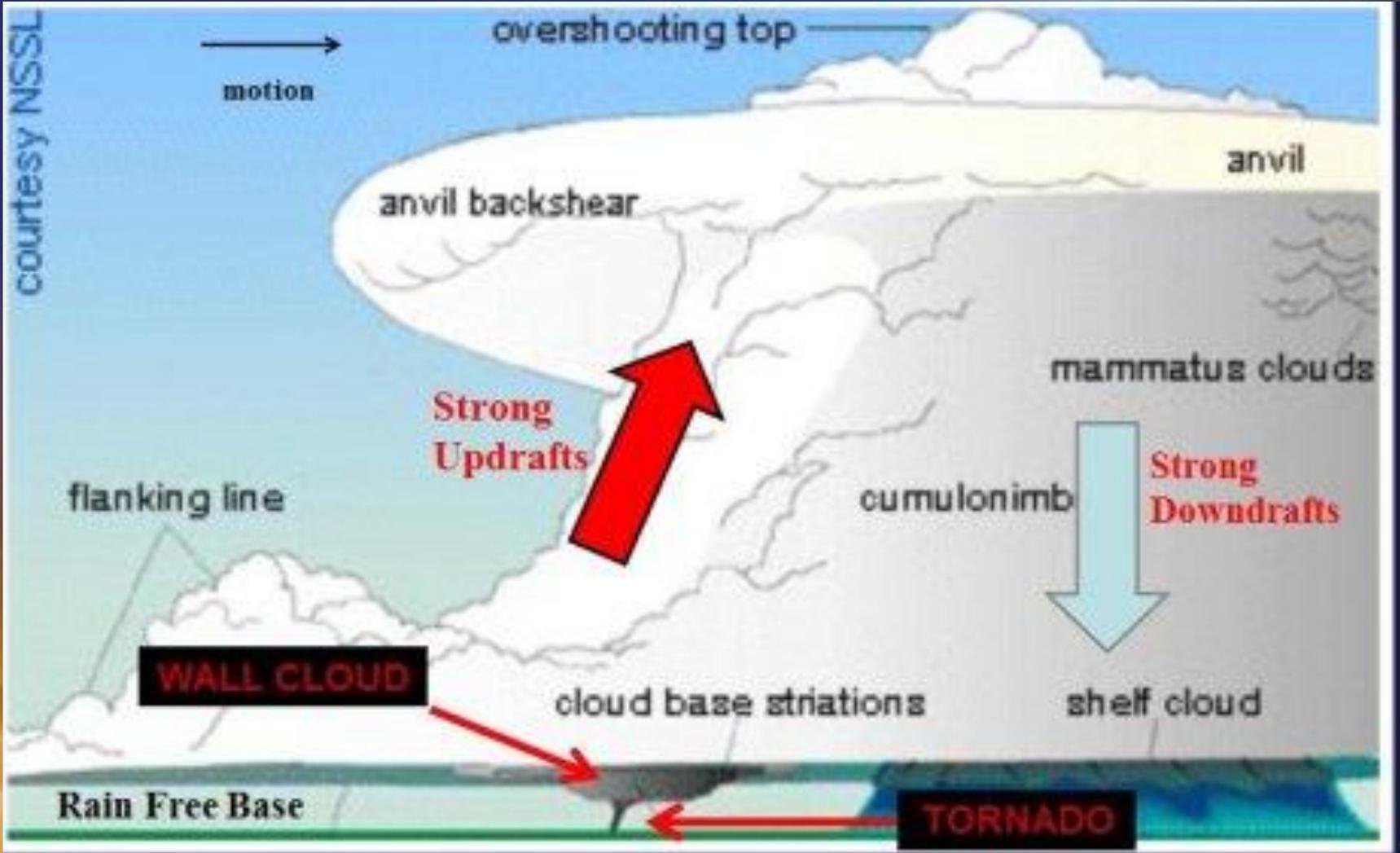
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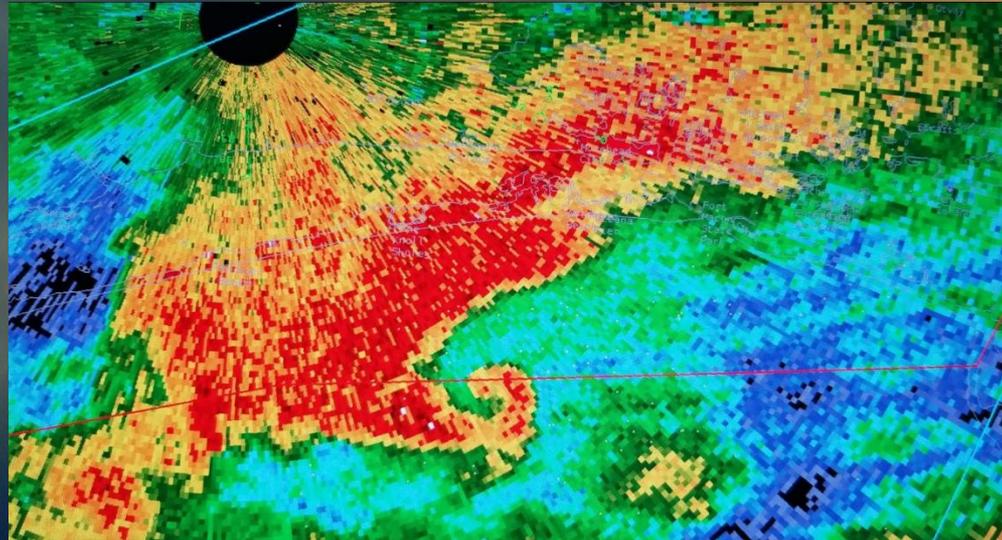
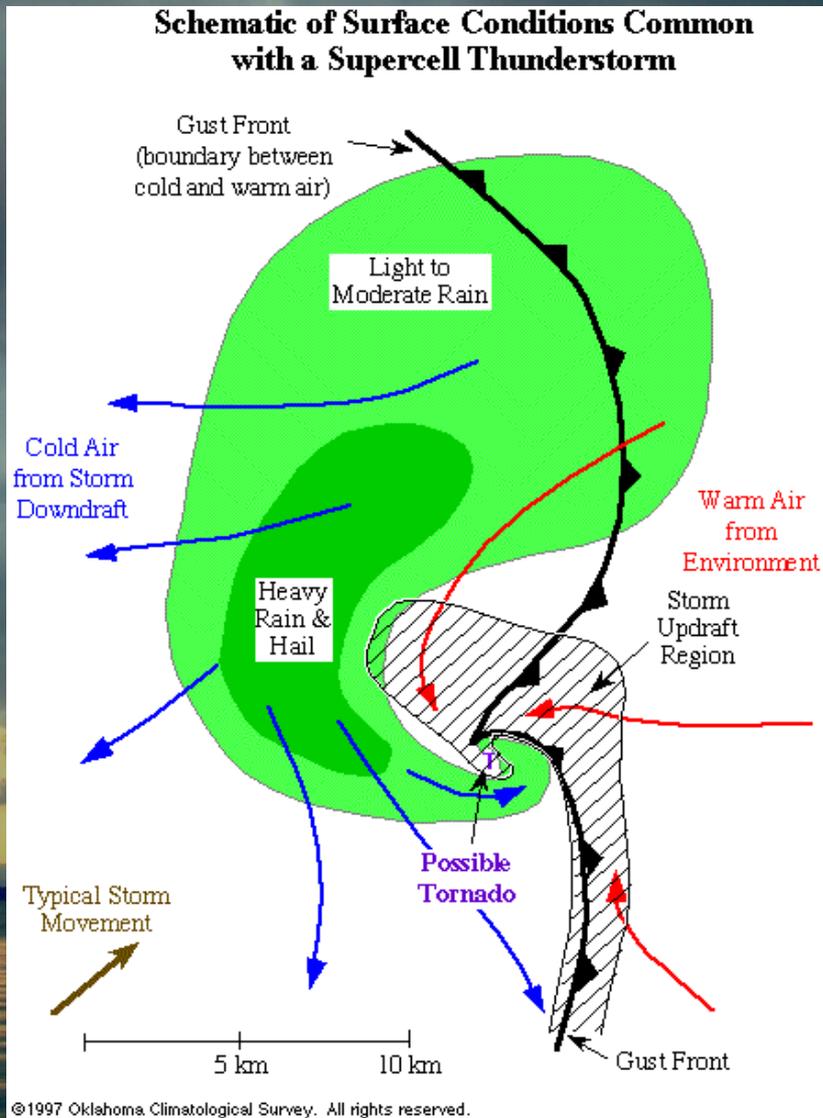
Shear determines type and how long the storm survives.



# Supercell



# Supercell from above, and on radar



Atlantic Beach EF-1 Tornado, November 13, 2018

“Hook Echo”



# The Enhanced Fujita Scale

Tornadoes are classified according to the intensity of damage they cause to objects

| <u>SCALE</u> | <u>MPH</u> | <u>EXPECTED DAMAGE</u> |
|--------------|------------|------------------------|
| EF0          | 65-85      | LIGHT                  |
| EF1          | 86-109     | MODERATE               |
| EF2          | 110-137    | CONSIDERABLE           |
| EF3          | 138-167    | SEVERE                 |
| EF4          | 168-199    | DEVASTATING            |
| EF5          | 200-234    | INCREDIBLE             |



# Tornado: Convergent Damage Path



Notice the trees are laying in a converging or criss-cross pattern.



Damage in Wayne county Illinois from an F3 tornado on 4/21/02



# When Should You Contact Us?

## Review

- Tornado or Funnel cloud (confirm rotation)
- Hail (any size)
- Wind damage- trees down, structural
- Flooding (closed roads, streams close to bankfull)
- Heavy rainfall (amounts of 2 inch or more in 24 hours or 2 inches in less than an hour).

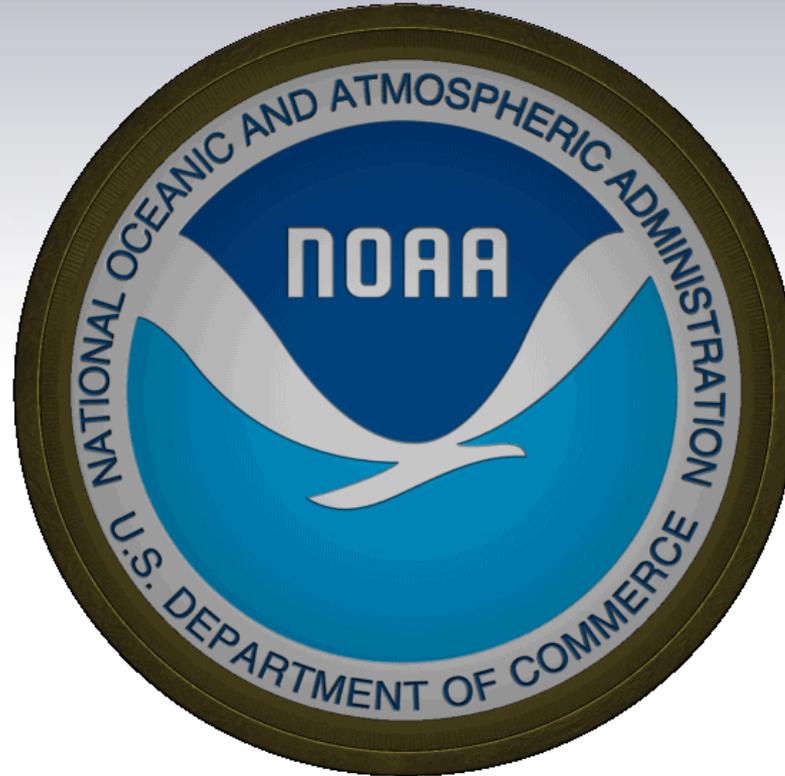


# Reporting Procedures Summary



1. Toll Free Number: **1-800-889-6889**
2. E-mail: **wxobs.mhx@noaa.gov**
3. Facebook 
4. Twitter or send them directly to us   
**@NWSMoreheadCity**
5. CoCoRaHS

# Thanks for Your Interest!



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