



Basic SKYWARN Training



Part 2: Severe Weather, Winter and Hurricane Climatology, and Thunderstorm Meteorology

National Weather Service, Wakefield VA

<http://weather.noaa.gov/akq>





Basic SKYWARN Training



- **Severe Thunderstorm Climatology**
 - *Peak Season – April through July*
 - *Can happen anytime!!*
 - *Long Tornado Season – Spring through Fall*
 - *Significant Fall Tornadoes Possible*

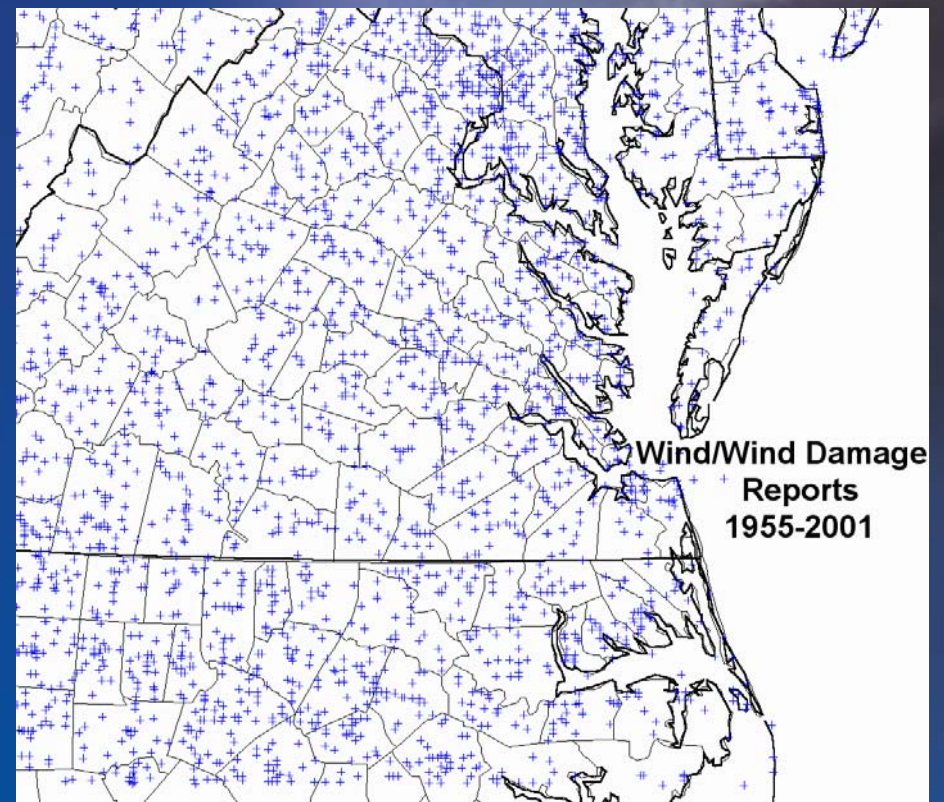
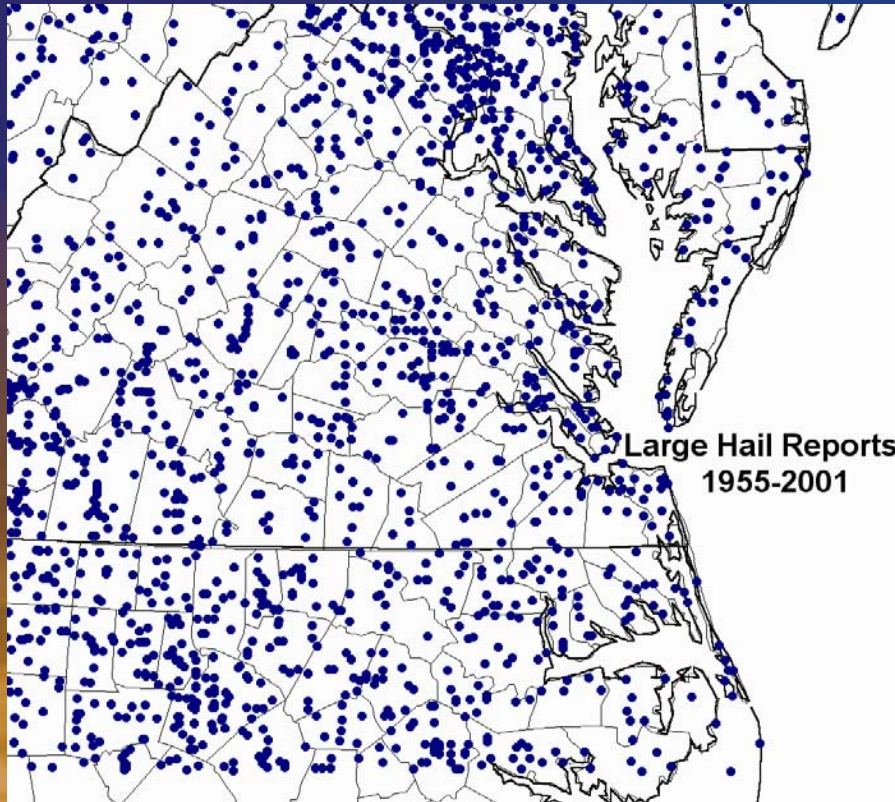




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Large Hail / Wind Damage Climatology

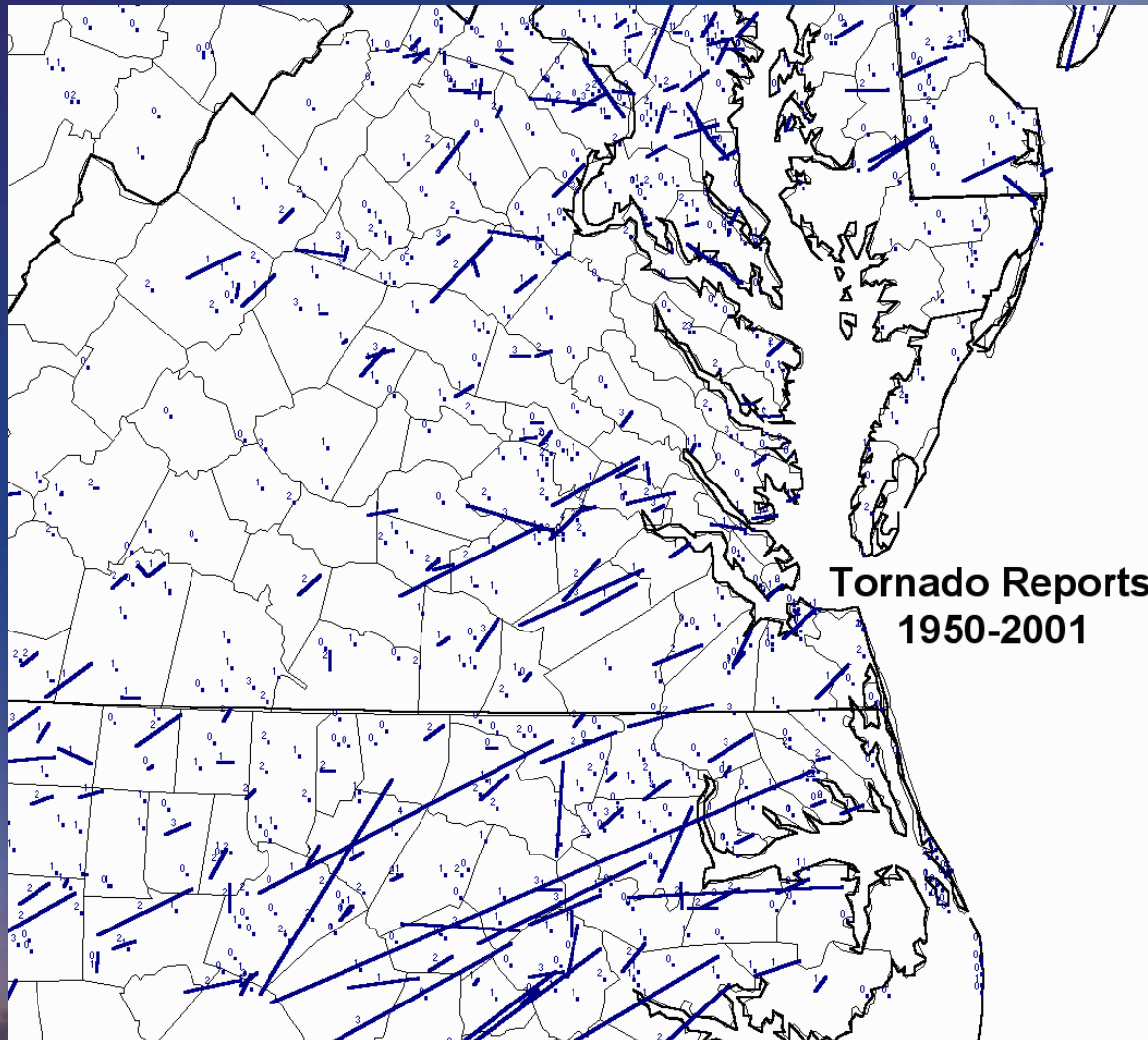




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Tornado Climatology



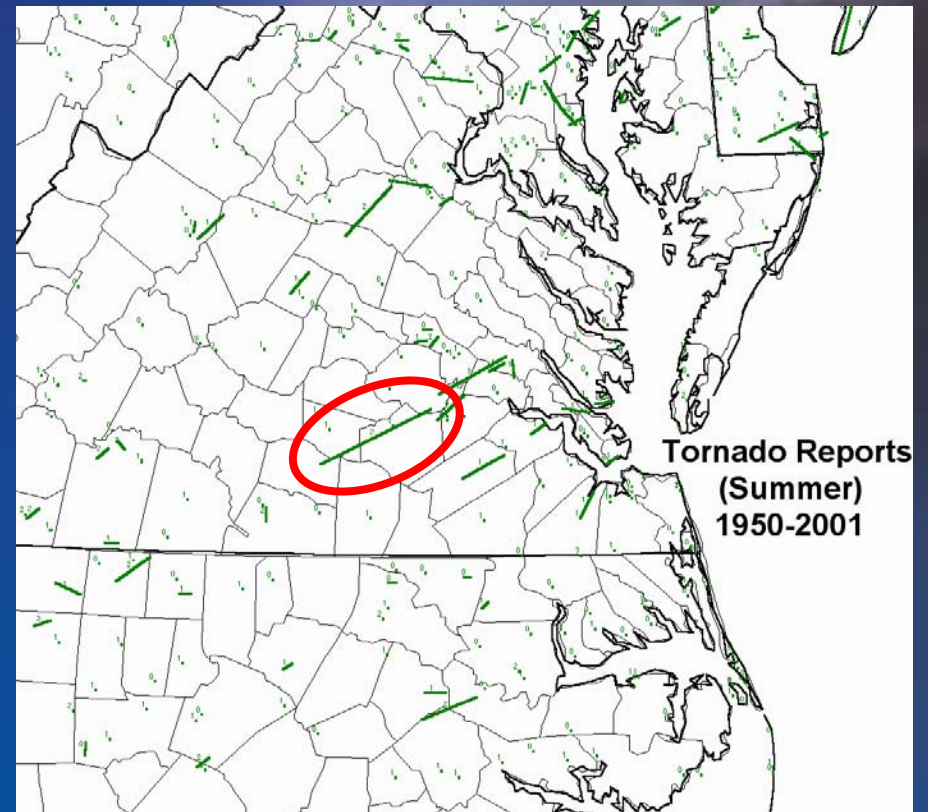
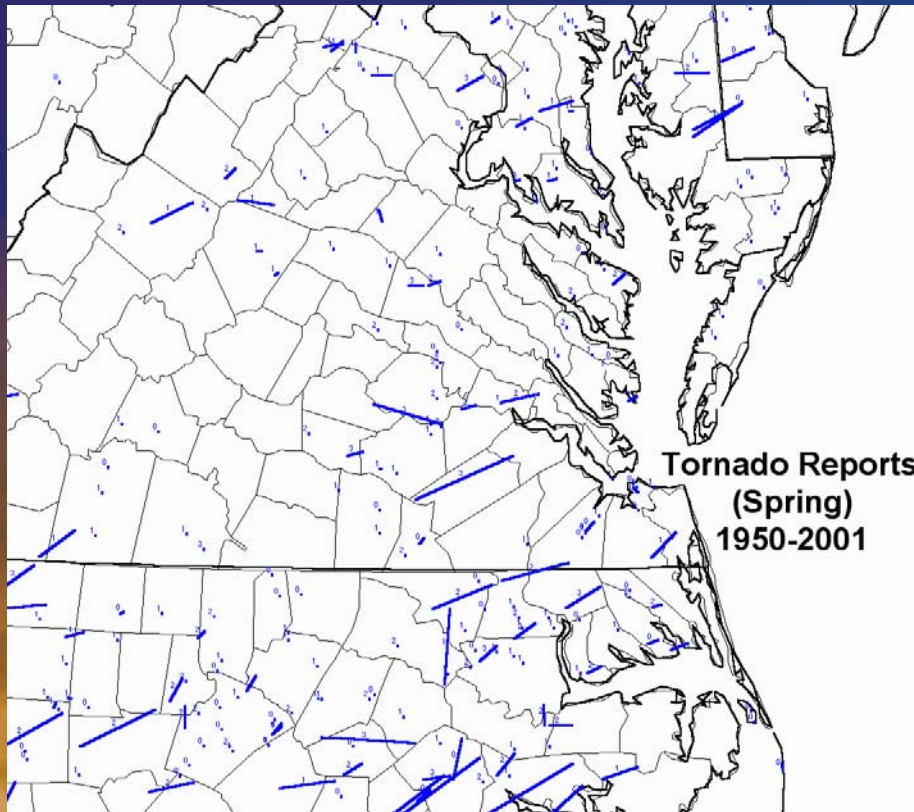
Tornado Reports
1950-2001





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Tornado Climatology (Spring/Summer)

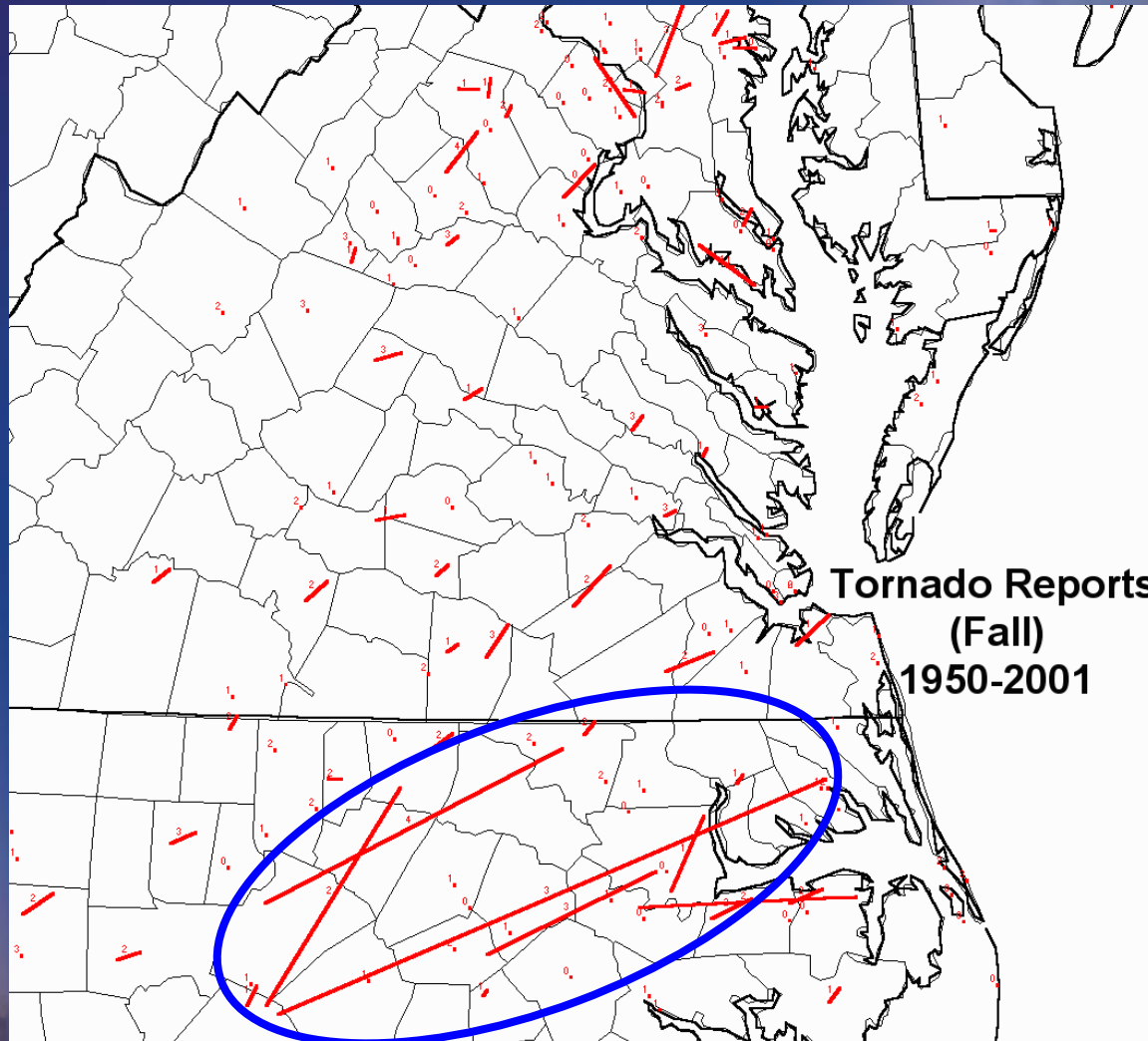




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Tornado Climatology (Fall)





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- **Winter Climatology**
 - *Seasonal Snowfall Highly Variable*
 - *Ice Storms are Occasional Occurrence*
 - *Below Zero Temps are Rare*
 - *Nor'easters Generally Provide Most Significant Winter Precipitation*





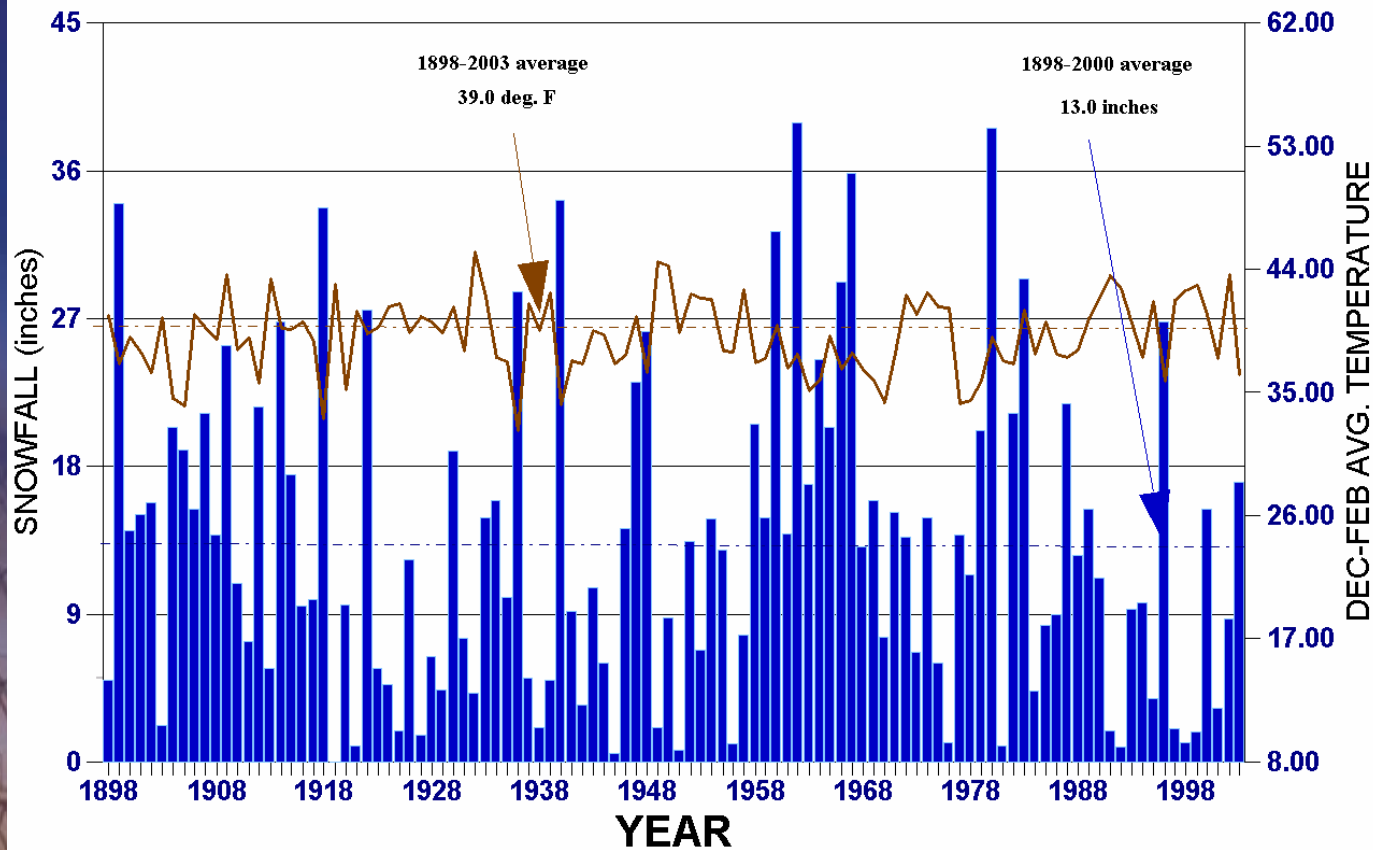
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Richmond Historical Snowfall

SNOWFALL VS. TEMPERATURE

AT RICHMOND (1898-2003)





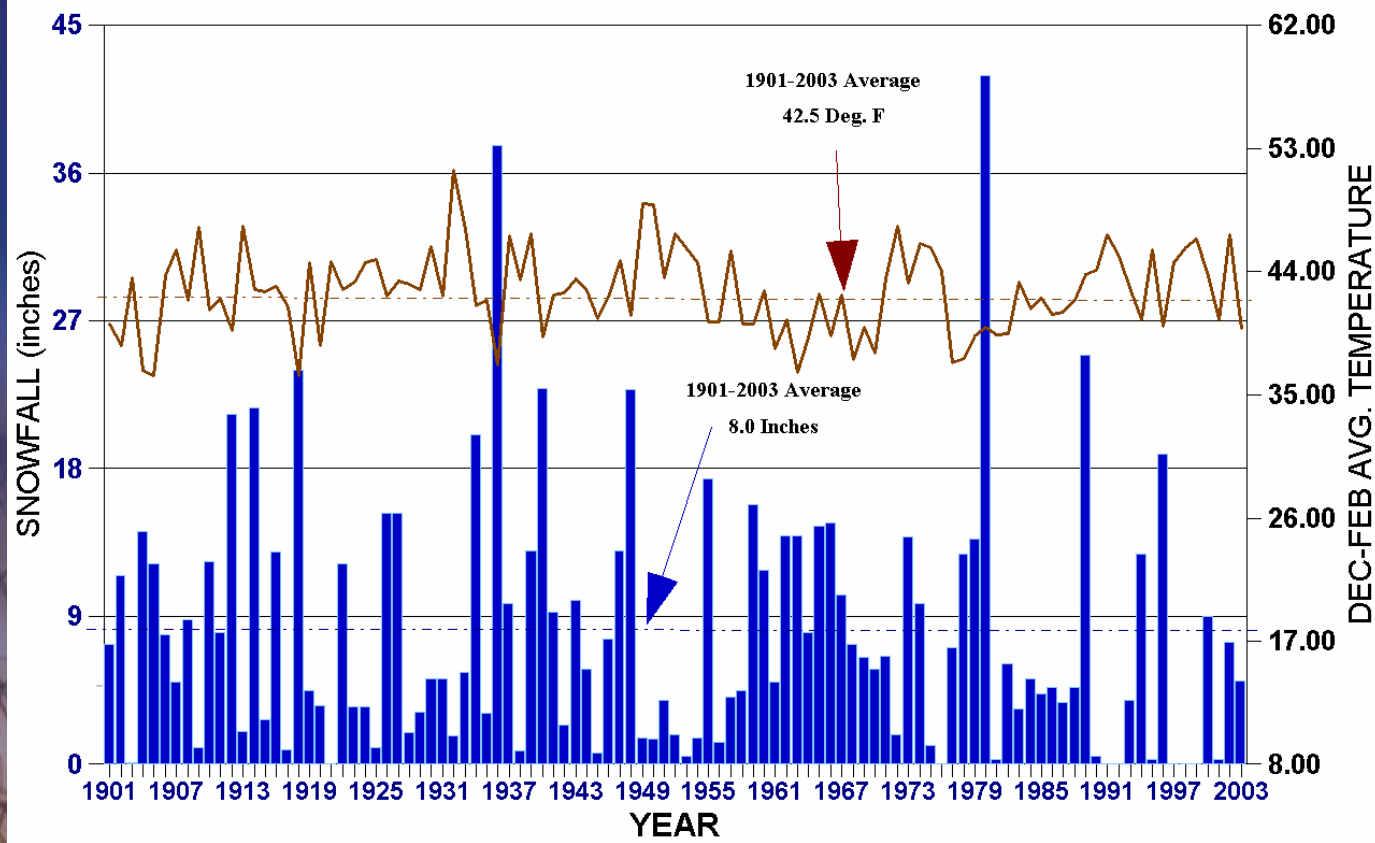
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Norfolk Historical Snowfall

SNOWFALL VS. TEMPERATURE

AT NORFOLK (1901-2003)





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- Hurricane/Tropical Storm Climatology
- Tropical Threat both Coastal and Inland

– *Isabel (2003)*

– *Hazel (1954)*

– *1933 Hurricane*

Wind/Storm Surge

– *Camille (1969)*

– *Agnes (1972)*

– *Floyd (1999)*

Inland Flooding

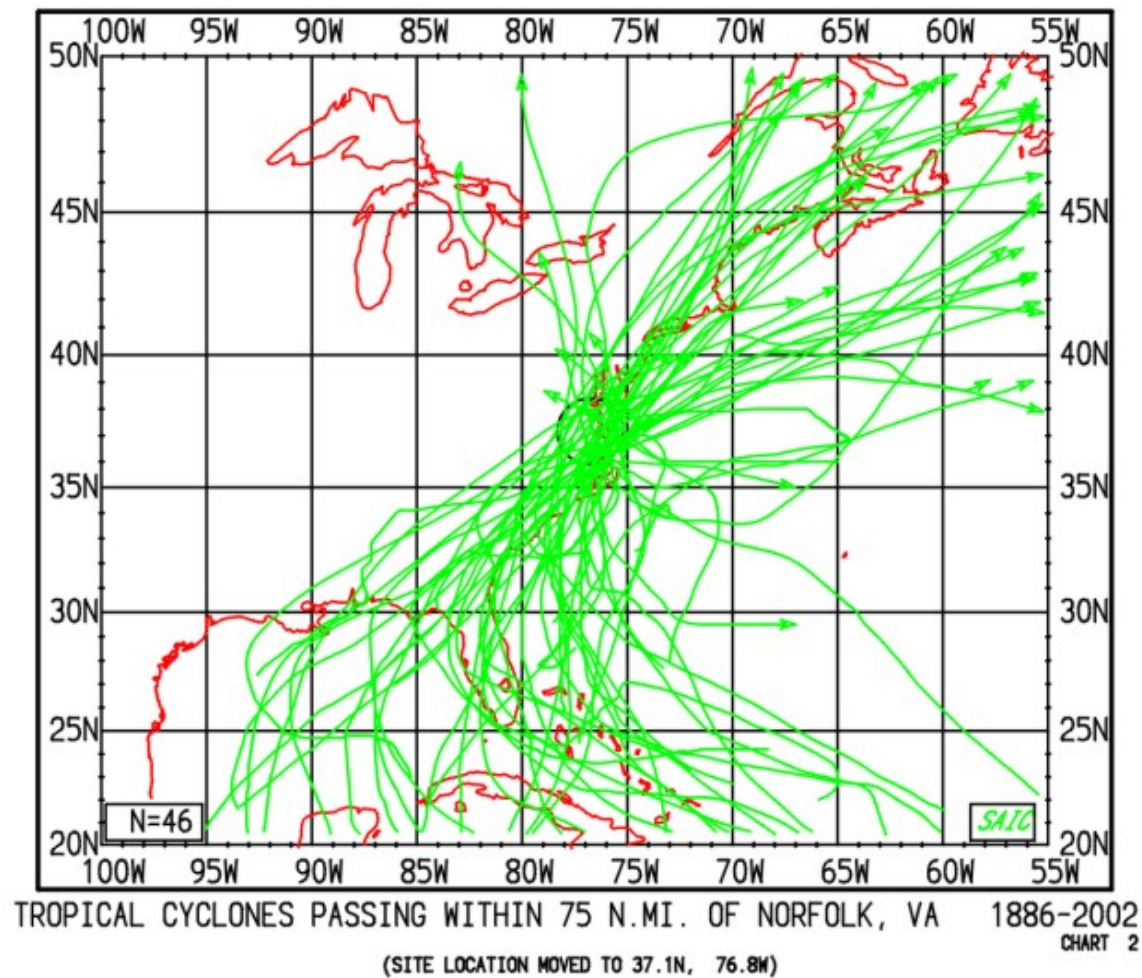




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Norfolk Tropical Cyclone History

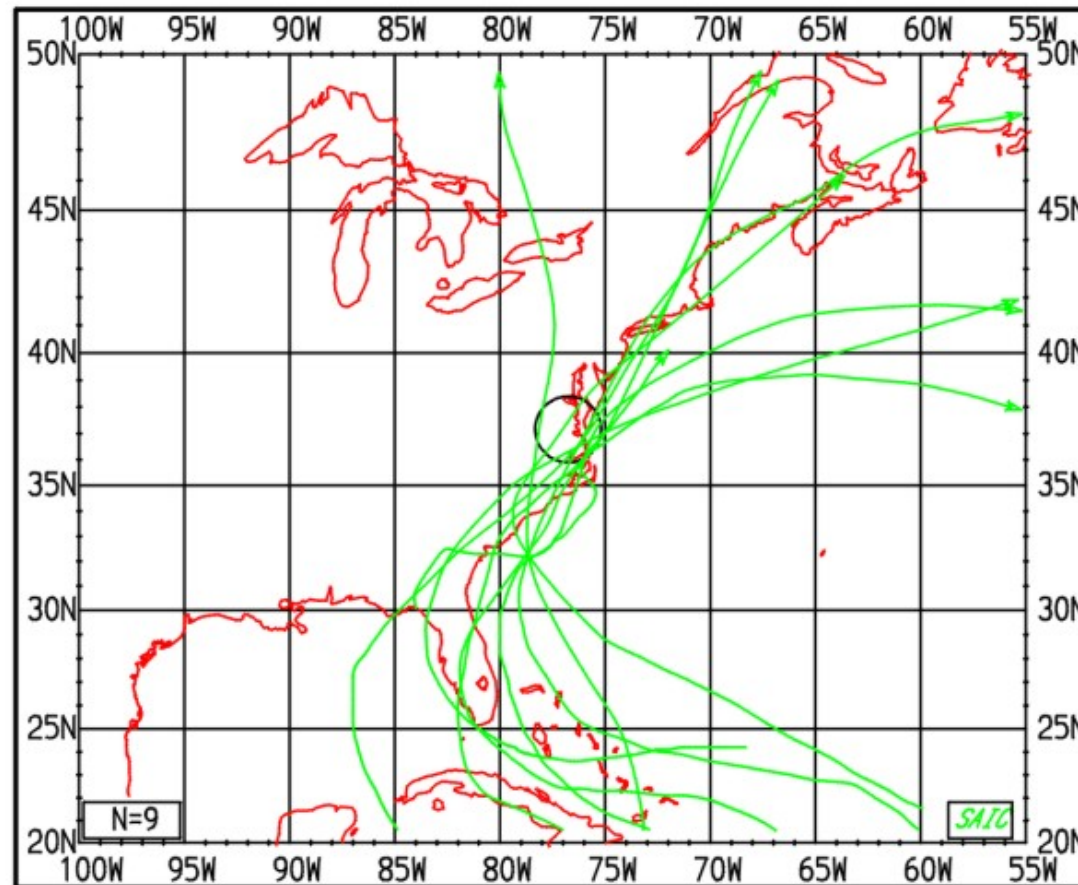




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Norfolk Hurricane History



HURRICANES PASSING WITHIN 75 N.M.I. OF NORFOLK, VA 1886-2002

(SITE LOCATION MOVED TO 37.1N, 76.8W)

CHART 3





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Norfolk Hurricane History

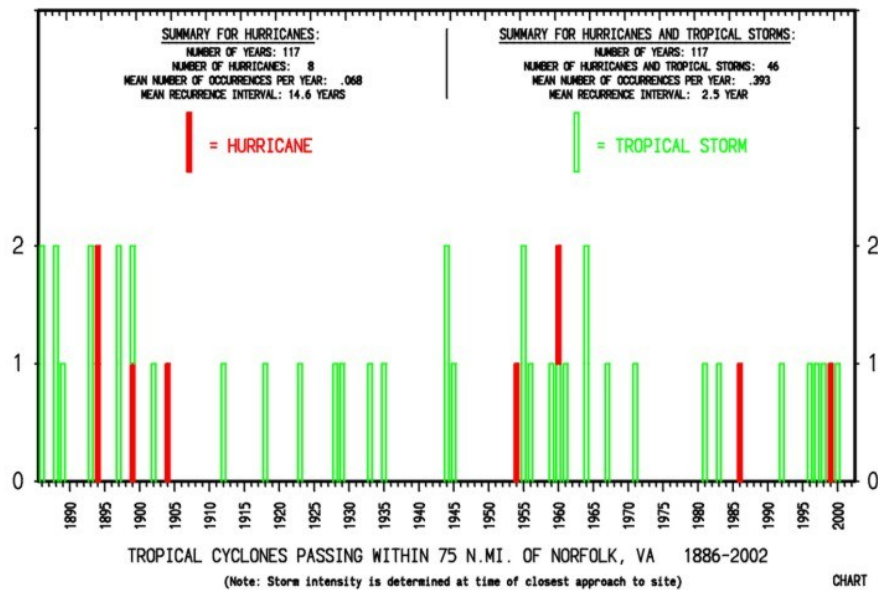


CHART 4

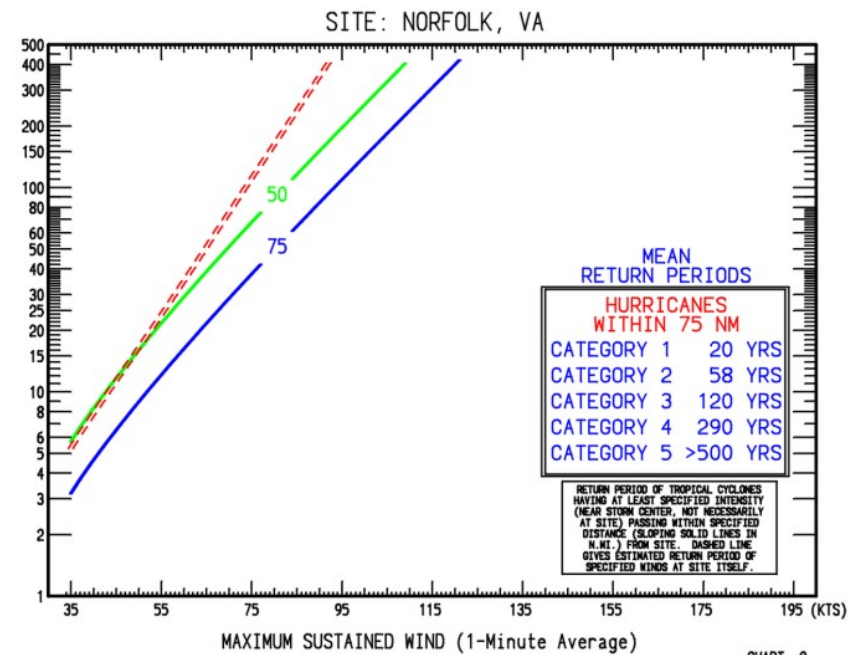


CHART 9





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- **Thunderstorm Meteorology**
 - ***Thunderstorm Life Cycle***
 - Towering Cumulus
 - Mature
 - Dissipating
 - ***Supercell Thunderstorm***
 - ***Squall Line***

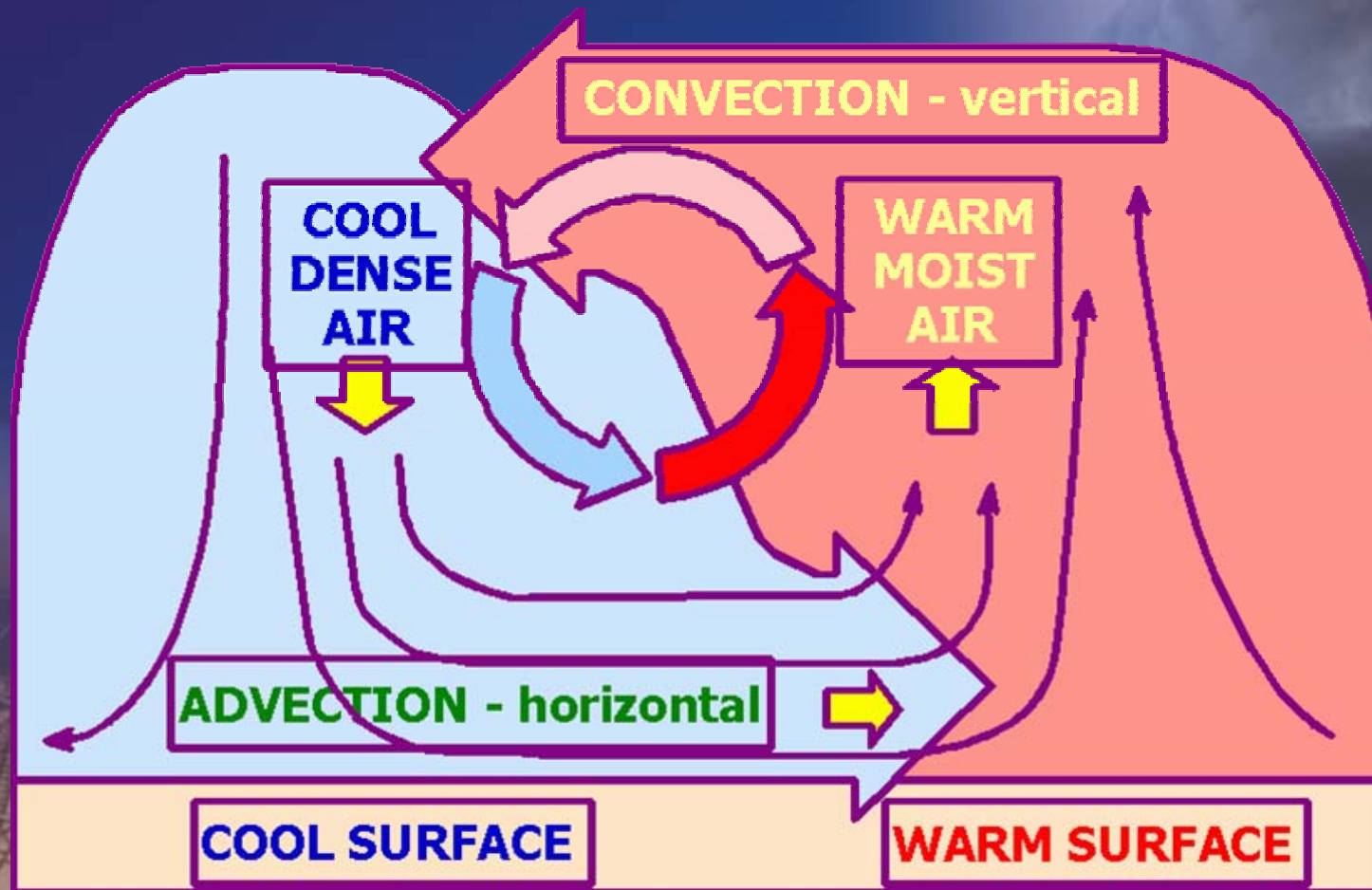




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Thunderstorms – A Convective Phenomena



Convection – A vertical circulation caused by solar heating of the earth's surface

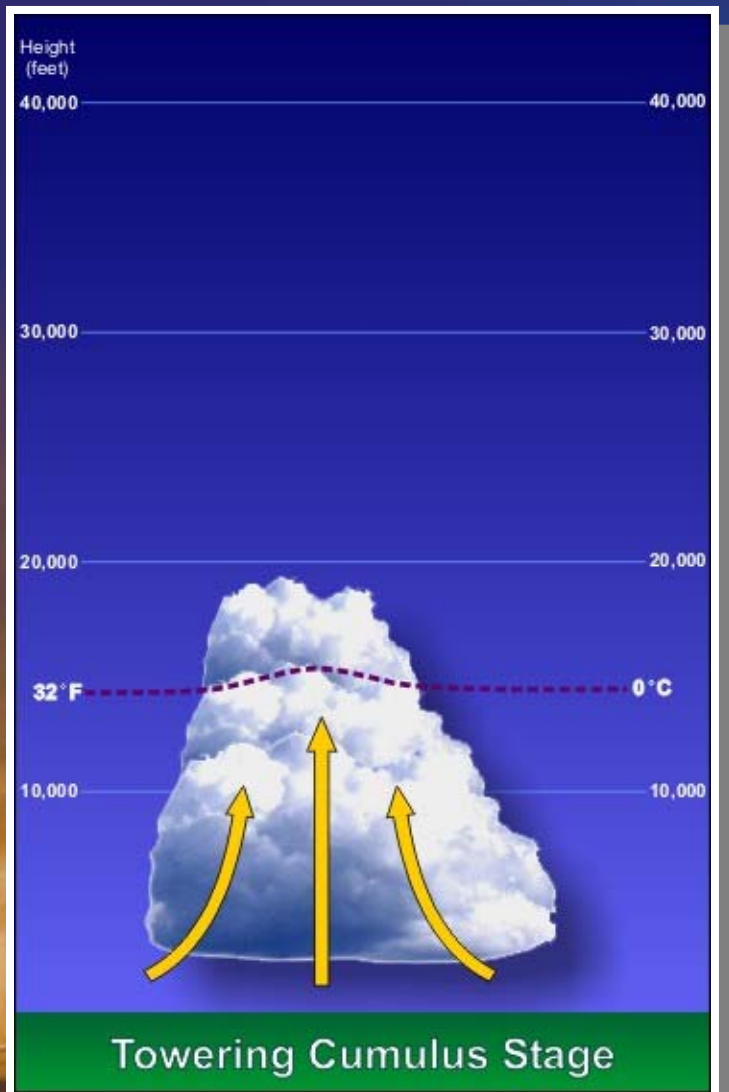




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Thunderstorms – Towering Cumulus Stage



Towering Cumulus Stage

Warm air near the ground, heated by the sun, rises, cools and condenses to form cumulus clouds - UPDRAFT develops



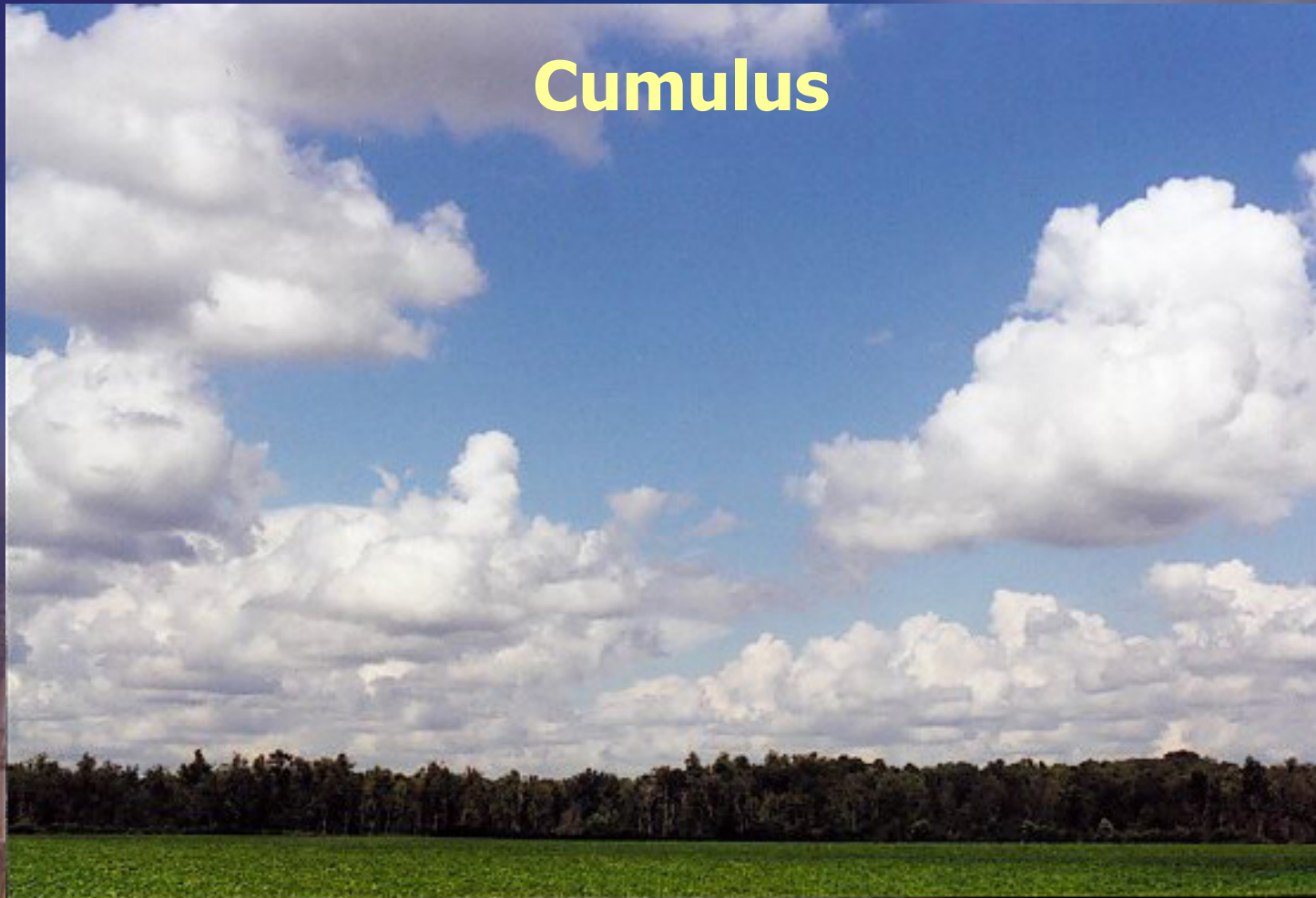


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Thunderstorms – Towering Cumulus Stage

Cumulus

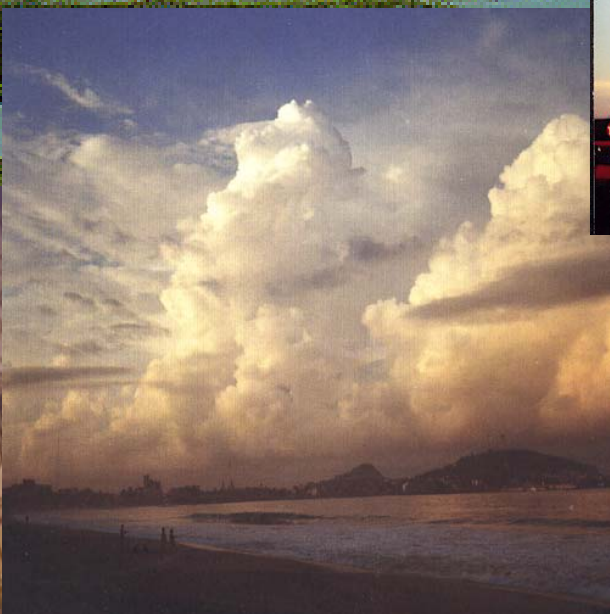




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Thunderstorms – Towering Cumulus Stage

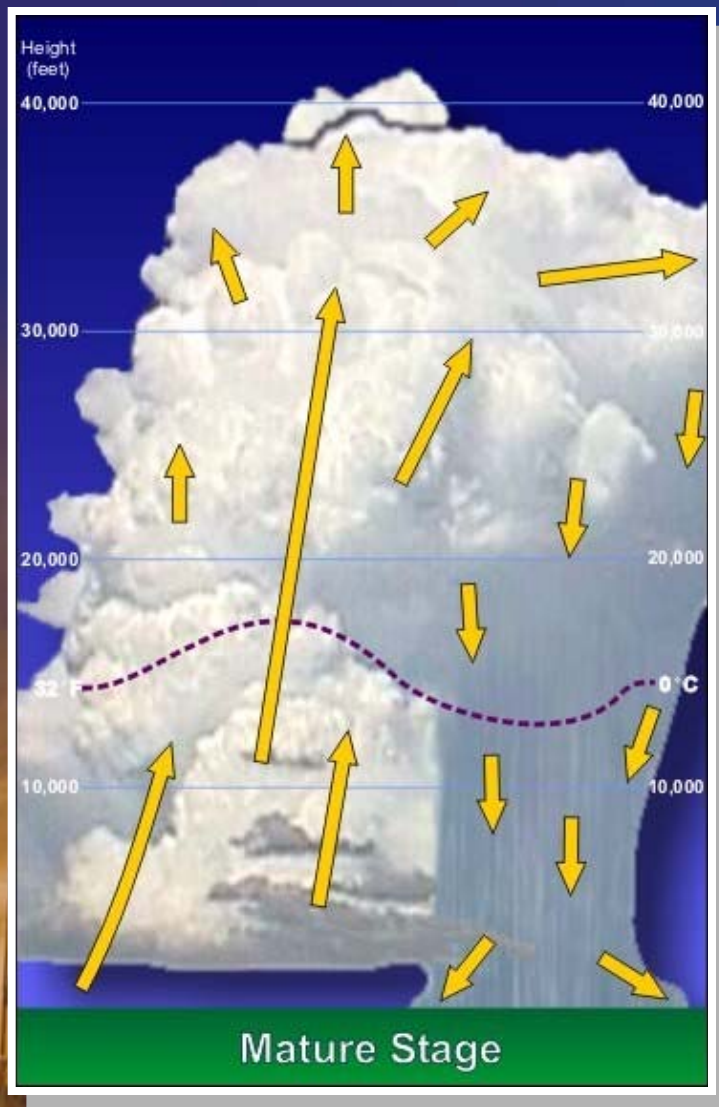




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Thunderstorms – Mature Stage



Mature Stage

Updraft persists and strengthens; Rain falls. Precipitation drag and evaporative cooling create **DOWNDRAFT** and **OUTFLOW** boundary



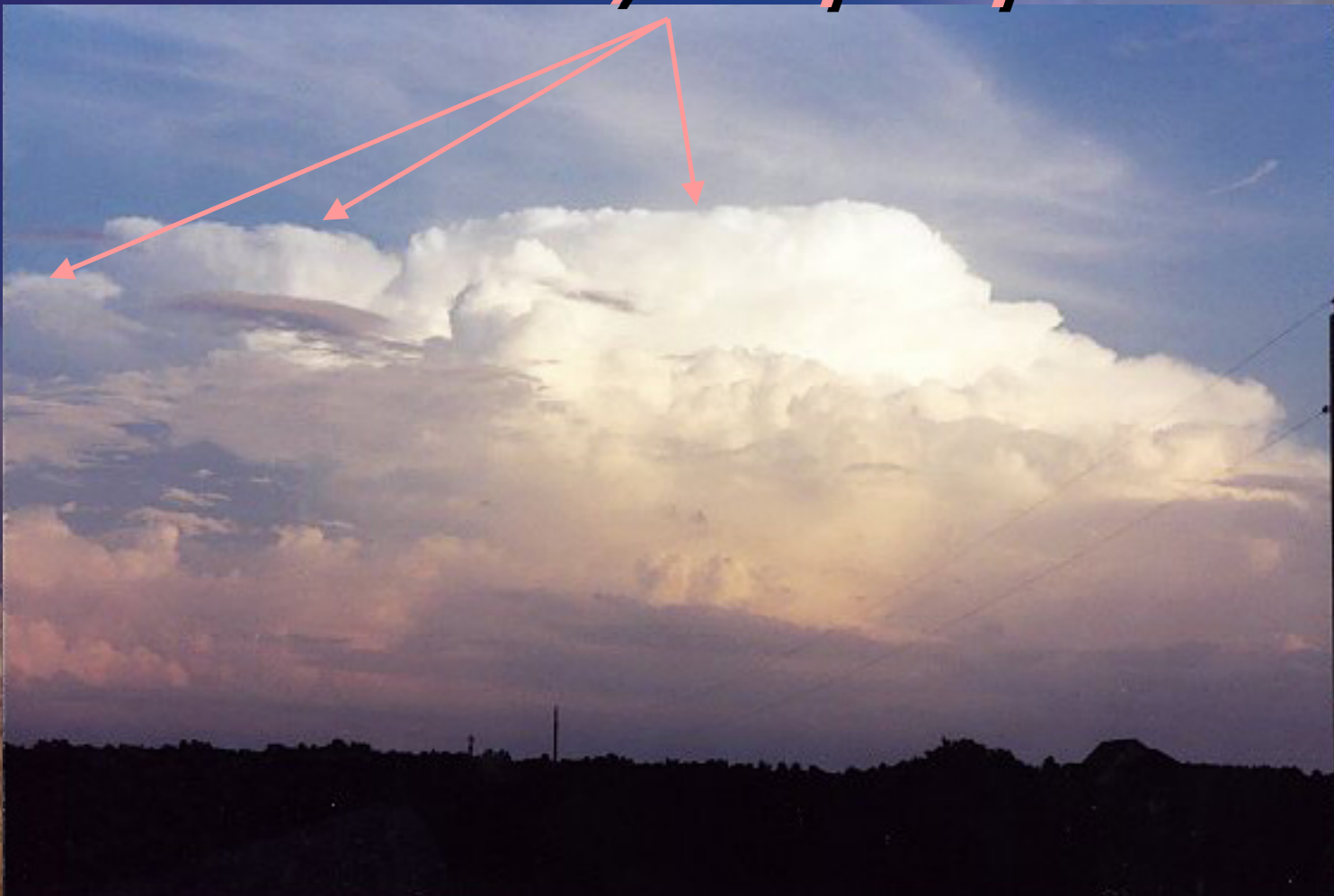


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Thunderstorms – Mature Stage

Thunderstorm w/Multiple Updrafts

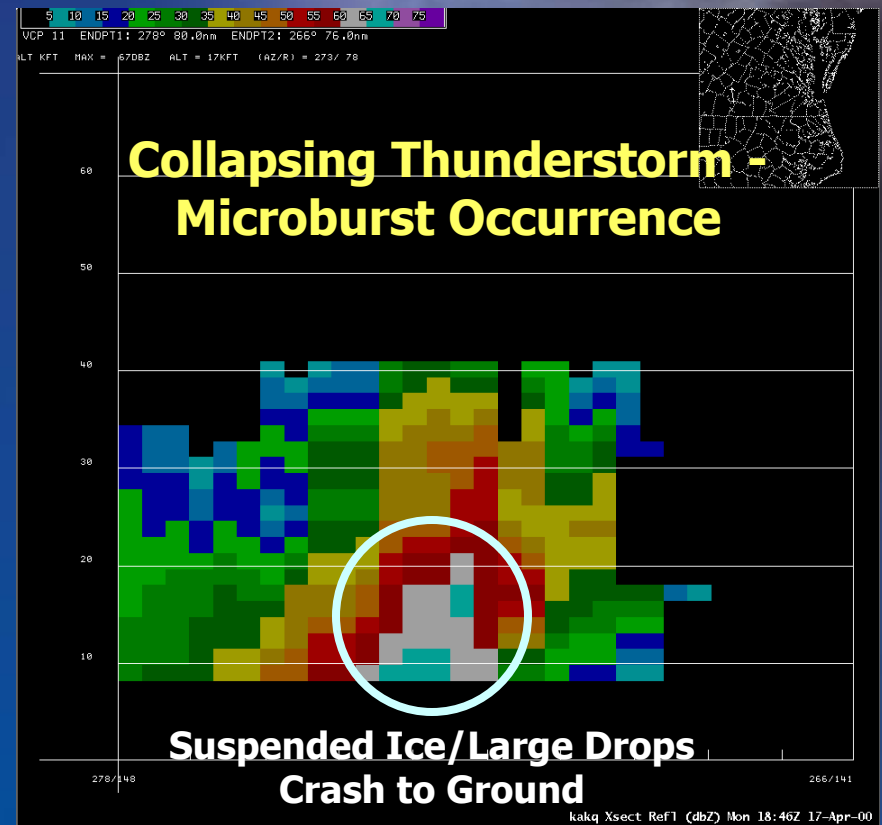
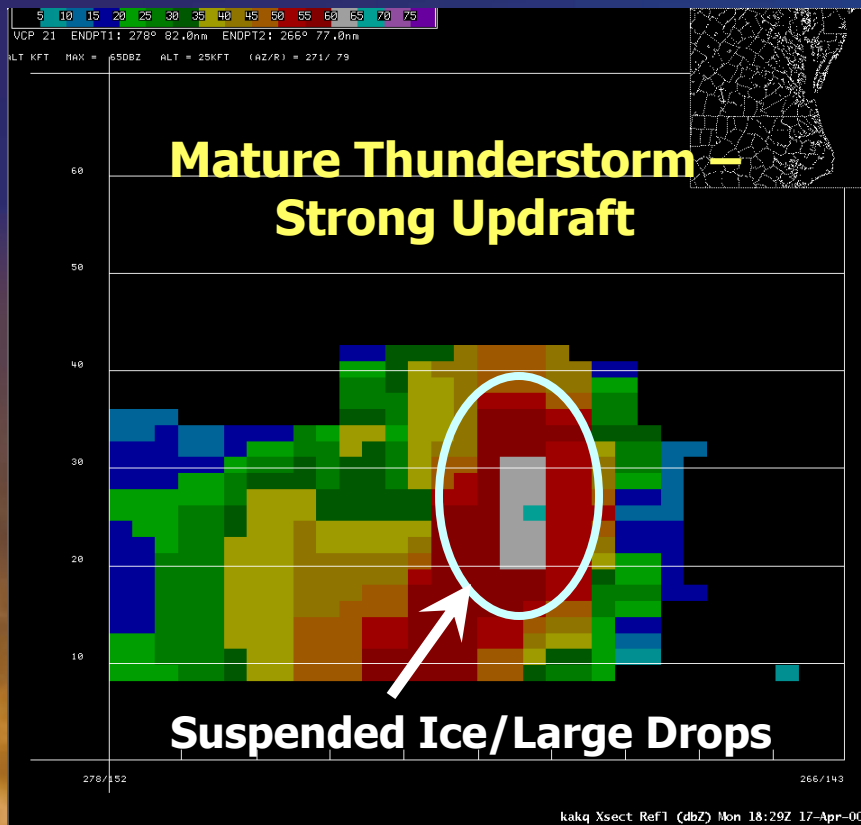




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Thunderstorms – Anatomy of a Microburst

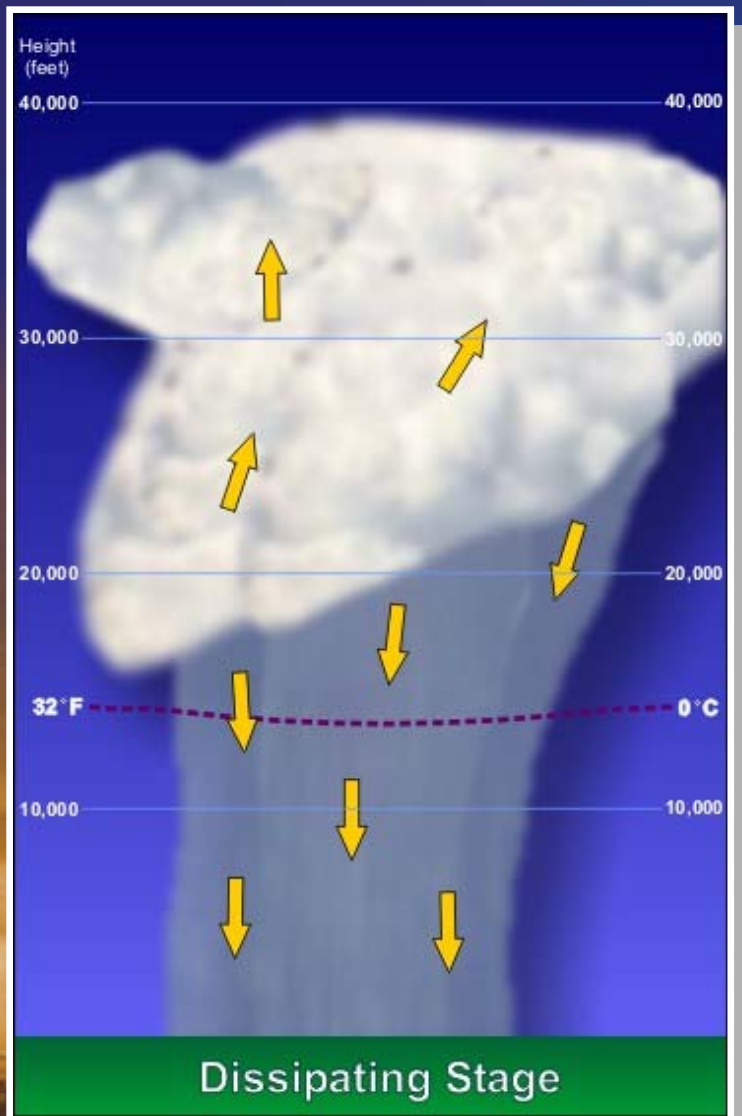




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Thunderstorms – Dissipating Stage



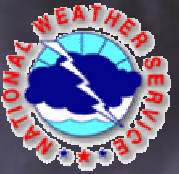
Dissipating Stage

Downdraft cuts off storm inflow, removing energy source. Storm gradually weakens and dissipates.





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Thunderstorms – Supercell Thunderstorms

- **Supercell Thunderstorm Characteristics**
 - *Nearly Always Severe (Hail/High Winds)*
 - **Cause of Nearly all F2+ Tornadoes**
 - **Most Common West of Appalachians**
 - **Seen 3-5 Days per Year in Mid-Atlantic**
 - **Radar Signature - Hook Echo**



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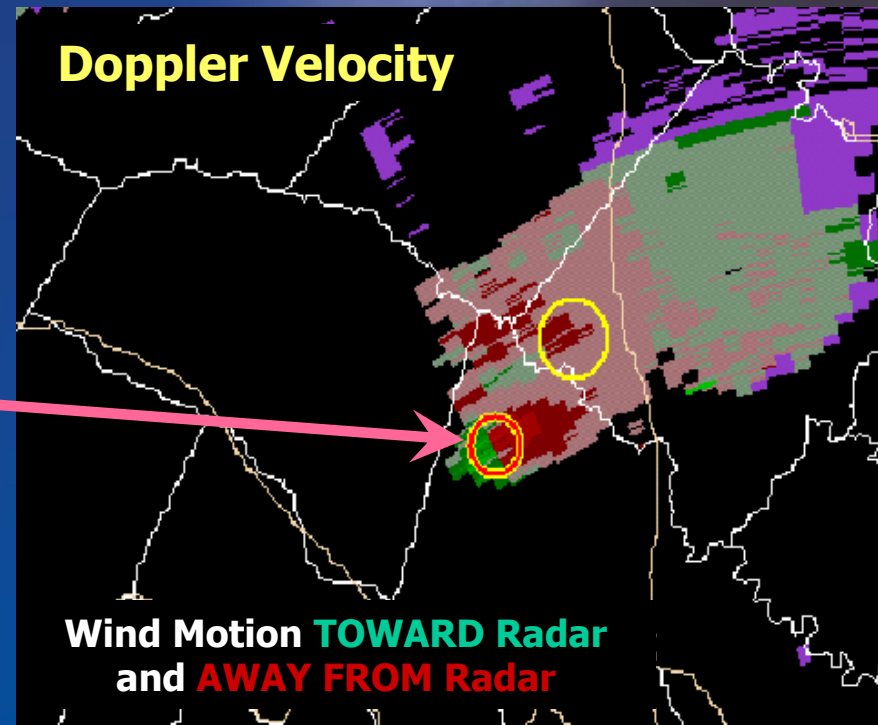
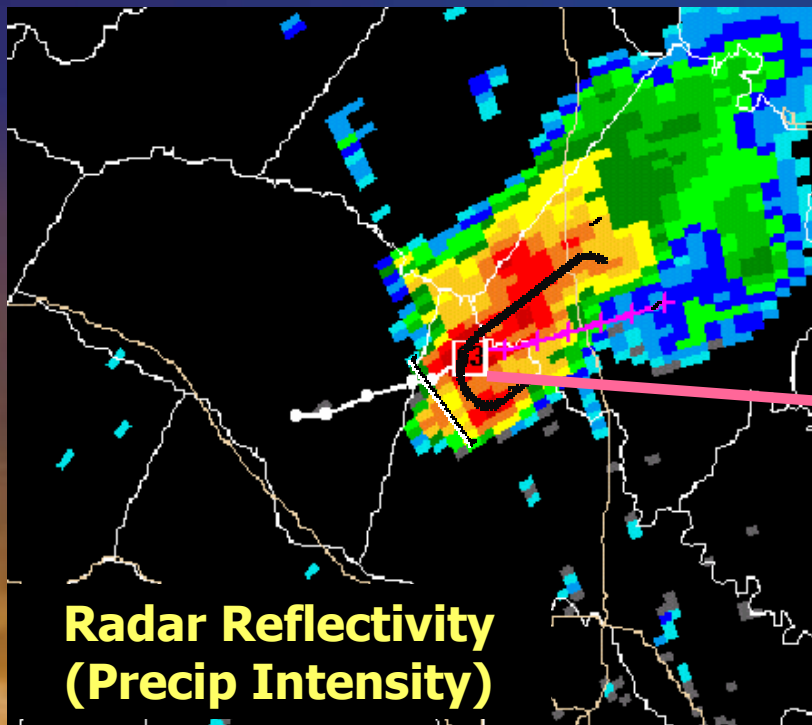


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Thunderstorms – Supercell Thunderstorms

April 1, 1998



Note: Radar is off bottom right corner of both images



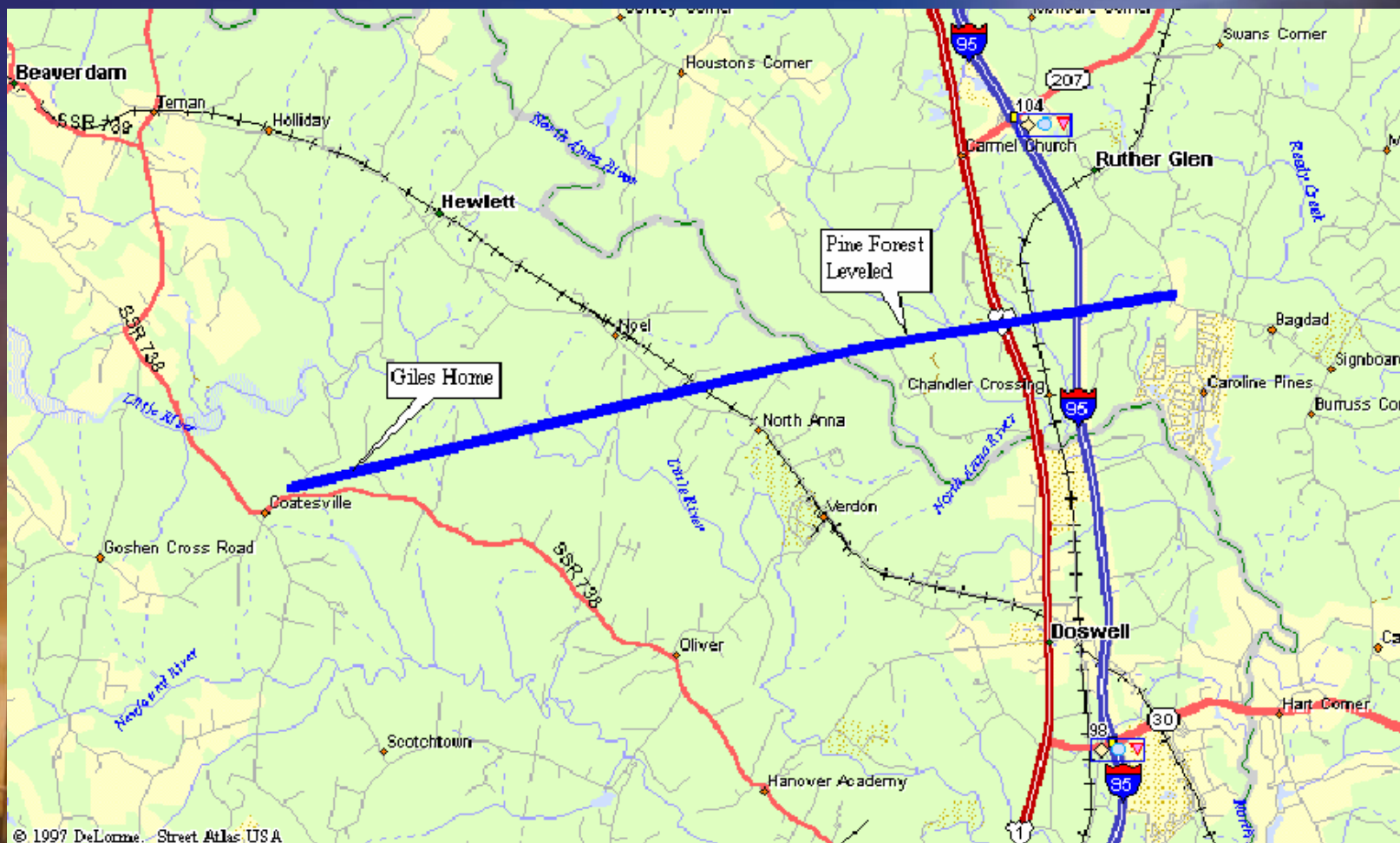


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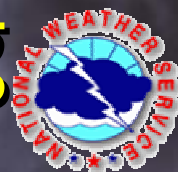
Thunderstorms – Supercell Thunderstorms

April 1, 1998 – Hanover Tornado



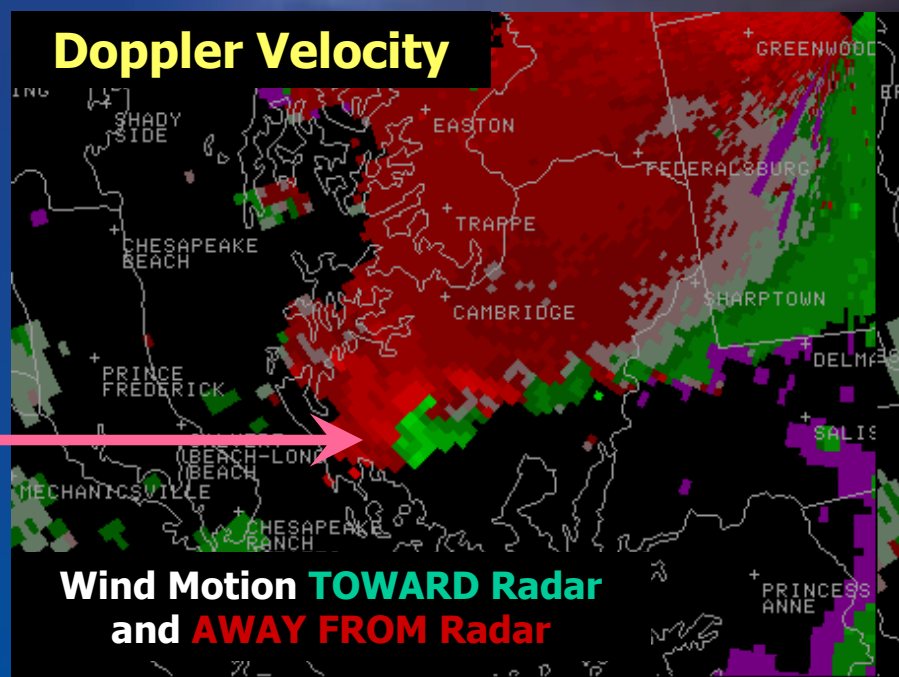
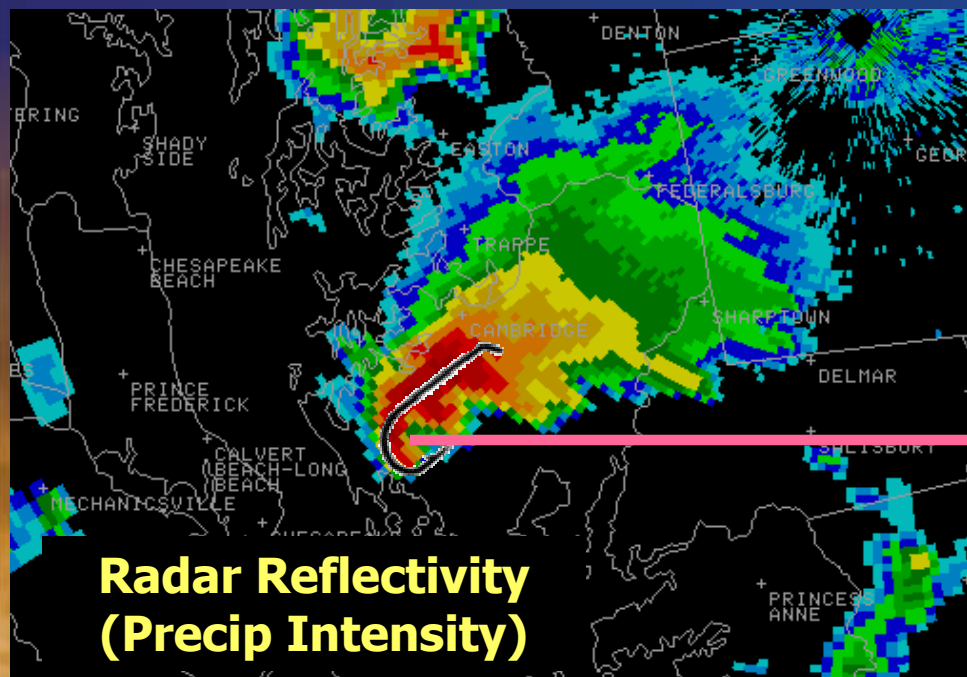


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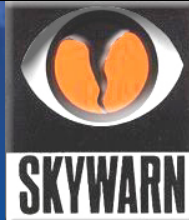


Thunderstorms – Supercell Thunderstorms

April 28, 2002



Note: Radar is near top right corner of both images



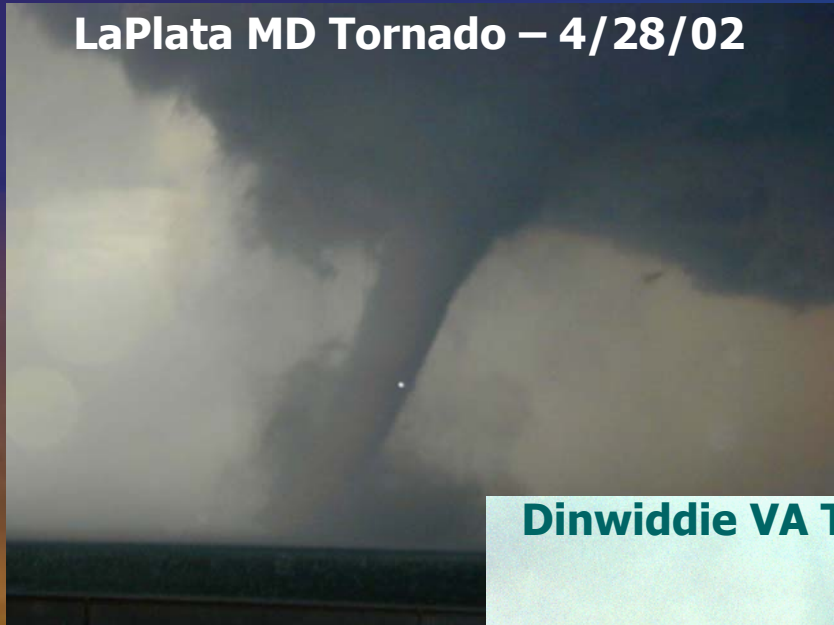


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Thunderstorms – Mid Atlantic Tornadoes

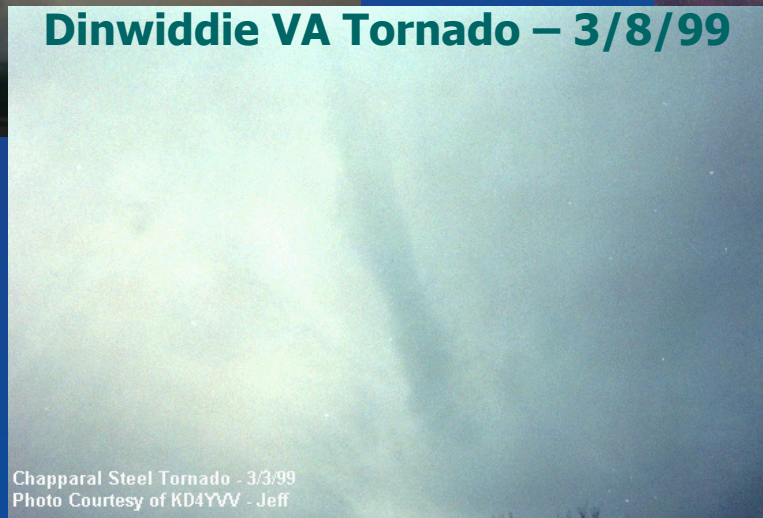
LaPlata MD Tornado – 4/28/02



Petersburg VA Tornado
8/6/93



Dinwiddie VA Tornado – 3/8/99



Chapparral Steel Tornado - 3/3/99
Photo Courtesy of KD4YVW - Jeff





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Thunderstorms – Squall Lines

- **Squall Line Characteristics**
 - *Damaging Winds on Leading Edge*
 - *Often Move at 50+ mph*
 - *Common in Eastern U.S.*
 - **Seen 15-20+ Days per Year in Mid-Atlantic**
 - *Radar Signature - **Bow Echo***





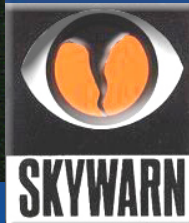
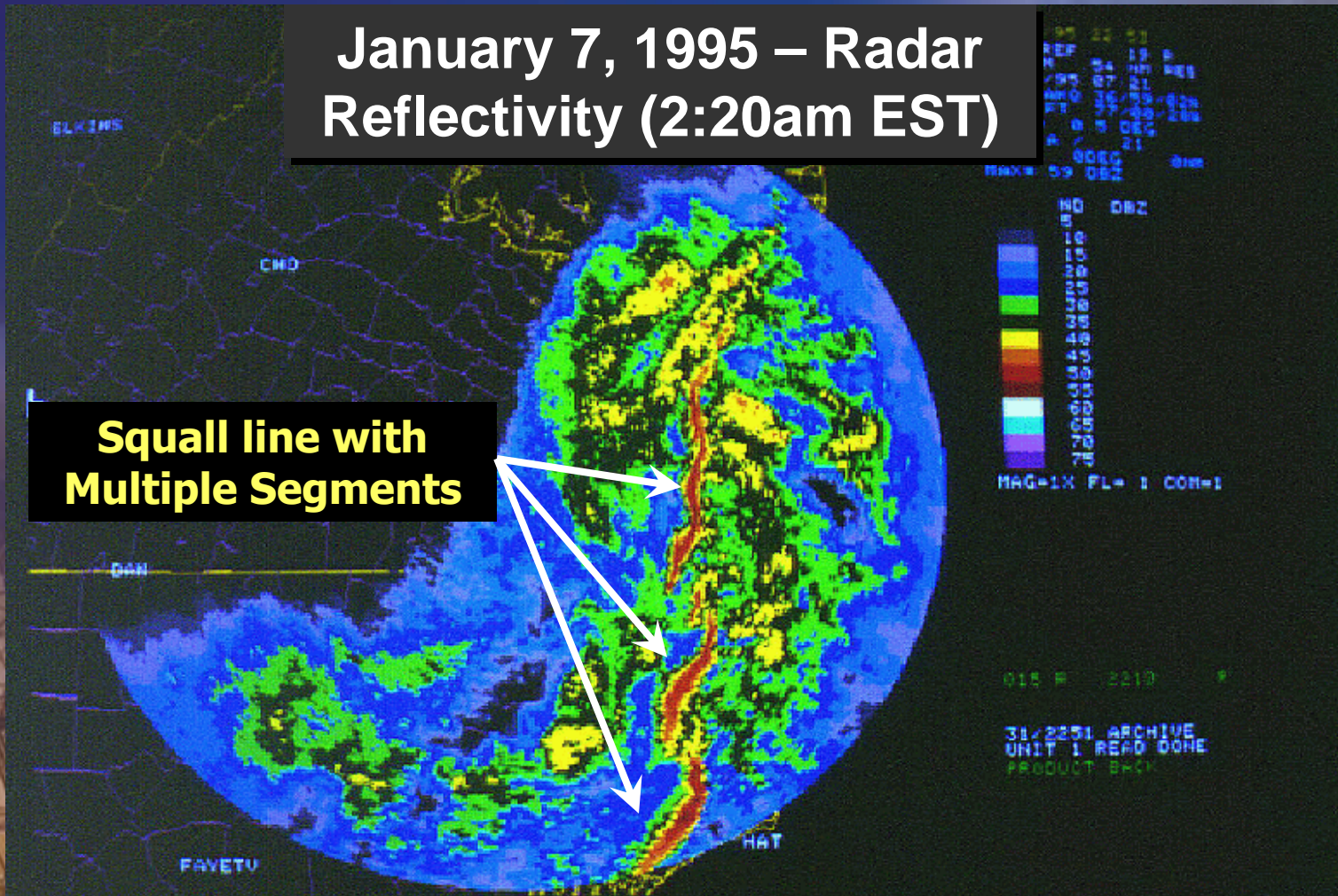
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Thunderstorms – Squall Lines

January 7, 1995 – Radar Reflectivity (2:20am EST)

Squall line with Multiple Segments





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Thunderstorms – Squall Lines

January 7, 1995 – Doppler
Velocity (2:05am EST)

Downburst Winds \geq
50 kt (58 mph)

Squall line Depicted
in Wind Field

1:25 22 54
VEL 26 W
SW 27 NW 82E
PT 25 07 83
KIND 38 50 82W
PT 27 00 28W
E 5 DEG
E 21
CENTR 0000
MAX -94 KT 77 KT

ND
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31/2251 ARCHIVE
UNIT 1 READ DONE
PRODUCT ENCL



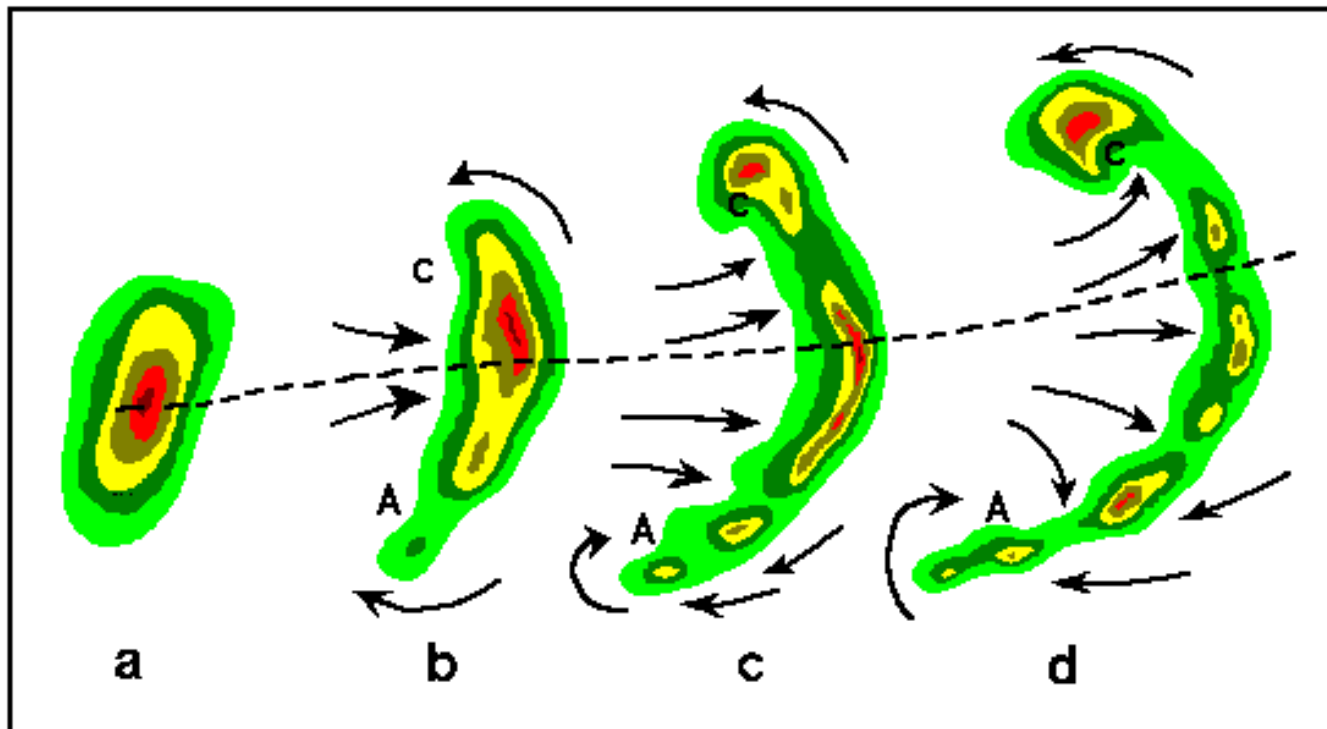
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Thunderstorms – Bow Echo Scenario

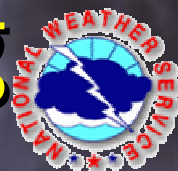


Bow Echo. Typical evolution of a thunderstorm radar echo (a) into a bow echo (b,c) and into a comma echo (d). Dashed line indicates axis of greatest potential for downbursts. Arrows indicate wind flow relative to the storm. Note regions of cyclonic rotation (C) and anticyclonic rotation (A); both regions, especially C, are capable of supporting tornado development in some cases.

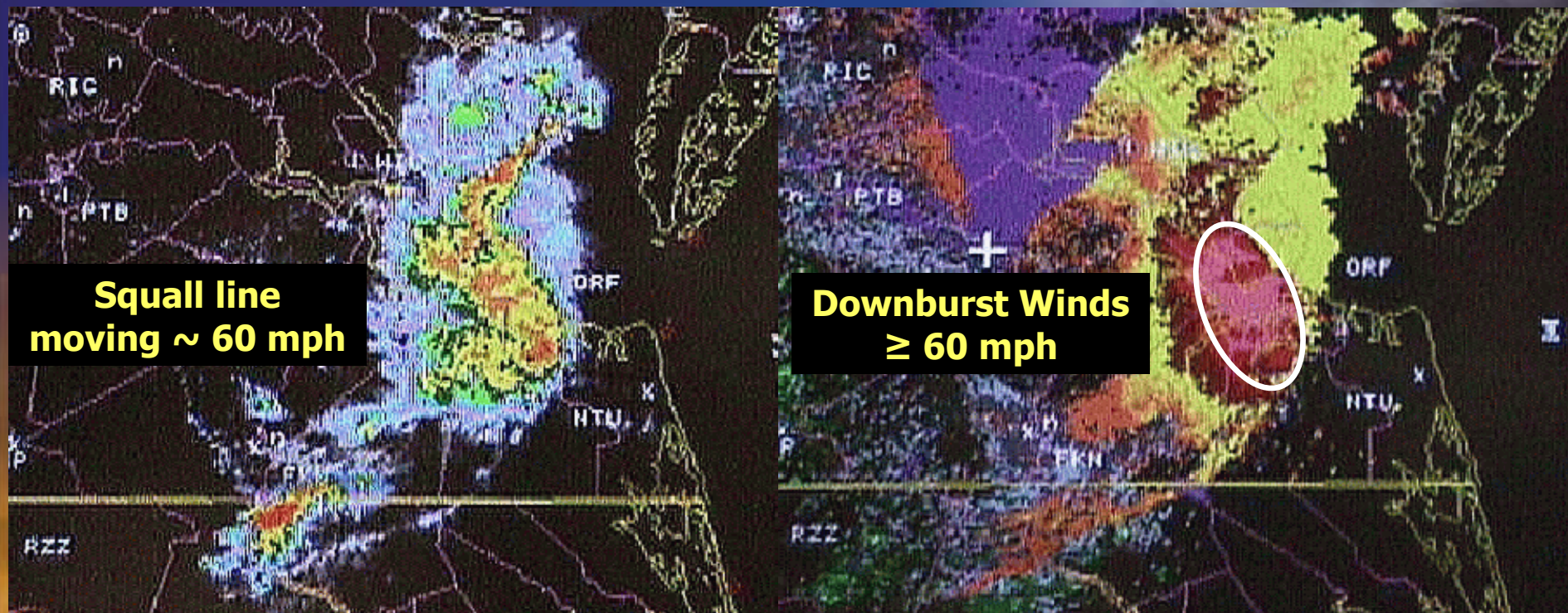




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Thunderstorms – Squall Lines



**Squall line
moving ~ 60 mph**

**Downburst Winds
≥ 60 mph**

**June 16, 1998
Radar Reflectivity**

**June 16, 1998
Doppler Velocity**



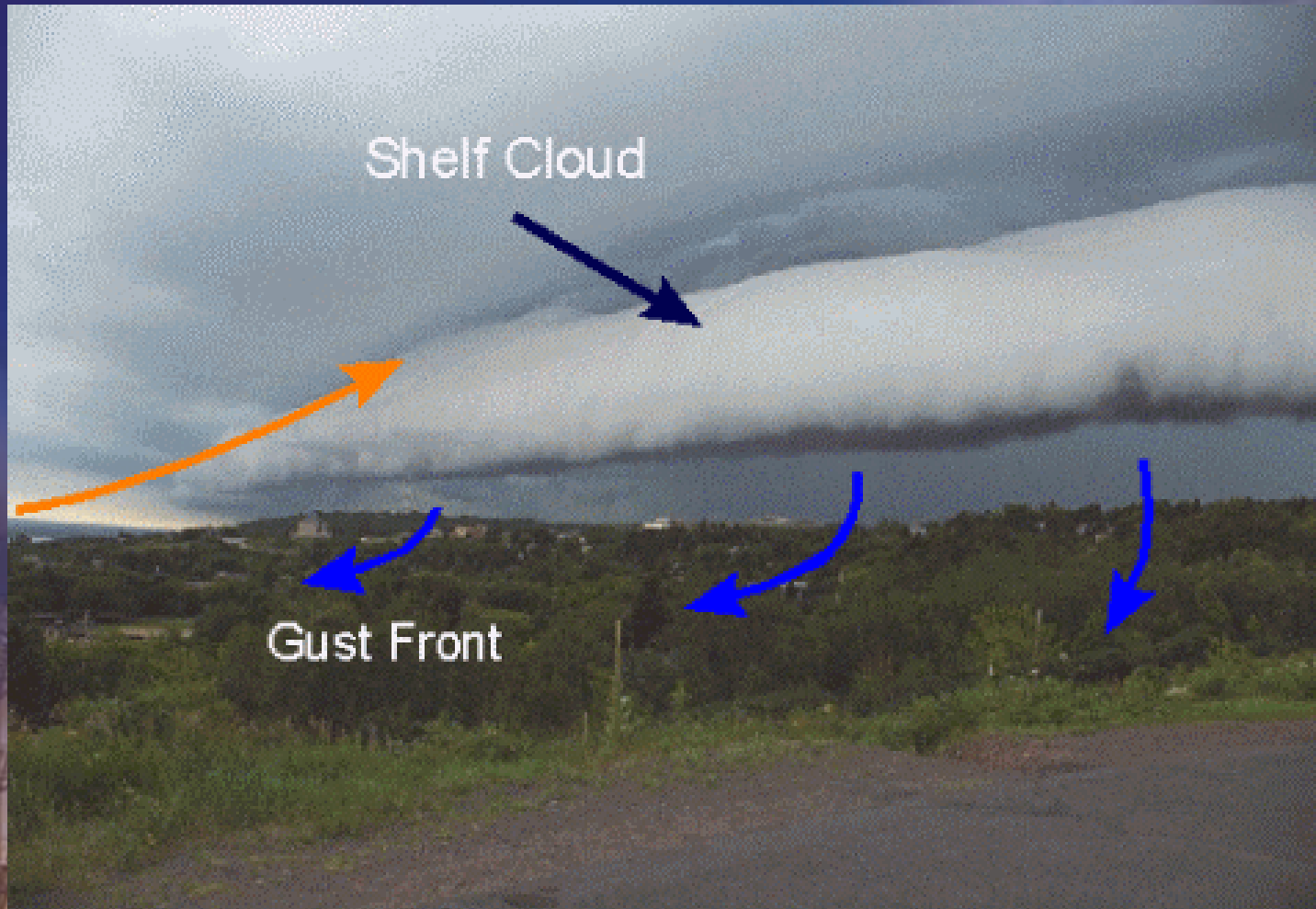
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Thunderstorms – Gust Front/Shelf Cloud



Shelf Cloud

Gust Front

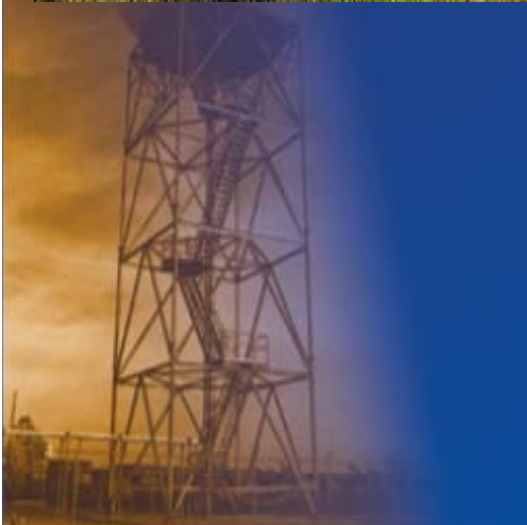




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Thunderstorms – Gust Front/Shelf Cloud





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End of Part 2

Are There Any
Questions??

