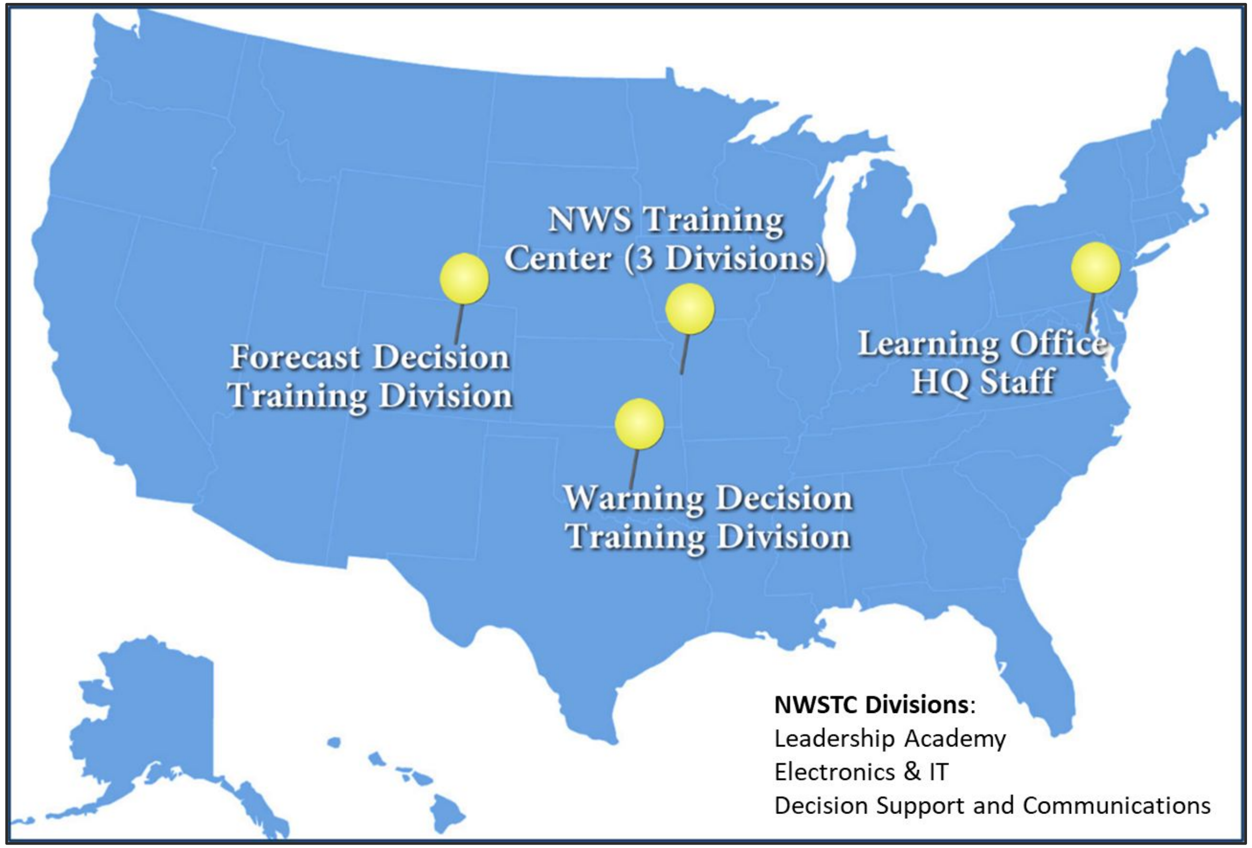
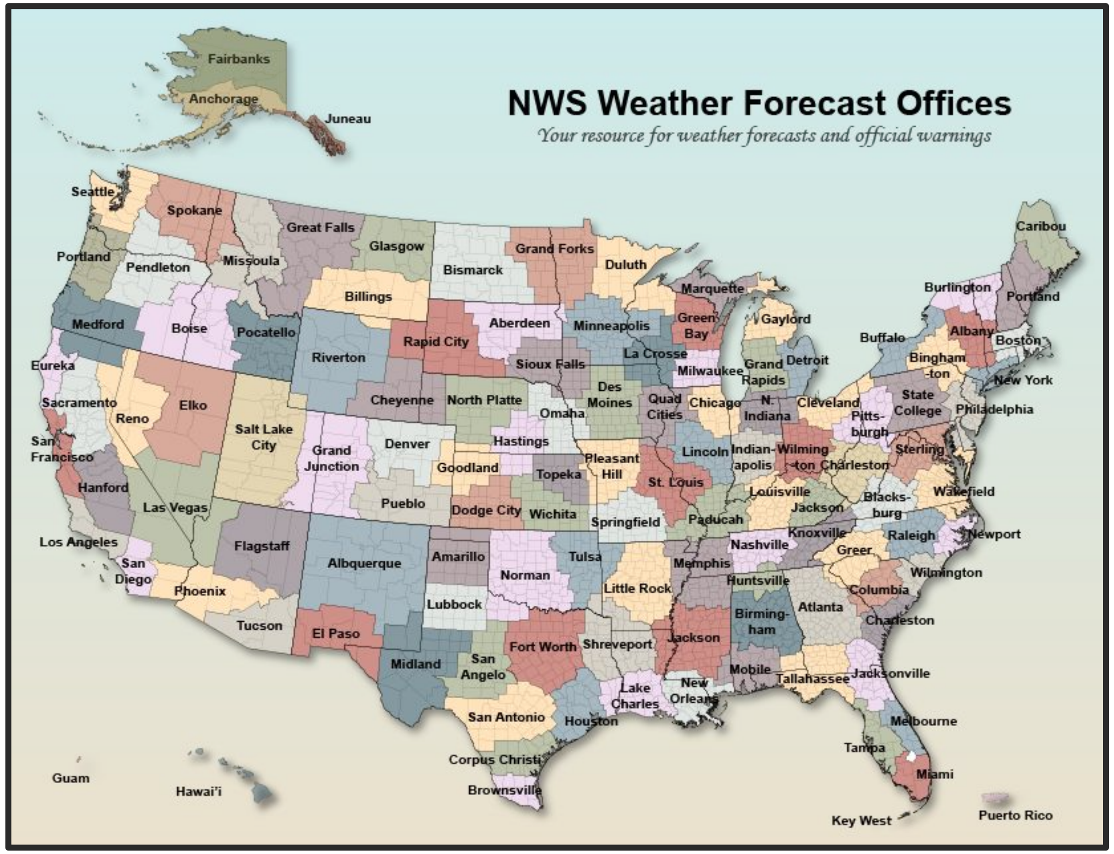
Application of Meteorological Theory to Severe Thunderstorm Forecasting

Title: Intro to Radar Principles and Dual-Pol Parameters

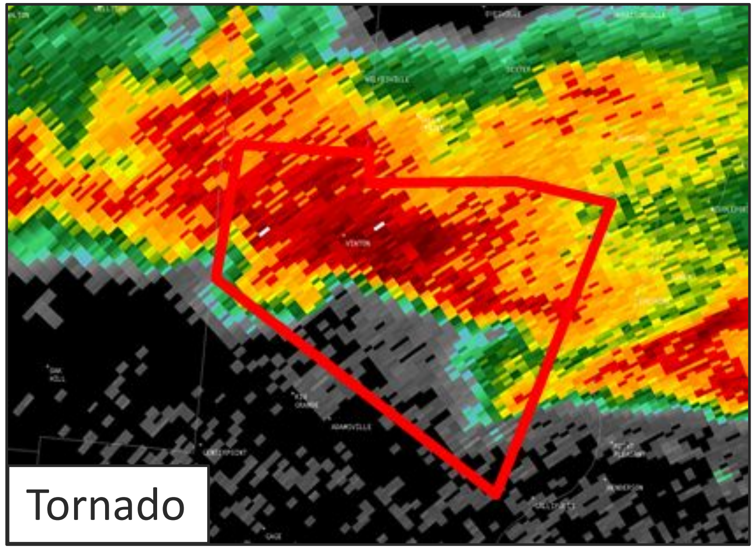
Why Us?

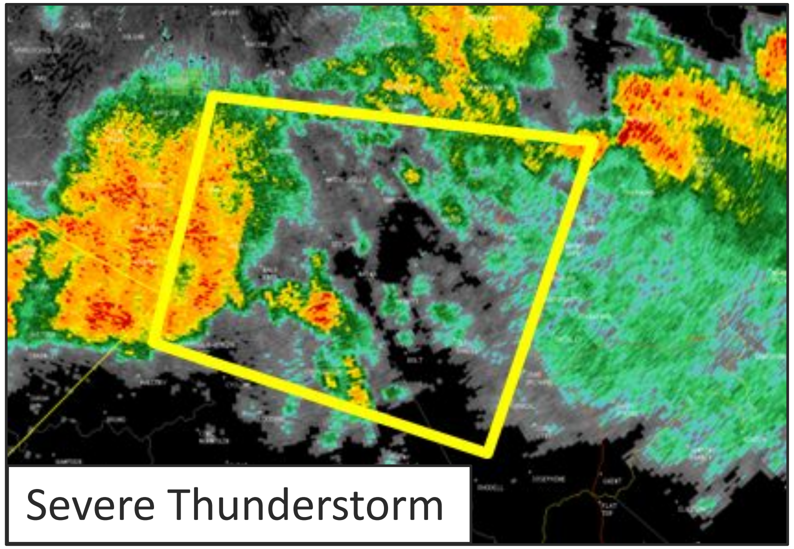


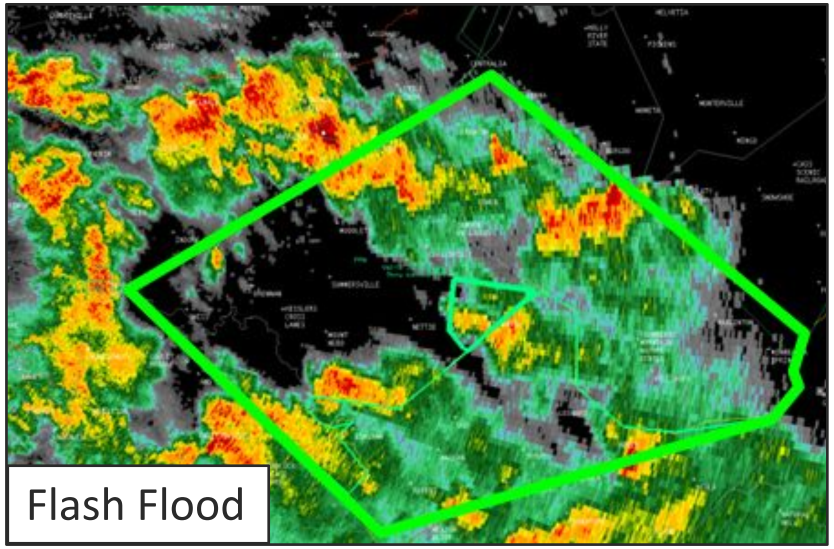


Warning Decision Training Division teaches weather radar theory & applications to NWS forecasters for use in warning operations

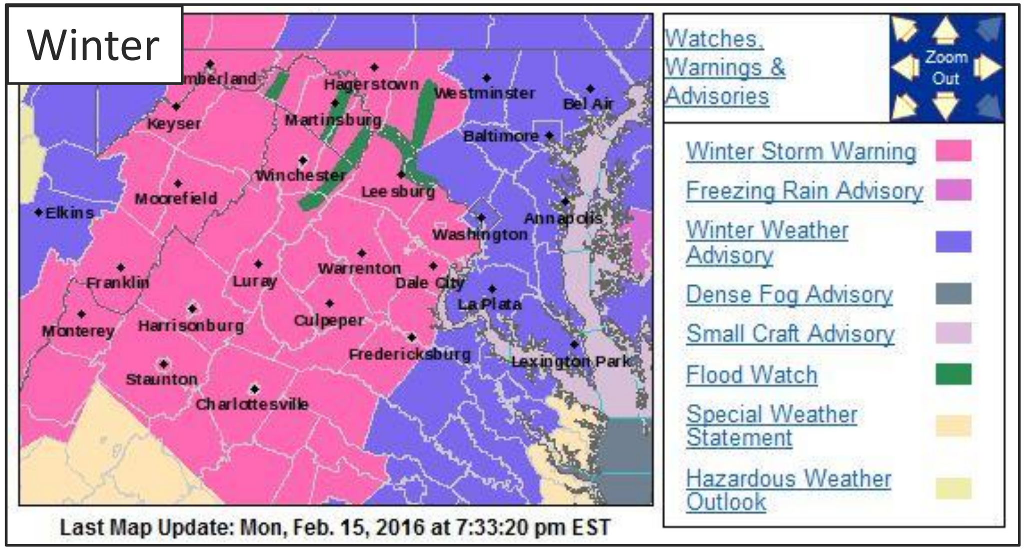
We Train on Warning Decision Making & Operational Tasks







- Job-centered
- Time-sensitive tasks
- Evidence-based
- Focus on service to the public



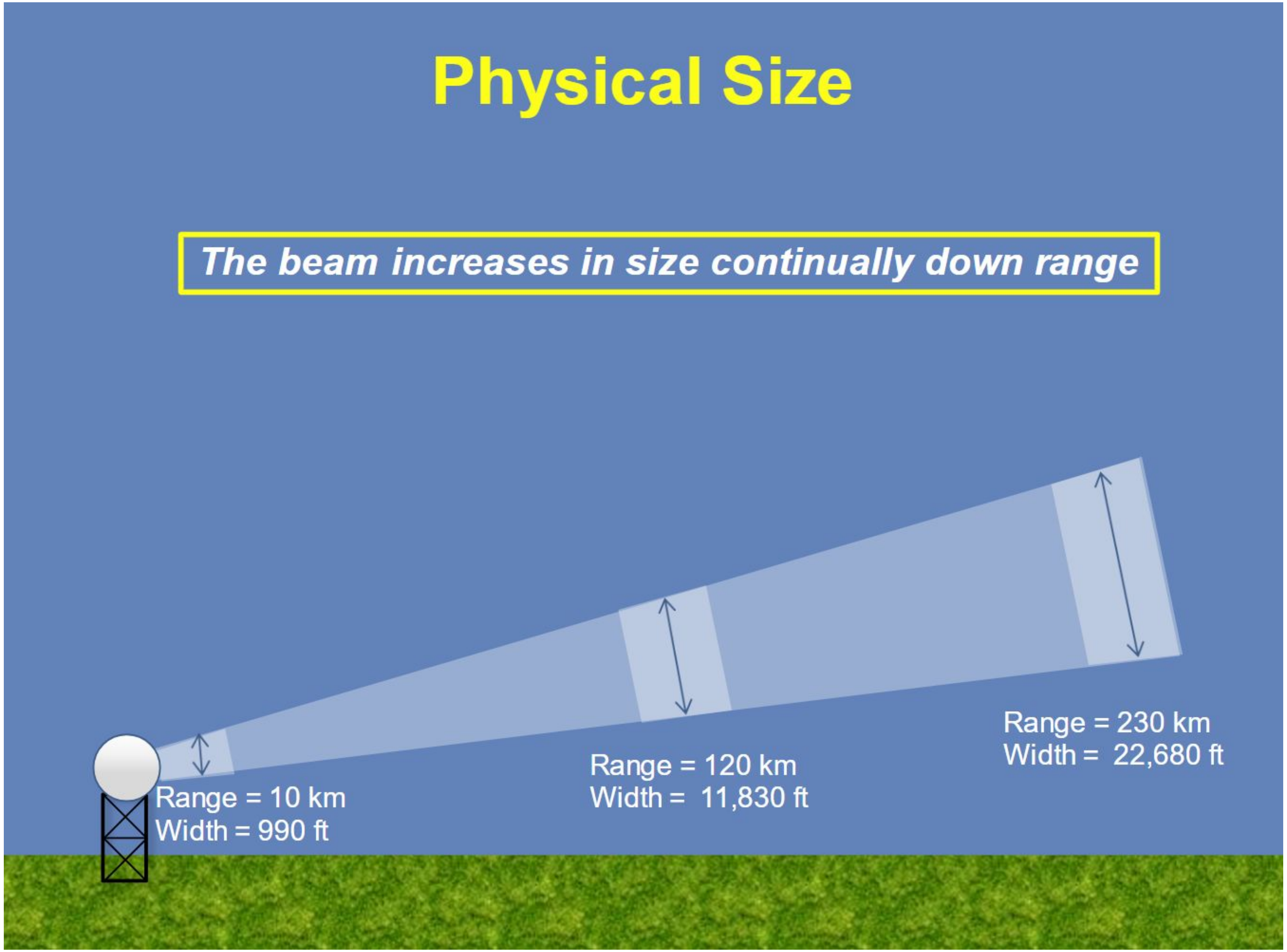
Goals for Today

- Part 1: Basics of radar

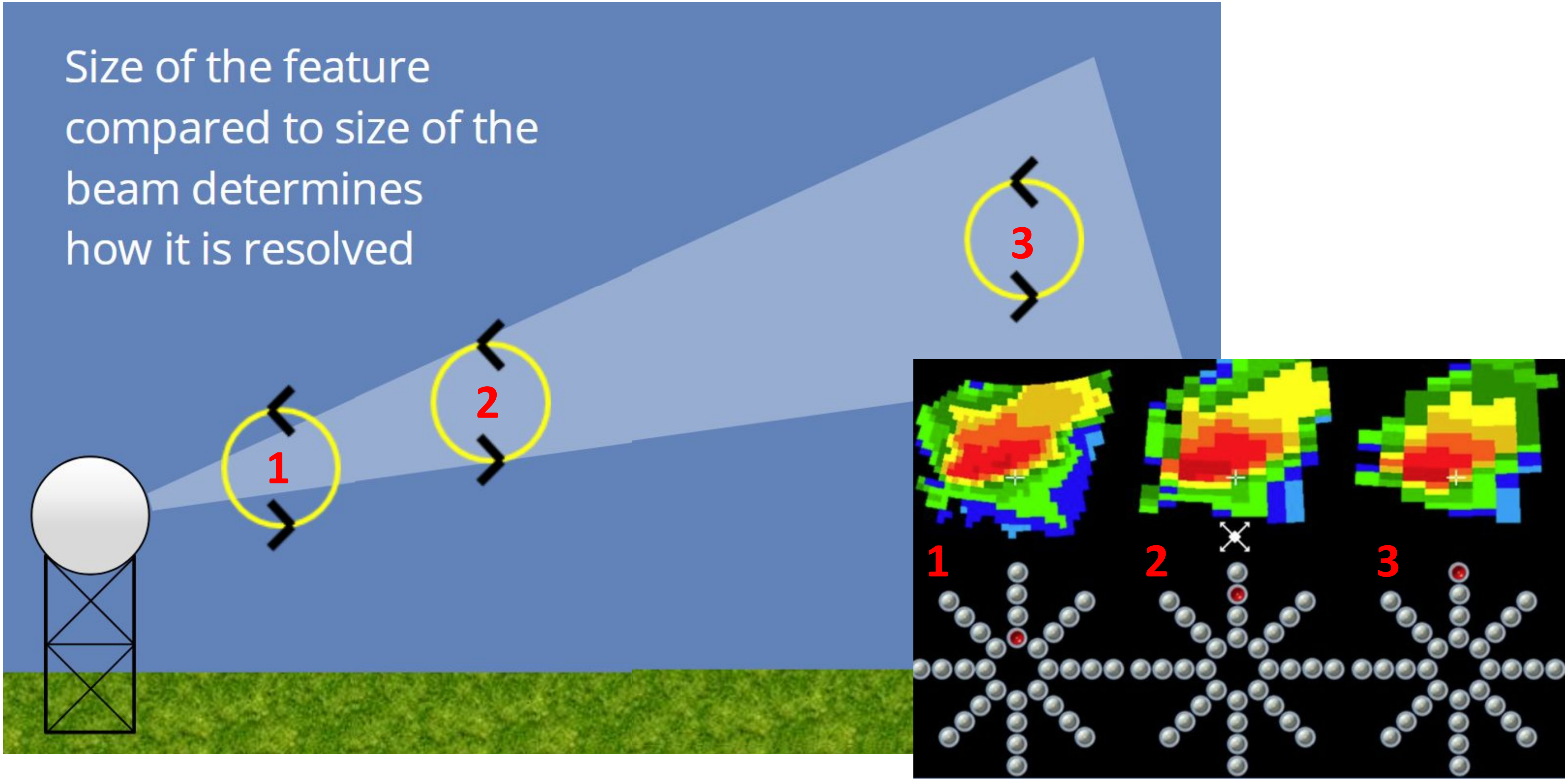
- Part 2: Radar analysis using Dual-Pol

- Part 3: What can go wrong?

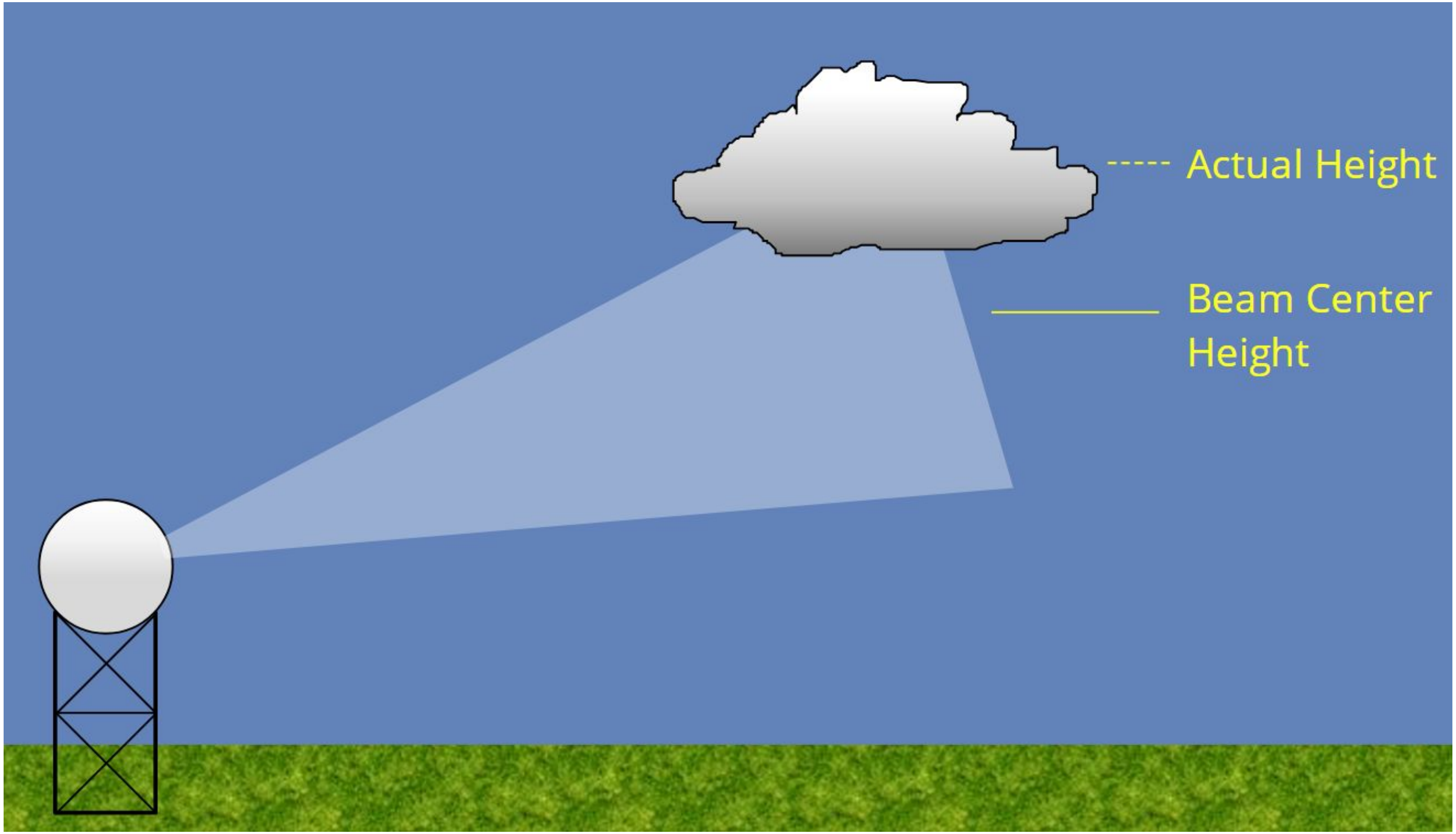
How Does Distance from the Radar Impact that Volume's Size?



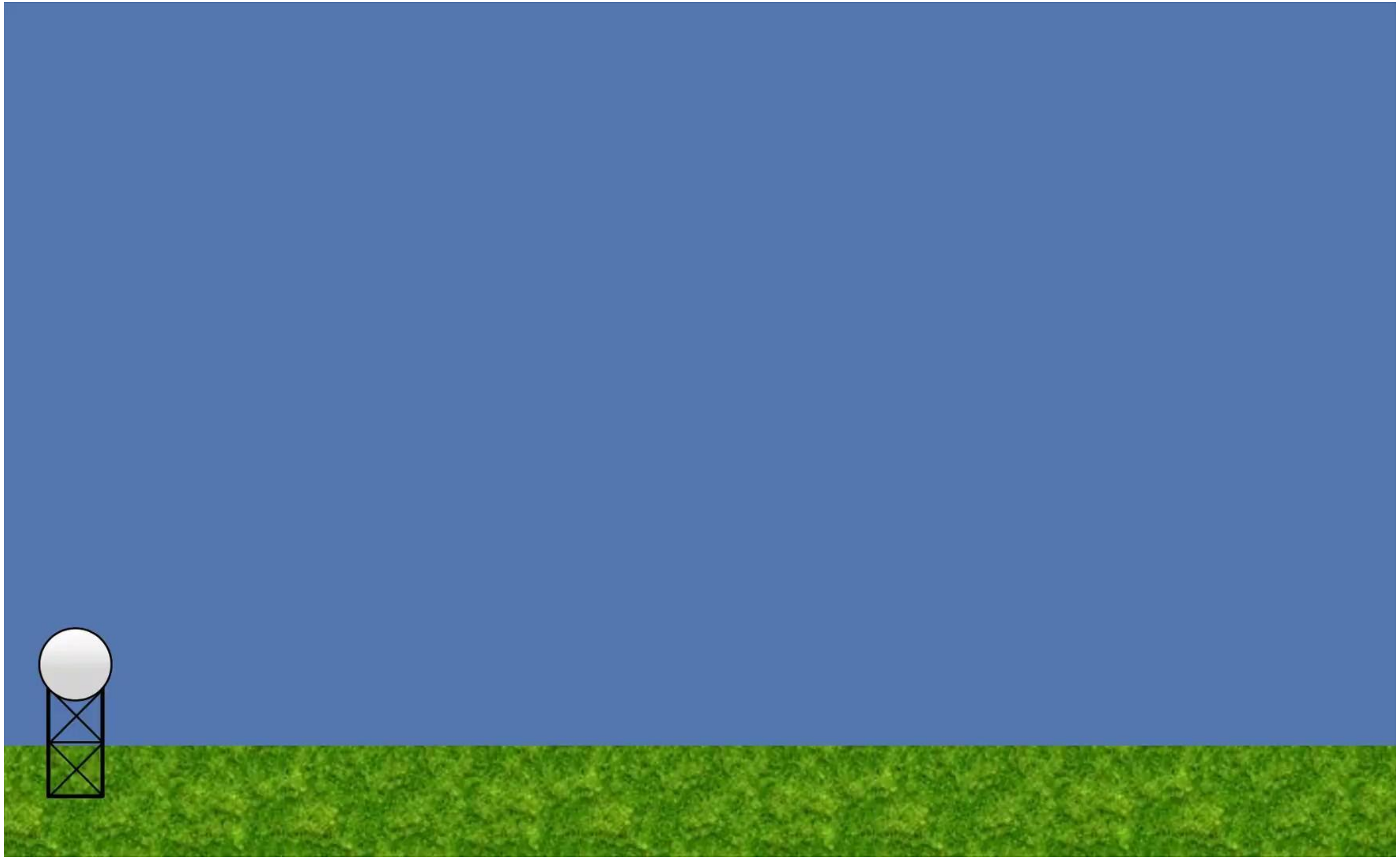
How Does Distance from the Radar Impact Feature Interpretation?



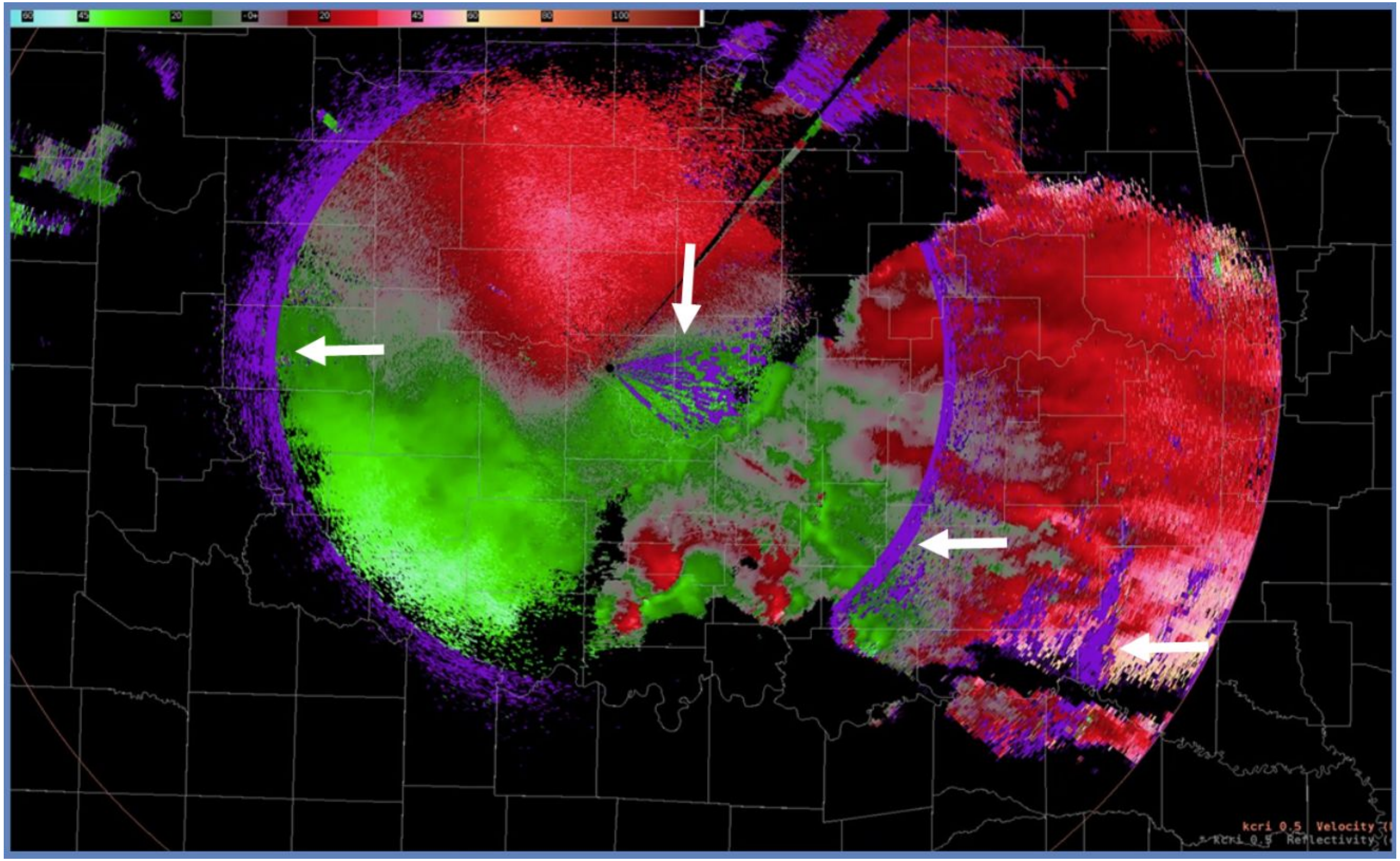
Radar Height and Sampling Uncertainty



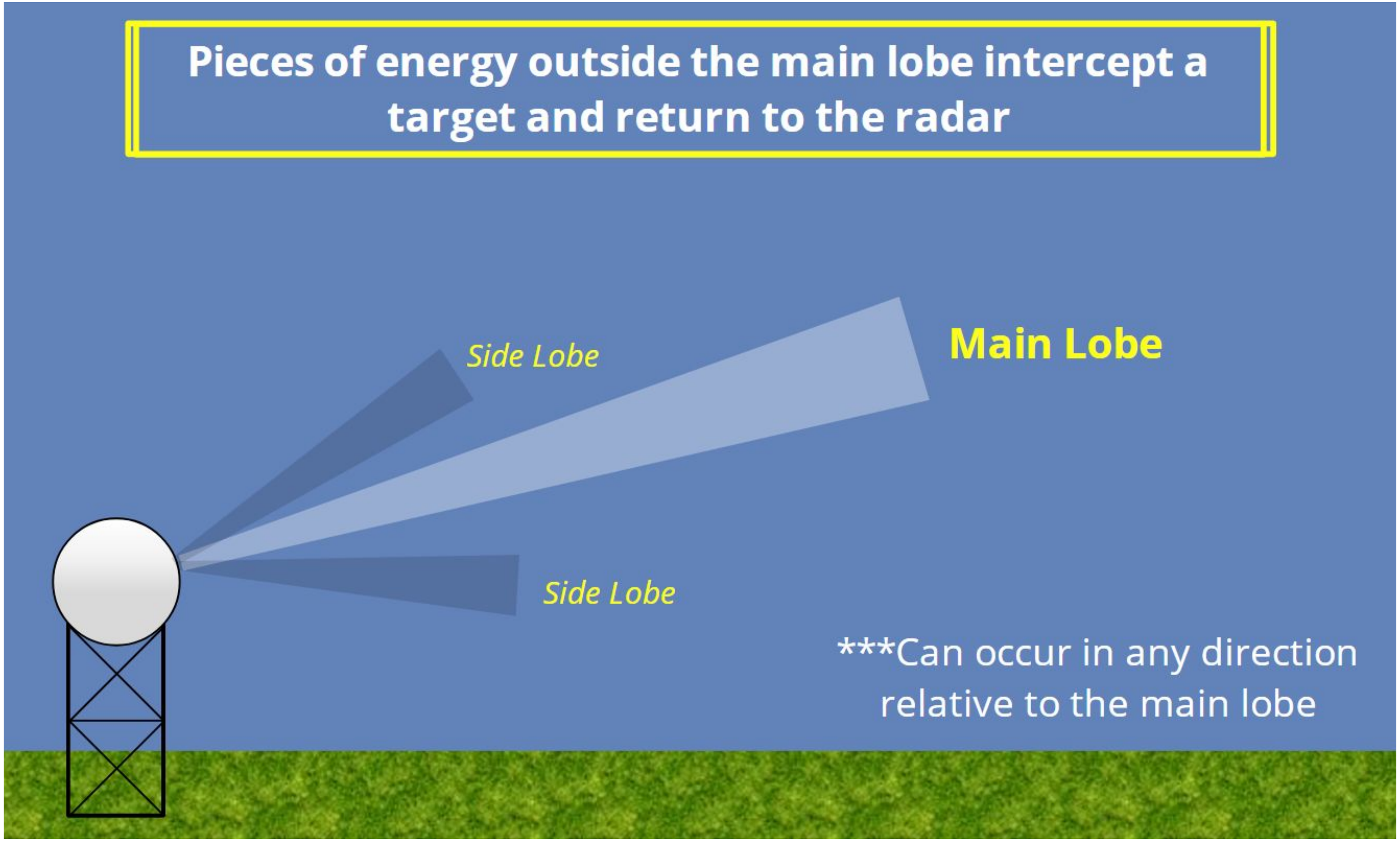
Range Folding



Range Folding

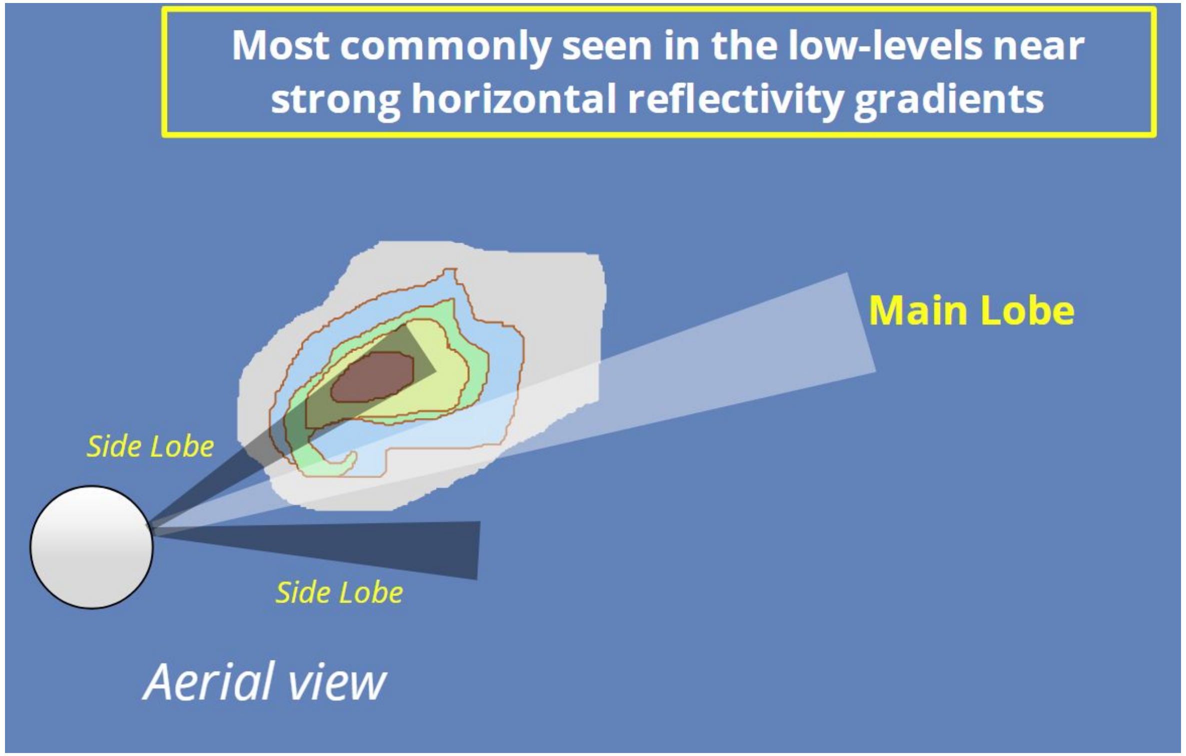


Side Lobe Contamination

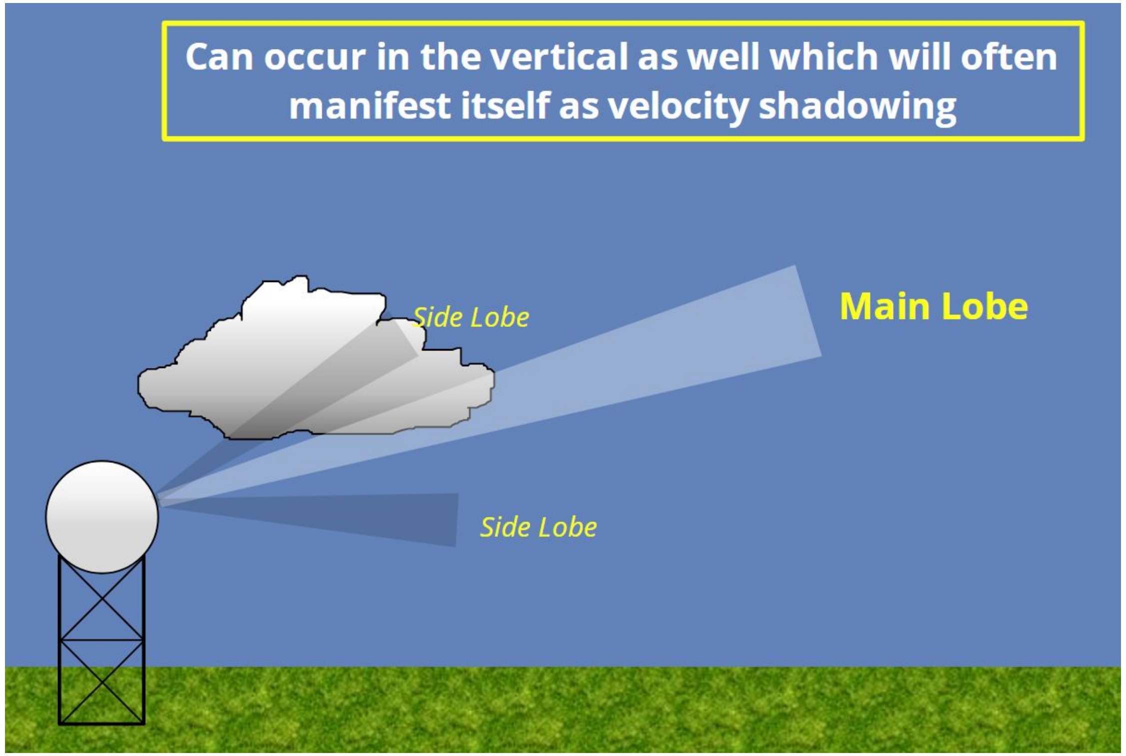


Side Lobe Contamination

Horizontal

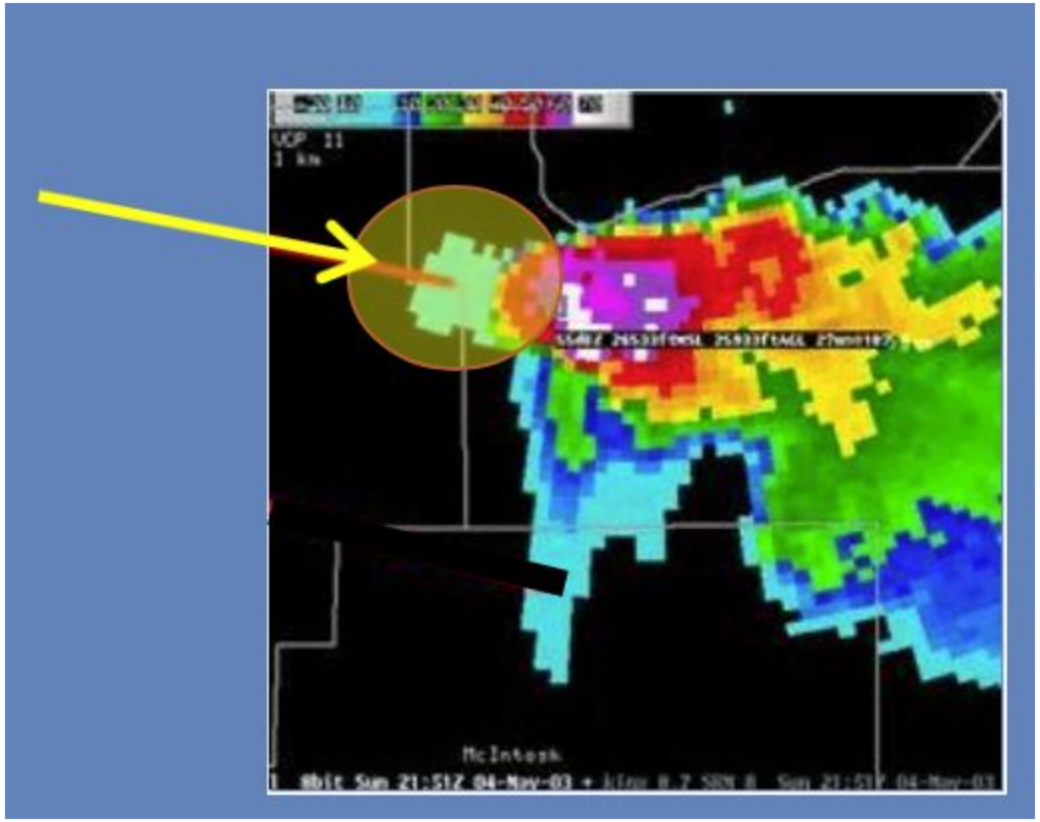


Vertical

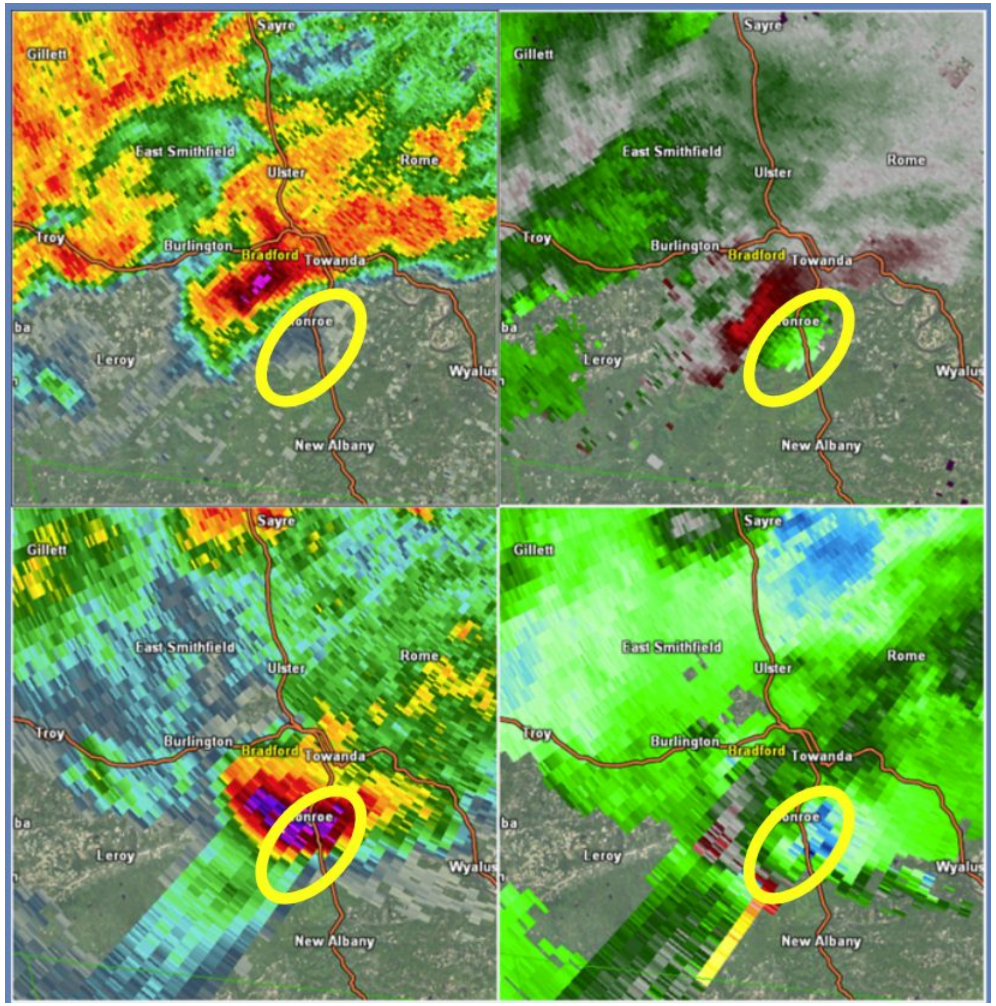


Side Lobe Contamination

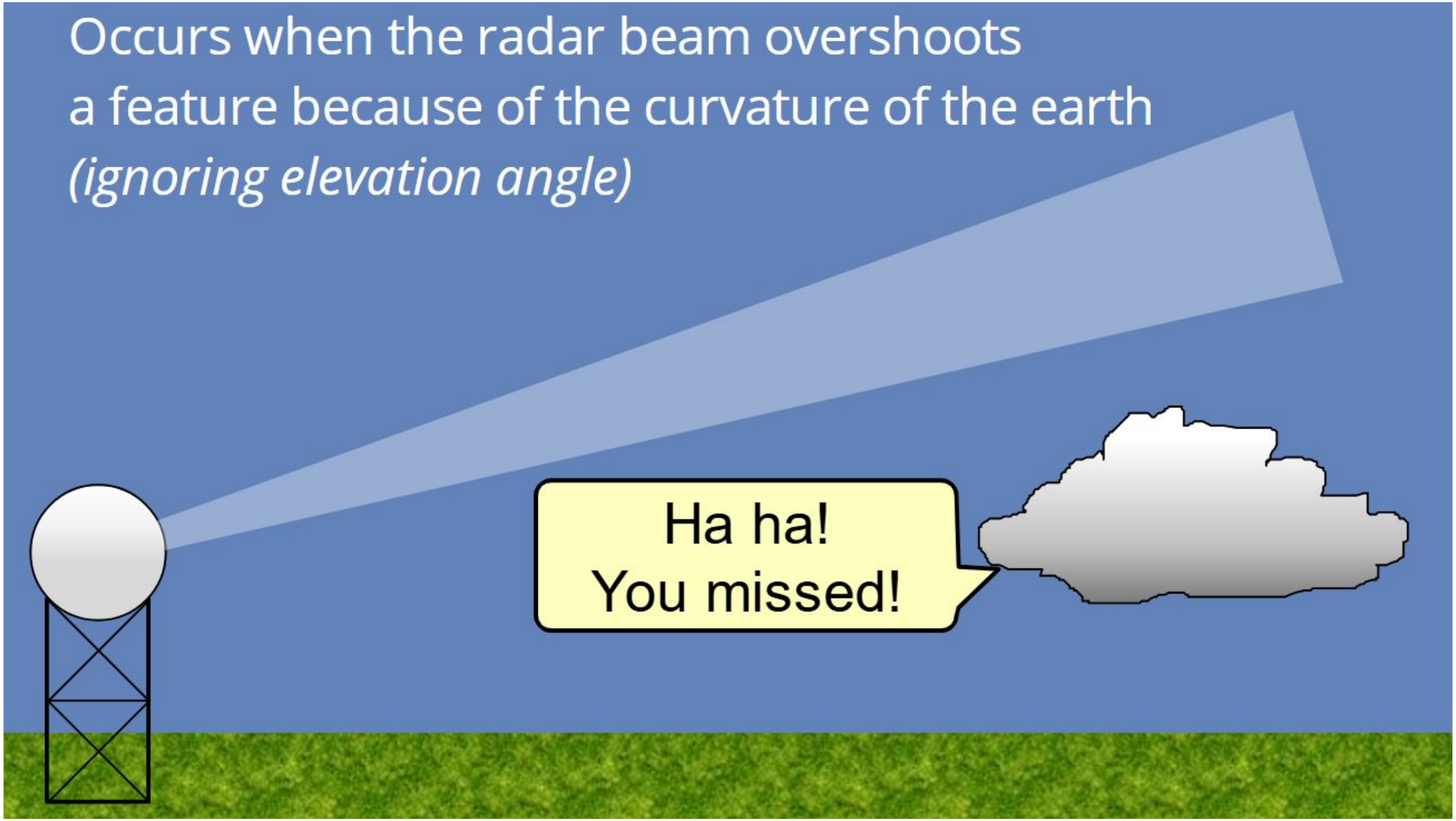
Horizontal



Vertical



What's Happening Below the Lowest & Highest Beam?



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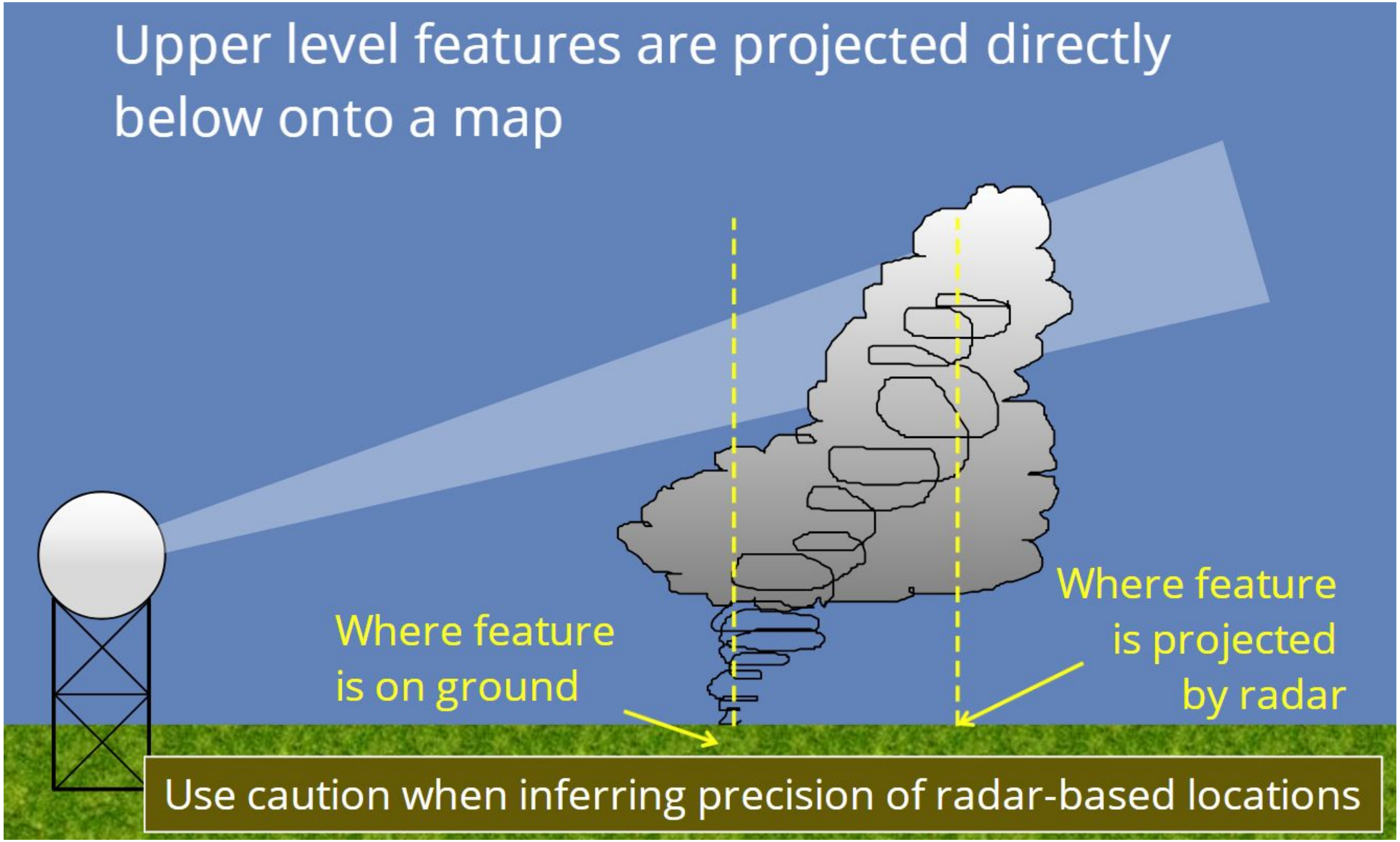
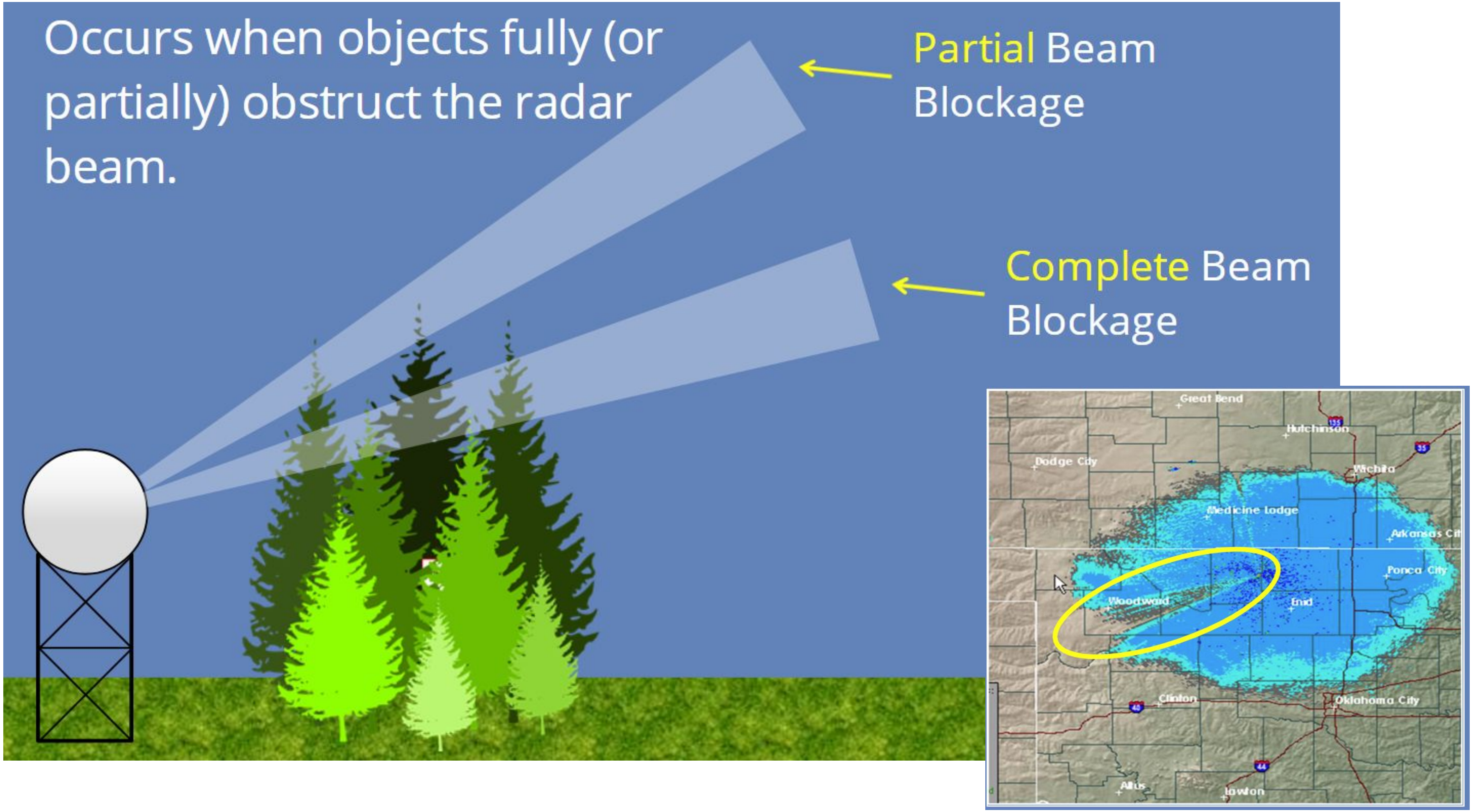
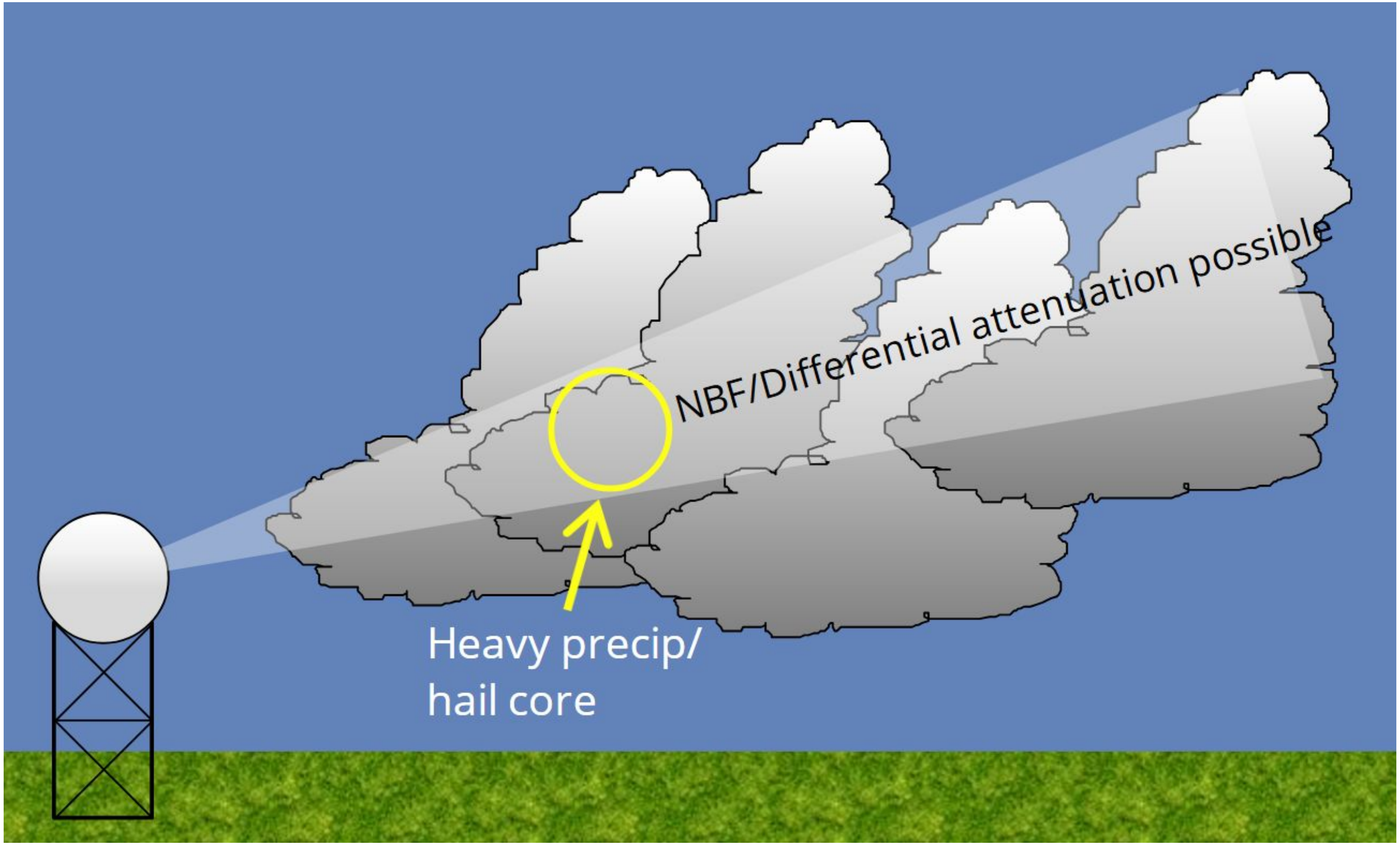


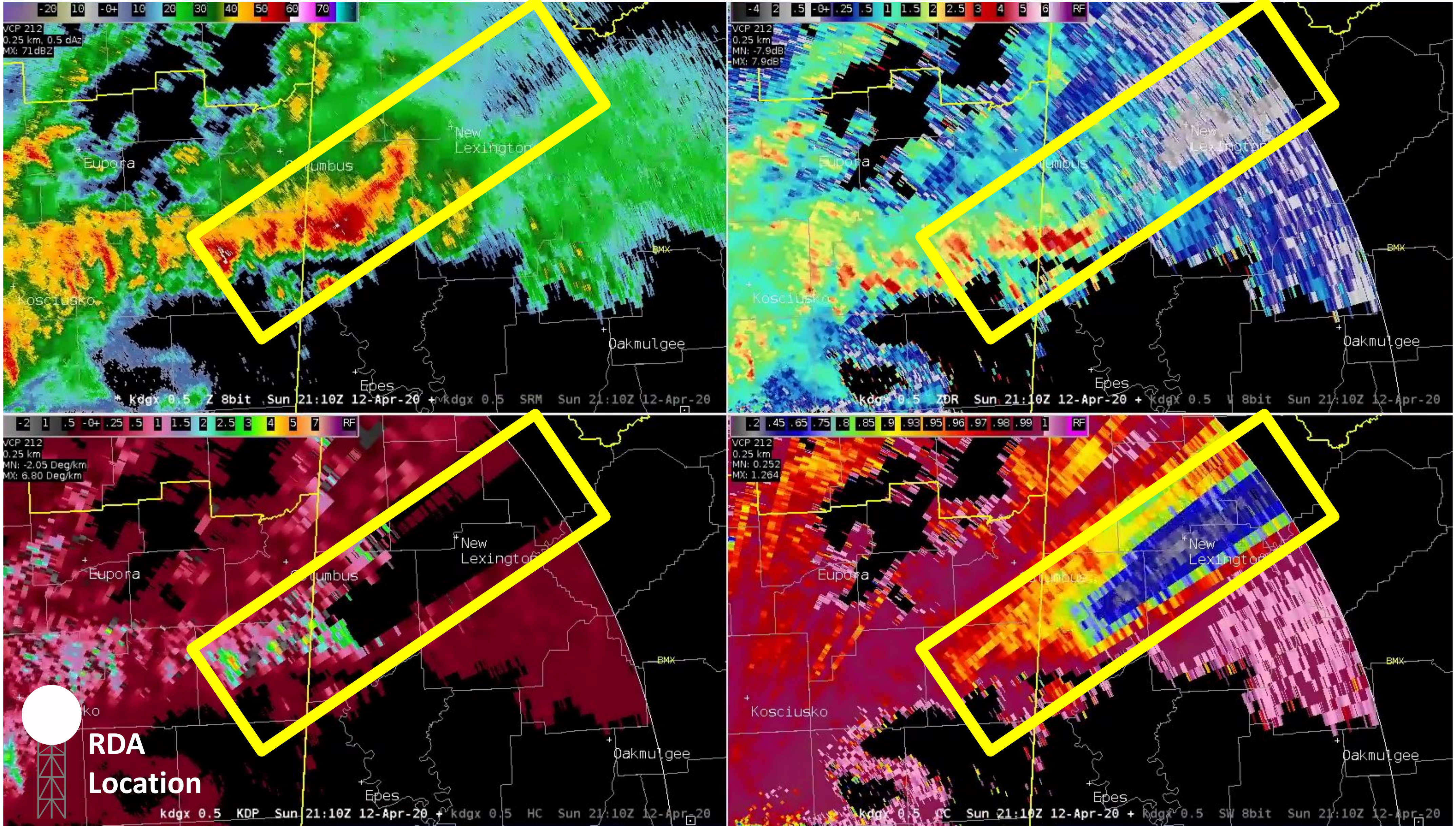
Beam Blockage



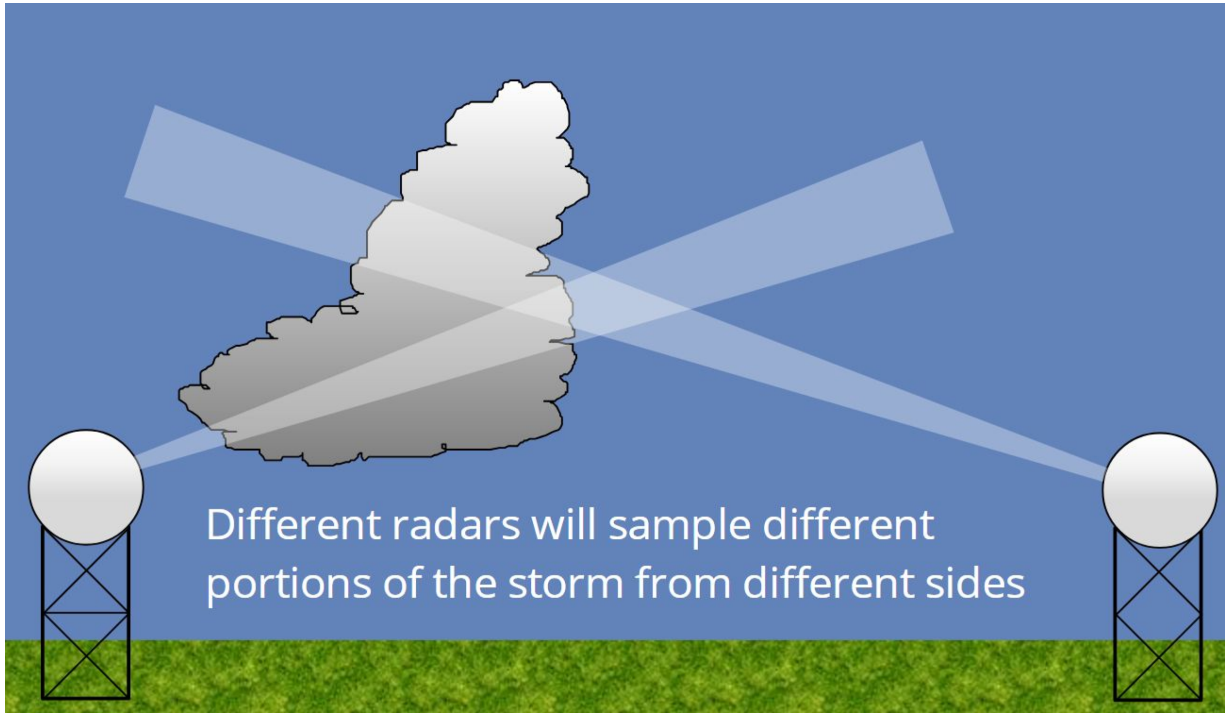
Non-Uniform Beam Filling / Differential Attenuation

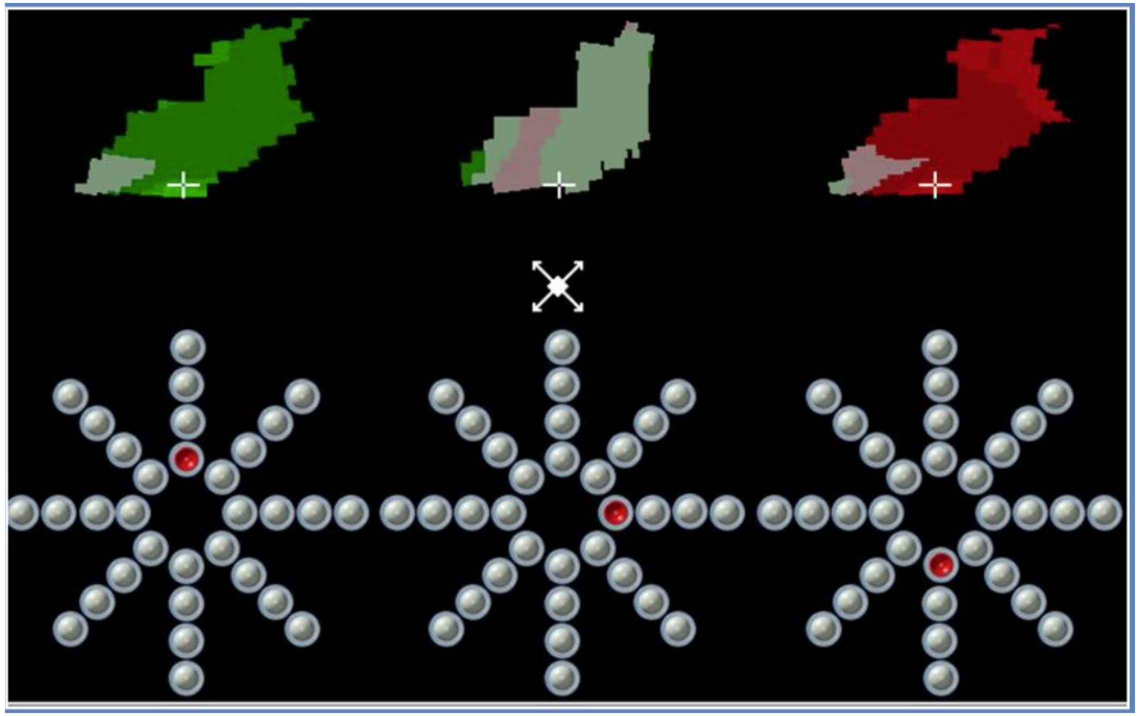


Example of Non-Uniform Beam Filling / Differential Attenuation



Viewing Angle Matters



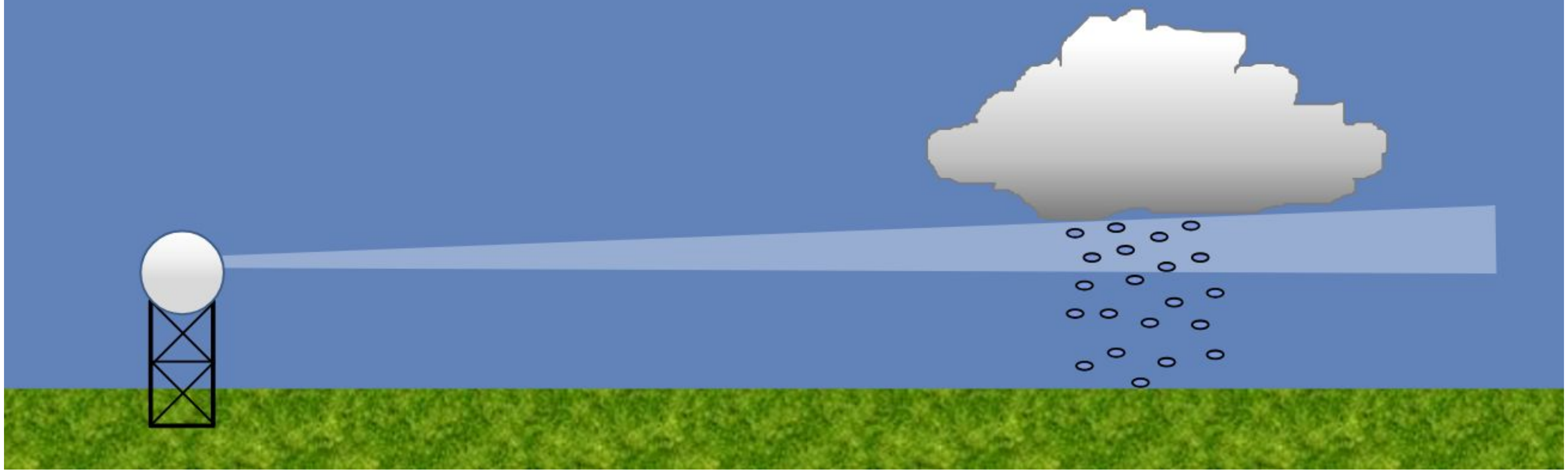


Same storm, different radars

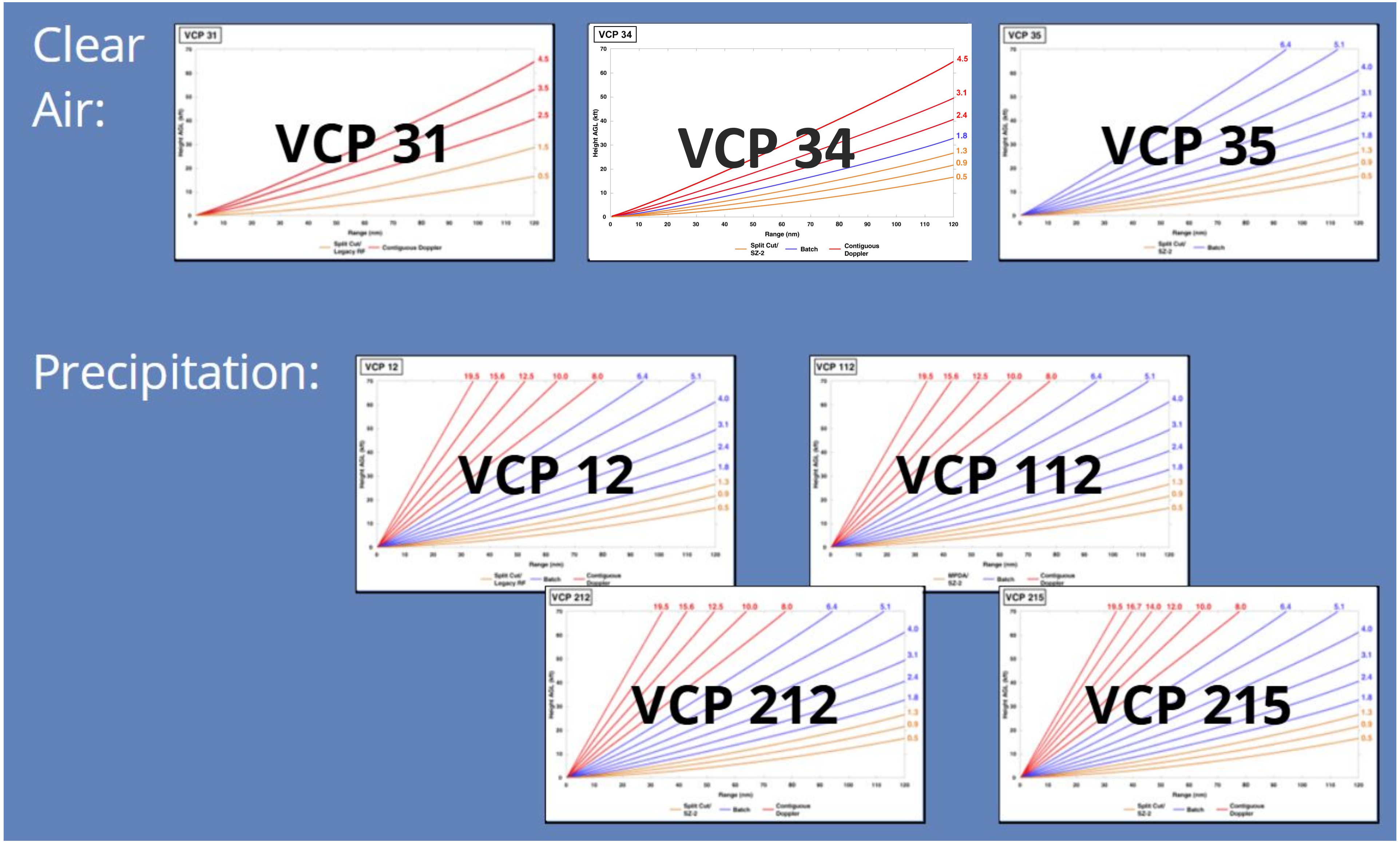
Operational Modes

CLEAR AIR: Designed for events with no detectable precipitation or when precipitation is light or small in areal coverage

PRECIPITATION: Designed for use when significant precipitation is present within the radar umbrella

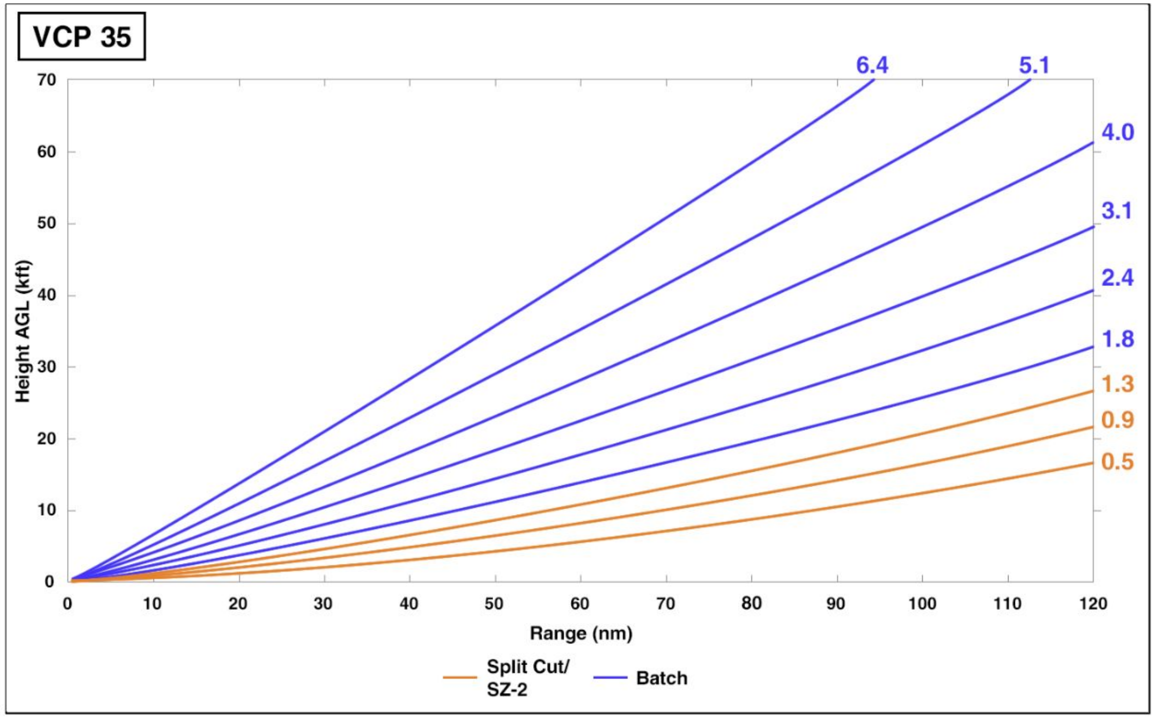


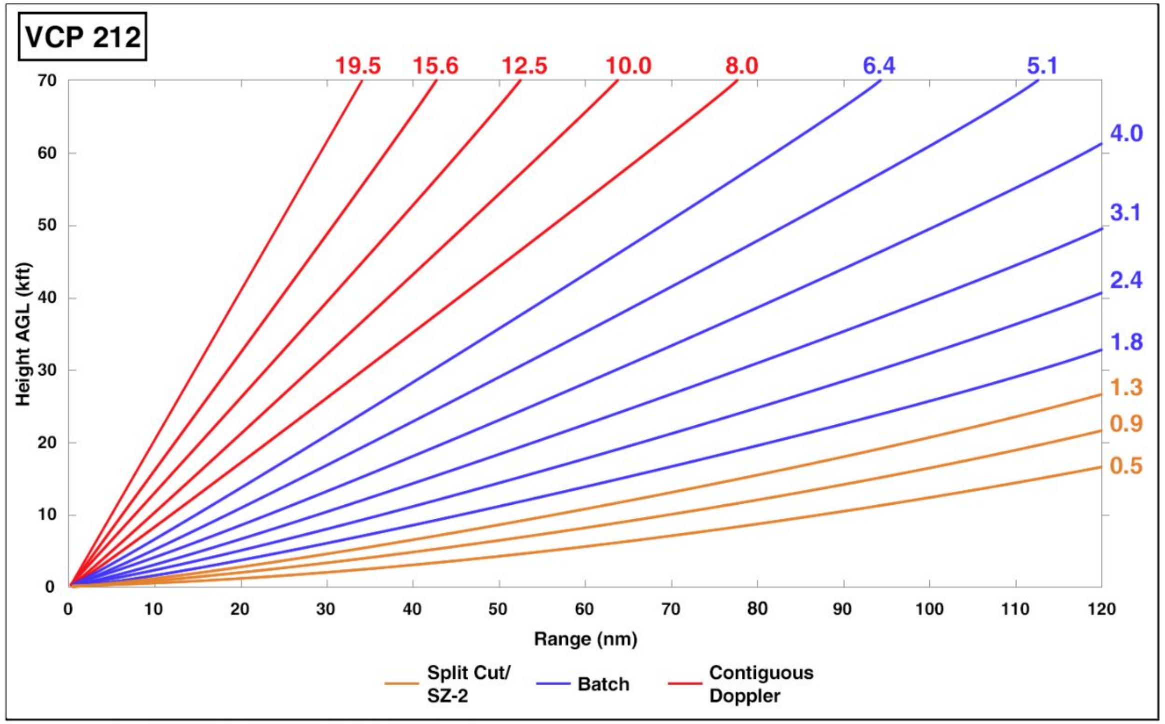
Radar Follows a Pre-Defined Scanning Strategy



How High Up In the Atmosphere Is the Radar Sampling?

Depends on the VCP **and** the dynamic scanning settings!

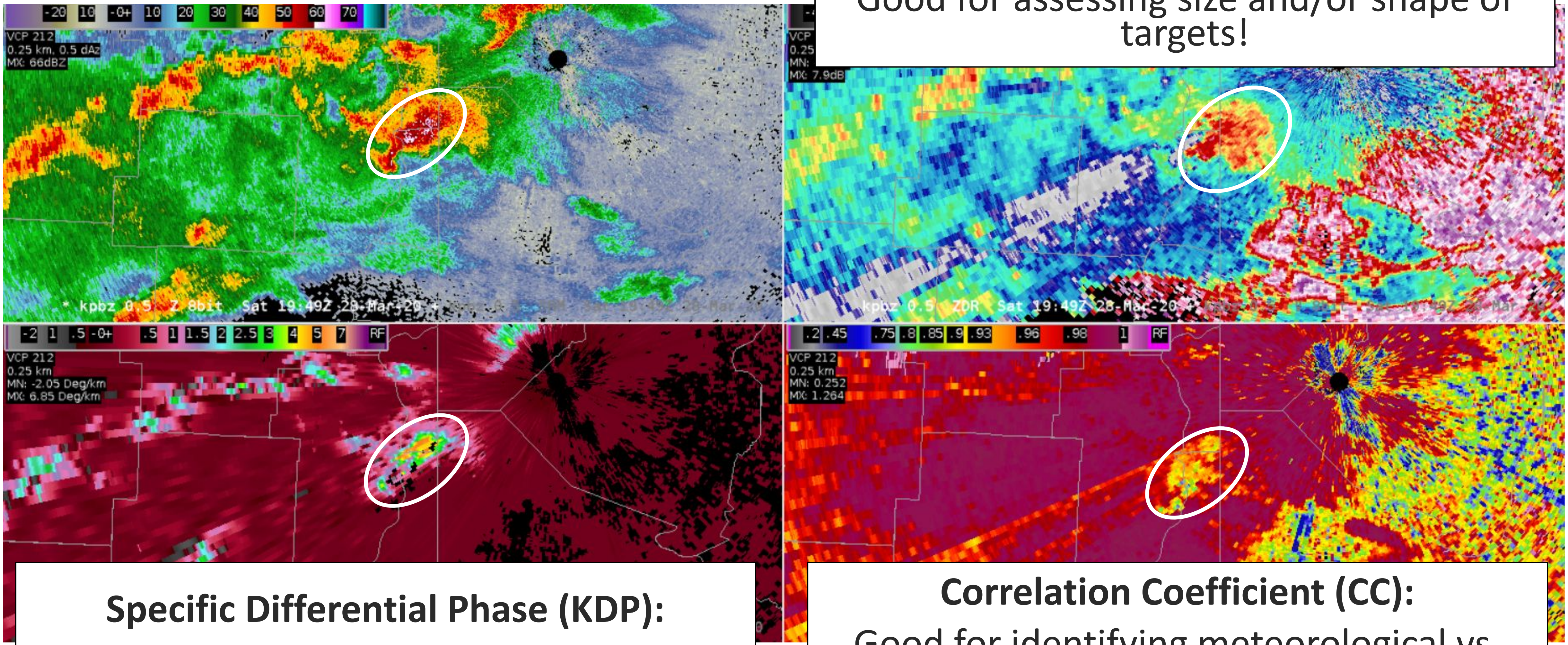




Dual-Pol Review

Differential Reflectivity (ZDR):

Good for assessing size and/or shape of targets!



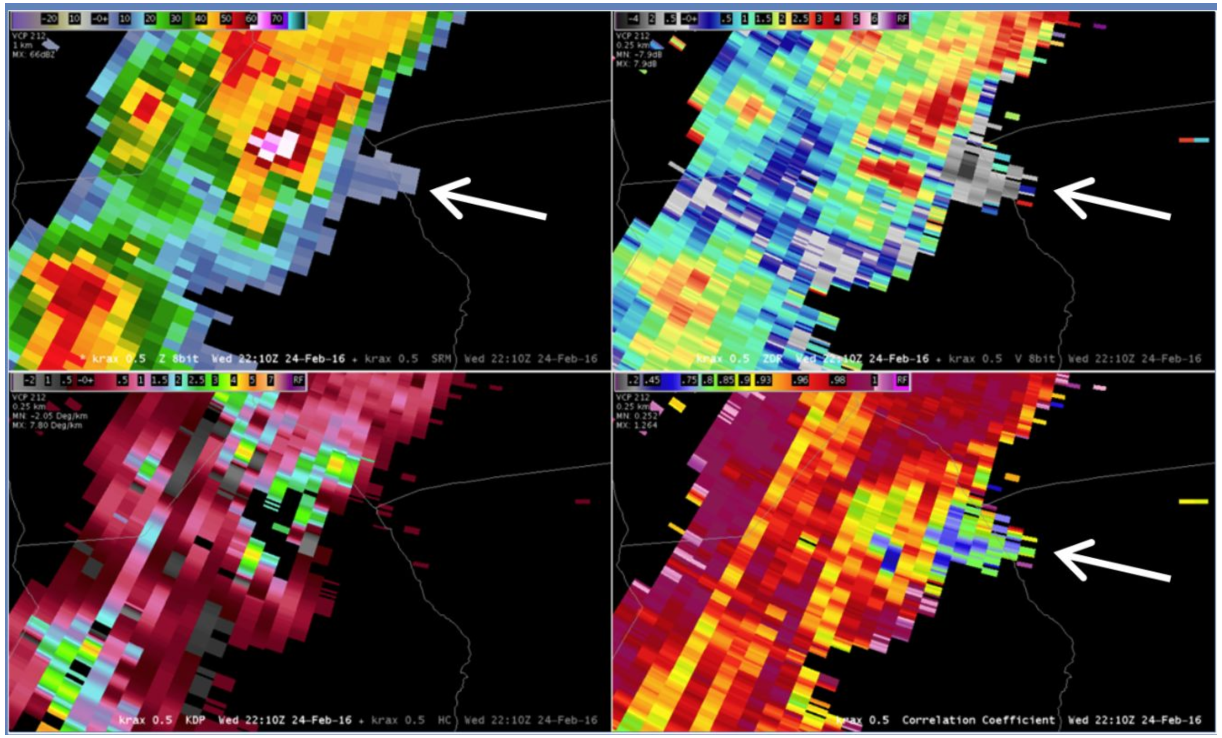
Specific Differential Phase (KDP):

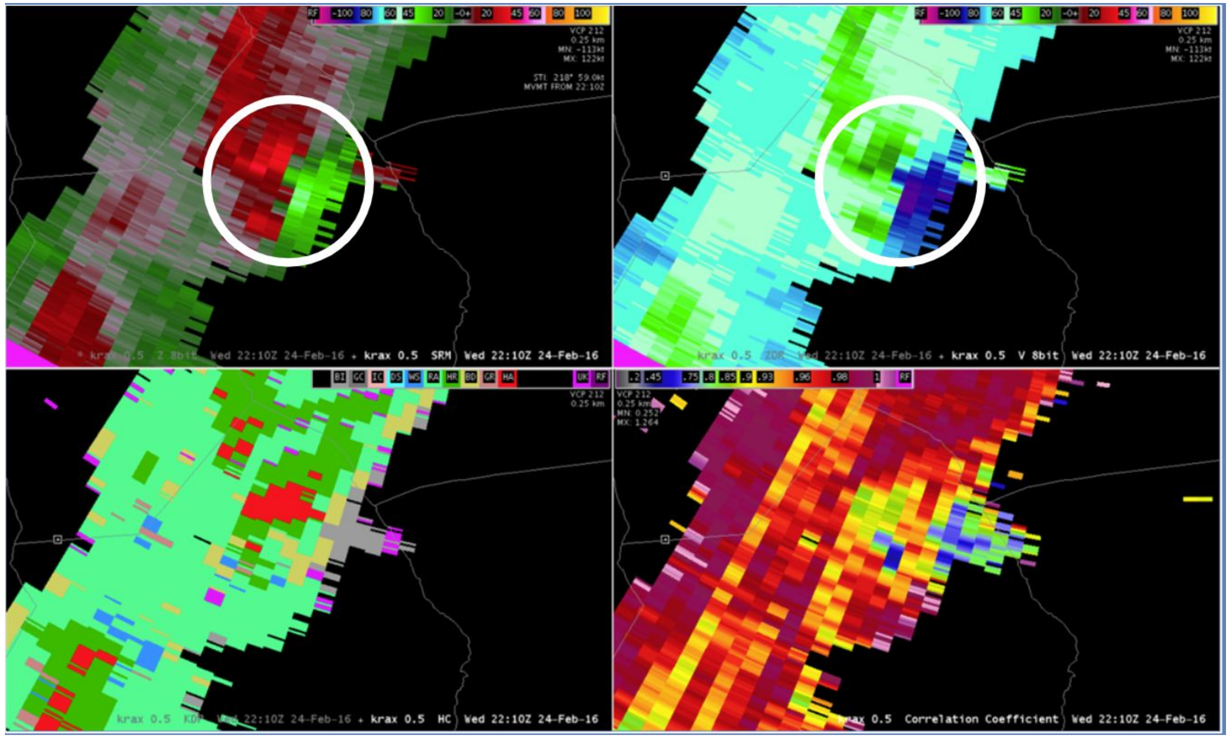
Good for assessing liquid water content!

Correlation Coefficient (CC):

Good for identifying meteorological vs. non-meteorological targets!

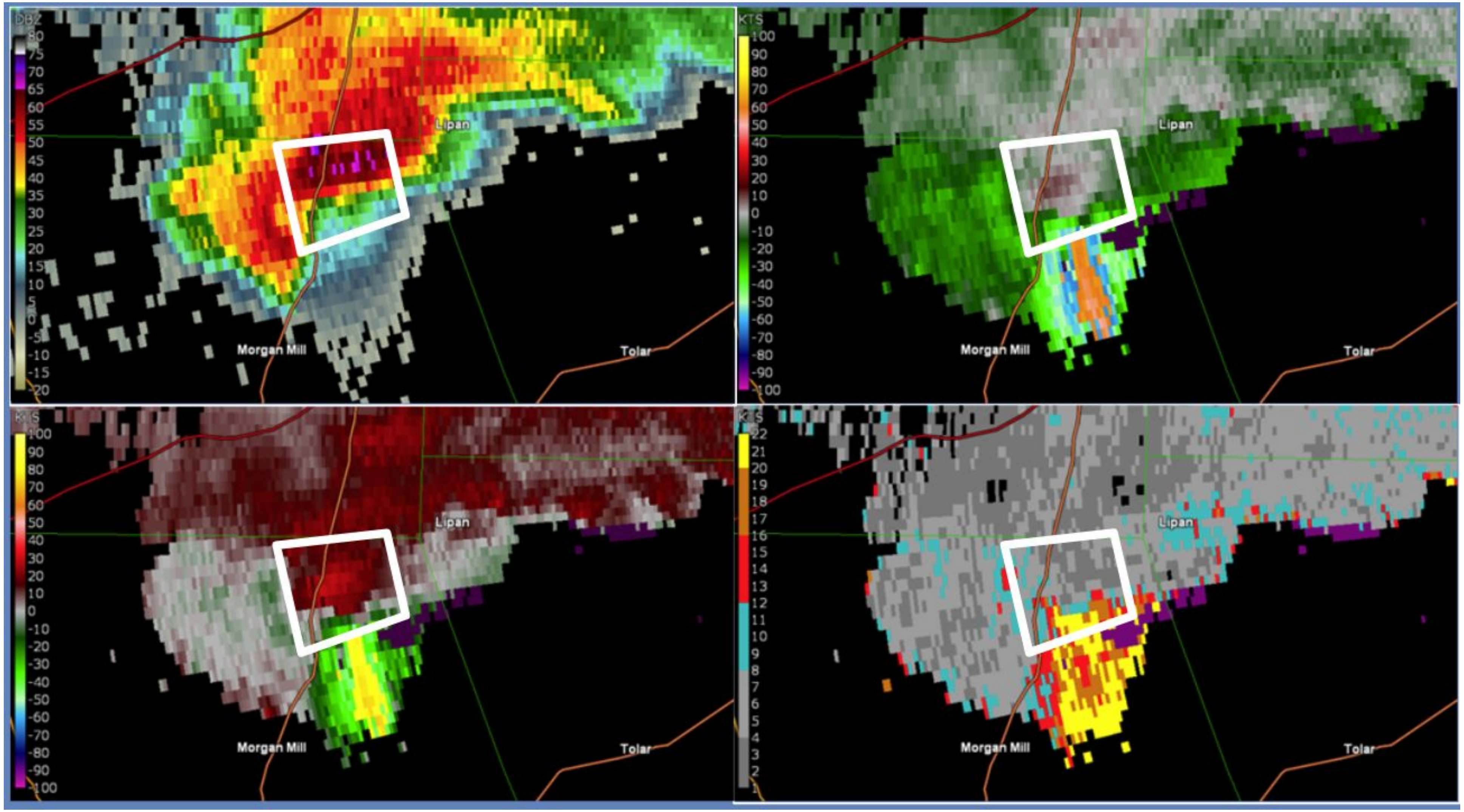
Horizontal Side Lobe Analysis using Dual-Pol





Vertical Side Lobe Analysis using Dual-Pol

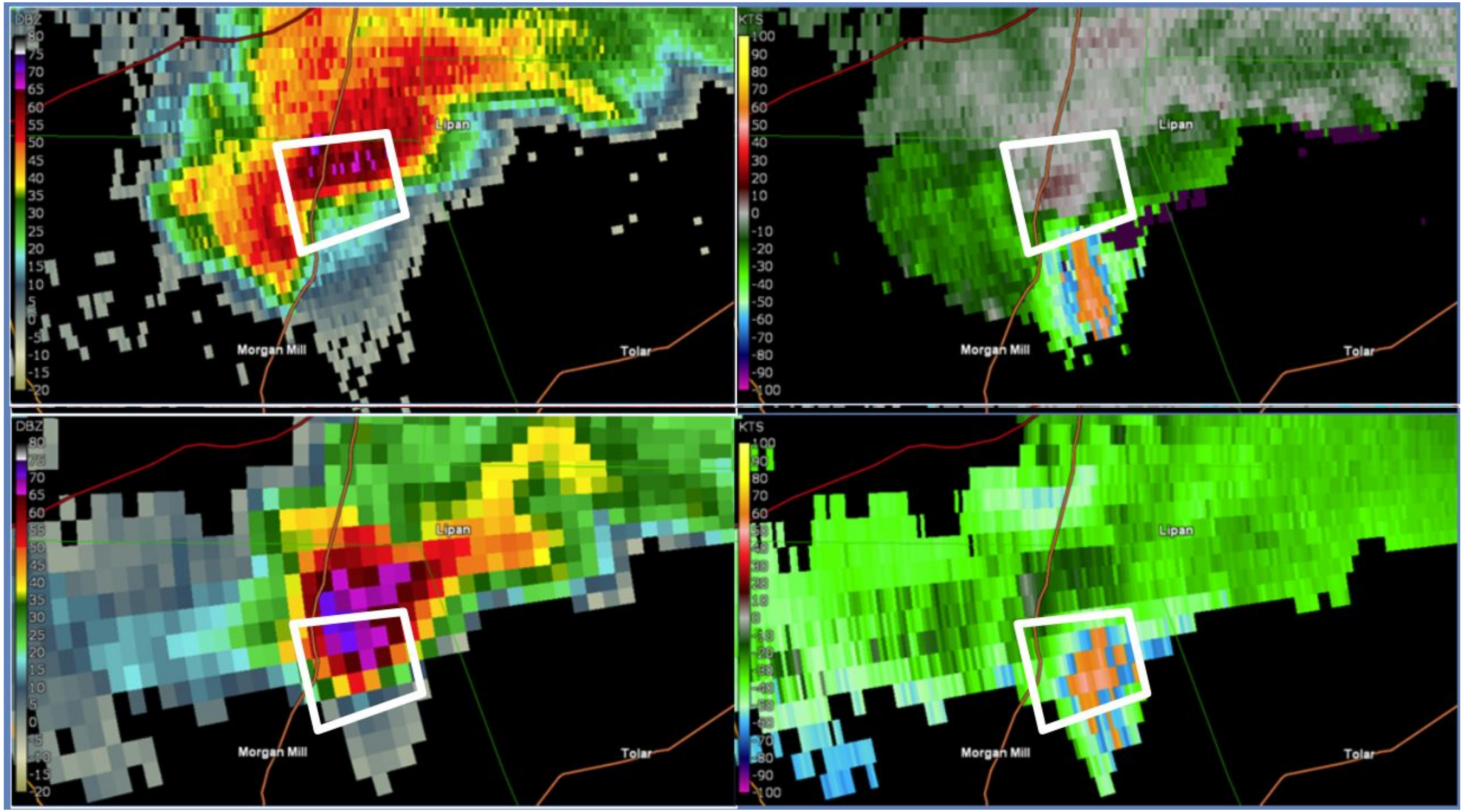
0.5 deg



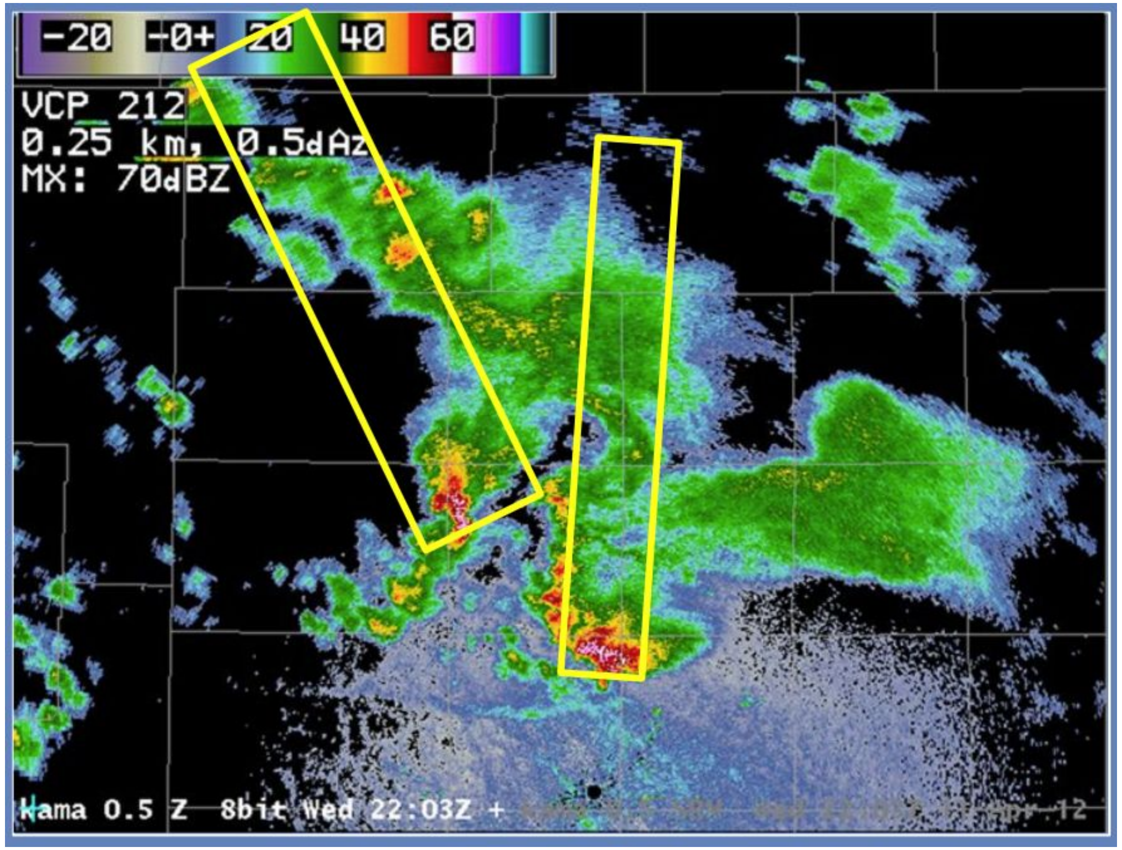
Vertical Side Lobe Analysis using Dual-Pol

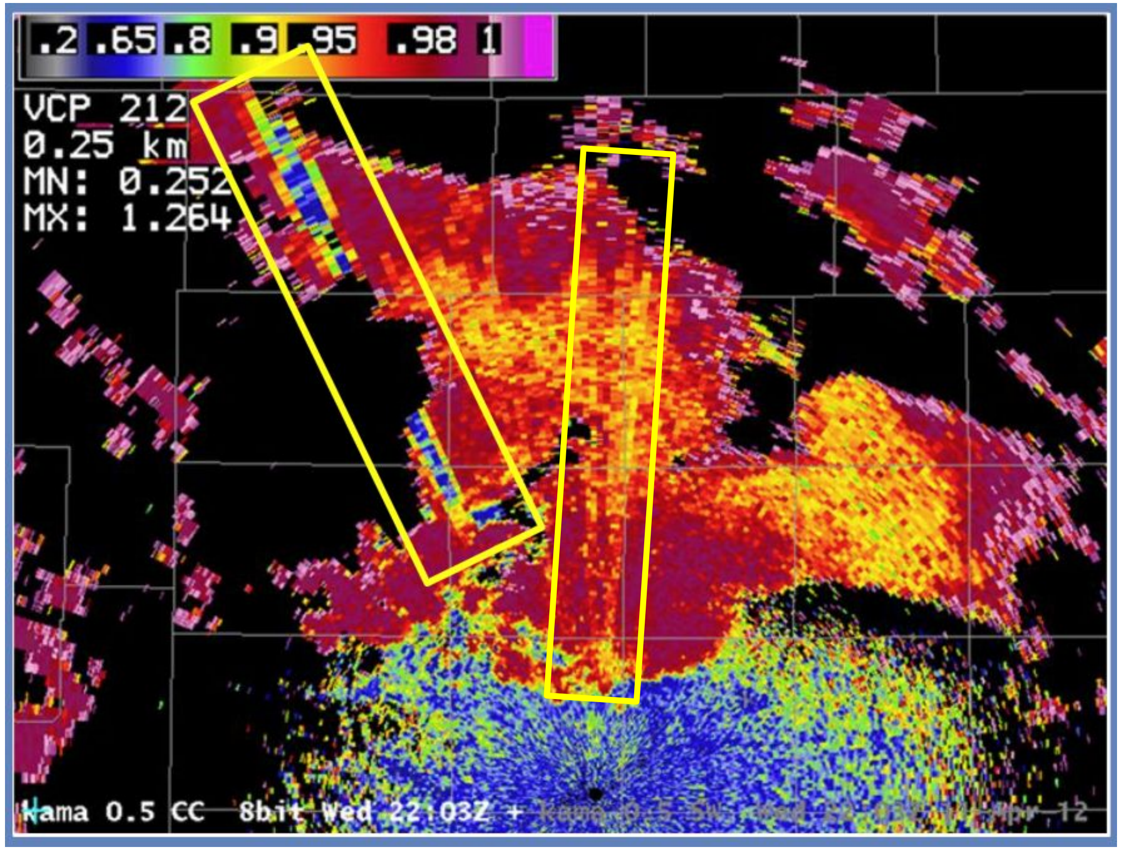
0.5 deg

3.4 deg



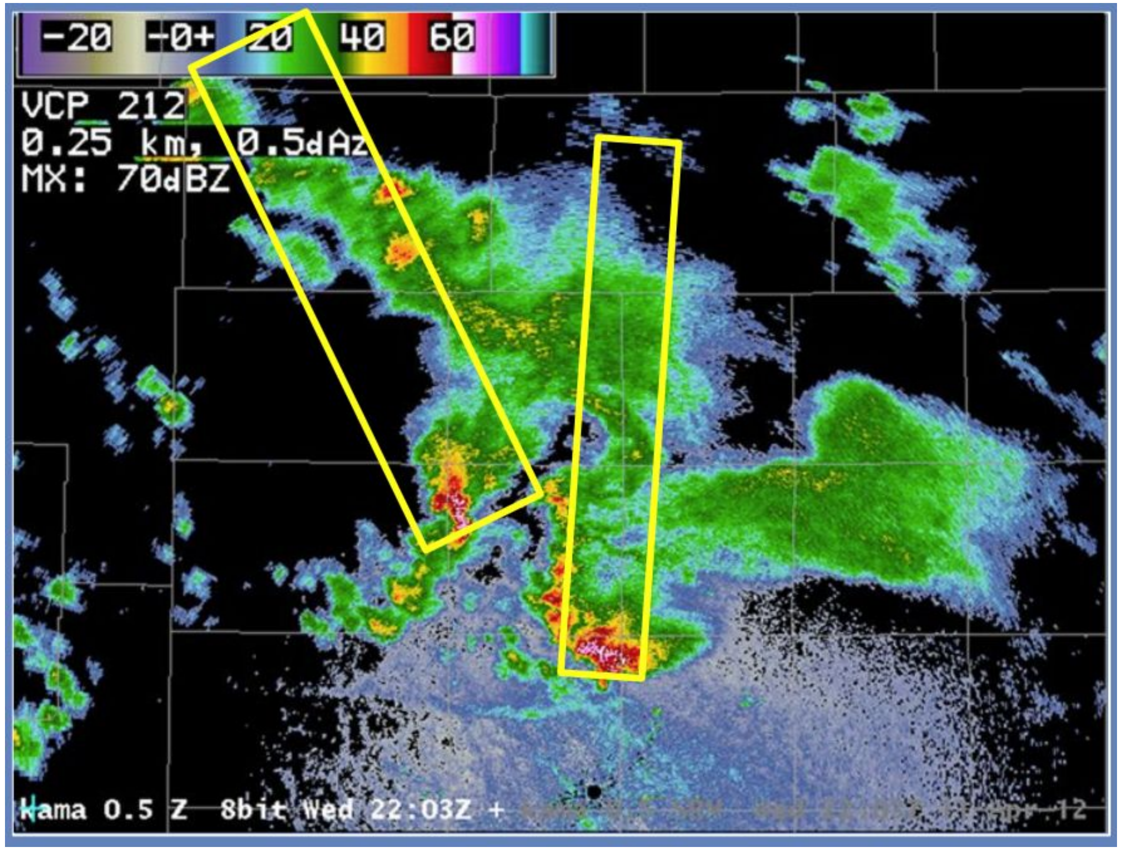
Non-Uniform Beam Filling in Dual Pol

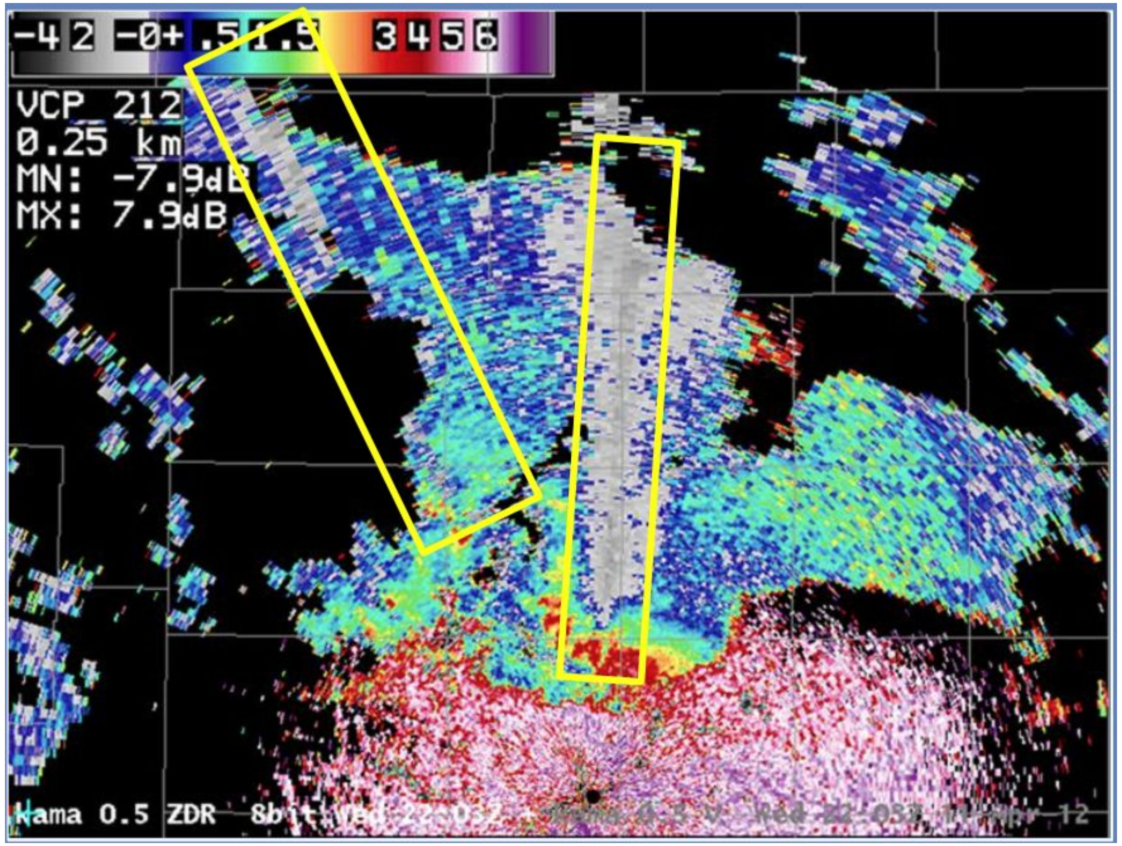




- NBF results from Φ_{DP} gradient in beam and lowers CC down radial

Differential Attenuation in Dual Pol





- Differential attenuation results from attenuation differences between horizontal and vertical affecting ZDR

Data Quality

- We've covered non-uniform beam filling and differential attenuation
- Data quality artifacts can also be seen in **reflectivity** and **velocity** data
- Some examples are…

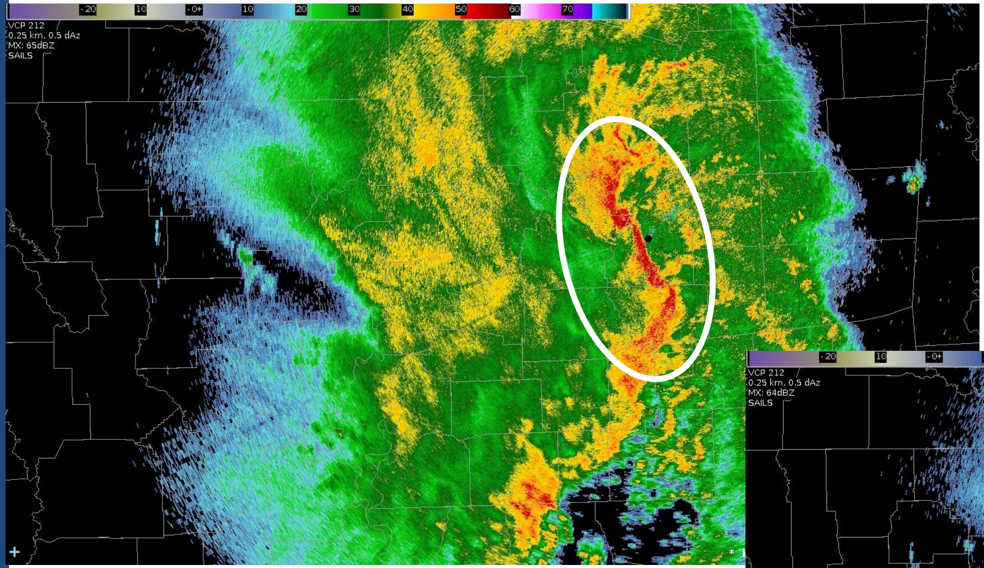
Wet Radome Effect

Biological Returns

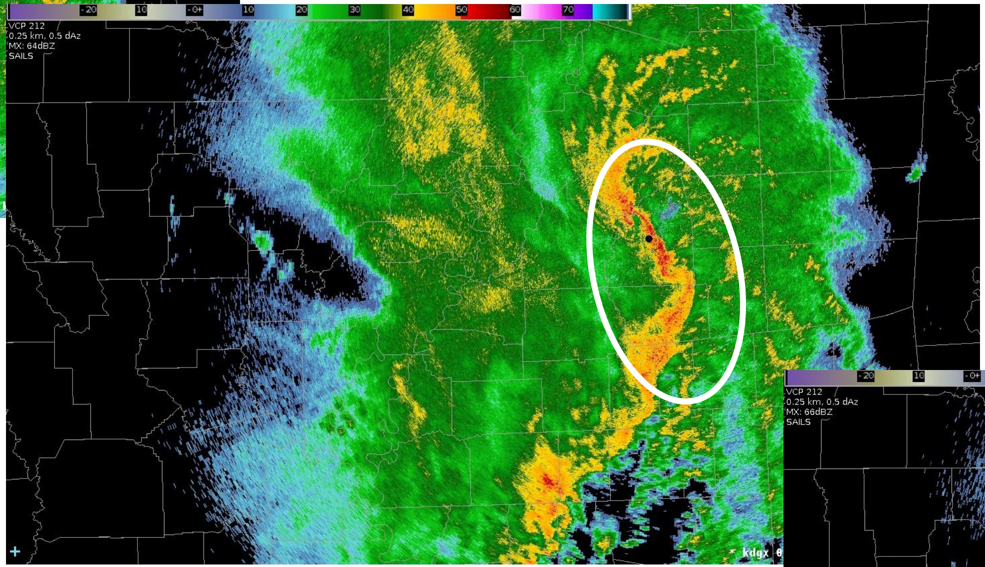
Range Folding

Wet Radome Effect

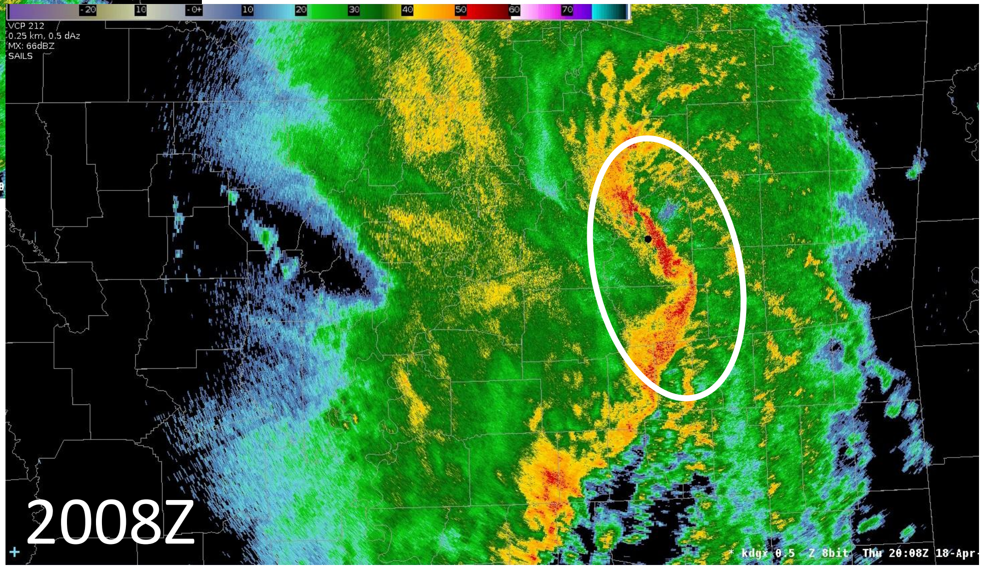
Notice what happens when the line passes over the radar



1959Z



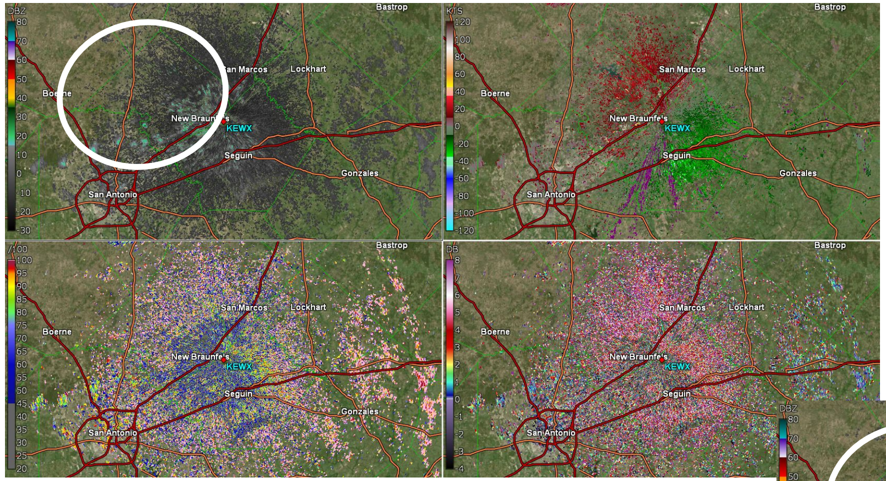
2006Z



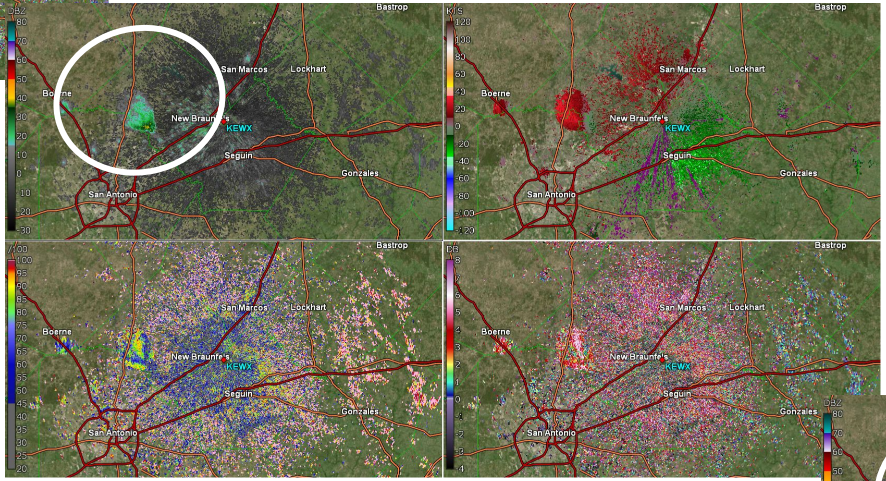
2008Z

Biological Returns

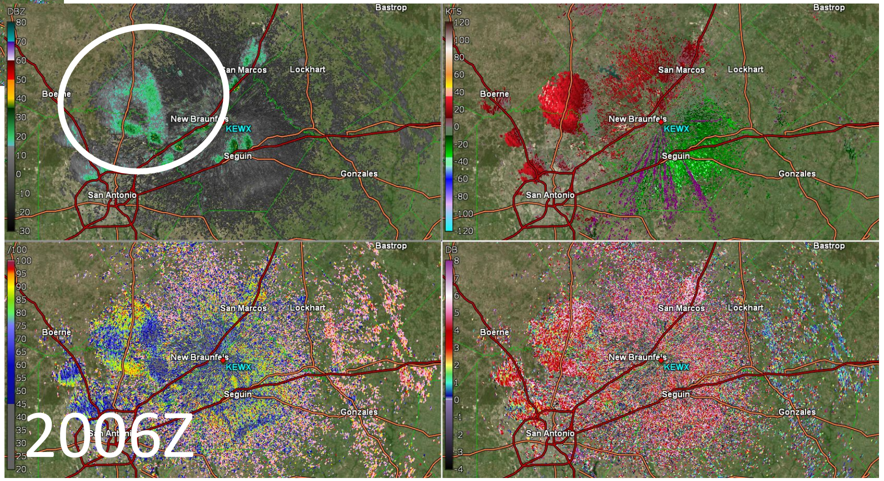
What could this artifact be from?



1959Z

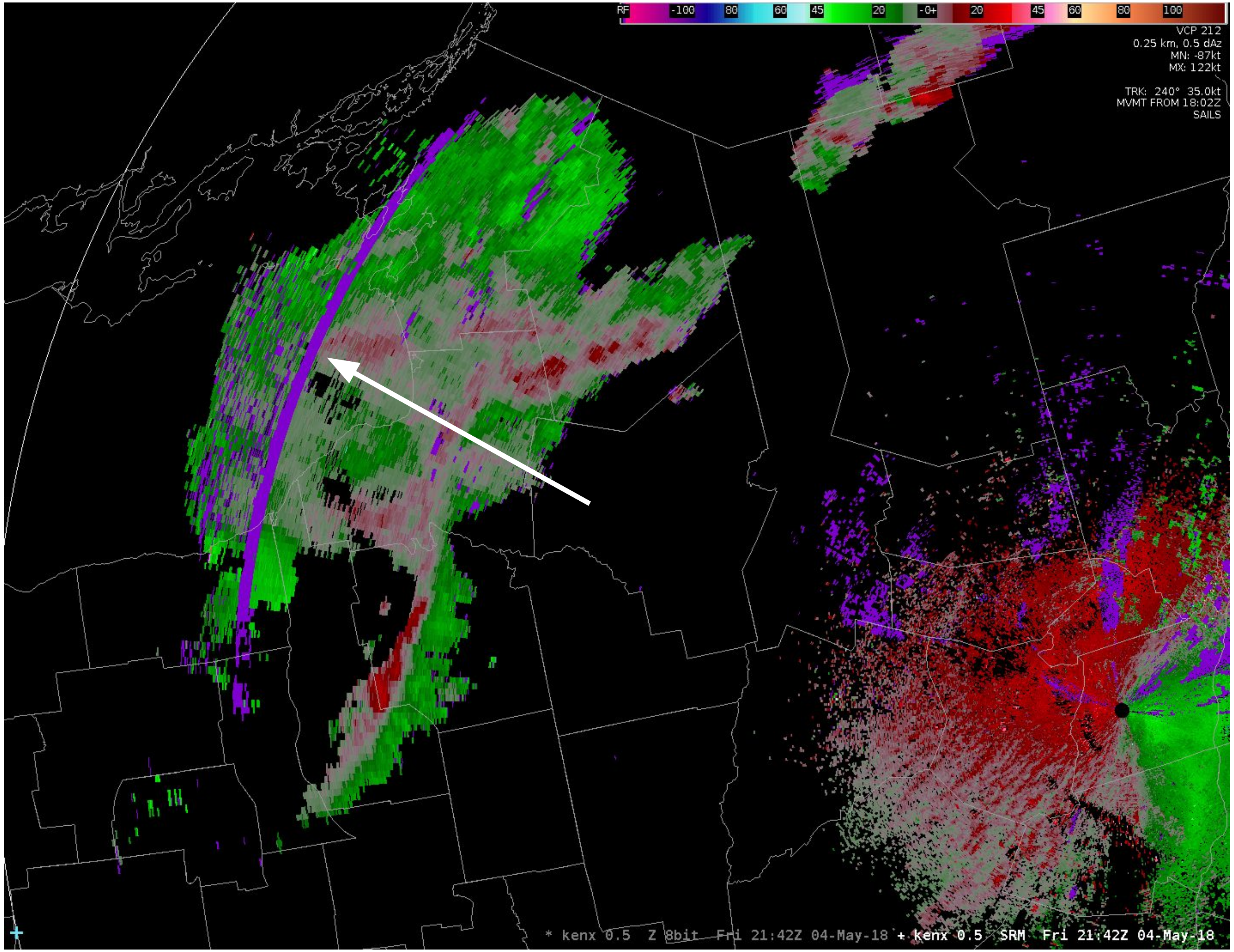


2003Z



2006Z

Range Folding

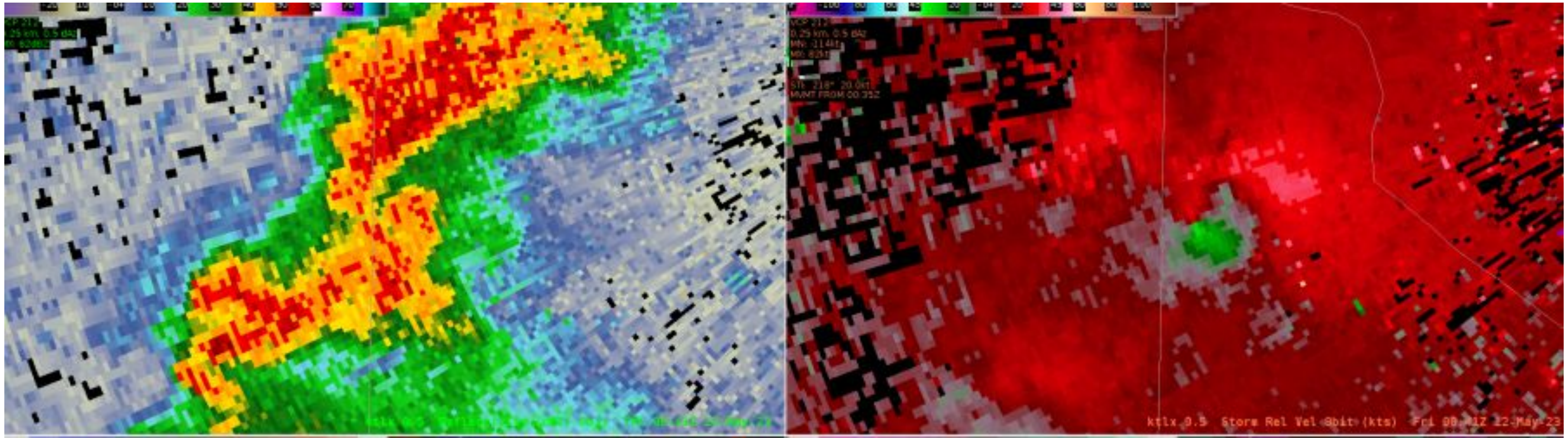


Data Application: Using SRM to assess Rotational Velocity (Vrot)

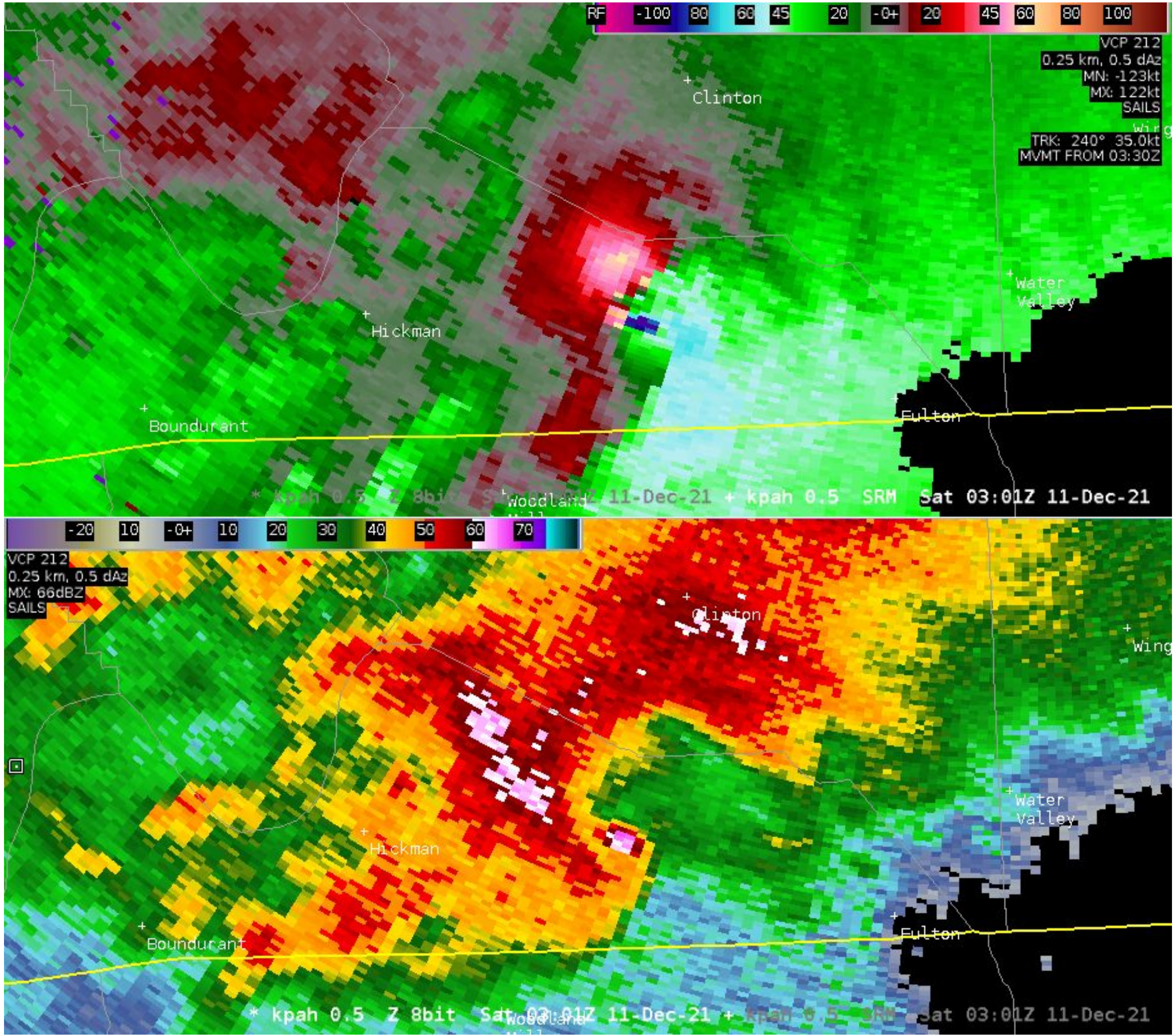
- Research has found a clear link between Vrot and tornado damage ratings (Thompson et al. 2017)

$$V_{rot} = \frac{|V_r max - V_r min|}{2}$$

- Guidelines for calculating Vrot:
  - Max inbound & outbound velocity gates should be co-located with the hook
  - Max inbound & outbound velocity gates should be ~ 1 - 2 nm apart



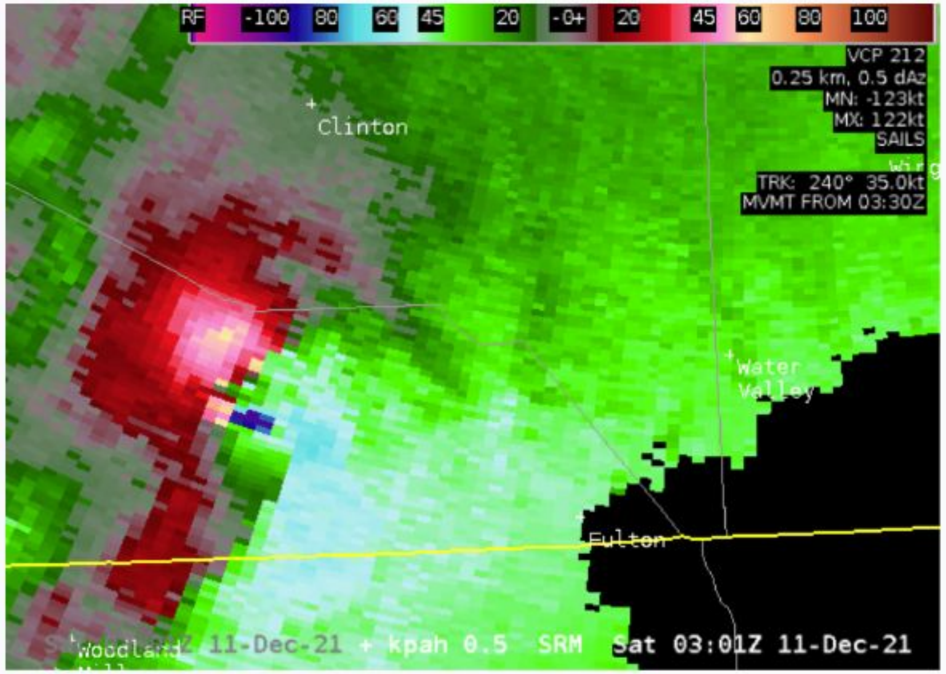
Poll Everywhere Exercise: Calculating Rotational Velocity



Respond at:
https://pollev.com/wdtdrac321

What is the rotational velocity with this supercell?

✓✓ 0



(A) 10 kts - 30 kts

0%

(B) 30 kts - 50 kts

0%

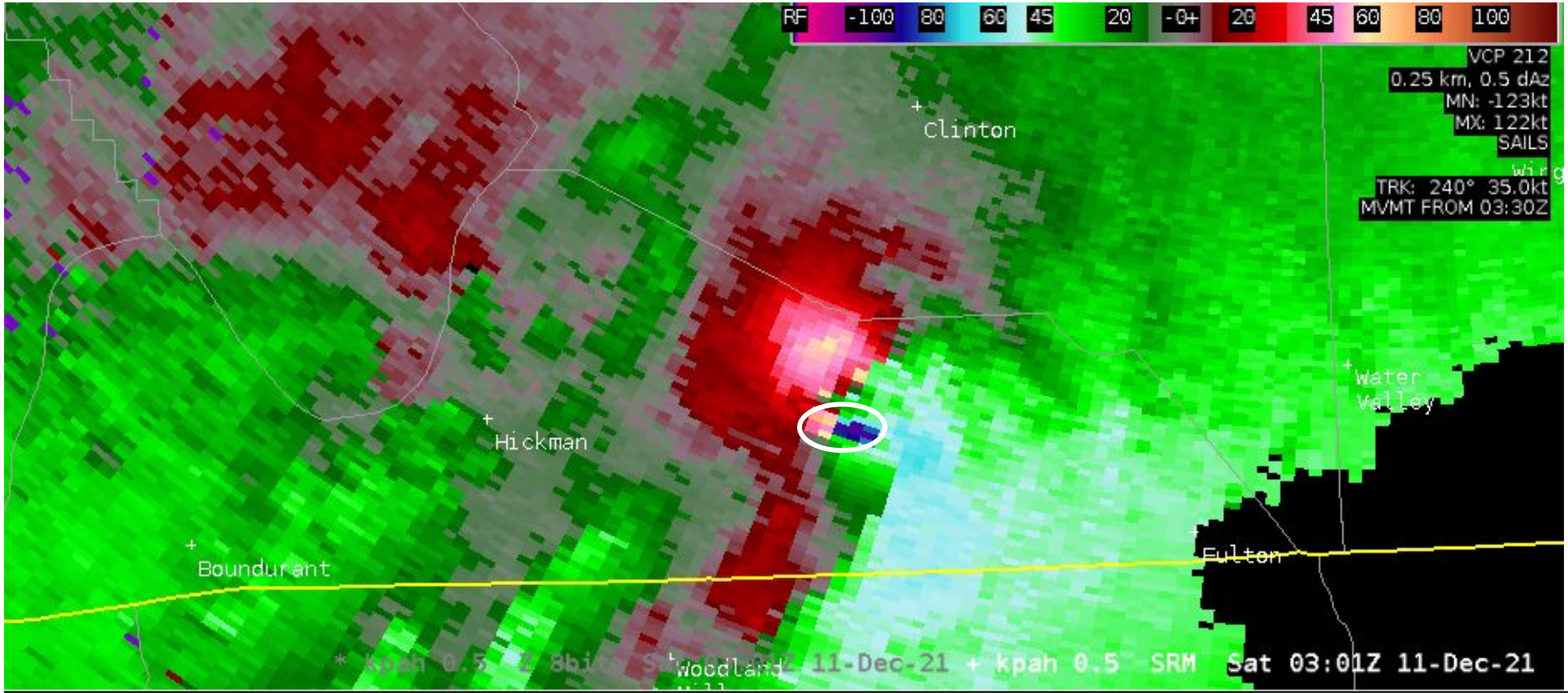
(C) 50 kts - 70 kts

0%

(D) 70 kts - 90 kts

0%

Poll Everywhere Exercise: Calculating Rotational Velocity



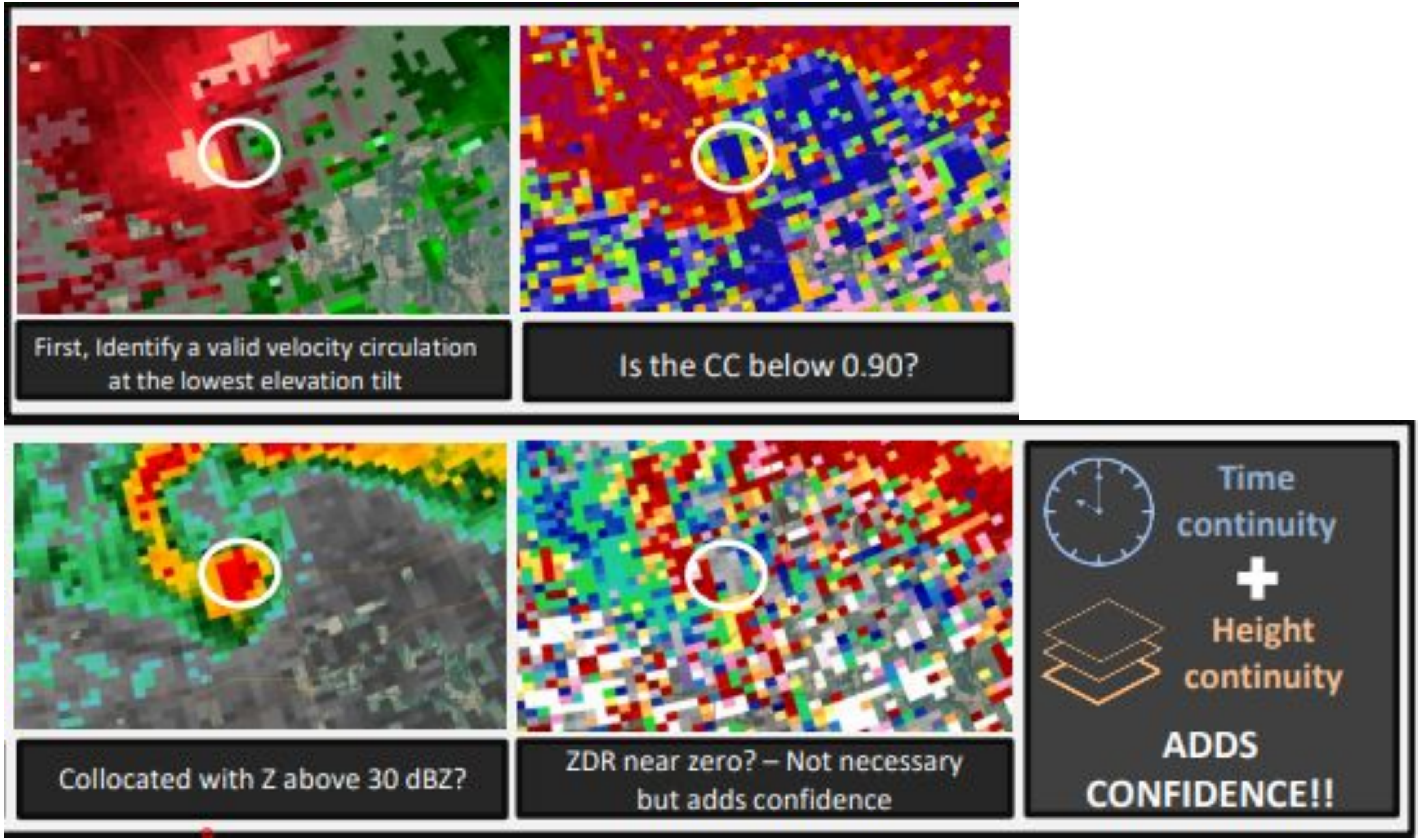
Answer:
~ 84 kts!

Impact-Based Tornado Warning Guidance

30 kt V_{rot}	40* kt V_{rot}	50* kt V_{rot}	70* kt V_{rot}
If STP >0 – Tornado Warning Likely Needed	Considerable Tag With TDS, STP >1	Considerable Tag Without TDS, STP >1	Catastrophic Tag With TDS, STP >6

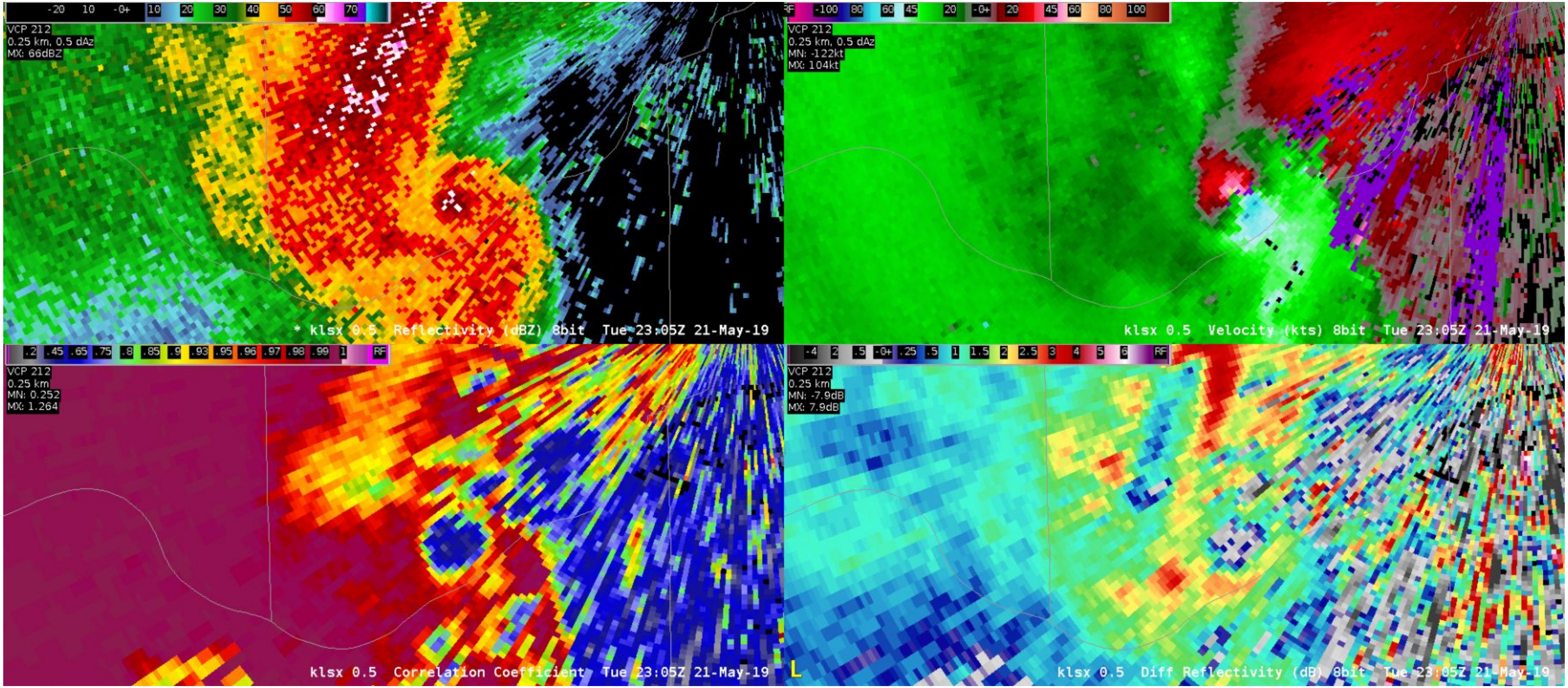
Data Application: Using DP variables to identify tornadic debris

Lofted debris from tornado -> randomly oriented -> very low CC values!



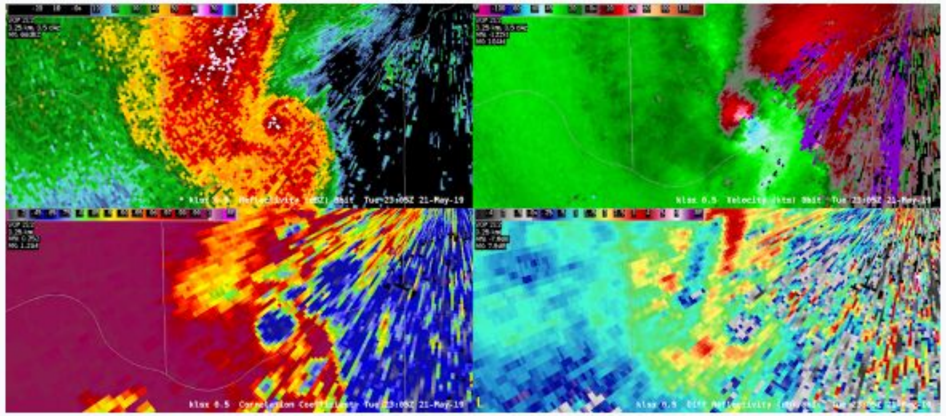
Poll Everywhere Exercise: Identifying a TDS

Respond at: https://pollev.com/wdtdrac321



Is there a tornado debris signature with this supercell?

0



Yes

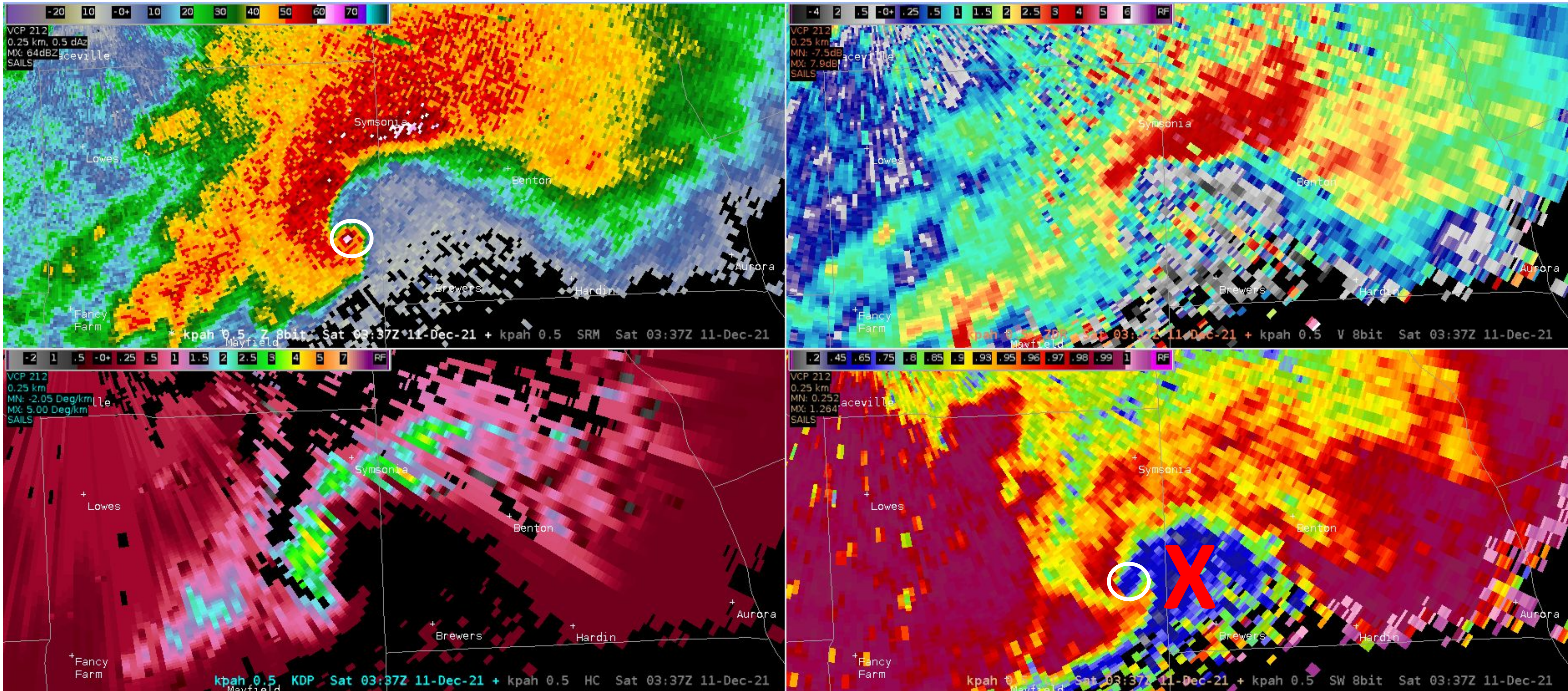
0%

No

0%

Identifying a TDS: Beware of the Inflow!

Beware of low CC from inflow air -> “don’t bite on bugs in the inflow!”



Key Takeaways from Part 1

1. We make a lot of assumptions about what is actually happening that the data doesn't actually show us

2. It's amazing that these systems (and their data) are as good as they are!

End of Day 1