Improvements to ground clutter mitigation for polarimetric Doppler weather radars

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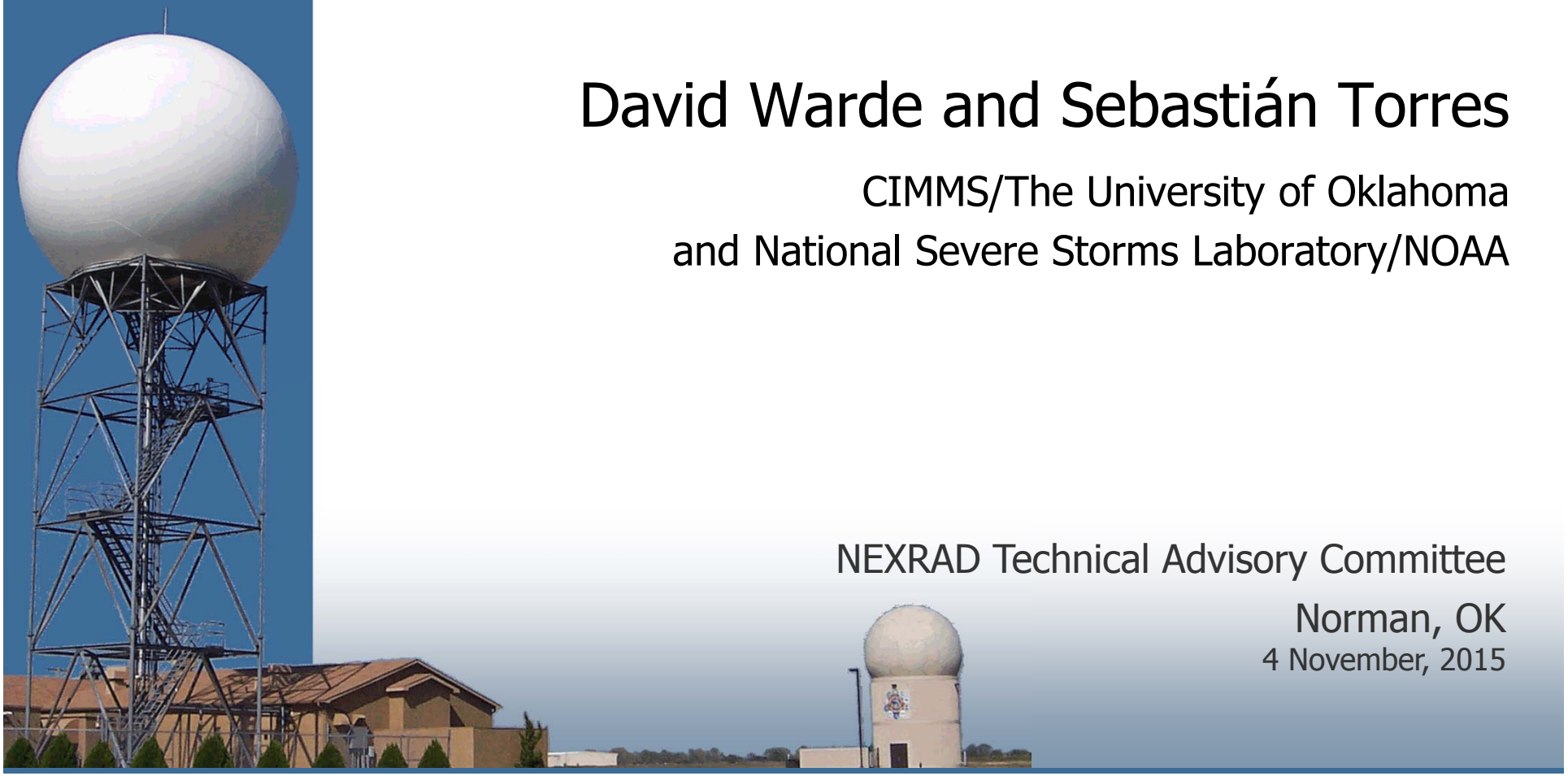

NEXRAD Technical Advisory Committee

Norman, OK

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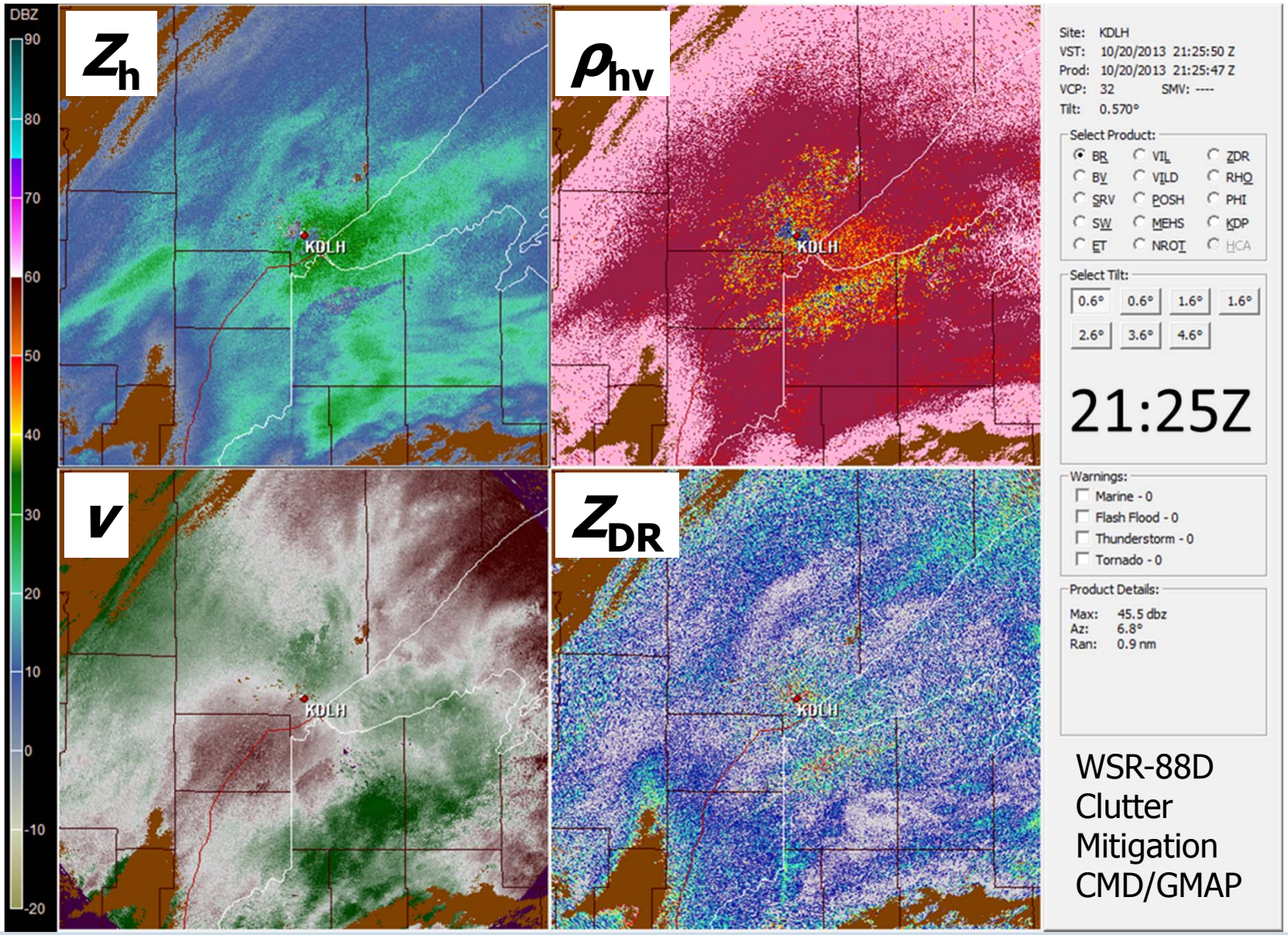
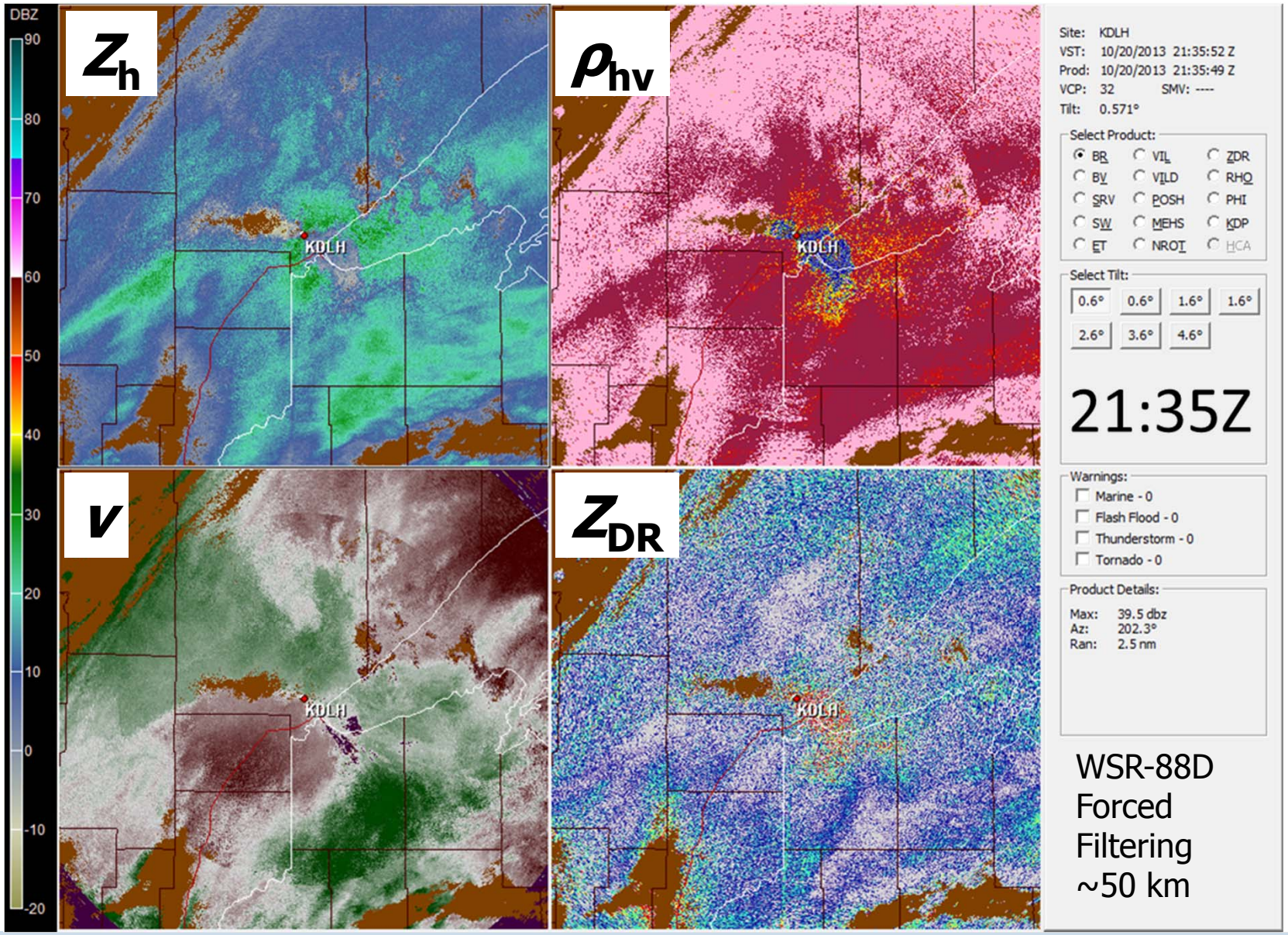
background

- What does Ground Clutter do?
  - Obscures/biases meteorological-variable estimates
- What does Ground Clutter look like?
  - Reflectivity: wide range of values
  - Doppler Velocity: near zero
  - Spectrum Width: very narrow (< 0.5 m/s)
- What can we do about Ground Clutter?
  - Filter to mitigate obscuration/bias
  - Misapplication of the filter affects data quality
    - Ground Clutter Filter may remove some weather signal
      - Challenge: zero-isodop weather (similar characteristics as ground clutter)
    - Tapered data window unnecessarily applied

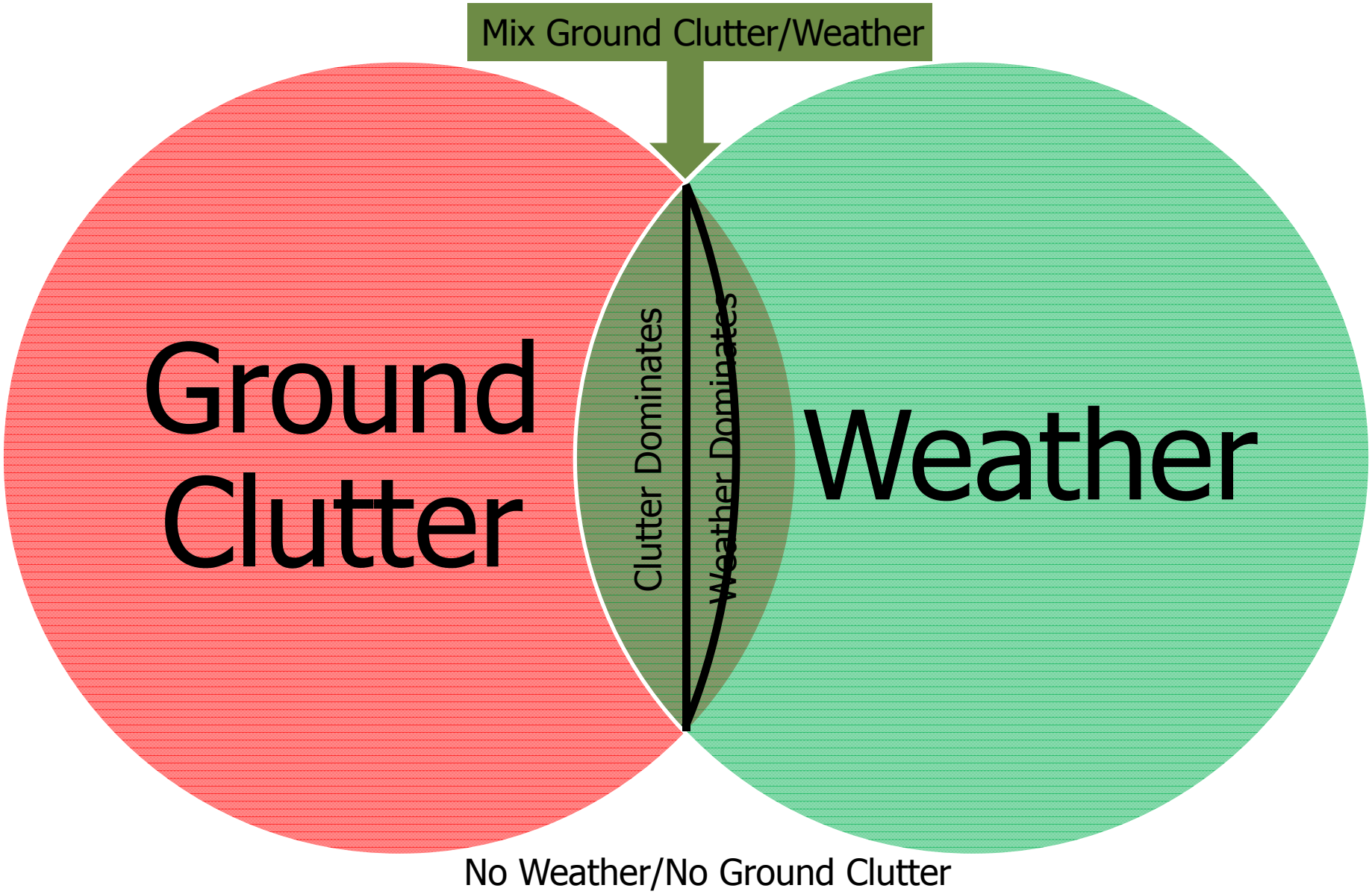
snowing in Duluth, MN



snowing in Duluth, MN



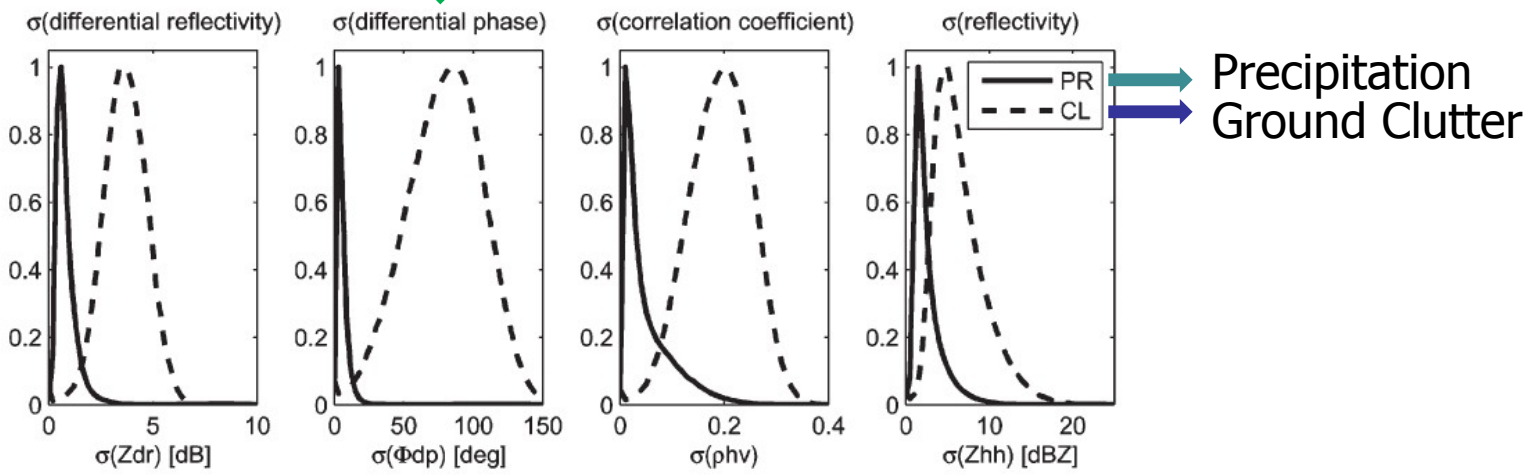
simple radar return classification



can we tell where weather is?

- Dual polarization variables should help
  - **DP variables don't discriminate well**
  - **spatial variability of DP variables do**

Best Discriminator: spatial standard deviation of ϕ_{DP}



(source: Rico-Ramirez, 2008, IEEE TGRS)

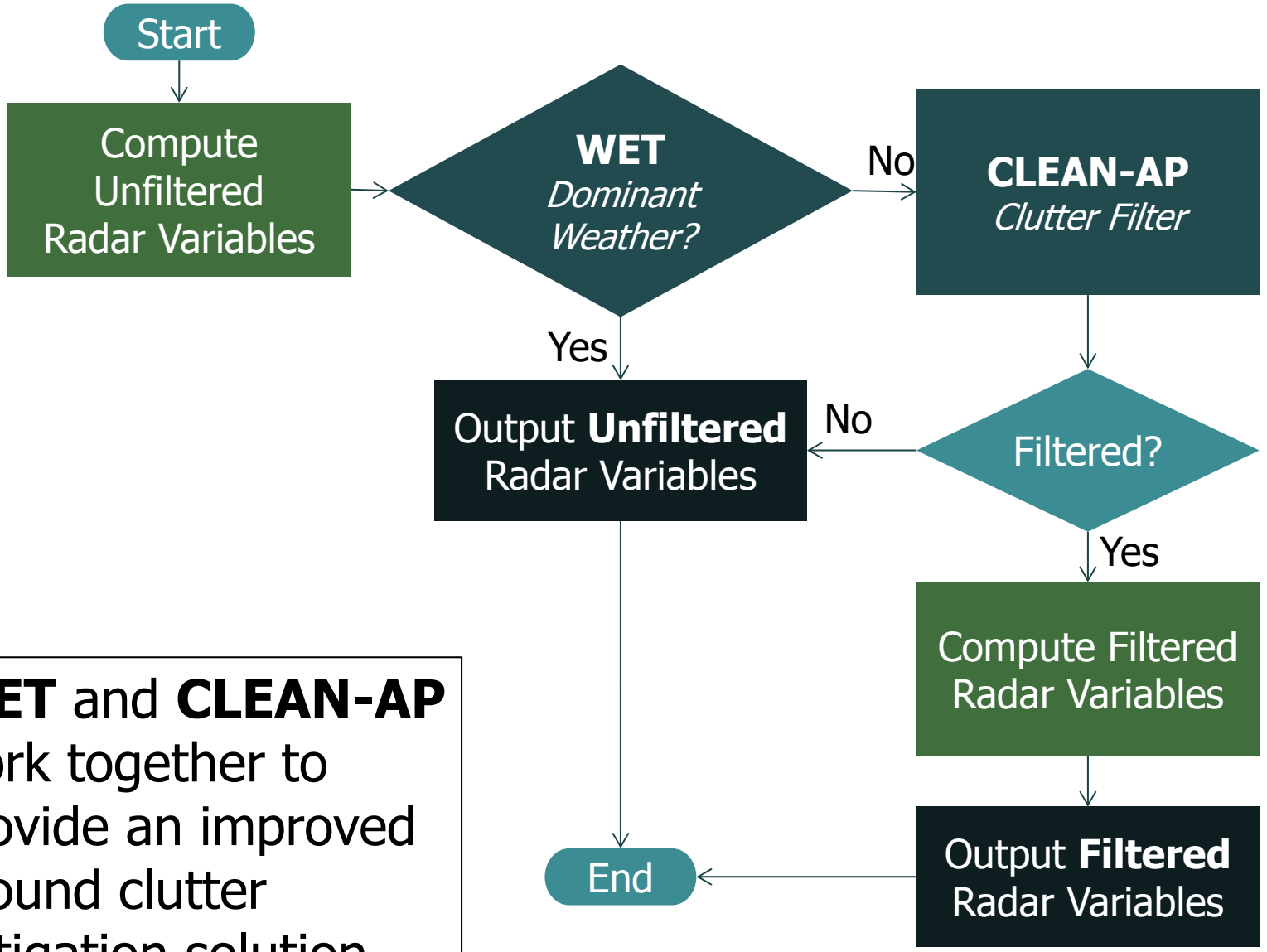
identifying dominant weather

- Weather returns exhibit smooth ϕ_{DP} in range
  - Variability of ϕ_{DP}: $\Delta\phi_{DP}(n) = \phi_{DP}(n+1) - \phi_{DP}(n)$
    - n indexes range gates
  - Measured variability is due to spatial variability and statistical uncertainty (variance)
    - $\left(\Delta\phi_{DP}\right)^2 = \sigma^2_{spatial}(\phi_{DP}) + \sigma^2_{estimate}(\phi_{DP})$
  - Spatial variability can be assessed by removing expected statistical uncertainty
    - Melnikov (2004) computed theoretical variance expression
- Dominant weather is identified as
  - Low spatial variability
    - Threshold on $\Delta\phi_{DP}$ based on look-up table
  - SNR > 20 dB and $\rho_{hv} \geq 0.99$

WET

Weather **E**nvironment **T**hreshold

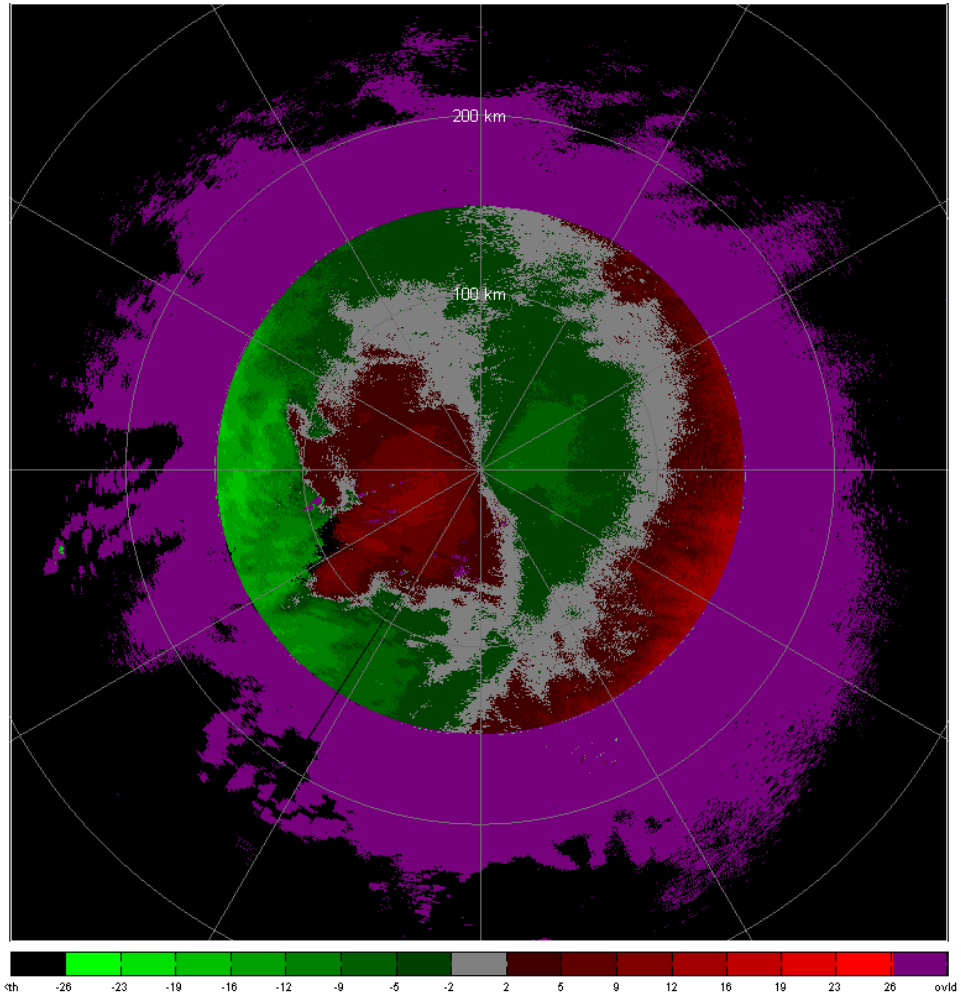
complete mitigation solution



WET and **CLEAN-AP** work together to provide an improved ground clutter mitigation solution

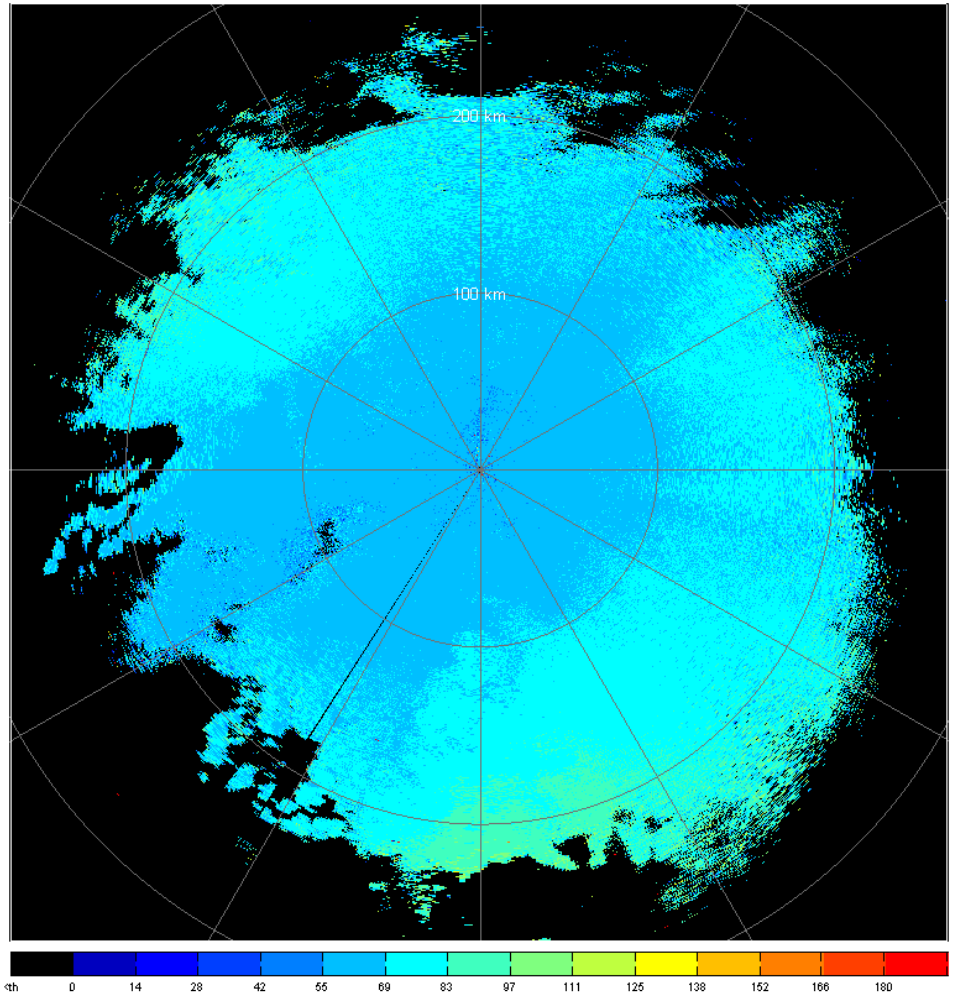
snow again, Duluth, MN (*v*)

WET/CLEAN-AP



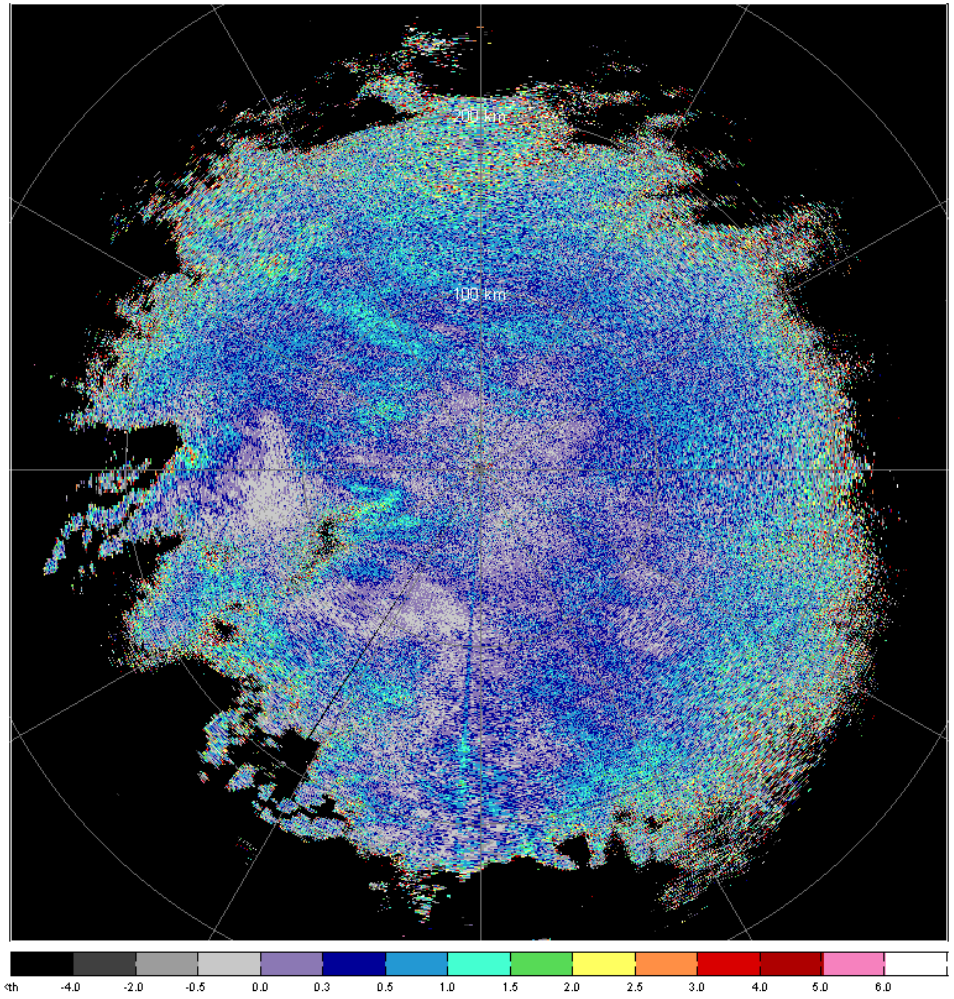
snow again, Duluth, MN (ϕ_{DP})

WET/CLEAN-AP



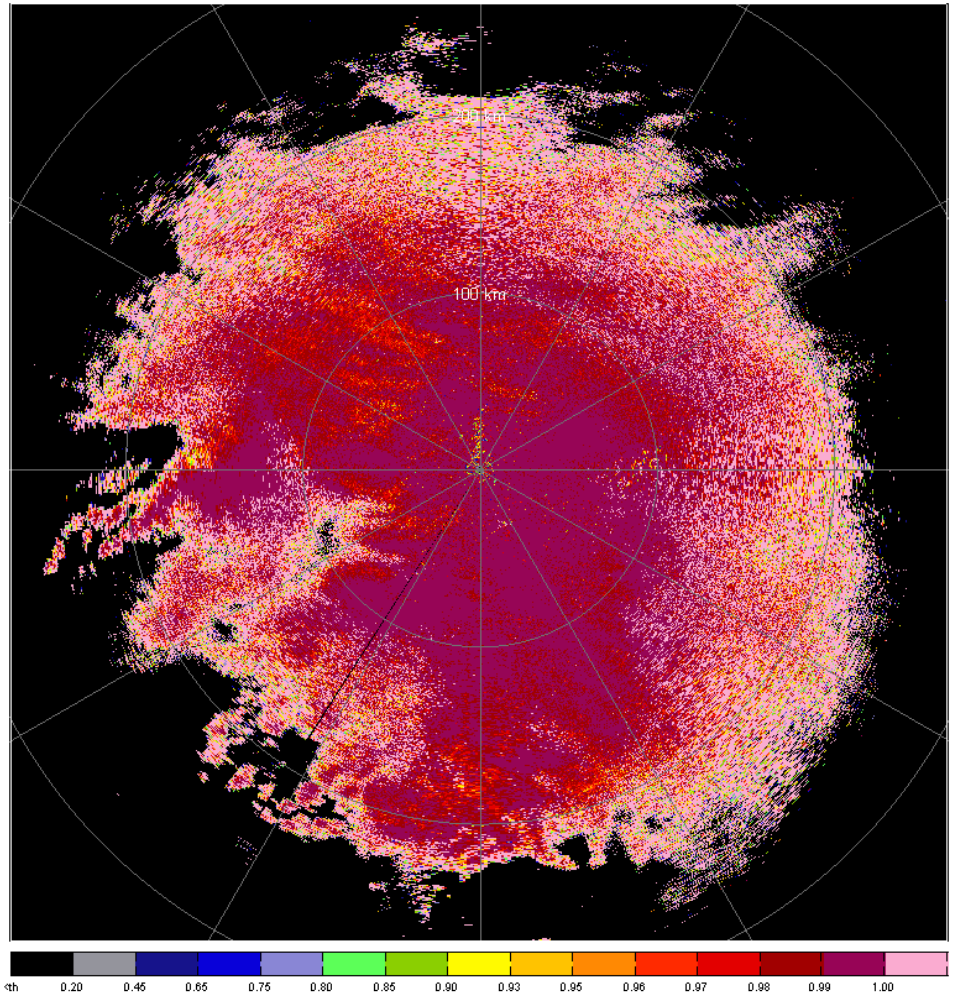
snow again, Duluth, MN (Z_{DR})

WET/CLEAN-AP

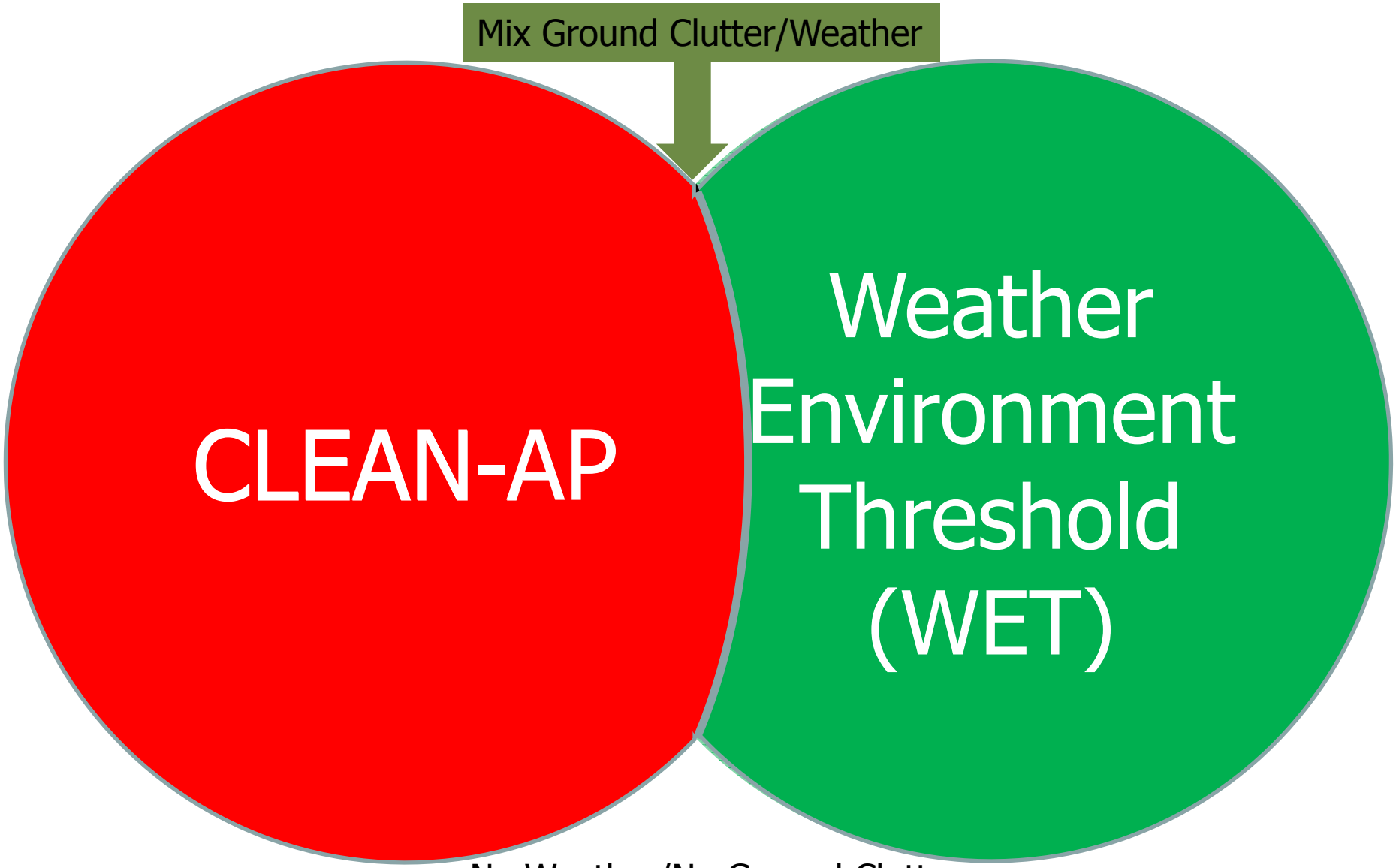


snow again, Duluth, MN (ρ_{hv})

WET/CLEAN-AP

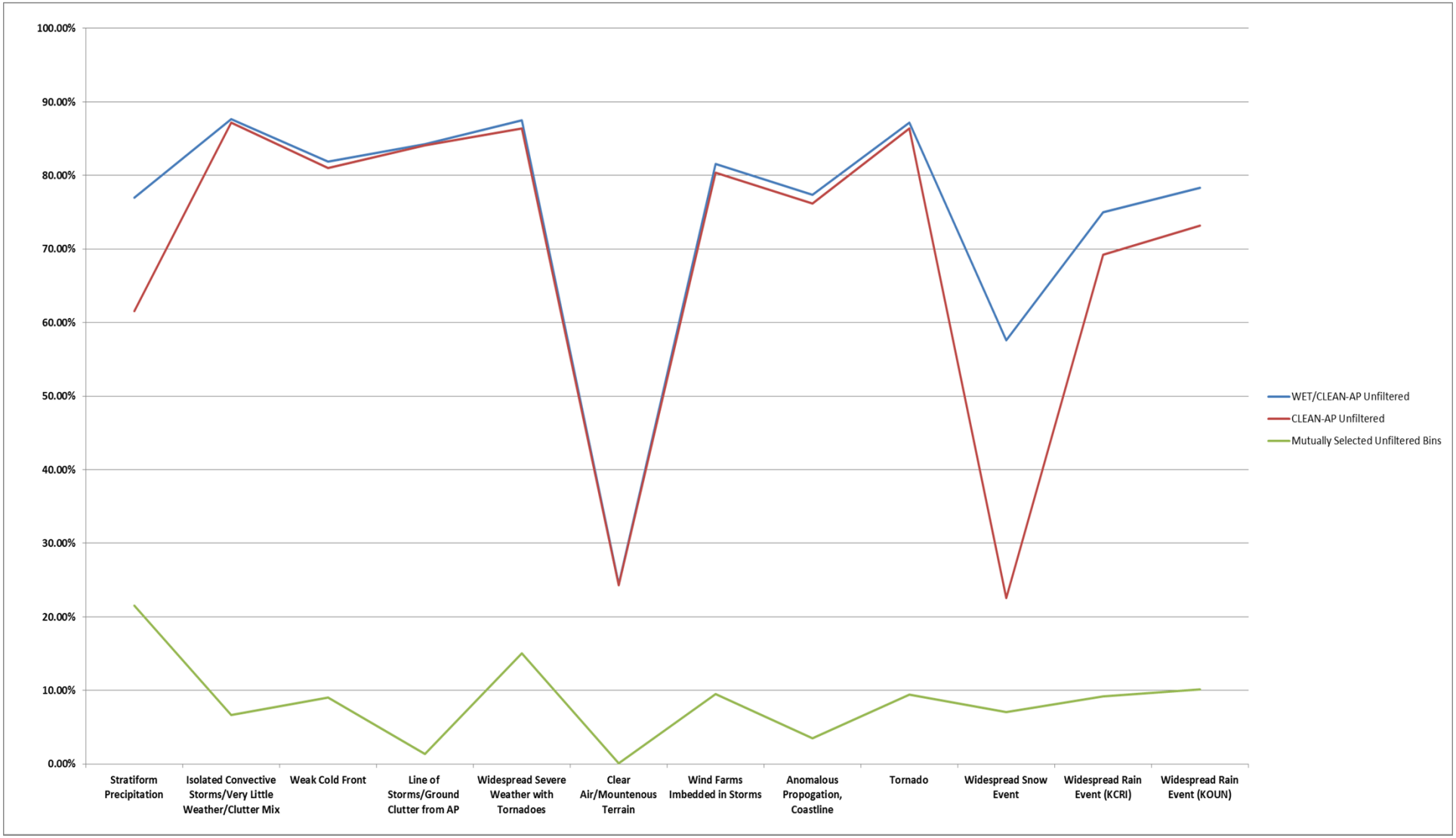


ground clutter mitigation



Back Up Slides Analysis

Test Cases, Unfiltered Range Bins



clutter affects DP variables more!

- Friedrich et al., JTECH, 26, 2009
  - Combine
    - Real weather level-I (I&Q voltages)
    - Ground Clutter level-I (I&Q voltages)
    - Using different mixing ratios

Parameter	Error of Estimate	CSR (dB)
Z_h	1.7 dB	-1
Φ_{DP}	3°	-6
Z_{DR}	0.2 dB	-9
ρ_{hv}	0.02	-13