Dual Polarization

- Two beams with different polarization directions: one with horizontal polarization (current polarization) and one with vertical polarization.

- New products (or moments) useful for:
  - Precipitation type.
  - Rain and snow rate estimates.
  - Identification of aircraft icing conditions.

  - Page produced by Kevin Scharfenberg, who was also an invited speaker at the 2008 Severe Storms and Doppler Radar Conference hosted by the Central Iowa NWA.
Dual Polarization

CONVENTIONAL DOPPLER RADAR
$Z_{DR} - \text{Differential Reflectivity}$

- $Z_{DR} \sim 10 \log \left( \frac{P_h}{P_v} \right) \text{[db]}$

- Average shape of what you are measuring.

- Typical values range from -2 db to 6 db.

- Type discriminator
  - $Z_{DR} > 0$?
  - $Z_{DR} < 0$?
  - $Z_{DR} = 0$?
$Z_{DR}$ – Differential Reflectivity
ZDR

- Good for:
  - Identifying areas of increasing median raindrop sizes
  - Identifying Hail shafts (ZDR \sim 0, high Z)
  - Updraft detection: ZDR > 0 above the environmental 0°C level

- Limitations
  - Biased toward larger hydrometeors – a handful of large hailstones can bias the signal to \sim 0.
CC ($\rho_{hv}$) – Correlation Coefficient

- Measures how similarly the horizontal and vertical returned powers behave in a sample volume.
- Diversity of hydrometeors
- Meteorological echoes: $\text{CC} > 0.80$
- Non-Meteorological echoes: $\text{CC} < 0.80$
- Rain: typically above 0.95.
- Hail: 0.90 to 0.95. Large Hail $\text{CC} < 0.80$ and $\sim 0$ ZDR.
- Bright band/Melting layer: 0.80 to 0.95,
- Good indicator of mixed precipitation regions
CC – Correlation Coefficient

<table>
<thead>
<tr>
<th>CC</th>
<th>-4</th>
<th>.2</th>
<th>.65</th>
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- Giant Hail (Mie Scatter)
- Decreasing Drop Size Diversity
- Decreasing Wetness, Size
- Dry, Small Hail
- Decreasing Wetness
- Large, Wet Aggregates
- Decreasing Wetness and Aggregation
- Dry
- Decreasing Crystal Habit Diversity

Intrinsically Values in Weak Signal
KDP ($\varphi_{DP}$) – Specific differential phase

- Takes advantage of difference in propagation speeds of pulses in different media (water vs. air).
- Takes range from radar into account to determine where phase difference is occurring.
- Proportional to $\varphi_{DP} = \varphi_h - \varphi_v$, called the differential phase shift.
- KDP increases as the size and concentration of raindrops increase.
- Useless in identifying where the heaviest rain is occurring.
- Increasing positive values of KDP indicate higher rainfall rates and larger drops.
KDP ($\Phi_{DP}$) – Specific differential phase

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<th>KDP (deg/km)</th>
<th>-2</th>
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NOT COMPUTED BECAUSE KDP TOO NOISY
Example

- Z > 50 dBZ
  - Local Maximum

- ZDR < 2 dB
  - Local minimum

- CC = 0.7 – 0.95

- What is this? Why?