Operational Utility of Spectrum Width

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Overview

• What is Spectrum Width (SW)?
• How can we use SW in an operational setting?
Spectrum Width (SW)

- Measure of the velocity dispersion within a pulse volume
- Low values = small dispersion
- High values = large dispersion
Factors Affecting SW

• Wind Shear
• Turbulence
• Signal-to-Noise Ratio (SNR)
• Particle Fall Speed Dispersion
  – Typically ignored due to max elevation of 20 degrees
• Antenna Rotation
  – Typically ignored because contribution to error is small
• Clutter/Clutter Residue
  – Typically minimized or eliminated
• System Noise
  – Typically minimized or eliminated
OPERATIONAL APPLICATIONS
Accelerated Flow

• Very smooth; Little turbulence
  – Narrow spectrum widths (< 4 m s\(^{-1}\))

• Examples
  – Intense updrafts
    • Can extend above BWER in reflectivity
    • Other causes for low SW
      – Condensation processes
      – Helicity inhibiting downward cascade of energy
  – Low-level updraft inflow
  – Tropical Storm inflow and eye wall intensification
Decelerating (Non-Accelerating) Flow

- Tends to be very turbulent
  - Leads to very broad spectrum widths (> 5 to 10 ms\(^{-1}\))

- Examples
  - Downdrafts
    - Precipitation cores
    - Except Rear Flank Downdrafts
  - Fronts/Convergence Zones (to be discussed later)
Acceleration/Deceleration Example

- 0.5 degrees
- 2111 UTC 13 July 2009
- South Dakota

- Precip Region
- Inflow Region
Acceleration/Deceleration Example

- Noisier precip core
- Strong smooth inflow
Acceleration/Deceleration Example

- Precip core
- Strong smooth inflow
Three Body Scatter Spikes (TBSS)

- Low reflectivity signature down radial of large hail
  - 10 to 30 km length
  - Low velocity values (< 5 m/s)
  - High spectrum widths (> 20 m/s)

- Most often, can be seen clearly in reflectivity
  - Parent storm echo structure can obscure
    - Spectrum width still shows signature

- Example
  - Hail core and Mesocyclone
TBSS Example

- 0.5 degrees
- 1901 UTC
- Huntsville, AL

- Does the TBSS stand out to you on this image?
TBSS Example

- How about in SW?
- Whoa! Right There!
TBSS Example

- Very low velocities
Fronts and Wind Shifts

• The interface between colliding air masses tend to experience high turbulence.
  – Examples: Cold Fronts, Gust Fronts, etc.
  – Leads to very broad spectrum widths

• Zones of wind shifts are characterized by high turbulence and wind shear.
  – Leads to very broad spectrum widths
Fronts and Wind Shifts Example

- 0.5 degrees
- 1225 UTC 08 May 2009
- Springfield, MO

Where are the boundaries?
Fronts and Wind Shifts Example

- Front/Boundary noticeable here on velocity
Fronts and Wind Shifts Example

• Did you see the boundary here?

• It shows up better on SW
Deep Convergence Zones

SRM

Zone of deep radial velocity convergence (as much as 10 km)
Orographic Effects

- Thunderstorms interacting with mountainous terrain can produce extreme turbulence. On radar, this would be noted by broad spectrum widths.

- Examples
  - Typhoon hitting Taiwan
Future Applications

• Due to increased accuracy of SW, and attention, more applications may be forthcoming
  – L&D 1979 mesocyclone model

• Turbulence algorithm
  – Better than earlier version with better estimator?
  – Help aviation community

• Others???
QUESTIONS?