Dual-Polarization (DP) Evaluation

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Overview

• Summary since last TAC
• Issues Resolved
• Improved Capability
• Remaining Challenges
DP: Summary since last TAC

• December 2009
  – Sensitivity difference between KOUN and KCRI
    • Between 6 and 8 dB
    • Examples shown
  – Calibration differences
    • Examples shown
  – SME Panel #1: Would DP sensitivity loss affect operations?
    • Up to 4 dB sensitivity loss ok, otherwise operational assessment needed.

• January 2010
  – Contractor redesigned receiver
  – Improved dynamic range and sensitivity

• March 2010
  – SME Panel #2
    • confirmed results of first panel
    • saw great potential for use of DP in operations
DP: Summary since last TAC

- March 2010 ENG
  - 5.0 to 5.5 dB Sensitivity Difference between KOUN and KCRI
    - 1.5 dB sensitivity loss due to frequency differences
      - KOUN = 2.7 GHz      KCRI = 2.95 GHz
    - 3.5 - 4 dB sensitivity loss due to DP H/W
      - The expected sensitivity loss for any given radar due to DP H/W will be 3.5 – 4 dB
DP: Summary since last TAC

• May 2010
  – Eng Signal processing assessment
  – Calibration differences resolved on KOUN and KCRI by ROC Eng and EI techs
  – ZDR not fully calibrated but good base data was available to begin algorithm evaluation

• June - August 2010
  – High ZDR values resolved - example shown
  – Fingerprint artifact resolved – example shown
  – 12 DP precipitation algorithm cases evaluated
    • Software bugs identified and fixed
    • 4 Algorithm science issues resolved, 4 issues remain
    • ZDR calibration not accurate enough for QPE use
**DP: Summary since last TAC**

- **August 2010**
  - Operational Assessment – will be briefed later

- **May 2010 – December 2010**
  - Improved capability
    - DP variables and algorithms – examples shown
  - Continued visual and statistical evaluation
  - ZDR calibration was too high before December 2010 and too low after
DP: Summary since last TAC

- January 2011
  - Hardware and software fixes to KOUN
- January – February 2011
  - Current Status
    - 4 algorithm science issues to be investigated and tested
    - ZDR calibration stable but 0.5 dB too low
      - Subjective human ZDR evaluation – examples shown
      - ZDR useful for forecaster visual interpretation but not good enough for DP QPE algorithm use
Issues Resolved
Initially, Sensitivity/Calibration
Not Good

- Initial KOUN / KCRI sensitivity and calibration issues
- 2325 UTC Sep. 22, 2009
- KOUN: VCP 21
- KCRI: VCP 221
- Heavy precip SE, clear air bloom, strong cold front
- ROC EI techs fixed calibration issues on KOUN and KCRI
- ROC ENG eventually sorted out the sensitivity issue.
Resolved: Sensitivity/Reflectivity Calibration Differences Between KOUN and KCRI
SNR/dBZ differences for NOP4 on 07/03/2010 at 06:29:25.69 VCP: 121, El: 0.527, Ru: 471
and for KOUN on 07/03/2010 at 06:29:19.84 VCP: 121, El: 0.533, Ru: 460

Azimuth (°)
Resolved: Very high ZDR in clear air returns

• Began on 6/29/10
• Persistent in all clear air returns since
• Does not seem to affect Zdr in weather
• Seen in all VCPs
• L-3/Baron investigated and resolved a scaling issue to properly cap ZDR values
Bad ZDR Values in Clear Air
Good ZDR Values in Clear Air
Resolved: Fingerprint

• 15 June 2010, 0700Z
• Present in ZDR and PHI
• Faulty LNA was the problem
Resolved DP Algorithm Science Issues

• Changes Submitted (Mark Fresch will cover in more detail)
  – DP QPE $R(Z,ZDR)$ underestimates tropical rain
  – DP QPE rates much different for very small blockage compared to no blockage
  – Quick fix for attenuation/non-uniform beam filling: being tested
  – ROC Apps drafted AEL changes; ROC SW Eng implemented, additional testing under way

• SMOOTHING BY THE DUAL POL PREPROCESOR
Dual-Pol Improved Capability Examples

• DP Variables
• DP Algorithms
  – precipitation accumulation
  – melting layer
  – hydrometeor classification
7/4/2010 KOUN: Improved Capability

- 2207 UTC
- VCP 121
- Bypass Map Clutter Filtering
- Linear convection
  - Heavy rain
  - Scarce lightning
  - Strong winds
  - Norman’s fireworks canceled
Very heavy rain, smaller rain drops, tropical

Bigger Drops in moderate quantities, but rain rates much less than just north

Bigger Drops in very low quantities
May 10, 2010 KOUN: Improved Capability

- 5/10/2010 2159 UTC
- Tornado outbreak
- Grapefruit hail
- Second best updraft ever seen by Les Lemon & Paul Schlatter
Tornado Debris Balls: Improved Capability

- May 10\textsuperscript{th} 2229 UTC
- Low CC and Low ZDR values within tornado debris balls (white circles)
DP Variables Differentiate Scatterers: Improved Capability
This is one reason why we are upgrading to Dual-pol

Boundary: is there light precipitation behind it?
This is one reason why we are upgrading to Dual-pol.

Low CC values behind boundary.
This is one reason why we are upgrading to Dual-pol ZDR:

Low CC, High ZDR: likely Biological echoes behind surface boundary.
DP Algorithms
Improved Capability

• Good base data for algorithm evaluation not provided until mid-May 2010
• 12 cases initially evaluated
  – Several issues identified with the Preprocessor, HCA, QPE, and ZDR calibration
  – Since then, OHD and ROC have been working with NSSL to refine the algorithms
• Even without all the issues fixed, there is evidence that DP QPE outperforms the PPS in the following situations:
  – removing non-precipitation echoes
  – mitigating hail contamination
  – Identifying the bright band.
Remaining Issues

• Algorithm Refinement Issues
• ZDR Evaluation
Remaining DP Algorithm Science Issues

- Mark Fresch will cover in more detail
  - QPE won’t work properly without ZDR calibrated to 0.1 dB
  - Biota Misclassified as Big Drops
  - Accumulation Discontinuity at Melting Layer
  - HCA mis-classifies non-precipitating echoes in some cases
Remaining ZDR Calibration Issue

• Subjective human analysis ZDR evaluation
• 9/23/10: 0012 UTC
• VCP 21
• Bypass map clutter filtering
• Light stratiform rain across much of Oklahoma. Essentially the poster child for being able to check for ZDR bias
Dry Snow Values range from 0.7 – 1.1 dB
Vast majority of Dry Snow Values right around 0.2 dB
Small rain drops in weak reflectivity and 0.995-0.998 CC: ZDR only as low as 0.7 dB
Small rain drops in weak reflectivity and 0.995-0.998 CC: Vast majority of ZDR 0-0.2 dB
Remaining ZDR Calibration Issue

- Subjective human analysis ZDR evaluation
  - 2/1/11
    - 0400 UTC
    - VCP 21
  - 2/4/11
    - 1535 UTC
    - VCP 21
- Bypass Map Clutter Filtering
- Stratiform snow events
Liquid
Melting Layer
Frozen

KOOUN
0400Z
VCP 21
01Feb11
Avg ZDR = -0.5

Avg ZDR = -0.3

ZDR

CC

KOUN
0400Z
VCP 21
01Feb11
ZDR Evaluation Summary

• 9/23/10 Light Stratiform Rain
  – 3 experts examined the data independently and came up with “0.7 to 0.8 dB too high” for bias

• Hardware and software fixes occurred in January 2011

• February 2011 Snow Storms
  – All events showed ZDR too low by ~0.5 dBz.
Summary

• Dual-Pol Improved Capability
  – Forecasters can use new DP variables to provide enhanced information and new capabilities

• Resolved Issues
  – System sensitivity, reflectivity calibration, DP base variable computation and display, and algorithm software bugs and refinement issues

• Remaining Issues
  – Algorithm refinement
  – ZDR calibration not sufficient for QPE algorithm to properly provide enhanced performance over Legacy algorithms
Questions?