WDT's Polarimetric Radar Identification System (POLARIS)

Using WSR-88D Network Dual-Polarized Radar Data for Real-Time Operational Applications

Chris Porter, Ben Baranowski, Chris Schwarz, and Lalitha Venkatramani - ***Weather Decision Technologies, Inc., Norman, OK***

POLARIS

Currently ingests WSR-88D
Level II radar data from 152 radars
143 CONUS + 4 Hawaii + 4 Alaska + Puerto Rico

13 Dell Xeon
X5570 blades ingest servers
(dual quad-core 2.93GHz)
are utilized

Pre-Condition Inputs to Identification System

- Spike Removal
- Calculate Signal-to-Noise Ratio
- Correct Z_{DR}, **RhoHV**, **PhiDP** based on SNR and apply radial smoothing
- Calculate K_{DP} and **SD(PhiDP) and SD(Z)** as in Park et al (2009)

Identification System

Based on Park et al (2009)

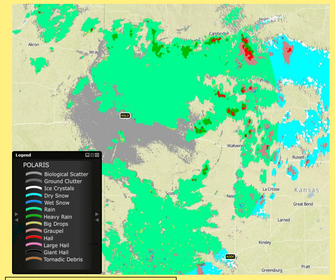
Input

- Z
- Z_{DR}
- RhoHV
- K_{DP}
- SD(Z)
- SD(PhiDP)

POLARIS has additional classifications shown in blue to the right that extends the work of Park et al 2009.

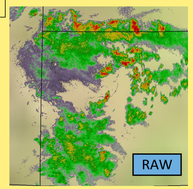
Output

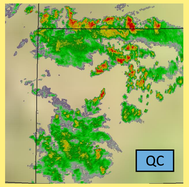
- Clutter / AP
- Biological Scatter
- Rain
- Heavy Rain
- Big Drops
- Rain/Hail
- Wet Snow
- Dry Snow
- Ice Crystals
- Graupel
- Small Hail
- Large Hail
- Giant Hail
- Tornadic Debris



WRF model data is used to obtain the freezing height level

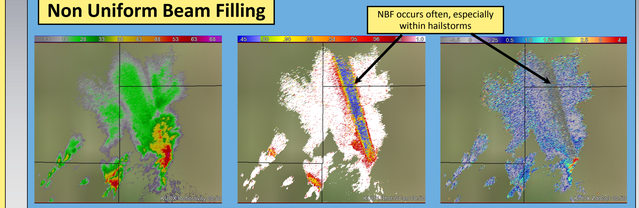
Non-Hydrometeor identification is used to quality control reflectivity



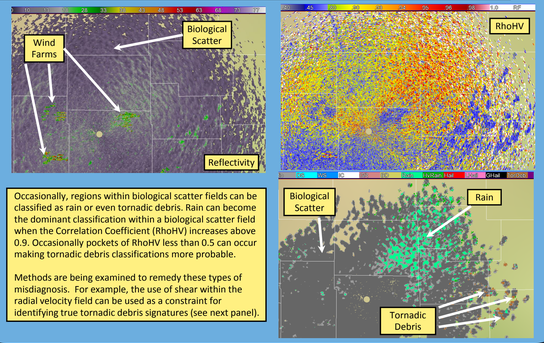


Data Challenges

Non Uniform Beam Filling



False identification of Precipitation in Biological Scatter Field

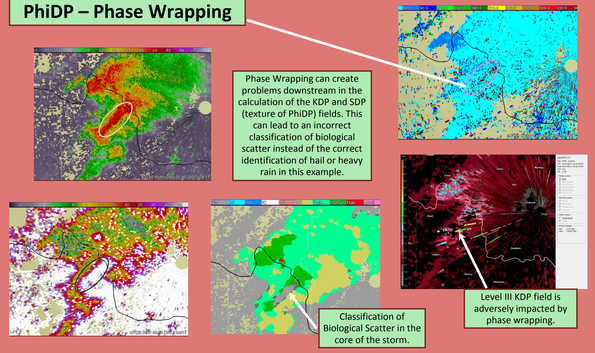


Occasionally, regions within biological scatter fields can be classified as rain or even tornadic debris. Rain can become the dominant classification within a biological scatter field when the Correlation Coefficient (RhoHV) increases above 0.9. Occasionally pockets of RhoHV less than 0.5 can occur making tornadic debris classifications more probable.

Methods are being examined to remedy these types of misdiagnosis. For example, the use of shear within the radial velocity field can be used as a constraint for identifying true tornadic debris signatures (see next panel).

Data Challenges

PhiDP – Phase Wrapping

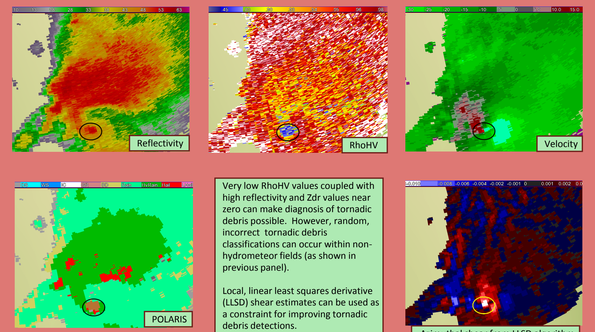


Phase Wrapping can create problems downstream in the calculation of the KDP and SDP (texture of PhiDP) fields. This can lead to an incorrect classification of biological scatter instead of the correct identification of hail or heavy rain in this example.

Classification of Biological Scatter in the core of the storm.

Level III KDP field is adversely impacted by phase wrapping.

Tornadic Debris

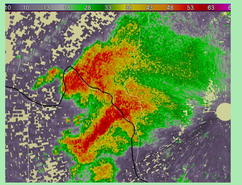


Very low RhoHV values coupled with high reflectivity and Zdr values near zero can make diagnosis of tornadic debris possible. However, random, incorrect tornadic debris classifications can occur within non-hydrometeor fields (as shown in previous panel).

Local, linear least squares derivative (LLSD) shear estimates can be used as a constraint for improving tornadic debris detections.

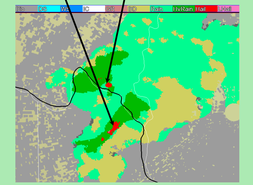
Azimuthal shear from LLSD algorithm (Smith and Elmore 2004)

Hail-Only Classification



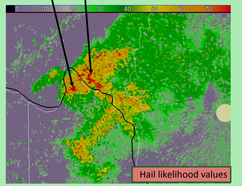
In addition to fine-tuning the tornadic debris classification, research is underway to enhance WDT's hail detection and size products (see Poster 340).

Hail cores are classified within the heavier precipitation regions. But are those the only locations at which hail could exist? Are there regions within heavy rain in which a hail classification is nearly as likely as the heavy rain classification?



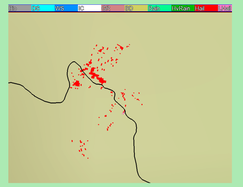
By plotting the hail classification likelihood values for all data bins, significant likelihood values are seen over larger regions of these storms.

For example, the arrows below point to locations of likelihood values over 0.8, although less than likelihood values for heavy rain.

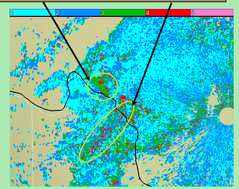


The image below on the right shows values from 1 to 5 for the number of classifications having a likelihood value equal to or greater than 75% of the highest likelihood value of all classifications for each data bin. As an example, suppose the greatest likelihood value for all classifications at a radar bin is 1.0 (highest possible value). The likelihood values for all other classifications are examined to see if any are greater than or equal to 0.75. The number of classifications having likelihood values greater than or equal to 0.75, including the original highest classification, is then assigned to that radar bin. Thus, if there are no classifications that have likelihood values equal to or greater than 75% of the highest likelihood value, then a value of one is assigned to that radar bin.

Example regions of interest where 2, 3 or more classifications have likelihood values that are "relatively " close to one another are circled in yellow.



The image on the left shows a hail "mask" where likelihood values exceed 0.7 for the hail classification.



The image on the right shows that for a majority of precipitation echoes, a dominant classification is obtained (no other classifications with likelihood values >=75% of the "dominant" classification). Regions shaded green and red represent regions that could reasonably be classified as one of three or four other classifications. Regarding hail classification, a process could be developed that combines the hail "mask" (above left) with information on the spread of likelihood values for a data bin. The union of those two sets of information could produce an extended region over which hail is possible or even likely. Research will continue on how best to combine this information.