



Winter 2012
Issue 21

Early Experiences with Dual Polarization at WFO Pittsburgh

On July 15, 2011, the WSR-88D co-located with the Weather Forecast Office (WFO) in Pittsburgh, PA (PBZ) became the fifth WSR-88D nationally, and the second in NWS Eastern Region, to receive the dual polarization (dual-pol) radar upgrade. In the months since PBZ received the dual-pol upgrade, several types of weather phenomena have been viewed with the dual-pol products.

One area where dual polarization variables add value to the warning process is hail detection. With legacy (single-pol) radar, a Three Body Scatter Spike (TBSS) is observed as a spike of weak reflectivity extending out from a thunderstorm and away from the radar site. This spike indicates hail in a thunderstorm. With dual-pol radar, the TBSS can be observed as a down-radial spike of

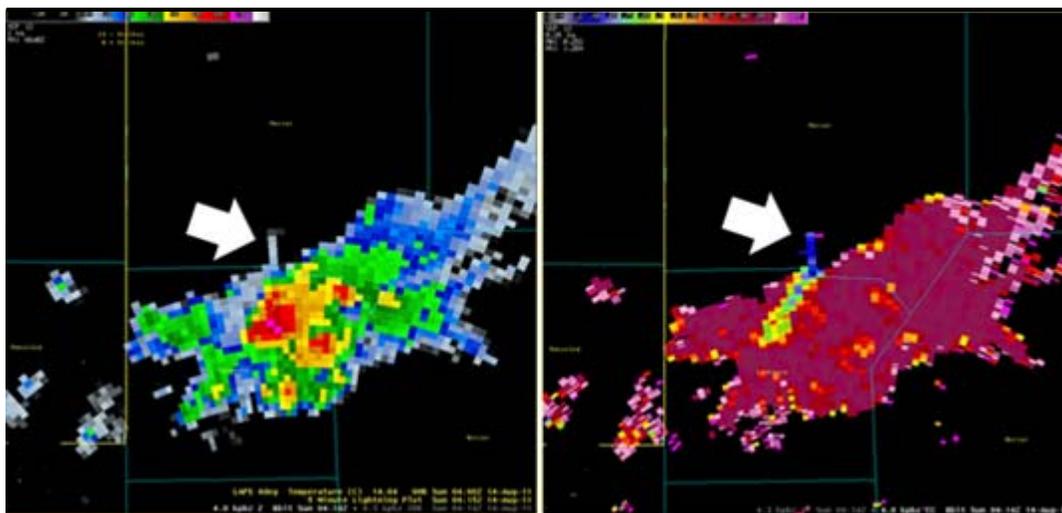


Figure 1: Reflectivity (Z) (left) and CC (right) at 4.3° from 0414Z on August 14. Note the spike of reflectivity on Z (left), and the corresponding spike of low CC (right). This storm produced half inch hail.

This article highlights three particular areas for study: hail detection, the Hydrometeor Classification Algorithm (HCA), and Quantitative Precipitation Estimation (QPE).

lower Correlation Coefficient (CC), in addition to the spike of lower reflectivity (Figures 1 and 2). Dual-pol has also indicated lowered CC

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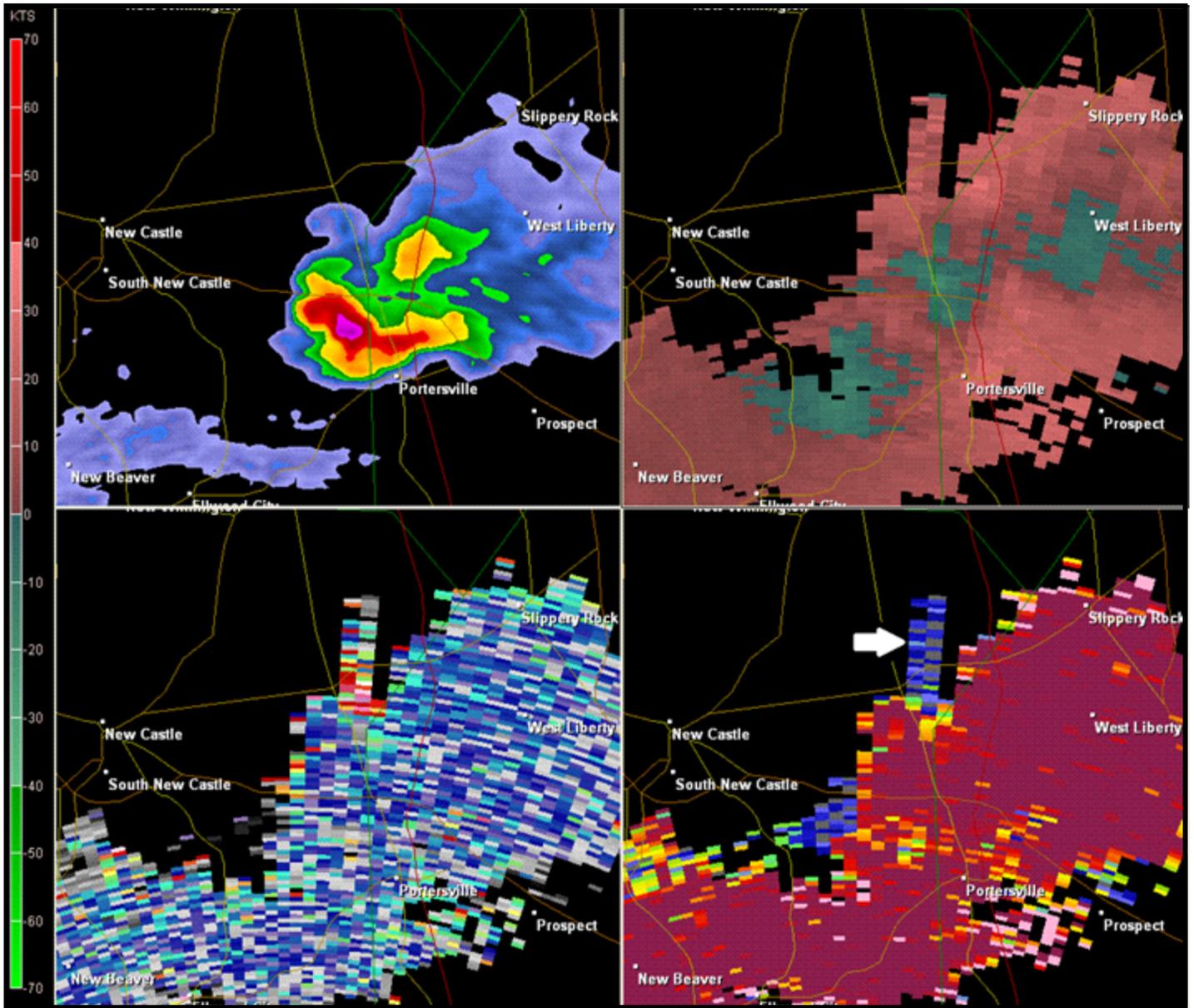


Figure 2: Clockwise from top-left: Z; Storm-Relative Motion (SRM); CC; and Differential Reflectivity (ZDR) at 8° from 1754Z on August 21. Note the spike in CC. This storm produced half-dollar size (1.5”) hail.

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values corresponding with both severe and sub-severe hail and in locations where the reflectivity’s TBSS is more difficult to detect in surrounding areas of light reflectivity (Figure 3). Dual polarization may also suggest an area of hail by showing a local minimum in CC, indicating size and shape

variation in hydrometeors (Figure 4). At this point, dual-pol data increases confidence that hail is present in a storm. However, at this time there is no definite way to correlate a dual-pol signal to a particular hail size. This is a topic for future research.

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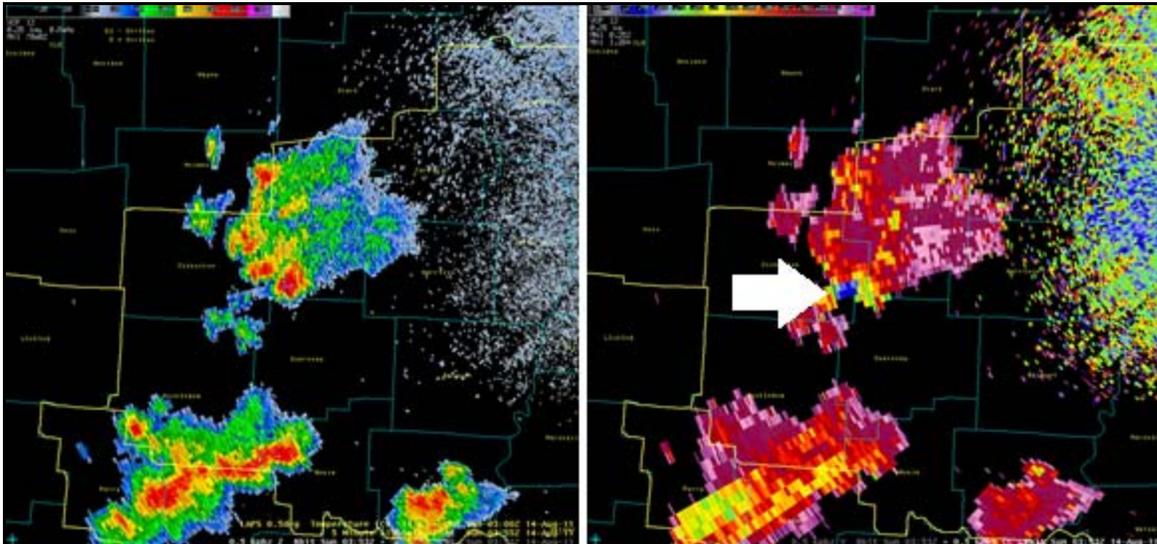


Figure 3: Reflectivity (Z, left) and CC (right) at 0.5° from 0353Z on August 14. This storm produced half inch hail.

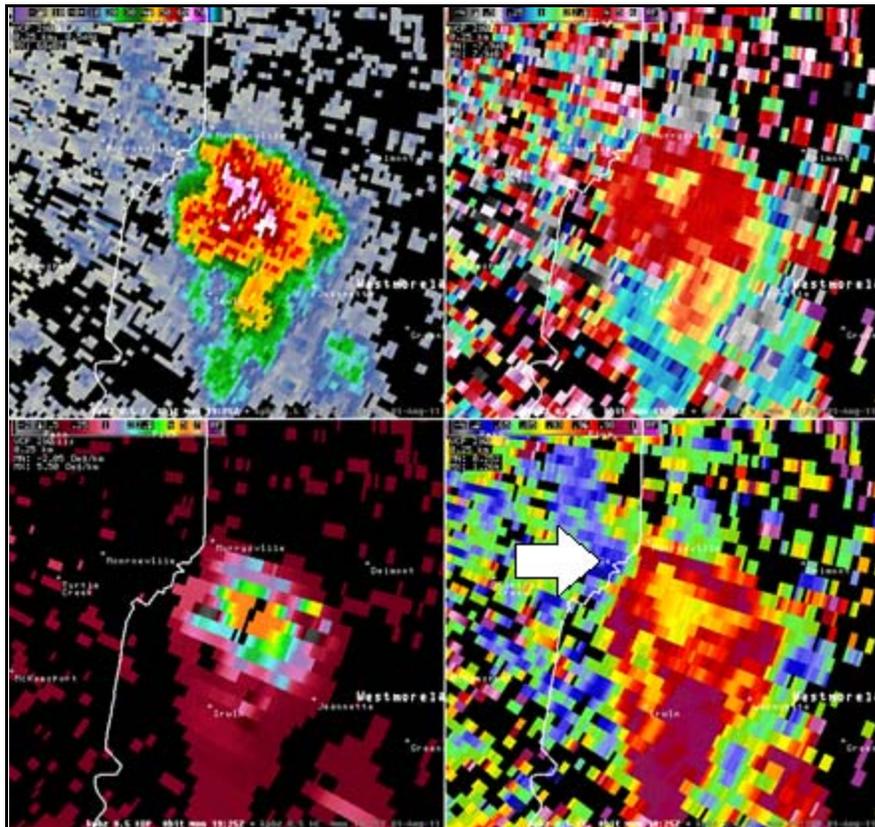


Figure 4: Clockwise from top-left: Z, ZDR, CC, and Specific Differential Phase (KDP) at 0.5° from 1925Z on August 1. This storm produced quarter size (1") hail.

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A derived product from the base data is the HCA, created by the National Severe Storms Laboratory (NSSL). Using a fuzzy logic system, the HCA identifies particles as one of 12 echo types. The echo types are mostly, but not all, meteorological in nature. Although the HCA performs poorly

for cold season classifications (Elmore 2011), the HCA does have some utility; the HCA can help distinguish hail. It was used to show emergency managers the location of a hail core relative to a large outdoor venue during a post-event briefing (Figure 5). The HCA identified a flock of birds at sunrise as biological scatterers (Figure 6).

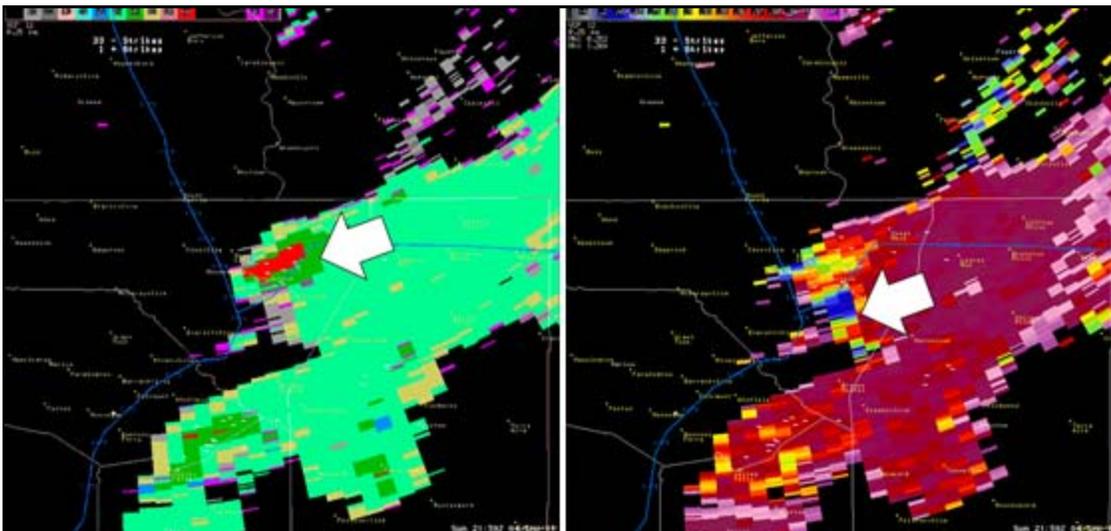


Figure 5: The Hydrometeorological Classification Algorithm (HCA, left) and Correlation Coefficient (CC, right) at 0.5° from 2195Z on September 4. Note how the HCA (left) indicates a rain-hail mix relative to the location of low CC (right).

On the other hand, the HCA identified a wind farm as several classifications, including ground clutter, biological, and wet snow (Figure 7). Wind farms are especially difficult for radar algorithms, due to the combination of moving (turbine blade) and stationary turbine blade and mast) targets.

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Figure 6: 0.5° HCA 08/04/11 - 1202Z

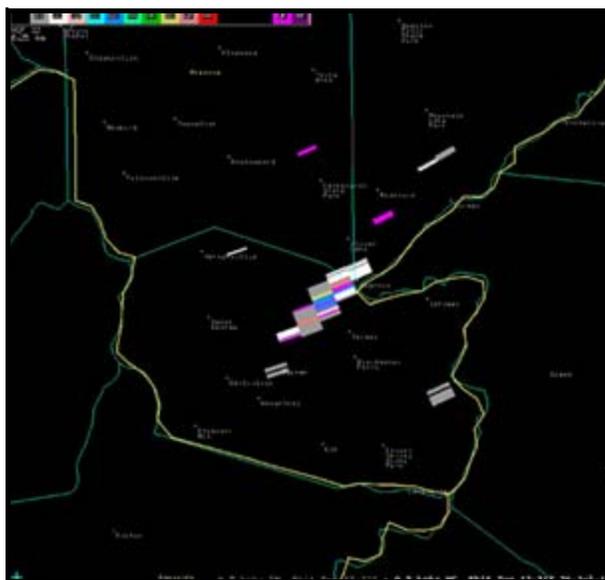


Figure 7: 0.5° HCA 07/26/11 - 1331Z

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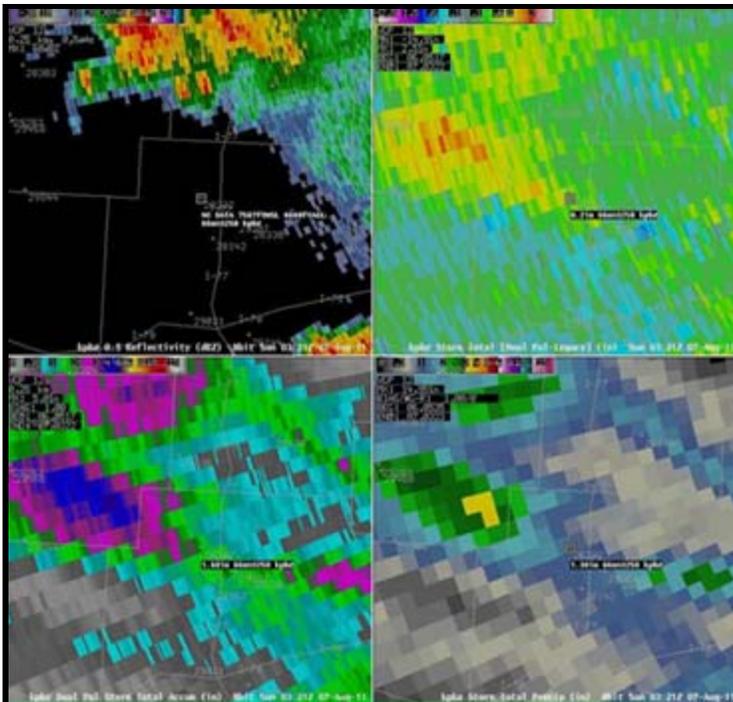


Figure 8: Clockwise from top-left: Base reflectivity; Difference between Dual-Pol and Legacy storm total accumulation; Dual-Pol storm total accumulation; Legacy storm total accumulation.

Precipitation estimation is expected to improve with the addition of dual-pol technology. Through the use of dual-pol base data and the HCA, several different precipitation rates will be used by precipitation algorithms, which should allow for more accurate rainfall estimates.

On the evening of August 6, 2011, scattered thunderstorms moved across Ohio into southwestern Pennsylvania and northern West Virginia. Real-time data from the Integrated Flood Observing and Warning System (IFLOWS) precipitation gages in Ohio showed that dual-pol rainfall estimates were more accurate than legacy rainfall estimates (QPE), with legacy estimates underestimating rainfall (Figures 8 and 9). Unfortunately, the IFLOWS gages in West Virginia were not working, so little ground truth was available in real-time as the thunderstorms continued moving to the southeast during the early morning hours of August 7. In this case, 24-hour precipitation amounts from cooperative observers indicated that dual-pol also outperformed Legacy estimates in these locations (Figure 10). That morning, dual-pol data was used to help forecasters make the decision to issue four flash flood warnings, all of which verified.

Rainfall estimates from dual-pol data have not always proven to be more accurate. During the afternoon of August 19, 2011, thunderstorms with heavy rain moved across urban areas of Pittsburgh and

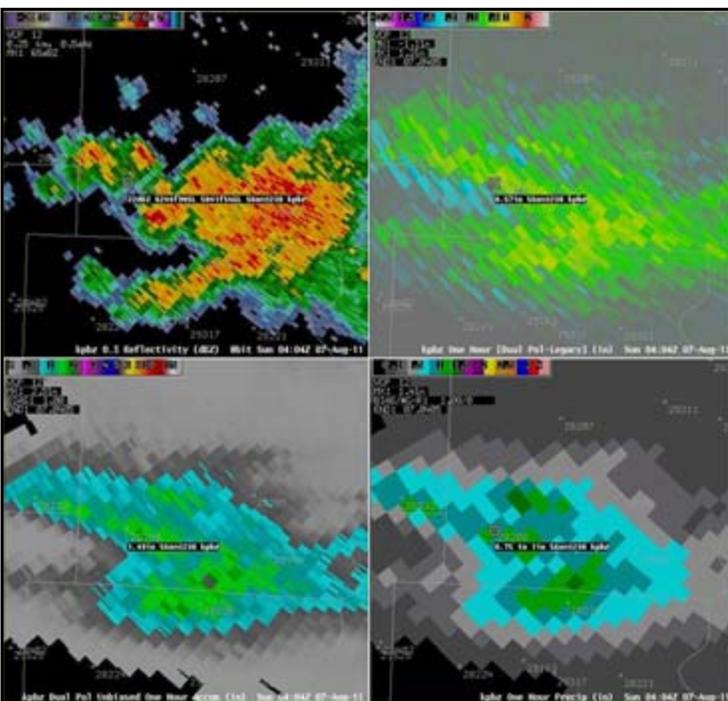


Figure 9: Clockwise from top-left: Base reflectivity; Difference between Dual-Pol and Legacy one-hour accumulation; Dual-Pol one-hour accumulation; Legacy one hour accumulation.

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Site	Gage	Legacy	Dual-Pol	Legacy (% Gage)	Dual-Pol (% Gage)
Canaan Valley	1.29	1.20	1.68	93	130
Davis	1.32	1.08	1.56	82	118
Fairmont	3.42	2.20	3.37	64	99
Fellowsville	3.75	2.50	4.00	67	107
Morgantown	1.97	1.60	2.03	81	103
Rowlesburg	2.8	1.70	2.71	61	97
Terra Alta	1.07	0.48	0.78	45	73

Figure 10: Rainfall comparison for sites receiving ≥ 1 inch of rain from 8/6/11 12Z to 8/7/11 12Z.

dropped two to three inches of rain in one hour. Drainage problems in a backed-up sewer system led to four fatalities approximately three miles northeast of downtown Pittsburgh. For this case, dual-pol underestimated the three hour precipitation by 1.0 to 1.5 inches, with legacy radar underestimating the three hour precipitation by 0.5 to 1.0 inches (Figure 11).

Overall, new dual-pol variables such as CC can be used as additional evidence that hail (both severe and sub-severe) is present in an updraft. However, at this point, dual-pol variables have not been as useful for detecting severe winds. Many more wind reports were observed than hail since the dual-pol upgrade. Thus, there were limited opportunities to evaluate rain-

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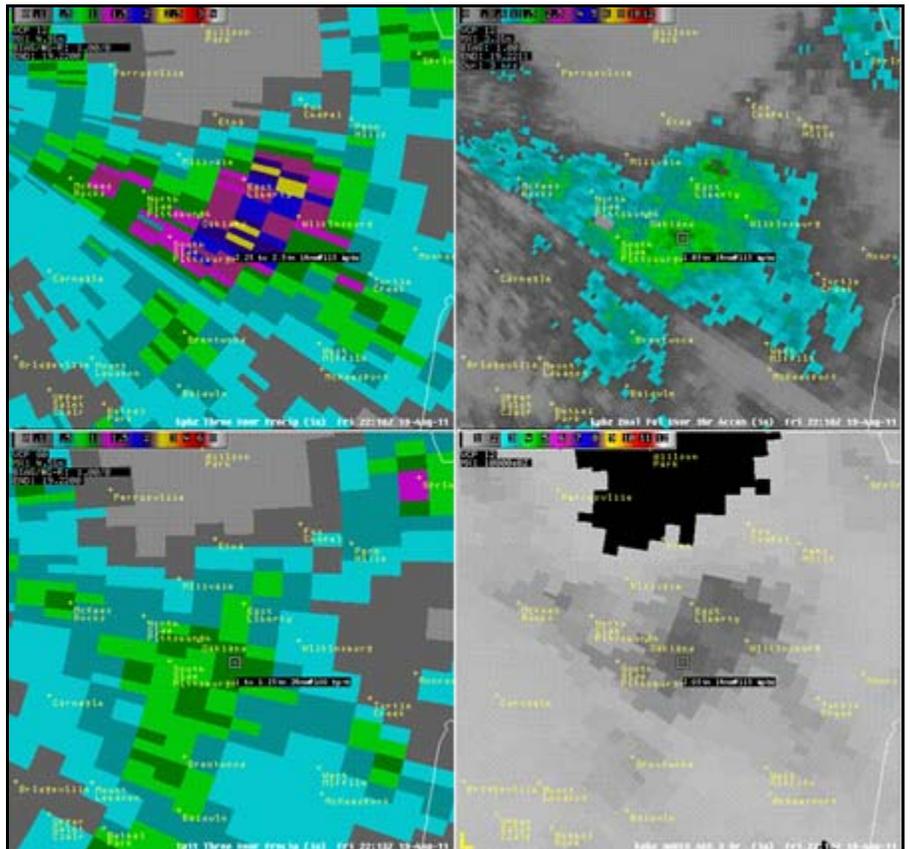


Figure 11: Clockwise from top-left: 3-hr precipitation estimations from KPBZ legacy; KPBZ Dual-Pol; KPBZ AMBER; and TPIT ending at 22Z on August 19.

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fall estimates for storms with possible hail contamination. Through the use of the HCA, areas classified as a rain-hail mix will have precipitation estimates reduced rather than classifying the location of high reflectivity as very heavy rain. Dual-pol rainfall estimates have generally (but not always, as observed in the Pittsburgh flash flooding event) been more reliable than legacy rainfall estimates. Since dual-pol rain rate equations (using dual-pol base variables) are based on research from central Oklahoma, these values may need to be adjusted for other regions of the country. This will be an area for additional research at WFO PBZ and other sites as dual-pol installations continue across the country.



Motorists were forced to abandon their vehicles on Washington Boulevard as flash flood waters quickly submerged their vehicles. Photo Courtesy of Chris Langer/Pittsburgh Tribune-Review.

References

Elmore, Kimberly L., 2011: The NSSL Hydrometeor Classification Algorithm in Winter Surface Precipitation: Evaluation and Future Development. *Wea. Forecasting*, **26**, 756–765.

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