Extreme Weather: Why You Should Take Advantage of Dual-Polarization Radar Systems

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Author – Alfred M. Klausmann, CCM

In addition to generating strong surface winds, tornadoes, and intense rainfall, thunderstorms can often produce hail. Hail with large diameters can result in significant damage to buildings, structures, vehicles, and other sensitive equipment. In most cases, direct in-situ observations of hail come from storm spotters or other cooperative observers and these observations are typically limited to populated areas. This leaves large areas with little direct observations of hail. Even in populated areas, a hail event may pass undetected between locations where a storm spotter may be situated.

Dual-polarization radar technology, now implemented at National Weather Service radars across the United States, provides significant added capability to diagnose hail in thunderstorms. Using radar reflectivity and two derived parameters available from dual-polarization radars, the differential reflectivity (i.e. difference between the horizontal and vertical reflectivity components), the correlation coefficient (correlation between horizontal and vertical reflectivity), and the areas of ground level hail impacts can be detected and hail size estimated.

Past Hail Events and Use of Dual-Polarization Radars

The April 1, 2015 Hail Event in near Fort Worth Texas

On April 1, 2015, a severe thunderstorm moved through the northwest suburbs of Fort Worth Texas and resulted in large hail impacts at various locations. Ground observations in the area of La Junta and Reno revealed a variety of hail sizes ranging from 1.00 to 2.5 inches in diameter. Figures 1 through 3 shows the data gathered by Exponent’s scientists.

Figure 1. Left image shows the probability of severe hail parameter (POSH) while the right side shows the maximum estimated hail size (MESH) in inches.
Figure 2. Radar images from the Fort Worth NEXRAD radar for April 1, 2015 at 2112 UTC. Reflectivity is shown on the left, differential reflectivity in the center, and correlation coefficient on the right. All images are from the lowest radar beam elevation angle of 0.5 degrees. The white ellipse highlights the hail region and the straight white line shows the position of the vertical cross section shown in Figure 3.

Figure 3. Vertical Cross section of radar reflectivity showing the collapse of a hail core in the severe thunderstorm northwest of Fort Worth, Texas. The hail core is depicted by the purple and white reflectivity regions in the thunderstorm with reflectivity levels above 60 dBZ.

As seen in Figure 3, the series of vertical cross sections of radar reflectivity shows the elevated hail core spreading downward and rapidly falling out of this portion of the thunderstorm. The radar data analysis can depict the time evolution of the hail structure in thunderstorms and offers insight into the dynamics of hail events. This data can be used together to estimate the likely hail size and the location of ground impacts.
East Texas Tornado Outbreak of April 29, 2017

On April 29, 2017, supercell thunderstorms generated several strong tornadoes across eastern Texas. One strong tornado with peak wind estimates of 145 miles per hour and a peak width of about 1 mile passed just east of the city of Canton, Texas and then moved north passing Fruitvale, Texas, causing significant damage to homes and business along a 40 mile path. Figure 4 shows the tornado clearly depicted on radar radial velocity images from the Dallas Fort Worth National Weather Service radar as it passed east of Canton and across Fruitvale, Texas. This type of imagery is valuable for identifying the location and path of tornadoes.

Figure 4. Dallas-Fort Worth National Weather Service Radar storm relative radial velocity field. The strong tornado (Enhanced-Fujita Scale EF3) is shown by the radial velocity couplet (green shades showing easterly winds coupled with bright red shades showing westerly winds) southeast of Canton Texas (left) and just south of Fruitvale, Texas (right). The EF3 category for tornadoes is for wind speeds of 136-165 miles per hour.

Tornado damage near Canton, Texas (image courtesy of the National Weather Service).
The Effectiveness of Dual-Polarization Radar

The replacement of the original National Weather Service Weather Surveillance Radar systems with dual-polarization radar systems in recent years offers a significant increase in our capability of detecting and analyzing high impact events. Dual-polarized radars can provide additional information regarding the size, shape and distribution of precipitation particles including hail in severe thunderstorm systems as well as detect thunderstorm induced wind events such as downbursts and tornadoes.

Insurers, risk managers and their counsel can utilize weather predictive tools to help assess damage in severe weather events and understand how meteorological tools can help in damage assessment.

How Exponent Can Help

Exponent’s Atmospheric Scientists and Buildings & Structures practices have strong capabilities and deep experience with severe hail storms. Our Atmospheric Scientists have successfully used the National Weather Service dual-polarization radar to perform a comprehensive analysis of severe weather. Additionally, our Buildings and Structures engineers have worked numerous adjusters to determine the nature and extent of damage, evaluate the contributions of perhaps several causal factors, and identify the most appropriate repairs.