A Hybrid Single-/Dual-Polarization Hail Detection and Sizing Algorithm for the WSR-88D

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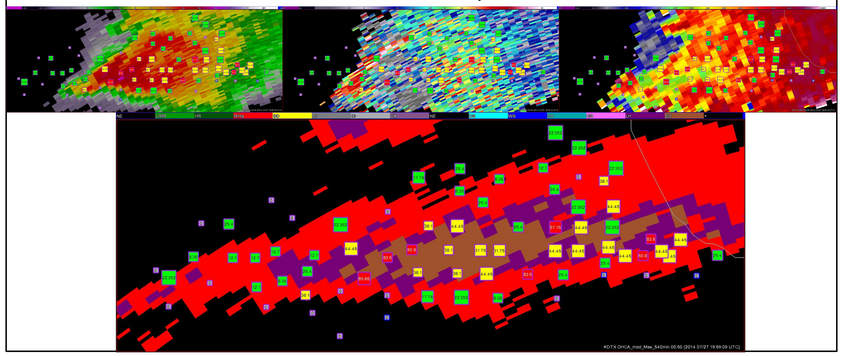
Introduction

The Enhanced Hail Detection Algorithm (HDA) uses a vertical integration of reflectivity, with weightings applied to both reflectivity and the height of the beam with respect to its position relative to the 0°C and -20°C, to produce an estimated size of the maximum hail size (MESH). The Hail Size Detection Algorithm (HSDA) is a fuzzy logic scheme which uses trapezoidal membership functions for reflectivity, differential reflectivity, and correlation coefficient to define the hail size categories within 6 different height layers relative to heights of wet-bulb temperature equal to 0°C and -25°C. This work seeks to implement the HDA in a gridded framework for single-radar use and compare that output with HSDA output.

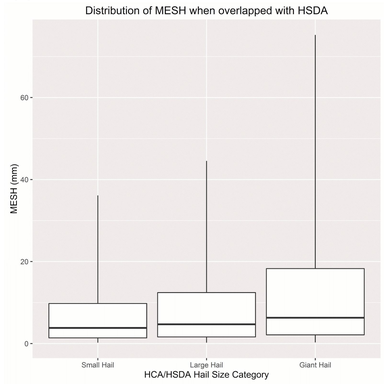


Data

306 SHAVE operations occurring near dual-polarized WSR-88Ds were selected. From these 306 cases, 10,635 volumes were used to extract MESH and HSDA output. This yielded a total of 123,746,980 voxels at the 0.5° scan in which there was either a MESH value, an HSDA detection, or both. Several of the cases were qualitatively analyzed to evaluate the overlap and performance of the algorithms.

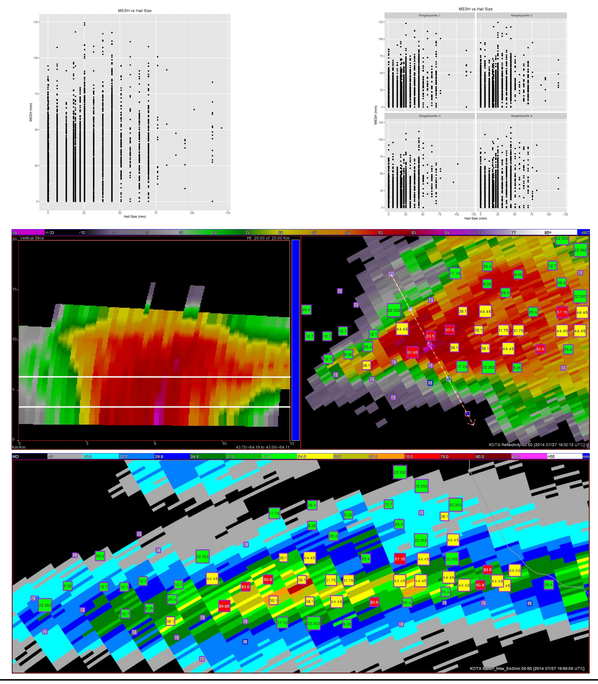
Overlap of HSDA and MESH Outputs

MESH was distributed for HSDA hail size categories when the two products overlapped on individual volumes at the 0.5° tilt.



Single-radar MESH

Observed hail diameters from SHAVE reports were compared to MESH and broken down into range quartiles. The range quartiles are defined by: 0-56 km, 56-87 km, 87-115 km, and 115+ km.



Discussion

Analysis of these four cases with respect to SHAVE reports indicated that both algorithms correctly identified hail size in Case 1 and overestimated hail size in Case 2. In Case 3, MESH values matched SHAVE reports, while the HSDA overestimated hail size. In Case 4, the HSDA values matched SHAVE reports, while MESH overestimated. The fuzzy logic scheme used in the HSDA relies more heavily on dual polarization information, such as Zdr, below the 0°C height. Near and above the freezing height, the HSDA became more weighted toward horizontal reflectivity. Since MESH relies on an integration of reflectivity between the 0°C and -20°C heights, MESH and the HSDA appeared to more closely match at these elevations. In addition, there was often poor spatial overlap between the HSDA values at 0.5° (which falls below the 0°C height in these examples) and MESH. At greater distances from the radar (such as the first case study from KDTX), this overlap appeared at lower scans. Overlap of the two different algorithms, or lack thereof, will limit future applications of such an algorithm.

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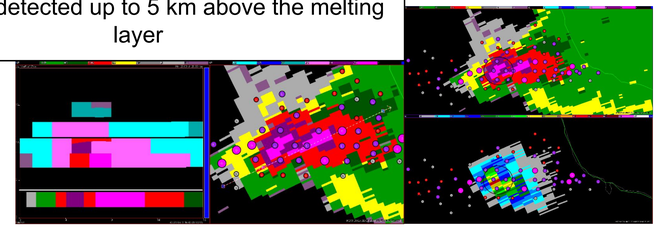
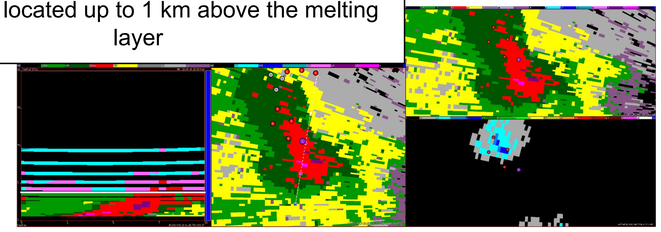
Results

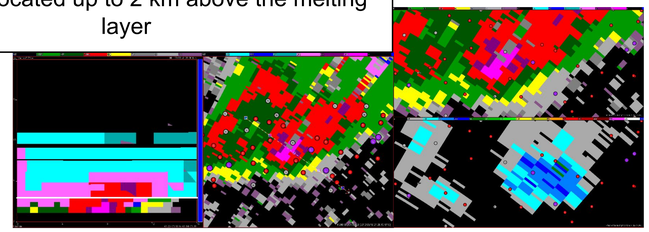
Case 1: KDTX 27 July, 2014
- 115 km from radar
- Some overlap
- Giant hail detected up to 5 km above the melting layer



Case 2: KPDT 20 July, 2012
- 25 km from radar
- Poor overlap
- Small hail located up to 1 km above the melting layer



Case 3: KENX 16 May, 2012
- 70 km from radar
- Poor overlap
- Large hail located up to 2 km above the melting layer



Case 4: KBOX 20 July, 2015
- 95 km from radar
- Some overlap
- Small hail located up to 8 km above the melting layer