WSR-88D Observations of an Extreme Hail Event Impacting Western South Dakota on 20 June 2015

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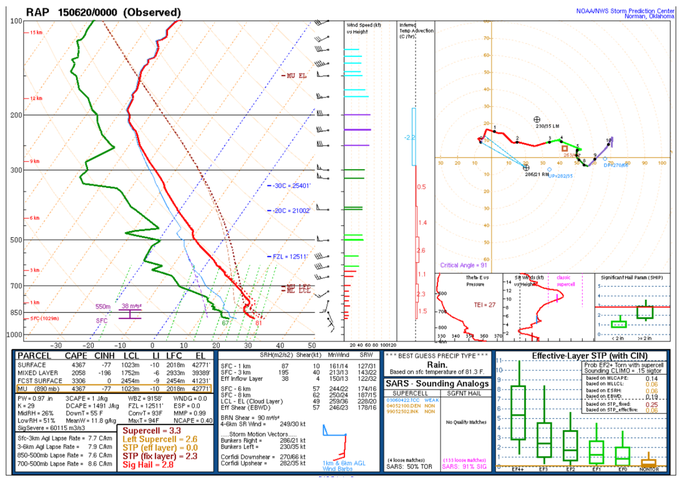
Introduction

- On 20 June 2015, an intense supercell thunderstorm with hail to at least 6 inches (15.2 cm) in diameter impacted western South Dakota in the vicinity of Nisland
- The storm produced widespread damage to vehicles, homes, and businesses, with news reports of hailstones penetrating the shingle roofs of homes and the metal roofs of barns
- The storm occurred within 100 km of the KUDX WSR-88D
- This study examined the character and evolution of the Nisland hailstorm from 0020–0230 UTC as seen by KUDX, in terms of overall storm intensity, along with the low-altitude dual polarization observations associated with six severe hail reports

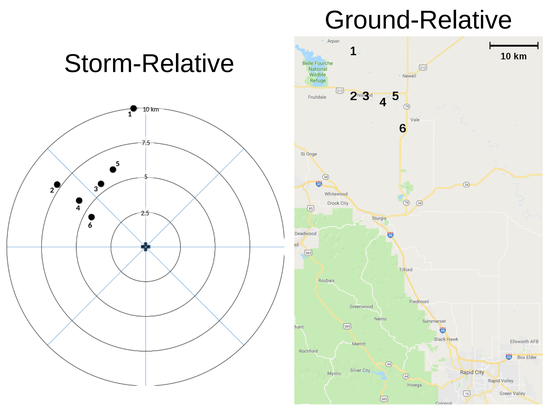
Radar Data Analysis

- *Storm intensity parameters examined*: storm-top divergence (STD), mid-altitude rotational velocity (MRV) and maximum expected size of hail (MESH)
- *Dual-polarization parameters examined*: reflectivity (Z), differential reflectivity (Z_{DR}), cross-correlation coefficient (ρ_{HV}), specific differential phase (K_{DP}), depolarization ratio (DR), and the hydrometer classification algorithm (HCA) including the new hail size discrimination algorithm (HSDA) categories of small hail (SH; < 25 mm), large hail (LH; 25–50 mm) and giant hail (GH; > 50 mm)
- Pre-processed Z, Z_{DR}, ρ_{HV}, and DR data were objectively analysed to a 0.005° x 0.005° x 250 m (latitude x longitude x height) grid using WDSSII. Products were also interpolated to the 0°C, −10°C, −20°C, −30°C, and −40°C heights as determined by the hourly 13 km RAP analyses

Storm Environment

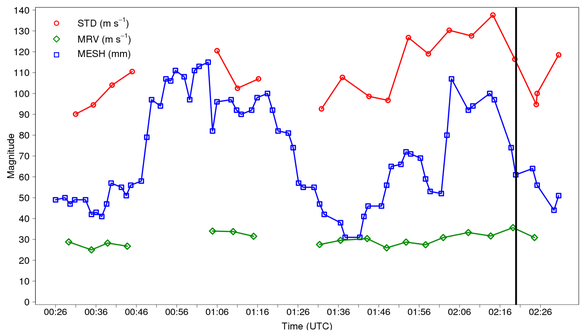


Location of Hail Reports

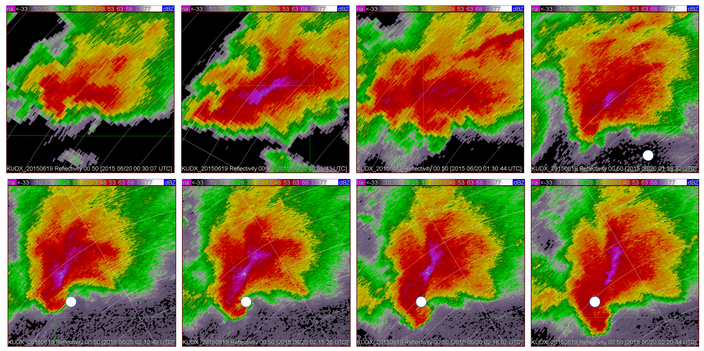


Report Number	Time (UTC)	Size (mm)	HSDA Result	Dist. To Nearest GH Area (km)
1	0208	44	GH	0
2	0213	64	SH	1.9
3	0215	114	SH	1.4
4	0220	152	SH	3.3
5	0220	114	SH	4.5
6	0226	70	SH	9.7

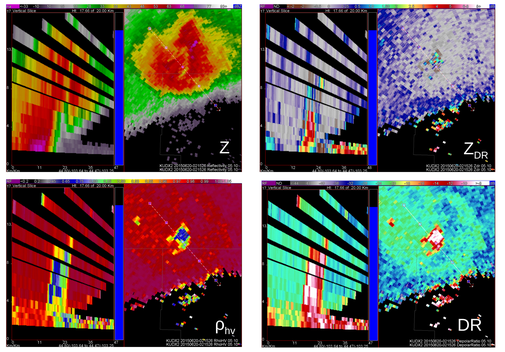
Time Series of STD, MRV and MESH



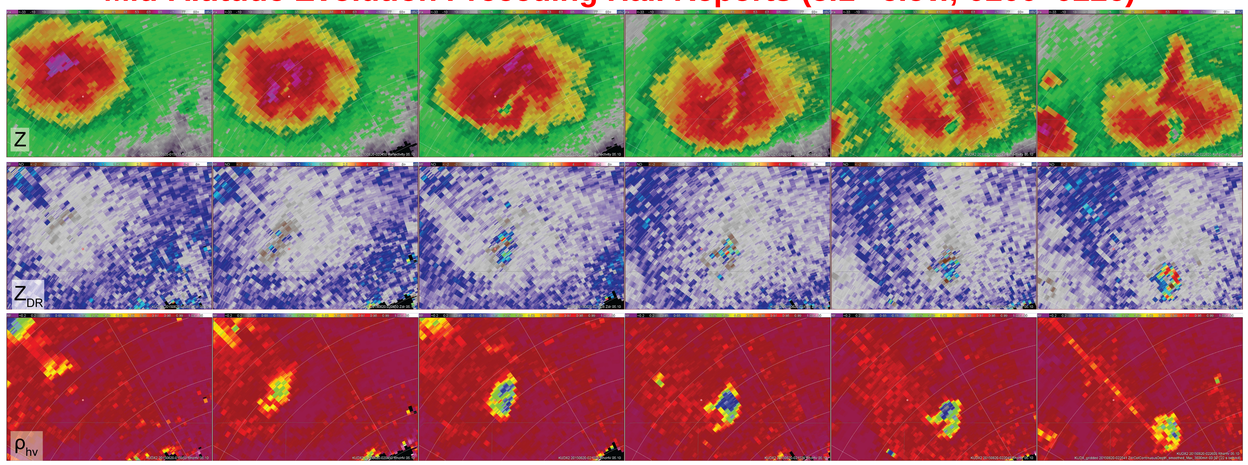
KUDX Reflectivity (0.5° elev.; 0030–0220)



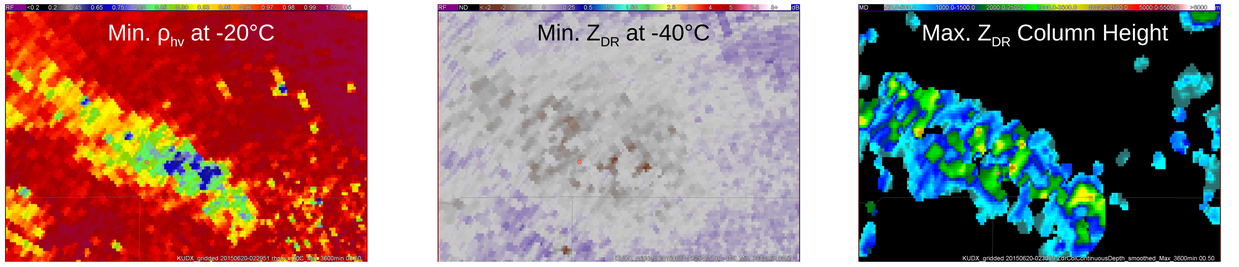
Vertical Cross-Section (0215)



Mid-Altitude Evolution Preceding Hail Reports (5.1° elev.; 0200–0226)

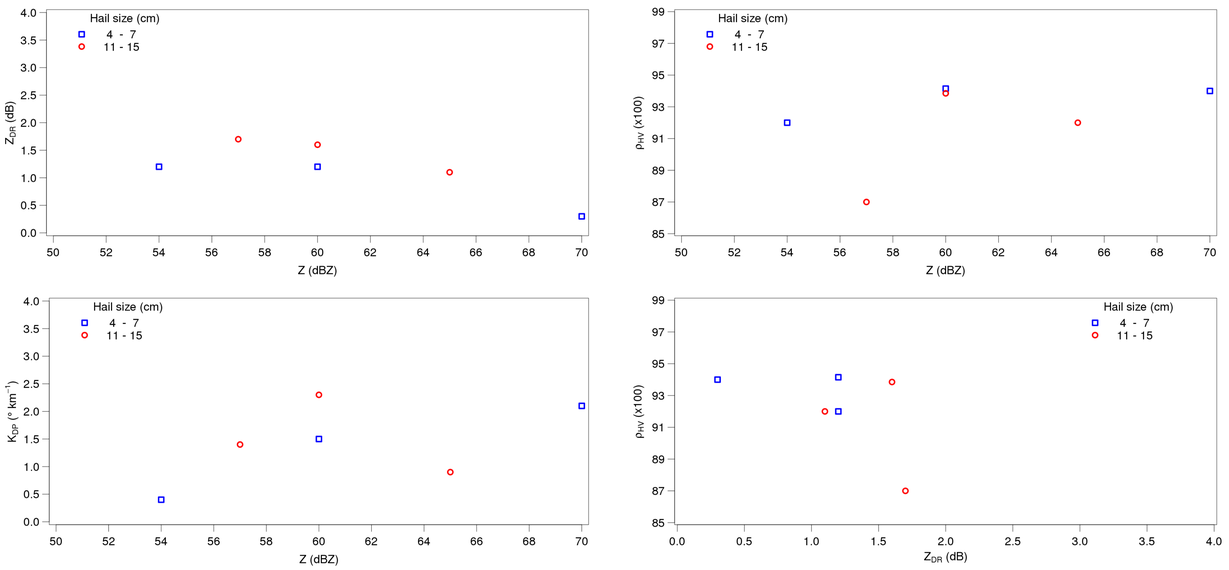


Temporal "Accumulation" – Polarimetric Signatures Aloft (0145–0230)



KUDX Dual-Polarization Observations above the Six Hailstone Reports

Z, Z_{DR}, ρ_{HV} and K_{DP} from the 0.5° elevation scan for a 1° x 1 km window (median of 8 values) above the locations of the hail reports at the times closest to the reports



Conclusions

- For the radar parameters used to assess storm intensity (STD, MRV and MESH):

1) All three parameters attained magnitudes typical of a supercell capable of producing giant hail
2) Only the STD suggested the potential of an extreme hail event, reaching a maximum of 138 m s^{-1}

- Shortly before and during the reported times of giant hail, ρ_{HV} aloft (e.g., 4–11 km AGL) dropped to lower than 0.6 in some places, and a large area of Z_{DR} < -1 dB was observed near and above the Z_{DR} column. Some of these observations occurred in very high Z (e.g., >70 dBZ) to the northwest of the BWER
- The low-altitude dual polarization observations show that most of the large hail was associated with high Z (e.g., ≥54 dBZ), low Z_{DR} (<2 dB), and low-to-moderate ρ_{HV} (0.87–0.94) and K_{DP} (0.4–2.3° km^{-1})
- At the time and location of the six severe hail reports, the HSDA performed poorly, indicating SH for the five giant hail reports and GH for the one large hail report. The cause appears to be Z_{DR} larger than the HSDA typically classifies for GH
- Although the HSDA indicated SH for the 5 giant hail reports, GH was identified nearby (within 10 km)