An Assessment of Environmental Parameters Supportive of Large Hail Across the Great Basin

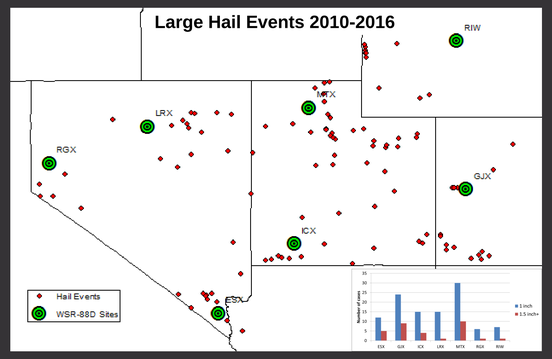
Michael Seaman and Christine Kruse, National Weather Service, Salt Lake City, UT

I. Introduction

Identification of convection capable of producing large hail (defined as 1" in diameter or greater) across the Great Basin remains problematic for a variety of reasons. Mainly, organized convection in the semi-arid climate of the Great Basin will typically feature a drier and deeper boundary layer compared to the central and eastern United States. This dry, deeply mixed boundary layer tends to reduce melting of hailstones within the sub-cloud layer (Rasmussen, 1987), resulting in large hail reaching the surface at lower maximum reflectivity thresholds than the Donavon Technique (Donavon, 2007) would suggest. Previously, a large hail study based on this technique was conducted across the Great Basin spanning 1996-2006 (Traphagan and Seaman, 2010). The results of this study reduced the maximum reflectivity thresholds for the Great Basin below those suggested by the Donavon Technique. Since 2010, operational experience has regularly indicated maximum reflectivity values above the thresholds established in the Great Basin hail study may not produce large hail, but rather a large amount of small hail. It was theorized these observations implied pulse type thunderstorms across the Great Basin may be too weak to produce large hail given typically marginal instability values, but rather organized convection with sufficient deep layer shear is typically necessary. This study utilized RAP/ RUC-derived proximity soundings to increase the temporal and spatial resolution of available freezing level data, as well as expand the ability to review additional environmental parameters.

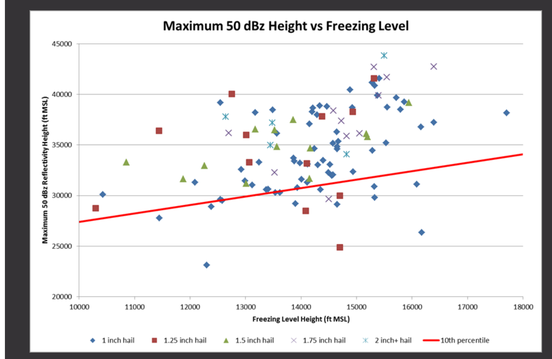
II. Methodology

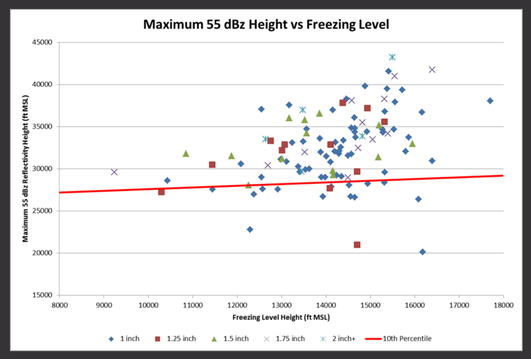
- Hail reports (0.75 inch and greater) were collected from Aug 1 2010-Sep 30 2016 within 140nm of 7 Intermountain RDAs.
- Maximum 50, 55, 60, and 65 dBz reflectivity height were determined within a 30 minute window, from 20 minutes before to 10 minutes after each report.
- Archived 0-hour RAP (2012-2016) and RUC (2010-2012) point BUFR soundings within 2 hours of a given hail report were retrieved from the closest representative site.
- Only the largest hail report was used for storms in which multiple large hail reports were received.
- Cases were eliminated where radar or sounding data was deemed unrepresentative, limited, or missing.

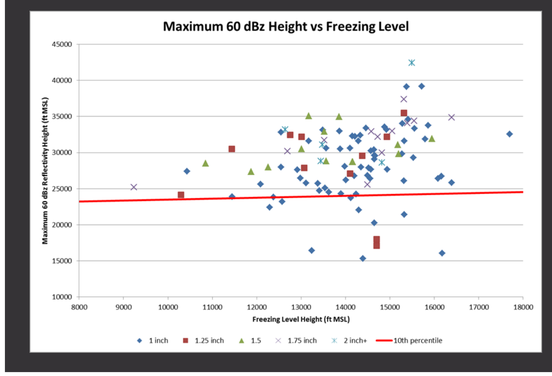


Plot of large hail events (red dots) and WSR-88D sites (green circles) used in the study. Graph depicts total number of 1" or larger hail events (blue) and 1.5 inch and greater (events (red) for each radar

III. Reflectivity vs Freezing Level

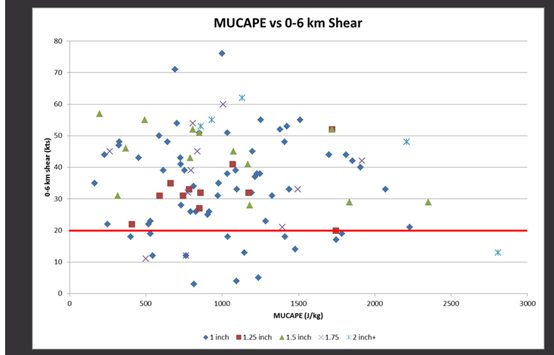


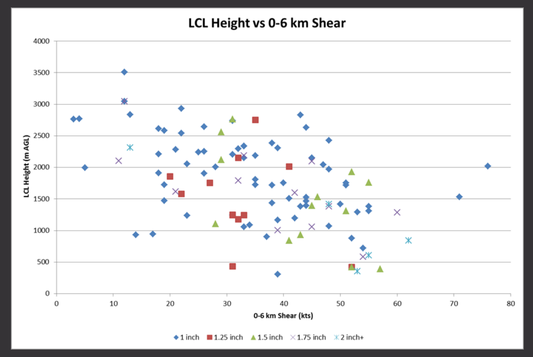


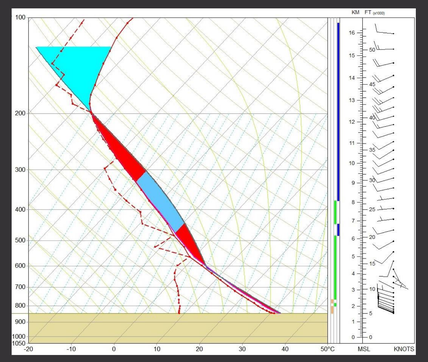


- Lower reflectivity thresholds for one inch hail were noted in the previous Great Basin hail study when compared to the Donavon Technique. This is suspected to be related to a drier sub-cloud layer resulting in less melting of hailstones.
- The results of this study refined those in the Great Basin hail study by adjusting reflectivity thresholds upwards, and better fit operational observations. These thresholds are still lower than those of the Donavon Technique.
- This refinement is likely due to higher temporal and spatial resolution using model point soundings as opposed to observed soundings, as well as improvements in radar technology since 2009.

IV. Near Storm Environmental Analysis







RAP derived BUFR sounding from 00z 7/18/2014 at KRNO. Sounding depicts a deeply mixed and dry boundary layer in a low shear environment. 1" hail was reported near Carson City, NV, at 0000z.

- 82% of large hail cases had 0-6km shear >= 20 kts (20th percentile was 22.5kts). Only 65% of cases with 0.75-0.88" hail had shear > 20 kts (not shown).
- Mesoscale and storm scale influences such as boundary interactions and anomalous propagation along terrain were also observed to locally enhance storm relative shear.
- Nearly all large hail cases below the 10th percentile for 0-6km shear had LCL heights > 2000m agl, potentially suggesting a deeper, drier boundary layer was present which limited melting. All but one of these cases occurred in NV.
- These results indicate instability alone (pulse type convection) is not sufficient in most cases to produce 1 inch hail, but rather organized convection with enhanced or rotating updrafts is typically a necessary component.

V. Acknowledgements and References

- RAP/RUC BUFR soundings interrogated using The Universal Rawinsonde Observation (RAOB) program from Environmental Research Services (http://www.raob.com/).
- Radar data was analyzed using GR2Analyst Software (http://www.grlevelx.com/).
- Donavon, R.A., and K.A. Jungbluth, 2007: Evaluation of a Technique for Radar Identification of Large Hail Across the Upper Midwest and Central Plains of the United States. Wea. Forecasting, 22, 244-254.
- Rasmussen, R.M., and A.J. Heymsfield, 1987: Melting and Shedding of Graupel and Hail. Part II: Sensitivity Study. J. Atmos. Sci., 44, 2764-2782.
- Traphagan, M.T., and M. Seaman, 2010: Using Radar Reflectivity Heights to Forecast the Presence of Large Hail Across the Intermountain West. WR-Technical Attachment 10-05.

Sept 4, 2007 – Leading edge of outflow moving into southern Salt Lake County

Contact information: Mike.Seaman@noaa.gov and Christine.Kruse@noaa.gov