THE SEVERE HAIL VERIFICATION EXPERIMENT

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I. INTRODUCTION

Severe weather diagnosis applications that have a high temporal (5 minute) and spatial (1 km) resolution require verification data on the same scales. However, no source for such high-resolution data exists on a wide scale in the United States (US) climate record (nor worldwide). Additionally, temporal and spatial inaccuracies in the US official climate record of severe weather events, the US National Climate Data Center's *Storm Data* publication, are well documented. Because the official record of storm events is highly dependent on the National Weather Service warning system, reports of severe weather are usually on the temporal and spatial scale of a US National Weather Service (NWS) warning, which typically last up to an hour and cover one or more counties. Storm-scale severe weather events frequently occur on a smaller spatial scale than the typical NWS warning, and the fine details of these events are usually missed during the verification process. Trapp et al (2006) and Witt et al (1998) cite many examples of how utilizing the severe weather reports in *Storm Data* for scientific research can be problematic.

With the onset of US WSR-88D base data distribution over the internet (Droegemeier 2002) and cheap, fast computing performance, it became possible to merge and process data from the entire CONtinental United States (CONUS). The Warning Decision Support System – Integrated Information (WDSS-II; Lakshmanan et al. 2007) has the capability to generate 3D radar data grids on the CONUS scale at a resolution of approximately 1 km (0.5 km, or better for some products) both horizontally and vertically and 1 to 5 minutes temporally in real-time (Lakshmanan et al. 2006). Such a system is co-located at the National Severe Storms Laboratory and Storm Prediction Center, with experimental products shared on the web site http://wdssii.nssl.noaa.gov (Smith and Lakshmanan 2006). When these high-resolution data are coupled with geographic information, it becomes possible to make a detailed assessment of when and where storm damage occurred at a much finer scale than *Storm Data* provides.

The Severe HAil Verification Experiment (SHAVE) was designed to take advantage of this ability to blend high-resolution radar data with geographic information. The primary objective of the experiment was to collect high temporal and spatial resolution data that describe the distribution of hail sizes in hail swaths produced by severe thunderstorms. These data enable several goals, including:

• to utilize the high-resolution verification data in the development of techniques for probabilistic warnings of severe thunderstorms,
• to evaluate the performance of a multi-sensor, multi-radar hail detection algorithm,
• to correlate changes in the hail size distribution with storm evolution, and
• to enhance climatological information about hail in the United States.

The high spatial and temporal resolution of the dataset collected during the project facilitates the development of decision-making tools that improve forecasts and warnings of severe hail as well as improving the historical record of hail events. In 2006, the project began on May 15, 2006 and continued through August 12, 2006. It utilized the real-time hail swath products from the CONUS WDSSII system to enhance data collection via verification telephone calls to select data points along a storm's path immediately following storm passage. Because the presence of hail is diagnosed via radar on the CONUS scale, it is possible to collect data from anywhere in the contiguous 48 states on a daily basis throughout the summer, which minimizes project "down days." Data were collected by a team of University of Oklahoma meteorology students working closely with scientists from the National Severe Storms Laboratory / University of Oklahoma Cooperative Institute for Mesoscale Meteorological Studies.

II. OPERATIONS AND STATISTICS

SHAVE operations started early in the day with the Operations Coordinator (OC; project day-to-day lead) would check the day's forecast. If the forecast looked favorable to thunderstorms with hail, a message would be sent to the students informing them of the start of the day's operations. Once storms formed, the OC would evaluate and then determine from which storms the SHAVE team would try to gather verification information. Using a mix of rural directories, reverse phone look-ups and searches using Google Earth (http://earth.google.com) and it associated data layers for local businesses (with include addresses and phone numbers), the SHAVE team would try to call as many points in the "hail swath" (Figure 1) as possible (the "hail swath" is the temporal maximum of radar indicated hail size). The reason was two-fold: 1) most points were either not available (i.e., busy phone or invalid phone number) and 2) if two or points were close together (usually within 1 km) then the reported hail sizes could be compared to help determine the quality of the reports. Operations typically began between 1100 and 1300 Local Time (LT) and ended around 2100 LT. SHAVE operated 83 days over the summer of 2006. The call success rate was near 40%. A summary of calling statistics in found in Table 1.

III. CONCLUSIONS AND REMARKS

More detailed discussion of SHAVE, enhanced verification and results can be found in Smith et al. (2006, 2007) and Ortega et al. (2006). SHAVE is continuing during the summer of 2007 with expansion to the verification of severe wind and tornadoes. This verification effort is being primarily focused in central Oklahoma, USA, near the Phased Array Radar in Norman, Oklahoma, USA.

SHAVE has provided a successful proof-of-concept for enhanced warning verification, warning guidance application validation, and severe storm climatology studies. Data are collected on the storm scale without regard to county boundaries or whether or not the storm is warned by the NWS.

Since Google Earth has worldwide coverage, where there are data layers with sufficient coverage (e.g., businesses with phone numbers, see Figure 3), the SHAVE method of verification is very amenable to locations where verification has been considered more challenging, as in Europe. His style of verification might be undertaken in Australia in the near future (H. Richter, personal communication).

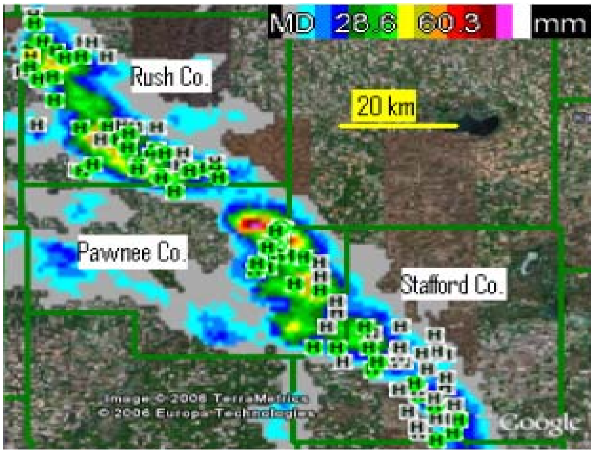

Figure 1: Hail swath with SHAVE reports overlaid

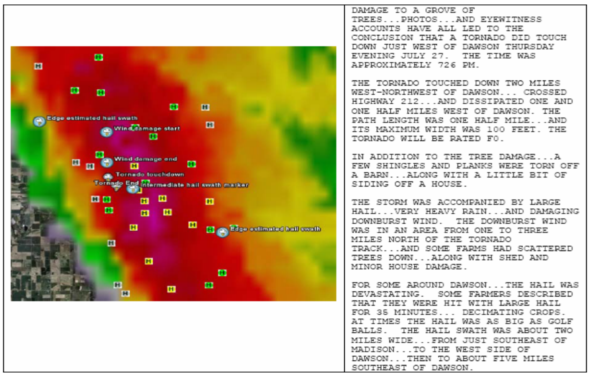

Figure 2: Low level reflectivity swath with SHAVE reports ("H" icons) and NWS reports (cloud icons and text on right)

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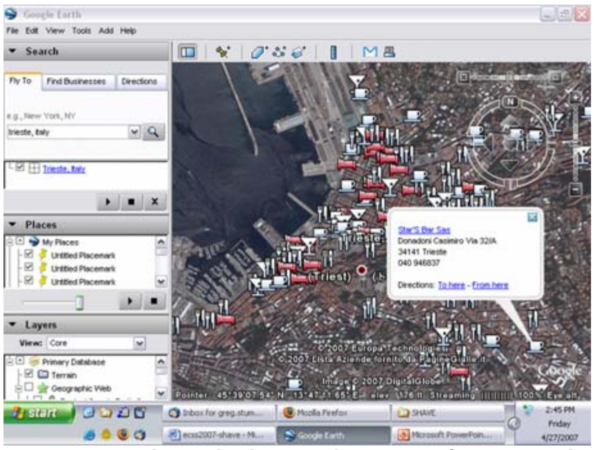
Figure 3: Google Earth showing the center of Trieste, Italy, locations of dining and lodging businesses, and the address and phone number of one business.

Data collection days	**83**
Total phone calls	**13854**
"Good" data points	4880
"Good" except time	658
Hail w/ questionable location	42
Hail w/ questionable size	371
Busy / intercept operator	777
Wrong location	47
No answer or machine	5485
Disconnected / Do Not Call	1286
Other	307

Table 1: SHAVE calling statistics

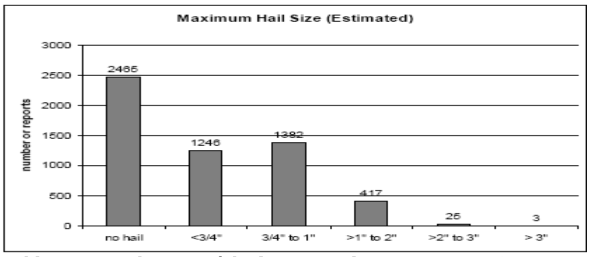

Table 2: Distribution of hail reports during SHAVE (size is in inches; 1" = 25.4 mm)

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