11B.3 AN ANALYSIS OF SEVERE HAIL SWATHS IN THE SOUTHERN PLAINS OF THE UNITED STATES

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1. Introduction

Severe hail is a common event in the Southern Plains of the United States. Given the coverage of WSR-88D radars over the Southern Plains and recent technological advancements, including hail detection algorithms, a climatology of severe hail swaths is currently being developed. Data from 15 radar sites across 8 states will be analyzed for the period spanning 1999-2003. Sample data from five cases, along with an explanation of the analysis process, will be presented.

2. Cases

To compile a list of candidate hail days, Storm Data hail reports for Oklahoma, Texas, New Mexico, Colorado, Kansas, Missouri, Arkansas, and Louisiana were gathered for the study period. Each candidate hail day had at least one severe hail report (.75 inches or greater) to be used in the study. For the sample cases, at least one significant hail report (hail of at least 2 inches) occurred. WSR-88D base and composite reflectivity data were obtained from all radars within the domain for the duration of each event. Using the WSR-88D reflectivity data and the Hailswath algorithm developed at Weather Decision Technologies, Inc., hail swaths were plotted across the region for each candidate hail day: 5-6 April 2003, 20-21 April 2003, 9-10 May 2003, 10-11 May 2003, and 28-29 June 2003. In this study, 5-6 April 2003 will be used for the figures shown.

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3. Hailswath Algorithm Analysis of Raw Data

For each case the WSR-88D composite reflectivity is processed by the Hailswath algorithm. The output is a footprint of where severe hail is likely occurring for each volume scan according to the Hail Detection Algorithm (HDA). This process is repeated for each volume scan, and the footprints are combined, resulting in a continuous swath of where severe hail is likely occurring. This swath is then output as a shapefile, and can be viewed and analyzed in its raw form (Fig. 1). This procedure is then repeated for the same radar to create footprints and swaths where the HDA detects significant severe hail (Fig. 2). The footprints can then be overlaid into a single image (Fig. 3) which shows where the most significant hail occurred. Additionally, the image can include each positive detection from the HDA for each individual volume scan (Fig. 4). In the example, it is shown that multiple storm cells were detected to have severe hail across the same path in North-central Texas. A method to verify the accuracy of this detection method is to also plot the location of all National Weather Service Local Storm Reports (NWS LSRs) for hail for the study date, shown in Figure 5 (note that only the significant hail swath is plotted in Figure 5).

4. Human Analysis of Hailswath Output

The output from Hailswath requires manual smoothing to remove the unrealistic jagged edge along the swaths in each footprint. Faster storm motions cause the raw swaths to have a more jagged appearance due to a greater distance between storm locations between successive volume scans. This produces footprints which are farther apart. Other factors, such as missing or incomplete volume scans and beam blockage, can cause small gaps in the raw swaths which require manual smoothing.

ArcView software easily allows shapefiles to be viewed and edited, and in this case smoothed. Simply tracing the main hail swath, and manually correcting for the jagged edges, while viewing base reflectivity as verification, allows for a smoothed hail swath to be created (Fig. 6). In addition, NWS LSRs can be overlaid in this image (Fig. 7). As such, any inconsistencies can be investigated. The end result is a set of coherent and concise swaths which represents all locations at which severe hail likely occurred for a given date.

From this complete set of swaths the spatial and temporal characteristics of the individual hail swaths are analyzed to determine their length, width, and total area.

5. Future Goal and Research

Currently a five-year climatology from 1999 through 2003 is being created. This will allow for much greater spatial and temporal analysis of hail occurrences across the study area. Additionally, seasonal and annual variability can be determined. Finally, the geographic location, as well as the seasonal and inter-annual variability, will be examined.

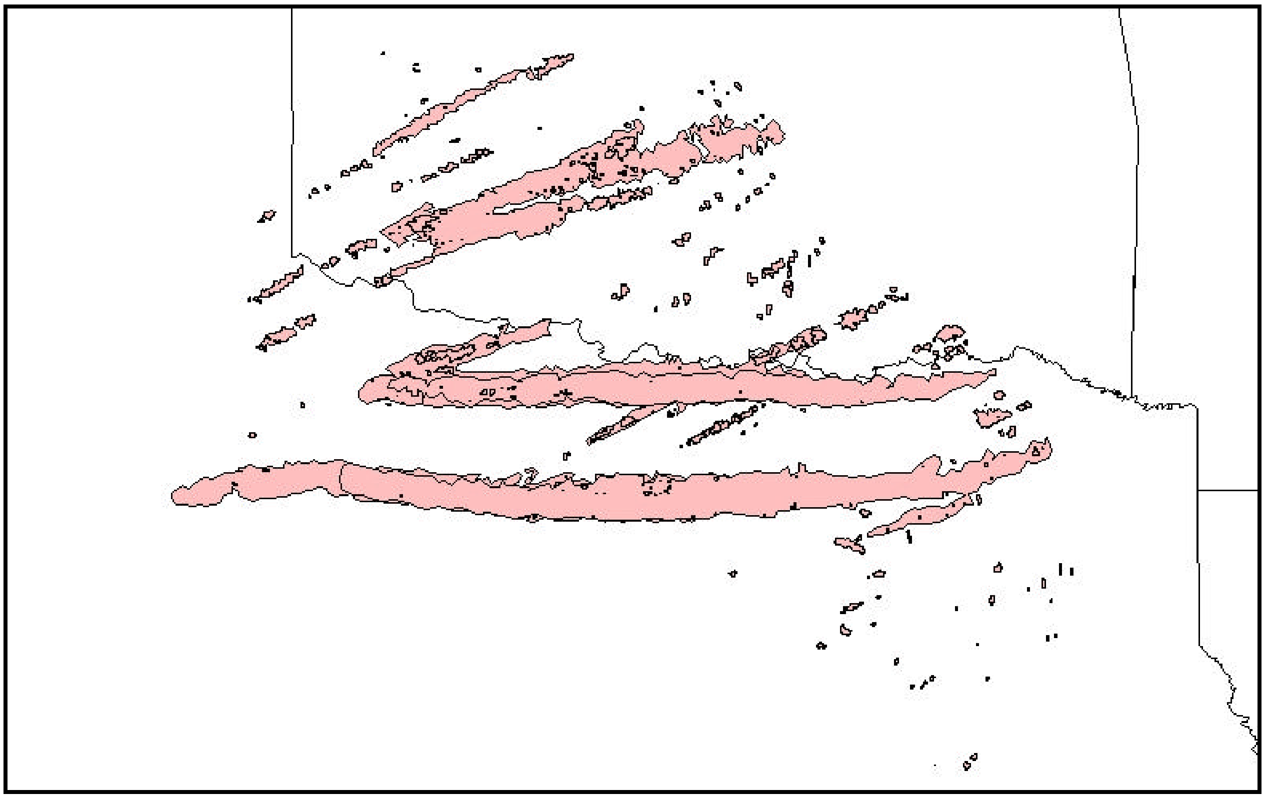

Figure 1. Hailswath raw output for severe hail on 5-6 April 2003 from KFWS and KFDR WSR-88D radars.

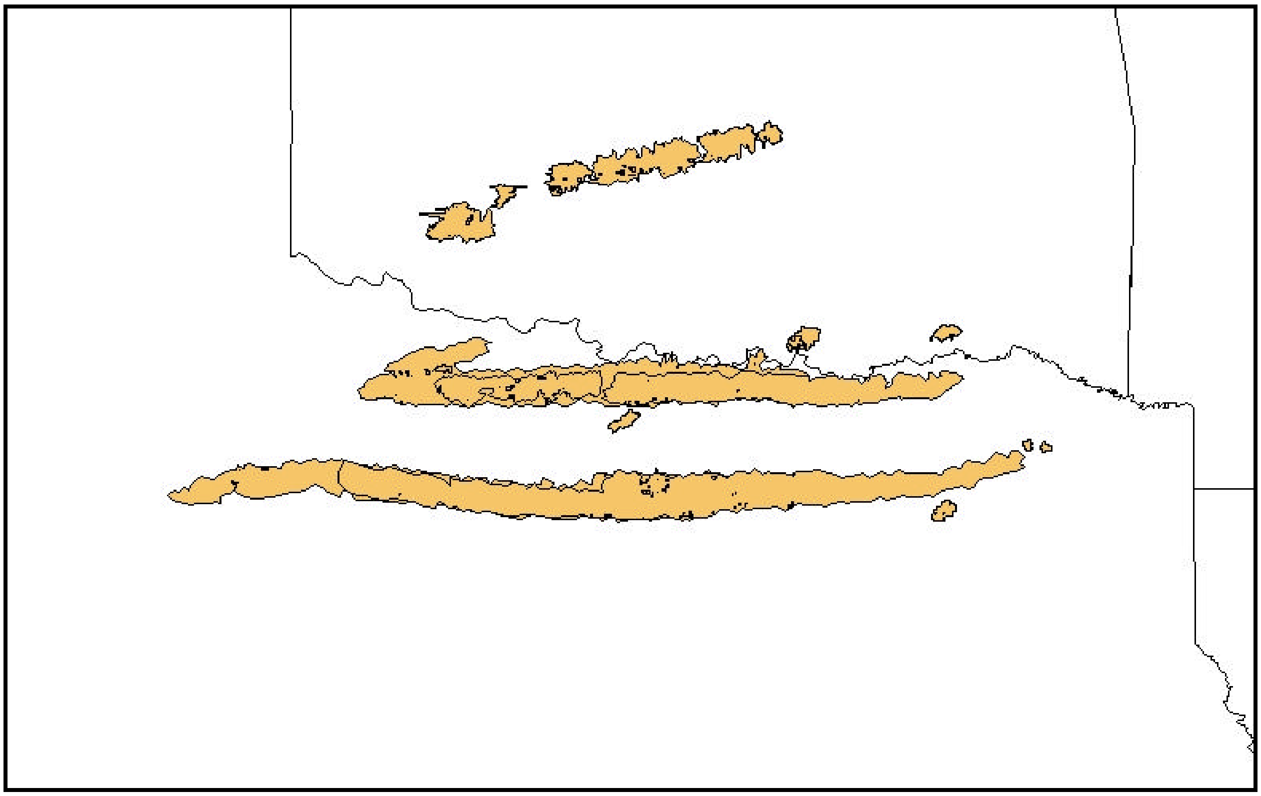

Figure 2. Hailswath raw output for significant severe hail (greater than 2.5 inches in diameter) on 5-6 April 2003 from KFWS and KFDR WSR-88D radars.

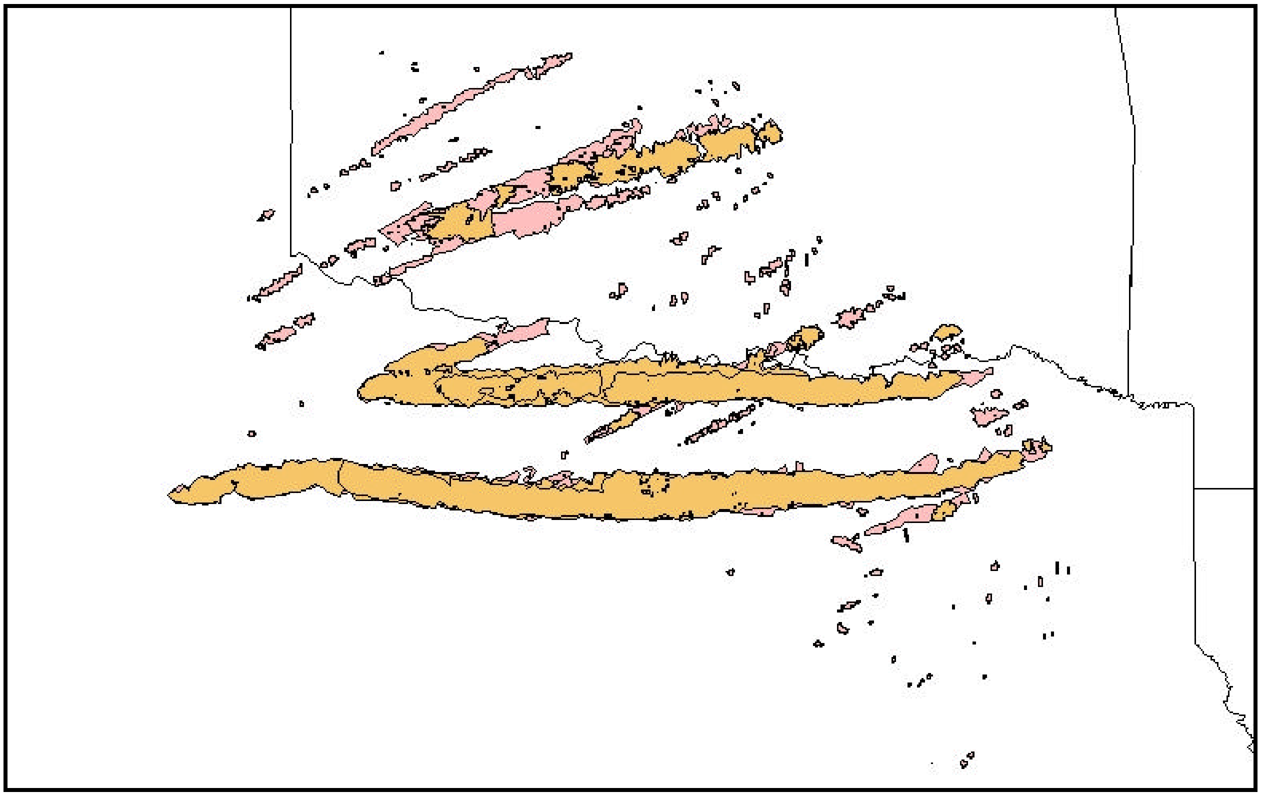

Figure 3. Hailswath raw output for both severe hail (pink) and significant severe hail (orange) on 5-6 April 2003 from KFWS and KFDR WSR-88D radars.

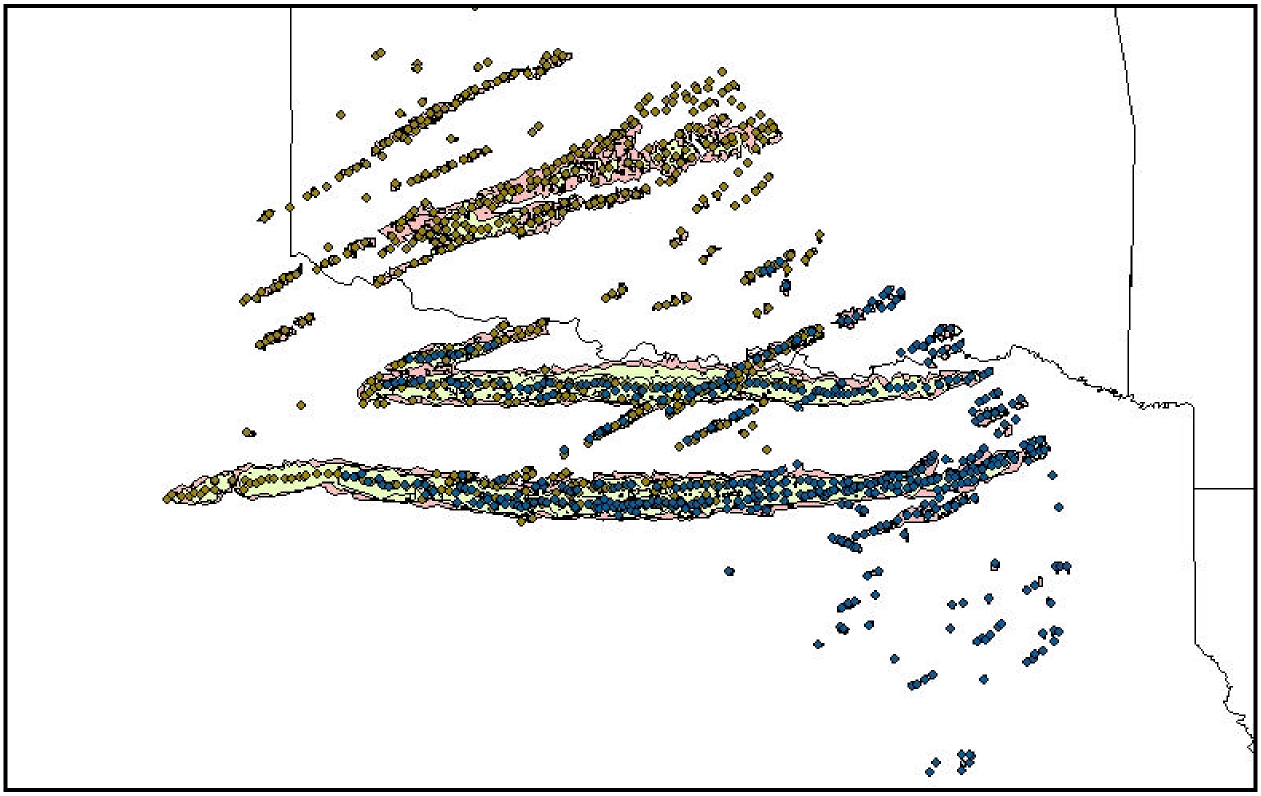

Figure 4. Hailswath raw output for both severe hail (pink) and significant severe hail (light green) on 5-6 April 2003 from KFWS and KFDR WSR-88D radars with attributes from the HDA overlayed. Each circle represents a positive severe hail identification by the HDA, which expects severe hail within 20 minutes. Blue circles are from KFWS and brown circles are from KFDR.

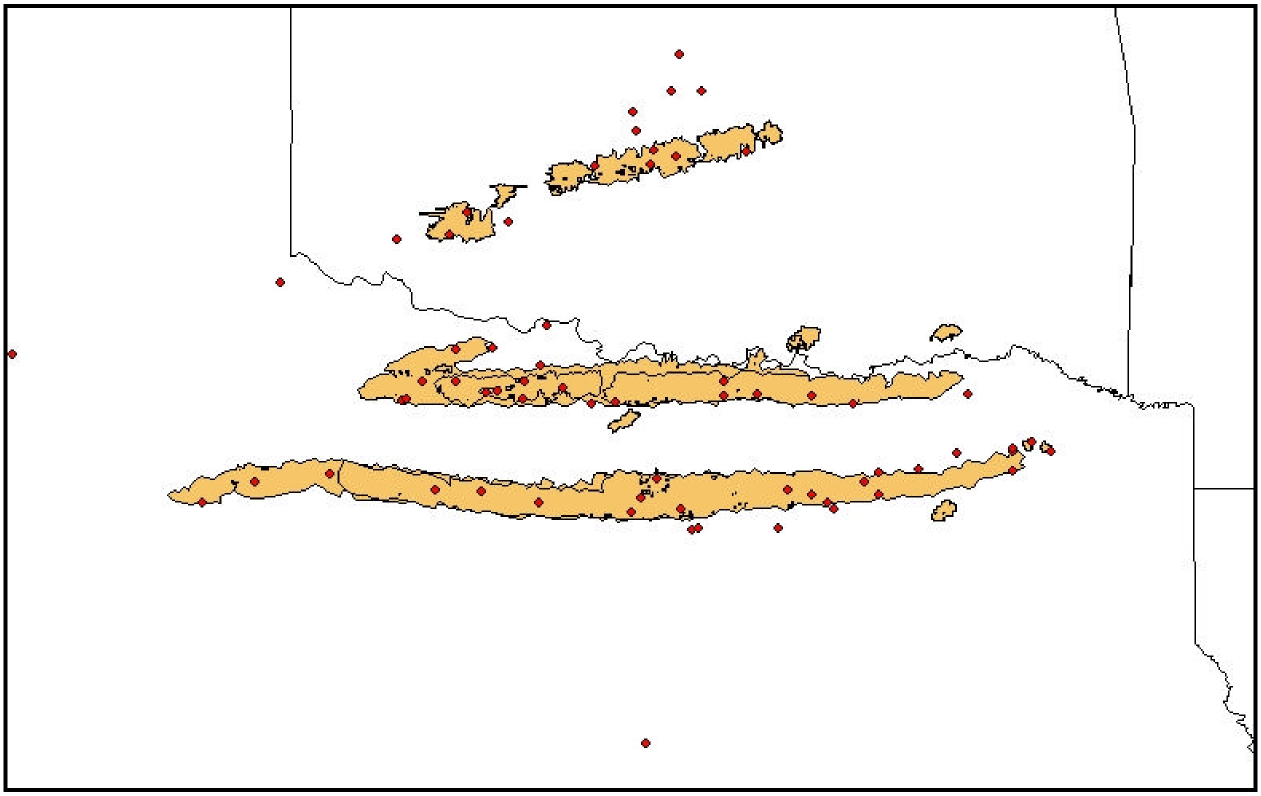

Figure 5. Hailswath raw output for significant severe hail on 5-6 April 2003 from KFWS and KFDR WSR-88D radars with NWS LSRs of hail marked with red circles. Some of the hail reports lay outside of the swath because significant hail is expected inside the contours. This means there is likely lower end severe hail (from .75 to 2.5 inches in diameter) outside of the swath (as shown in the figure 3 comparison). There also could be errors due to incorrect LSR report locations, dates, or times, or radar problems, which caused swaths to not be created in every proper location.

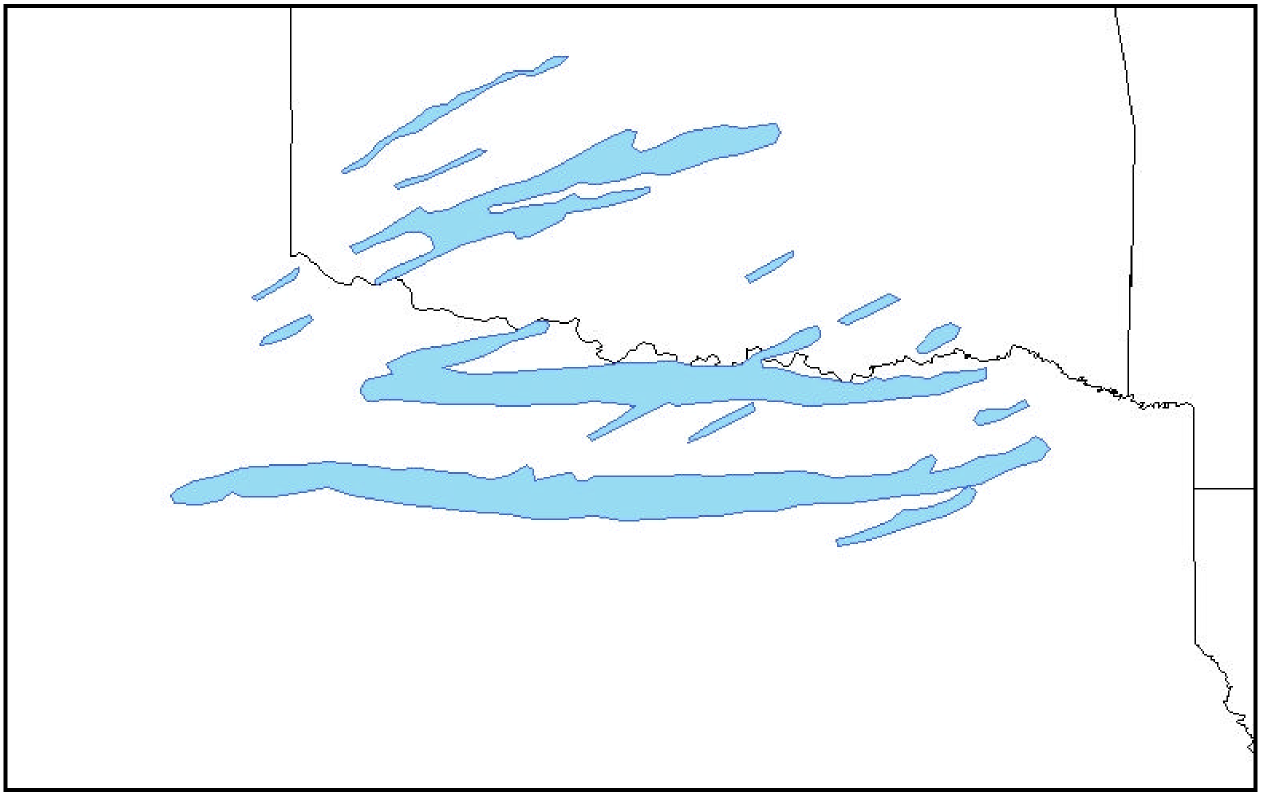

Figure 6. Manually smoothed contours of Hailswath output for severe hail on 5-6 April 2003 from KFWS and KFDR WSR-88D radars.

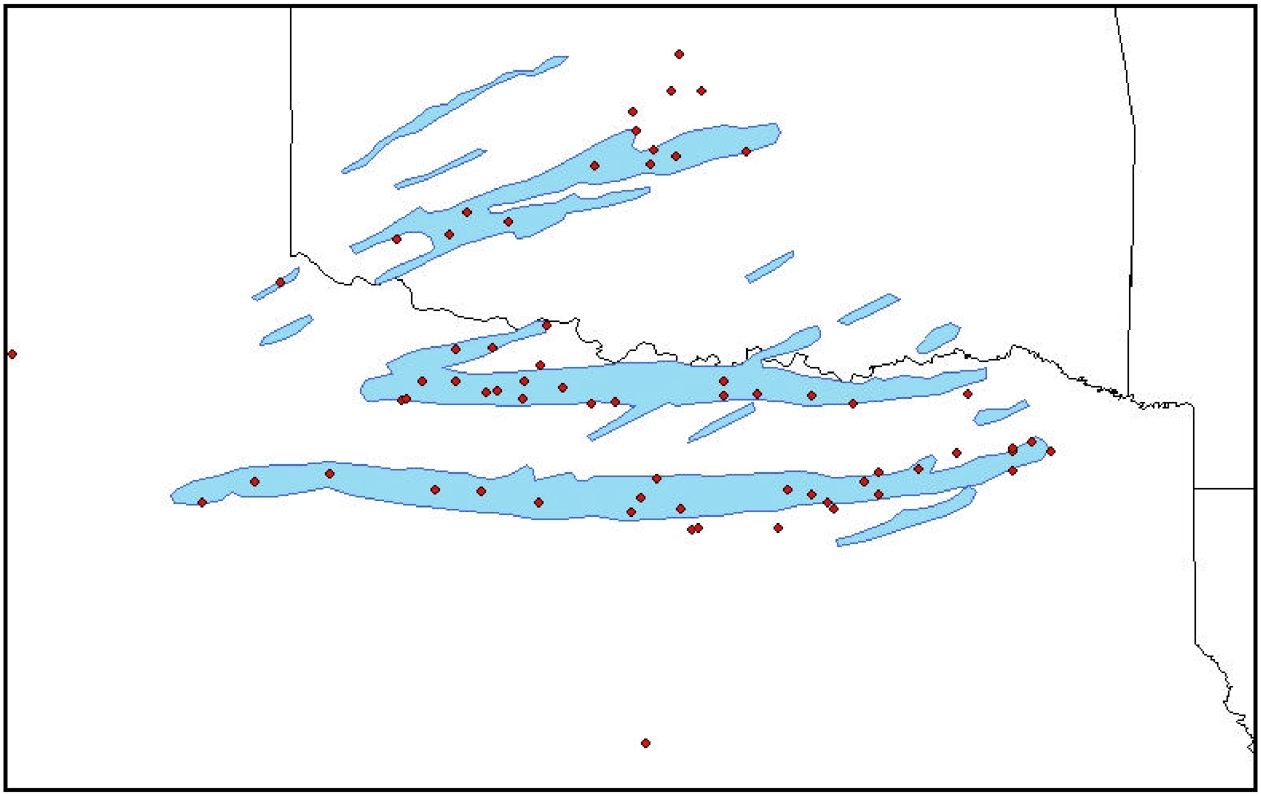

Figure 7. Manually smoothed contours of Hailswath output for severe hail on 5-6 April 2003 from KFWS and KFDR WSR-88D radars with NWS LSRs of hail marked with red circles. See Figure 5 for potential sources of error.