Insurance Institute for Business & Home Safety

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The following summary outlines data and methodology used to create the latest editions of IBHS hail storm and tornado frequency maps. These maps, created by Insurance Institute for Business & Home Safety (IBHS) Staff Statistician Hank Pogorzelski in conjunction with IBHS engineers, were produced using data from the Severe Weather Database files maintained by the NOAA Storm Prediction Center in Norman, Okla.

Hail Analysis

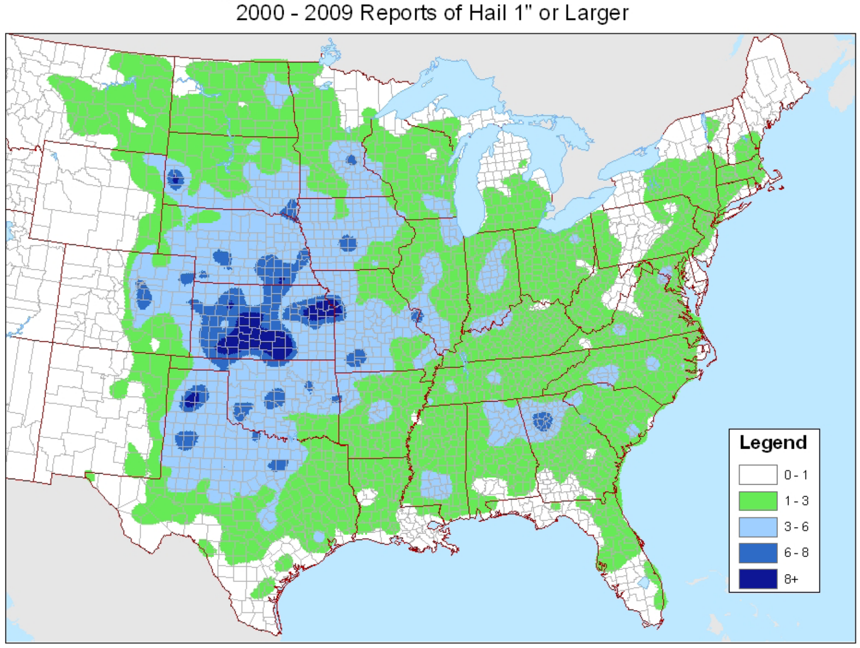
The Severe Weather Database files include hail reports from 1955 through 2009, although as explained in the summary, not all years were used. Individual reports contain a number of fields related to hail events, but the most relevant fields for this spatial analysis are date, time, location (represented by paired latitude/longitude coordinates), and the maximum size hail stone observed.

A close inspection of the data suggests it is reasonable to limit analysis to more recent years. Reasons for this include the fact that the total number of hail reports in the database have increased dramatically over time. Also, analyses by NOAA staff suggest areas with the most frequent hail events in Texas, Nebraska and Oklahoma have tended to shift slightly northward during the last 10 years to 20 years. During the first decade, the average number of annual reports of hail stones measuring one inch or greater was 450, as compared to 6,560 annually in the most recent 10 years of data. Part of the increase in hail reports can be explained by population growth (i.e., more observers to report hail) in regions that previously were sparsely populated. Other important factors are the improvement of technology used to help identify weather patterns likely to produce hail and the algorithms applied to radar data to detect hail, both of which have resulted in more hail reports. These factors have resulted in fewer unreported events. Consequently, IBHS analysis was limited to reports of hail with a maximum reported size of one inch or greater for the reporting years 2000 to 2009.

Hail Activity in the United States

Average Number of Hail Reports per 100 Square Miles

2000 - 2009 Reports of Hail 1" or Larger



Another modern development, which may be contributing to an increased reporting of hail events, is the inclusion of observations and reports from the public. The database often includes multiple reports that are very close to each other with respect to both time and place. For example, one record included 15 reports with identical latitude and longitude coordinates occurring on the same day, submitted only 15 minutes apart. These clearly represented one event and should be included in the analysis as a single report in order to prevent over-reporting. In other cases, multiple reports exist with time and location fields that are very similar but not identical. There is no other information available in the database that would make it possible to determine whether such reports represent the same or separate events.

To address the potential problem of over-counting events in a consistent way, the number of reports included in the IBHS frequency analysis were limited as follows: only one report was included in the spatial analysis if the record included multiple reports that were submitted within the same date and time (within a half hour of each other) and that included the same latitude and longitude coordinates (once rounded to the nearest two- tenths of a degree[1]). The single report used to represent the group of reports with similar or identical time and place fields uses the average of the unrounded latitude and longitude coordinates to determine its precise location for the frequency analysis. This reduced the number of reports of one inch or greater hail between 2000 and 2009 from 65,587 to 53,028.

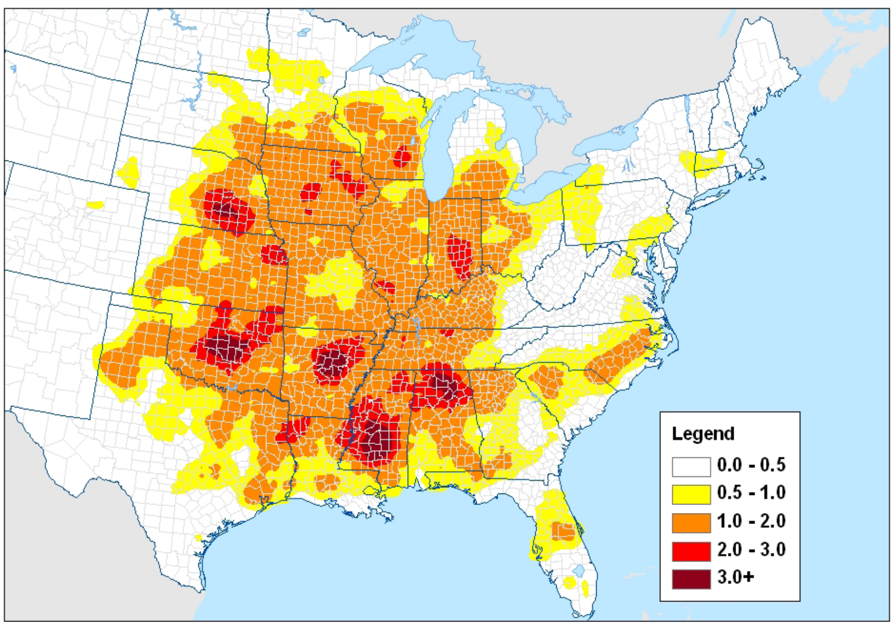
The coordinates of these 53,028 hail reports were then used to plot events on a map using ArcGIS mapping software. A 10 mile by 10 mile grid was then overlaid onto the map, and the number of hail reports within each grid cell was counted. The result was a frequency map, pixilated (at 10 mile by 10 mile intervals), with each cell representing the exact number of reports located within the cell. It also resulted in neighboring cells, which often have very different counts simply by chance, with no real significant difference in the likelihood of being affected by a hail storm. An average was used, instead of using the precise hail count for each grid cell to determine frequency. For each cell, the average of its hail count and the counts of the surrounding five by five grid of cells was calculated. The values of these averages fluctuate much less from one cell to its neighboring cells when compared to the original hail counts used to calculate averages. Next, a smaller one mile by one mile grid was created, and the average values of the 10 mile by 10 mile grid cells calculated in the prior step were used to interpolate the values for the set of smaller grid cells. The result of these steps is a map characterized by smooth transitions between areas of high frequency and low frequency.

Frequency values presented in the hail map include reports per 100 square miles, in keeping with the original counts within 10 mile by 10 mile grid cells. Values represent an average of the surrounding 50 mile by 50 mile area, as a result of step-averaging the grid cell values.

When comparing these maps with hail maps created using software developed by Haag Engineering, which are available on the IBHS website, a few things should be kept in mind. First, the Haag maps represent an average frequency over a 20-year period using data from the mid-1950s through the late 1990s. The current map represents a frequency for the 10-year time period from 2000 through 2009. In general, the Haag numbers might be expected to be twice those in the new map; however, as noted above, recent reporting years contain far more reports than the early years of hail reporting, including those used in the Haag analysis. This may help explain why some areas in the current map may have frequencies equal to or exceeding values presented in the Haag map, even though the Haag map includes hail measuring 0.75 inch to 0.99 inch, which are not included in the current map. Despite these factors, it should not be assumed that this indicates an increase in overall hail frequency over time. The increase in hail reports may simply reflect more comprehensive reporting.

Tornado Activity in the United States

Average Number of Tornado Reports per 100 Square Miles
Reporting Years 1957-2006, F2 and Stronger



Tornado Analysis

Storm reports from the Severe Weather Database files also were used in the spatial analysis of tornado activity in the contiguous United States. At the time this project began, the Severe Weather Database files included tornado reports from 1950 through 2006. Among the data fields included in these reports are touchdown and liftoff coordinates, which were used to plot the storm path and the F-scale (indicating storm intensity) used to impose strength criteria on the storms included in this analysis.

Unlike hail reporting, the number of reported F2 or stronger tornadoes does not show a long-run trend of increasing reports per year over time. This suggests a more consistent documentation of tornadoes. Reports of tornadoes also are far less numerous than hail reports. In order to maintain a large sample of tornadoes in the data set, this analysis includes all 5,884 reports of F2 or stronger tornadoes in the 50-year reporting period between 1957 and 2006.

The spatial analysis of tornado reports is very similar to that of hail reports. A grid is used to count tornado occurrences and similar techniques are used to smooth the transition from areas of high and low report frequencies. The main difference in the two analyses relates to the way tornadoes and hail events are represented spatially in the storm reports. Whereas a hail event may be represented by multiple reports along a hail swath, tornadoes are represented in a single report by a discrete path length that is determined by the touchdown and liftoff coordinates. Therefore, the tornado analysis does not require a protocol for handling multiple reports with similar time and place properties. Each tornado is counted once within each of the grid cells its path falls within.

Once the tornado paths are overlaid on the map and report frequencies are determined for each 10 by 10 mile grid cell, the steps are the same as those in the hail analysis. Each cell count is averaged with its neighboring cells. Due to the relative infrequency of tornadoes, a larger seven cell by seven cell area is then used to calculate average cell frequencies and balance the large differences in frequency from cell to cell, which can result from the random nature of touchdown and liftoff locations. As with the hail analysis, the map is overlaid with a grid of smaller one mile by one mile cells, and an interpolation technique, which used the average values of the 10 by 10 mile cells calculated in the prior step, is employed to estimate the values of the one mile by one mile cells. Frequency values represented in the tornado map remain in 100 square mile units, per 50 years reflecting the 50 years of activity included in the data.