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Predicting Severe Hail Events in South Florida

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Abstract

Various weather radar-based severe weather parameters have been developed with the intent of assisting National Weather Service meteorologists in their decision making regarding whether a particular storm will produce severe hail. Although less common in the subtropical climate of South Florida than in higher latitudes, severe thunderstorms do pose a significant threat to life and property. A noteworthy study initiated for the Southern High Plains by Porter et al. sought to develop a linear correlation between the elevation of storm reflectivity cores, height of the freezing level, and reports of severe criterion hail. This method proved a successful aide for use in NWS operations and was subsequently studied and implemented operationally in the Northern High Plains by Donovan and Jungbluth and Mid-Atlantic region by Kramar and Waters. The latter study was able to provide a distinct relationship between the aforementioned factors despite having a typically different local storm environment than the previous two. This presentation will include the results of a study to determine whether a technique used to predict severe hail at higher latitudes can be applied in South Florida. It also identifies temporal and seasonal tendencies of severe-hail producing thunderstorms.

After gathering a dataset of 1 inch diameter hail reports, rawinsonde observations representative of the near-storm environment of 54 storms producing hail one inch or greater in diameter (the criterion used by the NWS) were analyzed and the heights of the freezing level were cataloged. More than 70% of the events occurred between 1:00 and 5:00 pm local time and nearly 80% occurred between the months of May and July. Archived WSR-88D radar data from Key West, Miami, Melbourne, and Tampa were used, as appropriate, to determine the height above sea-level of the highest 50 dBZ reflectivity in each storm core. The height of the 50 dBZ reflectivity was strongly correlated with reports of severe hail, indicating it does have predictive value in the subtropics.

Given this result a procedure was developed on the Advanced Weather Information System (AWIPS) used by the forecasters at the NWS Miami Weather Forecast Office to display the 10th and 50th percentile heights of the 50 dBZ cores of the storms used in this study. The Local Analysis and Prediction System is used to indicate the observed freezing level height. This information, in conjunction with the radar display, allows the Miami forecasters to compare the observed 50 dBZ height with the percentiles derived from our study. If the height of the observed 50 dBZ core exceeds that of the 50th percentile of the storms in the study there is a good chance the storm will produce severe hail on the surface within about 10 to 15 minutes.

Methodology

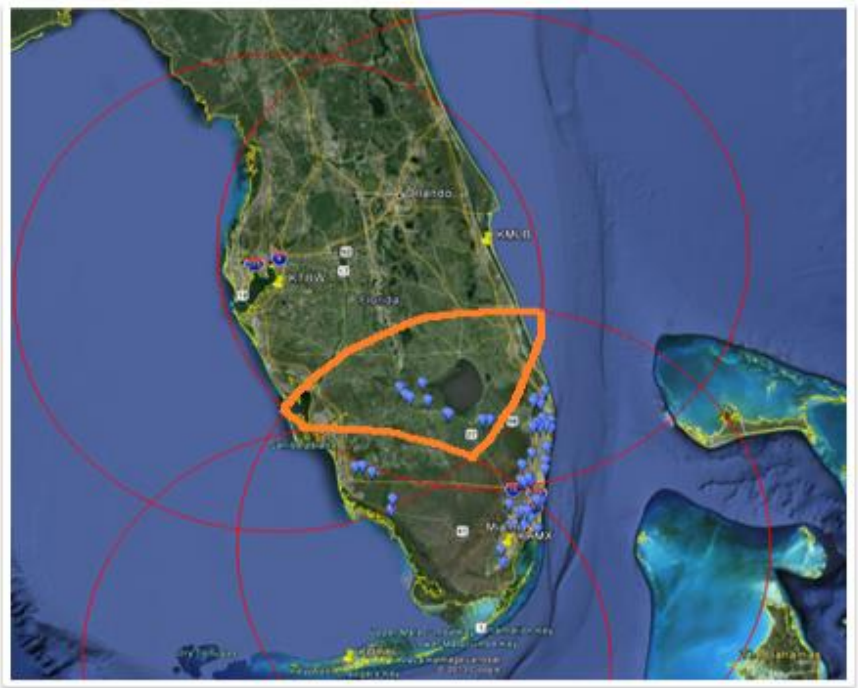
Using the NWS-established criterion of 1 inch or greater, hail reports were downloaded from the National Climatic Data Center (NCDC). A database of these reports from January 2000 to December 2012 was established.

Level 3 Doppler radar data from KBYX-Key West, KAMX-Miami, KMLB-Melbourne, and KTBW-Tampa (depending on the availability) were collected from the NCDC HAS Radar Archive and used to estimate the height of the highest 50 DBz cores in thunderstorms using the GR2Analyst[4] software.
Upper air sounding data from Tampa, Key West, and Miami were collected from the University of Wyoming's website[5] and used to estimate the freezing level for each report.

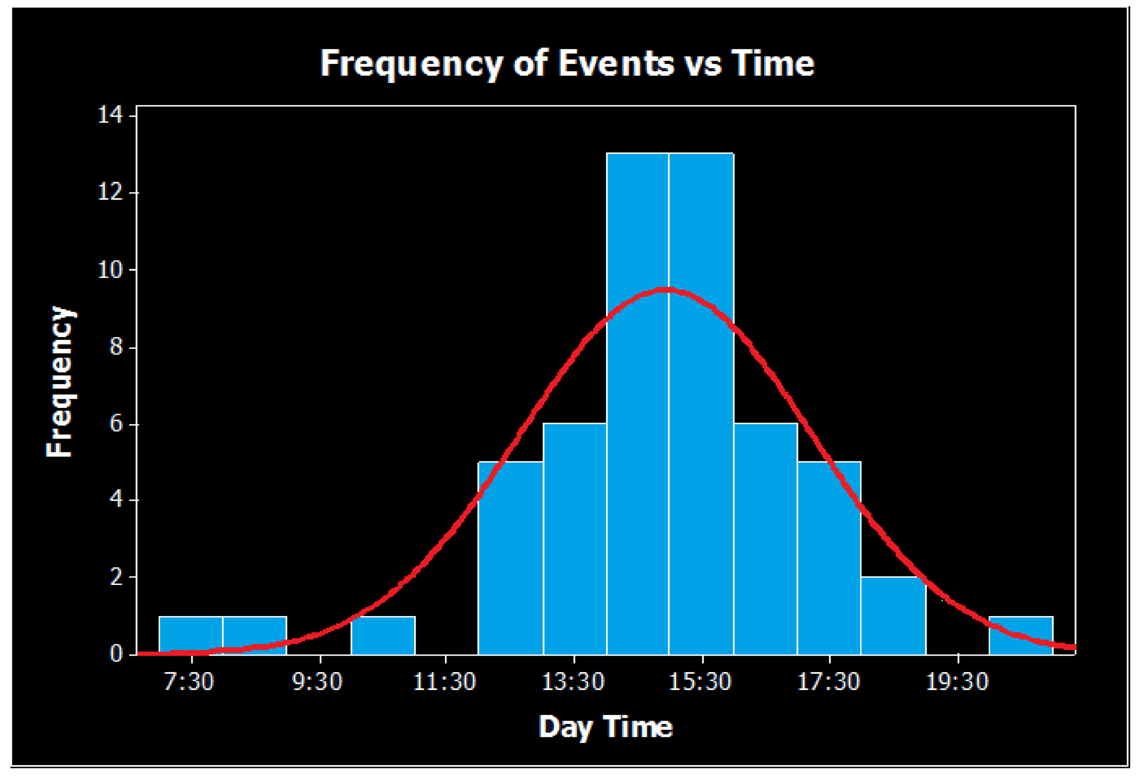
Qualifying reports were defined as those with sustained 50DBz cores for at least two consecutive volume scans (~10 minutes) prior the report time. This is consistent with results of Changnon[6], which suggested a full-grown hailstone may take on the order of 10 minutes to fall out from the storm updraft and reach the surface.

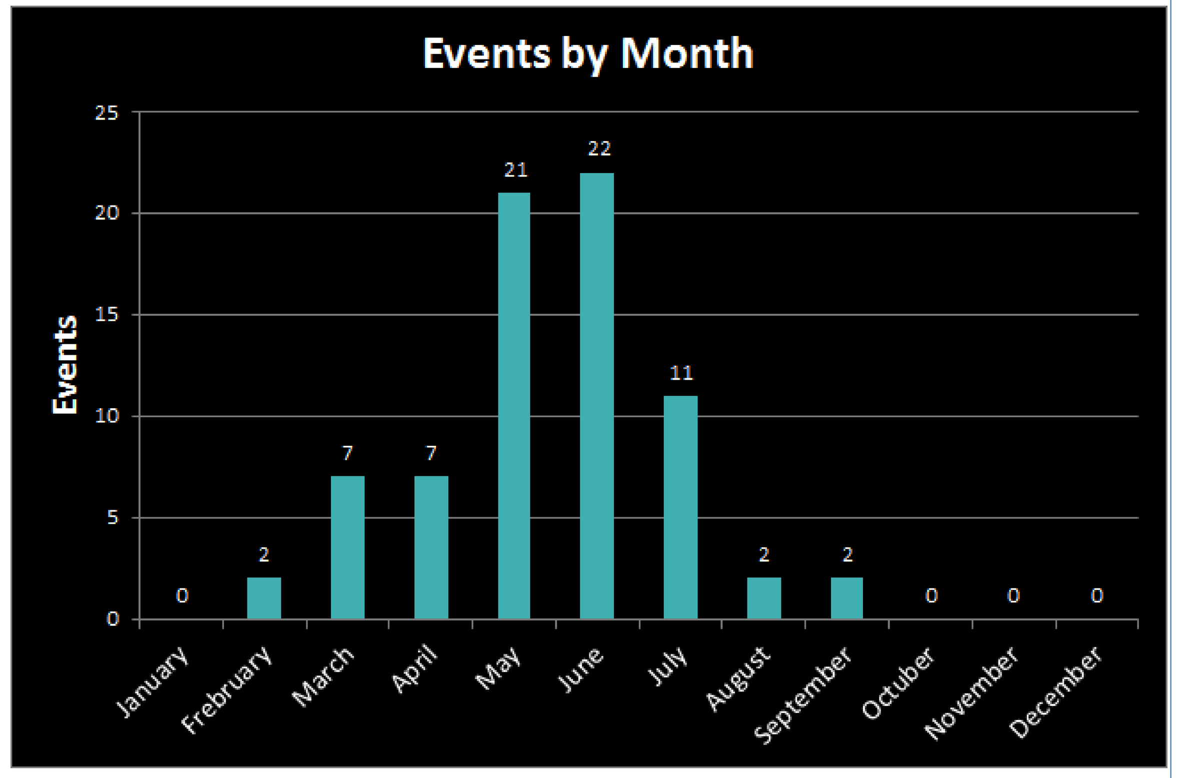
In total, 143 reports were documented. Quality control steps were performed on the reports, and some were discarded. The following criteria were used to discard the reports: (1) radar data was not available or adequate sampling of the 50DBz cores was not possible; (2) inaccuracies in timing and location could not be explained; (3) storm structure analysis did not support the expected hail size; (4) multiple reports of hail size were found for a particular date, so only the 1 inch hail event was used.

Radars Used

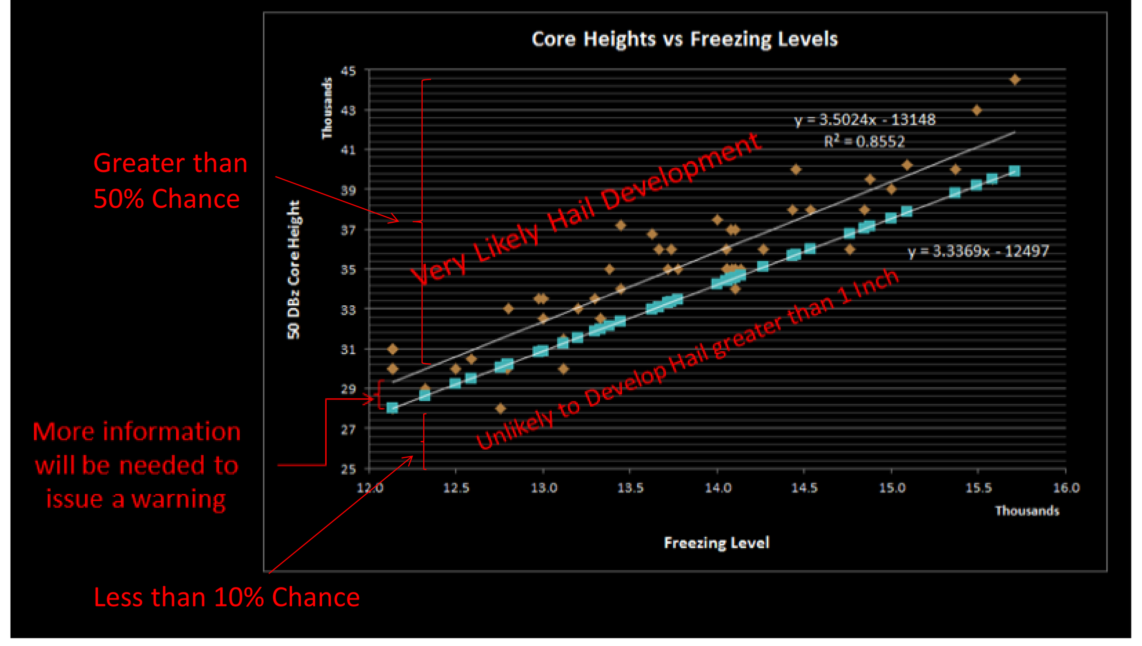


Results





One to 1.75 Inch Hail with 10%



Conclusions

- It was possible to establish a linear relationship between the Freezing Level and the 50DBz Cores of Storms to predict hail with a correlation coefficient of .86 given the parameters.
- This relationship now allows us to predict severe hail in South Florida. It is intended to be used along with the other products as ZDR, ϕDP, VIL, LC, etc.
- It's highly recommended that forecasters document severe storm reports using precise lat/lon locations to ensure an accurate database

Operational Application

Given these results, a procedure was developed on the Advanced Weather Information System (AWIPS) used by the forecasters at the NWS Miami Weather Forecast Office to display the 10th and 50th percentile heights of the 50 dBZ cores of the storms used in this study. The Local Analysis and Prediction System is used to indicate the observed freezing level height.

This information, in conjunction with the radar display, allows the Miami forecasters to compare the observed 50 dBZ height with the percentiles derived from the study. If the height of the observed 50 dBZ core exceeds that of the 50th percentile of the storms in the study there, is a good chance the storm will produce severe hail on the surface within about 10 to 15 minutes.

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