USING ATMOSPHERIC FREEZING LEVEL TO PREDICT SEVERE HAIL IN WFO MIAMI'S COUNTY WARNING AREA

José Díaz[1], Stephen Konarik[2], and J.E. Estupiñán[2,*]

[1]*Department of Physics: Atmospheric Sciences and Meteorology, University of Puerto Rico, Mayagüez Campus*

[2]*Miami Weather Forecast Office, National Weather Service, NOAA, Miami, FL*

ABSTRACT

Several studies have been performed over the last few years concentrating on developing a correlation between the elevation of a storm reflectivity core and the height of the freezing level with regard to several hail reports. These locally applied studies have proven to be highly successful aides for use in National Weather Service operations. 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. Examples of the use of the procedure will be shown.

1.0 INTRODUCTION

Various weather radar-based severe weather parameters have been developed with the intent of assisting National Weather Service (NWS) 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 (2005) sought to develop a linear correlation between the elevation of the 50 DBZ cores, the 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

**Corresponding author address:* Jeral Estupiñán, Miami Weather Forecast Office, National Weather Service, 11691 SW 17th Street, Miami, FL 33165; e-mail: jeral.estupinan@noaa.gov

operationally in the Northern High Planes by Donovan and Jungbluth (2007) and Mid-Atlantic region by Kramar and Waters (2009). 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 study includes the results of 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.

2.0 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 software.

Upper air sounding data from Tampa, Key West, and Miami were collected from the University of Wyoming's website 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 (1970), 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.

4.0 ANALYSIS AND RESULTS

After performing the quality control steps described above, 54 reports (about 38% of the initial reports) were used in this study. From the 54 quality controlled reports, 42 of them were hail of 1 inch. Two groups were formed: One Inch Hail Reports which had a Linear Correlation Factor (LCF) of 0.8602 and One Inch or Greater Hail Reports which had an LCF of 0.8554.

The observed high LCF suggests that there is a strong linear correlation between the 50 DBz cores and the freezing levels in South Florida. Figures 1 & 2 show the linear regression fit for both groups. The red line in Figure 2 shows the 10% Quantile Linear Regression. The addition of the greater than 1 inch hail to the analysis increases the slope. This is expected because of the relationship between hail size and height.

Sixty DBz storm cores were analyzed in this study as well. However, it was not possible to relate them to the freezing level.

Figure 3 shows a seasonal tendency for the events with almost 80% of the reports during the months of May, June, and July. More than 70% of the reports were 1:00 to 5:00 pm local time which supports the hypothesis described above.

3.0 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.

5.0 References

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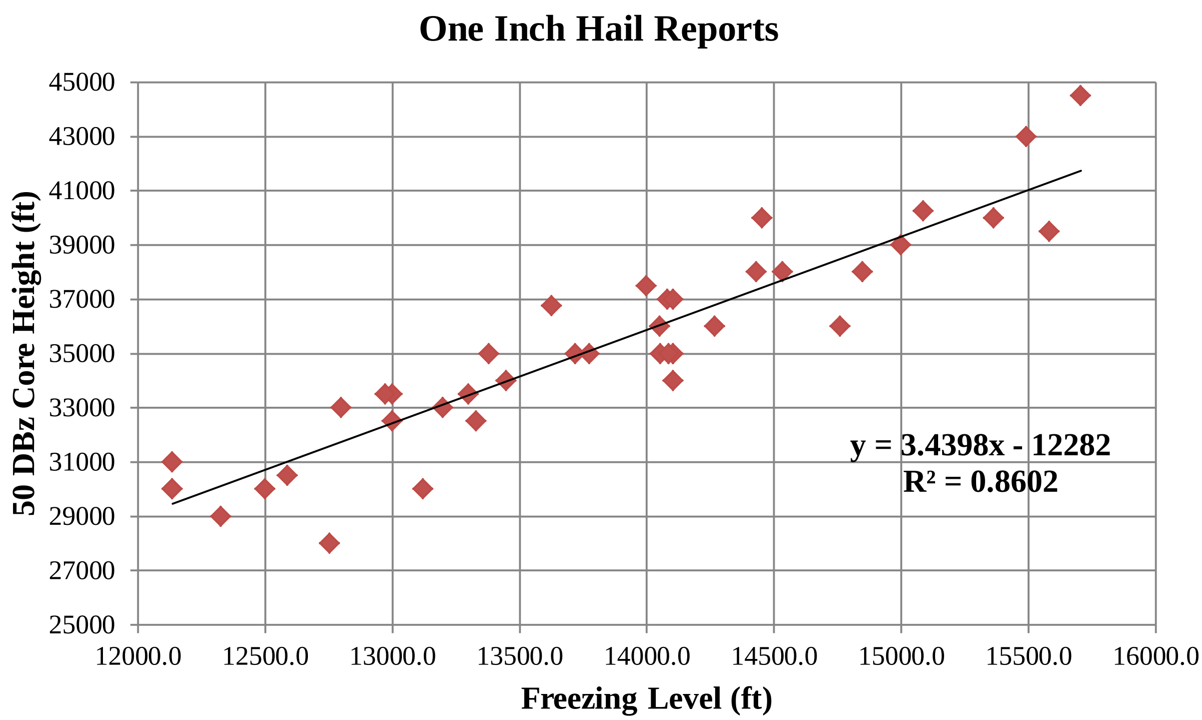

Figure 1: One Inch Hail Reports with Linear Regression Fit

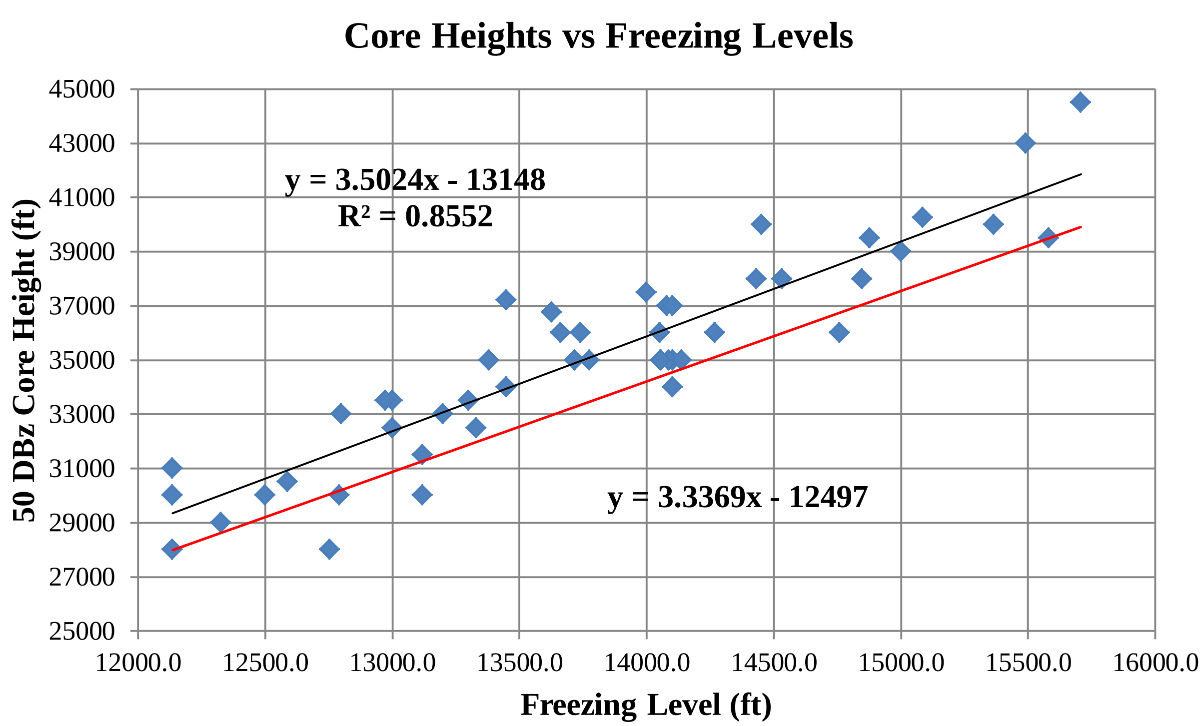

Figure 2: One Inch or Greater Hail Reports with Linear Regression Fit and the 10% Quantile Linear Regression (show in red)

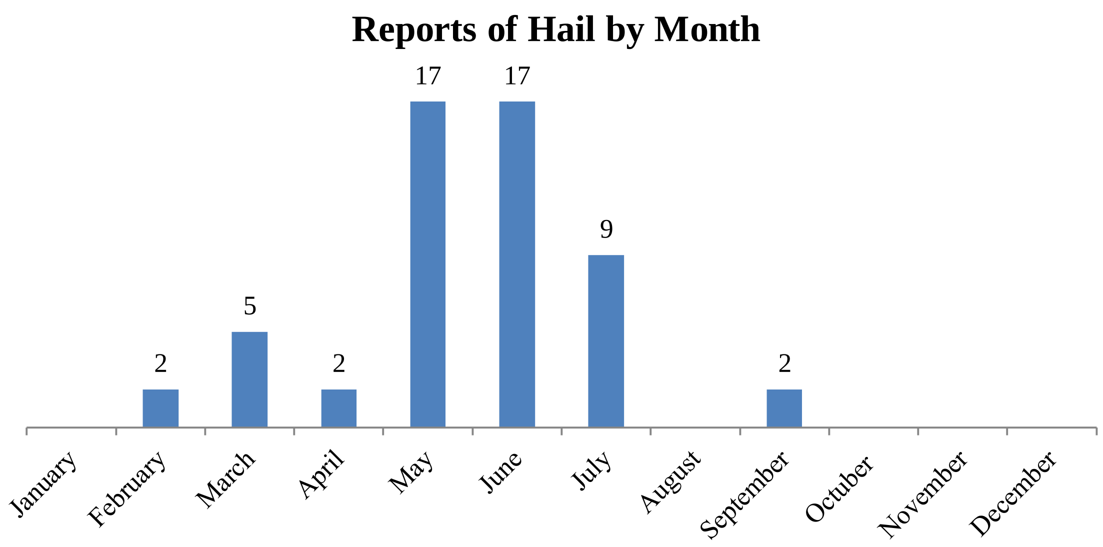

Figure 3: Seasonal Tendency by Month

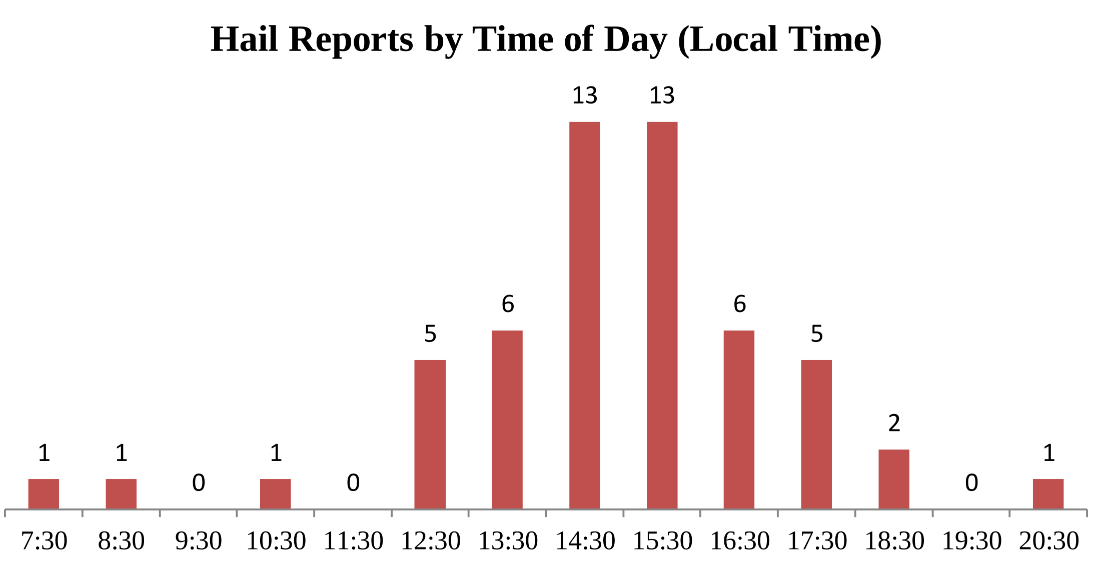

Figure 4: Seasonal Tendency by Time of Day (local time)