P3.21 The Distribution of Convective Precipitation in Tropical Cyclones after Landfall

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1. INTRODUCTION

The advent and subsequent upgrades of the National Lightning Detection Network (NLDN) have allowed for the study of the organization of convection in tropical cyclones as revealed by flash locations. Previous work by Corbosiero (2000) has shown that large azimuthal asymmetries in flash location in Atlantic basin tropical storms are related to vertical wind shear and storm motion. Over 80% of flashes in both the core and outer rainbands occurred downshear of the center, with core flashes having a downshear left and rainband flashes exhibiting a strong downshear right preference. Flashes were more frequent to the right of the track than the left, with core flashes favoring the right front and rainband flashes the right rear quadrants, respectively.

While the distribution of lightning in tropical cyclones is very clear, the distribution of total precipitation is less certain. Comparing these two distributions is the focus of this present work with an aim towards using the lightning data to help derive factors that determine the distribution of total rainfall in landfalling tropical cyclones.

2. DATA AND METHODOLOGY

Lightning data were obtained from archived observations of the NLDN, originally developed at the University at Albany, and currently operated and maintained by Global Atmospherics, Inc. The raw flash data of the NLDN contains the date, time, latitude, longitude, polarity, multiplicity and signal strength of the first stroke and is processed using programs provided by GAI. Full descriptions of the operation and equipment of the NLDN can be found in Orville et al. (1987) and Cummins et al. (1992, 1998).

Hourly precipitation data was obtained from the National Climatic Data Center (NCDC) TD3240 cooperative station data set. For each hour of study, the lightning and precipitation data were composited with respect to the interpolated center position. Only flashes and precipitation reports within 300 km of the center will be examined in this study.

3. RESULTS

Tropical Storm Charley (1998) made landfall along the southern Texas Gulf Coast during the early morning hours of 22 August. Thirteen deaths and 50 million dollars of total loss are attributed to the extensive inland flooding that resulted from the 120-460 mm of rain that fell (Rappaport, 1998). Figure 1 shows the locations, relative to the hourly storm center, of the almost 1500 hourly precipitation values available across southeastern Texas from 18 UTC 21 August to 00 UTC 23 August 1998. While the northern and eastern sides of Charley are well covered by the rain gauge data, there is no data available to the southwest of the center due to the storms proximity to the Mexican border. This, however, is not a limitation to the current study as there was no lightning recorded to the southwest of the center (to the left of the track and upshear of the center) and archived NCDC radar shows the same large right to left asymmetry in the reflectivity fields.

Figure 2 shows a precipitation analysis from the hourly data overlaid with lightning from the time period noted above. Because each precipitation observation represents one hour, figure 2 represents an average hourly precipitation with respect to the storm center over the 30-hour period. The lightning distribution consists of two separate regions of maximum flash density located to the northeast (downshear) of the center within 100 km of the core. Lightning in the outer rainbands shows a large left to right asymmetry with flashes curving to the east (downshear right) and radially outward from the center. These rainband flashes correspond fairly well with the heaviest amounts of precipitation in the outer regions of the storm, east and northeast of the center. In the core, there are several maxima of precipitation, only two of which electrically active. The other maxima, which contain the largest hourly precipitation values, contain no cloud-to-ground lightning and are thus believed to be stratiform in nature.

Unfortunately, archived hourly radar data from the NCDC homepage show a much more uniform distribution of reflectivity, especially in the outer rainbands, than the rain gauges would indicate. It appears that the rain gauge distribution is insufficient to accurately determine storm-relative rainfall. Thus for the conference, radar derived precipitation data will be examined to provide the spatial coverage needed to be correlated with the lightning data. A larger group of storms will also be examined.

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4. ACKNOWLEDGEMENTS

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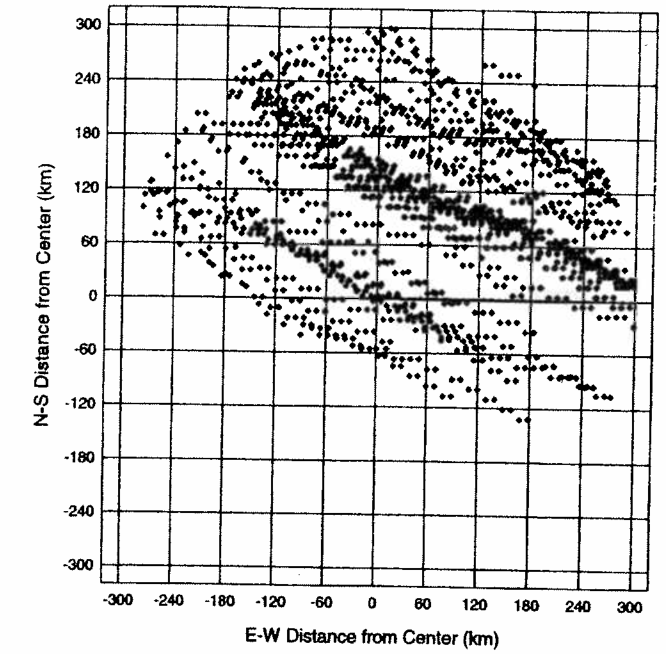

Figure 1: Locations of the 1500 hourly precipitation values within 300 km of the center of Tropical Storm Charley, 18 UTC 21 August through 00 UTC 23 August 1998.

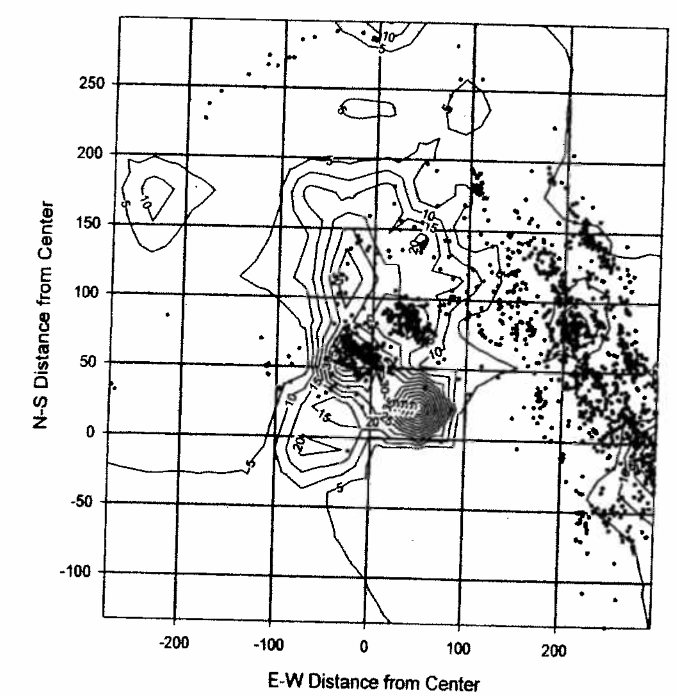

Figure 2: Average hourly precipitation analysis overlaid with lightning flashes within 300 km of the center of Charley (1998) for the same time period as Figure 1.