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RADAR DERIVED STRUCTURES OF TORNADIC MESOCYCLONES FROM TROPICAL CYCLONE (TC) FRANCES (1998) IN TEXAS AND LOUISIANA

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1 INTRODUCTION

On 7 September 1998 in the western Gulf of Mexico there was a tropical disturbance that sparked the interest of meteorologists. Although developmental conditions were limited, the system reached tropical depression strength at 2100 UTC on 8 September 1998. The poorly organized depression, located 400 km south of Galveston, TX, had a large area of convection on the east side of its center and became Tropical Storm Frances 24 hours later. By 10 September 1998, vertical wind shear (VWS) had decreased enough to allow intensification. Now, maximum sustained winds were 26 m s^{-1} and on the morning of 11 September 1998 TC Frances made landfall near Victoria, TX, spawning one tornado while staying just inland until evening (trajectory of cyclone shown in Fig. 1). TC Frances moved north-northeast, generated five more tornadoes, and was assigned tropical depression status at 0000 UTC on 12 September 1998. By 0300 UTC there was no longer tropical organization visible, despite spawning six tornadoes that could not be included in this study.

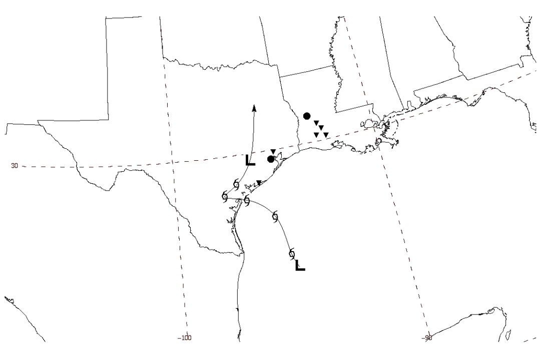

Figure 1: Smoothed track of TC Frances beginning at 2100 UTC on 8 September 1998. The arrow denotes the approximate track of the remnants of Frances. Triangles and circles show the locations of tornadoes associated with TC Frances and KHGX and KPOE, respectively.

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2 PAST STUDIES

The studies of tornadoes occurring in TCs in the United States is well documented. For example, Hill et al. (1966) discovered that more intense outer rainband cells were the most favorable for tornadogenesis. In a recent review of TC tornadoes, McCaul (1993) showed a concentration of tornado occurrences in the RF quadrant, with the RR a distant second. Later, Vescio et al. (1996) studied tornadoes that were associated with Beryl (1994). The increased availability of WSR-88D data has resulted in more detailed studies of the tornadic convective cells found in TCs. Spratt et al. (1997) used WSR-88D data to investigate tornado generation in outer rainbands associated with TCs. They found that mesocyclone characteristics were identifiable for up to two hours in outer rainband tornadic cells. The mean vertical extent of the circulation was 3.5 km. In a similar study, Suzuki et al. (2000), hypothesized that the convective cell updrafts tilted the environmental horizontal vorticity present in high shear environments, like a TC, and generated sufficient vertical vorticity to support a mesocyclone. They also cite a surface boundary as a possible source of increased environmental horizontal vorticity. Markowski et al. (1998) found a number of VORTEX–95 tornadoes that were associated with pre–existing boundaries. Scheck (2001) examined six cases and found meso β scale baroclinic zones in the vicinity of five different TC–tornado events. Rao et al. (2000) studied the Tampa tornado events associated with Earl (1998).

3 DATA

WSR-88D level II data (Crum et al. 1993) from both Houston (KHGX) and Fort Polk (KPOE) was used, one hour beginning at 2345 UTC 10 September from KHGX and seven hours following 1500 UTC 11 September from KPOE. The WSR-88D Algorithm Testing and Display System (WATADS) software and level II data were used in computing and visualizing the results. The Skew–T Hodograph Analysis and Research Program (SHARP) after Hart et al. (1991), was utilized at the Storm Prediction Center to plot hodographs and compute BRN, CAPE, and SRH. SLUBREW was used to generate surface analyses.

4 RESULTS

A significant convective cell, located within an outer rainband, possessed a long-lived, quasi-steady rotating updraft. At 2218 UTC 11 September 1998 it generated a tornado responsible for five million dollars of F0 damage along its two mile path, plus two injuries, in Acadia Parish, LA. Figure 2 shows the intensifying cell at 2250 UTC, as the mesocyclone became discernable nearly 8 km AGL. The cell's spiral shape is indicative of a strong mesocyclone. Though the reflectivities within the core of the cell were not impressive, they were sufficient to suspect severe weather.

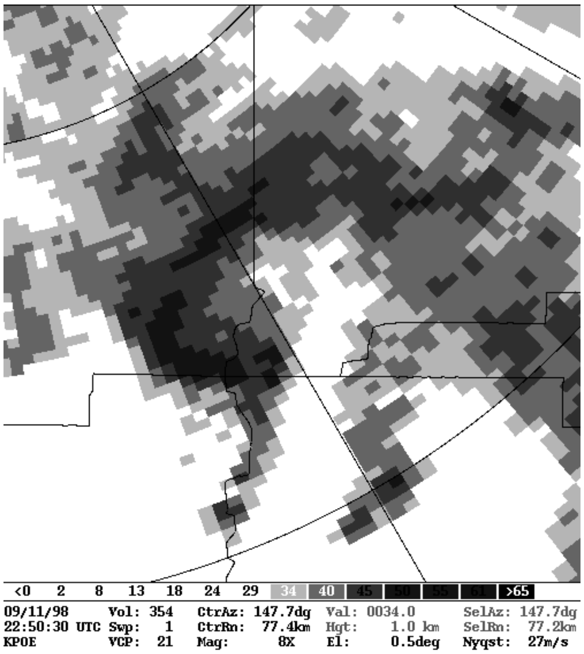

Figure 2: PPI of the 0.5° elevation reflectivity (dBZ; above 20 dBZ) of the Fort Polk, LA (KPOE) radar at 2250 UTC 11 September 1998. The cell in question is located 80 km from KPOE.

The second tornado spawned by the cell was in Evangeline Parish, LA near Basile at 2256 UTC 11 September 1998. It caused F1 damage as it was on the ground for five miles and flying debris caused three minor injuries. The mesocyclone circulation continued to be visible at 8 km AGL and the tornadic circulation was visible up to 2 km.

Continuing northward, the cell caused one last tornado at 2315 UTC 11 September 1998 which was responsible for F0 damage in Allen Parish, LA. The spiral shape became more defined, but the mesocyclone circulation became confined to below 4 km AGL even as the tornado circulation was visible to nearly 2 km AGL. [1]

The cell was observable for over 75 minutes before its mesocyclone dissolved. It had a mean convective echo top (>18 dBZ) of 12.9 km and the mean maximum reflectivity was 51.5 dBZ. The mean rotational velocity observed at 0.5° elevation was 15.1 m s^{-1} and it was not tornadic until it crossed a zonally oriented baroclinic boundary.

[1] A Powerpoint presentation of this material is available at *http://www.eas.slu.edu/Comet/trop.html*.

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