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STRONG UPDRAFT FEATURE ASSSOCIATED WITH HURRICANE EARL DURING LANDFALL

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1. INTRODUCTION

On 2-3 September 1998 hurricane Earl made landfall along the Gulf of Mexico coast, east of Panama City, FL. The University of Alabama in Huntsville Mobile Integrated Profiling System (MIPS) was located at the airport in Tallahassee, FL and made measurements of Earl with a 915 MHz Doppler wind profiler as the system moved across the Florida panhandle. As the center of Earl approached MIPS, a particularly strong updraft feature, having a magnitude of ~15 m s^{-1} within the lowest 3.0 km above ground level was associated with a rain band.

An analysis of the changes hurricane Earl underwent as it made landfall are presented. Measurements used include surface thermodynamic and pressure observations, lightning data, National Weather Service Doppler Weather Surveillance Radar (WSR-88D) data, and Geostationary Earth Orbiting Satellite (GOES) data. Then an analysis focusing on the boundary layer properties and the updraft feature's depth, intensity and duration as measured by the MIPS 915 MHz Doppler wind profiler are presented.

2. MESOSCALE ANALYSIS AT LANDFALL

As Earl approached and entered the Florida panhandle it was very asymmetrical and never exhibited a classical hurricane appearance. The storm briefly reached hurricane strength before landfall, but the deepest convection remained east of the center and the highest winds remained well east and southeast of the center (Mayfield, 1998).

An upper air trough extended across the eastern United States as hurricane Earl made landfall on the Florida coast. Earl interacted with this trough over the northern Gulf of Mexico and turned northeast as it made landfall. Figure 1 shows an infrared (IR) image from the Geostationary Earth Orbiting Satellite-8 at 0245 UTC 3 September 1998. This image shows a large cloud shield north and east of the storm's center and no cloud cover to the southwest indicating that dry air associated with the approaching 500 mb trough was being ingested into the storm from the southwest.

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As Earl made landfall, composite WSR-88D radar images show that nearly all precipitation associated with the hurricane was to north and east of the center, with no convection in the southwest quadrant of the system. Figure 2 shows a 0 UTC 3 September 1998 composite WSR-88D image. Cloud-to-ground lightning data from the National Lightning Data Network (NLDN) for the period 0000 – 0600 UTC 3 September 1998 indicated most of the cloud-to-ground lightning was associated with the rain shield north and east of the center of Earl and with a convective line that formed along the surface boundary to the south of the storm's center.

Surface observations indicate that the large rain shield that moved on shore ahead of the center of Earl produced a large pool of cool air at the surface over the Florida panhandle, southeast Alabama and southern Georgia. Temperatures in this region were between 21ºC and 23ºC. As Earl made landfall, a warm front developed along the coast to the east of the center of the storm. At Tallahassee, FL the temperatures rose from 23ºC at 0500 UTC to 26ºC at 0600 UTC 3 September 1998 as the warm front moved northward.

3. STRONG UPDRAFT EVENT

The UAH MIPS was located at the Tallahassee, FL Airport as hurricane Earl made landfall and moved across the Florida panhandle. The center of Earl passed approximately 50 km to the northwest of the UAH MIPS location. During this time the 915 MHz Doppler wind profiler measured an unusually strong updraft feature in the boundary layer. Figure 3 shows the velocity field W that is defined by $W = w + w_T$, where w is the vertical air motion and w_T is the precipitation particle terminal fall speed for the period 0000 – 0200 UTC 3 September 1998 (2100 – 2200 EST 2 September 1998). This plot shows downward velocities primarily between 0 and -1 m/s, characteristic of snow fall speed, above the melting level at 5 km and generally -5 to -7 m/s values within the rain region below. The exception is a strong updraft that occurred just after 0230 UTC 3 September 1998 (21.50 EST 2 September 1998), extending from just above the surface to approximately 1.5 km and reaching a maximum value of W of 6 m/s near 1 km.

Surface observations from the Tallahassee, FL Airport Automated Surface Observing System showed no significant variations in temperature, pressure, wind speed or direction as the updraft event passed overhead. This event occurred prior to the warm front

reaching the UAH MIPS location at the Tallahassee, FL Airport and thus the shallow cold layer near the surface likely prevented any surface reflection of the updraft feature.

4. FUTURE ANALYSIS

Further analysis of the updraft event is ongoing. The precipitation particle terminal fall speed, w_T, is going to be taken out of the total measured vertical velocity, W to obtain the true vertical air motion, w. This will be done by calibrating the 915 MHz Doppler wind profiler reflectivity factor (Z) with the nearby Tallahassee WSR-88D and applying a Z-w_T relationship in order to differentiate the true wind velocities from the velocity of the precipitation particles.

5. REFERENCES

Mayfield, M., 1998: Preliminary Report Hurricane Earl 31 August – 3 September 1998, http://www.nhc.noaa.gov/1998earl.html, 11pp

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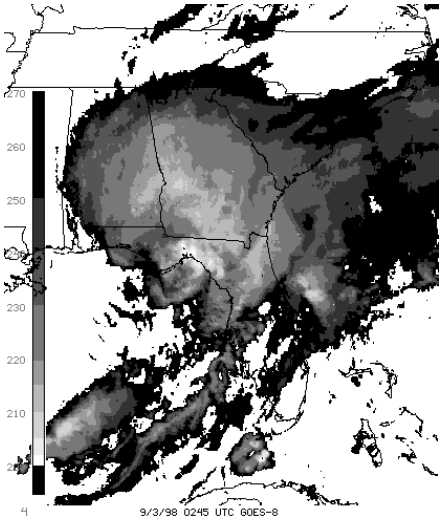

Figure 1. 0245 UTC S IR Image

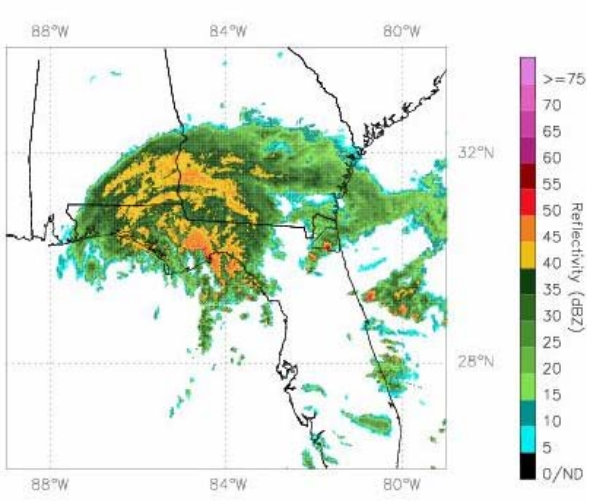

Figure 2. 0300 UTC WSR-88D Composite Image

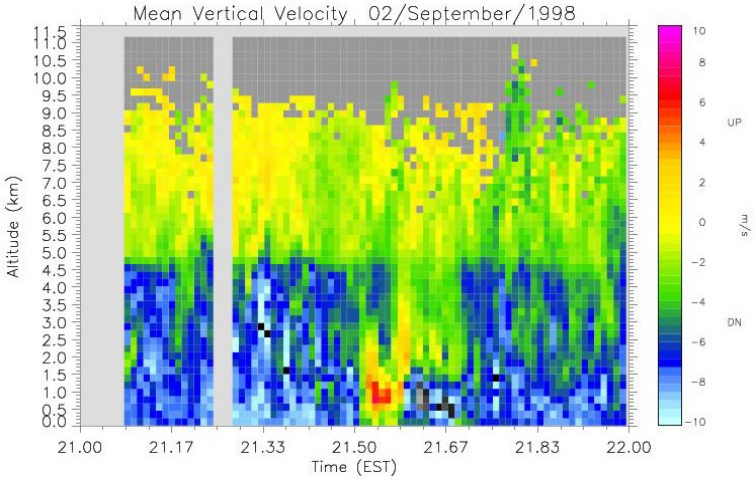

Figure 3. MIPS 915 MHz Doppler Wind Profiler Vertical Velcoity