P1.65 DOPPLER-OBSERVED AND MODEL-SIMULATED LOW-LEVEL WIND SURGES IN HURRICANE DANNY'S (1997) EYE WALL

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1. INTRODUCTION

Hurricane Danny made landfall along the Alabama Coast in July 1997. The slow-moving storm drifted in Mobile Bay and remained within 50 km of the National Weather Service's WSR-88D Doppler radar in Mobile for nearly 12 hours. Danny, originally a highly symmetric storm over the open Gulf, became very asymmetric and extremely convective over the elevated water temperatures of Mobile Bay.

2. LOW-LEVEL WIND SURGES IN THE EYE WALL

Blackwell (2000) documented the existence of low-level wind maxima in Hurricane Danny's boundary layer. During the asymmetric transition of Danny in Mobile Bay, a small eye wall meso-vortex (EWMV) developed within Danny's broader eye (Fig. 1).

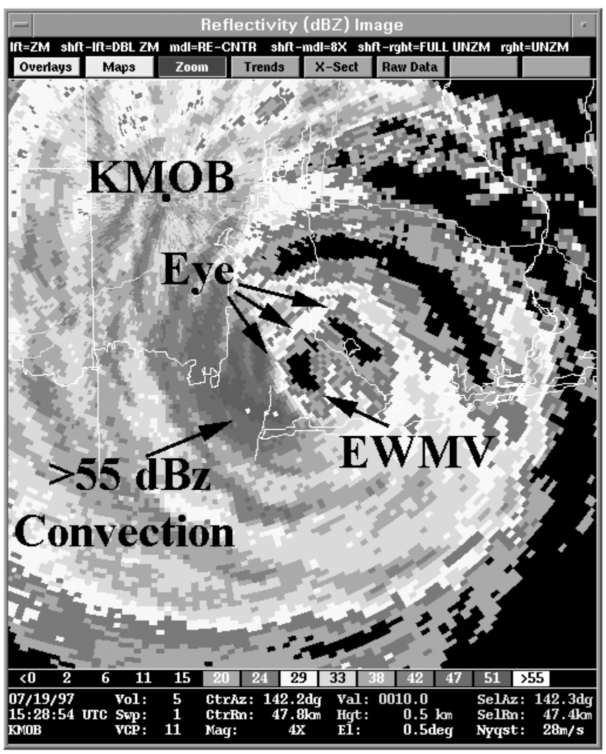


Figure 1. Doppler WSR-88D base reflectivity (1528 UTC, 19 July 1997) of an increasingly asymmetric and convective Hurricane Danny in Mobile Bay. A well-defined eye wall meso-vortex within a broader eye, is apparent adjacent to intense convection in the western eye wall.

Boundary layer winds, as indicated by Doppler base velocities, began to fluctuate within the heavily-convective western eye wall of the storm (Fig. 2). As Danny became increasingly asymmetric over Mobile Bay, the maximum winds in the west-side eye wall began to display a cyclic pattern of strengthening and weakening. Intensification appeared to occur as the EWMV became better defined adjacent to the intense west-side convection. Temporary weakening commenced when the EWMV became less defined within the broader eye.

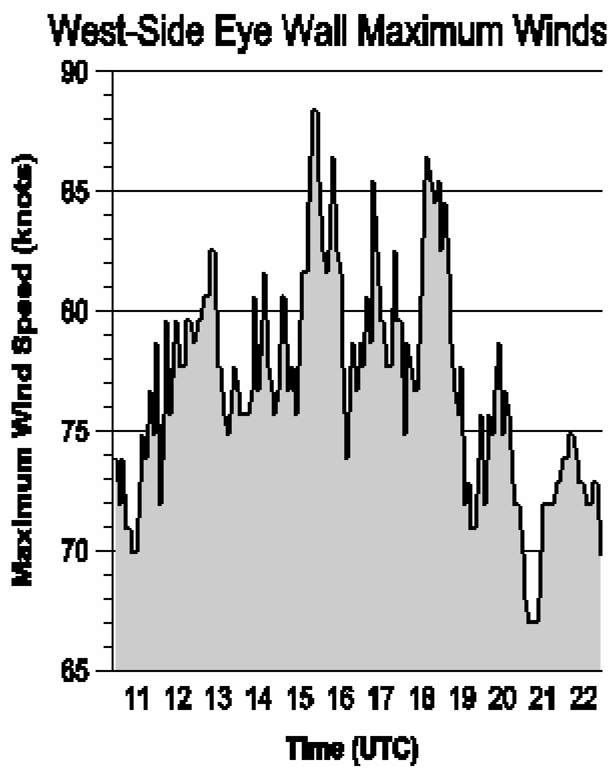
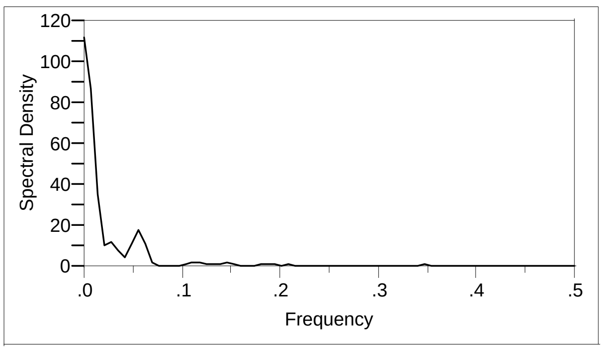


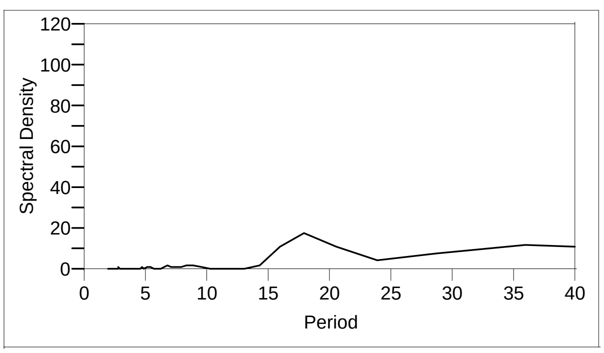
Figure 2. Time series of maximum WSR-88D base velocities (knots) in Danny's western eye wall between 1030 and 2230 UTC, 19 July 1997.

The storm reached maximum intensity between 1500 and 1900 UTC with winds exceeding 85 knots during three distinct periods. Even after the 1930 UTC landfall of Danny, a distinct oscillation remained apparent in west-side eye wall winds, albeit at lower velocities as the storm weakened.

A frequency distribution and periodogram of the WSR-88D maximum wind time series reveals the cyclical presence of these low-level wind surges. The spike in frequency around 0.6 (Fig. 3a) and the spike in period every 18th observation (Fig. 3b) indicates the presence of a 108 minute periodicity in these wind surges[1]. Seven such wind surges occur between 1200 and 2200 UTC in Danny's western eye wall. Similar behavior was not observed in Danny's non-convective eastern side where maximum winds were weaker and at considerably higher altitudes.



a.



b.

Figure 3. a) Frequency distribution, and b) periodogram of maximum base velocities in Danny's western eye wall between 1030 and 2230 UTC, 19 July 1997. (Courtesy: Madhuri Mulekar, Dept. of Mathematics and Statistics, University of South Alabama).

3. DISCUSSION

The WSR-88D base reflectivity imagery (not shown) reveals the sequential development of EWMVs adjacent to Danny's convective western eye wall. These EWMV occurrences appear to coincide with the cyclical strengthening of the eye wall winds, as indicated in Fig. 2. It is hypothesized that Danny contains an EWMV within the periphery of Danny's broader eye, and that this EWMV completes one cyclonic orbit around the eye in a little over 100 minutes. As the EWMV approaches the intense west-side convection, it is hypothesized that the EWMV strengthens, resulting in an intensification of the boundary layer winds in the adjacent eye wall. Later, the EWMV weakens at it rotates away from the intense convection and toward the non-convective east side of Danny; thus, west-side boundary layer winds temporarily relax. However, these winds once again increase as the EWMV orbits back toward the convective western eye wall roughly 1.5 hours later.

4. MODELING OF WIND SURGES

Using the PSU/NCAR mesoscale model, MM5, a simulation of hurricane Danny is being studied to investigate the relationship between eye wall meso-vortex development and low-level wind surges after the storm enters Mobile Bay. The model is initialized with GFDL initial fields and NAVY (OTIS) SST fields. The original GFDL bogus vortex, which was much larger than the real Danny, is removed and replaced with a smaller bogus vortex of similar intensity to Danny. Two domains are used with horizontal resolutions 9km and 3km respectively. The use of a 3 km horizontal resolution allows explicit modeling of convection, a process crucial to the accurate simulation of hurricane meso-vortex development. Results of this modeling effort will be displayed at the conference.

5. REFERENCES

Blackwell, K.G., 2000: The evolution of Hurricane Danny (1997) at landfall: Doppler-observed eyewall replacement, vortex contraction/intensification, and low-level wind maxima. Mon. Wea. Rev., **128**, 4002–4016.

________., and J.M. Medlin, 1999: Doppler-observed eyewall replacement cycles in Hurricane Danny near the Alabama coast and corresponding fluctuations in storm intensity, organization, and precipitation. *23rd Conference on Hurricanes and Tropical Meteorology*, Dallas, TX, American Meteorological Society, 10-15 January 1999, pp. 196-199

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[1] Doppler volume scans occur at 6 minute intervals. Thus, base velocities are sampled every 6 minutes.