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EVOLUTION OF THE COASTAL WINDFIELD DURING THE LANDFALL OF HURRICANE FLOYD (1999)

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1. INTRODUCTION

On 15 September, 1999, as part of the Hurricanes at Landfall component of the US Weather Research Program, the Hurricane Research Division of the National Oceanographic and Atmospheric Administration (NOAA) conducted two single- plane experiments in Hurricane Floyd with P-3 aircraft from NOAA's Aircraft Operations Center (AOC). The flight patterns were intended to survey the vortex and it's environment as it made landfall on the North Carolina coast.

Each aircraft passed along the coast and GPS sondes were dropped to sample the onshore and ofshore flow. Fig. 1 shows the flight tracks. The first aircraft, NOAA 43, flew figure 4 patterns to measure the winds on all sides of the storm and then moved to the Carolina coast. NOAA 43 then flew south hugging the coast (Fig 1a). When NOAA 42 arrived on station at 0430 UTC, 16 September, the hurricane was only 80 km from the coast. Because of restrictions on flying over land, due to earlier reports of tornadoes in Floyd's outer rainbands, NOAA 42 flew a truncated figure 4 pattern, and then repeated the trapezoidal shaped pattern shown in Fig 1b, to repeatedly sample the coastal windfield.

In addition to the aircraft sampling the storm, there sere several supplemental surface stations deployed on the coast. The University of Oklahoma parked a portabletDoppler on Wheels (DOW) near Wilmington and Texas Tech University (TTU) installed two portable 10m wind towers. The NOAA aircraft flew near these surface sites to collect Doppler and GPS sonde data to augment the boundary-layer observations. The Weather Service Doppler radars at Wilmington (KLTX) and Morehead City (KMHX) were in prime position to observe the storm, but unfortunately only the KLTX digital radar data were archived after 2246 UTC.

Airborne Doppler data were collected along the coast for ~9 h, so we should be able to describe the wind field evolution from several radar analyses. We will present the dual-Doppler reflectivity and wind fields, and relevant GPS sonde data to evaluate changes in the winds as the hurricane crossed the coast, with an emphasis on contrasting onshore and offshore flow regimes.

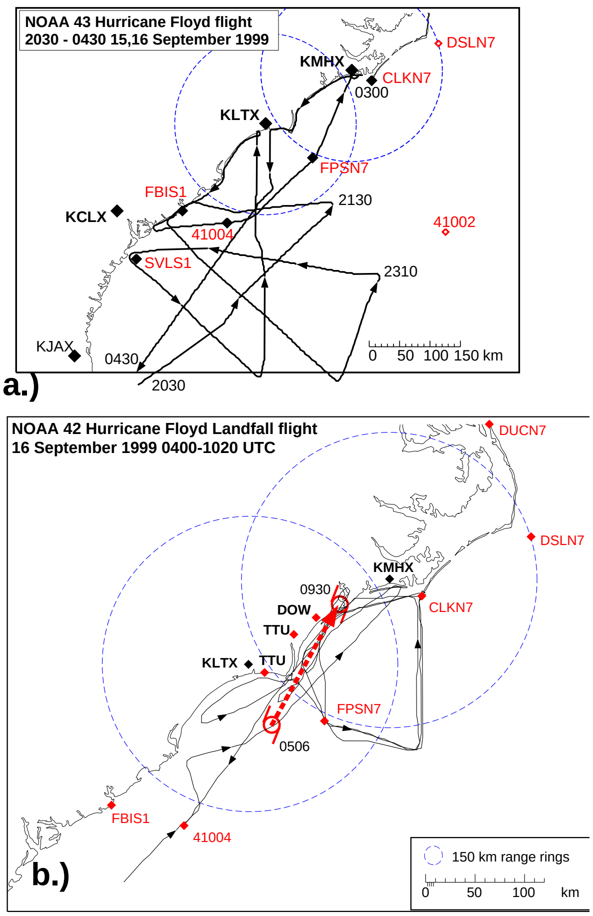

Figure 1. Flight tracks of a.) NOAA 43, 2030 15 Sept. to 0430 16 Sept, and b.)NOAA 42, 0400-1000 UTC, 16 Sept. 1999. Thick dotted line shows H Floyd's track from 0506 to 0906 UTC. Dotted circles indicate 150 km range from WSR-88D radars at Wilmington and Morehead City, North Carolina.

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2. RADAR DATA ANALYSIS.

The tail Doppler radar antenna scanned forward and aft (F/AST, Jorgensen et al. 1996), yielding intersecting rays with a seperation of ~45°. The KLTX WSR-88D collected a volume scan every 5 min, scaning from 0.5° to 19.5°. Data from the two radars were combined to solve for the winds in a pseudo-triple Doppler analysis, using Gamache's variational technique (Gamache, 1997). Two constraints are applied : the windfield must closely satisfy the equation of continuity, and the projection of the windfield back on the Doppler

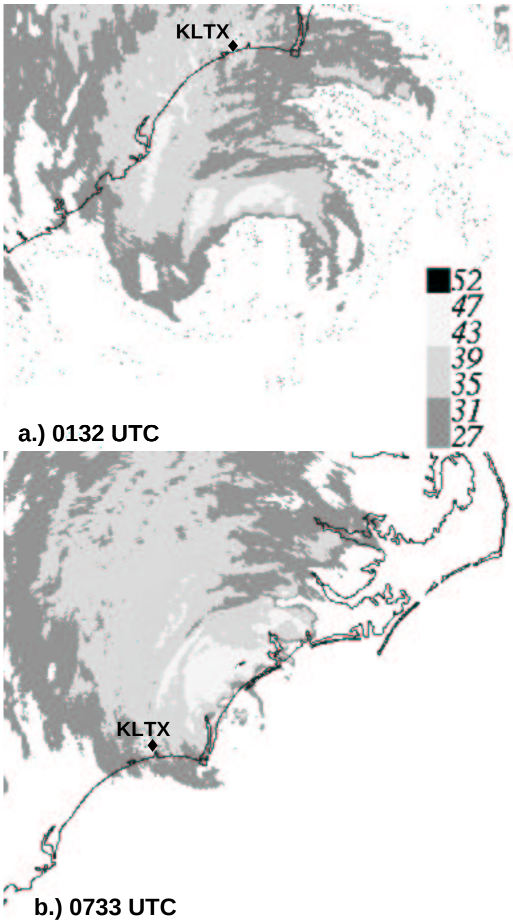

Figure 2. Wilmington(KLTX) WSR-88D images from a.)0132 and b.)0732 UTC 16 September 1999. Successively lighter shades of gray indicate reflectvity > 25, 33, and 41 dBZ.

rays must closely match the observed Doppler velocities.

.3. RESULTS

Floyd moved rapidly along the Carolina Coast, making a grazing landfall around 0800 UTC. There was a pre-existing frontal boundary that appaerntly moved in from the west and interactied with the storm (Pasch 1999). Fig. 2a, from KLTX at 0132 UTC, shows that the the southern half of the eyewall and surrounding bands had been eroded away. Six h later (Fig 2b) it is difficult to find a center in the reflectivity, and all the rain is over land. Note that the area covered by dBZ >33 had increased, perhaps influenced by the front.

A south-to-north section through a Doppler analysis for 0330 UTC, when NOAA 43 was tracking south from KLTX, is a sample of the storm structure. The reflecivity is stratiform, with dBZ decreasing quickly above 5 km or so (Fig 3a). Winds >35 m/s are in a fairly shallow layer. There is a compnet of inf

low > 5 m/s up to 8-9 km, and some hint of outflow at higher altitudes. This analysis box is in the onshore flow regime. At the conference we will present anayses from

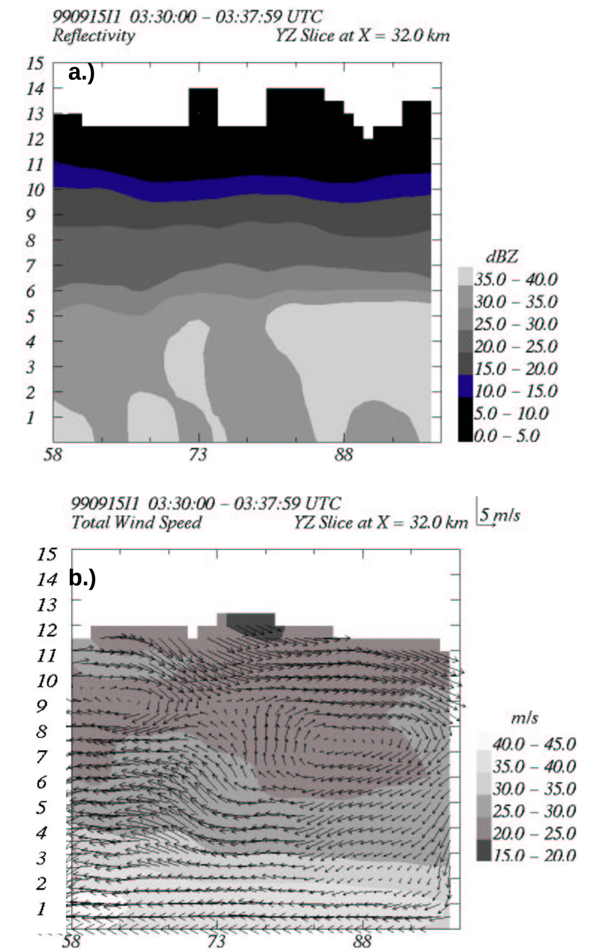

Figure 3. Vertical cross-section through Floyd at 0330 UTC. a.)Reflecivity, in 5 dBZ steps. b.) horizontal wind speed, contoured in 5 m/s steps. Vectors show motion in this plane. Horizontal scale indicates distance N of strom center in km. Height scale also in km.

the offshore flow regimes, using the sonde data to provide finer details of the boundary layer.

4. ACKNOWLEDGEMENTS

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