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HURRICANE BOUNDARY LAYER ROLLS OBSERVED DURING THE LANDFALL OF HURRICANE ISABEL

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1. INTRODUCTION

Hurricane boundary layers (HBL) have been shown to contain small-scale convective features called HBL rolls that may be responsible for perturbations in surface wind field structure. Some studies have documented their presence in the HBL at landfall and their role in transport of momentum throughout the boundary layer (Wurman and Winslow, 1998), but their link to wind field irregularities and damage patterns is still poorly understood.

The goal of the present study is to investigate HBL rolls, specifically momentum transfer and its potential reflection at the surface using high temporal and spatial resolution data acquired from Hurricane Isabel during the Characterization of Atmospheric Turbulence and Flood Initiation and Validation Experiment (CAT-FIVE).

2. EXPERIMENT

On September 18, 2003 Hurricane Isabel made landfall near Drum Inlet, North Carolina, as a category 2 hurricane. In order to document this event, two teams drove to the North Carolina coast carrying instrumented towers and mobile radars. The first team led by Texas Tech University (TTU), was in charge of two wind engineering mobile instrumented towers (WEMITE), three 10-meter SBCCOM towers and a Shared Mobile Atmospheric Research and Teaching (SMART) radar. The second team led by Oklahoma University was in charge of a second SMART radar. Collaborative deployment and scanning strategies were chosen so that the synoptic scale as well as smaller scale features of the hurricane at landfall could be documented.

This paper will focus on the experiment conducted to characterize HBL rolls. In order to analyze the effects of the HBL rolls on the surface wind field the TTU team deployed three SBCCOM towers and one SMART radar, SR-2, at Craven County Regional Airport in New Bern, NC. The three towers were located in the vicinity of the radar (Figure 1), so that surface data and low-level Doppler data could be correlated. Two of the towers sampled at 5 Hz, while the third sampled at 0.5 Hz. The radar intermittently completed 90° sector scans with a gate spacing of 66.7 m, using three different elevation angles, 0.5°, 0.8° and 1.5°.

3. METHOD AND RESULTS

This study is based on two types of data: tower data and radar data. For the SBCCOM towers used in the the experiment, the wind speed and direction were recorded at a

Figure 1: Experimental setup used during CAT-FIVE including 3 SBCCOM towers from TTU and one SMART-radar.

unique level of 10 meters. The tower recorded over 60 hours of data of Hurricane Isabel landfall (Figure 2). The tower data

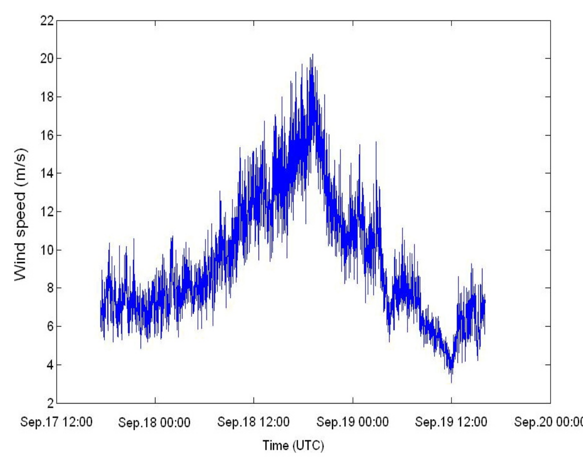

Figure 2: One-minute mean wind speed as recorded by SBCCOM White tower located at Craven County Airport during the landfall of Hurricane Isabel.

will be compared to the radar data to investigate the correlation between surface and low-level radar derived wind. Radar data require two pre-processing steps before any kind of analysis could be conducted. First, bad data due to blockage, second-trip echoes and ground clutter were removed. Then, the velocity data were unfolded. Both unfolding and editing were completed with SOLO II, a software developed by NCAR.

Radars measure the wind moving toward or away from the

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radar. So, the parameter recorded by the radar is actually the radial component of the wind. Thus, the first approach used to compare tower and radar data was to study the radial part of the wind for each instrument. The towers measure the total wind, so, to obtain the radial component, the wind direction and wind speed were first averaged across a 30-second window centered on the true time of the radar observations. The averaged wind was then projected onto the radar-tower axis. The results presented in this paper are based on data from radar bins directly located above SBCCOM White. The time window chosen corresponds to a time period a roll was identified on radar images above the towers. Figure 3 is a time series of the radial wind speed of SBCCOM White (10 m) and SR-2 at 1.5° elevation angle, which is approximatively 30.4 m above the ground. The time series shows that a correlation exists between the two data sets, although the significance of the passing rolls requires further investigation. Results using two other elevation angles (0.5°, 0.8°) are similar (not shown).

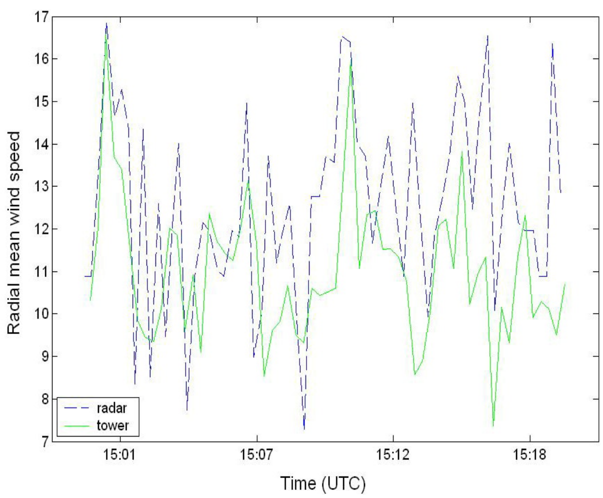

Figure 3: SR-2 and SBCCOM White radial wind speed comparison.

4. CONCLUSION

The TTU team deployed successfully three towers and a SMART radar to investigate the effects of the HBL rolls on the surface wind field. Rolls were identified on the radar data, and some of them were located near and over the experimental setup.

The approach used in this paper to study a possible correlation between low-level radar data and tower data indicates encouraging results. However, to optimally compare radar and tower data it will be important to better understand the relationship between volumetric and point wind measurements. Further analysis of the temporal averaging criteria used on the tower data may lead to better results. Further examination of the radar data will enable positive identification of the rolls and a direct comparison. These results will be presented at the conference.

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