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IMPLEMENTING A SINGLE-DOPPLER RADAR TECHNIQUE FOR TROPICAL CYCLONES AND INTEGRATING RADAR-DERIVED WIND FIELDS INTO H*WIND SURFACE ANALYSES

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1. INTRODUCTION

The Hurricane Research Division's hurricane wind analysis system (H*Wind) is a tool that produces surface (10 m) wind analysis using multiple data sources, such as aircraft flight level data, dropsondes, buoys, and satellite winds. The data are adjusted to a common framework of 10 m, 1 minute winds, taking into account marine or open terrain exposures (Powell et al. 1996). The primary data for H*Wind are aircraft observations. Aircraft sample the inner core of a tropical cyclone during a few traverses at a single altitude. However, as the tropical cyclone approaches land, overland flights are restricted, resulting in data gaps in the inner core.

The WSR-88D coastal Doppler radar network, enables continuous monitoring of landfalling tropical cyclones within ≈ 200 km of the coastline. This operational radar network provides digital Doppler data at six-minute intervals. Radar-derived wind fields can be generated automatically by the Ground-Based velocity Track Display (GBVTD), a single-Doppler radar technique for tropical cyclones that can provide H*Wind with estimates of the inner-core wind fields at altitudes above 0.5 km.

In this work, H*Wind will be modified to include GVBTD-derived wind fields when tropical cyclones are within range, typically 150-230 km from the radar. H*Wind usually assimilates all available data within a two to three hour period in order to obtain adequate spatial coverage over the analysis domain. GBVTD will provide much higher temporal and spatial resolution for wind estimates than any current data sources. Doppler data can track evolving asymmetries in the wind fields, crucial in de-aliasing such asymmetries in surface wind analyses from data collected over longer time periods. It also provides the only source of remotely sensed wind data in heavy rain. Wind fields and tracks derived from WSR-88D data every six minutes have the potential to improve our understanding of the storm's inner-core. Fig. 1 is an example of an H*Wind surface wind analysis and a GBVTD derived wind field. From this figure it can be seen that GBVTD can add considerable information about the wind structure of the storm. For example, the radius of maximum wind in the GBVTD analysis is smaller than the H*Wind analysis.

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2. GBVTD

A wind retrieval scheme, GBVTD, has been developed to deduce the tropical cyclone's inner-core wind fields at a specified altitude. Normally, because of the earth's curvature and the sampling limitation of the radar, the lowest altitude resolved is above 0.5 km. This method developed by Lee et al. (1999) uses single Doppler velocity data from a single radar to deduce the tropical cyclone's primary circulation. GBVTD uses by Fourier analysis of Doppler radar data on rings centered on the tropical cyclone's vorticity center. Lee et al. (1999) developed this technique using simulated data and tested it on radar data from Typhoon Alex (1987). They determined features in the wind field up to wave number three and showed that most of the variance is explained by the wave number zero and one. The GBVTD wind field requires the addition of the environmental mean wind from an independent source, in order to obtain the ground-relative winds of interest to forecasters.

3. ENVIRONMENTAL MEAN WIND

There are several methods available to calculate the environmental mean. One way to estimate the environmental mean wind is to apply the Hurricane-customized Extension of the Velocity Azimuth Display (HEVAD) technique (Harasti and List, 2001). HEVAD estimates the wave number zero component of the tangential and radial wind, and the environmental mean wind in the region at and beyond the radius of maximum wind. In effect, the technique finds the modified-Rankine vortex and environmental wind that best fit the Doppler data. A harmonic analysis is performed on the VAD data concentric

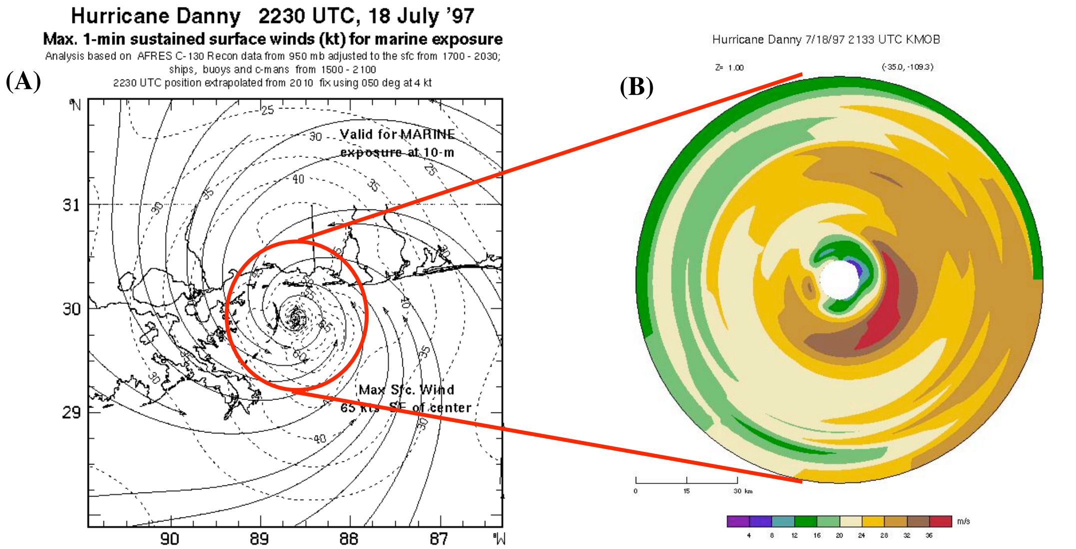

Fig. 1 H*Wind analysis (A) and GBVTD (B) derived wind field for Hurricane Danny (1997).

with the radar, and the resulting Fourier coefficients are related to the wind components. The HEVAD-derived mean wind may be combined with GBVTD-derived winds to yield the ground-relative wind field at a specified altitude.

To produce reliable GBVTD and HEVAD wind analyses requires an accurate estimate of the vorticity center (Lee and Marks, 2000; Harasti and List, 2001). One method, already part of the GBVTD package, uses the Simplex minimization algorithm to find a vorticity center. The GBVTD-Simplex algorithm objectively estimates a tropical cyclone vorticity center by determining the location that maximizes
the GBVTD-retrieved mean tangential wind for a ring of specified radius. Lee and Marks (2000) tested it using axisymmetric and asymmetric analytical tropical cyclones. GBVTD will provide much higher temporal and spatial resolution for wind estimates in the inner core region than any current data analysis system.

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