P11A.6 REAL-TIME IMPLEMENTATION OF VORTRAC AT THE NATIONAL HURRICANE CENTER

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1 INTRODUCTION

The Vortex Objective Radar Tracking and Circulation (VORTRAC) system is currently being implemented and tested for real-time use at the National Hurricane Center (NHC) under the auspices of the Joint Hurricane Testbed program. Using the full-volume, full-resolution coastal Weather Surveillance Radar – 1988 Doppler (WSR-88D) data, VORTRAC tracks the intensity (central pressure) and the radius of maximum wind of landfalling tropical cyclones. It is a fusion of several single-Doppler radar data quality control and wind analysis methods. This paper presents an overview of the components of the VORTRAC system along with examples taken from case studies of Hurricanes Charley (2004) and Katrina (2005).

2 VORTRAC COMPONENTS

The data quality control components of VORTRAC include the Bargen and Brown (1980) unfolding algorithm B, the gradient velocity azimuth display (GVAD) method of Gao et al. (2004), and simple ground clutter and noise removal techniques. The GVAD method intializes the Bargen and Brown method with an estimate of the wind near the radar as a function of altitude, even if the radial velocity data is aliased. If there is insufficient data to provide reliable GVAD wind estimates then the original VAD method of Browning and Wexler (1968) is utilized instead.

The wind analysis component of VORTRAC combines the following methods: the ground-based velocity track display (GBVTD; Lee et al. 1999), the GBVTD-Simplex method (Lee and Marks 2000), and the hurricane volume velocity processing (HVVP; Harasti 2003). All three of these methods utilize radial velocity data taken from a single radar volume scan. Both GBVTD and HVVP estimate various wind components found within the circulation of the tropical cyclone. VORTRAC requires estimates of the GBVTD mean tangential wind component and the HVVP transverse component of the environmental wind with respect to the radar-azimuth direction of the tropical cyclone center. The latter component provides a correction to the former component yielding and unbiased estimate of the mean tangential wind. Figure 1 shows a flow chart of the VORTRAC procedure.

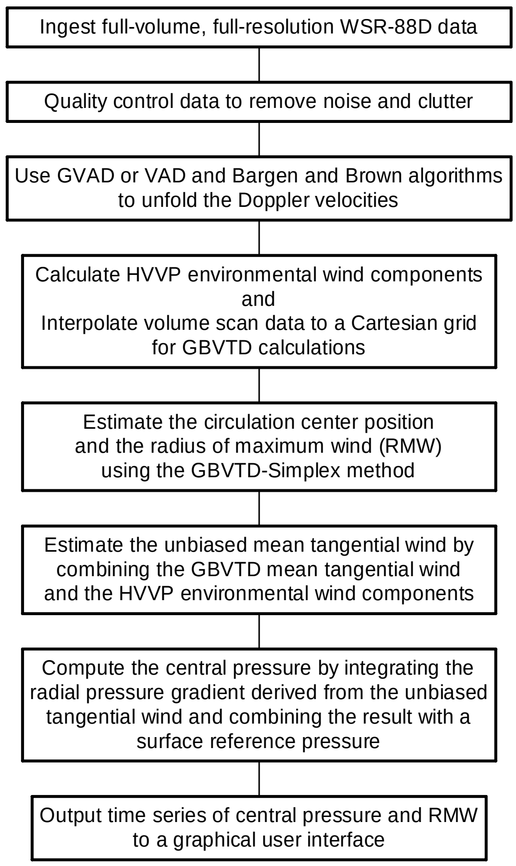

Fig. 1. Flow chart of VORTRAC procedure.

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3 PRELIMINARY TESTS OF VORTRAC

3.1 Hurricane Charley (2004)

Charley moved northward near the southwestern Florida coast as a category three hurricane on 13 August 2004. It was within range of the WSR-88D units at Key West (KBYX) and Tampa (KTBW) for about 14 hours prior to veering north-eastward and rapidly intensifying to a category four hurricane while making landfall in Florida. Figures 2 and 3 show the composite reflectivity and unfolded radial velocity images provided by the KBYX volume scan data near 1521 UTC. Note the very intense and compact circulation with an RMW of only 12 km.

WSR-88D data from KBYX and KTBW for the time period 0800-2100 UTC 13 September 2004 were combined with nearby pressure observations, and an example of the VORTRAC output is shown in Fig. 4, prior to its implementation at NHC. The central surface pressure as a function of time is estimated from the VORTRAC algorithms with much higher temporal resolution compared to the infrequent measurements of central pressure that were obtained by aircraft reconnaissance dropsondes. In particular, the onset of the rapid intensification is clearly visible in the VORTRAC results yet undetected in the dropsonde observations and NHC advisory ~6 hours before landfall (and thus unexpected and not forecast by NHC). HVVP significantly improved upon the pressure estimates derived from GBVTD alone by 3-8 mb.

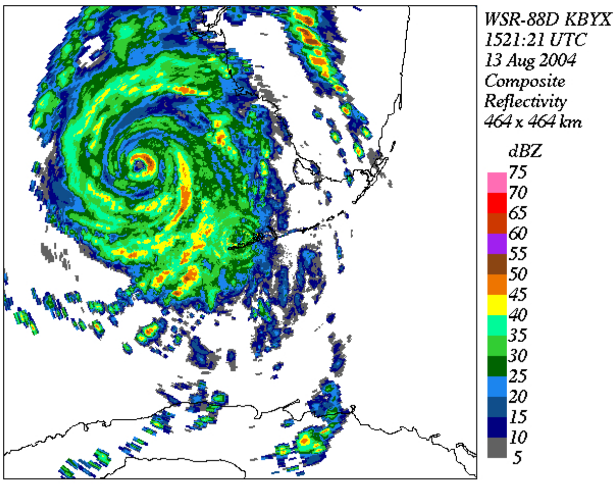

Fig. 2. Composite reflectivity image of Hurricane Charley derived from KBYX volume scan data near 1521 UTC. Key West is at the center of the image with the coastlines of Florida and Cuba shown as black lines toward the north and south, respectively.

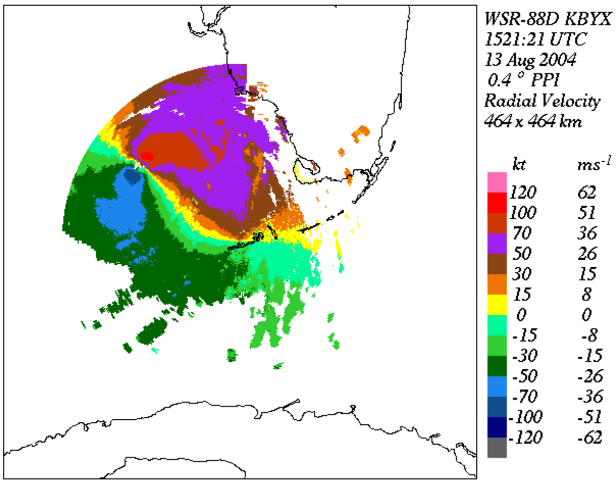

Fig. 3. Single-elevation radial velocity image of Hurricane Charley taken from KBYX volume scan data near 1521 UTC. Key West is at the center of the image with the coastlines of Florida and Cuba shown as black lines toward the north and south, respectively.

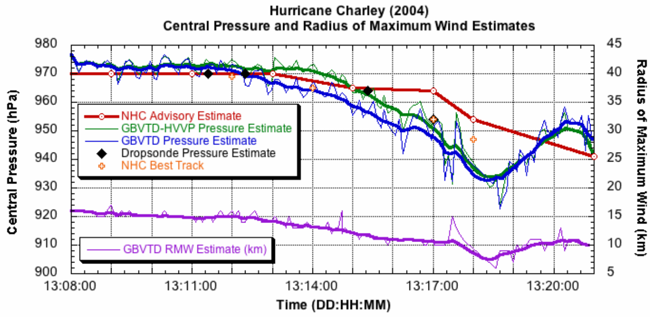

Fig. 4. Example of VORTRAC output for Hurricane Charley (2004).

3.2 Hurricane Katrina (2005)

Hurricane Katrina was a category five hurricane before it weakened to a category three hurricane a few hours before landfall along the central Gulf of Mexico coast on 29 August 2005. Figures 5 and 6 show the composite reflectivity and unfolded radial velocity images provided by the Slidell, Louisiana (KLIX) WSR-88D volume scan data near 1043 UTC. In contrast to Hurricane Charley (2004), Katrina had a very broad circulation with an inner wind maximum near 28 km radius. Katrina appears to be almost twice as large as Charley (comparing Figs. 2 and 5, which have different spatial extents as indicated in their legends).

WSR-88D data from KLIX for the time period 0900-1130 UTC 29 August 2005 were combined with nearby pressure observations, and an example of the VORTRAC output is shown in Fig. 7, which was not available to NHC at that time. In this case, the pressure changes in Katrina were not as dramatic as those of Charley. Except for the initial time period near 08 UTC, when the entire radial velocity data near Katrina's eye were not within radar range, the accuracy of the VORTRAC pressure estimates are well validated by the aircraft reconnaissance pressure estimates.

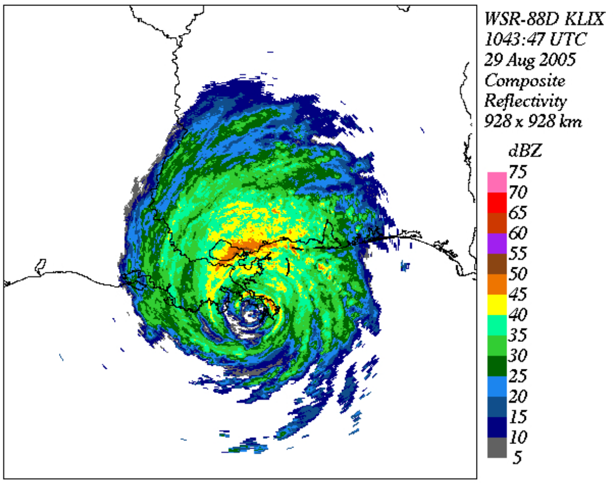

Fig. 5. **.** Composite reflectivity image of Hurricane Katrina derived from KLIX volume scan data near 1043 UTC. New Orleans Louisiana is near the center of the image.

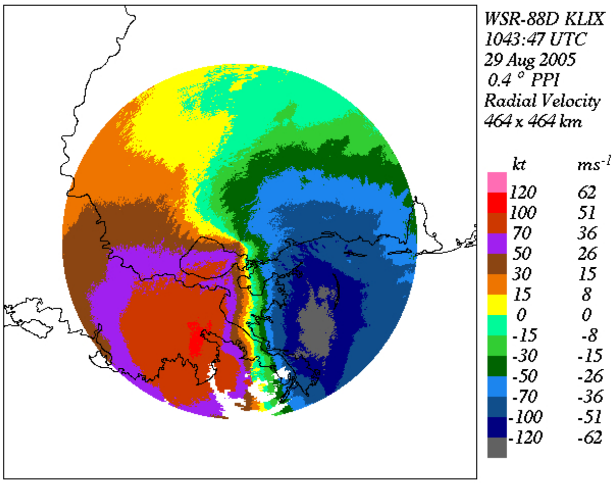

Fig. 6. Single-elevation radial velocity image of Hurricane Katrina derived from KLIX volume scan data near 1043 UTC. New Orleans Louisiana is near the center of the image. Note the spatial scale is half that of Fig. 5.

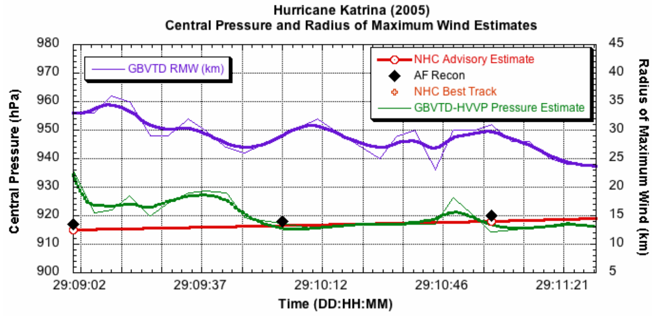

Fig. 7. Example of VORTRAC output for Hurricane Katrina (2005).

4 SUMMARY AND FUTURE WORK

As part of a Joint Hurricane Testbed algorithm transition project, VORTRAC is a fusion of several single-Doppler radar data quality control and wind analysis methods that will provide time series estimates of the central pressure and core radius tropical cyclones to forecasters at NHC. VORTRAC has been tested with substantial success using archived WSR-88D data sets of Hurricanes Charley (2004) and Katrina (2005). Tests on archived WSR-88D data of other hurricanes are currently underway, including tests on synthetic data sets using analytic wind models. Full implementation of VORTRAC at NHC will be complete by the end of the 2007 hurricane season.

5. ACKNOWLEDEMENTS

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