JHT Mid-term Report

(September 1 2011 – February 17 2012)

Improved Automation and Performance of VORTRAC Intensity Guidance

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Introduction:

This document gives a mid-term progress report on the "improved automation and performance of Vortex Objective Radar Tracking and Circulation (VORTRAC) intensity guidance" for the JHT. VORTRAC uses a series of algorithms to deduce the central pressure and radius of maximum wind (RMW) of a landfalling TC in near real time from WSR-88D Level II radar data and environmental reference pressure data from nearby coastal weather stations. VORTRAC was officially accepted for operation at the National Hurricane Center (NHC) in 2008. In its current operational form, VORTRAC requires external scripts to fetch this data and user input of an initial TC position, RMW estimate, and radar selection. This procedure was not streamlined and encountered difficulties during several landfalling hurricanes. The PIs have suspected that improperly handled "exceptions" encountered during VORTRAC execution might contribute to the interruptions of VORTRAC in real time operations. The purpose of this project is to improve the capability to automatically diagnose central surface pressure and its tendency from radar-derived wind fields at TPC/NHC as additional guidance for TC intensity change near landfall when a TC center is within the Doppler range of a coastal WSR-88D.

Accomplishments:

The progress in this performance period (9/1/2011-2/17/2012) can be divided into two categories:

1. Reestablish communications with the new NHC VORTRAC contact, Wallace Hogsett, who replaced the retired Colin McCadie in 2010. The PIs had a conference call with NHC to discuss expectations of the project and obtain updates on the computer infrastructure at NHC for accessing vital datasets in real time during operations. The upgraded VORTRAC code will be designed and configured based on this information.
2. The main focus of the first year project is to identify possible points of failure by running historical landfalling datasets through VORTRAC package. This information is critical to form the basis to improve the automation and performance of VORTRAC. A total of 12 US landfalling hurricanes between 2005 and 2011 were selected as the test cases (See Table 1) and their tracks are illustrated in Fig. 1. The level II data of the 12 hurricanes were downloaded from NCDC and the VORTRAC package was updated to handle the Level II Message 31 format. Then the PIs ran these 12 storms through VORTRAC and are currently analyzing the results. Preliminary findings will be presented in the 66th IHC.

The preliminary examination of these VORTRAC runs of the 12 hurricanes has already provided useful insights on several areas that can be improved in the VORTRAC logic, especially on improving the stability of the VORTRAC-derived circulation centers and radius of maximum wind (RMW). The VORTRAC analysis of Hurricane Ike from KHGX data are used to illustrate challenges for the current software, along with some identified improvements that can be made to the VORTRAC package. Hurricane Ike approached KHGX from the southeast quadrant then curved northward passing east of KHGX is (Fig. 2). The 12-hour (03-15 UTC) time series of RMW, VORTRAC-retrieved central pressure and the distance from the radar to Ike's circulation center is illustrated in Fig. 3. The Doppler velocity and reflectivity of Ike at 0310 UTC are also shown in Fig. 3 when Ike's center just entered KHGX's Doppler range.

The dominant reflectivity signature was the principal band, not the primary eyewall. The primary eyewall and the principal band possessed distinct peak approaching Doppler velocities separated by missing data in the clear air, while the receding wind maxima cannot be differentiated. As a result, VORTRAC identified an incorrect RMW (~60 km) and an incorrect center displaced to the northeast of the geometric center based on the reflectivity. The incorrect RMW was slowly adjusted in time and approached a more reasonable value ~40 km few hours later. Fluctuations of the RMWs on the order of 20 km occurred after 07 UTC that were physically not plausible. Once VORTRAC locked in several incorrect RMWs and center locations at the beginning of the analysis, it was very difficult for VORTRAC to adjust to the "correct" center because the statistical information will discard the "correct" as an outlier. Similar experiences with other test cases suggest that the initial analyses near the edge of Doppler range are the most difficult, but also the most critical to the stability and quality of the continuing analysis. In particular, center determination in cases like Ike requires additional program logic, and may require additional algorithms. Improvements in radar data quality control, automatic inclusion of real-time operational center and RMW estimates, and new radar algorithms are currently being evaluated to better handle this situation.

Ike, with a relatively large eye near landfall, passed by KHGX at a distance of less than 30 km. KHGX was essentially inside the eyewall between 07-10 UTC. In this situation, VORTRAC is unable to provide useful information because the full tangential winds in the eyewall cannot be derived in theory. The pressure rise of Ike seen in Fig. 3 after 05 UTC is an artifact because Ike was too close to KHGX. Even if VORTRAC was able to identify the correct RMW at ~30 km, the computation domain of the pressure deficit would be too limited to properly apply the environmental surface pressure measurements as boundary conditions. The central pressure of Ike peaked around 09 UTC, which coincided with Ike's center passing by KHGX at the closest range. After that, Ike's central pressure deepened as Ike moved away from KHGX. This artificial pressure evolution was also found in other hurricanes passing too close to the radar. These results underscore the need to disseminate VORTRAC results with a warning flag when the radar is located within the RMW, or when there are insufficient data to properly apply the environmental surface pressure measurements.

Summary and Future Work:

The project is progressing well and on schedule. We completed the VORTRAC runs for 12 historical hurricanes. Preliminary examination of the 12 cases including Ike has revealed several challenging characteristics capable of confusing the VORTRAC algorithm. Detail study of these 12 cases will be conducted to compile a list of factors that create problems for the VORTRAC algorithm. We will modify the logic used in VORTRAC to improve the results for real-time operations.

Table 1. The list of 12 hurricanes used in this study.

Year	Max. Intensity (Kts)	Hurricane
2005	110	Katrina
2005	105	Dennis
2005	105	Wilma
2005	100	Rita
2005	65	Cindy
2005	65	Ophelia
2007	80	Humberto
2008	75	Dolly
2008	90	Gustav
2008	95	Ike
2009	60	Ida
2011	75	Irene

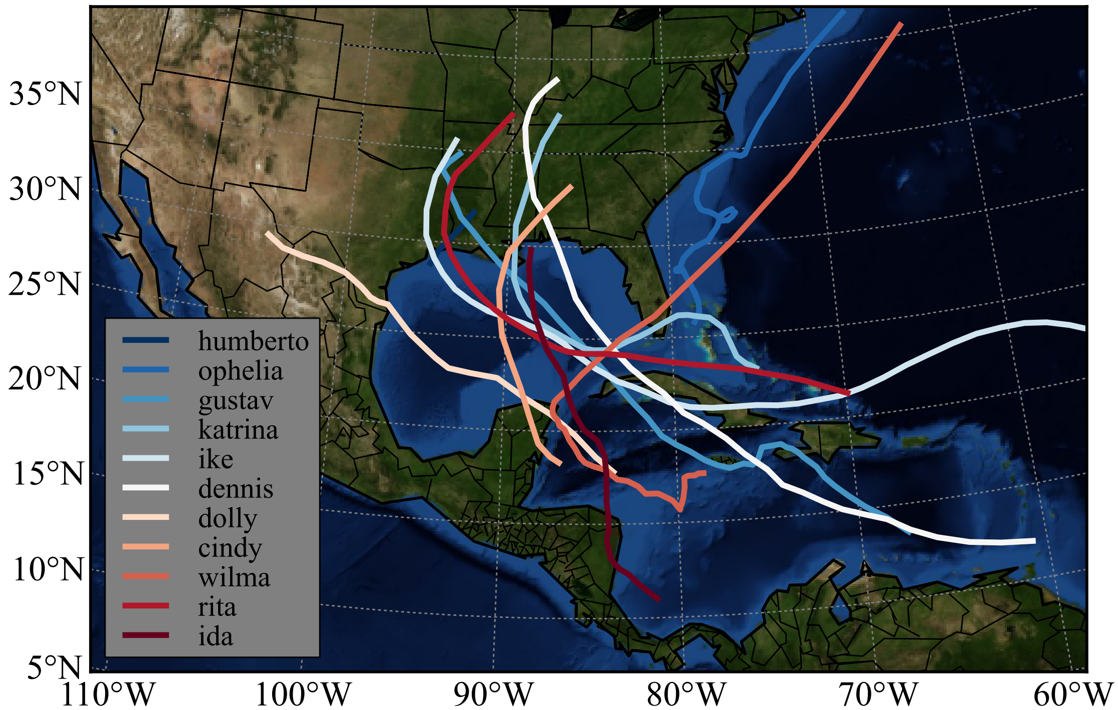

Figure 1. The best tracks of 12 hurricanes selected in this study.

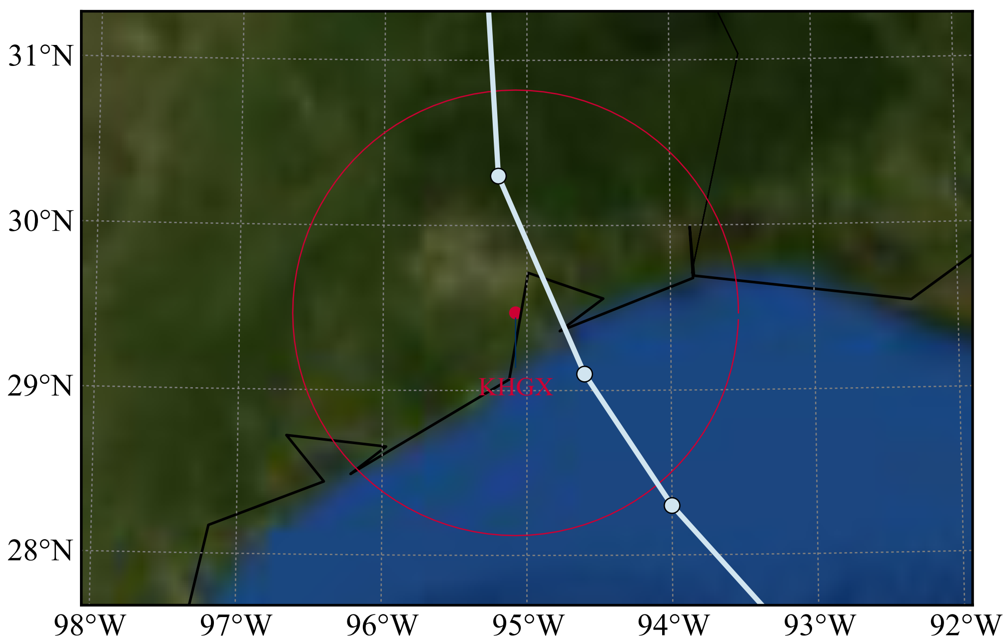

Figure 2. Best track of Hurricane Ike near KHGX.

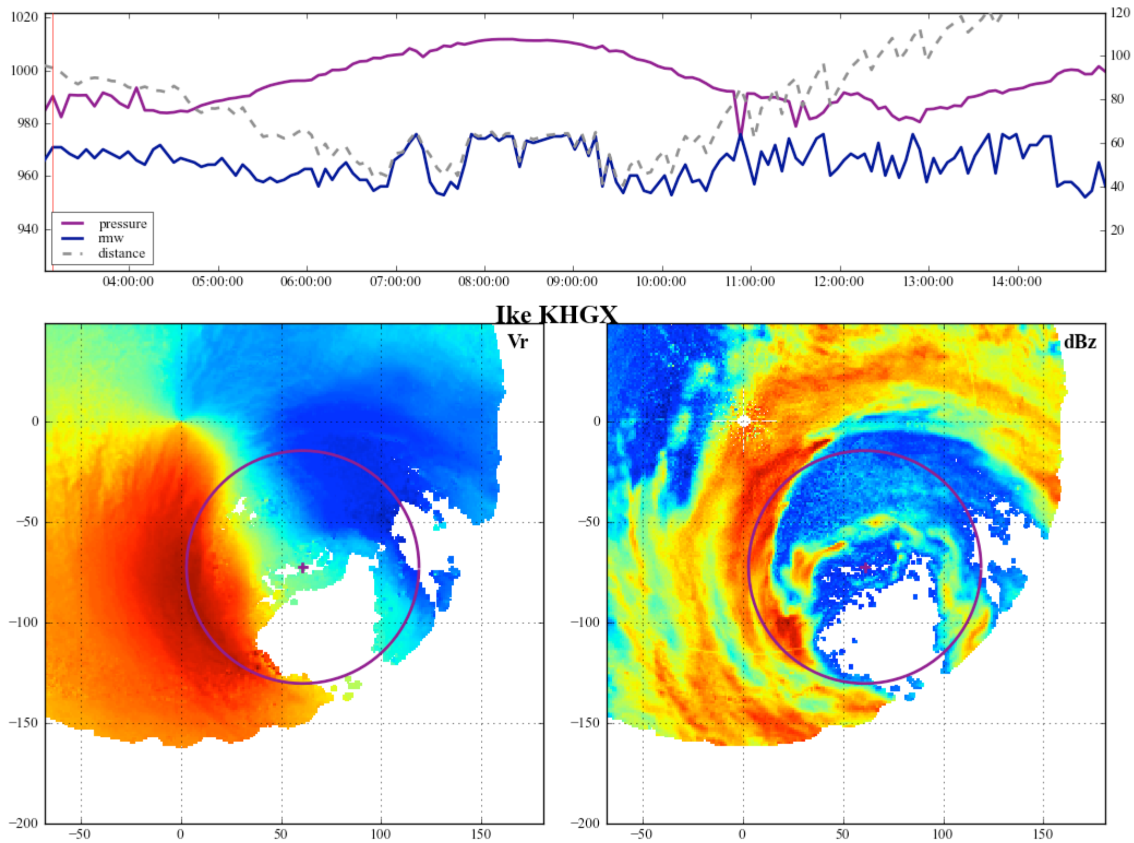

Figure 3. Top panel illustrates Hurricane Ike's central pressure, radius of maximum wind (RMW) and the distance between the radar and the VORTRAC-determined hurricane center. Lower panels present the observed Doppler velocity (left) and reflectivity (right). The KHGX radar is located at (0, 0) and the purple circle is the VORTRAC-derived RMW at this time.