

NOAA Joint Hurricane Testbed (JHT) Progress Report, Year 2

Date: January 31, 2012
Project Title: *Development of a Real-Time Automated Tropical Cyclone Surface Wind Analysis*
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Project Dates: Aug.2011-Jul.2013

1. Long-Term Objectives and Specific Plans to Achieve Them

Although surface and near surface wind observations and flight-level winds and their proxies exist in sufficient quantity to create high quality tropical cyclone surface wind analyses (cf., H*Wind analyses; Powell et al. 1998), a real-time and fully automated surface wind analysis system is not available at the National Hurricane Center (NHC). Such analyses could however be invaluable; providing useful information for a variety of operational products.

In this project we endeavor to create a real-time and fully automated surface wind analysis system at NHC by combining accepted operational wind reduction procedures and a comparably simple variational data analysis methodology (Knaff et al. 2011). Specifically, this project will make use of the Franklin et al (2003) flight-level to surface wind reduction findings along with current operational procedures and the automated analysis and quality control (QC) procedures used in the multi-platform tropical cyclone surface wind analyses (MTCSWA; Knaff et al. 2011). The aircraft reconnaissance wind data (flight-level and SFMR), and the MTCSWA satellite-based MTCSWA will be used. The MTCSWA will serve as a first guess field with very low weighting and the aircraft-based data will be composited over a finite period of time and analyzed. The analysis will be performed on a polar grid at a common 700-hPa level and adjusted to the surface level (i.e. 10-m). The proposed wind analysis will run at NHC and make use of the local data stream and JHT servers. The resulting two-dimensional wind analysis will produce 1-min sustained winds valid for 10 meter (m) marine exposure with sufficient resolution to properly capture the radii of maximum winds. The polar grid resolution and domain size will be consistent with the resolution of the aircraft reconnaissance data and the needs of the forecasters.

The timeline for Year 2 of this project is provided in the Appendix.

2. Accomplishments

The accomplishments on the three main project tasks are described below.

Aug 2012 – Real-time testing at CIRA and on JHT servers continues

Dec 1012 – Evaluation of the analyses, gather feedback from NHC

Jan 2013 – Modify analysis parameters based on feedback and evaluation results

Feb 2013 – Rerun cases, if necessary

1. **Real-time Testing:** Using procedures developed in Year 1, which determined the analysis timing, flight-level-to-surface reduction factors, data weights for the variational analysis and inflow angles, scripts were run on a CIRA workstation that gathered all the necessary data and created analyses when sufficient aircraft data were available. The outputs of the analyses (analyses are generated at T-:30, T and T+1:30) were posted to ftp://rammftp.cira.colostate.edu/knauff/JHT_TCSWA/ analyses for each storm are posted in subdirectories by ATCF storm number. The file naming convention B, E, and L in the name for analyses generated at T-:30, T and T+1, respectively was adopted. In addition, **extra effort** was made to create X vs. Y files of the wind analyses (*.grd) and files that contained the flight-level and SFMR wind vectors adjusted to a common 700 hPa analysis level (*.sfc) in GEMPAK/NAWIPS format. The files cover a large domain (600 km x 600 km) and are available in the same ftp location as above.
2. **Modify analysis based on feedback and evaluation of results:** Conducting real-time analyses often demonstrates flaws in the techniques used. This was certainly the case during our real-time testing. Analyses showed that if azimuthal gaps in the aircraft coverage were large the analysis system did a poor job of carrying the data information into the data void regions. This resulted in many odd looking analyses. There were two causes for this difficulty. 1) MTCSWA weights were actually negative in the core region of the storm, and 2) the azimuthal data filters were large enough in some cases. Fortunately the problems could be rectified by 1) slightly increasing the data weights of the MTCSWA inside 150 km and making the filter weights dynamic (i.e. a function of data coverage). The data weights are now ~ 1/40th of the aircraft-based data whereas before they were essentially zero or as mentioned above negative. We also learned that our variational data analysis method needs to be constrained, albeit weakly. In addition when azimuthal gaps are larger than 120 degrees the azimuthal filter is increased allowing the information from the existing data to be use more efficiently in data void regions. We also fixed a logical error in the wind radii estimation algorithm that failed with the large size of Hurricane Sandy, whose 34-kt wind radii extended beyond our 600 km analysis domain. Finally, we relaxed the first pass of the automated quality control to allow more data to make it into the analyses. Some inner core winds were being erroneously removed from the analyses.
3. **Rerun 2010-2012 Cases:** Using the modifications mentioned above all the T+1:30 analyses that were possible 2010-2012 were rerun and posted to the ftp site listed in item 1. Efforts are underway to update the web site showing these results. Only 2012 is completed now. Re-running the 2012 cases resulted in improved analyses as shown in Figure 1-3, which shows some representative cases.

A couple notes about these figures are that the reruns graphics contain a slightly larger domain and that we accidentally overwrote over the original Sandy analyses. The larger domain now matches that of the MTCSWA plots produced by NESDIS operations and allows for better comparison to those inputs. Nonetheless these figures show the impacts of the changes in our analysis software. Many analysis caused artifacts

caused by a lack of information and an analysis that was nearly unconstrained in certain areas are now rectified.

3. Plans for the remainder of Year 2

Year 2 will continue with the milestones (Appendix). The plan is work with NHC technical staff as the season approaches to enable display and or transition to operations, depending on JHT decisions. We continue to need some help getting this product seen by the Specialists. NHC will need to ingest the files generated at CIRA and display them on operational NAWIPS displays. Success of Year 2 of this project continues to depend on getting technical support from NHC and JHT.

References:

Franklin, J. L., M. L. Black, and K. Valde, 2003: GPS dropwindsonde wind profiles in hurricanes and their operational implications. *Wea. Forecasting*, **18**, 32–44.

Knaff, J.A., M. DeMaria, D.A. Molenaar, C.R. Sampson and M.G. Seybold, 2011: An automated, objective, multi-satellite platform tropical cyclone surface wind analysis. *J. of App. Meteor.*, **50**, 2149-2166.

Powell, M. D., S. H. Houston, L. R. Amat, and N. Morisseau-Leroy, 1998: The HRD real-time hurricane wind analysis system. *J. Wind Eng. Ind. Aerodyn.*, **77-78**, 53–64.

Appendix: Year-2 Project timeline:

- Apr 12 – modify code following post-IHC recommendations
- May 2012 – Start to test the automated routines in real-time at CIRA
- May 2012 – Begin Development scripts to automate the local (CIRA) data ingest, quality control and analysis on a JHT workstation (if available)
- Jun 2012 – Work with NHC to develop text and graphical output.
- Aug 2012 – Real-time testing at CIRA and on JHT servers continues
- Dec 1012 – Evaluation of the analyses, gather feedback from NHC
- Jan 2013 – Modify analysis parameters based on feedback and evaluation results
- Feb 2013 – Rerun cases, if necessary
- Mar 2013 – Present results at the IHC/ Interdepartmental Hurricane Forum
- May 2013 – Prepare the analysis for a full season of real time testing
- Jun 2013 – Gather feedback and make appropriate changes to the analysis system
- Jun 2013 – Transition the analysis to NHC control, if approved for implementation.
- Jun 2013 – Project ends

*completed

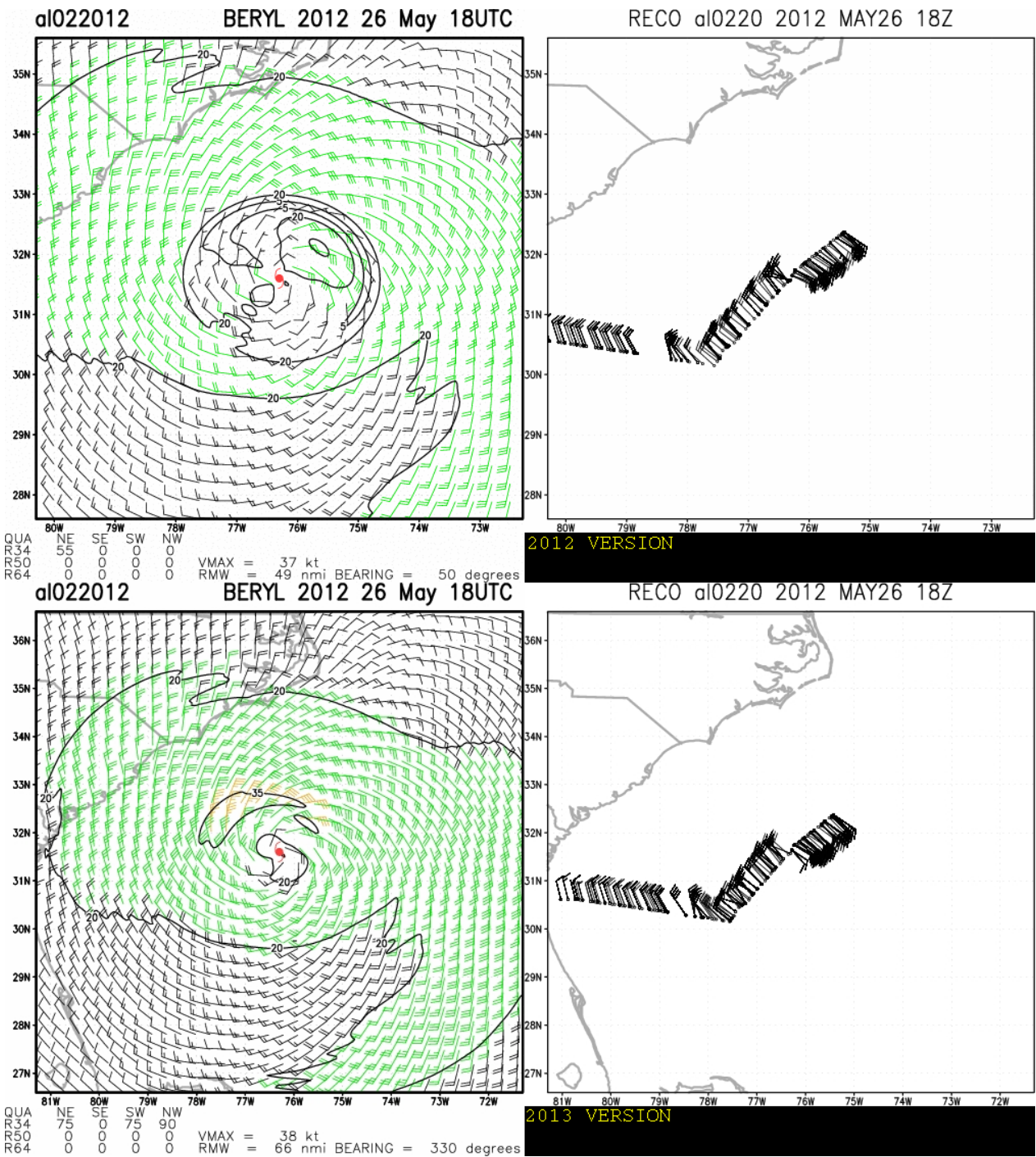


Figure 1: Example of tropical cyclone Beryl on 26 May 18 UTC. The version of the analysis used during the 2012 hurricane season (top) and the new analysis proposed for the 2013 hurricane season (bottom).

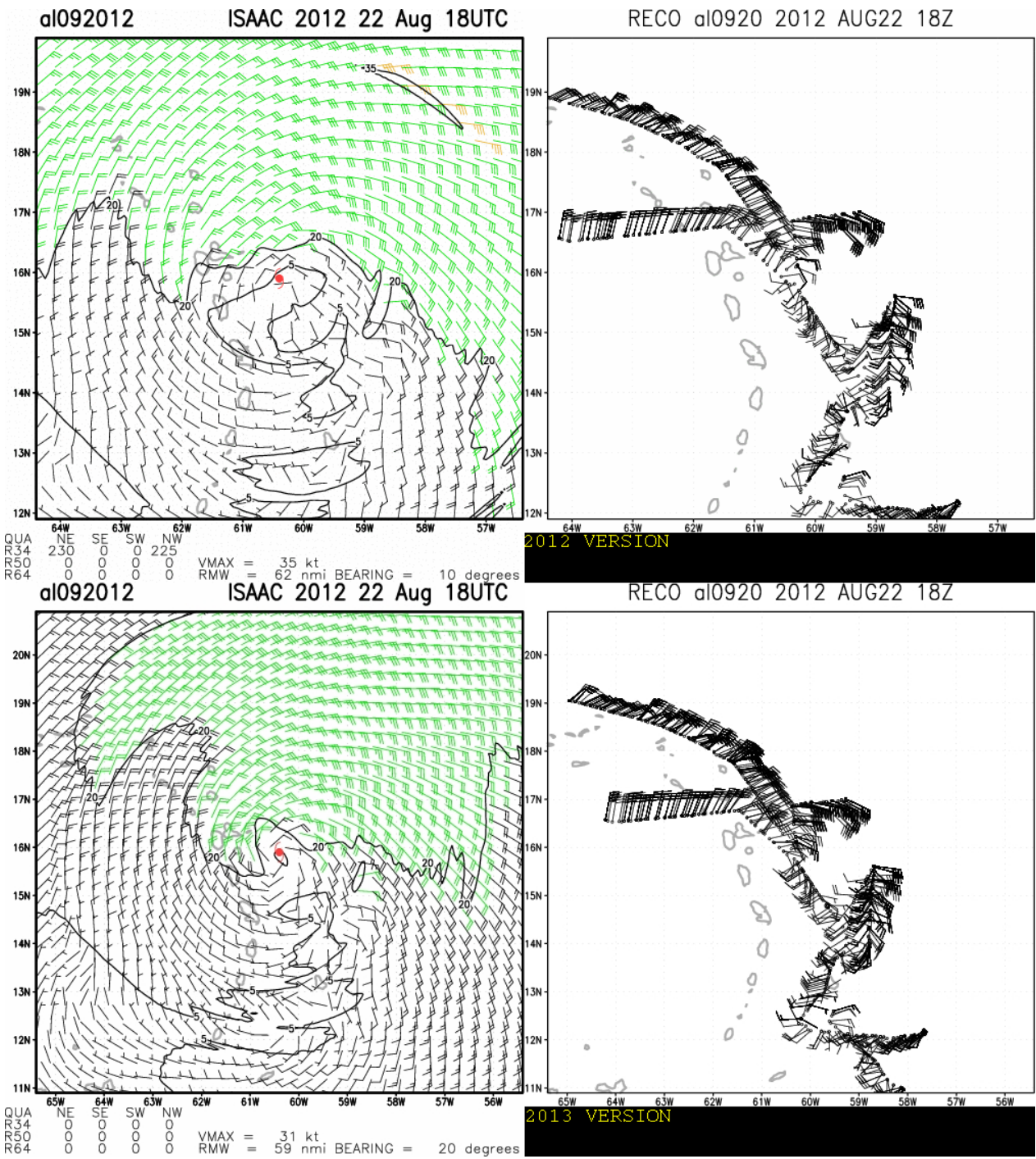
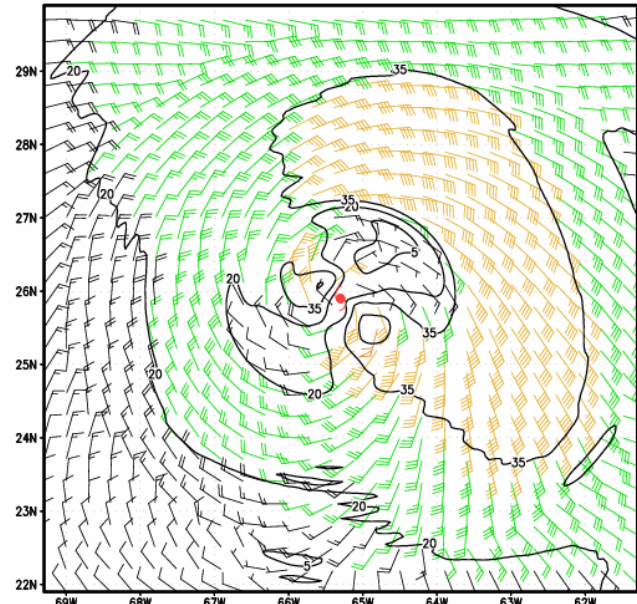


Figure 2: Same as Fig. 1 except for Tropical Storm Isaac on 22 August 18 UTC.

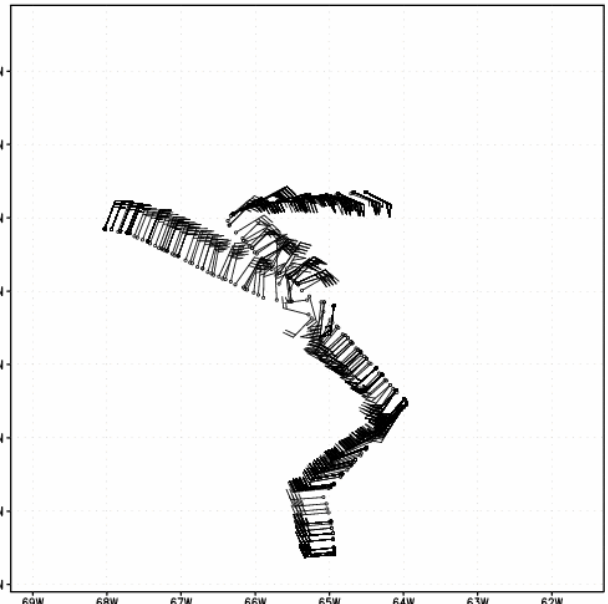
dl172012 RAFAEL 2012 16 Oct 06UTC



QUA	NE	SE	SW	NW	
R34	220	200	40	185	
R50	0	45	20	25	
R64	0	0	0	0	

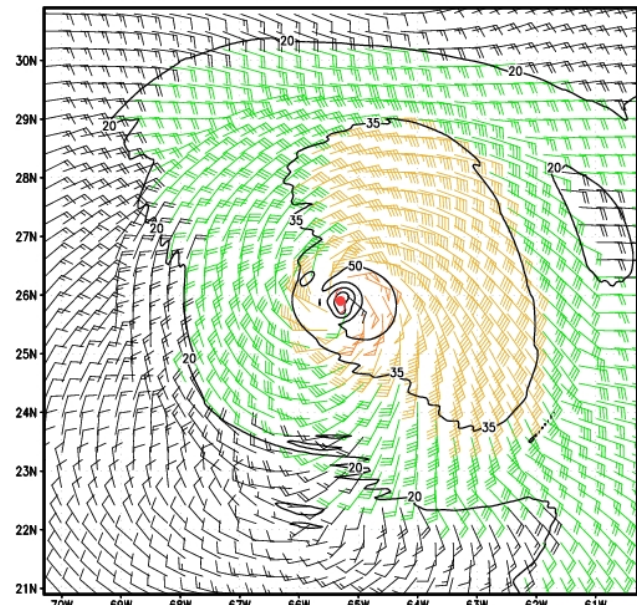
VMAX = 59 kt
 RMW = 38 nmi BEARING = 140 degrees

RECO dl1720 2012 OCT16 06Z



2012 VERSION

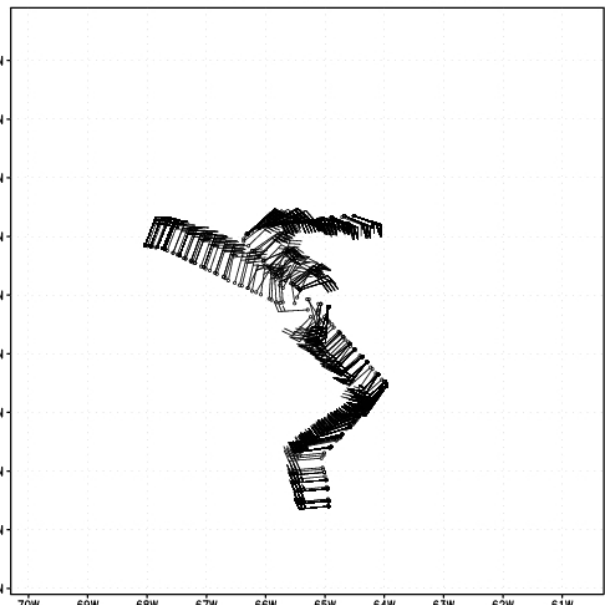
dl172012 RAFAEL 2012 16 Oct 06UTC



QUA	NE	SE	SW	NW	
R34	210	200	55	185	
R50	50	50	25	30	
R64	0	0	0	0	

VMAX = 62 kt
 RMW = 38 nmi BEARING = 130 degrees

RECO dl1720 2012 OCT16 06Z



2013 VERSION

Figure 3: Same as Fig. 1 except for Hurricane Rafael on 16 October at 06 UTC.

