NOAA Joint Hurricane Testbed (JHT)
Progress Report, Year 1

Date: Aug 1, 2012
Project Title: *Development of a Real-Time Automated Tropical Cyclone Surface Wind Analysis*
Principal Investigators: Renate Brummer, Mark DeMaria (Co-I), John Knaff (Co-I)
Affiliations: Brummer (CIRA/CSU), DeMaria and Knaff (NOAA/NESDIS)
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 six main project tasks are described below.

1. **Desired analysis properties were determined** through discussion with NHC project advisors. The basic questions of when the analysis would be run, how datasets would be weighted and the flight-level-to-surface wind reductions that

would be used were determined for the initial analysis attempts.

Analysis timing: Analyses would be triggered at 30 minutes prior to synoptic time (T), at T and again at T+1:30. This would fit the Hurricane Specialist's potential need namely generation of the TC Bogus/TC vitals/request for model guidance at T-:30 and T and just prior to releasing the advisory package.

Flight-level-to-surface reduction factors (FLTSRF): Franklin et al. (2003) is used as guidance, where eyewall FLTSRF would be used within twice the radius of maximum wind (RMW) and outer vortex FLTSRF would be used outside four times RMW and a linearly weighting of eyewall and outer vortex FLTSRF would be used for 2RMW < r < max (4RMW, 2RMW+25 n mi). In addition the FLTSRF would be a function of storm direction reduction factors (i.e., left quadrants would be (4%) 12% to 17 % higher than the right quadrants in the (inner core) outer vortex, depending on level). This will be maintained in the outer vortex. Finally it was agreed that convective FLTSRF would be used throughout, thus producing conservatively high surface wind estimates. Many of these changes were made post IHC as the method for addressing FLTSRF was updated following that meeting.

Data weights for the variational analysis: It was decided that the data weights for the flight-level winds and the SFMR surface wind estimates would be a function of the magnitude of the flight-level winds. SFMR would be preferentially weighted when the flight-level winds exceeded hurricane strength and flight-level winds would be preferentially weighted when the flight-level winds were less than 50-kt. Again more equal weighting will be used when the flight-level winds are between 50 and 64 kt.

Inflow angles: A consensus was reached that 20 degree inflow seemed reasonable.

2. **Scripts and programs to combine aircraft center fixes, operational best tracks and OFCI/OFCL** were created. These take into account whether the analysis is run at T-:30, T, or T+1:30. Points from the CARQ lines and the latest available official forecast and all of the aircraft center fixes in the fdecks are sorted and provided to the analysis software. These files (*.inp) are the starting point for each analysis.

3. **Scripts and programs were developed to ingest real-time aircraft flight-level, and SFMR datasets**. GPS sonde decoders are under development.

4. **The design of the local data ingest (i.e. aircraft from NHC, MTCSWA from NESDIS, a/f decks from NHC) and analysis** was completed. Aircraft, ATCF, and MTCSWA datasets are being mirrored locally and the *.inp files will be generated automatically at T-:30, T and T+1:30, when Atlantic and East Pacific storms become active.

5. **Automated analyses created and posted on CIRA ftp servers:** Using the *.inp files, and the automated data ingest, analyses are generated at T-:30, T and T+1:30 and posted to ftp://rammftp.cira.colostate.edu/knaff/JHT_TCSWA/ analyses for each storm are posted in subdirectories. Preliminary analyses produced errors that have been since rectified. We are now are waiting for the next TC reconnaissance mission to continue the debugging process. The file naming convention has B, E, and L in the name for analyses generated at T-:30, T and T+1, respectively. Examples of the late analyses for Tropical Storm Debby are shown in Figure 1 -3.

6. **NAWIPS Grids Created:** The X vs. Y files that result from our analysis are created using GEMPAK. The files cover a large domain and can be picked up at ftp://rammftp.cira.colostate.edu/knaff/JHT_TCSWA/ in the atcf named directories. Files have a .grd suffix.

3. Plans for Year 2

Year 2 will continue with the milestones (Appendix). The plan is to run the analyses during the 2012 hurricane season, fixing bugs and adding capabilities(e.g., motion relative wind files in gempak format) and coordinating with NHC technical staff as the season goes along. 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 depends on getting some 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. Molenar, C.R. Sampson and M.G. Seybold, 2011: An automated, objective, multi-satellite platform tropical cyclone surface wind analysis. *J. of Applied Meteorology and Climatology.* **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.

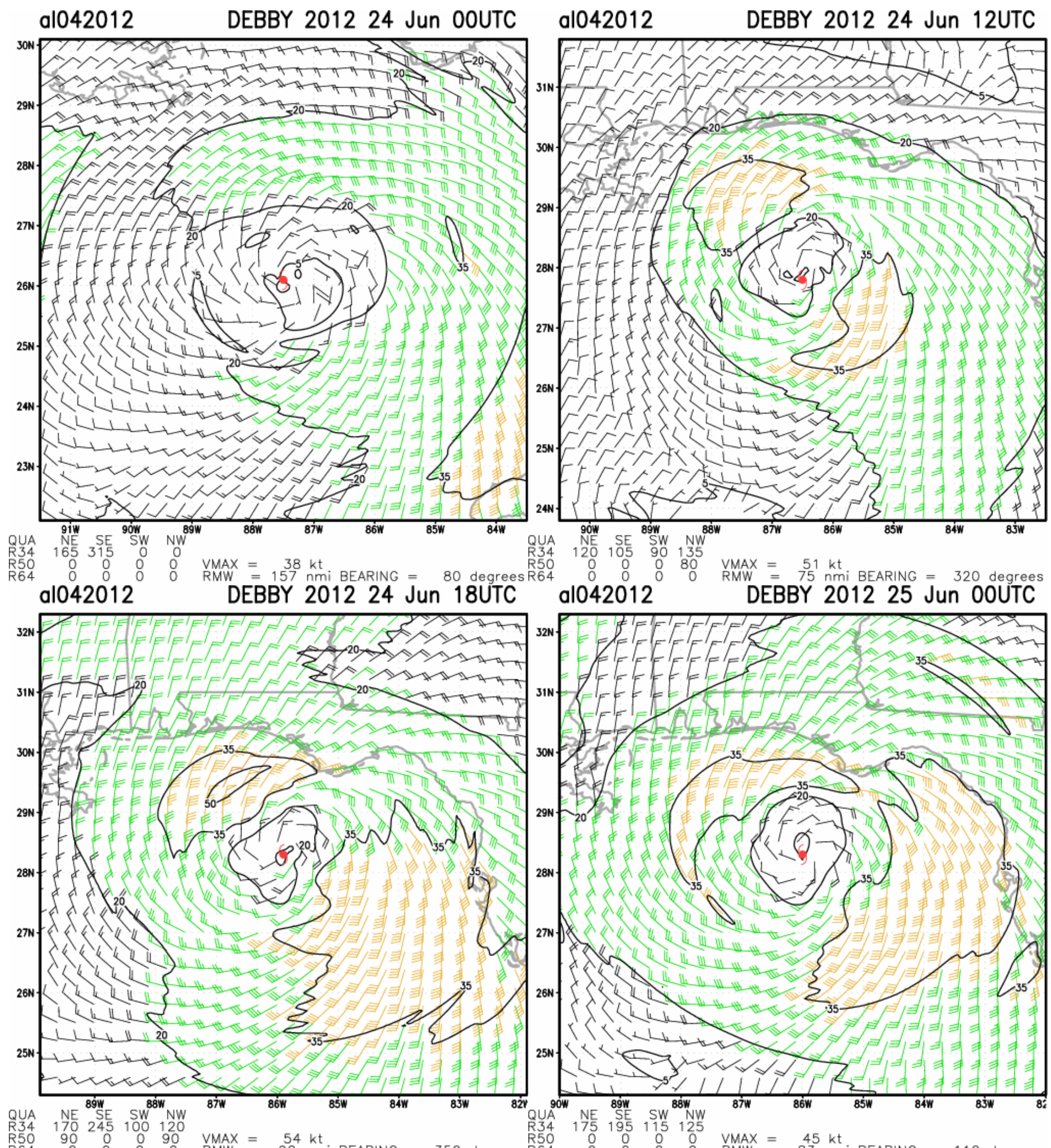

Figure 1: Late (T+1:30) surface wind analyses for Tropical Storm Debby. Analyses shown for 24 June 00 UTC – 25 June 00 UTC. Wind radii information and storm statistics shown at the bottom of each panel.

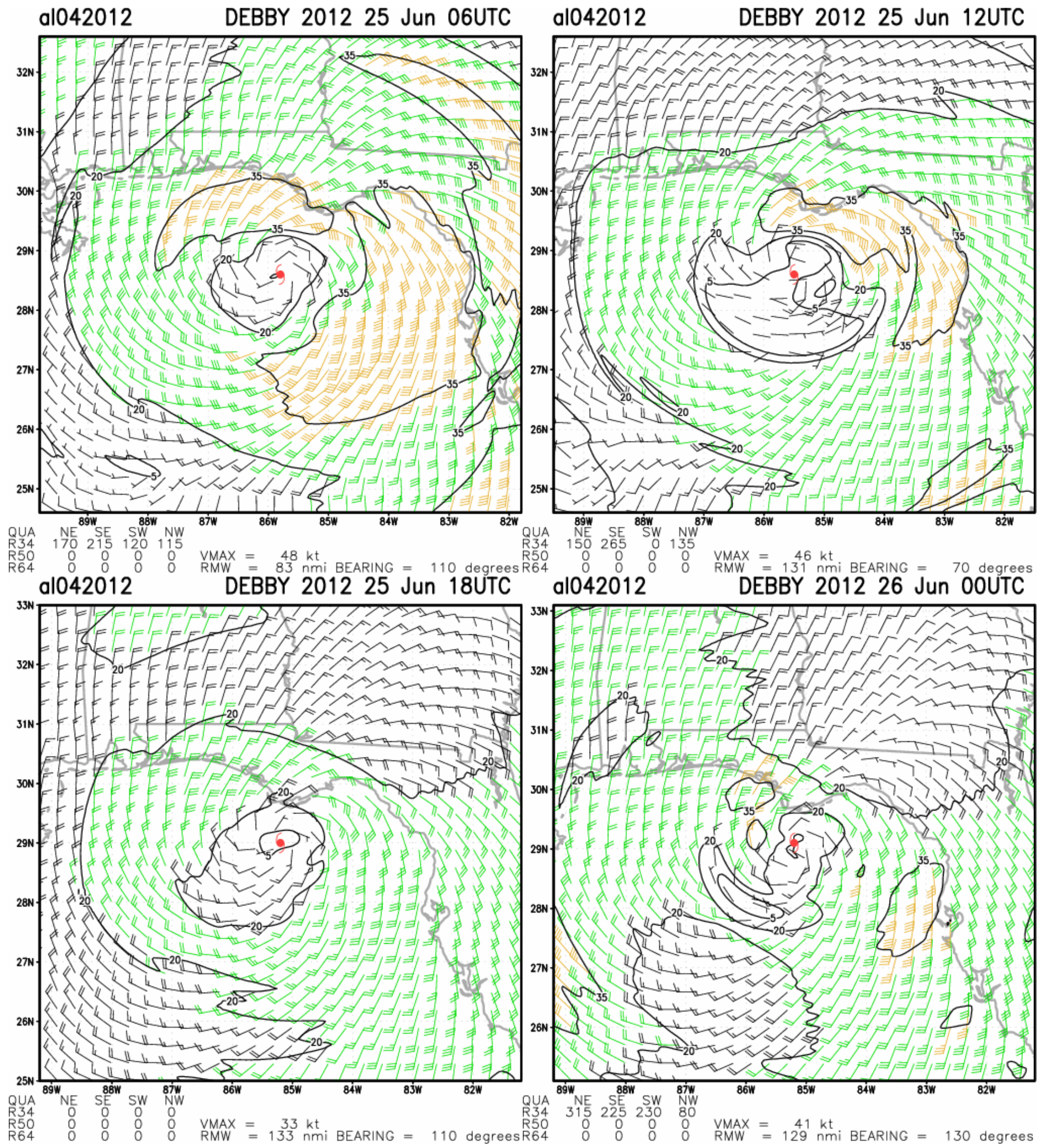

Figure 2: Same as figure 1, except for 25 June 06 UTC – 26 June 00 UTC.

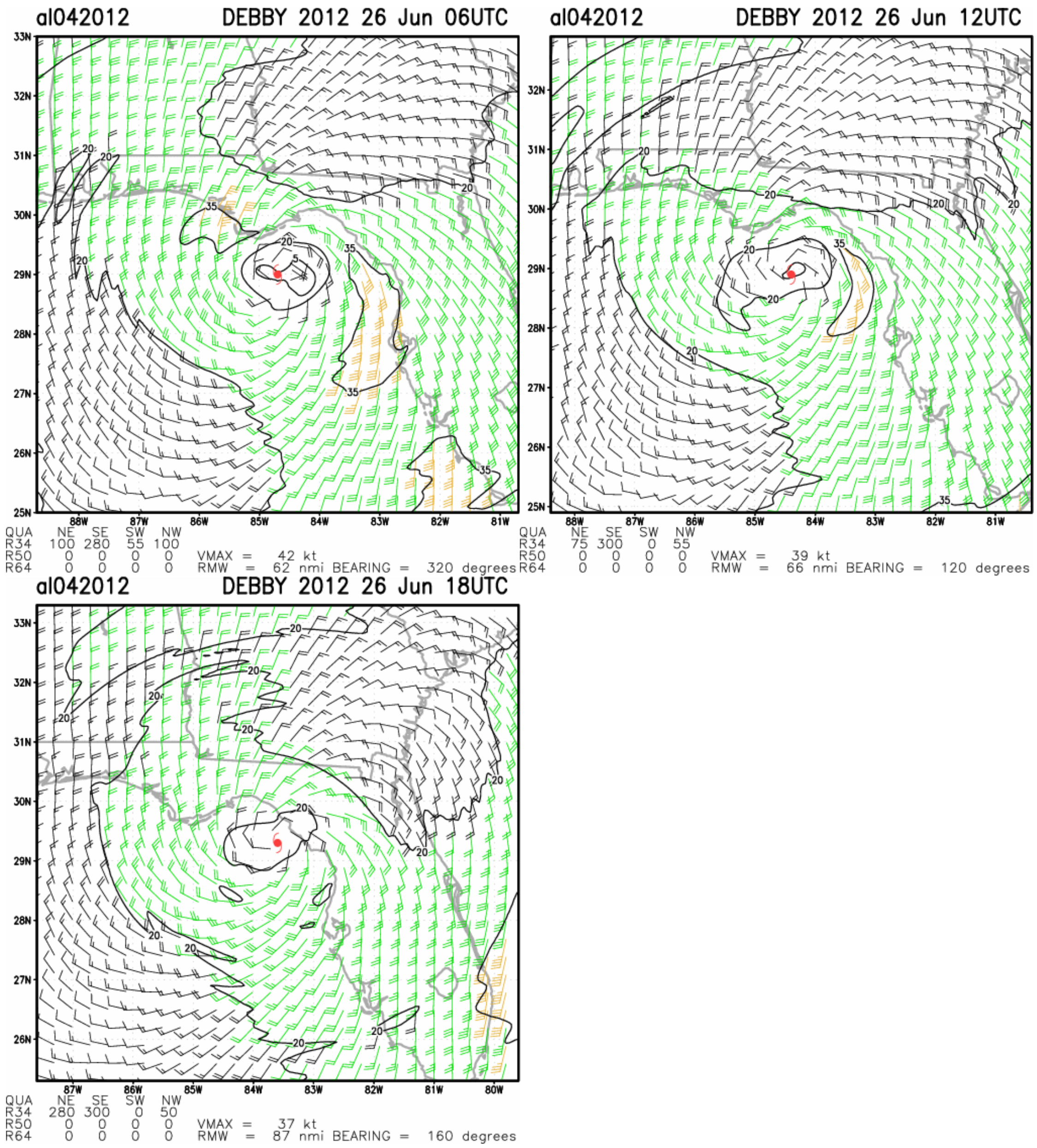

Figure 3: Same as figure 1, except for 26 June 06 UTC – 26 June 18 UTC.

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)
June 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
May 2013 – Prepare the analysis for a full season of real time testing
June 2013 – Gather feedback and make appropriate changes to the analysis system
June 2013 – Transition the analysis to NHC control, if approved for implementation.
June 2013 – Project ends