

**Development and Implementation of NHC/JHT
Products in ATCF
Final Report for Second Year (2006)**

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Introduction

This report describes progress for the first year of a two-year project addressing implementation of JHT products into the ATCF, upgrading the capability of the ATCF, and addressing NHC user requirements as discussed at our yearly requirements meeting and throughout the year. The primary tasks in the proposal were:

- 1) To evaluate wind radii CLIPER models developed and implemented during the previous season,
- 2) To implement the Monte Carlo wind probabilities on ATCF,
- 3) To implement the Goerss Probability Consensus Error (GPCE) on ATCF,
- 4) To streamline imagery overlays and add products as requested,
- 5) To improve objective best track capability on ATCF,
- 6) To automate the tropical cyclone fix entry in NHC operations, and
- 7) To modify ATCF user interface and code to improve forecaster efficiency.

Work on most of the items has begun and in some items work is nearly complete. A description of work completed for each of the major tasks is described in the next seven sections.

Wind Radii CLIPER Model Evaluation

The wind radii CLIPER model evaluation was submitted as part of the mid-year progress report. The evaluation is also included as part of a paper to be published in Weather and Forecasting describing one of the models and its performance. Results of the evaluation indicate that both wind radii CLIPER algorithms provide acceptable baselines for evaluating wind radius forecasting skill when compared with the official best tracks from the operational centers (Fig 1). The PI developed homogeneous statistics, standard deviations and significance tests for the forecast wind radii as part of this effort. These are all now folded into the ATCF homogeneous statistics.

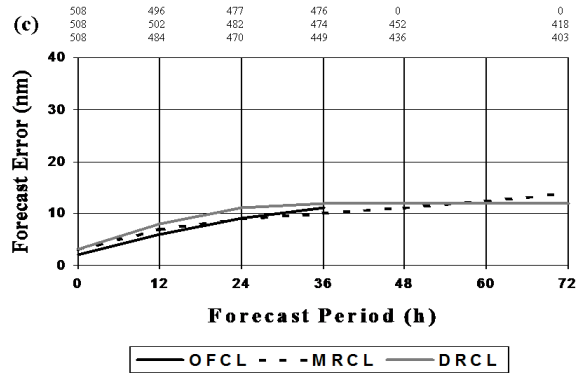
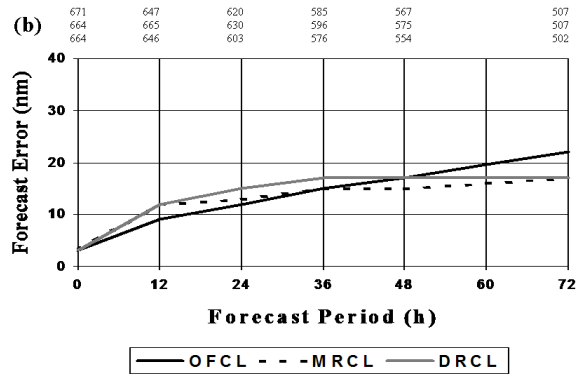
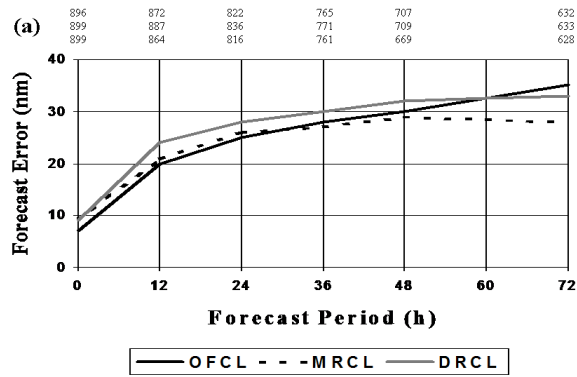


Figure 1. 2004 verification of wind radii forecast through three days. Shown are plots of mean absolute error in nautical miles (1 nm = 1.85 km) for R34 (a), R50 (b) and R64(c) for the official forecast (OFCL), the regression wind radii CLIPER (MRCL) and the parametric wind radii CLIPER (DRCL). The number of cases is listed at the top for each of these models, respectively, from top to bottom.

Monte Carlo Wind Probabilities

The Monte Carlo Wind Probabilities integration is complete. The probability messages were added for 2005, breakpoints and gridded probability computation were added in 2006 and 2007 (Figure 2). A single storm run of the gridded probabilities runs in approximately six minutes on a typical ATCF workstation at NHC. These are now being run on the ATCF at NHC to provide single storm probabilities with the advisory package, and as an aid for setting warnings and watches.

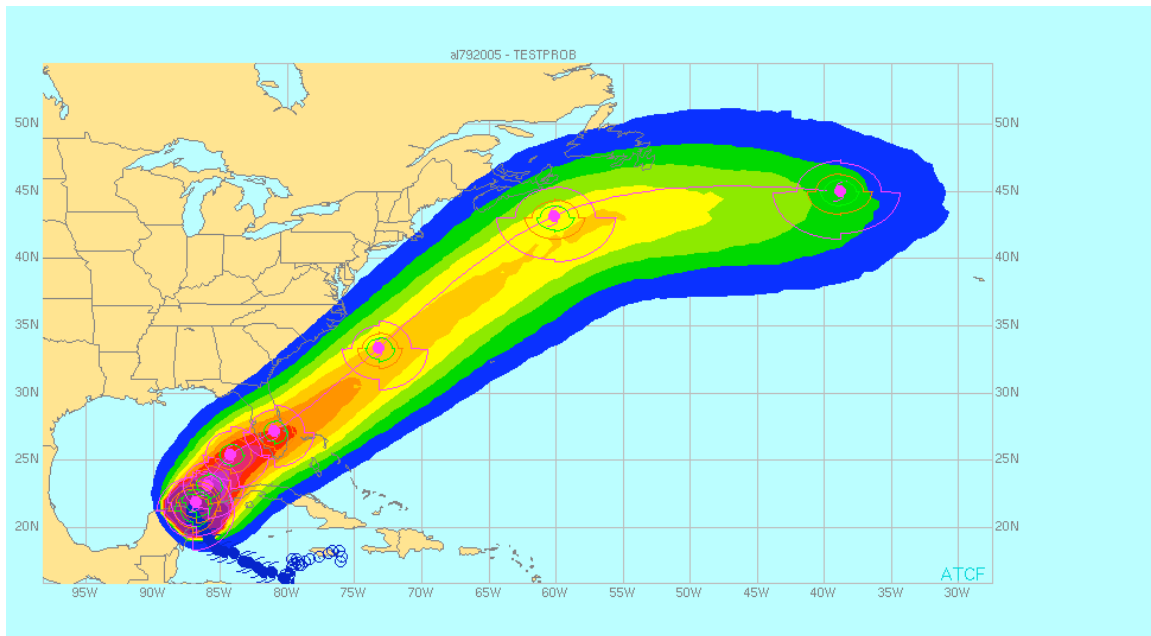


Figure 2. Example of 34 knot 120-hour cumulative wind probabilities for a single storm. The computation takes about six minutes on a typical ATCF workstation at NHC. The forecast track and wind radii for this particular run of the probabilities are overlaid on the graphic for reference. Contour fill starts at 20% (blue) and continues in increments of 10% to 100%.

GPCE

We have completed installation of the computation, display and storage of GPCE (Fig. 3) and updated the GPCE statistics in 2006 and 2007. Some preliminary statistics regarding GPCE performance have been performed. The statistics are currently rudimentary and not available through the ATCF GUI.

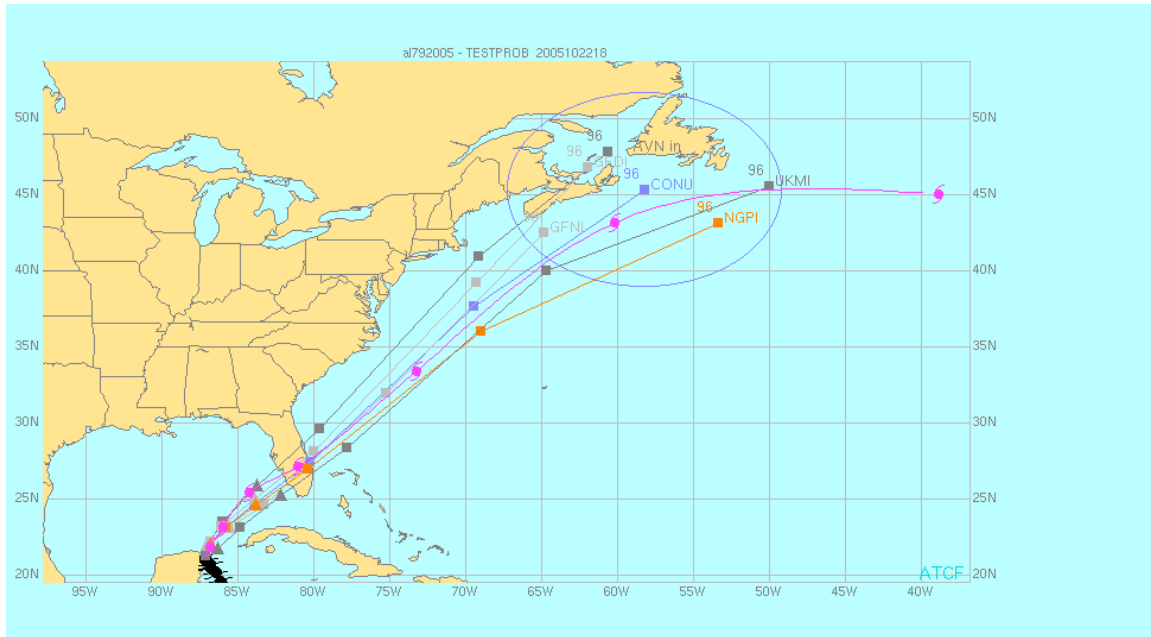


Figure 3. Example of Goerss Probability Consensus Error (GPCE) display on ATCF. GPCE was developed to work with either CONU or GUNA. The GPCE area shown (blue oval) represents an area where there is a 70-75% chance in 96 hours that the verifying track position will occur. Also shown are the multi-model ensemble (CONU) members (labeled) and an official forecast track (purple hurricane symbols).

Imagery Overlays

The imagery overlay capability was in a rudimentary state before this project began. With help from NHC (Chris Sisko), we have improved the imagery retrieval so that the dialog no longer waits for all the imagery to arrive before returning control to the user. We also diagnosed a problem with the NHC firewall that prevented imagery access on the ATCF at NHC. Access to the imagery has been improved in that it is now available as part of the best track dialog. Finally, the image data files have been split into storm directories under the images directory. This was done so that the number of files in a directory doesn't exceed operating system limits. Finally, the AMSU imagery was added to the suite of files available for display. An example of the imagery overlay is shown in Figure 4. All imagery is currently stored by and obtained through the NRL TC Page. We expect to get a/c imagery from NHC to include as part of the imagery archive later this year.

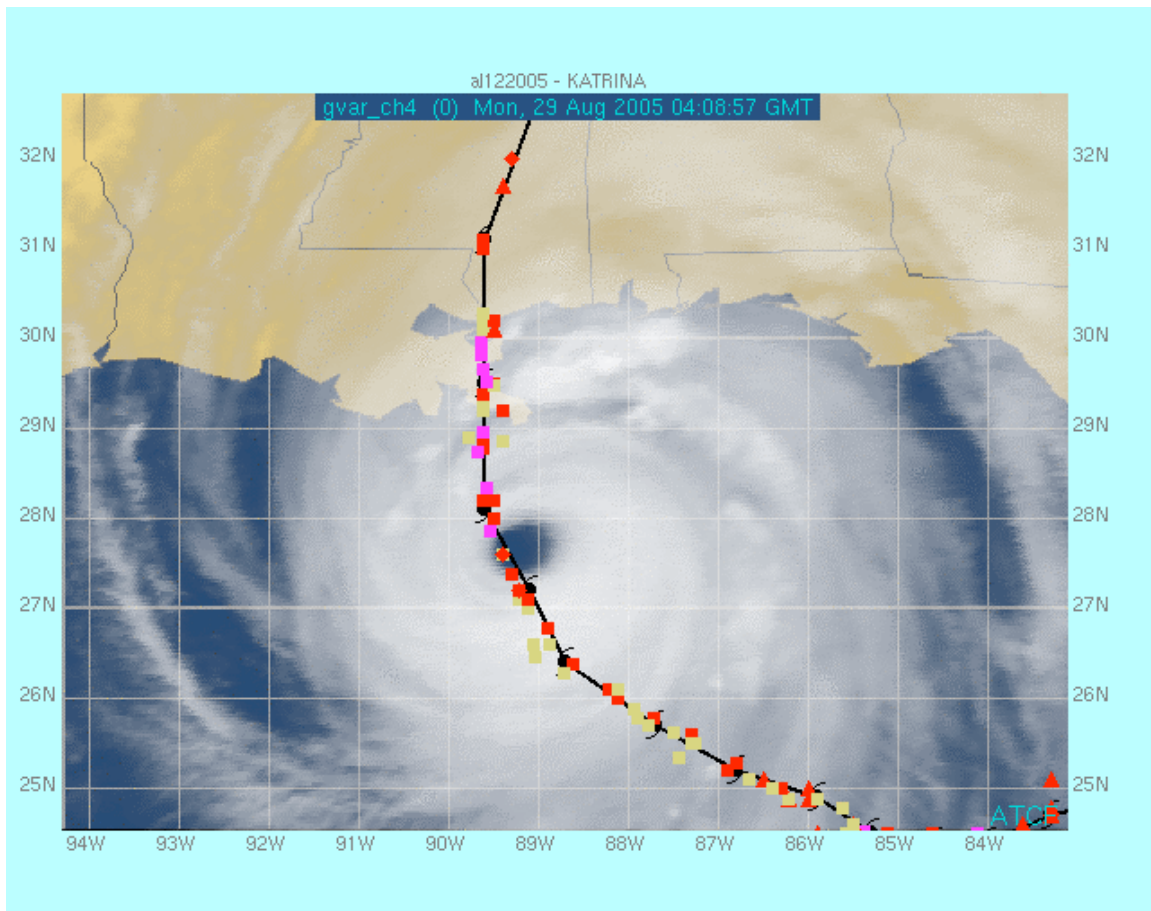


Figure 4. Example of satellite imagery overlay on ATCF. This is an IR image from GOES overlaid on the Katrina track (black typhoon symbols) and fixes of various type. These images are all approximately 10 degree x 10 degree storm centered geographically located TIFF files that reside on a server associated with the TC Page at NRL. Images displayed on ATCF are consistent with those of the TC Page.

Objective Best Track

The objective best track routines for intensity and wind radii have been developed. These routines currently allow a choice of least squares or weighted average to fit the data. The weights for the fixes are currently set by fix type. More work could be done to set the weights according to errors associated with the fix type. There also exists an override capability so that a weight for a fix type from a specific fix agency can be specified. An example of the objective best track for intensity and wind radius (NE quadrant) is shown in Fig. 5. The objective best track routines provide efficient paths for quality control of both fix and best track values.

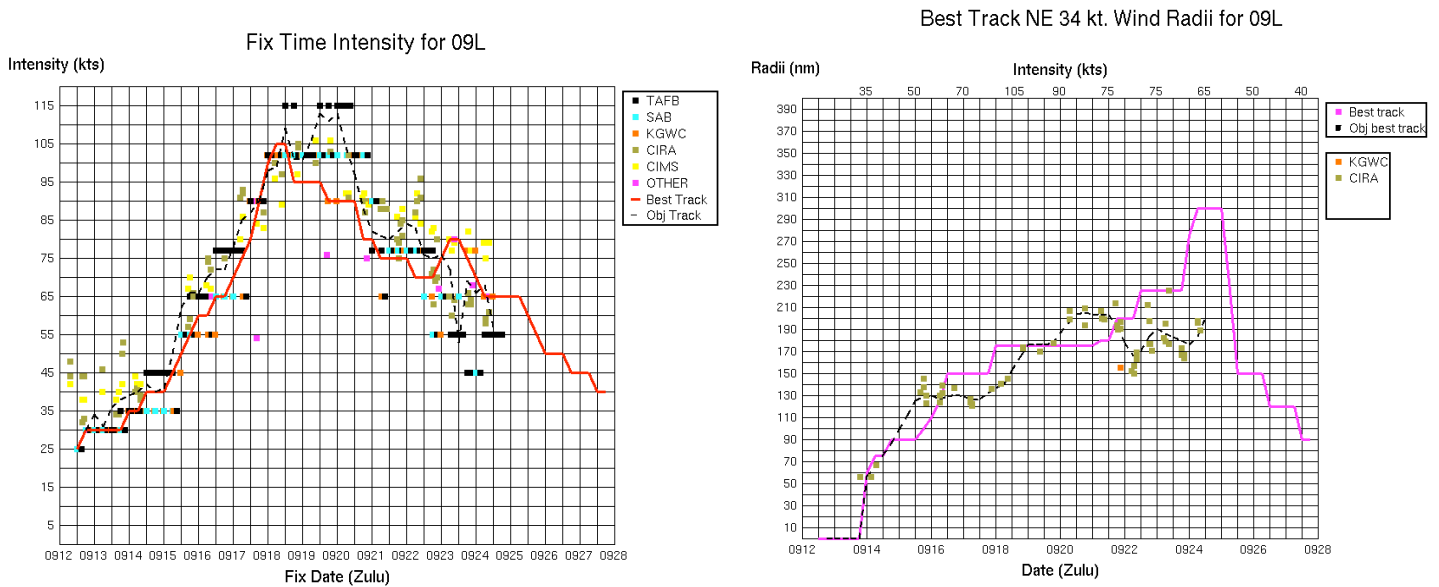


Figure 5. Objective best track intensity and NE quadrant wind radius on ATCF. Solid orange line indicates the best track intensity and solid magenta line indicates best track values of NE quadrant wind radius. Dashed lines indicate the objective best track values.

Automate Tropical Cyclone Fix Entry

The dialogs and software to allow ingest of specific fix types with error checking. For this year, expect to see a couple additions and maybe some minor modifications. This has become a timesaving measure for NHC forecasters. It also prevents gross errors from getting into fix decks. Figure 6 shows the new menu items associated with the fix ingest.

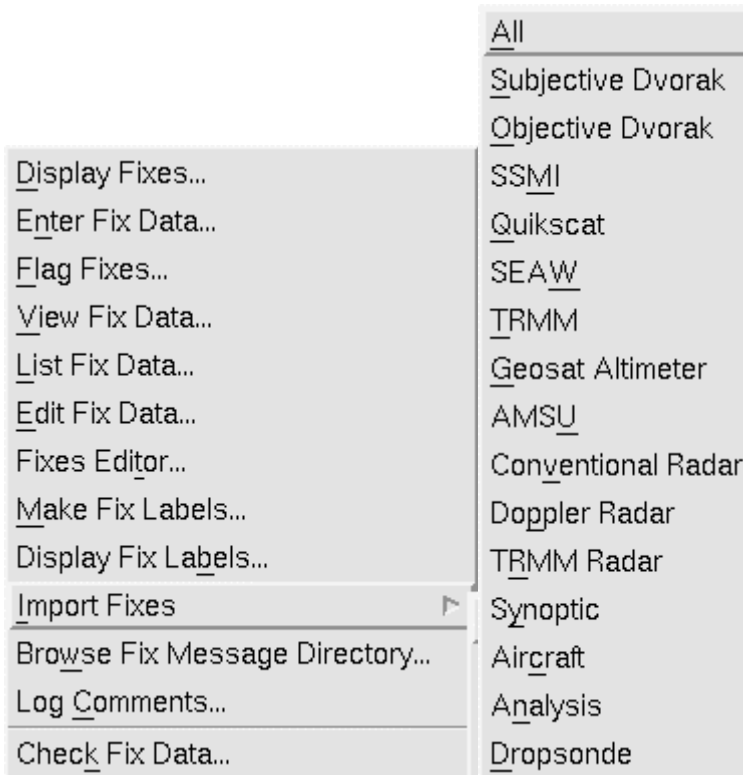


Figure 6. The “Import Fixes” sub-menu is part of the “Fixes” menu on ATCF. The sub-menu brings up a list of possible fix types to import into ATCF. Once a fix type has been selected, all fixes of that type for that particular storm are quality controlled and ingested into ATCF. NHC is working to automate most of its fixes, thereby saving time and reducing human errors associated with typing fixes into menus.

User Interface

Although this task was included as an afterthought, it has been the largest of the tasks and usually takes priority over the other tasks. We have addressed approximately 35 of these requirements from the 2004, 2005 and 2006 requirements lists

List of ATCF Requirements addressed for 2004 upgrade:

- 1 Allow "none" selection of Center/Intensity type for A/C and Synoptic fixes
- 2) When entering an ODT intensity fix, a position should not be required
- 3) Output comments associated with a/c fixes in the fix list
- 4) Default for a 90s storm should be DB rather than TD. Applies to Rebest and Start A Storm
- 5) Develop error bounds checking on 34, 50 and 64 kt wind radii. Applies to Edit Best Track, Re-Best, and Compute dialog.
- 6) Editing best track merge problem. Related to missing 34 kt wind radii
- 7) Improve the listing of the best track to 1 line per best track record
- 8) Display forecast guidance out to 7 days
- 9) Add button to display objective aids dialog that clears objective aids
- 10) Add zoom/un-zoom/full map buttons to forecast track dialog to allow for quick zoom/un-zoom over guidance when making a forecast track

----- Added Oct 2004 -----

- 11) Develop tool to plot objective and best track wind radii vs time with forecast/best track intensity information displayed
- 12) Changed nhc advisory to disable the radii edit boxes for tau's greater than or equal to 96
- 13) Worked on Jim's tc position estimate and tc update message handling
- 14) More work on nhc advisory, geography reference handling
- 15) Implemented dots on time/intensity and time/radii official line when invoked from forecast dialog
- 16) Revived fix conversion code for Chris
- 17) Modified Advisory – Storm State dialog to make list boxes longer and change the `fcst_type` line in the `.adv` file
- 18) Modified checkfdeck to add verbose/concise option for Chris, added extra output for Chris, output entire fix line
- 19) nhc advisory code, if a special is made, replace the current official forecast in adeck with the same forecast and change the techname to the `center_old` name. The new special forecast becomes the new OFCL for that dtg
- 20) Added Dissipated choice to the storm state dialog and added extra tau to the tau listbox
- 21) Fixed a problem with an ungraceful failure of the 4 panel script
- 22) Added option in preferences to display colors based on Saffir-Simpson scale. Added colors to the color preferences dialog
- 23) Modified the objective aids to display out to 10 days (vice 7) and plot out to 5 days as solid, 10 days as dashed lines

- 24) Capability to rebest the wind radii directly from the wind radii vs time graph
- 25) Capability to eliminate EX, TD, DB, XX from objective aid verification
- 26) Add ability to compute statistics by fix site
- 27) Expanded options for the display of wind radii and intensities, allow selection of single or multiple DTGs and single or multiple wind radii.
- 28) Put development level in bogus
- 29) Change defaults in rebest to use old dev level if special type (e.g, XT)

----- Added Oct 2005 -----

- 30) Interactively change line thickness in objective aids dialog
- 31) Add OFCV (Official Valid) once the advisory is sent out. OFCL is the working official forecast
- 32) Add buttons to get previous 00, 06, 12, 24, 36, 48 h run for a given suite of forecast aids
- 33) Add capability to deselect aid (toggle on and off)
- 34) Create circle option in make wind radii and best track dialogs
- 35) Make OFCI default in forecast wind radii
- 36-39) Add option to make wind radii forecast to populate with (4 options)
- 40) Allow forecast wind radii at all taus to 120
- 41) Fix the 12 ft seas bug.

----- Oct-Dec 2006 -----

- 42) Started interactive radial wind radii graphs for rebest and forecast wind.
 - 43) Continued working on fixing ATCF glitches associated with OS change to RHEL 4.0.
 - 44) Added a wind probability title color legend.
 - 45) Added a motion vector and speed label to the radial wind radii graph.
 - 46) Added plotting fix wind radii dots to the rebest radial wind radii graph.
 - 47) Plotting fixes that are within the time range of the fix preferences highlight-fixes range.
 - 48) Added plotting of the aids wind radii to the forecast-wind radial wind radii graph.
 - 49) Decreased the frequency of the axis labeling on the wind radii radial graph.
- Fixed a problem with the homogeneous stat.s dialog.

Conclusions

Most tasks in the original proposal were completed. We have also addressed many NHC user requirements with a limited budget. The following are estimates of completion status of functions covered in the original proposal.

- 1) To evaluate wind radii CLIPER models developed and implemented during the previous season (100%)
- 2) To implement the Monte Carlo wind probabilities (100%),
- 3) To implement the Goerss Probability Consensus Error (GPCE)
 - a. Data retention (100%)
 - b. Display (100%)
 - c. Evaluation (50%),
- 4) To streamline imagery overlays and add products as requested (100%),
- 5) To improve objective best track capability (80%),
- 6) To automate the tropical cyclone fix entry in NHC operations (100%), and
- 7) To modify ATCF interface and code to improve forecaster efficiency (100%).

Acknowledgements

We wish to acknowledge the efforts of Chris Sisko, James Franklin, James Gross and Colin Mcadie (NHC), John Knaff and Mark DeMaria (NOAA/NESDIS), Tim Marchok (GFDL), Ed Fukada (JTWC), Jim Goerss (NRL) and the NRL TC Page group. We also wish to thank the members of the Joint Hurricane Testbed.