JHT Project Supplemental Information as of January 2006
Improvements in Deterministic and Probabilistic
Tropical Cyclone Surface Wind Predictions
August 1, 2003-August 1, 2005

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This project included two parts. The first was to improve the SHIPS forecasts through inclusion of aircraft reconnaissance and GOES radial profile information, and the second was to develop a Monte Carlo model for estimating the probabilities of 34, 50 and 64 knot winds associated with the NHC official forecast. The final report for this project was submitted in August of 2005.

At the time of final report, one part of the project was not completed. The tests of the intensity model that combined the GOES and reconnaissance data (the GOES and Recon Intensity Prediction model, GRIP) were not completed yet. Preliminary results from 2004 suggested that there was some limited predictability information in that data, but the tests on independent data were inconclusive. The difficulty was due to the very small size (only about 400 cases) of the sample that included both GOES and reconnaissance data.

To improve the sample size, the recon data processing program was repeated with analyses performed every 6 hours, instead of 12 hours, and all of the 2004 cases were added. These additions nearly doubled the size of the 1995-2004 dependent sample, which now contains 808 cases with at least a 6 hr forecast, and 247 cases with a 120 hr forecast. Nearly all of these cases also heat ocean heat content (OHC) analyses available, so that information was also added to the GRIP data set.

The standard 16 predictors from the SHIPS model were first fitted to the GRIP sample. Then, predictors from the GOES, recon and OHC data were tested for significance. Five variables were selected as being significant, as listed below. Many other variables were tested.

Table 1. Supplemental Predictors Included in the GRIP Model

1. Percent GOES pixel count from 50 to 200 km radius
2. Standard deviation of the GOES brightness temperature relative to the azimuthal average
3. The mean tangential wind averaged from r=-20 to +20km from the radius of max winds
4. The deviation of the integrated kinetic energy, relative to the average value for a given intensity
5. The OHC averaged along the storm track

The first two and last variables in Table 1 were already included in the "Perturbation" SHIPS model, which corrects the original SHIPS forecast. However, in the GRIP model, all variables are included together, so the influence of the satellite and recon data is greater than in a perturbation model. Also, by far, the largest increase in variance explained comes from the 3rd variable, derived from the reconnaissance data.

Figure 1 shows the reduction in the average intensity error when the dependent data is fit to the GRIP model. These improvements are more than twice as large as when the GOES and OHC data are added to the SHIPS perturbation model for the dependent sample.

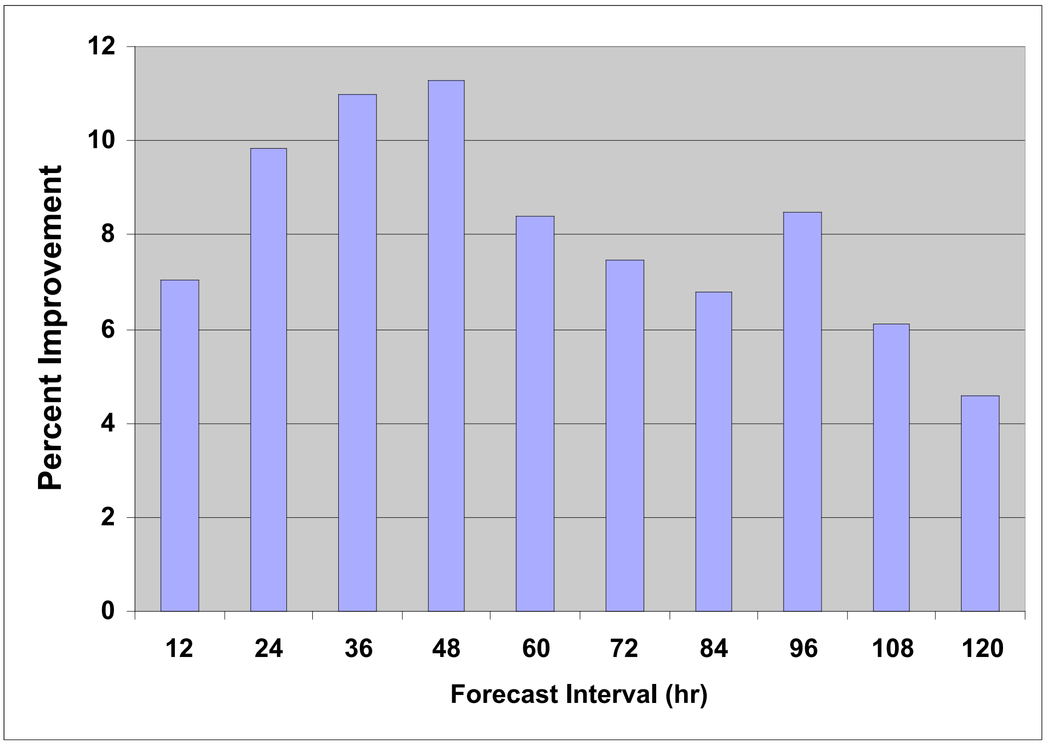

Figure 1. The percent improvement (percent reduction in model intensity error) of the fit of the GRIP model to the dependent data when the GOES and recon predictors are added to the standard 16 SHIPS predictors.

Although Fig. 1 indicates that the fit of the model improves with the GOES and recon predictors, the true test is the impact on the forecasts for independent cases, and under real-time conditions which include track errors, and replace the perfect prog fields with those from the NCEP global model. The GRIP model was run in a simulated real time mode on all cases from the 2005 Atlantic hurricane season. The very active tropics in 2005 provided a large sample, with 169 cases with at least a 12 hour forecast, and 85 cases with a 120 hr forecast. Because the 2005 sample was so large, a second test was run, where all of the 2005 cases were added to the sample before the coefficients were derived. This second test is not a valid operational evaluation, but helps to demonstrate the impact of a larger sample size.

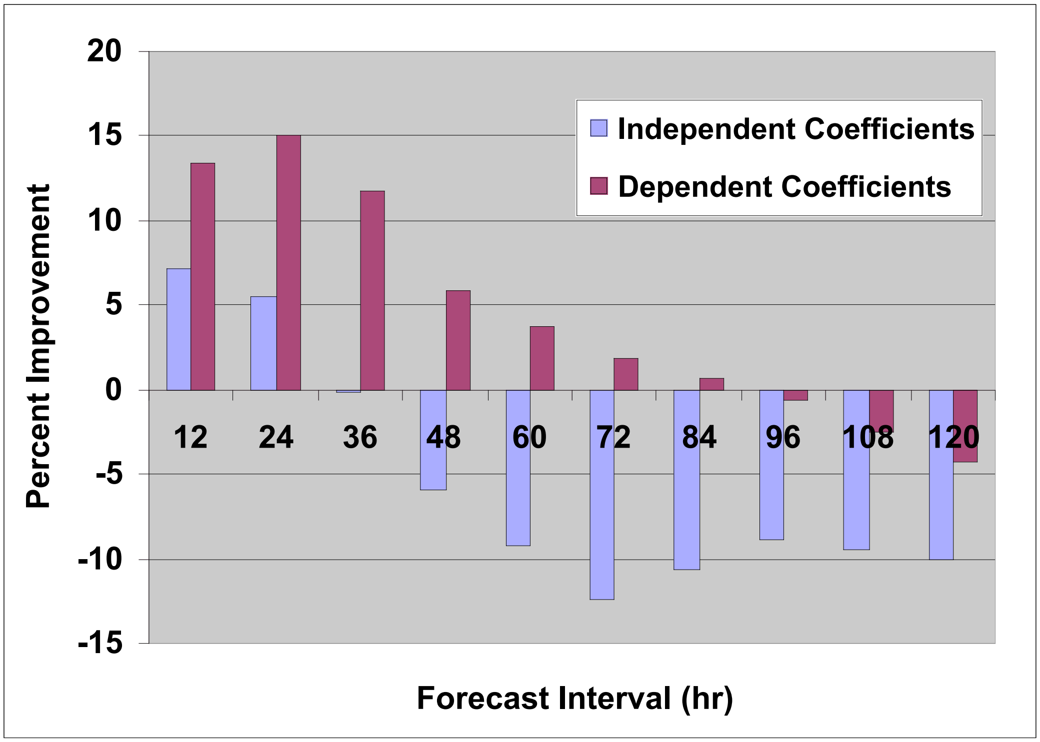

Figure 2. The improvement of the GRIP model relative to the SHIPS model for the simulated real-time runs for all cases in 2005 with recon data. The model was run with independent and dependent coefficients.

Figure 2 shows the 2005 forecast improvements with the independent and dependent coefficients. For both cases, the forecast improved at 12 and 24 hours. This improvement confirms the result from the fit of the model that there is significant short-term intensity prediction information in the satellite and recon data. However, the degradation at the longer times for the case with independent coefficients is likely due to the fact that the developmental sample is still too small. The sample for the basic SHIPS model includes almost a factor of 10 more cases than the GRIP sample. Thus, a method needs to be developed to take advantage of the large sample for the basic environmental variables, and the small sample of supplemental information utilized in the GRIP model.

As the sample size becomes very large, the number of forecasts for any individual year becomes small relative to the total sample. Thus, the dependent and independent coefficients eventually become equal. The improvements with the dependent coefficients in Fig. 2 represent what may be possible when a large enough sample becomes available.

Because the sample size limitations of the GRIP model currently prevent forecast improvements beyond 36 hr, the project PIs suggest that this model is not yet ready for operational implementation. Further research is needed to determine a method to combine the information from both the large and small samples. A model that separates thermodynamic and dynamical factors is currently be tested, which may help with this problem. The possibility of utilizing the input to the GRIP model for short term intensity forecasting, including rapid intensification, will also be pursued.