Enclosed is the JHT Semi-annual Report for:

A PROPOSAL FOR TRANSITION OF RESEARCH TO OPERATIONS:

Upgrades to the Operational GFDL Hurricane Prediction System

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Upgrades to the GFDL Hurricane Prediction System, developed through JHT funding during FY04, were successfully implemented into the operational version of the GFDL model before the start of the 2004 hurricane season. The improvements helped to significantly reduce a problem pointed out by forecasters at TPC/NHC, who found a tendency of the model to under-develop weak systems and often dissipate depressions, even when the observed storms developed. With these changes implemented operationally, the model showed small intensity skill and was comparable to the SHIPS model, particularly in the Atlantic. With the model upgrades that were made possible through JHT funding, the GFDL model had the lowest track error of any other dynamical model guidance in both the Atlantic and East Pacific basins, over the past two hurricane seasons.

As outlined in this current JHT proposal, further improvements to the operational GFDL Hurricane Prediction System continued to be made and tested over the past year, including the model resolution, model physics and vortex initialization. Although not part of the original JHT work plan, as was previously reported, a major effort was made over the past year, to improve the current axi-symmetric model used in the vortex initialization. The reason for this was to reduce the model's spin-down and spin-up problem during the first 12 hours of the forecast which was partly due to inconsistent physics between the current axi-symmetric model used in the initialization, and the three-dimensional prediction model. Beginning in September 2003, an extensive effort was made to develop a new axi-symmetric version from the current operational three-dimensional hurricane model so that identical moist and boundary layer physics would be used in the two models. Testing of this new axi-symmetric model was begun in the early winter of 2003 and indicated that in some cases the spin-up/spin-down problem was reduced, and the initial intensity was closer to the observed initial condition. However, since some track forecasts were significantly degraded it was decided that this new axi-symmetric model was not ready for operational implementation in 2004. Over the past 6 months, minor changes were made in the boundary condition and the targeting of the observed structure, which fixed this problem. This new version was extensively tested and is now ready for operational implementation in 2005.

Post-season analysis has suggested that another source of track error in the current system was that the initial storm size (rb) was systematically too large in the model, particularly in the West Atlantic. After careful testing, the calculation of this parameter was adjusted, with encouraging results. One final change, which was tested in parallel throughout the 2004 hurricane season, was to remove the mass initialization step in the initialization package. These changes were implemented into a triply-nested high-resolution version of the GFDL model (1/12 degree in the innermost nest) developed in collaboration with scientists at URI and funded by a separate JHT project.

To evaluate this new version of the GFDL hurricane prediction system, a test bed of 130 cases from the Atlantic hurricane season was chosen in collaboration with Richard Pasch of TPC/NHC. These cases include Hurricanes Isabel (2003), Charley, Danielle, Frances, Ivan, Jeanne, Karl and Lisa (2004). In addition, a set of cases from the East Pacific was also selected, which included Hurricanes Celia, Howard, Isis and Javier from the 2004 season.

Preliminary testing of the upgraded GFDL forecast system has indicated a significant reduction in track error at all time levels in the Atlantic Basin (Fig. 1,top). The reduction in error averaged about 9% in the 3 to 5 day forecast time period. The reduction in the average track error was largest for the 4 major landfalling storms during the 2004 season, with an average reduction in error of 16% in 3, 4 and 5 days (Fig. 1, bottom) for these cases, with over 75% of the tracks showing reduced error. Indeed the landfall position was much better forecasted with the new model (Fig. 2) for these critical forecasts. It is also encouraging that the northerly bias noted in the Western Atlantic was dramatically reduced with the upgraded forecast system (Fig. 3) as the northerly bias at 3, 4 and 5 days decreased from 55, 91 and 179 nm to 29, 53 and 117 nm, respectively. In the preliminary testing in the East Pacific, the track error was not significantly changed. However, the GFDL model performed exceptionally well in this basin during the past 2 years, and the cases tested so far were already highly skillful.

There was very little difference in the average intensity error with the new model. Although the intensity of the developing storms such as Isabel, Ivan and Frances, was much better forecasted the model still suffers from a severe positive bias in sheared situations that reduced the model's overall intensity skill. In the cases tested so far, this resulted in very large intensity errors for storms such as Lisa and the early period of Jeanne. It is anticipated that the inclusion of bulk physics may help reduce the model's intensity bias in these sheared cases. As outlined in the JHT project, this will be evaluated more extensively in the coming year using both the Lin and Ferrier microphysics schemes. Currently a version of the GFDL model with both microphysics schemes has been developed and will soon be imported into the high-resolution version of the model. Nevertheless, based on the impressive reduction in overall track error shown in the new modeling system, particularly in the Atlantic basin, it is anticipated the new model will be made operational in 2005. However, before a final decision is reached, many of these test cases will be rerun with the new T384 GFS model that also is currently being evaluated for operational implementation at NCEP in the late spring 2005.

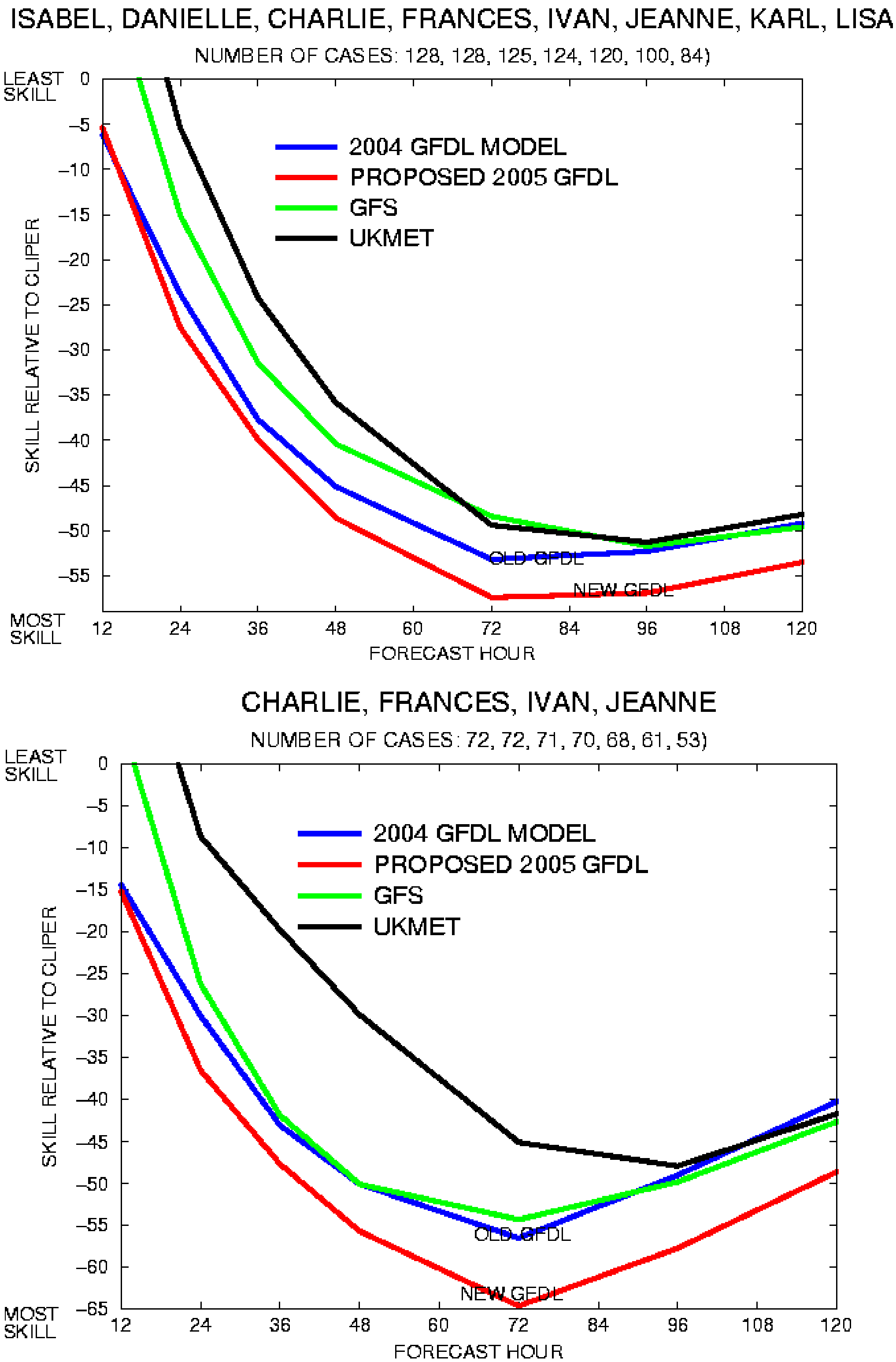

Fig. 1 Average track errors for all cases (top) run with the new GFDL forecast system (red line) compared to the operational GFDL (blue), the GFS (green) and the UKMET models (black). Also shown is the average track errors of these four models (bottom) for the four major landfalling Atlantic storms in 2004.

Improved Forecast of Landfall

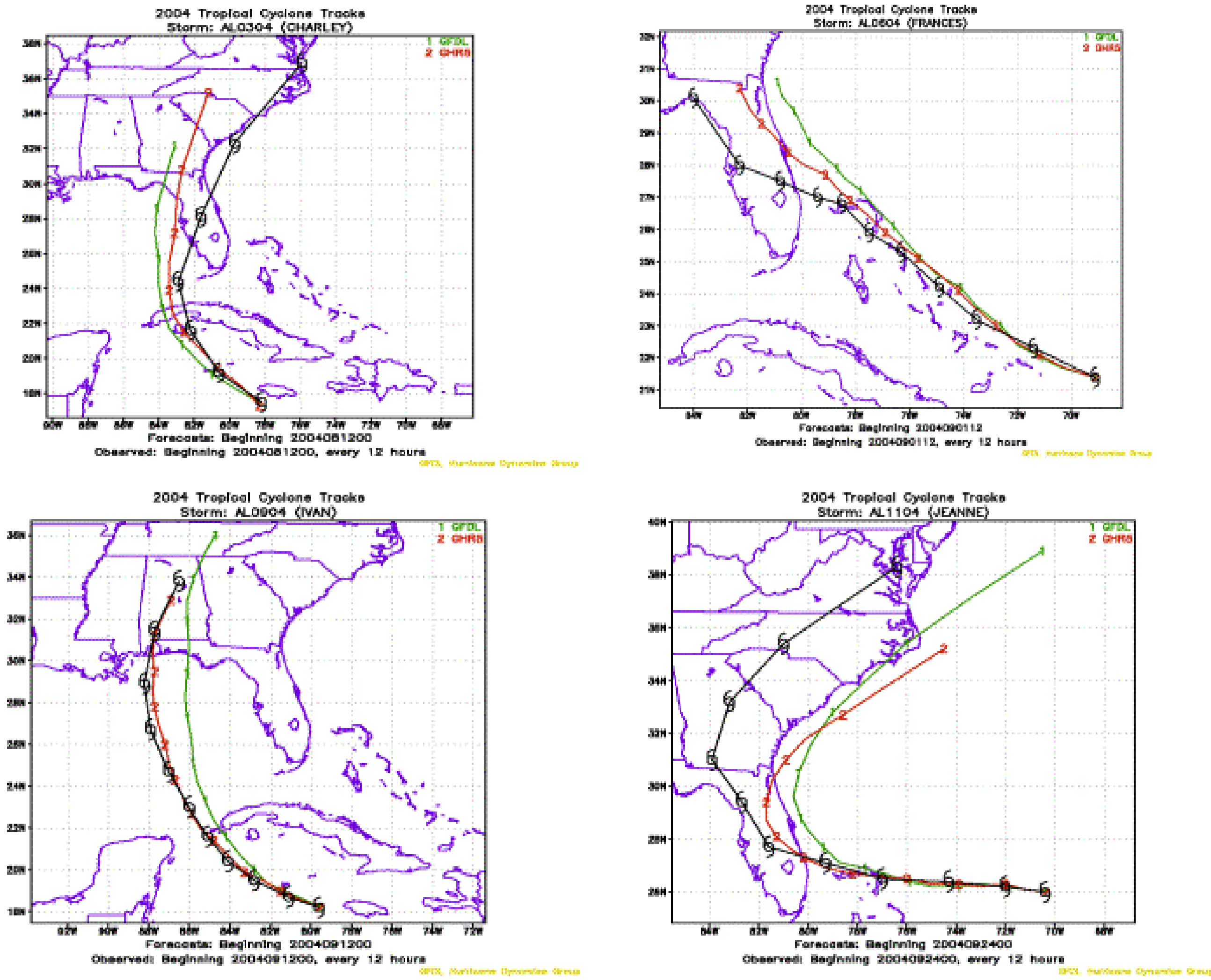

Fig. 2 Sample forecast tracks for the operational GFDL model (green line) compared to the proposed 2005 GFDL model (red line), for the four major landfalling hurricanes during the 2004 hurricane season.

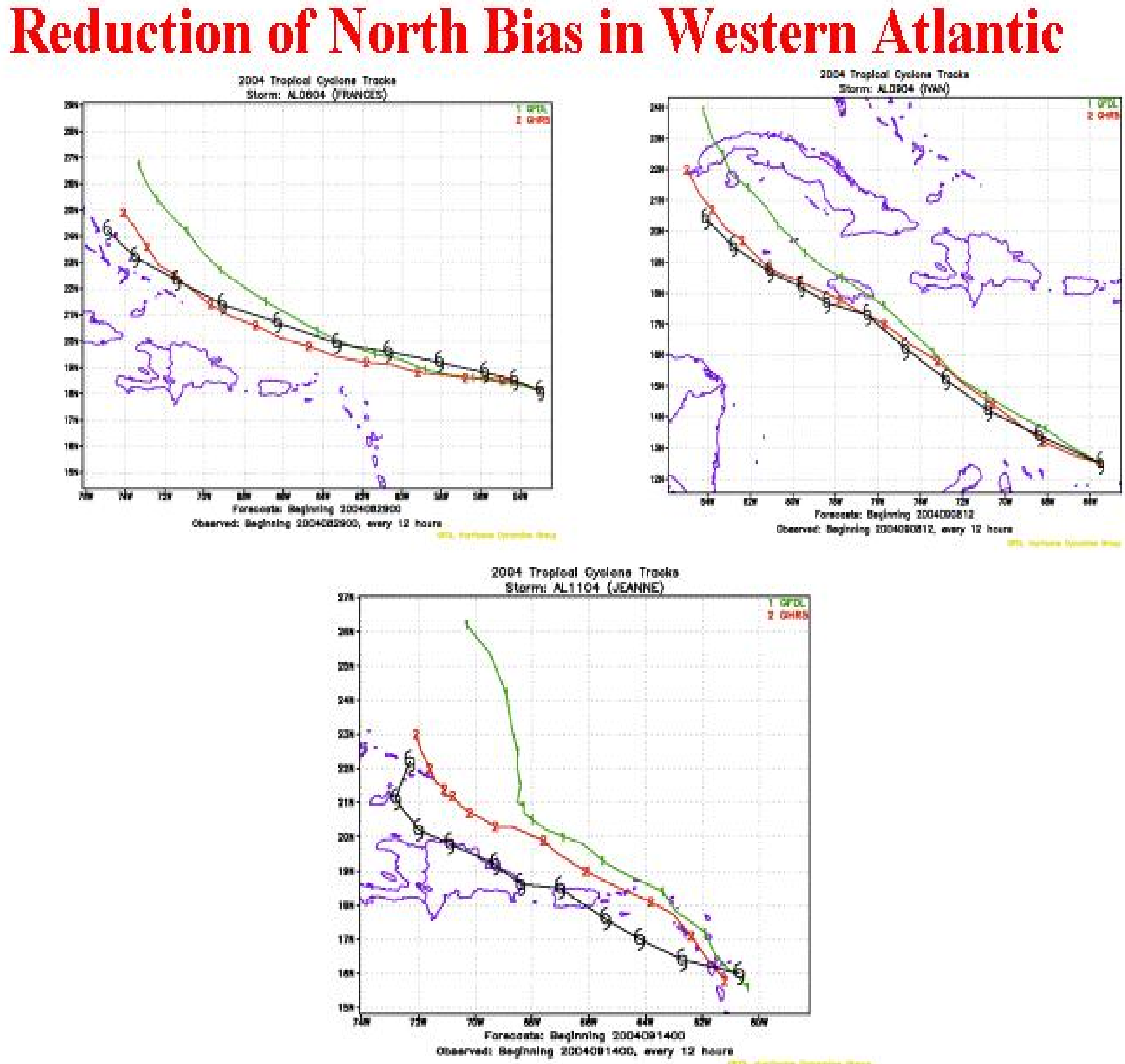

Fig. 3 Sample forecast tracks for the operational GFDL model (green line) compared to the proposed 2005 GFDL model (red line), for Hurricanes Frances (top left), Ivan (top right) and Jeanne (bottom) that show the reduction of the north bias with the new model in the Western Atlantic basin.