10C.3 A SUMMARY OF UPGRADES TO THE OPERATIONAL GFDL HURRICANE MODEL FOR 2003

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1.0 INTRODUCTION

Since 1995 the GFDL Hurricane Prediction System has provided operational guidance for forecasters at TPC in both the Atlantic and Eastern Pacific ocean basins (Kurihara et al. 1998). In addition, a version of the GFDL model (GFDN) has been used by the Navy to provide operational guidance for storms in most of the other ocean basins as well. With the installation of a new generation computer at the National Centers for Environmental Prediction (NCEP), the computer power available for operational models was significantly increased in 2003 enabling major upgrades in the GFDL model physics to be made and evaluated for operational implementation (Bender et al. 2003). These changes included an increase of the number of vertical sigma levels from 18 to 42, adoption of the Simplified Arakawa-Schubert (SAS) convective parameterization and non-local boundary layer scheme used in NCEP's global forecast system (GFS), a new mass initialization, improvements to the filter algorithms that remove the global vortex from the GFS analysis and assimilation of a more realistic Gulf Stream structure in the ocean model. Parallel testing of the new model was done during January 2003, and indicated a significant decrease in track error for reruns of cases during the 2001 and 2002 hurricane seasons. Based on these results, the new modeling system was made operational in May 2003, in time for the 2003 hurricane season. This paper will summarize the performance of this model in both the Atlantic and Eastern Pacific, and compare the errors with those from other dynamic guidance.

2.0 RESULTS

The upgraded GFDL hurricane model performed very well throughout the 2003 hurricane season by providing highly accurate track guidance through 5 days (*Figs. 1&2*). The skill relative to the Climatology and Persistence model (CLIPER) exceeded 55% at all time levels beyond 36h in the Atlantic. The very small track errors at 12 and 24 hours represent a significant improvement over previous years and were likely due to the upgrades to the model initialization that were made operational in 2003. Overall, in both the Atlantic and the Eastern Pacific basins the GFDL model had the lowest track error of any other dynamical model guidance.

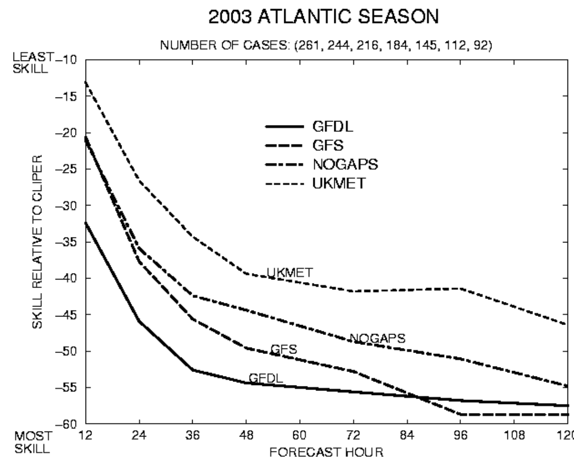

Fig. 1 *Summary of the track error plotted relative to CLIPER for the 2003 Atlantic hurricane season, for the GFDL model (solid line), compared to the GFS model (long-dashed line), the NOGAPS model (dot-dashed line) and the UKMET model (short dashed line). The versions of the models plotted are the operational interpolated models that were available to the forecasters in real time.*

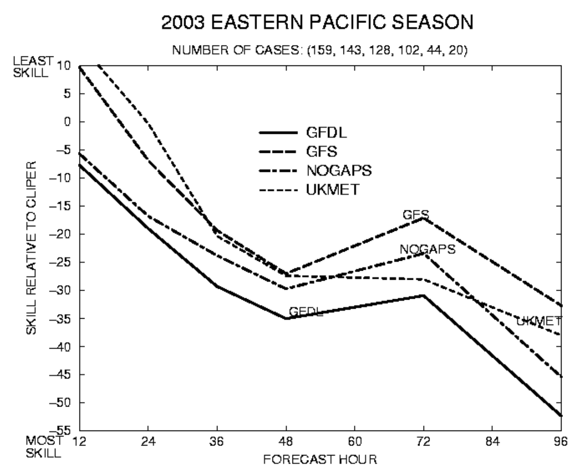

Fig. 2 *Summary of the track error plotted relative to CLIPER for the 2003 Eastern Pacific hurricane season for the models presented in Figure 1.*

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It is also encouraging to note that the 2003 track errors in the Atlantic at 72h for both the GFDL (135 nm) and GFS (150 nm) models were the smallest ever *(Fig 3)*. Except for the 2001 hurricane season in which the GFDL did not perform well, the overall trend of both models has been showing steady improvement in their track performance over the past nine years.

The GFDL hurricane model is coupled with the Princeton Ocean Model in the Atlantic Basin (Bender and Ginis 2000). Improvements to the system has enabled a more realistic ocean response to be simulated. Fig. 4 shows the SST cooling produced by Hurricane Isabel in the coupled system.

Further upgrades to the operational GFDL hurricane prediction system have continued to be made and tested both in the model physics and vortex initialization. One of the serious problems with the new model that was often observed during the past hurricane season was that it often tended to under-predict the intensity of weak systems, particularly depressions. In many cases the model incorrectly dissipated these storms when in reality the systems developed. Considerable effort has recently been made to try to remedy this problem by making several changes to the model physics, particularly the moist physics. These changes appear to have greatly reduced this problem.

The model also suffered from a serious spin-down and spin-up during the first 12 hours of the forecast. One of the likely reasons was inconsistent physics between the current axi-symmetric vortex spin-up used in the initialization, and the three dimensional model used in producing the forecast. To address this problem, an improved axi-symmetric version of the model was developed with identical moist and boundary layer physics between the two models. Testing of this new axi-symmetric model indicated that in some cases the spin-up/spin-down problem was dramatically reduced. Also, the initial intensity was often better matched to the observed initial condition. It is anticipated that this new model will become operational in 2004.

Despite the major improvements in track prediction, the upgraded model still continues to show little overall skill in its intensity prediction. Although it is likely that some of the above-mentioned new changes proposed for the 2004 version of the model will help improve the intensity skill, more work needs to be done. In particular, the model still over-intensifies systems in sheared environments and is not able to resolve the fine eye-wall structure in intense hurricanes. To address the latter problem, a high-resolution version of the forecast model has been developed with a third nest with double the current finest resolution (1/12 degree resolution). In addition, this new model is being tested with several bulk-microphysics schemes to better resolve the moist processes. While current computer limitations do not make this model operationally feasible in the current computer system at NCEP, with further scheduled computer upgrades it may be possible to run this high resolution version of the GFDL model operationally in the 2005 hurricane season. In the upcoming season, a version of this model will be run in parallel for a number of cases and compared with the current operational forecast system.

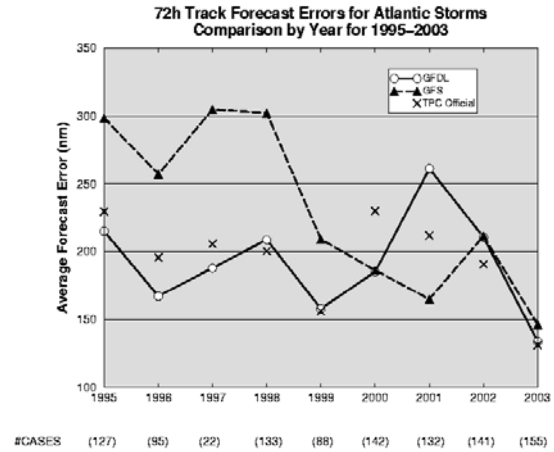

Fig. 3 *The 72h forecast error in the Atlantic basin for the GFDL model (solid line, open circles), the GFS model (dashed line, triangles), compared to the TPC official forecast (X) for the years 1995 through 2003.*

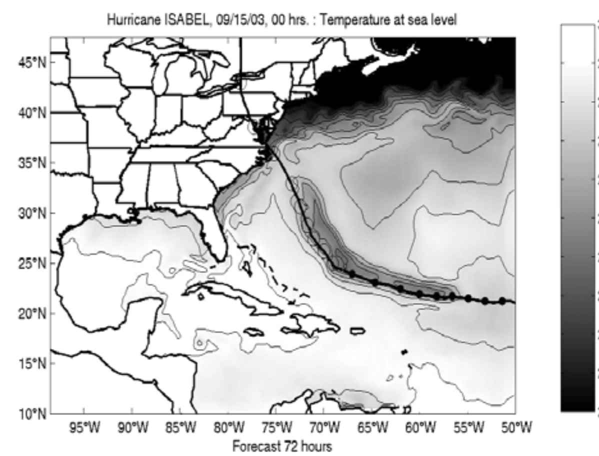

Fig. 4 *The GFDL coupled model forecast of the sea surface temperature during Hurricane Isabel initiated at 0000 UTC, Sept. 15, 2003.*

3.0 REFERENCES:

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{ HYPERLINK "http://wwwt.emc.ncep.noaa.gov/gfdl_2003_upgrades.pdf" }

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