Joint Hurricane Testbed (JHT) Program

For the
Environmental Modeling Center/National Centers for Environmental Prediction
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Hurricane Model Transitions to Operations at NCEP/EMC

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July (2003) to May (2004) Progress Report

This proposal calls for the continuation of funded work on the GFDL hurricane model upgrades as well as the initiation of a prototype Hurricane forecast system. The second area of work is the commencement of the transition from the GFDL to WRF model that is scheduled to become the next operational hurricane model in ~2006. The progress toward these tasks and goals are indicated in italic directly in the original Time Line given for this project. Some of these results were presented at EMC at the modeling workshop in early December. Additional results were given in more detail at the 58th IHC meeting in March and at the recent AMS Tropical Conference.

Time Line

Year One: July to December, 2003

1) Code and begin to test bulk microphysics packages in collaboration with GFDL. *Code has been implemented into GFDL system for the Ferrier scheme. We will work with GFDL(Bender) in making comparisons with the Lin scheme. The unique feature of the Ferrier scheme is the option to have a complete hyrometeor species (cloud water, rain, cloud ice and precip. ice) in the micropohysics calculations but to combine these species into total condensate in the advective calculations. This was found to be computationally efficient in the ETA model forecast system, but this will have to be tested in the GFDL forecast system where physics packages are called more frequently. We anticipate problem areas on how to blend the microphysics package with other convective parameterizations and also with large scale condensation. The basic programming approach to handle microphysics in the GFDL model has been designed and coded by Bender and Tuleya over the last two years. Bender has already upgraded an earlier version to successfully run the Lin microphysics. In some prooblematic case studies such as Debby(200), the bulk microphysics*

package appeared to handle a sheared case much better than convective parameterization alone (see figure below). The Ferrier scheme can be implemented in both the 2-nest _°, 1/6° operational model or the test _°, 1/6°, 1/12° 3-nest version that is currently being tested by URI in collaboration with GFDL and EMC. The bulk schmes will be tested this upcoming season (see #1 of year two plan)

2) Run parrallel version of GFDL model with NOAH LSM for 2003 season for significant landfalling storms. Identify and address problem areas. Also run historic cases from 1995 to present. *Weixing has successfully coded and run the Noah LSM for several cases of 2003 including Isabel. One complication is that the operational GFDL model code has changed , so the Noah LSM code had to be integrated into the 2003 GFDL model which includes a new surface physics interface and increased vertical resolution. These problems have been rectified so that the GFDL model can be run with the NOAH LSM using the 2003system . Basically results have shown some improvements in the quality of the forecast especially precipitation. The LSM has led to less spurious low rainfall amounts away from the storm center. Recently, Weixing has run ~25 historic cases from 1995-2002 with the 2003 GFDL model are to get a more compete picture of the skill of the LSM. The initial land condition were taken*

directly from a separate land analysis system run at EMC, the LDAS. A list of cases run is shown in the table below .

Historic cases		
Cases	**Landfall time**	**Model landfall**
1. Danny_1997071912	92012(24)*	92012 (24)
2. Bonnie_1998082612	82700(12)	82700 (12)
3. Earl_1998090212	90306(18)	90312 (24)
4. Hermine_1998091912	92100(36)	92012 (24)
5. Frances_1998091012	91106(18)	91112 (24)
6. Grorges_1998092712	92812(24)	92812 (24)
7. Charley_1998082112	82212(24)	82212 (24)
8. Bet_1999082212	82300(12)	82300 (12)
9. Dennis_1999090412	90500(12)	90506 (18)
10. Floyd_1999091512	90606(18)	90612 (24)
11. Harvey_1999092112	92118(06)	92118 (06)
12. Irene_1999101512	101518(06)	101518 (06)
13. Gordon_2000091712	91800(12)	91800 (12)
14. Helene_2000092112	92212(24)	92206 (18)
15. Barry_2001080512	80606(18)	80606 (18)
16. Gabrielle_2001091312	91412(24)	91518 (54)
17. Edouard_2002090412	90500(12)	90506 (18)
18. Fay_2002090612	90706(18)	90706 (18)
19. Hanna_2002091412	91412(00)	91412 (00)
20. Isidore_2002092512	91512(24)	91512 (24)
21. Kyle_2002101112	101112(00)	101112 (00)
22. Lili_2002100212	100312(24)	100312 (24)
Year of 2003		
Bill_63000	(18)	(24)
Bill_63012	(06)	(12)
Claudette_71412	(30)	(36)
Claudette_71512	(06)	(06)
Isabel_91712	(30)	(30)
Isabel_91806	(12)	(12)
Isabel_91812	(06)	(06)

For the historic cases shown in the table below, there is a small, but consistent track error reduction within the first 36hr after landfall. Also the case of Bill(2003) showed even larger track improvements after landfall.

Change in track error(km) for the historic cases from 1997-2002 (noah-slab)									
After landfall	**0h**	**6h**	**12h**	**18h**	**24h**	**30h**	**36h**	**42h**	**48h**
22 case Average	**-.3**	**-3.7**	**-8.3**	**-10.6**	**-12.0**	**-14.0**	**-13.4**	**1.3**	**8.7**

The figure above shows that the model correlation between model and RFC analysis shows a consistent small but steady improvement using the Noah LSM. for the 4 cases validated in 2004. Also the equitable threat score for Isabel indicates a more general improvement in reducing spurious precip away from the storm track. On the other hand the high rainfall amounts were reduced in Noah, leading to a degradation in threat score in this case. However, it is anticipated that when all the historic cases are evaluated, a reduction of high amounts will lead to improved rainfall skill. Unrealistic high amounts in the GFDL model have been shown in the rainfall verification JHT rainfall project (EMC,GFDL,HRD).

3) In collaboration with GFDL install test versions of GFS surface parameterizations into GFDL model and run several real data cases. *This project has been delayed with more emphasis on an early start of Hurricane WRF task item slated for the second half of year one and year two. EMC has assigned additional personnel for the Hurricane WRF transition. A prototype Hurricane WRF system has been initiated. This system includes the same NMM-WRF dynamic core that will be used for the extratropical mesoscale forecasts that will replace the ETA model. The NMM WRF code has been assimilated into the WRF software structure and includes the traditional pre-*

prossessing and interpolation of model initial conditions (i.e. WRF SI) and WRF model integration. Some integrations have already been performed, including cases of Isabel and Claudette. The present system is being benchmarked for computational expediency in a uniform(non-nested) mode for `parallel` *testing this upcoming hurricane season. Preliminary results with a domain, resolution,and processor configuration similar to the GFDL model may be run in ~2 hours on NCEP's IBM system for a five day, only ~2x that of the nested GFDL model.*

4) Install WRF physics packages into GFDL parallel model and compare results with operational codes.

EMC has hired an additional person for the above-two tasks. GFS physics packages will be put in the WRF framework so all NCEP models including Hurricane WRF and extra-tropical WRF can utilize a full suite of GFS physics packages. When avalibable these physics packages will be assimilated into the GFDL system for testing and comparison. It is anticipated that a significant number of GFS packages will be available for testing in both the GFDL model and HWRF in year #2 of this proposal.

5) In collaboration with Bender determine whether and which model upgrades should be made operational for 2004 season. *Bender initiated two main changes in the operational system for 2004. The first is the modification of the SAS convection to allow more cyclogenic behavior so weak storms have a better retention rate. This problem arose from the transition from Kurihara convection(cyclogenic) to SAS(less cyclogenic) for the 2003 tropical season. Also implemented as suggested was the incorporation of 1-D ocean coupling by the URI group to make the GFDL model system more physically consistent from the Atlanitic to Eastern Pacific basin.*

Year Two: July 2004 to July 2005

I believe the year two time-line should be unaltered. Some of the issues to be addressed is the feasibility of operational implementation of a suite of proposed GFDL model improvements. These depend on the actual model improvements realized and the impact of the scheduled computer upgrade at NCEP this coming year. A uniform-mesh WRF proto-type system should be in place with physics upgrades being implemented as they are made available. Nesting software is presently being developed, but much work needs to be done.

1) Run bulk microphysics packages for test suite to test forecast performance. *(see above)*
2) Evaluate Hurricane WRF proto-type model and forecast system. Compare Hurricane WRF to GFDL model with WRF physics packages.*(see above, already started)*

3) Begin testing nested and movable nest WRF model when available*.(already started. One advantage in WRF nesting is the software architecture is already in place. On the other hand, different dynamic cores with their specific boundary conditions have to be formulated and tested.)*

4) In collaboration with Bender, Surgi, Lord, and NHC determine feasibility of installing GFDL model upgrades into the 2005 operational suite. *These include the Noah LSM, bulk microphysics, and possibly a high resolution GFDL model.*

5) Determine the feasibility of running operationally a Hurricane WRF proto-type forecast system for the 2005 season*. (Probably a uniform mesh model)*