Hurricane Model Transitions to Operations at NCEP/EMC

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Work Plan, Time Line and Progress

The work plan for this JHT project has three basic thrusts: 1) Evaluate the addition of the NOAH land surface model (LSM) into the HWRF system; 2) Collaboration with EMC personnel in improving intensity forecasts through improvements in the initial condition and model physics; and 3) Troubleshoot the HWRF forecast system. This collaborative project with EMC is on a half-time basis.

1. Collaborate in the implementation of the NOAH LSM and upgraded initial conditions for the 2010 tropical season.

- For the past several years, preliminary experiments were run by Tuleya for several Atlantic 2008-2010 cases utilizing the NOAH LSM. Results varied but unfortunately indicated some degradation in track skill especially using the 2009-2010 HWRF model. These results were complicated and the degradations were initially exasperated in the recent transition to the standard WRF-V3R2 software. Unfortunately this transition to WRF V3 caused additional problems in causing warm temperature noise in the nest grid over land. Recently, the integrity of the code is being investigated with some improvements shown when certain word format options are used. Tuleya has been running a revised version of the HWRF model with NOAH LSM using the operational 2011 HWRF but with the Netcdf option. Apparently there are issues with the binary format option in the operational HWRF when using the NOAH LSM option. Using this revised format option apparently alleviates most of the issues of boundary noise and track degradation. Improvements were notable for the relevant case of Hurricane Irene for the HWRF version with the LSM (i.e. H11L). This version of the HWRF is being run in parallel for the 2011 Atlantic hurricane season. The results are shown in Figure 1. This year results indicate that compared to the degradation in the past, the NOAH LSM results were practically identical to the operational 2011 HWRF through four days.

- Several enhancements to the HWRF system were made earlier to accommodate the inclusion of the NOAH LSM including runoff data to WRF auxiliary output. Recently this hourly runoff grid data has been successfully directed to a simple routing stream model. This technique was tested for several 2011 cases including Irene with successful stream flow resulting. However there remain some outstanding issues in that the deep runoff variables are incorrect. This has to be investigated. Now being updated for the operational 2011 HWRF. With the inclusion of the Noah LSM into the HWRF system, more objective verification of landfall decay and rainfall should be made. It is unclear whether this will be investigated by EMC or HRD.

2. Collaboration with EMC personnel in improving intensity forecasts through improvements in the initial condition and model physics.

- As previously reported Tuleya reformulated the Kwon HWRF operational surface physics in terms of thermal and momentum roughness lengths and coded this formulation into a revised surface flux routine for HWRF. This revision was used in the transition of HWRF V3R2 code to DTC and will serves as the basis for the 2011 operational surface code method. Recently Tuleya worked with URI scientists in further simplifying the operational surface physics. He attended a Fall meeting at EMC to discuss the surface flux and ocean-wave interaction.

3. Troubleshoot the HWRF forecast system.

- Tuleya has recently revised and written the 2011 scientific physics documentation of the HWRF system for the DTC HWRF tutorial. He gave the presentation of the HWRF physics at the WRF hurricane tutorial in Boulder. See http://www.dtcenter.org/HurrWRF/ and http://www.dtcenter.org/HurrWRF/users/docs/scientific_documents/HWRF_final_2-2_cm.pdf. This documentation has proved helpful both for in-house and the user community. Tuleya has recently recommended a bug fix for a benign bug in the surface flux code discovered by DTC.

- As mentioned, the introduction of the NOAH LSM into HWRF has been troublesome. This summer, Tuleya has changed the input file format which apparently has improved the HWRF forecast performance in track and intensity. Much of the long standing noise problems have been eliminated. Further tests are needed to identify the reasons behind the differences between the binary and netcdf versions.

- Tuleya participated in physics and diagnostic HFIP committees to improve the capabilities of HWRF and other regional hurricane models. He worked with the HWRF group in suggesting changes in the HWRF initialization technique and comparing it with the GFDL initialization code. Tuleya also participates and collaborates with HRD scientists in the improvements of the HWRF system.

Track errors HWRF with Noah LSM

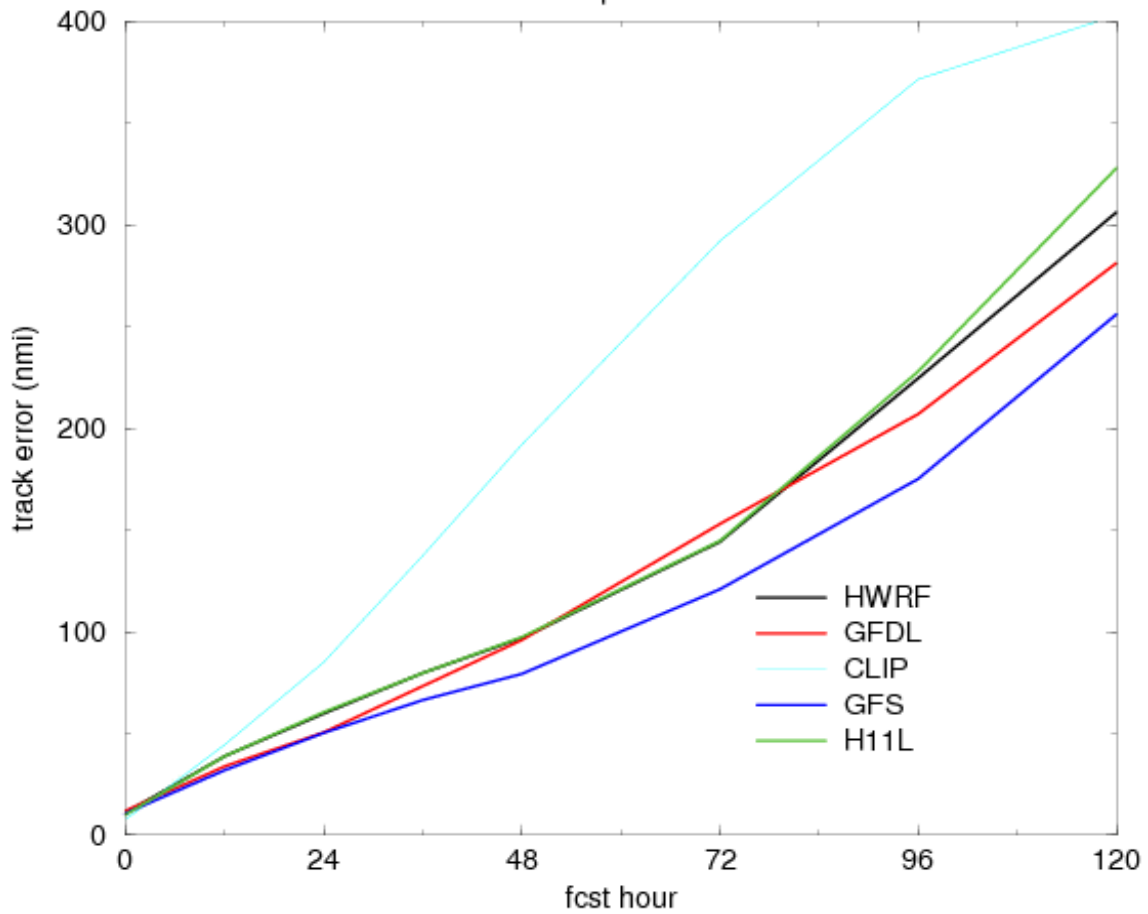### 2011 ATL season comparison with other models

Fig.1 Comparison of NOAH LSM (H11L,green) track with the operational HWRF for the 2011 Atlantic season. These two models were practically identical through 96h with some degradation at 5 days with the NOAH LSM. The operational GFS(AVNO, blue) shows a superior.