Hurricane Model Transitions to Operations at NCEP/EMC

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12-month report
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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. A one year review was made at the recent 65th IHC meeting.

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

- Preliminary experiments were run by Tuleya for several Atlantic 2008 cases utilizing the NOAH LSM. Results indicated some increased track skill. However, subsequent model changes in the code were implemented into the current operational 2010 HWRF system. The 2010 operational HWRF system was run for both historical 2008 cases as well as in parallel 2010 cases in the Atlantic in real time using the NOAH LSM. Unfortunately there was some degradation in track as shown in Fig.1. There was some improvement at mid range in intensity forecasts. These results are being analyzed together with a new WRF code implementation to transition to the standard WRF3R2 software. Unfortunately this transition to WRF V3 caused additional problems in causing warm temperature noise in the nest grid over land (Fig.2). The integrity of the code is presently being investigated.

- Several enhancements to the HWRF system were made earlier to accommodate the inclusion of the NOAH LSM (HLSM): 1) HLSM now saves runoff data as well as low level wind and rainfall data hourly to WRF auxiliary output. 2) A new post-processing script now interpolates hourly model runoff grid data directly to the routing Conus grid for stream model input. 3) Work is continuing to initialize HLSM with more realistic initial conditions of soil moisture from NAM and NLDAS, rather than GFS. All these enhancements will be more thoroughly evaluated in year two. With the inclusion of the Noah LSM into the HWRF system, more objective verification of landfall decay and rainfall is planned.

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 serve as the basis for the 2011 operational surface code method. Results indicated some improvement in intensity compared to the operational 2010 code.

- Tuleya released a more generalized surface code to the HWRF group and NOAA research groups that allowed one to toggle between the HWRF (and GFDL) 2009 enhanced enthalpy surface flux and those based on the Kwon surface physics (i.e. HWRF 2010). This code has been used by both HRD and ESRL scientists in HWRF sensitivity experiments.

- One of the improvements to the upcoming HWRF 2011 season is the improvement to hurricane tracks through the inclusion of a revised SAS scheme. Unfortunately, this new convective scheme caused an unacceptable reduction of intensities in both HWRF and the GFDL hurricane models. Tuleya tuned his surface flux formulation to increase the enthalpy energy in high wind regimes. Except for the high wind regime of enthalpy fluxes, the scheme remains similar to the Kwon HWRF 2010 observationally based (CBLAST) formulation (Fig3). This revision has enabled the proposed 2011 operational system to retain the improved track forecasts resulting from the revised SAS scheme while not degrading the overall intensity skill.

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 has prepared and will give the presentation of the HWRF physics at the upcoming tutorial in Boulder next month. 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. Several additional bugs have been discovered in developing this physics package documentation.

- As mentioned, the introduction of the NOAH LSM has introduced noise in the surface temperature field near the nest boundary. Tuleya is working on removing this problem and as well as analyzing the track degradation so viable forecasts can be made with the LSM included.

- Tuleya continues to participate in physics and diagnostic HFIP committees to improve the capabilities of HWRF and other regional hurricane models. He continues to work 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.

- Tuleya has developed a diagnostic PDF program as an additional method to analyze the capability of HWRF intensity forecasts. This method revealed the reasons that the HWRF 2010 season under predicted the storm intensity for the 2010 season while not indicating any problems using a test suite of cases from 2008 and 2009. The PDF method indicted that the test suite was not representative enough across a more complete distribution of observed tropical storms from 2008 through 2010. This PDF diagnostic will be used by the DTC.

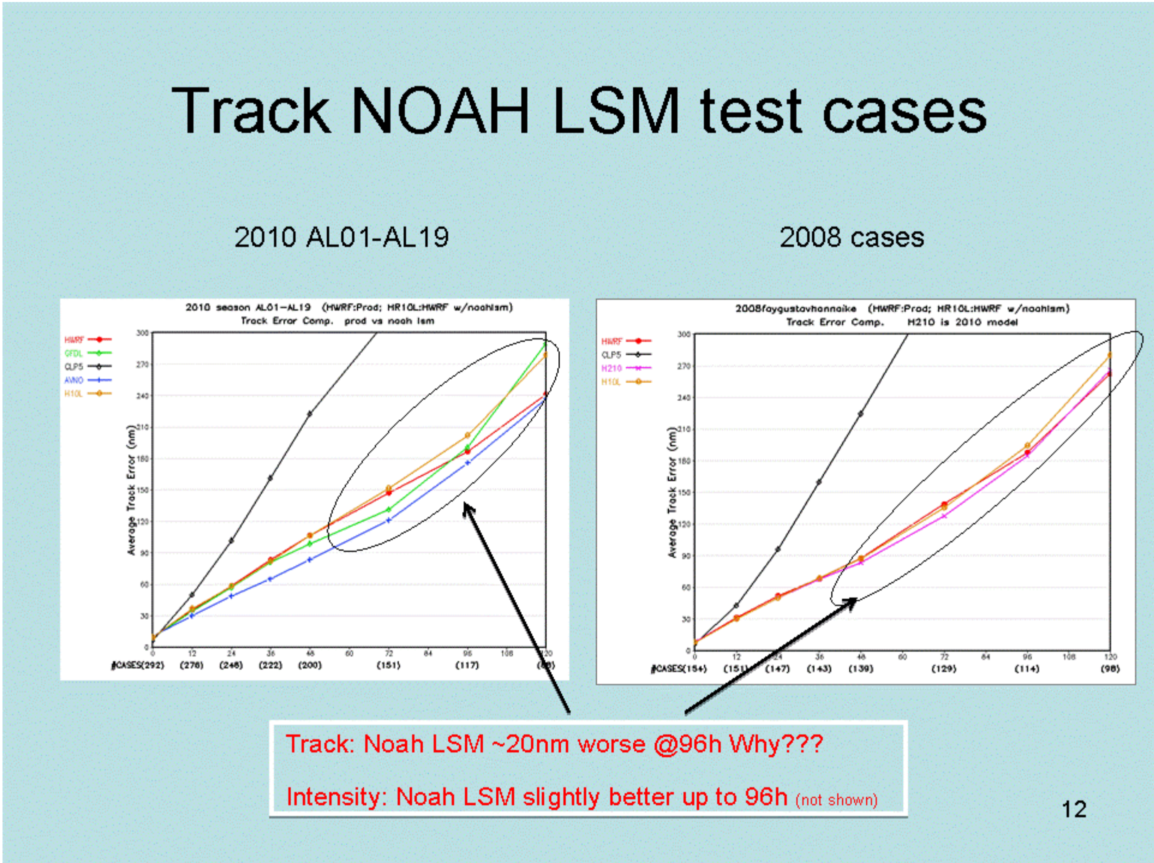

Fig. 1 Track error comparison results for a suite of HWRF runs using the 2010 system with the NOAH LSM option (H10L,orange) for ~300 cases for 2010 Atlantic season (left) and ~150 cases for the 2008 Atlantic season(right). HWRF 2010 control cases are shown in red. Note degradation at forecast periods beyond 48hr.

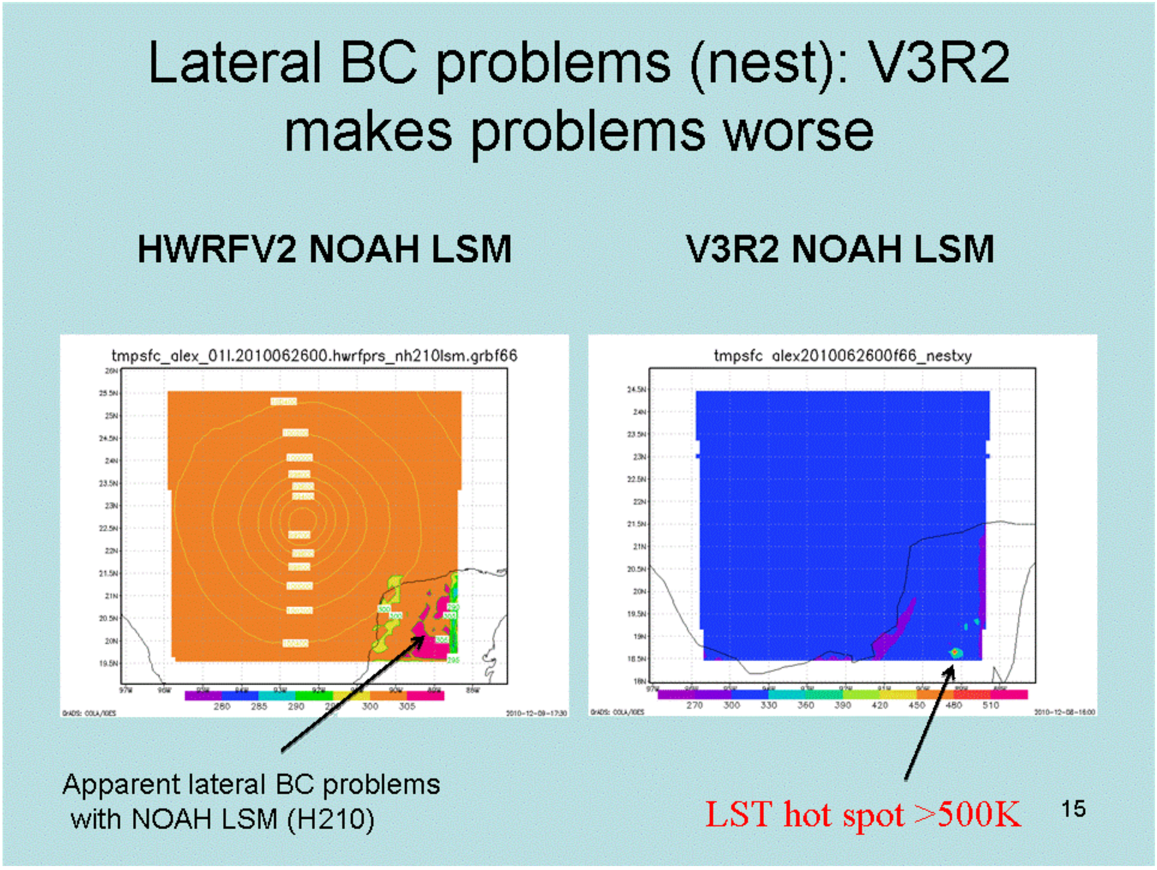

Fig.2 An example of NOAH LSM boundary problems in NEST for both the HWRF 2010 code(left) and the HWRF V3 code(right). The surface temperature is plotted for a case of Alex as the model vortex leaves the Yucatan peninsula.

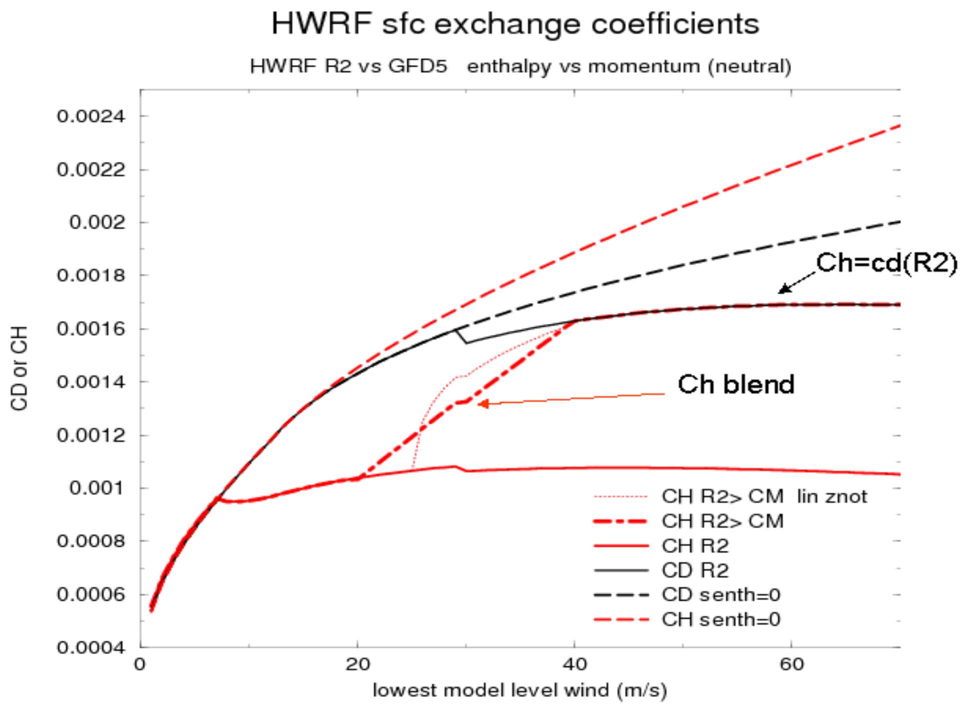

Fig.3 A revised calculation of surface exchange coefficients for enthalpy fluxes (red lines) and momentum fluxes (black). R2 refers to momentum and enthalpy coefficients equivalent to the HWRF 2010 production model. Ch "blend" indicates the revision made for HWRF 2011. Ch & CD are now reformulated in terms of roughness lengths. The dashed CD & CH upper lines are values for GFDL coefficients for the GFD5 parallel run of 2010.