Establishing the Weather Research and Forecast (WRF) Model at NWS Miami and Incorporating Local Data sets into Initial and Boundary Conditions

COMET Outreach Project S04-44694

Dr. Brian J. Etherton , University of North Carolina Charlotte
Dr. Pablo Santos, SOO NWS Miami

January 9, 2006

Section 1: Summary of Project Objectives

The objectives of this study, as outlined in the research proposal, were as follows:

1) To provide high resolution forecast guidance to WFO Miami using the WRF model,

2) To incorporate high resolution diagnostic fields, namely, the LAPS analysis fields and a locally generated high resolution SST data set, into the locally run WRF; and

3) To validate the impact on the model runs by comparing WRF model QPF forecasts to 88D precipitation estimates and the standard Eta model QPF forecasts.

Long term goals also included comparisons of the results obtained in this study to WFO Melbourne, FL ADAS/ARPS system in an attempt to study the performance of the different models in the Florida Peninsula weather regime.

The first of these goals was accomplished in the summer of 2004 – the WRF model was run at the University of North Carolina Charlotte, with output provided to forecasters. There were two methods by which NWS forecasters could observe the output. One was to use a web site (http://personal.uncc.edu/betherto/wrf/) created for this project. The second was to display the data at NWS Miami via AWIPS but with limited output due to bandwidth limitations. Both methods are in use. The WRF Model being used for this particular project is the Advanced Research and Weather (ARW) core ran at 5 km resolution.

The second goal was partially completed. The use of the LAPS analysis fields for initial conditions of WRF was accomplished – but a lack of time contributed to the very high resolution Sea Surface Temperature (5km) data not being included in the WRF simulations. It is hoped that in the future, this work can be completed. However, the new 1/8 of degree high resolution NCEP data set is being used for the model runs.

The third goal of this work is ongoing as part of the publication we are preparing. WRF QPFs made with and without LAPS initial conditions have been compared to precipitation data, but instead of using the raw 88D data, we are using the Southeast River Forecast Center (SERFC) Multi-Sensor Quantitative Precipitation Estimates (QPE) which use rain gage, radar, and satellite data (Kondragunta et al., 2005; Seo and Breidenbach, 2002) to produce the QPEs on a 4 km grid. The data was obtained through the Hydrometeorological Prediction Center (HPC) National Precipitation Verification Unit (NPVU) site (http://www.hpc.ncep.noaa.gov/npvu/). We will be comparing both WRF forecasts to the NAM precipitation forecasts as well. The performance metrics consists of Threat Scores.

Section 2: Project Accomplishments/Findings

Figure 1 illustrates grid based hourly threat scores for 50 (06Z cycle) and 56 (18Z cycle) cases during a two month experiment ran during June and July of 2005. These preliminary results illustrate a substantial improvement in the LAPS based initialization versus the standard NAM12 initialization. Similar performance metrics are being calculated for the NAM12 model for comparison to standard guidance.

Figure 2 illustrates with a specific example the impact of the local initialization on a model variable along with the resulting one hour QPF Forecast. This illustrates with an example the performance improvement indicated in Fig. 1 in more general terms. Figure 3 shows the radar echo pattern valid around the time of the one hour forecast in Fig.2 for validation purposes.

In addition to evaluating precipitation forecasts, we are also conducting a comparison of WRF forecasts of temperature, pressure, moisture, and wind resulting from differences in the initial conditions. Given that precipitation is the result of other atmospheric processes, understanding the more fundamental model variables helps understand the precipitation differences among different initializations.

Section 3: Benefits and Lessons Learned: Operational Partner Perspective

In order to make this project work, the WFO partner had to work with the Forecast Systems Lab (FSL) to properly modify the Local Analysis and Prediction System (AWIPS). This had to be done because of two reasons: 1) The domain needed to be expanded to properly accommodate the model domain, and 2) The software also had to be reconfigured so that it could make use of the cloud analysis package to properly create diabatic initialization grids for the WRF. As part of the process, FSL had to provide with one additional binary file (lapsprep), not included in the AWIPS standard LAPS distribution, so that the last step to create the initialization grids could be executed. All the steps were documented along the way also. This learning process has been very beneficial because COMET's STRC WRF EMS, recently released by Bob Rozumalski, incorporates this capability for LAPS local initialization. Bob Rozumalski used the lessons learned by WFO Miami to add the LAPS initialization capability to the STRC WRF EMS. The documentation was also passed along by WFO Miami to Bob and is currently being incorporated into the STRC WRF EMS documentation package.

This experiment has also taught us that it is possible to locally initialize a high resolution model with improvement in performance. Further, we have also learned that LAPS has the utilities to create not only initialization files, but also boundary conditions from AWIPS SBN grids. This opens up a world of possibilities because in the future, as additional development is conducted with the STRC WRF EMS, it would be possible to locally initialize the model as well as create the boundary conditions using LAPS. This would eliminate bandwidth worries and would fulfill the promise of a truly Local Analysis and **Prediction** System in a cost effective manner.

Section 4: Benefits and Lessons Learned: University Partner Perspective

Bringing the WRF model to UNC Charlotte was a great boost to the research and education efforts here. Initially, the COMET funds were used to employ Chris Blanton as a summer intern, working on the project. This seed led to his coming here for graduate school, making him the first graduate student at UNC Charlotte to have Dr. Etherton (new faculty) as advisor.

In addition, the WRF model provides many opportunities for students in the classroom. The dynamic meteorology course at UNC Charlotte has incorporated the WRF model into the lab component of the course. Last year, students learned to run the WRF model and to post-process the data. These skills are quite valuable to undergraduate students.

Further – having WRF running at UNC Charlotte opened the doors to other research efforts, in collaboration with other universities. These opportunities would not have presented themselves if UNC Charlotte did not have this WRF capability.

Section 5: Publications and Presentations

This COMET project has resulted in two conference papers (Etherton and Santos, 2005, 2006) and one publication currently under preparation. The first paper was presented at the 2005 AMS Conference in Numerical Weather Prediction, in Washington D.C. The second paper will be presented at the 2006 AMS Annual Meeting in Atlanta, Georgia.

A publication is in preparation, and will be submitted to Weather and Forecasting during the early part of 2006. This publication documents the differences between WRF forecasts initialized from LAPS and those initialized from NAM tiles. A comparison to the standard NAM (currently the Eta model) will also be included.

Section 6: Summary of University/Operational Partner Interactions and Roles

During the developmental phase of this project, the research partner at UNCC concentrated on configuring the model for South Florida as well as on getting the local initialization working. The operational partner, the SOO, concentrated on reconfiguring LAPS to make that happen while also collecting feedback from the operational staff on their observations to help identify any potential systematic problems.

As part of this project, the SOO at WFO Miami conducted a modeling training session in late 2004 /early 2005 and another one is in preparation for the spring. This will include a more in depth discussion fn the WRF Model that addresses both, the soon to be implemented NCEP version in the spring and the locally ran version along with an in depth discussion of the experiment results. The PI, Brian from UNCC, is working with the SOO to put the material together.

References

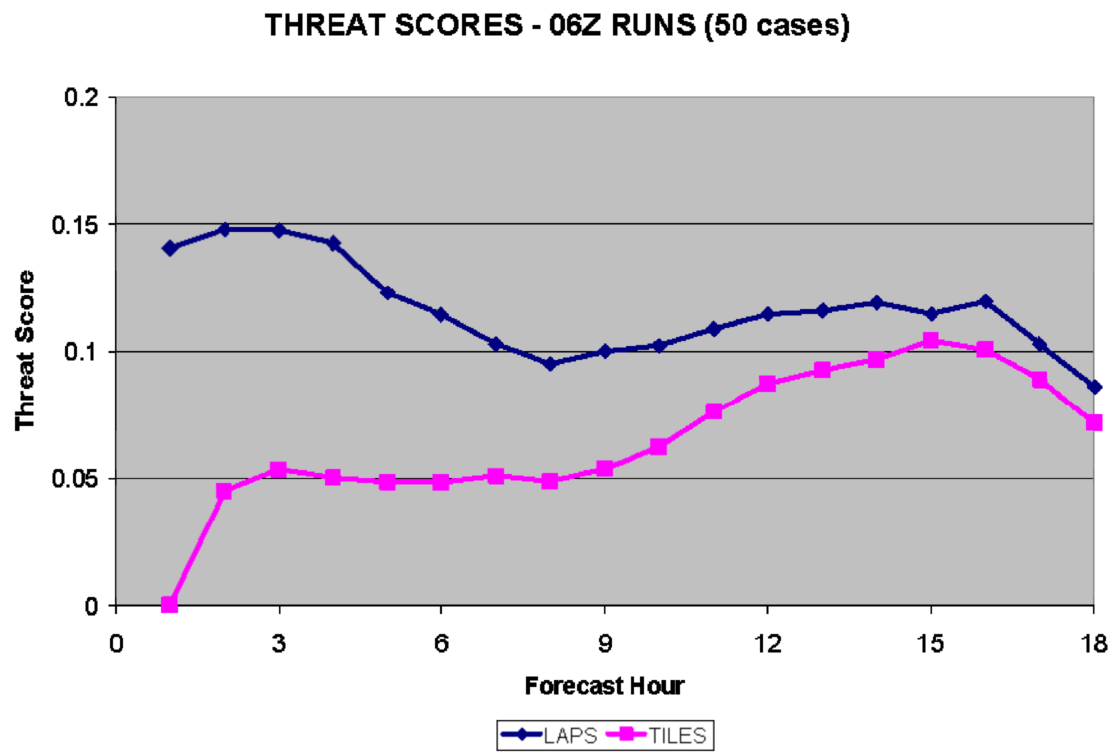
Etherton, B. and P. Santos, 2005: A comparison of WRF forecasts made using different sources for initial and boundary conditions. AMS 17th Conference on Numerical Weather Prediction, Washington, D.C.

Etherton, B. and P. Santos, 2006: Sensitivity Of WRF Forecasts for South Florida to Initial and Boundary Conditions. AMS Annual Meeting, 10th Symposium on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface (IOAS-AOLS), Atlanta, GA.

Kondragunta, C., D. Kitzmiller, D. J. Seo, and K. Shrestha, 2005: Objective Integration of Satellite, Rain Gauge, and Radar Precipitation Estimates in the Multisensor Precipitation Estimator Algorithm. 19th Conf. on Hydrology, AMS 85th Annual Meeting, San Diego, CA.

Seo D. J. and J. P . Breidenbach, 2002: Real-time correction of spatially nonuniform bias in radar rainfall data using rain gauge measurements. *J. Hydrometeorology*, **3**, 93-111.

Figures



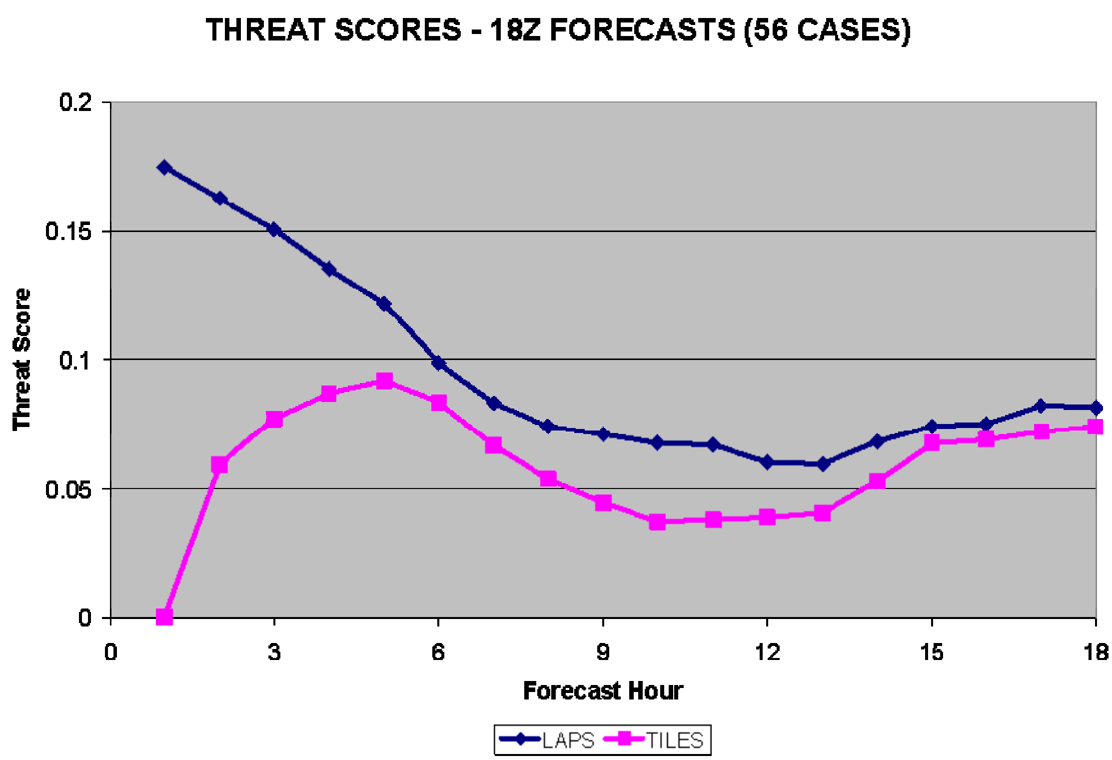


Figure 1: Threat Scores of WRF model runs for the 06Z (top) and 18Z (bottom) cycles using LAPS (blue time series) and NAM12 (magenta time series) for initial conditions.

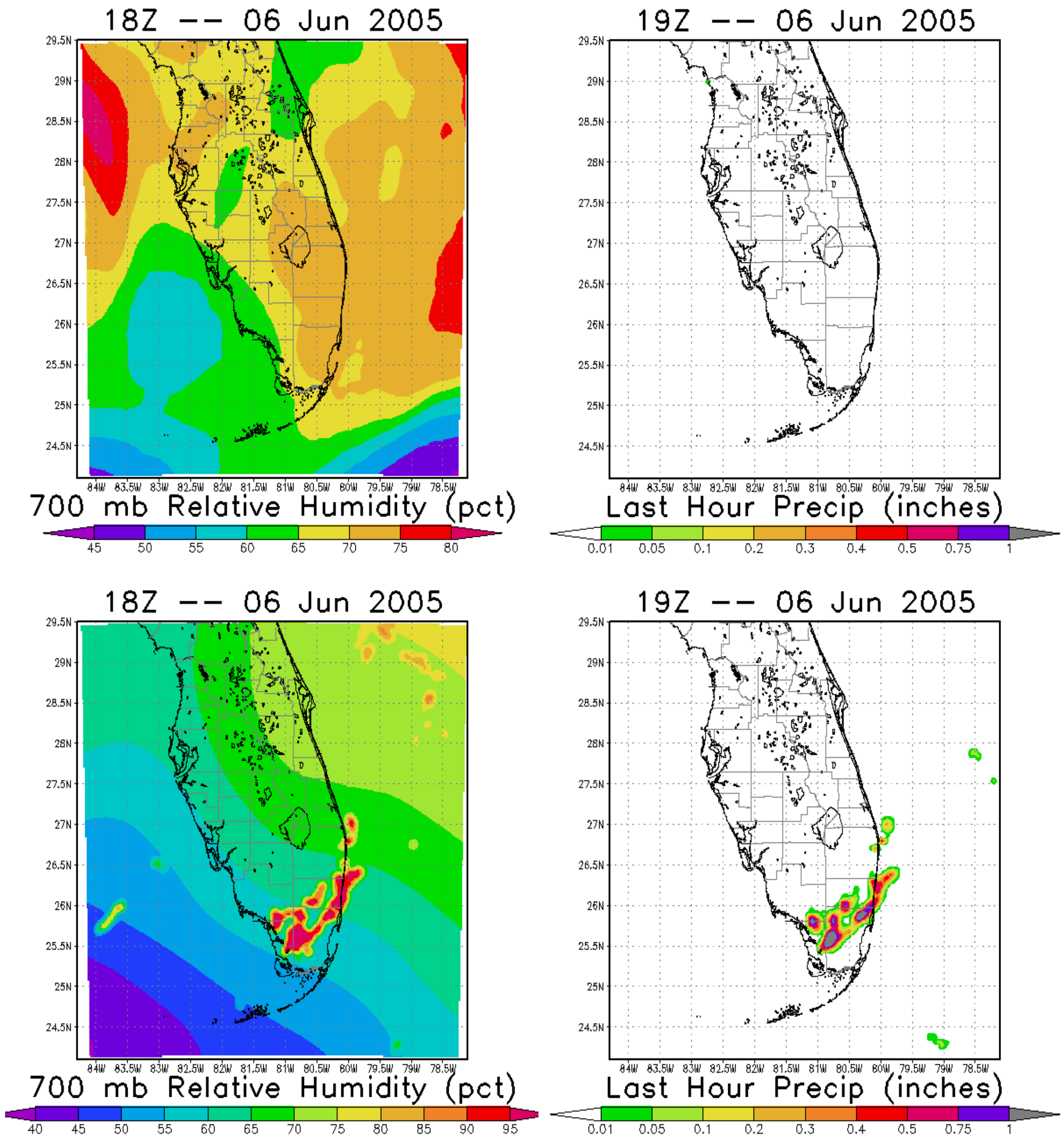


Figure 2. Example of 700mb Relative Humidity at the analysis time (18Z, left panels) and the corresponding 1 hour forecasts (right panels) for two WRF simulations; the standard NAM12 initialization (top) and the LAPS initialization (bottom).

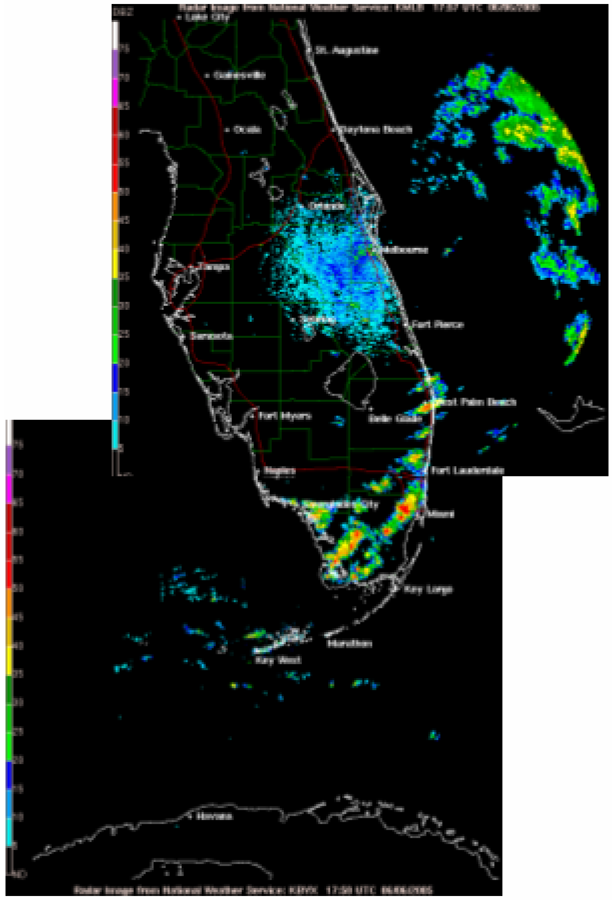


Figure 3. Radar Composite Reflectivity around 19Z on June 06, 2005.