J1.8 **The effect of local initialization on Workstation ETA**

Brian Etherton
Department of Geography and Earth Sciences
University of North Carolina at Charlotte
McEniry Bldg. Room 428
Charlotte, NC 28223
betherto@uncc.edu

Pablo Santos
National Weather Service
11691 SW 17th Street, Miami, FL 33165
pablo.santos@noaa.gov

1. INTRODUCTION

In South Florida, mesosacle weather features have a significant impact on day to day weather forecasts as they represent the primary forcing. Some of these features are: tropical waves, seas breezes, land breezes, thermal troughs, and outflow boundaries. The warm waters of the Gulf Stream also play an important role on the thermodynamic properties of the local air mass. Many of these features are not represented properly in the guidance from the National Centers for Environmental Prediction (NCEP) and therefore high resolution diagnostic as well as prognostic tools are necessary to support local forecasts. The advent of the Local Analysis and Prediction System (LAPS) at the Weather Service Forecast Offices (WFO) has provided the ability to ingest local data sets into locally controlled high resolution diagnostic analyses that capture and represent better some of these features.

This paper presents preliminary results of a study focusing on the impact of using the enhanced LAPS diagnostic analyses on the initialization of a locally run mesoscale model. The model used for the study is the Workstation Eta. The study period ran from August 4, 2003 to October 11, 2003. Therefore, the emphasis in this preliminary paper is during the latter part of South Florida's convective season. In addition to measuring the impact of using LAPS to initialize the workstation Eta, the impact of different physical configurations on the model's performance is studied as well. Long term plans also include the incorporation of high resolution SST analyses into the initialization cycle to study their impact on the model's performance. This work is part of a COMET Partnership Project currently in effect between the University of Miami (UM) and WFO Miami.

2. OBJECTIVES

The emphasis of this paper is two-fold: 1) to investigate the impact of incorporating high resolution analyses that assimilate non-traditional data sets into the model's initialization cycle; and 2) to investigate the performance of the model under different physical configurations. With that in mind, the objectives of this paper are: 1) to quantitatively measure the model's performance under different physical/initial conditions using grid based threat scores, bias scores, probability of detection, false alarm ratio, and root mean square errors; and 2) to qualitatively analyze the model's performance and impact on operations using forecasters input.

3. DATA

3.1 Local Analysis and Prediction System (LAPS)

LAPS became available to the WFO with the advent of the Advanced Weather Interactive Processing System (AWIPS). LAPS has a diagnostic as well as a predictive component. The diagnostic component consists of high resolution three dimensional analyses of the weather using locally and centrally available meteorological observations (Albers, 1995; Albers et al., 1996). It integrates data from virtually every meteorological observation system into a high-resolution grid framework centered on a forecast office's domain of responsibility. Data from local data networks of surface observing systems, Doppler radars, satellites, wind and temperature (RASS) profilers (404 and boundary-layer 915 MHz), as well as aircraft are incorporated every hour into a three-dimensional grid covering a 600 km by 600 km area in the case of WFO Miami. The resolution of the hourly LAPS surface analyses is 10 km with 39 vertical levels from 1000 mb to 50 mb at 25 mb intervals. The analysis domain centered on WFO Miami County Warning Area (CWA) is shown in Figure 1.

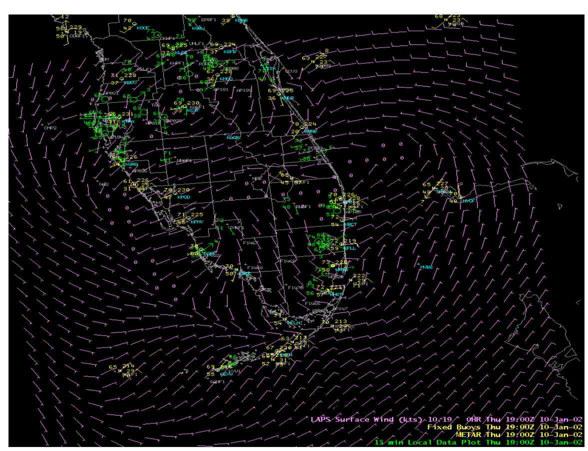

Figure 1: Domain of WFO Miami LAPS analyses.

The analyses for each hour use the AWIPS RUC 40 km grid 1 hour forecast from the previous hour. Figure 2 represents a summary of all the data sources LAPS is capable of assimilating into its three dimensional analyses.

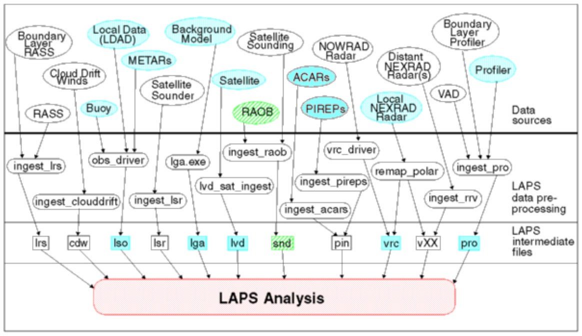

Figure 2: Schematic of Data Sources LAPS is capable of ingesting into its three dimensional hourly analyses. However, only those highlighted in blue and green are used in the operational LAPS analyses run at a typical WFO running AWIPS Operational Build 2.

As it is evident in this figure, not every data source that LAPS is capable of ingesting is taken advantage of at the local WFO level. However, in an attempt to improve the quality of the analyses, WFO Miami has worked on incorporating additional local data networks into the analysis via the Local Data Acquisition and Distribution (LDAD) system, a component of AWIPS. This effort has led to a substantial increase in surface data going into the analyses. Figure 3 illustrates the dramatic increase in data availability to the forecasters and to the LAPS analyses.

The impact on the surface analyses is shown on Figure 4. The addition of just a few non-standard inland

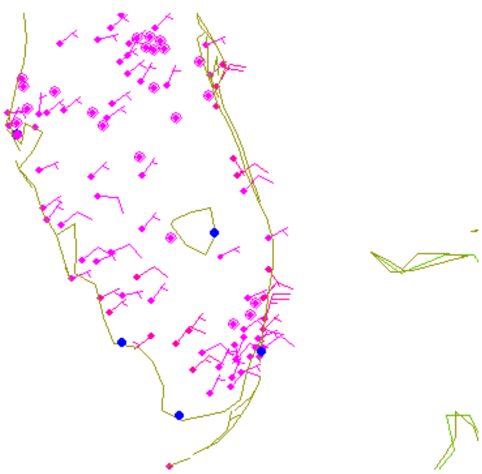

Figure 3a: Typical plot of surface Non-standard data networks (97 data points shown) ingested into AWIPS and the LAPS analyses at WFO Miami.

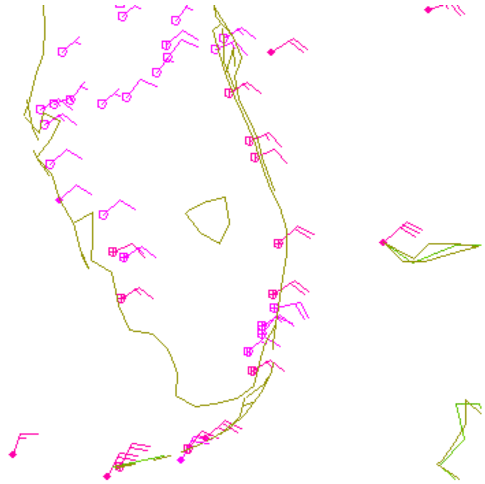

Figure 3b: Typical surface data availability across WFO Miami LAPS domain from standard data networks (METAR, Buoys, CMAN, Ships).

stations (shown in blue) and the station off the east shore of Lake Okeechobee enables the LAPS analyses to more accurately depict the intrusion of the cold air into WFO Miami's CWA. It also enables the analysis to depict better what local forecasters call the "lake shadow" effect on the surface temperatures. The availability of these *enhanced* analyses to the forecasters enables more accurate monitoring of surface conditions which could lead to critical short term forecast updates or even warnings.

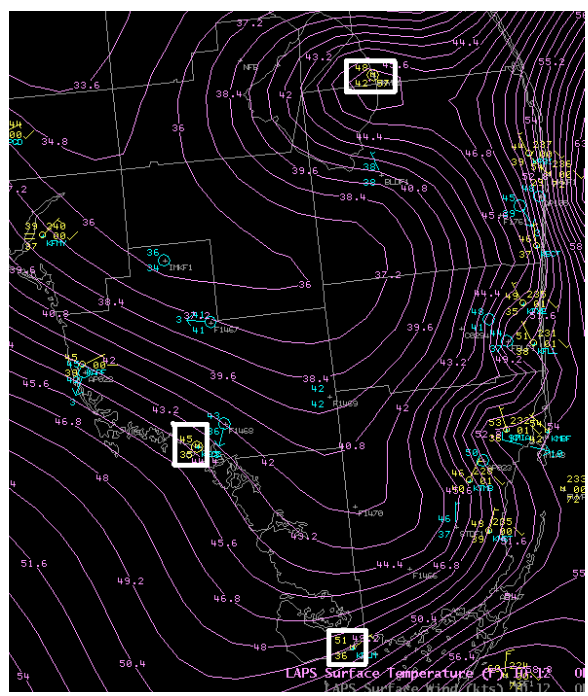

Figure 4: LAPS surface temperature analysis valid on January 10, 2002 at 1200 UTC. Sites in blue and a square around them indicate non-standard data points.

The predictive component of LAPS used at WFO Miami for this experiment is the Workstation Eta. The model is briefly described in the follow section.

3.2 Workstation Eta

The Workstation Eta is a version of NCEP's Eta model but pre-packaged to facilitate the use of Local Area Models (LAM) in the forecast offices. It is a complete, full physics system nearly identical to the operational Eta model. It is supported by the National Weather Service (NWS) Science and Operations Officer (SOO) Science Training and Resource Center (STRC) (http://strc.comet.ucar.edu/) collocated with the Cooperative Program for Operational Meteorology, Education, and Training (COMET) and the University Corporation for Atmospheric Research (UCAR) in Boulder, CO. It has nesting capability, support for NCEP reanalysis grids, and support for the Eta 12 km tile files for boundary and initial conditions.

4.0 METHODOLOGY

This section provides a description of the model set up for purposes of the experiment and describes the objective as well as subjective methods by which the model's performance is being evaluated.

4.1 Model Set Up

The model was run on three different configurations. The first one is referred to as the NWS WsEta (run locally at WFO Miami), which represents a similar run to the NCEP operational Eta but run at a higher resolution and initialized from the operational Eta 12 tile files. The second and third runs are referred to as the University of Miami (UM) Eta9 (9 km) and UM Eta3 (3 km) runs. These are the outer and inner domains of a nested run, respectively. They were run at the University of Miami in partnership with the NWS office in Miami. The specifications for each of these three runs are given in Table 1. The NWS WsEta is considered the control run since it is similar to the NCEP operational Eta run.

Model Name (Res)	Cycle	Length	Mode	CP	BC	IC
NWS WsEta 10 km	06Z, 18Z	18 Hrs hourly output	Hydro -static	BMJ	Eta 12	Eta 12
UM Eta9 9 km	06Z, 18Z	18 Hrs hourly output	Non-Hydro -static	KF	Eta 12	Eta 12
UM Eta3 3 km	06Z, 18Z	18 Hrs hourly output	Non-Hydro -static	None	UM Eta9	LAPS

Table1: Model runs configurations tested in this study. CP refers to convective parameterization with BMJ being Betts-Miller-Janjic parameterization (Betts and Miller, 1986; Janjic, 1994), and KF being Kain-Fritsch (Kain and Fritsch, 1993). BC and IC refer to boundary and initial conditions used, respectively. Eta12 refers to NCEP's operational Eta 12 km files used for either BC or IC.

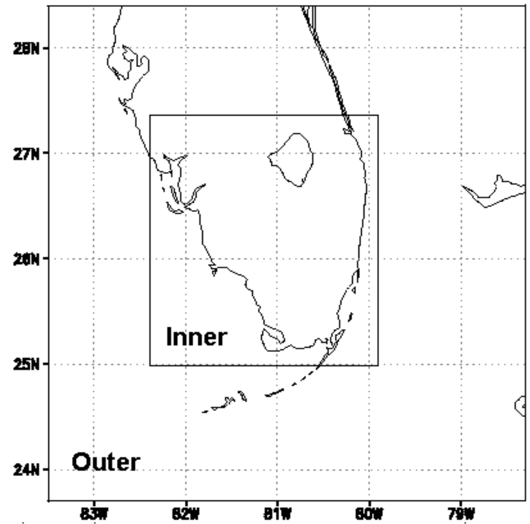

Figure 5: Model domains for NWS WsEta (Outer), UM Eta9 (Outer), and UM Eta3 (Inner).

Notice from Table 1 that with the exception of LAPS being used to initialize and UM Eta9 used as boundary conditions for UM Eta3, the operational Eta 12 was used for boundary as well as initial conditions of all other runs. Figure 5 illustrates the domain of the NWS WsEta, the UM Eta9 (Outer), and the UM Eta3 (Inner) runs. Due to bandwidth limitations, the Eta 12 output is made available by NCEP in tile files covering different sectors across the country. Figure 6 shows the Eta 12 tile files regions used as boundary and/or initial conditions as described in Table 1. These tile files were chosen to cover the domain of the experiment which is predominantly in a synoptic easterly regime during convective season.

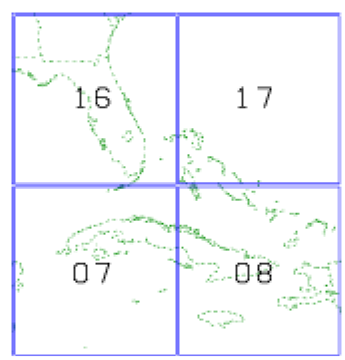

Figure 6: Eta 12 tile files used as boundary and/or initial conditions as illustrated in Table 1.

4.2 Model Evaluation

The model evaluation is based on analysis of grid scale calculations of threat and bias scores, root mean square errors (RMSE), probability of detection (POD), and false alarm ratio (FAR) for different precipitation thresholds. Given an Area Forecast (Af) of precipitation, an Area Observed (Ao) of precipitation, and the area over which both of these intersect, referred to as Area Correct (Ac), the threat score is defined as shown in Figure 7.

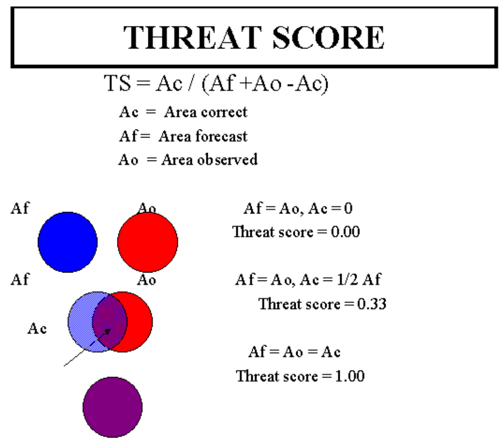

Figure 7: Schematic illustration of the definition of Threat Score.

Therefore, the smaller the threat score the less skill in the forecast. The RMSE is simply the root of the average of the squared difference between model forecasts and radar values, averaged over all grid points while the bias score is the average of the difference between the model forecasts and the radar values, averaged also over all grid points. In mathematical form, the bias score for N number of grid points is:

$$BIAS = \frac{1}{N}\sum_{i=1}^{N}(M_i - R_i) \qquad (1)$$

where M_i and R_i are the model precipitation forecasts and radar observed precipitation at each grid point, respectively. The RMSE is given by:

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(M_i - R_i)^2} \qquad (2)$$

and it represents a statistical measure of the magnitude of the varying error.

The Probability of Detection (POD) is defined as:

POD = (NORGF)/(NORGF + NORGNF) (3)

where NORGF are the number of observed rainy grids that were forecast and NORGNF are the number of observed rainy grids not forecast. The FAR is defined as:

FAR = NFRGF/NTRGF (4)

where NFRGF is the number of false rainy grids forecasts and NTRGF is the number of total rainy grids forecasts. Ideally, one would like a high POD while keeping a low FAR for best performance.

These statistics were calculated for each of the model configurations shown in Table 1 for the 06Z and the 18Z runs, separately, and averaged over the study time period, that is, August 4, 2003 to October 11, 2003. The number of model runs included in the calculations was 135. For each model cycle, the statistics were stratified into two periods. For the 06Z cycle the periods are the 12Z to 18Z and the 18Z to 00Z time frames. For the 18Z cycle, the periods are the 00Z to 06Z and the 06Z to 12Z time frames. The reason the first 6 hours of the forecasts were left out of the analysis is because it was observed that all three model configurations had problems initiating and/or spinning up convection within this time frame even when precipitation was already occurring.

As a final means of evaluation, forecasters at NWS Miami filled out an evaluation sheet where they had the chance to write down their observations regarding the performance and/or utility of all three model configurations. These inputs are being evaluated and categorized in an attempt to determine, in combination with the objective analysis above, weaknesses and strengths in the model performance. The goal is to help determine how this tool can best be used as high resolution guidance.

5. PRELIMINARY RESULTS

As of this writing, the data is being processed to conduct thoroughly the analysis described in the previous section. However, preliminary results shown in Figures 8 through 10 for the entire study period and a precipitation threshold of 0.50 inches indicate that in general the UM Eta3 model runs show the most skillful forecasts of all as far as precipitation is concerned. Preliminary analysis of forecasters observations indicate this as well, with the main observation being that the model seems to do best with the diurnally driven portion of the convection. This is highlighted well in Figures 8 through 10 where for the 06Z model cycle all three model configurations perform best in the late afternoon hours where as in the 18Z cycle the models generally show more skill in the 6-12 hours forecast period, the late portion of the day time convective cycle**.** An example of this behavior in the model's performance is illustrated in Figure 11. Figure 11 also demonstrate one observation made by some of the forecasters and that is how the BMJ hydrostatic runs (NWS WsEta) create generally broader precipitation forecasts that are generally much lower than the observed precipitation patterns contrary to the KF Non-hydrostatic runs (UM Eta9).

6. SUMMARY AND FUTURE WORK

This paper presents preliminary results on a COMET Partners project between UM and WFO Miami. The preliminary results indicate that the UM Eta3 model configuration initialized with LAPS was overall the best

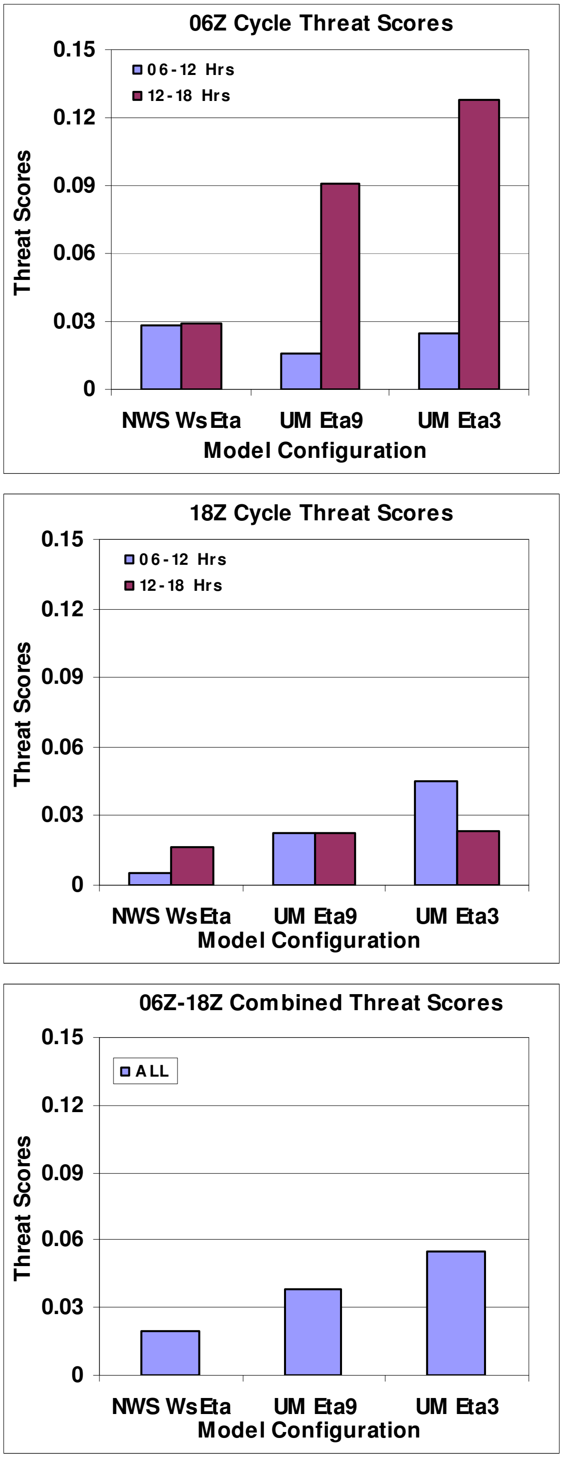

Figure 8: Threat scores for all three model configurations for the 06Z model cycle (top panel), 18Z model cycle (middle panel), and both cycles combined (bottom panel). Precipitation threshold is 0.5 inches.

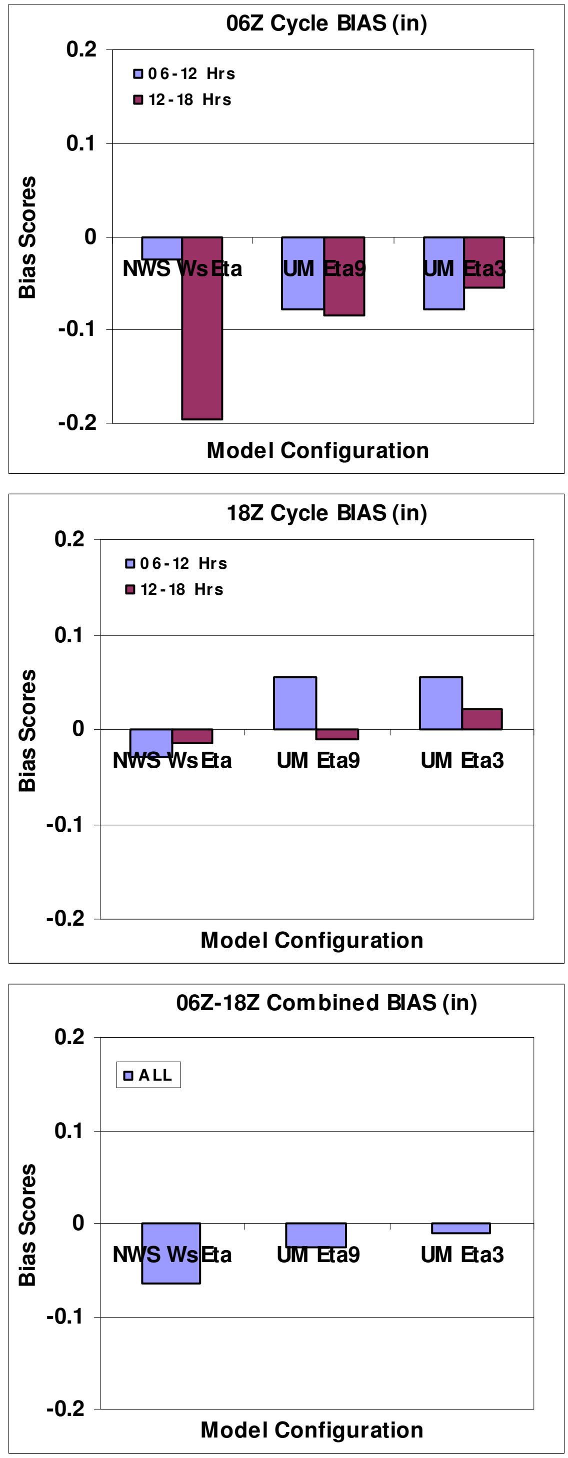

Figure 9: Bias scores for all three model configurations for the 06Z model cycle (top panel), 18Z model cycle (middle panel), and both cycles combined (bottom panel). Precipitation threshold is 0.5 inches.

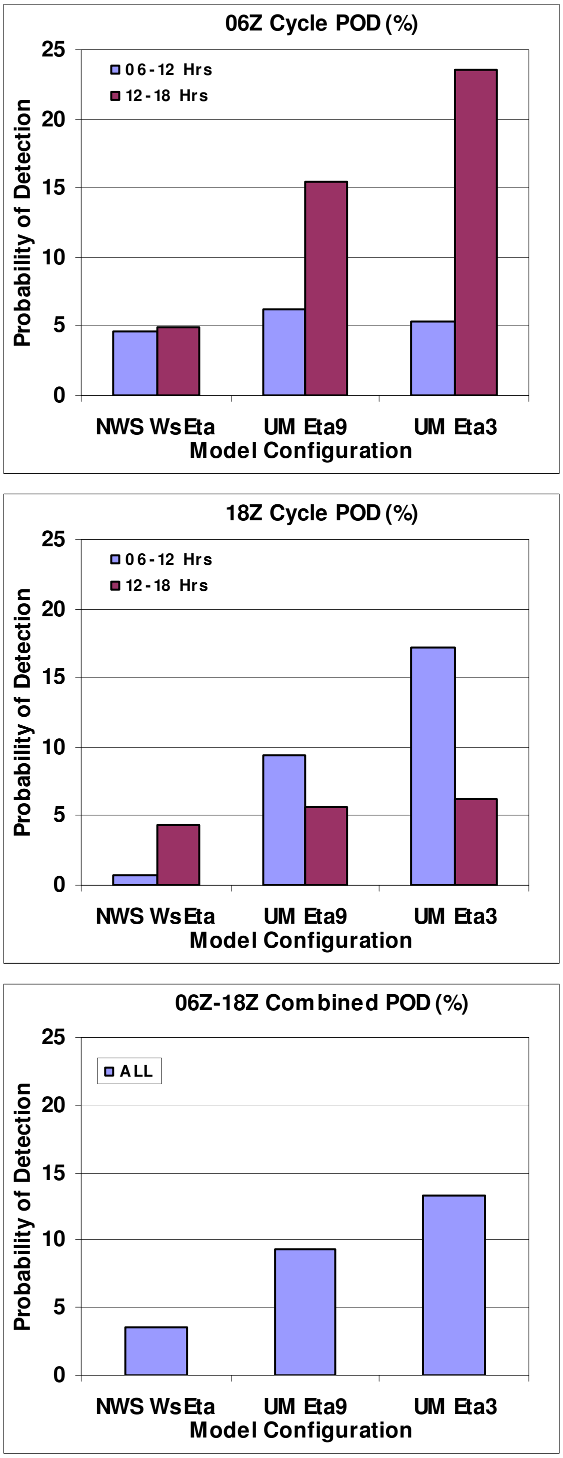

Figure 10: Probability of Detection (POD) for all three model configurations for the 06Z model cycle (top panel), 18Z model cycle (middle panel), and both cycles combined (bottom panel). Precipitation threshold is 0.5 inches.

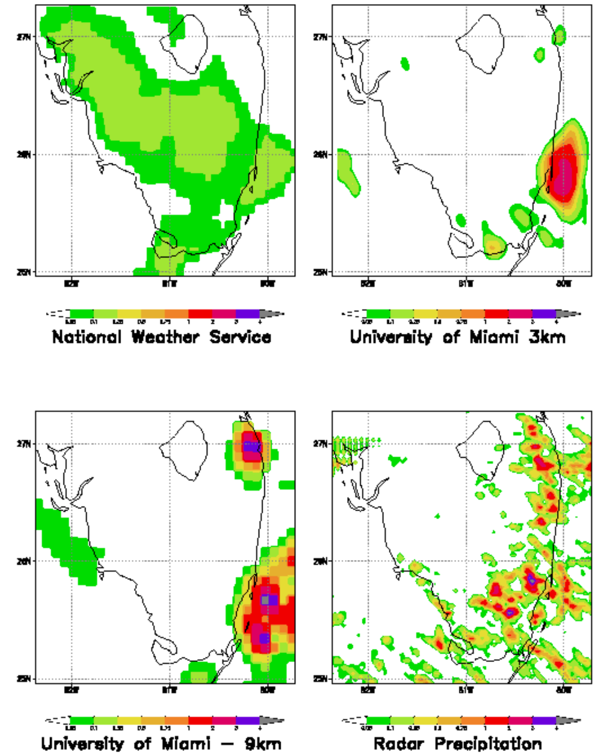

Figure 11a: 12Z-18Z precipitation forecasts from the September 24, 2003 06Z run from the NWS WsEta (top left), UM Eta9 (lower left), and UM Eta3 (top right). Lower right is the 6 hours radar accumulations.

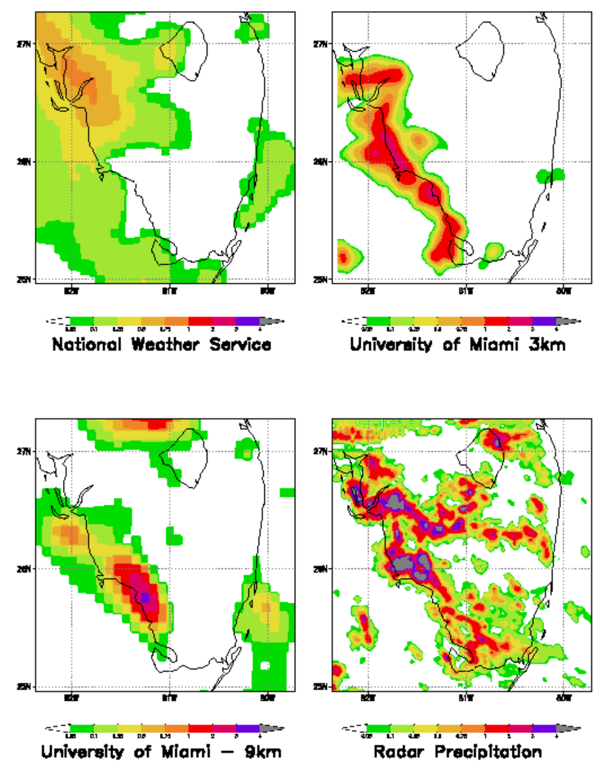

Figure 11b: as 11a but for the 18Z-00Z time period.

performing model during the latter part of the 2003 South Florida Convective season. However, a more in depth analysis is needed and is currently under way in an attempt to highlight differences among different precipitation thresholds and/or regimes. The results will also be evaluated in light of the physical configurations used, their different designs and assumptions (BMJ vs KF convective parameterization, grid scale precipitation, etc). Given the overall still low threat scores and POD, a comprehensive categorization and analysis of the forecasters input is also currently under way in an attempt to establish the real impact this enhanced tool (enhanced LAPS analyses and high resolution local modeling) has in operations. Future work includes assimilating high resolution SSTs into the initialization cycle by the end of the year. The impact of this change will be documented through a one month experiment to be run through January-February 2004. This represents the last portion of this COMET Partners project.

7. REFERENCES

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