P1.2 The effect of using AWIPS LAPS and High Resolution SSTs to locally initialize the Workstation ETA

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1. INTRODUCTION

In South Florida, mesoscale weather features (e.g. land/sea breezes, thermal troughs, outflow boundaries, etc.) have a significant impact on day to day weather forecasts as they represent the primary forcing for convection. The Gulf Stream can have a profound effect on the local thermodynamics through air mass modification. Unfortunately, SSTs are not well-resolved in current guidance from the National Centers for Environmental Prediction (NCEP). For example, the Rapid Update Cycle (RUC) model assimilates NCEP's Real-time global sea surface temperature analysis (RTG_SST) which is a daily (at 12 UTC) product on a relatively coarse 0.5 degree by 0.5 degree grid. This is particularly problematic in the presence of significant SST gradients associated with the western periphery of the Gulf Stream. The combination of mesoscale-driven circulations and proximity of the Gulf Stream necessitates the use of high resolution products and forecast tools in order to provide the detailed information necessary for improving local forecasts. The advent of the Local Analysis and Prediction System (LAPS) at the Weather Service Forecast Offices (WFO) has made it possible to ingest high resolution data sets in support of local high resolution analyses that better resolve some of these features.

Using precipitation as a metric, this study examines the impact of initializing a numerical weather prediction model with high resolution data. The work presented here has two basic components the first of which consists of an upgrade to the Advanced Weather Interactive Processing System (AWIPS) LAPS diagnostic analyses via the use of local mesonet data to improve analyses and initialize a mesoscale model. The Workstation Eta (WsEta, see section 2.3) model is used for this study. Phase one of the study ran from 4 August 2003 to 11 October 2003. In addition to evaluating the impact of the LAPS initialization of the WsEta, the impact of different model configurations (Table 2) on the model's performance was studied as well. Phase two consists of incorporating high resolution SST analyses into the initialization/forecast cycle to study their impact on the model's performance (i.e. precipitation). The second phase ran from 15 July 2004 to 15 August 2004. This work is the result of two distinct COMET Partners Projects (http://comet.ucar.edu/outreach/partnow.htm) the first of which paired the National Weather Service (NWS) Forecast Office in Miami with the University of Miami (UM) and second with the Florida Institute of Technology (FIT). The UM project was designed to develop software to initialize the WsEta via LAPS while the latter project was geared toward the development of high resolution SST composites for use in model initialization and to improve over-ocean estimates of the 2 m air temperature.

The emphasis of this paper is two-fold: 1) to investigate the impact of incorporating high resolution analyses and non-traditional data sets into the model's initialization/forecast cycle; and 2) to investigate the performance of the model under different configurations (Table 2). To accomplish these goals, model performance for different configurations (i.e., physical/initial conditions as in Table 2) is evaluated using grid based threat scores, bias scores, and probability of detection for different precipitation thresholds. A quantitative assessment of the impact of initializing the model with the AWIPS LAPS analyses and initialization using a high resolution SST dataset versus an initialization using NCEP's real time global SST (RTG_SST) analysis is also investigated.

2. DATA

2.1 Local Analysis and Prediction System (LAPS)

LAPS became available to the WFO with the advent of AWIPS. As delivered in AWIPS, LAPS is a diagnostic tool only. It consists of high resolution three-dimensional analyses of the atmosphere using locally and centrally available meteorological observations. LAPS incorporates data from virtually every meteorological observation system onto a high-resolution grid centered on a domain of the users choosing. Data from local 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 into the analysis (Albers, 1995; Albers et al., 1996; Birkenheuer, 1999; McGinley, 2001; Schultz and Albers, 2001). At the Miami WFO, the analyses are produced every hour in a three-dimensional grid covering a 600 km by 600 km area. The horizontal resolution of the hourly LAPS surface analyses is 10 km with 39 vertical levels from 1000 mb to 50 mb at 25 mb intervals in the case of WFO Miami. The analysis domain centered on WFO Miami County Warning Area (CWA) is shown in Fig. 1.

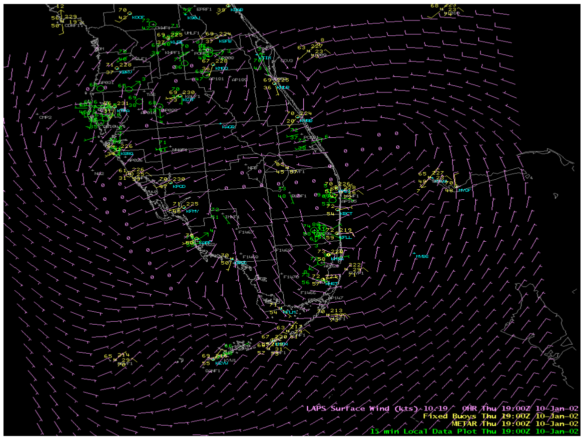


Figure 1: Domain of WFO Miami LAPS analyses.

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

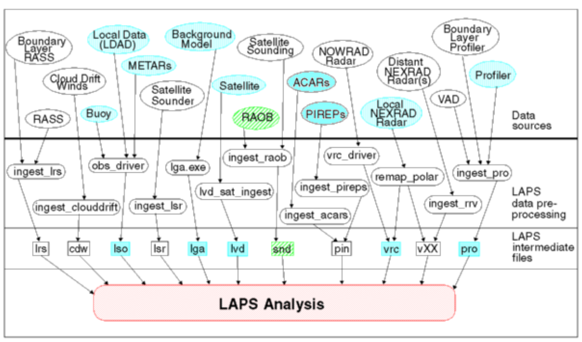


Figure 2: Schematic of LAPS Data Sources. Although LAPS is capable of ingesting many different data streams, only those highlighted in blue and green are used in the operational LAPS analyses at a typical WFO running AWIPS Operational Build 3.

As it is evident in Fig. 2, not all data that LAPS is capable of ingesting is actually used operationally at the local WFO level. Despite the fact that LAPS is equipped with a Kalman filter (for quality control), as well as balance and cloud analysis diabatic packages, as of this writing, neither of these are used in the WFO AWIPS version due to hardware limitations. However, in an attempt to improve the quality of the local analyses, the WFO in 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 the amount of surface data going into the analyses. Figure 3 illustrates the dramatic increase in data availability to the forecasters and to the LAPS analyses.

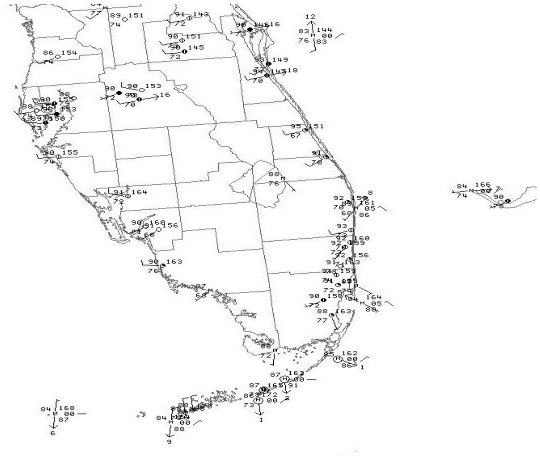


Figure 3a: Typical surface data availability across WFO Miami LAPS domain from standard data networks (METAR, Buoys, CMAN, Ships).

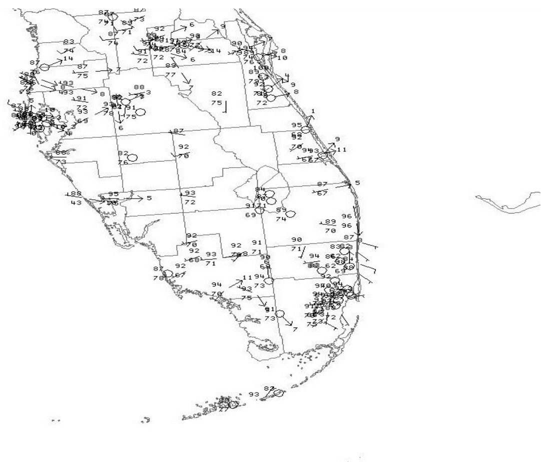


Figure 3b: Typical plot of surface Non-standard (mesonets) data networks ingested into AWIPS and the LAPS analyses at WFO Miami.

An example of the qualitative impact on the surface analyses from these non-standard surface reporting sites is shown on Fig. 4. The addition of the non-standard inland stations, including those around Lake Okeechobee, enhances the LAPS analyses of both inland and coastal gradients, as well as the effect of the Lake on the surface fields. The availability of these additional data and their ingest into the analyses increases the ability of a forecaster to monitor changing surface conditions that could lead to critical short term forecast updates and warnings.

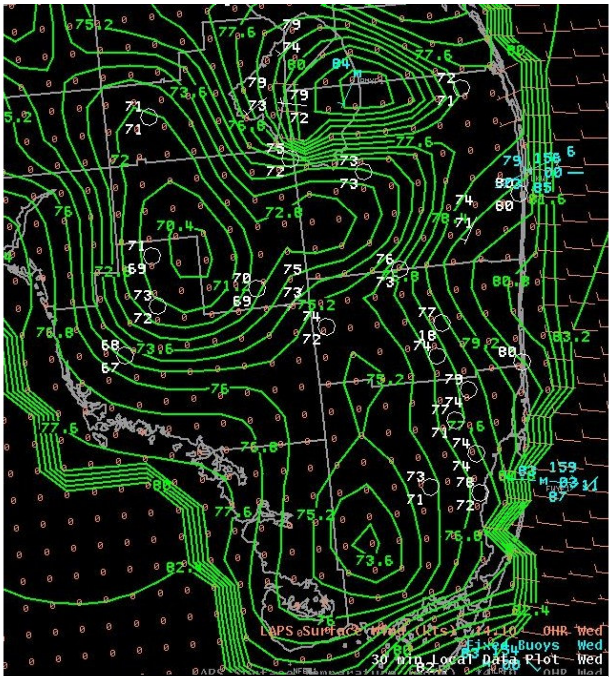


Figure 4: LAPS surface temperature analysis for 1100 UTC 14 July 2004. Sites annotated in white depict locations of the non-standard surface observations that are ingested into the analysis.

Quantitatively, the inclusion of the non-standard data sources or mesonets results in a substantial improvement of the analysis versus the background field, in this case the 1 hour AWIPS RUC40 forecast. Table 1 shows the mean root mean square (RMS) errors for four basic surface fields calculated for the background and analysis fields separately throughout the study periods using first the analyses that used only standard (Metars, CMANS, and Buoys) data networks and then the analyses that used standard plus non-standard (mesonets) data networks across the LAPS domain. Generally, the inclusion of the local mesonets in the analyses resulted in an improvement that increased from 20% to 30% with standard data sets only to 60% when adding the mesonets in the RMS for the temperature and mean sea level pressure (MSLP) fields with respect to the standard RUC background field. For the dew point and wind speed fields, the improvements went from 4% to 11% and from 6% to 20%, respectively, for the summer 2003 portion of the experiment. Similar results were observed for the summer 2004 portion of the experiment as shown in Table 1.

2.2 Sea Surface Temperature Data Sets

During the second phase of this study, emphasis was on quantitatively comparing the model performance using two different SST data sets. The first SST data set is NCEP's RTG_SST Analysis (Thiebaux et al., 2001; http://polar.wwb.noaa.gov/sst/). It consists of a daily, real-time, global, sea surface temperature analysis that uses in-situ observations and high resolution polar orbiting satellite (POES) data. This analysis was developed at NCEP's Marine Modeling and Analysis Branch (MMAB) and was implemented in the NCEP production suite 30 January 2001. It provides the daily ocean surface temperatures for the Eta model with a 55 km resolution and updated twice a day.

Field	RUC (40)	LAPS Analysis		#Stns	
		Std	All	Std	All
Summer 2003 Experimental Period					
T (F)	4.32	3.15	1.73	45	236
Td (F)	4.77	4.58	4.24	40	203
WS (kts)	2.66	2.50	2.13	45	240
MSLP (mb)	0.85	0.65	0.33	30	31
Summer 2004 Experimental Period					
T (F)	4.00	3.06	1.75	45	128
Td (F)	4.32	4.19	3.96	40	106
WS (kts)	3.02	2.75	2.38	45	131
MSLP (mb)	0.85	0.67	0.36	33	38

Table 1. Root Mean Square (RMS) errors for selected fields of the model background (AWIPS RUC 40 1 hour forecast) versus LAPS analyses with standard (Std) and standard plus non-standard (All) datasets for both summer experimental periods. #Stns refers to the number of stations used to calculate the RMS across the LAPS domain.

The second SST data set is comprised of NESDIS GOES SST retrievals (Maturi et al., 2004). The sea surface temperature (SST) data provided by NOAA NESDIS is a 'merged' data stream that combines both the GOES-10 and GOES-12 SST products from the satellite's imager using two channels (3.9 and 11µm). With the exception of a 05-06 UTC blackout period for data processing, SST data flow continuously in 30 min. intervals. The 30 min. data are combined to produce hourly SST files. Removal of both cloud-contaminated radiances (via a cloud mask) and radiances that are affected by sun glint at 3.9 µm, precede application of the regression-based SST retrieval algorithm (Maturi et al. 2004). Area McIDAS (i.e., Man computer Interactive Data Access System, Krauss, 1972) files are sub-sampled (Maturi, personal communication) to produce 6 km horizontal resolution lat/lon grids covering the area from 60°N to 45°S latitude and from 180°W to 30°W longitude.

The SST grids are retrieved hourly from the NOAA server in Silver Spring MD at the Florida Institute of Technology (FIT). Because of processing, bandwidth issues, etc., the hourly grids are available in 'near-real' time (about a three hour lag). From these grids, FIT extracts a sub domain that coincides with an analysis region (~ 700 km^2) used in a forecast/assimilation cycle by the National Weather Service in Melbourne, FL ARPS Data Assimilation System (ADAS, Case et al. 2002). Although the SSTs are updated hourly by simply replacing an old value with a new observation, persistent cloud cover can, at times, lead to SST composites that are no longer valid. However, with the exception of the early stages of a cold start (i.e. no previous data), because the composites are run continuously, missing data are not an issue. In order to gauge the impact of clouds and appropriately apply/assess the composites, a 'data latency' map accompanies the SST files. The SST composite and data latency data are placed on the NOAA NWS Southern Region server in both text and NetCDF format. The former is used for modeling purposes and the latter for ingest on the AWIPS platform by the regional NWS offices in Florida.

2.3 Workstation Eta

The Workstation Eta is a version of NCEP's Eta model (Black, 1994; Chen et al., 1997; Janjic, 1994, 1996; Rogers et al., 1995; Zhao et at., 1997). 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/) which is part of the Cooperative Program for Operational Meteorology, Education, and Training (COMET) administrated by the University Corporation for Atmospheric Research (UCAR). The workstation Eta has one-way nesting capability, support for NCEP reanalysis grids, and support for NCEP Eta 12km output files for boundary and initial conditions. Due to bandwidth limitations, the Eta 12 output is made available by NCEP in tile files covering different sectors across the country. The workstation Eta does not, however, include support for LAPS ingest into the initialization cycle as delivered. That capability was added as part of this study.

2.4 WSR-88D Rainfall Data

The model skill was measured by quantifying its ability to forecast precipitation. The WSR-88D three hourly rainfall totals from AWIPS were assumed to be ground truth for calculating performance metrics. These totals were archived throughout the study periods. These data files were used to perform the model evaluation described in the following section.

3.0 METHODOLOGY

3.1 WsEta Configurations

The WsEta model was run in 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 ran at a higher resolution (10km versus 12km at NCEP). This run was 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 grid configuration, respectively. They were run at the University of Miami in partnership with the NWS office in Miami. The UM runs were different in configuration than the NWS runs. Specifications for each of these three runs are given in Table 2. The NWS WsEta is considered to be 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	UM Eta9/ LAPS

Table2. Model information and associated configurations. 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 the boundary and initial conditions used, respectively. Eta12 refers to NCEP's operational Eta 12 km tile files used for either BC or IC. LAPS was used to initialize the UM Eta3 runs only.

Table 2 indicates that the operational Eta 12 was used for boundary and initial conditions of the NWS WsEta and UM Eta9 runs, whereas UM Eta9 was used for boundary and initial conditions of the UM Eta3 runs, and LAPS analyses were used for initial conditions of the UM Eta3 runs only. NCEP's RTG_SST sea surface temperatures were used in the first phase of the experiment (Aug 4-Oct 11, 2003). During the second phase (Jul 15-Aug 15**,** 2004) only the UM Eta9 was tested but ran with two different SST data sets (NCEP's RTG_SST and NESDIS GOES SST) to contrast their impact on model performance.

Figure 5 illustrates the domain of the NWS WsEta, the UM Eta9 (Outer), and the UM Eta3 (Inner) runs. The inner domain follows NWS Miami mainland county warning area (CWA) while the outer domain falls within the LAPS analysis and is nearly identical to the NWS WsEta domain. 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 2. These tile files were chosen to cover the domain of the experiment which is predominantly in a synoptic easterly regime (see section 4.1) during convective season.

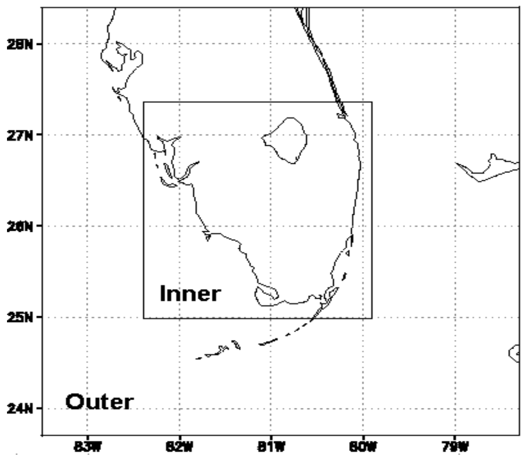


Figure 5: Model domains for NWS WsEta (Outer), UM Eta9 (Outer), and UM Eta3 (Inner).

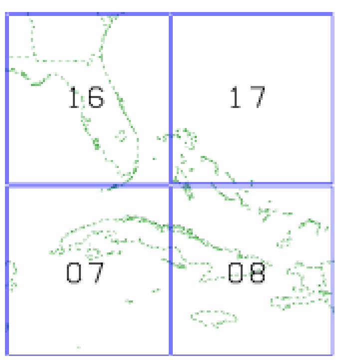


Figure 6: Eta 12 tile files used as boundary and/or initial conditions as illustrated in Table 2.

3.2 Model Evaluation

The model evaluation is based on analysis of grid point calculations of threat (TS) and bias (BS) scores, and probability of detection (POD) for different precipitation thresholds (0.25, 0.50, and 1.00 inches). 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:

$$TS = \left(\frac{Ac}{Af + Ao - Ac} \right) \qquad (1)$$

The smaller the threat scores the less skill in the forecast. If the area forecast and area observed are identical, then Ac = Af = Ao, and the threat score is 1. If the forecast and observed areas are the same size, and half overlap, then Af = Ao = 1, wheras Ac = 0.5, and TS = 1/3.

The bias score is simply the average of the difference between model forecasts and radar values, averaged over all grid points. In mathematical form, the bias score for N number of grid points is:

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

where M_i and R_i are the model precipitation forecasts and radar observed precipitation at each grid point, respectively.

The Probability of Detection (POD) is defined as:

$$POD = \left(\frac{Ac}{Ao} \right) \qquad (3)$$

where Ac is the number of observed rainy grids that were forecast and Ao is the total number of observed rainy grids. Ideally, one would like a high POD. A POD of 1.0 would mean that every grid point that rained was accurately forecast. The primary difference between POD and TS is that POD has no penalty for over forecasted precipitation.

These quantities, TS, BIAS, and POD, were calculated for each of the four model configurations shown in Table 2 for the summer 2003 study, and for the two UM Eta9 configurations (one initialized with the RTG_SST and the other with high resolution SSTs) for the summer 2004 study. These statistics were calculated for both the 06Z and the 18Z runs, separately, and averaged over the study time. The grid used for analysis of these values was the UM Eta9 grid. The number of model runs included in the calculations was 135 during the summer of 2003 while it was 56 during the summer of 2004. For each model cycle, the statistics were stratified into two periods. For the 06Z cycle the periods are the 12Z to 18Z (6-12 hour forecasts) and the 18Z to 00Z (12-18 hour forecasts) time frames. For the 18Z cycle, the periods are the 00Z to 06Z and the 06Z to 12Z time frames (6-12 and 12-18 hour forecasts, respectively). The first 6 hours of the forecasts were left out of the analysis 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.

4. RESULTS

4.1 Summer 2003 Experiment

Our first experiment took place during the late summer and early fall of 2003. This is a time of year which is usually characterized by weak synoptic flow, predominantly from the east. Figure 7 shows the average wind direction and speed at 1000 millibars from the NCEP/NCAR reanalysis for the months of August and September 2003. Winds in this reanalysis were on average light and from the east during this time period.

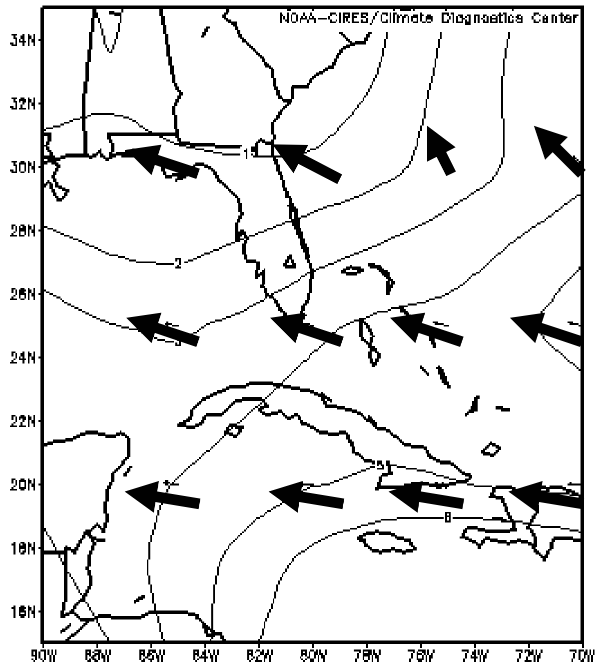


Figure 7: Average 1000mb wind direction and speed for August and September 2003 from the NCAR/NCEP Reanalysis field. Wind speeds in knots.

Figure 8 shows the results for the TS and POD scores for all three precipitation thresholds for the Aug 4-Oct 11 2003 portion of the experiment. For clarification purposes, 06Z-06-12 Hrs in the figure follows the convention CY-H1-H2 Hrs which means forecast hours H1 to H2 from model cycle CY. Therefore, 06Z-06-12 Hrs means the 12Z-18Z forecast period from the 06Z model run. Overall, these figures illustrate that as the precipitation threshold increases, the accuracy of the NWS Eta decreases considerably. This degradation in performance appears to be associated with the Betts Miller Janic (BMJ) convective parameterization scheme which creates large areas of light-to-moderate rainfall that do not resemble the convective cellular characteristic of summer time Florida rainfall. This is also why, for the lowest precipitation threshold (0.25), the NWS Eta shows the largest scores overall (ALL in the figure for all time periods combined) and particularly during the early morning and late night hours (06Z-06-12 Hrs and 18Z-12-18 Hrs) while at the larger thresholds the UM Eta9 and UM Eta3 show larger scores.

During the sea breeze driven part of the diurnal convective cycle, from 18Z (2 P.M. E.D.T.) to 06Z (2 A.M. E.D.T.), the UM Eta9 and UM Eta3 runs show considerable forecast improvements over the NWS Eta. This is reflected in both the threat and POD scores of the 06Z-12-18 Hrs period for all precipitation thresholds. The 18Z-06-12 Hrs period shows also improvement over NWS Eta in both TS and POD scores for the higher precipitation thresholds, but only in the POD scores for the 0.25 threshold. These results are consistent with the fact that most summer time Florida precipitation is purely mesoscale/convective driven, thus non-hydrostatic processes (missing from the NWS WsETA but present in the UM configurations) cannot be ignored.

Figure 8 also suggests that LAPS apparently does not have a significant impact on the UM Eta3 precipitation forecast accuracy. The percentage improvement of LAPS over NoLAPS runs is shown in Fig. 9. Overall, the use of LAPS slightly decreases the model accuracy across the board, with the exception of the 06Z based runs and then only at the 1.0 in precipitation threshold.

A similar analysis as that shown in Fig. 9 was performed but cases were separated into “light wind” regimes and “non-light wind” regimes in Fig. 10. Light wind regimes were defined as having the mean value of 925 mb and 10 meter wind speeds, averaged over the entire UM Eta3 domain, less than 10 knots. Non-light wind regimes had mean domain wide 925 mb and 10 meter winds of greater than or equal to 10 knots. In total, of the 135 model runs included in the summer 2003 phase of the experiment, 70 classified as light wind regimes and 65 as non-light wind regimes. The purpose of this exercise was to separate, as much as possible, sea breeze days from days where synoptic features such as tropical waves or fronts might have influenced the flow across the domain. For the non-light wind regimes cases, LAPS had a negative impact on the UM Eta3 ability to forecast precipitation across the board with the exception of the 06Z-06-12 Hrs period for the highest precipitation threshold, 1.0 inch. However, for the light wind regime cases, LAPS shows a positive impact for all precipitation thresholds for both, the 06Z-06-12 Hrs and 06Z-12-18 Hrs, periods. For the 1.0 in threshold, the overall impact across all cycles and periods is positive in both scores. Notice also that the improvement is most substantial in the earlier hours of the integration (as much as 20% to 40% or higher) as expected because the boundary conditions dominate more in the latter hours of the integration.

An interesting result is that overall, UM Eta3 showed to be the most skillful model with the afternoon and evening portion of the convective cycle. Yet LAPS did not impact it positively for the 18Z-06-12 Hrs cycle as it did the 06Z-06-12 Hrs cycle runs. As previously mentioned in section 2.1, the AWIPS version of LAPS

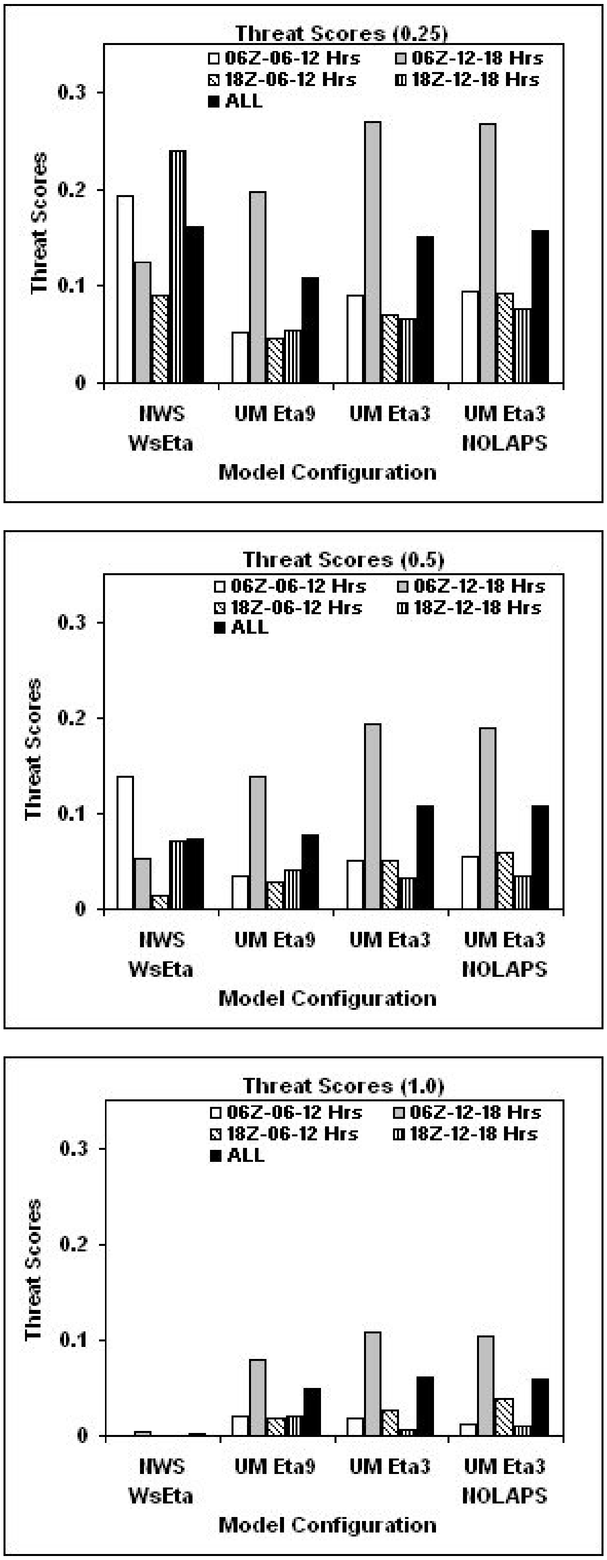


Figure 8a. Summer 2003 threat scores (TS) for all four model configurations for 0.25 in (top panel), 0.5 in (middle panel), and 1.0 in (bottom panel) precipitation thresholds. **CYZ-H1-H2 Hrs** means for forecast hours H1 to H2 from cycle CY.

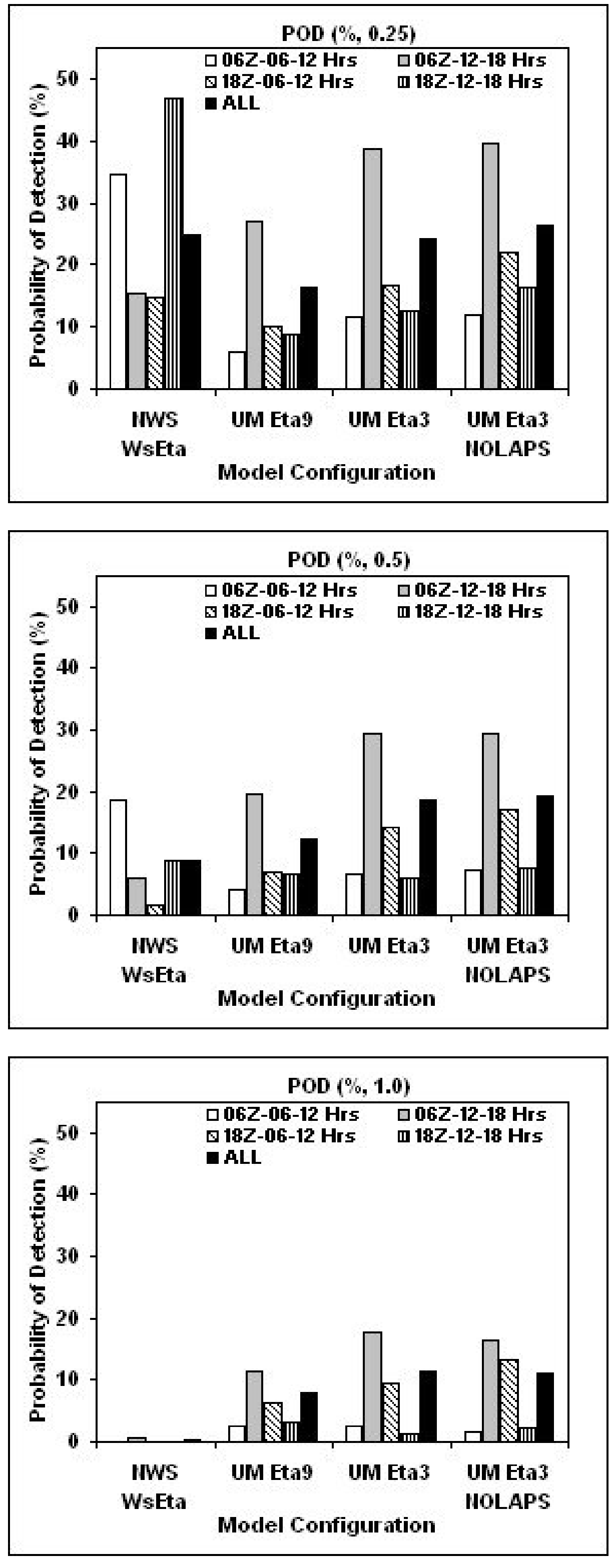


Figure 8b. As in 8a but for probability of detection (POD).

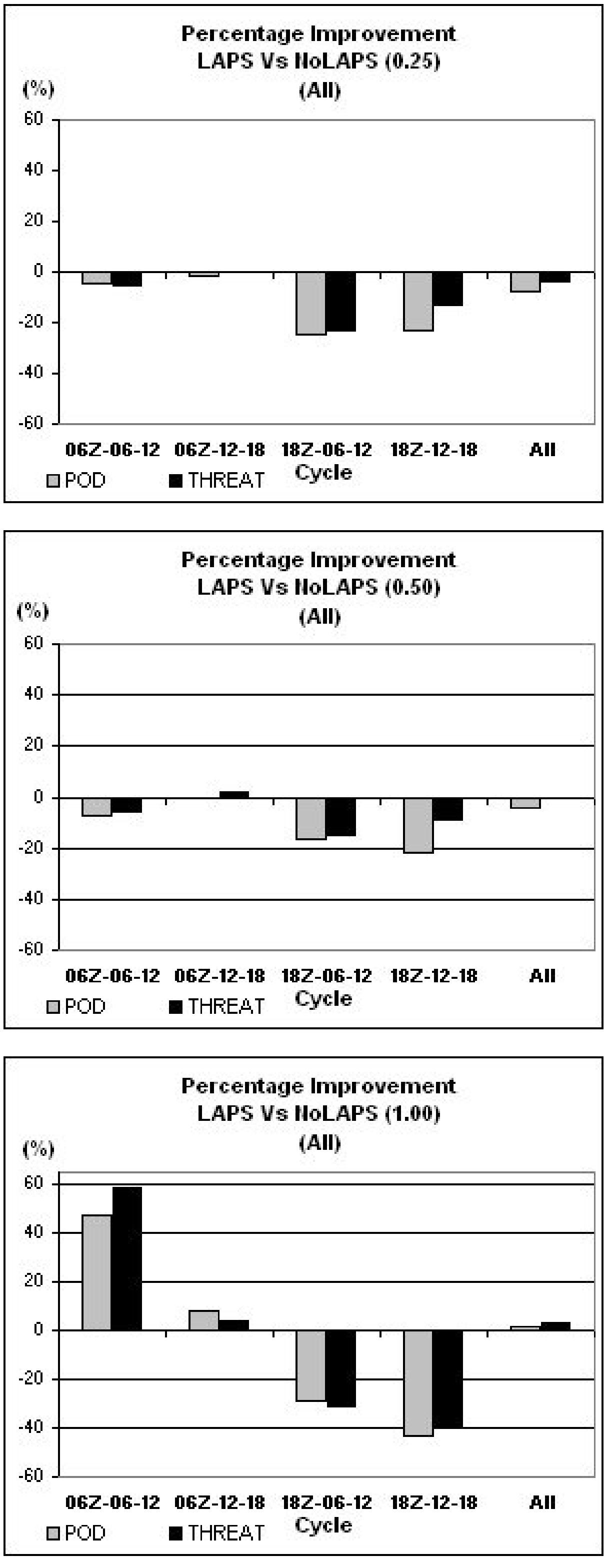


Figure 9. Summer 2003 percentage of POD and TS improvement of LAPS over NoLAPS UM Eta3 runs. **CYZ-H1-H2** means for forecast hours H1 to H2 from cycle CY. **All** in title means all wind regimes. **All** in time axis means all periods.

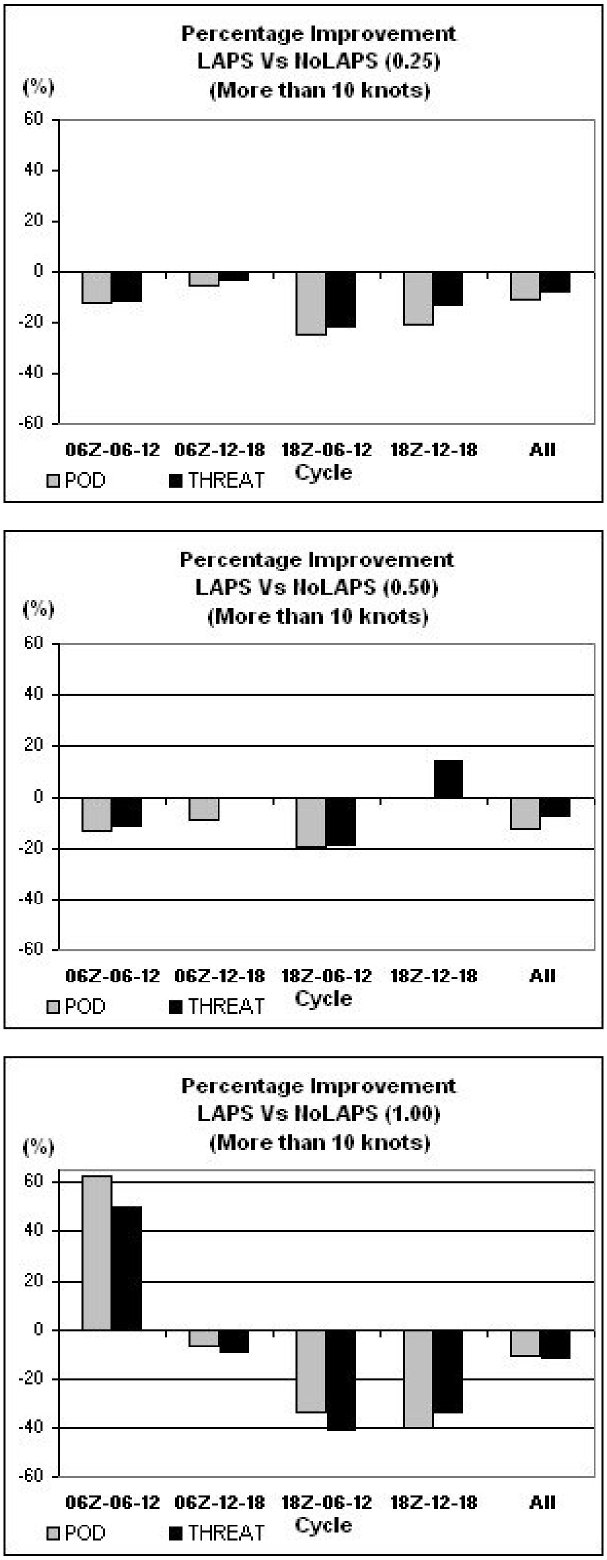
LAPS does not use its balancing as well as diabatic cloud analysis packages. The authors believe that given that around 18Z convection is in general initiating or already going across the domain, that the lack of these tools inhibits LAPS ability to properly resolve cloud structures and other critical mass field dependant features. This, in part, may be responsible for degrading the LAPS initialized forecasts at 18Z for the UM Eta3 where sea breeze driven convection is ongoing through the late evening hours.

An example of the UM Eta3 precipitation forecast accuracy during the convective portion of the diurnal cycle is shown in Fig. 11. The figure shows two examples of 6 hourly precipitation amounts for three of the four model configurations shown in Fig. 8 (NWS Eta, UM Eta9, and UM Eta3 without LAPS) contrasted against the radar observed accumulations for the 06Z-12-18 Hrs period. This figure qualitatively illustrates the improved precipitation forecasts of the UM Eta3 run. The UM Eta3 appears to better resolve details of the spatial distribution when compared to the radar observed convective rainfall.

The results obtained from the TS and POD score analyses, namely the superiority of the UM Eta3 runs, are also reflected with the bias scores. Figure 12 illustrates the bias scores calculated for the summer 2003 portion of the study averaged throughout the period for all model configurations. Overall (All for all periods combined), UM Eta9 and UM Eta3 show the smallest biases in addition to exhibiting higher skill forecasting higher amounts of rain.

4.2 Summer 2004 Experiment

Before the summer 2004 experiment was conducted, the WsEta analyzed water temperatures or sea surface temperatures (SSTs) after RTG_SST and GOES SST were input into the model, were compared to buoy SSTs for a period of 24 model cycles between Jan 10 and Feb 16, 2004 to see if any improvement was observed as measured by the root mean square (RMS) errors and bias scores. This simple test was conducted during the winter because that is when the sea surface temperature variability is greatest across the region. Three sites were used for the validation: buoy 42013 off the west central Florida coast, Dry Tortugas CMAN station in the Florida Keys, and Fowey Rocks CMAN station just offshore Biscayne Bay in southeast Florida. For the UM Eta9 configuration, using RTG_SST and GOES SST as input data, the RMS for sea surface temperatures were 3.25 F and 1.97 F, respectively. Biases were 1.63 F and 1.16 F, respectively. This improvement can impact the model's ability to depict surface fluxes given the water's large heat capacity. With this validation, the impact of the two different SST data sets on model performance during the summer 2004 phase is addressed.



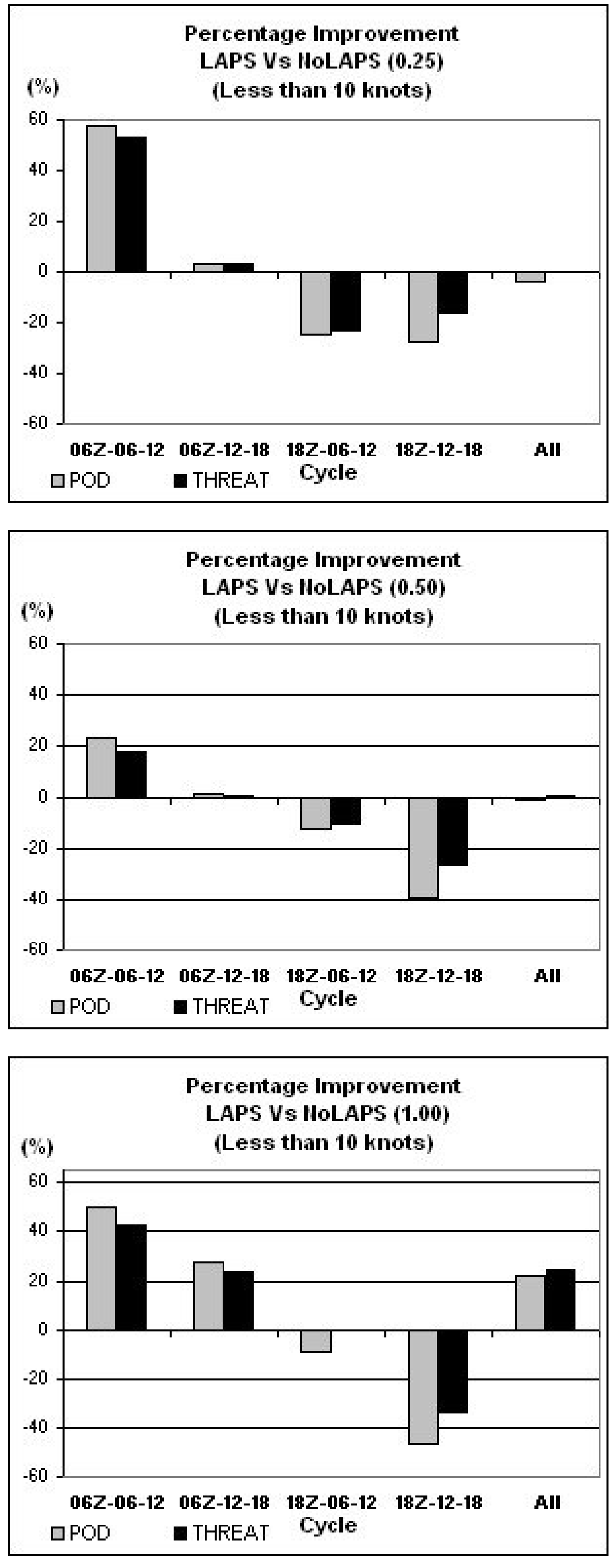


Figure 10a. Summer 2003 percentage of POD and TS improvement of LAPS over NoLAPS UM Eta3 runs when mean 925 mb plus 10m wind speed was greater or equal to 10 knots across LAPS domain. CYZ-H1-H2 means for forecast hours H1 to H2, cycle CY.

Figure 10b. As in 10a but for wind speed less than 10 knots.

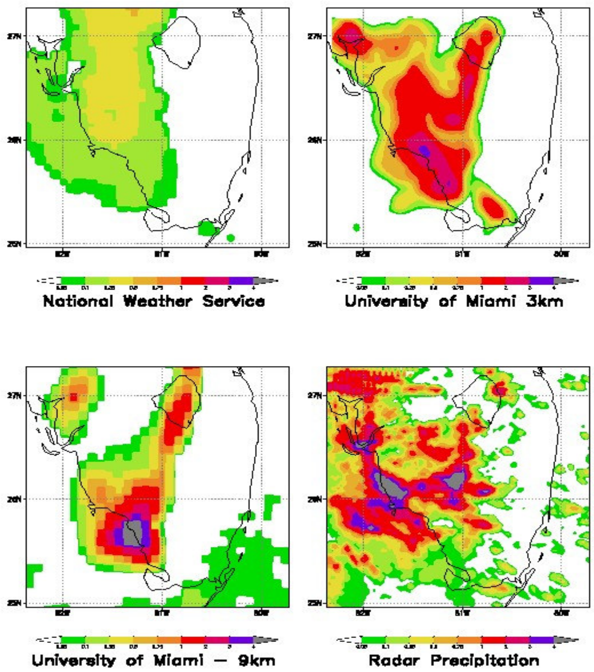


Figure 11a. 18Z-00Z precipitation forecasts from the 0600 UTC August 16, 2003 run from the NWS WsEta (top left), UM Eta9 (lower left), and UM Eta3 (top right). Lower right is the 6 hours radar observed accumulations. Threat Scoreas are 0.0 (NWS Eta), 0.25 (UM Eta9), and 0.37 (UM Eta3) for 0.5 inches precipitation thresholds.

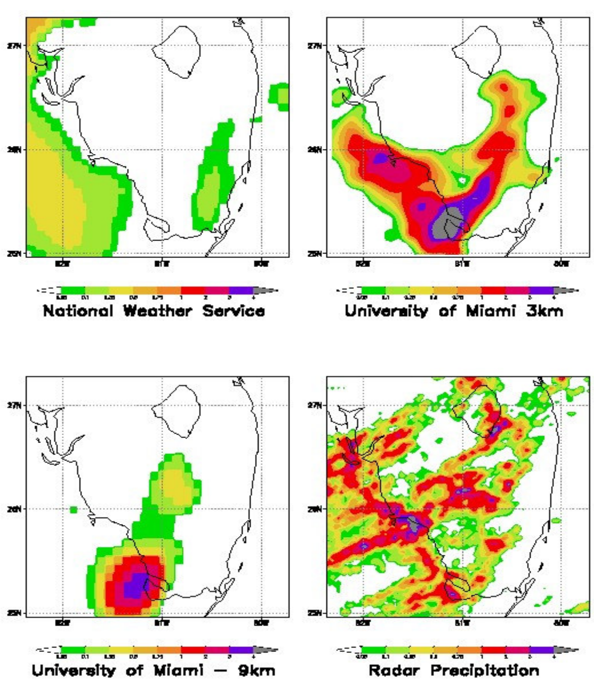


Figure 11b. As 11a but for 0600 UTC September 14, 2003 run. Threat Scoreas are 0.0 (NWS Eta), 0.11 (UM Eta9), and 0.29 (UM Eta3).

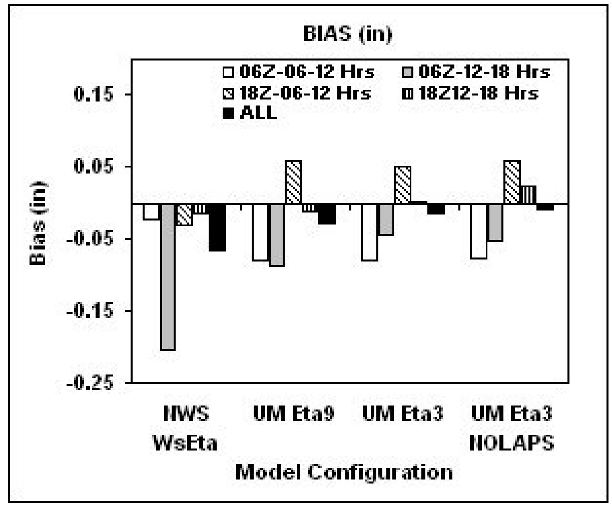


Figure 12. Summer 2003 bias scores for all model configurations and cycles. **CYZ-H1-H2** means for forecast hours H1 to H2 from cycle CY.

Figure 13 shows the threat scores (TS) and probability of detection (POD) for the two model configurations tested during the summer 2004 experiment. NCEP refers to the UM Eta9 initialized with the NCEP RTG_SST data set. LSST refers to the UM Eta9 initialized with the GOES 12 SSTs. This figure illustrates that the higher resolution GOES 12 SSTs have very little or negative impact in the accuracy of model rainfall forecasts.

Figure 14 confirms this finding in quantitative terms. This figure illustrates the percentage improvement of the TS and POD scores (positive or negative) of the locally produced SST (LSST) runs over the NCEP runs. As shown, the introduction of the higher resolution SSTs seems to degrade the performance of the model with the impact most noticeable in the 18Z cycle runs.

It is reasonable to expect that any effect of the higher resolution SSTs in mesoscale circulations such as sea breezes could be masked in regimes where synoptic influences dominate the weather regime. With this in mind, the analysis in Fig. 14 was conducted but stratified by light versus non-light wind regimes. As before, light wind regimes were defined as having the mean value of 925 mb and 10 meter wind speeds, averaged over the entire UM Eta9 domain, less than 10 knots, non-light wind regimes greater than or equal to 10 knots. Of the 56 runs during the summer 2004 experiment, 27 were classified as light and 29 as non-light.

Figure 15 illustrates the results of the wind regime analysis. Overall the LSST runs are degraded all across the board with respect to the NCEP runs for the non-light wind regimes. However, in the light wind category, the higher resolution SSTs seems to have a more positive impact particularly during the morning hours,

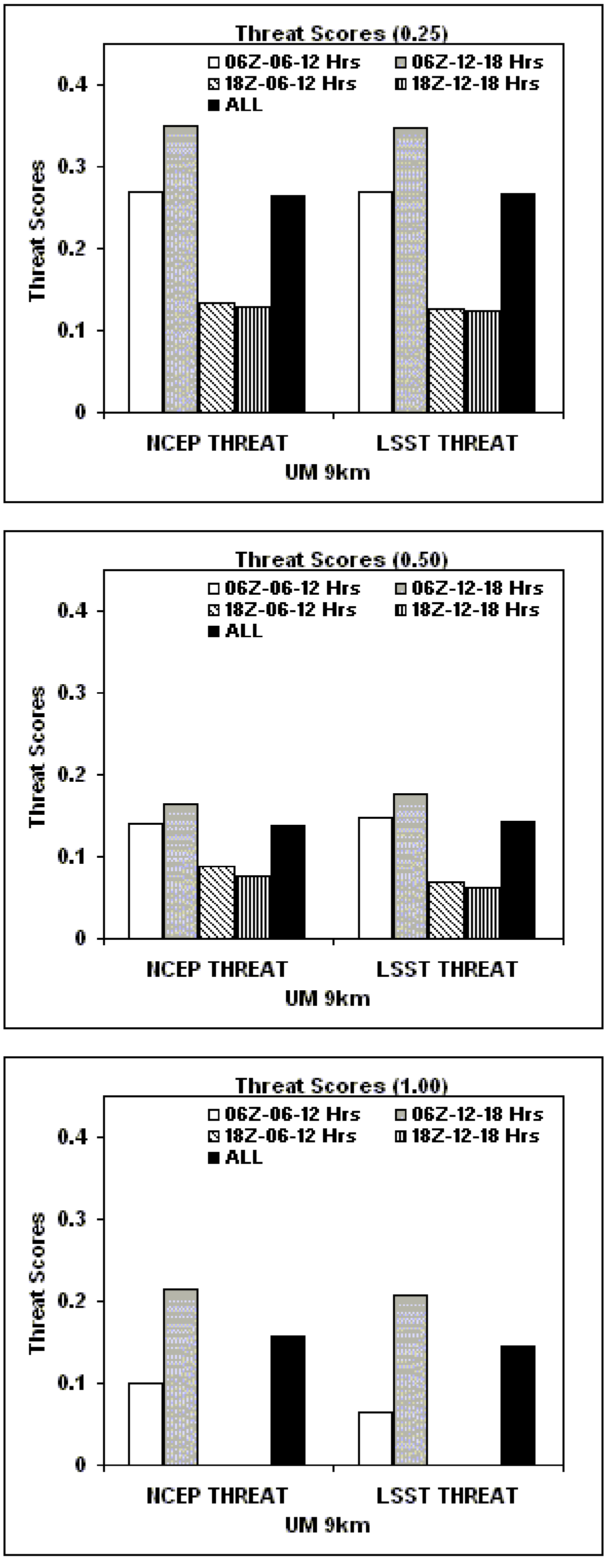


Figure 13a. Summer 2004 threat scores (TS) for the two configurations tested (NCEP and LSST) for 0.25 in (top panel), 0.5 in (middle panel), and 1.0 in (bottom panel) precipitation thresholds. **CYZ-H1-H2 rs** means for forecast hours H1 to H2 from cycle CY.

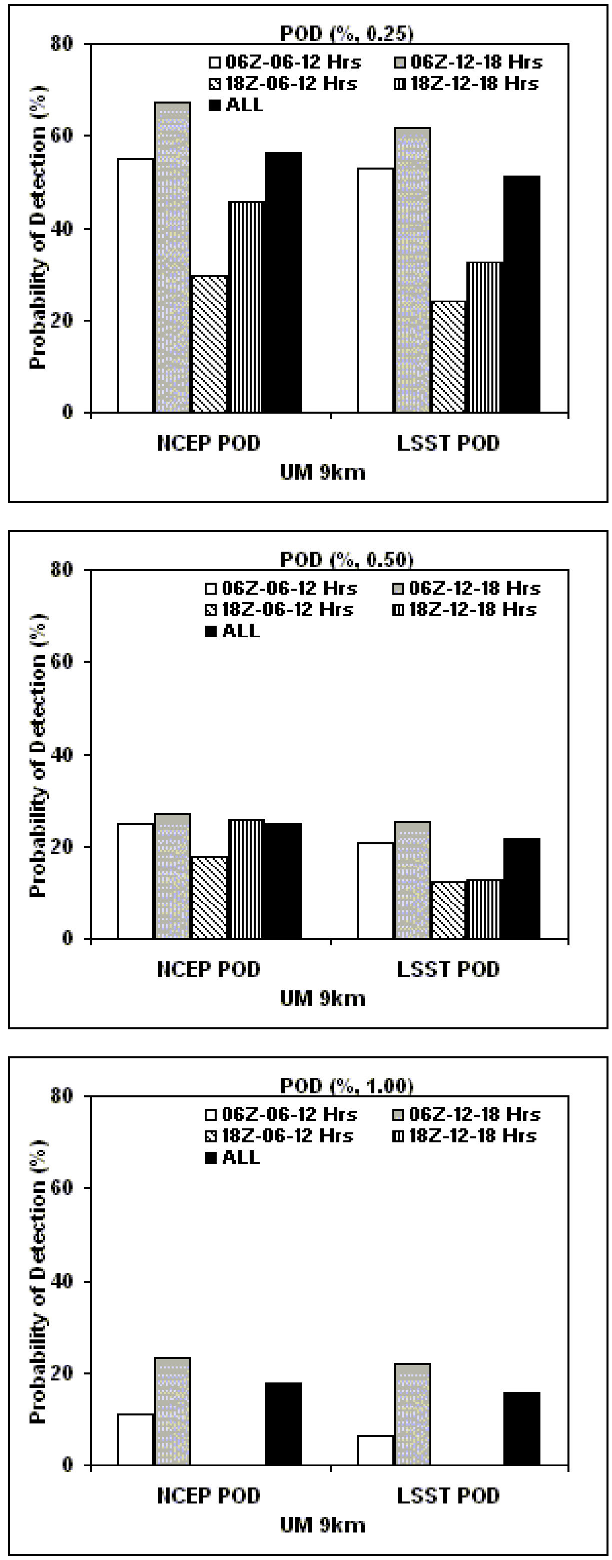


Figure 13b. As in 13a but for probability of detection (POD).

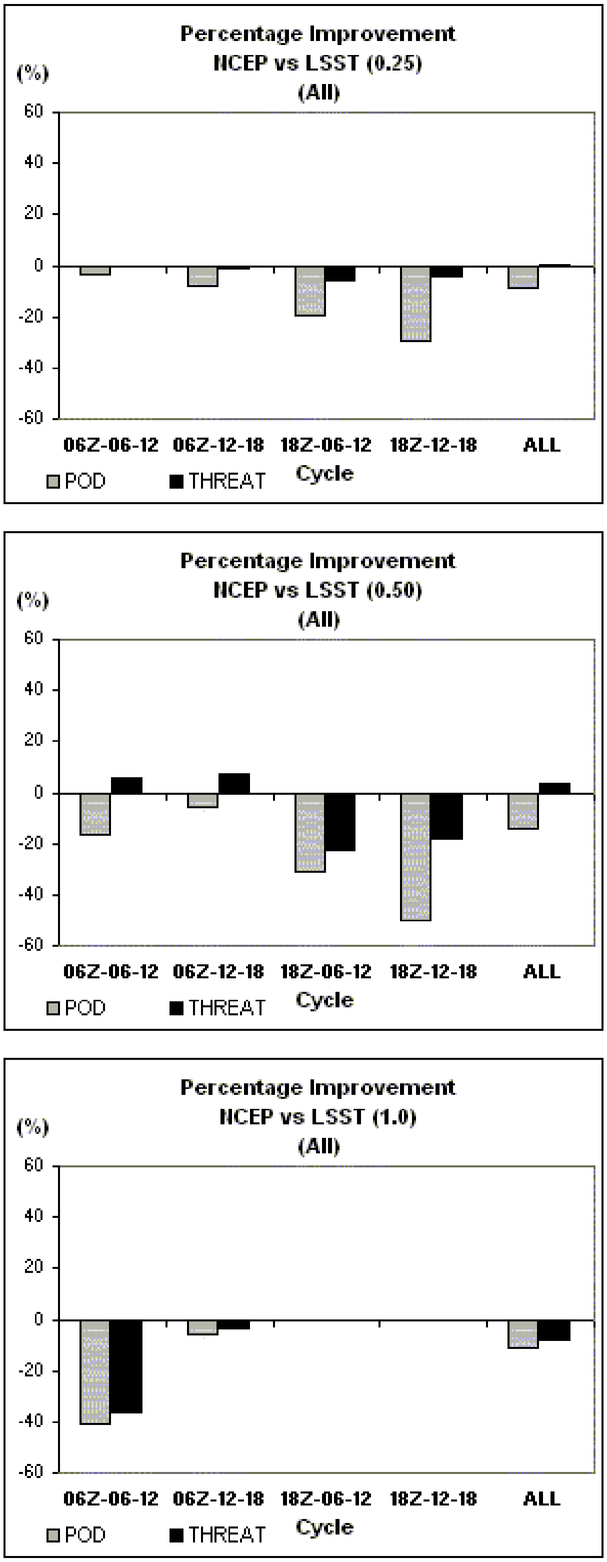


Figure 14. Summer 2004 percentage of POD and TS improvement of LSST over NCEP UM Eta9 runs. **CYZ-H1-H2** means for forecast hours H1 to H2 from cycle CY. **All** in title means all wind regimes. **All** in time axis means all periods.

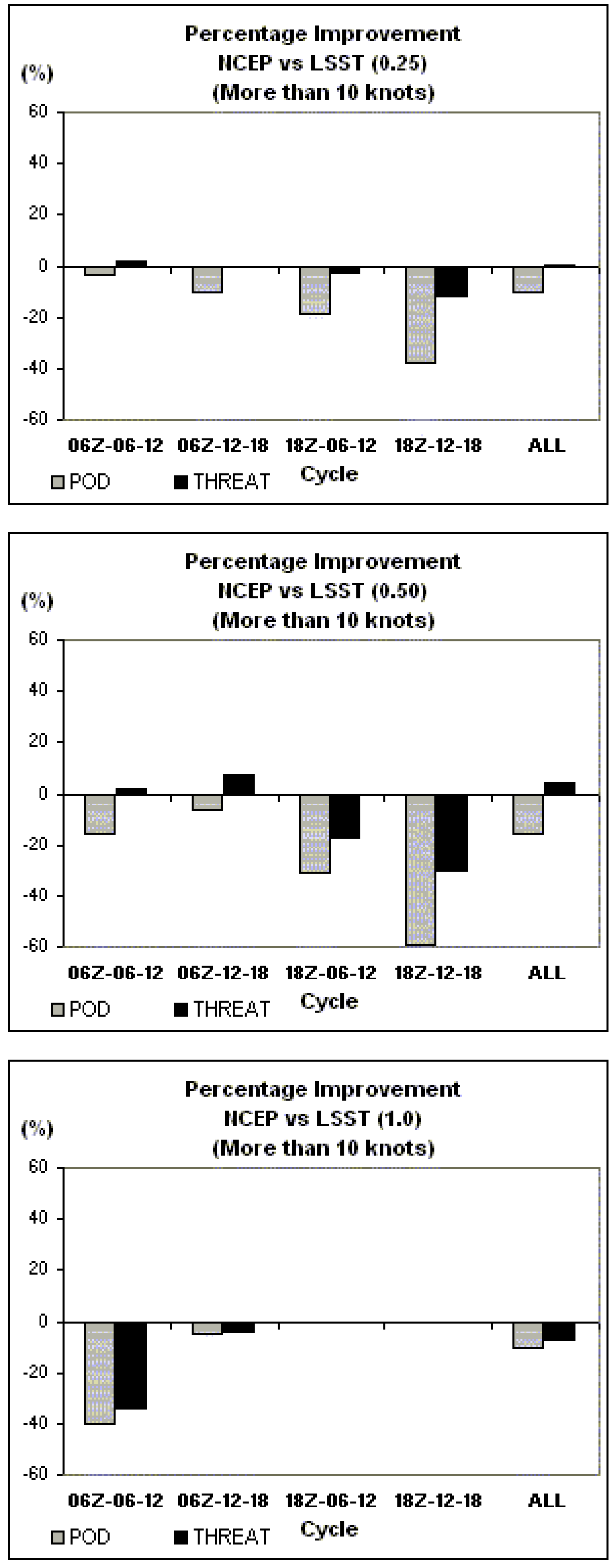


Figure 15a. Summer 2004 percentage of POD and TS improvement of LSST over NCEP UM Eta9 runs when mean 925 mb plus 10m wind speed was greater or equal to 10 knots across the model domain. **CYZ-H1-H2** means for forecast hours H1 to H2, cycle CY.

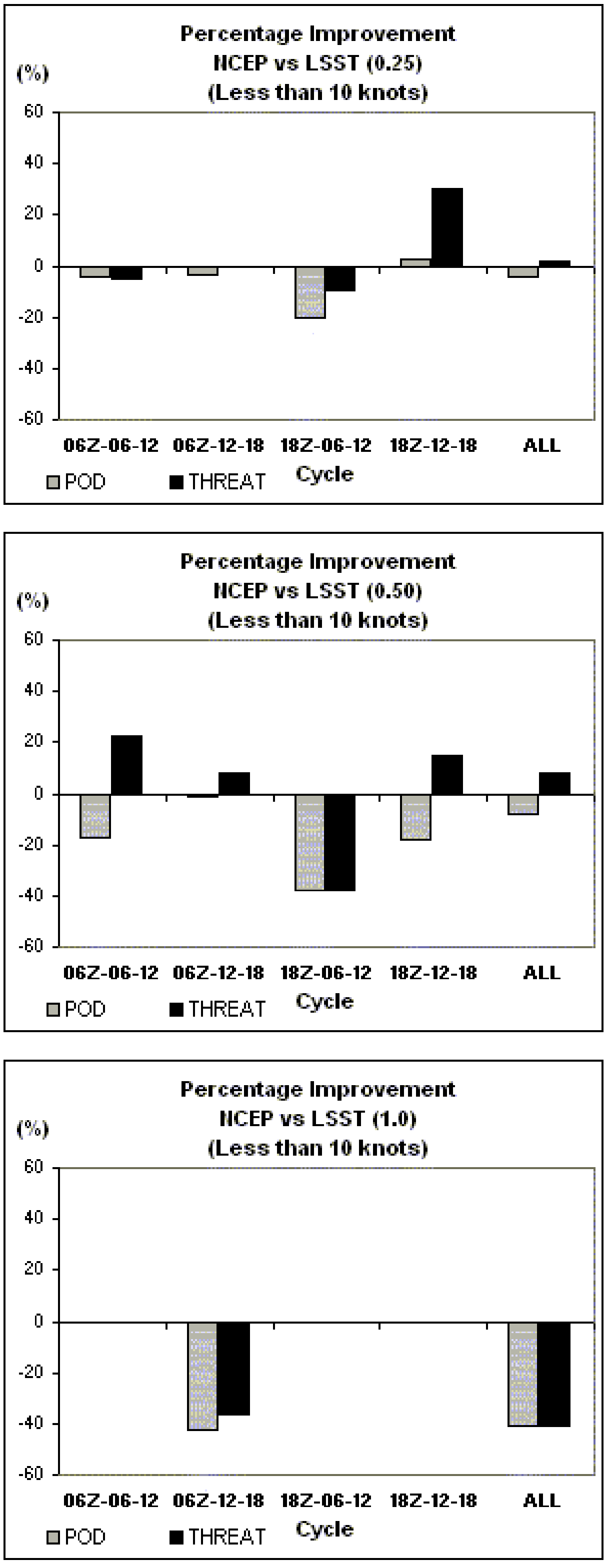


Figure 15b. As in 15a but for wind speed less than 10 knots.

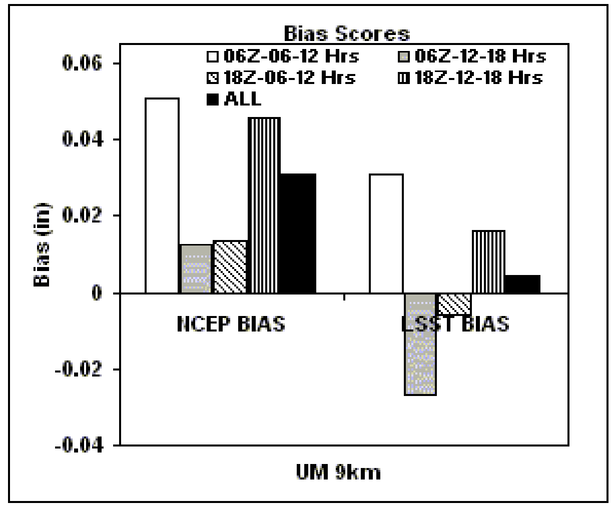


Figure 16. Summer 2004 bias scores for both model configurations and all cycles. **CYZ-H1-H2** means for forecast hours H1 to H2 from cycle CY.

when most convective activity during the summer is driven by land breezes.

Finally, Fig. 16 shows the bias scores for the 2004 experiment. It illustrates that that the LSST runs have a smaller bias that the NCEP based runs. At all times, the LSST runs produce less precipitation than the NCEP based runs.

5. SUMMARY AND FUTURE WORK

This study investigated the performance of the WsEta, model using different configurations and surface data sets. The performance of the model was measured using grid based threat scores, probability of detection, and bias scores across the model domains for three precipitation thresholds, namely, 0.25, 0.50, and 1.0 inches. The study was conducted in two phases.

The first phase was conducted during the summer of 2003. During this phase, four different model configurations were compared. The first one was the NWS WsEta run at 10 km resolution, in hydrostatic mode, using the BMJ convective parameterization scheme and the Eta12 tile files for boundary and initial conditions; the second configuration was the UM Eta9 run at 9 km resolution in non-hydrostatic mode, using the KF convective parameterization scheme, and the Eta12 tile files for boundary and initial conditions also; the third configuration was the UM Eta3 run at 3 km resolution in non-hydrostatic mode using explicit grid scale precipitation, and UM Eta9 for boundary and initial conditions; and the fourth configuration was the UM Eta3 configured as previously but using the local mesonet enhanced LAPS analyses for initial conditions instead.

Results for the first phase of the experiment highlight that overall, the non-hydrostatic configurations show substantially higher skill in forecasting summer time precipitation across South Florida, with the UM Eta 3 exhibiting the highest accuracy of all. This is particularly true with the afternoon and early evening portion of the convective cycle. Results also show that the impact of using LAPS to initialize the UM Eta3 is positive only in light wind regimes when land/sea breezes are the main forcing mechanisms at work driving the diurnal convection. In this case, observed improvements when using LAPS to initialize the model were as much as 20% to 40%. Most of this improvement was observed in the early morning runs (06Z). Despite the fact that the UM Eta3 was the most skillful model with the afternoon and early evening hours portion of the convective cycle, the 18Z runs were degraded when using LAPS to initialize the model. The authors believe one possible explanation for this is that the AWIPS LAPS, as of AWIPS Operational Build 3.0, did not have the balancing and diabatic cloud analysis packages on. This hinders LAPS ability to properly resolve cloud structures and/or mass dependant fields.

The second phase of the experiment also studied the model performance in forecasting precipitation in the same way as in the first phase. But this time only two model configurations were tested: the Um Eta9 using the NCEP RTG_SST for surface data set and the UM Eta9 using the high resolution GOES-12 SST for surface data set. Overall, results from this phase of the experiments indicate that the high resolution SSTs degraded the forecasts. The only exception to this was during the light wind weather regime when the model showed a small improvement particularly during the early morning hours or during the land breeze dominated portion of the convective cycle for the 0.25 and 0.50 precipitation thresholds.

The results in this study illustrate the importance of having high resolution guidance available locally to the forecast offices. They also illustrate that in order for this to be a success; the proper tools need to be made available at the local level. Incomplete data sets or diagnostic tools, such as the version of LAPS currently available to the offices with limited features and input data, does not fulfill the promise of a complete and robust local analysis and prediction system available locally to the forecast offices.

A fallow up project has recently been funded to extend the work in this paper to the Weather and Research Forecast model. That work is currently in its preparation stage to run a similar experiment to the one presented in this paper during the summer of 2005. Among the lessons learned to apply in the new project will be to adapt a beta version of LAPS that includes all features not included in the AWIPS version for use in the WRF project.

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