Applied Meteorology Unit (AMU)
Quarterly Report
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If anyone on the current distribution would like to be removed and instead rely on the WWW for information regarding the AMU's progress and accomplishments, please respond to Frank Merceret (407-853-8200, francis.merceret-1@kmail.ksc.nasa.gov) or Ann Yersavich (407-853-8217, anny@fl.ensco.com).

1. BACKGROUND

The AMU has been in operation since September 1991. Brief descriptions of the current tasks are contained within Attachment 1 to this report. The progress being made in each task is discussed in Section 2.

2. AMU ACCOMPLISHMENTS DURING THE PAST QUARTER

The primary AMU point of contact is reflected on each task and/or subtask.

2.1 TASK 001 AMU OPERATIONS

HARDWARE/ SOFTWARE INSTALLATION AND MAINTENANCE (MS. YERSAVICH)

During July, the AMU received and installed a scanner that will give personnel the ability to scan images of various types (hand-drawn, photographs, figures from journals, etc.) and create image files that can be imported into reports, presentations, and computer-based training courses. In August, the AMU received and installed a Hewlett Packard J210XC workstation on the AMU local area network. The system is up, however, complete configuration of this system will not occur until next quarter. This workstation will be used to run the Advanced Meteorological Interactive Data Display System (MIDDS) (the Eastern and Western Range MIDDS upgrade), the WSR-88D Algorithm Testing And Display System (WATADS), and possibly the Warning Decision Support System (WDSS).

2.2 TASK 002 TRAINING

Mr. Wheeler and Ms. Ann Yersavich attended several Hewlett Packard (HP) training courses during the past quarter. Mr. Wheeler attended two, one-week courses during August. The first course was on basic HP system administration and the second course was on network configuration. Ms. Yersavich attended the advanced HP system administration course the week of 9-13 September. These courses were offered by PRC (through CSR) as part of the new Advanced MIDDS system upgrade coming to the Eastern Range.

2.3 TASK 003 SHORT TERM FORECAST IMPROVEMENT (MR. WHEELER)

SUBTASK 6 MIDDS F-KEY MENU SYSTEM

During July, the RWO requested two modifications to the SKEWT display program. The first modification added a parcel analysis screen to the graphical output display. This analysis screen allows the forecaster to view and monitor the important data fields up to 700 mb and the helicity field. The second modification changed the automatic update cycle of the SKEWT program to only three times daily. At other times, the forecaster will have to update the program through the F-key menu system. Changing the update cycle allows the forecaster to view previous MDPI values and trends without the data being over-written by the new rawinsonde segment updates that occur several times daily. Also during July and August, all F-key menu systems were backed up.

During the 12 September Delta launch, the Launch Weather Officer (LWO) had trouble updating the tower 0002 wind speed graphical display through the AMU's F-key menu system. The active menu was for the NW sensor, however, the active sensor changed from the NW sensor to the SE sensor, thus requiring a manual switch to the proper menu (and then reboot) to accommodate this wind direction/active sensor change. Mr. Wheeler modified the Delta F-key menu system to allow the graphics update submenu to support either tower sensor without rebooting.

2.4 TASK 004 INSTRUMENTATION AND MEASUREMENT

ADVANCED MIDDS WEATHER SYSTEM UPGRADE (MR. WHEELER)

In July, Mr. Wheeler reviewed the Eastern Range MIDDS Upgrade Status Reports supplied by PRC. No comments were required, however, an updated list of RWO satellite display configurations was provided to PRC. Also, Mr. Wheeler attended the Eastern Range Advanced MIDDS Prototype equipment installation and overview briefing given by PRC in August. Although the system has not been up and running in order to perform an evaluation, most of the hardware systems and software layouts were demonstrated during the installation.

SUBTASK 4 LIGHTNING DETECTION AND RANGING SYSTEM (MR. DRAPE)

During July, the final preparations were made to distribute the LDAR CBT course. This effort took longer than expected in order to ensure the course would run properly on a 386 PC (or better) with an expanded number of possible display settings. The automatic setup routine used to install the course on the user's hard drive needed to be modified to properly install system libraries required by Microsoft Windows, Version 3.1. Other changes to the courseware were required in a few cases where text fields and graphic images were cropped under certain display resolution and font settings. The new setup routine and courseware modifications were then tested on several PC platforms to ensure all problems were resolved. The setup program was used to compress the necessary files and create the updated run-time version of the course on a set of four floppy diskettes, which were then copied for distribution. A total of nineteen sets of diskettes were distributed on 31 July to LDAR users and other interested organizations. Approximately ten more sets of the LDAR CBT diskettes have been distributed since that time. Anyone else interested in obtaining a copy of the LDAR CBT course should contact Ms. Yersavich.

SUBTASK 5 WSR-88D EVALUATION

Mr. Wheeler and Ms. Lambert completed their review and analysis of WSR-88D data for convection initiation and severe/non-severe storm determination during the past quarter. Mr. Wheeler analyzed each case using the WATADS at the NWS MLB office. Mr. Wheeler's evaluation focused on analysis of time series of key parameters (e.g., VIL, core aspect ratio). Ms. Lambert analyzed individual cases for convection initiation signatures using the 88Display software in the AMU. Ms. Lambert presented some preliminary results of this task at the 15th Conference on Weather Analysis and Forecasting in Norfolk, VA from 19-23 August 1996. The writing of the final report on convection initiation and severe/non-severe storm determination was completed in September. The report is undergoing internal review and will be published in November 1996.

SUBTASK 9 915 MHZ BOUNDARY LAYER PROFILERS (DR. TAYLOR)

During September, Dr. Taylor generated and provided to NYMA, Inc. data sets to be used to test the velocity divergence codes being developed by NYMA for the 915 MHz Radar Wind Profilers display workstations. In addition, he helped NYMA debug their velocity divergence software.

SUBTASK 12 WDSS EVALUATION: PROOF OF CONCEPT DEMONSTRATION

In August, Mr. Wheeler was tasked to perform an analysis of a Patrick Air Force Base (AFB) weather event that occurred on 13 August 1996. The effort is a joint AMU North and South report with Mr. Sharp of the NWS MLB representing the AMU South. During September, Mr. Wheeler completed the preliminary analysis and report of the Patrick AFB weather event and then he and Mr. Sharp briefed their results to Col. Adang, RWO staff and forecasters (all of the 45 WS). The briefing was well received, however, Col. Adang made two requests which will be completed prior to the delivery of the final report. Col. Adang requested that appropriate satellite imagery be included in the report (these images will be requested from SSEC at the University of Wisconsin) and WSR-88D data be reviewed to see if the WSR-88D detected a mesocyclone close to (in time and space) the weather event. Since these data were not saved at CCAS, they were reloaded at the NWS MLB and reviewed. Once these requests are completed, the report will be finalized and distributed in November.

KTAADN, INC.'S LIGHTNING PREDICTOR

During August, Ms. Yersavich worked with KTAADN to help correct the lightning predictor problems. Ms. Yersavich received two 8mm tapes from KTAADN containing software modifications and a Black Box Automatic Relay Switch to install. The installation of the Relay Switch was to reset the modem when a communication error occurred. Unfortunately, after installing the software modifications and the Relay Switch, some of the problems still persisted and could not be completely resolved without KTAADN physically looking at and troubleshooting the system on site at the AMU.

KTAADN visited the AMU on 29 and 30 August to work on the lightning predictor. The system had two known problems: the Unisys Skyvision subsystem was not working and the lightning predictor was not making reasonable predictions. KTAADN performed an analysis of the Skyvision failure modes and enabled a hardware and software system to detect and correct these failures.

The software upgrades which had been sent to the AMU on 23 July and 3 August included an upgraded KSC wind tower data assimilator, upgraded data assemblers, new neural network (NN) software modules, a new echo top based NN predictor state file, an upgraded lightning mapper, and an upgraded echo top temperature encoder. At the end of the second day, the Skyvision system was apparently working, the upgraded software was properly installed (fixing the known bugs in the lightning predictor), and the system was functioning as designed. Ms. Yersavich has sent KTAADN data tapes for their review and analysis, however, the quality of the predictions is not yet known.

2.5 TASK 005 MESOSCALE MODELING

SUBTASK 4 INSTALL AND EVALUATE ERDAS (MR. EVANS)

During July, Mr. Evans distributed *The Final Report on the Evaluation of the Emergency Response Dose Assessment System (ERDAS)*. Anyone else interested in obtaining a copy of the final report should contact Ms. Yersavich.

On 29 August, the National Centers for Environmental Prediction (NCEP) changed the projection of the NGM grids that is received by McIDAS. This significantly impacted the execution of ERDAS and PROWESS since the RAMS model expects the data in Mercator (lat./lon.) coordinates. RAMS requires the NGM grids to initialize and thus will not run without them. Therefore, both PROWESS and ERDAS were not running during September. During September, MRC/ASTER was tasked to modify the ERDAS and PROWESS software to allow RAMS to receive the Lambert Conformal grids for initialization. MRC/ASTER completed the software modifications in late September and Dr. Tremback installed the software in early October. Both ERDAS and PROWESS are now running daily.

ERDAS Transition to Operations

The AMU has been evaluating the Emergency Response Dose Assessment System (ERDAS) located in the Range Operations Control Center (ROCC) at KSC/CCAS since its installation in March 1994. Before the Air Force's 45th Space Wing including Range Safety (45 SW) , the Weather Squadron (45 WS), and the Eastern Range Program Office (SMC/CW-OLAK) accepts ERDAS as an operational emergency response system, they must determine its value, accuracy, and reliability. In support of this requirement, the AMU has evaluated ERDAS in a near-operational environment. Following the evaluation, the AMU was tasked to assist in the transition of ERDAS to the 45 SW as an operational system.

To support the transition, the AMU was tasked to develop several documents pertaining to training, testing, operations, and maintenance. During the past quarter, Mr. Evans has written and submitted these documents to CSR for their modification and submittal to the Air Force as part of the certification process. The following is a list of the developed documents and discussion of each:

- *ERDAS Training Materials*

This document contains the training procedures which were used during the 21-22 August 1996 training sessions for ERDAS users and maintenance personnel. The document contains many of the important commands needed to operate the system. However, it is not a stand alone users' guide for ERDAS. After the training session, the personnel were able to operate the system with the assistance of this document.

The training was divided into two sections. The first section, Maintenance Training – Basic Procedures was intended for those who will be performing day-to-day routine maintenance and monitoring of the system software and the data on the disk drives. The second section, Users' Training, was intended for those who will be running the models and displaying the output. The training sessions were attended by Mr. Gervais, Ms. Valek, Mr. Hatley, Mr. Jacobs, Mr. Dunham, and Mr. Mankowski of CSR, Mr. Overbeck and Mr. Parks of ACTA, Mr. Roeder of 45 WS/DOR, and Mr. Berlinrut of 45 SW/SESL.

- *Operations Acceptance Test Plan for the Eastern Range Dispersion Assessment System (ERDAS)*

The purpose of the Operational Acceptance Test Procedure (OATP) was to demonstrate that the ERDAS operates and functions properly at its location in Room 148 within ROCC. This document will be modified by CSR, submitted to the Air Force, reviewed for its applicability and completeness, and then followed during the certification process. The OATP contains descriptions of the conditions and procedures for testing the following:

- ERDAS Start-up: start-up and reboot
- ERDAS Connectivity: mounting/unmounting disks, automatic/manual start, and running RAMS
- ERDAS Operations: the user interfaces of ERDAS, RINGI, dispersion-REEDM, HYPACT-forecast, View function, HYPACT-hybrid, and printing

- ERDAS Archival: compressing and saving data
- ERDAS Power-off: shutdown

- *Operations Manual for the Eastern Range Dispersion Assessment System (ERDAS)*

The purpose of the Operations Manual is to provide instructions and guidance on the operation of ERDAS. The manual includes instructions on all major functions listed above in the OATP and references to the *ERDAS Users' Guide* developed by MRC/ASTER.

- *Maintenance Procedures for the Eastern Range Dispersion Assessment System (ERDAS)*

The purpose of the Maintenance Procedures is to provide instructions for maintaining the hardware of ERDAS. The document includes a description of the equipment, the technical publications relating to system maintenance, instructions for the power-up self-test, and instructions for inspection and cleaning.

- *Memorandum on Inputs to the System Segmentation Specification (SSS)*

The SSS contains a list of current ERDAS deficiencies and recommended enhancements. The deficiencies include minor problems such as bugs in the graphical user interface and more significant problems such as the slow run time due to computer hardware limitations. The recommended enhancements include short term, medium term, and long term items which will enable the system to be certified for operational use. The main sections in the SSS inputs are:

- Summary of ERDAS Evaluation Results
- Current ERDAS Hardware
- Maintenance Requirements
- Operating Requirements
- ERDAS Deficiencies
- Recommended ERDAS Enhancements

SUBTASK 7   29 KM ETA MODEL EVALUATION (DR. MANOBIANCO)

Mr. Nutter and Dr. Manobianco began plotting and analyzing bias, root mean square errors, and consistency statistics from observations and 29 km eta model forecasts from the warm season (1 May through 31 August 1996). In addition, they began analyzing results from the subjective component of the evaluation that focuses on the model's ability to predict the occurrence of east and west coast Florida sea breezes, thunderstorms within 25 miles of KSC/CCAS, and steady state winds in excess of 18 kt.

Dr. Manobianco presented the preliminary results from the objective component of the eta model evaluation at the 11th Conference on Numerical Weather Prediction in Norfolk, VA from 19-23 August 1996. Some additional results from the objective verification were included in a preprint that was prepared for the American Meteorological Society's 7th Conference on Aviation, Range and Aerospace Meteorology to be held 2-7 February 1996. The following sections summarize preliminary results from the warm season objective component of the 29 km eta evaluation.

Evaluation Criteria

The objective verification of the 29 km eta model examines bias (forecast - observed) and root mean square errors for wind, temperature, moisture, and height at selected pressure and height levels, stability parameters, 850-500 mb layer-averaged wind and moisture, sea-level pressure, 10 m wind, 2 m temperature, and 2 m dew point temperature. The station or point forecasts from the 0300 UTC and 1500 UTC meso-eta model cycles are verified against standard surface and rawinsonde observations. Hourly surface observations are taken at the Shuttle Landing Facility, FL (TTS), Edwards Air Force Base, CA (EDW), and Tampa, FL (TPA). Rawinsonde observations are taken twice daily at EDW, Cape Canaveral Air Station (XMR), and Tampa Bay area (TBW). The station forecasts are extracted from the meso-eta model grid point nearest to the rawinsonde observation sites. Although surface and rawinsonde observations are not co-located at XMR and TBW, the available sites differ by not more than 30 km (i.e. the meso-eta model grid spacing). In order to avoid confusion, all subsequent references to rawinsonde and surface verification will use the rawinsonde station identifiers (XMR, TBW, EDW).

Results

The results presented in the subsequent sections focus on the objective verification of 2 m temperature, 10 m wind speed as a function of forecast duration, and temperature, mixing ratio, and wind speed as a function of pressure for the warm season at XMR, TBW, and EDW.

2 m Temperature Bias and RMSE

Surface temperature bias (˚C) and RMSE (˚C) from the 0300 UTC (F03) and 1500 UTC (F15) cycles at XMR, TBW, and EDW are shown in Figure 1. The temperature bias for both cycles ranges from -3 to 1.5˚C but is mostly negative (too cold) throughout the 33-h forecast period at TBW and XMR (Figs. 1a, c). The bias exhibits a diurnal cycle that is most pronounced at EDW. For example, the largest negative and positive temperature errors at EDW occur at approximately the same time of day in either the F03 or F15 eta cycle. In fact, the F15 cycle starts out with a cold (negative) temperature bias of nearly -3˚C at EDW (Fig. 1c). The fluctuations of the diurnal cycle at XMR and TBW are smaller and are within about 1.5 ˚C (Figs. 1a, c). One possible explanation for the larger diurnal cycle in the EDW temperature bias may be that the forecast point data extracted from the model are almost 250 m lower than the actual station elevation at EDW. At TBW and XMR, the forecast and observed station elevations differ by less than 20 m.

The 2 m RMSE in temperature does not increase or decrease steadily throughout the 33-h forecast periods at any of the three stations for either the F03 or F15 cycles. Except at EDW, the RMSE in temperature is on the order of 1˚C to 3˚C. In general, the 2 m RMSE in temperature is larger at EDW than at XMR or TBW which may be related to differences in elevation between the observation site and the point in the eta model used to extract the forecast data. Finally, it is interesting to note that the RMSE in temperature at EDW on the order of 3.5˚C at the start of the F15 cycle is nearly twice as large as the RMSE at XMR or TBW (Fig. 1d). However, when the -3˚C bias at EDW is taken into consideration (Fig. 1c), the bias-corrected RMSE (not shown) is on the order of 2˚C and is at about the same level as the RMSE for XMR and TBW.

10 m Wind Speed Bias and RMSE

The bias and RMSE of wind speed (m s^{-1}) at XMR, TBW, and EDW are presented in Figure 2. As with temperature, a diurnal cycle is evident in wind speed errors (Figs. 2a, c). The wind speed errors are largest at EDW, with a maximum negative (slow) bias and an RMSE of nearly 3 m s^{-1}. The wind speed bias at TBW fluctuates about zero and runs about 1.5 m s^{-1} too fast at XMR. In terms of RMSE, the smallest errors occur at all three stations around the time that the model develops a boundary layer inversion in the forecast soundings (not shown). When the statistics are computed from both 0300 and 1500 UTC forecast cycles combined (not shown), there is roughly a 0.5 m s^{-1} increase in wind speed RMSE over the course of the 33-h forecast.

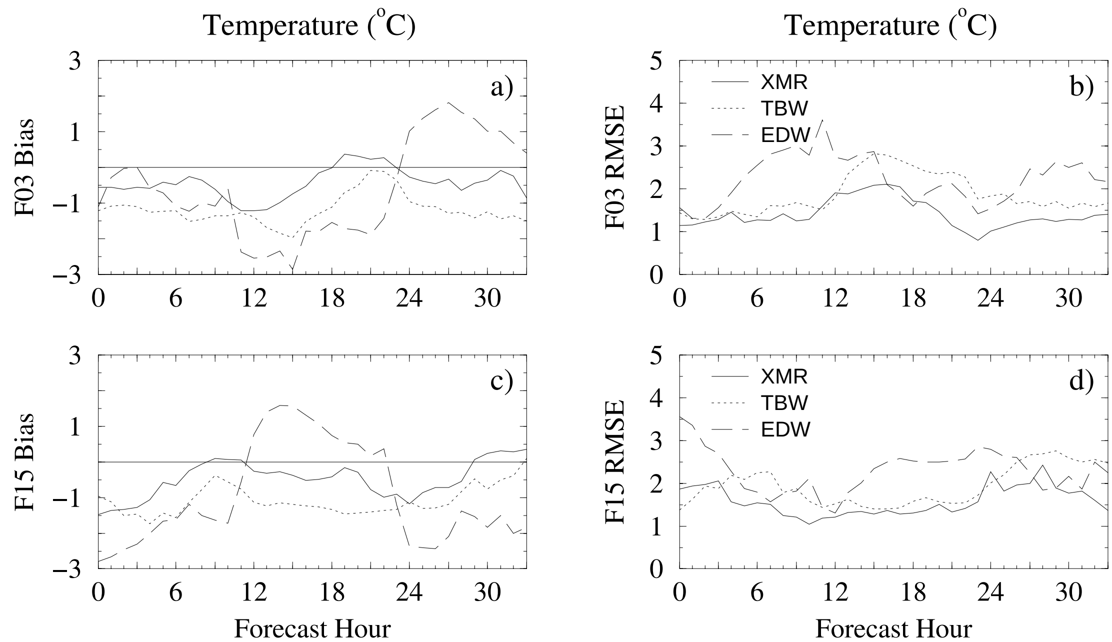

Figure 1. Average bias and root mean square error (RMSE) in 2 m temperature (˚C) from May through August 1996 at XMR (solid), TBW (dotted), and EDW (dashed) plotted as a function of forecast hour. The bias and RMSE from all available 29 km eta model forecasts initialized at 0300 UTC and 1500 UTC are shown in panels a) and c), respectively while the RMSE are shown in panels b) and d), respectively.

Upper Air Bias and RMSE

The vertical profiles of bias and RMSE for temperature (˚C), wind speed (m s^{-1}), and mixing ratio (g kg^{-1}) are plotted as a function of pressure in Figure 3. The data are obtained using both 0300 UTC and 1500 UTC forecast soundings, valid at 18 h for XMR and EDW and at 21 h for TBW. Because the general error characteristics are similar at all verification times, only the 18-h forecast statistics are presented here. It has yet to be determined if subtle temporal changes in vertical profiles of bias and RMSE are significant.

At all three stations, a cool bias in temperature exists below 700 mb (Fig. 3a). Above 600 mb, the forecasts exhibit a warm bias. In terms of RMSE, the magnitude of the temperature error between 900 and 300 mb fluctuates about 1˚C (Fig. 3b). The largest RMSE in temperature of more than 2˚C occurs above 200 mb at levels around the tropopause and into the lower stratosphere.

At XMR and TBW, vertical profiles of forecast wind speed are nearly unbiased below 600 mb (Fig. 3c). Corresponding values of RMSE are just over 2 m s^{-1} (Fig. 3d). The largest wind speed errors at these stations are found at the level of maximum wind speed in the upper troposphere, with

RMSE values approaching 4.5 m s^{-1}. Wind speed bias and RMSE at EDW are larger than at XMR and TBW below 400 mb.

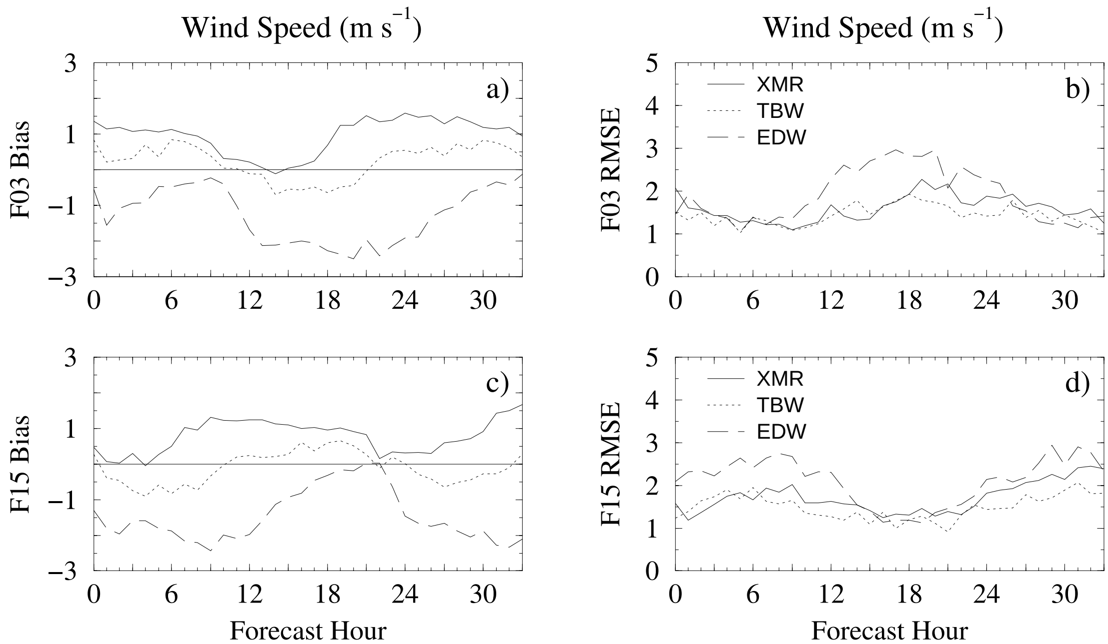

Figure 2. Average bias and root mean square error (RMSE) in 10 m wind speed (m s^{-1}) from May through August 1996 at XMR (solid), TBW (dotted), and EDW (dashed) plotted as a function of forecast hour. The bias and RMSE from all available 29 km eta model forecasts initialized at 0300 UTC and 1500 UTC are shown in panels a) and c), respectively while the RMSE are shown in panels b) and d), respectively.

The mixing ratio bias (Fig. 3e) indicates that the forecasts are generally too dry in the lower troposphere, most notably at XMR. Above 500 mb, the bias suggests that the forecasts tend to retain larger amounts of moisture than observed. In terms of RMSE (Fig. 3f), mixing ratio errors drop from around 2 g kg^{-1} at low-levels to near zero at 200 mb where there is very little water vapor present in the atmosphere. The results shown in Fig. 3f are consistent with those of Rodgers et. al (1996), who show 24-h RMSE in specific humidity from 40 km eta model forecasts during September 1994 ranging from nearly 2 g kg^{-1} at 1000 mb to less than 0.1 g kg^{-1} at 250 mb (see their Fig. 7).

Convective Parameter Bias and RMSE

At each of the three stations, precipitable water (PWAT, mm), convective available potential energy (CAPE, J kg^{-1}), convective inhibition (CINS, J kg^{-1}), lifted index (LIFT, ˚C), and K–index (KINX, ˚C) have been computed using standard GEMPAK routines. The bias and RMSE for these convective parameters are presented in Tables 1a, b, respectively. Forecasts initialized at 0300 and 1500 UTC are included in the data, verifying at 9, 21, and 33 hours for TBW and at 6, 18, and 30 hours for XMR and EDW.

The bias in PWAT and CAPE at all three stations indicates that the forecast soundings are drier and more stable than observed soundings (Table 1a). At XMR in particular, the PWAT bias is negative (too dry), the LIFT bias is positive (too stable), and the CAPE and KINX are negative (too stable). These errors are consistent with the vertical profiles of mixing ratio and temperature bias at

XMR that show forecast soundings are generally too dry below 600 mb (Fig. 3e) and thermodynamically too stable above (below) 600 mb with positive (negative) errors in temperature (Fig. 3a).

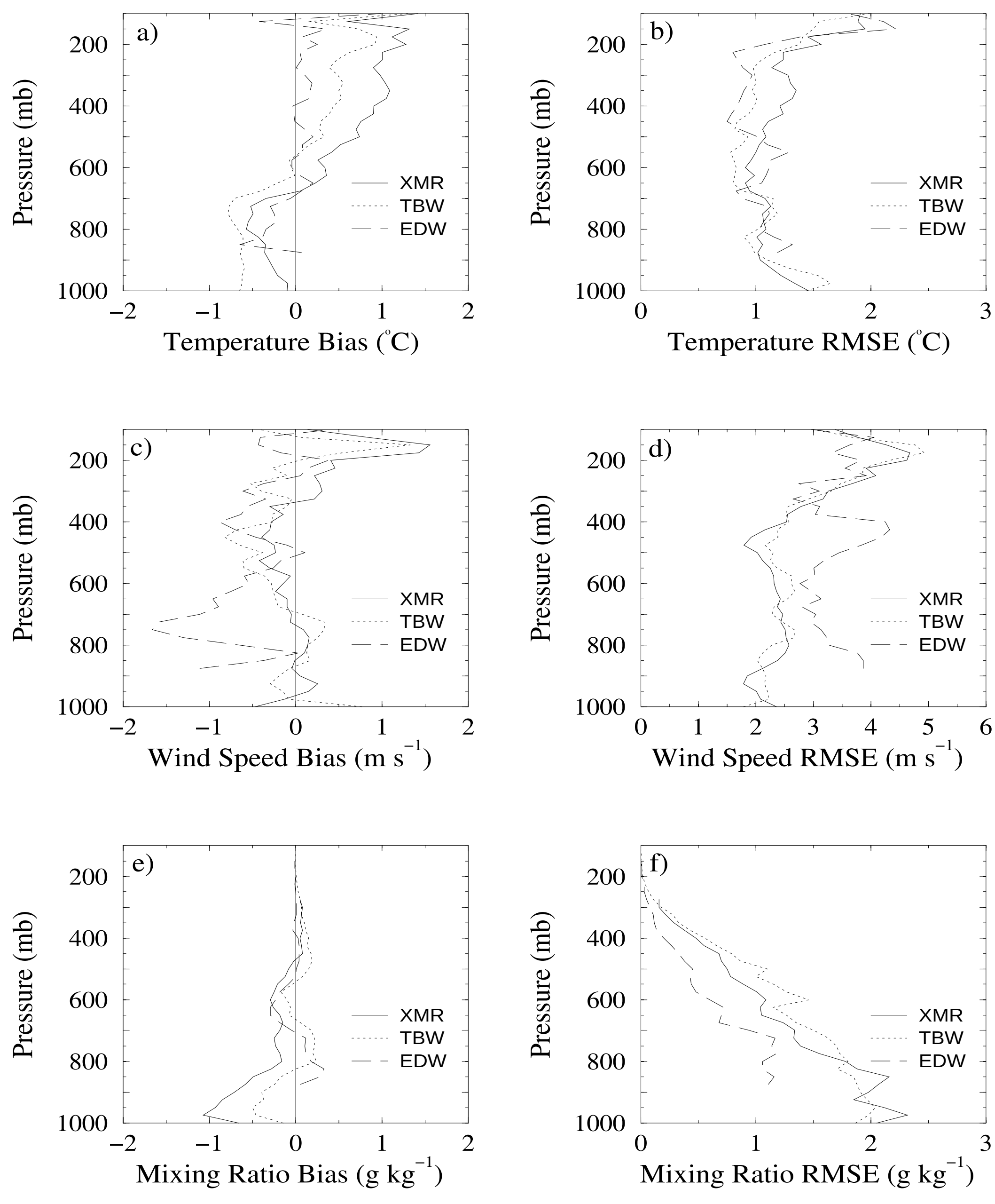

Figure 3. Average bias and root mean square error (RMSE) in temperature (˚C), wind speed (m s^{-1}), and mixing ratio (g km^{-1}) from May through August 1996 at XMR (solid), TBW (dotted),

and EDW (dashed) plotted as a function of pressure. The temperature, wind speed and mixing ratio bias are shown in panels a), c), and e), respectively with the RMSE are shown in panels b), d), and f), respectively. All available forecasts are verified at 18 h for XMR and EDW and at 21 h for TBW.

Table 1a. Bias in Forecast Convective Parameters

Site	Hour	PWAT	CAPE	CINS	LIFT	KINX
XMR	06	-1.28	-571.22	8.57	1.42	-0.22
	18	-1.90	-565.34	1.57	1.50	-2.05
	30	-1.83	-743.49	-3.77	1.92	-1.83
TBW	09	-0.22	-214.18	-7.79	0.79	1.18
	21	-0.09	-316.08	-19.60	1.10	-0.94
	33	-0.44	-325.38	-17.88	1.31	0.51
EDW	06	-0.87	-1.17	-6.29	-0.29	1.55
	18	-2.16	-2.54	-3.85	-0.03	-0.52
	30	-1.92	-3.92	2.26	-0.10	-0.44

Table 1b. RMSE in Forecast Convective Parameters

Site	Hour	PWAT	CAPE	CINS	LIFT	KINX
XMR	06	4.07	1168.72	63.91	2.55	5.88
	18	5.28	1062.68	41.45	2.74	6.97
	30	4.88	1195.79	42.06	3.00	6.79
TBW	09	4.76	827.40	54.51	2.35	6.84
	21	5.36	806.40	61.52	2.53	7.17
	33	5.04	817.97	50.04	2.51	7.05
EDW	06	3.89	13.07	39.50	2.33	6.09
	18	3.89	12.51	32.09	2.04	7.00
	30	4.14	27.07	45.84	2.44	7.28

The bias for convective parameters in Table 1a fluctuates with verification time. An inspection of individual convective parameter biases from the 0300 and 1500 UTC forecast cycles (not shown) provides evidence of a diurnal cycle. The fluctuations in the overall bias trends for convective parameters are due, in part, to the diurnal variations of biases from the 0300 UTC and 1500 UTC convective parameters. The RMSE of the convective parameters (Table 1b) do not increase or decrease consistently throughout the duration of the forecast cycles.

The convective parameters shown in Table 1b are typically used to forecast the probability of thunderstorm occurrence. Convective activity is almost certain to occur, for example, when the KINX approaches 40. However, the magnitude of the RMSE errors for these parameters are large enough so that a parameter such as KINX may have a value above or below the thresholds usually associated with convective activity.

Summary

As of September 1996, results from the warm season evaluation suggest that model errors may be influenced partly by diurnal fluctuations of various atmospheric parameters such as temperature, moisture, and wind. In addition, there is evidence that point forecasts of vertical atmospheric profiles are drier and more stable than observed. This result is interesting especially since a preliminary analysis of forecast precipitation at XMR (not shown) indicates that the eta model predicts excessive precipitation despite the fact that the model atmosphere appears to be too dry and too stable during the four month period from May through August 1996. It is possible that the forecast model soundings are too dry and too stable at times when the model is not producing precipitation. In fact, the model may overestimate instability and precipitation only when the observed soundings are unstable and moist. However, a more detailed examination of forecast and observed soundings and precipitation is required to address these issues.

In general, error characteristics suggest that the meso-eta model produces an appreciable amount of day-to-day variability. However, the overall magnitude of the errors is reasonably small and quite encouraging considering the fact that rawinsonde temperature and wind speed measurement uncertainty is on the order of 0.6˚C and 3.1 m s^{-1}, respectively (Schwartz and Benjamin 1995). Although it is not yet clear whether deterministic forecasts from the meso-eta model can provide added value to daily forecasts at KSC/CCAS, the initial results are promising. It will be interesting to see how well the meso-eta model performs during the cool-season, when the Florida weather is influenced more by large-scale, synoptic weather systems.

References

Rodgers, E., T. L. Black, D. G. Deaven, G. J. DiMego, Q. Zhao, M. Baldwin, N. Junker, and Y. Lin, 1996: Changes to the operational "early" eta analysis/forecast system at the National Centers for Environmental Prediction. *Wea Forecasting*, **11**, 391-413.

Schwartz, B., and S. G. Benjamin, 1995: A comparison of temperature and wind measurements from ACARS-equipped aircraft and rawinsondes. *Wea. Forecasting*, **10**, 528-544.

2.6 AMU CHIEF'S TECHNICAL ACTIVITIES (DR. MERCERET)

MID-TROPOSHERIC WIND CHANGE CLIMATOLOGY

Dr. Merceret completed the wind change climatology and generated probability of exceedance curves for 0.25, 1, and 4 hour wind changes. These data were provided to both the Shuttle and Titan communities for use in their risk analysis. The results were also presented to NASA, USAF, and NWS personnel at a technical interchange meeting at the NWS MLB. A journal article will be submitted next quarter.

NOTICE

Attachment 1: AMU FY-96 Tasks

TASK 001 AMU OPERATIONS

• Operate the AMU. Coordinate operations with NASA/KSC and its other contractors, 45th Space Wing and their support contractors, the NWS and their support contractors, other NASA centers, and visiting scientists.

• Establish and maintain a resource and financial reporting system for total contract work activity. The system shall have the capability to identify near-term and long-term requirements including manpower, material, and equipment, as well as cost projections necessary to prioritize work assignments and provide support requested by the government.

• Monitor all Government furnished AMU equipment, facilities, and vehicles regarding proper care and maintenance by the appropriate Government entity or contractor. Ensure proper care and operation by AMU personnel.

• Identify and recommend hardware and software additions, upgrades, or replacements for the AMU beyond those identified by NASA.

• Prepare and submit in timely fashion all plans and reports required by the Data Requirements List/Data Requirements Description.

• Prepare or support preparation of analysis reports, operations plans, presentations and other related activities as defined by the COTR.

• Participate in technical meetings at various Government and contractor locations, and provide or support presentations and related graphics as required by the COTR.

TASK 002 TRAINING

• Provide initial 40 hours of AMU familiarization training to Senior Scientist, Scientist, Senior Meteorologist, Meteorologist, and Technical Support Specialist in accordance with the AMU Training Plan. Additional familiarization as required.

• Provide KSC/CCAS access/facilities training to contractor personnel as required.

• Provide NEXRAD training for contractor personnel.

• Provide additional training as required. Such training may be related to the acquisition of new or upgraded equipment, software, or analytical techniques, or new or modified facilities or mission requirements.

TASK 003 SHORT TERM FORECAST IMPROVEMENT

• Develop databases, analyses, and techniques leading to improvement of the 90 minute forecasts for STS landing facilities in the continental United States and elsewhere as directed by the COTR.

• Design McBASI routines to enhance the usability of the MIDDS for forecaster applications at the RWO and SMG. Consult frequently with the forecasters at both installations to determine specific requirements. Upon completion of testing and installation of each routine, obtain feedback from the forecasters and incorporate appropriate changes.

• Subtask 2 - Fog and Stratus At KSC

•• Develop a database for study of weather situations relating to marginal violations of this landing constraint. Develop forecast techniques or rules of thumb to determine when the situation is or is not likely to result in unacceptable conditions at verification time. Validate the techniques and transition to operations.

Subtask 6 - MIDDS F-key Menu Systems

•• Document the MIDDS F-key menu systems developed by the AMU.

Subtask 7 - WINDEX and Microburst Daily Potential Index (MDPI)

•• Evaluate the WINDEX and MDPI.

TASK 004 INSTRUMENTATION AND MEASUREMENT SYSTEMS

• Evaluate instrumentation and measurement systems to determine their utility for operational weather support to space flight operations. Recommend or develop modifications if required, and transition suitable systems to operational use.

• Subtask 3 - Doppler Radar Wind Profiler (DRWP)

•• Evaluate the current status of the DRWP and implement the new wind algorithm developed by MSFC. Operationally test the new algorithm and software. If appropriate, make recommendations for transition to operational use. Provide training to both operations and maintenance personnel. Prepare a final meteorological validation report quantitatively describing overall system meteorological performance.

• Subtask 4 - Lightning Detection And Ranging (LDAR) System

•• Develop training material for the NASA/KSC Lightning Detection And Ranging (LDAR) system which will include a computer based training (CBT) course, video, and user's manual.

• Subtask 5 - Melbourne NEXRAD

•• Evaluate the effectiveness and utility of the Melbourne NEXRAD (WSR-88D) operational products in support of spaceflight operations. This work will be coordinated with appropriate NWS/FAA/USAF personnel.

• Subtask 9 - Boundary Layer Profilers

•• Evaluate the meteorological validity of current site selection for initial 5 DRWPs and recommend sites for any additional DRWPs (up to 10 more sites). Determine, in a quantitative sense, advantages of additional DRWPs. The analysis should determine improvements to boundary layer resolution and any impacts to mesoscale modeling efforts given additional DRWPs. Develop and/or recommend DRWP displays for operational use.

• Subtask 10 - NEXRAD/McGill Inter-evaluation

•• Determine whether the current standard NEXRAD scan strategies permit the use of NEXRAD to perform the essential functions now performed by the PAFB WSR-74C/McGill radar evaluating weather Flight Rules and Launch Commit Criteria (including the proposed VSROC LCC).

• Subtask 11 - MIDDS Upgrade

•• Support the current 45 WS/Eastern Range MIDDS Upgrade Project. Support shall include reviewing vendor documents and products and providing technical advice.

• Subtask 12 - WSR-88D Exploitation: NSSL's Warning Decision & Support System (WDSS) Proof of Concept Demonstration

•• Support NSSL's WDSS Proof of Concept Demonstration at NWS MLB in the summer of 1996. This support shall include a one-month evaluation of the WDSS for potential transfer into operations.

• Subtask 13 - AF Improvement and Modernization (I&M) and Range Standardization and Automation (RSA) Support

•• The AMU will support AF I&M projects and AF RSA project. The AMU support will include

1) Reviewing vendor documents, designs, prototypes, and products
2) Reviewing system interoperability and data communications among system nodes (e.g., data types and formats),
3) Testing vendor products and prototypes,
4) Attending vendor briefings and reviews, and
5) Documenting our technical advice, comments, and suggestions.

• Subtask 14 - Data Integration and Display

•• Identify systems currently available for integrating and displaying east central Florida, White Sands, and Edwards AFB area mesoscale and synoptic data sets. After the systems are identified, the AMU shall analyze communications and hardware requirements for each system and determine if the infrastructure exists to run the system in the current or near-future MIDDS environment. Data sets to be processed by the systems include radar lightning, radar, satellite, profiler, rawinsonde, surface, and aircraft data.

• Subtask 15 - LDAR Data and Display

•• The AMU shall investigate data reduction methods for providing LDAR data to MIDDS. In addition, the AMU shall identify options for MIDDS display of LDAR data that are less intensive than the current LDAR system display.

• Subtask 16 - SLF Weather Equipment Cost-Benefit Study

•• The AMU will perform a cost-benefit study of the options to modify or prelacy existing SLF meteorological equipment with the goal of transferring the equipment to the Eastern Range. The work will be performed using options hours only.

TASK 005 MESOSCALE MODELING EVALUATION

• Evaluate Numerical Mesoscale Modeling systems to determine their utility for operational weather support to space flight operations. Recommend or develop modifications if required, and transition suitable systems to operational use.

• Subtask 1 - Evaluate the NOAA/ERL Local Analysis and Prediction System (LAPS)

•• Evaluate LAPS for use in the KSC/CCAS area. If the evaluation indicates LAPS can be useful for weather support to space flight operations, then transition it to operational use.

• Subtask 2 - Install and Evaluate the MESO, Inc. Mesoscale Forecast Model

•• Install and evaluate the MESO, Inc. mesoscale forecast model for KSC being delivered pursuant to a NASA Phase II SBIR. If appropriate, transition to operations.

• Subtask 3 - Acquire the Colorado State University RAMS Model

•• Acquire the Colorado State University RAMS model or its equivalent tailored to the KSC environment. Develop and test the following model capabilities listed in priority order:

1) Provide a real-time functional forecasting product relevant to Space shuttle weather support operations with grid spacing of 3 km or smaller within the KSC/CCAS environment.

2) Incorporate three dimensional explicit cloud physics to handle local convective events.

3) Provide improved treatment of radiation processes.

4) Provide improved treatment of soil property effects.

5) Demonstrate the ability to use networked multiple processors.

Evaluate the resulting model in terms of a pre-agreed standard statistical measure of success. Present results to the user forecaster community, obtain feedback, and incorporate into the model as appropriate. Prepare implementation plans for proposed transition to operational use if appropriate.

• Subtask 4 - Evaluate the Emergency Response Dose Assessment System (ERDAS)

•• Perform a meteorological and performance evaluation of the ERDAS. Meteorological factors which will be included are wind speed, wind direction, wind turbulence, and the movement of sea-breeze fronts. The performance evaluation will include:

1) Evaluation of ERDAS graphics in terms of how well they facilitate user input and user understanding of the output.

2) Determination of the requirements that operation of ERDAS places upon the user.

3) Documentation of system response times based on actual system operation.

4) Evaluation (in conjunction with range safety personnel) of the ability of ERDAS to meet range requirements for the display of toxic hazard corridor information.

5) Evaluation of how successfully ERDAS can be integrated in an operational environment at CCAS.

6) Evaluate the ability of ERDAS to predict cloud and plume dispersion. Factors to consider include cloud rise, bifurcation, trajectory, and horizontal/vertical dispersion.

- Subtask 7 - 29 km Eta Model Evaluation

•• Evaluate the most effective ways to use the NCEP 29 km eta model to meet 45 WS, SMG, and NWS MLB requirements. The AMU shall determine the data acquisition requirements, and design and implement the evaluation protocol. The evaluation protocol includes:

1) Finalize the data acquisition requirements for the 29 km eta model evaluation based on recommendations from the technical working group (45 WS, SMG and NWS MLB).

2) Design the evaluation protocol for the 29 km eta model. The evaluation strategy will consist of two main components. The first component will use an objective and subjective evaluation strategy to assess model forecast skill. The second component will involve daily, real-time forecasting by AMU personnel using 29 km eta model output to determine the most effective ways to visualize, interpret and use a mesoscale model for short-range forecasting in east central Florida (KSC/CCAS and surrounding areas).

3) Collect data and perform real-time forecasting from 1 May through 31 August 1996 and 1 October 1996 through 31 January 1997 then analyze the results from the warm and cool season, respectively.

4) Prepare and deliver the first draft of the 29 km Eta model evaluation final report by 28 March 1997.