Applied Meteorology Unit (AMU)

Quarterly Report

Second Quarter FY-96

Contract NAS10-11844

30 April 1996

ENSCO, Inc.
445 Pineda Court
Melbourne, Florida 32940
(407) 853-8105 (AMU)
(407) 254-4122

Distribution:

NASA HQ/ME/J. Ernst
NASA HQ/ME/F. Estis
NASA HQ/Q/F. Gregory
NASA HQ/M/W. Littles
NASA HQ/M-7/B. O'Connor
NASA HQ/AS/F. Cordova
NASA KSC/TM/R. Sieck
NASA KSC/TM/J. Harrington
NASA KSC/MK/L. Shriver
NASA KSC/CD/J. Honeycutt
NASA KSC/TM-SPO/B. Harris
NASA KSC/TM-SPO-3/J. Zysko
NASA KSC/TM-SPO-3/J. Madura
NASA KSC/TM-SPO-3/F. Merceret
NASA KSC/DE-TPO/K. Riley
NASA KSC/DE-TPO/J. Nicholson
NASA KSC/IM-NAO-A/P. McCalman
NASA KSC/TE-ISD/C. Lennon
NASA KSC/TE-ISD-3A/L. Maier
NASA JSC/MA/T. Holloway
NASA JSC/ZS8/F. Brody
NASA JSC/DA8/M. Henderson
NASA MSFC/ELS4/D. Johnson
NASA MSFC/SA0-1/A. McCool
45 WS/DOR/A. Guiffrida
45 WS/SY/R. Thorp
45 WS/SY/B. Boyd
45 RANS/CC/D. Thompson
45 OG/CC/G. Harmon
45 MXS/CC/S. Ungvarsky
45 LG/CCR/R. Fore
CSR 1330/M. Maier
CSR 4140/H. Herring
45 SPW/SESL/D. Berlinrut
SMC/CWP/D. Carroll
SMC/CWP/J. Rodgers
SMC/CWP/D. Sandburg
SMC/CWP/R. Bailey
SMC/CWP (PRC)/P. Conant
Phillips Laboratory, Geophysics Division/LY/R. McClatchey
Hq AFSPC/DOOW/A. Ronn
Hq AFSPC/DOOW/J. Schattel
Hq AFSPC/DOW/G. Wittman
Hq AFMC/J. Bonewitz
Hq AWS/CC/J. Dushan
Hq AWS/XO/Director of Technology, Plans, and Programs
Hq USAF/XOW/T. Lennon
Office of the Federal Coordinator for Meteorological Services and Supporting Research
SMC/SDEW/B. Hickel
SMC/MEEV/S. Simcox

NOAA “W/OM”/L. Uccellini
NOAA/OAR/SSMC-I/J. Golden
NOAA/ARL/J. McQueen
NWS Melbourne/B. Hagemeyer
NWS/SRHQ/H. Hassel
NWS “W/SR3”/D. Smith
NSSL/D. Forsyth
NSSL/C. Doswell
NWS/”W/OSD5”/B. Saffle
NWS/”W/OSD23”/D. Kitzmiller
NWS/EFF/M. Branick
NWS/OSF Applications Branch/A. White
NWS/OSF Operations Branch/T. Crum
PSU Department of Meteorology/G. Forbes
FSU Department of Meteorology/P. Ray
N.C. State Department of Marine, Earth, & Atmospheric Sciences/S. Koch
NCAR/J. Wilson
NCAR/Y. H. Kuo
30 WS/CC/R. Keefer
30 WS/DOS/S. Sambol
30 WS/DO/C. Crosiar
14 AF/DOW/R. Miller
SMC/CLGR/L. Palermo
NOAA/ERL/FSL/J. McGinley
Halliburton/NUS Corp./H. Firstenberg
MRC/ASTER/C. Tremback
ENSCO ARS Div. V.P./J. Pitkethly
ENSCO Contracts/S. Leigh

SPECIAL NOTICE TO READERS

AMU Quarterly Reports are now published on the Wide World Web (WWW). The Universal Resource Locator for the AMU Home Page is:

http://technology.ksc.nasa.gov/WWWaccess/AMU/home.html

The AMU Home Page can also be accessed via links from the NASA KSC Home Page. The AMU link is under the KSC servers section.

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 OPERATION OF THE AMU

HARDWARE / SOFTWARE INSTALLATION AND MAINTENANCE (MS. YERSAVICH AND MR. WHEELER)

In January, the AMU received an IBM PC Server 310 (Pentium processor) to replace the Meteorological Interactive Data Display System (MIDDS) IBM Model 80. Prior to the installation of any software, Computer Science Raytheon (CSR) removed the PRONET card from the Model 80 and installed it in the PC Server 310. The AMU then installed the system software and all previous McIDAS software was backed up from the Model 80 and restored to the 310. The AMU has seen a marked improvement in system performance, especially in commands that are executed locally on the workstation. The transfer and recompiling of gridded data has improved by a factor of 10.

In March, the IBM RS/6000 Model 390's internal 5-GB 8-mm tape drive malfunctioned and was unable to ingest and process tapes. IBM was called upon to help in the troubleshooting procedures and it was determined that the best solution was for IBM to replace the tape drive with a new one under the current maintenance agreement. The tape drive was replaced and has functioned properly since that time.

Also in March, one of the 2 GB external disk drives attached to the PROWESS system failed to perform. Under the extended service agreement with CoComp, Inc. the drive was replaced within 24 hours, the disk was then reconfigured and the data were restored from the previous week's backup. A Microsoft virus eradicator was installed on all the AMU Macintoshes, in addition, five of those received an operating system upgrade.

PROCUREMENT

The AMU submitted several purchase requests in March for additional computer hardware and software. Purchase items of note include three Macintosh PowerPC Model 7500s, a Gateway 2000 Pentium PC, external modems, Apple external CD-ROMs, and a scanner.

The high end Macintosh PowerPCs with X-terminal emulation software will satisfy the AMU's need for additional Macintoshes and X-terminals. The Macintosh PowerPCs with their associated software will provide more word and data processing platforms, enable all AMU personnel to access the UNIX workstations simultaneously, and will be replacing Macintoshes 7 years old or greater. The Pentium PC purchased will be replacing a 386 PC system purchased for the 1989 Galileo mission and will be used for the Doppler Radar Wind Profiler (DRWP) climatology.

The Apple external CD-ROMs will ease the installation of software on the Macintosh PowerPCs that do not have an internal CD-ROM. Software packages have become so large that installation by 3.5″ diskettes is very time-consuming and inefficient. The CD-ROMs allow the installer to insert the CD and then perform other tasks while the installation occurs. The 28,800 bps v.34 external modems are necessary for remote internet access to email servers and gathering data for the evaluation of the 29 km Eta model. The scanner will allow the AMU 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.

MISSION IMMEDIATE TASKS

Mr. Wheeler assisted in solving several MIDDS workstation problems during this period. The Launch Weather Officers (LWOs) for Atlas and Shuttle operations requested minor fixes be made to their workstations. These fixes ranged from a graphical display not being updated correctly to not being able to save the changes that they had made in their operational support forecast. All fixes were done with no impact to the LWO's work schedule in support of the operation.

2.2 TASK 003 IMPROVEMENT OF 90 MINUTE LANDING FORECAST

SUBTASK 6 MIDDS F-KEY MENU SYSTEMS (MR. WHEELER)

Changes were made to several of the LWO's F-key menu systems in support of Atlas, Delta, Shuttle, and Titan. The changes added the capability to change the scale of the horizontal and vertical axes for temperature, wind direction and speed displays and to reload the forecast and slide presentation editor. Also, the SKEWTN rawinsonde plotting program was added to the forecaster terminal. New McBASI plotting routines were developed and incorporated into the F-key menu system on the Range Weather Operations' (RWO) Wide Word Workstation for the display of gridded Eta data. The RWO now has the capability of comparing the Eta, NGM, and MRF model products out to 48 hours. Monthly back ups continued for the RWO F-key menus and all related utilities. The new backup routines developed for the F-key maintenance documentation were used and worked without any problems.

Mr. Wheeler supported the RWO and PRC, Inc. in the evaluation and development of the Graphical User Interface (GUI) for the Advanced MIDDS weather system. Mr. Wheeler also attended several meetings with PRC, Inc. which focused on command usage and functionality of the new weather display system.

MIDDS F-KEY MENU SYSTEMS DOCUMENTATION

Ms. Yersavich and Mr. Wheeler completed the *Maintenance Manual for F-Key Menu Systems the AMU Developed for the MIDDS* at the beginning of February. The document was reviewed by the 45th Weather Squadron (45 WS) and returned by mid-February. The final report was distributed to the 45 WS and the National Weather Service Melbourne office (NWS MLB) on 22 February 1996.

Anyone else interested in obtaining a copy of the final report should contact Ms. Yersavich. Below is an example of the back up and restore procedures used on the RWO terminals.

Current back ups of each terminal's configuration and menu system(s) must be maintained to ensure that menu system functionality can be restored if the terminal configuration or F-key menu system is inadvertently corrupted. Back ups and restores of the menu system are done from the OS/2 operating system using the following commands:

BACK UP

1. For each terminal do the following from the "C:" prompt:

   Enter **MENUBU.CMD**

   This command runs a BATCH file that performs the following commands:

   In this example **nn** corresponds to the terminal number.

   CD \MCIDAS\DATA

   C:\MCIDAS\TOOLS\ZIP C:\MCIDAS\DATA\T**nn**MENU C:\MCIDAS\DATA*.MNU

   C:\MCIDAS\TOOLS\ZIP C:\MCIDAS\DATA\T**nn**MISC BASICVV1 CONTEXT.SLT *.GRA *.NAM SAVESTR SKEDFILE STRTABLE

   C:\MCIDAS\TOOLS\ZIP C:\MCIDAS\DATA\T**nn**ASK *.ASK

   C:\MCIDAS\TOOLS\ZIP C:\MCIDAS\BAT\T**nn**BAT C:\MCIDAS\BAT*.BAT

   C:\MCIDAS\TOOLS\ZIP C:\MCIDAS\ET\T**nn**ET C:\MCIDAS\ET*.ET

   C:\MCIDAS\TOOLS\ZIP C:\MCIDAS\MCB\T**nn**MCB C:\MCIDAS\MCB*.MCB

   C:\MCIDAS\TOOLS\ZIP C:\MCIDAS\VIRT\T**nn**VIRT C:\MCIDAS\VIRT\VIRT*

2. Place a formatted-blank or a previously used terminal-back up disk into the 'A' drive for the terminal you are backing up.

3. Enter **TBACKUP.CMD**

   This command runs a BATCH file that copies all .ZIP files to the 'A' drive.

RESTORE (from floppy, floppy in A drive)

For each terminal do the following from the 'C:' prompt:

Enter **AMENURS.CMD**

This will unzip all zipped files on the floppy into the appropriate directories. See the example BATCH file above.

SUBTASK 7 EVALUATION OF THE MICROBURST-DAY POTENTIAL INDEX (MDPI) AND WIND INDEX (WINDEX) (MR. WHEELER)

During this past quarter, work began and was completed on computing the WINDEX values for each local sounding from May through August 1995. Work continues on writing the verification and implementation of the MDPI and WINDEX Forecasting Tools report. However, due to the change in task priorities, the final report has been rescheduled from March 1996 to April 1996.

2.3 TASK 004 INSTRUMENTATION AND MEASUREMENT

SUBTASK 3 50 MHZ DOPPLER RADAR WIND PROFILER (DRWP)

Ms. Yersavich has processed all archived profiler McIDAS MD files from mid December 1995 to March 1996. In February, Ms. Yersavich produced ASCII profiler data sets for each day in the 1995 profiler McIDAS MD file archive (October - December). These data sets were transferred to Dr. Merceret for use in his climatological analysis of profiler data.

Ms. Yersavich provided Mr. Crisler of Lockheed Martin and Mr. Bostick of Aerospace Corp. with standard ASCII data sets of the 50 MHz profiler data for the 29 December 1995, 3, 8, 9 January 1996, and 14, 16 February 1996 Titan simulation test days. The 50 MHz profiler performance logs that were maintained by Ms. Yersavich and Capt. Heckman of the 45 WS for each of those days were also provided to Mr. Crisler, Mr. Bostick, and Ms. Maier of NASA/KSC. These ASCII profiler data sets were produced using the same software which is used to generate the profiler data files for Dr. Merceret's climatological analysis.

The daily data quality monitoring of the 50 MHz profiler will continue through April.

SOFTWARE MODIFICATIONS TO THE 50 MHZ DRWP DISPLAYS (MS. LAMBERT)

Capt. Heckman of the 45 WS requested changes be made to the 50 MHz DRWP displays on the Digital VT340 terminal to improve the quality control (QC) of the profiler's data. This task is being performed under option hours using KSC funds. At the present time, QC of the data is made difficult due to both the size of the display and the resolution of the height scale. The proposed modifications will be made to the profile display of wind speed and direction, and to the spectral data QC display of the east, north, and vertical beams. The changes to the profile display are necessary to make the units of the plots consistent with the jimsphere plots, and the changes to the QC display are necessary to increase the resolution and size of the plots as well as making them consistent with the jimsphere plots.

The requested changes to the wind profile display were completed by Ms. Lambert in March. They include a speed scale in knots instead of m/s with tick marks every 5 knots and labels every 20 knots, a height scale in thousands of feet instead of kilometers with tick marks every 1000 feet and labels every 10000 feet, and a user-selectable maximum wind speed. Only one of the several requested changes to the QC display was made in March. The number of cycles on the screen at one time was reduced from three to two, which made the plots taller. The remainder of the modifications to be made in April include reducing the width of the vertical beam spectral data display and the signal-to-noise ratio plots, increasing the width of the east and north beam spectral data plots, reducing the displayed range of speeds, changing the height coordinate to thousands of feet, and changing the speed coordinate to knots. The software documentation will be updated and distributed in May 1996.

SUBTASK 4 LIGHTNING DETECTION AND RANGING (MR. DRAPE)

Development of a computer-based training (CBT) prototype on the Lightning Detection And Ranging (LDAR) system was completed in March 1996. This software program provides a convenient method of familiarizing the user with LDAR operational concepts and illustrating typical LDAR data signatures. The run-time module is being distributed as a set of four floppy diskettes which contain four CBT lessons. The course content is described as follows.

Course Introduction - provides general information about the CBT course and a brief description of LDAR.

LDAR System Overview - describes LDAR principles of operation, key design features, measures of data quality, as well as its overall capabilities and limitations.

Display System Operation - describes the general functions, menu items, and frequently used procedures involving the LDAR display system.

LDAR Data Interpretation - allows the user to replay examples containing known LDAR data signatures using a program which emulates the LDAR display system.

The first three lessons impart LDAR system operational concepts using hypertext, graphical displays, and digitized photographic images. The lesson content is presented in a logical sequence with a general overview provided first followed by more detailed information. However, the user is free to choose his/her own path through the material based on individual needs. This significantly reduces the amount of time needed to complete the course, and allows the information to appeal to a broader range of users from novices to experts. An example of one of the graphical illustrations is depicted in Figure 1, which is used to describe the components that comprise the LDAR system. In the CBT course, the user is prompted to click on one of the LDAR components shown in the diagram which displays the appropriate description in a text field.

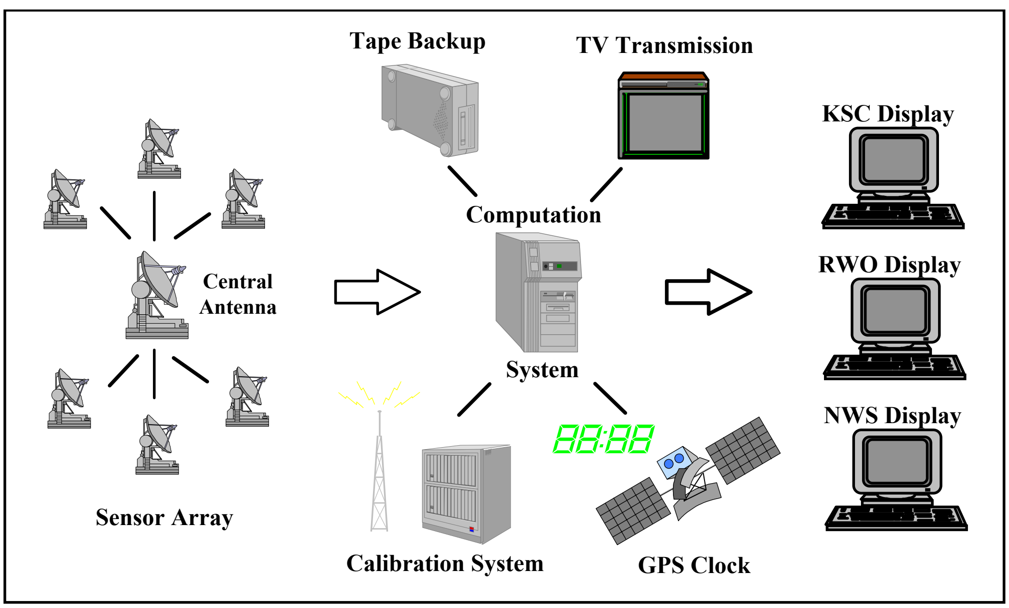

Figure 1. Graphical Illustration of LDAR System Architecture

The fourth CBT lesson provides the user with the capability of replaying selected examples of LDAR data sets which illustrate different signature patterns encountered in practice. The LDAR emulation program was developed in Microsoft Visual Basic which is used to select data sets and display the data on a 3-D map that looks and behaves much like the actual LDAR system. The data interpretation lesson includes examples of LDAR data sets selected from the following categories:

- Local storm development containing multiple cells,
- Storms associated with passage of a cold front,
- Noise signatures from aircraft and miscellaneous sources.

The CBT prototype was submitted (2 April) for evaluation by organizations familiar with LDAR and use the system on a regular basis, including 45WS at CCAS, NWS MLB, Spaceflight Meteorology Group (SMG) at JSC, and the NASA Instrumentation Systems Directorate (TE-ISD-3A) at KSC. An evaluation form is being provided to collect feedback on the CBT course content, presentation, and overall effectiveness. After a 30-day evaluation period, both written and verbal comments will be analyzed in order to plan whatever improvements may be necessary. Release of the first production version of the LDAR CBT software is expected to occur by June 1996.

SUBTASK 5 WSR-88D EVALUATION (MR. WHEELER)

Mr. Wheeler and Ms. Lambert continued their review and analysis of WSR-88D data for convection initiation and severe/non-severe storm determination. A case-by-case storm summary was completed and distributed to all agencies (see below). Ms. Lambert and Mr. Wheeler received training on the WSR-88D Algorithm Testing And Display System (WATADS) software at the NWS MLB which will be used in the case analyses. The AMU also started processing the archived level II radar data from each case for use in WATADS. Once the data for all the cases are processed, they will be individually reloaded into WATADS for storm identification and analysis.

Sixteen convective case study days were selected from the data collected over the 1995 summer based on the occurrence of convective activity and data availability. The final report on the NEXRAD exploitation task will describe the radar signatures indicative of convection initiation and severe storm formation and the radar products in which they appear. A brief summary of the radar weather events that occurred on each day is presented below.

20 June 1995: The initial winds were weak and westerly at the surface backing to southerly at 1.5 km. Some horizontal convective rolls (HCRs) became visible with reflectivity values of 35 - 40 dBZ as they interacted with the sea breeze along the coast. The most interesting event of the day was when a low reflectivity boundary (~10 dBZ) of unknown origin appeared 25 km northwest of the Melbourne WSR-88D (radar), propagated to the northwest about 10 km, and initiated a convective line. The period ended with passage of the sea breeze.

26 June 1995: The winds were south-southwesterly at the surface and veered to westerly at 1 km. The significant convection affecting the area was initiated by outflow boundaries produced by convection west of the radar observing area. These boundaries propagated to the east and interacted with HCRs to initiate the convection west of the radar. The convection grew into a strong line and remained strong as it propagated to the east and produced very strong outflow winds.

28 June 1995: The flow at the beginning of the period was northwesterly and enhanced lines of low reflectivity (<10 dBZ), parallel to the flow, indicated the presence of HCRs. A westward-propagating boundary, possibly the sea breeze front, was barely visible over the ocean with negative reflectivity values. The first cells initiated over land and the coastline north of the radar. Subsequent collisions between outflow boundaries from these cells produced a strong convective cell, and the interaction of this cell with the sea breeze front produced a strong line of convection.

10 July 1995: The winds at the beginning of the period were southwesterly with HCRs as indicated by the presence of reflectivity "streaks" parallel to the flow. The sea breeze front was again visible over the ocean with negative reflectivity values. A line of convection formed when an outflow boundary from storms west of the area propagated east and interacted with HCRs west of the radar. This convection produced an outflow boundary that initiated an intense line of convection when it collided with the sea breeze front.

11 July 1995: The wind direction was northwesterly at the surface backing to westerly at 1.5 km. An odd feature that appeared to be smoke from a fire in eastern Orange County was seen in the reflectivity field early in the period. An outflow boundary from a cell to its south intercepted the smoke and initiated a convective cell. This cell propagated to the east along its own outflow boundary, then developed a strong convective line southward along the river breeze when it reached the Indian River. A tornado was reported over the Titan complex with this line.

12 July 1995: On this day the winds were north-northeasterly. Cells formed along the coastline and over the ocean and produced mostly westward propagating outflows. These outflows triggered convective cells over land west of the area, and one of them produced a microburst. Although these cells produced outflow boundaries that collided with each other near the radar and over the Cape, none of the collisions initiated convection. Most of the convection produced on this day was only moderately intense and short lived.

13 July 1995: Initial convection initiation was missed because the radar was down from 1537 - 1725 UTC. The general flow pattern was easterly. Prior to the radar outage, convection developed north-northwest of the Cape and south of the radar. An outflow boundary produced by the northern convection initiated more convective cells as it propagated south. A divergent signature in the velocity field indicative of a microburst appeared with one of these cells. The convection to the south produced a northward moving boundary, and as the boundaries approached each other convection developed in the air between them, west of the radar. These cells advected west away from the area with the easterly flow.

17 July 1995: A line of convective cells initiated early in the morning west of the Cape and propagated to the southeast. It dissipated before it reached the radar, but redeveloped as it moved southeast. Another line had formed west-northwest of the Cape and propagated to the southeast, producing an outflow boundary that initiated another line of convection ahead of it. The new line propagated rapidly to the southeast and eventually overtook the original line. Strong winds in excess of 20 m/s occurred as the lines merged and moved offshore.

20 July 1995: Convective cells were forming on a pre-existing east-west oriented boundary south of the radar and advecting to the east in the westerly flow. These cells produced a northward moving outflow boundary that was barely discernible in the reflectivity field. As the river breeze propagated inland, west of the Cape, it initiated convection by interacting with HCRs in that area. These new cells strengthened and produced a southward moving outflow boundary. The two outflow boundaries propagated toward each other along the sea breeze front until they collided over Melbourne and produced a severe storm. This storm generated lightning that struck the radar and made it inoperable for over a week.

8 August 1995: HCRs could be seen in the reflectivity field as ~0 dBZ lines oriented quasi-parallel to the northwest flow. Existing convective cells advected to the south along the coast from an area north of the Cape. Outflow from these cells pushed the sea breeze front southwestward. Two outflow boundaries, one to the west of the sea breeze propagating south and one west of this propagating southeast, joined with the sea breeze front to form a semi-circular scalloped boundary that was closing in on itself. Convection was enhanced at the intersection points on the boundary, but no strong convection developed.

10 August 1995: HCRs could be seen in the reflectivity field as ~0 dBZ lines oriented quasi-parallel to the northwest flow. An intense cell that had initiated on the sea breeze front just north of the Cape produced an outflow that pushed the northern end of the sea breeze front to the southwest. A cell that initiated on this part of the sea breeze produced a microburst over Cocoa Beach. Similarly, a cell that had initiated on the southern end of the sea breeze (south of the radar) produced an outflow that pushed that end to the northwest. The two lines began converging on the eastern end and produced intense but short lived convection as they came together.

1 September 1995: Two large areas of precipitation, one over the ocean to the northeast and one to the southwest of the radar, produced outflow boundaries which propagated toward each other. The boundary to the southwest propagated to the northeast and initiated a strong convective line. This line propagated to the east and collided with a thin line along the coast. An intense north/south oriented convective line ~150 km long formed as a result, with the northern end just south of the Cape. The velocities in the outflow produced from this line exceeded 20 m/s as it propagated over the ocean.

6 September 1995: Many small cells erupted over land in the presence of southerly flow, but there were no obvious boundaries present. The initiation mechanism of these cells is not known, but an alternating convergence/divergence pattern seen west of the radar suggests that strong HCRs existed and could have been responsible for this outbreak. The sea breeze moved inland quickly and enhanced the convective cells it interacted with. Strong convection did not occur on this day.

7 September 1995: HCRs had developed in the southwesterly flow, and the first cell of the day initiated from the interaction between an HCR and the sea and river breezes over the Cape. The sea breeze moved inland slowly and interacted with HCRs and outflow boundaries from cells that had formed ahead of the sea breeze front. Two strong northeast/southwest oriented convective lines formed, one along the coast from the Cape to Patrick AFB, and the other from Vero Beach to about 40 miles to the southwest. The strongest convection, with possible hail, occurred in the southern line.

8 September 1995: The flow was southwesterly and HCRs existed but could barely be seen in the reflectivity field until deeper convective clouds formed over them. After the 'random' initiation of cells, an unorganized north/south oriented line of convection formed ~70 km west of the radar through interaction of the outflow boundaries from the dissipating cells. This line produced an eastward moving outflow boundary which eventually collided with the sea breeze just west of the radar. A strong line of convection formed at the intersection about 30 km west of the radar and produced a strong outflow in excess of 20 m/s.

12 September 1995: The flow on this day was south-southeasterly, and the radar was down for a 1.5 hour period in which convection initiated. When the radar came on line, many convective cells existed along the coast north and south of the radar. These cells produced outflows which initiated convection inland. Many outflow boundaries existed which, when colliding with other boundaries, initiated convection. The cells developed to the west and were out of the area within 2 hours.

If there are any questions or comments on any of the cases or any aspect of the study, please contact Winnie Lambert (407-853-8130, winnie@fl.ensco.com) or Mark Wheeler (407-853-8205, markw@fl.ensco.com) at the AMU. The final report on the NEXRAD exploitation task should be delivered in June 1996.

2.4 TASK 005 MESOSCALE MODELING

SUBTASK 2 INSTALL AND EVALUATE MESO, INC.'S MASS MODEL (DR. MANOBIANCO)

At the end of January 1996, a teleconference was convened with NASA Headquarters, NASA KSC, RWO, SMG, and NWS MLB to review the results of the MASS evaluation and discuss options for a "mid-course correction" to the AMU mesoscale modeling task. A subsequent teleconference with the same parties was convened during the first week of February 1996 to make a decision regarding the "mid-course correction" for the AMU modeling task. Based on consensus from RWO, SMG, and NWS MLB during the February 1996 teleconference, the AMU was directed to terminate all work with MASS and write a final report. In addition, the AMU was tasked to prepare plans to continue running the current or upgraded version of MASS on a non-interference, zero-labor cost basis. Finally, the AMU was tasked to begin evaluating National Center for Environmental Prediction's (NCEP) 29 km Eta model.

The "mid-course correction" to the AMU modeling task was based on consensus that

- The current version of MASS does not provide sufficient added value over NCEP models to justify the cost of continuing the evaluation with the intent to transition MASS for operational use,

- An evaluation of the 29 km Eta model over the next 12 months will likely result in a low-to-medium risk, short-term payoff, namely that the AMU will be able to determine the utility of NCEP's best mesoscale model for local forecasting, and

- The real-time data deficiencies (e.g. limited access to NCEP gridded data and no access to digital NEXRAD and 915 MHz DRWP data) would likely be corrected over the next 12-24 months which may increase the utility of local modeling systems such as MASS if these data can be incorporated into the systems in real-time.

Dr. Manobianco completed the first draft of the MASS evaluation final report at the end of March 1996 and distributed a copy to RWO, SMG, and NWS MLB for review. He requested that RWO, SMG, and NWS MLB forward any comments, questions, concerns, etc. about the report to him by 15 April 1996. Dr. Manobianco also prepared a plan to continue running the current version of MASS since the updated version is still being tested by MESO, Inc.

The MASS final report concludes with recommendations for improving local mesoscale modeling systems such as MASS and lessons learned from the MASS evaluation. The main points from this portion of the MASS final report are included in the following sections.

Recommended Local Mesoscale Modeling Enhancements

In order to make MASS a cost-effective system, the AMU recommends the following changes and improvements.

- Extend the 11 km runs from 12 h to 24 h and expand the 11 km domain from 45x60 to 75x70 grid points and 20 to 30 vertical levels.

- Discontinue twice-daily 24-h 45 km (coarse grid) runs and perform only twice-daily 11 km (fine grid) runs.

- Initialize MASS with 48 km or 29 km Eta rather than 80 km NGM gridded fields.

- Initialize sea surface temperatures (SST) with real-time analyses rather than monthly climatology.
- Install version 5.9.3 of the MASS data pre-preprocessor that contains a new soil texture database, improved vegetation climatology, and a new three-dimensional multivariate optimum interpolation for objective analysis of initial data.
- Install version 5.9.3 of the MASS model that allows larger long-to-short time step ratios which shorten total model run times, and contains improved boundary layer, surface hydrology, and microphysical parameterizations.
- Run MASS on a faster workstation than the 4-processor Stardent 3000.
- Improve the operational communication networks so that local mesoscale model products could be accessed by RWO, SMG, and NWS MLB in a timely, efficient manner.

In their subjective evaluations of MASS, the RWO and NWS MLB indicated that it would be beneficial to extend the 11 km runs from 12 h to 24 h. In fact, SMG inquired about this option after reviewing the AMU's proposed MASS configuration memorandum that was distributed in early 1994. SMG favored this configuration so that 24-h 11 km forecasts initialized at 0000 UTC could provide guidance for Shuttle landings occurring after 1200 UTC when similar 12-h 11 km forecasts would have expired.

In order to execute the 24-h 11 km runs over a larger domain, it would be necessary to discontinue 45 km runs so that the forecasts can be completed in a timely manner. Preliminary tests indicate that 24-h 11 km MASS model products would be available at roughly the same time that 24-h 45 km MASS model products are now available. The horizontal extent of the 11 km domain should be expanded in order to minimize the impact of boundary conditions which have more time to affect the interior solution in longer runs. The boundary conditions for 11 km runs would be provided every 6 h by the 48 km (or 29 km) Eta model rather than every hour by the 45 km model runs.

In order to make substantial improvements in warm season explicit precipitation forecasts, it is likely that deficiencies with respect to model resolution, model physics, and initialization data would need to be corrected. Currently, it is difficult to initialize the mesoscale structure of atmospheric moisture, temperature, winds, and moisture in the soil and surface cover layer from the data sources ingested by MASS. The data available from WSR-88D radars, 915 MHz DRWP, Radio Acoustic Sounding Systems (RASS), satellites (GOES-I, J and GPS), and soil moisture probes may offer the opportunity to improve initialization and short-range forecasts by MASS if they can be incorporated into the system in real-time. The recommended enhancements to MASS listed above focus primarily on upgrades to the software and changes to the real-time run configuration. However, these software upgrades and modifications to the configuration do not increase the horizontal resolution of MASS and do not include better initialization data except for Eta grids and real-time SST.

It is important to point out that increasing the resolution of MASS, and using better physical parameterizations and initialization data will not necessarily improve the utility of MASS forecasts to the point where they will always have added value over NCEP models. The primary benefit of running a local mesoscale model is that it can be tailored for specific, forecasting problems. However, local workstation-based, real-time modeling systems must run fast enough so that the forecasts can be used before they expire. This obvious and critical aspect of these systems must be balanced against the desire to improve the quality of the simulations by increasing the resolution, using more sophisticated physical parameterizations, and incorporating better mesoscale initialization data. Since the monetary cost of computational power continues to decrease with further advances in microprocessor and parallel processing technology, there is still opportunity for rapid advancement in model performance. Hence, a workstation-based numerical forecast system should be viewed as a dynamic entity and should evolve in tandem with the processing power available at a specified cost.

Another advantage of local modeling is that users can choose the

- Type and frequency of output products,
- Model configuration (the cycle times, grid resolution, model physics, domain size, etc.), and
- Types of local data (e.g. WSR-88D, 915 MHz and 50 MHz profiler, KSC/CCAS tower, etc.) and parameters (e.g. vegetation, land use, soil moisture, etc.) used for model initialization.

Nevertheless, these advantages must be weighed against the life-cycle costs and expertise needed to maintain a local modeling system. The real-time run statistics for MASS (not shown) indicate that MASS would be a very reliable operational system. However, the current version of MASS delivered on the Stardent 3000 has not been upgraded since March 1993. If MASS were ever transitioned for operational use, the AMU suggests

- Periodic hardware upgrades to take advantage of cheaper, faster workstations that could support finer resolution runs with more sophisticated physical parameterizations over larger domains,
- Periodic software upgrades to take advantage of improvements in the MASS pre-processor and model, and
- Technical system support provided by the vendor to resolve major problems with new or existing versions of MASS.

Finally, there is a problem with the large amount of data generated by local mesoscale models that can not easily be distributed to users in a timely, efficient manner. In fact, the NWS also faces this problem since NCEP generates several gigabytes of model output each day that all Weather Forecast Offices (WFOs) cannot access due to inadequate communication bandwidth. While this deficiency presents a challenge to local modeling at KSC/CCAS, it should not stand in the way of progress on such an effort. The transition plan for a system like MASS should specify requirements for sufficient communication bandwidth to handle the large volume of data produced by a local mesoscale model.

Lessons Learned from MASS Evaluation

The AMU's work on the installation and evaluation of MASS spanned nearly 3 years from early 1993 through the end of 1995. During that time, the AMU learned a number of valuable lessons about the evaluation, application, and utility of local mesoscale models. These lessons are described briefly in this section so that any future efforts with local modeling can take advantage of this information. To some extent, the design of the 29 km Eta model evaluation will consider these points.

The first five points relate to the installation and evaluation of MASS.

- The software routines that handle data pre-processing should be structured to accept local real-time data sets prior to the delivery of a modeling system to KSC/CCAS. To accomplish this task, the vendor would need current, sample data sets (e.g. from MIDDS) so that the system could be tested using the same data stream that would be available locally at KSC/CCAS.

- The evaluation protocol for MASS could have included more benchmarking with existing NCEP models (e.g. NGM, Eta, regional spectral model, Rapid Update Cycle, etc.), other forecast methods (e.g. persistence, climatology, etc.), and other forecast tools (e.g. Neumann-Pfeffer thunderstorm probabilities). The additional benchmarking would help to quantify the added value of a local model and provide information for a cost-benefit analysis that would be required before a decision was made to transition a local modeling system for operational use.

- The evaluation protocol could have included more phenomenological verification and stratified model error based on specific weather regimes. For example, RMSE and bias errors in temperature, winds, and moisture could have been stratified by layer-averaged wind direction. In addition, the verification could have focused more on events such as the sea-breeze.

- The evaluation protocol could have included daily, real-time forecasting by AMU personnel to determine the most effective ways to visualize, interpret and use MASS for short-range forecasting in east central Florida (KSC/CCAS and surrounding areas).

- In general, the evaluation of mesoscale models should use all available mesoscale data sets. However, these data sets can be quite large and require extensive processing and quality control before they can be used for verification. For the evaluation of 11 km MASS runs, the KSC tower and KSC/CCAS and Florida water management rain gauge observations had sufficient horizontal resolution to verify hourly wind and precipitation forecasts, respectively. Similarly, the 50 MHz DRWP data had sufficient temporal resolution to verify hourly wind profiles above 2 km from either the 45 km or 11 km runs. Future mesoscale model evaluations could use these same data sets in addition to data from the KSC/CCAS 915 MHz boundary layer profilers, Melbourne WSR-88D, and geostationary satellites (GOES-I, J).

The last two points relate to the real-time subjective evaluation of MASS by forecasters and meteorologists at RWO, SMG, and NWS MLB.

- The distribution of model graphics as image products was too limiting because forecasters could not overlay MASS output with satellite images, observations, or other model output (from NCEP's NGM or Eta model), select other model variables not provided in the current image, change the location of cross sections, skew-t's, or station plots, and change contour intervals, colors, etc.

  In the future, gridded local model output could be sent back to forecasters so that they could develop and examine their own suite of products.

- Prior to the subjective evaluation, the AMU could have provided more thorough familiarization and training on MASS for RWO, SMG, and NWS MLB. This would have allowed the AMU to present more specific details regarding the model configuration, capabilities, product suite and availability, and to address questions, issues, concerns, etc. about MASS.

Future Work with MASS

Based on the "mid-course correction" to the AMU mesoscale modeling task, Dr. Manobianco prepared a plan to continue running the current version of MASS since the updated version is still being tested by MESO, Inc. When the real-time MASS runs are restarted at the end of April 1996, the model configuration will be modified to discontinue the 24-h 45 km forecasts and to run one 24-h 11 km forecast. In addition, the 11 km domain will be expanded from 45x50 to 75x70 grid points and the vertical resolution will be increased from 20 to 30 layers. Finally, the model will be initialized using real-time sea surface temperatures rather than monthly climatological analyses and 48 km Eta rather then 80 km NGM gridded fields.

The primary reason for continuing the MASS runs and sending output to MIDDS is to give RWO, SMG, and NWS MLB the opportunity to conduct additional, informal evaluation over a larger number of cases than was possible during 1995. However, the AMU cannot guarantee that daily MASS forecasts will be available since no additional labor is allocated for maintaining the real-time schedule. Nevertheless, the real-time run statistics suggest that MASS is reliable enough that it should not require much effort to keep it running during the 1996 warm season. Since all future work with MASS at this point is informal, the AMU will not archive forecasts nor do any further statistical verification. However, the AMU may examine MASS output as time permits during the real-time internal forecasting that will be done as part of the 29 km Eta model evaluation.

In preparation for the "mid-course correction" discussed above, the AMU identified a number of deficiencies affecting the modeling task that include

- Delayed access to NCEP gridded data,
- Insufficient communication bandwidth between the AMU PC and MIDDS, and
- No access to 915 MHz profiler data or digital NEXRAD data.

Except for access to digital NEXRAD data, these deficiencies should all be remedied as part of RWO's plan to upgrade MIDDS. The plan calls for the installation of a direct data line connecting RWO to NCEP and a separate AMU data server running TCP/IP which should be in place by December 1996. The access to digital NEXRAD data would require a high speed communication line connecting NWS MLB and RWO. The MIDDS upgrade has no current provision for access to digital NEXRAD data.

By the time the 29 Eta model evaluation is completed in March 1997, most if not all of these deficiencies will likely have been corrected. At that time, there is the possibility that the AMU could be tasked to resume work with MASS especially if further examination of MASS by RWO, SMG, or NWS MLB reveals that it has more added value that was not discovered as part of their limited subjective evaluation performed during the 1995 warm season.

SUBTASK 4 INSTALL AND EVALUATE ERDAS (MR. EVANS)

The AMU has been evaluating the Emergency Response Dose Assessment System (ERDAS) located in the Range Operations Control Center (ROCC) at CCAS/KSC since its installation in March 1994. Before the Air Force's 45th Space Wing including Range Safety (45 SW) , the 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. This will enable the 45 SW to determine if and how it should be transitioned to an operational environment.

The following discussion is an overview of the results, conclusions, and recommendations of the AMU's evaluation of ERDAS.

ERDAS is a prototype software and hardware system configured to produce routine mesoscale meteorological forecasts and enhanced dispersion estimates on an operational basis for the KSC/CCAS region. ERDAS includes two major software systems run and accessed through a graphical user interface. The first software system is the Regional Atmospheric Modeling System (RAMS), a three-dimensional, multiple nested grid prognostic mesoscale model. The second software system is the Hybrid Particle And Concentration Transport (HYPACT) model, a pollutant trajectory and concentration model. ERDAS also runs the Rocket Exhaust Effluent Diffusion Model (REEDM).

Mission Research Corporation (MRC)/ASTER developed ERDAS for the Air Force for the purpose of providing emergency response guidance to operations at KSC/CCAS in case of an accidental hazardous material release or an aborted vehicle launch. The ERDAS development occurred during the period 1989 to 1994 under Phase I and II Small Business Innovative Research (SBIR) contracts. ERDAS was delivered to the Air Force's Range Operations Control Center (ROCC) in March 1994. The AMU was tasked with keeping ERDAS running and evaluate ERDAS from March 1994 to December 1995. The development and evaluation of ERDAS was funded by the Air Force Space and Missile Systems Center, Los Angeles Air Force Base. The evaluation of ERDAS included:

- Evaluation of the sea breeze predictions,
- Comparison of launch plume location and concentration predictions,
- Case study of a toxic release,
- Evaluation of model sensitivity to varying input parameters,
- Evaluation of the user interface,
- Assessment of ERDAS' operational capabilities, and
- Comparison of ERDAS models to Ocean Breeze Dry Gulch (OBDG) diffusion model.

Conclusions

Some of the principal conclusions of the ERDAS meteorological model evaluation were that

- RAMS predicted the 3-dimensional wind field reasonably well during non-cloudy conditions but slightly overpredicted surface wind speeds due to the height of lowest vertical grid point.
- RAMS did reasonably well at predicting wind direction shifts due to passage of sea breeze fronts during non-cloudy conditions. This result is not surprising since the modules used for predicting explicit cloud microphysics are disabled to allow the model to run in a reasonable time on the current computer hardware.

- RAMS was very sensitive to the soil moisture parameter for predicting the location and intensity of the sea breeze at KSC/CCAS.

- For cases where RAMS predicted a sea breeze, it predicted passage of sea breeze one to three hours earlier than observed in approximately 60% to 70% of the cases. This result may be due to parameterization of soil moisture, sea surface temperatures and/or land use classification.

Some of the principal conclusions of the ERDAS diffusion model evaluation were that

- HYPACT-predicted plume trajectory from 3 May 1994 Titan launch closely followed the observed trajectory with some variation over time. This launch was the only launch that significant observed plume data were available during the ERDAS evaluation.

- The use of the REEDM model to calculate the source term for HYPACT proved promising for use in launch plume modeling but some modifications to the technique are needed. HYPACT should be modified to handle buoyant plumes rather than treating the plumes as passive tracers.

- Launch plumes predicted by HYPACT overlapped the observed deposition patterns for 4 of 5 Shuttle launches analyzed in 1994-1995. One predicted plume did not overlap but was located within 35° of the observed plume.

- ERDAS did very well at predicting the trajectory of an N_2O_4 release on 20 August 1994 when the modeled source was moved from Launch Complex 41 to the center of the Cape. The modeled source was moved to compensate for the complex land/water features which are difficult to resolve with the 3-km grid.

- The 3-km grid spacing of the current ERDAS configuration is too large to resolve all of the detailed land/water features in the KSC/CCAS area. A smaller grid spacing would improve the resolution but model run time prohibits a smaller grid configuration on the current computer hardware.

- A special study was conducted to compare the currently certified OBDG model with the ERDAS models to determine if the ERDAS models changed launch availability. The study was limited in that it looked at dispersion during 30 2-hour periods over a 6-month period. These periods included late afternoon hours similar to the original OBDG study but it also included a higher percentage of late morning cases than the original OBDG study and included nighttime cases which were not included in the original OBDG study. The results of the study showed that

    - Cases where the winds shifted over time and space were the ones where major differences existed between the OBDG model and the ERDAS models. The currently certified OBDG model did not adequately handle wind shifting situations while the ERDAS models provided a more realistic picture of dispersion when wind shifts occurred.

- The ERDAS models could provide safety personnel with a better understanding of the three-dimensional wind field causing plume dispersion resulting from a potential toxic spill. Information on vertical plume development is not available from the OBDG model. This information can help safety personnel in making evacuation decisions and answer questions such as:
  - Will potential toxic plumes which have lofted upward eventually mix back down to surface? Are concentrations aloft large enough to pose a threat to populated areas if they reach the surface?
  - Will potential toxic plumes which have moved offshore eventually move back onshore?
- Comparing diffusion model predictions made by the OBDG model and the ERDAS models in this limited comparison study produced results which showed that using the ERDAS models for non-continuous spill scenarios improves launch processing availability in 19 of 29 cases. For continuous spill scenarios, ERDAS improves launch processing availability in 2 of 29 cases. A non-continuous spill is one that has a limited release duration (less than approximately one hour). The OBDG model assumes a continuous release.

Recommended Enhancements

ERDAS is a system which provides safety personnel with mesoscale and diffusion modeling capabilities that are more advanced than the current models (e.g. OBDG). ERDAS, as it runs at the end of the evaluation phase, performs as designed for the functions that are important for dispersion prediction. Therefore, ERDAS is ready to begin the phased approach of transitioning from the AMU to Range Safety Operations. Initially, ERDAS will provide Safety with a system to assist them in day-to-day operations and decision-making. With phased improvements and enhancements, ERDAS will become a system which will provide Safety with a state-of-the-art dispersion forecast and analysis system for use in launch and day-to-day operations. The phased transition of ERDAS to operations has begun and the AMU recommends that it continue until ERDAS becomes a fully-functioning, certified dispersion system.

The following enhancements will provide ERDAS with better capabilities to support operations and can be implemented in a phased approach.

Immediate implementation requirements to transition system to operations include

- Documentation on software maintenance, hardware maintenance, certification testing, and training needed to transition system to operations.

Short term technical enhancements include

- System should be moved to a faster, more powerful computer to provide results in less time than current platform,
- User interface needs minor revisions to provide users full capabilities of system,
- The Observed Data/Forecast blending feature needs sufficient testing since it is important for diffusion predictions,

- Current data interface to MIDDS should be modified for operations to provide smoother initialization data input, and
- ERDAS should be validated against tracer data.

Intermediate and long term technical enhancements which should be studied and possibly implemented include

- Activating the explicit cloud microphysics modules,
- Reducing the finest RAMS grid resolutions from the currently-implemented 3-km resolution,
- Adding near real-time input parameters for RAMS initialization such as soil moisture measurements and sea surface temperatures,
- Automate quality control of input data used to initialize RAMS,
- HYPACT should be modified to handle deposition of solid and liquid plume particulates as well as plume rise due to buoyant plumes,
- HYPACT should be modified to allow for calculation of cumulative dosages as well as instantaneous concentrations, and
- Implement four-dimensional data assimilation (nudging) in RAMS along with development of Local Analysis and Prediction System (LAPS).

LAPS is a system which ingests and displays near real-time 3-D meteorological data from a variety of sources including wind profilers, rawinsondes, surface observations, buoys, towers, WSR-88D, and GOES-8 visible and infrared radiance, and sounding data. The LAPS data are used to initialize and update models such as RAMS and to provide dispersion models with observed 3-D data rather than predicted data.

The Eastern Range has validated a requirement to transition ERDAS to operational status. The results and recommendations presented here should assist in that process.

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

WIND PROFILING CLIMATOLOGY

Dr. Merceret designed an analysis strategy and wrote software to conduct a climatology of wind changes detected by the KSC 50 MHz Doppler Radar Wind Profiler (DRWP). The climatology will be used by the Shuttle Program to evaluate the contribution of the DRWP data to flight safety and launch processing in comparison to its cost. The automated quality control algorithm included in the software was tested and refined and mass processing of the 1995 data was begun. All of the 1995 data sets were quality controlled. The 15 minute, 1 hour, 2 hour, and 4 hour difference files were created and archived. Next quarter, the statistics for the 1995 data will be generated and analyzed. The data for January, February, and March 1996 will also be processed.

Space Administration, or the United States Government. Any such mention is solely for the purpose of fully informing the reader of the resources used to conduct the work reported herein.

Attachment 1: AMU FY-96 Tasks

TASK 1 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 2 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 3 IMPROVEMENT OF 90 MINUTE LANDING FORECAST

- 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 4 INSTRUMENTATION AND MEASUREMENT SYSTEMS EVALUATION

- 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.

TASK 5 MESOSCALE MODELING

- 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.