Applied Meteorology Unit (AMU)

Quarterly Update Report

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1. Background

A level of effort, task order contract was signed by ENSCO, Inc. and NASA on 9 September 1991. The contract covers a basic period of 3 years with two 1 year options. The level of effort specified is 5 man-years per year. The mission of the AMU is to perform and support applications research and technology transition which is focused on the weather impacts to NASA launch, landing and ground operations.

One week after contract signing, the entire staff of five personnel were in place at the AMU facility in the Range Operations Control Center (ROCC). Early activities centered on getting the team settled, learning the operation of all the equipment in the AMU, and arranging initial tasking. Task orders for daily operation of the AMU (Task 001) and AMU Training (Task 002) were issued immediately upon signing of the contract.

The AMU hosted a meeting at the Cape Canaveral Forecast Facility (CCFF) of members of the weather community supporting space flight operations on 26-27 September. The meeting was attended by representatives of NASA, USAF, and NOAA. The purpose of the meeting was to discuss the prioritization of tasks for the AMU. This meeting identified the following as short term priorities:

- Evaluation and transition to operations of the KSC Doppler Radar Wind Profiler (DRWP)
- Support to Airborne Field Mill (ABFM) Winter Deployment
- Evaluation of the 0.2 cloud cover rule
- Development of forecast rules for Winter fog and stratus at the Shuttle Landing Facility (SLF)
- Next Generation RADAR (NEXRAD) algorithm evaluation
- Development of a mesoscale analysis capability
- Evaluation of Shuttle Trainer Aircraft (STA) downlinked winds
- Evaluation of the Lightning Detecting and Ranging (LDAR) system

The group also identified long term priorities:

- Development of NEXRAD advanced applications
- Mesoscale model implementation
- Evaluation of existing KSC meteorological research and data for local application

- Sensor system (unspecified) evaluation
- Study of Easterly flow forecasting
- Data Integration
- Development of user-friendly displays
- Evaluation of NASA Flight Rules
- AI Applications

The 26-27 September meeting resulted in the AMU receiving Task 003 with direction to complete the evaluation of the 0.2 cloud cover rule and development of a fog and stratus forecasting algorithm. Also, based upon the priorities, the AMU was issued Task 004 and directed to prepare for support of the STA Downlink test as well as the ABFM Winter deployment. Task 005 work was begun in November on the development of a mesoscale analysis capability.

The next section of this report contains descriptions of each of the 5 tasks issued to date as well as a discussion of planned AMU activities in support of the tasks. After the task discussion, we will describe AMU accomplishments to date. Section 4 contains a project summary detailing products to be delivered in the first year as well as products planned for the first three years of operation.

2. Task Descriptions

This section contains descriptions of each of the five tasks formally issued to the AMU by NASA (see shadow boxes). Following each task statement are AMU activities in support of the tasking.

2.1 Task 1 AMU Operations

> Operate the AMU. Coordinate operations with NASA/KSC and its other contractors, ESMC and their support contractors, the NWS and their support contractors, other NASA centers, and visiting scientists.

AMU Activities: There are six important daily AMU activities. Each is important in setting the framework for the accomplishment of the AMU mission. We expect these tasks to evolve over the life of the AMU contract.

1. <u>Develop a KSC forecast based upon the STS launch and landing criteria:</u> It is important that AMU personnel understand the problems and requirements faced by the operational forecasters supporting the STS launches and landings. This forecast will only be used in-house by AMU personnel for evaluation of forecasting systems and

methodology. Only statistical results will be released in report form. The forecasts will be made once per day at various times to coincide with the normal STS launch windows. The responsibility for the forecasts will rotate among the AMU personnel. In addition to maintaining statistical performance data, discussions and a record will be made of items such as performance of models used, utility of various sensor systems, and what systems were needed but not available. This daily activity promotes continued proficiency on all weather equipment at the AMU and CCFF as well as a continuing focus on STS flight rules and the requirement for information to support weather forecasting in the context of those rules.

2. Participate in the daily CCFF weather forecast discussion: This discussion brings local meteorologists together via phone and closed circuit TV to discuss the local weather and forecast. It provides an opportunity for interaction of AMU researchers with the operations community and could serve as a forum for presenting new ideas. Operations forecasters are given the opportunity to identify problems with data, methods, or equipment which could be integrated with on-going AMU work.

3. Routine interface with STS weather support offices: If the AMU is to succeed, there must be regular interface and coordination between the AMU personnel and the many offices involved in STS weather support. AMU interaction with the NASA weather support community during operations will need very careful coordination to ensure the AMU does not interfere with operational groups supporting NASA or Air Force operations. While all the contacts need not occur daily, they should occur often enough to maintain rapport and a sense of team spirit. Contacts with CCFF, SMG, NWS-Melbourne, KSC Weather Projects Office, and CSR will occur daily. Regular contact will be made with the NASA Weather Support Office, 45th Weather Squadron, MSFC, GSFC, and other laboratories such as the USAF Phillips Laboratory at Hanscom AFB, MA.

4. Participate in mission operations: This will be required in order to evaluate effectiveness of techniques used by STS weather support personnel. The AMU plays no operational role in weather support to the STS. Our participation is limited to observing and possibly testing new methodology on the AMU equipment in parallel with operations. Evaluation of our techniques and results of our efforts will only be disclosed after the fact - never during an operation.

5. Conduct regular weekly staff meetings with AMU personnel: These meetings are necessary to pass on corporate information of concern to

all employees and to review the status of actions, goal setting, and performance plans for the near term.

6. Start-up tasks: Those activities necessary to get the AMU started such as security paperwork, moving personal articles to the AMU facility, organizing the work area, equipment proficiency and initial training. These activities do not include training of personnel which is covered under Task Order 002.

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.

AMU Activities: These administrative details are covered in the Work Control Plan (DRD 2).

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.

AMU Activities: Equipment in the AMU is maintained by the Air Force under their contract with CSR. They will be notified promptly when problems occur. The AMU GSA vehicle is maintained in accordance with NASA directives.

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

AMU Activities: In the normal conduct of AMU activities, there will be occasions when software and/or hardware additions will be needed in the AMU. In some cases, these additions will occur as a result of specific tasks. For all recommendations, some or all of the following tasks will be performed:

- Software: Collect and evaluate performance data of the particular software package and, if practical, accomplish testing of software performance vs. requirements.

- Hardware: Evaluate performance and reliability of new hardware. Conduct in-house trade studies.

- Reporting: Provide a report or trade study outlining results of the evaluation as well as the strengths and weaknesses of the system evaluated. For systems actually tested in the AMU, reports of actual performance and accuracy data would be included.

These activities will require interface with several agencies.

- Provider of HW/SW system.
- CSR if product is to be integrated for testing in the ROCC and to discuss feasibility of future installation.
- SMG, CCFF, and NOAA for coordination.

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

AMU Activities: Reports are submitted as specified in the contract.

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

AMU Activities: ENSCO will provide the following support as required.

- Data collection as required for the report.
- Analysis of the data.
- Development of the report or presentation.
- Coordination of draft copy with KSC Weather Projects Office before final draft.
- Report prepared in accordance with “Guidelines to Format Standards” (N69-34000) issued by the Committee on Scientific and Technical Information (COSATI)
- Camera-ready master provided to SI-SAT-52, Information Services Section.

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

AMU Activities: ENSCO will provide the following support as required.

- Review schedules of meetings with KSC Weather Projects Office to ensure AMU is properly represented at upcoming meetings.

- Review requirements with KSC Weather Projects Office and prepare presentations as appropriate.
- Generate graphics for presentations.
- Coordinate draft presentation materials.
- Arrange for travel as required.
- Prepare for and participate in meetings as required by the COTR.
- Develop project presentation materials.
- Present materials if so directed.

2.2 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.

AMU Activities: NASA Headquarters supplied an excellent reference manual which served as initial training on the STS program. Some additional facilities tours are planned in the near future to aquaint AMU personnel with all facets of the STS program.

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

AMU Activities: This training was provided by KSC/TM.

Provide NEXRAD training for contractor personnel.

AMU Activities: The Air Force invited the AMU to participate in Air Force training of local weather personnel on the new NEXRAD equipment.

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.

AMU Activities: No activity has been required under this task to date.

2.3 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. Specific efforts will be designated as numbered subtasks. The initial two subtasks are specified below. Additional subtasks will be of similar scope and duration, and will be assigned by technical directives issued by the COTR.

Subtask 1 - Two tenths cloud cover 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 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.

AMU Activities: Subtasks 1 and 2 as well as other subtasks anticipated under Task 003 will focus on some aspect or parameter required in the 90 minute landing forecast for KSC. The first step in these subtasks is to examine the historical data relating to the parameter in order to understand the temporal (daily, monthly, and seasonal) variability of the particular parameter. Once the historical variability is understood, methods for observing and forecasting the parameter will be investigated. Typically, a decision tree will be constructed which can be used by a forecaster as an aid in generating a forecast. Once this is completed, the decision tree or method must be tested and verified by using independent data for evaluation. The results will then be transitioned for use by the forecasters. The specific procedure or steps to be followed in subtasks 1 and 2 are described below.

Subtasks 1&2:

- The AMU acquired the X68 Surface Observations and will soon receive Cape Rawinsondes for the past 5 years.
- The AMU developed software to ingest and archive data for the two subtasks. In this process, we looked ahead to other possible studies so the data base we are developing can be used for other purposes. The databases have been developed on one of the AMU PC's in DBase IV. Although normal surface observations at X68 prior to 1991 did not include the tenths of cloud cover for each layer in the remarks, this information was recorded by the observer every three hours on the Form 10b. In order to develop a complete data base, the AMU is

entering the actual cloud cover information and interpolated data into the data base manually.

Subtask 1:

- Categorize the data base and compile statistics for cloud study. The AMU will be looking at several different stratification's of the data such as by time of year, wind regime (both low and mid-levels), etc.

- Examine problem cases for cloud study. During the course of these investigations, several unusual cases will likely surface. These cases will be examined in more detail in an effort to uncover clues to the forecasting problem.

- Finalize statistics for cloud study. Results will be reviewed in light of problem cases and adjustments to the algorithm will be made as necessary.

- Develop forecast rules for 2/10 cloud cover cases. Based on the results of our investigations, a decision tree will be developed for use by the forecasters.

- Write preliminary report. The results to this point will be published in a report.

- Verify the 2/10 cloud cover decision algorithm. Up to a year will be spent on evaluation of the algorithm using independent data - essentially working with the method in real time both in the AMU and with the CCFF forecasters.

- Write and deliver Final report of Subtask 1. The final report will include the results of the algorithm evaluation as well as a recommendation and Transition Plan for the technique.

Subtask 2:

- Select cases for fog study. Based on observations in our data base, fog cases will be selected for detailed study. Once cases have been selected, case-specific data will be acquired for the study. Potential sources of data include NMC analyses, satellite data, Florida observations, and tower data. Case studies will be accomplished and used in developing the fog forecasting algorithm.

- Based on the results of our case studies, rules for fog forecasting will be developed.

- The results of subtask 2 to this point will be published in a report and will be discussed with the SMG and CCFF forecasters.

- These forecast rules will be verified by the AMU over a 1 year period.

- The final report will include the results of the fog forecasting algorithm evaluation as well as a recommendation and Transition Plan for the technique.

2.4 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 1 STA Downlink Test Support

Provide meteorological and data collection support to the NASA/JSC Shuttle Training Aircraft (STA) winds position data downlink demonstration tests.

Subtask 2 Airborne Field Mill (ABFM) Test Support

Provide meteorological and data collection support to the NASA/MSFC ABFM FY92 winter deployment.

Subtask 3 Doppler Radar Wind Profiler (DRWP)

Evaluate the current status of the DRWP and implement the new wind algorithm developed by MSFC.

AMU Activities: Work under Task 004 includes a broad range of activities including:

- Providing meteorological support to special data collection activities (e.g., Airborne Field Mill Project) and tests (e.g., Shuttle Training Aircraft downlink test) and

- Evaluating and / or transitioning new instrumentation and measurement systems (e.g., WSR-88D, Doppler Radar Wind Profiler, Lightning Detection And Ranging System, Terminal Doppler Weather Radar).

Subtask 1:

One AMU meteorologist supported the Shuttle Training Aircraft Downlink Test. He provided weather support, assist other team members in the operation of the

AMU/Ground Station Equipment, coordinated data archive, and gave advice on the setup of the downlink display.

Subtask 2:

One AMU meteorologist is supporting the winter FY92 deployment of the Airborne Field Mill project. Responsibilities of the AMU meteorologist include:

- Monitoring the weather before and during each flight and relaying that information to other Ground Support personnel,
- Providing daily and updated weather briefings and an outlook for a 24 to 48 hour period,
- Collecting all data products for archives,
- Performing pre-mission coordination with the Eastern Test Range and other NASA offices,
- Assisting other team members in the operation of the AMU ground station equipment, and
- Providing weather summaries for each mission.

Subtask 3:

The DRWP subtask is complex and involves several aspects which are discussed individually below:

- **Evaluation of the DRWP (Jan. 92):**

The AMU has prepared a report which evaluates the current status of the NASA/KSC 50 MHz DRWP. The report includes recommendations to NASA/MOW regarding the remaining work required to validate the instrument and its associated software and transition it to operational use. That report was delivered by the AMU on 24 January 1992.

- **Implementation of the MSFC Algorithm in the DRWP (Feb. - Sep. 92)**

The AMU will implement the new wind algorithm developed by MSFC on the DRWP hardware. The implementation will utilize the code and specifications developed by MSFC and will require modification of the MSFC code to conform to the data base structures in the Data Analysis Processor (DAP) of the DRWP. The implementation will also require modification of existing and development of new code to satisfy the new user interface and display requirements associated with the new wind algorithm.

- **Performance Testing of the MSFC Algorithm and Software (May 92 - Jan. 93)**

After implementation, the AMU will test the new wind algorithm software in accordance with NASA/KSC certification standards. The AMU will also perform meteorological validation and evaluation of system performance in relation to operational requirements. This will include:

- Comparisons of wind profiles produced by the consensus technique and the new wind algorithm,
- Evaluations of the accuracy, resolution, and reliability of the new wind algorithm, and
- Evaluations of the ability of the operators to effectively use the new interactive wind algorithm to meet operational requirements.

The AMU will also make any minor software modifications suggested by the results of these performance tests.

- **Develop and Deliver Software Documentation (Jul. 92 - Mar 93)**

The AMU will provide complete software documentation for the implementation of the new wind algorithm in accordance with KSC certification standards. This documentation for the new wind algorithm will include:

- Software Requirements Specification
- Software User's Manual
- Software Maintenance Manual
- Software Test Description and Report

- **Training for Maintenance And Operations Personnel (Mar 93)**

The AMU will provide training on the effective use of the new wind algorithm for operations personnel. This training will be conducted in an operational environment. The AMU will also provide training on the design and maintenance of the transitioned software for those personnel charged with maintaining the DAP.

- **Develop and Deliver a Meteorological Validation Report (Preliminary Report Aug. 92 - Final Report Mar. 93)**

The AMU will prepare and deliver a Meteorological Validation Report. This report will include quantitative information regarding the meteorological performance of the DRWP including discussions of resolution, accuracy, and reliability. The report will also contain a thorough discussion of the implementation and testing of the new wind algorithm.

2.5 Task 5

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

AMU Activities: For the purposes of this task, mesoscale models includes mesoscale analysis systems, mesoscale model initialization, and mesoscale models. Mesoscale models will generally be confined to the meso-beta (20 - 200km) scale. Before an analysis or model system to can be considered for testing by the AMU, three questions should be considered:

- Is the model generic in that it will work well anywhere or must it be tailored to the Cape? Are model parameterizations right for the Cape or must they be rederived? If the model must be tailored, are the potential benefits worth the effort?
- What hardware is required to run the analysis and forecast in real-time? What additional hardware is required and what is the cost?
- Are observing systems currently installed or planned to be installed adequate to support the analysis? What additional systems must be purchased in order to make the model worthwhile for use at the Cape and what is the possibility that such acquisitions will occur?

Assuming the hardware and observing systems are in place and the effort required to get the model up and running is acceptable, steps would then be taken to acquire the software and install it at the AMU in a test mode. Once this is accomplished, a series of tests would be conducted to validate the model. This includes developing an understanding of the conditions under which the model performs well and conversely, the conditions under which the model performs poorly.

To satisfy subtask 1, the AMU plans to acquire the Local Analysis and Prediction System (LAPS) developed by Dr. John McGinley at NOAA/ERL, Boulder, Colorado. LAPS is an analysis and prediction system built on the meso-beta scale. Meso-beta models require several hours of prediction in order to spin-up to a state where useful forecasts can be produced. Accordingly, LAPS is constructed on the premise that it is vital to first properly characterize the atmosphere over the area of interest and then make a prediction. The analysis would be used to bridge the gap between time 0 and the first good model prediction. The LAPS analysis could provide several products for the CCFF and SMG which characterize the atmosphere. The analysis is performed on a 57 x 57 x

10 grid. In Colorado, the grid spacing used is 10 Km. Due to data density over the Cape, a smaller horizontal grid spacing could be effectively used; however, that change could require the use of more grid points. The LAPS analysis is in three parts:

- Winds - this would make use of WINDS network, Rawinsonde, Jimsphere, Doppler Radar Wind Profiler, surface and WSR-88D winds.
- Clouds - this analysis makes use of multi-channel satellite radiances, pilot reports, surface aviation observations, and radar reflectivity.
- Temperature and moisture - this makes use of local Rawinsonde and satellite soundings.

To pursue the acquisition and installation of LAPS, the following steps have begun:

- Visit ERL (John McGinley) for discussions and orientation to LAPS software. Bring the LAPS wind analysis software back to KSC. (Dec. 92)
- Get wind analysis working locally and study results. Implementation either on ENSCO RISC 6000 or ENSCO MicroVAX in a test mode. (Note RISC 6000 located in Suntree facility and MicroVAX located at CCAFS). Input data could come from WINDS, Balloons (Rawin and Jimsphere), and Profiler initially with clear air WSR-88D added later. (Dec. - Apr. 92)
- Coordinate acquisition of data lines to occur about the same time the RISC 6000 arrives in AMU (est. June 92). At that time begin processing wind analysis in real time.
- Bring ERL personnel here to install entire analysis package (Jun. - Aug. time frame)
- Study results, develop displays/products for forecaster use (Aug. - Dec. 92)
- Begin looking at forecast algorithms (LAPS first then others) (1993)

3. AMU Accomplishments During the Past Quarter

3.1 Task 001 Operation of the AMU

The AMU started several activities under the Operation of the AMU Task:

Daily Forecast Simulations: It is important for the AMU personnel to understand the problems and constraints facing CCFF and SMG forecasters. Accordingly, the AMU began a process of reviewing the weather, producing a forecast, and participating in the daily 45th Weather Squadron weather discussion. The daily forecasts are go/no go forecasts valid at the Shuttle Landing Facility. The forecasts are made against STS constraints for cloud cover, visibility, and cross-winds. The constraints used are the worst case set considering all launch and RTLS requirements.

In the course of making these forecasts, the AMU have identified deficiencies in its own forecast tools and have corrected them by making better use of existing MIDDS capabilities. MIDDS has been found to be generally powerful on the national and regional scale but severely lacking on the local scale. The analysis system produced under Task 005 will improve this situation.

Another valuable tool for forecasters to use in understanding the time history of upper level dynamics is the DRWP. The AMU developed a simple capability for the CCFF and SMG forecasters to display the data from the NASA DRWP. The MIDDS BARBJ command had been developed by Unisys for the SMG but was not being used by the CCFF because the command was developed with non-standard inputs. Now the DRWP can easily be viewed in a time-height format by the forecasters.

<u>STS-48 Landing:</u> The AMU team was present for the STS-48 landing attempt at KSC on 18 September 1991. The weather situation was very interesting in that it was an easterly flow situation and low level showers developed off shore after sunset. These showers advected toward the Cape just prior to the decision point for the deorbit burn. This resulted in a decision to divert the mission to Edwards AFB. The AMU performed a case study of the situation and arrived at two main suggestions:

- First, a low level stability index is suggested for low level easterly flow situations to identify the likelihood for low level shower (tops below 10K feet) development. An index is being developed which is similar to the Lifted Index but takes low level entrainment into account. In the long term, it is hoped a combination of this index with the vertical velocity from the LAPS analysis will prove to be useful in these situations.

- Second, better IR enhancement curves for MIDDS are suggested. Some experimentation has resulted in an enhancement curve which highlights low level warm clouds in one color and cold upper level clouds in another color. This enhancement curve has been passed on to the CCFF and SMG. Future plans include looking at the IR curves developed by NESDIS and which are already available on MIDDS. The AMU will provide guidance on when/how the different enhancements should be used.

<u>AMU Computer Purchase:</u> Funds were approved by NASA/MOW for purchase of computer hardware to support AMU analysis and model development. The AMU has completed an ADP plan, taken NASA procurement training, and has begun the process of

submitting the paperwork necessary for the purchase to the KSC Procurement Office. Purchase of one IBM RISC 6000 Powerstation 550 or equivalent and one IBM RISC 6000 Powerstation 320 or equivalent along with appropriate software and maintenance is planned. This procurement action is still on schedule; it is hoped the hardware will be in place by the June to July 1992 time frame.

3.2 Task 002 Training

ENSCO conducted its own MIDDS training in the AMU. The AMU MIDDS coordinator spent one and a half days at the SMG for familiarization and attended the November McIDAS Users Group meeting in Madison, Wisconsin. In addition to MIDDS training, an AMU briefing book prepared by NASA/MOW has been very useful. This book contains background on the STS program and organization as well as weather support requirements.

Three AMU members completed the entire Air Force NEXRAD training course which consisted of 5 days of classroom training and 2 days of hands-on training with an instructor.

3.3 Task 003 Improvement of 90 Minute Landing Forecast

Under subtasks 1 and 2 of this task, the AMU has begun to collect data and build a database which will not only support these subtasks but will be useful to other studies as well. The database will be brought up to the current time and new data will be automatically added in real time in the future. During early December the final software to ingest the X68 surface observations into the database was completed. After this was accomplished a small database was created to validate all of the data fields. These fields were checked against the original form 10s and the raw data received from Marshall Space Flight Center. Following this testing, five years worth of data (1986-1990) were loaded into DBase IV to form the starting point for both the 2/10 cloud cover and the fog/stratus study.

Since the database did not contain the precise amount of clouds for each layer (in tenths), the next objective for the 2/10 cloud cover study was to determine how many hours of data would have to be manually entered using Form 10b's for the amount of clouds (tenths) below 10000 feet. In order to accomplish this, query functions within DBase IV were used. The first set of queries performed eliminated all observations which violated shuttle landing constraints (i.e., ceilings < 10,000 feet, precipitation, cross-wind, visibility < 7). In addition, all observations were removed which were characterized by clear skies or when all clouds were above 10,000 feet. The remaining observations were characterized by scattered clouds below 10,000 feet. By using the query function on DBase IV it was determined that approximately 23,000 observations out of a possible 43,000 met the above criteria.

To date, the Form 10a's and Form 10b's have been obtained for nearly the entire period and over two years of actual and interpolated cloud amounts have been manually entered into the data base. Work on these two subtasks is on schedule.

3.4 Task 004 Instrumentation and Measurement

3.4.1 Subtask 1 STA Downlink Test Support

Weekly teleconferences were held in preparation for an early January 1992 demonstration test. Several discussions were held on the possibility of splitting the data output from the modem and allowing the transmission of the signal to KSC and JSC via dial-in modem. Because of cost, it was put on hold until after the January test. A test of the computer to McGill radar interface did not work. After several hours of testing and changes in code the error was found and corrected. A tape was received from NASA/MOW containing the video output (received signal at JSC) of the November test. It was reviewed and compared with current setup.

The STA test actually occurred on 6-8 January 1992. Wind data were received in the AMU on the 6 and 7th and were relayed to JSC on the 8th. The only deficiency in the test was the loss of data from the STA during the shuttle approach simulation phase of the flight. This was believed to be due to antenna shadowing or transmitter failure. Data received appeared to be of high quality from a qualitative point of view. Further testing and evaluation will be required before the system could become operational.

3.4.2 Subtask 2 ABFM Test Support

Active support to the ABFM began in December. Teleconferences were held weekly through the month and no major problems developed. Discussions were held with MSFC on equipment and supply issues. An inventory of supplies was performed and a supply request was submitted to Kennedy Space Center. Meetings were held on duties and configurations. CSR technician support was arranged. MSFC began shipping all required equipment by the end of December. The first actual flight took place on 16 January 1992. Since the deployment started, there have been several highly successful data collections.

The aircraft was fitted with heaters on the field mills to reduce the restriction on flying in icing conditions. The ABFM deployment will last 8 weeks, ending in early March. The AMU is supplying one meteorologist full time to support the mission planning and data collection effort.

3.4.3 Subtask 3 Wind Profiler

AMU personnel participated in the Radar Wind Profiler Certification Planning Meeting held at MSFC on 12 December. During this meeting, tasking and schedules for the hardware certification and meteorological validation were presented. In addition, MSFC presented results from a new technique used to estimate wind profiles from the radar returns. A follow-up trip was made the following week to gather additional information about the meteorological validation completed by MSFC and additional meteorological analyses they anticipate performing during the coming months. Discussions regarding implementation of the new velocity extraction technique developed by MSFC were also held during the visit.

Based on the interaction with MSFC, the AMU has prepared and distributed a report which details the steps necessary for meteorological validation of the DRWP. Subtask 3 has been issued and we have just begun the process described in Section 3 above.

3.5 Task 005 Mesoscale Modeling

A visit was made to NOAA/ERL in December to lay the groundwork for implementation and testing of the analysis system from the ERL Local Analysis and Prediction System (LAPS). Dr. John McGinley provided hard copies of the LAPS software and will provide a tape of the entire analysis system in the near future. The advanced LAPS analysis makes use of a calculus of variations formalism for analysis of the winds and integration of radial velocities from a Doppler radar. Options for implementation of the analysis system are currently being investigated. As the first step, the wind analysis will be implemented.

4. Project Summary

AMU projects are limited to the domain bounded by what can be accomplished given our personnel and funding. The major products or results to be produced are divided into two categories: short range (first year) and long range (three years).

4.1 Short Range

- To complete the study and deliver a report on the 0.2 Cloud Cover flight rule. The report will contain recommendations on when the rule is applicable and when it is not. Additionally, it will provide CCFF and SMG forecasters with guidelines for forecasting short term changes in cloud cover. A follow-up report will be issued after another year of verification activities.

- To complete the study and deliver a report on Winter fog forecasting at the SLF. The report will contain an algorithm or decision tree which will aid the CCFF and SMG forecasters in predicting this phenomena. A follow-up report will be issued after another year of verification activities.

- To complete the implementation of the MSFC DRWP wind calculation algorithm. This will include development of a user interface for the wind quality control position during STS launches. The implementation will be demonstrated at the end of the first year with testing, documentation, and final operational implementation by early 1993.

- To implement the wind analysis from NOAA/ERL's LAPS system in real time on the AMU RISC 6000 computer by the end of the first year. This will be followed by implementation and testing of the entire LAPS system.

4.2 Long Range

- To complete the implementation of the MSFC wind algorithm on the DRWP and transition it to operational use.

- To complete the implementation and testing of LAPS and if appropriate, transition it to operational use.

- To implement a three dimensional meso-beta forecast system which can be initialized from LAPS and which will provide forecasts out to 18 hours.

From ENSCO's perspective, the AMU project is off to a good start. An outstanding team is in place and working hard to achieve results. Tasking is in line with the priorities set at the Task Prioritization Meeting in September and meaningful results are achievable. The 45th Weather Squadron is an outstanding host and support from the Range Contractor, CSR has been superb. They have been working some important issues which will make the AMU more productive.

- The AMU is very constrained for space. Office space, floor space for equipment, and telephones are extremely limited. There may be no resolution to the lack of floor space but the installation of consoles should allow growth to occur vertically.

- Power for new equipment is not currently available. This may impact installation of the RISC 6000 system in June 92 and consequently will hinder the implementation of LAPS.