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# An Overview of the Applied Meteorology Unit (AMU)

# Overview

- AMU History
- Working Relationships
- Functional Purpose
- Tasking Process
- Project Examples
  - Formal Prioritized Tasks
  - Mission Immediate Tasks
  - Option Hours Tasks
- Summary
- Acronyms
- Complete Project List

# AMU History

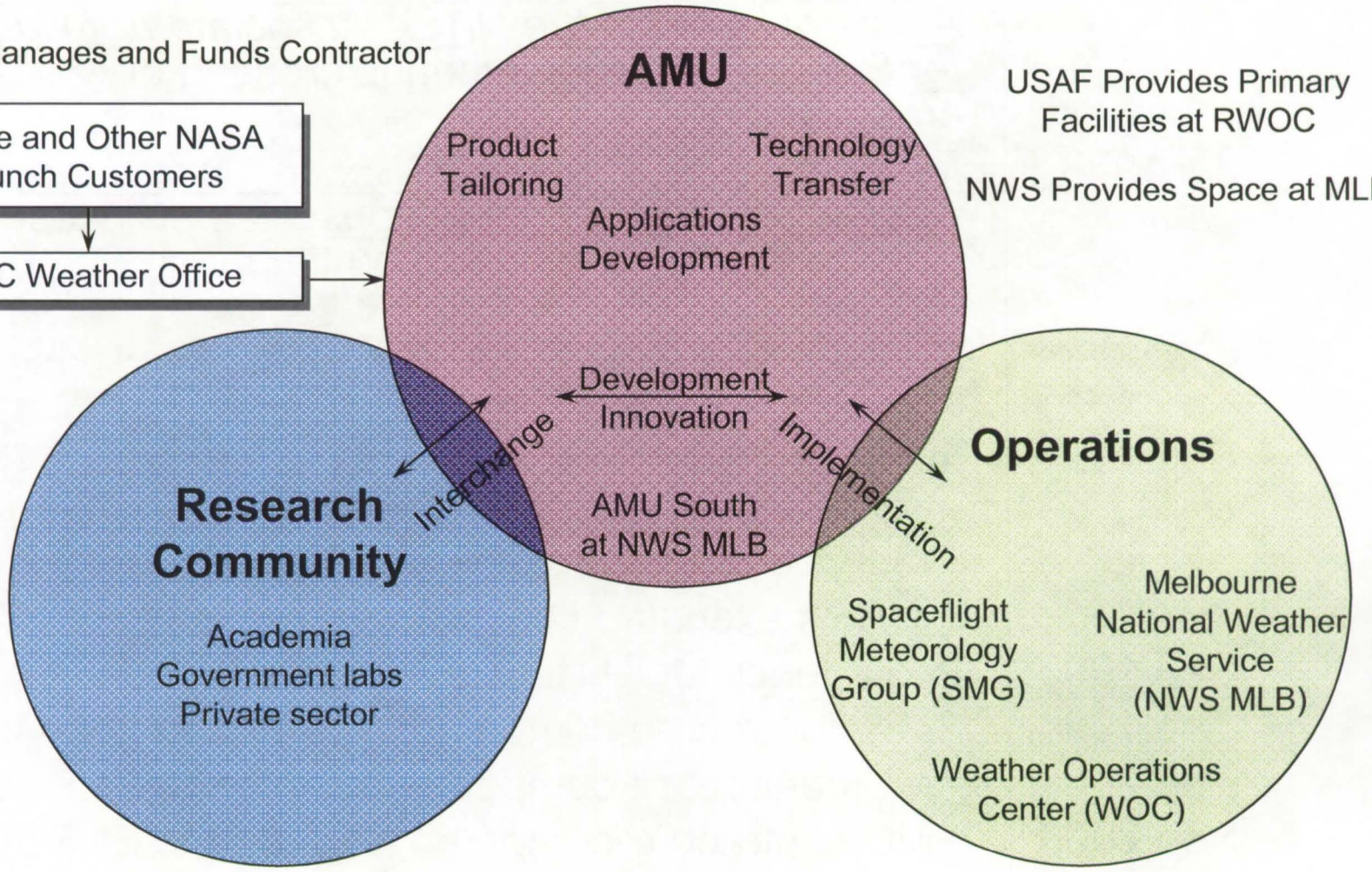
- Oct 1986: *Report of the Space Shuttle Weather Forecasting Advisory Panel to the NASA Associate Administrator for Space Flight* recommends creation of AMU-type organization
- Jul 1988: *Meteorological Support for Space Operations: Review and Recommendations*, National Research Council strongly supports Shuttle panel recommendation
- Oct 1989: Concept approved by Director, National Space Transportation System
- Sep 1991: Inter-agency Memorandum of Understanding (MOU)
  - » Signed by NASA, Air Force, National Weather Service
  - » NASA executed contract with ENSCO, Inc.
- Sep 1995: Interagency MOU Revised and Renewed
- Sep 1996: AMU contract re-competed, awarded to ENSCO, Inc.
- Sep 2001: AMU contract re-competed, awarded to ENSCO, Inc.
- Sep 2006: AMU contract re-competed, awarded to ENSCO, Inc.

# Working Relationships

NASA Manages and Funds Contractor

Shuttle and Other NASA Launch Customers

KSC Weather Office



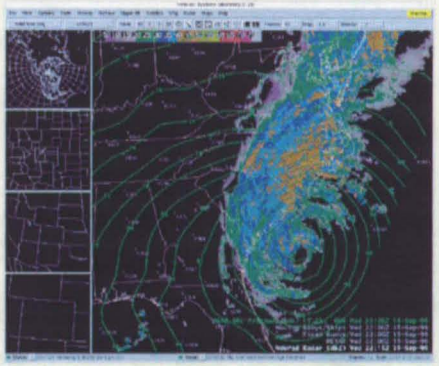

USAF Provides Primary Facilities at RWOC

NWS Provides Space at MLB

# Functional Purpose

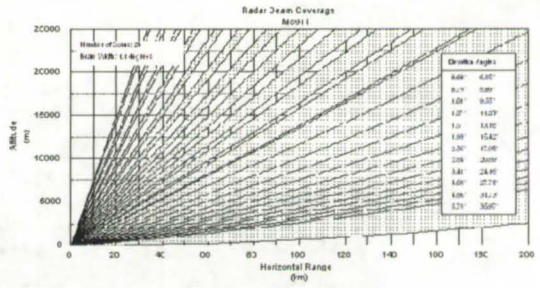
- Goals
  - Enhance total system safety
  - Increase launch/landing opportunities
  - Reduce unnecessary down-time and schedule impacts due to weather
  - Minimize costs

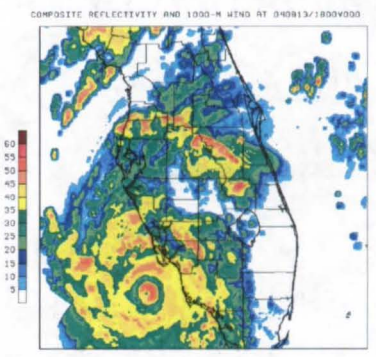
- Methodology
  - Test, evaluate and develop new technology, techniques and processes
  - Transition improved capability to operational customers
  - Facilitate technical exchange between research and operations
  - Provide technical expertise to assist in effective operation, maintenance and modernization of existing resources

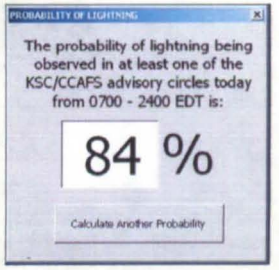


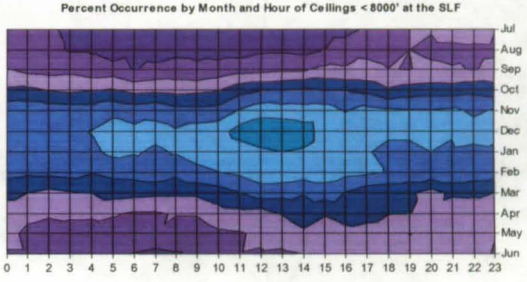
# Functional Purpose

- Examples
  - Revised WSR-74C scan strategy for the 45 WS to improve vertical resolution over KSC/CCAFS
  - Evaluated and transitioned the Local Data Integration System (LDIS) to operations at SMG and NWS MLB
  - Developed statistical forecast equations that calculate the probability of lightning occurrence for the day and incorporated them into a GUI for the 45 WS
  - Developed cloud ceiling forecast equations for SMG



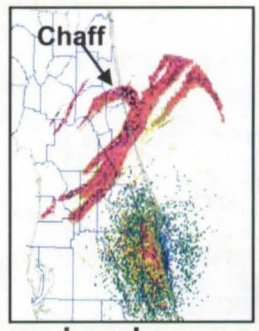

$$Y = a + bX$$

# Tasking Process

- Formal Prioritized Tasks – Annual Cycle
  - Survey spaceflight operations weather community
    - Input from USAF, NWS and NASA
    - Technical interchange meetings
    - Local weather support workshops (e.g., Unit Radar Committee)
  - NASA, USAF and NWS meet annually to select tasks and set priorities by consensus
  - Selected tasks approved by NASA
  - Formal tasking issued by AMU Chief
  - Semi-annual review with additional reviews as required

# Tasking Process

- Mission Immediate Tasks – Time Critical
  - Customer initiated after a significant event
  - Verbal tasking issued by AMU Chief
  - Must meet these criteria:
    - Results needed as soon as possible
    - Unique AMU expertise and capabilities are required
    - Minimal interference with formal prioritized tasks

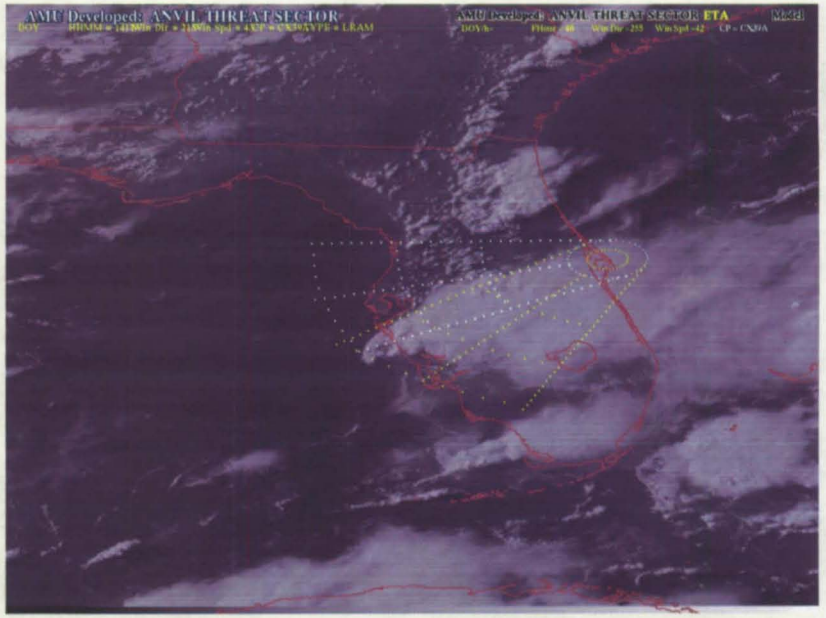



- Option Hours Tasks
  - Case-by-case basis
  - Formal tasking issued by AMU Chief
  - Must meet these criteria:
    - Externally funded
    - No interference with formal prioritized tasks
    - Must be approved by NASA

# Formal Prioritized Task Examples

## Anvil Forecasting

- Improve predictions of triggered lightning threat to space launch/landing vehicles using "Anvil Threat Sector" tool
  - Derives average winds between 300 & 150 mb from latest sounding and most current NAM, GFS and RUC model point data
  - Can display every hour from 3-60 hr using NAM and every 12 hr from 72-168 hr using GFS
  - Runs on 45 WS & SMG Meteorological Interactive Data Display System (MIDDS)
  - Improved short- and long-range anvil forecasts for triggered lightning LCC evaluations



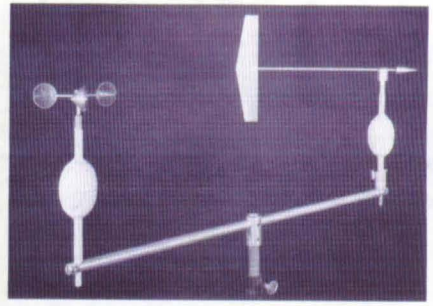

Forecast Tool

# Formal Prioritized Project Examples

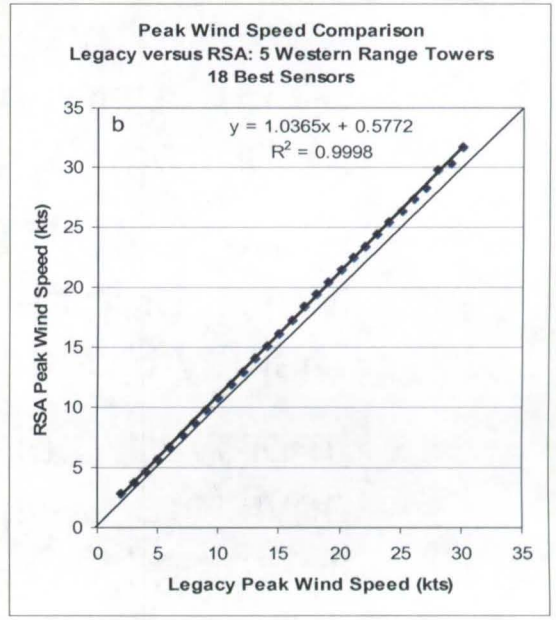
## RSA/Legacy Wind Sensor Comparison

- Compare wind speed/direction from RSA ultrasonic and legacy mechanical sensors at the Eastern and Western Ranges
  - Address concern over technology change from mechanical to ultrasonic
  - Acquired one-minute data from 5 towers on each range
  - Determined bias and variance of average and peak speeds for RSA sensors with respect to legacy
  - Determined a small, systematic, positive bias in RSA wind speed

RSA Ultrasonic



Legacy Mechanical

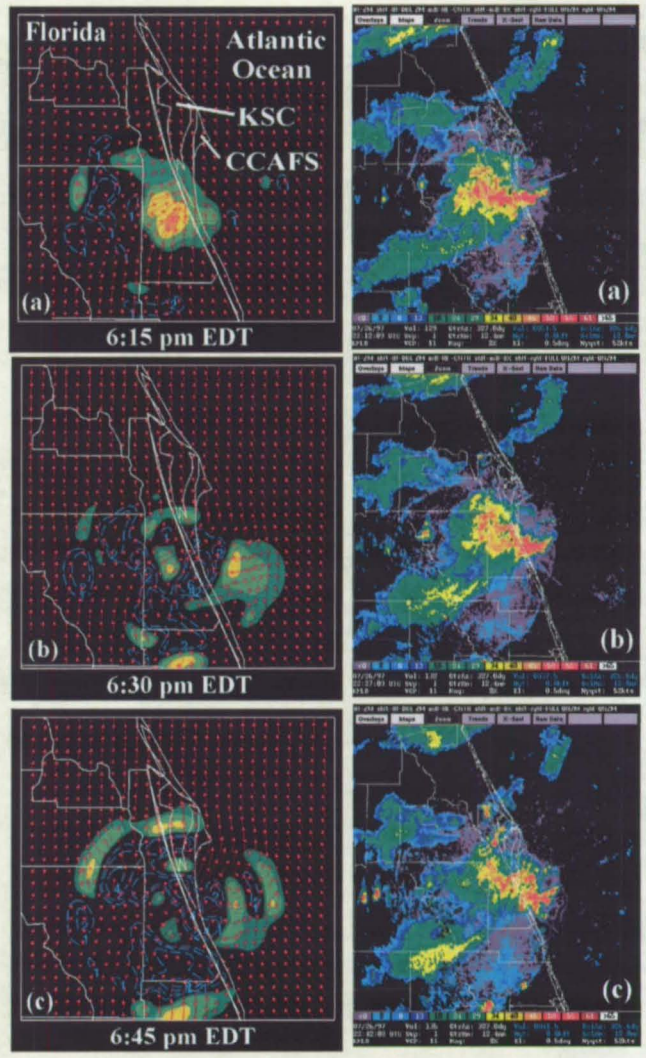



Instrumentation

# Formal Prioritized Project Examples

## Data Integration into Computer Models

- Configure and Implement a real-time Local Data Integration System (LDIS)
  - Ingests and assimilates all operationally available data onto a high-resolution analysis grid
    - Visible & infrared satellite imagery
    - Data from all Florida WSR-88D radars
    - Rapid Update Cycle model grids
    - Textual data from MIDDS
  - Depicts mesoscale aspects of clouds and winds over KSC & CCAFS
  - Forecasters have access to timely high-resolution products that enhance weather nowcasts and short-range (< 6 hr) forecasts for operational requirements




Computer Models

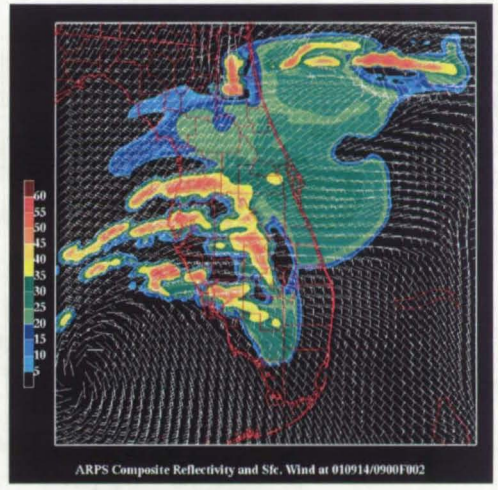
# Formal Prioritized Project Examples

## Local Prediction with Computer Models

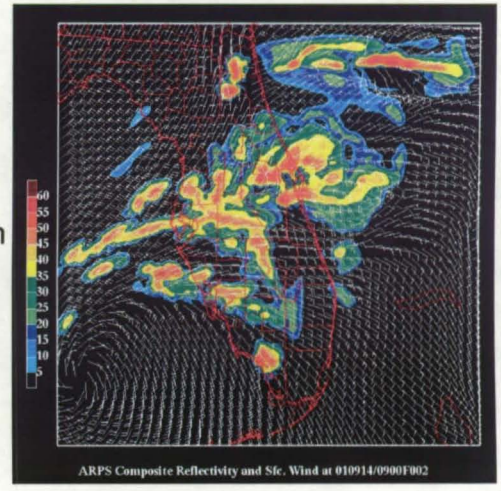
- Implement Advanced Regional Prediction System (ARPS) model
  - Local high-resolution prediction not available with national models
  - Numerical prediction 4 times per day
    - Run at SMG and NWS MLB
    - Forecasts out to 9 hours
    - Visual output every half hour
  - Uses LDIS to integrate data into model
    - High quality initial conditions
    - Improved forecast accuracy
  - Tropical Storm Gabrielle example:
    - Tornadic storms over east-central FL
    - Convection correctly predicted with LDIS+ARPS (bottom panel)

Tropical Storm Gabrielle case:

ARPS forecast at 2 hours without radar data




ARPS forecast at 2 hours with radar data from Melbourne, FL integrated

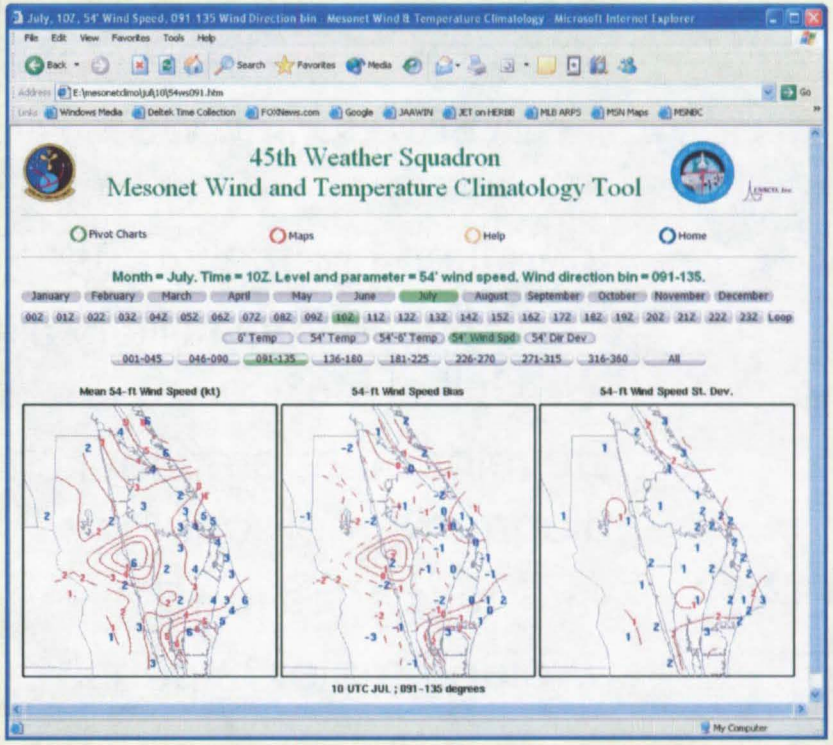



Computer Models

# Formal Prioritized Project Examples

## KSC/CCAFS Tower Climatology

- Nine-year tower climatology to depict diurnal and seasonal variations across KSC/CCAFS
  - Thorough quality control of all tower data at 6 ft and 54 ft
  - Calculated statistics for temperatures, winds, and stability
    - Stratified by hour, month, variable, and wind direction
    - Revealed geographical, instrument, and siting biases
  - Graphical User Interface
    - HTML/Java-based
    - Geographical contour plots and pivot charts
    - All results available to user through click of a button

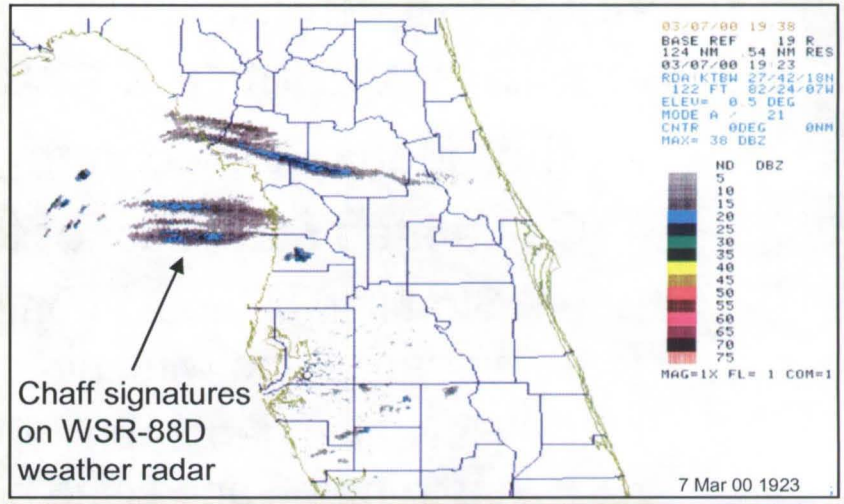


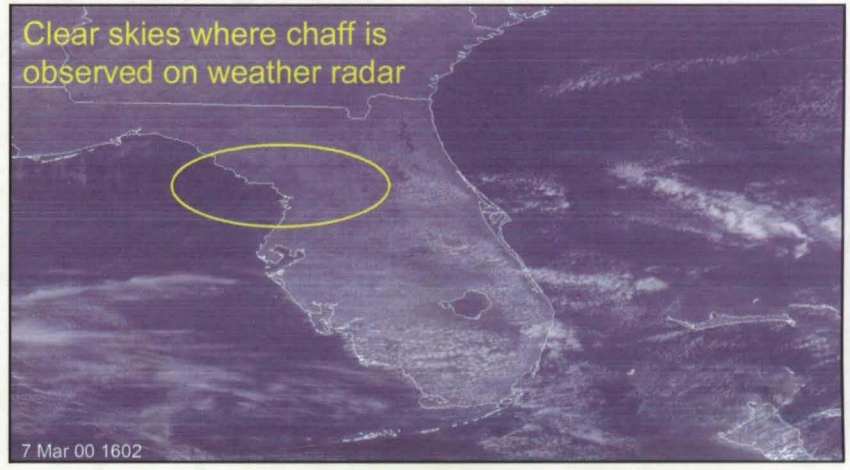

Statistical Analysis

# Mission Immediate Project Examples

## Weather Radar Interference: STS-56

- Determine cause of weather radar signatures during STS-56 launch
  - Analyzed weather radar cross-sections
    - WSR-88D and WSR-74C radars
  - Identified chaff as cause
    - Dropped from military aircraft in Gulf of Mexico
  - Developed operational chaff diagnosis methodology
    - Transferred to 45 WS
  - Avoided major expensive study




Shuttle Launch

# Option Hours Project Example

## Weather Evaluation for Shuttle Imaging

- Columbia Accident Investigation Board stated that imaging system must provide at least 3 useful views of Shuttle from launch to SRB separation
- Mixed Option Hours/AMU support:
  - Determined technologies that can provide high resolution cloud fields to LWOs
  - Developed statistical model that calculates the probability of obtaining 3 simultaneous views, based on upgraded camera network embedded within simulated cloud fields
  - Developed a satellite-image overlay that helps LWO provide day-of-launch guidance to the Shuttle Launch Director about effects of clouds on views


Out-of-Cycle Support

# Summary

- NASA and NRC report conclusions led to establishment of the AMU in 1991
  - Governed by inter-agency MOU
  - Staffed by ENSCO, Inc.
- AMU bridges gap between research and operations by developing applications and tailoring products for technology transfer
- AMU provides products to customers that help them:
  - Enhance total system safety and minimize costs
  - Increase launch and landing opportunities
  - Reduce down-time and schedule impacts due to weather
- AMU tasks assigned by customers through NASA:
  - Formal Prioritized, Mission Immediate, and Option Hours

# Common Acronyms

| | |
|---|---|
| **45 WS** | 45th Weather Squadron |
| **AMU** | Applied Meteorology Unit |
| **CCAFS** | Cape Canaveral Air Force Station |
| **KSC** | Kennedy Space Center |
| **LCC** | Launch Commit Criteria |
| **LDIS** | Local Data Integration System |
| **LWO** | Launch Weather Officer |
| **MIDDS** | Meteorological Interactive Data Display System |
| **MOU** | Memorandum Of Understanding |
| **MRF** | Medium Range Forecast |
| **MSFC** | Marshall Space Flight Center |
| **NASA** | National Aeronautics and Space Administration |
| **NLDN** | National Lightning Detection Network |
| **NWS MLB** | National Weather Service Melbourne |
| **SLF** | Shuttle Landing Facility |
| **SMG** | Spaceflight Meteorology Group |
| **SRB** | Solid Rocket Booster |
| **STS** | Space Transportation System |
| **USAF** | United States Air Force |
| **WOC** | Weather Operations Center |
| **WSR-74C** | Weather Surveillance Radar, model 74C |
| **WSR-88D** | Weather Surveillance Radar 1988 Doppler |

# Project List
## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| 0.2 Cloud Cover Flight Rule Evaluation | • Rule based on limited ability to accurately forecast at SLF<br>• Rule may be unduly restrictive | • Flight Rule modification recommendations<br>• Weather databases for decision assistance | • Flight Rule change increased availability of SLF for Shuttle landings | Jun 93 |
| 50 MHz Radar Wind Profiler Algorithm | • Data quality and reliability not proved adequate for wind persistence as required by ascent community | • Operational MSFC algorithm software<br>• User's Manual<br>• Maintenance Manual<br>• Software Requirements Specification | • System acceptable for day of launch use<br>– Titan and Atlas using DRWP for loads<br>– Shuttle uses for persistence<br>• Data refresh interval decreased from 30 to 5 minutes<br>• Result: increased vehicle safety | Feb 94 |
| ASOS Evaluation | • Cost of 24-hour weather observations at SLF using a Non-COTS system | • ASOS deployment options | • Detailed quantitative information to aid in decision-making process | Mar 94 |
| SLF Wind Tower Siting Assessment | • Potentially unrepresentative wind observations for Shuttle landing due to sheltering effect and distance from runway | • Assessment<br>• Methodology for evaluation<br>• Recommendations for fix | • Trees removed adjacent to runway resulting in more useful observations<br>• Improved use of wind data in engineering analysis of vehicle response to winds on landing | May 94 (Spacing)<br>Apr 95 (Sheltering) |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| SLF Fog Development Evaluation | • Limited ability to accurately forecast fog development at SLF -- reduces availability of KSC for landing<br>• Each landing diverted to EAFB incurs $1M in ferry flight costs | • Fog forecast decision trees<br>• MIDDS display programs<br>• Weather databases for decision assistance | • More confidence in forecast<br>– Increased likelihood of landing Shuttle at SLF<br>– Increased landing safety | Jun 94 |
| NEXRAD/McGill Scan Strategy Comparison | • Cost of continuing to operate and maintain PAFB WSR 74C/McGill radar<br>• Inadequate understanding of radars' beam coverage impacted FR and LCC evaluations | • Determined and compared effective beam coverage of MLB WSR 88D and PAFB WSR 74C/McGill radars over KSC/CCAFS vicinity | • More accurate evaluation of FR & LCC<br>• Increased vehicle safety<br>• Improved weather warnings<br>• Potentially reduced costs for Shuttle FR & LCC evaluation | Jul 94 |
| MASS Model Evaluation | • Insufficient ability to forecast local weather hazards affecting launch, landing, and ground operations | • Determined accuracy and reliability of MASS model<br>• Recommended model not be implemented for operations | • Saved implementation, certification, and operations costs | Dec 95 |

# Project List
## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| MIDDS Exploitation | • MIDDS greatly under-used<br>• MIDDS not user-friendly<br>– Not designed for operations<br>– Designed for research | • F-key menu system documentation<br>• Operational macro programs<br>• Maintain menus | • MIDDS used more effectively - significant increase in access to data<br>• Reduced number of keystrokes for typical command by factor of 83<br>• Reduced training costs<br>• Reduced system maintenance costs | Feb 96 |
| 915 MHz Wind Profiler Evaluation | • Limited ability to access boundary layer winds<br>• Data quality and reliability not proved adequate for wind persistence as required by ascent community | • Collaborated on site selection<br>• Assist in development of system requirements<br>• Review of vendor designs and products<br>• Documentation sufficient for certification | • Improved thunderstorm and toxic diffusion forecasts resulting in<br>– Increased vehicle safety<br>– Safer / more efficient ground operations<br>– Less ground operations downtime<br>• Collaborative efforts resulted in elimination of need for additional profilers | Apr 96 |
| MDPI and WINDEX Evaluation | • Limited ability to forecast microbursts<br>• High false alarm rate | • Operational macro program and forecast index | • More accurate and timely microburst warnings and advisories | May 96<br>Nov 97 (update) |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| LDAR Evaluation and Transition | • Lack of ability to detect cloud-to-cloud and in-cloud lightning<br>• Unacceptable ability to observe and forecast lightning hazard<br>• LDAR not fully utilized by forecasters | • Computer-based training course | • Increased forecaster accuracy resulting in<br>– Avoidance of lightning hazard (natural and triggered)<br>– Safer, more efficient day-to-day ground operations<br>– Less ground operations downtime | Jul 96 |
| Mid-Tropospheric Wind Change Climatology | • Unable to quantify risk avoidance benefit of Doppler radar wind profiler<br>• Quantified benefit required for 50 MHz DRWP cost benefit analysis by Shuttle/Titan | • 0.25-, 1-, 2-, and 4-hour wind change climatology<br>• Probability of exceedance curves for wind change magnitudes | • Understanding of risks of unacceptable wind change as a function of time<br>• Operational risks can be assessed for design of launch constraints | Jul 96 |
| I&M and RSA Support | • New and upgraded weather data collection and display systems must meet customer needs | • Review vendor briefings, documents, and products<br>• Review system interoperability and data communications<br>• Test vendor products and prototypes<br>• Provide technical advice, comments, and suggestions | • Ensure proposed systems are operationally useful and satisfy customer requirements<br>– MIDDS upgrade support<br>– Proposed move of False Cape profiler<br>– Requirement for additional weather radar<br>– Collaborated on removing requirement for 449 MHz profiler and additional 915 MHz profiler – saved $1.3M | Ongoing since Aug 96 |

# Project List
## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| NEXRAD Exploitation | • NEXRAD under-exploited<br>– High false alarm ratio in NEXRAD severe weather algorithms<br>– NEXRAD algorithms tuned to mid-western environment<br>– Limited ability to recognize convection initiation and severe storm signatures in NEXRAD products<br>– Limited understanding of capability of VAD wind profile | • Determination of severe weather and convection initiation signatures | • Enhanced user understanding of NEXRAD products which best display signatures important to convection initiation and severe storm detection<br>– Reduced false alarms<br>– Reduced failure to detect severe weather<br>– Safer and more efficient daily ground operations<br>– Less ground operations downtime<br>• VAD wind profile evaluation transferred to NWS saving evaluation costs | Jan 97 |
| LDAR Data Compression and Filtering | • LDAR's high data rates make it difficult to ingest and process LDAR data in MIDDS | • Investigated data compression and filtering techniques<br>• Identified options for less data-intensive display | • Information necessary for making a technical decision | Mar 97 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Radar/PIREP | • Unable to resolve cloud top difference between radar and pilot reports<br>• Number one operational LCC issue at start of task | • Determined cause of inconsistency<br>• Alerted users to potential problems with radar-estimated cloud tops | • Improved LCC evaluations | Mar 97 |
| National Mesoscale Model Evaluation (29 km Eta) | • Insufficient ability to forecast local Wx hazards affecting launch, landing, and ground operations | • Determined most effective ways to visualize, interpret, and use 29 km Eta model for short range forecasting | • Improved short-range forecasts for ground, launch, and landing operations | Jun 97<br>Apr 98 (Update) |
| Warning Decision Support System (WDSS) Evaluation | • Ineffective assimilation of radar data<br>• High false alarm ratio in severe weather detection | • NSSL's algorithms tuned to central Florida weather environment<br>• Evaluation was a joint effort of the AMU and NWS MLB | • Improved public safety and increased accuracy<br>• System for convection analysis and nowcasting (SCAN, which includes WDSS) included in 45 SW I&M budget | Jun 97 |
| Cell Trend Comparison of WATADS Vs. WSR-88D | • Limited understanding of capabilities of new WSR-88D products<br>• Forecaster data overload | • Recommendations for use of the new products | • Improve lead time in issuance of weather warnings and advisories<br>• Improve forecasters' understanding of thunderstorm structure | May 98 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| 915 MHz Wind Profiler Data Quality Control (QC) | • No QC performed on data; contaminated data displayed with accurate data | • Acquire, develop, and test QC routines for real-time and post-analysis use<br>• Quality and reliability of wind data sufficient for operations | • Forecaster ability to distinguish between good and bad data<br>• Forecaster knowledge of data contaminants, including certain meteorological conditions | Jun 98 |
| MIDDS-X Transition | • Limited understanding of capabilities and functionality of MIDDS-X | • Technical expertise<br>• Recommendations for use and display of satellite and graphic products | • Improved forecasters' and LWOs' understanding of the system | Nov 98 |
| AMU MIDDS-X Conversion | • Weather system functionality moved to new platform | • Conversion programs<br>• New displays and products | • Improved speed and display characteristics | Dec 98 |
| Data Integration Model/ Data Deficiency (LDIS Phase I) | • No automated tools to assimilate mesoscale data in central Florida<br>• Limited availability of nowcasting tools<br>• Forecaster data overload | • Prototype analysis system<br>• Evaluation report identifying mesoscale data sources and describing proof-of-concept analysis system | • Proof-of-concept system demonstrating<br>– Improved short-term forecasts for ground, launch, and landing operations<br>– Improved weather warnings and advisories | Jan 99 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Operations Research Support | • Organizations doing weather research lacked convenient access to AMU databases | • Provide data and software developed internally by the AMU.<br>• Provide copies of previously published AMU reports.<br>• Review documents, write memoranda, and provide technical consultations as requested. | • AMU databases available to all weather organizations doing research | Ongoing Since Jul 99 |
| Local Data Integration System Extension (Phase 2) | • Need for real-time assimilation of mesoscale data in central Florida<br>• Limited availability of nowcasting tools<br>• Forecaster data overload | • Configuration and simulation of prototype analysis system with real-time data for a 2-week period<br>• Evaluation report discussing system performance, data influence, and forecaster tools | • Improved nowcasting capabilities<br>• Knowledge of hardware necessary for a real-time analysis system<br>• Understanding utility of all operationally-available data | Aug 99 |
| ERDAS RAMS Evaluation | • Insufficient ability to forecast fine scale weather affecting launch, landing, and ground operations<br>• Upgraded RAMS configuration in ERDAS required formal evaluation | • Interim and final evaluation reports of RAMS model errors and benchmark of results against the national Eta model | • Improve specific short-term forecasts for ground, launch, and landing operations<br>• Determine added value of ERDAS RAMS | Jun 00 (Interim)<br>Jun 01 (Final) |

# Project List
## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Improve Anvil Forecasting (Phase 1) | • Anvil forecasting is a difficult task – necessary to predict triggered Lightning LCC and FR violations<br>• No Techniques exist that forecast anvil formation or determine anvil length | • Report on technical feasibility of forecasting anvils<br>• Consultation on Decision to Proceed with Phase 2 | • Determination whether or not development of an anvil forecasting technique is feasible | Mar 00 |
| WSR-74C Integrated Radar Information System (IRIS) Exploitation (Phase 1) | • Need to evaluate capabilities of the IRIS Radar Product Generator | • Final report recommending prioritized list of IRIS products<br>• Recommendation for a revised radar scan strategy | • Fully exploit IRIS capabilities<br>• Reduce vertical gaps in radar coverage by 37% over KSC/CCAFS | Apr 00 |
| Detecting Chaff Source Regions | • Limited understanding of weather radar interference during launch support<br>• Chaff echoes could mask LCC-related weather echoes | • Report documenting source regions of chaff affecting radars around KSC during the winter months | • Documentation provides operational resource showing known chaff source regions | Jun 00 |
| WSR-74C IRIS Exploitation (Phase 2) | • Need to customize products and tools for operational forecasting | • Memorandum describing seasonally varying radar scan strategies<br>• Information on special purpose radar products | • Capability to optimize radar scan for seasonally varying conditions<br>• Information to be used for a quote request to a software vendor | Apr 01 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Local Data Integration System (Phase 3) | • Need for real-time mesoscale data assimilation in central Florida<br>• Limited availability of nowcasting tools<br>• Forecaster data overload | • Assistance in installing and configuring LDIS at customer offices<br>• Memorandum detailing the procedures for implementing the mesoscale data analysis system | • Customers have access to timely high resolution meteorological analyses for launch and landing support and routine forecasting operations | Apr 01 |
| Neumann-Pfeffer Replacement | • Inaccurate performance of the current Neumann-Pfeffer Thunderstorm Probability Index (NPTPI) prompted the Air Force Institute of Technology (AFIT) to develop a more reliable algorithm<br>• 45 WS requested new AFIT software be implemented for forecaster use before the 2001 warm season | • Converted and commented AFIT code that operates on a PC in the RWO<br>• Memorandum explaining how to use the code | • Improved thunderstorm probability forecast tool that will calculate and display the current day's probability and time of thunderstorm occurrence | Jun 01 |

# Project List
## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Extend ERDAS RAMS Evaluation | • Need for improved forecasting of fine-scale weather affecting launch, landing, and ground operations<br>• Need to evaluate RAMS forecasts in real-time | • Tools to evaluate RAMS quality in real-time<br>• Training on use of tools<br>• Evaluation of performance for various weather elements<br>• Recommendations on improving RAMS<br>• Final report documenting all of the above | • Knowledge of the quality of RAMS forecasts for range safety<br>• Tools to evaluate RAMS in real-time | Aug 01 |
| Statistical Short-range Forecast Tools | • Need for short-range (0-6 hr) guidance in forecasting winds and cloud cover for launch, landing, and ground operations | • Statistical forecast guidance equations and charts<br>• Database of all data used in task<br>• Final report describing development and use of tools | • Improved short-range forecasts of cloud ceilings and peak winds | Aug 01 (Ceiling)<br>Jun 02 (Winds)<br>Jun 03 (SLF Winds) |
| Local Data Integration System (Phase 4) | • Incorporate additional data sets into the real-time LDIS<br>• Fine-tune and improve the continuity of analyzed weather features | • On-site and remote assistance to ingest new observational data sets<br>• Memorandum summarizing the improvements and fine-tuning of LDIS | • Improved real-time analysis products for launch and landing support and routine forecasting operations | Oct 01 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Improve Anvil Forecasting (Phase 2) | • Need to develop observations-based operational tool for anvil forecasting | • Objective anvil forecast tool for 0-3 hours in advance<br>• Training on use of the forecast tool<br>• Final report documenting tool and training | • Improved short-range forecasts of anvil clouds for prediction of triggered lightning LCC and FR | Apr 02 |
| Advanced Meteorological Profiling System (AMPS) Moisture Profiles | • AMPS is scheduled to replace the Meteorological Sounding System (MSS) as the operational system<br>• Differences in RH profiles between AMPS and the MSS may cause change in values of stability indices | • Analysis of cool-season dual-sensor RH profiles from AMPS and MSS<br>• Report on impact of RH differences on thunderstorm forecasting indices used by 45 WS<br>• Interim operational recommendations based on projection of cool-season results to warm-season | • Interim operational procedures for correcting AMPS-derived thunderstorm forecasting indices<br>• Prevent potential degradation of thunderstorm forecasting skill due to impact of systematic difference in AMPS RH profiles on thunderstorm forecasting indices | Jul 02 |
| Land Breeze Forecasting | • Impact of nocturnal land breezes on low-level wind direction, low temperatures, and fog development<br>• Challenge in predicting occurrence, onset time, duration, speed, and direction | • Comprehensive climatology of land breezes and their characteristics in the wind-tower network.<br>• Final report with subjective forecast tools to help determine the land breeze occurrence, onset time, and movement | • Better understanding of land breeze occurrence, timing, and direction with the help of report and subjective tools developed by the AMU | Sep 02 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Improve Anvil Forecasting (Phase 3) | • Need to develop model-based operational tool for anvil forecasting | • Objective anvil forecast tool for 0-72 hours in advance<br>• Training on use of the forecast tool<br>• Final report documenting tool and training | • Improved long-range forecasts of anvil clouds for prediction of triggered lightning LCC and FR | Dec 02 |
| LDIS Optimization and Training | • Incorporate additional data sets into the real-time LDIS<br>• Need for training and maintenance of the LDIS<br>• Explore advanced features and techniques not currently implemented or available | • On-site and remote assistance to ingest new observational data sets<br>• Training manual to help customers maintain real-time LDIS | • Improved real-time analysis products for launch and landing support and routine forecasting operations | Mar 03 |
| Extend AMPS Moisture Analysis | • AMPS moisture profiles in previous task may not represent warm season profiles<br>• Warm season profiles created by extrapolating cool-season results | • Analysis of warm-season dual-sensor RH profiles from AMPS and MSS | • Operational procedures for correcting AMPS-derived thunderstorm forecasting indices | Jun 03 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Updating ADAS/ARPS Software | • Documentation of AMU modifications to ADAS/ARPS source code needed for future software upgrades | • Reference manual documenting in detail AMU modifications to the baseline ADAS/ARPS software | • Ability to take advantage of ADAS/ARPS software upgrades and incorporate AMU-unique modifications into the new releases. | Aug 03 |
| Mini-SODAR Evaluation | • Quality of new Mini-SODAR wind speed and direction data at SLC 37 unknown.<br>• The Mini-SODAR will be used to evaluate launch pad winds for operations | • Comparison of Mini-SODAR wind speed and direction with nearest tall tower.<br>• Final report on performance characteristics of Mini-SODAR as a replacement for a tall tower | • Ability to assess Mini-SODAR wind speed and direction data quality used for critical Go/No Go launch decisions by 45 WS forecasters and launch weather officers | Sep 03 |
| ARPS Optimization and Training | • Assistance needed for testing and optimizing the operational ARPS forecast cycle<br>• Documentation required to transfer ARPS maintenance to local offices | • Recommended improvements to the ARPS operational configuration<br>• Reference guide for the operational ARPS/ADAS | • Improved reliability and accuracy of ARPS model predictions<br>• Better understanding of the forecast cycle procedures and software file structure | Feb 04 |
| Anvil Transparency Relationship to Radar Reflectivity | • Anvil opaqueness is a critical element in evaluating FR and LCC<br>• Surface, pilot, and satellite observations currently used, but all have limitations | • Threshold dBZ value that corresponds to the anvil transparency threshold<br>• Final report describing analysis and results | • Objective method that uses current radar data to analyze anvil transparency | Jun 04 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Mesonet Temperature and Wind Climatology | • Anecdotal evidence suggests certain mesonet towers show biases in temperature and wind speed and direction – no objective study done to confirm<br>• Forecasters need to be aware of biases when issuing warnings and advisories, and evaluating LCC and FR | • Collective and individual tower temperature and wind climatologies in charts and geographical form<br>• Individual tower biases in charts and geographical form<br>• An HTML interface to access biases and climatologies<br>• Final report describing analysis and results | • Climatologies and biases for mission planning decisions, forecaster training, and as an aid in evaluating FR and LCC<br>• An HTML/Java based GUI that provides an intuitive and easy-to-use method of accessing the charts and geographical data | Jul 04 |
| Balloon Data Format | • New system produces data in different format than previous system.<br>• New format can be read in real-time, but difficult to use archive for diagnostics and research | • New software that converts data to standard ASCII format<br>• Software delivered to CSR, the range technical services contractor | • Balloon data in easy-to-read ASCII format<br>• Allows for intuitive visual inspection of data and use as input to analysis software | Oct 04 |
| Expanded Tower Statistics Task for Edwards AFB and Northrup Strip | • The likelihood of using Edwards AFB or Northrup Strip has increased since the loss of STS-107<br>• Average and peak wind climatologies of both sites unknown | • Consultation to MSFC personnel who will conduct work on this task | • Climatological values at Edwards AFB and Northrup Strip will be displayed in a GUI similar to that developed by the AMU for the KSC/CCAFS wind tower network<br>• These values assist forecasters in developing the wind forecasts | Oct 04 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Objective Lightning Probability Forecast | • Current lightning probability forecast made using subjective techniques<br>• Forecasters desire an objective technique based on statistical analysis of historical data | • Objective, PC-based tool that calculates the probability of lightning occurrence for the day<br>• Final report describing analysis and results<br>• Training on use of tool | • Increased objectivity in daily lightning probability forecasts | Feb 05 |
| Severe Weather Forecast Decision Aid | • Process for making forecasts of severe weather potential has not been updated to reflect current knowledge | • A forecast decision aid (e.g. flow chart, nomogram, decision tree)<br>• Final report describing analysis and results<br>• Training on product use | • A more objective method for assessing severe weather potential based on current knowledge and practices | Mar 05 |
| Mesoscale Model Phenomenological Verification Evaluation | • Forecasters use model data to assist in predicting weather phenomena<br>• There is uncertainty in the ability of these models to forecast the phenomena of interest<br>• Traditional point verification statistics do not provide accurate measure of model performance on specific phenomena | • Documentation of existing or potential model verification techniques of weather phenomena<br>• If found, determine feasibility of integrating the verification software into AWIPS for real-time operational use | • Knowledge of the existence of phenomenological verification techniques, and/or if any are under development<br>• Knowledge of whether the techniques found could be integrated into operations | Mar 05 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| User Control Interface for ADAS Data Ingest | • Need for a user-friendly graphical interface to manage and tune ADAS by duty forecasters | • GUI that directly interacts with operational ADAS cycle | • Management and quality-control of observational data stream will improve ADAS output<br>• ADAS tuning can be handled by duty forecasters without any prior expertise of ADAS software | Feb 06 |
| Meteorological Techniques and State of the Science Research | • Demands of daily operations limit forecasters' ability to search the literature and attend conferences to find new technologies that can help improve weather support to the space program | • Seminars or teleconferences to present findings that have potential for improving weather support to the space program<br>• Summaries in AMU Monthly and Quarterly Reports<br>• Limited case studies to demonstrate applicability of new products and technique | • Access to new scientific developments of techniques and tools through AMU expertise | Ongoing |
| Hail Index | • 45 WS does not have confidence in the performance of current hail forecasting tools<br>• Evaluation of current tools needed to determine their strengths and weaknesses<br>• 45 WS also desires a tool that can forecast reliable probability of hail occurrence | • Phase I: Quantitative evaluation of the performance of current tools<br>• Phase II: If desired by 45 WS, develop a new tool that could potentially improve hail forecasts | • The Phase I quantitative evaluation provided insight to strengths and weaknesses of current hail forecasting tools | May 05 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| ARPS/ADAS Optimization and Training Extension | • Need for incorporating additional data sets into the real-time ARPS/ADAS<br>• Assistance needed for upgrading software and hardware<br>• Need for improved numerical predictions of summer convection | • Assistance for upgrades and programs to process new data sources<br>• Limited sensitivity study of warm-season convection forecasts in ARPS | • Improved ADAS analyses and up-to-date software version with latest capabilities<br>• Increased confidence in ARPS numerical weather prediction guidance | Oct 05 |
| Updated Anvil Threat Corridor Forecast Tool | • Anvil tool code not set up to ingest new AMPS data for soundings and new model data formats from NCEP<br>• Current anvil tool graphic display created by commands entered manually on a MIDDS terminal | • Anvil tool code that ingests current sounding and model data formats<br>• A GUI on the MIDDS system to access the anvil tool | • The anvil tool now uses current data sources<br>• The GUI interface provides easier and more intuitive access to the anvil tool | Nov 05 |
| RSA/Legacy Sensor Comparison | • Users concerned about the quality of the data from the new RSA ultrasonic wind sensors, and possible differences between the Legacy and RSA sensors | • Comparison of Legacy and RSA sensor data from 5 Western Range (WR) and 5 Eastern Range (ER) towers<br>• Final reports on performance characteristics of RSA wind speed and direction sensors | • An in-depth understanding of changes in peak wind speed statistics due to changes from Legacy mechanical to RSA ultrasonic anemometers having no moving parts | WR: Feb 06<br>ER: Mar 06 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Stable Low Cloud Development | • Limited ability to forecast low cloud development near the SLF, causing reduced availability for landing opportunities | • Climatology of stable low cloud onset time<br>• Identification of weather regimes, patterns, and atmospheric profiles under which stable low clouds form | • Knowledge of when and how rapid stable low cloud development tends to occur, and conditions under which it occurs<br>• Forecasters may provide better 30-90 minute predictions of low cloud development based on new understanding | Jan 06 |
| Situational Climatology of Cloud-to-Ground Lightning | • The lightning threat index map issued by NWS MLB forecasters is created from scratch using a blank map, taking considerable time and effort<br>• The resulting map is based on a subjective analysis of current and forecast parameters that relate to thunderstorm formation and spatial distribution | • Warm season gridded climatologies of lightning probability and frequency of occurrence<br>• Climatologies are based on flow regime and specified time intervals<br>• 2.5 x 2.5 km grid covers entire state of Florida and adjacent waters | • The probability and frequency of lightning occurrence are used to create a first-guess field that forecasters will use to create the lightning threat index map<br>• The climatologies provide an objective background from which to develop the map<br>• The background map will increase consistency between forecasters and decrease their workload | Jan 06 |

# Project List
## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Forecasting Low-Level Convergent Bands Under Southeast Flow | • Difficulty forecasting convergent bands under synoptic southeast flow<br>• Convergent bands can produce clouds, rain and thunderstorms that impact operations | • Comparison of days with southeasterly flow to identify under what conditions convergent bands are produced and how they can be forecast | • A capability to forecast convergent band formation and whether or not they will produce weather phenomena that will negatively impact operations | May 06 |
| Objective Lightning Probability Forecast: Phase II | • The GUI developed in Phase I requires that users find the appropriate data and input the parameter values manually before a probability of lightning occurrence is calculated<br>• This takes valuable time and effort in a time-critical situation | • A tool on MIDDS that will retrieve the required parameter values for the equations automatically | • The automated capability will save time when calculating the probability of lightning occurrence<br>• Lowered probability of operator error in entering an incorrect value<br>• Customers still have GUI to conduct sensitivity studies on changes in parameter values | May 06 |

# Project List

## Formal Prioritized and Sustained

| AMU Task | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Anvil Forecast Tool in AWIPS | • The anvil tool is available on MIDDS, but MIDDS will be decommissioned by the 45 WS when the new RSA AWIPS is approved for operational use<br>• SMG forecasters rely more on AWIPS than MIDDS for weather information in making Flight Rule forecasts | • The anvil tool available in AWIPS through the GUI drop-down menus and dialog boxes | • Continued access to the anvil tool on AWIPS after MIDDS is decommissioned<br>• Current access to the anvil tool for forecasters who rely more on AWIPS than MIDDS | To be determined, dependent on training schedule |
| Operational Weather Research and Forecasting (WRF) Model Implementation | • Improve local numerical weather prediction by transitioning to the most advanced community model<br>• Initialize the WRF model with ADAS to benefit from the maturity of the local ADAS configuration | • Hardware/software performance comparison<br>• Prototype WRF configuration using ADAS for initial data<br>• Modified ADAS User Control Interface to control WRF initialization and run-time | • Access to local forecast output from the most advanced numerical weather prediction model available<br>• Capability to maintain, control, and modify WRF model configuration and input parameters | Jun 06 |
| ADAS/ARPS Modifications for Improvement of Forecast Operations | • Advances to the operational ADAS configuration required for both diagnostic and prognostic improvements<br>• Need for additional visualization products for assessing lightning and severe weather threats | • Programs/utilities to assimilate additional observational data sets<br>• Utilities to calculate and display new visualization products depicting lightning and severe weather threats | • Continued improvements to the quality of high-resolution analysis and forecast products<br>• New graphical products to help forecasters assess the short-term threats for lightning and severe weather | Jun 06 |

# Project List

## Mission Immediate

| Mission Requirement | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Improve detection of low level clouds for launch and landing operations and range optics | • Limited ability to detect low level clouds in low light conditions as required to evaluate LCC and FR | • Developed satellite enhancement to resolve low level clouds | • Improved RTLS, AOA, EOM and range optics forecasts | Oct 91 |
| After Hurricane Andrew, 45 WS tasked to provide warnings, advisories, and aviation forecasts to federal emergency personnel in south Florida | • Within 24 Hours, reconfigure AF equipment to provide totally new support to large area with diverse requirements | • Set up National Lightning Detection Network in RWO<br>• Configured MIDDS workstation in RWO<br>• Trained RWO forecasters on equipment use<br>• Provided guidance on south Florida forecast techniques | • During Andrew recovery –<br>– Increased forecast lead time and accuracy for south Florida<br>– Improved response time<br>– Enhanced safety of people in perilous situation | Aug 92 |
| Determine frequency of low visibilities at SLF near sunrise | • Sudden fog development at SLF could endanger Shuttle landings | • Developed graphs depicting frequency of low visibilities at SLF | • Improved understanding of how often low visibilities occur at the SLF | Oct 92 |
| Understand effect of various wind averaging techniques on displayed SLF winds | • Lack of confidence in wind measurements resulting from different averaging techniques used by different meteorological systems | • Analytical and observational analysis of averaging effects resolving the major issues | • Enhanced confidence in measured SLF winds | May 93 |

# Project List

## Mission Immediate

| Mission Requirement | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Determine cause of weather radar interference during launch of STS-56 | • Cause of weather radar interference during launch unknown - could mask LCC-related weather echoes | • Radar cross-section analysis indicated interference caused by chaff<br>• Operational technique for chaff diagnosis | • Reduced frequency of occurrence of weather radar interference by chaff during operations<br>• Saved over $250K in cost avoidance for chaff study<br>• Minimize uncertainty of cause of weather radar interference | Jun 93 |
| Understand electrostatic discharge detected by LDAR during launch of STS-55 | • Cause of electrostatic discharge detected by LDAR unknown<br>• Concern about potential for damage to orbiter | • Determined moisture content of atmosphere near vicinity of discharge<br>• Helped understand STS-55 LDAR event | • Confidence that current LCC adequate | Jun 93 |
| 13 August 1996 case of severe storms at Patrick Air Force Base (PAFB) | • Severe thunderstorm that caused extensive damage at PAFB was not forecast | • Memorandum describing the AMU analysis of the radar data and recommendations on how to interpret the radar data to determine difference between severe and non-severe storms | • Techniques for radar data analyses to improve thunderstorm forecasts | Mar 97 |
| February 2000 anvil rain during an Atlas launch countdown | • Determine the nature of unusual radar echoes approaching the KSC/CCAFS area from the west | • Determined that the radar echoes did not exhibit signature typical of chaff, but appeared to be anvil rain | • Additional information for launch weather team decision-making process<br>• Permitted on-time launch despite a complex weather situation | Feb 00 |

# Project List
## Option Hours

| Mission Requirement | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| PROWESS Model Evaluation | • Insufficient ability to forecast local weather hazards affecting launch, landing, and ground operations | • System checkout and acceptance test<br>• Identified weather infrastructure deficiencies<br>• Recommended no further action until deficiencies removed | • Saved implementation, certification, and operations costs | Apr 96 |
| 50 MHz Radar Wind Profiler QC Display Upgrade | • Difficult to interpret and view profiler data display<br>• Display not adequate for operational QC | • Test plan and report<br>• Operator training<br>• Upgraded display software | • Easier comparison of profiler and Jimsphere data<br>• Profiler used operationally to detect dangerous changes in winds | May 96 |
| Cost Benefit Study of Options to Modify or Replace the SLF Weather Equipment | • Weather instrumentation, data collection and processing equipment at SLF becoming obsolete and un-maintainable<br>• Need recommendations on how to replace the system | • Report describing weather system replacement options and associated costs<br>• Briefing to SLF data users | • SLF data users have knowledge on which to base decision for replacing the obsolete system | Sep 96 |
| Emergency Response Dose Assessment System (ERDAS) Evaluation | • Current toxic system is 2-D and is only a diagnostic model<br>• Current Toxic System is Grossly Deficient | • Evaluation report<br>• Transition ERDAS to operations<br>• Implement prognostic 3-D eispersion analysis system for Range Safety | • Improved toxic diffusion corridor and dosage forecasts<br>• Safer ground operations | Oct 96 |

# Project List
## Option Hours

| Mission Requirement | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Model Validation Program | • Toxic diffusion models' capabilities and limitations poorly understood<br>• Mesoscale and diffusion models need verification for varying meteorological conditions | • Mesoscale model (RAMS) output data<br>• Diffusion model (HYPACT) output data<br>• Data produced for 3 field sessions (~ 60 Releases)<br>• Evaluation of toxic model performance | • Enhanced understanding of toxic models' capabilities and limitations resulting in<br>– Greater safety for ground and launch operations<br>– Increased launch availability | Jan 99 |
| HyperSODAR Evaluation | • Lack of sufficient spatial and temporal resolution in wind profile measurements at the SLF to support engineering analysis of Shuttle response to wind gusts during landing | • Report documenting the accuracy and availability of HyperSODAR data | • Gave decision-makers an accurate assessment of HyperSODAR data accuracy and availability based on data collected at KSC and comparison with data collected at White Sands Missile Range | Nov 99 |
| 50 MHz DRWP Quality Control Training | • Personnel responsible for QC of DRWP Data have no formal training or written guidelines on proper QC techniques<br>• Proper QC critical for day-of-launch decisions | • One-day formal training session at Weather Station A<br>• Electronic and hard copies of<br>– MS PowerPoint presentation<br>– Documents containing QC checklist and explanation of DRWP variables and algorithms necessary for proper QC of the data | • Proper training helps personnel make appropriate decisions when conducting manual QC<br>• Documents are available to personnel as a guideline during the QC<br>• More reliable DRWP output for end users of the data | Feb 00 |

# Project List
## Option Hours

| Mission Requirement | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Delta II Rocket Explosion<br>(Provided opportunity to evaluate the models used to predict toxic plume dispersion at CCAFS and determine utility of WSR-88D to track plumes) | • No knowledge on how well the WSR-88D detected and tracked explosion plumes<br>• No knowledge of the accuracy of RAMS, HYPACT, and REEDM predictions of toxic plume characteristics and dispersion | • Report documenting results from the Delta II case study:<br>– Analysis of performance of WSR-88D, RAMS, HYPACT, and REEDM<br>– Recommendations for future products and use of WSR-88D and models | • Guidelines now available for guidance in using the WSR-88D for tracking plumes, and on model performance in predicting the plume trajectory, thickness, and concentration | Jul 00 |
| HyperSODAR Software Specification | • Need to obtain high spatial and temporal resolution wind profiles over the Shuttle Landing Facility | • A set of software specifications for the HyperSODAR that were used to develop a request for proposal (RFP) | • Received a valid set of specifications that allowed the Shuttle Program to develop an RFP | Mar 01 |
| Extension/Enhancement of the ERDAS/RAMS Evaluation | • AMU customers outside of CCAFS expressed interest in viewing RAMS in real-time<br>• Systematic low-level cold bias discovered in RAMS forecasts<br>• Tests needed to determine impact of large-scale model boundary conditions on RAMS prediction accuracy | • Memorandum outlining the technical steps needed to send RAMS data to AMU customers in real-time<br>• Isolated cause of low-level cold bias to be excessive fog in model<br>• Re-ran select RAMS forecasts with different boundary conditions; found little impact on RAMS accuracy | • Customers understood technical requirements for transmitting RAMS data in real-time<br>• Better understanding of strengths and weaknesses in real-time RAMS configuration; information helpful for RSA modeling solution decision-making<br>• Better understanding of large-scale model impact on regional numerical forecasts | Jun 01 |

# Project List
## Option Hours

| Mission Requirement | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Airborne Field Mill Experiment (ABFM) Aircraft Track Overlay on Radar Data | • ABFM program designed to collect data in thunderstorm anvils to determine if lightning LCC should be relaxed<br>• Graphics software needed to overlay research aircraft track on WSR-74C displays | • Software that ingested aircraft location data and overlaid the aircraft track on the radar display<br>• Real-time technical and forecasting support to NASA ABFM Project scientists | • Ability for ABFM scientists to determine location of the aircraft relative to existing storms such that the pilot could be vectored to safely collect data<br>• Enabled the ABFM program to collect data needed to improve lightning launch commit criteria | Jul 01 |
| Low Temperature Recovery Forecast | • No tool exists to help forecasters determine when or if a recovery from a Shuttle low temperature LCC violation would occur<br>• Could result in possible costly delays to Shuttle launches<br>• New tool should be in graphical, easy-to-use form | • Shuttle low temperature recovery forecast tool as a GUI in an MS Excel file<br>• User's Guide describing how to use the tool<br>• Maintenance manual describing how to interpret, check out, troubleshoot, or modify the software | • Operational forecasters have an automated tool that converts wind, humidity, and temperature forecasts into a forecast of the LCC violation | Sep 01 |

# Project List
## Option Hours

| Mission Requirement | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Support to ABFM Field Program Scientists | • Visiting scientists not familiar with location or operation of equipment in AMU lab<br>• Help needed for training on equipment, software maintenance, and retrieving local data sets | • Operation and maintenance, training, and software support for the AMU-developed aircraft track overlay software (Jul 01)<br>• Training and consulting on use of WSR-74C, LDAR, WSR-88D, MIDDS, and other equipment and software in the AMU<br>• Local data sets on requested media<br>• Data analysis support for technical interchange meetings | • Minimized spin-up time for ABFM scientists in learning location and how to use equipment<br>• Access to local expertise in thunderstorm forecasting and data analysis<br>• AMU team member always available in person or on call during field program to troubleshoot equipment or software, archive dData, and advise on local forecasting or data analysis issues | Nov 01 |
| Support for KSC Boundary Layer Winds Analyses | • Classification of daily meteorological regimes needed for 915-MHz radar wind profiler study | • Identified meteorological regimes and significant precipitation events during period of record of study | • Confirmed accuracy of automated rainfall detection and integrated quality-control algorithms for the 915-MHz profilers | Aug 02 |

# Project List
## Option Hours

| Mission Requirement | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Analysis of Rain Measurements in Support of STS-107 Accident Investigation | • No rain climatology existed for Shuttle exposure<br>• No knowledge of whether the amount of rain experienced by STS 107 while on the pad was out-of-family | • Charts of rain climatologies for every Shuttle mission<br>– Total rainfall during exposure<br>– Maximum daily rainfall during exposure<br>– Average daily rainfall during exposure<br>• Memorandum describing the charts and how to interpret them | • Information on rainfall during all Shuttle exposures to help determine if STS-107 rainfall exposure was out-of-family<br>• New database and climatologies of rainfall during each Shuttle exposure period allows for analysis of future Shuttle rainfall exposures | Apr 03 |
| Objective Verification of Numerical Weather Prediction (NWP) Models | • Traditional objective point validation not adequate for high-resolution NWP models; subjective techniques too costly<br>• Need for objective technique to validate weather phenomena | • Joint project with Dynacs / ASRC Aerospace personnel<br>• Technique for objective identification and verification of sea breezes in observed and forecast grid fields | • Automated model verification technique that can be transitioned into customer operations as required | May 03 |

# Project List
## Option Hours

| Mission Requirement | Weather Support Problem | AMU Product | Customer/Operational Benefit | Delivery Date |
|---|---|---|---|---|
| Prior to Launch, Shuttle LWO Must Determine Probability that Forecast Cloud Cover will Allow the Optical Imaging System (OIS) to Obtain 3 Useful Views of the Shuttle from Launch to Solid Rocket Booster Separation (SRBS) | • Clouds can obscure optical imaging of the Shuttle during launch<br>• No tool or methodology exists to determine the effect of clouds on the OIS | • Concept study to determine if technologies are available to produce a valid forecast cloud field<br>• Statistical model of cloud field to simulate viewing conditions and compute probabilities of 3 useful views by the OIS<br>• Look-up tables and graphic displays of probabilities for LWO | • Ability for the LWO to provide objective guidance to the Shuttle Launch Director concerning effects of clouds on viewing conditions from launch to SRBS | Oct 03 (Study)<br>Mar 04 (Model) |
| Evaluate Meteorological Precursors to the Severe High Wind Event on 4 March 2003 | • Cause of strong wind event over KSC not understood<br>• Forecasters needed post-analysis to determine the type of event and cause | • Memorandum describing sequence of events and contributing factors in the development of the strong winds | • Detailed analysis of weather data leading up to the event<br>• Forecasters understand what caused the strong wind and how to predict such a wind in the future | Dec 03 |
| Implement the Volume-Averaged Height Integrated Radar Reflectivity (VAHIRR) algorithm on the WSR-88D to evaluate the new LLCC | • A new LLCC, VAHIRR, was developed to address the issue of missed launch opportunities due to overly conservative LLCC<br>• Current procedure to evaluate VAHIRR requires manual and somewhat subjective evaluation of current WSR-88D products | • The VAHIRR algorithm implemented within the WSR-88D architecture | • A color-filled geographic 2-dimensional display of VAHIRR output values<br>• Colors indicate locations where the VAHIRR LLCC is and is not violated<br>• Full implementation of VAHIRR reduces unnecessary launch scrubs due to violation of LLCC | Feb 06 |

040

# REPORT DOCUMENTATION PAGE

*Form Approved*
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**14. ABSTRACT**

The Applied Meteorology Unit (AMU) acts as a bridge between research and operations by transitioning technology to improve weather support to the Shuttle and American space program. It is a NASA entity operated under a tri-agency aggreement by NASA, the US Air Force, and the National Weather Service (NWS). The AMU contract is managed by NASA, operated by ENSCO, Inc. personnel, and is collocated with Range Weather Operations at Cape Canaveral Air Force Station. The AMU is tasked by its customers in the 45th Weather Squadron, Spaceflight Meteorology Group, and the NWS in Melbourne, FL with projects whose results help improve the weather forecast for launch, landing, and ground operations. This presentation describes the history behind the formation of the AMU, its working relationships and goals, how it is tasked by its customers, and examples of completed tasks.

**15. SUBJECT TERMS**

Applied Meteorology Unit, AMU, weather, meteorology, technology transition

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