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Applied Meteorology Unit (AMU) Quarterly Report

Third Quarter FY-06 | Contract NAS10-01052 | 31 July 2006

Executive Summary

This report summarizes the Applied Meteorology Unit (AMU) activities for the third quarter of Fiscal Year 2006 (April - June 2006). A detailed project schedule is included in the Appendix.

Task: Climatology of Cloud-to-Ground (CG) Lightning

Goal Develop climatologies of gridded CG lightning densities and frequencies of occurrence for the Melbourne, FL National Weather Service (NWS MLB) county warning area. These grids are used to create a first-guess field for the lightning threat index map that is available on the NWS MLB website. Forecasters previously created this map from scratch. Having the climatologies as a background field will increase consistency between forecasters and decrease their workload.

Milestones Delivered all files containing the lightning climatologies, the data, and the code used to create the climatologies to NWS MLB. Completed and distributed a final memorandum describing how the climatologies were created.

Discussion All the files were installed on the NWS MLB computer system, and then the code was compiled and tested to ensure that it worked properly on their operating system. The climatologies and their descriptions are posted on the NWS MLB website.

Task: Forecasting Low-Level Convergent Bands Under Southeast Flow

Goal Provide guidance to operational personnel that will help improve their forecasts of cloud bands under large-scale southeast flow. When these bands occur, they can lead to cloud, rain, and thunderstorm occurrences that adversely affect launch, landing, and ground operations at Kennedy Space Center/Cape Canaveral Air Force Station (KSC/CCAFS).

Milestones Completed the first draft of the final report.

Discussion The conclusions from this task indicated low-level wind speed and direction, low-level high pressure ridge position, east coast sea breeze front activity and upper-level jet streak position have the greatest influence on convergent band formation and movement during southeasterly flow.

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Executive Summary, *continued*

Task: Objective Lightning Probability Tool: Phase II

Goal Update the lightning probability forecast equations used in 45th Weather Squadron (45 WS) operations with new data and create a graphical user interface (GUI) in the Meteorological Interactive Data Display System (MIDDS) that automatically gathers the data needed as input to the equations developed in Phase I of this task. The new data may improve the performance of the equations, and the automated tool will increase forecaster efficiency.

Milestones The MIDDS GUI was tested and transitioned to operations. Sounding data needed for the task were downloaded and processed.

Discussion The MIDDS GUI was tested by comparing its output to that of the current tool, and several discrepancies were found. Errors in the code were found and eliminated, and then the MIDDS GUI was transitioned to operations. Immediately upon transition, the AMU provided training to the 45 WS on how to use the GUI. The code for the GUI was also delivered to the Spaceflight Meteorology Group (SMG).

Task: Stable Low Cloud Phase II: Nocturnal Event Feasibility Study

Goal Conduct a study on rapidly-developing low cloud ceiling events during the nighttime hours in the cool season months and determine if representative meteorological conditions can be identified to assist in forecasting these events. Cloud ceilings are one of the greatest forecast challenges identified by SMG and 45 WS forecasters. The ability to forecast low cloud ceilings at night will improve support to nighttime shuttle launches and landings.

Milestones Modified existing AMU code to include special surface observations and wrote software to analyze cloud ceilings and present weather at central Florida METAR sites. Obtained additional CCAFS soundings for the years 2004-2005. Compiled an inventory of archived Man-computer Interactive Data Access System (McIDAS) data in the AMU and researched outside data sources to fill gaps in the AMU archive.

Discussion Because low cloud ceilings events do not always occur on the hour, existing software from the Phase I task was modified to include special observations. In an effort to obtain additional satellite imagery, price quotes received from the Space Science and Engineering Center revealed it would be less expensive if ordered for individual days in which low clouds formed at the SLF. A free source of satellite data was found at the NOAA Comprehensive Large Array-data Stewardship System site and is being evaluated for possible use in this task.

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Executive Summary, *continued*

<u>Task</u> — <u>Situational Lightning Climatologies for Central Florida. Phase II</u>

Goal — Develop composite soundings for the eight atmospheric flow regimes used in Phase I to forecast lightning occurrence over east central Florida. The NWS MLB forecasters will compare these composites with current and forecast soundings, allowing them to refine the lightning threat based on the differences between the climatological and current/forecast soundings.

Milestones — Acquired the 16-year database of soundings from four Florida stations and interpolated the data to 25 mb intervals. Created composite soundings for each flow regime and station, and then formatted them to display in the National Skew-T Hodograph Analysis Research Program software (NSHARP). Delivered the NSHARP soundings to NWS MLB.

Discussion — The forecasters at NWS MLB have the NSHARP software and will use it to compare the composite soundings for the flow-regime-of-the-day to daily soundings from the four Florida stations.

<u>Task</u> — <u>Anvil Threat Corridor Forecast Tool in AWIPS</u>

Goal — Migrate the Anvil Threat Corridor Forecast Tool from MIDDS to the Advanced Weather Interactive Processing System (AWIPS). This tool is used in launch and landing operations to determine the threat from natural or triggered lightning due to flight through anvil cloud. The SMG is depending more on AWIPS for operations and the 45 WS plans to replace MIDDS with AWIPS. The 45 WS and SMG requested that the AMU transition the anvil tool to AWIPS to ensure it will remain available for operations.

Milestones — Obtained AWIPS training materials and documentation from the NWS Training Center, obtained the source code for the anvil tool on MIDDS, and began development of a GUI that can be run in AWIPS.

Discussion — The GUI will be accessible from the main menu in AWIPS. Much of the MIDDS code that calculates the layer-averaged wind velocity was converted to code used in AWIPS. Some of the code that determines the latitude and longitude points for the threat sector graphic was also converted from MIDDS to AWIPS.

<u>Task</u> — <u>Volume Averaged Height Integrated Radar Reflectivity (VAHIRR)</u>

Goal — Transition the VAHIRR algorithm into operations. The previous lightning launch commit criteria (LLCC) for anvil clouds to avoid triggered lightning were restrictive and lead to unnecessary launch delays and scrubs. The VAHIRR algorithm was developed as a result of the Airborne Field Mill program as part of a new LLCC for anvil clouds. This algorithm will assist forecasters in providing fewer missed launch opportunities with no loss of safety compared with the previous LLCC.

Milestones — Modified code to disqualify VAHIRR calculations when invalid data is present. Set up a server in the AMU to ingest and process the WSR-88D data.

Discussion — WSR-88D data are only valid up to 70,000 ft and the software was modified to take this into account. The server in the AMU will be used to test a live data feed and will ingest the WSR-88D data and run the VAHIRR algorithm. The output will be displayed on the AMU's AWIPS.

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Task: Operational Weather Research and Forecasting (WRF) Model Implementation

Goal Test and implement an appropriate configuration of the WRF model over the Florida peninsula for forecasting operations at SMG and NWS MLB to assist in the WRF transition effort taking place at both locations.

Milestones Completed the script configuration for initializing and running the WRF Environmental Modeling System (EMS) software from analyses generated by the Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS).

Discussion The scripts that will generate ADAS analyses for initializing the WRF model within the NWS WRF EMS software were delivered to the customers. The only missing piece is the initialization of cloud and precipitation fields in the WRF EMS, which can be done with a code correction available from the Global Systems Division in Boulder, CO.

Task: ADAS/ARPS Modifications for Improvement of Forecast Operations Task

Goal Provide assistance in assimilating new datasets into ADAS, optimize the ADAS operating parameters, develop graphics that display the likelihood of supercell and significant tornado occurrence, and graphics showing the potential for CG lightning. Other ADAS fields have become an integral part of forecast operations at NWS MLB and SMG. These groups requested modifications and graphical products further improve the utility of ADAS/ARPS output.

Milestones Wrote and delivered a data-ingest program for assimilating the South Florida Water Management District surface observations into ADAS. Provided recommendations for improving the ADAS weighting scheme.

Discussion The new data-ingest routine allows ADAS to ingest and analyze surface observations from the South Florida Water Management District. One recommendation to improve the analysis is to increase the ADAS horizontal weights. This would result in a smoother, well-blended analysis.

Special Notice to Readers

Applied Meteorology Unit (AMU) Quarterly Reports are now available on the Wide World Web (www) at http://science.ksc.nasa.gov/amu/.

The AMU Quarterly Reports are also available in electronic format via email. If you would like to be added to the email distribution list, please contact Ms. Winifred Lambert (321-853-8130, lambert.winifred@ensco.com). If your mailing information changes or if you would like to be removed from the distribution list, please notify Ms. Lambert or Dr. Francis Merceret (321-867-0818, Francis.J.Merceret@nasa.gov).

Background

The AMU has been in operation since September 1991. Tasking is determined annually with reviews at least semi-annually. The progress being made in each task is discussed in this report with the primary AMU point of contact reflected on each task.

AMU ACCOMPLISHMENTS DURING THE PAST QUARTER

SHORT-TERM FORECAST IMPROVEMENT

Climatology of Cloud-to-Ground Lightning (Ms. Lambert)

The forecasters at the National Weather Service in Melbourne, FL (NWS MLB) produce a daily cloud-to-ground (CG) lightning threat index map for their county warning area (CWA) that is available on their web site. Given the hazardous nature of frequent lightning in central Florida, especially during the warm season months of May through September, this map helps users discern the probable lightning threat for the day at any location of interest. The map is color-coded in five levels from Very Low to Extreme threat (Figure 1). The placement of the different threat levels in the CWA depend on the location of the low-level ridge, forecast sea breeze propagation, and other factors that influence the spatial distribution of thunderstorms over the CWA. The forecasters create each threat index map manually from a blank map using considerable time and effort. As a result, the NWS MLB forecasters requested the AMU to create gridded warm-season CG lightning climatologies that could be used as a first-guess starting point when creating the lightning threat index map. This would increase consistency between forecasters and decrease workload, ultimately benefiting the end-users of the product. It would also provide forecasters the ability to extend the lightning threat forecast into Day-2 and beyond during the warm season.

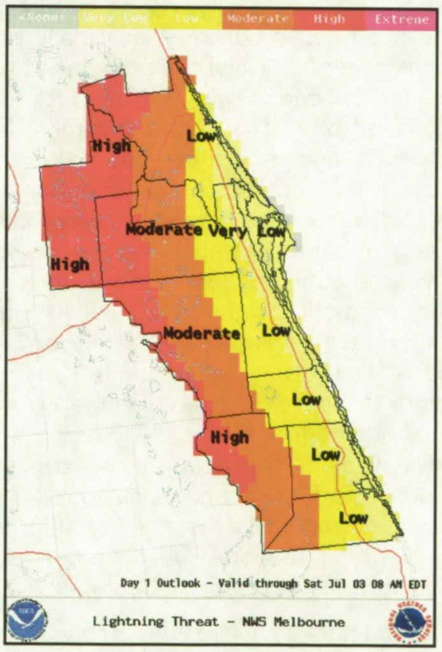

Figure 1. The NWS MLB Lightning Threat map for 3 July 2004. The color legend for each threat level is at the top of the image.

Product Delivery

Ms. Lambert delivered all files for the 24- and 6-hour climatologies of CG frequency and density to Mr. Volkmer at NWS MLB in April, along with the code and data used to create the climatologies. She also showed Mr. Volkmer how to compile and run the programs, and provided documentation on the parameters in the code that must be changed when new data are used to create new climatologies.

Documentation

Ms. Lambert wrote and distributed a final memorandum that describes the data and code, and provides instructions on how to run the programs. The memorandum also discusses data issues and errors in the code that were corrected, and possible improvements to the code for future work. The memorandum was distributed to NWS MLB and Mr. Phil Shafer of the Florida State University.

The climatologies are available to the public on the new Innovative Meteorological Products, Applications, and Collaborative Techniques (IMPACT) Meteorology Unit (IMU) website at http://www.srh.noaa.gov/mlb/amu_mlb/IMU2.html through the Lightning Threat link at the bottom of the page. The site was created by NWS MLB personnel and contains the lightning threat for the day, a brief description of the flow regimes, and the graphic images of the climatologies associated with each flow regime.

For more information on this work and a copy of the memorandum, contact Ms. Lambert at lambert.winnie@ensco.com or 321-853-8130.

Forecasting Low-Level Convergent Bands Under Southeast Flow (Dr. Bauman)

Forecasting the occurrence and timing of convergent bands under synoptic southeast flow is challenging for 45th Weather Squadron (45 WS) operational personnel. When the convergent bands occur, they are sometimes associated with rain, gusty winds and thunderstorm activity. Such weather could cause suspension of daily ground operations as well as violations of Launch Commit Criteria (LCC) and Flight Rules (FR) during operations. At other times the convergent bands only produce benign clouds. There have also been cases of southeast flow with no clouds present. Southeast flow leading to the production of convergent bands has occurred in every month of the year, though the forecast precursors may vary seasonally. The 45 WS requested that the AMU study convergent band formation under southeast flow and attempt to determine precursors to convergent band formation during southeast flow regimes. The ability of the 45 WS to predict weather caused by these convergent bands would work toward enhancing protection of personnel and material assets of the 45th Space Wing, Cape Canaveral Air Force Station (CCAFS), and Kennedy Space Center (KSC).

Dr. Bauman completed his analysis of the archived data. Based on the data collected from 21 case days during the period April 2004 – February 2006, Dr. Bauman concluded there were four parameters that could be tied to the behavior of the low-level convergent cloud bands during easterly flow. Three of the parameters are associated with low-level meteorological phenomena, and the other parameter is associated with upper-level winds.

The three low-level parameters found to be important by Dr. Bauman are the

- Low-level (surface to 700 mb) layer-averaged wind speed and direction,
- Low-level high pressure ridge location, and
- Location and movement of the east coast sea breeze front.

He determined that if the layer-averaged wind speed was relatively strong at > 8 knots, cloud bands were more likely to cross the coast and move inland. The layer-averaged direction was important as it represented the cloud-level steering flow. It was also related to the position of the low-level high pressure ridge relative to KSC/CCAFS and the circulation around the ridge. Dr. Bauman found that the curvature in the layer-averaged streamlines was also helpful in determining the trajectory of the cloud bands.

If the east coast sea breeze was developing or located in the eastern half of peninsular Florida, subsidence behind the front generated in the offshore return flow aloft inhibited the cloud band development resulting in cloud band dissipation. Once the sea breeze front had moved west of the center of the peninsula, the subsidence was less of an inhibitor for cloud development.

The one upper-level parameter was the existence of a 250 mb jet streak, particularly the location of jet streak entrance and exit regions and areas of divergence or convergence around the streak. Dr. Bauman found that the influence from a 250 mb jet streak in the vicinity was not as great as that from the low-level parameters described previously. As a general rule, the data indicated that the position, movement and strength of a jet streak were important to monitor in conjunction with the low-level parameters. For instance, if the convergent area of a jet streak was over the KSC/CCAFS area, then it may have supported the existing subsidence behind the east coast sea breeze. However, in the presence of divergence aloft, the sea breeze usually had the greatest influence on the cloud bands. However, Dr. Bauman found in some cases that the strength of the upper level divergence associated with the jet streak may be enough to negate the low level subsidence behind the sea breeze.

Final Report

Dr. Bauman wrote a first draft of the final report and submitted it for internal AMU review. Upon final approval, the final report will be available on the AMU website.

Contact Dr. Bauman at 321-853-8202 or bauman.bill@ensco.com for more information.

Objective Lightning Probability Tool: Phase II (Ms. Lambert and Mr. Wheeler)

The 45 WS forecasters include a probability of lightning occurrence in their daily morning briefings. This information is used by personnel involved in determining the possibility of violating LCC, evaluating FR, and planning for daily ground operation activities on KSC/CCAFS. A set of logistic regression equations that calculate the probability of lightning occurrence was developed by the AMU in Phase I of this task. These equations outperformed several standard forecast methods used in operations. The graphical user interface (GUI), developed in Phase I allows forecasters to interface with the equations by entering parameter values to output a probability of lightning occurrence. The forecasters must gather data from the morning sounding and other sources, then manually input that data into the GUI. The 45 WS requested that a tool be developed on the Meteorological Interactive Data Display System (MIDDS) that retrieves the required parameter values automatically for the equations to calculate the probability of lightning for the day. This will reduce the possibility of human error and increase efficiency, allowing forecasters to do other duties. The 45 WS also requested modifications to the data that are input to the equations in the hope of improving accuracy.

Ms. Lambert and Mr. Roeder of the 45 WS tested the MIDDS GUI created by Mr. Wheeler using the Man-computer Interactive Data Access System (McIDAS) BASIC Language Interpreter (McBASI). They compared the output values between the MIDDS and Excel GUIs to determine if the MIDDS GUI was working properly, and found several discrepancies. Ms. Lambert examined the McBASI code, corrected several logic errors, and conducted another comparative test. The MIDDS GUI now calculates the same probability values as the Excel GUI. Mr. Wahner of Computer Sciences Raytheon (CSR) installed the McBASI files on the MIDDS terminals in the Range Weather Operations Center, and Ms. Lambert demonstrated the GUI to the 45 WS at their June training meeting. She also emailed the McBASI files to the Spaceflight Meteorology Group (SMG) for their use.

Ms. Lambert downloaded, and then input and processed the 2004/2005 1200 UTC warm season soundings from Miami, Tampa Bay, and Jacksonville, FL in S-PLUS. She also imported and began processing the 1000 UTC Cape sounding data from the same period. These data will be used in the development of the updated equations.

Ms. Lambert presented this work at the 1st International Lightning Meteorology Conference in Tucson AZ. The ILMC was held on April 26–27 immediately following the 19th International Lightning Data Conference, held on April 24–25. Both conferences were sponsored by Vaisala.

Contact Ms Lambert at 321-853-8130 or lambert.winfred@ensco.com or Mr. Wheeler at wheeler.mark@ensco.com for more information.

Stable Low Cloud Phase II: Nocturnal Event Feasibility Study (Mr. Barrett and Dr. Bauman)

For all shuttle missions, SMG issues 30 to 90 minute forecasts for low cloud ceilings at the Shuttle Landing Facility (SLF). Cloud ceilings are one of the greatest forecast challenges identified by SMG and 45WS forecasters, especially rapid ceiling development below 8000 ft in a stable environment. The first phase of this work analyzed the onset, location, and dissipation times of low clouds in a stable environment during daylight hours for the cool season months of November through March. The AMU determined that the mean inversion height and strength were similar between event and non-event days, while the mean relative humidity was slightly higher on the event days. The main discerning factor between the event and non-event days was the wind profile. On 85% of the event days the winds veered with height through 8000 ft, while the winds veered with height on only 17% of the non-event days. The objective of Phase II is to determine if representative meteorological conditions can be identified that are conducive for the sudden development of low cloud ceilings in the nighttime during the cool season months. If such conditions can be identified, they will be used to support cloud ceiling forecasts for nighttime shuttle launches and landings.

The approach of Phase II will be similar to that of Phase I. Mr. Barrett and Dr. Bauman will use a database of satellite images, SLF surface observations, and CCAFS (XMR) soundings taken during the cool seasons in the years 1995 to 2005 for the analysis. Current FR prohibit landing a shuttle in ceilings below 5000 ft for a Return-To-Launch-Site abort, and below 8000 ft for a nominal End-of-Mission landing. Therefore, Mr. Barrett and Dr. Bauman will analyze days with observations of ceilings below 8000 and 5000 ft. They will use either long or short infrared (IR) satellite imagery, or possibly a combination of both. It is often easier to detect low stratus or fog at night by combining short and long IR satellite imagery, known as a "Fog" product. They will also analyze the 2200 UTC XMR soundings to determine the heights of any temperature inversions and veering/backing layers, similar to the procedure in Phase I. The morning 1000 UTC XMR sounding may also be used for verification purposes, since it should be more representative of a nighttime thermodynamic environment.

Mr. Barrett wrote a program that analyzes the percentage of ceilings at and below 8000 and 5000 ft at a METAR site for every hour of the day. The program also determines which ceilings were due to rain and fog. He will modify the program to take into effect missing observations when calculating the percentages and to not include ceilings at exactly 8000 or 5000 ft. Mr. Barrett also modified the existing AMU program that reads the surface data to include special surface observations. This will facilitate the capture of low cloud ceilings that occurred between hourly observations. He discovered a bug in this program that caused many of the surface observations to be thrown out. Even after he fixed the bug, he noted that some observations will be missing for other reasons, such as data transmission or instrument problems.

If there are any cases with missing satellite data, the AMU could order the needed IR satellite imagery from the Space Science and Engineering Center (SSEC). In anticipation of such a need, Mr. Barrett obtained price quotes from the SSEC and determined that SSEC data would be less expensive if only individual days with low cloud events were ordered. For the entire period 1995 – 2002, 15-minute IR satellite imagery costs nearly $32,000. The cost for one year is close to $4,500, while one day (24 hours) is about $58.00. Alternately, Mr. Barrett found a free source of satellite data from the NOAA Comprehensive Large Array-data Stewardship System ftp server in AREA, JPEG, and GIF file formats, available at different horizontal resolutions that could also be used in this task.

Contact Mr. Barrett at 321-853-8205 or barrett.joe@ensco.com or Dr. Bauman at 321-853-8202 or bauman.bill@ensco.com for more information.

Situational Lightning Climatologies for Central Florida, Phase II (Dr. Short)

The threat of lightning is a daily concern during the warm season in Florida. Recent research has revealed distinct spatial and temporal distributions of lightning occurrence that are strongly influenced by large-scale atmospheric flow regimes. In Phase I, the AMU created gridded lightning density and frequency climatologies that the forecasters at NWS MLB currently use to issue daily lightning threat maps for their CWA (Lambert et al. 2006, also see the section "Climatology of Cloud-to-Ground Lightning" in this report). The purpose of Phase II is to create the climatological soundings of wind speed, wind direction, temperature, and dew point at Jacksonville (JAX), Tampa (TBW), Miami (MFL), and XMR for each of eight flow regimes from a 16 year database of soundings. The NWS MLB forecasters will compare current and forecast soundings to the climatological soundings, allowing them to refine the daily lightning threat based on the differences between the climatological and current/forecast soundings.

Flow Regime and Sounding Data

The same daily flow regime data used in Phase I were used in this task. These data were provided to the AMU by Mr. Irv Watson of the NWS in Tallahassee (TAE) and Mr. Phil Shafer of the Florida State University (FSU). The daily soundings were stratified by flow regime and station so that composite soundings could be calculated for each sounding location. One additional flow regime not provided by NWS TAE/FSU was included in Phase I and this work: a catch-all category named 'Other' when a flow regime could not be identified. This resulted in a total of eight flow regimes:

- NE Northeast flow over Florida,
- NW Northwest flow over Florida,
- PAN Possible ridge over the Florida panhandle,
- SE-1 Ridge between TBW and JAX,
- SE-2 Ridge north of JAX,
- SW-1 Ridge south of MFL,
- SW-2 Ridge between MFL and TBW, and
- Other Regime undefined

The JAX, TBW and MFL 1200 UTC soundings were used to determine daily flow regimes and, therefore, were used to create the climatological soundings. These data were obtained from the NOAA Global Systems Division (GSD) website at http://raob.fsl.noaa.gov/. Since XMR is the only sounding location within the NWS MLB CWA, NWS MLB requested climatological soundings for this station as well. Due to 45 WS operational requirements, the morning sounding at XMR is released at 1000 instead of 1200 UTC. Because this is the closest regularly scheduled sounding to 1200 UTC, NWS MLB requested the AMU calculate climatological soundings for the XMR 1000 UTC sounding. These data were provided to the AMU by Mr. Wahner of CSR.

The sounding data included the mandatory and significant levels. Significant levels are used to describe significant variations in temperature, dew point, wind speed, or wind direction between the mandatory levels. While the number of mandatory levels is constant, the number of significant levels varies from day-to-day.

GEMPAK Interpolation and Compositing

The sounding data were formatted for input to the General Meteorological Package (GEMPAK, desJardins et al., 1996). The mandatory and significant level data between 1000 mb to 100 mb from each sounding was interpolated to 25 mb intervals using functions in GEMPAK. A vertical resolution of 25 mb was chosen for the composite soundings in order to assure that important features such as temperature inversions, stable layers, dew point gradients, and wind speed maxima would be represented.

The interpolated data were then stratified by station and flow regime. Composite soundings were produced for each station and each flow regime by averaging temperature, water vapor mixing ratio, and the u- and v-wind components. After averaging, the dew point was computed from the average mixing ratio. This procedure was followed because water vapor mixing ratio is the thermodynamic variable of interest, although dew point is more familiar. The average wind speeds and directions were computed from the u- and v-wind components.

NSHARP Formatting and Display

The composite soundings were formatted for display and analysis by the National version of the Skew-T Hodograph Analysis and Research Program (NSHARP, Hart et al. 1997). Figure 2 shows the XMR composite sounding for the SE-1 flow regime displayed in NSHARP. Dr. Short delivered the 32 NSHARP composite soundings (4 soundings and 8 flow regimes) to Mr. Volkmer at NWS MLB for display and analysis using

NSHARP on their systems. They are now using these soundings operationally to assist in creating the daily lightning threat index map. Table 1 shows several commonly used parameters from the XMR composite soundings and the number of soundings for each regime.

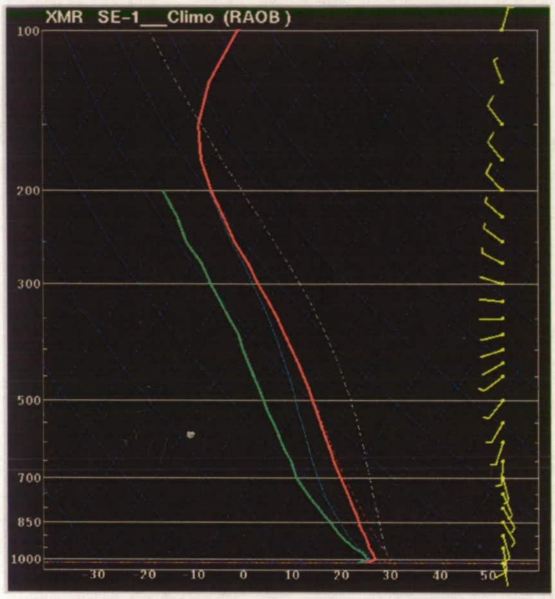

Figure 2. Composite sounding from XMR for the SE-1 flow regime. Solid lines show temperature (red), dew point (green), and wet-bulb (cyan) versus pressure. The dashed white line shows a moist adiabat. The average wind speed and direction profile is shown by the yellow wind barbs on the right-hand-side.

Table 1. Stability parameters from the composite soundings for the eight flow regimes at XMR

Flow Regime	Number of Soundings	LI	K	TT	PW
NE	155	-5	22	42	1.53
NW	86	-6	26	43	1.60
PAN	105	-6	24	43	1.55
SE-1	284	-8	28	45	1.75
SE-2	209	-7	28	44	1.81
SW-1	233	-6	30	44	1.76
SW-2	217	-7	31	46	1.83
Other	713	-6	29	44	1.74

Contact Dr. Short at short.david@ensco.com or 321-853-8105 for more information.

INSTRUMENTATION AND MEASUREMENT

Anvil Forecast Tool in AWIPS (Mr. Keen and Mr. Barrett)

The forecasters at SMG and 45 WS have identified anvil forecasting as one of their most challenging tasks when predicting the probability of LCC or FR violations due to the threat of natural or triggered lightning. In response, the AMU developed an anvil threat corridor graphic that can be overlaid on satellite imagery using the MIDDS. This tool helps forecasters estimate the location of thunderstorms that might produce an anvil threat 1, 2, and 3 hours into the future. It has been used extensively in launch and landing operations. The SMG is depending more on the Advanced Weather Interactive Processing System (AWIPS) during operations and the 45 WS has plans to replace their MIDDS with AWIPS. To ensure it will remain available for operations, the forecasters tasked the AMU to transition the anvil tool from MIDDS to AWIPS. The AMU will also create a GUI to ensure easy access to the tool.

To prepare for work required in this task, Mr. Barrett obtained copies of the AWIPS Systems Managers' Manual for Build 4.3, as well as training materials from NWS Training Center AWIPS courses:

- AWIPS System Management,
- AWIPS Local Application Development, and
- AWIPS Localization.

Mr. Keen is familiar with AWIPS algorithms from his earlier work on ENSCO's MetWise system. Mr. Barrett has experience in the operational use of AWIPS as the AWIPS focal point at the NWS office in Key West, Florida. He also had development experience in the localization of the WarnGEN program used to issue weather watches, warnings, and statements.

Mr. Keen began developing a GUI that will be accessible from the Tools menu in AWIPS. Mr. Keen and Mr. Barrett converted much of the McBASI code that calculates the layer-averaged wind velocity into the Tool Command Language code used in AWIPS. Currently, the program can only read in and use observed sounding data to calculate the velocity. They will soon add the capability of reading profiler and model data to make the calculations. They also converted some of the code that determines the latitude/longitude points to be plotted for the threat sector.

Contact Mr. Barrett at 321-853-8205 or barrett.joe@ensco.com or Mr. Keen at 321-783-9735 ext. 248 or keen.jeremy@ensco.com for more information on this task.

Volume Averaged Height Integrated Radar Reflectivity (VAHIRR) Algorithm (Mr. Keen, Ms. Miller, Mr. Gillen, and Dr. Merceret)

Lightning LCC (LLCC) and FR are used for all launches and landings, whether Government or commercial, using a Government or civilian range (Willett et al. 1999). These rules are designed to avoid natural and triggered lightning strikes to space vehicles, which can endanger the vehicle, payload, and general public. The current LLCC for anvil clouds, meant to avoid triggered lightning, have been shown to be overly restrictive. They ensure safety, but falsely warn of danger and lead to costly launch delays and scrubs. A new LLCC for anvil clouds, and an associated radar algorithm needed to evaluate that new LLCC, were developed using data collected by the Airborne Field Mill research program managed by KSC (Dye et al. 2006). Dr. Harry Koons of Aerospace Corporation conducted a performance analysis of the VAHIRR algorithm from a safety perspective. The results suggested that the LLCC based on this algorithm would assist forecasters in providing a lower rate of missed launch opportunities with no loss of safety compared with the previous LLCC.

Dr. Merceret directed ENSCO to disqualify a point from the VAHIRR calculation if a single invalid reflectivity exists in a point's volume space and Ms. Miller made the change. The frequency and pattern of invalid reflectivity in sample volume scans led her to inquire with the Radar Operations Center about the cause of invalid reflectivity. She learned that the Radar Data Acquisition and Radar Product Generator (RPG) cut off data at 70,000 ft. Ms. Miller's design of the VAHIRR program was processing data beyond this height for some elevations. Therefore she modified code to process an input-specified gate range per elevation rather than a fixed gate range over all scans. The change eliminated the presence of invalid reflectivity in the input data. Regardless, Ms. Miller retained the code to disqualify a point if invalid reflectivity is ever present.

Ms. Miller updated the VAHIRR documentation to reflect the code changes and compiled all documentation into appendices of the VAHIRR final memorandum. She incorporated Dr. Merceret's edits for the final memorandum and circulated the document again for internal review.

Dr. Bauman, Mr. Barrett, Mr. Case, Ms. Miller, and Mr. Keen met to develop a VAHIRR test plan using real-time NWS MLB WSR-88D data in the AMU. The plan they developed includes building an AWIPS server on an existing AMU computer, installing the RPG and AWIPS server on the AMU network, and then receiving real-time radar data through the existing AMU data feed from Marshall Space Flight Center. The VAHIRR code will run on the RPG, and its output will go through the AWIPS server to the AMU developmental AWIPS client for display.

Mr. Barrett installed the RedHat Linux Enterprise Server Version 4 operating system on the AMU computer that will be used as the AWIPS server. Mr. Barrett and Mr. Keen connected this new Linux server to the AMU AWIPS client. This will allow the AWIPS client to read files from the Linux server, which is necessary in order to test the VAHIRR algorithm.

For more information on this task, contact Mr. Keen at keen.jeremy@ensco.com or 321-783-9735 ext. 248; Ms. Miller at miller.juli@ensco.com or 321-783-9735 ext. 221; Mr. Gillen at gillen.robert@ensco.com or 321-783-9735 ext. 210; or Dr. Merceret at 321-867-0818 or Francis.J.Merceret@nasa.gov.

MESOSCALE MODELING

Operational Weather Research and Forecasting (WRF) Model Implementation (Mr. Case)

The WRF model is the next generation community mesoscale model designed to enhance collaboration between the research and operational sectors. The NWS as a whole has begun a transition toward WRF as the mesoscale model of choice to use as a tool in making local forecasts. AMU customers have derived great benefit from the maturity of the Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS) in support of its varied forecast programs, and would like to use ADAS for providing initial conditions for WRF. To assist in the WRF transition effort, the AMU has been tasked to conduct preliminary work towards testing and implementing an appropriate configuration of the WRF model over the Florida peninsula. This includes conducting a hardware performance comparison study, configuring and testing an ADAS/WRF setup, and modifying the ADAS GUI for controlling the tunable initialization and parameterization settings for ADAS/WRF.

Mr. Case modified the suite of scripts currently used by the NWS MLB for running the ARPS model initialized with ADAS. These scripts formed the backbone for running ADAS to initialize the Advanced Research WRF (ARW) directly or for providing initialization data to the WRF Environmental Modeling System (EMS) software. The EMS was provided to NWS offices for local modeling using WRF, with the capability of running either the ARW or the Non-hydrostatic Mesoscale Model (NMM) versions of WRF.

Running ARPS or ARW from Scripts

Mr. Case developed a prototype configuration for running the ARW using ADAS for initial conditions and the Rapid Update Cycle (RUC) and/or North American Mesoscale (NAM) models for boundary conditions. The prototype is designed from the current ARPS scripts that are run operationally at the NWS MLB office. The configuration is capable of running either the ARPS or ARW models using ADAS for initial conditions. Post-processing utilities have also been tested for this ADAS/ARW configuration, with many of the same graphics capabilities as in the current ADAS/ARPS at NWS MLB.

The prototype configuration first generates fixed fields (terrain height, vegetation, and soil type), boundary conditions, the ADAS analysis, and soil initialization as in the current operational ARPS configuration at NWS MLB. The fixed fields for the ARW model are then created using a utility written by the ARPS developers at the Center for Analysis and Prediction of Storms (CAPS) called "wrfstatic". After these steps, the ADAS data and boundary conditions are converted to the ARW grid with a nearly identical resolution and map projection as the ARPS grid using another utility developed by CAPS called "arps2wrf". Both CAPS utilities can initialize all fixed fields and boundary conditions for the ARW.

Unfortunately, ADAS cannot be used directly to initialize the NMM with high-resolution initial conditions because CAPS has not yet developed a routine to convert from the ARPS grid to the NMM rotated latitude-longitude grid. However, Mr. Case developed a methodology, described in the next section for using ADAS to initialize either the ARW or NMM within the EMS software.

Producing Initialization Data for EMS

The shell scripts described above were modified to generate 0-hour initialization files from the ADAS/ARW. Requiring only several minutes to complete a 4-km Florida peninsula domain on a 3 single-processor 3.0-GHz Linux workstation, this process creates the ADAS and soil analysis, converts it to the ARW grid using "arps2wrf", and then runs the ARW model briefly to create a 0-hour forecast file. This is essentially an ADAS analysis on the ARW grid coordinate system. The post-processing script then interpolates the initialization file to a pressure-coordinate file in the GRIdded Binary (GRIB) data format, which is the standard input data format for EMS.

To ingest the pressure-coordinate ADAS GRIB files into WRF, Mr. Case created two GRIB parameter files specific to the variables found in the ADAS dataset. These parameter files define the GRIB numerical identifiers for each variable, the vertical coordinates, etc. of the external grid dataset being interpolated to the WRF grid. Finally, two configuration files unique to the EMS were created for the ADAS initialization files in which the file-naming convention, directory location, and time attributes are defined.

Current Limitations and Corrective Measures Required

Mr. Case ran both ARW and NMM simulations using an ADAS analysis for the initial conditions following the procedures described above. He found one significant deficiency that needs to be corrected for this procedure to create an ADAS "hot-start" initialization of WRF. The cloud and precipitation microphysics derived by the ADAS cloud analysis scheme cannot currently be initialized into the EMS due to limitations in the official WRF code.

Code exists at GSD to correct this issue. Mr. Case became aware of special code to initialize the microphysics in WRF for the Local Analysis and Prediction (LAPS) "hot-start". The personnel at GSD modified the code used to initialize both the NMM and ARW with the microphysics fields from LAPS. The modified source code should be obtained from GSD and compiled on a local workstation in order to initialize the WRF microphysics variables from ADAS.

For more information, contact Mr. Case at case.jonathan@ensco.com.

ADAS/ARPS Modifications for Improvement of Forecast Operations (Mr. Case)

For the past several years, ADAS mesoscale analyses have been produced in an experimental, operational mode at NWS MLB and SMG. Since that time, ADAS fields have become an integral part of forecast operations and additional modifications and graphical products are desired to further improve their utility. The AMU was tasked to

- Ingest additional unique local data sets,
- Examine the ADAS parameters for an optimized configuration when analyzing observations,
- Implement new visualization products to help forecasters assess the potential for supercell thunderstorms and significant tornadoes, especially those associated with tropical activity, and
- Implement techniques to improve threat assessments of lightning potential.

New ADAS Data Ingest Routine

Mr. Case had already developed data-ingest routines to assimilate intermediate Automated Surface Observing System direct dial-in observations and data from the Florida Roadway Weather Information System, done as part of the ARPS Optimization and Training Extension Part II task. Therefore, the only remaining data source specified in the ADAS/ARPS Modifications task plan is the South Florida Water Management Distract (SFWMD) data. Mr. Case thus wrote and delivered a data-ingest routine to re-format the comma-separate SFWMD data that the NWS MLB receives, and assimilate the data into ADAS.

Optimizing ADAS Configuration for Surface Fields

The NWS MLB forecasters have noted that the RUC background field appears to dominate the observational data analyzed by ADAS. As part of this task, Mr. Case optimized the configuration of the error variances and the influence ranges to establish a well-blended analysis that favors the observations over the background field.

The quality and amount of detail in the ADAS analyses are affected by the amount of observations assimilated, observation quality, and user-configurable range and error parameters. Larger (smaller) values assigned to the range parameters yield smoother (more detailed) analyses because the observations have more (less) influence on grid points at farther distances. Similarly, larger (smaller) errors assigned to a data source results in a smaller (larger) influence of that data on the resulting nearby grid points.

In ADAS, the Bratseth objective analysis scheme (Bratseth 1986) determines the value of a variable at each grid point based on a background field, the distance between the grid point and nearby observations, and the error variances of each data source. The weights assigned to the background field and observations vary between 0 and 1 and are inversely proportional to the error variances designated to each data source by user-configurable error files. The weights applied to observations are also inversely proportional to the distance between the grid point and observation location, based on a Gaussian-like function, and are controlled by user-configurable distance parameters. For ADAS input, the "e-folding distance", or the distance between an observation and grid point at which the computed weight for that grid point is e^{-1} (~0.37), is called "xyrange". This parameter controls the amount of detail in the analysis.

Mr. Case examined a set of control error variances and influence range parameters assigned to the background field and observations. He varied these errors and configurable parameters to determine how much the background field was modified by the observations with a different set of errors or range parameters. He found that the assigned background and observational errors had minimal influence on the variations in analysis patterns. Therefore, his focus was directed toward the impact of varying the horizontal e-folding parameter (xyrange) on the resulting surface analysis. The control value for the "xyrange" parameter in the following experiments is 16 km for surface observations. The images presented are show analyses from 14 March 2006 in which there were substantial differences between the background surface RUC fields and the surface observations.

On the afternoon of 14 March 2006, a cold front approached Florida from the northwest, and a moderate west-southwest flow prevailed ahead of the front across the peninsula. Surface temperatures exceeded 80°F across most of the peninsula. These temperatures were significantly underestimated by the 1800 UTC RUC 3-hour forecast, which served as the background field to the 2100 UTC ADAS analysis.

Control ADAS Analysis

Figure 3 shows the differences between ADAS and the background field for the control ADAS configuration at 2100 UTC 14 March 2006, using xyrange=16-km. Numerous positive temperature adjustments of 2–6°F (Figure 3a) and negative dew point adjustments as much as -10°F (Figure 3b) occurred in the control analysis across much of Florida due to a cool, moist bias in the background RUC field. The combination of the background westerly flow being too strong over the interior of the peninsula and an anomalous sea breeze over the Florida east coast resulted in the pattern of u-wind analysis increments and vector differences in Figure 3c. The observed winds were more southerly than the RUC background at many locations in central Florida (Figure 3d). Needless to say, the ADAS analysis adjusted strongly to the observations in the control configuration. However, several areas of the analysis reverted to the background field due to the lack of observations, especially over south Florida.

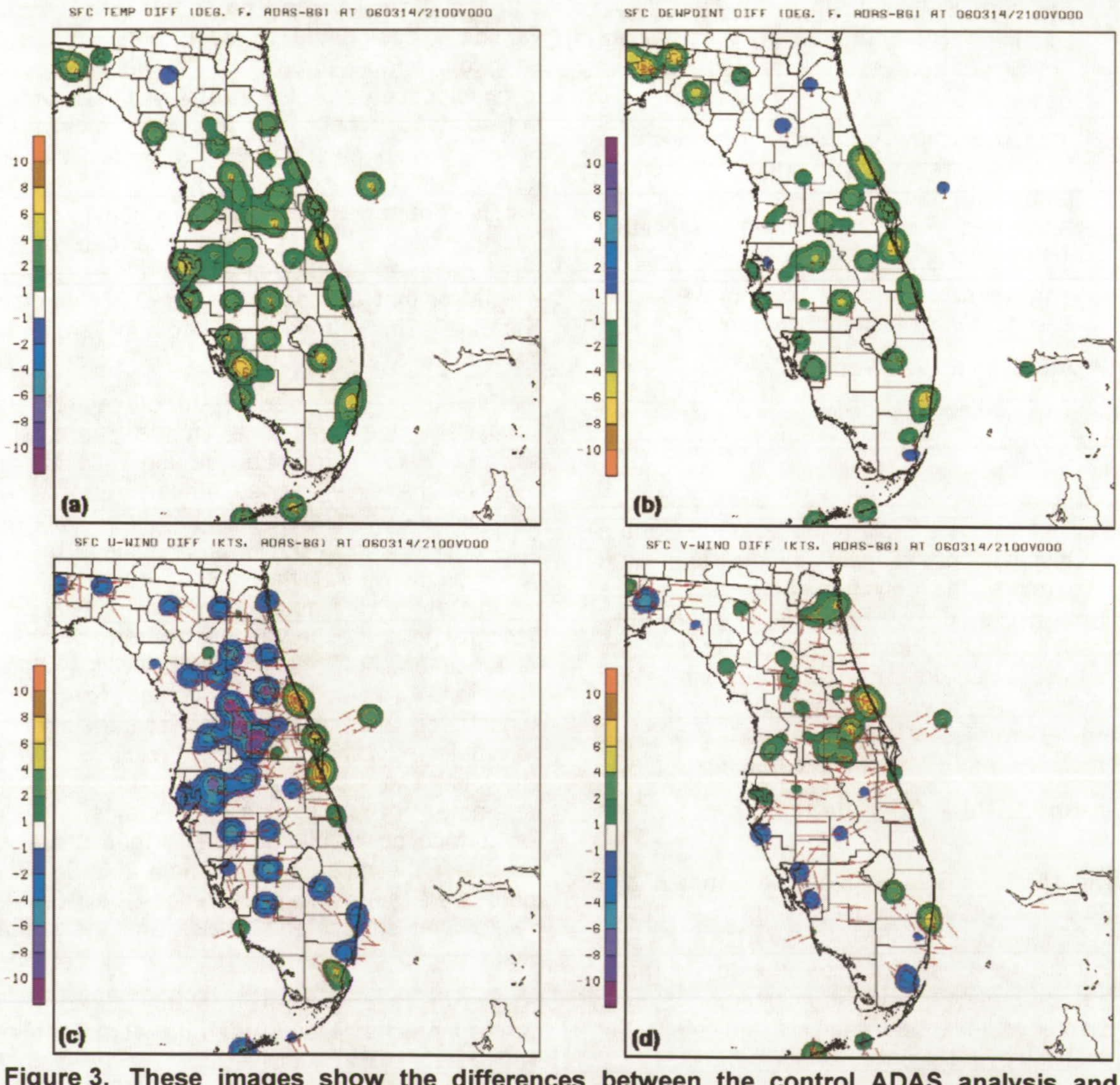

Figure 3. These images show the differences between the control ADAS analysis and background field (ADAS – RUC) at 2100 UTC 14 March 2006 for the surface variables (a) temperature, (b) dew point, (c) u-wind component and vector differences, and (d) v-wind component and vector differences. The dew point difference color scale is opposite of the other variables in order to depict dry (moist) biases in the background field with green-orange (blue-purple) colors.

Experiment 1: xyrange=24 km

In this experiment, Mr. Case increased "xyrange" by 50% from 16 to 24 km. The results depicted a larger horizontal influence of the observations such that the analysis increments began to blend together instead of form distinct "bulls-eyes" around most observation locations, especially for the temperature and u-wind component increments (Figure 4). The magnitudes of the analysis increments appear to be comparable to the control experiment for each variable.

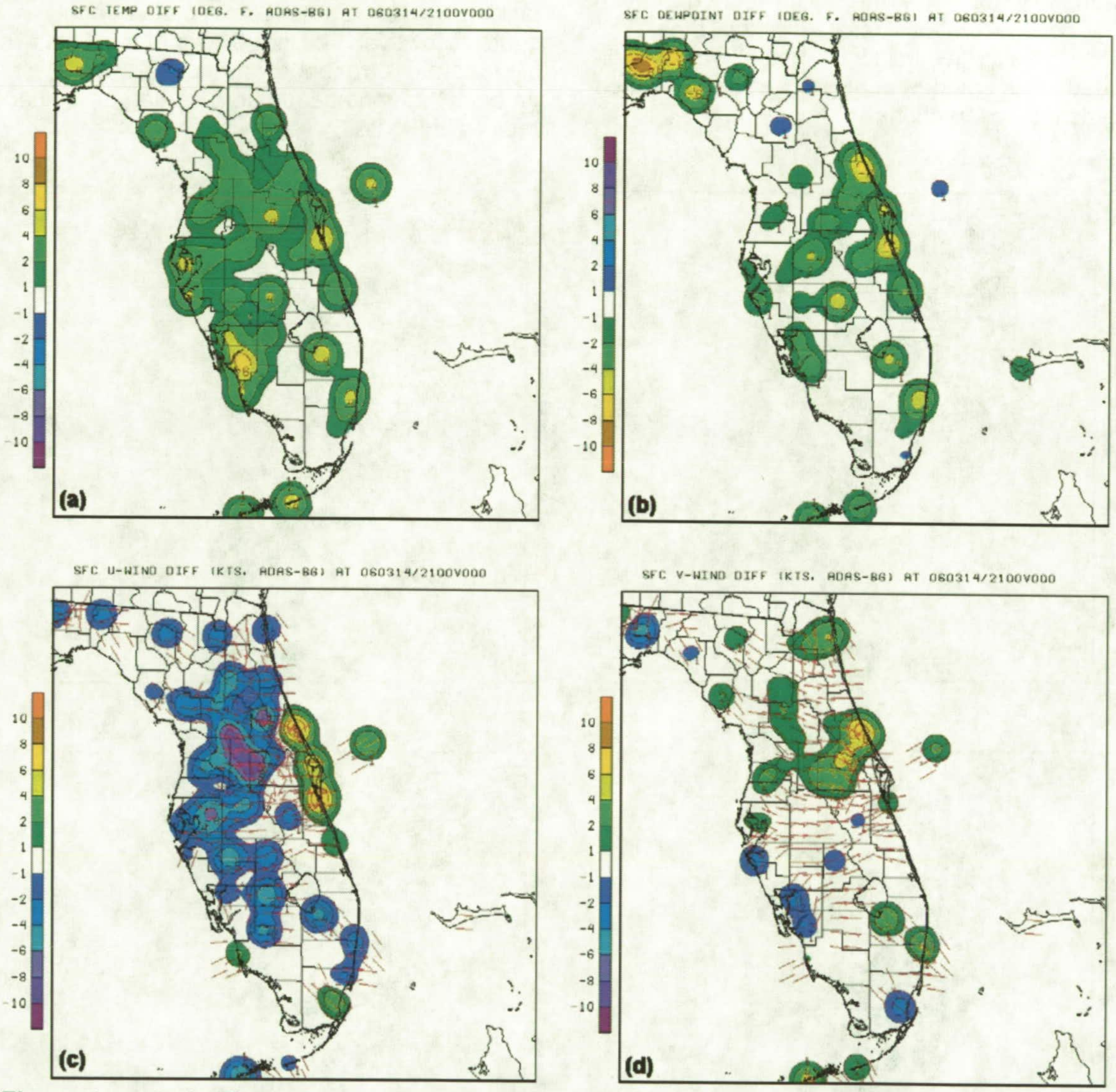

Figure 4. **As in Figure 3 except that xyrange = 24 km instead of 16 km.**

Experiment 2: xyrange=32 km

In experiment 2, "xyrange" was doubled from 16 to 32 km. The resulting analyses in Figure 5 show that the background temperature, dew point, and u-wind fields were adjusted towards the observations over much of the Florida peninsula with the exception of the southwestern portion where no observations existed at this time. The result of this larger influence range was a well-blended and smooth analysis heavily weighted towards the observations.

One of the risks in creating a smoother analysis is that sharp transition lines and mesoscale features such as the sea-breeze boundary would be depicted over a broader region and the gradients would not be as sharp. In addition, using a larger influence range could cause observational data values to be spread too far leading to a mis-representative analysis in spots. However, if the background fields are significantly erroneous, as in this case, it is probably advantageous to use larger influence radii as in Figure 5.

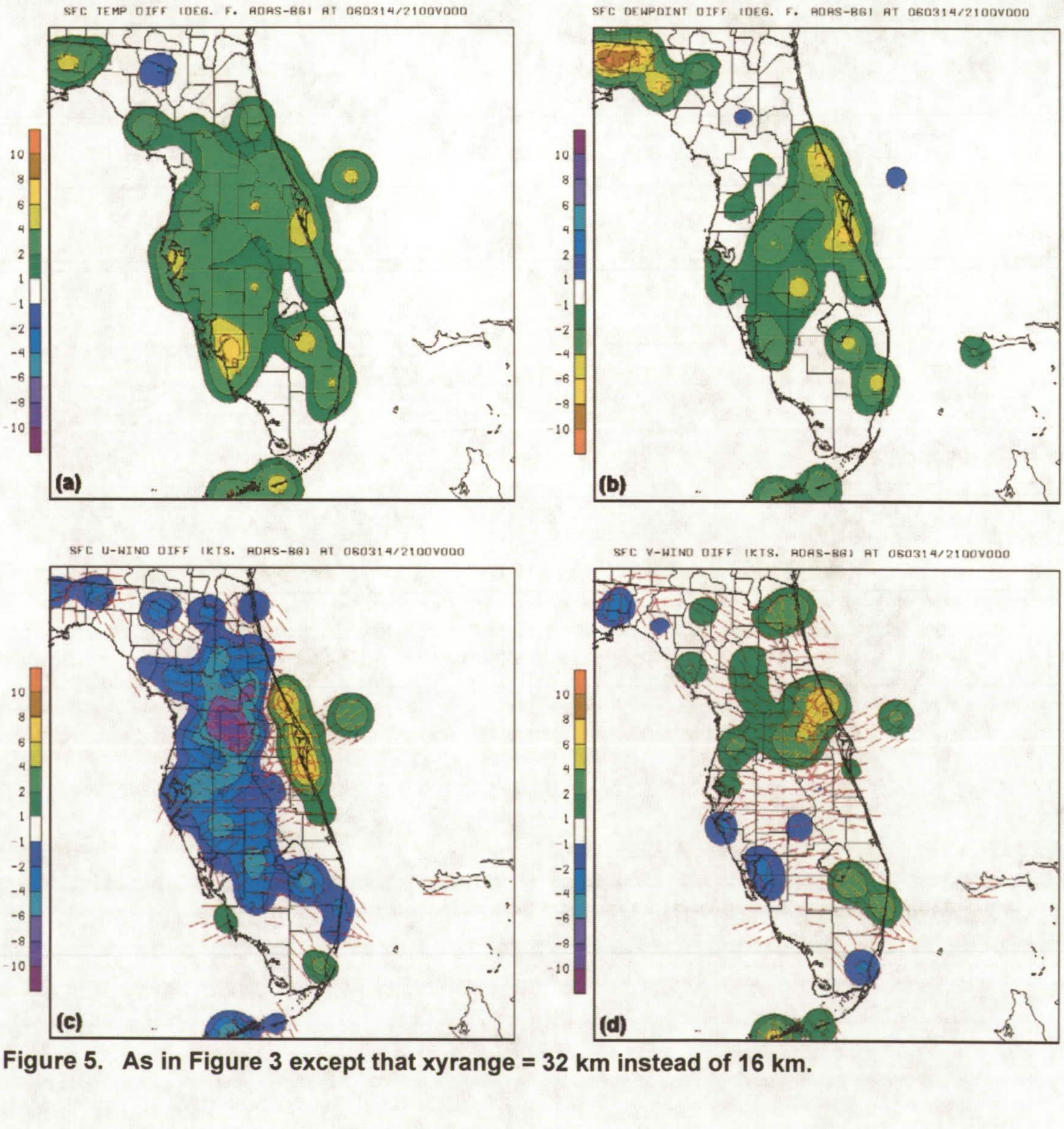

Figure 5. As in Figure 3 except that xyrange = 32 km instead of 16 km.

Analysis Comparison

A comparison of the 2100 UTC surface temperature from the background, control, and experiments 1 and 2 illustrate how the various configurations affected the resulting analyses (Figure 6). The varying degrees of smoothness in Figures 6b–d all show that the analysis favors the observations over the anomalously cool RUC background field in Figure 6a, particularly in the extreme northwest portion of the domain and along the Florida east coast. However, the 32-km xyrange analysis in Figure 6d clearly results in the smoothest analysis and the most widespread corrections to the background field.

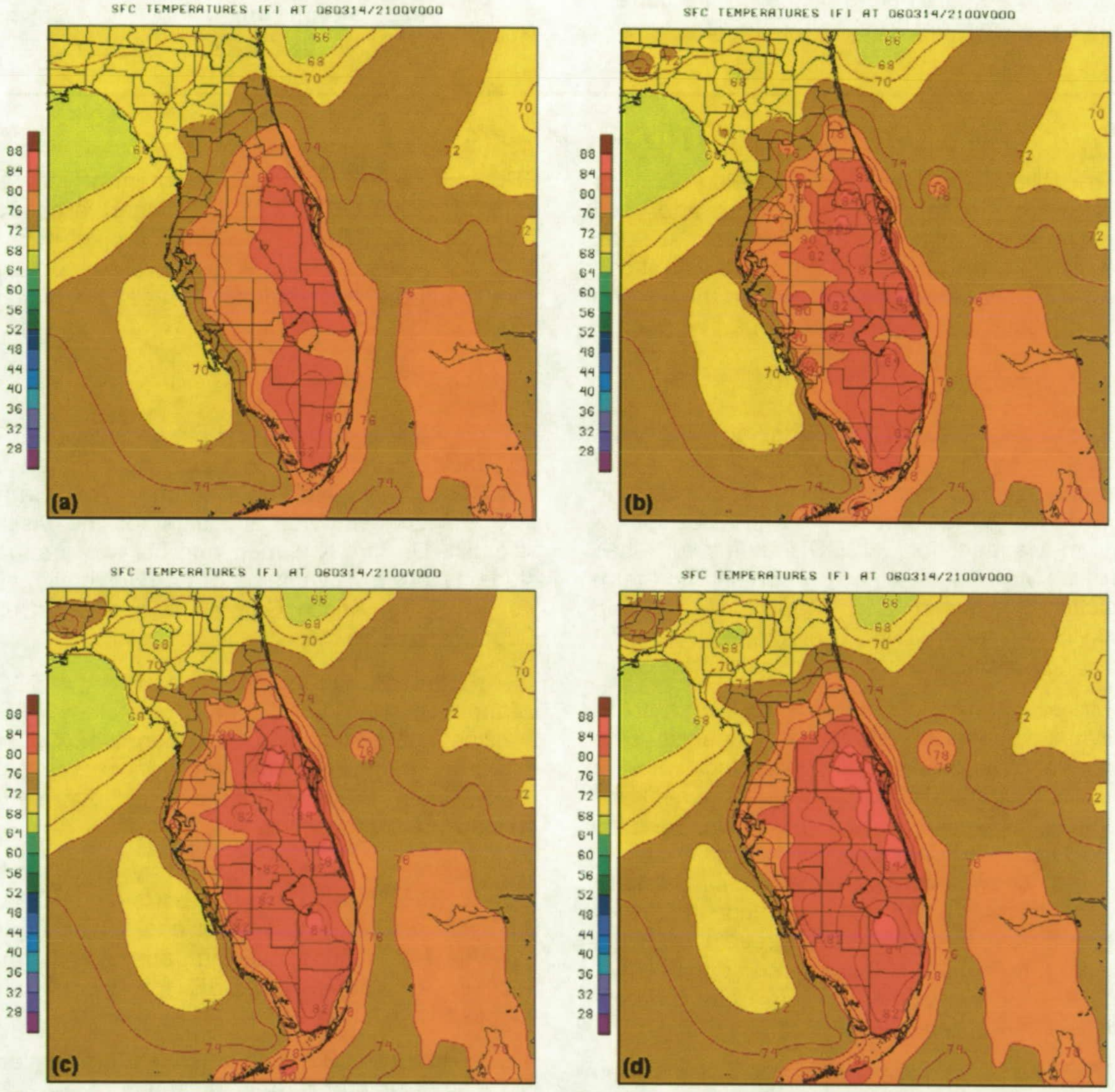

Figure 6. Surface temperature fields at 2100 UTC 14 March 2006 for the (a) RUC background field, (b) Control ADAS analysis with xyrange = 16 km, (c) ADAS analysis with xyrange = 24 km, and (d) ADAS analysis with xyrange = 32 km.

The GUI tool available from the AMU's User Control Interface for ADAS Data Ingest task could be used to modify the influence range parameters so that future tuning of the ADAS analysis details can be controlled by the user/forecaster, based on the needs of the ADAS application. It may be advantageous to increase or decrease the influence range parameters based on the current weather situation, observational data density, and the accuracy of the background field. For example, if the background fields are rather poor, the available observational data are relatively sparse, and/or the weather features are dominated by the larger scales, it could be beneficial to the forecaster to increase the influence range parameters to generate a smoother, more accurate surface field.

For more information, contact Mr. Case at (256)-961-7504 or case.jonathan@ensco.com.

AMU CHIEF'S TECHNICAL ACTIVITIES (Dr. Merceret)

Dr. Merceret continued development of software to ingest soil moisture and soil temperature data from the KSC mesonet sites as well as from the RSA towers equipped with these sensors. The soil moisture data will be used in the model sensitivity study. He also began work on a KSC Innovative Partnership Program project with ENSCO called GEMSTONE, a separate contract from the AMU. The GEMSTONE project aims to develop and test-fly a solar-powered constant-level long-duration balloon sonde for volume initialization of numerical models.

AMU OPERATIONS

Mr. Wheeler, one of the original AMU team members, and Mr. Case, an AMU team member for eight years, left the AMU for other positions in ENSCO. Mr. Wheeler accepted the position of Program Manager for ENSCO's United Air Lines contract. Mr. Case joined NASA's Short-term Prediction Research and Transition group in Huntsville, AL as an ENSCO employee in support of their numerical weather prediction efforts.

Mr. Joe Barrett joined the AMU in April to fill Mr. Wheeler's position. Mr. Barrett has eight years of experience in the field of meteorology with the National Weather Service where he was Lead Forecaster at the Key West, FL office. He also has a graduate degree in computer science, which will be valuable in the execution of AMU tasks and in system administration of AMU equipment. Dr. Leela Watson agreed to join the AMU in July to fill Mr. Case's position. She will bring with her extensive numerical weather prediction and tropical storm expertise.

Mr. Wheeler worked with different vendors on AMU software and hardware purchases. He submitted several purchase requests and received several items that had been ordered previously. He also backed up all data from the cluster before turning it off and getting it ready to turn in as excess property.

Mr. Barrett installed and set up a new PC for Dr. Short. Along with Mr. Case, he updated the AMU Local Area Network document. Mr. Barrett also set up computer accounts for the visiting scientist, Dr. Jim Koermer, and his two graduate students from Plymouth State University. Dr. Koermer, Ms. Kristin Cummings and Ms. Betsy Dupont arrived in the AMU in May.

In May, Mr. Derek Monaghan from ENSCO's Information Systems and Technology (IST) Division installed a new server in the AMU for external communications and reconfigured the AMU printers to run through a single print server instead of each individual PC.

Mr. John Artman and Ms. Mary Etta Trembly from ENSCO's IST Division assisted the AMU staff with receiving delivery of and setting up the new AMU modeling cluster in June. Dr. Bauman submitted a request to CSR for five 20 amp circuits to power the cluster.

In April, Dr. Bauman attended the National Hurricane Conference held in Orlando, FL and Mr. Case supported the Atlas V launch. Mr. Case, Dr. Bauman, and Ms. Lambert held an annual Industrial Security Review with the 45th Space Wing in May. Dr. Bauman supported a Delta II launch in June.

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List of Acronyms

30 SW	30th Space Wing
30 WS	30th Weather Squadron
45 RMS	45th Range Management Squadron
45 OG	45th Operations Group
45 SW	45th Space Wing
45 SW/SE	45th Space Wing/Range Safety
45 WS	45th Weather Squadron
ADAS	ARPS Data Analysis System
AFSPC	Air Force Space Command
AFWA	Air Force Weather Agency
AMU	Applied Meteorology Unit
ARPS	Advanced Regional Prediction System
ARW	Advanced Research WRF
AWIPS	Advanced Weather Interactive Processing System
CAPS	Center for Analysis and Prediction of Storms
CCAFS	Cape Canaveral Air Force Station
CG	Cloud-to-Ground
CSR	Computer Sciences Raytheon
CWA	County Warning Area
EMS	Environmental Modeling System
FR	Flight Rules
FSU	Florida State University
FY	Fiscal Year
GEMPAK	General Meteorological Package
GRIB	GRIdded Binary
GSD	Global Systems Division
GUI	Graphical User Interface
IR	Infrared
JAX	Jacksonville, FL 3-letter identifier
JSC	Johnson Space Center
KSC	Kennedy Space Center
LAPS	Local Analysis and Prediction
LCC	Launch Commit Criteria
LLCC	Lightning LCC
McBASI	McIDAS BASIC Language Interpreter
McIDAS	Man Computer Interactive Data Access System
MIA	Miami, FL 3-letter identifier
MIDDS	Meteorological Interactive Data Display System
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NLDN	National Lightning Detection Network
NMM	Non-hydrostatic Mesoscale Model
NOAA	National Oceanic and Atmospheric Administration
NSHARP	National Skew-T Hodograph Analysis and Research Program
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
NWS MLB	NWS in Melbourne, FL
RPG	Radar Product Generator
RSA	Range Standardization and Automation
RUC	Rapid Update Cycle
SLF	Shuttle Landing Facility
SMC	Space and Missile Center
SMG	Spaceflight Meteorology Group
SPoRT	Short-term Prediction Research and Transition
SRH	NWS Southern Region Headquarters
SSEC	Space Science and Engineering Center
TAE	Tallahassee, FL 3-letter identifier
TBW	Tampa, FL 3-letter identifier
USAF	United States Air Force
UTC	Universal Coordinated Time
VAHIRR	Volume Averaged Height Integrated Radar Reflectivity
WRF	Weather Research and Forecasting Model
WSR-88D	Weather Surveillance Radar 1988 Doppler
XMR	CCAFS 3-letter identifier

Appendix A

AMU Project Schedule
31 July 2006

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
Situational Climatology of CG Lightning Flash Counts	Collect NLDN data and FORTRAN code from Florida State University and NWS Tallahassee	Apr 05	Jun 05	Completed
	Analyze and test code on AMU or NWS system	Jul 05	Aug 05	Completed - Delayed due to issues in data transmission and analysis
	Modify code to produce desired gridded output, deliver code and output to NWS MLB	Aug 05	Oct 05	Completed - Delayed as above
	Memorandum	Nov 05	Dec 05 (*Jun 06*)	Completed - Delayed as above
Forecasting Low-Level Convergent Bands Under Southeast Flow	Develop standard data/graphics archive procedures to collect real-time case study data	Apr 05	Apr 05	Completed
	Collect data real-time during southeast flow days	Apr 05	Jan 06	Completed - Delayed due to customer request to collect more winter cases
	Data analysis	Jul 05	Feb 06	Completed - Delayed as above
	Final report	Feb 06	Mar 06 (*Jul 06*)	Delayed as above

AMU Project Schedule 31 July 2006				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
Objective Lightning Probability Phase II	Begin developing the MIDDS tool with McBASI	Dec 05	Feb 06	Completed - Delayed due to final software corrections
	Calculate new forecast parameters	Jan 06	Feb 06 (*Aug 06*)	Delayed due to delays in Lightning Climatology task
	Develop and test new equations	Mar 06	Apr 06 (*Sep 06*)	Delayed as above
	Update the MIDDS tool with new equations	Apr 06	Apr 06 (*Sep 06*)	Delayed as above
	Final report	Mar 06	May 06 (*Oct 06*)	Delayed as above
Stable Low Cloud Phase II: Nocturnal Events	Data Collection: surface obs, soundings, IR satellite imagery	Apr 06	July 06	On schedule
	Data Analysis	May 06	Aug 06	On schedule
	Final report	Aug 06	Sep 06	On schedule
Situational Lightning Climatologies for Central Florida: Phase II	Data Collection: soundings from MIA, TBW, JAX, and CCAFS; flow regime dates	Apr 06	Apr 06	Completed
	Calculate composite soundings	May 06	May 06	Completed
	Final memorandum	May 06	Jun 06 (*Aug 06*)	Delayed for reformatting of composite soundings
RSA/Legacy Sensor Comparison	Data Collection and Pre-Processing	Dec 04	May 05	Completed - Delayed due to request for more data
	Data Evaluation	Dec 04	Jun 05	Completed - Delayed as above
	Final Report	July 05	Sep 05 (*May 06*)	Completed - Delayed as above

AMU Project Schedule 31 July 2006				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
Anvil Forecast Tool in AWIPS	AWIPS training at GSD	Jul 05	Nov 05 (*Apr 06*)	Delayed pending transfer of funds
	Develop software for calculation and display of anvil threat corridor	Dec 05	Apr 06 (*Jul 06*)	Delayed as above
	Test and evaluate performance of the software	Apr 06	May 06 (*Aug 06*)	Delayed as above
	Final memorandum	May 06	June 06 (*Sep 06*)	Delayed as above
Volume-Averaged Height Integrated Radar Reflectivity (VAHIRR)	Acquisition and setup of development system and preparation for Technical Advisory Committee (TAC) meeting	Mar 05	Apr 05	Completed
	Software Recommendation and Enhancement Committee (SREC) meeting preparation	Apr 05	Jun 05	Completed
	VAHIRR algorithm development	May 05	Oct 05 (*Jul 06*)	Completed – Delayed due to new code development made necessary by final product requirements
	ORPG documentation updates	Jun 05	Oct 05 (*Sep 06*)	Completed – Delayed as above
	Configure ORPG and AWIPS system in the AMU for live data testing.	Oct 05	Jan 06 (*Aug 06*)	Delayed as above
	Preparation of products for delivery and memorandum	Oct 05	Jan 06 (*Sep 06*)	Delayed as above
User Control Interface for ADAS Data Ingest	Develop control GUI	Apr 04	Jan 05	Completed
	Installation assistance and documentation	Jan 05	Mar 05 (*Apr 06*)	Completed - Delayed waiting for operating system upgrades at NWS MLB

AMU Project Schedule
31 July 2006

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
Operational Weather Research and Forecasting (WRF) Model Implementation	Hardware performance comparison study	Jul 05	Aug 05	Completed
	Configure and test WRF with ADAS initialization	Aug 05	Apr 06	Completed, with the exception of cloud/precip initialization
	Modify ADAS GUI to Control WRF Initialization and Run-Time	Jan 06	Apr 06	Completed
	Operational Implementation and Memorandum	Apr 06	Jun 06 (*Jul 06*)	Completed, except for final memorandum
ADAS/ARPS Modifications for Improvement of Forecast Operations	Provide assistance in creating programs for assimilating new data sets into ADAS	Jan 06	May 06	Completed
	Develop diagnostic/prognostic graphics that display the potential for CG lightning, and likelihood of supercells and significant tornado events.	Jan 06	Apr 06	Completed
	Improve ADAS weighting scheme and influence radii to optimize the blend of background and observations	Feb 06	Apr 06	Completed
	Final memorandum	Jun 06	Jun 06	Completed

NOTICE