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Applied Meteorology Unit (AMU) Quarterly Report

Fourth Quarter FY-06 Contract NAS10-01052 31 October 2006

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Executive Summary

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

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 Used the Cape Canaveral Air Force Station (CCAFS) sounding to determine the flow regime for the day, determined lightning occurrence in a new valid area, created new lightning probabilities based on flow regime with the new flow regime days and valid area, created new daily lightning climatology, and determined the optimal layer for the average relative humidity calculation.

Discussion By using the CCAFS sounding to help determine the flow regime of the day, the number of days that could not be classified in a defined regime was decreased by 70%. The new valid area, now completely within the 5 n mi warning circles, reduced the number of lightning days due to the decrease in area and its location closer to the coast. This caused an average 11% decrease in the flow regime lightning probabilities.

Task Peak Wind Tool for General Forecasting

Goal Develop a tool to forecast the peak wind speed for the day from the surface to 300 ft on Kennedy Space Center (KSC)/CCAFS during the cool season (October – April). The tool should be able to forecast the timing of the peak wind speed and the background average wind speed, based on observational data available for the 45 WS 0700L weather briefing.

Milestones Acquired CCAFS morning soundings for four cool seasons, October 2002 – April 2006. The database includes a total of 720 soundings with a vertical resolution of 100 ft.

Discussion This work began with a preliminary analysis of temperature and wind speed profiles from the morning soundings for cases with and without surface-based inversions. The highest average wind speeds in the lowest 5000 ft occurred in the absence of a surface-based inversion.

Continued on Page 2

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Executive Summary, *continued*

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

Goal — Conduct a study on rapidly-developing low cloud ceiling events at the Shuttle Landing Facility (SLF) 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 Spaceflight Meteorology Group (SMG) and 45 WS forecasters. The ability to forecast low cloud ceilings at night will improve support to nighttime shuttle launches and landings.

Milestones — Identified possible nighttime stable low cloud events for the years 1994–2005 and analyzed temperature inversions, relative humidity, and winds in the CCAFS soundings for the same period. Restored archived satellite data from tape and copied it into MIDDS.

Discussion — Surface observations from the SLF were analyzed to identify possible events in which nighttime low ceilings developed in the absence of precipitation or fog. About 30 possible events per year were identified, but satellite data and soundings were not available for each event. There were only 37 possible events in which both satellite and sounding data were adequate. As a result, additional satellite data will need to be ordered. CCAFS soundings at 2200 and 1000 UTC were analyzed, in order to classify the thermodynamic environment in which the stable low cloud events occur.

Task — Anvil Threat Corridor Forecast Tool in AWIPS

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 — Developed a GUI and software, integrated the GUI and software into AWIPS, wrote installation instructions and a draft Users Guide. Delivered the GUI, software, installation instructions and Users Guide to SMG.

Discussion — The GUI and supporting software was developed, integrated into the AMU developmental AWIPS and tested prior to delivery to SMG. Some errors were noted and will be addressed after the SMG review. The Users Guide was written during AMU testing of the software and was also delivered to SMG for review.

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Executive Summary, *continued*

Task — Volume Averaged Height Integrated Radar Reflectivity (VAHIRR)

Goal Transition the VAHIRR algorithm into operations using WSR-88D data. 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 Implemented a real-time National Weather Service (NWS) Melbourne, FL (MLB) Weather Surveillance Radar 1988 Doppler (WSR-88D) Level II data feed for the stand-alone Open Systems Radar Product Generator (ORPG).

Discussion The server in the AMU is being used to disseminate real-time NWS MLB WSR-88D data to a stand-alone ORPG. ENSCO first tested integration with a developmental ORPG, and the VAHIRR algorithm was successful in creating a product from the data. ENSCO then installed an operational ORPG in the AMU where testing of the VAHIRR algorithm using real-time data is in progress.

Task — Weather Research and Forecasting (WRF) Model Sensitivity Study

Goal Conduct several WRF sensitivity case studies to determine the best configuration to use operationally at SMG and NWS MLB for predicting warm season convective initiation. Determining the best model configuration will assist forecasters in their short-term thunderstorm forecasting for the general public and evaluating flight rules and launch commit criteria.

Milestones Acquired data for seven convective initiation days with different flow regimes over east-central Florida. Modified scripts in order to run the Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS)-WRF model configuration and began preliminary model runs. Began to install and configure the Local Analysis and Prediction System (LAPS) software to initialize the WRF model.

Discussion All data for candidate convective initiation days were archived in order to run future tests on each combination of WRF initializations. The scripts used to initialize the WRF model with ADAS were modified to accomplish the initialization. All the needed software was obtained and installed for converting raw data to a form usable by the LAPS software. Scripts are being written for configuring and running LAPS.

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

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

The 45th Weather Squadron (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 launch commit criteria (LCC), evaluating flight rules (FR), and planning for daily ground operation activities on Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS). The AMU developed a set of logistic regression equations that calculate the probability of lightning occurrence 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 requested that warm season data from the years 2004 and 2005 be added to the 15-year 1989–2003 data set. They also requested modifications to the data that are input to the equations in the hope of improving their accuracy.

MIDDS Tool

Ms. Lambert noticed that the MIDDS tool, created using the Man-computer Interactive Data Access System (McIDAS) BASIC Language Interpreter (McBASI), sometimes retrieved incorrect stability parameter values. She and Mr. Paul Wahner of Computer Sciences Raytheon (CSR) found the cause to be the sounding data source. The GUI uses the 1000 UTC CCAFS (XMR) sounding that is re-transmitted to MIDDS from the NOAAPort system. If that sounding is not received, the GUI returns values from the most recent 1000 UTC sounding, which would be at least 24 hours old.

At the last AMU Quarterly Report teleconference, the customers requested that the GUI use the same data source as that used to create the equations. The sounding data for the equation development came directly from CCAFS Weather Station A before being processed through the NOAAPort system. The weather station soundings contain three types of levels: thousand-foot, mandatory, and significant. Ms. Lambert used the mandatory and significant levels in the equation development. Mr. Wahner found a MIDDS routine named SKEWTJ that calculates stability parameters using all three level types from the weather station sounding data and the same McIDAS routines as used in MIDDS and for the equation development. He modified the GUI to use this routine, and then performed tests to ensure it was running properly and to compare its output to that from the original GUI.

There were some differences in the values of the stability parameters between the two GUIs. On one particular day, the Lifted Indices calculated by the original and new GUIs were -1.6 and -0.6, resulting in probabilities of 68% and 64%, respectively. Given that the only difference is the data source, Ms. Lambert and Mr. Wahner assumed that differences in the number of levels between the two soundings must account for the difference.

Ms. Lambert informed the customers at the Spaceflight Meteorology Group (SMG) and 45 WS of the new GUI and the differences in output. They both agreed that the new GUI would be most appropriate as it uses data from the same source (MIDDS), even though that data included the thousand-foot data not used in the equation development. Ms. Lambert will compare the results from the new GUI with that of the Excel GUI to ensure they calculate the same probabilities before delivering the GUI.

Flow Regime Discriminator

After stratifying the days by flow regime in the Phase 1 work, Ms Lambert found that 44% of the days could not be categorized into any of the defined regimes. Given that lightning occurred on 45% of those days, they could not be discounted. Therefore, Ms. Lambert stratified them into a new flow regime category named ‘Other’. The 45 WS suggested that perhaps the low-level winds in the 1000 UTC XMR sounding could be used to determine a flow regime for the ‘Other’ days for the Phase II work. This would reduce the number of days in that category and increase the number of days in the defined categories such that more robust statistics could be calculated.

Ms. Lambert determined the ‘synoptic’ flow regime of the day using a combination of the average 1000–700 mb wind directions at from the 1200 UTC Miami (MFL), Tampa (TBW), and Jacksonville (JAX), FL soundings, as outlined in Lericos et al. (2002). She then calculated the average 1000–700 mb wind direction at XMR for all available 1000 UTC soundings, which she used to determine the ‘local’ flow regime of the day. Since there are two regimes each for southeast and southwest flow, Ms. Lambert consulted with Mr. Roeder of the 45 WS to determine which regime would be used when the XMR mean direction was from the southeast or southwest. They decided the default regimes would be SE-2 and SW-1, regimes in which the ridge is south of JAX/north of TBW and south of TBW/north of MFL, respectively. Ms. Lambert developed an algorithm with the following logic:

- If the local flow regime is not missing
  - If synoptic regime is ‘Other’, replace with local regime.
  - If synoptic regime is ‘Missing’, replace with local regime.
  - If synoptic regime is ‘SW-2’, replace with local regime if it is ‘SE-1’.
  - If synoptic regime is ‘SE-1’, replace with local regime if it is ‘SW-2’
- If the local flow regime is missing, do not change the synoptic regime.

The last two if statements under “If the local flow regime is not missing” are to account for times when the ridge was just north or south of the KSC/CCAFS area. For example, it is possible that the average direction in the 1200 UTC soundings could determine that the ridge was north of TBW, but the flow at XMR indicated the ridge was actually south of the KSC/CCAFS area. These two statements were executed infrequently. There were 59 cases in which the synoptic SE-1 flow was changed to SW-2, and only 18 cases in which the synoptic SW-2 flow was changed to SE-1.

The changes to number of days for each flow regime after this algorithm was applied are shown in Table 1. The bold black numbers in the ‘After’ column show an increase in the number of days and the bold red numbers show a decrease. The algorithm increased the number of SW-2, SE-1, NW, and NE cases, and also reduced the number of Other and Missing days by ~70%. The SW-1 and SE-2 regimes did not change. This was due to the fact that southeast flow at XMR was considered to be the SE-1 regime and southwest flow was considered to be the SW-2 regime. The synoptic regimes could only be replaced by one of these two regimes.

Table 1. Results of replacing the synoptic flow regime using the local flow regime at XMR.

Flow Regimes	*Before*	*After*
SW-1	301	301
SW-2	256	**606**
SE-1	318	**438**
SE-2	248	248
NW	100	**307**
NE	114	**317**
Missing	187	**58**
Other	1077	**326**

New Valid Area

The valid area for cloud-to-ground (CG) lightning occurrence in Phase I was the entire area shown in Figure 1. For Phase II, the 45 WS requested that the valid area be reduced to include only the 10 circles on KSC and CCAFS, those circles to the right of the vertical black line in Figure 1. While the 45 WS is responsible for providing warnings to Astrotech, they are not required to consider it in their daily planning forecasts, which is the purpose of the equations.

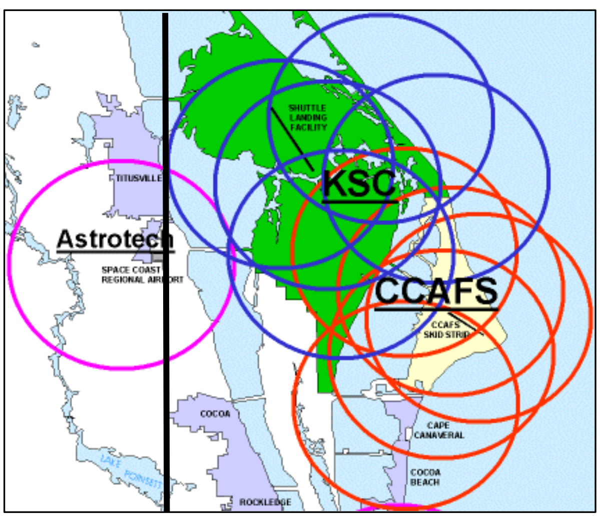

Figure 1. The 5 n mi lightning warning circles on KSC/CCAFS and Astrotech. The valid area for the Phase II work is within the 10 blue (KSC) and red (CCAFS) circles with centers to the right of the vertical black line.

While it is a more simple computation to use the area of a rectangle than to determine whether each strike occurred within one or more of the warning circles, this procedure includes areas not inside the warning circles. Lightning strikes in these areas could bias the calculations such that higher probabilities would be created that are unrepresentative of the area inside the circles. Ms. Lambert devised a mathematical algorithm that determined how far each strike occurred from the center of each of the 10 circles. Those strikes within 5 n mi of any circle were considered in the valid area, and the day on which those strikes occurred was considered a lightning day. As with Phase I, the number of strikes was not considered in the lightning occurrence probabilities. Lightning occurrence in this new valid area was used to determine lightning and non-lightning days, which were then used to calculate new probabilities of lightning occurrence based on flow regime.

New Flow Regime Lightning Probability Tables

After using XMR data as a flow regime discriminator and calculating lightning occurrence in the new valid area, Ms. Lambert updated the flow regime lightning probability tables. She distributed the six tables, one for each warm season month and one for the entire season, and an associated descriptive memorandum (Lambert 2006) to the customers. The Phase II probability values were, on average, ~11% less than the values from Phase I due to the decrease in size of the valid area and a smaller average flash density in that area.

The tables also showed the percent improvement of the flow regime lightning probabilities over the forecast benchmarks of 1-day persistence. Because of the new 2004-2005 data, creating a new valid area, and determining the flow regime with the aid of XMR data, Ms. Lambert had to re-create this benchmark.

The 1-day persistence was straightforward: If lightning occurred on the previous day, the forecast would be for lightning on the current day. April 30 was used to determine the 1-day persistence for May 1 in all years. In every month, the flow regime lightning probabilities showed a percent improvement over a 1-day persistence forecast ranging from 32–42%.

New Daily Lightning Probability

Also due to the longer period of record (POR), the new flow regime days, and the new valid area, Ms. Lambert re-calculated the daily lightning probabilities. These values were used in Phase I as predictors in all five equations, and were also used as forecast benchmarks when testing the performance of the equations.

She began the calculation with summing the number of years in which lightning occurred on each day in the warm season. With a 17-year POR, the maximum number per day is 17. Ms. Lambert divided the number for each day by 17 to calculate a raw climatology, shown as the thin black curve in Figure 2.

Seventeen is a small number of observations from which to calculate a robust climatology. A common procedure to minimize the noisiness of a curve is to use a weighted average of the observations several days before and after the day of interest. This increases the number of observations artificially to infer what the long-term climatology would be if enough observations were available. In Phase II as in Phase I, Ms. Lambert used a Gaussian weighting function to accomplish the smoothing defined by the equation

$$P = \frac{1}{N}\left\{\frac{\sum_{k=1}^{7}\left[W(F_{n-k}+F_{n+k})\right]+F_n}{\sum_{k=1}^{7}\left[W*2\right]+1}\right\},$$

where W is the Gaussian weighting function

$$W = \exp\left[\frac{-\left(k^2\right)}{2*\sigma^2}\right],$$

P = climatological probability on the day of interest,

N = number of years in the POR (17),

F = raw probability on day of interest,

n = day number of interest, and

k = number of days distant from n.

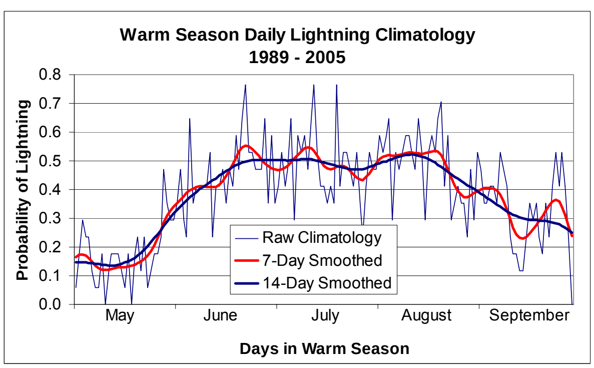

Figure 2. The climatological daily raw (thin black curve), 7-day smoothed probabilities (red curve), and 14-day smoothed probabilities (dark blue curve) for the warm-season months in 1989–2005.

As requested by the 45 WS, she used a 14-day smoothing function (range of k = ±14, σ = 7) instead of the 7-day function used in Phase I. This created a smoother curve through the warm season. For comparison, Figure 2 contains the probabilities from the 7-day smoother along the red curve and those from the 14-day smoother along the dark blue curve. Ms. Lambert will use the values along the dark blue curve as candidate predictors in the new equation development for each month, and as a forecast benchmark to determine the performance of the new equations.

Optimal RH Layer

The average relative humidity (RH) in the 800–600 mb layer is an important predictor in four of the five equations developed in Phase I. This parameter was determined as valuable in the study that created the Neumann-Pfeffer Thunderstorm Index (Neumann 1971) over 30 years ago. It has been used in several studies since that time, but no rigorous attempts have been made to determine if 800–600 mb is truly the optimal layer for this predictor. In collaboration with Mr. Roeder of the 45 WS, Ms. Lambert employed an iterative technique to determine the optimal layer for the average RH calculation using the 1000 UTC XMR sounding.

Ms. Lambert began by calculating the average RH in 15 200-mb levels between 950 and 400 mb, the base of each layer incremented by 25 mb from 950–600 mb. She then determined the layer with the highest linear correlation to lightning occurrence for each month. The centers of the five layers were all within 50 mb of each other. Ms. Lambert used the center of these five layers for a subsequent test in which the average RH in 24 layers ranging from 25 to 400 mb thick were calculated, and then correlated to lightning occurrence in each month. Layers that ranged in thickness from 25 to 300 mb showed the highest correlations, and the differences in correlation values were insignificant.

Given the closeness of the center layers for each month and the insignificant differences in correlation between different layer thicknesses within each month, Ms. Lambert and Mr. Roeder decided to combine all the data and create one optimal layer for the season. Ms. Lambert followed the same procedure outlined above and found that the 825-525 mb layer-averaged RH is the most highly correlated to lightning occurrence in the warm season.

Equation Development and Testing

Ms. Lambert began calculating all of the stability and moisture parameters from the 1000 UTC XMR soundings that will be used as candidate predictors in the equation development. She will begin equation development and testing in the next quarter.

Contact Ms Lambert at 321-853-8130 or lambert.winfred@ensco.com for more information and for a copy of the flow regime lightning probability tables and memorandum.

Peak Wind Tool for General Forecasting (Dr. Short and Ms. Lambert)

The expected peak wind speed for the day is an important element in the daily morning forecast for ground and space launch operations at KSC and CCAFS. The 45 WS must issue forecast advisories for KSC/CCAFS when they expect peak gusts to exceed 35 kt, 50 kt, and 60 kt thresholds at any level from the surface to 300 ft. However, the 45 WS forecasters indicate that peak wind speeds are a challenging parameter to forecast, regardless of their value. They requested that the AMU develop a tool that will help them forecast the daily average and highest peak non-convective wind speed, and the timing of the peak speed, from the surface to 300 ft on KSC/CCAFS for the cool season (October-April). The AMU will use a 4-year database of high resolution soundings and other observational data available by the morning weather briefing at 0700 local time to develop a tool that provides a forecast of the peak wind speed for the day, its timing, and the average wind speed at the time of the peak.

AFWA Meteorological Techniques

The Air Force Weather Agency (AFWA) publication on Meteorological Techniques (AFWA 2005) provides general guidelines on forecasting surface wind speed in Chapter 1, Section III. One method of particular interest for this task involves an analysis of the morning sounding to forecast wind speed later in the day. The guidelines suggest that low-level temperature inversions can shield the surface from higher wind speeds aloft until the inversion breaks due to surface heating. One guideline reads as follows: “If winds increase above the inversion (and the inversion is below 5,000 feet), expect maximum gusts during maximum heating to be 80 percent of the 5,000 feet wind speed.” This AFWA publication also provides the caveat that this and other guidelines are only general estimates. Actual values may differ widely due to local terrain, and should be determined locally from forecast studies.

High Resolution Sounding Data

Dr. Short acquired a 4-year database of XMR high-resolution morning soundings from Mr. Wahner of CSR. The soundings were taken within an hour of 1000 UTC during the cool seasons in the period 1 October 2002 – 10 April 2006. A total of 720 soundings were available, representing 87% of the 829 days in the POR. The soundings have a vertical resolution of 100 ft and include wind speed and direction, pressure, temperature, and dew point temperature from the surface to approximately 100 000 ft. The analysis will focus on the lowest 8000 ft of each sounding, the region where non-convective wind speeds aloft can directly affect wind speeds near the ground.

Initial Analysis of High-Resolution Soundings

Dr. Short performed an initial analysis of the sounding data to identify the surface-based temperature inversions. Approximately 65% of available soundings had a surface-based inversion, where the temperature at the first 100 ft level above the surface was higher than the surface temperature. Figure 3 shows average temperature profiles up to 5000 ft from soundings with and without a surface-based temperature inversion.

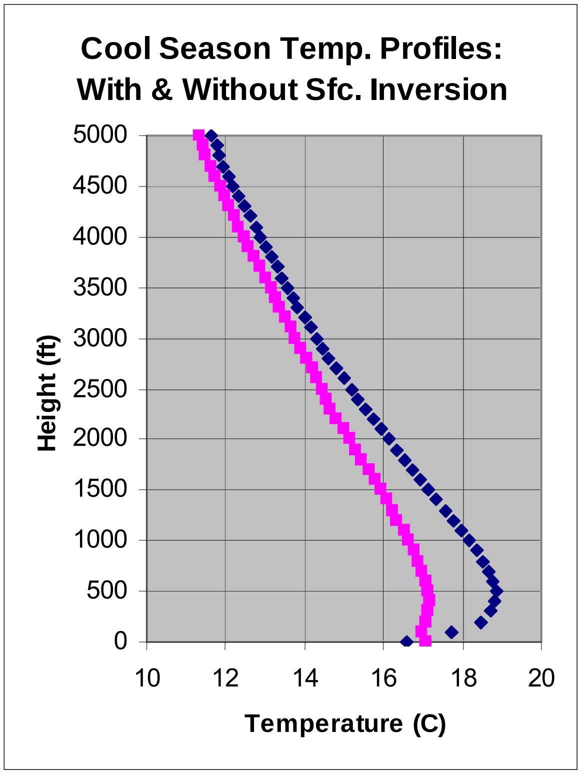

Figure 3. Temperature (C) versus height (ft) for cool season profiles with (dark blue diamonds) and without (pink squares) a surface-based inversion. Sample sizes are 466 (with; dark blue) and 254 (without; pink).

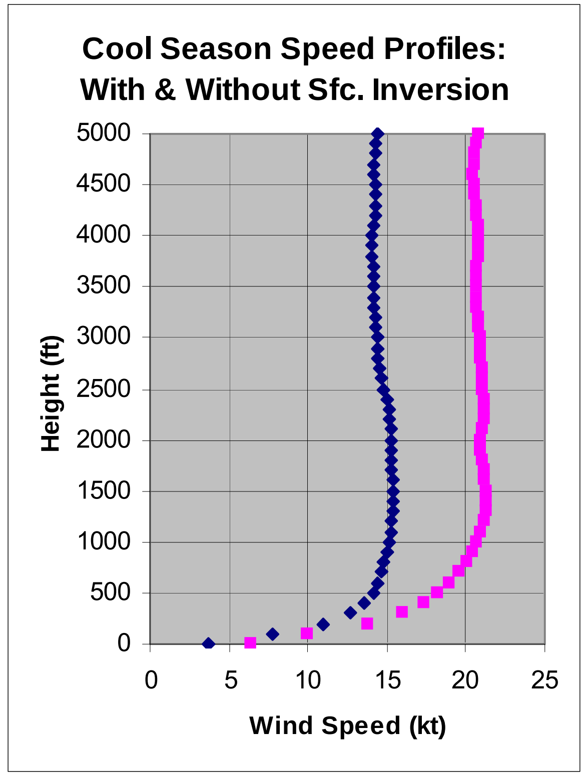

Figure 4. Wind speed (kt) versus height (ft) for cool seasons profiles with (dark blue diamonds) and without (pink squares) a surface-based inversion. Sample sizes are 466 (with; dark blue) and 254 (without; pink).

The average surface-based temperature inversion shown in Figure 3 was about 500 ft. Above that, the temperature decreased from 18.1 °C at 1000 ft to 12.9 °C at 4000 ft, a lapse rate of 5.2 C° per 3000 ft, about half that of the dry adiabatic lapse rate of 3 °C per 1000 ft, and close to the moist adiabatic lapse rate.

Figure 4 shows average wind speed profiles up to 5000 ft from soundings with and without surface-based temperature inversions. Wind speed increased rapidly from the surface to about 1000 ft for both cases. Above that level, the average wind speed for cases with a surface-based inversion remained nearly constant at about 15 kt, whereas the average for cases without a surface-based inversion remained nearly constant at about 21 kts.

The wind speed profiles shown in Figure 4 reveal that surface-based inversions in the database were associated with lower wind speeds aloft and near the surface. Dr. Short and Ms. Lambert will pursue further investigations of wind speed data from the tower network on KSC/CCAFS to determine statistics of the peak wind-speed-of the-day with, and without surface based temperature inversions.

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

Using a software program created by Mr. Barrett, he and Dr. Bauman analyzed SLF surface observations from 1994-2005 for all cool season days (November–March) when a ceiling was observed. They removed from consideration all the observations that contained a ceiling with the occurrence of fog and/or precipitation. The remaining observations with ceilings were used to determine if they were associated with stable low cloud development events. The following criteria were used to identify the beginning of a possible event:

- No low ceilings, precipitation, or fog occurred within the previous three hours,
- An event must start between 2200 UTC and 1200 UTC, since only nighttime events were considered,
- Events in which high clouds would obscure low clouds were not used, because it was impossible to distinguish between low cloud rapid development and advection in the satellite imagery, and
- Events in which low clouds developed over several hours were not used, since only rapid development is a concern in this task.

The following criteria were used to identify the end of a possible event:

- Precipitation or fog occurred within three hours,
- Events must have ended by 1200 UTC, since only nighttime events were considered, and
- The ceilings dissipated or rose to above 8000 ft.

Mr. Barrett and Dr. Bauman identified 360 possible events through this algorithm, approximately 30 events per year. Of those 360 possible ceiling events the AMU had archived infrared satellite imagery for only 48. However, only 37 of those 48 had both the 2200 and 1000 UTC XMR soundings, which were needed to analyze the nighttime thermodynamic environment. Mr. Barrett ordered additional satellite imagery from the NOAA Comprehensive Large Array-data Stewardship System (CLASS) for the possible events in which archived satellite imagery was missing. Mr. Barrett and Dr. Bauman created a Microsoft® Excel© spreadsheet that contained the start and end times of possible stable low cloud events as well as the available satellite imagery and sounding data that were available for those events. Based on all of the data in the spreadsheet, Dr. Bauman began to review the satellite imagery that Mr. Barrett installed on MIDDS to determine if the infrared imagery was of high enough resolution to determine whether or not rapidly developing stable low cloud events could be identified.

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.

INSTRUMENTATION AND MEASUREMENT

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

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.

Mr. Keen developed the GUI (Figure 5) that is accessible from the Tools dropdown menu in AWIPS (Figure 6). Mr. Keen and Mr. Barrett converted the McBASI code that calculates the layer-averaged wind velocity into the Tool Command Language (Tcl) code used in AWIPS. The program can read in and use observed sounding data, KSC 50 MHz wind profiler data and model forecasts from the Rapid Update Cycle (RUC), Weather Research and Forecasting (WRF) model and Global Forecast System (GFS) model to calculate the layer averaged wind velocity. They also converted the code that determines the latitude/longitude points to plot the graphical threat sector (Figure 7) in AWIPS.

Mr. Barrett installed the code for the GUI and threat sector plotting routine on the AMU developmental AWIPS. Dr. Bauman tested the GUI and plotting functions and wrote a draft Users Guide based on the testing he conducted. Dr. Bauman then delivered the GUI and threat sector plotting code to Mr. Lafosse and Mr. Hoeth at SMG for testing on their AWIPS.

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 on this task.

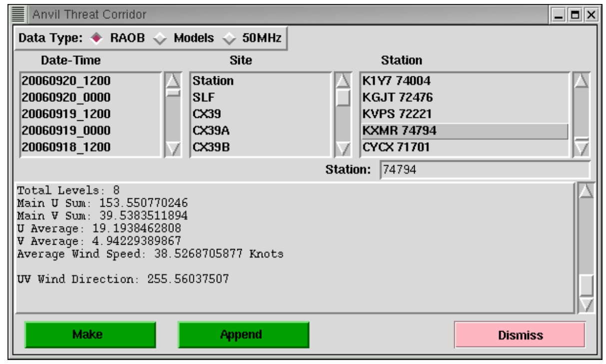

Figure 5. With the Anvil Tool GUI, users can select from three types of data (RAOB, Models and 50 MHz Profiler), the date-time of the data, the center point of the graphical plot (Site) and data source (Station). The wind information derived from the data source is displayed in the bottom half of the GUI.

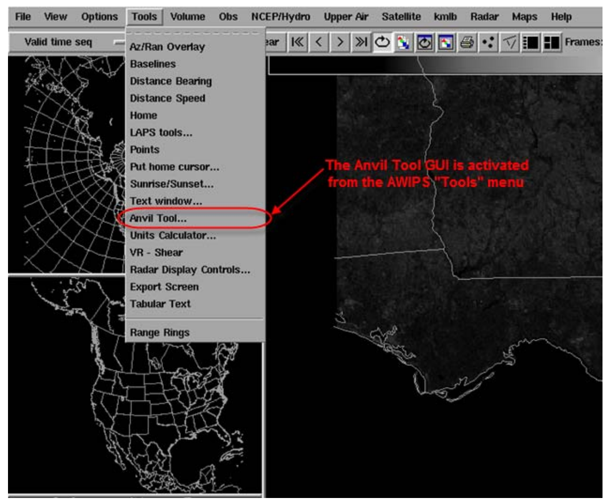

Figure 6. The Anvil Tool GUI is accessed from the "Tools" dropdown menu on the AWIPS Main Menu.

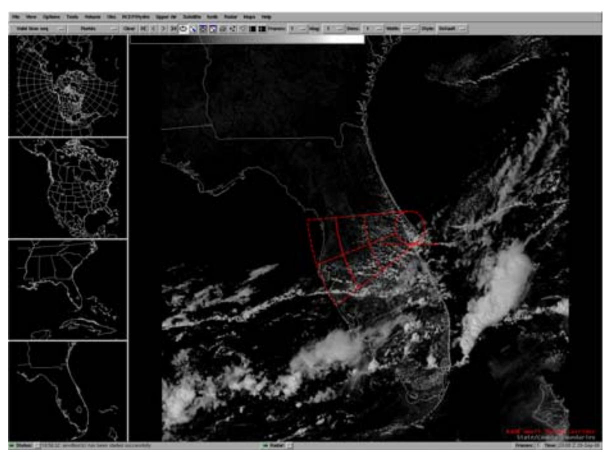

Figure 7. AWIPS display showing the Anvil Tool threat sector based on the XMR sounding.

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.

Mr. Keen installed and configured a Local Data Manager (LDM) on the development Open Systems Radar Product Generator (ORPG) machine located at the ENSCO facility in Cocoa Beach. He and Ms. Miller set up the development ORPG to read a live feed of National Weather Service (NWS) Melbourne, FL (MLB) Weather Surveillance Radar 1988 Doppler (WSR-88D) Level II data from the AMU's data server, via the LDM. The VAHIRR algorithm successfully created an output product from this data. An example is shown in Figure 8. The output product is viewable only by a local display tool. The VAHIRR algorithm used NWS MLB WSR-88D data as input. VAHIRR values are only calculated for grid points where the lowest and highest elevation scans lie outside of a cloud. Disqualified grid points are displayed in white, while negative or zero VAHIRR values are displayed in black.

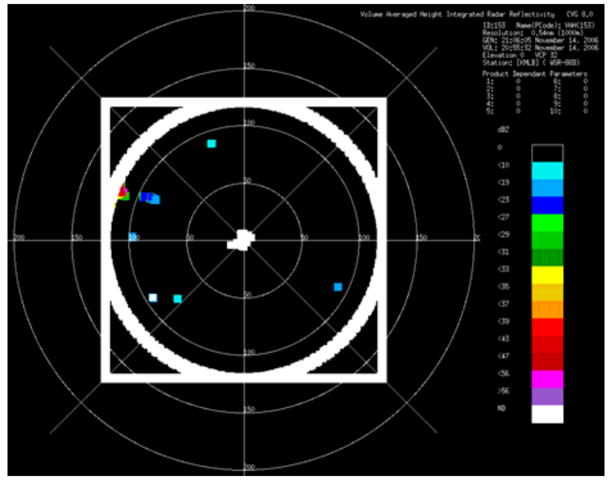

Figure 8. VAHIRR output product centered over East Central Florida. The VAHIRR values in the legend at right have units dBZ-kft.

Mr. Barrett installed the Common Operations and Development Environment (CODE) and ORPG software on a Red Hat Linux machine. This machine will be used as an operational ORPG at the AMU to create the VAHIRR product, using a live feed of radar data. Mr. Barrett and Ms. Miller also installed and configured LDM on this machine. They are in the process of testing the VAHIRR algorithm at the AMU with the LDM feed. After this testing is complete, they will set up the ORPG to copy the real-time output products to AWIPS.

For more information on this task, contact Ms. Miller at miller.juli@ensco.com or 321-783-9735 ext. 221; Mr. Gillen at 321-783-9735 ext. 210 or gillen.robert@ensco.com; Mr. Barrett at 321-853-8205 or barrett.joe@ensco.com, or Dr. Merceret at Francis.J.Merceret@nasa.gov or 321-867-0818.

MESOSCALE MODELING

Weather Research and Forecasting (WRF) Model Sensitivity Study (Dr. Watson)

The WRF model is the next generation community mesoscale model designed to enhance collaboration between the research and operational sectors. The SMG and the NWS MLB are moving forward with implementing the WRF model operationally into their AWIPS systems. The WRF model has two dynamical cores – the Advanced Research WRF (ARW) and the Non-hydrostatic Mesoscale Model (NMM). There are also two options for the initialization of the WRF model – the Local Analysis and Prediction System (LAPS) and the Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS). Having a series of initialization options and WRF cores, as well as many options within each core, provides SMG and NWS MLB with a lot of flexibility as well as challenges. This includes determining which configuration options are best to address specific forecast concerns. The goal of this task to assess the different configurations available and to determine which configuration will best predict warm season convective initiation. To accomplish this, the AMU was tasked to

- Compare the WRF model performance using ADAS versus LAPS for the ARW and NMM model cores,
- Compare the impact of using a high-resolution local forecast grid with 2-way, 1-way, and no nesting, and
- Examine the impact of assimilating soil moisture sensor data on WRF model performance.

Determining Convective Initiation Days

The first step in the task was to identify candidate days for convective initiation during the summer (July–September) season. Dr. Watson identified seven candidate convective initiation days in this period for the model comparison studies. There were three different large scale flow patterns over the east-central Florida region on these days: easterly, southerly, and southwesterly. In addition, Dr. Watson will identify two null cases (non-convection days) and use them in the comparison studies.

Dr. Watson archived the RUC and the North American Mesoscale (NAM) model data, WSR-88D Level II radar data, GOES-12 satellite data, and surface data from the summer season in order to run future tests on each combination of WRF initializations. Figure 9 shows 3-hourly images of WSR-88D Level II radar reflectivity data from one convection event on 17 August 2006.

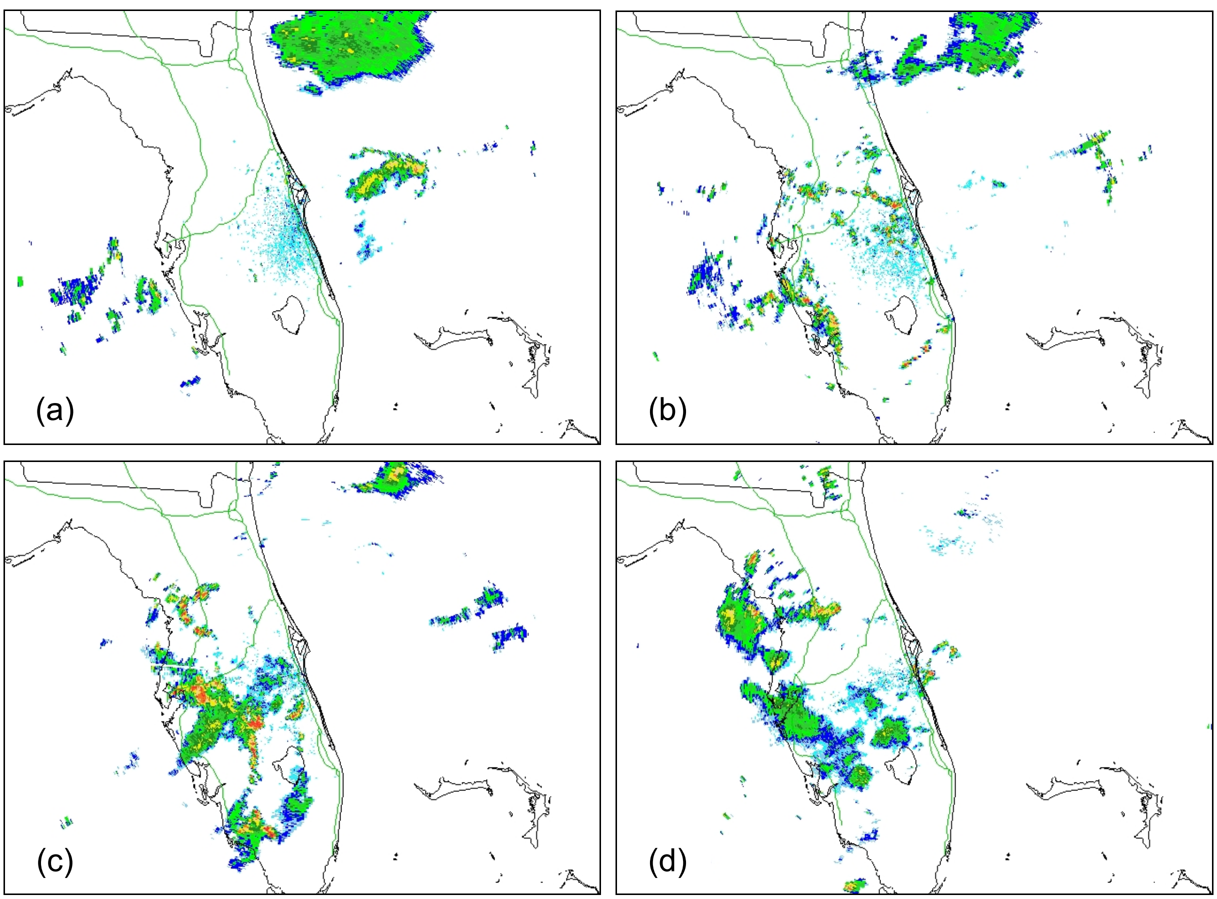

Figure 9. WSR-88D Level II radar reflectivity data displays depicting a warm season convective initiation event on 17 August 2006 at (a) 1500 UTC, (b) 1800 UTC, (c) 2100 UTC, and (d) 0000 UTC 18 August 2006.

ADAS/WRF & LAPS/WRF Model Configuration

Dr. Watson used scripts written by Mr. Jonathan Case to initialize the WRF model with output from ADAS. These scripts formed the core for running ADAS to initialize the WRF ARW model directly or to initialize data for use in the WRF Environmental Modeling System (EMS). The WRF EMS has the capability of running either the ARW or NMM versions of WRF. Dr. Watson modified the scripts written by Mr. Case in order to run archived data cases and to use the Grid Analysis and Display System (GrADS) to create the output graphics.

Each model run in the sensitivity study will be integrated 12 hours with 3 runs per day, at 0900, 1200, and 1500 UTC. The possibility of adding a 0600 UTC run exists as well. Due to the limitations of the RUC data, Dr. Watson will investigate the possibility of using the NAM model data for initial and boundary conditions for each model run. The RUC data would limit model runs to 9 hours, while the NAM data would allow for a 12-hour model integration and possibly up to a 21-hour integration.

Dr. Watson made preliminary test runs using ADAS to initialize the WRF ARW model directly. The model test domain covers the entire Florida peninsula and adjacent coastal waters at a grid spacing of 4 km. Three-hourly composite reflectivity from an ADAS/ARW simulation initialized at 1500 UTC 17 August 2006 is shown in Figure 10. At the model initial time (Figure 10a), a small area precipitation occurred off the east coast of Florida. Over the following 9 hours, precipitation occurred east of Cape Canaveral and along the west coast of Florida and then throughout the peninsula of Florida. Comparison of the model simulated versus observed composite reflectivity in Figure 9 demonstrates that the ADAS/ARW configuration performed reasonably well in simulating this case convective initiation.

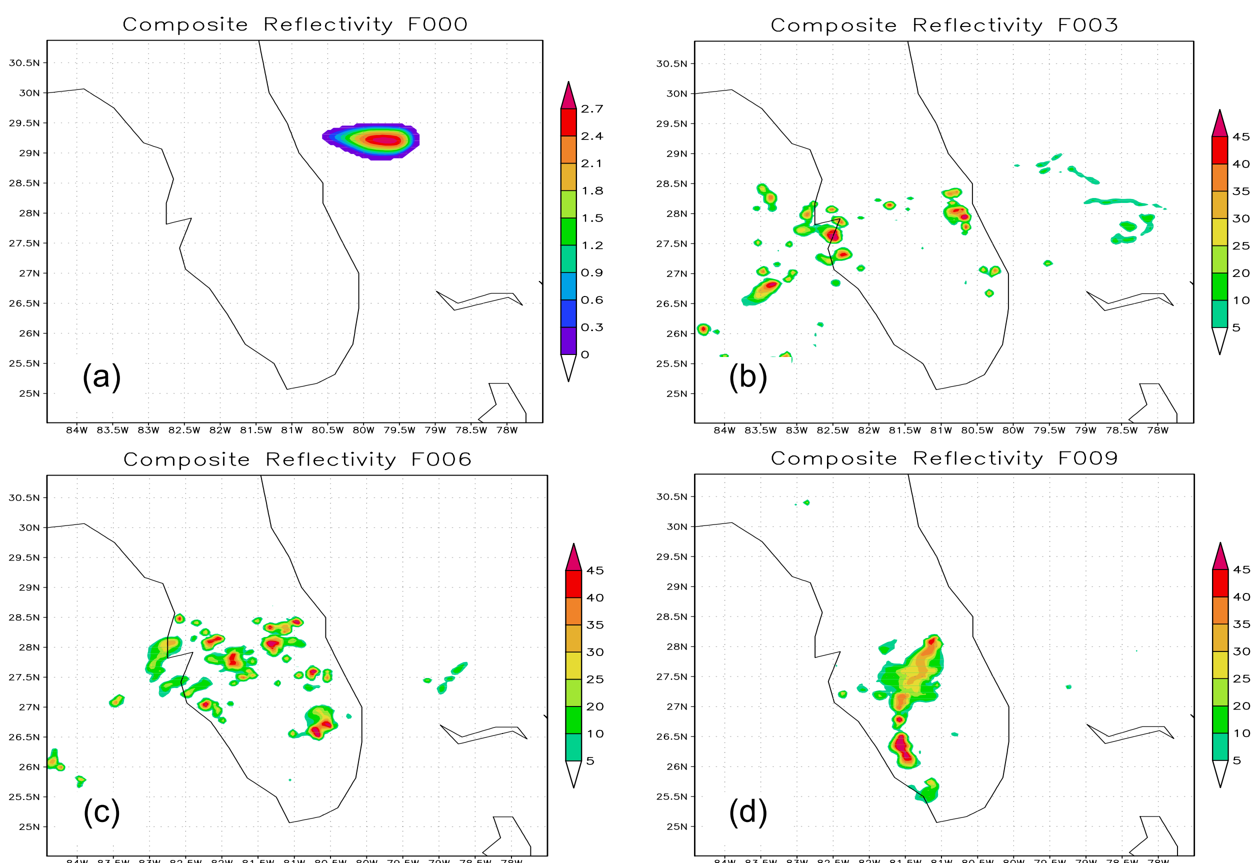

Figure 10. ADAS/ARW-predicted composite reflectivity depicting warm-season convective initiation from the 1500 UTC 17 August model run, with valid times at (a) 1500 UTC (0-h forecast), (b) 1800 UTC (3-h forecast), (c) 2100 UTC (6-h forecast), (d) 0000 UTC 18 August (9-h forecast).

Unfortunately, ADAS cannot be used to initialize the WRF NMM model directly as there is no routine to convert from the ARPS grid to the WRF NMM rotated latitude-longitude grid. However, by using the WRF EMS software it is possible to use ADAS to initialize either the ARW or NMM core, with one caveat. In the current version of the WRF EMS software, the cloud and precipitation microphysics cannot be initialized, which prohibits a “hot-start” initialization of WRF. Through conversations with Mr. Case and Dr. Robert Rozulmalski at COMET, Dr. Watson learned of existing code at the Global Systems Division (GSD) of the Earth System Research Laboratory (ESRL) to correct this issue. This code fix will be included in the next WRF EMS update that she will implement on the AMU modeling cluster.

Dr. Watson also began the process of setting up and configuring the LAPS software. The first step in this process was to convert the raw data into the NetCDF format to make it acceptable for ingest into the LAPS software. Dr. Watson corresponded with personnel at GSD regarding software for converting raw WSR-88D Level II radar data to NetCDF format. She obtained and installed the precompiled binary files that she received from GSD. She also obtained and installed software for converting GOES-12 satellite data in McIDAS AREA file format to NetCDF format. Dr. Watson is currently writing scripts to configure and run LAPS.

For more information, contact Dr. Watson at watson.leela@ensco.com or 321-853-8264.

AMU CHIEF’S TECHNICAL ACTIVITIES (Dr. Merceret)

Dr. Merceret began work on a KSC Innovative Partnership Program project with ENSCO called GEMSTONE, a separate contract from the AMU. GEMSTONE aims to develop and test-fly a solar-powered constant-level long-duration balloon sonde for volume initialization of numerical models. He also analyzed alternate configurations of the Eastern Range 915-MHz boundary layer wind profiler network as requested by the Range Technical Services Contractor, CSR.

Dr. Merceret reviewed weather support requirements documents for the new Constellation program to ensure that they were accurate and complete. He also began organizing a Technical Interchange Meeting to examine requirements, infrastructure, and concepts of operation with the meteorological and engineering communities.

AMU OPERATIONS

System engineer Mr. Derek Monaghan from ENSCO's Information Systems & Technology (IST) Division initiated and completed IP restructuring of all AMU computer systems as part of the ENSCO-wide IP restructuring scheme.

System engineers Mr. John Artman and Ms. Mary Etta Trembly from ENSCO's IST Division powered on the new AMU numerical weather prediction (NWP) modeling cluster and installed the operating system and other services necessary to install and run the NWP models for AMU tasks.

Due to the excessive noise and heat it created, Dr. Bauman requested to move the cluster to ENSCO’s Melbourne office as sufficient power and air conditioning are available in their server room. The cluster was moved to ENSCO’s Melbourne office and powered on. Heat sensing power strips monitor the ambient temperature in the room. When a predetermined threshold is reached the cluster will be powered down gracefully to prevent damage to the system.

All AMU computer systems were powered down on 29 August and the AMU was not staffed on 30 August due to declared HURCON II conditions for the approaching Tropical Storm Ernesto. Computer systems and the AMU staff were fully operational on 31 August.

As part of the Anvil Tool in AWIPS task, Mr. Barrett and Mr. Keen noticed that significant wind level data for XMR was not being ingested into AWIPS. Also, the AMPS upper-air data in AWIPS were not current and the Skew-T analysis program could not read the AMPS data properly. Mr. Barrett verified that other AWIPS servers were also missing XMR significant wind data at CCAFS and Vandenberg AFB as well as NWS offices. The AMU verified that XMR data was being received at AFWA, but possibly not transmitted to the National Centers for Environmental Prediction (via AFWA). In addition, the MIDDS in the AMU and 45 WS were missing significant wind level data, but still receiving the full set of CCAFS AMPS data. Mr. Barrett reported this deficiency to the 45 WS for their action.

Mr. Barrett developed an Excel spreadsheet to record and track all the software installed on AMU systems, and another to record the updated AMU network configuration. He passed the Brainbench MS Windows XP Desktop Administration test, the first of two tests that are required by the AMU system administrator. He also set up a PC workstation for the newest member of the AMU, Dr. Leela Watson. Mr. Barrett updated the PC and Linux data backup procedures and the AMU Hurricane Plan to reflect recent changes in the network configuration and backup procedures.

Ms. Lambert, Dr. Short, and Dr. Bauman supported the three launch attempts of Shuttle Discovery. Mr. Barrett traveled to Johnson Space Center to observe SMG operations during the landing, while Ms. Lambert supported the landing at the AMU. Dr. Short and Dr. Watson supported the launch of STS-115 and Mr. Barrett supported the landing. Dr. Bauman and Dr. Watson supported the Delta II/GPS launch.

REFERENCES

AFWA, 2005: Meteorological Techniques. AFWA TN-98/002, Revised 10 January 2005. Air Force Weather Agency/DNT, Offutt Air Force Base, Nebraska 68113.

Dye, J. E., M. G. Bateman, D. M. Mach, C. A. Grainger, H. J. Christian, H. C. Koons, E. P. Krider, F. J. Merceret, and J. C. Willett, 2006: The scientific basis for a radar-based lightning launch commit criterion for anvil clouds. Preprint 8.4, 12th Conf. on Aviation, Range, and Aerospace Meteorology, Atlanta, GA, Amer. Meteor. Soc., 4 pp. [Available online at: http://ams.confex.com/ams/pdfpapers/100563.pdf]

Hart, J.A., Lindsay, Robert, and Whistler, Jim, 1997: Sharp -v3.01(beta) Advanced Interactive Sounding Analysis for NAWIPS. NOAA/NWS, Storm Prediction Center, Aviation Weather Center.

Lambert, W., 2006: New Lightning Probabilities Based on Flow Regime. NASA Applied Meteorology Unit Memorandum, 7 pp. [Available from ENSCO, Inc., 1980 N. Atlantic Ave., Suite 230, Cocoa Beach, FL 32931].

Lericos, T. P., H. E. Fuelberg, A. I. Watson, and R. L. Holle, 2002: Warm season lightning distributions over the Florida Peninsula as related to synoptic patterns. *Wea. Forecasting*, **17**, 83 – 98.

Neumann, C. J., 1971: Thunderstorm forecasting at Cape Kennedy, Florida, utilizing multiple regression techniques. NOAA Technical Memorandum NWS SOS-8.

Willett, J. C., H. C. Koons, E. P. Krider, R. L. Walterscheid, and W. D. Rust, 1999: Natural and Triggered Lightning Launch Commit Criteria (LLCC), Aerospace Report A923563, Aerospace Corp., El Segundo, CA, 23 pp.

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
CCAFS	Cape Canaveral Air Force Station
CG	Cloud-to-Ground
CSR	Computer Sciences Raytheon
EMS	Environmental Modeling System
FR	Flight Rules
FSU	Florida State University
FY	Fiscal Year
GFS	Global Forecasting System
GSD	Global Systems Division
GUI	Graphical User Interface
JAX	Jacksonville, FL 3-letter identifier
JSC	Johnson Space Center
KSC	Kennedy Space Center
LAPS	Local Analysis and Prediction
LCC	Launch Commit Criteria
LDM	Local Data Manager
LLCC	Lightning LCC
McBASI	McIDAS BASIC Language Interpreter
McIDAS	Man Computer Interactive Data Access System
MFL	Miami, FL 3-letter identifier
MIDDS	Meteorological Interactive Data Display System
MSFC	Marshall Space Flight Center
NAM	North American Mesoscale model
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NMM	Non-hydrostatic Mesoscale Model
NOAA	National Oceanic and Atmospheric Administration
NSSL	National Severe Storms Laboratory
NWP	Numerical Weather Prediction
NWS	National Weather Service
NWS MLB	NWS in Melbourne, FL
ORPG	Open Radar Product Generator
POR	Period of Record
RH	Relative Humidity
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
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 October 2006

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
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
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
Peak Wind Tool for General Forecasting	Data collection: wind towers, XMR 100-ft soundings, 915-MHz profilers	Sep 06	Oct 06	On Schedule
	Software development: wind tower data QC, sounding inversion detection, 915 MHz total power display	Sep 06	Dec 06	On Schedule
	Data analysis	Dec 06	Feb 07	On Schedule
	Interim evaluation	Feb 07	Mar 07	On Schedule
	Forecast tool development, if approved	Mar 07	May 07	On Schedule
	Final report	Jun 07	Jul 07	On Schedule

AMU Project Schedule
31 October 2006

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
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 MFL, 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*)	Completed - Delayed for reformatting of composite soundings
Anvil Forecast Tool in AWIPS	AWIPS training at GSD	Jul 05	Nov 05 (*Apr 06*)	Ongoing as needed
	Develop software for calculation and display of anvil threat corridor	Dec 05	Apr 06 (*Oct 06*)	Delayed due to delay in training
	Test and evaluate performance of the software	Apr 06	May 06 (*Oct 06*)	Delayed as above
	Final memorandum	May 06	June 06 (*Nov 06*)	Delayed as above

AMU Project Schedule 31 October 2006				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
Volume-Averaged Height Integrated Radar Reflectivity (VAHIRR)	Acquisition and setup of development system and preparation for Technical Advisory Committee meeting	Mar 05	Apr 05	Completed
	Software Recommendation and Enhancement Committee 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 (*Oct 06*)	Delayed as above
	Preparation of products for delivery and memorandum	Oct 05	Jan 06 (*Nov 06*)	Delayed as above
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

AMU Project Schedule 31 October 2006				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
WRF Model Sensitivity Tests	Identify candidate convective initiation days and archive data	Jul 06	Sep 06	Completed
	Configure LAPS to initialize WRF	Aug 06	Oct 06	On Schedule
	Compare LAPS-WRF vs. ADAS-WRF performance	Aug 06	Jan 07	On Schedule
	Compare use of high-resolution grid with 2-way, 1-way, and no nesting	Jan 07	Mar 07	On Schedule
	Assess impact of soil moisture data on WRF performance	Feb 07	Apr 07	On Schedule
	Final report and recommendations	Apr 07	Jun 07	On Schedule

NOTICE