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Applied Meteorology Unit (AMU) Quarterly Report

Fourth Quarter FY-04　　　　Contract NAS10-01052　　　　31 October 2004

Executive Summary

This report summarizes the Applied Meteorology Unit (AMU) activities for the fourth quarter of Fiscal Year 2004 (July - September 2004). A detailed project schedule is included in the Appendix.

Task　　　Objective Lightning Probability Forecast: Phase I

Goal　　Develop a set of statistical equations to forecast the probability of lightning occurrence for the day. This will aid forecasters in evaluating flight rules and determining the probability of launch commit criteria violations, as well as preparing forecasts for ground operations.

Milestones　Five equations were developed, one for each month in the warm season, to forecast the probability of lightning occurrence at Kennedy Space Center (KSC) / Cape Canaveral Air Force Station (CCAFS). Development of a graphical user interface (GUI) began to allow forecasters user-friendly access to the equations.

Discussion　The new equations show improved skill in forecasting daily lightning occurrence over forecasts using 1-day persistence, daily climatology, monthly climatology, and the flow regime lightning probabilities. These equations will be transitioned for operational use.

Task　　　Severe Weather Forecast Decision Aid

Goal　　Create a new forecast aid to improve the severe weather watches and warnings for the protection of KSC/CCAFS personnel and property.

Milestones　Lightning and non-lightning days were determined using the Cloud-to-Ground Lightning Surveillance System (CGLSS) data. An analysis of stability indices from the morning CCAFS sounding for lightning/non-lightning days was completed. Florida National Weather Service (NWS) Office severe weather procedures were reviewed and the 45 WS severe weather checklist was revised.

Discussion　The analysis of stability parameters revealed no clear predictors to forecast thunderstorm or severe weather days. Therefore, work began on reviewing details of current operational NWS and 45 WS severe weather checklists.

Task　　　Hail Index

Goal　　Evaluate current techniques used by the 45 WS to forecast the probability of hail occurrence and size. Hail forecasts are required to protect personnel and material assets at KSC, CCAFS, PAFB and the Melbourne International Airport. The evaluation results will be used by the 45 WS to determine if a new technique is needed.

Milestones　Obtained operational computer code and a 15-year archive of CCAFS rawinsonde data from Computer Sciences Raytheon personnel. The code was modified to run on AMU computer systems.

Discussion　The hail forecasts generated with the AMU version of the operational code were confirmed to be consistent with a limited 45 WS archive of forecasts generated during the summer of 2000.

Executive Summary, *continued*

Task   Shuttle Ascent Camera Cloud Obstruction Forecast

Goal   In response to a request from the Shuttle Program to implement a recommendation of the Columbia Accident Investigation Board, develop a model to forecast the probability that at least three of the shuttle ascent imaging cameras will have a view of the shuttle launch vehicle unobstructed by cloud at any time from launch to Solid Rocket Booster separation.

Milestones   Computer simulations and analyses of viewing probabilities were completed and a draft final report is being revised. The AMU remains on standby to present briefings to the Shuttle Launch Director and Integration Control Boards as required.

Discussion   Model tests with variations in the three cloud characteristics of base height, thickness, and size show that cloud thickness has the greatest impact on the ability of the imaging network to maintain three simultaneous views of a launch vehicle. The sides of thicker clouds increase the effective cloud cover because the camera viewing angles are usually shallow at less than 45°.

Task   ARPS Optimization and Training Extension

Goal   Provide assistance and support for upgrading and improving the operational Advanced Regional Prediction System (ARPS) and ARPS Data Analysis System (ADAS) at the NWS Melbourne (MLB) and Spaceflight Meteorology Group (SMG) forecast offices.

Milestones   Obtained ARPS software release version 5.1.2 from Weather Decision Technologies Inc., and modified/compiled source code from this software version to include unique AMU-developed features.

Discussion   The latest version of ARPS was obtained and configured with AMU-unique features from the current ARPS version. ARPS version 5.1.2 has many improvements and features that will make future maintenance much easier at NWS MLB.

Task   User Control Interface for ADAS Data Ingest

Goal   Develop a GUI to help forecasters manage the data sets assimilated into the operational ADAS run at NWS MLB and SMG.

Milestones   Developed an interactive map of Florida that will allow users to monitor and quality control individual surface observations across the ADAS domain.

Discussion   Work continued on the development and enhancement of the framework and features for the control GUI. The primary focus was on the dynamic interactive map for quality controlling surface observations. This map shows all the locations of the Florida surface observations sites, and allows the user to see the data from each station by moving a mouse over the station of interest on the map.

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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: Phase I (Ms. Lambert and Mr. Wheeler)

The 45th Weather Squadron (45 WS) forecasters include a probability of thunderstorm 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, and planning for daily ground operation activities on Kennedy Space Center/Cape Canaveral Air Force Station (KSC/CCAFS). Much of the current lightning probability forecast is based on a subjective analysis of model and observational data. The forecasters requested that a lightning probability forecast tool based on statistical analysis of historical warm-season data be developed. Such a tool would increase the objectivity of the daily thunderstorm probability forecast. The AMU is developing statistical lightning forecast equations that will provide a lightning occurrence probability for the day by 1100 UTC (0700 Eastern Daylight Time (EDT)) during the months May – September (warm season). The tool will be based on the results from several research projects. If tests of the equations show that they improve the daily

lightning forecast, the AMU will develop a PC-based tool from which the daily probabilities can be displayed by the forecasters. The three data types to be used in this task were described in previous AMU Quarterly Reports (Q4 FY03 and Q1 FY04):

- Cloud-to-Ground Lightning Surveillance System (CGLSS) data,
- 1200 UTC sounding data from synoptic sites in Florida, and
- 1000 UTC CCAFS sounding (XMR) data.

Ms. Lambert is using the S-PLUS® software package (Insightful Corporation 2000) to process and analyze the data, and to develop the lightning forecast equations.

Equation Development and Testing

Previous AMU Quarterly Reports (Q4 FY03 – Q3 FY04) described the predictand and predictors to be used in the equation development. The CGLSS data were used to create a binary predictand for lightning occurrence (1) and non-occurrence (0). The predictors include the stability parameters from the XMR sounding and the flow regime probabilities developed from the synoptic Florida rawinsonde sites. Once the predictand and predictors were prepared, equation development began. The data were first stratified into development and testing data sets, then by month

to create individual monthly forecast equations. Of the 15 years in the period of record, 13 were used for equation development and two were set aside for testing the equations. The stratification did not involve choosing individual warm season years, but individual warm season days. There are 153 days in the warm season, and two different years were chosen for each day. The random number generator in Microsoft® Excel© was used to create two sets of 153 numbers between and including 1989 and 2003. The resulting sets of years were assigned to each day in the warm season, such that there were essentially two-years worth of data in the data set. For example, the testing data set contains May 1 1992 and 2000, May 2 1998 and 1999, May 3 1989 and 2002, and September 30 1990 and 2003. All other dates were made part of the development data set. This random method was chosen to reduce the likelihood of capturing any transient climatological patterns in the development data set, and producing results with the testing data that are not representative of the long-term skill of the equations.

The method of choice when using binary predictands (1=lightning 0=no lightning) is logistic regression:

$$y = \frac{e^{(b_0 + b_1 x_1 + \ldots + b_k x_k)}}{1 + e^{(b_0 + b_1 x_1 + \ldots + b_k x_k)}},$$

where y is the predicted probability of occurrence, b_0 is the intercept, b_k are the coefficients for the predictors, x_k, and k is the number of predictors. This method is cited by Wilks (1995) as most appropriate when using binary predictands, and was proven by Everitt (1999) to produce superior results when compared to linear regression. There were 13 predictors available for the equations: 10 stabilitiy indices from the XMR sounding including

- Total Totals (TT),
- K-Index (KI),
- Cross Totals (CT),
- Lifted Index (LI),
- Severe WEAther Threat (SWEAT) Index,
- Showalter Index (SSI),
- Thompson Index (TI)
- Temperature at 500 mb, (T500),
- Mean Relative Humidity in the 800-600 mb layer (RH),
- Precipitable water up to 500 mb (PW),

the individual flow regime probabilities and the monthly climatology from the synoptic soundings

and CGLSS data, and the smoothed daily climatology values calculated from the CGLSS data.

The S-PLUS© 6 statistical software package (Insightful Corporation 2000) was used to develop and test the equations.

Equation Development

One equation was developed for each month in the warm season, for a total of five. The logistic regression equations were created using the development data set. Each predictor was added one at a time to a logistic regression equation to determine its contribution to the reduction in residual deviance of the forecast for the binary predictand. First, each of the predictors was tested as the lone variable in the equation and its contribution to the reduction in residual deviance determined. The variable with the largest contribution to the reduction in the deviance was chosen as the first predictor in the equation. Next, the other predictors were added individually with the first in a two-predictor set of equations. The second predictor that reduced the residual deviance by the largest amount in combination with the first was chosen for the equation. This iterative process continued for all 13 predictors. At times, the deviance explained for two or more variables was very similar. In these cases, individual equations were created using each of the predictors. As many as seven equations were created for each month in this manner. While more automatic predictor selection methods, such as principal component analysis, could have been employed, the manual process used here allowed for more control over understanding exactly how each individual predictor contributed to the variance. It was also facilitated by the small number of predictors available for selection.

Figure 1 shows the plot of the reduction in residual deviance as each predictor was added for the August equation. The S-PLUS ANOVA function (analysis of variance) was used to determine the values in Figure 1. This function shows the reduction in residual deviance from that of an equation that produces a probability equal to the monthly climatological value (M Climo in Figure 1). As seen in Figure 1, KI reduced the residual deviance beyond the monthly climatology forecast by the largest amount (~20%), followed by the flow regime lightning probabilities (Flw Reg), TT, the daily climatologies (D Climo), SSI, etc.

The final predictor sets for each equation were chosen in a two-step process. The first was to eliminate the predictors that created a reduction in the deviance of less than 0.5%, close to where the slope of the curve in Figure 1 begins to flatten. Next, the Brier Score (BS) for the probability predictions from each equation was calculated for the development and testing data sets. The BS is calculated using the equation

$$BS = \frac{1}{n}\sum_{i=1}^{n}(p_i - o_i)^2,$$

where n is the number of forecast/observation pairs, p is the probability forecast from the equation, and o is the binary lightning observation (Wilks 1995). Since there were two or more possible equations for each month, the equation that produced the lowest BS values for both the development and testing data sets was chosen as the final equation for the month.

Three predictors stood out in all five equations: 1) the flow regime lightning probabilities, 2) the smoothed daily climatology, and 3) the 1-day persistence. The flow regime probabilities and the daily climatology were used in every equation, while persistence was in every equation except for August. The mean RH in the 800-600 mb layer was the next most common predictor. The August equation contains the first five predictors (not including M Climo) in Figure 5: KI, Flw Reg, TT, D Climo, and SSI..
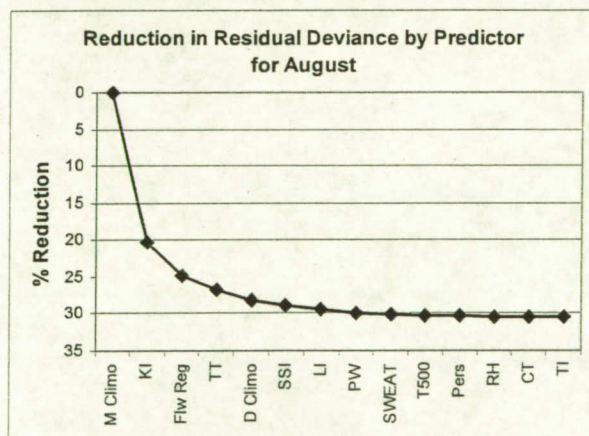

Figure 1. Plot of the reduction in residual deviance from a monthly climatology prediction (M.Climo) as each predictor was added for the August equation. The percent reduction is on the y-axis and the names of each predictor are on the x-axis.

Equation Testing

The first test of the equations was whether or not they showed an improvement in skill over benchmark forecast methods. This involved calculation of the Brier Skill Score (SS) as

$$SS = \frac{BS - BS_{ref}}{BS_{perfect} - BS_{ref}},$$

where BS is the Brier Score of the equation being tested, BS_{ref} is the reference or benchmark forecast, and $BS_{perfect}$ is the Brier Score of a perfect forecast, which is always 0. Four methods were used as benchmark forecasts: the smoothed daily climatology, the monthly climatology, the flow regime probabilities, and 1-day persistence. The results with the testing data are in Table 1.

The equations produce an increase in skill over all four forecast methods in all months, although the improvement values are mixed. It appears that the improvement over the daily climatology and flow regime probabilities is minimal in August.

Table 1. The percent (%) improvement in skill of the logistic regression equation forecasts over the benchmark forecasts of persistence, climatology, and flow regime probabilities. These results were calculated using the testing data.

Forecast Method	May	Jun	Jul	Aug	Sep
Persistence	31	53	38	39	43
Daily Climatology	27	18	27	7	21
Monthly Climatology	34	20	27	12	22
Flow Regime	34	13	20	3	21

In the next test, the equation probability forecasts for the testing data were stratified by the lightning observations of 0 and 1, then the distributions of the probability values for each stratification, lightning days and non-lightning days, were calculated. The testing data for each month contained no more than 62 observations, so all months were combined to make the resulting distributions more robust. Figure 2 shows the two probability distributions for lightning and non-lightning days. The blue curve for non-lightning days shows a peak above 40% at probability values of 0.2 then decreasing to below 15% at 0.4, followed by a slight rise then a slow decrease to just below 10% at 1. This curve would indicate an increased possibility of false alarm forecasts. The pink curve for lightning days shows low frequencies below 5% up to probability values

of 0.4, then gradually increasing to 40% at 1, increasing above the non-lightning day curve at ~ 0.56 probability. This would show that probability forecasts above ~ 0.56 are more likely to be calculated on lightning days as opposed to non-lightning days.
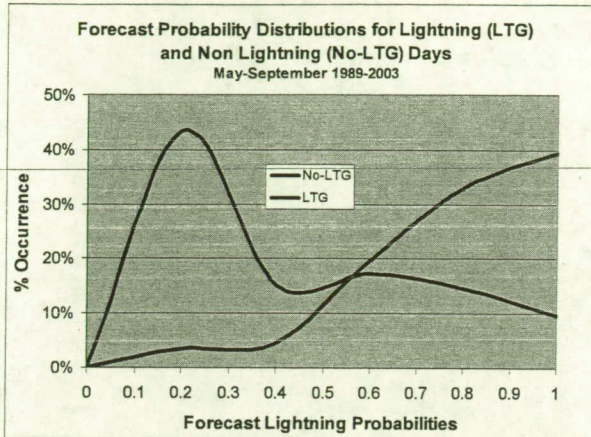

Figure 2. The forecast probability distributions for lightning (pink) and non-lightning (blue) days in the testing data. The y-axis values represent the frequency of occurrence of each probability value, and the values on the x-axis represent the forecast probability values output by the equations.

Figure 3 shows the reliability diagram for probability forecasts using the testing data set. The forecast probability is along the x-axis and the frequency of lightning occurrence for each probability value is along the y-axis. The pink curve represents perfect reliability and the blue curve is the reliability of the forecast equations. Once again, the forecasts for all months were combined to increase the size of the data set. The inset rectangle shows the number of observations in each probability range used to calculate the reliability curve. That the blue line is below the pink line indicates that the equations consistently overforecast lightning occurrence below probabilities of 0.4, but show good reliability at higher probability forecasts, except for 0.8. A detailed examination of the data revealed no clear pattern of why there was such a discrepancy at this value. It could be an artifact of the data set, and a larger data set may not exhibit such behavior.
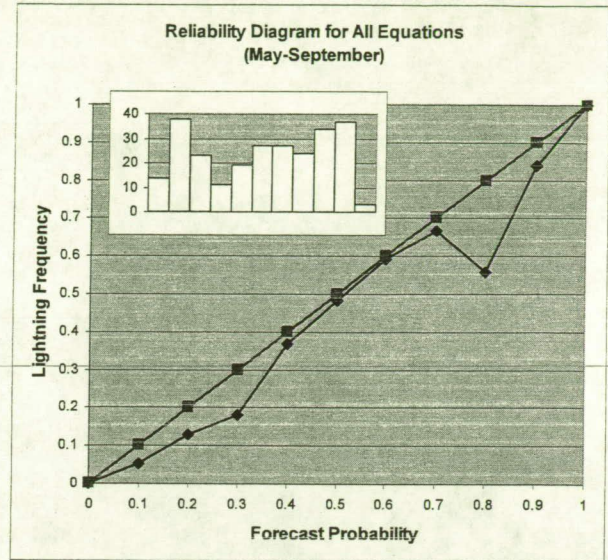

Figure 3. The reliability diagram of the probability forecasts for all months. The pink curve represents perfect reliability and the blue curve represents the probability forecast reliability. The inset rectangle is the histogram showing the number of observations in each probability range.

The final test was to create a contingency table and calculate statistics such as probability of detection (POD) and false alarm ratio (FAR). This type of forecast verification is most appropriate for categorical forecasts. It is less clear-cut for probability forecasts that express levels of uncertainty in which no probability value in the range 0 – 1 is necessarily wrong or right (Wilks 1995). Nonetheless, it is a familiar and easily understood method that can shed light on forecast performance provided an appropriate probability threshold value is defined representing the yes/no forecast division. Once again, the forecasts for all months were combined to calculate more robust statistics. The observations were well defined at yes (1) and no (0). After several tests a cutoff probability value of 0.61 was chosen because the hit rate (HR) was highest at this point. The contingency table and results are in Table 2. Definitions for HR, critical success index (CSI), POD, FAR, Heidke skill score (HSS), and Kuipers skill score (KSS) can be found in Wilks (1995) and Everitt (1999).

Table 2. The contingency table for the cutoff probability value of 0.61. Probability values ≥ 0.61 are considered a 'yes' forecast, and values < 0.61 are considered 'no' forecasts.

		Observation	
		Yes	No
Probability Forecast (0.61)	Yes	80	41
	No	32	104

POD = **71.4%** FAR = **33.9%** HR = **71.6%**
CSI = **0.523** HSS = **0.428** KSS = **0.432**

The HR, POD, FAR, and CSI values are 100% for a perfect forecast and 0% for the worst possible forecast. The HSS and KSS are 1 for perfect forecasts, 0 for performance equivalent to a random forecast, and < 0 for performance worse than that of a random forecast. The HR is the percentage of forecasts that were correct, lightning or not, and the POD is the percentage of 'yes' forecasts in the number of 'yes' observations. These values are relatively high at 71.6% and 71.4%, respectively. The FAR is the percentage of 'no' observations in the number of 'yes' forecasts. It is relatively low at 33.9%, but still high enough to be considered as a factor when using these equations for forecasting lightning occurrence. The CSI is the percentage of correct 'yes' forecasts in the sum of all 'yes' forecasts and observations. The value is better than 0.5, but not an indicator of good performance. The HSS and KSS values are scores representing the forecast performance compared to a reference random forecast, the difference being that in the KSS the random forecast is constrained to be unbiased. The values are not high, but are positive indicating performance better than that of random forecasts.

Graphical User Interface

All of the equations showed an increase in skill over the benchmark forecasts of daily and monthly climatology, persistence, and the flow regime lightning probabilities. As a result, the new equations will be added to the current set of tools and procedures used by the 45 WS forecasters to make the daily lightning probability forecast.

In order to use these equations, the forecasters need an interface that will facilitate user-friendly input and fast output. A graphical user interface (GUI) is being developed using Microsoft® Excel© Visual Basic. The 45 WS is involved in the GUI development by providing comments and suggestions on the design. This will ensure that the final product will address their operational needs.

For more information on this work and for copies of the memorandum and tables mentioned, contact Ms. Lambert at 321-853-8130 or lambert.winifred@ensco.com.

Severe Weather Forecast Decision Aid (Mr. Wheeler and Dr. Bauman)

The 45 WS Commander's morning weather briefing includes an assessment of the likelihood of local convective severe weather for the day in order to enhance protection of personnel and material assets of the 45th Space Wing, CCAFS, and KSC. The severe weather elements produced by thunderstorms include tornadoes, wind gusts ≥ 50 kts, and/or hail with a diameter ≥ 0.75 in. Forecasting the occurrence and timing of these phenomena is challenging for 45 WS operational personnel. The AMU has been tasked with the creation of a new severe weather forecast decision aid, such as a flow chart or nomogram, to improve the various 45 WS severe weather watches and warnings. The tool will provide severe weather guidance for the day by 1100 UTC (0700 EDT).

As described in the previous AMU Quarterly Report (Q3 FY04), analyses of 14 different stability indices provided little information to distinguish severe weather days from non-severe weather days. Dr. Bauman and Mr. Wheeler briefed the 45 WS on the status of this task and began to conduct additional analyses and methodologies based on suggestions from the 45 WS personnel to see if it would still be possible to develop an objective forecasting tool based on data from the 1000 UTC XMR sounding.

In the first part of the task, the data were stratified between severe/non-severe event days and the XMR stability indices were checked to see if they could be used to discern between the two. However, the stability indices between severe/non-severe weather days were found to be indistinguishable. After meeting with the 45 WS, Dr. Bauman and Mr. Wheeler decided to re-stratify the data set into thunderstorm/non-thunderstorm days and attempt to discern between them using the XMR stability indices. Dr. Bauman developed a database of lightning strike data using CGLSS data to distinguish between

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Table 3. Example of lightning strike data for the first 15 days in May 2003 obtained from CGLSS and displayed in the ArcView software. Cells with "Y" indicate lightning occurred in that county, or at KSC/CCAFS. Days with no lightning in any region are shaded in gray.

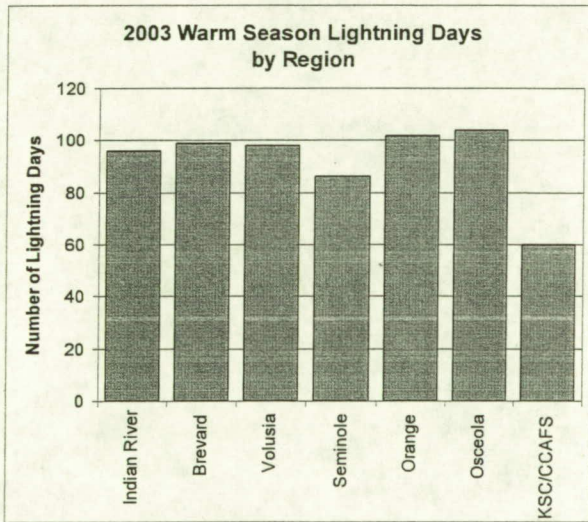| Date	Indian River	Brevard	KSC/CCAFS	Volusia	Seminole	Orange	Osceola	Strikes
1	Y	Y					Y	97
2	Y						Y	13
3				Y				31
4								0
5								0
6								0
7								0
8								0
9								0
10								0
11								0
12				Y				76
13								10
14	Y	Y		Y	Y	Y		171
15	Y	Y					Y	1112

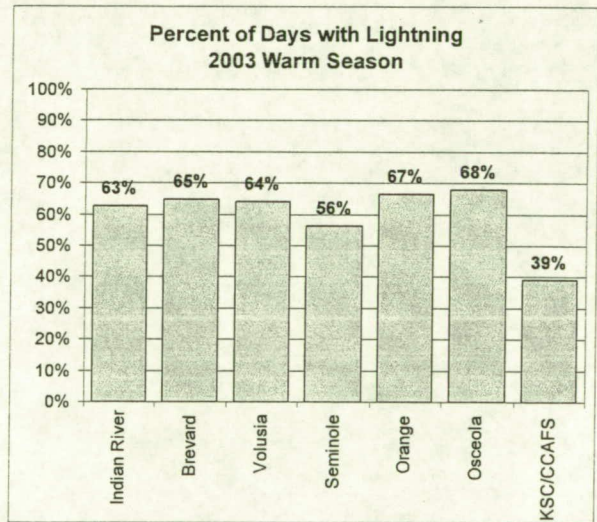Figure 5. Number of lightning days by region for the period May – September 2003.

Figure 6. Percent of lightning days by region for the period May – September 2003.

Shuttle Ascent Imaging Network Before and After Upgrade

In response to the CAIB recommendation, the Intercenter Photo Working Group proposed a substantial upgrade to the imaging network. The upgrade included additional long-range ground-based and airborne cameras. Figure 7 shows 10 ground-based, and 2 airborne long-range camera sites in the proposed upgrade. The original network consisted of five long-range camera sites. The proposed upgrade drops the southernmost site and adds 6 ground-based sites and 2 airborne cameras located 15 n mi NW and SE of the SRB separation point, at 65 000 ft.
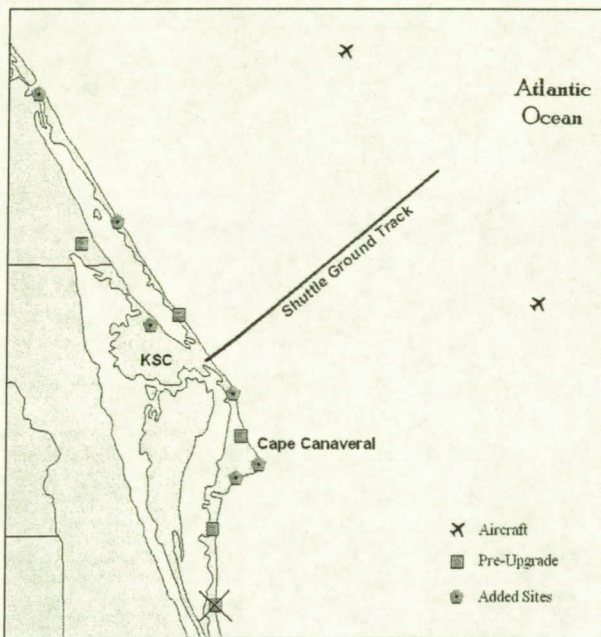

Figure 7. Locations of all original and proposed-upgrade long-range camera sites. The airborne cameras are at 65 000 ft 15 n mi NW and SE of the SRB separation point. The solid line represents the ground-track of a Shuttle ascent trajectory to the ISS from lift-off to SRB separation.

Sensitivity of Post-Upgrade Camera Network Performance to Cloud Characteristics

Dr. Short completed a sensitivity analysis of the performance in the proposed-upgrade camera network to variations in cloud base height, cloud thickness and cloud horizontal dimensions. The measure of performance was the ability of the network to provide at least three simultaneous views of the Shuttle continuously from launch to SRB separation. Because natural clouds show variability in altitude, thickness and size, it was important to develop an understanding of the impact of these variations on the camera network performance.

Figure 8 shows fractional cloud coverage versus the percent of time between lift-off and SRB separation that the Shuttle was viewable simultaneously by at least three cameras in the upgraded network for cloud bases at 4000, 8000, and 30 000 ft, with a 500 ft cloud thickness, and a cloud horizontal dimension of 4 n mi. For overcast conditions (8/8 or 1) the percent time viewable is greatest for 30 000 ft bases due to the increased time it takes the Shuttle to reach cloud base and be obscured from the ground-based cameras for the remainder of the ascent. Once the Shuttle is above the overcast, the two airborne cameras cannot satisfy the requirement for three simultaneous views. For cloud coverages of 6/8 and less the time viewable exceeds 90 % for the low, middle, and high cloud base thresholds.
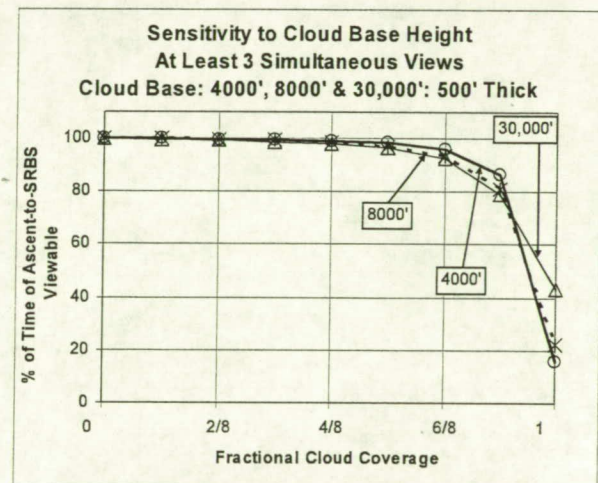
Figure 8. Fractional cloud cover versus % of time from lift-off to SRB separation that the Shuttle was viewable simultaneously by at least three cameras for cloud bases at 4000 ft, 8000 ft, and 30 000 ft.

Figure 9 shows fractional cloud coverage versus percent of time between lift-off and SRB separation viewable by at least three cameras, for cloud bases at 8000 ft and cloud thicknesses of 500 ft (solid curve) and 5000 ft (dashed curve). It is evident that thick clouds are more efficient at obscuring views of the Shuttle than thin clouds due to 3D effects. The sides of thick clouds obscure a greater part of the sky than thin clouds, when viewed at elevation angles < 90°.

fields for ARPS simulations. Finally, a limited examination of several ARPS warm-season convective cases will be necessary to offer suggestions for adaptable parameter modifications leading to improved forecasts of convective initiation and coverage. Therefore, the AMU was tasked to develop routines for incorporating new observational data sets into the operational ADAS and provide the NWS MLB with assistance in making the upgrades and improvements described above.

Mr. Case focused on configuring the newest version of ARPS (5.1.2), obtained from Weather Decision Technologies Inc. He incorporated modifications he had made to the current operational version 4.5.2 at NWS MLB. Mr. Case also compiled all primary and utility programs that may be used within the operational ARPS/ADAS cycles. He is currently modifying the operational scripts and testing each program within the operational cycle.

One of the benefits of upgrading to ARPS 5.1.2 is that, beginning with version 5.0, the ARPS source code was translated from the FORTRAN-77 language to FORTRAN-90. The FORTRAN-90 code construct has dynamic memory allocation within all ARPS programs, making re-compilation of the code unnecessary when changing model grid dimensions. This new feature of ARPS 5.1.2 results in easier maintenance and more flexibility for running different model domains in the future at NWS MLB.

Contact Mr. Case at 321-853-8264 or case.jonathan@ensco.com for more information on this work.

User Control Interface for ADAS Data Ingest (Mr. Keen and Mr. Case)

The integrity of real-time, continuous diagnostic grids from the operational ADAS has become very important, with a requirement to be operationally managed at the forecaster level. Forecasters at NWS MLB and SMG have the need for a user-friendly GUI in order to quickly and easily interact with ADAS to maintain or improve the integrity of each 15-minute analysis cycle. The intent is to offer operational forecasters the means to manage and quality control the observational data streams ingested by ADAS without any prior expertise of ADAS required. Therefore, the AMU was tasked to develop a GUI tool to help forecasters manage the data sets assimilated into ADAS.

Mr. Keen developed an interactive map of Florida surface observation sites. This map will serve as a foundation for interactive quality control features at each site. Also, map backgrounds and observation labels can be modified based on customer feedback and requirements. Examples of the dynamic map are shown in Figures 11 and 12. All surface observations, including standard METAR, the Florida Automated Weather Network (FAWN), and Automatic Position Reporting System cooperative observations will be plotted on the map (Fig. 11). The user can then perform a simple "mouse-over" of any of the plotted observation points to examine the raw data being analyzed by ADAS (Fig. 12).

Future development will include a capability for the user to click on any observation site and manipulate the quality-control flags for any of the primary meteorological variables (pressure, temperature, dewpoint, and wind speed/direction). In addition, a capability will be developed to modify the quality-control flags for groups of observations (e.g. exclude all FAWN dewpoint observations).

Contact Mr. Case at 321-853-8264 or case.jonathan@ensco.com, or Mr. Keen at 321-783-9735 x248, or keen.jeremy@ensco.com for more information on this work.

backup hardware and software after one of the backup tape drives failed.

Mr. Case traveled to SMG from 26 – 29 July for technical interchange, and to present final results from the Anvil Transparency and Mesonet Temperature and Wind Climatology tasks. Dr. Bauman traveled to the Short-term Prediction Research and Transition Center (SPoRT) at Marshall Space Flight Center in Huntsville, AL from 9-10 August for a technical interchange meeting to better understand SPoRT's mission and how the AMU and SPoRT can work together.

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Appendix A

AMU Project Schedule 31 October 2004				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date	Notes/Status
Objective Lightning Probability Phase I	Literature review and data collection/QC	Feb 03	Jun 03	Completed
	Statistical formulation and method selection	Jun 03	Oct 03	Completed, but delayed due to errors found in COTS software
	Equation development, tests with verification data and other forecast methods	Aug 03	Nov 03	Completed, but delayed as above
	Develop operational products	Nov 03	Jan 04	Delayed as above
	Prepare products, final report for distribution	Jan 04	Mar 04	Delayed as above
Mesonet Temperature and Wind Climatology	Process data and calculate climatology of biases/deviations	Jul 03	Feb 04	Completed
	Develop tabular and geographical displays	Feb 04	Apr 04	Completed
	Final Report	Apr 04	Jun 04	Completed
	Assistance in transitioning product into operations	Jul 04	Jul 04	Delayed, Waiting to schedule training sessions with customers
Severe Weather Forecast Tool	Local and national NWS research, discussions with local weather offices on forecasting techniques	Apr 03	Sep 03	Completed
	Develop database, develop decision aid, fine tune	Oct 03	Apr 04	Delayed due to higher priority Shuttle Ascent Camera Cloud Obstruction Forecast Task
	Final report	May 04	Jun 04	Delayed as above
Hail Index	Evaluate Current Techniques	Aug 04	Feb 05	On Schedule
	Memorandum	Mar 05	May 05	On Schedule

AMU Project Schedule 31 October 2004				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date	Notes/Status
ARPS/ADAS Optimization and Training Extension	Provide the NWS Melbourne with assistance in upgrading to ARPS version 5.x.	Aug 04	Oct 04	On Schedule
	Provide the NWS Melbourne with assistance in porting the operational ADAS to a Linux workstation	Oct 04	Dec 04	On Schedule
	Assist the NWS Melbourne in upgrading to the 20-km RUC pressure coordinate background fields	Oct 04	Dec 04	On Schedule
	Develop routines for incorporating new data sets into ADAS	Dec 04	May 05	On Schedule
	Examine a limited number of warm-season convective cases	May 05	Jul 05	On Schedule
User Control Interface for ADAS Data Ingest	Develop control graphical user interface (GUI)	Apr 04	Jan 05	On Schedule
	Installation assistance and documentation	Jan 05	Mar 05	On Schedule