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Applied Meteorology Unit (AMU) Quarterly Report

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Executive Summary

This report summarizes the Applied Meteorology Unit (AMU) activities for the third quarter of Fiscal Year 2009 (April - June 2009). A detailed project schedule is included in the Appendix.

Task — Peak Wind Tool for User Launch Commit Criteria (LCC)

Goal Update the Phase I cool season climatologies and distributions of 5-minute average and peak wind speeds. The peak winds are an important forecast element for the Expendable Launch Vehicle and Space Shuttle programs. The 45th Weather Squadron (45 WS) and the Spaceflight Meteorology Group (SMG) indicate that peak winds are a challenging parameter to forecast. The Phase I climatologies and distributions helped alleviate this forecast difficulty. Updating the statistics with more data and new time stratifications will make them more robust and useful to operations.

Milestones Continued running the 8-hour scripts, removed October data that were contaminated by tropical storms.

Discussion During work on another task, four October days in the period of record (POR) were found to be affected by tropical storm winds. The goal of this task is to calculate the probabilities of cool season wind not including tropical storm winds. These data were removed, which required recalculation of the October climatologies and probabilities. Once the 8-hour probabilities are completed, the October values for the 2- and 4-hour probabilities will be recalculated.

Task — Objective Lightning Probability Tool, Phase III

Goal Update the lightning probability forecast equations used in 45 WS operations with new data and new stratification based on the progression of the lightning season. Update the Microsoft Excel and Meteorological Interactive Data Display System (MIDDS) GUIs with the new equations. The new data and stratifications are likely to improve the performance of the equations used to make the daily lightning probability forecasts for operations on Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS).

Milestones Calculated the daily lightning climatology using the Cloud-to-Ground Lightning Surveillance System (CGLSS), received daily climatology of precipitable water (PW) from the 14 WS.

Discussion The climatology shows that the lightning season extends into October. The PW climatology will be used to determine the beginning and end of each lightning sub-season.

Continued on Page 2

Distribution (continued from Page 1)

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Executive Summary, *continued*

Task	Peak Wind Tool for General Forecasting, Phase II
Goal	Update the tool used by the 45 WS to forecast the peak wind speed for the day on KSC/CCAFS during the cool season months October-April. The tool forecasts the timing of the peak wind speed for the day, the associated average speed, and provides the probability of issuing wind warnings in the KSC/CCAFS area using observational data available for the 45 WS morning weather briefing. The period of record will be expanded to increase the size of the data set used to create the forecast equations, new predictors will be evaluated, and the performance of the Phase I and Phase II tools will be compared to determine if the updates improved the forecast.
Milestones	Completed writing and executing S-PLUS scripts to calculate linear regression equations for peak wind speed, average wind speed, and timing of the peak wind speed. Added precipitation observations, KSC/CCAFS wind tower data, climatological winds, 45 WS wind advisories, and North American Mesoscale (NAM) model forecast winds to the verification data set.
Discussion	The S-PLUS scripts calculated single and multiple linear regression equations with the developmental data set, which included observations from the cool season months from October 1996 to February 2007. The data set was stratified by weather pattern, wind direction, precipitation, and stability. Separate regression equations were calculated for each of the stratifications. The prediction methods that performed the best on the developmental data set will be evaluated on the verification data set, which includes observations from the cool season months of March 2007 to April 2009.

Task	Situational Lightning Climatologies for Central Florida: Phase IV
Goal	Recalculate lightning climatologies for the Shuttle Landing Facility and eight other airfields in the National Weather Service at Melbourne (NWS MLB) county warning area using individual lightning strike data to improve the accuracy of the climatologies, and update the GUI. In a previous task, lightning climatologies were calculated using gridded lightning data providing less accurate results. As in the previous task, stratify the climatologies for each location by flow regime and, new for this task, not stratified by flow regime.
Milestones	Updated the graphical user interface (GUI) and delivered the final version. Completed the final report.
Discussion	Updated the GUI based on NWS MLB and SMG feedback, made the requested changes and delivered the final product. Completed and delivered the final report, which is now available on the AMU website.

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Executive Summary, *continued*

Task	Severe Weather and Weak Waterspout Checklist in MIDDS
Goal	Migrate the functionality of the web-based Severe Weather Forecast Decision Aid and the Weak Waterspout Checklist to MIDDS. The likelihood of severe weather occurrence is included in the 45 WS morning weather briefing, but is a difficult parameter to forecast. This information is used by range customers to protect personnel and other assets of the 45th Space Wing, CCAFS, and KSC. In the current program, the forecasters enter values manually to output a threat index. Making these tools more automatic in MIDDS will reduce human errors and increase efficiency, allowing forecasters to do other duties.
Milestones	Provided GUI training to 45 WS forecasters.
Discussion	The training showed 45 WS forecasters the how to use the GUI properly and how to interpret the results.

Task	ADAS Update and Maintainability
Goal	Acquire the latest version of the Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS) for the local data integration system (LDIS) at NWS MLB and SMG, and update the AMU-developed shell scripts that were written to govern the LDIS so that it can be easily maintained. In addition, the AMU will update the previously developed ADAS GUI.
Milestones	Continued modifying previously written shell scripts to run ARPS/ADAS using the Perl programming language. Modified programs that convert Meteorological Assimilation Data Ingest System (MADIS) data to ASCII format such that they are ADAS-compatible.
Discussion	Used the Perl programming language to rewrite the existing scripts that process the background model, satellite, and radar data used to initialize the ARPS/ADAS model system. Obtained programs available through the National Oceanic and Atmospheric Administration (NOAA)/Earth System Research Laboratory (ESRL)/Global Systems Division (GSD) that convert MADIS surface, RAOB, wind profiler, and ACARS data in NetCDF format to ASCII format. Modified these programs such that the output is ADAS-compatible.

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Executive Summary, *continued*

Task	HYSPLIT/WRF-EMS
Goal	Configure the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model on a NWS MLB Linux machine. The HYSPLIT model is used by NWS MLB for computing trajectories, dispersion, and deposition of atmospheric pollutants to assist local emergency managers. HYSPLIT will be modified to ingest output from operational models in near-real time. This will assist NWS MLB forecasters in the event of any incident involving toxic substances dispersed into the atmosphere. A comparable version of HYSPLIT will support SMG forecasters for Space Shuttle landing attempts during scenarios involving low-altitude smoke and high-altitude anvil clouds from thunderstorms.
Milestones	Completed and delivered the final report.
Discussion	The final report was completed after customer reviews and it is now available on the AMU website.

Task	Verify MesoNAM Performance
Goal	Verify the performance of the 12-km resolution NAM model (MesoNAM) forecasts for CCAFS and KSC. Verification will be accomplished by an objective statistical analysis consisting of comparing the MesoNAM forecast winds, temperature and moisture, as well as the changes in these parameters over time, to the observed values at customer selected KSC/CCAFS mesonet wind towers. The objective analysis will give the forecasters knowledge of the model's strength and weaknesses, resulting in improved forecasts for operations.
Milestones	Acquired wind tower observations and MesoNAM forecasts. Completed quality control (QC) of the wind tower observations. Started developing scripts in S-PLUS software.
Discussion	Acquired and completed QC of the wind tower observations that will be used to verify the MesoNAM forecasts. Acquired and inventoried the MesoNAM forecast files. Started developing scripts in S-PLUS software to manipulate the data so it can be stratified per customer requirements.

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Executive Summary, *continued*

<u>Task</u>	<u>HYSPLIT Graphical User Interface</u>
Goal	Develop a GUI that allows forecasters to update selected parameters within the HYSPLIT model used at NWS MLB. The HYSPLIT model is used by NWS MLB for computing trajectories, dispersion, and deposition of atmospheric pollutants to assist local emergency managers. The GUI will allow easy adjustment of selected parameters on daily and emergency runs. This will help NWS MLB forecasters improve efficiency and reduce human error when running HYSPLIT in support of an incident involving toxic substances dispersed into the atmosphere.
Milestones	Held a meeting to understand the level of detail NWS MLB expected in the layout and functionality of the HYSPLIT GUI. Designed the HYSPLIT GUI layout, wrote initial code and background scripts for user input fields and widget functionality.
Discussion	The meeting with NWS MLB personnel assisted greatly in determining the layout and functionality of the HYSPLIT GUI. Began development of the HYSPLIT GUI and background code to manage the different parameter files needed for the model runs. This allows forecasters to automatically provide trajectory and concentration forecasts on a scheduled basis using national and local model data and provide timely information on hazardous conditions to their customers.

Special Notice to Readers

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

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 Crawford (321-853-8130, Hcrawford.winifred@ensco.comH). If your mailing information changes or if you would like to be removed from the distribution list, please notify Ms. Crawford or Dr. Francis Merceret (321-867-0818, HFrancis.J.Merceret@nasa.govH).

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

Peak Wind Tool for User LCC (Ms. Crawford)

The peak winds are an important forecast element for the Expendable Launch Vehicle and Space Shuttle programs. As defined in the Launch Commit Criteria (LCC) and Shuttle Flight Rules (FR), each vehicle has peak wind thresholds that cannot be exceeded in order to ensure safe launch and landing operations. The 45th Weather Squadron (45 WS) and the Spaceflight Meteorology Group (SMG) indicate that peak winds are a challenging parameter to forecast, particularly in the cool season. To alleviate some of the difficulty in making this forecast, the AMU calculated cool season climatologies and distributions of 5-minute average and peak winds in Phase I (Lambert 2002). The 45 WS requested that the AMU update these statistics with more data collected over the last five years, using new time-period stratifications, and a new parametric distribution. These modifications will likely make the statistics more robust and useful to operations. They also requested a graphical user interface (GUI) similar to that developed in Phase II (Lambert 2003) to display the wind speed climatologies and probabilities of meeting or exceeding certain peak speeds based on the average speed.

Prognostic Probability and GUI Status

Ms. Crawford continued running the 8-hour scripts that prepare the data for calculating peak speed probabilities based on the mean speed. As part of a task Ms. Crawford is working with Dr. Merceret (see AMU Chief's section), she found four October days during the period of record (POR) affected by tropical storm winds in the Kennedy Space Center (KSC) / Cape Canaveral Air Force Station (CCAFS) area. The goal of this task is to calculate the probabilities of cool season winds, not tropical storm winds. Such data could contaminate the values and had to be removed. After removing the data from those four days, Ms. Crawford recalculated the October climatologies and diagnostic probabilities and updated the GUI with the new values. Ms. Crawford removed the tropical storm data before calculating the 8-hour probabilities for October. Once the 8-hour probabilities are completed, she will recalculate the October values for the 2- and 4-hour probabilities and update their values in the GUI.

Contact Ms Crawford at 321-853-8130 or crawford.winnie@ensco.com for more information.

Objective Lightning Probability Tool, Phase III (Ms. Crawford)

The 45 WS includes the probability of lightning occurrence in their daily morning briefings. This information is used by forecasters when evaluating LCC and FR, and planning for daily ground operations on KSC and CCAFS. The AMU developed a set of logistic regression equations that calculate the probability of lightning occurrence for the day in Phase I (Lambert and Wheeler 2005). These equations outperformed several forecast methods used in operations. The Microsoft Excel GUI developed in Phase I allowed forecasters to interface with the equations by entering predictor values to output a probability of lightning occurrence. In Phase II (Lambert 2007), two warm seasons were added to the POR, the equations redeveloped with the new data, and the GUI transitioned to the Meteorological Interactive Data Display System (MIDDS). The MIDDS GUI retrieves the required predictor values automatically, reducing the possibility of human error. In this phase, three warm seasons (May–September) will be added to the POR, increasing it to 20 years (1989–2008), and data for October will be included. The main goal of this phase is to create the equations based on the progression of the lightning season instead of creating an equation for each month. These equations will capture the physical attributes that contribute to thunderstorm formation more so than a date on a calendar. The Excel and MIDDS GUIs will be updated with the new equations.

Determining Stratifications

Ms. Crawford calculated the raw and 14-day smoothed daily lightning climatology from the Cloud-to-Ground Lightning Surveillance System (CGLSS) data for May–October (Figure 1). She used the same 14-day Gaussian smoother as in Lambert (2007). It revealed that October should be considered as part of the lightning season. Five distinct sub-seasons are evident in Figure 1 (dates are approximate):

1) Pre-lightning 1–13 May,
2) Ramp-up 14 May–22 June,
3) Lightning proper 23 June–12 August,
4) Ramp-down 13 August–12 October, and
5) Post season 13–31 October.

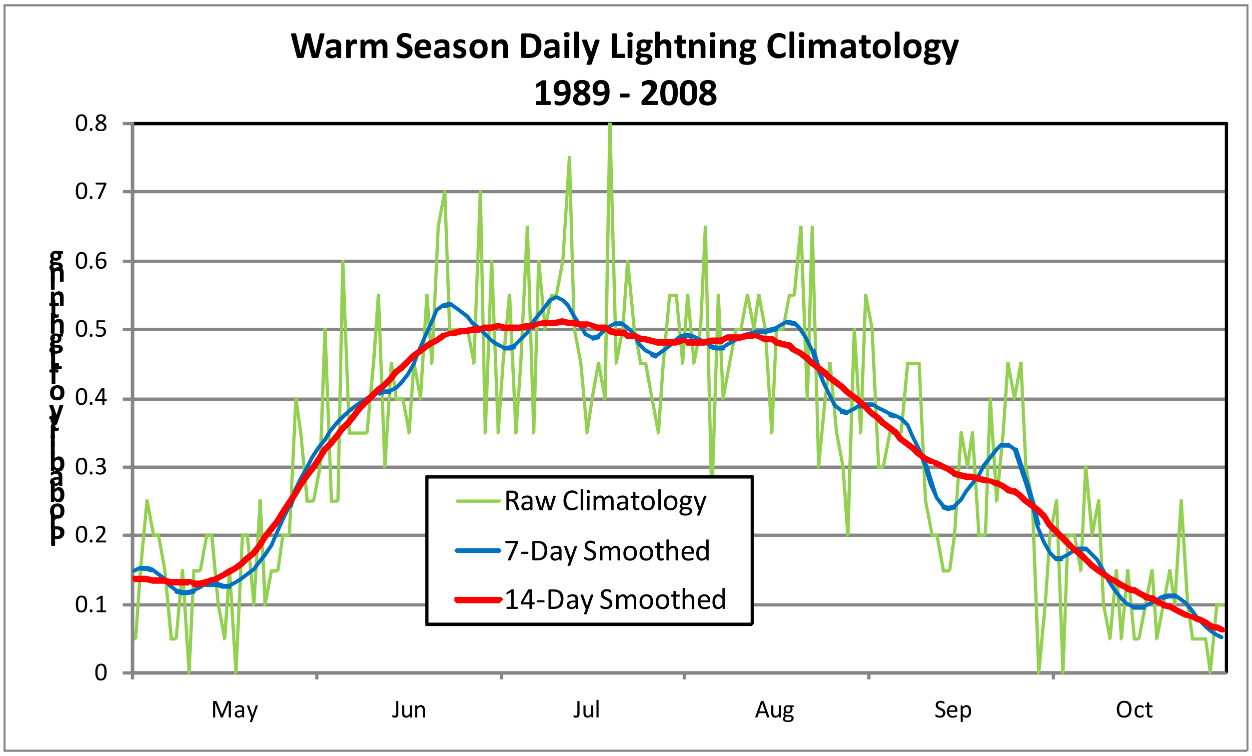


Figure 1. The daily raw (green curve), ±7-day smoothed (blue curve), and ±14-day smoothed (red curve) climatological probability values of lightning occurrence for the warm-season months including October in 1989–2008.

Ms. Crawford met with Mr. Roeder and Dr. Bauman to discuss methods for determining the onset dates for each season. For stratifying the data in the POR, they decided to determine the beginning dates of the sub-seasons in each individual year. The pre-season will always begin on 1 May, and the post-season will always end on 31 October. Ms. Crawford will use the wet season start and end dates for each year determined by the National Weather Service in Melbourne, FL (NWS MLB), available on their website, for the beginning of the ramp-up and post-seasons. These dates were determined by post-analysis of precipitable water (PW) and rain rate data, but in operations the sub-season transition date must be determined in real-time. Mr. Roeder suggested using statistical properties of the NWS MLB onset date distribution and PW values in an algorithm that would display the current sub-season to the forecaster and would direct the GUI to use the correct equation. Ms. Crawford will explore this option and determine its feasibility for operations.

Mr. Roeder asked the 14 WS to create a PW climatology for the warm season that could possibly help determine the onset dates for the lightning proper and ramp-down sub-seasons. The PW mean and standard deviations values from this climatology are in Figure 2. The smoothed values were calculated using the same 14-day Gaussian smoother as in Lambert (2007).

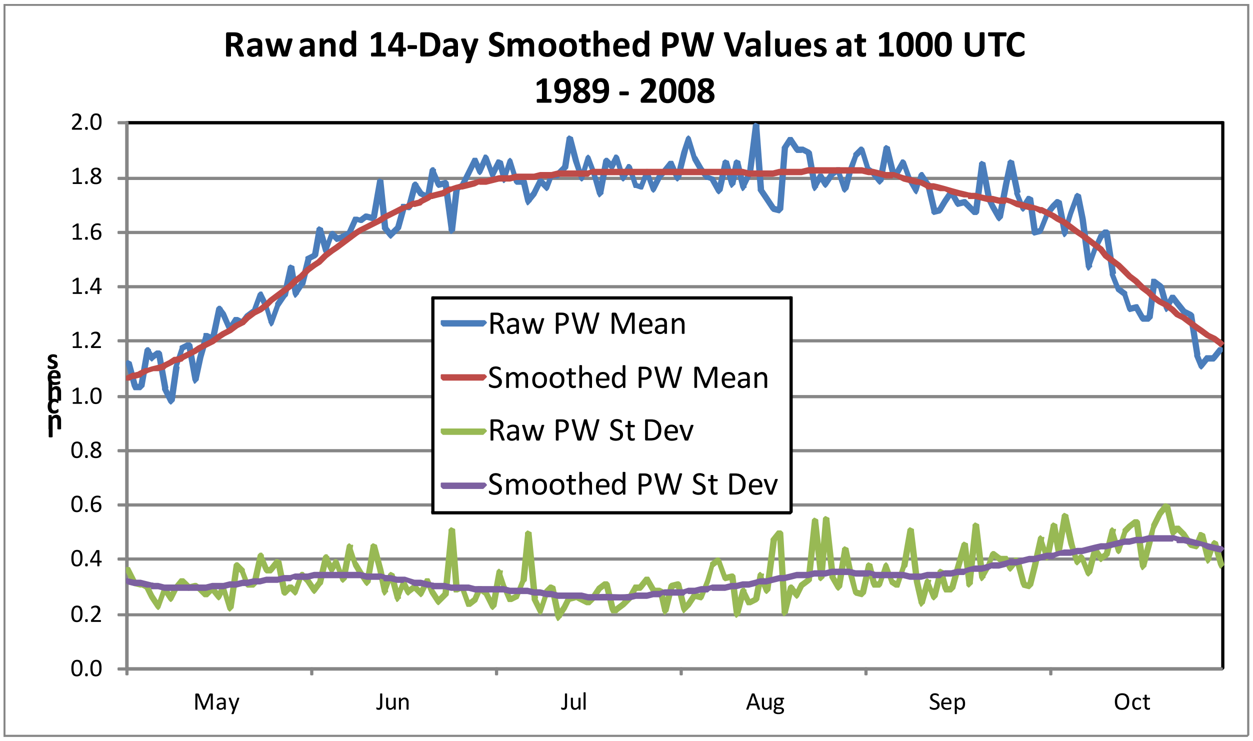


Figure 2. The raw and 14-day smoothed PW values in inches for the warm season 1989–2008.

The general shape of the smoothed curve in Figure 2 matches that of the 14-day smoothed daily lightning climatology in Figure 1. Figure 3 shows a direct comparison of the trends in both data sets. The PW means and standard deviations were divided by 3 so they can be displayed in the same scale as the lightning probability values. The PW mean values peak later in June than do the lightning probability values. The plateau of PW means lasts into early September, where the lightning probabilities begin to decline in mid-August. A “bump” in values exists in both curves during late September. The smoothed standard deviations are steady throughout the season until toward late September when they steadily increase. Methods to use the PW mean, standard deviation, or a combination of both will be explored to see if they can be used to define the beginning of the lightning proper and ramp-down sub-seasons in the POR.

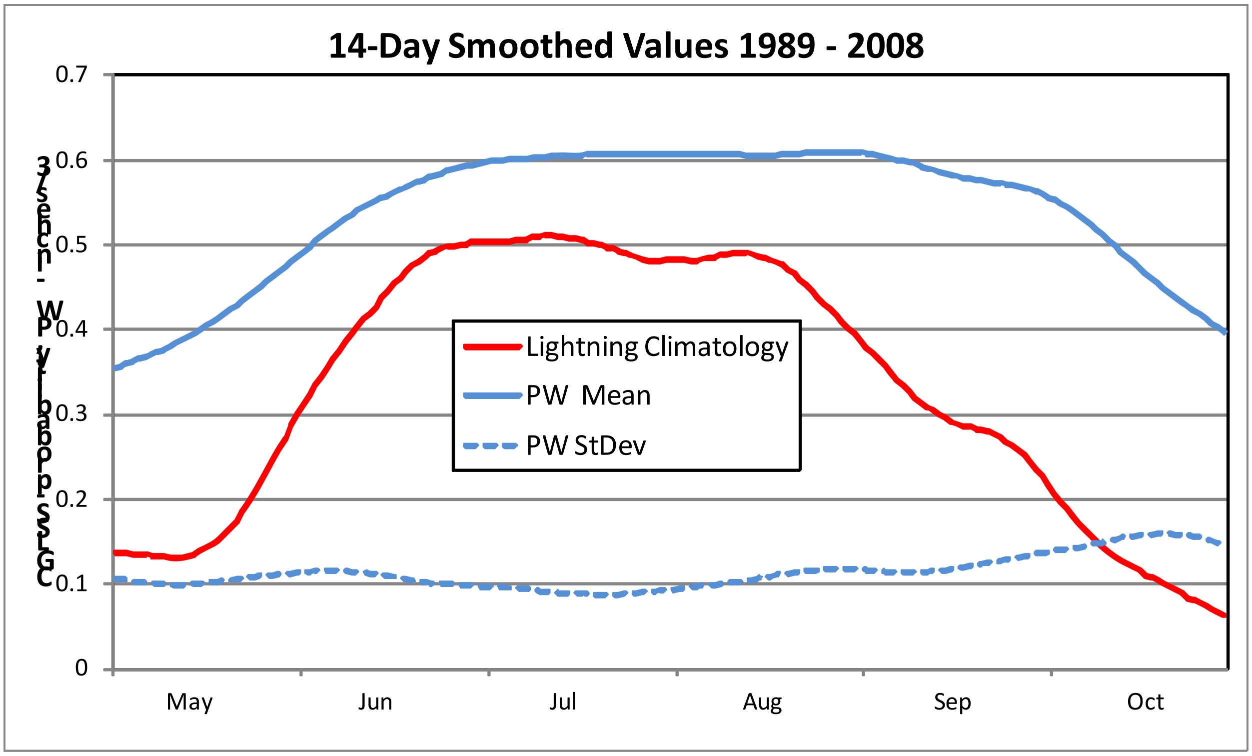


Figure 3 The 14-day smoothed PW mean (solid blue), PW standard deviation (dashed blue), and daily lightning climatology (red) values in inches for the warm season 1989–2008.

Task Status

With approval from the 45 WS, work on this task will be delayed up to two months in order for Ms. Crawford to assist Dr. Merceret in gathering wind tower data and analyzing statistical results as part of his tropical storm peak wind tool task. Work on that task is described in the AMU Chief's section of this report.

Contact Ms Crawford at 321-853-8130 or crawford.winnie@ensco.com for more information.

Peak Wind Tool for General Forecasting, Phase II (Mr. Barrett)

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. In Phase I of this task (Barrett and Short 2008), the AMU developed a tool to help forecast the highest peak non-convective wind speed, the timing of the peak speed, and the average wind speed at the time of the peak wind from the surface to 300 ft on KSC/CCAFS for the cool season (October – April). For Phase II, the 45 WS requested that additional observations be used in the creation of the forecast equations by expanding the POR. In Phase I, the data set included observations from October 2002 to February 2007. In Phase II, observations from March and April 2007 and October 2007 to April 2008 will be added. To increase the size of the data set even further, the AMU will consider adding data prior to October 2002. Additional predictors will be evaluated, including wind speeds between 500 ft and 3000 ft, static stability classification, Bulk Richardson Number, mixing depth, vertical wind shear, inversion strength and depth, wind direction, synoptic weather pattern and precipitation. Using an independent data set, the AMU will compare the performance of the Phase I and II tools for peak wind speed forecasts. The final tool will be a user-friendly GUI to output the forecast values.

As in Phase I, the tool will be delivered as a Microsoft Excel GUI. In addition, at the request of the 45 WS, the AMU will make the tool available in MIDDS, their main weather display system. This will allow the tool to ingest observational and model data automatically and produce 5-day forecasts quickly.

Predictors and Stratifications

Mr. Barrett calculated the predictors to evaluate from the 1100 UTC CCAFS soundings in the developmental data set, which included observations from the cool season months of October 1996 to February 2007. The predictors included wind shear, stability, and wind speed parameters. The wind shear parameter was the wind shear in the lowest 1000 ft. The stability parameters were:

- Inversion depth and strength,
- Differences in temperature between 1000 ft and 16, 100, 200, 300, 400, and 500 ft,
- Differences in temperature between 2000 ft and 16, 100, 200, 300, 400, and 500 ft,
- Morning and afternoon mixing heights, and
- Bulk Richardson Number.

The wind speed parameters were:

- Maximum wind speeds from the surface to 500 ft, 1000 ft, 2000 ft, and 3000 ft,
- Maximum wind speed between 1000 ft and 2000 ft,
- Maximum wind speed between 2000 ft and 3000 ft,
- Average wind speed from the surface to 500 ft and 1000 ft,
- Average wind speed between 500 ft and 1000 ft,
- Average wind speed between 1000 ft and 2000 ft,
- Average wind speed between 2000 ft and 3000 ft,
- Wind speeds at 16 ft through 3000 ft,
- Wind speeds at the morning and afternoon mixing heights, and
- Maximum wind speed from the surface to the morning and afternoon mixing heights.

The data set was also stratified using the synoptic weather pattern, wind direction, precipitation, Richardson Number, and Gradient Richardson Number, for a total of 60 stratifications. The total number of observations in each method varied due to missing or undefined data. For example, if the wind shear was zero, the Richardson and Gradient Richardson numbers could not be calculated.

Equations for Peak and Average Wind Speed

Mr. Barrett wrote scripts in the S-PLUS programming language to calculate the single linear regression equations for average and peak wind speed, using all of the predictors. Based on the Mean Absolute Errors (MAE) of the equations, he selected the best predictors to create multiple linear regression equations for all the stratifications. The multiple linear regressions used 11 stability parameters, 14 of the wind speed parameters, and the wind shear parameter. He used stepwise regression in S-PLUS to select which of the 26 parameters to include in each multiple linear regression.

Mr. Barrett also created single and multiple linear regression equations using robust functions in S-PLUS. The non-robust functions used least-squares methods in which the outliers can have a very large influence on the linear fit across the data. Other the other hand, robust methods reduce the influence of outliers and can decrease biases in parameter estimates while providing a good fit to most of the data points (Insightful Corporation, 2002).

Equations for Timing of Peak Wind Speed

Mr. Barrett repeated the same procedures outlined above to predict the timing of the peak wind speed. He found that the linear relationships with the predictors were weak, so he also investigated the usefulness of categorizing the observations by wind shear, stability, or wind speed thresholds. The predicted values were then calculated from the mean observed value in each category above and below each threshold instead of by a regression equation.

Comparison of Phase I and Phase II tools

Mr. Barrett determined the best methods from the developmental data set for predicting the peak wind speed, average wind speed, and the timing of the peak wind speed. The best methods were determined to be the ones that minimized the MAE and did not contain a large number of stratification categories. If the number of categories exceeded 10, then the individual categories were considered to contain too few data to create a good linear fit. The best methods will be used to calculate the peak wind speed, average wind speed, and timing for the verification data set that includes observations from the cool-season months of March 2007 to April 2009. For comparison purposes, the stratification that includes all days with observations will also be used in the verification data set. The methods that perform the best with the verification data set will be incorporated into the Phase II version of the Peak Wind tool. Table 1 lists the methods that will be evaluated on the verification data set.

Mr. Barrett will compare the performance of the Phase I and II methods to the peak wind speed climatology created in the Peak Winds for User LCC task, 45 WS wind warnings and advisories, and forecast winds from the 12-km resolution North American Mesoscale (NAM) model (MesoNAM).

Contact Mr. Barrett at 321-853-8205 or barrett.joe@ensco.com, for more information.

Table 1. The stratifications to be evaluated using the verification data set and using the single and multiple linear regression (SLR and MLR) equations developed using robust and non-robust methods.

Regression Methods	***Average and Peak Wind Speed Stratifications***	***Peak Wind Speed Timing Stratifications***
SLR equations	– None – 4 Wind Direction / Precipitation categories	– None – Occurrence/Non-Occurrence of Precipitation
MLR equations	– None – 4 Wind Direction / Precipitation categories	**MLR not used** (see main text) Categories: – Maximum speed in lowest 2000 ft – 16 – 1000 ft temperature difference. Stratifications same as for SLR equations

Situational Lightning Climatologies for Central Florida: Phase IV (Dr. Bauman)

The threat of lightning is a daily concern during the warm season in Florida. Research has revealed distinct spatial and temporal distributions of lightning occurrence that are strongly influenced by large-scale atmospheric flow regimes. In the previous phase, Dr. Bauman calculated the gridded lightning density and frequency climatologies based on the flow regime as in Lambert et al. (2006) for 1-, 3- and 6-hr intervals in 5-, 10-, 20-, and 30-NM range rings around the Shuttle Landing Facility (TTS) and eight other airfields in the NWS MLB county warning area. The 5- and 10-NM range rings are consistent with the aviation forecast requirements at NWS MLB, while the 20- and 30-NM range rings at TTS assist SMG in making forecasts for FR violations of lightning occurrence during a shuttle landing. For this phase, Dr. Bauman will use individual strike data from the National Lightning Detection Network (NLDN) to create more accurate climatological values for each range ring than was possible with the gridded data set. Also, the size of the range rings around each site will be corrected since the range ring distances in the last phase were calculated as diameters, but should have been radii. The 10- and 20-NM diameter range rings were still useful for NWS MLB since they represented 5- and 10-NM radius range rings, but they were not useful for SMG. Also, using gridded lightning data required estimating circular range rings from square grids. This resulted in over- and underestimating the lightning climatologies at each site, depending on the size of the range ring.

GUI Completion

Dr. Bauman modified the HyperText Markup Language (HTML) GUI based on feedback from NWS MLB and SMG. He then delivered the final version of the GUI. The modifications included adding a monthly stratification in addition to displaying data for the entire warm season and adding an “All Sites” stratification to permit the forecasters to view data from all nine sites on the same web page. The “All Sites” web pages are stratified by month/entire warm season and by flow regime.

Final Report

Dr. Bauman completed and delivered the final report. It is now available on the AMU website.

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

INSTRUMENTATION AND MEASUREMENT

Severe Weather and Weak Waterspouts Checklists in MIDDS (Mr. Wheeler)

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 kt, and/or hail with a diameter ≥ 0.75 in. Forecasting the occurrence and timing of these phenomena is challenging for 45 WS operational personnel. In a previous task, the AMU developed the web-based Severe Weather Forecast Decision Aid worksheet to assist forecasters in determining the probability of issuing severe weather watches and warnings for the day. The forecasters enter values into the worksheet manually to output a threat index. For the current task, the 45 WS requested the AMU to migrate the functionality of the worksheet to MIDDS, which is able retrieve many of the needed parameter values for the worksheet automatically. They also requested the AMU to transfer the functionality of their Weak Waterspout Checklist, if time permits. Making these tools more automatic will reduce the possibility of human error and increase efficiency, allowing forecasters to do other duties.

GUI Training

Mr. Wheeler provided training to the 45 WS, showing them how to use the GUI properly and how to interpret the results. The final report was completed in the previous Quarter.

For more information contact Mr. Wheeler at wheeler.mark@ensco.com or 321-853-8264.

MESOSCALE MODELING

ADAS Update and Maintainability (Dr. Watson)

Both NWS MLB and SMG have used a local data integration system (LDIS) since 2000 and routinely benefit from the frequent analyses. The LDIS uses the Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS) package as its core, which integrates a wide variety of national and local-scale observational data. The LDIS provides accurate depictions of the current local environment that help with short-term hazardous weather applications and aid in initializing the local Weather Research and Forecasting (WRF) model. However, over the years the LDIS has become problematic to maintain since it depends on AMU-developed shell scripts that were written for an earlier version of the ADAS software. The goal of this task is to update the LDIS with the latest version of ADAS and upgrade and modify the AMU-developed shell scripts written to govern the system. In addition, the previously developed ADAS GUI will be updated.

Modification of Existing Scripts

Dr. Watson continued to modify the previously written shell scripts and rewrite them using the Perl programming language. The existing suite of shell scripts runs a complete model system, which includes the pre-processing, main model integration, and post-processing steps. The pre-processing step prepares the terrain, surface characteristics data sets, and the objective analysis for model initialization. In the previous quarter, Dr. Watson rewrote the terrain and surface data programs in Perl. During this quarter, she finished modifying the shell scripts that process the background model, the GOES infrared and visible satellite data, and the WSR-88D Level II radar data used to initialize ADAS.

The 3-D analysis for the model initialization is created within the ADAS script. ADAS ingests a variety of observational data (radar reflectivity and radial velocity, infrared and visible satellite data, surface observations, etc.) and analyzes these data onto the ARPS grid using the Bratseth objective analysis technique. All surface observations, except the KSC/CCAFS wind tower data, are available through the National Oceanic and Atmospheric Administration (NOAA) / Earth System Research Laboratory (ESRL) / Global Systems Division (GSD) Meteorological Assimilation Data Ingest System (MADIS). The data are available in NetCDF format and must be converted to a format acceptable for use within ADAS. GSD provides various programs that convert the available data to an ASCII format; however, further modifications are needed in order to use the data within ADAS. Dr. Watson modified the GSD programs that convert all surface, rawinsonde, wind profiler, and automated aircraft data to ASCII format such that they are ADAS-compatible. She wrote the new Perl scripts to give the user more flexibility in the directory structure of the model and scripts than in the previous versions, and the user is also given more input options. The scripts can also be run independently of the rest of the model. Samples of resulting ADAS analyses are shown in Figure 4: composite reflectivity (a) and sea level pressure (b) images at 1800 UTC 2 July 2009.

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

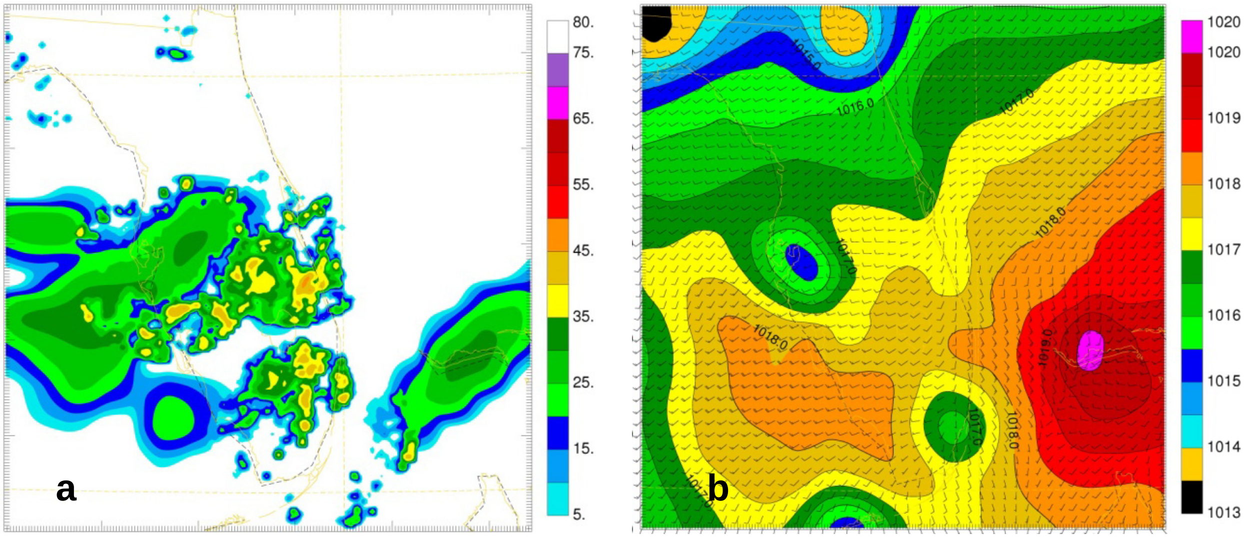


Figure 4. a) ADAS composite reflectivity (dbZ) and b) sea level pressure (mb) and wind (m/s) from 1800 UTC 2 July 2009.

HYSPLIT WRF/EMS Task (Mr. Dreher)

NWS MLB is responsible for providing support to county emergency managers across central Florida in the event of any incident involving the release of harmful chemicals, radiation, and smoke from fires and/or toxic plumes into the atmosphere. NWS MLB uses the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model to provide trajectory, concentration, and deposition guidance during such events. In addition, forecasters at SMG have expressed interest in using HYSPLIT to support airborne particle and anvil trajectory forecasts that may have situational implications during a Shuttle landing attempt. Currently, NWS MLB and SMG rely on a PC-based version of the HYSPLIT model that is difficult to run and manage in an operational environment. The first goal of this task is to install and configure a version of HYSPLIT on a Linux-based computer able to routinely ingest the National Centers for Environmental Prediction (NCEP) model guidance such as output from the Global Forecast System (GFS), NAM and the Rapid Update Cycle (RUC). Since NWS MLB and SMG also run locally configured versions of the WRF model, the second goal of this task is to develop a software utility that converts WRF output into HYSPLIT format. This will allow forecasters to automatically provide trajectory and concentration guidance on a scheduled basis using either NCEP products or from a locally configured WRF model and, therefore, provide timely information on hazardous conditions to their customers.

Task Status

Mr. Dreher completed and delivered the final report. It is now available on the AMU website.

For more information, contact Dr. Bauman at bauman.bill@ensco.com or 321-853-8202.

Verify MesoNAM Performance (Dr. Bauman)

The 45 WS Launch Weather Officers (LWO) use the MesoNAM text and graphical product forecasts extensively to support launch weather operations. However, the actual performance of the model has not been measured objectively. In order to have tangible evidence of model performance, the 45 WS tasked the AMU to conduct a detailed statistical analysis of model output compared to observed values. The model products are provided to the 45 WS by ACTA, Inc. and include hourly forecasts from 0 to 84 hours based on model initialization times of 00, 06, 12 and 18 UTC. The objective analysis will compare the MesoNAM forecast winds, temperature and dew point, as well as the changes in these parameters over time, to the observed values from the sensors in the KSC/CCAFS wind tower network shown in Table 2. Objective statistics will give the forecasters knowledge of the model's strength and weaknesses, which will result in improved forecasts for operations.

Table 2. Towers, launch activities and sensor heights at KSC and CCAFS that will be used in the objective analysis to verify the MesoNAM forecasts.

Tower Number	***Supported Activity and Facility***	***Sensor Heights***
0002	Delta II (LC-17)	6 ft, 54 ft, 90 ft
0006	Delta IV (LC-37)	54 ft
0108	Delta IV (LC-40)	54 ft
0110	Atlas V/Falcon (LC-41)	54 ft, 162 ft, 204 ft
0041	Atlas V (LC-41)	230 ft
393 / 394	Shuttle/Constellation (LC-39A)	60 ft
397 / 398	Shuttle/Constellation (LC-39B)	60 ft
511 / 512 / 513	Shuttle Landing Facility	6 ft, 30 ft

The 45 WS requested the data sets be stratified by 45°, 90°, 180° and all direction wind sectors, and by year, warm season (May-September), cool season (October-April), month and model initialization time. They also requested the sector directions be oriented to discriminate between on-shore/off-shore flow for each tower and to analyze the model forecasts only for the current operational version of the MesoNAM using the following statistics:

- Bias (mean difference).
- Standard deviation of Bias.
- Hypothesis test for Bias = 0.
- Root Mean Square Error (RMSE).
- Standard deviation of RMSE.
- Hypothesis test for RMSE = 0.
- Hypothesis tests to determine if Bias and RMSE at same levels of different towers are the same. If not, composite Bias and RMSE for those levels to increase the sample size and make the statistics more robust.
- Hypothesis test to determine if composited Bias and RMSE = 0.

Wind Tower Data

Dr. Bauman acquired the KSC/CCAFS wind tower data for the period October 2006 to April 2009 from the AMU archive, and used the AMU wind tower quality control (QC) software to remove erroneous observations from the dataset. He then wrote S-PLUS scripts to import and modify the QC'd wind tower observation files to remove unneeded time periods and sensor heights from the dataset for each tower. The locations of the towers used for the verification are shown on the map of KSC/CCAFS in Figure 5.

Since the tower data are reported every 5 minutes and the MesoNAM forecasts are hourly, Mr. Roeder of the 45 WS requested the AMU calculate the mean value for each observed parameter at the top of every hour using the observations from 30 minutes prior and 30 minutes after the hour. Ms. Crawford provided existing S-PLUS scripts and helped Dr. Bauman modify those scripts to reformat the tower data and calculate the mean values as requested by Mr. Roeder.

Figure 5. Map of KSC/CCAFS showing the locations of the wind towers used to verify MesoNAM forecasts. The verification tower locations are indicated by red pentagons and labeled with tower number and supported launch activity.

MesoNAM Forecast Products

Dr. Bauman requested and obtained the ACTA MesoNAM forecasts from Mr. Parks of the 45 WS. The current operational version of the MesoNAM is the 12-km WRF model. The 12-km WRF model became operational in August 2006. Based on the seasonal stratifications requested by the 45 WS and model availability, Dr. Bauman will evaluate the MesoNAM forecasts beginning with the October 2006 data, which is the first cool season month in the data set. A total of three cool seasons will be used: 2006-2007, 2007-2008 and 2008-2009. He will also evaluate the 2007 and 2008 warm seasons. If time permits, the 2009 warm season will be included.

Dr. Bauman inventoried the MesoNAM data files provided by Mr. Parks and determined 92% of the model runs from October 2006 through April 2009 are available. However, 57% of the files from January-February 2009 are missing and the AMU has made a request to ACTA to try to recover those files.

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

HYSPLIT Graphical User Interface (Mr. Wheeler)

Both NWS MLB and SMG requested the AMU to develop a GUI for the HYSPLIT model. Both groups use HYSPLIT for computing trajectories, complex dispersion, and deposition during releases of hazardous atmospheric pollutants and during wildfires. This is a continuation of the recent AMU task in which the AMU installed and configured a Linux version of HYSPLIT that provides trajectory and concentration guidance automatically using output from the NCEP models and from the WRF Environmental Modeling System (EMS) run at NWS MLB and SMG. The AMU developed Linux parameter files containing the various model runtime options for the HYSPLIT simulations. However, changing the values in the parameter files for different scenarios is a time-consuming task prone to human error. The forecasters at NWS MLB and SMG requested the AMU create a GUI to interface with the parameter files and change the variables in an operational environment easily and quickly. The HYSPLIT GUI will reduce the possibility of human error and increase efficiency, allowing forecasters to do other duties.

Previous Work

In the previous AMU task (Dreher, 2009), Mr. Dreher obtained and installed the latest version of HYSPLIT on a Linux system that ingests routine NCEP model products. He also configured a utility program to convert WRF EMS output into HYSPLIT binary format. Mr. Dreher wrote several scripts that run through a Linux job-scheduling capability to produce automated HYSPLIT trajectory and concentration guidance from the RUC and NAM models. The scripts are configured to download the NAM and RUC guidance, convert the meteorological grids into the proper format, run the model from several latitude/longitude sites, and post-process the data to create output graphics. The scripts reference parameter files for each product that contain the necessary trajectory and concentration HYSPLIT variables. This allows forecasters to modify the model configuration without editing the automated scripts.

Software Development and Testing

Mr. Wheeler used the parameter files that Mr. Dreher developed as a starting point for the development of the HYSPLIT GUI. He convened a meeting at the NWS MLB office to review the task and discuss in detail the layout and functionality of the HSYPLIT GUI. The Tool Command Language (Tcl) / Toolkit (Tk) programming language is being used for the code development. This will allow the HYSPLIT GUI to function and run under several different operating systems.

Development

Figure 1 shows an example of the HYSPLIT GUI layout. Tcl/Tk is a scripting language that allows the developer to configure a GUI to work with user input and background information. The GUI has different buttons, widgets and control files that allow the user to control the information selected for output. The following are the major site categories in the HYSPLIT GUI and a description of their functionality:

- **Fixed Sites:** The forecaster can enter or update information such as, Name, Latitude, Longitude, Forecast Time, Model choice, Emission Duration and Rate on the 10 daily updated sites. The HYSPLIT model runs daily for these 10 sites.
- **Floating Sites**: The forecaster can enter or update the same information as for Fixed Sites along with a playbook option on five additional daily sites. Once changed, these sites will be added to the 10 daily HYSPLIT model run.
- **Emergency Site**: The forecaster can enter or update the same information as for Fixed Sites along with a playbook option on a single site and then have the HYSPLIT model run with those parameters once the submit button is clicked.

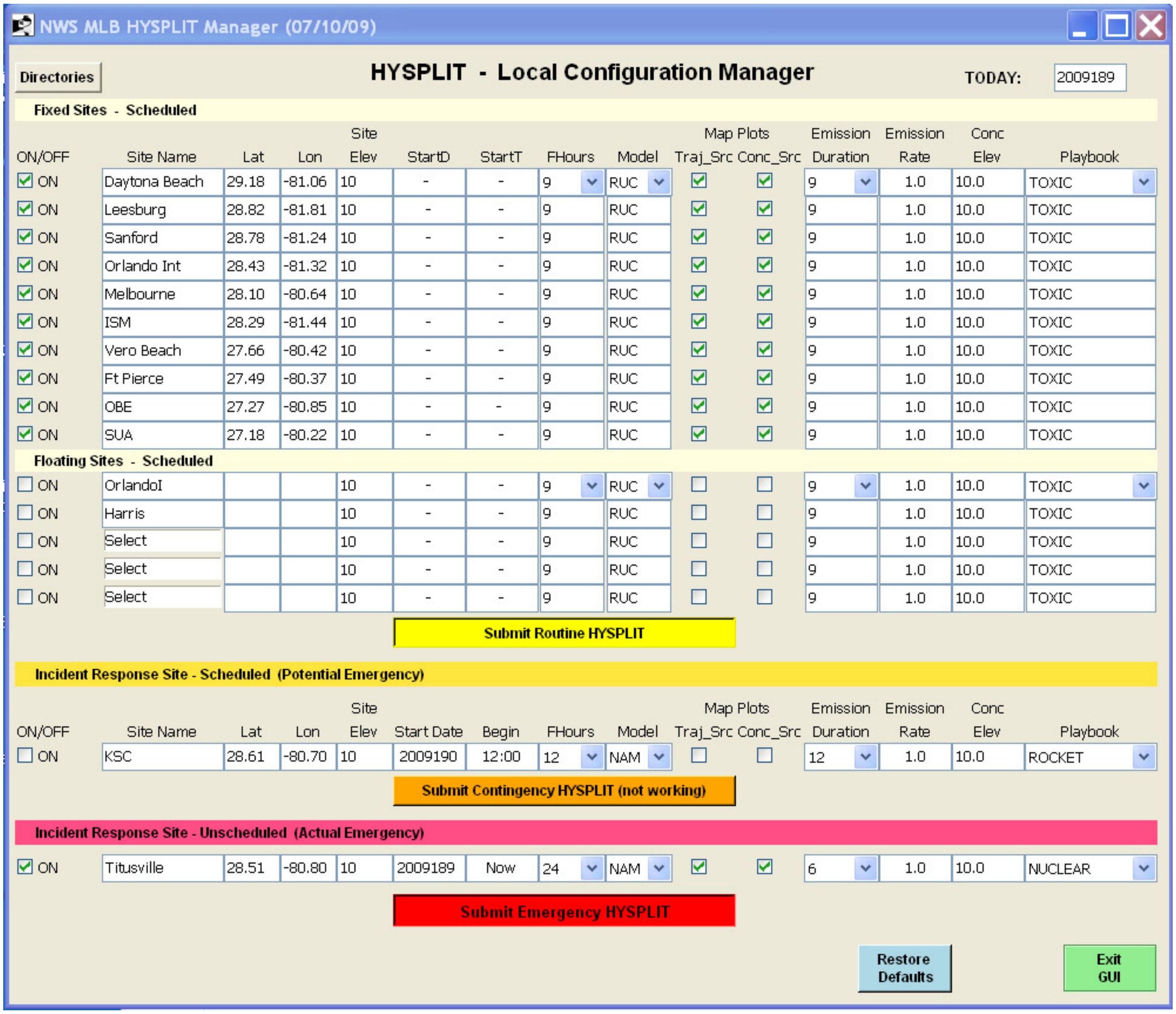
An additional category “Incident Response Site – Scheduled” has been added but will not be functional with this version of the GUI.

The forecaster has control over all the input and selectable fields. All titles, fields and labels will display a pop-up help box describing their functionality when the mouse is moved over the name. Once the forecaster is done modifying information, they click on a “Submit” button, which will then update the selected model parameter files or make an emergency HYSPLIT model run.

Testing

Mr. Wheeler will begin testing when he completes the GUI. Each of the fields will be tested and verified that the HYSPLIT model parameter files update and the model runs with the selected parameter changes. These tests will be conducted at the AMU and NWS MLB.

For more information contact Mr. Wheeler at wheeler.mark@ensco.com or 321-853-8264.



HYSPLIT - Local Configuration Manager

TODAY: 2009189

Fixed Sites - Scheduled

ON/OFF	Site Name	Lat	Lon	Site Elev	StartD	StartT	FHours	Model	Map Plots Traj_Src	Map Plots Conc_Src	Emission Duration	Emission Rate	Conc Elev	Playbook
☑ ON	Daytona Beach	29.18	-81.06	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC
☑ ON	Leesburg	28.82	-81.81	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC
☑ ON	Sanford	28.78	-81.24	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC
☑ ON	Orlando Int	28.43	-81.32	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC
☑ ON	Melbourne	28.10	-80.64	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC
☑ ON	ISM	28.29	-81.44	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC
☑ ON	Vero Beach	27.66	-80.42	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC
☑ ON	Ft Pierce	27.49	-80.37	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC
☑ ON	OBE	27.27	-80.85	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC
☑ ON	SUA	27.18	-80.22	10	-	-	9	RUC	☑	☑	9	1.0	10.0	TOXIC

Floating Sites - Scheduled

ON/OFF	Site Name	Lat	Lon	Site Elev	StartD	StartT	FHours	Model	Map Plots Traj_Src	Map Plots Conc_Src	Emission Duration	Emission Rate	Conc Elev	Playbook
☐ ON	OrlandoI			10	-	-	9	RUC	☐	☐	9	1.0	10.0	TOXIC
☐ ON	Harris			10	-	-	9	RUC	☐	☐	9	1.0	10.0	TOXIC
☐ ON	Select			10	-	-	9	RUC	☐	☐	9	1.0	10.0	TOXIC
☐ ON	Select			10	-	-	9	RUC	☐	☐	9	1.0	10.0	TOXIC
☐ ON	Select			10	-	-	9	RUC	☐	☐	9	1.0	10.0	TOXIC

Incident Response Site - Scheduled (Potential Emergency)

ON/OFF	Site Name	Lat	Lon	Site Elev	Start Date	Begin	FHours	Model	Map Plots Traj_Src	Map Plots Conc_Src	Emission Duration	Emission Rate	Conc Elev	Playbook
☐ ON	KSC	28.61	-80.70	10	2009190	12:00	12	NAM	☐	☐	12	1.0	10.0	ROCKET

Incident Response Site - Unscheduled (Actual Emergency)

ON/OFF	Site Name	Lat	Lon	Site Elev	Start Date	Begin	FHours	Model	Map Plots Traj_Src	Map Plots Conc_Src	Emission Duration	Emission Rate	Conc Elev	Playbook
☑ ON	Titusville	28.51	-80.80	10	2009189	Now	24	NAM	☑	☑	6	1.0	10.0	NUCLEAR

Figure 6. Example of the HYSPLIT Local Configuration Manager GUI.

AMU CHIEF'S TECHNICAL ACTIVITIES (Dr. Merceret)

Comparison of Tropical Storm (TS) and Non-TS Peak Winds (Dr. Merceret and Ms. Crawford)

Peak winds are important operationally as noted in the Peak Wind Tool for User LCC section earlier in this report. The work reported there and in previous work by the AMU (Lambert 2002) has focused on the statistics of peak winds as a function of mean wind speed and height in the absence of conditions associated with tropical storms (TS). For similar operational reasons, the 45 WS requested the KSC Weather Office to develop a tool for assessing the probability of exceeding peak wind constraints at a given height and mean wind speed during TS conditions. A product to evaluate these conditions based on gust factors (GF) was delivered by Merceret (2008, 2009).

These non-TS and TS analyses each generated probabilities of peak winds exceeding specified thresholds at specified heights. The meteorological environments differed as did the methods used to perform the analyses. Dr. Merceret and Ms. Crawford sought to compare the results from the two studies where there was data available at the same heights and wind speeds. For this analysis, the comparisons are based on GF. Comparisons of TS and non-TS GF have been reported in previous studies (Paulsen and Schroeder, 2005; Krayer and Marshall, 1992), but this study takes advantage of a unique opportunity to make a more definitive comparison.

The literature search to date reveals that previous comparisons of TS and non-TS GF were made from different towers at different and not always similar sites. Since GF are known to be strongly influenced by upwind surface properties (Schroeder *et al.* 2002; Paulsen and Schroeder 2005), the difference in sites adds a source of variance to an already noisy measurement. In the study reported here, all of the data are taken from the same towers at the same locations, thus eliminating most of the site variance.

Methodology

Since GF are widely cited in the literature and the TS study had already generated models for TS GF that were consistent with that literature, the AMU non-TS peak wind statistics (mean and standard deviation) were converted to the equivalent GF statistics by dividing them by the mean wind speed in each stratification. The data were stratified by tower number, mean wind speed, height, month and wind direction.

The data are from Towers 002, 006, 110 and 313. In each case the tower is instrumented on two sides and each side is stratified separately resulting in eight tower categories. The 12-ft height was not used because it is dominated by the local details of the surface (including growth of shrubbery and surface moisture) and meaningful statistics or comparisons seemed unlikely. All remaining heights were used, resulting in height categories of 54, 90, 145, 162, 204, 295, 394 and 492 ft. Not every tower was instrumented at every height and only Tower 313 had heights above 204 ft.

The non-TS data were originally stratified by mean wind speed in 1-kt intervals. The TS data were originally stratified in 10-kt bins as described in Merceret (2008). In order to facilitate direct comparisons, Dr. Merceret re-binned the non-TS data to the same 10-kt bins as the TS data using the recorded sample sizes of the data to recalculate both the mean and the standard deviation for the bin. In addition, for possible future use in building a GF model for the non-TS data, he also created 5-kt mean wind speed bins.

The original non-TS data were available for the months of January through April and October through December as well as all combined (dry season) for cases of northeast flow. Ms. Crawford processed additional data in the identical manner generated for southwest flow, onshore flow and offshore flow regimes for the dry season only (not individual months).

Analysis to Date

For each side of each tower at each height and each seasonal and directional stratification, Dr. Merceret generated a pair of matrices containing the mean and standard deviation of the GF as functions of height and mean wind speed, respectively. He did this separately for the 5-kt and 10-kt bins. An example is given in Table 3.

The purpose of this arrangement is to facilitate a direct comparison with the TS data that is already available in this format, and then to attempt to model the GF as a function of height and wind speed in the same manner as Merceret (2008, 2009). At present, the matrices are being used to provide additional quality control on the data and to determine whether certain stratifications can be combined to increase sample size and reduce workload.

The first quality control check is to ensure that the opposite sides of a tower give results (at a given height and wind speed) that do not differ significantly. If they do, this calls into question the measurements on both sides unless there is a logical explanation for the difference. In order to make that comparison, Dr. Merceret made an additional matrix for each pair (side a and side b) of matrices for the mean. He followed the same process for the standard deviation matrices.

Table 3. Matrices of the GF mean and standard deviation for Tower 313, Side 1, 10-kt bins, dry season NE flow.

Mean Gust Factor

Speed (kt)	***Height (ft)***					
	54	***162***	***204***	***295***	***394***	***492***
20	1.467	1.302	1.266	1.197	1.160	1.138
30		1.331	1.289	1.208	1.164	1.138
40				1.230	1.180	1.157

Gust Factor Standard Deviation

Speed (kt)	***Height (ft)***					
	54	***162***	***204***	***295***	***394***	***492***
20	0.107	0.077	0.073	0.073	0.071	0.068
30		0.078	0.070	0.059	0.055	0.057
40				0.055	0.061	0.085

The new matrix contains the “relative delta” (RD) of the two sides at each height and wind speed. The RD is defined as the difference between the two observations divided by their mean. If the two sides give identical readings, RD = 0. Color-coded shading on the spreadsheet containing the data indicate when RD > 0.1 (yellow) and RD > 0.25 (red). This visual flag makes it easy to identify tower asymmetries. An example is shown in Table 4.

Table 4. Relative Delta matrix for Tower 002, 5-kt bins, on-shore flow.

Relative Delta GF SD

Speed (kt)	***Height (ft)***			
	54	***90***	***145***	***204***
15	0.007	0.022	-0.008	0.000
20	0.021	0.045	0.016	0.008
25	0.038	0.030	0.031	0.034
30		0.161	0.110	0.026
35				-0.340

None of the data for the mean GF in any stratification were flagged, but the standard deviation data showed some significant asymmetries, especially on Tower 313. Dr. Merceret and Ms. Crawford are currently exploring the hypothesis that because of the wind direction stratifications, one side of Tower 313 was nearly always in the immediate wake of the tower, thus resulting in larger variance due to wake turbulence. The fact that the effect is much weaker on the other towers is consistent with the difference in orientation of the two sides instrumented on those towers. Tower 313 is instrumented on the NE and SW sides (upwind/downwind in our stratifications) whereas the other three towers are instrumented on the NW and SE sides (both sides simultaneously crosswind in our stratifications). Also, in a few cases, flagged data turned out to be the result of mistyping or miscopying data during the generation of the spreadsheets. These errors have been corrected.

Analysis Planned for the Near Term

The immediate next steps for Dr. Merceret and Ms. Crawford are to complete the quality control process including determining whether the hypothesis about the orientation of the sensors on Tower 313 is correct. Where appropriate, they will combine data from the opposite sides of a tower to create a single stratification category rather than two for that tower. This will result in the establishment of a validated master database from which all future analysis will proceed. At that point, direct comparisons with the TS data will begin.

AMU OPERATIONS

Information Technology

Capt Luis Martinez, RSA IIA Deputy Program Manager, directed Ms. Karol Fowler of Lockheed-Martin Property Management to proceed with the transfer of the AMU Advanced Weather Interactive Processing System (AWIPS) Equipment from the Air Force to NASA. Ms. Corean Schmidt and Ms. Maureen Sides from Yang Enterprises inventoried and put NASA tags on the AWIPS equipment.

Mr. Erik Magnuson from ENSCO's Aerospace Sciences and Engineering (ASE) division started working on the AWIPS client computers in the AMU lab to upgrade the operating system software.He completed upgrading the operating system (OS) software on the three AWIPS workstations in the AMU lab and installed AWIPS Build 9. He also upgraded the OS, installed the AWIPS and updated the BIOS on the two servers, which corrected the previous issue of perceived hard disc failures. Mr. Magnuson and Mr. Stonie Cooper of Planetary Data, Inc. realigned the NOAAPort Receive System satellite dish, which resulted in a 2 dB signal gain. They also upgraded the satellite receiver hardware and NOAAPort software. The AMU staff began testing the AWIPS client systems to verify they are functioning properly.

Mr. Barrett, Dr. Bauman and Mr, Wheeler completed NASA Risk Management System (RMS) training for RMS Version 5.2 to manage the AMU IT Security Plan and supporting documentation within RMS. They also met with Mr. Tony Killiri and Ms. Ann Marie Keim of KSC, to discuss the test of the IT Security Plan. The test is required once every three years.

Mr. Wheeler installed Ethernet cables for the NASA visiting scientist, Dr. Jim Koermer, and three students to give them access to their NASA accounts and the Internet while working in the AMU area.

Conferences, Meetings, and Training

Dr. Bauman completed two abstracts for the 34th National Weather Association (NWA) Annual Meeting to be held in Norfolk, VA from 17-22 October 2009 and uploaded them to the NWA website.

Ms. Crawford and Dr. Bauman attended the annual Range Commanders Council Meteorology Group Meeting at Johnson Space Center and presented a briefing titled "Recent Weather Technologies Delivered to America's Space Program by the Applied Meteorology Unit".

Mr. Barrett, Ms. Crawford and Mr. Wheeler attended ESRI Geographic Information System (GIS) Training in Orlando on 21 May.

Lanch Support

- Mr. Wheeler and Dr. Merceret supported the Atlas launch on 3 April.
- Ms. Crawford and Ms. Wilson supported the launch attempts of STS-127 on 13 and 17 June.
- Mr. Barrett and Dr. Merceret supported the Atlas V launch on 18 June and the launch attempt of the Delta IV on 26 June.
- Dr. Watson and Dr. Merceret supported the Delta IV launch on 27 June.

Mr. Wheeler, Dr. Bauman and Mr. Lane from ENSCO's ASE division updated the Space Shuttle Cloud Imaging Satellite Image Overlay for the STS-125 launch trajectory at the request of the Space Shuttle Launch Weather Officer, Ms. Winters. In a 2005 AMU task to support return-to-flight, the Overlay was generated only for International Space Station (ISS) trajectories since only ISS missions were planned. For the Hubble repair mission, the AMU input a new launch trajectory into the Overlay model and then migrated the results into the 45 WS MIDDS for Ms. Winters to use for STS-125 as a briefing tool for the Launch Director.

General

Dr. Bauman participated in a teleconference with Mr. Roeder of the 45 WS and personnel from Marshall Space Flight Center (MSFC) to discuss implementing and testing MSFC-developed radar algorithms on the 45 WS new Doppler weather radar.

Mr. Joseph Dreher left the AMU. His last day in the AMU was 10 April.

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LIST OF ACRONYMS

14 WS	14th Weather Squadron
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
AMS	American Meteorological Society
AMU	Applied Meteorology Unit
ARPS	Advanced Regional Prediction System
AWIPS	Advanced Weather Interactive Processing System
CCAFS	Cape Canaveral Air Force Station
CGLSS	Cloud-to-Ground Lightning Surveillance System
CSR	Computer Sciences Raytheon
EMS	Environmental Modeling System
FR	Flight Rules
FSU	Florida State University
FY	Fiscal Year
GF	Gust Factor
GFS	Global Forecast System
GIS	Geographic Information System
GSD	Global Systems Division
GUI	Graphical User Interface
HTML	Hypertext Markup Language
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
JSC	Johnson Space Center
KSC	Kennedy Space Center
LCC	Launch Commit Criteria
LDIS	Local Data Integration System
LDM	Local Data Manager
MADIS	Meteorological Assimilation Data Ingest System
MAE	Mean Absolute Error
MesoNAM	12-km resolution NAM
MIDDS	Meteorological Interactive Data Display System
MLR	Multiple Linear Regression
MSFC	Marshall Space Flight Center
NAM	North American Model
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NLDN	National Lightning Detection Network
NM	Nautical Miles
NOAA	National Oceanic and Atmospheric Administration
NWS MLB	National Weather Service in Melbourne, FL
PC	Personal Computer
POR	Period of Record
PW	Precipitable Water
QC	Quality Control
RD	Relative Delta
RMSE	Root Mean Square Error
RUC	Rapid Update Cycle
SLR	Single Linear Regression
SMC	Space and Missile Center
SMG	Spaceflight Meteorology Group
SPoRT	Short-term Prediction Research and Transition
Tcl/Tk	Tool Command Language / Tool Kit
TS	Tropical Storm
TTS	Shuttle Landing Facility 3-letter Identifier
USAF	United States Air Force
UTC	Universal Coordinated Time
WRF	Weather Research and Forecasting Model

Appendix A

AMU Project Schedule
31 July 2009

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date	Notes/Status
Peak Wind Tool for User LCC Phase II	Collect and QC wind tower data for specified LCC towers, input to S-PLUS for analysis	Jul 07	Sep 07	Completed
	Stratify mean and peak winds by hour and direction, calculate statistics	Sep 07	Oct 07	Completed Nov 07
	Stratify peak speed by month and mean speed, determine parametric distribution for peak	Oct 07	Nov 07	Completed
	Create distributions for 2-hour prognostic peak probabilities, and develop GUI to show climatologies, diagnostic and 2-hour peak speed probabilities	Nov 07	Oct 08	Completed Feb 09
	Create distributions for 4-hour prognostic peak probabilities and incorporate into GUI	Oct 08	Jan 09	Completed Mar 09
	Create distributions for 8-hour prognostic peak probabilities and incorporate into GUI	Jan 09	Apr 09	Delayed
	Create distributions for 12-hour prognostic peak probabilities and incorporate into GUI	Apr 09	Jul 09	Delayed
	Final report	Jul 09	Sep 09	On Schedule
Objective Lightning Probability Tool – Phase III	Collect CGLSS data for May–Sep 2006–2008 and Oct 1989–2008, analyze to determine if Oct data are needed	Mar 09	May 09	On Schedule
	Determine dates for lightning season stratifications	Jun 09	Jun 09	Reprogrammed
	Collect sounding data for May–Sep 2006–2008, and Oct 1989–2008 if needed, create candidate predictors for each stratification.	Jul 09	Sep 09	On Schedule
	Create and test new equations; compare performance with previous equations	Oct 09	Jan 10	On Schedule
	Incorporate equations in Excel GUI	Feb 10	Feb 10	On Schedule
	Final Report	Mar 10	May 10	On Schedule

AMU Project Schedule
31 July 2009

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date	Notes/Status
Peak Wind Tool for General Forecasting - Phase II	Collect wind tower data, CCAFS soundings, and SLF observations	Sep 08	Sep 08	Completed
	Interpolate 1000-ft sounding data to 100-ft increments for October 1996 to April 2008. Compare interpolated data to 100-ft sounding data for October 2002 to April 2008.	Sep 08	Oct 08	Completed Nov 08
	QC SLF observations	Oct 08	Nov 08	Completed
	QC wind tower data	Nov 08	Jan 09	Completed
	Create prediction equations for peak winds	Feb 09	Apr 09	Completed Jun 09
	Compare Phase I and II tools: • Using 2 cool-seasons of 45 WS-issued wind warnings/advisories; • To either MOS or model forecast winds; and • To wind tower climatology from the Peak Wind for User LCC task.	Jun 09	Nov 09	On Schedule
	Create and test Excel GUI application	Dec 09	Jan 10	On Schedule
	Transition tool to MIDDS to provide 5-day peak wind forecasts, using model data	Jan 10	Jun 10	On Schedule
	Final Report and training	Jul 10	Sep 10	On Schedule
Situational Lightning Climatologies for Central Florida: Phase IV	Develop and run scripts in S-Plus to create lightning data files broken down by time period, distance from location and flow regime	Jan 09	Feb 09	Completed
	Develop HTML GUI	Mar 09	Apr 09	Completed
	Write Final Report	Apr 09	May 09	Completed
Severe Weather and Weak Waterspouts Checklists in MIDDS	Develop MIDDS utilities to extract sounding parameters	Nov 08	Dec 08	Completed
	Transfer functionality of question-and-answer decision aids into MIDDS code	Dec 08	Jan 09	Completed
	Weak Waterspout Checklist	Dec 08	Jan 09	Completed
	Final Report and Training	Jan 09	Jan 09	Completed
	Develop GUI code	Feb 09	Mar 09	Completed

AMU Project Schedule
31 July 2009

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date	Notes/Status
ADAS Update and Maintainability Task	Install and configure LDM on amu-cluster and retrieve real-time date	Jan 09	Feb 09	Completed
	Install and configure latest version of ADAS code	Feb 09	Mar 09	Completed
	Modify and upgrade AMU-developed scripts	Feb 09	Nov 09	On Schedule
	Update GUI software code	Dec 09	Feb 10	On Schedule
	Final Report and training	Feb 10	Mar 10	On Schedule
HYSPLIT/WRF-EMS	Acquire and configure HYSPLIT on NWS MLB Linux machine	Oct 08	Dec 08	Completed
	Configure HYSPLIT to ingest NCEP model products	Oct 08	Dec 08	Completed
	Develop utility to convert WRF EMS output into HYSPLIT	Oct 08	Jan 09	Completed
	Final report and training	Feb 09	Apr 09	Completed
Verify MesoNAM Performance Task	Acquire ACTA MesoNAM forecasts and KSC/CCAFS wind tower observations	Jun 09	Jun 09	Completed
	QC wind tower observations, stratify by month, season and wind direction	Jun 09	Sep 09	On Schedule
	Objectively verify model forecasts against wind tower observations	Oct 09	Mar 10	On Schedule
	Final report	Apr 10	Jun 10	On Schedule
HYSPLIT GUI Task	Develop, Code and Configure GUI	Apr 09	Sep 09	On Schedule
	Test and Evaluate GUI	Sep 09	Oct 09	On Schedule
	Final report and training	Oct 09	Nov 09	On Schedule

NOTICE