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Applied Meteorology Unit (AMU) Quarterly Report

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NWS Melbourne/D. Sharp
NWS Melbourne/S. Spratt
NWS Melbourne/P. Blottman
NWS Melbourne/M. Volkmer

Executive Summary

This report summarizes the Applied Meteorology Unit (AMU) activities for the second quarter of Fiscal Year 2009 (January - March 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 — Combined data to eliminate time stratification. Tested several parametric extreme value distributions on the 2-hour prognostic probabilities. Delivered the graphical user interface (GUI) containing the climatologies, diagnostic probabilities, and 2– and 4–hour observed probabilities to the GUI and delivered it to the 45 WS.

Discussion — The 2-hour probabilities for each hour were not smooth and created a very large Excel file. After testing and consultation with the 45 WS, the hourly files were combined, resulting in no time stratification. None of the parametric distributions fit the prognostic probability curves. Therefore, only the observed prognostic probabilities will be created.

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 — Collected the Cloud-to-Ground Lightning Surveillance System (CGLSS) data for the warm season months May–September 2006–2008 and for October 1989–2008; began analyzing the data to determine if October data are needed.

Discussion — The new stratifications for the equations include a pre-lightning season in May, a transition season in May–June that increases to the main lightning season in June–August as seen in the daily lightning climatology from Phase II. It also shows a transition season of decreasing lightning activity from mid-August through September. It appears that drop-off continues into October. The October data will be examined to determine the climatological end of the lightning season.

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Distribution (continued from Page 1)

NWS Southern Region HQ/"W/SR"/ S. Cooper
NWS Southern Region HQ/"W/SR3" D. Billingsley
NWS/"W/OST1"/B. Saffle
NWS/"W/OST12"/D. Melendez
NSSL/D. Forsyth
30 WS/DO/J. Kurtz
30 WS/DOR/D. Vorhees
30 WS/SY/M. Schmeiser
30 WS/SYR/G. Davis
30 WS/SYS/J. Mason
30 SW/XPE/R. Ruecker
Det 3 AFWA/WXL/K. Lehneis
NASIC/FCTT/G. Marx
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46 WS/WST/E. Harris
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ENSCO, Inc./S. Masters

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 Kennedy Space Center (KSC)/Cape Canaveral Air Force Station (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 updating and testing the AMU software program to perform quality-control (QC) on the KSC/CCAFS wind tower data. Wrote a Perl script to determine the daily highest peak wind speed for each tower. Performed manual QC on daily peak wind speeds of 60 kt or greater to eliminate erroneous large outliers. Analyzed the 1200 UTC surface synoptic weather pattern for each day. Calculated predictors to evaluate for the tool.

Discussion Each day was categorized into one of seven weather patterns. Then, days were eliminated from the Period of Record (POR) on which a tropical storm or hurricane affected Florida. The following predictors to evaluate for the tool were calculated from the morning CCAFS soundings: average wind direction, depth and strength of the inversion, temperature lapse rate, wind shear, wind speed in the lowest 3000 ft above Mean Sea Level, mixing height, and Bulk Richardson Number.

Task Situational Lightning Climatologies for Central Florida: Phase IV

Goal Recalculate lightning climatologies for the Shuttle Landing Facility (SLF) 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 Completed stratification of all lightning data for all sites by flow regime, time interval and distance. Completed the GUI and delivered it to customers. Completed a first draft of the final report and submitted it for internal AMU review.

Discussion Processed all of the lightning data and flow regime files and created a database of spreadsheets stratified by flow regime, time interval and distance using S-PLUS and Excel software. Output the data files in a format for use in a web-based GUI, built the GUI tool and delivered it to NWS MLB and SMG for their comments.

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Executive Summary, *continued*

<u>Task</u> <u>Severe Weather and Weak Waterspout Checklist in MIDDS</u>

Goal Migrate the functionality of the web-based Severe Weather Forecast Decision Aid and the Weak Waterspout Checklist to the Meteorological Interactive Data Display System (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 Converted the MIDDS programs that access the real-time data automatically for the severe weather and weak waterspout worksheets into a GUI. Demonstrated the GUI to the 45 WS.

Discussion The GUI code was compared with previously developed code and tested to ensure the calculations were done correctly, and that the correct weights were being applied in order to calculate an appropriate severe weather threat index value. The GUI received a favorable review from the 45 WS and will be transitioned to the 45 WS workstations by Computer Sciences Raytheon (CSR) personnel in the near future.

<u>Task</u> <u>ADAS Update and Maintainability</u>

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 Determined what data to use in LDIS and how data would be acquired. Set up the Local Data Manager (LDM) software on the local modeling cluster. Downloaded and configured the latest version of ARPS/ADAS. Began modifying and rewriting previously written shell scripts to run ARPS/ADAS using the Perl programming language.

Discussion Dr. Watson began studying the Perl language and used it to rewrite the existing scripts that run the terrain and surface data portion of the ARPS/ADAS model system.

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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 configuration of HYSPLIT at NWS MLB. Completed installation of HYSPLIT on the SMG Linux cluster. Completed a draft version of the final report that is currently undergoing customer review.
Discussion	The HYSPLIT configurations at NWS MLB and SMG include several parameter files that contain many of the necessary trajectory and concentration HYSPLIT model runtime variables. They also contain utility programs to convert NWS MLB and SMG WRF model data into HYSPLIT binary format. 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 http://science.ksc.nasa.gov/amu/.

The AMU Quarterly Reports are also available in electronic format via email. If you would like to be added to the email distribution list, please contact Ms. Winifred Crawford (321-853-8130, crawford.winifred@ensco.com). 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, 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

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 Parametric Distributions

Ms. Crawford continued investigating potential parametric distributions for the 2-hour prognostic probabilities using data from Tower 0020/21. As reported in the previous AMU Quarterly Report (Q1 FY09), the hourly files were very large and slowed the GUI response time. In addition, the cumulative distribution function (CDF) curves for the hourly data were not smooth, with some curves crossing each other. An example of the 1-hour CDFs is shown in Figure 1. The data are from the Tower 0020 54 ft wind sensor in January at 0400 UTC (2300 EST).These should be interpreted as the probability of meeting or exceeding a specific peak speed over the next two hours (04–0600 UTC) given the observed 5-minute mean speed at 0400 UTC. These CDFs begin to cross each other at 13 kt (red curve). In general, the CDF curves for mean speeds higher than 12 kt were erratic. This would make fitting a parametric distribution to the data very difficult if not impossible. Ms. Crawford combined the hourly values into 3-, 6-, 12- and 24-hour groups to determine if such groupings would solve the issue. The first three groupings exhibited similar issues to the 1-hour data. The 24-hour data represents no time stratification, but resulted in smooth curves more conducive to a parametric fit.

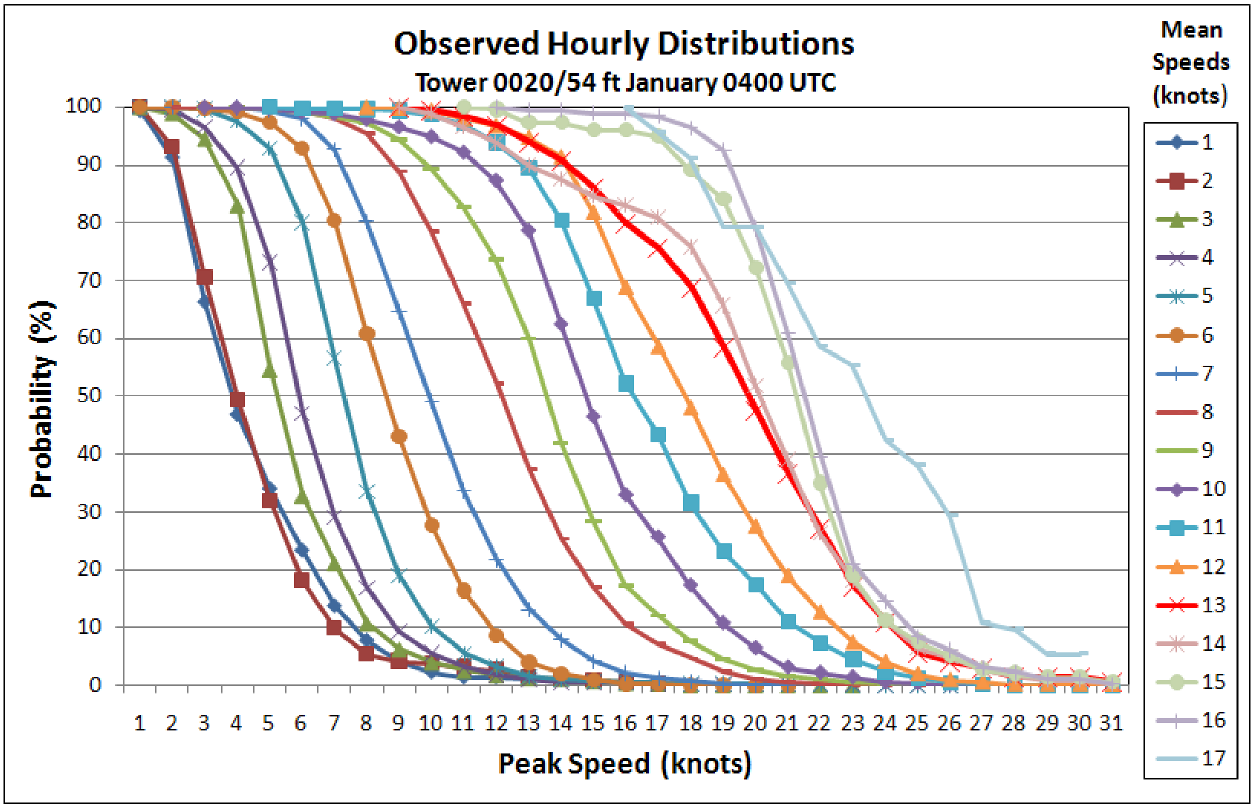


Figure 1. The observed CDFs from Tower 0020/54 ft at 0400 UTC in January. The legend at right shows the curve colors associated with each 5-minute mean speed.

After reviewing the 2-hour prognostic data for each hour, Mr. Roeder and Ms. Crawford concluded that there are not enough data to stratify by hour and properly model the higher wind speeds important to operations. This was also true for the 3-, 6-, and 12-hour stratifications. Therefore, they decided the data will not be stratified by time. Ms. Crawford combined the hourly files into one and created the observed probabilities.

Ms. Crawford calculated the Gumbel parameters for the combined 2-hour probabilities, and found that this distribution did not fit the data. She then tested two other well-known extreme value parametric distributions: the Weibull and Generalized Extreme Value (GEV) distributions (Wilks 2006). She also tested the Gaussian distribution. None of the distributions were able to fit the data. Figure 2 shows an example of this using data from Tower 0020 at 54 ft in January. The black curve is the observed CDF for the 24-hour, or non-time stratified, 2-hour probabilities for the 15 kt 5-minute mean speed. In the range 15–22 kt peak speed, the Gumbel distribution estimates probabilities too low, and from > 23 kt it estimates probabilities too high. The Weibull distribution estimates probabilities too high from 17–31 kt peak speeds. The Gaussian and GEV distributions provided the best fit, but still overestimated the probabilities between 21 and 31 kt peak speeds. Between 25 and 31 kt peak speeds, the Gaussian distribution overestimated the probabilities less than the GEV.

After consulting with Dr. Merceret and Mr. Roeder, Ms. Crawford concluded that no single parametric distribution could be used to model the prognostic probabilities. While the Gumbel distribution provided an excellent fit to the diagnostic probabilities, it does not in this case. One reason could be that, since the prognostic probabilities combine data over several hours using the re-sampling technique described in the AMU Quarterly Report Q1 FY08, differing physical mechanisms could be dominant at different times. The best-fit parametric distribution may be a combination of the above-mentioned distributions. It would be difficult to determine the percent contribution of each. Due to these issues, only the observed probabilities will be available in the GUI.

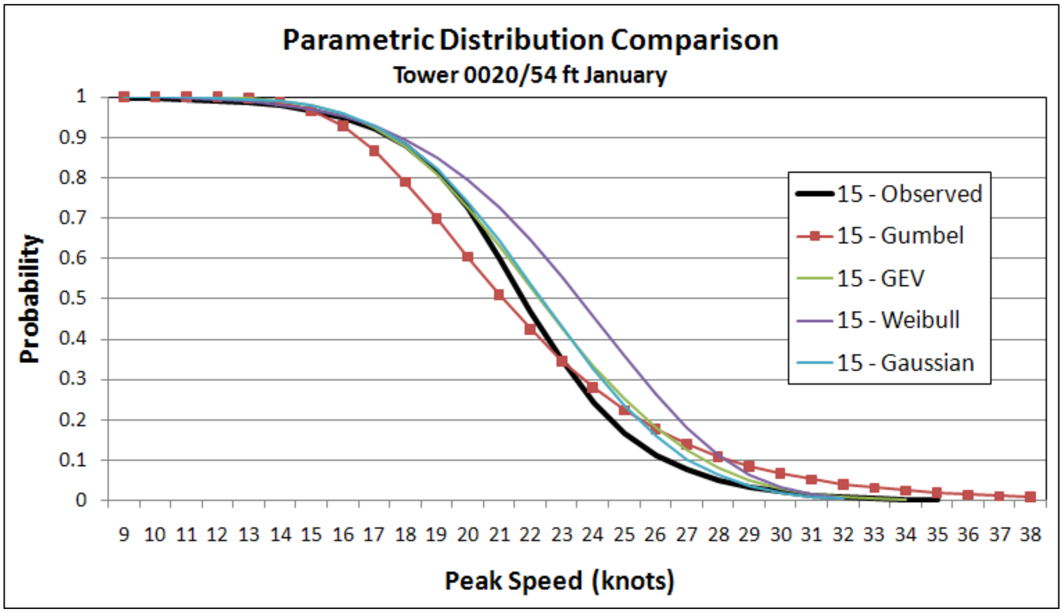


Figure 2. The observed and modeled CDFs from Tower 0020/54 ft in January for the 15 kt 5-minute mean speed. The legend at right shows the curve colors associated with each model and the observations. The observed CDF is solid black.

Prognostic Probability and GUI Status

Ms. Crawford completed running the 4-hour scripts and processed the output to produce the 4-hour peak speed probabilities. She incorporated the 4-hour observed probabilities into the GUI and delivered it to the 45 WS. Ms. Crawford then began running the 8-hour scripts. It takes 38-40 minutes to process two sensors/one month/one hour, only slightly longer than the 4-hour scripts

At the beginning of the Quarter, Ms. Crawford distributed the GUI containing the climatologies and diagnostic probabilities to the 45 WS along with a memorandum describing how to use it. She also gave a demonstration of the GUI at a 45 WS training meeting. Ms. Crawford later incorporated the 2-hour observed probabilities into the GUI and delivered it to the 45 WS. Two previous versions of the AMU Quarterly Report, Q3 and Q4 FY-08, have examples of the GUI forms.

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 Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS). The AMU developed a set of logistic regression equations that calculate the probability of lightning occurrence 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 period of record (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.

Figure 3 shows the daily lightning climatology used as a predictor in the Phase II equations. It was created from Cloud-to-Ground Lightning Surveillance System (CGLSS) data observed to occur in the KSC/CCAFS lightning warning areas during the warm seasons in 1989–2005. The progression of the lightning season is most obvious in the 14-day smoothed data with a pre-lightning period in early May, an increasing transition lightning period from mid-May to mid-June, a lightning period from mid-June to mid-August, and a decreasing transition period from mid-August through the end of September. The end of the latter transition season is not apparent in Figure 3, and may end sometime in October. This is why data from October will be included in Phase III.

Ms. Crawford acquired the CGLSS data for October 1989–2008 and May–September 2006–2008 for the task from Mr. Madison of Computer Sciences Raytheon (CSR). The CGLSS data for the warm seasons 1989–2005 were acquired and processed in Phases I and II. She imported the data into S-PLUS and began exploratory data analysis to determine the extent of lightning events in October to determine a climatological end to the transition season.

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

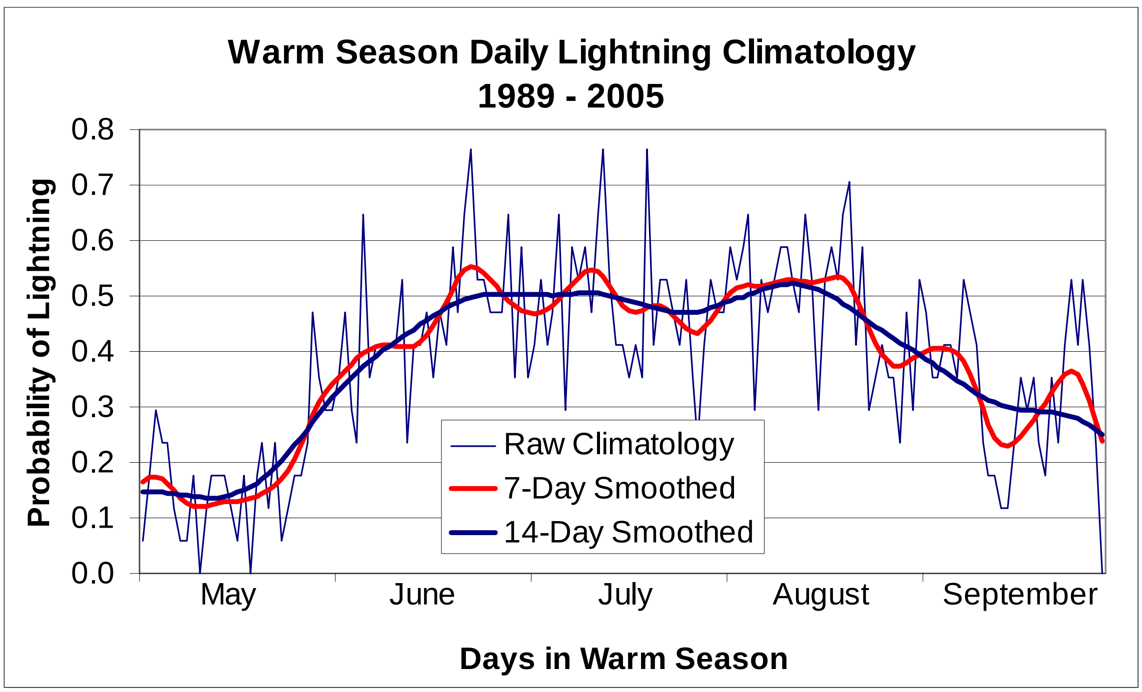


Figure 3. The daily raw (thin blue curve), ±7-day smoothed (red curve), and ±14-day smoothed (thick blue curve) climatological probability values of lightning occurrence for the warm-season months in 1989–2005 (from Lambert 2007 Figure 5a).

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.

KSC/CCAFS Wind Tower Data QC

Mr. Barrett completed rewriting and testing the AMU software program that performs quality-control (QC) on the KSC/CCAFS wind tower data. The original version was written in the Fortran programming language, while the new version is in the Java language. He ran the software to QC the tower data used in the task. He then wrote and executed a Perl script to determine the highest daily peak wind speed for each tower, as well as the highest daily peak wind speed from all of the towers.

In order to eliminate large outliers, Mr. Barrett manually examined each daily peak wind speed of 60 kt or greater. If the observations from the tower appeared erroneous, then the highest daily peak wind speed from one of the other towers was used. In some cases, observations from multiple towers were bad. Table 1 describes the daily peak wind speeds that were determined to be bad.

Synoptic Weather Pattern

Mr. Barrett analyzed the surface synoptic weather pattern at 1200 UTC on each day in the POR, the cool season months of October 1996 to April 2008. The surface charts were obtained from the National Weather Service Hydrometeorological Prediction Center's short-term (http://www.hpc.ncep.noaa.gov/dailywxmap/index.html) and long-term (http://docs.lib.noaa.gov/rescue/dwm/data_rescue_daily_weather_maps.html) archives. Each day was categorized into one of the following, with the number of days in parentheses:

- High pressure over Florida, with light and variable winds across East Central Florida (399),
- High pressure to the north or west of Central Florida, with northwest, north, northeast, or east winds across East Central Florida (1061),
- High pressure to the south or east of Central Florida, with southeast, south, southwest, or west winds across East Central Florida (363),
- Cold front over North Florida or the Florida Peninsula (281),
- Cold or stationary front over Central Florida (224),
- Cold or stationary front over South Florida or Florida Keys (203),
- Tropical storm or hurricane affecting Florida (15), and
- Surface weather map unavailable (1).

The task will not use days in which a tropical storm or hurricane affected Florida.

Predictors for Peak Wind Tool

Mr. Barrett wrote and executed Perl scripts to calculate the predictors from the morning CCAFS soundings. The following predictors will next be evaluated for their skill in predicting the peak non-convective wind speed, timing of the peak speed, and average wind speed at the time of the peak wind:

- Average wind direction in the lowest 300 ft Mean Sea Level (MSL),
- Depth and strength of the surface-based inversion,
- Temperature lapse rate in the lowest 2000 ft MSL,
- Maximum and average wind speeds in the lowest 3000 ft MSL,
- Wind shear between the surface and 1000 ft MSL,
- Wind speed in the lowest 3000 ft MSL,
- Mixing height,
- Wind speed at the top of the mixing layer,
- Maximum wind speed in the mixing layer, and
- Bulk Richardson Number.

The S-PLUS statistical software package will be used to help determine the best predictors to use in the tool. The soundings and tower observations from the cool-season months of October 1996 to February 2007 will be used to create the prediction equations. The peak wind forecasts from the Phase I and II tools will be compared to each other using observations from the cool-season months of March 2007 to February 2009.

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

Table 1. Erroneous daily peak wind speeds in the KSC/CCAFS tower network in the cool-season months from October 1996 to April 2008.

Date	Bad peak speeds and tower	Next highest peak speed and tower	Date	Bad peak speeds and tower	Next highest peak speed and tower
11/12/1996	60 kt, Twr 397	30 kt, Twr 398	**2/27/2002**	74 kt, Twr 511	33 kt, Twr 3131
1/10/1997	74 kt, Twrs 511 to 513	20 kt, Twrs 22 and 61	**3/11/2002**	74 kt, Twrs 511 and 513	21 kt, Twrs 3131 and 3132
2/20/1997	74 kt, Twrs 512 and 513	27 kt, Twr 3132	**3/14/2002**	70 kt, Twr 393	16 kt, Twr 511
12/2/1998	74 kt, Twr 511	20 kt, Twr 3132	**10/1/2002**	74 kt, Twr 513	28 kt, Twrs 62 and 403
12/14/1998	74 kt, Twrs 511 to 513	27 kt, Twr 300	**10/4/2002**	74 kt, Twrs 512 and 513	16 kt, Twrs 403 and 3132
4/13/2000	74 kt, Twr 513	33 kt, Twr 20	**10/17/2002**	74 kt, Twr 513	28 kt, Twr 393
4/21/2000	74 kt, Twrs 511 to 513	27 kt, Twr 21	**11/8/2002**	74 kt, Twr 512	20 kt, Twr 61
11/29/2000	74 kt, Twrs 512 and 513	23 kt, Twrs 393 and 394	**11/15/2003**	74 kt, Twrs 511 and 512	26 kt, Twrs 393 and 398
2/6/2001	74 kt, Twrs 512 and 513	13 kt, Twrs 393, 714 and 805	**1/31/2003**	74 kt, Twr 512	20 kt, Twrs 300 and 3131
2/16/2001	74 kt, Twrs 512 and 513	28 kt, Twrs 20, 61 and 1101	**12/6/2006**	74 kt, Twrs 512 and 513	15 kt, Twr 3132

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 National Weather Service in Melbourne (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.

Data Processing

Dr. Bauman started processing the data from files provided by the 14th Weather Squadron. There was one comma separated value (.csv) format file per site containing NLDN cloud-to-ground (CG) lightning strike data within 30 NM of the center of the runway. The file for each site contained the date, time, latitude and longitude, peak current, polarity, bearing and distance from the center of the runway of every strike for the POR that included all months in the years 1989-2007. Normally, a .csv-formatted file can be opened as a spreadsheet in Excel, but each file surpassed the 1,048,576 row limit imposed by Excel 2007. Therefore, Dr. Bauman imported the .csv files into the S-PLUS software package to process the lightning data files. S-PLUS reformatted the files into a proprietary format that uses an object class called a data frame to store matrix shaped data. These data can then be manipulated using the S-PLUS scripting language. Since only the warm season months of May-September were of interest, Dr. Bauman first extracted the warm season months from each file. Using the new files containing only warm season NLDN data, he processed each site's file and sorted them by year, month and day to prepare them to be merged with the flow regime data.

The flow regime data were contained in five Excel spreadsheet files each representing one warm season month. Each of the five files contained three columns of data with year, day and flow regime. To prepare these files for merging with the lightning data, Dr. Bauman imported the files into S-PLUS and wrote an S-PLUS script to insert a column representing the numeric month into each file, merged the five files and then sorted the new file based on year, month and day. With the lightning and flow regime files in similar formats, Dr. Bauman wrote an S-PLUS script to merge each site's 30-NM range lightning data file with the flow regime file. The resulting merged file for each site contained the 30-NM range lightning strike data and its corresponding flow regime for each day in the POR.

Dr. Bauman wrote S-PLUS scripts to extract 1-, 3- and 6-hour interval data from the merged file resulting in three time-interval based merged files for each site. Then, he wrote S-PLUS scripts to create 5-, 10- and 20-NM range data files for each of the three time intervals. The resulting 108 files were then sorted by the eight flow regimes, creating 864 new files. Finally, stratifying the data by month resulted in a total of 4,320 data files in S-PLUS data frame format. However, the S-PLUS data frames are not compatible with the format needed to develop the GUI, so Dr. Bauman wrote S-PLUS scripts to process and reformat the data frames and export them in Excel (.xls) format.

GUI Development

Dr. Bauman developed a web-based HyperText Markup Language (HTML) GUI that can be used with most web browsers on computers with popular operating systems (e.g., Windows, Mac and Linux). Both NWS MLB and SMG indicated a web-based HTML GUI would be compatible with their operations. The Excel files exported from S-PLUS were not in a format conducive to GUI development. To put the data in a more presentable format for the forecasters, Dr. Bauman wrote Excel macros in Microsoft Visual Basic to merge the individual spreadsheets generated by S-PLUS into one warm season Excel 2007 workbook and five monthly workbooks per site. Each workbook contained a worksheet for each of the eight flow regimes with 1-, 3- and 6-hour interval tables displaying the number of days with NLDN CG lightning, the climatological probability of lightning and corresponding probability charts for all time intervals and at 5-, 10-, 20- and 30-NM ranges. At the request of NWS MLB and SMG, Dr. Bauman fixed the y-axis to the same value for all charts of the same time interval for all sites based on the maximum value for each time interval for all sites. The forecasters stated fixing the y-axis to the same maximum value would be operationally beneficial to them. The maximum y-axis values on the 1-hourly graphs were fixed at 70%, on the 3-hourly graphs at 80%, and on the 6-hourly graphs at 90%.

Each site's six workbooks contained 120 probability tables and 120 corresponding charts resulting in a total of 2,160 tables and charts contained within 54 Excel workbook files. Although navigable in Excel, it would be cumbersome for the operational forecasters to move among the different sites, flow regimes and time intervals.

Adding time interval displays to the Excel workbooks would have required generating 27 additional tabs per workbook for the nine sites. Dr. Bauman, NWS MLB and SMG decided a web-based GUI would provide the best tool to allow the forecasters quick and easy access to the data.

The main page of the GUI is shown in Figure 4 and presents the forecaster with an overview map of the nine sites and their range rings plus a navigation menu at the top of the page. Dr. Bauman wrote the navigation menu code in the JavaScript language using Microsoft FrontPage software. The main navigation menu is displayed on every page of the GUI and provides the forecaster with one-click access to each site, a page containing a description of the data and flow regime definitions plus navigation back to the Main Page. The forecaster can also click within the 5-NM range ring on the map to navigate to the site's main page.

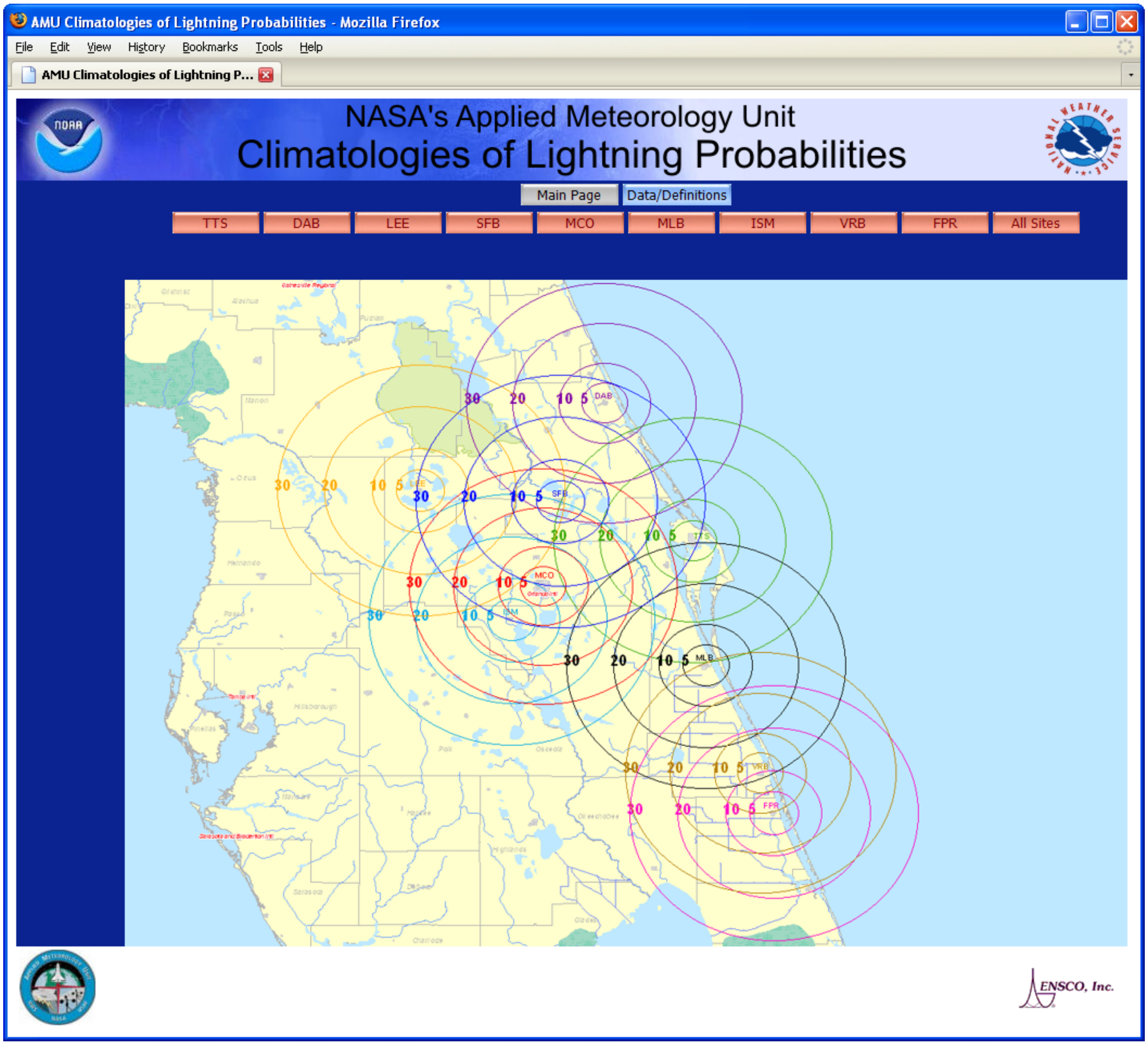


Figure 4. The main page of the Climatologies of Lightning Probabilities GUI displaying a map of the nine sites and main navigation menu (gray, blue and red buttons) at the top of the page.

Once the forecaster has chosen a site, they are presented with the main page for that site as shown for TTS in Figure 5. The forecasters are presented with two additional navigation menus allowing them to view the climatological lightning probabilities by time interval or flow regime. The main navigation menu remains visible so they can easily switch to another site, access the **Data/Definitions** page or go to the **Main Page**.

An example of the data for the 1-hour time interval for TTS is shown in Figure 6. The data table of the climatological probability of lightning for each flow regime is presented on the left of the page and the corresponding chart is shown to the right of each table. The forecaster can use the vertical scroll bar to navigate down and up on the page to view the statistics for all eight flow regimes.

Final Report

Dr. Bauman wrote the first draft of the final report and submitted it for internal AMU review.

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

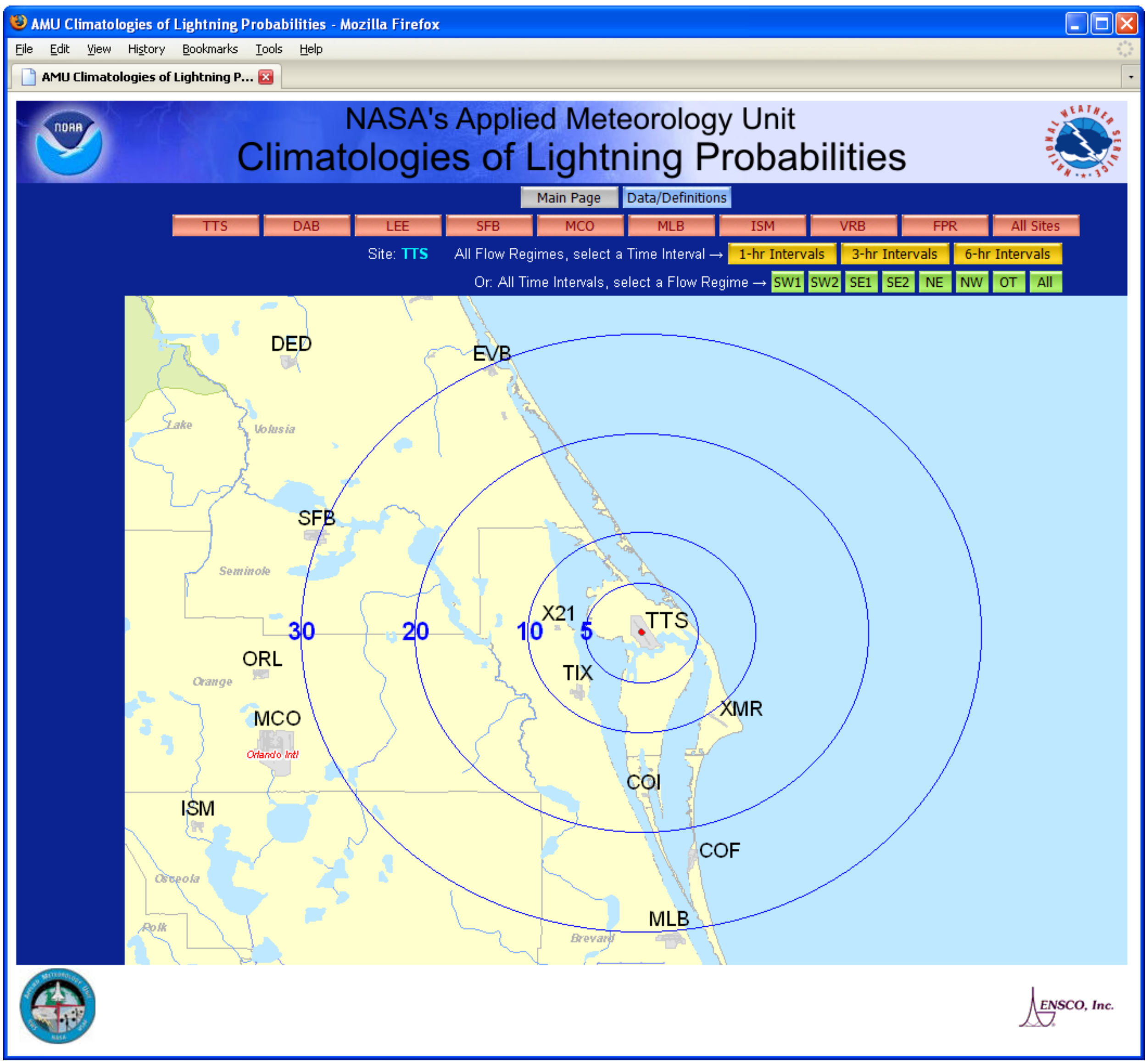
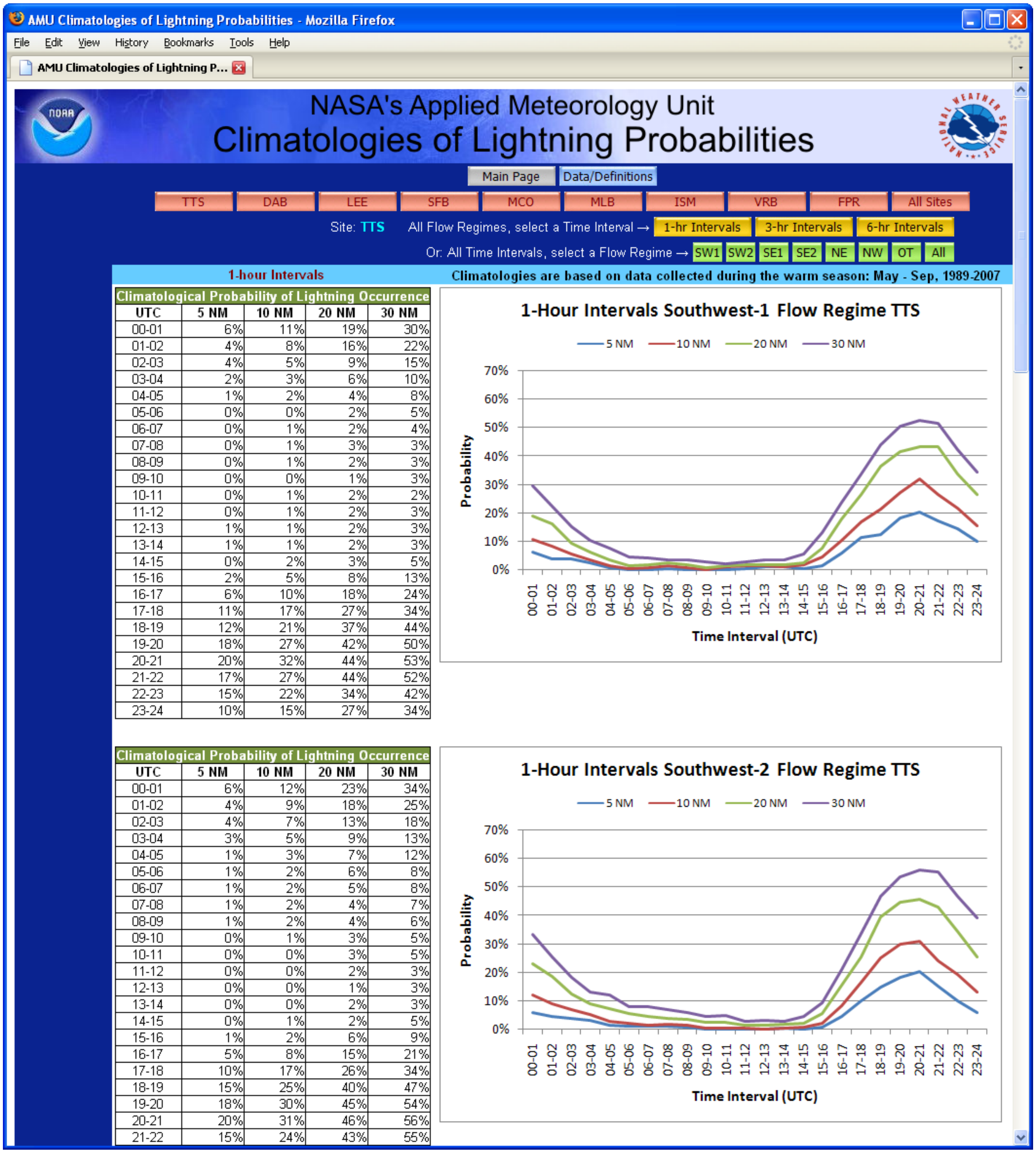


Figure 5. The main page for TTS showing a map of the site with the range rings displayed, the main navigation menu (gray, blue and red buttons), time interval navigation menu (yellow buttons) and flow regime navigation menu (green buttons).



Climatological Probability of Lightning Occurrence

UTC	5 NM	10 NM	20 NM	30 NM
00-01	6%	11%	19%	30%
01-02	4%	8%	16%	22%
02-03	4%	5%	9%	15%
03-04	2%	3%	6%	10%
04-05	1%	2%	4%	8%
05-06	0%	0%	2%	5%
06-07	0%	1%	2%	4%
07-08	0%	1%	3%	3%
08-09	0%	1%	2%	3%
09-10	0%	0%	1%	3%
10-11	0%	1%	2%	2%
11-12	0%	1%	2%	3%
12-13	1%	1%	2%	3%
13-14	1%	1%	2%	3%
14-15	0%	2%	3%	5%
15-16	2%	5%	8%	13%
16-17	6%	10%	18%	24%
17-18	11%	17%	27%	34%
18-19	12%	21%	37%	44%
19-20	18%	27%	42%	50%
20-21	20%	32%	44%	53%
21-22	17%	27%	44%	52%
22-23	15%	22%	34%	42%
23-24	10%	15%	27%	34%

Climatological Probability of Lightning Occurrence

UTC	5 NM	10 NM	20 NM	30 NM
00-01	6%	12%	23%	34%
01-02	4%	9%	18%	25%
02-03	4%	7%	13%	18%
03-04	3%	5%	9%	13%
04-05	1%	3%	7%	12%
05-06	1%	2%	6%	8%
06-07	1%	2%	5%	8%
07-08	1%	2%	4%	7%
08-09	1%	2%	4%	6%
09-10	0%	1%	3%	5%
10-11	0%	0%	3%	5%
11-12	0%	0%	2%	3%
12-13	0%	0%	1%	3%
13-14	0%	0%	2%	3%
14-15	0%	1%	2%	5%
15-16	1%	2%	6%	9%
16-17	5%	8%	15%	21%
17-18	10%	17%	26%	34%
18-19	15%	25%	40%	47%
19-20	18%	30%	45%	54%
20-21	20%	31%	46%	56%
21-22	15%	24%	43%	55%

Figure 6. The TTS data for the 1-hour time intervals and all flow regimes. The data showing the climatological probability of lightning is in tabular form on the left side of the page with corresponding charts to the right of the tables. The forecaster can use the scroll bar on the right to view other flow regimes not shown in this figure. Forecasters can access the other two time intervals or any of the flow regime-based data by clicking on the appropriate button on either of the two sub-navigation menus. The other sites are still accessible from this page from the main navigation menu.

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. MIDDS 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.

MIDDS

The primary advantage of using MIDDS is the ability to automatically populate values available in the MIDDS databases without forecaster intervention. The forecaster will still need to answer subjective questions that MIDDS will assign the appropriate values to using criteria from the severe weather worksheet climatology before calculating a total threat score for the day.

Software Development and Testing

Mr. Wheeler developed and tested the functionality of the Severe Weather Forecast Decision Aid automatic data input and the subjective questions into a MIDDS program using the Tool Command Language / Tool Kit (Tcl/Tk) language Interpreter. Tcl/Tk allows the flexibility of coding to retrieve, process, and apply functions to MIDDS data in the weather data database and then display output into a GUI.

GUI Development

MIDDS stores local data sets, model output and other gridded data, and radar and satellite images in fixed areas on a server. Man-computer Interactive Data Analysis System (McIDAS) commands and GUI programs can access and manipulate different data formats based on gridded, point or textual data structure. Tcl/TK is a scripting/programming and graphical language that allows access to the real-time data, allows retrieval of selected parameters and calculations of stability indices.

The XMR morning sounding at 1000 UTC was the primary focus of the data retrieval routines. Values and threat scores were computed for 14 out of the 26 total questions in the worksheet. The other 12 questions were subjective and must be answered by the forecaster. These questions were handled by displaying the question for the forecaster and having a help button to display a textual or graphic product to help them answer the question. Then based on their response, computing a weighted value is computed.

An added feature for the Severe Weather Forecast Decision Aid GUI is that all the sounding information, including stability indices and the Total Threat Score for the day, is displayed on the MIDDS text screen and also saved into a daily text file. This file can then be viewed or printed later. As the Severe Weather GUI is initialized, the text in Figure 7 is displayed to the user to show the program is working while it retrieves and calculates the sounding data and variable values.

Figure 7. The Severe Weather Forecast Decision Aid initial screen display.

Once all the stability and other severe weather thresholds have been calculated, the main Severe Weather Forecast Decision Aid GUI interface is displayed (Figure 8). The user would then answer the subjective questions. Pressing the Help button for an item opens a separate window that displays the help for that item. The user may also press the "View MIDDS Graphics" button to display a MIDDS screen of a graphical or text product that helps the user answer the question.

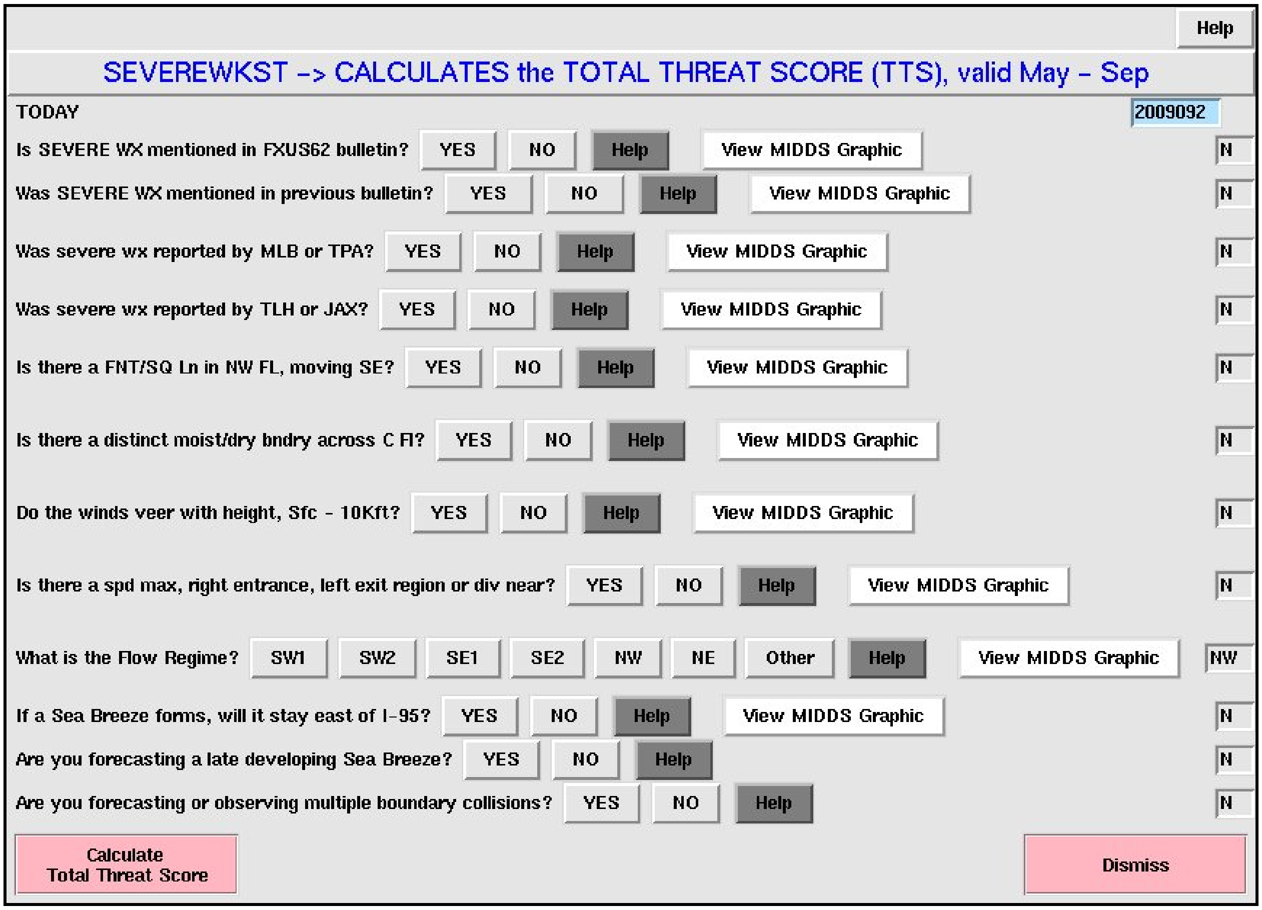


Figure 8. Example of the Severe Weather Decision Aid GUI screen display.

After all the questions have been answered, the forecaster would click the “Calculate Total Threat Score” button to display the threat score as in Figure 9. Besides displaying the threat score, the window also shows the weights and probability of severe weather based on different ranges of the threat score. At the same time the threat score in Figure 9 is displayed, the sounding stability values and other important thresholds are displayed in the MIDDS text window. Figure 10 shows an example of how these data are displayed.

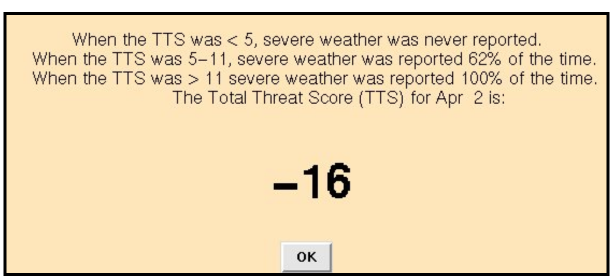


Figure 9. Example of the Severe Weather Decision Aid Total Threat Score screen display.

Testing

Once the GUI code development was completed, Mr. Wheeler developed several ways to test the code. An additional module of the code was developed so that all variables and weights would be listed to the screen. After the code was run, these output values were compared with the sounding variables to make sure the calculations were done correctly. Also, the weighted values were compared with those on the original study worksheet to make sure the proper weights were applied. Both tests showed positive results. Once initial testing was completed, Mr. Wheeler demonstrated the GUI to 45 WS personnel and received positive comments. Mr. Wheeler will provide a briefing and training on the GUI to the 45 WS in late April.

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

```
Developed by the Applied Meteorology Unit (AMU)
Today's Date is: 2009092
----------------------------------------------
greatest threat value vv
       Lifted Index  >-3 : 0.8
            K Index  >28 : 20.7
  Total Total Index  >48 : 44.4
    Showalter Index  >=3 : 2.5
     Thompson Index  >=40: 19.9
       Cross Totals  >=24: 20.5
    Vertical Totals      : 23.9
         CAPE FMaxT  3500: 477  j/kg
      1000-700mb RH  70% : 65 %
Low Level Jet 25kt - LL Wind Dir 205 at 13 kt
Inversion BL 8000ft      : 8900 ft
               MDPI  >1  : 0.4
       Precip Water  >1.5: 1.39 in
             Windex      : 16.4
  850mb Temp GT 20C      : 14.6
    Convective Temp      : 84.56 F
  Forecast Max Temp      : 86.0 F
     MaxT - Conv Tp  >=5 : 1.44


Total Threat Score for TODAY: -16
```

Figure 10. Example of the Severe Weather Decision Aid text window screen display.

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.

Obtaining Local Data

Dr. Watson held a teleconference with NWS MLB and SMG personnel to discuss which data to include in the ADAS analysis and from where to obtain a live feed of the data. They determined that the LDIS would incorporate

- Florida Automated Weather Network (FAWN) data,
- Surface METAR, ship and buoy observations,
- Profiler data,
- Aircraft Communication Addressing and Reporting System (ACARS) data,
- Infrared and visible satellite images,
- Automatic Position Reporting System (APRS) data,
- KSC/CCAFS tower data,
- WSR-88d Level II radar data, and
- Model data for the background analysis.

SMG will provide the satellite, radar, METAR, KSC/CCAFS tower, and model data to the AMU using the Local Data Manager (LDM) software. ENSCO's Information Systems and Technology division personnel set up the LDM software on the local cluster and the AMU began receiving preliminary data from SMG. Dr. Watson is obtaining the remaining datasets from the Meteorological Assimilation Data Ingest System (MADIS).

Modification of Existing Scripts

NWS MLB and SMG agreed that the existing shell scripts should be rewritten using the Perl programming language. Therefore, as the first part of the task, Dr. Watson began studying Perl scripting books to learn the language in order to modify the current shell scripts.

Next, Dr. Watson downloaded and configured the latest version of ARPS/ADAS (version 5.2.10) on the local cluster. Once the code was installed, she began rewriting and testing the new Perl scripts. The existing suite of shell scripts runs a complete model system that includes the preprocessing step, the main model integration, and the post-processing step. The preprocessing step prepares the terrain, surface characteristics data sets, and the objective analysis for model initialization. Dr. Watson rewrote the terrain and surface data programs in Perl such that the user is allowed more flexibility in the directory structure of the model and scripts than in the previous versions and the user is allowed more input options. In addition, the terrain and surface data programs were written so that they can be run independently of the rest of the model.

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

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), North American Model (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.

Automated HYSPLIT Configuration

Mr. Dreher made several modifications to the HYSPLIT configuration at NWS MLB. He added the ability to run HYSPLIT using the operational NCEP RUC 13-km model. Mr. Dreher obtained and modified the existing code from Mr. Glenn Rolph at the National Oceanic and Atmospheric Administration (NOAA). The program was originally written to convert the older RUC 20-km grids into HYSPLIT format, so the source code array dimensions were enlarged to support the higher resolution grid configuration. Only a single model time can be converted at once, so Mr. Dreher combined multiple times into a single larger file that is used to drive the requested RUC HYSPLIT simulations.

At the request of NWS MLB, Mr. Dreher updated the scripts to run HYSPLIT from multiple latitudes, longitudes, and elevations, and post-process the data to create various output graphics. The scripts were configured to run on a scheduled basis using cron jobs, which enable users to execute commands or scripts automatically. The cron jobs reference new central parameter files for each NCEP product that contain many of the necessary trajectory and concentration HYSPLIT model runtime variables. This allows forecasters to make changes quickly to the model configuration without having to edit the automated scripts. Mr. Dreher also added the option to display the HYSPLIT output in Google Earth™ or within geographic information system (GIS) applications.

Environmental Modeling System (EMS) Issue

During initial testing of the new WRF-to-HYSPLIT conversion program written for NWS MLB, Mr. Dreher discovered a bug with the treatment of the WRF vertical levels within the WRF EMS. The model output vertical levels were written top-down instead of the ground-up configuration in the operational version of WRF post processing system run at NCEP. The files created by the WRF EMS postprocessor caused a runtime error when ingested into HYSPLIT. Mr. Dreher debugged this issue with Dr. Robert Rozumalski at the NOAA NWS Science and

Training Research Center. It has since been corrected in the latest version of the EMS, which was released in February 2009. The new EMS was tested and configured on the AMU Linux cluster; but due to other customer priorities it has not yet been installed at NWS MLB. Based on discussions with NWS MLB, it was deemed beyond the scope of this task to modify the older version of EMS to be compatible with HYSPLIT. However, NWS MLB expects to upgrade their EMS in the near future and will be able to run HYSPLIT using local WRF model output.

Task Status

Mr. Dreher traveled to SMG to install and configure HYSPLIT on their Linux cluster. The SMG installation includes the capability to provide automated HYSLPIT forecasts using the same NCEP model products used in the NWS MLB version and the local version of WRF run at SMG.

Mr. Dreher completed a draft version of the final report that was reviewed internally by the AMU. He submitted the report for external customer review. Once those reviews and modifications are completed the report will be submitted to NASA for approval.

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

AMU CHIEF'S TECHNICAL ACTIVITIES (Dr. Merceret)

Dr. Merceret gave a presentation on proposed upgrades to the hurricane peak wind tool to the Cape Canaveral Chapter of the AMS. As a result of comments and suggestions from the audience at that meeting, he added significant additional capabilities to the tool.

Dr. Merceret and Ms. Crawford began an inter-comparison of gust factors from the AMU peak wind climatology with those obtained by Dr. Merceret in Hurricanes Frances and Jeanne. They compared the gust factors for mean wind speeds ranging from 15 to 34 knots at 54, 90 and 204 feet for Towers 2, 6 and 110, and examined stratifications by month and wind direction sectors. Preliminary results suggest the following:

1. Consistent with the existing literature, the non-tropical storm (TS) gust factors are smaller than the TS gust factors at a given height and mean wind speed.
2. The gust factors depend on the wind direction, most likely due to the difference in upwind surface conditions between the ocean to the east and the complex mixture of land and shallow water to the west. Difference in surface roughness and thermal properties are known to have a major effect on gust factors, so this result is also consistent with existing literature.

Future work will include looking at the relationship between the TS and non-TS gust factors to determine if the model developed by Merceret (2008) can be adapted for use for non-TS conditions.

AMU OPERATIONS

Information Technology

Mr. Barrett set up a new laptop to be used by AMU personnel during travel.

Conferences and Meetings

Three AMU team members presented at conferences during the 89th Annual American Meteorological Society meeting held 11-15 January 2009 in Phoenix, AZ:

- Mr Dreher gave an oral presentation titled "Statistical Short-Range Guidance for Peak Wind Speeds at Edwards Air Force Base, CA" during the 25th Conference on International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology.
- Dr. Bauman gave two oral presentations at the 13th Symposium on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface (IOAS-AOLS). The first was titled "Observation Denial and Performance of a Local Mesoscale Model", and the second was titled "Weather Research and Forecasting Model Wind Sensitivity Study at Edwards Air Force Base, CA".
- Dr. Bauman presented a poster authored by Mr. Barrett titled "Anvil Forecast Tool in the Advanced Weather Interactive Processing System" at the 25th Conference on IIPS for Meteorology, Oceanography, and Hydrology.

Launch Support

- Ms. Crawford supported the Delta IV-Heavy launch of NROL-26 on 17 January.
- Mr. Dreher supported the Delta II launch of Kepler on 6 March.
- Mr. Barrett supported the launch of Shuttle Discovery on 15 March
- Dr. Watson supported the postponed attempt to launch the Atlas V on 17 March.
- Dr. Bauman supported the Delta II launch on 24 March
- Ms. Wilson of the KSC Weather Office supported all of the above launches

General

Dr. Bauman asked the KSC Weather Office to request that the Air Force formally transfer the AMU Advanced Weather Interactive Processing System (AWIPS) equipment to NASA that was to be installed under the now defunct RSA program. The AMU requires AWIPS to support SMG and NWS MLB tasks. Over the past few months, Ms. Hosley of SLRSC has been working with Capt Martinez and Mr. Perez of SMC to complete the necessary paperwork to transfer the equipment. Mr. Barrett and Dr. Bauman conducted an inventory the AMU AWIPS equipment with Ms. Petit from SLRSC.

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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
CDF	Cumulative Density Function
CG	Cloud-to-Ground
CGLSS	CG Lightning Surveillance System
CSR	Computer Sciences Raytheon
EAFB	Edwards Air Force Base, CA
EMS	Environmental Modeling System
EST	Eastern Standard Time
FAWN	Florida Automated Weather Network
FR	Flight Rules
FSU	Florida State University
FY	Fiscal Year
GEV	Generalized Extreme Value
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
McIDAS	Man-computer Interactive Data Analysis System
MIDDS	Meteorological Interactive Data Display System
MSFC	Marshall Space Flight Center
MSL	Mean Sea Level
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	National Weather Service
NWS MLB	NWS in Melbourne, FL
PC	Personal Computer
POR	Period of Record
QC	Quality Control
RUC	Rapid Update Cycle
SLF	Shuttle Landing Facility
SMC	Space and Missile Center
SMG	Spaceflight Meteorology Group
SPoRT	Short-term Prediction Research and Transition
Tcl/Tk	Tool Command Language / Tool Kit
TTS	Shuttle Landing Facility 3-letter Identifier
USAF	United States Air Force
UTC	Universal Coordinated Time
WRF	Weather Research and Forecasting Model
XMR	CCAFS Sounding 3-letter Identifier

Appendix A

AMU Project Schedule
30 April 2009

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New 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 (*Nov 07*)	Completed
	Stratify mean and peak winds by hour and direction, calculate statistics	Sep 07	Oct 07 (*Nov 07*)	Completed
	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 (*Feb 09*)	Completed
	Create distributions for 4-hour prognostic peak probabilities and incorporate into GUI	Oct 08	Jan 09 (*Mar 09*)	Completed
	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	On Schedule
	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	On Schedule
	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 30 April 2009				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New 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 (*Nov 08*)	Completed
	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	On Schedule
	Create and test Excel GUI application	May 09	Jun 09	On Schedule
	Compare Phase I and II tools using 2 cool-seasons of 45 WS-issued wind warnings/advisories	Jul 09	Aug 09	On Schedule
	Compare Phase I and II tools to either MOS or model forecast winds	Sep 09	Oct 09	On Schedule
	Compare Phase I and II tools to wind tower climatology from AMU's Peak Wind for User LCC task	Nov 09	Dec 09	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	On Schedule
	Write Final Report	Apr 09	May 09	On Schedule

AMU Project Schedule
30 April 2009

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
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
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	On Schedule

NOTICE