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Applied Meteorology Unit (AMU) Quarterly Report

First Quarter FY-10 | Contract NNK06MA70C | 31 January 2010

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NWS Melbourne/B. Hagemeyer
NWS Melbourne/D. Sharp
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Executive Summary

This report summarizes the Applied Meteorology Unit (AMU) activities for the first quarter of Fiscal Year 2010 (October - December 2009). A detailed project schedule is included in the Appendix.

<u>Task</u> <u>Peak Wind Tool for User Launch Commit Criteria (LCC)</u>

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 The new 2- and 4-hour October probabilities and the 8-hour probabilities were incorporated into the graphical user interface (GUI), and then delivered to the 45 WS. Began running the scripts for the 12-hour probabilities.

Discussion The new 2- and 4-hour probabilities for October were re-calculated after removing tropical storm data from the original data files. The 12-hour scripts take 36-40 minutes to process, similar to the time taken for the 8-hour scripts.

<u>Task</u> <u>Objective Lightning Probability Tool, Phase III</u>

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 Imported and processed sounding data in S-PLUS.

Discussion The flow regime and stability parameters will used to develop an objective method for determining the start and end date of the lightning sub-seasons for each year.

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. Roberts
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
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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 — Using the verification data set, compared the Phase I and II forecasts of peak and average wind speed to climatology and model forecast winds. Compared the Phase I and II forecasts of peak wind speed to wind warnings and advisories issued by the 45 WS.

Discussion — The comparison showed that the Phase II methods performed slightly better than Phase I for peak and average wind speed. The model forecast winds, which consisted of output from the 12-km North American Mesoscale (MesoNAM) model, were the most accurate in the comparison. The climatology performed the worst in the comparison. In the comparison of the 45 WS wind warnings and advisories to the Phase I and II forecasts of peak wind speed, the 45 WS outperformed both methods.

Task — Upgrade Summer Severe Weather Tool in MIDDS

Goal — Upgrade the Severe Weather Tool by adding weather observations from the years 2004-2009, re-analyzing the data to determine the important parameters, and update the tool with the new information. The likelihood of severe weather occurrence for the day is included in the morning weather briefing. 45 WS forecasters use the Severe Weather Tool, developed by the AMU, to assist in making this forecast. Updating the database and MIDDS GUI will likely improve the performance of the tool and will increase forecaster confidence in the output.

Milestones — Began updating the severe weather parameter database for the years 2004-2009 with central Florida severe weather events, jet stream data and flow regime patterns. Started making some adjustments to the MIDDS GUI.

Discussion — Severe weather related data was retrieved to update the previous severe weather database (1989-2003) with additional reports and parameter data for the years 2004-2009. The AMU Severe Weather Worksheet GUI will also be updated to add additional functionality.

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Executive Summary, *continued*

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 the National Weather Service in Melbourne, FL (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 Finished modifying and rewriting previously written shell scripts to run ARPS/ADAS. Downloaded and installed the latest beta version of the Weather Research and Forecasting (WRF) Environmental Modeling System (EMS) software.

Discussion Used the Perl programming language to finish modifying and rewriting the existing scripts that run the complete ARPS/ADAS modeling system. Implemented the latest version of WRF EMS to test the new suite of Perl scripts used to run ADAS by running a cold season case study.

Task Verify MesoNAM Performance

Goal Verify the performance of the 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 Completed calculating model verification statistics for Towers 0002, 0393/0394 (Pad 39A) and 0397/0398 (Pad 39B).

Discussion Tested stratifying the data by 45°, 90° and 180° as requested by the 45 WS and determined sample size justifies using nothing less than a 180° stratification. After this stratification was approved by the 45 WS and all of the model and observational data were combined in Excel files, calculating model verification statistics commenced and was completed for five towers.

Task HYSPLIT Graphical User Interface

Goal Developed a GUI that allows forecasters to update selected parameters within the Hybrid Single-Particle Lagrangian Integrated Trajectory (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 allows easy adjustment of parameters in daily and emergency runs. This helps 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 Completed testing of the HYSPLIT GUI functionality at NWS MLB. Completed the final report.

Discussion Finished internal and on-site testing of the HYSPLIT GUI at NWS MLB. NWS MLB forecasters began using the GUI in real-time operational support of 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.winnie@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 at the end of each task summary.

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

After completing the new 2- and 4-hour probabilities for October and the 8-hour probabilities for all months, Ms. Crawford incorporated them into the GUI. The new 2- and 4-hour probabilities for October were re-calculated after removing tropical storm data from the original data files. The 8-hour probabilities were created using the modified original data. She then delivered the GUI to Mr. Roeder for testing and distribution to the Launch Weather Officers (LWOs). Ms. Crawford began running scripts to create the 12-hour probabilities. The scripts take 36-40 minutes to process data for 2 sensors/1 hour/1 month/all years 1995-2007. This is similar to the time taken for the 8-hour scripts. She completed the runs for the months January through April, and began running scripts for the October probabilities.

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.

Determining Stratifications

As described in previous AMU Quarterly Reports (Q3 FY09 and Q4 FY09), five sub-seasons are evident in the daily lightning climatology:

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-lightning (~13–31 October).

Ms Crawford determined that sounding data may be needed to develop an objective method for establishing the start/end dates of each sub-season for each year. The method must be appropriate for an operational setting such that the start date can be determined in real-time.

Ms. Crawford began processing the soundings so the flow regime and stability parameters can be explored for possible discriminators of lightning season begin and end dates. She imported all the sounding data into S-PLUS and created the flow regime days from the Florida soundings, and then used the CCAFS (XMR) morning soundings as discriminators for days in which a flow regime could not be determined. She provided the flow regime data to Mr. Wheeler for his work on the Severe Weather Tool task.

Task Status

Ms. Crawford continued working with Dr. Merceret while processing soundings, by assisting with analyzing statistical results as part of their comparison between tropical storm and non-tropical storm peak winds. That work is complete, and work will resume on this task in the next Quarter. 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.

Comparison of Phase I and II Average and Peak Wind Speed Predictions to Climatology and Model Forecast Winds

Mr. Barrett used a verification data set to compare the Phase I and Phase II forecasts of peak and average wind speed to climatology and model forecast winds. The Phase II forecasts consisted of several prediction methods that performed well in the developmental data set. The verification and developmental data sets included observations for the cool season months from March 2007 to April 2009 and October 1996 to February 2007, respectively. The Phase II methods that were selected for the comparison are shown in Table 1 of AMU Quarterly Report Q3 FY09. The most accurate Phase II methods will be used in the Phase II version of the Peak Wind Tool for General Forecasting.

Four climatological methods were evaluated in the comparison, based on the mean wind speeds in the developmental data set and the climatology winds at 54-, 90- and 204-ft. The climatology winds at 54-, 90- and 204-ft were calculated during a previous AMU task (Lambert 2003), and were based on observations from several wind towers across KSC and CCAFS.

The model forecast winds were derived from 00 UTC and 06 UTC runs of the 12-km North American Mesoscale model (MesoNAM). The MesoNAM included hourly forecasts out to 84 hours, although the comparison only used the Day-1 (0800 – 0800 local time) forecasts. The comparison used the MesoNAM data for the grid point closest to the XMR sounding. Levels 2 to 18 of the MesoNAM were evaluated, along with the strongest winds in the lowest 1000-, 2000-, and 3000-ft of the model. The exact height of each model level varied in time, due to changes in surface pressure and temperatures aloft. However, the approximate height of level 2 was around 200 ft Mean Sea Level (MSL) and level 18 was around 3100 ft MSL. Three sets of MesoNAM forecasts were used in the comparison. The first set included the strongest wind at each model level during the 24-hour period. The second set was a bias-corrected version of the first set, with each model level bias corrected from the mean error in the first set. The third set was a least-squares single linear regression, which related the first set to the observed wind speed.

Figure 1 shows the mean error for peak and average wind speed. Only the 00 UTC MesoNAM is shown, since there were only minor differences between the 00 UTC and 06 UTC runs of the MesoNAM. The Phase I and II methods had a bias near 0, while the bias in the MesoNAM varied by model level. Figure 2 shows the mean absolute error (MAE) for peak and average wind speed. The linear regression and bias-corrected MesoNAM winds were the most accurate, especially at the lower model levels. Figure 3 shows the MAE for peak and average wind speed in the 00 UTC and 06 UTC runs of the MesoNAM. The MAE in the 00 UTC runs was slightly lower than the 06 UTC runs.

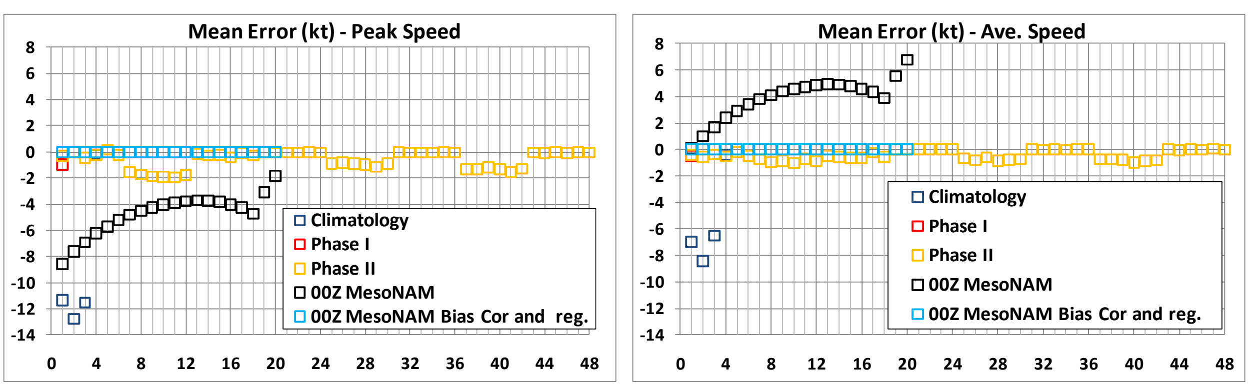

Figure 1. Mean error in kt (y-axis) for the peak and average speed. The 00 UTC MesoNAM winds (model levels 2-18 and strongest winds in lowest 1000-, 2000-, and 3000-ft) are plotted along points 1-20 (black and light blue). The climatology methods are plotted at points 1-4 (dark blue). The Phase I method is plotted at point 1 (red). The Phase II methods are plotted at points 1-48 (yellow).

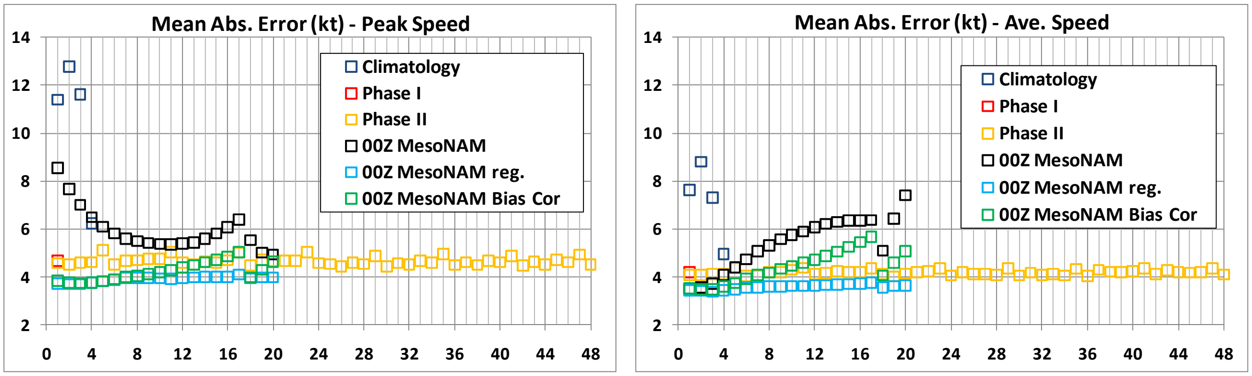

Figure 2. MAE in kt (y-axis) for peak and average speed. The 00 UTC MesoNAM winds (model levels 2-18 and strongest winds in lowest 1000-, 2000-, and 3000-ft) are plotted along points 1-20 (black, light blue, and green). The climatology methods are plotted at points 1-4 (dark blue). The Phase I method is plotted at point 1 (red). The Phase II methods are plotted at points 1-48 (yellow).

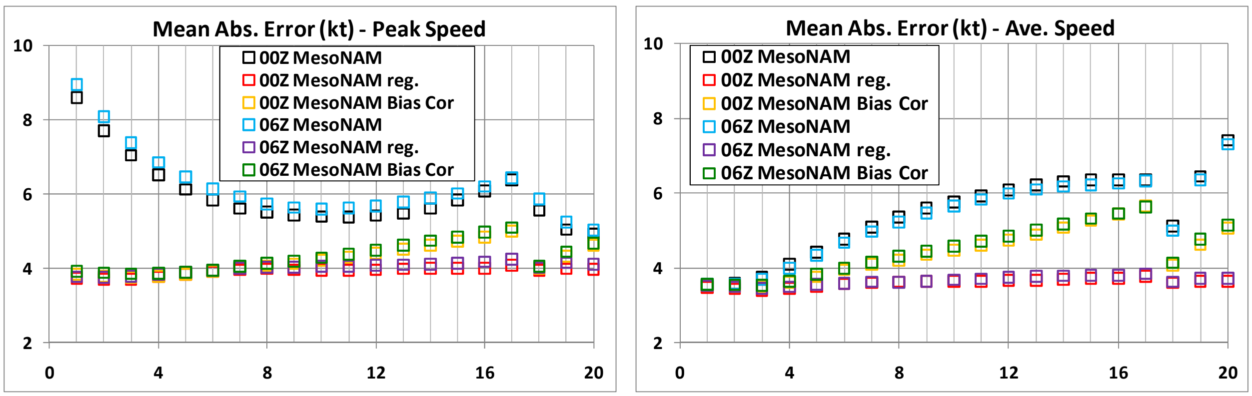

Figure 3. MAE in kt (y-axis) for peak and average speed. Points 1-17 depict levels 2-18 of the model. Points 18-20 depicts the strongest winds in the lowest 1000-, 2000-, and 3000-ft. The black, red, and yellow squares are for the 00 UTC MesoNAM, the blue, purple and green squares are for the 06 UTC MesoNAM.

Overall, the MesoNAM forecasts were the most accurate in the comparison. The 00 UTC MesoNAM performed only slightly better than the 06 UTC MesoNAM. The Phase I and II forecasts were similar, although the best Phase II methods were slightly more accurate than the Phase I forecasts. The climatology forecasts performed the worst.

Comparison of Phase I and II Peak Wind Speed Predictions to 45 WS Warnings and Advisories

The Phase I and II forecasts were also compared to the 45 WS wind warnings and advisories on days in which the 45 WS issued at least one wind warning or advisory. Table 1 shows the comparison for days in which the strongest 45 WS wind warning or advisory was for 25-34 kt and 35-49 kt. A “hit” was defined as an observed peak wind in the correct forecast interval (25-34 kt or 35-49 kt). An “over-forecast” was defined as an observed peak wind that was weaker than the forecast interval. An “under-forecast” was defined as an observed peak wind that was stronger than the forecast interval. The 45 WS wind warnings for winds of 50 kt or greater are not shown, since only two warnings were issued during the verification period. The values in Table 1 show the 45 WS out-performed the Phase I and II methods, because the 45 WS had the most hits. On days in which the 45 WS issued a wind warning for 35-49 kt, the 45 WS tended to over-forecast more often than under-forecast, while the Phase I and II methods under-forecast more often than they over-forecast.

Table 1. Verification for days in which the highest 45 WS wind warning/advisory was 25-34 kt (left) and 35-49 kt (right). Phase II methods are shown in blue. The abbreviation "reg" means "regression".

Method	25 - 34 kt			35 - 49 kt		
	Hits	*Under-forecast*	*Over-forecast*	*Hits*	*Under-forecast*	*Over-forecast*
least-squares single reg.	35	13	4	35	29	3
robust single reg.	32	19	1	29	36	1
stepwise least-squares reg.	36	13	4	33	30	3
stepwise robust reg.	34	15	3	34	30	3
least-trimmed squares reg.	31	17	4	31	33	3
robust single reg., bias-corrected	34	12	6	37	26	3
stepwise robust reg., bias-corrected	35	12	6	37	26	3
least-trimmed squares reg., bias-corrected	34	13	6	35	27	3
Phase I	34	16	2	34	31	1
45 WS	45	6	2	41	2	28

Development of the Phase II GUI

Mr. Barrett began work on the Phase II version of the Microsoft Excel GUI. The Phase I version of the Excel GUI used the morning sounding as input to the prediction equations. The 45 WS forecaster manually entered data, and then the GUI calculated and displayed the predicted peak and average wind speed, the timing of the peak speed, and the probability that the peak speed will meet or exceed 35 kt, 50 kt, and 60 kt. In the comparison described above, the MesoNAM forecasts were more accurate than the Phase I and II methods. Therefore, the Phase II version of the Excel GUI will use MesoNAM data as input. MesoNAM forecasts are provided to the 45 WS by ACTA, Inc. and include hourly forecasts from 0 to 84 hours based on the model runs at 00, 06, 12 and 18 UTC. The 45 WS receives the MesoNAM forecasts via email, and they can be stored on a computer hard drive as a text file. The Excel GUI will be able to automatically read the MesoNAM text files and display the same forecast parameters as the Phase I version. After the Phase II version of the Excel GUI has been completed, Mr. Barrett will begin work on the MIDDS tool.

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

INSTRUMENTATION AND MEASUREMENT

Upgrade Summer Severe Weather Tool 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. Forecasting the occurrence and timing of severe weather is challenging for 45 WS operational personnel. In Phase I, the AMU analyzed stability parameters and synoptic patterns from Central-Florida severe weather days in the years 1989-2003 to determine which were important to severe weather development. The AMU then created an objective HTML-based tool using the important predictors to assist forecasters in determining the probability of issuing severe weather watches and warnings for the day. Work in a follow-on task resulted in a MIDDS-based GUI to replace the HTML tool. This new tool retrieved stability parameters and other information from MIDDS automatically, minimizing the forecaster's interaction with the tool. The result was a reduction in the possibility of human error and increased efficiency, giving forecasters more confidence in the tool output and allowing them more time to do other duties. For this task, the 45 WS requested the AMU upgrade the severe weather database by adding weather observations from the years 2004-2009, re-analyzing the data to determine the important parameters, make adjustments to the index weights depending on the analysis results, and update the MIDDS GUI. Updating the database and MIDDS GUI will likely improve the tool's performance and increase forecaster confidence in the output.

Severe Weather Database

Mr. Wheeler retrieved the 2004-2009 severe weather reports from the Storm Prediction Center and data from severe weather days in that period from the National Climatic Data Center database. He is integrating and comparing these severe reports with the existing AMU database. Once completed, there will be a 30 year record of severe weather reports and associated weather parameters for the months May through September. Mr. Wheeler will also include data from the local rawinsondes as well as the Florida large-scale flow regime data created in previous AMU work. He will use archived upper air data from Plymouth State University to plot and analyze the jet stream characteristics over Florida to include whether or not East-Central Florida was under the influence of “no jet streak”, “upper level divergence”, “jet streak overhead”, or “jet streak exit region”. Once he updates the database , he will analyze the data and reassess all the previous severe weather indices and signatures and retune the parameter weight values as needed.

Severe Weather Forecast GUI

Mr. Wheeler began updating the functionality of the MIDDS Severe Weather Forecast GUI (Figure 4) using the Tool Command Language / Tool Kit (Tcl/Tk) language Interpreter. Tcl/Tk allows flexibility of coding to retrieve, process, and apply functions to MIDDS data in the weather data database and then display output into the GUI.

The GUI retrieves and calculates most of the severe weather parameters from the XMR 1000 UTC morning sounding. It calculates values and threat scores for 14 out of the 26 total questions in the worksheet. Twelve of the questions are more subjective and need to be answered by the forecaster. These questions were handled by displaying the question for the forecaster, having mouse over help to display a descriptive text, and a View Graphic button. The View Graphic button displays a MIDDS graphic image of the parameter to help the forecaster answer the question. The GUI calculates an index value based on the forecaster response. When the forecaster presses the Calculate Total Threat Score, the GUI adds all the index values and displays the total to the forecaster. The magnitude of the total represents the severe weather threat for the day. All the calculated values and parameters are written to a file that can be viewed later.

For more information contact Mr. Wheeler at wheeler.mark@ensco.com or 321-853-8105.

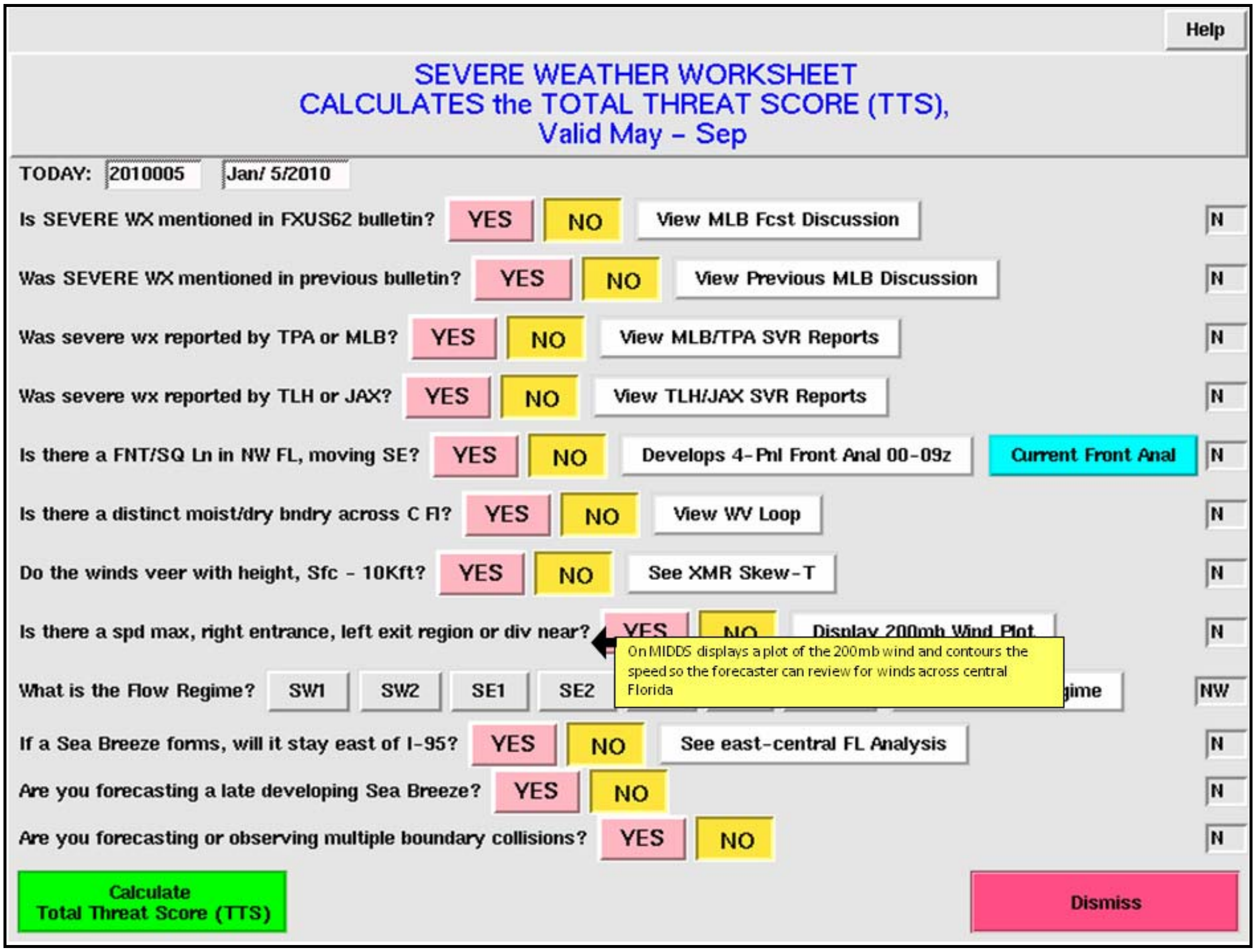

Figure 4. The Severe Weather Worksheet GUI with mouse-over help displayed in the yellow box toward the bottom of the GUI with a black arrow on the upper left.

MESOSCALE MODELING

ADAS Update and Maintainability (Dr. Watson)

Both the National Weather Service in Melbourne, FL (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 NWS MLB/SMG 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 finished modifying the previously written shell scripts and rewriting them using the Perl programming language. The existing suite of shell scripts runs a complete model system including the pre-processing step, the main model integration, and the post-processing step. In the previous quarter (AMU Quarterly Report Q4 FY09), Dr. Watson modified the shell scripts that initialize soil temperatures and moisture variables used in ADAS, modified the shell scripts that create the model initial and boundary conditions used in the WRF model, and wrote a Perl script that performs a temporal interpolation of the first-guess background model fields in the ADAS analyses. Dr. Watson sent the completed scripts to NWS MLB and SMG to begin installing and testing. She also sent a preliminary outline of how to set up and run the scripts.

One of the options for the main model integration is the use of the WRF model. The WRF numerical weather modeling system consists of two dynamical cores, the Advanced Research WRF (ARW) and the Non-hydrostatic Mesoscale Model (NMM). The ARW core was developed primarily at the National Center for Atmospheric Research while the NMM was developed at the National Centers for Environmental Prediction (NCEP). The WRF Environmental Modeling System (WRF EMS) software was developed by the NWS Science Operations Officer Science and Training Resource Center. A benefit of using the WRF EMS is that it incorporates both dynamical cores into a single end-to-end forecasting model (Rozumalski 2006). The software consists of pre-compiled programs that are easy to install and run. Dr. Watson downloaded and installed the latest beta version of the WRF EMS and tested the new suite of Perl scripts she modified to run ADAS.

As detailed in a previous AMU Quarterly Report (Q3 FY09), data ingested into ADAS included Level II WSR-88D data from six Florida radars, GOES visible and infrared satellite imagery, KSC/ CCAFS wind tower network data, and all Florida surface and upper air observations from the National Ocean and Atmospheric Administration (NOAA)/Earth System Research Laboratory (ESRL)/Global Systems Division (GSD) Meteorological Assimilation Data Ingest System (MADIS). Figure 5a shows the radar site locations in Florida, Figure 5b shows the KSC/CCAFS wind tower locations and Figure 5c shows a sample of the MADIS surface observation locations.

The next step in this task is to update the existing ADAS GUI. The original GUI was developed in 2006 (Case and Keen 2006) and was created using Tcl/Tk. Dr. Watson began learning the Tcl/Tk programming language in order to modify and update the existing GUI.

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

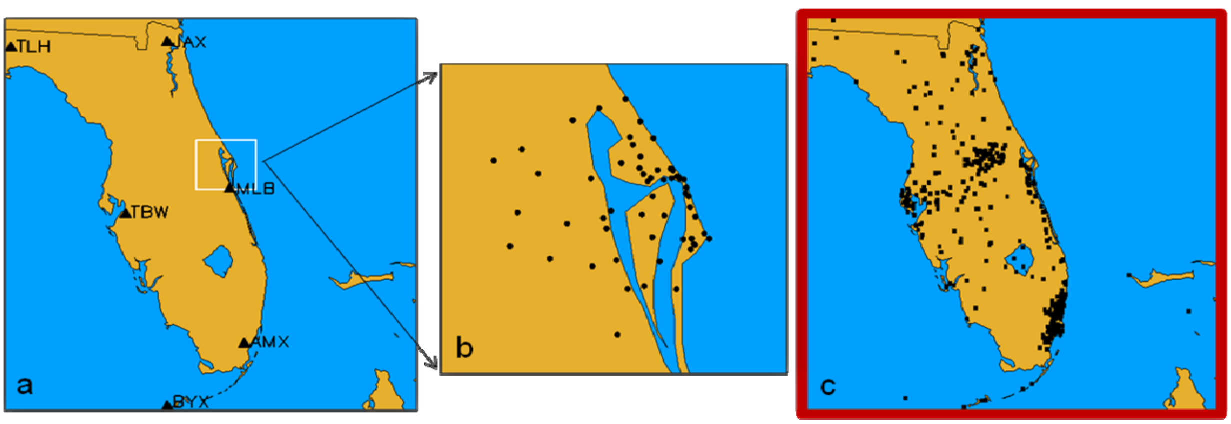

Figure 5. The locations of a) WSR-88D radars over the Florida peninsula, b) KSC/CCAFS wind tower network, and c) MADIS surface observations over the Florida peninsula. The red box around the MADIS data indicates it is a new data source in the updated ADAS scripts.

Verify MesoNAM Performance (Dr. Bauman)

The 45 WS LWOs 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)/ Falcon 9 (LC-40)	54 ft
0108	Delta IV (LC-40)/Falcon 9 (LC-40)	54 ft
0110	Atlas V (LC-41)/Falcon 9 (LC-40)	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

Data Stratification

Dr. Bauman stratified the Excel worksheets by month and began to calculate the statistics to determine model performance. The 45 WS requested the data be stratified by 45°, 90°, 180°, and 360° sectors to determine which produced a sufficient sample size to calculate reliable statistics. By starting with the smallest stratification of 45°, Dr. Bauman calculated bias statistics for three towers to determine if the sample size was sufficient to be statistically significant, and found it was not. He did the same for the 90° stratification and found the sample size was also too small. After consulting with Mr. Roeder of the 45 WS, he and Dr. Bauman decided a stratification of 180° had a sufficient sample size and the statistics for each tower would be calculated as "onshore" and "offshore".

Towers 0002, 0006 and 0110 have dual sensors located on the northwest and southeast side of each tower. Figure 6 depicts which sensor is chosen to report real-time observations to the forecaster display based on the observed wind direction. The northwest sensor is always used when the winds are between 249° and 22° (light red arc) and the southeast sensor is always used when the winds are between 69° and 203° (light green arc). However, both sensors display observations in the gray area, 23° to 68° or 204° to 248°. The sensor used in the gray area is based on the last sensor used before the winds are in the gray area. For example, if the southeast sensor was the previously selected sensor based on wind direction, then that sensor will continue to be the selected sensor until winds are observed between 248° and 23°. Conversely, if the northwest sensor was the previously selected sensor, it will remain so until the winds are observed between 68° and 204°.Data from both sensors are saved for archive regardless of wind direction. For this task, the northwest sensor was used for winds between 226° and 45° (thin red arc in Figure 6) and the southeast sensor was used for winds between 46° and 225°(thin green arc in Figure 6).

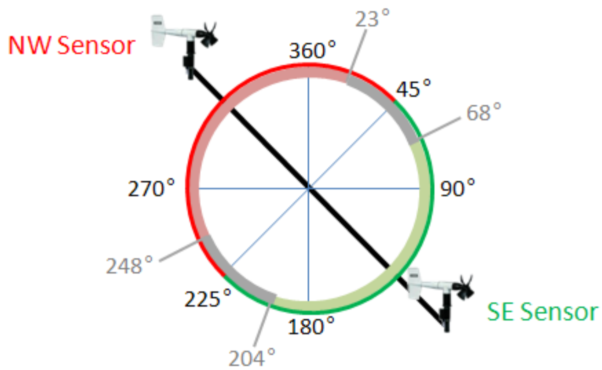

Figure 6. Dual sensor configuration on Towers 0002, 0006 and 0110. Sensors are mounted on the northwest and southeast side of each tower. The northwest sensor is always selected when the winds are between 249° and 22° (light red arc) and the southeast sensor is always selected when the winds are between 69° and 203° (light green arc). Either sensor can be used in the two gray regions when the winds are between 23° and 68° or 204° and 248°.

Figure 7 shows the locations of Towers 0002, 0006 and 0110. The coastline orientation in the vicinity of Tower 0002 is northeast to southwest. Therefore, the onshore stratification only used data from the southeast sensor and the offshore stratification only used data from the northwest sensor. Towers 0006 and 0110 are affected by a coastline orientation from northwest to southeast. Therefore, their onshore stratification required using the northwest sensor for winds from 316° to 45° and the southeast sensor for winds from 46° to 135°. Conversely, their offshore stratification required using the northwest sensor for winds from 226° to 315° and the southeast sensor for winds from 136° to 225°. To summarize the sensor configurations for onshore and offshore flow:

For Tower 0002:

- Onshore: SE sensor 46° to 225°
- Offshore: NW sensor 226° to 45°

For Towers 0002 and 0110:

- Onshore: NW sensor 316° to 45° and SE sensor,46° to 135°
- Offshore: NW sensor 226° to 315° and SE sensor 136° to 225°

Dr. Bauman wrote Microsoft Visual Basic scripts in Excel that select the appropriate sensors for the onshore and offshore calculations for the dual-sensor towers.

Figure 7. Map of KSC/CCAFS showing the locations of the mesonet wind towers. The onshore and offshore stratifications were determined by the coastline alignment relative to the Atlantic Ocean for each tower.

The mesonet wind tower configurations at the Shuttle/Constellation pads presented a similar challenge to computing onshore and offshore statistics as for the dual-sensor towers. As Figure 7 shows, Tower 0393 (Pad 39A) and Tower 0397 (Pad 39B) are on the northwest side of each pad and have sensors mounted on the northwest side of each tower. Tower 0394 (Pad 39A) and Tower 0398 (Pad 39B) are on the southeast side of each pad and have sensors mounted on the southeast side of each tower. This sensor configuration is similar to that described above for the dual-sensor towers except the sensors are not on the same tower. Dr. Bauman also wrote Microsoft Visual Basic scripts in Excel to extract the appropriate data from each of these towers and then combine the data at each pad to compute statistics for the onshore and offshore components.

Verification Examples

Statistics Dr. Bauman has computed thus far include bias, standard deviation of bias and root mean square error. The model bias of temperature (T) and dewpoint temperature (T_d) showed a diurnal fluctuation for onshore, offshore and 360° sectors. Figure 8 shows charts of the onshore and offshore model bias of T and T_d for Pad 39A using sensors from Towers 0393 (northwest sensor) and 0394 (southeast sensor) for January. The model bias of T was most pronounced with a warm bias of up to 4 °F. Figure 9 shows the standard deviation of the bias of T and T_d and indicates the model error increased with the forecast period for both parameters.

The bias of wind speed and wind direction did not show the same diurnal fluctuation as the T and T_d. However, the standard deviation of the bias for wind speed and direction have shown similar trends as the T and T_d thus far. As shown in Figure 10 and Figure 11 for wind speed and direction, respectively, onshore and offshore flow at Pad 39A, the trend of the model error increased during the forecast period for both onshore and offshore flow during January.

Dr. Bauman will continue to calculate verification statistics for the remaining towers. He has also discussed developing a web-based GUI with the 45 WS so the large amount of data being generated can be more easily and quickly accessed by the LWOs. For more information contact Dr. Bauman at bauman.bill@ensco.com or 321-853-8202.

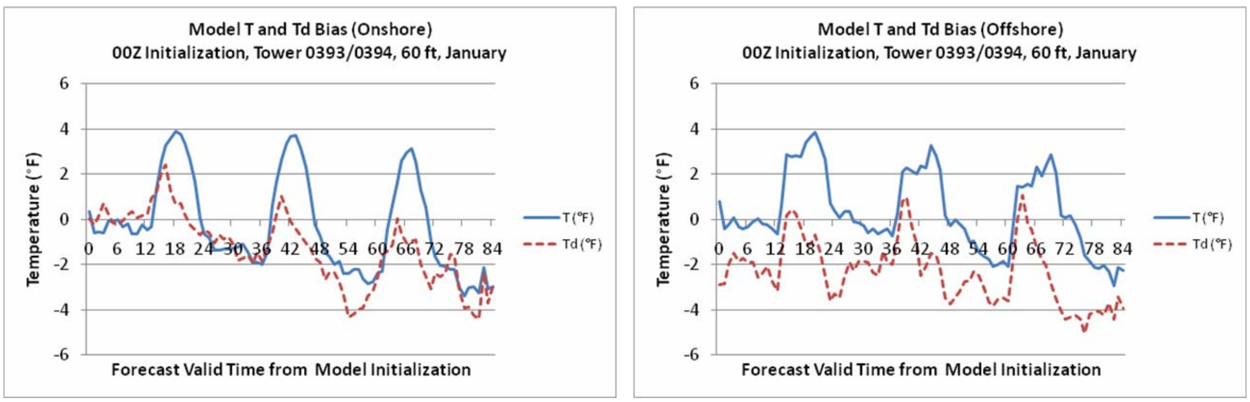

Figure 8. Onshore (left) and offshore (right) stratification charts showing model bias of T (blue line) and T_d (red dashed line) from a 00Z model initialization at Pad 39A using observations from sensors at Towers 0393 and 0394 at a sensor height of 60 ft for January.

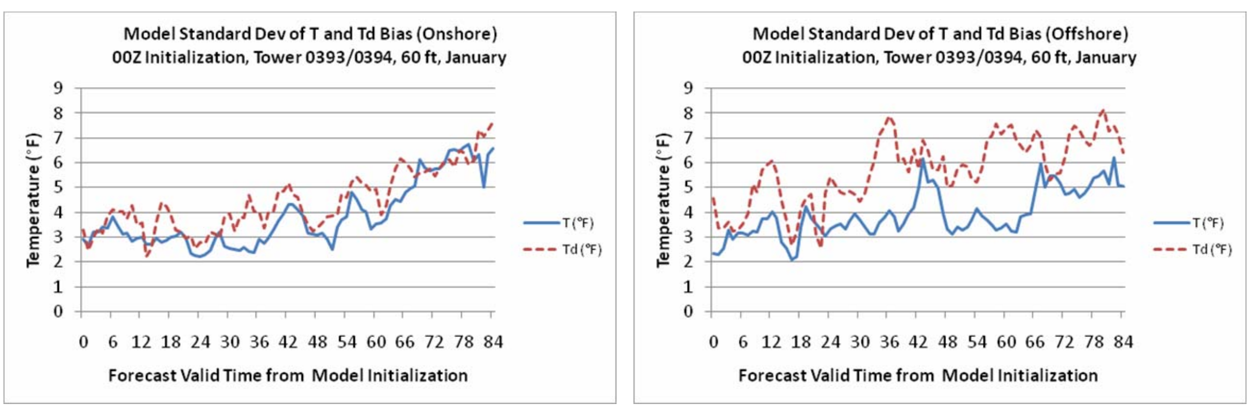

Figure 9. As in Figure 8 except for standard deviation of bias.

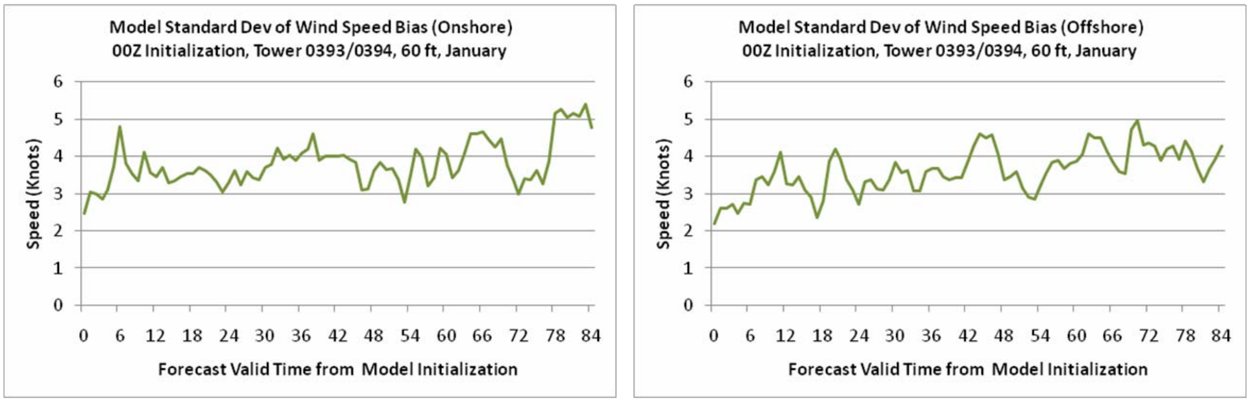

Figure 10. Onshore (left) and offshore (right) stratification charts showing model standard deviation of bias of wind speed from a 00Z model initialization at Pad 39A using observations from sensors at Towers 0393 and 0394 at a sensor height of 60 ft for January.

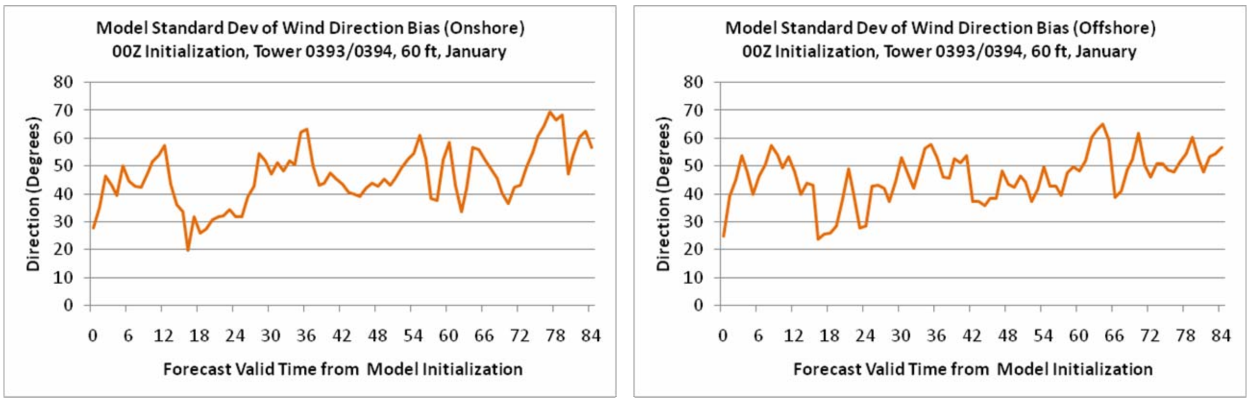

Figure 11. As in Figure 10 except for wind direction.

HYSPLIT Graphical User Interface (Mr. Wheeler)

Both NWS MLB and SMG requested the AMU to develop a GUI for the Hybrid Single-Particle Lagrangian Integrated Trajectory (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 (Dreher 2009) 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 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 completed HYSPLIT GUI reduces the possibility of human error and increases efficiency, allowing forecasters to do other duties.

Individual Agency Responsibilities

Forecasters at NWS MLB are responsible for providing meteorological support to state and county emergency management agencies across East-Central Florida in the event of incidents involving the significant release of harmful chemicals, radiation, smoke from fires and/or toxic plumes into the atmosphere. Accurate and timely guidance is critical for decision makers charged with protecting the health and well-being of populations at risk. Information that can describe the geographic extent of areas possibly affected by a hazardous release, as well as to indicate locations of primary concern, offers better opportunity for prompt and decisive action. The HYSPLIT model is an invaluable tool that helps the forecasters provide trajectory, concentration, and deposition guidance during such events, and the GUI will make their support of the operations mentioned above more timely.

Forecasters at SMG also use HYSPLIT and have a need for the GUI. It would allow them to more easily manage certain parameters they use in assessing the weather FR for smoke and other obstructions to visibility during shuttle landings at KSC and Edwards Air Force Base in California. SMG may also be responsible for similar forecasts at other landing sites for the Constellation Program.

GUI Testing

Mr. Wheeler and members of NWS MLB went through several testing cycles of fixing bugs and making changes to the GUI. They tested each of the fields to verify that the HYSPLIT model parameter files updated with the proper values and that the model ran with the selected parameters. During final testing, NWS MLB forecasters successfully used the GUI to develop daily and emergency runs. The NWS MLB forecasters began using the interface in support of real-time operations.

Final Report

Mr. Wheeler completed and delivered the final report. It is now available on the AMU website at http://science.ksc.nasa.gov/amu.

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

AMU CHIEF'S TECHNICAL ACTIVITIES (Dr. Merceret)

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

Dr. Merceret and Ms. Crawford completed the comparison of mean gust factors (GF) and their standard deviations (GFSD) between TS and non-TS environments. The goals of this work were to determine differences between non-TS and TS GF and GFSD, and if a model could be developed for the non-TS environment in which the probability of exceeding a specific peak value can be calculated, as for the TS environment (Merceret 2009).

Studies similar to this exist in the literature, some with conflicting results. The conflicts could be attributed to the fact that these studies collected their TS and non-TS data from different locations and, in some studies, different instrumentation. The benefit of this study is that the TS and non-TS data were collected at the same location, the KSC/CCAFS area, using the same instruments. This prevented differing surface attributes and instrument characteristics from affecting the comparison.

Results

The results of the GF comparison are consistent with those found in previous studies:

- Non-TS GF are less than TS GF, and
- Non-TS GF decrease systematically with height in the same functional form as the TS GF in Merceret (2009).

However, the non-TS GF did not show a consistent change with speed as did the TS GF. The range of speeds in the non-TS data was smaller than for the TS data, resulting in only two speed bins. It is difficult to determine a pattern with so few points.

The results from the GFSD comparison are not clear. Most of the ratios of non-TS to TS GFSD were greater than one, but five were less than one. There was also no consistent variation of non-TS GFSD with speed or height among the towers. This does not allow development of a model for the non-TS GFSD. Consequently, a model to determine the probability of exceeding specific peak speeds cannot be developed.

Stability

The TS data in Merceret (2009) were likely from neutral environments (Vickery and Skerlj 2005). The non-TS data were not stratified by stability, but rather time of day with the assumption that stability differs between day and night hours. Using data collected during daylight hours likely filtered out mostly stable cases, leaving neutral to unstable cases. Although unstable cases could not be removed, they are likely to have higher GF than neutral cases (Monahan and Armendariz 1971). The inclusion of unstable cases makes stronger the result of non-TS GF being less than TS GF.

Inclusion of unstable cases could be a cause of the inconsistent trends in the non-TS GFSD values. Any future work in this area will require the calculation of stability parameters to stratify the data into stable, neutral, and unstable environments.

Conference Presentation

Dr. Merceret and Ms. Crawford submitted a manuscript titled "A Comparison of Tropical Storm (TS) and Non-TS Gust Factors for Assessing Peak Wind Probabilities at the Eastern Range" to the 14th Aviation, Range, and Aerospace Conference held in conjunction with the 90th American Meteorological Society (AMS) Annual Meeting in Atlanta, GA, 17-21 January 2010. They also created presentation slides that Ms. Crawford presented at the conference. The abstract, manuscript, and slides are available online at http://ams.confex.com/ams/90annual/techprogram/paper_156464.htm.

AMU OPERATIONS

Conferences, Meetings, and Training

Dr. Bauman, Mr. Wheeler, and Ms. Crawford attended the National Weather Association (NWA) 34th Annual Meeting in Norfolk, VA, 19 – 22 October 2009. Dr. Bauman presented a poster and an oral presentation. His poster was titled "Central Florida Flow Regime Based Climatologies of Lightning Probabilities" and was co-authored by Matt Volkmer and Dave Sharp of NWS MLB, and Richard Lafosse and Kurt Van Speybroeck of SMG. His oral presentation was titled "Cost-Benefit Analysis: Evaluating a Potential Weather Radar Tool for Space Vehicle Lightning Launch Commit Criteria". Mr. Wheeler presented a poster titled "Configuring a Graphical User Interface for Managing Local HYSPLIT Model Runs through AWIPS". Ms. Crawford attended the NWA Publications Committee meeting. Abstracts for these presentations can be found online at http://www.nwas.org/meetings/nwa2009/.

Dr. Bauman and Dr. Watson submitted manuscripts for the 90th AMS Annual Meeting in Atlanta, GA, 17-21 January 2010. They also prepared presentation slides that were presented at the conference. Dr. Bauman's oral presentation was titled "An Objective Verification of the North American Mesoscale Model For Kennedy Space Center and Cape Canaveral Air Force Station". The abstract, manuscript and slides are online at http://ams.confex.com/ams/90annual/techprogram/paper_162253.htm. Dr. Watson's presentation was titled "Maintaining a Local Data Integration System in Support of Weather Forecast Operations" with co-authors Pete Blottman and Dave Sharp of NWS MLB and Brian Hoeth of SMG. The abstract, manuscript and slides for this presentation are also available online at http://ams.confex.com/ams/90annual/techprogram/paper_164799.htm.

Dr. Bauman attended the SPoRT Science Advisory Committee meeting in Huntsville, AL from 17 – 20 November.

Launch Support

- Mr. Barrett supported the first launch attempt of the Ares I-X on 27 October, and Ms. Crawford supported the successful launch of Ares 1-X on 28 October.
- Mr. Wheeler supported the first launch attempt of the Atlas V AV-024 on 14 November, and Dr. Watson supported the successful launch of Atlas V AV-024 on 23 November.
- Dr. Watson supported the successful launch of the STS-129 on 16 November.
- Dr. Bauman supported the launch attempt of the Delta IV on 3 December and Ms. Crawford supported the successful launch of the Delta IV on 5 December.

AMU Visiting Scientist

Dr. Lisa Huddleston was temporarily detailed to the KSC Weather Office and visited the AMU on a cross-training opportunity from August to December 2009. Dr. Huddleston, who has a life-long interest in weather phenomena, requested this cross-training to broaden her knowledge of operational meteorology. She works in the Orbiter Structures, Handling, & TPS branch of the Mechanical Systems Division of the NASA Engineering Directorate. She also serves as the Program NASA System Engineer for Orbiter Thermal Control Systems.

While at the AMU, Dr. Huddleston's primary focus involved improvements to the 45 WS Lightning Spreadsheet that calculates the probability of a stroke hitting a target within a specified distance of a complex given the lightning uncertainty ellipse data. She improved the lightning spreadsheet to allow a user-definable box with bound limits to include strikes only within the box, to interpolate the closest point on an ellipse between the calculated points, and to open a Google Maps link automatically in which the user can define a number of perimeter points plotted on Google Maps. Dr. Huddleston used

Visual Basic to significantly reduce the size of the spreadsheet and to make calculations faster.

Her other projects included development of an application to take a user input temperature in Celsius or height in feet and return a line of all the RAOB parameters in the climatology interpolated to that temperature or height for a given month/year. In addition, she developed a new tool to calculate the onset of 20 kt sustained wind from tropical cyclones given the winds and wind radii from the NHC forecast.

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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
ARW	Advanced Research WRF
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
GFSD	GF Standard Deviation
GSD	Global Systems Division
GUI	Graphical User Interface
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
MAE	Mean Absolute Error
MesoNAM	12-km resolution NAM
MIDDS	Meteorological Interactive Data Display System
MSFC	Marshall Space Flight Center
MSL	Mean Sea Level
NAM	North American Model
NCEP	National Centers for Environmental Prediction
NMM	Nonhydrostatic Mesoscale Model
NOAA	National Oceanic and Atmospheric Administration
NWA	National Weather Association
NWS MLB	National Weather Service in Melbourne, FL
POR	Period of Record
QC	Quality Control
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
USAF	United States Air Force
UTC	Universal Coordinated Time
WRF	Weather Research and Forecasting Model
XMR	CCAFS 3-letter Identifier

Appendix A

AMU Project Schedule
31 January 2010

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	Completed in Jul 09
	Create distributions for 12-hour prognostic peak probabilities and incorporate into GUI	Apr 09	Jul 09	Delayed
	Final report	Jul 09	Sep 09	Delayed
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	Completed
	Determine dates for lightning season stratifications	Jun 09	Sep 09	Reprogrammed
	Collect sounding data for May–Sep 2006–2008, and Oct 1989–2008 if needed, create candidate predictors for each stratification.	Jul 09	Nov 09	Delayed
	Create and test new equations; compare performance with previous equations	Dec 09	Mar 10	On Schedule
	Incorporate equations in Excel GUI	Apr 10	Apr 10	On Schedule
	Final Report	May 10	Jul 10	On Schedule

AMU Project Schedule 31 January 2010				
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	Completed
	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
Upgrade Summer Severe Weather Tool in MIDDS	Acquire and update the severe weather database and adjust weights	Nov 09	Feb10	On Schedule
	Update GUI software code	Feb 10	Mar 10	On Schedule
	Final Report and training	Apr 10	May 10	On Schedule
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	Completed
	Update GUI software code	Dec 09	Feb 10	On Schedule
	Final Report and training	Feb 10	Mar 10	On Schedule

AMU Project Schedule 31 January 2010				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date	Notes/Status
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	Completed
	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	Completed
	Test and Evaluate GUI	Sep 09	Oct 09	Completed
	Final report and training	Oct 09	Nov 09	Completed

NOTICE