ENSCO, Inc.
1980 N. Atlantic Ave., Suite 230
Coca Beach, FL 32931
(321) 783-9735, (321) 853-8202 (AMU)

Applied Meteorology Unit (AMU) Quarterly Report

Fourth Quarter FY-07 Contract NNK06MA70C 31 October 2007

Distribution:

NASA HQ/M/AA/W. Gerstenmaier
NASA KSC/AA/W. Parsons
NASA KSC/MK/L. Cain
NASA KSC/LX/J. Talone
NASA KSC/PH/ R. Willcoxon
NASA KSC/PH-A2/D. Lyons
NASA KSC/PH/M. Leinbach
NASA KSC/PH/S. Minute
NASA KSC/VA/S. Francois
NASA KSC/VA-2/C. Dovale
NASA KSC/KT/D. Bartine
NASA KSC/KT-C/R. Nelson
NASA KSC/KT-C-H/J. Madura
NASA KSC/KT-C-H/F. Merceret
NASA KSC/KT-C-H/J. Ward
NASA JSC/MA/W. Hale
NASA JSC/WS8/F. Brody
NASA JSC/WS8/R. Lafosse
NASA JSC/WS8/B. Hoeth
NASA JSC/WS8/S. Early
NASA MSFC/EV13/D. Edwards
NASA MSFC/EV13/B. Roberts
NASA MSFC/EV13/S. Deaton
NASA MSFC/EV13/R. Decker
NASA MSFC/MP71/G. Overbey
NASA MSFC/SPoRT/W. Lapenta
NASA DFRC/RA/E. Teets
NASA LaRC/M. Kavaya
45 WS/CC/A. Boerlage
45 WS/DO/M. Gauthier
45 WS/DOU/M. McAleenan
45 WS/DOR/K. Nordgren
45 WS/DOR/P. Phan
45 WS/DOR/F. Flinn
45 WS/DOR/ T. McNamara
45 WS/DOR/J. Tumbiolo
45 WS/DOR/K. Winters
45 WS/SYA/B. Boyd
45 WS/SYR/W. Roeder
45 RMS/CC/M. Wasson
45 RMS/LGP/R. Fore
45 SW/SESL/D. Berlinrut
45 SW/XPR/R. Hillyer
45 OG/CC/B. Gruber
CSR 4500/H. Herring
CSR 7000/M. Maier
SMC/RNP/S. Exum
SMC/RNP/T. Knox
SMC/RNP/R. Bailey
SMC/RNP (PRC)/K. Spencer
HQ AFSPC/A3FW/J. Carson
HQ AFWA/DN/M. Surmeier
HQ AFWA/DNXT/G. Brooks
HQ AFWA/XOR/M. Treu
HQ USAF/XOW/R. Stoffler
HQ USAF/A30-WX/M. Zettlemoyer
HQ USAF/A30-WX/L. Zucarello
NOAA "W/NP"/L. Uccellini
NOAA/OAR/SSMC-I/J. Golden
NOAA/NWS/OST12/SSMC2/J. McQueen
NOAA Office of Military Affairs/M. Babcock
NWS Melbourne/B. Hagemeyer
NWS Melbourne/D. Sharp
NWS Melbourne/S. Spratt
NWS Melbourne/P. Blottman
NWS Melbourne/M. Volkmer

Continued on Page 2

Executive Summary

This report summarizes the Applied Meteorology Unit (AMU) activities for the fourth quarter of Fiscal Year 2007 (July - September 2007). 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 Gathered data from the Kennedy Space Center (KSC)/Cape Canaveral Air Force Station (CCAFS) wind tower network that was collected during the cool season months October–April in the years 1995–2007. Developed a new quality control (QC) algorithm that flags peak speed values. Conducted a manual QC to eliminate speed values that were repeated four or more times.

Discussion The original QC algorithm that was replaced flagged too many real peak speeds as it allowed lower peak values in the 3–8 kt mean speed range than for 0–2 kt mean speed. The new algorithm flags far fewer real values as well as many erroneous values. The towers at the Shuttle Launch Complexes appeared to have many repeated values.

<u>Task</u> <u>Peak Wind Tool for General Forecasting</u>

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

Milestones Began writing the final report and completed a graphical user interface (GUI) to interact with the forecast equations.

Discussion The 45 WS provided feedback on the GUI and insight as to how it will be used by operational forecasters. The tool will be modified until it meets the forecaster requirements.

Continued on Page 2

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/M. Barnhill
30 WS/DOR/S Storr
30 WS/SY/M. Schmeiser
30 WS/SYR/G. Davis
30 WS/SYR/D Vorhees
30 WS/SYS/J. Mason
30 SW/XPE/R. Ruecker
Det 3 AFWA/WXL/K. Lehneis
NASIC/FCTT/G. Marx
46 WS//DO/J. Mackey
46 WS/WST/C. Chase
412 OSS/OSWM/P. Harvey
UAH/NSSTC/W. Vaughan
FAA/K. Shelton-Mur
FSU Department of Meteorology/H. Fuelberg
ERAU/Applied Aviation Sciences/ C. Herbster
ERAU/CAAR/I. Wilson
NCAR/J. Wilson
NCAR/Y. H. Kuo
NOAA/FRB/GSD/J. McGinley
Office of the Federal Coordinator for Meteorological Services and Supporting Research/R. Dumont
Boeing Houston/S. Gonzalez
Aerospace Corp/T. Adang
ACTA, Inc./B. Parks
ITT/G. Kennedy
Timothy Wilfong & Associates./T. Wilfong
ENSCO, Inc./E. Lambert
ENSCO, Inc./A. Yersavich
ENSCO, Inc./S. Masters

Executive Summary, *continued*

Task	Situational Lightning Climatologies for Central Florida, Phase II
Goal	Create the climatological probability of lightning occurrence and mean number of strikes for each flow regime as in Phase I for the two 12-hour periods 0000–1200 and 1200–2400 UTC, and in 5-, 10-, 20-, and 30-n mi circles surrounding the Shuttle Landing Facility (SLF) in 1-, 3-, and 6-hour increments. The 12-hour climatologies will be used by the forecasters at the National Weather Service in Melbourne, FL (NWS MLB) to update their daily lightning threat index map. The SLF climatologies will aid in the aviation forecast requirements at NWS MLB, and provide a tool to SMG to assist them in making forecasts for Flight Rule violations of lightning occurrence during a shuttle landing.
Milestones	Completed and delivered the final report.
Discussion	After making modifications based on internal AMU and external customer reviews, the final report was completed, delivered, and posted on the AMU website.

Task	Situational Lightning Climatologies for Central Florida, Phase III
Goal	Customize the Advanced Weather Interactive Processing System (AWIPS) to allow display of the composite soundings created in Phase II. This will give forecasters at NWS MLB the capability to compare the current state of the atmosphere with climatology. After comparing current soundings to composite soundings, forecasters can make appropriate adjustments to their lightning forecast for the day.
Milestones	Customized AWIPS so that composite and archived soundings could be plotted. New file directories were created in AWIPS so that soundings could not be deleted automatically. Unique site identifiers were created for each composite sounding. A file was created to hold the data for all of the composite soundings.
Discussion	After customizing AWIPS, both composite and archived soundings can be viewed in AWIPS. The user will be able to overlay a composite or archived sounding on a current sounding.

Continued on Page 3

Executive Summary, *continued*

Task	Volume Averaged Height Integrated Radar Reflectivity (VAHIRR)
Goal	Transition the VAHIRR algorithm into operations using Weather Surveillance Radar 1988 Doppler (WSR-88D) data. The previous lightning launch commit criteria (LLCC) for anvil clouds to avoid triggered lightning were restrictive and lead to unnecessary launch delays and scrubs. The VAHIRR algorithm was developed as a result of the Airborne Field Mill program (ABFM) as part of a new LLCC for anvil clouds. This algorithm will assist forecasters in providing fewer missed launch opportunities with no loss of safety compared with the previous LLCC.
Milestones	Several tests were carried out on the VAHIRR product after some required software changes. It passed all tests except for the comparison to the Volume Integral product from the ABFM program. Four new VAHIRR-derived products were created to help determine what caused the differences between the VAHIRR and Volume Integral products.
Discussion	In comparing the VAHIRR and Volume Integral products, a significant positive bias was noted in some VAHIRR values. However, the average radar reflectivities were similar between the two products. Work will continue to determine if the differences in the products were due to different vertical grid spacing between the VAHIRR and ABFM products.

Task	Tower Data Skew-T Tool
Goal	The rapid reduction in visibility and ceiling associated with marine incursions is a concern to 30th Weather Squadron (30 WS) forecasters during launch operations at Vandenberg Air Force Base (VAFB). Such conditions are a launch safety concern for new launch vehicles that require they be viewable by remote cameras until radar lock-on. The 30 WS developed the Tower Data Skew-T Tool to help monitor the progress of marine-layer incursions. The AMU will evaluate the effectiveness of this tool for the 30 WS.
Milestones	Completed and distributed the final memorandum.
Discussion	After making modifications based on internal AMU and external customer reviews, the memorandum was completed and delivered.

Task	Weather Research and Forecasting (WRF) Model Sensitivity Study
Goal	Conduct several WRF sensitivity case studies to determine the best configuration to use operationally at SMG and NWS MLB for predicting warm season convective initiation. Determining the best model configuration will assist forecasters in their short-term thunderstorm forecasting for the general public and evaluating flight rules and launch commit criteria.
Milestones	Completed and delivered the final report.
Discussion	After making modifications based on internal AMU and external customer reviews, the final report was completed, delivered, and posted on the AMU website.

Continued on Page 4

TABLE of CONTENTS

Executive Summary, *continued*

Task: Impact of Local Sensors

Goal: Determine the impact to high resolution model forecasts due to denial of local observations. Impending budget cuts may result in the elimination of some weather observation systems on KSC/CCAFS. Loss of these data may affect output from local weather prediction models. Forecasters at the 45 WS and SMG use such model output for their operational forecasts. To determine the effects of losing these data sources, the model will be run using four different data ingest configurations, including and excluding the data. The results will help determine the importance of the instruments that may be eliminated.

Milestones: Identified candidate warm season days for June and July 2007 and archived the data. Configured the Local Analysis and Prediction System (LAPS) to work with the task datasets. Wrote scripts to ingest local wind tower and RAOB data into LAPS and began creating LAPS analyses. Completed all Weather Research and Forecasting (WRF) model runs to use as background model data for the LAPS analyses.

Discussion: Ten candidate days were identified for the months of June and July 2007. A new version of LAPS was downloaded and configured to ingest all available high-resolution datasets. The new scripts convert raw wind tower and RAOB data to a format ingestible by LAPS. The following LAPS/WRF model configurations will be used in this task: 1) the WRF model will be run at 3-km grid spacing for each candidate day, 2) the output will be used as background for a 1-km LAPS analysis, and 3) the LAPS/WRF configuration will be run at 1-km grid spacing over east-central Florida, including the KSC/CCAFS area.

Task: Radar Scan Strategies for the PAFB WSR-74C Replacement

Goal: Develop a scan strategy for the new radar that will replace the 45 WS Weather Surveillance Radar Model 74C (WSR-74C). Data from the new radar will be used by forecasters at the 45 WS, SMG, and NWS MLB to issue weather warnings and watches. The new radar will also aid in detecting cloud electrification to improve the timeliness of lightning advisories, and maintain the capability to evaluate LLCC.

Milestones: Using the 45 WS operational requirements for the new radar, compared the vertical resolution of three scan strategies: 1) angles from the radar vendor; 2) angles suggested by the 45 WS, and 3) the AMU-designed WSR-74C strategy with one additional elevation angle.

Discussion: There are four operational requirements that provide guidelines on the time and vertical resolution of the radar volume scans. The comparison between the three scan strategies showed that each was able to meet at least one of the requirements, but none could meet all four.

Special Notice to Readers

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

The AMU Quarterly Reports are also available in electronic format via email. If you would like to be added to the email distribution list, please contact Ms. Winifred Lambert (321-853-8130, lambert.winifred@ensco.com). If your mailing information changes or if you would like to be removed from the distribution list, please notify Ms. Lambert or Dr. Francis Merceret (321-867-0818, Francis.J.Merceret@nasa.gov).

Background

The AMU has been in operation since September 1991. Tasking is determined annually with reviews at least semi-annually. The progress being made in each task is discussed in this report with the primary AMU point of contact reflected on each task.

AMU ACCOMPLISHMENTS DURING THE PAST QUARTER

SHORT-TERM FORECAST IMPROVEMENT

Peak Wind Tool for User LCC (Ms. Lambert and Dr. Short)

The peak winds are an important forecast element for the Expendable Launch Vehicle (ELV) 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 testing another theoretical 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 from Phase II (Lambert 2003) that will display the mean and peak speed climatologies and probabilities of meeting or exceeding certain peak speeds based on the average speed.

Data and Quality Control

Ms. Lambert collected tower data from the cool season months October–April in the period 1995–2007, including January–April 1995. She updated the AMU quality control (QC) program to read in and process the files for the new period of record (POR). The towers and heights used in LCC evaluations are shown in Table 1. Only the data from these tower and height combinations, including the backup heights, will be analyzed.

Table 1. Programs, towers, and heights of data that will be analyzed in this task.

Launch Program	*Tower(s)*	*Primary Height*	*Backup Height*
Shuttle	393/394 *(SLC 39A)* 397/398 *(SLC 39B)*	60 ft	N/A
Atlas	110	204 ft	54 ft
Delta II	2	90 ft	54 ft
Delta IV	6, 108	54 ft	12 ft

Ms. Lambert replaced the peak-to-average speed ratio check in the QC program with a new equation. While conducting a task for SMG, Dr. Lee Burns at Marshall Space Flight Center (MSFC) identified errors in the logic of this check, which used the following logic (MSPD = 5-minute mean speed and R = ratio):

- MSPD < 2 kt, R = no limit
- MSPD = 2 kt, R = 10
- MSPD ≥ 3 kt and ≤ 8 kt,
  R = 2.6 + 0.16*MSPD
- MSPD > 8 kt,
  R = 2.5 below 50 ft, 2.0 above 50 ft

The MSPD is multiplied by R to get the maximum allowable peak speed. The blue curve in Figure 1 shows the resulting maximum peak speeds allowed for each 5-minute mean speed using the logic above. No limit on mean speeds less than 2 kt would allow peak speeds to approach infinity. The ratio value for 2 kt allowed a peak speed of 20 kt, but the equation for speeds in the range 3–8 kt reduced the maximum peak speeds to 10–21 kt, respectively. This is not physically realistic. The maximum peak speeds should increase monotonically with mean speed, not decrease from infinity at 0–1 kt mean speed to 20 kt at 2 kt mean speed, then to 10 kt at 3 kt mean speed as results from this algorithm.

Ms. Lambert created a linear regression equation to best fit the blue curve in Figure 1, and made adjustments to the slope and intercept to ensure realistic peak speeds for each mean speed were allowed. The red curve in Figure 1 shows the maximum allowable peak speeds according to the equation

Peak = 2.2*MSPD + 10.6.

Ms. Lambert replaced the original algorithm described previously with the new linear regression equation in the QC program, and ran the program for all towers and heights in Table 1. She did a manual comparison between the original and new algorithms and noted that many valid peak speeds flagged by the original algorithm were not flagged by the new one, yet the new algorithm flagged most erroneous values.

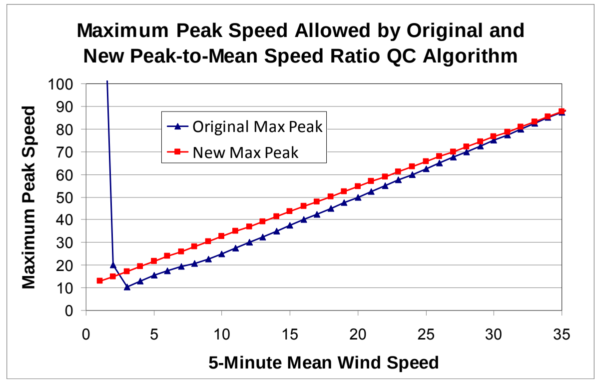

Figure 1. The curves showing the maximum allowable peak speed using the original algorithm (blue) and the new algorithm (red).

After running the automated QC program, Ms. Lambert conducted a manual QC using a script developed by Mr. Barrett that finds repeated mean and peak speed and direction values when there are four or more repetitions. She noted that the towers at SLC 39A and B had the most repetitious data by far compared to the other towers and heights. The data are now ready for analysis.

Contact Ms Lambert at 321-853-8130 or lambert.winnie@ensco.com, or Dr. Short at short.dave@ensco.com or 321-853-8105 for more information.

Peak Wind Tool for General Forecasting (Mr. Barrett and Dr. Short)

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

Mr. Barrett created linear regression equations to predict the peak wind speed, and then developed an Excel GUI to display the predicted peak speed and its timing, along with the average wind speed. The details of the equations were described in the previous AMU Quarterly Report (FY07, Q3). Mr. Barrett received feedback on the forecast tool from the 45 WS. He is updating the tool based on that feedback, as well as writing the final report. Progress on this task has been delayed as Mr. Barrett was directed to focus on the Volume Averaged Height Integrated Radar Reflectivity (VAHIRR) task.

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

Situational Lightning Climatologies for Central Florida, Phase II (Dr. Bauman)

The threat of lightning is a daily concern during the warm season in Florida. Recent research has revealed distinct spatial and temporal distributions of lightning occurrence that are strongly influenced by large-scale atmospheric flow regimes. In Phase I, Ms. Lambert created 6- and 24-hour gridded cloud-to-ground lightning density and frequency climatologies based on the flow regime that the forecasters at the National Weather Service in Melbourne, FL (NWS MLB) use to issue daily lightning threat maps for their county warning area (Lambert et al. 2006). Phase II of this work consisted of three parts. In the first part, Dr. Short created climatological soundings of wind speed, wind direction, temperature, and dew point at Jacksonville, Tampa, Miami, and CCAFS for each of eight flow regimes from a 16-year database of soundings (Short 2006). In the second part of the Phase II work, Dr. Bauman calculated the same climatologies as in Phase I for the two 12-hour periods 0000–1200 UTC and 1200–2400 UTC. In the third part of the Phase II work, Dr. Bauman created the flow regime climatologies for 5-, 10-, 20-, and 30-n mi circles centered on the Shuttle Landing Facility (SLF) in 1-, 3-, and 6-hour increments. The 5- and 10-n mi circles are consistent with the aviation forecast requirements at NWS MLB. The 20- and 30-n mi circles at the SLF will assist SMG in making forecasts for FR violations of lightning occurrence during a shuttle landing.

Dr. Bauman completed the final report after addressing comments made during internal AMU and external customer reviews. After receiving final approval from NASA, the report was distributed and posted on the AMU website at the URL http://science.ksc.nasa.gov/amu/final.html.

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

Situational Lightning Climatologies for Central Florida, Phase III (Mr. Barrett)

The threat of lightning is a daily concern during the warm season in Florida. Recent research has revealed distinct spatial and temporal distributions of lightning occurrence that are strongly influenced by large-scale atmospheric flow regimes in Florida. The first two phases of this work involved developing spatial and temporal climatologies of lightning occurrence based on the flow regime. In the first part of Phase II, Dr. Short created climatological, or composite, soundings of wind speed and direction, temperature, and dew point temperature at Jacksonville (JAX), Tampa (TBW), Miami (MFL), and CCAFS (XMR), Florida for each of eight flow regimes, resulting in 32 soundings (Short 2006). These soundings could only be displayed using the National version of the Skew-T Hodograph analysis and Research Program (NSHARP). For Phase III, NWS MLB requested that the AMU make these composite soundings available for display in the Advanced Weather Interactive Processing System (AWIPS) so that they can be overlaid onto current soundings. This will allow the forecasters to compare the current state of the atmosphere with climatology. After comparing current soundings to composite soundings, the NWS MLB forecasters can make adjustments to the forecast of lightning in their Hazardous Weather Outlook and lightning threat index products.

Customize AWIPS

The AWIPS receives soundings in Binary Universal Form for the Representation of Meteorological data (BUFR) format, then decodes and stores them in Network Common Data Form (NetCDF) format:

- BUFR is a standard format used by the World Meteorological Organization (WMO) (http://dss.ucar.edu/docs/formats/bufr/), and
- NetCDF is a set of interfaces used to create, access, and share scientific data (http://www.unidata.ucar.edu/software/netcdf/docs/netcdf-tutorial.html).

Only two sounding files per day are generated in AWIPS. One file includes all of the soundings received worldwide between 0000 and 1200 UTC, and the other includes all soundings received between 1200 and 0000 UTC. Old soundings are purged automatically each day, so that only about two weeks of soundings are stored in AWIPS.

Mr. Barrett customized the developmental AWIPS workstation in the AMU so that both composite and archived soundings could be plotted in AWIPS. The new menus are shown in Figure 2. He created new directories in AWIPS so that composite and archived soundings would not be automatically purged.

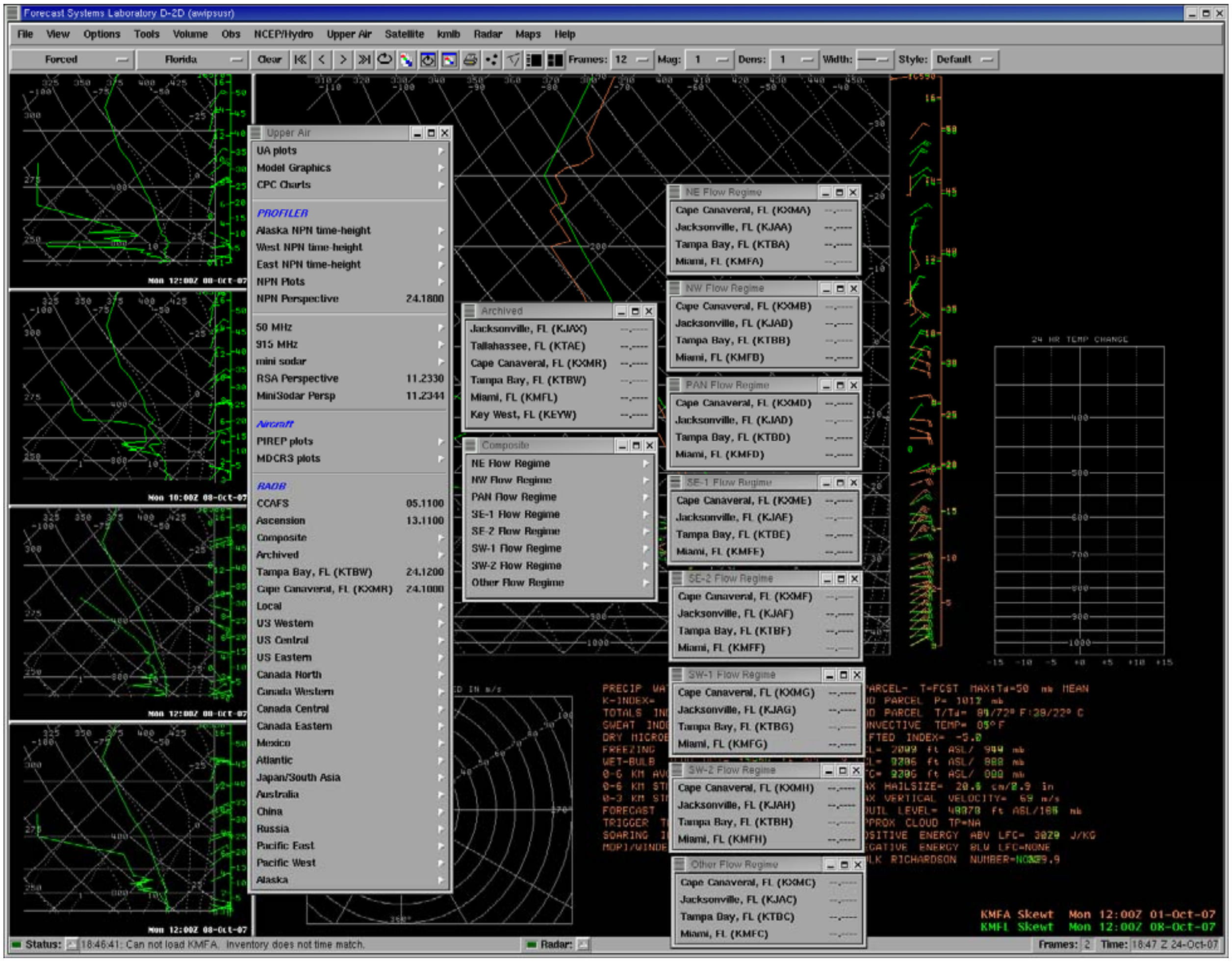

Figure 2. The Upper Air menus in AWIPS. The left menu is the main Upper Air menu, the two middle menus are for Archived (top) and Composite (bottom) soundings, and the menus on the right are the Composite sounding submenus for each flow regime. In the background are archived soundings from 1200 UTC on 8 October, 2007 at MFL, JAX, CCAFS, TBW and Tallahassee, Florida.

Mr. Barrett used a unique four-character site identifier for each composite sounding so that each could be viewed separately. The first three characters were based on the site identifier of the observed sounding, while the last character was based on the flow regime (Table 2).

Table 2. Site identifiers for the 32 composite soundings. A description of the flow regimes is available in Bauman (2007).

Flow Regime	*MFL*	*JAX*	*TBW*	*CCAFS*
NE	KMFA	KJAA	KTBA	KXMA
NW	KMFB	KJAB	KTBB	KXMB
Other	KMFC	KJAC	KTBC	KXMC
PAN	KMFD	KJAD	KTBD	KXMD
SE-1	KMFE	KJAE	KTBE	KXME
SE-2	KMFF	KJAF	KTBF	KXMF
SW-1	KMFG	KJAG	KTBG	KXMG
SW-2	KMFH	KJAH	KTBH	KXMH

Mr. Barrett then created a NetCDF file using a 1200 UTC MFL sounding to test the new customized composite sounding menu. The test file contained data for 8 of the 32 composite soundings (KMFA-KMFH in Table 2), for demonstration purposes. These test soundings were displayed successfully (Figure 3). Mr. Barrett was also able to view archived soundings in AWIPS by copying the NetCDF files before they were purged. This will allow forecasters to use archived soundings in AWIPS for case studies (Figure 4).

The next step will be to create a NetCDF file containing the 32 composite soundings. Mr. Barrett will write software to convert the composite soundings from NSHARP to NetCDF format. He will deliver the NSHARP-to-NetCDF conversion software, NetCDF file, AWIPS customization instructions, and final report.

Work on this task is delayed due to work on the VAHIRR task. It has been reprogrammed with a final delivery date of February 2008 instead of November 2007. Contact Mr. Barrett at 321-853-8205 or barrett.joe@ensco.com for more information.

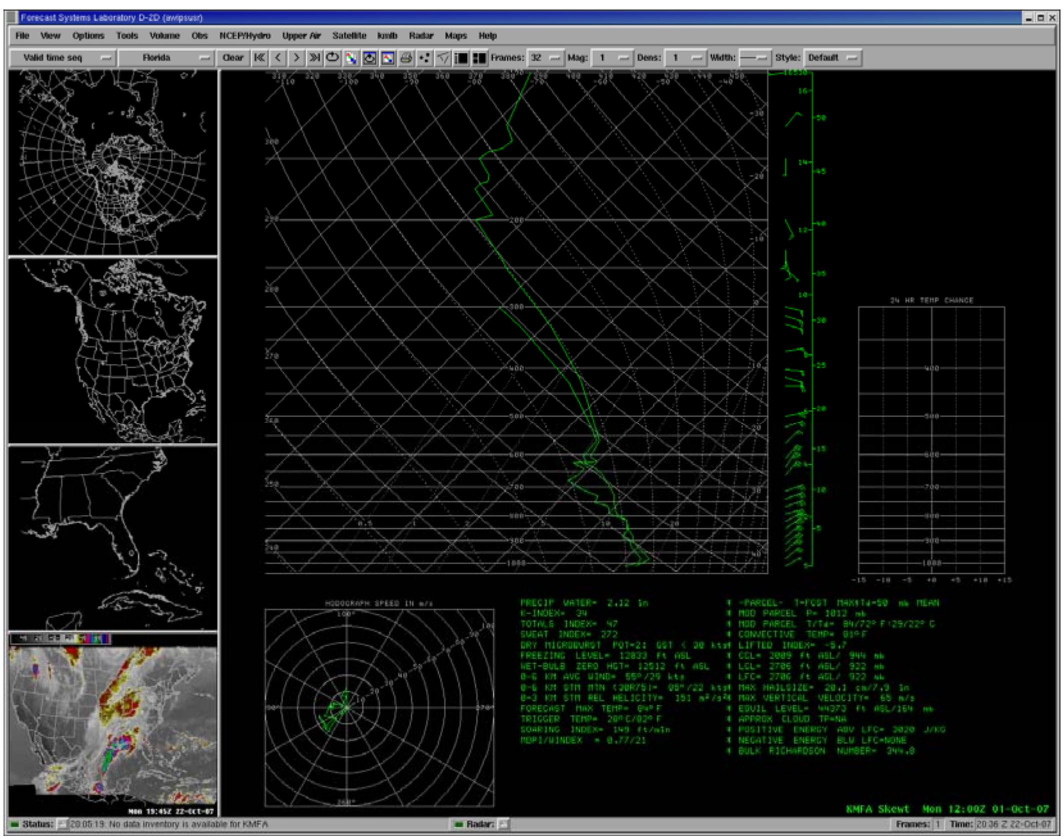

Figure 3. The test MFL sounding from 1200 UTC on 1 October, 2007 displayed using the new composite sounding menu for KMFA (see Table 2).

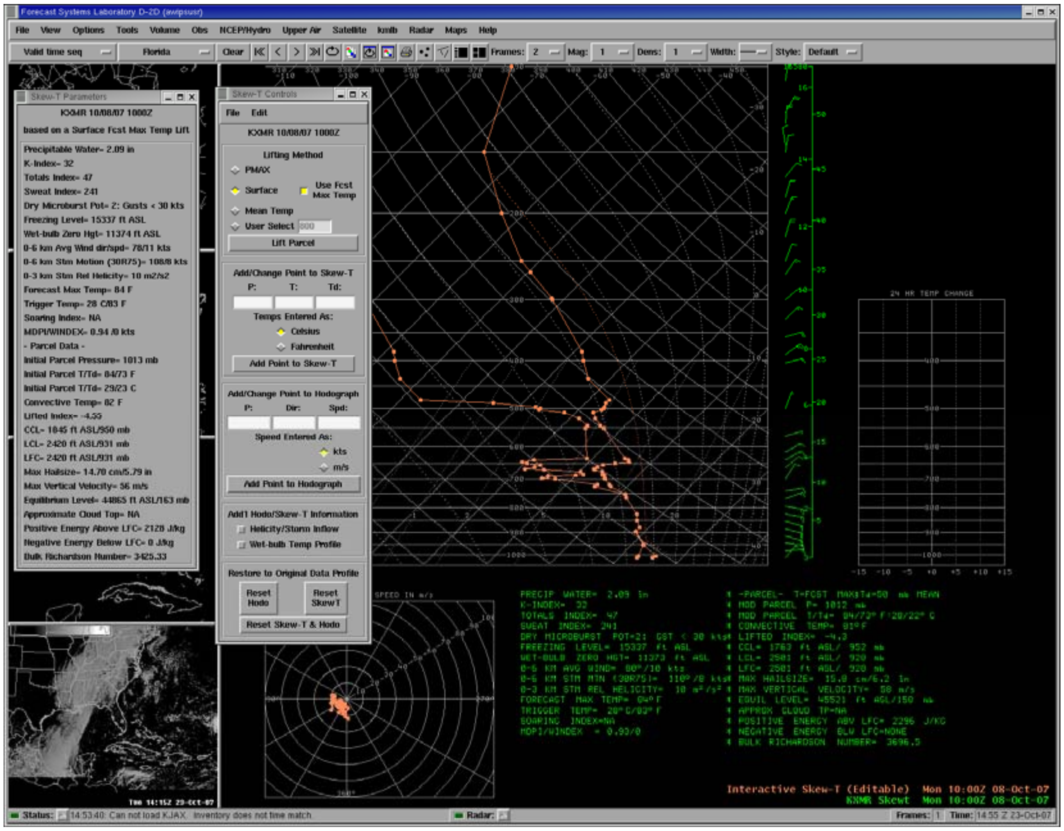

Figure 4. An archived KXMR sounding being edited with the AWIPS Interactive Skew-T program.

INSTRUMENTATION AND MEASUREMENT

Volume Averaged Height Integrated Radar Reflectivity (VAHIRR) Algorithm (Mr. Barrett, Ms. Miller, Ms. Charnasky, Dr. Merceret, and Mr. Gillen)

Lightning LCC (LLCC) are used for all launches, whether Government or commercial, using a Government or civilian range (Willett et al. 1999). Shuttle lightning FR are also used for all landings. These rules are designed to avoid natural and triggered lightning strikes to space vehicles, which can endanger the vehicle, payload, and general public. The current LLCC for anvil clouds, meant to avoid triggered lightning, have been shown to be overly restrictive. They ensure safety, but falsely warn of danger and lead to costly launch delays and scrubs. A new LLCC for anvil clouds, and an associated radar algorithm needed to evaluate that new LLCC, were developed using data collected by the Airborne Field Mill research program managed by KSC (Dye et al. 2006, 2007). Dr. Harry Koons of Aerospace Corporation conducted a risk analysis of the VAHIRR algorithm. The results indicated that the LLCC based on the VAHIRR algorithm would pose a negligible risk of flying through hazardous electric fields.

Previous Work

The AMU determined that additional software development and testing of the VAHIRR radar product was necessary (AMU Quarterly Report Q2 FY07) in order to address the following issues:

- Account for the radar cone-of-silence,
- Change how cloud thickness is calculated by the VAHIRR radar product, and
- Account for the elevation of the radar when calculating the cloud height and thickness.

Ms. Miller implemented these software changes. Mr. Barrett, Ms. Charnasky, and Ms. Miller performed further testing of the VAHIRR radar product on an Open Radar Product Generator (ORPG)-clone at ENSCO's Cocoa Beach office (AMU Quarterly Report Q3 FY07).

ABFM/VAHIRR Differences

Mr. Barrett performed a comparison test between the VAHIRR product and the ABFM Volume Integral product. All of the tests conducted at ENSCO's Cocoa Beach office passed except the ABFM comparison test. Mr. Barrett found that the VAHIRR values had a large positive bias compared to the Volume Integral values. In response, he created four VAHIRR-derived products to help determine the cause of these large differences:

- VAHIRR Average Reflectivity,
- VAHIRR Cloud Thickness,
- VAHIRR Cloud Top, and
- VAHIRR Cloud Bottom.

Figure 5 shows the VAHIRR product for comparison to these four products, which are shown in Figures 6–9 in the order given above. Mr. Barrett and Dr. Merceret analyzed the output from the VAHIRR and the four VAHIRR-derived products. They determined that the average reflectivity in the VAHIRR product was usually similar to the Volume Integral product. However, the cloud top, cloud bottom, and cloud thickness in the VAHIRR product were often significantly higher than in the Volume Integral product. This helped explain the positive bias in the VAHIRR values in relation to the Volume Integral values.

Mr. Barrett and Dr. Merceret noticed differences in the way the VAHIRR and Volume Integral products calculate cloud thickness. The Volume Integral product takes the difference in height between the cloud top and cloud bottom and then adds one vertical grid space, or 1 km, and uses 1-km vertical grid spacing through the entire volume. However, the VAHIRR product uses the native elevation scans, and the vertical distance between these scans are not equally spaced through the volume. In addition, the vertical distance between adjacent elevation scans increases with distance from the radar. Like the Volume Integral product, the thickness in VAHIRR is the difference in height between the cloud top and cloud bottom. Instead of adding 1 km to the thickness, the VAHIRR product adds one-half the vertical distance between the elevation scan at the cloud top and the next higher elevation scan. It then adds one-half the vertical distance between the cloud bottom and the next lower elevation scan to the thickness. If the vertical distance between adjacent elevation scans is greater than 1 km, this may introduce a positive bias in the VAHIRR cloud thickness relative to the Volume Integral product.

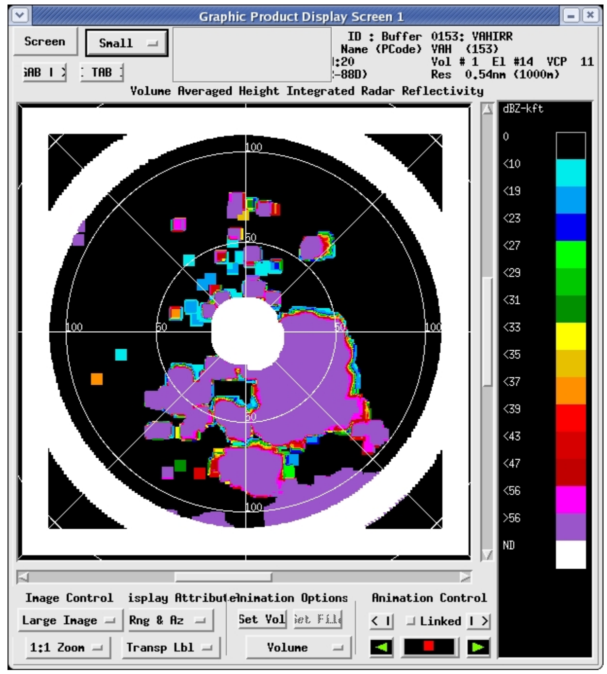

Figure 5. The VAHIRR product from the radar volume scan at 2054 UTC on 2 June 2001. Values are in dBZ-kft.

If the vertical distance between elevation scans is less than 1 km, this may introduce a negative bias in the VAHIRR cloud thickness. If the cloud bottom is below or within half a vertical grid space of the freezing level, the VAHIRR product sets the cloud bottom to the height of the freezing level. If the cloud bottom is at or below the freezing level, the Volume Integral product appears to set the cloud bottom to the one-half vertical grid space below the freezing level. For example, if the freezing level is 5 km and the cloud bottom is 5.1 km, the VAHIRR product sets the cloud bottom to 5.0 km and the Volume Integral product sets the cloud bottom to 4.6 km. If the cloud bottom is 4.2 km, the Volume Integral product sets the cloud bottom to 4.5 km. The VAHIRR product could not have a cloud bottom below 5.0 km since it only uses reflectivity values at or above the freezing level to calculate cloud bottom and top, but it appears that the Volume Integral product uses reflectivity values throughout the vertical column to calculate these values.

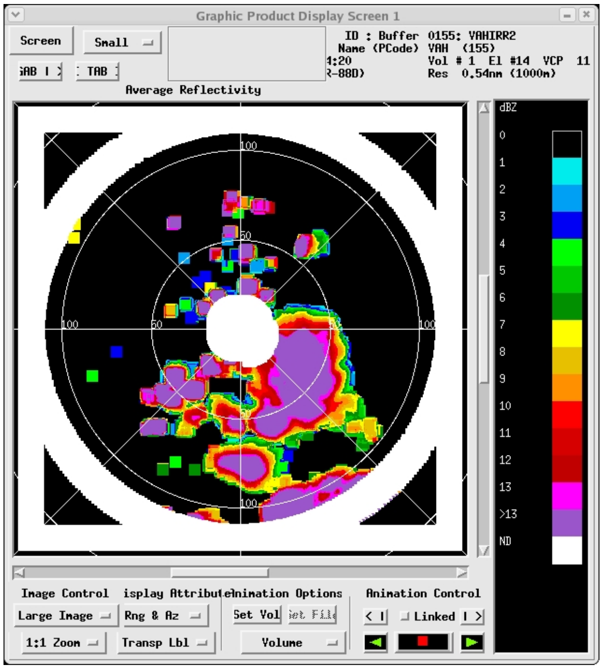

Figure 6.   VAHIRR Average Reflectivity product from the volume scan at 2054 UTC on 2 June 2001. Values are in dBZ.

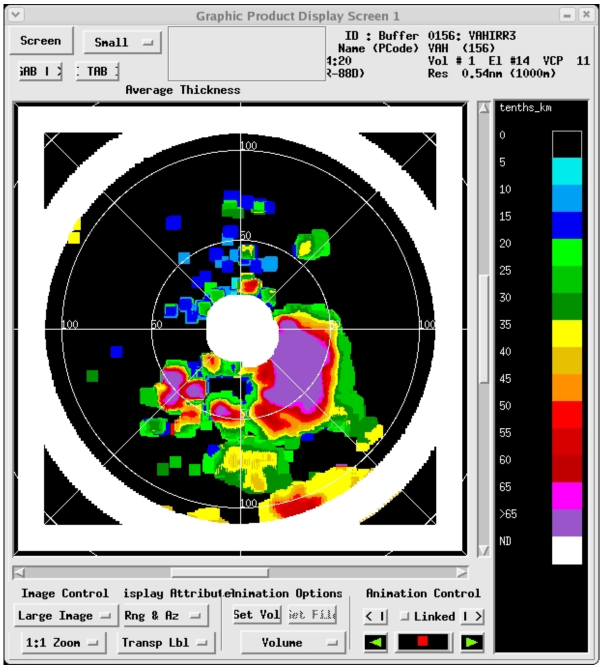

Figure 7.   VAHIRR Cloud Thickness product from the volume scan at 2054 UTC on 2 June 2001. Values are in tenths of a kilometer.

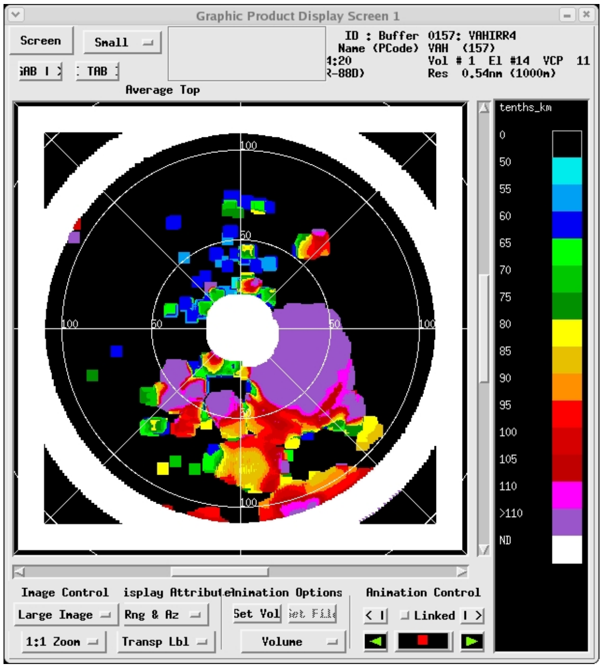

Figure 8.   VAHIRR Cloud Top product from the volume scan at 2054 UTC on 2 June 2001. Values are in tenths of a kilometer.

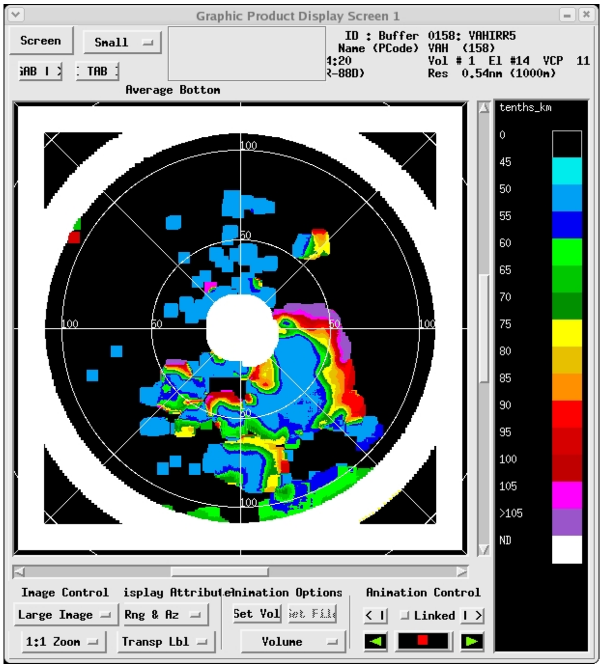

Figure 9   VAHIRR Cloud Bottom product from the volume scan at 2054 UTC on 2 June 2001. Values are in tenths of a kilometer.

Mr. Barrett modified the code to write VAHIRR data inputs such as cloud thickness, average reflectivity, sample size, etc., to binary files. He wrote a program that can read the binary files and output the data to a text file. The text file can then be imported into a spreadsheet application. This will help to evaluate whether the VAHIRR values are calculated correctly. He also modified the VAHIRR source code so that the freezing level and cone-of-silence values can be viewed in the VAHIRR product. Mr. Barrett found a possible error in the VAHIRR source code in which the calculation of the ground range of the radar echoes does not take into effect the standard radar refraction and curvature of the earth. This may affect the accuracy of the latitude/longitude coordinates of the VAHIRR values.

Mr. Barrett and Dr. Merceret will continue to evaluate the differences between the VAHIRR and Volume Integral products. They will determine whether the latitude/longitude coordinates of the radar reflectivity and VAHIRR values on the ORPG-clone are accurate. They will perform two tests to see if the differences between the two radar products are due to differences in vertical grid spacing:

1) For clouds having a limited range of thickness, they will compute the ratios of cloud thickness, average reflectivity, and VAHIRR as a function of distance from the radar:
   - VAHIRR Thickness/Volume Integral Thickness,
   - VAHIRR Reflectivity/Volume Integral-Reflectivity, and
   - VAHIRR/Volume Integral;
2) For clouds within a fixed distance from the radar, where the beam spacing is significantly greater than 1 km, they will compute the above ratios as a function of cloud thickness.

The ratios of cloud thickness and VAHIRR should increase with distance from the radar for a fixed cloud thickness. The ratios should decrease with increasing cloud thickness for a fixed distance from the radar, as long as the beam spacing at that distance is significantly greater than one km. The results from the two tests should determine whether the differences are due to errors by the ABFM project, VAHIRR radar product, or both.

Other Software Issues

Mr. Barrett and Ms. Miller were able to fix a problem in which the VAHIRR product would occasionally fail on the ORPG-clone. They determined that the cause was an out-of-memory error. To fix the problem, Mr. Barrett increased the memory allocated per radar process from 40 MB to 60 MB.

Mr. Barrett received a copy of the source code and gridded radar data from the ABFM program. Since most of the ABFM source code is written in the Interactive Data Language (IDL), he installed an evaluation copy of IDL and read through the materials for an IDL training course.

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

Tower Data Skew-T Tool (Mr. Wheeler)

The rapid reduction in visibility and ceiling associated with marine-layer incursions is a concern to 30th Weather Squadron (30 WS) forecasters during launch operations at Vandenberg Air Force Base (VAFB). Such conditions will become a launch safety concern with new launch vehicles that require they be viewable by remote cameras until radar lock-on. The incursion occurs when the marine layer (cooler/moist air) moves inland from the Pacific Ocean. The VAFB radiosonde is a critical data source in analyzing this phenomenon. To fill in for a temporary loss of radiosonde data due to software or sonde problems, the 30 WS developed the Tower Data Skew-T Tool (Wells 2005) to help monitor the progress of marine-layer incursions. The AMU will evaluate the effectiveness of this tool for the 30 WS using data collected during two previous marine-layer incursion events.

Mr. Wheeler wrote a final memorandum describing the procedures and results of this task. After making modifications based on internal AMU and external customer reviews, he distributed the memorandum to the 30 WS. For a copy of the final memorandum or other information, contact Mr. Wheeler at wheeler.mark@ensco.com or the AMU staff at amu@ensco.com or 321-853-8203.

Impact of Local Sensors (Dr. Watson and Dr. Bauman)

Forecasters at the 45 WS use observations from the KSC/CCAFS wind tower network and daily radiosonde observations (RAOB) to issue and verify wind advisories, watches, and warnings for operations. The SMG also uses these observations to support Shuttle landings at the KSC SLF. Due to impending budget cuts, some or all of the mainland wind towers (Figure 10) and XMR RAOBs may be eliminated. The loss of these data may impact the forecast capability of the 45 WS and SMG. The AMU was tasked to conduct an objective independent modeling study to determine how important these observations are to the accuracy of the model output used by the forecasters as input to their forecasts. To accomplish this, the AMU will perform a sensitivity study using the Weather Research and Forecasting (WRF) model run with and without KSC/CCAFS wind tower and XMR RAOB observations. The AMU will assess the accuracy of model forecasts by comparing operationally significant model output parameters with observations at the short-term forecast intervals of 0, 3, 6, 9 and 12 hrs. The model forecasts will be displayed graphically with the observations overlaid for comparison to determine the model performance when initialized with and without wind tower and RAOB observations. These analyses will help the 45 WS determine the importance of the instruments slated for elimination.

Determining Warm Season Candidate Days

The POR for choosing warm season candidate days was June through September 2007. Dr. Watson and Dr. Bauman decided that potential warm season candidate days had to meet three criteria. First, the 45 WS must have issued a wind advisory or warning for the KSC/CCAFS area. Forty-seven days met this criteria based on the 45 WS June through September 2007 weather warning databases. Next, days consisting of dominant synoptic-scale forcing patterns were eliminated from consideration. Daily weather maps were examined and used to eliminate days in which there was a front or low pressure system over Florida or in the immediate area. Of the 47 potential days already chosen, 20 met this criterion. Finally, the KSC/CCAFS wind towers must have recorded significant wind events, or winds greater than 18 kt. In the end, 20 of the days in the POR met all three criteria.

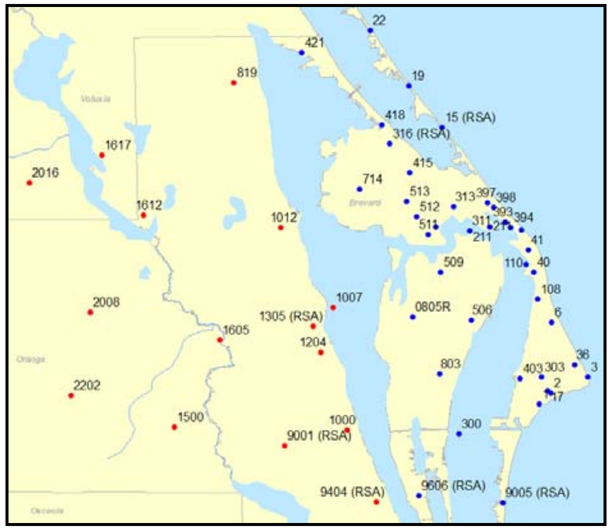

Figure 10. Map of the KSC/CCAFS area showing mainland tower locations (red dots) and island/cape tower locations (blue dots).

LAPS/WRF Model Configuration

The AMU will use the WRF Environmental Modeling System (EMS) initialized with the Local Analysis and Prediction System (LAPS) for all model runs. The LAPS/WRF model will be run using four data ingest configurations: 1) all available data including radar, satellite, surface observations, wind tower, and XMR RAOB data, 2) all available data except mainland wind tower data, 3) all available data except XMR RAOB data, and 4) all available data except mainland wind tower and XMR RAOB data.

Dr. Watson downloaded the most recent version of LAPS and configured it to ingest all available high-resolution datasets, including visible and infrared satellite imagery, Weather Surveillance Radar 1988-Doppler (WSR-88D) data from NWS MLB, and data from the Meteorological Assimilation Data Ingest System (MADIS). Dr. Watson then wrote scripts to convert raw XMR RAOB and 5-minute wind tower data into a format ingestible by LAPS. She created two sets of wind tower data for this task: 1) including all wind tower data from KSC/CCAFS, and 2) excluding only the mainland tower data. For each LAPS analysis time, wind tower data from 15 minutes before to 5 minutes after that time were used to create the analysis. Only data from 1000 UTC XMR RAOB were used in the LAPS analysis.

Dr. Watson and Dr. Bauman met with Mr. Roeder of the 45 WS to determine the best model configuration, and decided that a 3-km WRF model run initialized at 0600 UTC would be appropriate. This run uses the 12-km North American Model (NAM) for initial and boundary conditions and covers the entire Florida peninsula and surrounding coastal waters. The output from this WRF configuration would be used as background model data for a 1-km LAPS analysis at 0900 UTC. They chose this time because it is the closest standard model initialization time to the daily 1000 UTC XMR RAOB included in the LAPS analysis. Four different LAPS analyses were made for each candidate day that used all available data

1) Including radar, satellite, surface observations, wind tower and RAOB data,
2) Except mainland wind tower data,
3) Except RAOB data, and
4) Except mainland wind tower and RAOB data.

Wind speed fields from the four different analyses at 0900 UTC on 19 July 2007 are shown in Figure 11. Note that there are only small differences in the spatial distribution of wind speed for the different analyses. However, the tests will show how these small differences evolve during the WRF model runs.

Using the 0900 UTC LAPS analyses, a hot-start initialization of the WRF model will be run at a grid spacing of 1 km for the "with and without" studies. A hot-start initialization is a diabatic initialization using an already-balanced analysis. The 1-km domain will cover east-central Florida and the surrounding coastal waters. Each model run will be integrated out 12 hours and will use NAM 12 km model data for the boundary conditions. As with the LAPS analyses, the model will be run four times per candidate day based on the four different LAPS data ingest configurations mentioned above.

For more information contact Dr. Watson at watson.leela@ensco.com or 321-853-8264 or Dr. Bauman at bauman.bill@ensco.com or 321-853-8202.

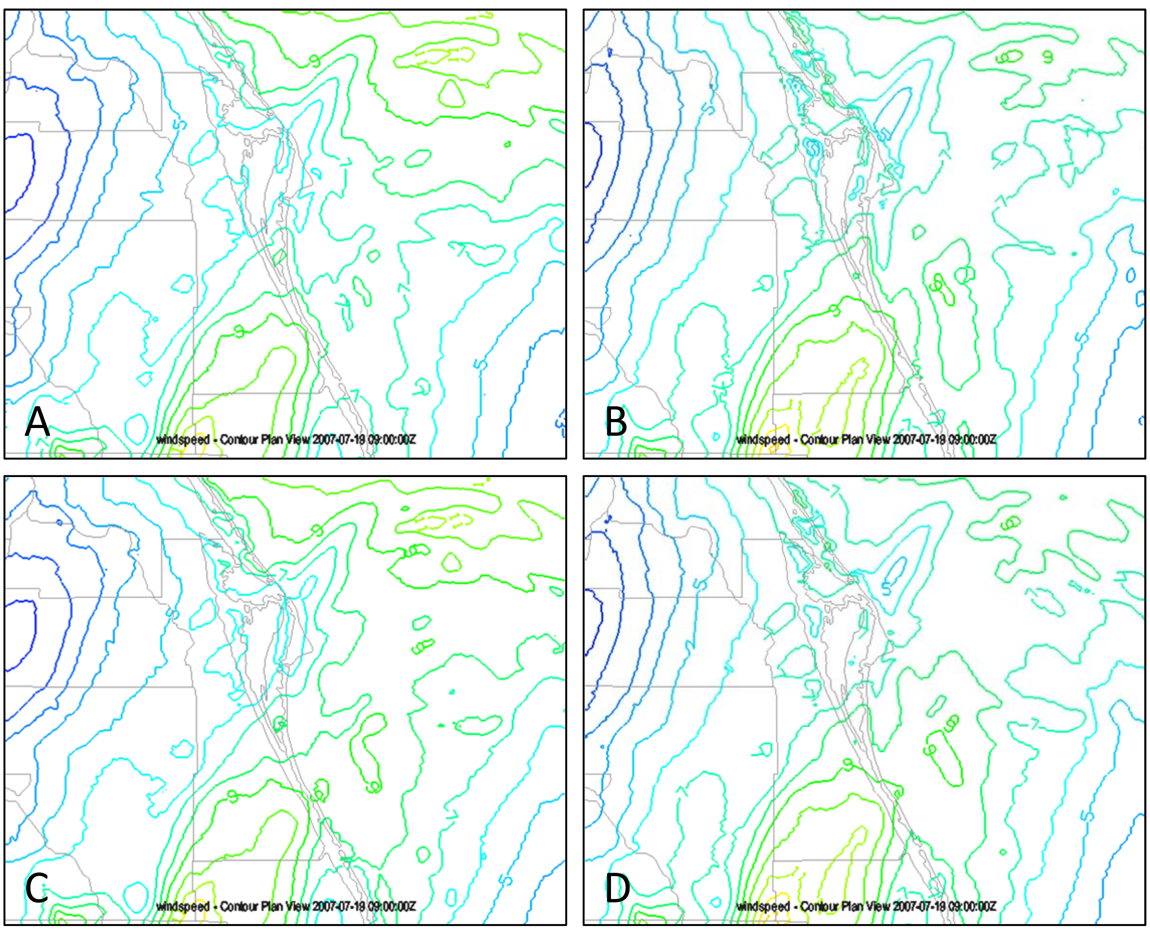

Figure 11. 1-km LAPS analyses of wind speed in knots at 0900 UTC on 19 July 2007 A) including all data, B) excluding mainland wind tower data only, C) excluding XMR RAOB data only, and D) excluding all mainland wind tower and XMR RAOB data.

Radar Scan Strategies for the PAFB WSR-74C Replacement (Dr. Short)

The 45 WS is planning to replace the Weather Surveillance Radar, Model 74C (WSR-74C) at Patrick Air Force Base (PAFB) with a Doppler, Dual Polarization radar, the RadTec 43/250. This new radar will be located 20 n mi northwest of PAFB. A new scan strategy is needed to take advantage of the new radar's advanced capabilities for detecting severe weather phenomena associated with convection within the 45 WS area of responsibility, while providing high vertical resolution data over the KSC and CCAFS launch pads. Rapid updates of 3 min or less are required for evaluating LLCC and monitoring the growth and electrification of convective clouds. Radar products generated by the new data processing system will be used by forecasters of the 45 WS, SMG and NWS MLB to provide weather warnings and watches for convective wind events such as downbursts and mesoscale vortices which can spawn tornadoes. The new radar will also provide capabilities to detect cloud electrification, improving the timeliness of lightning advisories, while maintaining the capability for evaluation of LLCC. The AMU will evaluate the capabilities of the new weather radar and develop several scan strategies customized for the operational needs of the 45 WS. The AMU will also develop a plan for evaluating the scan strategies in the period prior to operational acceptance, planned for November 2008. The 45 WS will use the results of the evaluation to choose one or more of the scan strategies developed by the AMU.

Radar Location, Modes of Operation and Capabilities

Figure 12 shows the proposed location of the new radar, 20 n mi northwest of the existing WSR-74C site at PAFB and about 23 n mi west of the launch complexes on KSC and CCAFS.

Table 3 provides a summary of several capabilities of the new radar under its two fundamental modes of operation; single polarization with Doppler, and dual polarization with Doppler. Radar reflectivity (dBZ) is available with both single and dual polarization. Horizontal (H) and vertical (V) dBZ data are provided in the dual polarization mode. Classification of hydrometeors as solid and liquid is the main advantage provided by dual-polarization radar. Particle classification allows a more informed diagnosis of the microphysical environments associated with rain, hail, graupel and ice crystals, and the potential of the storm for generating severe weather and/or lightning. Rainrate estimation is improved by dual-polarization technology through differences in the reflectivity of horizontally and vertically polarized microwaves by large, deformed rain drops. Second trip echoes can be filtered automatically by advanced signal processing techniques when the single polarization mode is used. Automated unfolding of Doppler velocities allows the useful range of Doppler velocity imaging to be extended beyond 60 n mi when in single polarization mode. With dual polarization, the range is confined to about 40 n mi to get an unambiguous Doppler velocity of 50 kt, which is the wind threshold for severe weather occurrences.

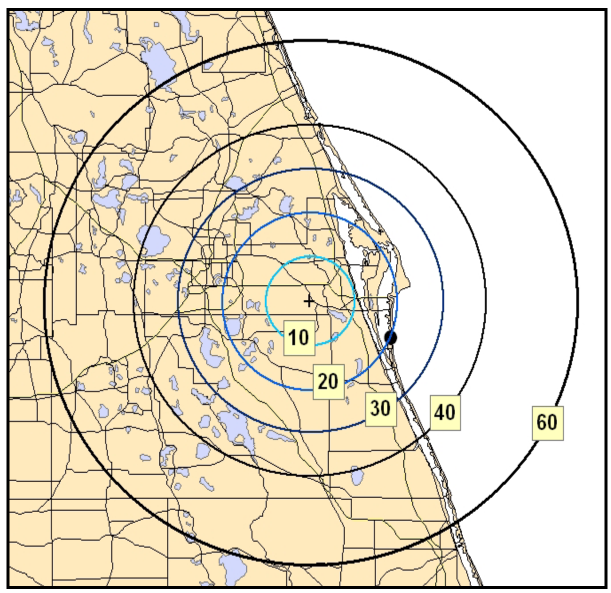

Figure 12. Proposed location of the new Doppler, Dual Polarization radar (+), and the existing WSR-74C radar on Patrick Air Force Base (•). Range rings are at 10, 20, 30, 40 and 60 n mi from the new radar.

Table 3. Radar capabilities using Single and Dual Polarization, both with Doppler velocity.

Parameter	*Single Polarization*	*Dual Polarization*
Particle Classification	Not Possible	Possible and Effective
Rainrate Estimation	dBZ only	H&V dBZ, Z_{DR}, K_{DP}, Φ_{DP} (more accurate)
Second Trip Echo filter	Possible w/random phasing	Not possible
Doppler Velocity Unfolding	Yes w/Dual Pulse Repetition Frequency	Not Recommended

Operational Requirements

The 45 WS has defined four operational requirements that will affect the radar scan strategy. Some compromises will be necessary as is not be possible to achieve all requirements simultaneously with a single scan strategy. The four operational requirements and related comments are as follows:

1) The volume scan must update every 3 minutes or less, and less than 2.5 minutes is desired. The current WSR-74C update cycle is 2 minutes 40 seconds, with a scan rate of 6 rpm and 12 elevation angles. Approximately 3 seconds are required for the antenna to stabilize from one elevation angle to the next. The new antenna is capable of rotating at 6 rpm, providing up to 18 elevation angles during a 3-minute volume scan. Antenna stabilization requires 2.5 seconds. Therefore, complete scans at 12 different elevation angles can be completed in 2.5 minutes. A volume scan comprised of 13 elevation angles can be completed in 2 minutes and 42.5 seconds.
2) High vertical resolution reflectivity data are needed in the layer where the atmospheric temperature ranges from +5C to -20C. High vertical resolution is accomplished by having as many elevation angles in the scan strategy as possible. Climatological data from the Range Reference Atmospheres, provided by the Range Commanders' Council Meteorology Group (Henning and Roberts 2006), shows the corresponding altitude range is from about 7000 to 27,000 ft (Short 2000).
3) The largest vertical spacing between beams over the KSC/CCAFS space launch complexes should be ≤ 2000 ft, and < 1500 ft is desired. The current WSR-74C scan strategy provides an average vertical spacing of 2020 ft over the altitude interval from 10,000 to 25,000 ft in the range interval from 9 to 60 n mi (Short 2000). Radar beam width also plays a role in determining vertical gaps, with a wider beam width resulting in smaller gaps. The beam width of the new radar is 0.95°, less than the WSR-74C at 1.05°. The desired vertical spacing requires a customized sequence of elevation angles.
4) Equal vertical spacing between beams is desired. The current WSR-74C scan strategy provides vertical gaps that are nearly constant with range, at a given altitude. This design provides a sampling of the 3-dimensional structure of storms that is almost independent of their distance from the radar.

Comparison of Three Scan Strategies

Figure 13 shows a comparison of the vertical gaps for three scan strategies, each comprised of 13 elevation angles.

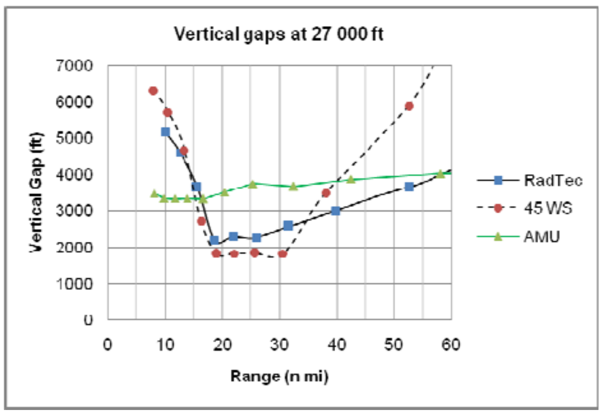

Figure 13. Vertical gaps at 27,000 ft altitude versus range for three scan strategies developed by the radar vendor RadTec Engineering Inc. (blue squares), the 45 WS (red circles), and the AMU for the WSR-74C (green triangles).

Dr. Short determined the vertical gaps between adjacent radar beams, assuming a beam width of 0.95°. He calculated gaps at an altitude of 27 000 ft, near the upper limit of the -20°C isotherm over east-central Florida. Vertical gaps at lower altitudes are smaller, decreasing directly in proportion to altitude. The RadTec and 45 WS designs shown in Figure 13 both have the objective of minimizing vertical gaps within 5 n mi of the launch complexes at KSC and CCAFS. Thus, the minima in vertical gaps over the range interval are from 18 to 28 n mi. The AMU scan strategy was designed to provide uniform vertical gaps, especially in the range interval from 10 to 20 n mi, the approximate distance from the WSR-74C to nearest and farthest space launch complexes.

This comparison shows that the constraint of 13 elevation angles does not allow development of a scan strategy that meets requirements 3 and 4. This confirms the earlier statement that one scan strategy alone will not meet all operational requirements.

Contact Dr. Short at short.dave@ensco.com or 321-853-8105 for more information.

MESOSCALE MODELING

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

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

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

Dr. Watson completed the final report after addressing comments made during internal AMU and external customer reviews. After receiving final approval from NASA, the report was distributed and posted on the AMU website at the URL http://science.ksc.nasa.gov/amu/final.html.

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

AMU CHIEF'S TECHNICAL ACTIVITIES (Dr. Merceret)

Dr. Merceret submitted an article to the Journal of Applied Meteorology and Climatology that presents the coherence and correlation results from his 2006 study of spatial properties of winds in the lowest 3 km of the atmosphere.

Dr. Merceret provided technical guidance to the team working on LC-39 lightning instrumentation for the Shuttle Program. He also provided technical support to the Constellation Program Ground Systems development and review of their systems requirements documents.

AMU OPERATIONS

IT Security

Dr. Bauman, Mr. Barrett, Mr. Wheeler and Mr. Rhoades of ENSCO's Information Systems & Technology (IST) Division worked on the AMU IT Security Plan. They worked with Ms. Diana Kniffin (KSC/IT) and Mr. Josh Manning (KSC/KT) in order to have the plan done by 30 September. The draft plan was finalized 31 August with support from Mr. Manning and was deemed ready for submission to the NASA review team. It was approved by the NASA/KSC/CIO on 21 September.

Dr. Bauman worked with Mr. Bryan Boatright (KSC Networking) and Mr. Charlie Mixon (CSR Requirements Processing Specialist) to switch the AMU from the ENSCO to the NASA communications network in the Range Operations Control Center (ROCC). Switching to the NASA network will improve IT security for the AMU. He held a meeting with Dr. Merceret, Mr. Boatright, Mr. Sean Bower (Supervisor, CSR Network Modifications) and Mr. Mixon to encourage the USAF and NASA personnel to talk directly with each other and begin the process of switching the AMU from the ENSCO to the NASA communications network in the ROCC.

General

All AMU personnel completed Information Assurance training from the Air Force's Advanced Distributed Learning System in order to obtain Local Area Network accounts on the Air Force computer network

Mr. Barrett installed the Man-computer Interactive Data Access System (McIDAS) software on a computer running Linux to replace the AMU Meteorological Interactive Data Display System (MIDDS) computer running HP UNIX. This change was required based on the newly-implemented AMU IT Security Plan. He also completed the configuration of a Network Attached Storage device that will be used as a backup device and computer file repository.

Dr. Bauman began modifying the AMU web page code so it will load faster once published. He is also adding a section showcasing examples of AMU work.

Launch Support

Dr. Watson supported the Delta II Phoenix launch, Dr. Bauman supported the STS-118 (Endeavour) launch, Ms. Lambert supported the Delta II Dawn launch, and the AMU team supported the STS-118 landing.

Conferences and Meetings

AMU team members began preparing for the 32nd NWA Annual Meeting in Reno, NV in October as follows:

- Mr. Barrett finished the first draft of a poster presentation titled "Creating Interactive Graphical Overlays in the Advanced Weather Interactive Processing System Using Shapefiles and DGM Files" and sent it to his co-authors for review.
- Ms. Lambert began work on a poster describing the results of Objective Lightning Probability Phase II task.
- Dr. Bauman completed the first draft of his presentation titled "Flow Regime Based Climatologies of Lightning Probabilities for Spaceports and Airports" and sent it to his co-authors for review.

Dr Short Sabbatical Notes

Dr. Short completed a four-month sabbatical at Nagoya University in Japan on 31 July and returned to the AMU in mid-August. The goal of his work was to look closely at shallow convective rain from the Tropical Rainfall Measuring Mission (TRMM) precipitation radar in an attempt to improve rainfall rate retrieval algorithms and to improve knowledge of small-scale boundary layer convection over the tropical oceans. He developed a simple rain cell model and tuned it to match statistics of radar reflectivity from shallow isolated convection that was observed by the TRMM Radar over the central Pacific Intertropical Convergence Zone. Dr. Short wrote a journal article based on his sabbatical research titled "Interpreting Spaceborne Radar Observations with a Rain Cell Model" and submitted it to Geophysical Research Letters.

Plymouth State University Visitors

Dr. Koermer, Ms. Dinon, and Mr. Morin used NWS MLB or TBW WSR-88D data to refine the convective periods that were identified during the previous summer. They updated their CCAFS radiosonde archive to include most soundings taken during the warm seasons of 1995–2005. They also developed a web-based visualization tool to view single archived radar images or loops overlaid with 5-minute KSC/CCAFS wind tower peak winds that are time-matched with the radar observations. Finally, they developed software to read and analyze the archived CCAFS sounding data to use for developing data sets for new convective wind indices.

Dr. Koermer, Ms. Dinon, and Mr. Morin ended their visit at the AMU in early August. They gave a presentation to the 45 WS and AMU showing the preliminary results of their work on convective peak winds.

REFERENCES

Bauman, W. H., 2007: Situational Lightning Climatologies for Central Florida, Phase II, Part 3. NASA Contractor Report CR-2007-214736, Kennedy Space Center, FL, 24 pp. [Available from ENSCO, Inc., 1980 N. Atlantic Ave., Suite 230, Cocoa Beach, FL 32931 and online at http://science.ksc.nasa.gov/amu/final.html.]

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

Dye, J. E., M. G. Bateman, H. J. Christian, E. Defer, C. A. Grainger, W. D. Hall, E. P. Krider, S. A. Lewis, D. M. Mach, F. J. Merceret, J. C. Willett, and P. T. Willis, 2007: Electric fields, cloud microphysics and reflectivity in anvils of Florida thunderstorms, *J. Geophys. Res.*, **112**, D11215, doi10.1029/2006JD007550.

Henning, R. G., and B. C. Roberts, 2006: Current activities of the Range Commanders' Council Meteorology Group. Paper 8.2, 12th Conference on Aviation, Range, and Aerospace Meteorology, 29 January-2 February, 2006 in Atlanta, GA. [Available online at http://ams.confex.com/ams/pdfpapers/100809.pdf

Lambert, W., 2002: Statistical Short-Range Guidance for Peak Wind Speed Forecasts on Kennedy Space Center/Cape Canaveral Air Force Station: Phase I Results. NASA Contractor Report CR-2002-211180, Kennedy Space Center, FL, 39 pp. [Available from ENSCO, Inc., 1980 N. Atlantic Ave., Suite 230, Cocoa Beach, FL 32931 and http://science.ksc.nasa.gov/amu/final.html.]

Lambert, W., 2003: Extended Statistical Short-Range Guidance for Peak Wind Speed Analyses at the Shuttle Landing Facility: Phase II Results. NASA Contractor Report CR-2003-211188, Kennedy Space Center, FL, 27 pp. [Available from ENSCO, Inc., 1980 N. Atlantic Ave., Suite 230, Cocoa Beach, FL 32931 and http://science.ksc.nasa.gov/amu/final.html.]

Lambert, W., D. Sharp, S. Spratt, and M. Volkmer, 2006: Using Cloud-to-Ground Lightning Climatologies to Initialize Gridded Lightning Threat Forecasts for East Central Florida. Preprints, *Second Conf. on Meteorological Applications of Lightning Data,* Paper 1.3, Atlanta, GA, Amer. Meteor. Soc., 4 pp.

Short, D. A., 2000: Final Report on IRIS Product Recommendations. NASA Contractor Rep. CR-2000-208572, Kennedy Space Center, FL, 18 pp. [Available from ENSCO, Inc., 1980 N. Atlantic Ave., Suite 230, Cocoa Beach, FL, 32931 and http://science.ksc.nasa.gov/amu/final.html.]

Short, D., 2006: Situational Lightning Climatologies for Central Florida, Phase II. Applied Meteorology Unit Memorandum, 8 pp. [Available from ENSCO, Inc., 1980 N. Atlantic Ave., Suite 230, Cocoa Beach, FL 32931]

Wells, L., 2005: Marine Layer Stratus Study, 30th Weather Squadron Field Memorandum, FM-05/001, 37 pp. [Available from 30 WS, 900 Corral Road, Bldg. 21150, VAFB, CA 93437-5002]

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

List of Acronyms

30 SW	30th Space Wing
30 WS	30th Weather Squadron
45 RMS	45th Range Management Squadron
45 OG	45th Operations Group
45 SW	45th Space Wing
45 SW/SE	45th Space Wing/Range Safety
45 WS	45th Weather Squadron
ABFM	Airborne Field Mill Program
ADAS	ARPS Data Analysis System
AFSPC	Air Force Space Command
AFWA	Air Force Weather Agency
AMU	Applied Meteorology Unit
ARPS	Advanced Regional Prediction System
ARW	Advanced Research WRF
AWIPS	Advanced Weather Interactive Processing System
BUFR	Binary Universal Form for the Representation of Meteorological data
CCAFS	Cape Canaveral Air Force Station
CSR	Computer Sciences Raytheon
EMS	Environmental Modeling System
FR	Flight Rules
FSU	Florida State University
FY	Fiscal Year
GSD	Global Systems Division
GUI	Graphical User Interface
JAX	Jacksonville, FL 3-letter identifier
JSC	Johnson Space Center
KSC	Kennedy Space Center
LAPS	Local Analysis and Prediction System
LCC	Launch Commit Criteria
LLCC	Lightning LCC
MADIS	Meteorological Assimilation Data Ingest System
McIDAS	Man-computer Interactive Data Access System
MFL	Miami, FL 3-letter identifier
MIDDS	Meteorological Interactive Data Display System
MLB	Melbourne, FL 3-letter identifier
MSFC	Marshall Space Flight Center
MSPD	Mean 5-minute Wind Speed
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NetCDF	Network Common Data Form
NMM	Non-hydrostatic Mesoscale Model
NOAA	National Oceanic and Atmospheric Administration
NSHARP	National Skew-T Hodograph analysis and Research Program
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
NWS MLB	NWS in Melbourne, FL
ORPG	Open Radar Product Generator
PAFB	Patrick Air Force Base, FL
POR	Period of Record
QC	Quality Control
R	Ratio
RAOB	Radiosonde Observation
RSA	Range Standardization and Automation
SLF	Shuttle Landing Facility
SMC	Space and Missile Center
SMG	Spaceflight Meteorology Group
SPoRT	Short-term Prediction Research and Transition
TBW	Tampa, FL 3-letter identifier
TRMM	Tropical Rainfall Measuring Mission
USAF	United States Air Force
UTC	Universal Coordinated Time
VAFB	Vandenberg Air Force Base
VAHIRR	Volume Averaged Height Integrated Radar Reflectivity
VBG	VAFB 3-letter identifier
WRF	Weather Research and Forecasting Model
WSR-74C	Weather Surveillance Radar Model 74C
WSR-88D	Weather Surveillance Radar 1988 Doppler
XMR	CCAFS 3-letter identifier

Appendix A

AMU Project Schedule
31 October 2007

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
Objective Lightning Probability Phase II	Calculate new forecast parameters	Jan 06	Feb 06 (*Oct06*)	Completed Delayed due to delays in Lightning Climatology task
	Develop and test new equations	Mar 06	Apr 06 (*Feb 07*)	Completed Delayed as above
	Update the MIDDS tool with new equations	Apr 06	Apr 06 (*Jun 07*)	Completed Delayed as above
	Final report	Mar 06	May 06 (*Aug 07*)	Completed Delayed as above
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*)	Delayed due to need for manual QC
	Stratify mean and peak winds by hour and direction, calculate statistics	Sep 07	Oct 07 (*Nov 07*)	Delayed as above
	Stratify peak speed by month and mean speed, determine theoretical distribution for peak	Oct 07	Nov 07	On Schedule
	Create distributions for peak winds 2, 4, 8, and 12 hours	Nov 07	Dec 07	On Schedule
	Develop a GUI that shows climatologies, probabilities of exceeding peak	Dec 07	Feb 08	On Schedule
	Final report	Feb 08	Apr 08	On Schedule

AMU Project Schedule 31 October 2007				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
Peak Wind Tool for General Forecasting	Data collection: wind towers, XMR 100-ft soundings, 915-MHz profilers	Sep 06	Oct 06 (*Feb 07*)	Completed Delayed to obtain 915-MHz profiler data
	Software development: wind tower data QC, sounding inversion detection, 915 MHz total power display	Sep 06	Dec 06 (*Mar 07*)	Completed Delayed to modify the AMU wind tower QC software
	Data analysis	Dec 06	Feb 07 (*Jun 07*)	Completed Delayed to add recent data sets
	Interim evaluation	Feb 07	Mar 07	Completed
	Forecast tool development, if approved	Mar 07	May 07 (*Nov 07*)	Delayed as above
	Final report	Jun 07	Jul 07 (*Nov 07*)	Delayed as above
Situational Lightning Climatologies for Central Florida: Phase II	Modify code and develop algorithms needed to create climatologies	Nov 06	Mar 07	Completed
	Calculate number of lightning strikes in all boxes and output one value for each circle size for each flow regime	Mar 07	May 07	Completed
	Final memorandum	May 07	Jun 07 (*Aug 07*)	Completed Delayed due to extended customer review of GUI
Situational Lightning Climatologies for Central Florida, Phase III	Customize AWIPS so that the composite soundings can be viewed in the D2D application	Jul 07	Sep 07 (*Oct 07*)	Delayed due to work on VAHIRR task
	Develop application to create NetCDF files from NSHARP upper-air sounding files	Nov 07	Dec 07	On Schedule
	Add NetCDF files to AWIPS	Dec 07	Feb 08	On Schedule
	Final Report	Jan 08	Feb 08	On Schedule

AMU Project Schedule
31 October 2007

AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
Volume-Averaged Height Integrated Radar Reflectivity (VAHIRR)	Acquisition and setup of development system and preparation for Technical Advisory Committee meeting	Mar 05	Apr 05	Completed
	Software Recommendation and Enhancement Committee meeting preparation	Apr 05	Jun 05	Completed
	VAHIRR algorithm development	May 05	Oct 05 (*Jul 06*)	Completed – Delayed due to new code development made necessary by final product requirements
	ORPG documentation updates	Jun 05	Oct 05 (*Sep 06*)	Completed Delayed as above
	Configure ORPG and AWIPS system in the AMU for live data testing.	Oct 05	Jan 06 (*Apr 07*)	Completed Delayed as above
	Conduct Acceptance Test Procedures	May 07	Aug 07 (*Nov 07*)	Completed – Failed, testing to find reason for failure
	Preparation of products for delivery and memorandum	Oct 05	Jan 06 (*Dec 07*)	Delayed as above
Subtask 26: Tower Data Skew-T Tool	Data collection: RSA wind towers, VBG soundings, VBG ASOS observations	Mar 07	Apr 07	Completed
	Data analysis, case study review using the 30 WS Tower Data Skew-T Tool	Apr 07	Jul 07	Completed
	Memorandum and presentation to 30 WS	Aug 07	Aug 07	Completed

AMU Project Schedule 31 October 2007				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date (*New End Date*)	Notes/Status
Impact of Local Sensors	Identify candidate warm and cool season days and archive data	Jul 07	Jan 08	On Schedule
	Configure LAPS to ingest all data and write scripts to ingest all Eastern Range wind tower and RAOB data	Aug 07	Sep 07	Completed
	Run LAPS-ARW "with and without" tests for all warm and cool season candidate days	Sep 07	Jan 08	On Schedule
	Validate and compare forecast results	Sep 07	May 08	On Schedule
	Final Report	May 08	Jun 08	On Schedule
Radar Scan Strategies for PAFB WSR-74C Replacement	Development and analysis of scan strategies based on vendor suggestions, radar characteristics and 45 WS requirements	Aug 07	Nov 08	On Schedule
	Develop plan for evaluating scan strategies	Dec 08	Jan 08	On Schedule
	Develop training on implementation of new scan strategy into the radar's configuration files	Feb 08	Mar 08	On Schedule
	Final Report	Mar 08	May 08	On Schedule
WRF Model Sensitivity Tests	Identify candidate convective initiation days and archive data	Jul 06	Sep 06	Completed
	Configure LAPS to initialize WRF	Aug 06	Oct 06 (*Feb 07*)	Completed Delayed due to satellite data conversion issues
	Compare LAPS-WRF vs. ADAS-WRF performance	Aug 06	Jan 07 (*May 07*)	Completed Delayed as above
	Compare use of high-resolution grid with 2-way, 1-way, and no nesting	Jan 07	Mar 07 (*May 07*)	Completed Delayed as above
	Assess impact of soil moisture data on WRF performance	Feb 07	Apr 07 (*May 07*)	Completed Delayed as above
	Final report and recommendations	Apr 07	Jun 07 (*Aug 07*)	Completed Delayed as above

NOTICE