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Assessing Upper-level Winds on Day-of-Launch

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Executive Summary

On the day-of-launch, the 45th Weather Squadron (45 WS) Launch Weather Officers (LWOs) monitor the upper-level winds for their launch customers to include NASA's Launch Services Program (LSP). During launch operations, the payload/launch team sometimes asks the LWO if they expect the upper-level winds to change during the countdown, but the LWOs did not have the capability to quickly retrieve or display the upper-level observations and compare them to the numerical weather prediction model point forecasts. The LWOs requested the Applied Meteorology Unit (AMU) develop a capability in the form of a graphical user interface (GUI) that would allow them to plot the upper-level wind speed and direction observations and then overlay point forecast profiles from available numerical weather prediction models on the charts. The observations would be taken from the Cape Canaveral Air Force Station (CCAFS) Automated Meteorological Profiling System (AMPS) rawinsondes located near the CCAFS Skid Strip and the Kennedy Space Center (KSC) 50 MHz wind profiler located adjacent to the Shuttle Landing Facility (SLF) and the 915 MHz wind profiler located south of the SLF. The model data included the National Centers for Environmental Prediction North American Mesoscale, Rapid Refresh and Global Forecast System models. Comparing the model output to the observations would allow the LWOs to objectively assess the performance of these models.

The AMU developed an Excel-based GUI for the LWOs to assess the model forecast upper-level winds compared to the observations. This GUI allows the LWOs to first initialize the models by comparing the 0-hour model forecasts to the observations and then to display model forecasts in 3-hour intervals from the current time through 12 hours. The AMU wrote Excel Visual Basic for Applications scripts that drive the GUI by automatically acquiring, downloading and processing the observations and model forecast data, and then displaying the resulting output in text format in Excel spreadsheets and in graphic format as Excel charts. The output of the observational data provides the LWO with the observation type and location, date and time, height, and wind direction and speed. The output of the model data provides the LWO with the model type and forecast point location, date and time of the model start and forecast intervals, height and wind direction and speed.

Issues with software compatibility and Information Technology (IT) Security presented several challenges to this task. To create the charts requested by the LWOs required using features only available in Excel 2010. Therefore the 45 WS had to obtain permission from the 45th Space Wing (45 SW) IT Security to procure and install this version of Excel on one of their computers so they could run the tool. During VBA testing, the AMU discovered that 45 SW IT Security restricted 45 WS access to the server hosting the model data. The AMU requested that the curators of Spaceport Weather Data Archive host the model point forecast files on their server for 45 WS access via File Transfer Protocol (FTP) after the AMU confirmed the 45 WS could access the KSC server. During progression of the task, NASA/KSC IT Security removed the FTP capability from their servers followed by removal of Hypertext Transfer Protocol capability during the tenure of this task, negating the ability of the scripts in the GUI to automatically access the data files from the KSC Weather Data Archive. The KSC Weather Office initiated a request to NASA IT Security to help solve this dilemma and allow the 45 WS automated access to the files on the KSC Weather Data Archive.

If the IT Security issues can be overcome and this tool becomes operational, it will provide an objective method for the LWOs to compare the forecast upper-level winds for the KSC/CCAFS area to the observed data from KSC and CCAFS and assess each model's potential to accurately forecast changes in the upper-level winds through the launch count.

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1. Introduction

On the day-of-launch, the 45th Weather Squadron (45 WS) Launch Weather Officers (LWOs) monitor the upper-level winds for their launch customers to include NASA's Launch Services Program (LSP). During launch operations, the payload/launch team sometimes asks the LWOs if they expect the upper-level winds to change during the countdown. The LWOs did not have the capability to quickly retrieve or display the upper-level observations and compare them directly in the same display to the numerical weather prediction model point forecasts. The LWOs requested the Applied Meteorology Unit (AMU) develop a graphical user interface (GUI) that will plot upper-level wind speed and direction observations from the Cape Canaveral Air Force Station (CCAFS) Automated Meteorological Profiling System (AMPS) rawinsondes located near the CCAFS Skid Strip with point forecast¹ wind profiles from the National Centers for Environmental Prediction (NCEP) North American Mesoscale (NAM), Rapid Refresh (RAP) and Global Forecast System (GFS) models to assess the performance of these models. The AMU suggested adding observations from the Kennedy Space Center (KSC) 50 MHz wind profiler located adjacent to the Shuttle Landing Facility (SLF) and the 915 MHz wind profiler located south of the SLF to supplement the AMPS observations with more frequent upper-level profiles and the 45 WS agreed. Figure 1 shows a map of KSC/CCAFS with the locations of the observation sites and the point forecast from the model data.

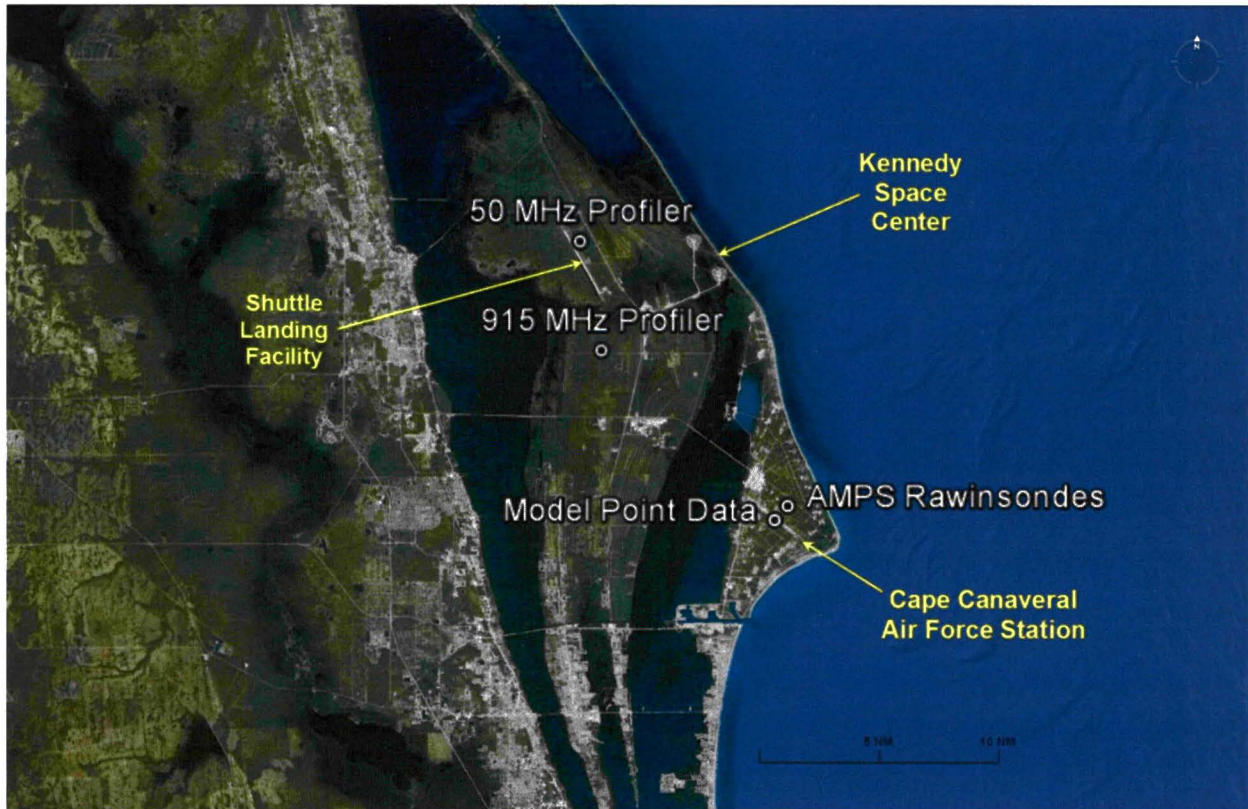


Figure 1. Map of KSC/CCAFS showing locations of the observations from the 50 MHz and 915 MHz profilers at KSC and the AMPS rawinsondes at CCAFS. The location of the point forecast from the model data is shown at CCAFS.

¹ A point forecast is generated from a gridded data set such as a numerical weather prediction model for a single point within the grid. The data at the forecast point is usually not located on a grid point and, therefore, the forecast point consists of data interpolated from the nearest grid points in the data set.

2. Data

The goal of this task is to build a GUI that allows the LWOs to compare model wind profile output to observed wind profiles closest in time to the 0-hour model forecasts. This will allow them to determine which model has the best performance, i.e. to initialize the models. Their requirement is to display model forecasts in 3-hour intervals from the current time through 12 hours.

The AMU reviewed the availability of the observational and model data in the 45 WS Meteorological Interactive Data Display System (MIDDS). They determined MIDDS could not be used as the data ingest and display for this task because the model point data is not ingested by the AMU MIDDS server. Therefore, the AMU considered using Microsoft Excel to download, ingest, format and display the data. The AMU verified that the observations were available on the Spaceport Weather Data Archive at KSC (<http://trmm.ksc.nasa.gov>). The archive consists of all locally collected weather observations at KSC and CCAFS. The model forecast point data for CCAFS (XMR) was available on the National Oceanic and Atmospheric Administration National Operational Model Archive & Distribution System (<http://nomads.ncdc.noaa.gov>) in Gridded Binary (GRIB) format but Excel cannot read GRIB format files. The AMU discovered the Iowa State University Archive Data Server (<http://mtarchive.geol.iastate.edu>) decodes the model GRIB files and provides them in a format that can be ingested by Excel. After discussing this with the 45 WS, all agreed the AMU would develop an Excel GUI that will ingest data from the Spaceport Weather Data Archive and Iowa State University Archive Data Server with scripts developed using Visual Basic for Applications (VBA) in Excel.

2.1 Data Acquisition

One challenge with using near real-time data in Excel was to ensure the latest available model data was being acquired and that it was time-matched to the observations. NCEP runs the RAP model every hour and the NAM and GFS models every six hours at 0000, 0600, 1200, and 1800 Coordinated Universal Time (UTC). Each model produces forecasts at least 12 hours beyond the initial time. The RAP and NAM models output forecasts at 1-hour intervals while the GFS model outputs forecasts at 3-hour intervals. Since each model has a different run time to complete the entire forecast cycle, the AMU conducted tests of the data availability of the files on the Iowa State server to determine how long after model initialization time the files were ready for download. The AMU concluded that the RAP model forecasts are available from the Iowa State data server about 1 hour 45 minutes after each hour, the NAM model forecasts are available about 3.5 hours after each initialization time, and the GFS model forecasts are available about 5 hours after each initialization time.

Acquiring observational files from the Spaceport Weather Data Archive website presented two significant challenges for real-time data access. First, the website only acquires observational data once per hour from MIDDS via a dial-up modem. This presents a potential problem with the AMPS observations because a sounding may only be partially complete when the files are acquired from MIDDS resulting in an incomplete sounding profile on the website. The VBA script that processes the observational data will download and process an incomplete AMPS file, which means the height of the wind speed and direction profile will be limited to the height the radiosonde obtained when the file was acquired from MIDDS. In these instances, the LWO will have to wait one hour for the complete AMPS profile to be available for download. Second, there are intermittent times when a file exists but contains no data. Because the file exists on the server, the VBA script will download the file but will not be able to process it.

2.2 Data Processing

Before the data files are retrieved, several scripts are run to determine the current UTC time to ensure the latest model data is downloaded for processing. All time conversions used in the VBA scripts in this task are based on the local time of the user's computer. However, before converting local time to UTC, the AMU needed to perform a check to determine if the current date was within Standard Time (ST) or Daylight Saving Time (DST). To do so, the AMU downloaded an Excel DST module from Pearson Software Consulting, LLC that does this calculation (<http://www.cpearson.com/EXCEL/DaylightSavings.htm>). To make use of this module, the AMU first used the Excel built-in function "=NOW()" to obtain the local time from the user's computer. Next, the DST module is called to determine whether local time is in ST or DST using the function "=IsDateWithinDST()". Finally, to determine the correct UTC, the AMU VBA code adds 5 hours to local time during ST or 4 hours during DST. The UTC time is saved in the Excel GUI and accessed by each script that needs to determine which model data and observations to download. The AMU then wrote a VBA script to automatically run the time calculation every time the GUI is started. In Excel VBA, naming a macro "Auto-Open" will automatically run all of the code within that macro each time the macro-enabled Excel file is opened.

The LWO's requested using the observations for two applications. First, they want to use them to initialize each model's 0-hour forecast by comparing the observations to each model to determine which model is performing the best. Second, they want to use them to show the launch team how the upper-level winds are forecast to change by displaying the model forecast valid at or near the same time of the most recent observation plus the model forecasts for the next 0-12 hours.

2.2.1 Model Initialization

For the LWOs to initialize the models against the observations based on UTC, a VBA script retrieves the latest available model runs by issuing a File Transfer Protocol (FTP) command to download the observations closest to the model time. Since the observations will be compared to the model 0-hour forecasts, the observations should time-match each model's start time as close as possible. The AMU developed VBA scripts to download, ingest and format the profiler and AMPS observations from the Spaceport Weather Data Archive server. The data files on the server are in American Standard Code for Information Interchange (ASCII) format and are ingested into Excel as a text file. After downloading and ingesting the data files, the VBA code removes all unneeded parameters and reformats the data to prepare it for creating charts. A 50 MHz profiler data file as ingested into Excel is shown in Figure 2a and the reformatted data is shown in Figure 2b.

Another VBA script written by the AMU extracts the observation's height, wind direction and speed, data type, location, date and time from the reformatted data and creates charts containing the vertical profiles of wind speed and direction as shown in Figure 3. The data type, date and time of the observation are displayed in the upper left of the chart. The background and profile colors were chosen by the LWOs because they make the display easy to read in an operational setting.

The AMU tested the GUI VBA scripts at random times throughout the day to ensure the correct model data and observations were downloaded based on model initialization and availability times. There were occasions when the model data or observations were not available. Therefore, the AMU put error checks into the scripts so the software would not fail but instead return a message to the user that the data or observation is not available, allowing them a choice to leave it out or check for it later.

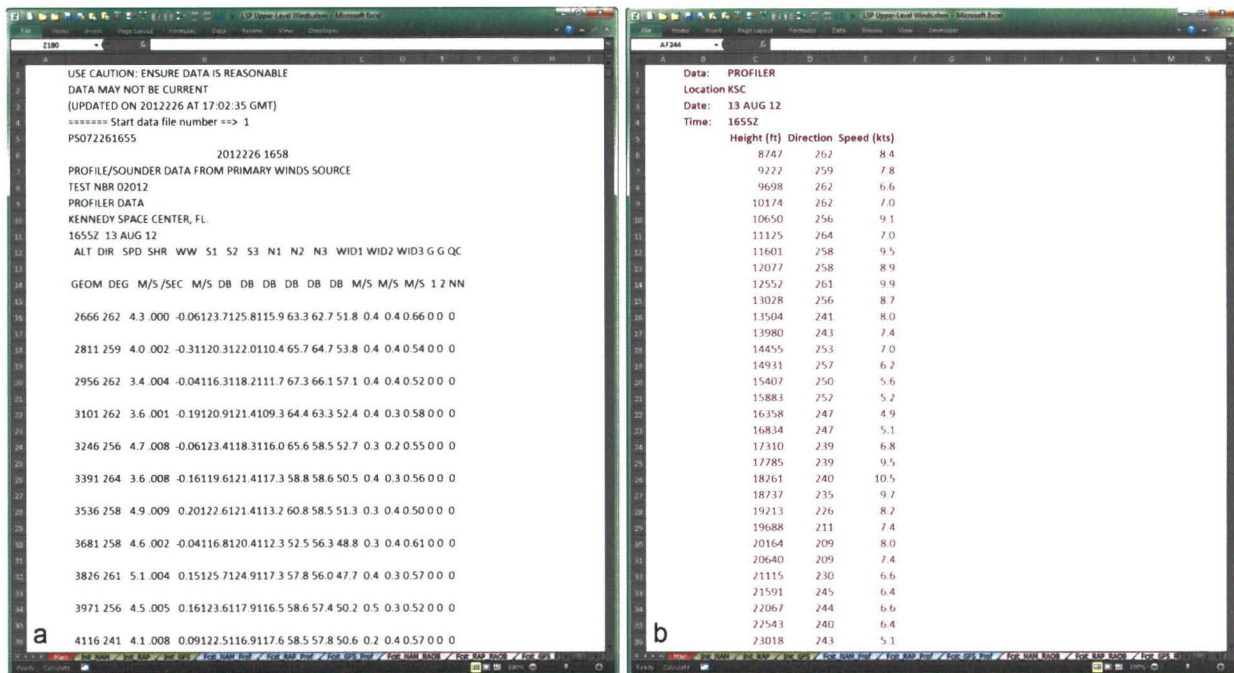


Figure 2. a) Data from the 50 MHz profiler after being ingested into Excel and b) after unneeded parameters were removed, displaying the sensor type and location, date, time, height, wind direction and speed.

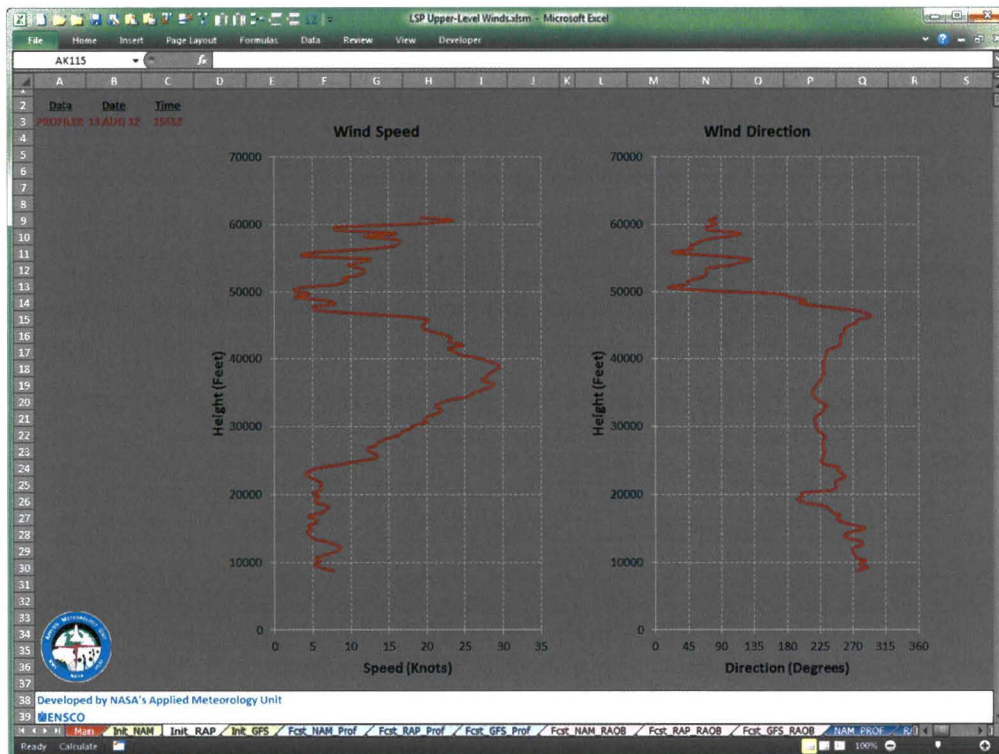


Figure 3. Wind speed (left) and wind direction (right) profiles at 1555 UTC 13 August 2012 from the 50 MHz wind profiler (dark red lines) plotted in Excel. Data type, date and time are shown in the upper left of the chart.

The 50 MHz profiler collects data from approximately 8,000-60,000 ft while the 915 MHz profiler collects data from approximately 400-10,000 ft. To provide a more-or-less continuous wind profile from these two instruments, the AMU wrote a VBA script to download, ingest and process the 915 MHz profiler files in the same manner as for the 50 MHz profiler files. Due to the nature of the 915 MHz profilers, the AMU needed to add quality control parameters to the observations by finding and replacing missing observations coded as “999” or “9999” with the observations from the height immediately below the missing data. The replaced observation is changed to red text in the reformatted spreadsheet to highlight the changes for the LWOs. From the reformatted 915 MHz profiler observations, another VBA script creates wind speed and direction profiles and adds them to the existing 50 MHz profile charts as shown in Figure 4. The 915 MHz profiles are shown by the orange lines and the 50 MHz profiles are shown by the dark red lines. The AMU did not interpolate the data at the interface height of the two sensors.

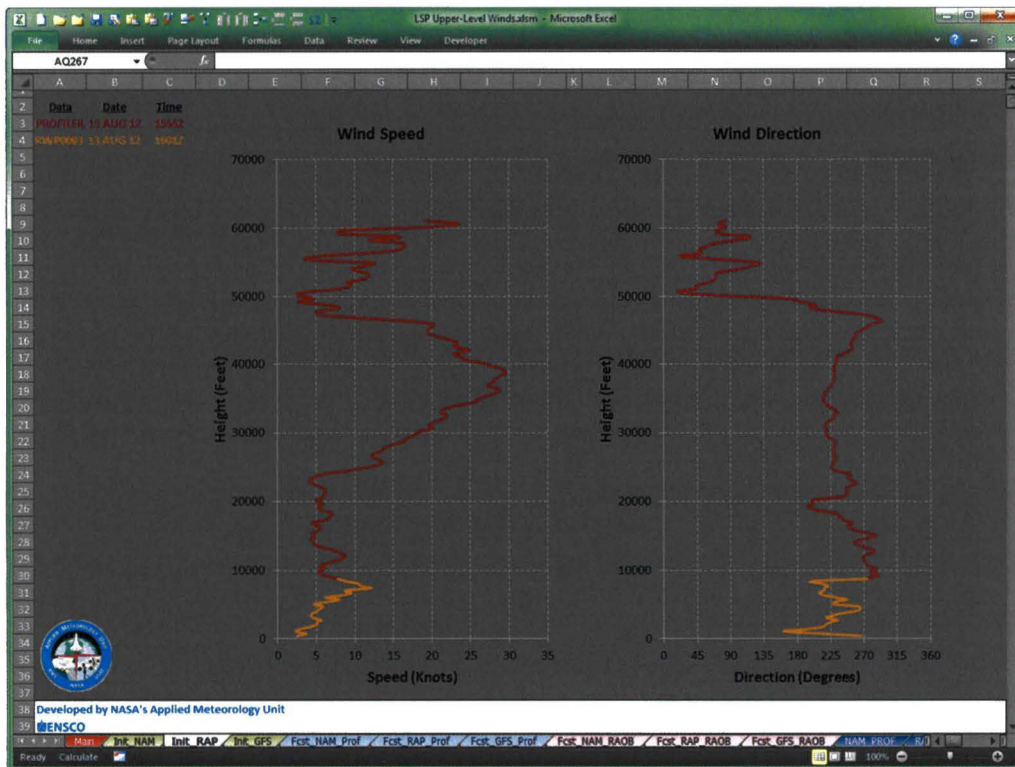


Figure 4. As in Figure 3 with the addition of the 1601 UTC 13 August 2012 915 MHz wind profiler (orange lines) plotted in Excel.

Another VBA script downloads, ingests and reformats the AMPS XMR radiosonde observations from the Spaceport Weather Data Archive. The AMPS files are also in ASCII format and are ingested into Excel as a text file. After downloading and ingesting the files, the VBA code removes all unneeded parameters and reformats the AMPS observations similar to the 50 MHz and 915 MHz profiler observations. From the reformatted data, another VBA script creates wind speed and direction profiles of AMPS and overlays them on the existing 50 MHz/915 MHz profile charts as shown in Figure 5. The AMPS profiles are shown by the green lines and the 50 MHz profiles and 915 MHz profiles are as shown in Figure 4.

The AMU then wrote VBA scripts to download and process the model forecast point data from the Iowa State University server. The data files are in ASCII format and ingested into Excel as text files. Each script reformats the files and displays the tabular data to the user. From the reformatted data, the next VBA script creates wind speed and direction profiles of the model forecast point data and overlays the data on the 50 MHz profiler charts as shown in Figure 6.

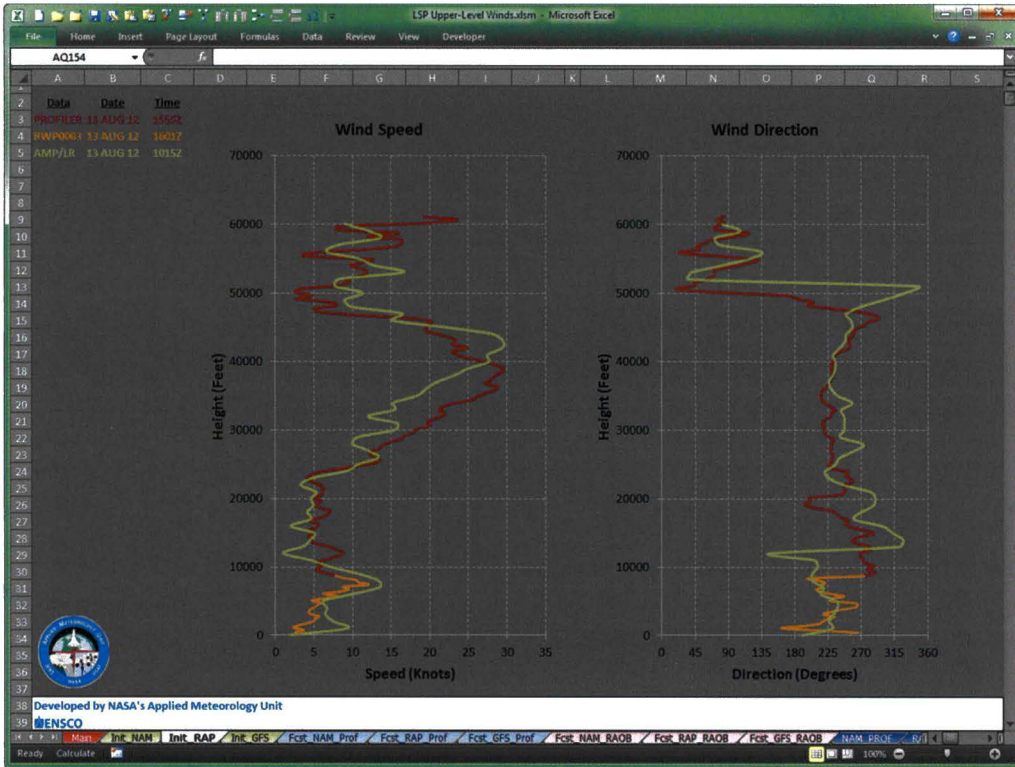


Figure 5. As in Figure 4 with the addition of the 1015 UTC 13 August 2012 AMPS (green lines) plotted in Excel.

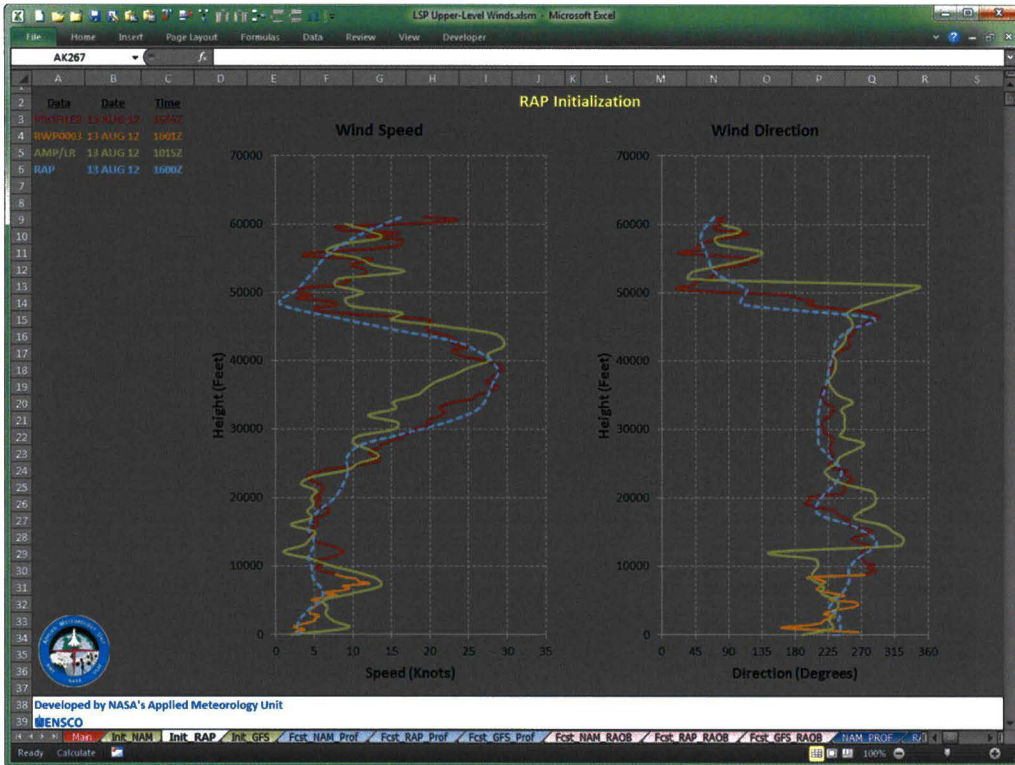


Figure 6. As in Figure 5 with the addition of the 1600 UTC 13 August 2012 RAP model 0-hour forecast (light blue dashed lines) plotted in Excel.

2.2.2 Model Forecasts

Since the requirement is to provide the LWOs with a GUI to overlay model forecasts in 3-hour intervals from the current time through 12 hours, the AMU developed VBA scripts to display the forecast wind profiles up to 12 hours after the latest observation at each model's highest temporal resolution to assess the upper-level wind changes on day-of-launch for the launch directors. To keep the forecast charts uncluttered, the model forecast point data is overlaid on the AMPS and profiler observations on separate charts.

The VBA script that creates wind speed and direction profiles of the model forecast time intervals also overlays them on the AMPS observation profile charts as shown in Figure 7. The AMPS observation (solid red line) at 1944 UTC 13 August 2012 is plotted with the NAM model hourly forecasts (dashed lines) based on the 1800 UTC 13 August 2012 model run valid from 2000 UTC 13 August 2012 to 0500 UTC 14 August 2012 in three-hour intervals. Even though the NAM forecasts are available hourly, forecast profiles valid every three hours are plotted on the chart to reduce clutter. The model forecast profiles are always plotted in four different shades of blue ranging from light (first model forecast valid time) to dark (last model forecast valid time) making it easier for the user to discern between the model forecast valid times. The forecast profile colors match the colors of the text showing data type, date and time displayed on the chart. To unclutter the model forecast profiles, the LWO can right-click on any line and delete it from the chart.

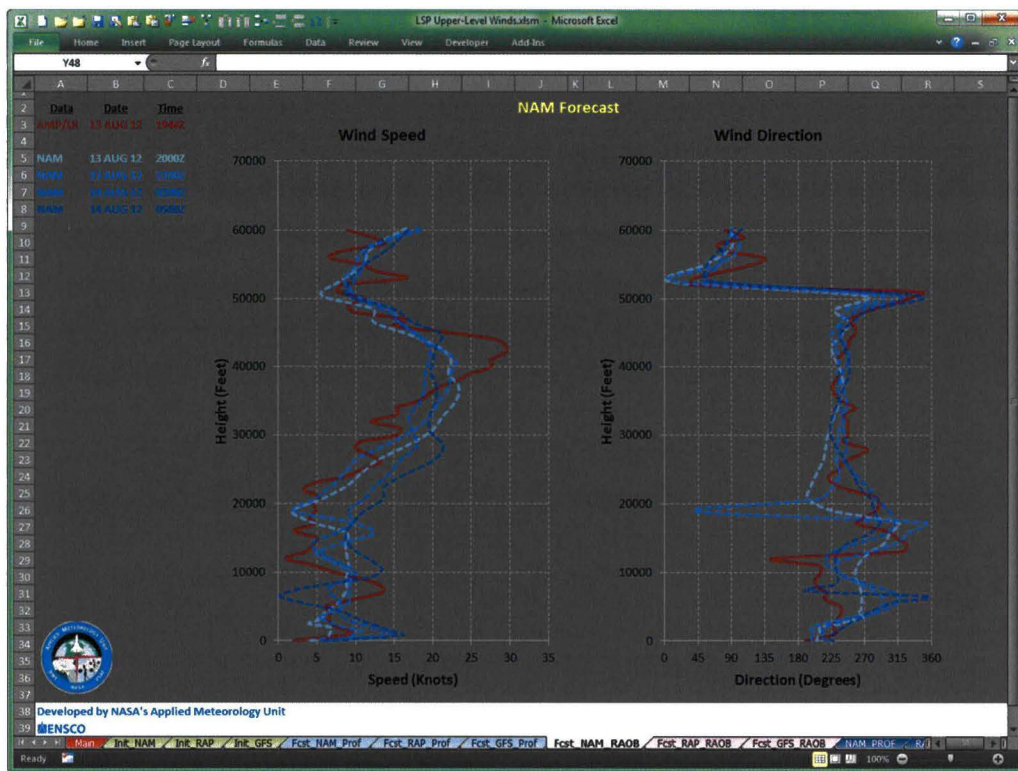


Figure 7. Wind speed (left) and wind direction (right) profiles from the 1944 UTC 13 August 2012 AMPS observation (dark red lines) and NAM model forecasts (dashed blue lines) valid every three hours from 2000 UTC 13 August 2012 through 0500 UTC 14 August 2012 plotted in Excel. Data type, date and time are shown in the upper left of the chart.

The model forecast point data profiles are also overlaid on the 50 MHz and 915 MHz profiler charts as shown in Figure 8. The 50 MHz profiler observation (solid red line) from 1655 UTC

13 August 2012 and the 915 MHz profiler observation from 1701 UTC 13 August 2012 are plotted with the NAM model hourly forecasts (dashed lines) from the 1800 UTC 13 August 2012 model run and valid from 1900 UTC 13 August 2012 to 0400 UTC 14 August 2012 in three-hour intervals. As before, only the NAM forecasts on the chart valid every three hours are plotted on the chart to reduce clutter using the color scheme described previously. To unclutter the model forecast profiles, the LWO can right-click on any line and delete it from the chart.

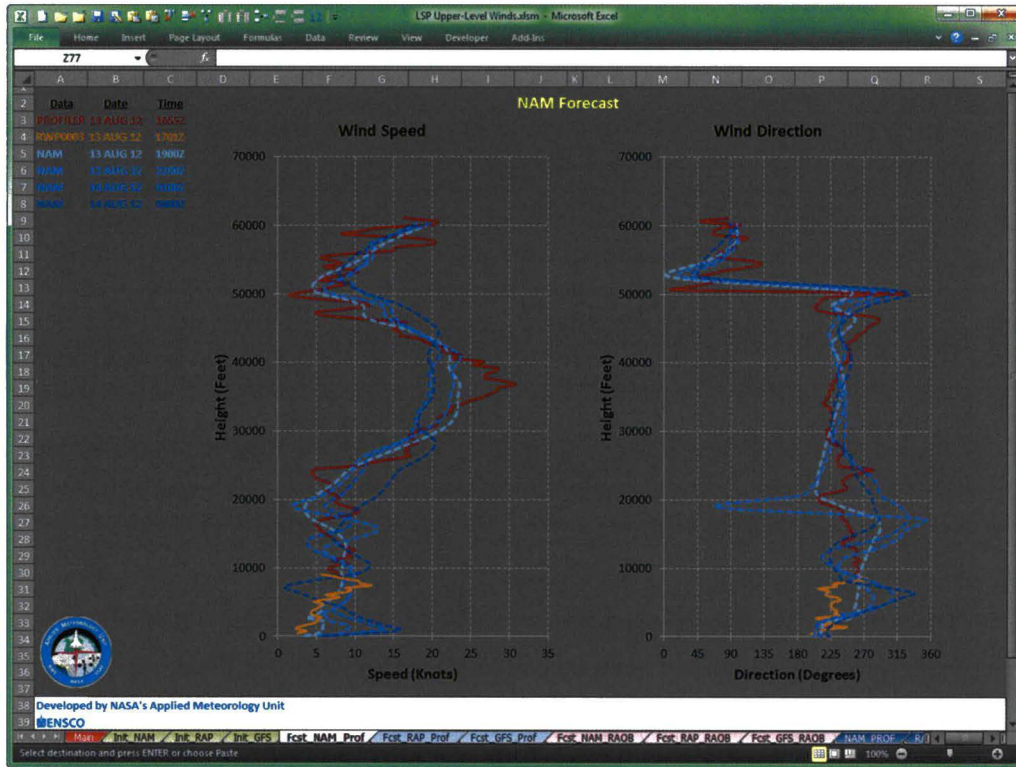


Figure 8. Wind speed (left) and wind direction (right) profiles from the 1655 UTC 13 August 2012 50 MHz profiler observation (dark red lines), 1701 UTC 13 August 2012 915 MHz profiler observation (orange lines) and NAM model forecasts (dashed blue lines) valid every three hours from 1900 UTC 13 August 2012 through 0400 UTC 14 August 2012 plotted in Excel. Data type, date and time are shown in the upper left of the chart.

3. Graphical User Interface

A single Excel workbook file serves as the GUI consisting of 25 tabs, or individual worksheets, that process and format the observations and model data as well as display tabular and graphic information. Within the Excel workbook there are 21 modules containing the VBA scripts that control all aspects of the GUI operations based on user input.

3.1 User Interface

The AMU developed a menu on the Main tab in the Excel GUI as shown in Figure 9. Upon opening the Excel workbook file, the Main tab is displayed and VBA scripts automatically run to determine and display the date, local time, UTC time and the results of the test for DST (Eastern Daylight or Standard Time since the tool will only be used in the Eastern Time zone) in the second row of the worksheet. There are three menus containing user-selectable model data and observations. The first menu, “*Initialize models*”, is designed to allow the LWOs to compare each model’s 0-hour forecast to the 50 MHz profiler, 915 MHz profiler and AMPS observations to determine which model is most accurate. The second menu, “*Compare Forecasts to Profiler Observations*”, allows the LWOs to compare each model’s 3-12 hour forecasts to the 50 MHz and 915 MHz profiler observations. The third menu, “*Compare Forecasts to RAOBS*”, allows the LWOs to compare each of the model’s 3-12 hour forecasts to the AMPS observations.

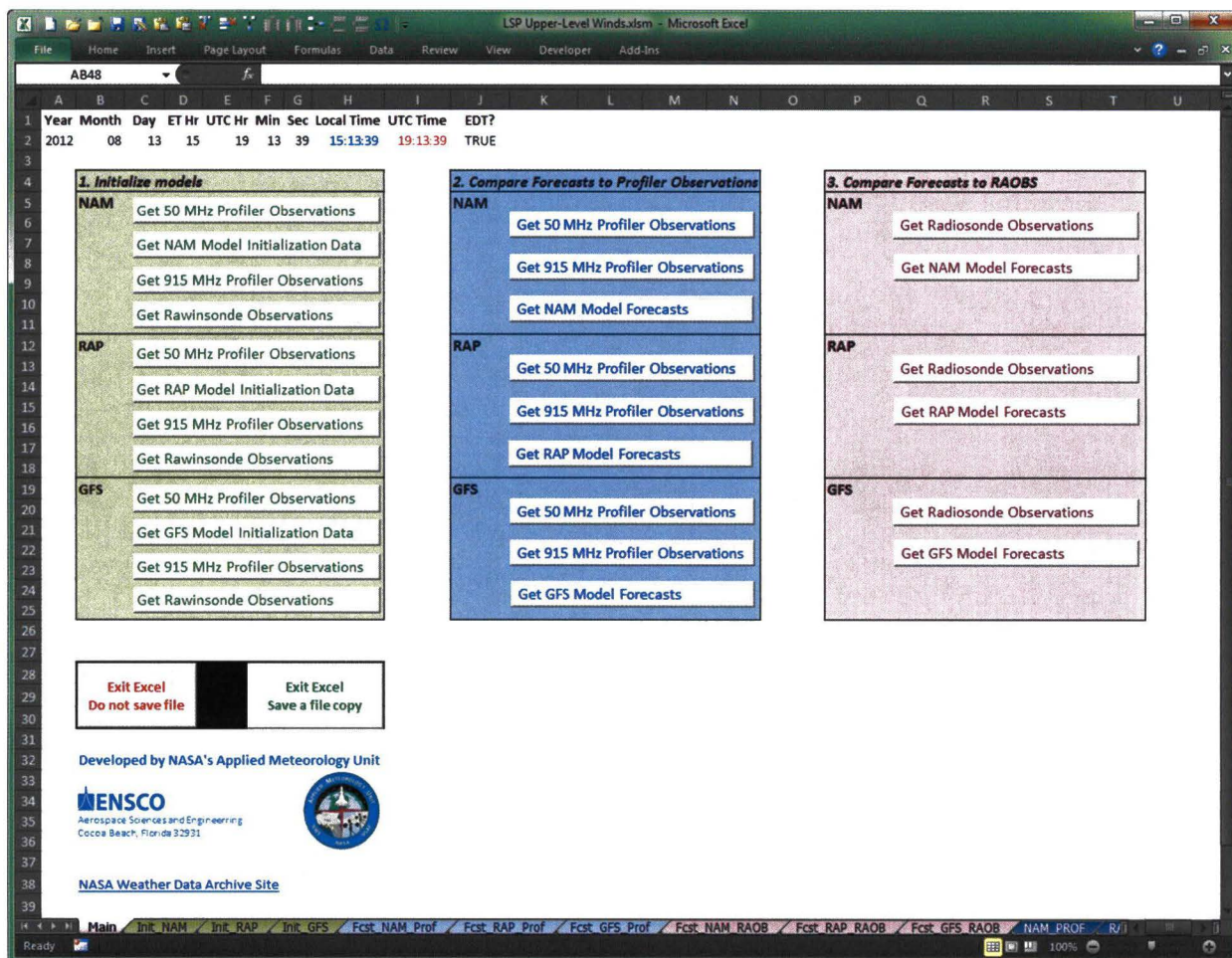


Figure 9. Main tab of the Excel GUI shows the primary user interface for selecting model data and observations to display.

In order to preserve the layout of the data and charts in each tab of the workbook, there are two buttons used to exit the GUI and Excel. The original file is never over written when the user chooses one of these buttons to exit. The button with green text will exit Excel and save a non-macro copy of the file in .xlsx format (Excel 2010) without any VBA code, but it will include all data and charts in the 25 tabs created during the session. It also automatically creates a filename for the saved file using the current date-time. A message box is then displayed to the LWO showing the filename and directory path to the file. The button with red text will exit Excel and will not save any version of the file.

3.2 Data Display

The AMU used multiple tabs to organize and process the textual and graphics data and displays. As shown in Figure 9, the tabs along the bottom of the workbook are color-coded to help users identify common displays or actions. The first nine tabs following the Main tab are color-coded to match the three colored menus on the Main tab. For example, the second light blue tab after the Main tab called "Fcst_RAP_Prof" corresponds to the light blue menu used to compare the RAP model forecasts to the profiler observations while the third pink tab after the Main tab called "Fcst_GFS_RAOB" corresponds to the pink menu used to compare the GFS model forecasts to the AMPS rawinsonde observations. After the LWO makes a choice from a menu, the resulting charts are displayed in the tab corresponding to the menu color, model and observation type.

Textual observation and model data are stored in separate tabs based on the model data start time that the observations will be compared to. This insures the observations are time-matched to each model. When an LWO chooses a model/observation pair from the menu, a VBA script automatically retrieves the observation and model data files from their respective servers, saves the raw data in the appropriate tabs, and then reformats the data to create charts and make the textual data easy for the LWO to read. An example of a reformatted textual observation data file from the AMPS rawinsonde at 1500 UTC on 13 August 2012 is shown in Figure 10. Similarly, an example of a reformatted textual GFS model data file from the 1200 UTC 13 August 2012 model run is shown in Figure 11. Besides looking at the example charts shown in Figures 3-8 that are created from the reformatted text data, the LWO can inspect the observations and model data displayed in neatly organized Excel spreadsheets in formats they are familiar with.

Height (ft)	Direction	Speed (kts)
16000	220	7.0
17000	215	9.7
18000	222	9.6
19000	238	10.7
20000	232	14.1
21000	239	13.8
22000	236	13.2
23000	227	11.5
24000	240	13.9
25000	242	15.0
26000	238	14.9
27000	235	17.2
28000	233	23.7
29000	227	24.3
30000	241	20.6
31000	248	19.0
32000	243	14.9
33000	243	12.2
34000	224	9.9
35000	185	8.5
36000	177	5.8
37000	195	2.9
38000	145	2.2
39000	8	6.0
40000	41	11.2
41000	38	10.3
42000	50	8.3

Figure 10. AMPS rawinsonde data after being ingested into Excel and reformatted displaying the sensor type and location, date, time, height, wind direction and speed.

Model: GFS	Location: 74794	Date: 13 AUG 12	Time: 1200Z	Height (ft)	Direction	Speed (kts)	Model: GFS	Location: 74794	Date: 13 AUG 12	Time: 1500Z	Height (ft)	Direction	Speed (kts)	Model: GFS	Location: 74794	Date: 13 AUG 12	Time: 1800Z	Height (ft)	Direction	Speed (kts)
90	214	6.3	90	223	4.3	88	167	5.4												
256	213	6.5	254	225	4.4	255	170	5.5												
443	213	6.5	444	225	4.7	444	174	5.5												
659	212	6.6	659	227	4.8	663	178	5.4												
900	212	7.1	904	228	5.2	907	192	5.6												
1179	210	7.7	1180	229	5.7	1185	205	6.0												
1492	210	8.5	1494	231	6.5	1501	217	6.8												
1847	212	9.6	1850	235	7.4	1858	226	7.6												
2245	216	10.6	2249	239	8.2	2259	233	8.3												
2697	220	11.4	2701	242	9.2	2714	237	9.3												
3205	223	12.2	3210	245	10.3	3221	241	10.2												
3774	224	13.1	3777	246	11.1	3793	244	11.0												
4412	224	13.9	4414	246	11.7	4432	245	12.0												
5124	225	14.6	5127	243	12.3	5142	245	13.3												
5916	226	14.8	5916	240	12.8	5933	243	14.2												
6792	229	15.2	6793	237	13.4	6809	242	14.9												
7759	232	15.6	7757	235	14.4	7779	241	16.3												
8821	232	16.9	8820	232	16.5	8840	240	18.0												
9982	229	18.7	9978	230	19.2	10000	239	20.1												
11246	229	20.7	11240	230	21.8	11263	239	22.1												
12612	231	21.8	12608	231	23.6	12633	237	23.5												
14082	235	20.9	14076	232	22.7	14103	235	22.9												
15658	238	16.0	15653	234	16.7	15678	238	18.3												
17341	238	10.3	17333	235	9.9	17361	242	11.6												
19129	197	2.0	19123	189	2.6	19155	231	4.0												
21026	73	4.1	21015	87	3.5	21046	45	1.1												
23013	28	4.6	23004	15	6.0	23038	17	6.5												

Figure 11. GFS model 3-hour forecast data after being ingested into Excel and reformatted displaying the model type and location, date, time, height, wind direction and speed for each 3-hour forecast interval.

4. Information Technology Challenges

Information Technology (IT) challenges during this task included incompatible versions of commercial off-the-shelf software and changing IT security requirements. These issues impacted the ability of the software to produce the required results and changed data acquisition methods.

4.1 Software

The software for this task was developed using Excel 2010, which was part of the standard AMU software load of Microsoft Office 2010 as approved by NASA IT System Administration and Security. After the AMU's first demonstration to the LWOs of the early development of the tool's functionality, the LWOs suggested that the AMU conduct tests of the tool on the 45th Space Wing (45 SW) network. Upon doing so, the AMU realized that most of the charting functionality created in the Excel 2010 version of the tool was not backwards compatible with the Excel 2007 version that was running on the 45 SW network. To solve this issue, the AMU requested the 45 WS install Excel 2010, which they did with permission from 45 SW IT Security.

4.2 IT Security

Testing the tool on the 45 SW network also revealed that 45 SW IT Security did not permit 45 SW computers to access the Iowa State University Archive Data server. The 45 WS suspected this would be an issue as access to .edu Universal Resource Locators (URL) is normally blocked by IT Security. Since AMU testing also revealed that access to the Spaceport Weather Data Archive, a .gov URL, was permitted, they asked the KSC Weather Office if the Spaceport Weather Data Archive curator, Mr. Gemmer of Abacus Technology, could routinely retrieve the model files from the Iowa State University Archive Data server and save them in a directory on the Spaceport Weather Data Archive for access by the 45 WS. Mr. Gemmer notified the KSC Weather Office that they could retrieve and save the model files for 45 WS access.

When this task was about 75% complete, the KSC Weather Office notified the AMU that the Spaceport Weather Data Archive was being phased out and transitioning to the Spaceport Weather Archive at a new URL, <http://wxarchive.ksc.nasa.gov>. The AMU tested access to the new site via the FTP being used in the VBA scripts and found that the directory structure used on the old site was not the same on the new site. Upon manual inspection of the new URL, the AMU discovered that the new site is built only for human interface to search and acquire data, not for automated retrieval of data by another computer. The AMU asked Mr. Gemmer for assistance and he indicated that due to NASA IT security regulations the FTP portion of the server would be shut down, but they could setup a directory structure to allow the automated transfer of files via Hypertext Transfer Protocol (HTTP). This was not an issue because the AMU would only have to modify the VBA code to use HTTP instead of FTP for the correct directory structure on the server.

Based on resolution of the challenges presented in the preceding paragraphs, the AMU continued to develop and complete the tool. After final testing on the NASA network and prior to transferring the tool to the 45 WS computer for testing, the AMU checked on the status of the HTTP directory structure on the new Spaceport Weather Archive URL so they could update the VBA code. Mr. Gemmer informed the AMU that since his last communication with the AMU, NASA IT Security was shutting down HTTP servers thereby disallowing the tool to automatically access any files on the Spaceport Weather Archive. The AMU met with Mr. Ebuon and Ms. Burdett of Abacus Technology to determine if there was another solution to allow the tool to automatically access the data on the servers. Four possible solutions were discussed:

- Use HTTP Secure access with password protection,
- Run the Excel GUI tool on the Spaceport Weather Archive server,
- Implement a Web service, which is a software system designed to support interoperable machine-to-machine interaction over a network, and
- Implement a Server Message Block or Common Internet File System that operates as an application-layer network protocol to provide shared access to files between nodes on a network.

Mr. Ebuon and Ms. Burdett believe the Web service is the best option but it will take some development work on the Spaceport Weather Archive server. They needed to discuss the options with other Abacus Technology and NASA personnel before making a final recommendation and developing a plan. As of the writing of this report, the KSC Weather Office had submitted an IT Work Request to NASA/KSC IT Security to request support to help provide a solution to this dilemma.

5. Summary and Future Work

The LWOs requested the AMU develop a capability in the form of a GUI that would allow them to plot upper-level wind speed and direction observations and then overlay point forecast profiles from the NCEP NAM, RAP and GFS models to assess the performance of these models. The AMU developed an Excel-based GUI for the LWOs to rapidly assess the model forecast of upper-level winds by comparing them to the CCAFS AMPS rawinsondes and the KSC 50 MHz and 915 MHz wind profilers and provide that information to the launch directors and other decision makers. The GUI allows the LWOs to first initialize the models by comparing the 0-hour model forecasts to the observations and determine which model has the best performance. The LWOs can then display the desired model forecasts in 3-hour intervals from the current time through 12 hours.

The AMU wrote Excel VBA scripts that drive the GUI by automatically acquiring, downloading and processing the observations and model point forecast data, and then displaying the resulting output in text format in Excel spreadsheets and in graphic format as Excel charts. The output of the observational data provides the LWO with the observation type and location, date and time, height, and wind direction and speed. The output of the model data provides the LWO with the model name and forecast point location, date and time of the model start and forecast intervals, height, and wind direction and speed.

Issues with software compatibility and IT Security presented several challenges to this task. To create the charts requested by the LWOs required using features only available in Excel 2010. Therefore the 45 WS had to obtain permission from 45 SW IT Security to procure and install this version of Excel on one of their computers so they could run the tool. 45 SW IT Security restricted 45 WS access to the Iowa State Data Archive. The AMU requested and the Spaceport Weather Archive curators agreed to host the model point forecast files from the Iowa State Data Archive on their server for 45 WS access. NASA IT Security removed the FTP capability from their servers followed by removal of HTTP capability during the tenure of this task, negating the ability of the scripts in the GUI to automatically access the data files from the KSC Weather Data Archive. The KSC Weather Office initiated a request to NASA IT Security to help solve this dilemma and allow the 45 WS automated access to the files on the KSC Weather Data Archive.

If the IT Security issues can be overcome and this tool becomes operational, it will provide an objective method for the LWOs to compare the forecast upper-level winds for the KSC/CCAFS area to the observed data from KSC and CCAFS and assess each model's potential to accurately forecast changes in the upper-level winds through the launch count. If the IT Security issues cannot be resolved, the AMU will amend this report to summarize the final outcome.

In the future, the AMU would like to add a local high resolution version of the Weather Research and Forecasting (WRF) model. The AMU is working on a task to assess and implement a high temporal and horizontal resolution WRF to be run locally. The intent of this task is to determine the optimum physics schemes and data assimilation methods to run WRF over east-central Florida on a routine basis. Once WRF is running routinely, the WRF forecasts could be added to this tool and used in the same manner as the NCEP NAM, RAP and GFS model forecasts.

List of Acronyms

45 SW	45th Space Wing	LWO	Launch Weather Officer
45 WS	45th Weather Squadron	MIDDS	Meteorological Interactive Data Display System
AMPS	Automated Meteorological Profiling System	NAM	North American Mesoscale
AMU	Applied Meteorology Unit	NCEP	National Centers for Environmental Prediction
ASCII	American Standard Code for Information Interchange	RAOBS	Radiosonde Observations
CCAFS	Cape Canaveral Air Force Station	RAP	Rapid Refresh
DST	Daylight Saving Time	SLF	Shuttle Landing Facility
FTP	File Transfer Protocol	ST	Standard Time
GFS	Global Forecast System	URL	Universal Resource Locator
GRIB	Gridded Binary	UTC	Coordinated Universal Time
GUI	Graphical User Interface	VBA	Visual Basic for Applications
HTTP	Hypertext Transfer Protocol	WRF	Weather Research and Forecasting
IT	Information Technology	XMR	CCAFS rawinsonde 3-letter identifier
KSC	Kennedy Space Center		
LSP	Launch Services Program		

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