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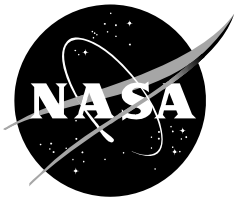

Severe Weather and Weak Waterspout Checklist in MIDDS

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January 2009

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Acknowledgements

Initial software code developed by Ms. Kathy Winters at 45th Weather Squadron.

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Executive Summary

The 45 WS Commander's morning weather briefing and the daily 24-Hour and Weekly Planning Forecasts include the likelihood of local convective severe weather for the day in order to enhance protection of personnel and material assets of the 45th Space Wing, CCAFS, and KSC. The severe weather elements produced by thunderstorms include tornadoes, wind gusts ≥ 50 kts, and/or hail with a diameter ≥ 0.75 in. Forecasting the occurrence and timing of these phenomena during the warm season is challenging for 45 WS operational personnel. In a previous task, the AMU developed the web-based Warm Season Severe Weather Forecast Decision Aid worksheet to assist forecasters in determining the probability of issuing severe weather watches and warnings for the day. The forecasters enter values into the worksheet manually to output a threat index. For the current task, the 45 WS requested the AMU to migrate the functionality of the worksheet to the Meteorological Interactive Data Display System (MIDDS); their operational data ingest and display system. MIDDS is able retrieve many of the needed parameter values for the worksheet automatically. They also requested the AMU to transfer the functionality of their Weak Waterspout Checklist.

The goal of this task was to develop a user-friendly MIDDS interface to determine if there is a threat for severe weather or weak waterspouts based on the morning sounding during the warm season. This goal was met successfully through the development of two MIDDS interfaces: one to determine the threat of severe weather and the other to determine the threat of weak waterspout occurrence. Both tools access most of the needed data from the MIDDS database automatically, and require the forecaster to answer only a few questions. Making these tools more automatic will reduce the possibility of human error and increase efficiency, allowing forecasters to do other duties.

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1. Introduction

The 45th Weather Squadron (45 WS) Commander's morning weather briefing and the daily 24-Hour and Weekly Planning forecasts include an assessment of the likelihood of local convective severe weather for the day in order to enhance protection of personnel and material assets of the 45th Space Wing, Cape Canaveral Air Force Station (CCAFS), and Kennedy Space Center (KSC). The severe weather elements produced by thunderstorms include tornadoes, wind gusts ≥ 50 kts, and/or hail with a diameter ≥ 0.75 in. Forecasting the occurrence and timing of these phenomena in the warm season is challenging for 45 WS operational personnel. In a previous task, the AMU developed the web-based Severe Weather Forecast Decision Aid worksheet (Bauman et al. 2005) to assist forecasters in determining the probability of issuing severe weather watches and warnings for the day. The forecasters enter values into the worksheet manually to output a threat index. For the current task, the 45 WS requested the AMU to migrate the functionality of the worksheet to the Meteorological Interactive Data Display System (MIDDS), their operational data ingest and display system. MIDDS is able retrieve many of the needed parameter values for the worksheet automatically. They also requested the AMU to transfer the functionality of their Weak Waterspout Checklist, which is only available on paper. Forecasters must fill in the values and calculate the threat manually. Making these tools more automatic will reduce the possibility of human error and increase efficiency, allowing forecasters to do other duties.

The primary advantage of using MIDDS is the ability to automatically populate values available in the MIDDS databases without forecaster intervention. The forecaster will still need to answer subjective questions that MIDDS will assign the appropriate values to using criteria from the existing web-based severe weather worksheet climatology before calculating a total threat score for the day. Initial MIDDS code developed by Ms. Kathy Winters of the 45 WS was used as a starting point for this MIDDS Forecaster Warm Season Severe Weather Forecast Decision Tool.

2. Previous Work

In the Severe Weather Forecast Decision Aid task final report (Bauman et al., 2005), the AMU presented a 15-year climatological study of severe weather events and related severe weather atmospheric parameters. The period of record (POR) for the analysis was May – September, 1989 – 2003. The data sources included local forecast rules, archived soundings, Cloud-to-Ground Lightning Surveillance System (CGLSS) data, surface and upper air maps, and two severe weather event databases covering east-central Florida. The AMU used the local forecast rules to set threat-assessment thresholds for stability parameters that were derived from the sounding data. The severe events databases were used to identify days with reported severe weather and the CGLSS data were used to differentiate between lightning and non-lightning days. These data sets provided the foundation for analyzing stability parameters and synoptic patterns with the goal of developing an objective tool to aid in forecasting severe weather events.

An interactive web-based Severe Weather Forecast Decision Aid (Figure 1) was developed to assist the duty forecaster by providing a level of objective guidance based on the stability parameters from the CCAFS (XMR) morning 1000 UTC sounding, CGLSS data, and synoptic-scale dynamics. The AMU tested and evaluated the Decision Aid during the 2006 warm season to verify that the values chosen for each parameter based on the climatological study were consistent with the Total Threat Score. An additional objective was to determine if there was a Total Threat Score threshold at which reported severe weather did or did not occur.

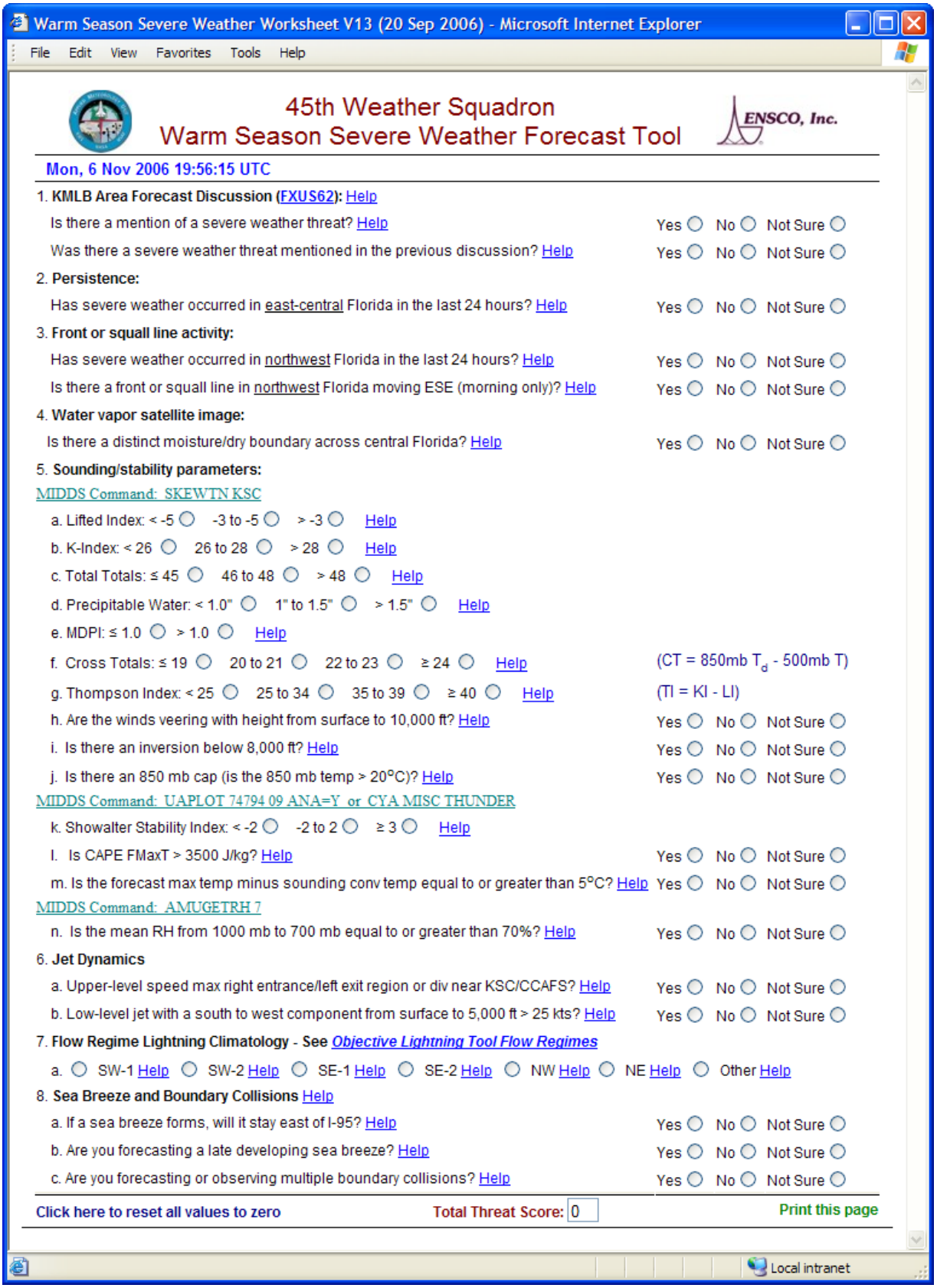

Figure 1. The Severe Weather Forecast Decision Aid worksheet.

3. MIDDS Software Development, Testing and Transition

The functionality of the Severe Weather Forecast Decision Aid's data input, including the subjective questions, was transferred into a MIDDS program using the Man-computer Interactive Data Access System (McIDAS) BASIC language Interpreter (McBASI) code, a language similar to BASIC. McBASI allows the flexibility of coding different modules to retrieve, process, and apply functions to data or weather parameters in the weather data database.

3.1 Development

MIDDS stores local data sets, model output and other gridded data, radar and satellite images in fixed areas on a server. Man-computer Interactive Data Analysis System (McIDAS) commands and Mcidas BASic language interpreter (McBASI) programs can access and manipulate different data formats based on gridded, point or textual data structure. The following features of MIDDS were used in the development of the different modules and routines needed to migrate the Severe Weather Forecast Decision Aid's functionality into a single forecaster routine

- **McBASI**: A programming language similar to the original BASIC language that allows users to group commands and/or parameters into a single file which can then be entered as a single McIDAS command,
- **ASK**: An interface utility that can be programmed to query the user for specified parameter values and then enter a McIDAS command with the user's responses as the command parameters, and
- **String Tables**: User- or code-defined strings that can be assigned to commands and/or parameters lists and then used as a short cut for entering commands and/or providing a parameter list.

The XMR morning sounding at 1000 UTC was the primary focus of the data retrieval routines. Automatic values and threat scores were computed for 14 out of the 26 total questions in the worksheet. The rest of the questions were subjective and need to be answered by the forecaster. These questions were handled by asking the forecaster the question, displaying a textual or graphic product that would help them answer the question and then, based on their response, a computed weighted value was assigned. The McBASI programs use the sounding data first to calculate the stability indices needed by the worksheet, and then store these values for other calculations in the forecaster-supplied answer portions of the Severe Weather Forecast Decision Aid module.

An added feature for the Severe Weather Forecast Decision Aid program is that all the sounding information including stability indices and the Threat Score for the day is displayed on the MIDDS text screen and also saved into a daily text file. This file can then be viewed or printed later.

McBASI code was also written to retrieve the necessary weather parameters for the Weak Waterspout Checklist, which was supplied by Mr. Bill Roeder of the 45 WS. The program automatically calculates most of the parameters on the checklist except one: it asks the forecaster to answer a question about the previous day's waterspout activity in the local area. Once all information is gathered, the program calculates and displays a weak waterspout threat score.

3.2 Severe Weather MIDDS Command

The command to start the Severe Weather Forecast Decision Aid in MIDDS is "SEVERE or RUN FILE=SEVERE.MCB". Most of the code works in the background, retrieving parameters from the weather database and computing indices. Once completed with the background data processing the Severe Weather Forecast Decision Aid program displays and/or asks the forecaster questions based on the previous worksheet (see Figure 1). In the below figures most text in blue boxes are data or questions that are presented to the forecaster.

Figure 2 displays an example of a subjective question asked (blue box) to determine if there is a severe weather threat for the day based on what the NWS Melbourne office is forecasting. On the MIDDS image screen (black) the morning forecast discussion from NWS Melbourne is displayed. Figure 3 shows another question example along with a graphic displayed to answer the question. This question has to do with frontal systems, troughs or squall lines that are approaching the central Florida area. The MIDDS image displays to the forecaster the most current frontal analysis for the southeastern United States. This design of displaying the most pertinent information to answer a question at the time the question is asked is used throughout this tool.

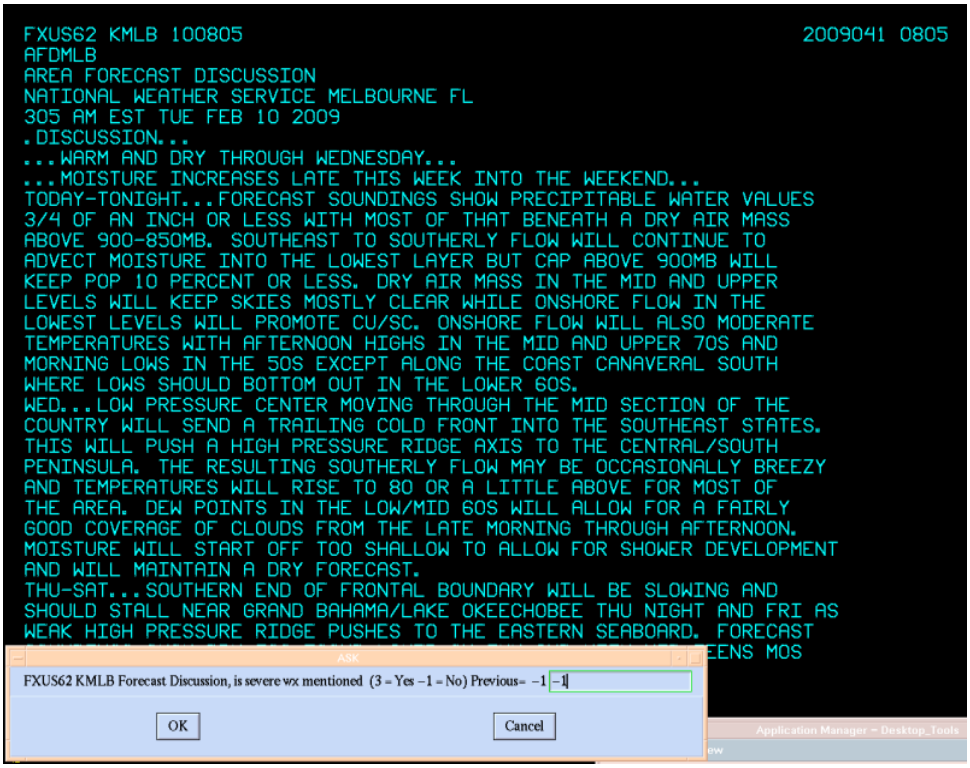

Figure 2. Example of the question asking if NWS MLB mentioned a severe weather threat in their NWS MLB area forecast discussion (AFD) displayed with the AFD text.

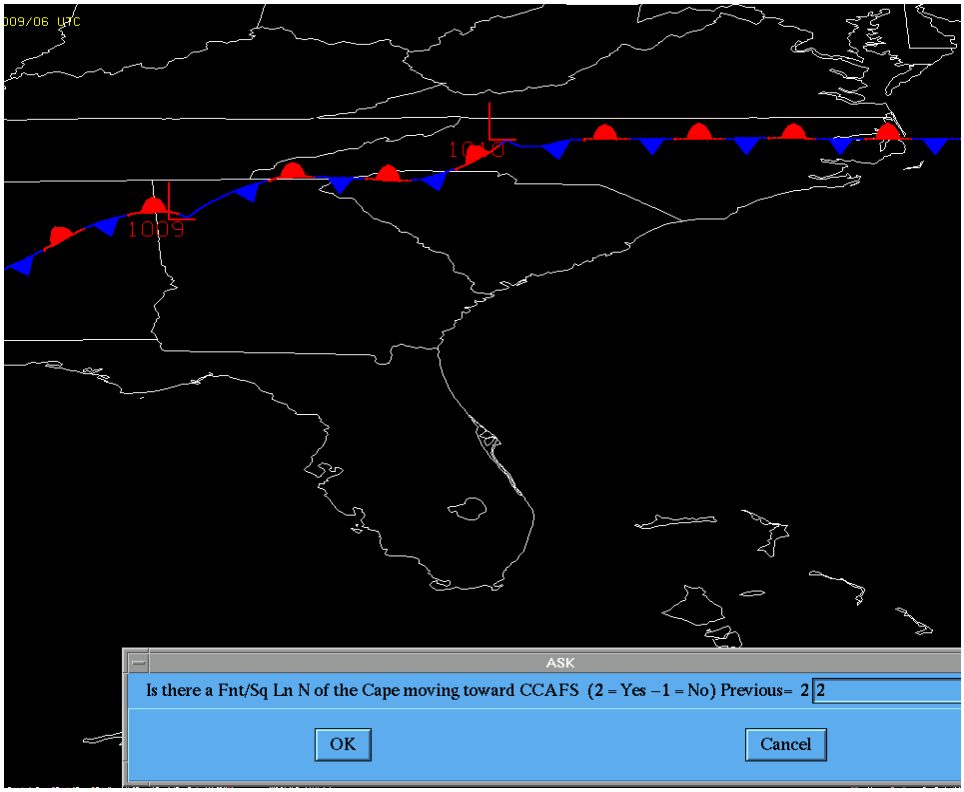

Figure 3. Example of the question on fronts, troughs and squall lines approaching central Florida and the MIDDS image display showing the locations of these features.

Several questions presented to the forecaster deal with the morning sounding and atmospheric stability. Figure 4 is an example of one of the questions that deal with the air mass stability: the value of the lifted index. The stability indices have already been calculated by MIDDS, but are displayed to the forecasters so they can change the values if they wish. If the forecasters agree with the value, they may just press "OK" and go on to the next question. On the MIDDS display the current sounding is provided along with all the sounding indices overlaid on top. After the forecaster answers all the questions, the final Threat Score is calculated and displayed. A table converting the total threat score to the likelihood of severe weather is provided just above the total threat score. Figure 5 is an example of the final text screen that displays the threat score to the forecaster. This display is also saved as a text file that can be viewed or printed later.

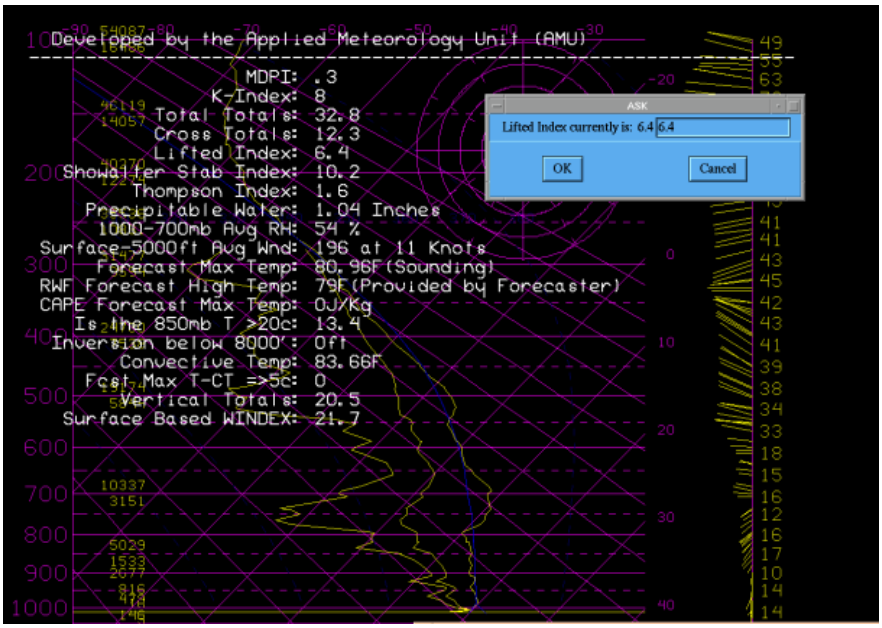

Figure 4. Example of a question on stability (Lifted Index) with the value displayed. The background image displays the sounding and calculated stability indices.

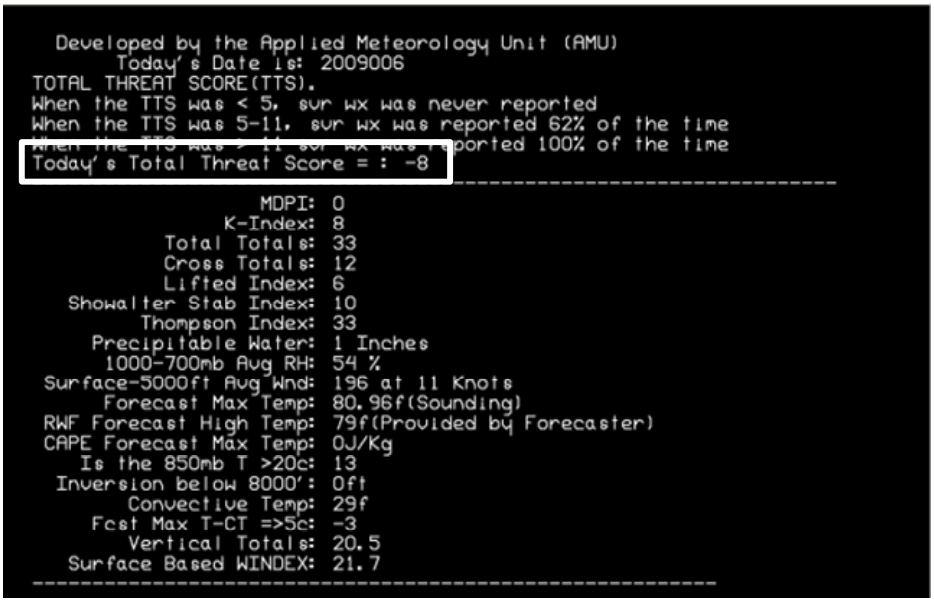

Figure 5. Example of the Severe Weather Forecast Decision Aid final MIDDS screen showing the severe weather threat score for the day (white box).

3.3 Weak Waterspout MIDDS Command

The command to start the Weak Waterspout Checklist in MIDDS is "WATERSPOUT or RUN FILE=WATERSPOUT.MCB. This program gathers the necessary stability indices automatically and shows questions similar to the Severe Weather Forecast Decision Aid in MIDDS. The weak waterspout-days are identified by adding together four factors: 1) monthly climatology, 2) vertical profile of wind speed, 3) precipitable water, and 4) persistence, the program then computes and displays a score to the user. Figure 6 shows an example of the final screen displayed to the forecaster when the Weak Waterspout MIDDS program is executed. The output displays to the forecaster most of the critical variables, their scores and the total threat score for the day. A table converting the total threat score to the potential for weak waterspouts is provided near the top of the screen.

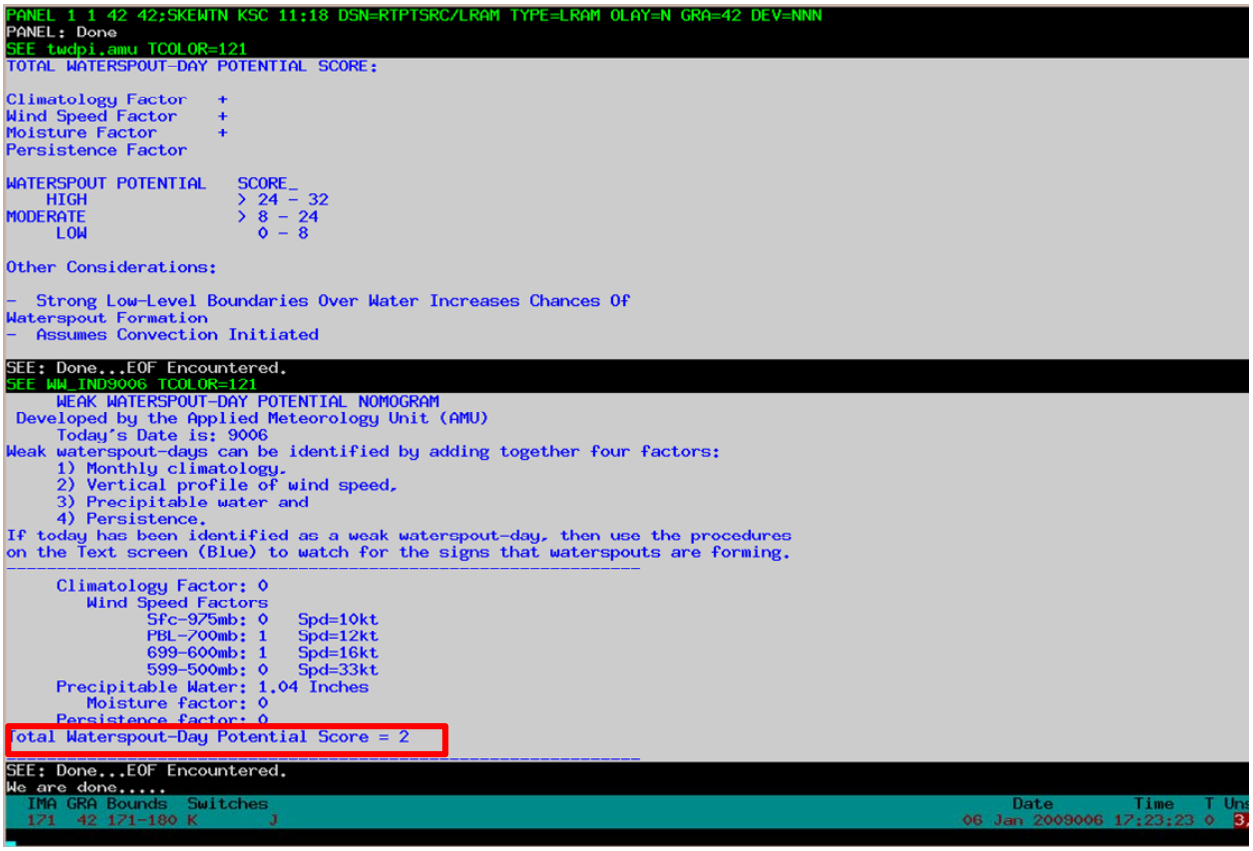

Figure 6. Example of Weak Waterspout Checklist final MIDDS screen showing the weak waterspout threat score for the day (red box).

3.4 Testing

Once the code development was completed, the AMU developed several ways to test it. An additional module of the code was developed so that all variables and weights would be displayed on the screen. After the code was run, these output values were compared to the observed sounding variables to make sure the calculations were done correctly. Also, the weighted values were compared to those from the original study worksheet to make sure the proper weights were applied. Both tests produced the expected values in all cases.

Because the MIDDS Severe Weather Forecast Decision Aid program was developed and tested using cool season data, not the warm season data for which it was developed, it will be tested again starting in May 2009 with real time data. Adjustments to the code will be made as necessary.

3.5 Transition

Once initial testing was completed, the programs were demonstrated to 45 WS personnel. They offered several suggestions formatting the questions asked and displaying of certain MIDDS graphics. These changes were incorporated into the final MIDDS programs.

The developed modules, programs and other needed files will be given to the 45 WS on a Compact Disk (CD) or, with their permission, installed on one or more of their MIDDS weather systems. Once the code is installed additional testing will be done to ensure proper operation.

4. Summary

The goal of this task was to migrate the functionality of the AMU web-based Severe Weather Forecast Decision Aid and the 45 WS Weak Waterspout Checklist to MIDDS, the operational data ingest and display system of the 45 WS. Forecasting the occurrence and timing of warm season severe weather and weak waterspouts is challenging for 45 WS operational personnel. These interactive tools assist forecasters in determining the probability of issuing severe weather watches and warnings for the day.

MIDDS is able retrieve many of the needed parameter values for the worksheet automatically. The AMU was able to develop user-friendly tools in MIDDS for both of these tools using McBASI coded programs. The tools retrieve needed values from MIDDS automatically, and require the forecaster to answer a few subjective questions. Both tools were tested and previewed to the 45 WS on MIDDS.

In their previous forms, the forecasters enter values into both tools manually to output a threat index. Making these tools more automatic will reduce the possibility of human error and increase efficiency, allowing forecasters to do other duties.

5. References

Bauman, W., M. Wheeler and D. Short, 2005: Severe Weather Forecast Decision Aid: Final Report. NASA Contractor Report CR-2005-212563, Kennedy Space Center, FL, 50 pp. [Available from ENSCO, Inc., 1980 N. Atlantic Ave., Suite 230, Cocoa Beach, FL, 32931.] http://science.ksc.nasa.gov/amu/final-reports/severe-tool-final.pdf

List of Acronyms

45 WS	45th Weather Squadron
AMU	Applied Meteorology Unit
CCAFS	Cape Canaveral Air Force Station
CD	Compact Disk
CGLSS	Cloud-to-Ground Lightning Surveillance System
KSC	Kennedy Space Center
LCC	Launch Commit Criteria
McBASI	McIDAS BASIc language Interpreter
McIDAS	Man-computer Interactive Data Access System
MIDDS	Meteorological Interactive Data Display System
POR	Period of Record
UTC	Universal Coordinated Time
XMR	CCAFS Balloon Facility identifier

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