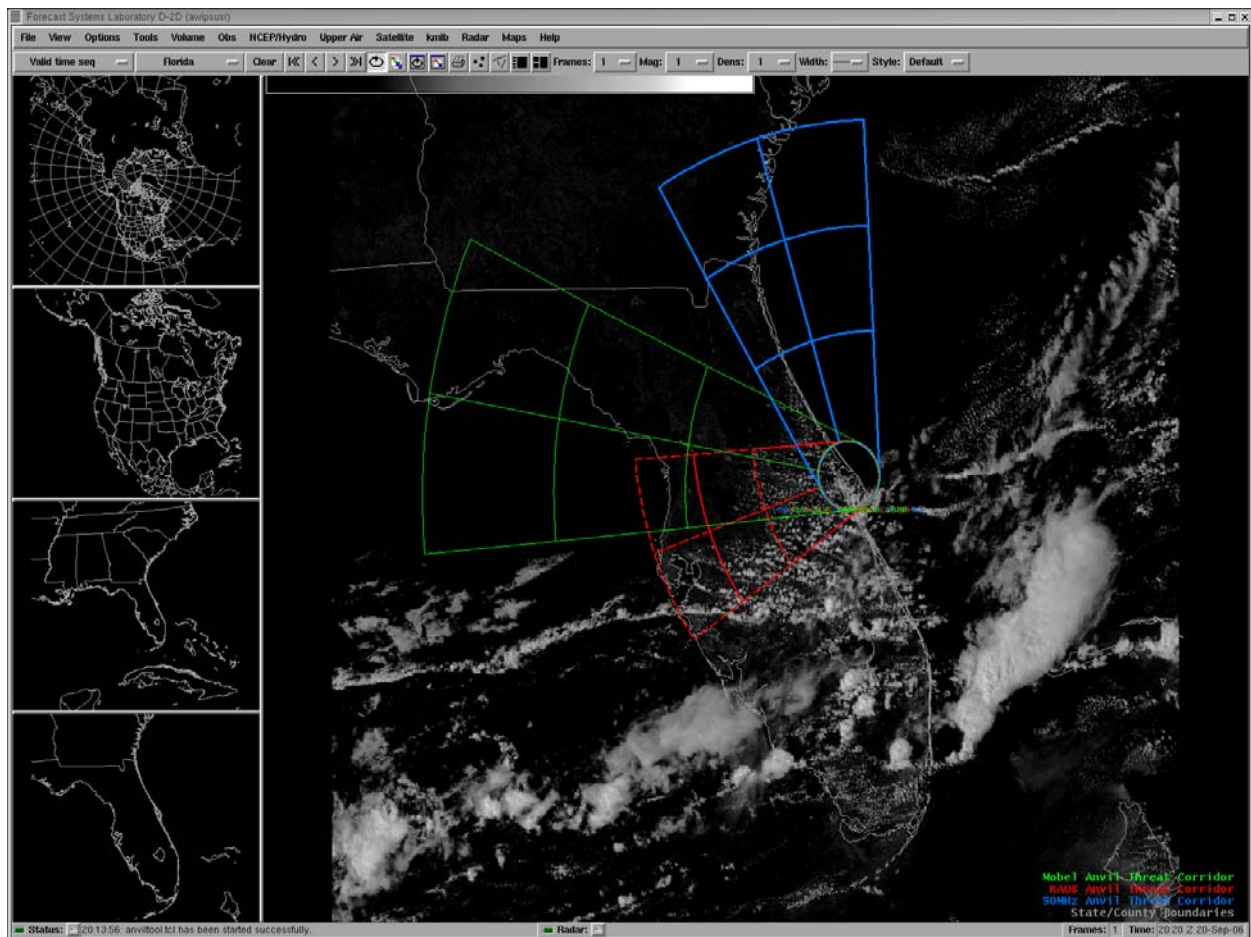


User Guide for the Anvil Threat Corridor Forecast Tool V2.4 for AWIPS

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1. Background

The Applied Meteorology Unit (AMU) originally developed the Anvil Threat Sector Tool for the Meteorological Interactive Data Display System (MIDDS). The capability was delivered in three phases beginning with a feasibility study in 2000 and the operational final product in December 2003. This tool is currently used operationally by the 45th Weather Squadron (45 WS) Launch Weather Officers (LWO) and National Weather Service (NWS) Spaceflight Meteorology Group (SMG) forecasters. Phase I of the task established the technical feasibility of developing an objective, observations-based tool for short-range anvil forecasting. The AMU was subsequently tasked to develop short-term anvil forecasting tools to improve predictions of the threat of triggered lightning to space launch and landing vehicles. Under the Phase II effort, the AMU developed a nowcasting anvil threat sector tool, which provided the user with a threat sector based on the most current radiosonde upper wind data from a co-located or upstream station. The Phase II Anvil Threat Sector Tool calculated the average wind speed and direction in the layer between 300 and 150 mb from the latest radiosonde for a user-designated station. The following threat sector properties are consistent with the propagation and lifetime characteristics of thunderstorm anvil clouds observed over Florida and its coastal waters (Short et al. 2002):

- 20 n mi standoff circle,
- 30 degree sector width,
- Orientation given by 300 to 150 mb average wind direction,
- 1-, 2-, and 3- hour arcs in upwind direction, and
- Arc distances given by 300 to 150 mb average wind speed.

Figure 1 is an example of the MIDDS Anvil Threat Sector tool overlaid on a visible satellite image at 2132 UTC 13 May 2001. Space Launch Complex 39A was selected as the center point and the Anvil Threat Sector was determined from upper-level wind data in the 1500 UTC rawinsonde observation at XMR, on Cape Canaveral Air Force Station (CCAFS). Narrow thunderstorm anvil clouds extended from central Florida to the space launch and landing facilities at the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station and beyond. The anvil clouds were generated around 1930 UTC (1430 EDT) by thunderstorm activity over central Florida and transported 90 n mi east-northeastward within 2 hours, as diagnosed by the anvil forecast tool.

Phase III, delivered in February 2003, built upon the results of Phase II by enhancing the Anvil Threat Sector Tool with the capability to use national model forecast winds for depiction of potential anvil lengths and orientations over the KSC/CCAFS area with lead times from 3 through 168 hours (7 days). In September 2003, AMU customers requested the capability to use data from the KSC 50 MHz Doppler Radar Wind Profiler (DRWP) in the Anvil Threat Sector Tool and this capability was delivered by the AMU in December 2003.

In March 2005, the AMU was tasked to migrate the MIDDS Anvil Threat Sector Tool capabilities onto the Advanced Weather Interactive Processing System (AWIPS) as the Anvil Threat Corridor Forecast Tool (Barrett et al. 2007). In April 2007, the AMU was tasked to modify the Anvil Threat Corridor Forecast Tool in AWIPS. SMG requested the AMU add the capability to read user-defined model files using the NWS AGRID software. The AGRID software is a Perl module used to read and write model gridded data in Network Common Data

Form (NetCDF) format. This guide describes Phase II of the Anvil Threat Corridor Forecast Tool in AWIPS.

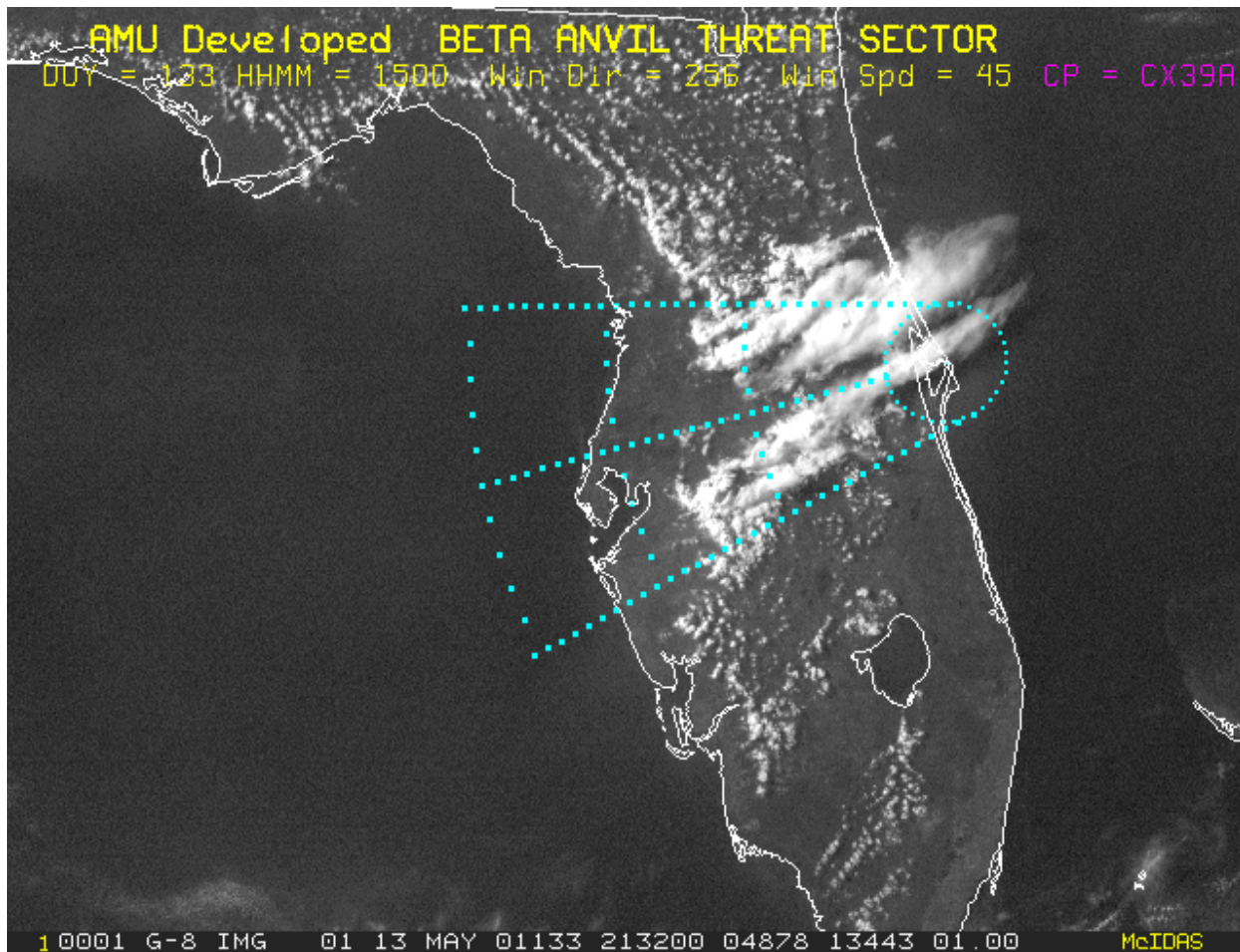


Figure 1. Example of the anvil forecast graphic overlaid on a visible satellite image of the Florida peninsula displayed in MIDDs. The Anvil Threat Sector was calculated from rawinsonde XMR data at 1500 UTC (1100 EDT) 13 May 2001. Thunderstorms that formed within the graphical threat sector produced anvil clouds that moved over the KSC/CCAFS area.

2. Operating the Anvil Threat Corridor Forecast Tool in AWIPS

The instructions in this section provide the user with a step-by-step guide to activate the Anvil Threat Corridor Forecast Tool (hereafter called “Anvil Tool”) and display the resulting graphics in the AWIPS primary display window. This User’s Guide assumes the user has been trained in the use of AWIPS.

2.1. Starting the Anvil Tool Graphical User Interface (GUI)

To access the Anvil Tool GUI, click the **Tools** dropdown menu from the AWIPS Main Menu and select **Anvil Tool Phase II...** (Figure 2). A dialog box will open and prompt the user to select a User Profile. After selecting a profile, the GUI starts up (Figure 3).

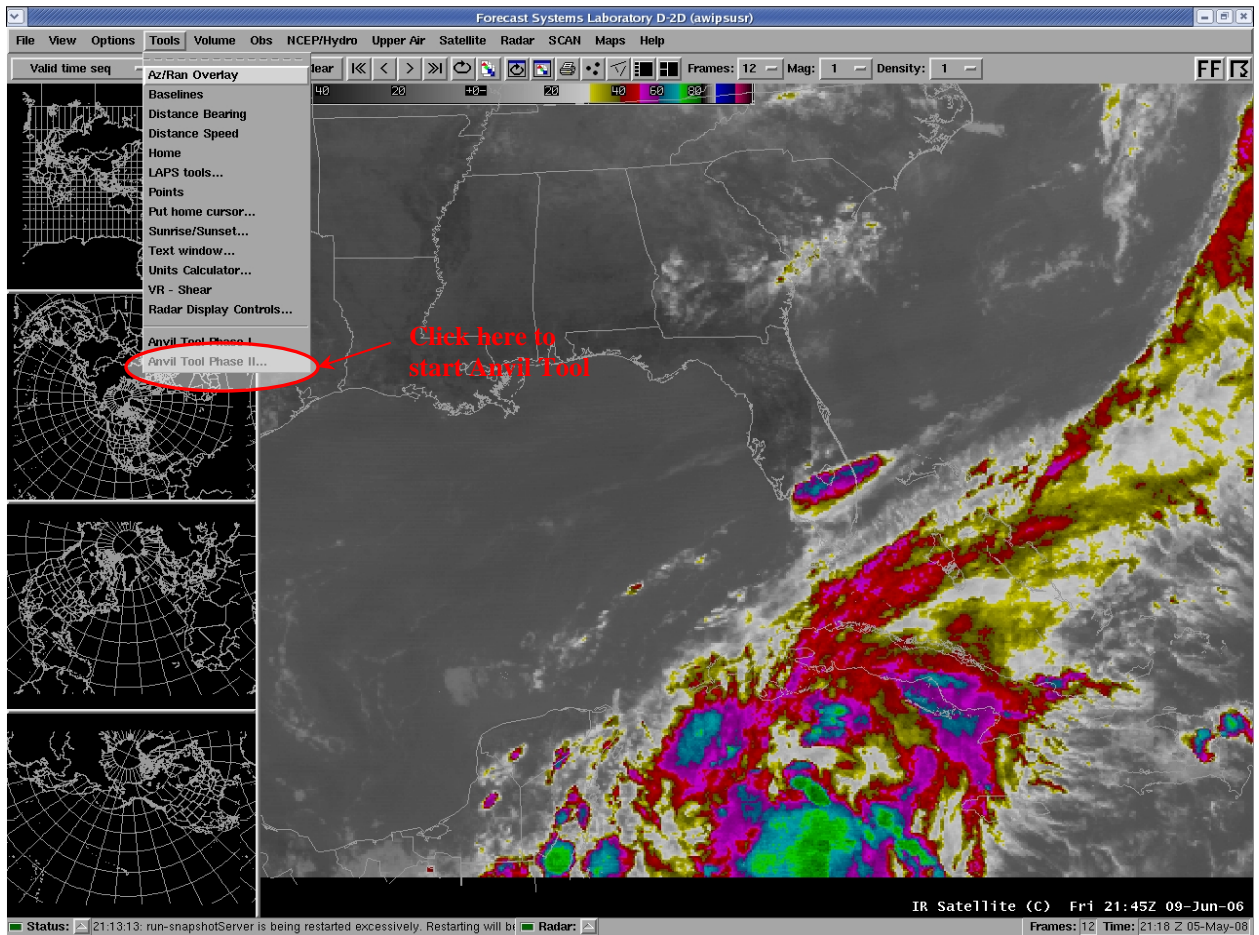


Figure 2. Illustration showing selection of the Tools dropdown menu from the AWIPS Main Menu and location of the AWIPS Anvil Tool GUI menu item.

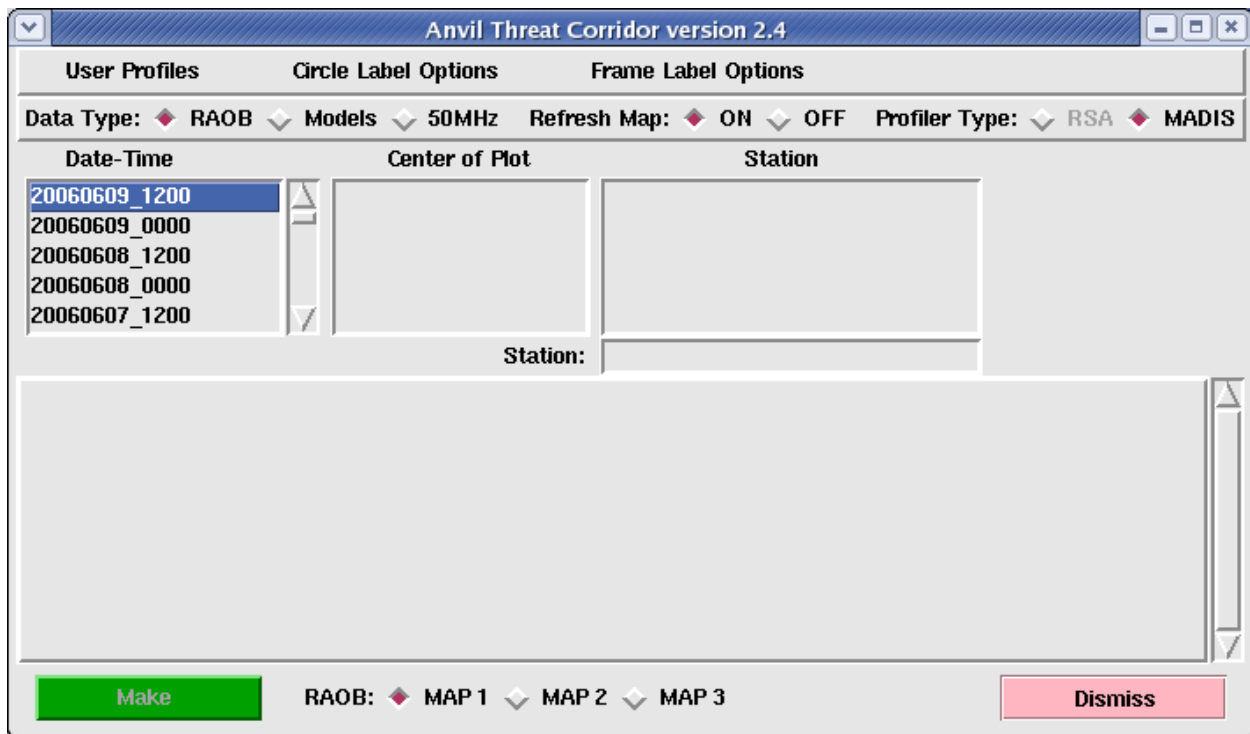


Figure 3. Anvil Tool GUI as displayed after the user has selected “Anvil Tool Phase II...” from the Tools dropdown menu.

The Anvil Tool GUI allows users to select a **Data Type**, toggle the map refresh on/off, place labels, and choose the **Profiler Type** (source of the KSC 50 MHz profiler data), the **Date-Time** of the data, the **Center of Plot**, and the **Station** (location of the **RAOB** or **50 MHz** profiler). If the **Data Type** is **Models**, the user selects a **Fcst Hour** (forecast hour) instead of **Station**. There are menus for **User Profiles**, **Circle Label Options**, and **Frame Label Options**. Labels can be placed near the center circle of the plot and/or at a specified distance and direction from the center of the circle (**Center of Plot**).

The default selection for the map refresh is “ON”. When the user creates a new Anvil Tool map with **Refresh Map** “ON”, the plot is automatically displayed in the AWIPS frame. If another Anvil Tool map is already displayed and the user does not change the existing map number shown at the bottom of the GUI, the new Anvil Tool map will overwrite the old one. If the user turns the **Refresh Map** “OFF”, the new Anvil Tool map is created but not automatically displayed. The user can still display the Anvil Tool map through the **Maps** dropdown menu* as shown in Figure 4.

*NOTE: SMG has placed the Anvil Tool maps under the Tools dropdown menu just below the Anvil Tool.

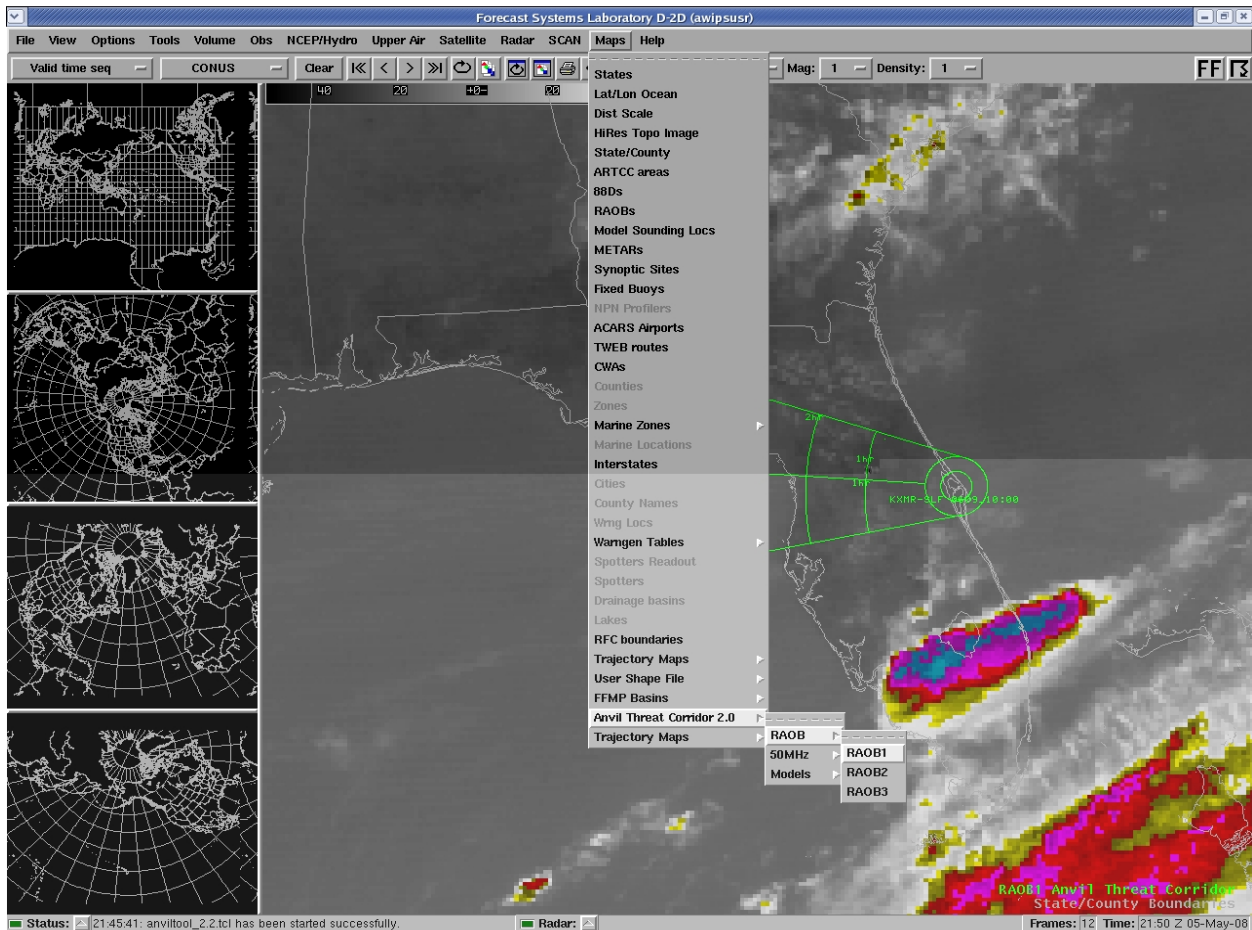


Figure 4. Illustration showing selection of the Anvil Tool maps from the Maps dropdown menu. In this example the three map options for the RAOB are shown.

The **Circle Label Options** menu has two menu buttons, **Show Label At Circle** and **Circle Label Position** (Figure 5). The **Show Label At Circle** button has two options, **Yes** and **No**. If the user selects **No**, then the **Circle Label Position** options are automatically grayed-out. The **Circle Label Position** button is used to place the label at the top, middle or bottom relative to the circle. This is done so the labels do not overwrite each other for up to three plots of the Anvil Tool, as shown in Figure 6.

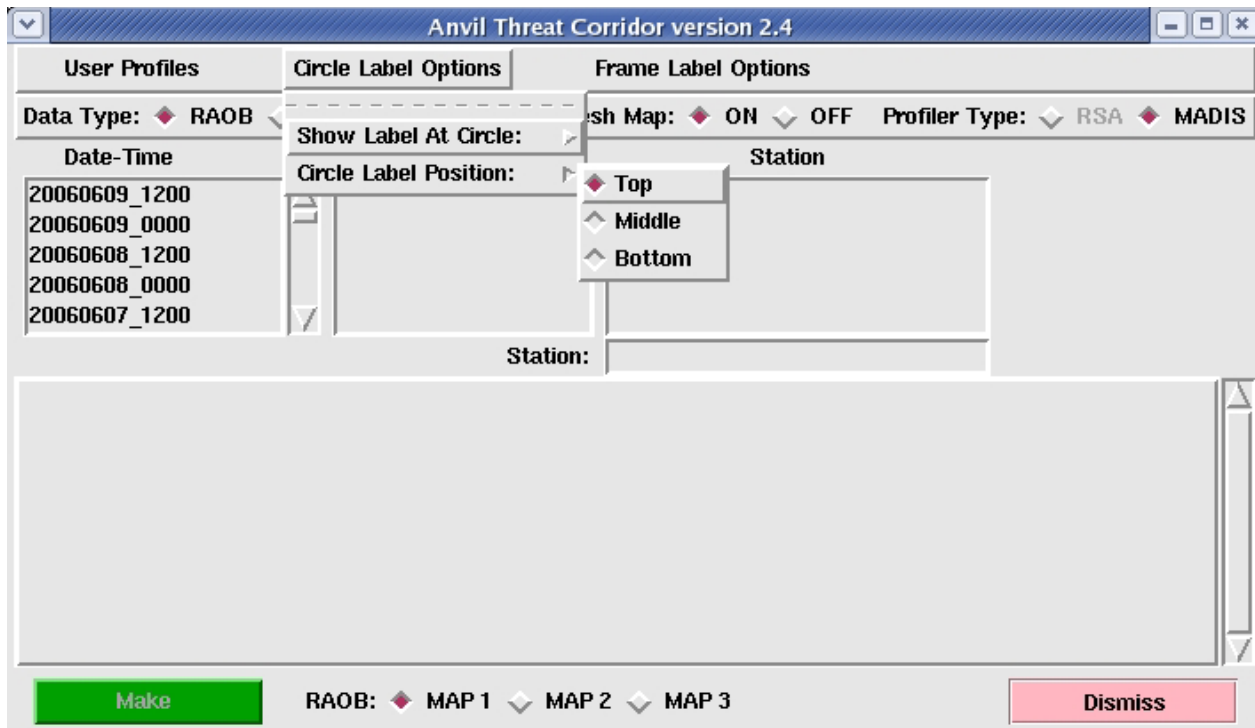


Figure 5. Anvil Tool GUI after the user has selected to display a circle label in the top position.

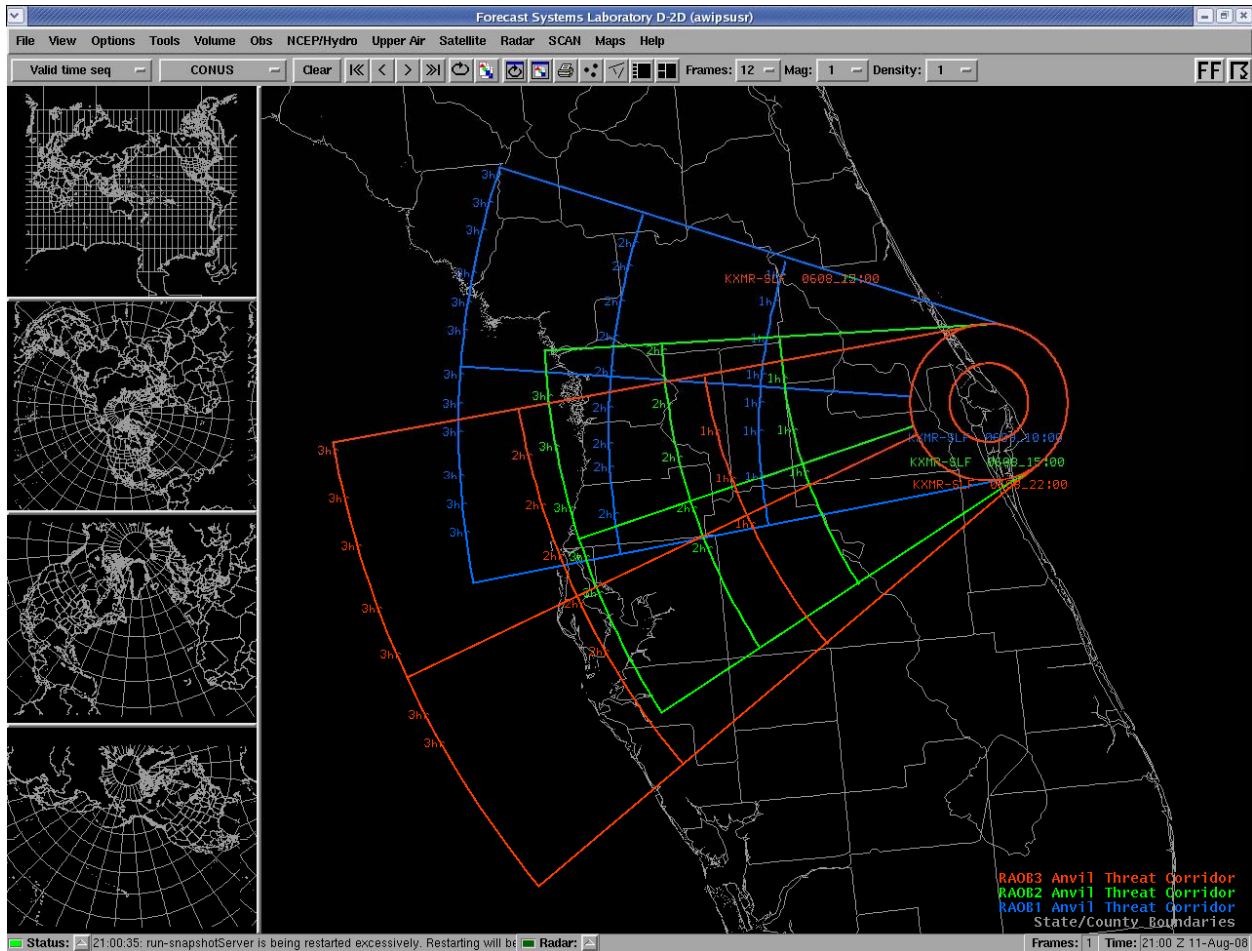


Figure 6. Three Anvil Tool maps with the data labels plotted at the center circle. The center location is SLF. The labels are plotted at the top, middle and bottom based on the GUI selection so they do not overwrite each other. The colors of each label correspond to the color of the Anvil Tool plot.

The user can also choose to plot the labels elsewhere in the frame of the image but away from the center circle. Figure 7 shows the frame label options in the GUI. When the user selects “No” next to **Show Label On Frame**, the other frame label options are automatically grayed-out. The user has the option to display the label at distances of 50, 100 or 200 n mi from the center of the circle (**Center of Plot**) and to the northeast, southeast, southwest or northwest of the center of the circle. Figure 8 shows the same plot as in Figure 6 but with the three labels plotted 100 n mi to the northeast of the center of the circle. The user also has the option to plot frame labels at the top, middle or bottom positions. This is useful if the labels are all plotted at the same distance and direction from the center of the circle so they do not overwrite each other.

If the user wants to change the label options on an existing Anvil Tool map, the map must be recalculated and replotted. In addition to the label placement options available in the GUI, the user can change the color, line type, line thickness, text magnification, etc. using the standard procedures available in AWIPS to customize the look of the Anvil Tool map.

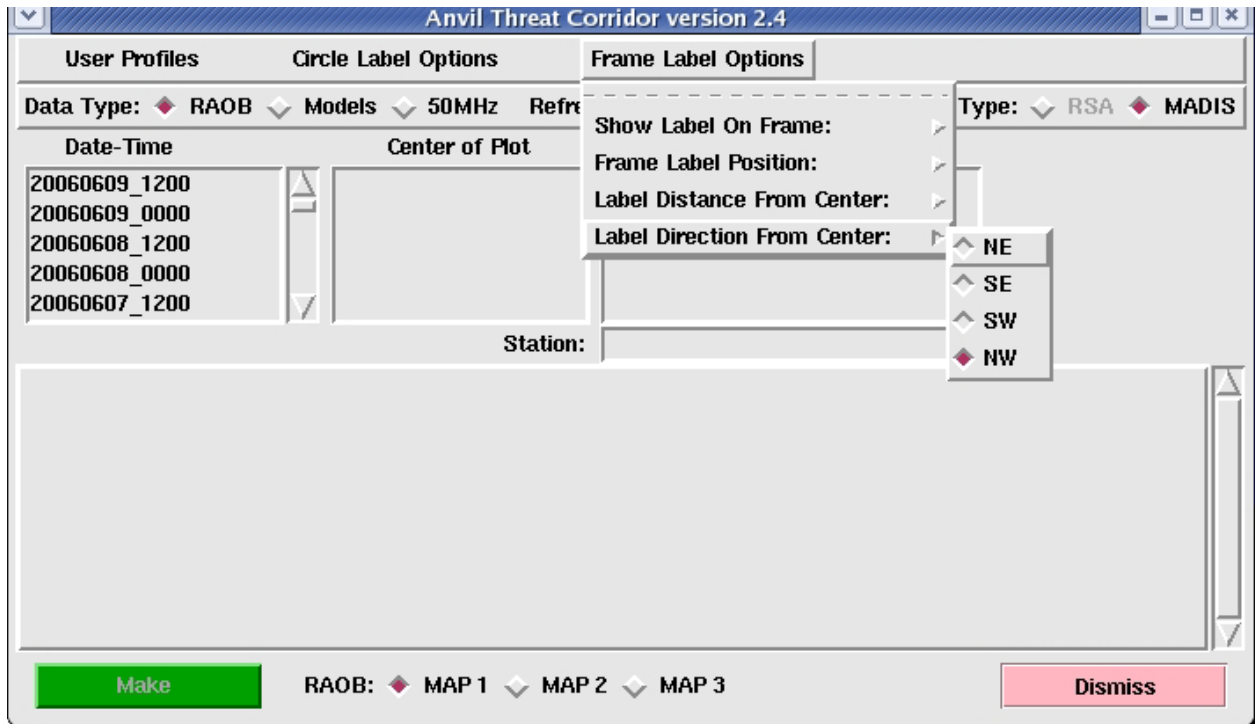


Figure 7. Anvil Tool GUI showing the Frame Label Options menu.

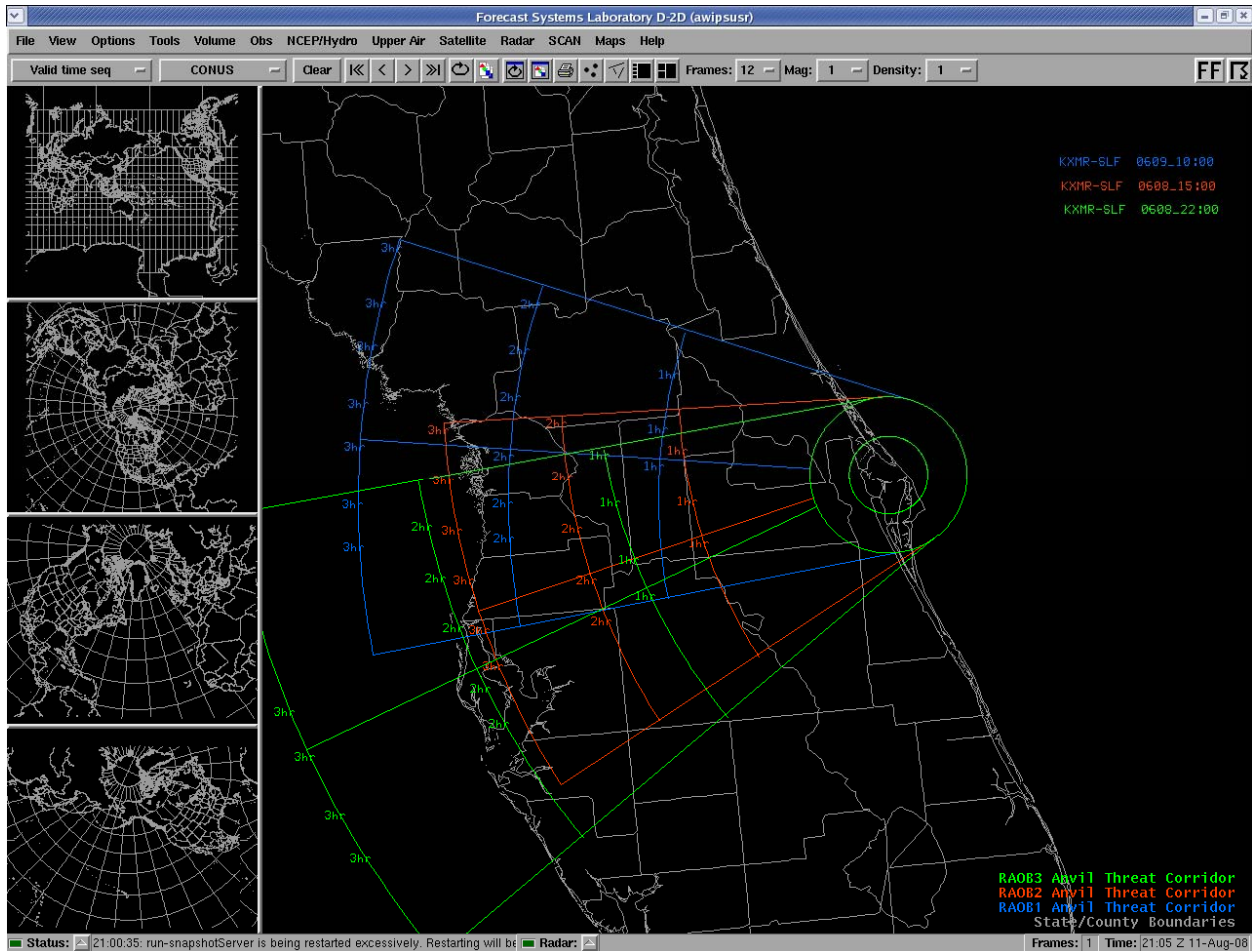


Figure 8. As in Figure 6 but the data labels are now plotted in the frame and away from the center circle. The labels are plotted at the top, middle and bottom based on the GUI selection so they do not overwrite each other. The colors of each label correspond to the color of the Anvil Tool plot.

2.2. User Profiles

User Profiles were added to the Anvil Tool to make it more configurable. They are text files with several parameters, such as data file paths and plot locations, and must be in the correct format for the Anvil Tool to work correctly. The tool will display an error message and immediately exit if it tries to read a User Profile in the wrong format. Each User Profile file should be stored in the /awips/fxa/awipsusr/AnvilTool directory, and the filename should have a .profile extension. The Anvil Tool installation comes with a default user profile, displayed in Figure 9. When the Anvil Tool GUI is started, the user is prompted to select a User Profile. The tool is then initialized with the data in the User Profile. The current User Profile can be viewed by clicking on the **Display Current Profile** button from the **User Profiles** menu. The user must restart the Anvil Tool in order to change the current User Profile. A new User Profile can be created with a text editor, or by clicking on the **Create New Profile** button from the **User Profiles** menu.

At least one User Profile must be available. If not, the user will get the following red banner message when the tool is started: “anviltool_2.4.tcl has terminated abnormally!” The tool will then immediately exit.

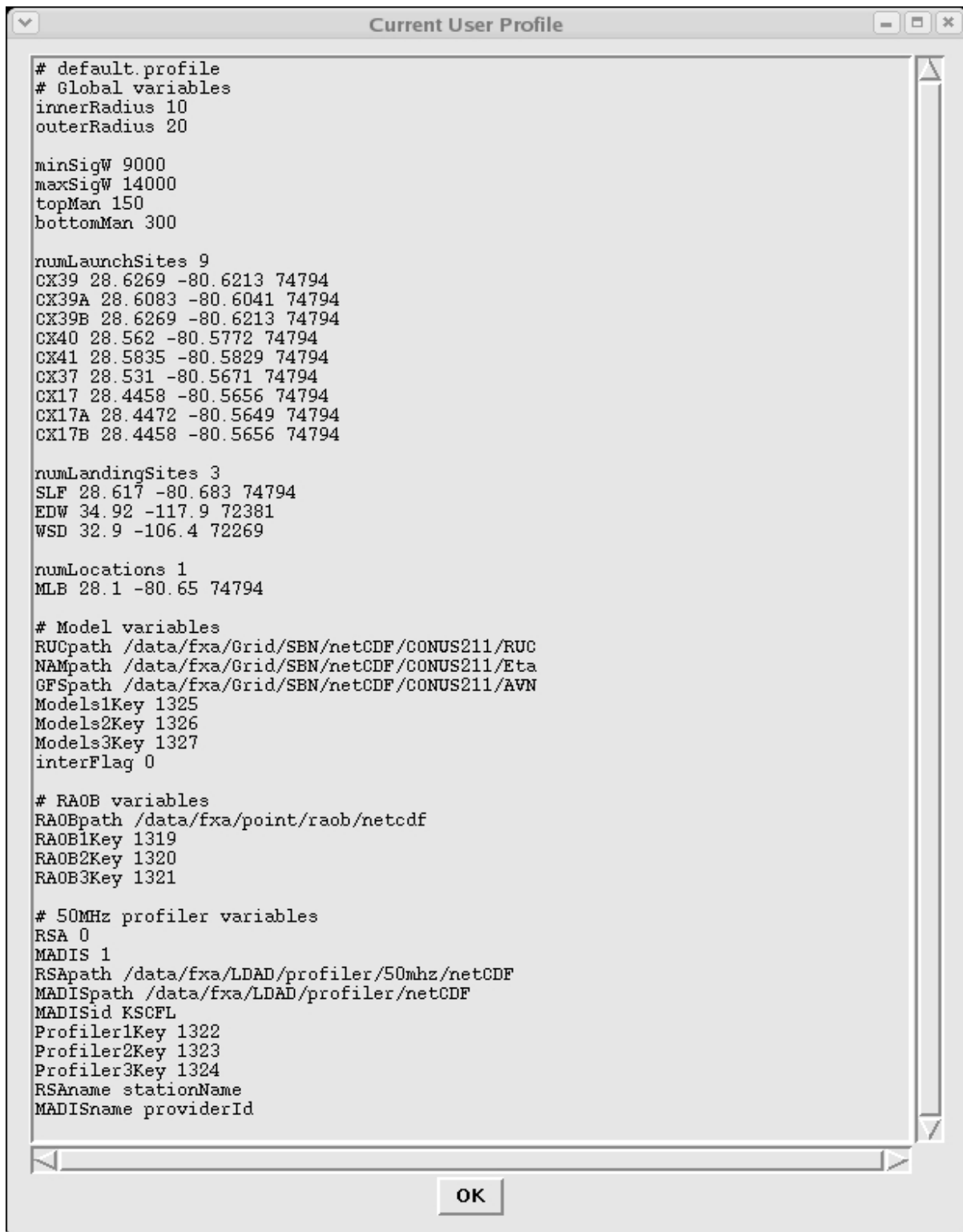


Figure 9. The default User Profile in the Anvil Tool.

A User Profile has the following parameters:

- innerRadius - the radius, in n mi, of the inner circle of the plot (does not have to be an integer),

- outerRadius - the radius, in n mi, of the outer circle of the plot (does not have to be an integer),
- minSigW - the height, in m, of the lowest significant level used to calculate the layer-average wind velocity (used in RAOB and 50 MHz data types),
- maxSigW - the height, in m, of the highest significant level used to calculate the layer-average wind velocity (used in RAOB and 50 MHz data types),
- topMan - the top mandatory level, in mb, used to calculate the layer-average wind velocity (used in RAOB and Models data types),
- bottomMan - the bottom mandatory level, in mb, used to calculate the layer-average wind velocity (used in RAOB and Models data types),
- numLaunchSites - the number of vehicle launch sites displayed in the **Center of Plot** listbox. The launch sites are listed after this parameter. Each launch site contains a name, latitude, longitude, and 5-digit identifier of the closest RAOB,
- numLandingSites - the number of vehicle landing sites displayed in the **Center of Plot** listbox. The landing sites are listed after this parameter. Each landing site contains a name, latitude, longitude, and 5-digit identifier of the closest RAOB,
- numLocations - the number of non-launch/landing sites displayed in the **Center of Plot** listbox. The locations are listed after this parameter. Each location contains a name, latitude, longitude, and 5-digit identifier of the closest RAOB,
- RUCpath - the directory containing the RUC model files,
- NAMpath - the directory containing the NAM model files,
- GFSpath - the directory containing the GFS model files,
- Models1Key to Models3Key - the product keys for the model Shapefiles,
- interFlag - set to 0 to use the nearest grid point to the center location and set to 1 to interpolate from the four surrounding grid points (used in Models data type),
- RAOBpath - the directory containing the RAOB files,
- RAOB1Key to RAOB3Key - the product keys for the RAOB Shapefiles,
- RSA - set to 1 to use RSA profiler data and set to 0 to not use RSA profiler data,
- MADIS - set to 1 to use MADIS profiler data and set to 0 to not use MADIS profiler data,
- RSApath - the directory containing the RSA profiler files,
- MADISpath - the directory containing the MADIS profiler files,
- MADISid - the identifier for the KSC profiler in the MADIS profiler files,
- Profiler1Key - Profiler3Key - the product keys for the profiler Shapefiles,
- RSAname - NetCDF variable name for the profiler names in the RSA profiler files, and
- MADISname – NetCDF variable name for the profiler names in the MADIS profiler files.

2.3. Displaying RAOB data with the Anvil Tool GUI

In Figure 10, the default **Data Type**, **RAOB**, has been selected and the user has selected a **Date-Time**. Once the **Date-Time** has been selected, the GUI displays a list of center locations (**Center of Plot**) and a list of rawinsonde observation stations (**Station**). If the user does not select a center location in the **Center of Plot** listbox, the “Station” default location is used. In this case, the Anvil Tool map will be centered at the location of the data source (**Station**). When the user selects a center location other than Station, the tool will automatically select the nearest rawinsonde (RAOB) in the **Station** listbox if it is available in AWIPS for the **Date-Time** selected. If the nearest **RAOB** to the center location is not available, then no **Station** will be highlighted. In Figure 11, the tool automatically selected **KXMR 74794** when the **SLF** center location was selected.

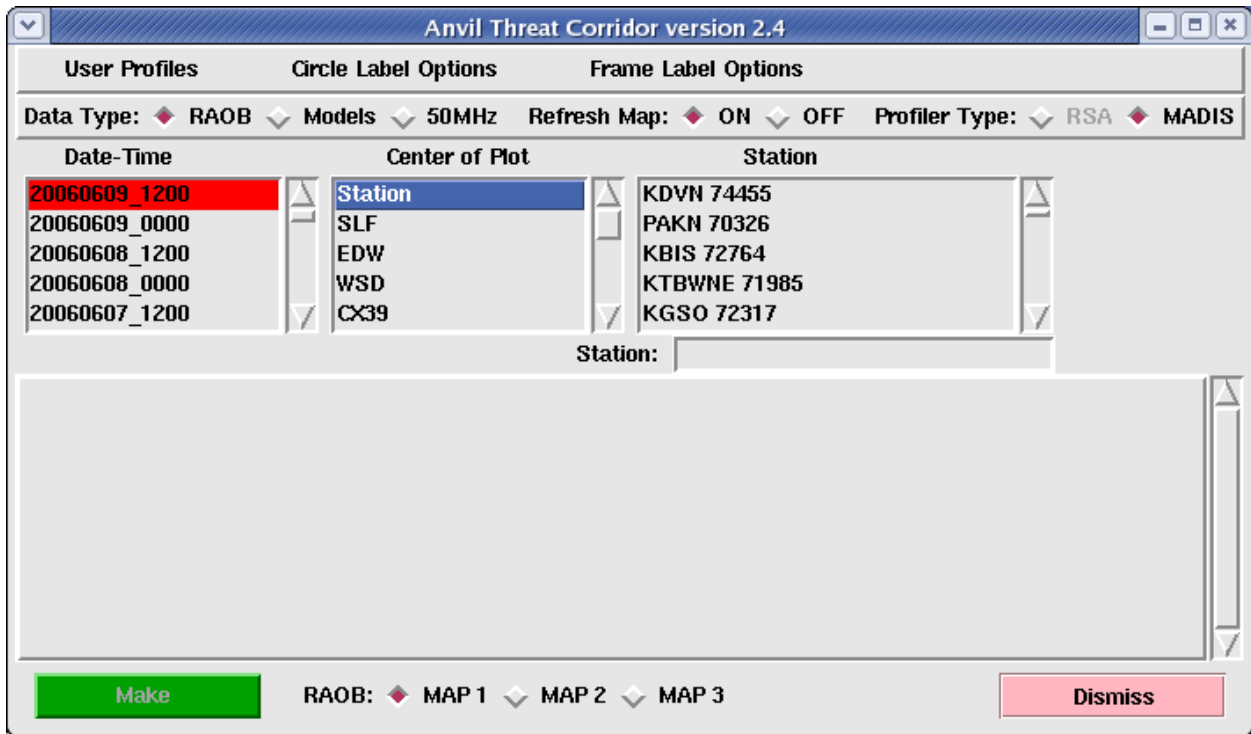


Figure 10. Anvil Tool GUI after the user has selected RAOB as the Data Type and a Date-Time of 20060609_1200 (9 June 2006, 1200 UTC), which is highlighted in red.

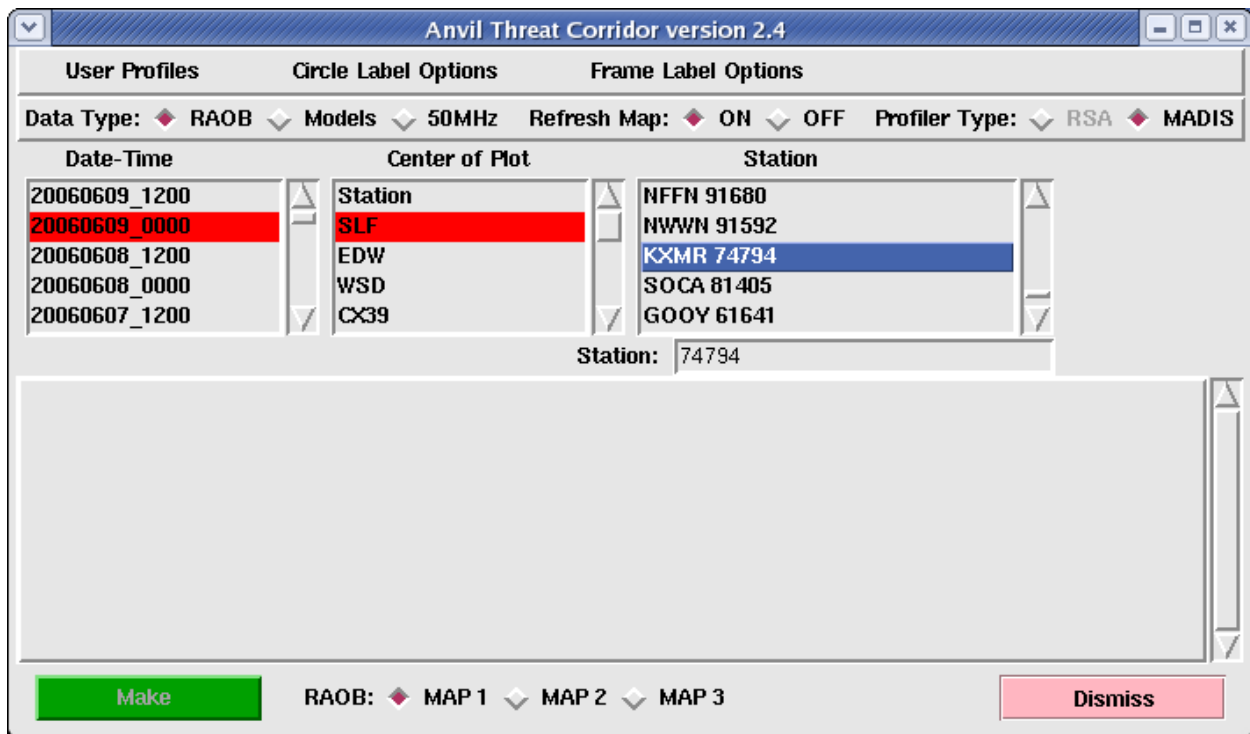


Figure 11. Anvil Tool GUI after the user has selected SLF as the Center of Plot, which is highlighted in red. The nearest station to SLF, KXMR, is automatically selected by the tool.

When the user clicks on a **Station** (in this example **KXMR 74794**), the layer-average wind velocity is calculated from the data in the RAOB and the output is displayed in the GUI's text box (Figure 12). Since there can be many stations in a **RAOB** file in AWIPS, there is a search box below the **Station** listbox that can be used to search for a particular **Station**. The tool will automatically select the first **Station** matching the characters in the search box.

If there are multiple observations available for the Station, then a dialog box will open with a selection of observation times. After the user selects a time, the layer-average wind velocity is calculated and displayed in the GUI's text box.

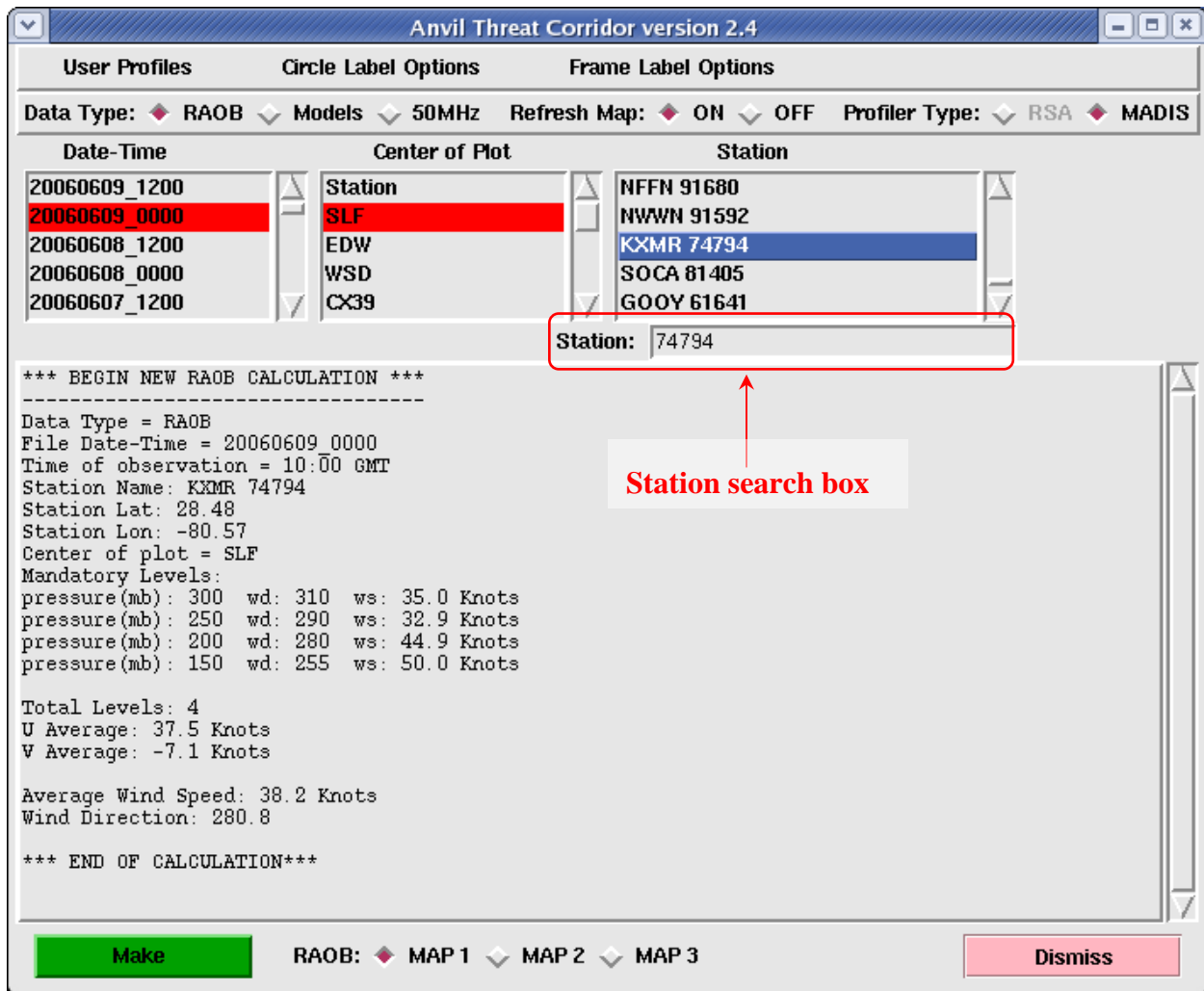



Figure 12. Anvil Tool GUI after the user has selected KXMR 74794 as the Station.

After the **Station** (in this example, KTBW) has been selected, the user can create the Anvil Tool map by clicking the green button labeled “**Make**” (). The text box in the GUI will display the name and latitude/longitude of the center location (**Center of Plot**) as shown in Figure 13. In this example the user chose **Station** for the **Center of Plot**. The Anvil Tool map is now displayed in AWIPS as shown in Figure 14. The user can now click **Dismiss** in the Anvil Tool GUI or leave the GUI open to plot other Anvil Tool maps.

The map labels in Figure 14 include the data source, (from the **Station** listbox), the center of the map (from the **Center of Plot** listbox), and the **Date-Time** of the data. If Station is selected for the **Center of Plot**, the label only includes the source and **Date-Time** of the data.

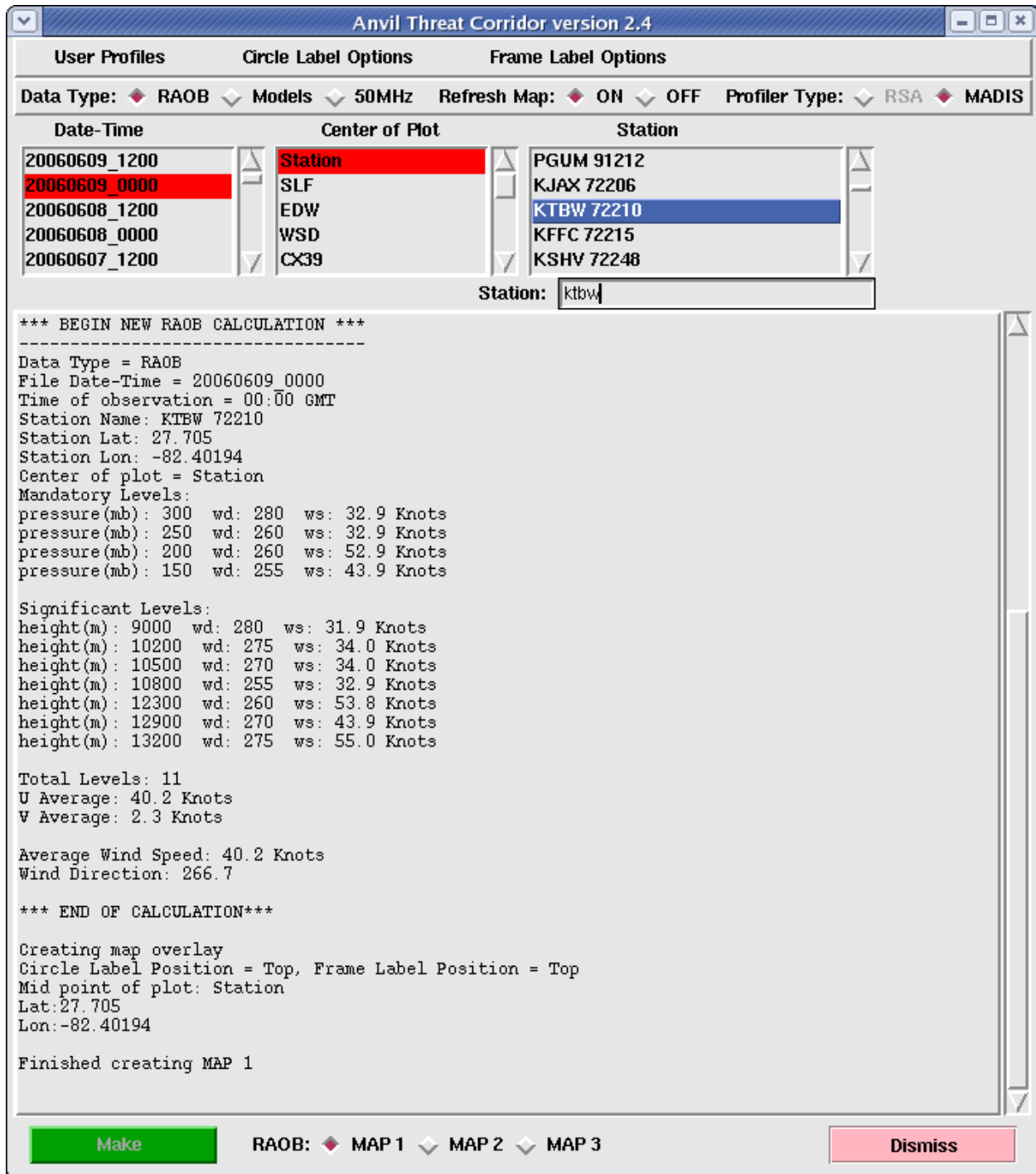


Figure 13. Anvil Tool GUI after the user has clicked on the Make button. The name and latitude/longitude of the Center of Plot, as well as the label positions, are displayed at the bottom of the GUI's text box.

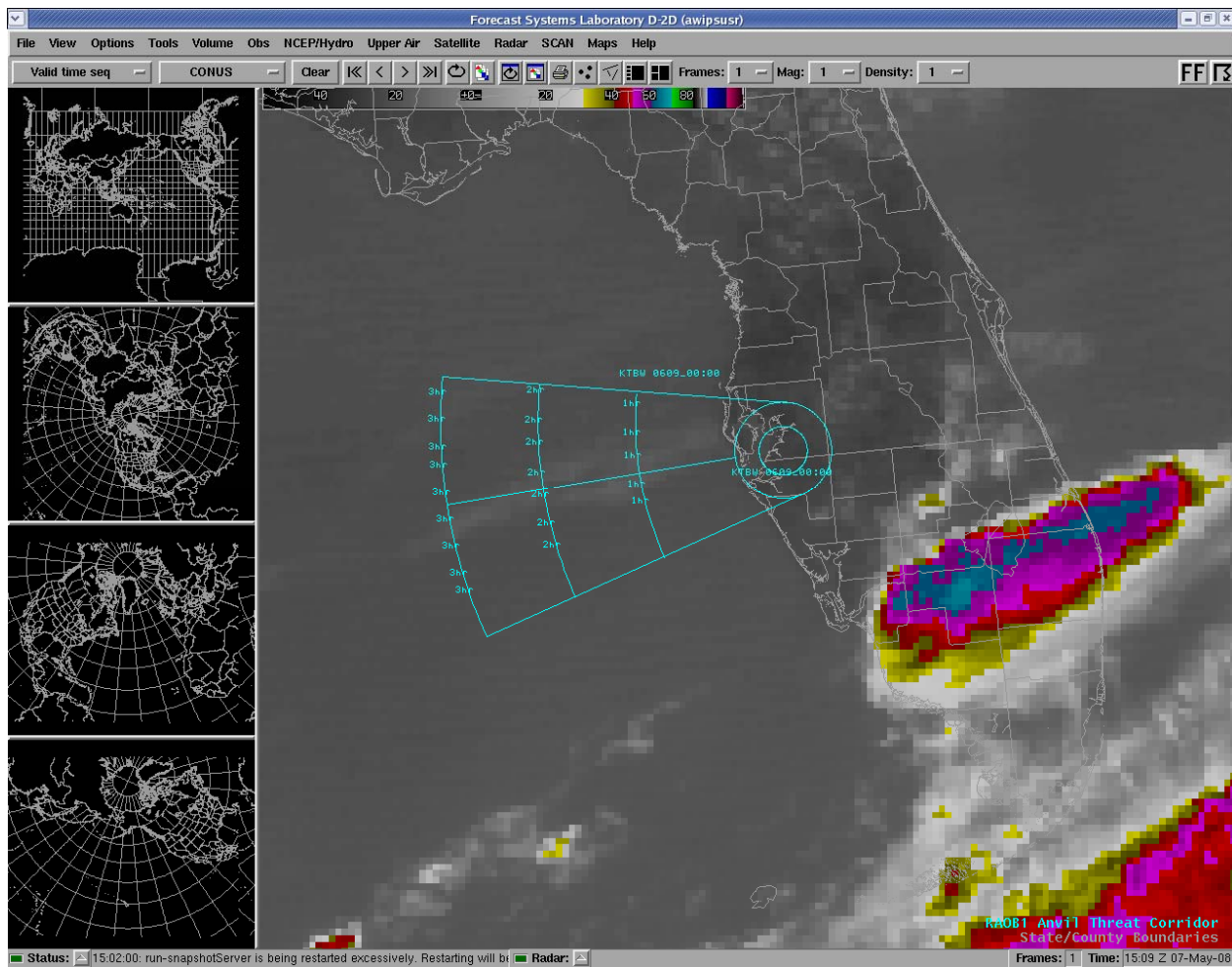


Figure 14. The Anvil Tool map plotted in AWIPS based on the RAOB selected from the Anvil Tool GUI. The source and Date-Time of the data are plotted on the map.

2.4. Displaying 50 MHz Profiler data with the Anvil Tool GUI

Processing data from the 50 MHz profiler in the Anvil Tool GUI is similar to processing the RAOB data, except the data are only available from one **Station** – the 50 MHz profiler at KSC. In Figure 15, **50MHz** has been selected as the **Data Type** and the available **Date-Time** of the 50 MHz data are displayed. Once the **Date-Time** has been selected, the GUI displays a list of locations under **Center of Plot** and displays times of the profiler data under **Station** that are closest to the previously selected **Date-Time** (now highlighted in red), as shown in Figure 16. The user can select a location (**Center of Plot**) where the Anvil Tool map will be centered when displayed in AWIPS. If the user does not select a location from the **Center of Plot** listbox, then the default of **Station** is used. The user must still click on a time in the **Station** listbox. When the user clicks on the time (in this case, 1800 UTC), the layer-average wind velocity is calculated and the data are displayed in the GUI's text box as shown in Figure 17. If the profiler data are not available, an error box will open with the message **Error: no files matched glob pattern “* *”**.

Until January 2008, **50 MHz** profiler data were delivered to the AMU AWIPS via the Range Standardization and Automation (RSA) program. Currently, the AMU receives no real-time

profiler data in AWIPS. SMG receives the profiler data hourly, via the Meteorological Assimilation Data Ingest System (MADIS).

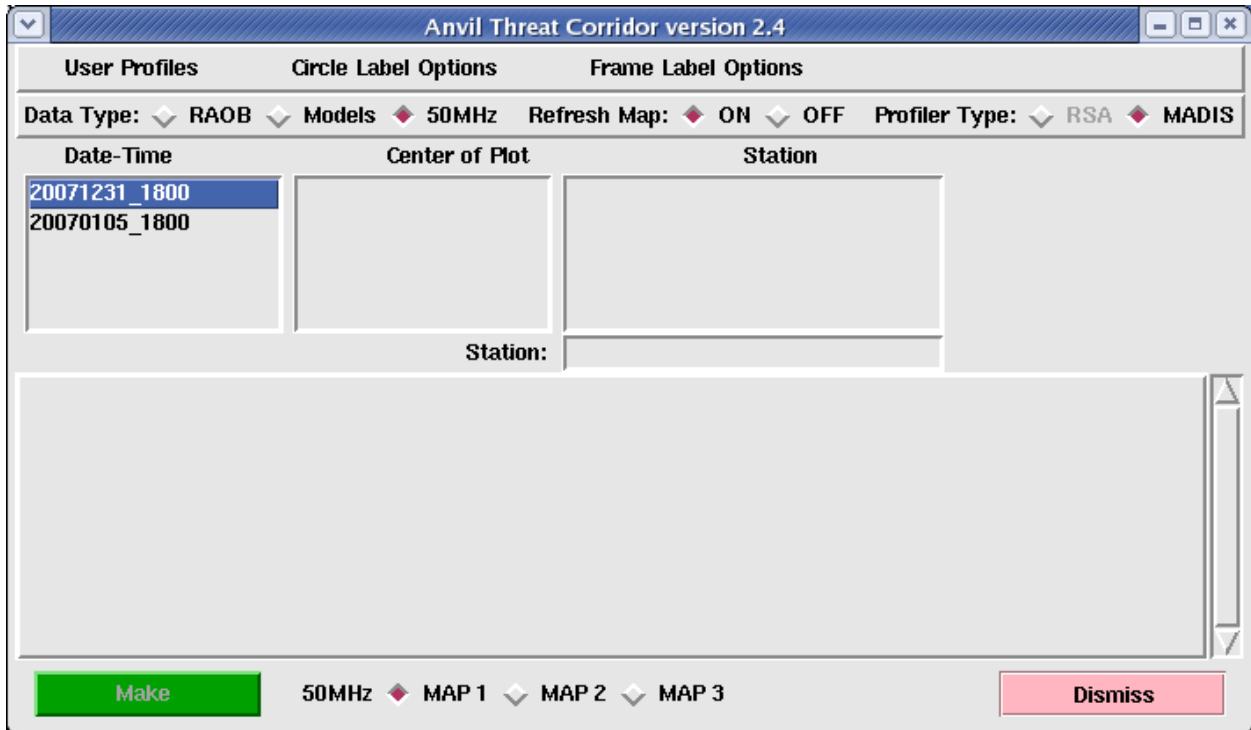


Figure 15. Anvil Tool GUI after the user has selected 50MHz as the Data Type.

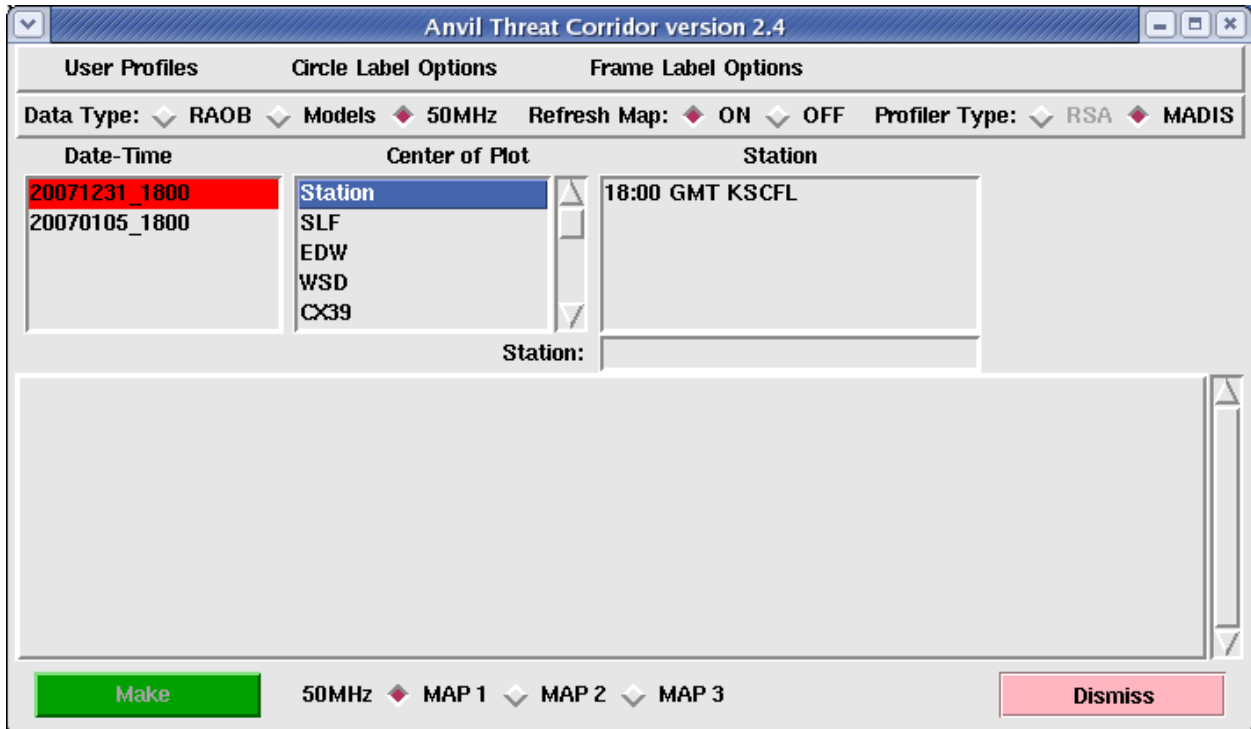


Figure 16. Anvil Tool GUI after a user has selected a Date-Time of 20071231_1800 (31 December 2007, 1800 UTC), which is highlighted in red. All of the observation times in the file are displayed in the Station listbox.

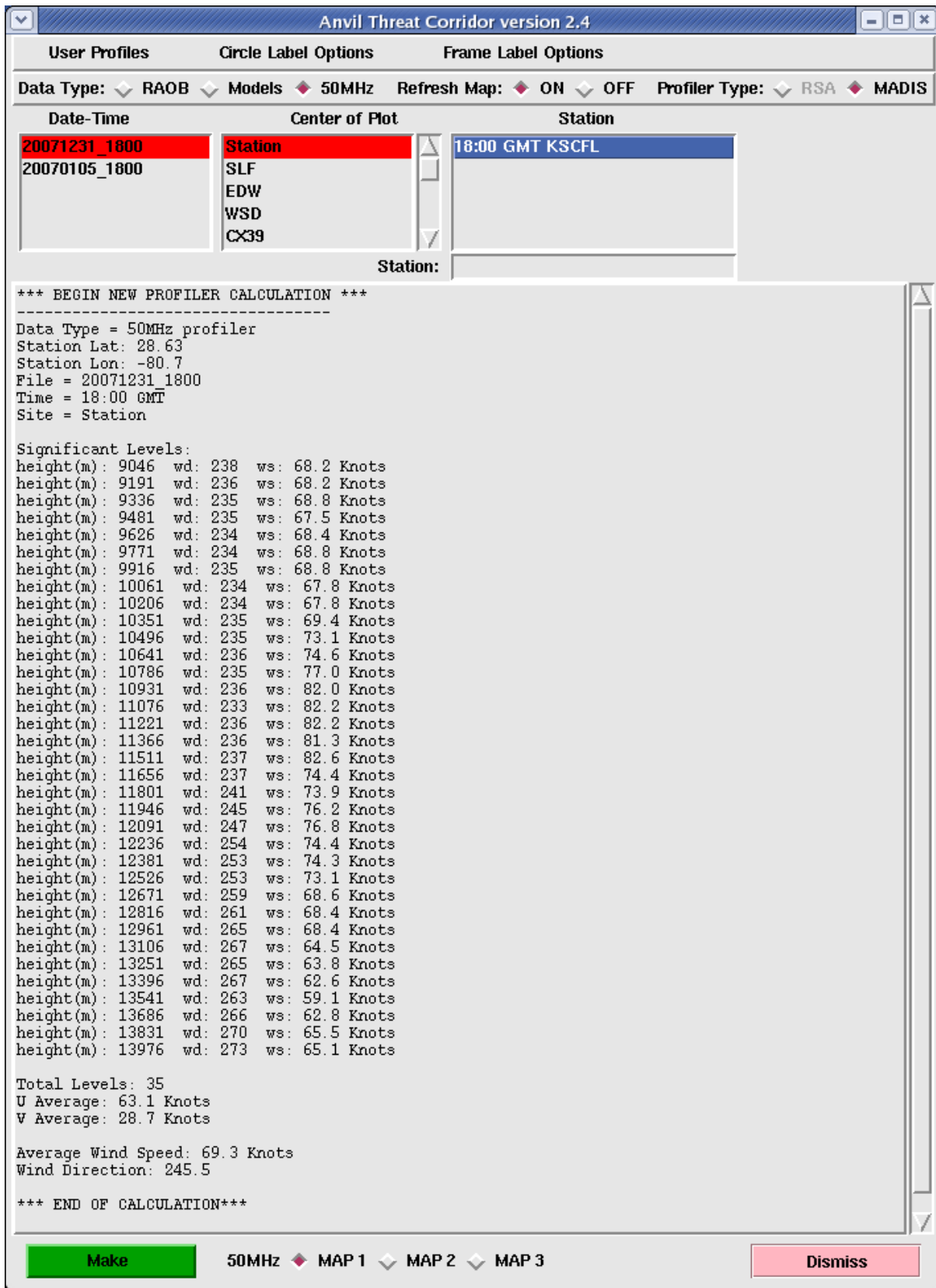
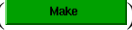


Figure 17. Anvil Tool GUI after the user selected 18:00 GMT as the profiler time in the Station listbox.

To create the Anvil Tool map for display in AWIPS, the user must click the green button labeled “**Make**” (). The text box in the GUI will display the name and latitude/longitude of the center location (**Center of Plot**) as shown in Figure 18. In this example the user chose **Station** for the center location. The Anvil Tool map is now displayed in AWIPS as shown in Figure 19.

The map labels in Figure 19 include the data source, (from the **Station** listbox), the center of the map (from the **Center of Plot** listbox), and the **Date-Time** of the data. If **Station** is selected for the **Center of Plot**, the label only includes the source and **Date-Time** of the data.

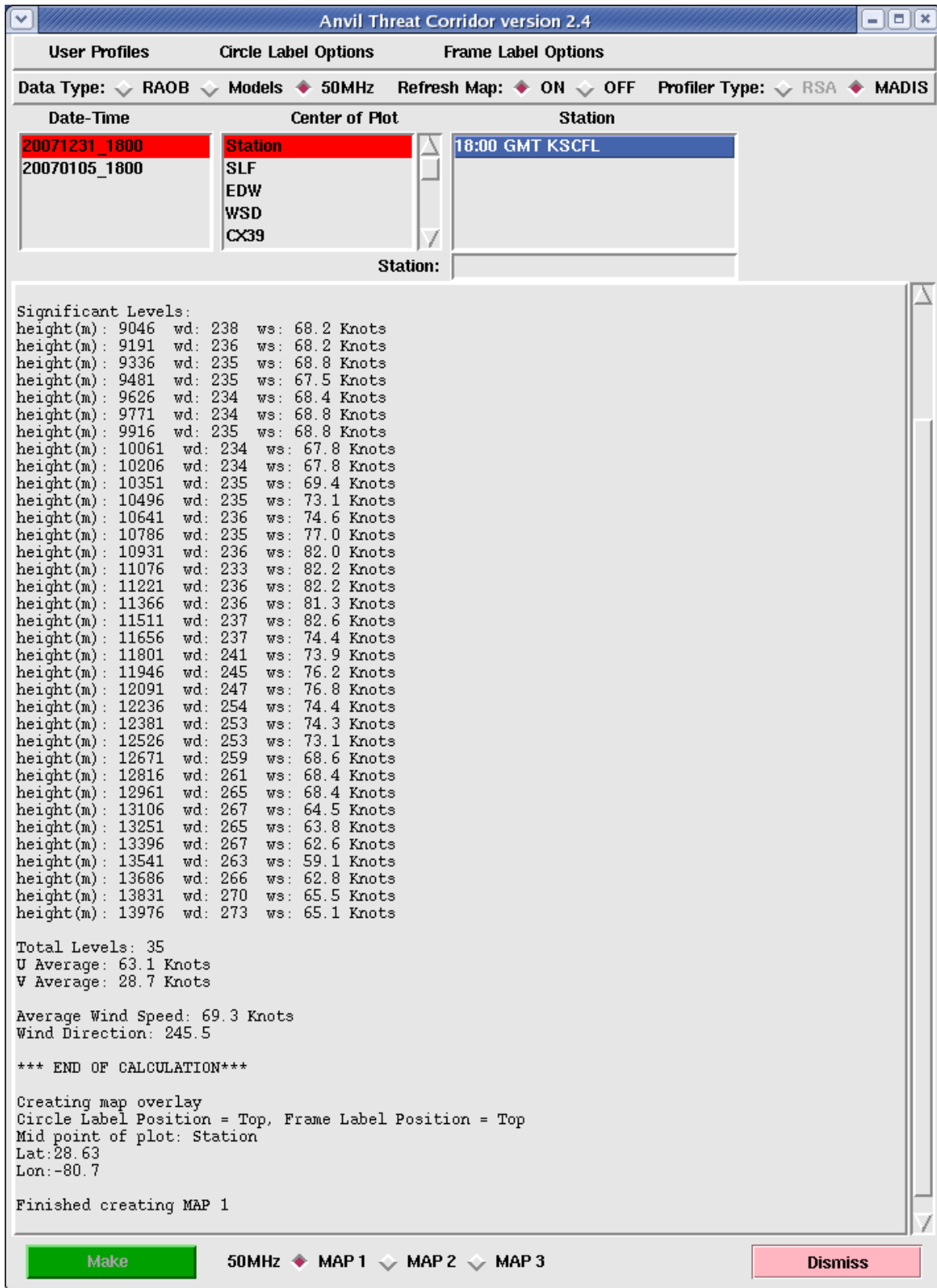


Figure 18. Anvil Tool GUI after the user has clicked on the Make button. The name and latitude/longitude of the Center of Plot, as well as the label positions, are displayed at the bottom of the GUI's text box.

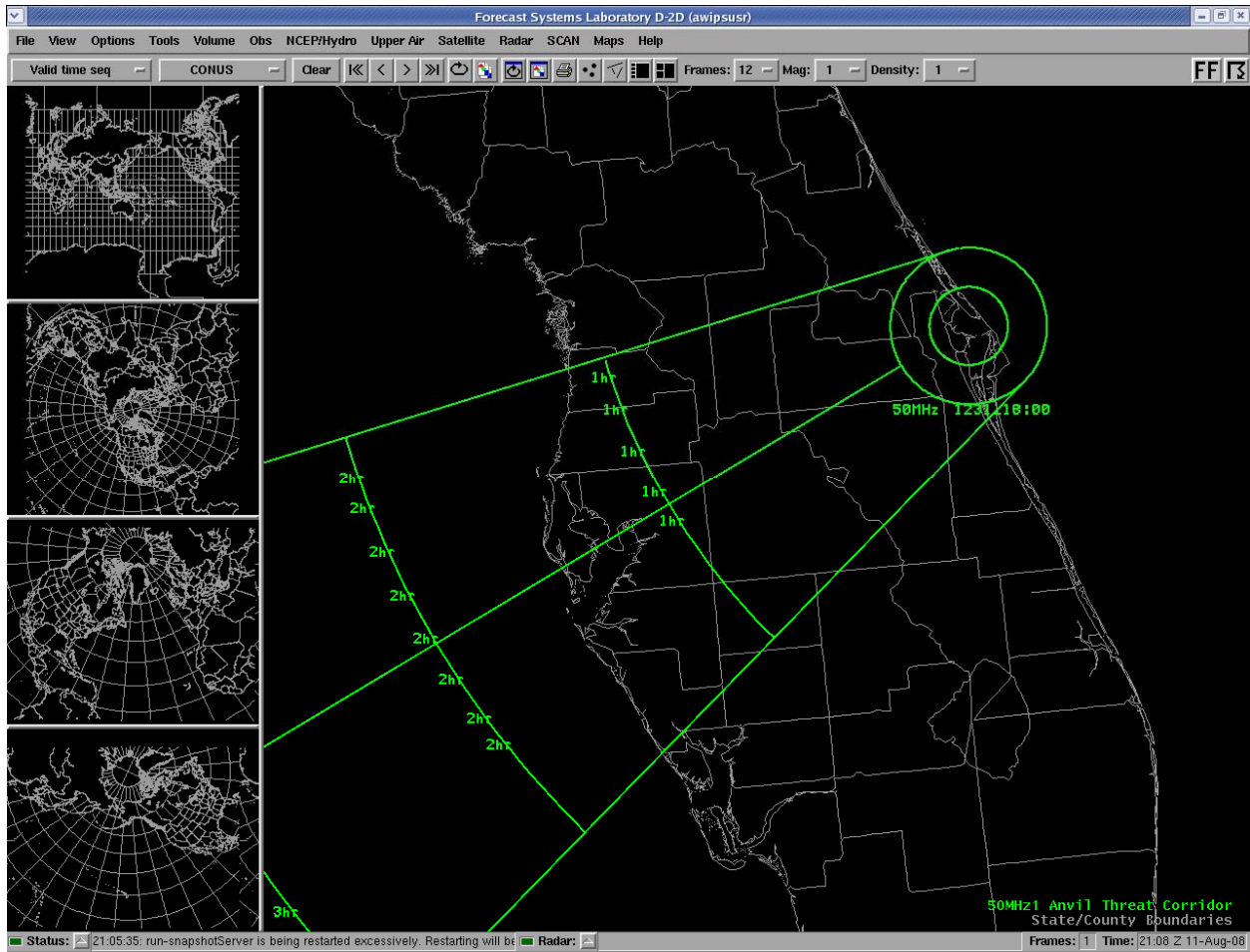


Figure 19. The Anvil Tool map plotted in AWIPS based on the 50 MHz profiler data selected from the Anvil Tool GUI. The label on the map includes the source of the data and Date-Time.

2.5. Displaying Model forecasts with the Anvil Tool GUI

Processing data from the model forecasts in the Anvil Tool GUI is similar to processing the RAOB and 50 MHz data with a few exceptions. The forecasts are available from three models - the Rapid Update Cycle (RUC), North American/Weather Research and Forecasting model (NAM) and Global Forecast System (GFS). Forecasts are available at multiple forecast hours, depending on the model. In Figure 20, **Models** has been selected as the **Data Type** and the GUI now displays a choice of the three models as **Model Type**, just above the **Date-Time** list. In this example, the **RUC** is selected.

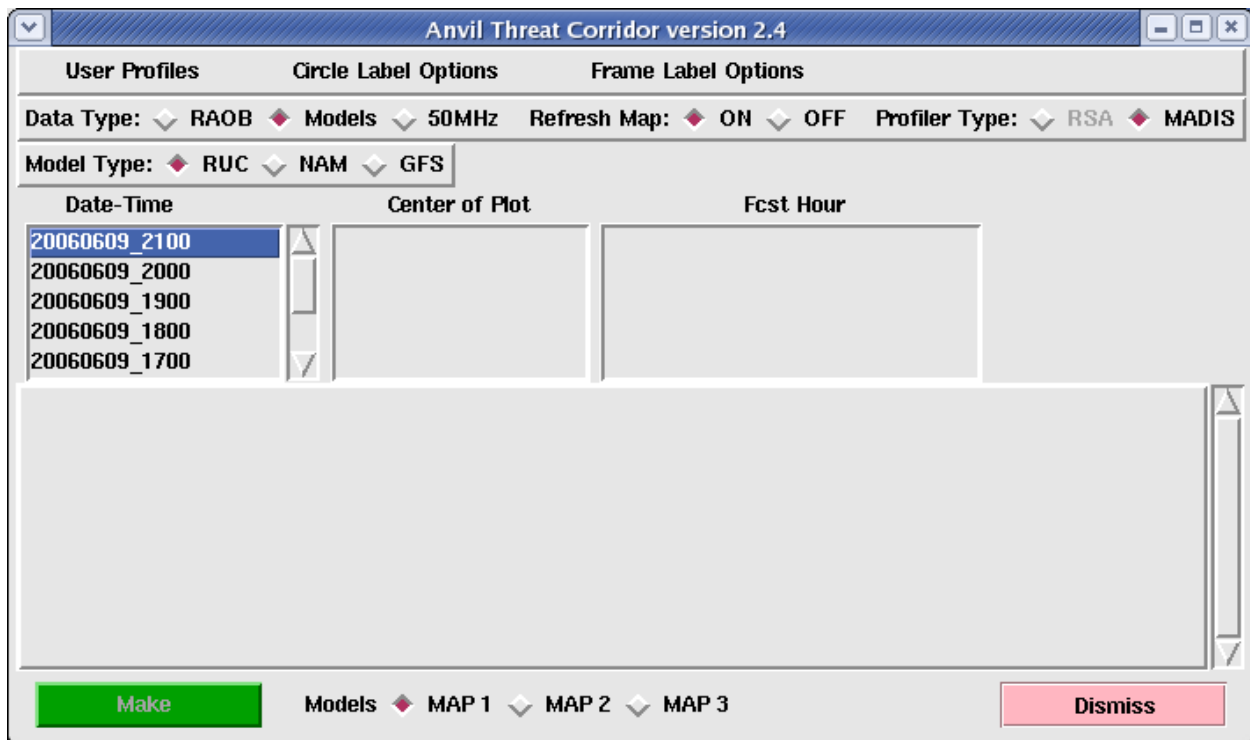


Figure 20. Anvil Tool GUI after the user has selected Models as the Data Type.

When the user selects the **Date-Time** (initialization time of the model) as shown in Figure 21 (highlighted in red), the GUI displays a list of locations (**Center of Plot**) and available forecast hours (**Fcst Hour**). The user will select a location from the **Center of Plot** listbox where they want the Anvil Tool map to be centered when displayed in AWIPS. In Figure 22, the location is **EDW**. For the model forecasts, the GUI does not present a **Station** listbox but instead displays the **Fcst Hour** listbox. The user must click on a **Fcst Hour**. When the user clicks on the **Fcst Hour** (in this example **0**), the layer-average wind velocity is calculated and the data are displayed in the GUI's text box as shown in Figure 23. If the data for the forecast hour are not available in AWIPS, a dialog box will open with the error message "That forecast hour is not available".

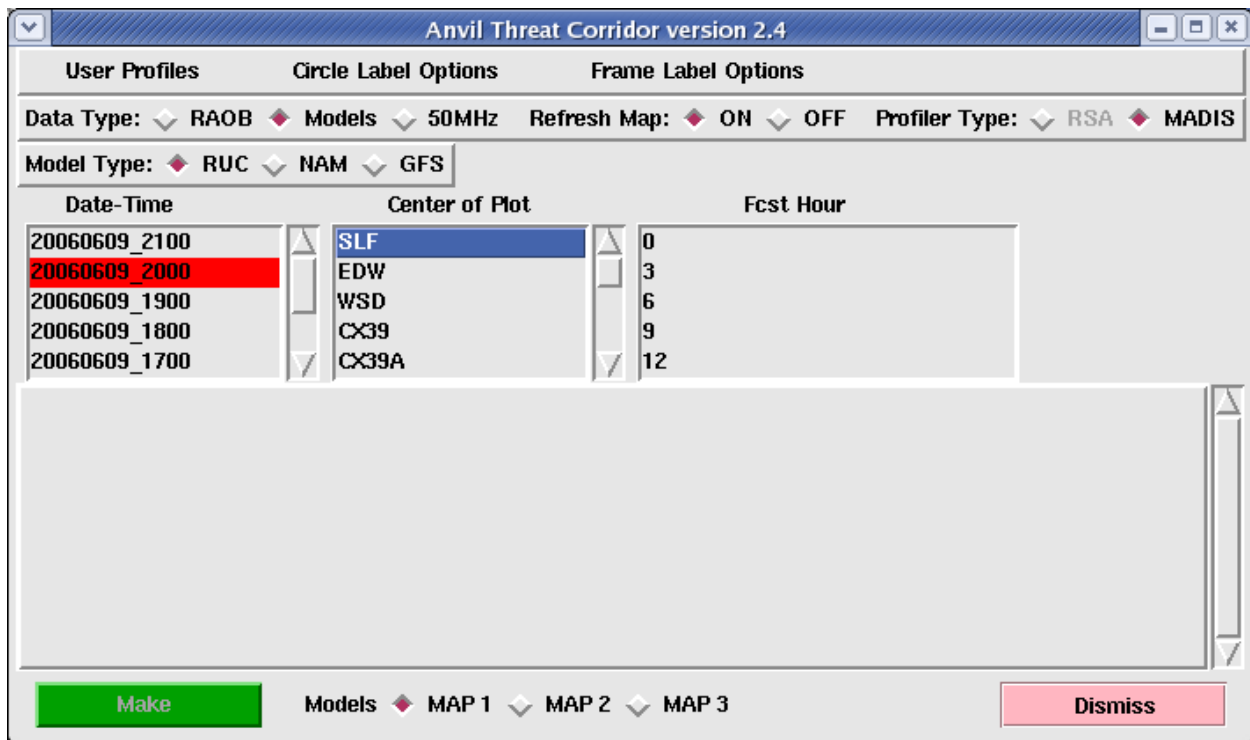


Figure 21. Anvil Tool GUI after a user has selected a Date-Time of 20060609_2000. The GUI displays the available forecast hours in the Fcst Hour listbox.

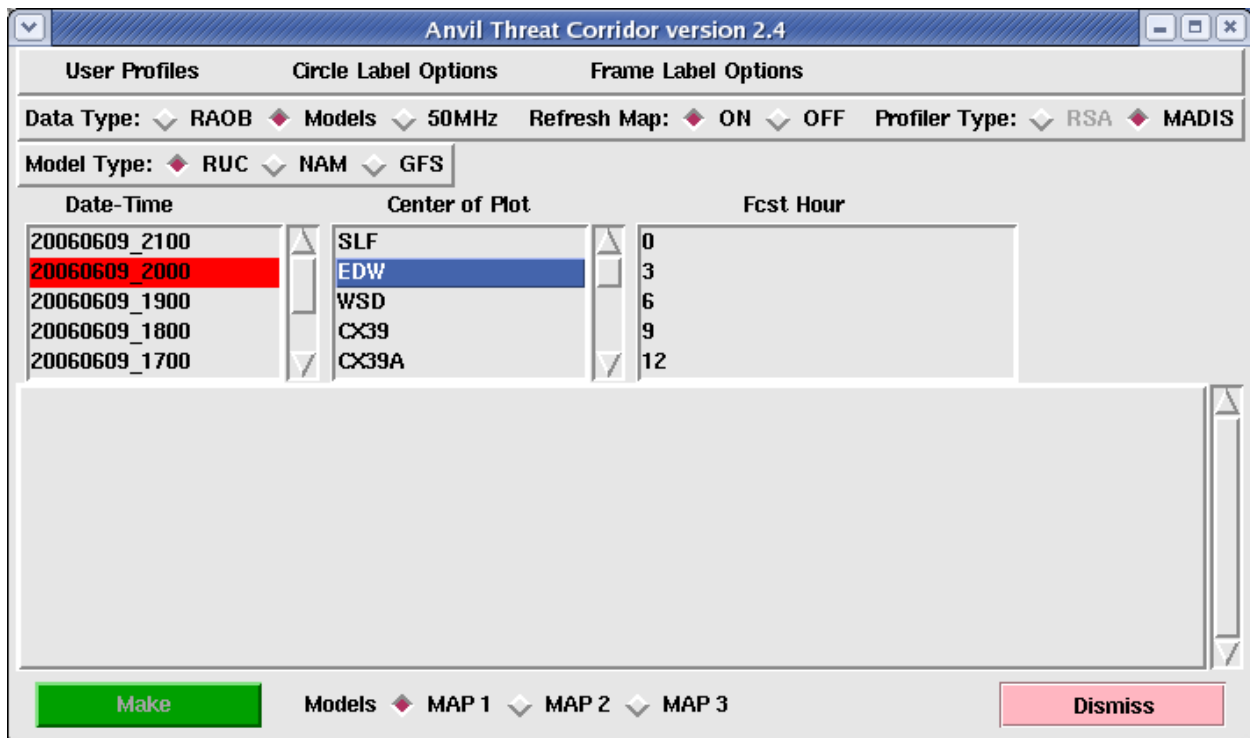


Figure 22. Anvil Tool GUI after a user has selected EDW as the Center of Plot.

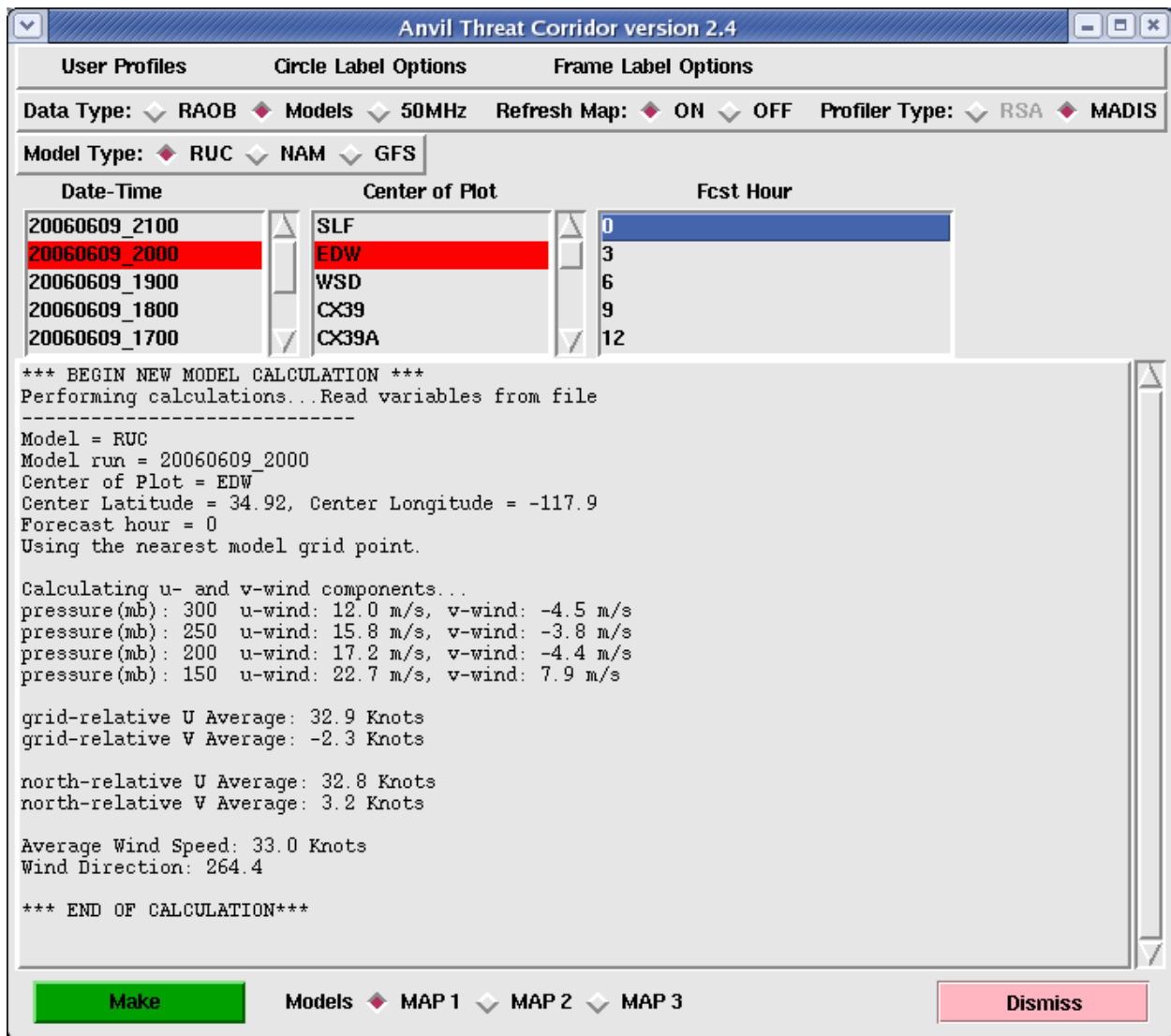


Figure 23. Anvil Tool GUI after the user has selected the model initialization time (Date-Time), location (Center of Plot), and forecast hour (Fcst Hour).

To create the Anvil Tool map for display in AWIPS, the user must click the green button labeled “**Make**” (Make). The text box in the GUI will display the name and latitude/longitude of the center location (**Center of Plot**) as shown in Figure 24. In this example the user chose **EDW** for the **Center of Plot**.

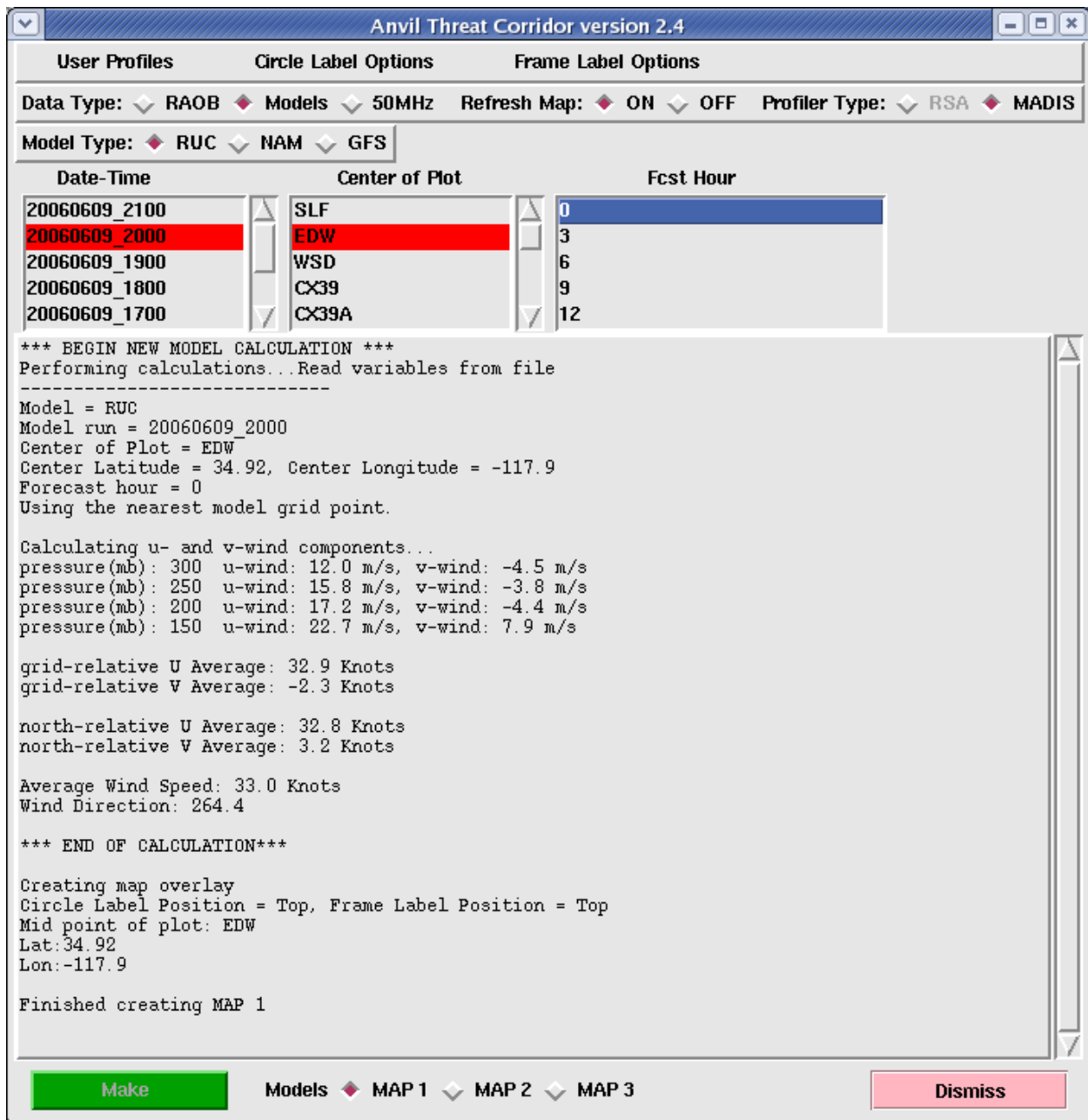


Figure 24. Anvil Tool GUI after the user has clicked on the Make button. The GUI's text box displays the center location where the graphic will be plotted in the AWIPS display.

The user can manually enter a latitude/longitude by clicking “Enter Location” in the **Center of Plot** listbox (Figure 25). After the forecast hour is selected, the user is prompted to enter a latitude value (North is positive) and longitude value (West is negative). In Figure 26, the tool calculated a map for a user-defined location over the southeast Gulf of Mexico, using RUC model data.

If the latitude/longitude value is not in the model's domain, missing values (-999) will be reported in the text box. If the model's NetCDF file stores wind data as wind speed/wind direction instead of as u- and v-wind components, the tool will report missing values for all latitude/longitude values.

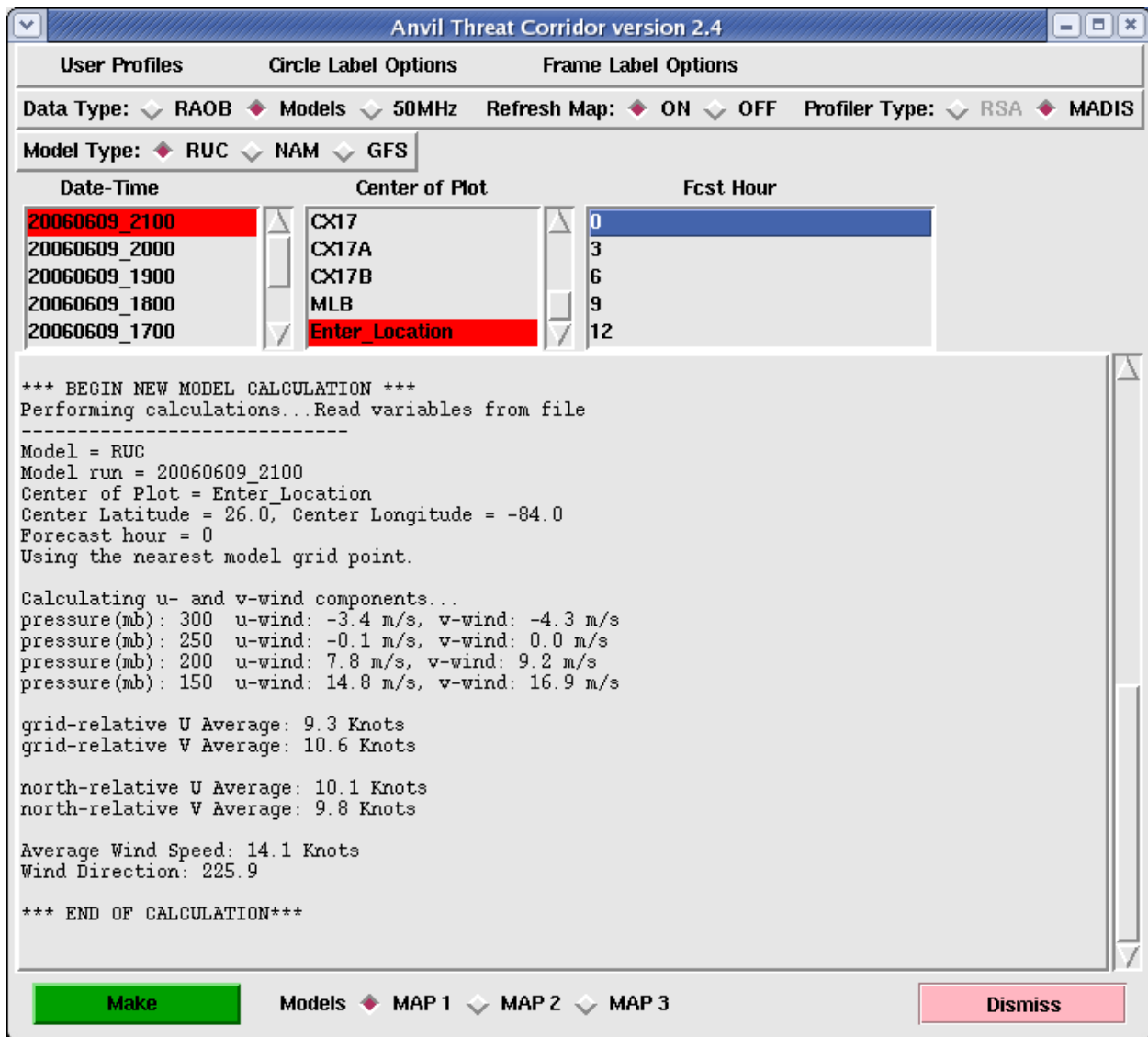


Figure 25. Anvil Tool GUI after the layer-average wind velocity was calculated for a user-defined latitude/longitude of 26.0 North/84.0 West.

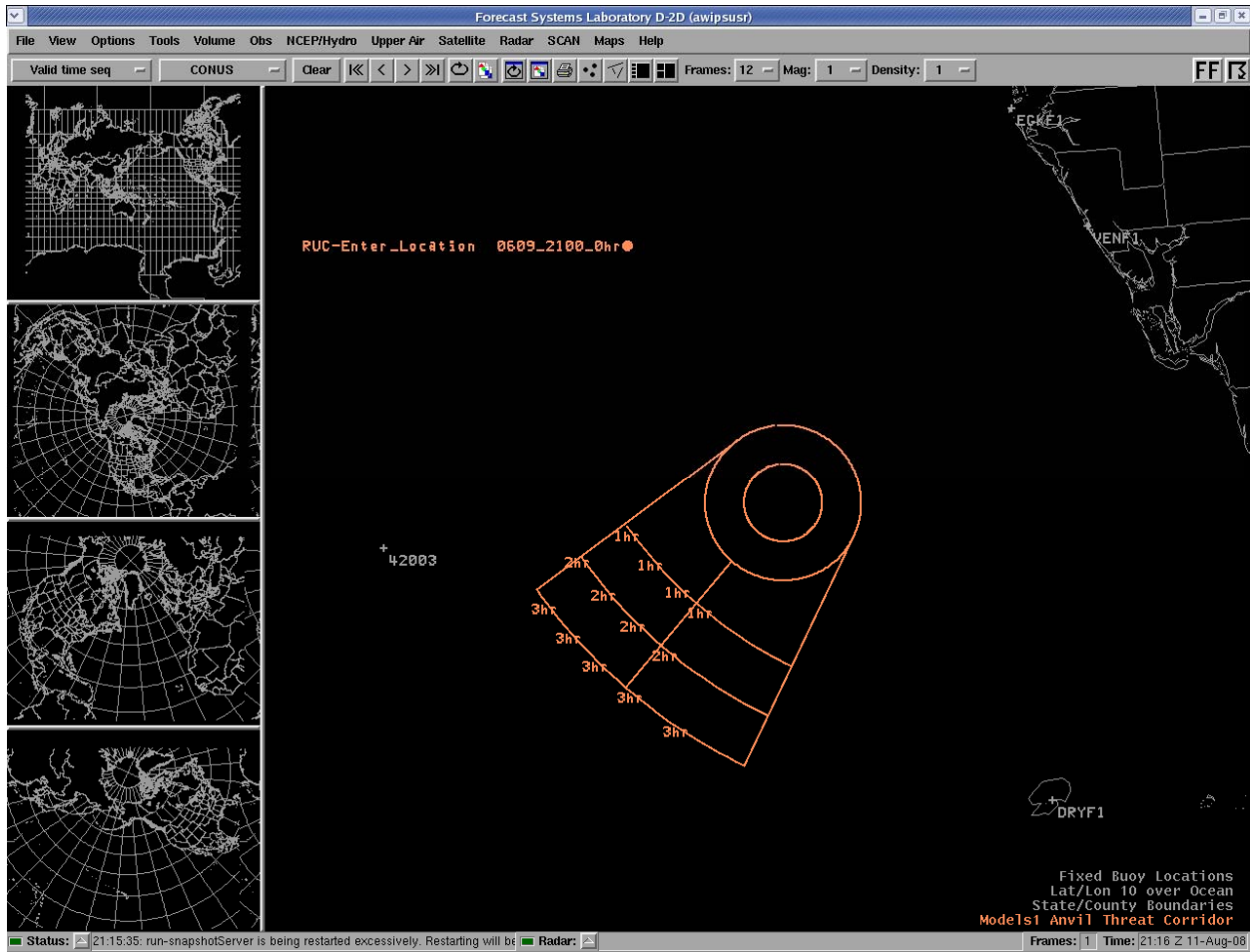


Figure 26. The Anvil Tool map plotted in AWIPS based on RUC model data selected from the Anvil Tool GUI. The user manually entered a center location of 26.0 North 84.0 West.

2.6. Displaying multiple Anvil Tool graphics in AWIPS

Multiple Anvil Tool maps can be displayed in AWIPS. If a user wants to display one Anvil Tool map from each of the three data types, they follow the procedures in the previous sections for each data type. In Figure 27, Anvil Tool maps from each data type are displayed.

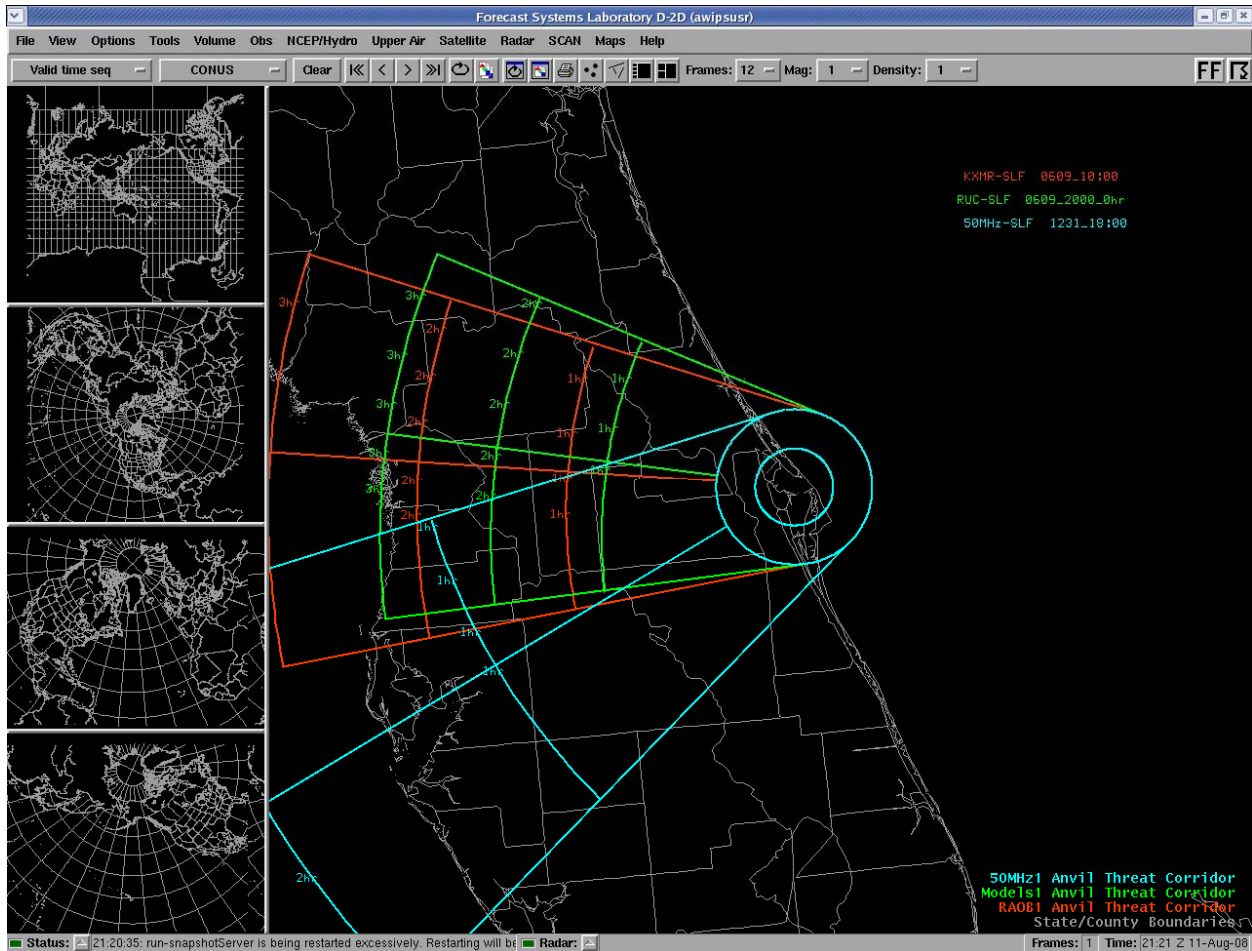


Figure 27. An example of the Anvil Tool maps plotted in AWIPS based on RAOB (red), 50 MHz (cyan) and RUC Model (green) after creating them in the Anvil Tool GUI.

To display multiple Anvil Tool maps from the same data type, users must select different map numbers by using the **MAP** options at the bottom of the Anvil Tool GUI. First, users create an Anvil Tool map for one of the three data types described in previous sections and use the default **MAP1**. Then they choose the same data type at a different observation or model forecast time (or model forecast type), but would choose **MAP2** or **MAP3** before clicking the **Make** button. This will display up to three Anvil Tool maps of the same data type overlaid on each other. In Figure 28, the RUC, NAM, and GFS models are used to display the Anvil Tool maps for 1800 UTC on 9 June 2006. In Figure 29, Anvil Tool maps are displayed from the morning RAOBs on 8 June 2006, at Jacksonville (JAX), Tampa (TBW), and XMR. If the user does not change the map number, the Anvil Tool graphic will overwrite the previous graphic in the AWIPS display that used the same map number. Up to nine Anvil Tool graphics can be overlaid on each other in one AWIPS frame using all three data types.

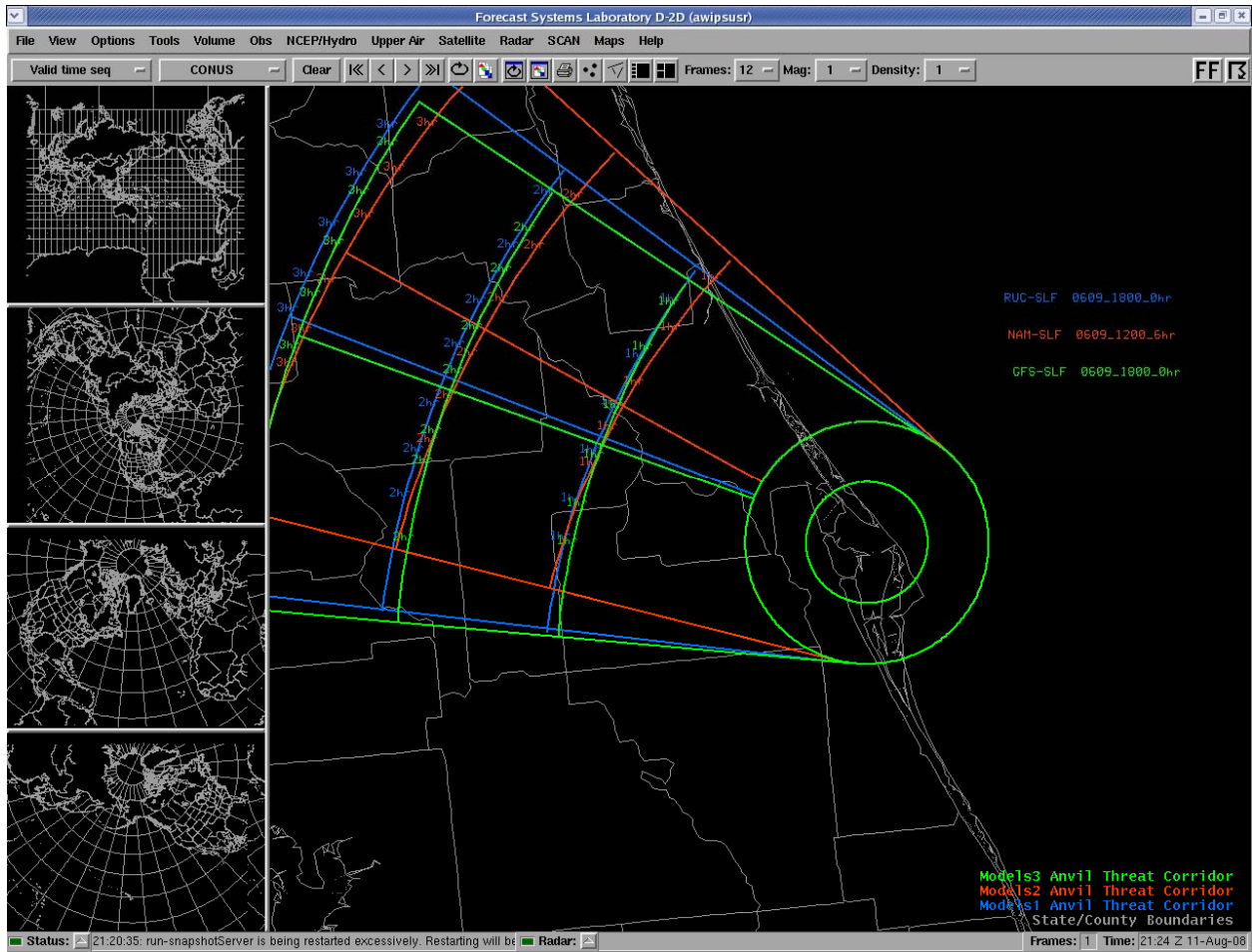


Figure 28. Anvil Tool maps plotted in AWIPS based on three different model forecasts for 1800 UTC on June 9 2006. The maps calculated from the RUC, NAM, and GFS are displayed in blue, red, and green, respectively.

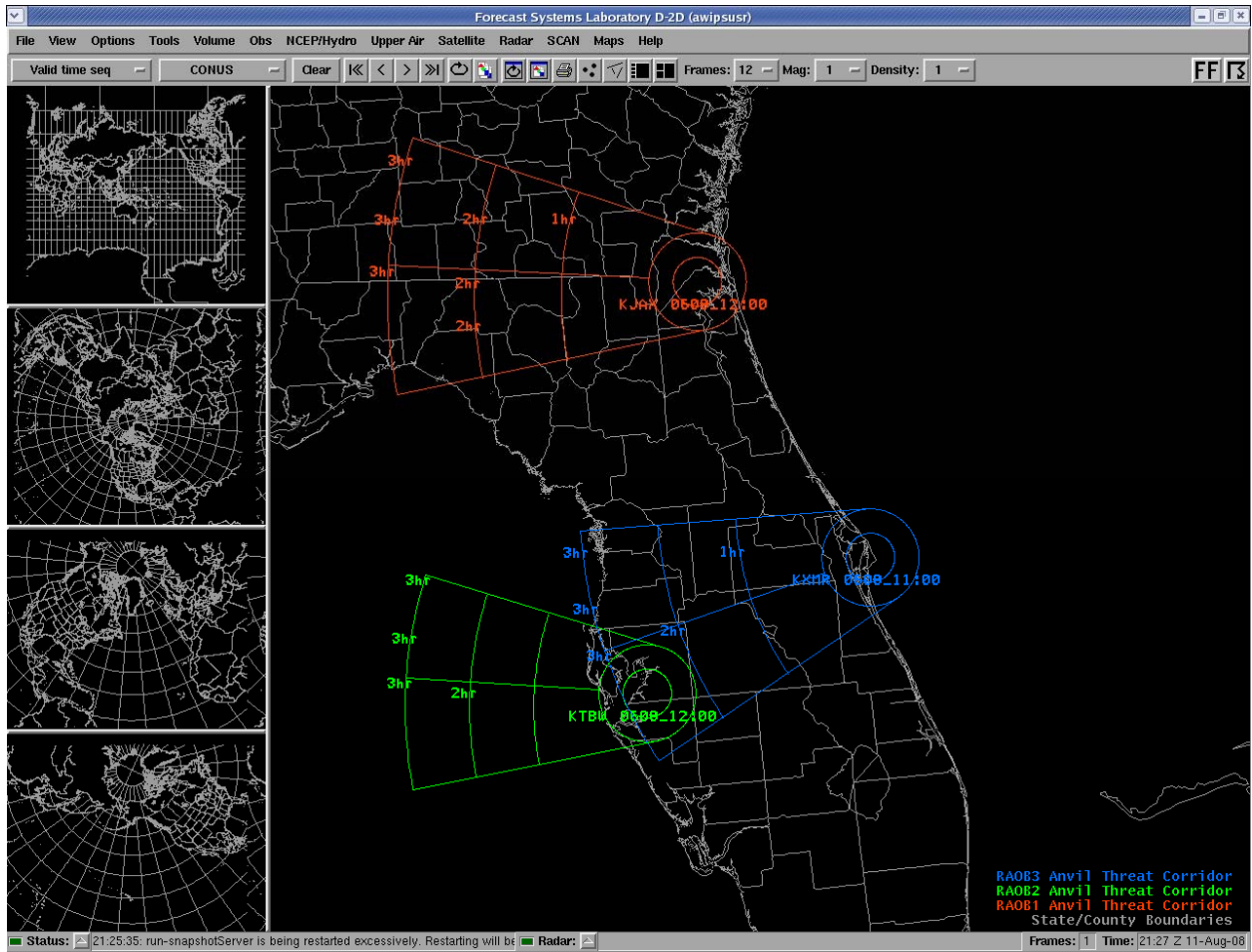


Figure 29. Anvil Tool maps plotted in AWIPS based on RAOBs at JAX (red), TBW (green), and XMR (blue) on 8 June 2006.

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