ANVIL FORECAST TOOL IN THE ADVANCED WEATHER INTERACTIVE PROCESSING SYSTEM (AWIPS)

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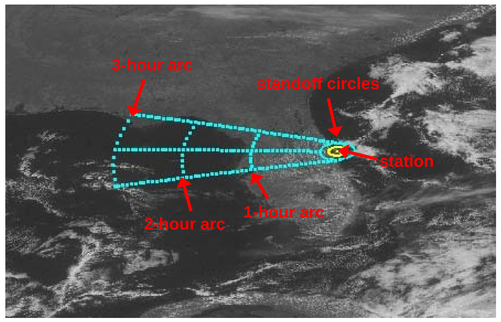
OVERVIEW

- Meteorologists from the 45th Weather Squadron and Spaceflight Meteorology Group (SMG) have identified anvil forecasting as one of their most challenging tasks when predicting the probability of violations of Lightning Launch Commit Criteria and Space Shuttle Flight Rules.
- In a previous task, the Applied Meteorology Unit (AMU) created a graphical overlay tool for the Meteorological Interactive Data Display System (MIDDS). The tool indicates the threat of thunderstorm anvil clouds up to three hours in to the future, using observed or model forecast winds as input.
- In Phase I of this task, the AMU transitioned the tool from MIDDS, so that SMG could use it in AWIPS.
- In Phase II, the AMU added additional capabilities to make it faster and more flexible.

DESCRIPTION OF THE GRAPHICAL OVERLAY

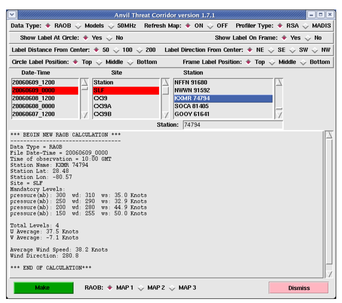
- The tool first calculates the upper-tropospheric layer-average wind velocity, usually between 300 mb and 150 mb. A graphic is then created with the following features:
  - Two standoff circles centered at the location of interest, usually with 10 and 20 NM radii,
  - A 30-degree sector width, and
  - One-, two- and three-hour arcs in the upwind location.
- The graphic is often overlaid onto a weather satellite or radar image.



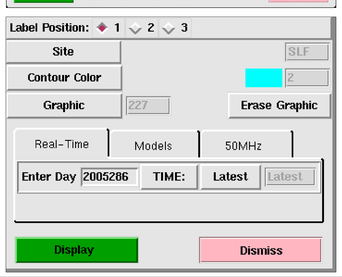
Graphic in MIDDS for Shuttle Landing Facility (SLF) at 1200 UTC, 7 March 2007.

PHASE I: MIGRATE TOOL FROM MIDDS TO AWIPS

- The MIDDS tool used code written in the McIDAS BASIC Language Interpreter (McBASI) programming language. The MIDDS interface was written in the Tcl/Tk language. The AMU rewrote all of the code into Tcl/Tk.
- The AWIPS tool read the observed or model wind from NetCDF files using the ncdump command-line utility.
- The graphic's lat/lon points were stored as a Shapefile, a Graphical Information System (GIS) file standard. The tool used version 1.2.10 of the Shapefile C library (http://shapelib.maptools.org) to create the Shapefile.
- After testing was completed, the software, installation instructions, and User Guide were delivered to SMG.



AWIPS Anvil Forecast Tool graphical user interface (GUI) from Phase I. The text box describes the input data used to calculate the layer-average wind velocity. In this example, the XMR rawinsonde observation from 1000 UTC on 9 June 2006 is used.

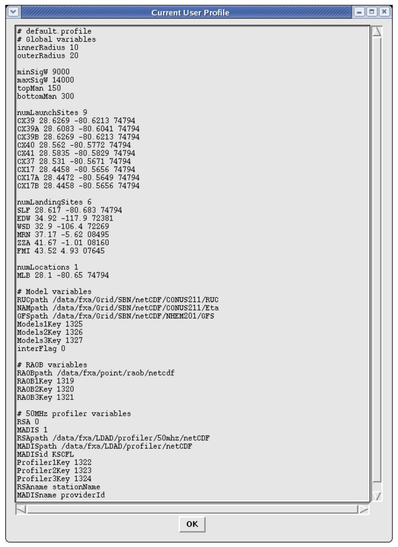


MIDDS Anvil Forecast Tool GUI.

PHASE II: MAKE THE AWIPS TOOL FASTER AND MORE CONFIGURABLE

- The AMU made two improvements to make the AWIPS Anvil Forecast Tool faster and more flexible:
  - Created "User Profiles" so that users can define model data files, atmospheric pressure levels, and other parameters used in the tool.
  - Modified the tool's source code to use a National Weather Service (NWS) application called AGRID, to make reading gridded model data easier and faster.

After testing was completed, the software, installation instructions, and User Guide were delivered to SMG.



SMG's User Profile.

I. User Profiles

A User Profile is a text file that defines several parameters previously hard-coded into the tool's source code. User Profiles make the tool more configurable and easier to maintain and update, since the parameters are easier to change. All of the User Profiles are stored in the installation directory, with a filename extension of ".profile". When the tool is started, the user is prompted to select a User Profile. A new User Profile can be created through the GUI or by creating a new file with a text editor. User Profiles can only be modified with a text editor. The tool must be restarted to change the current User Profile. The tool's installation files include a default User Profile named "default.profile". Refer to the extended abstract for a description of the User Profile parameters.

II. AGRID Software

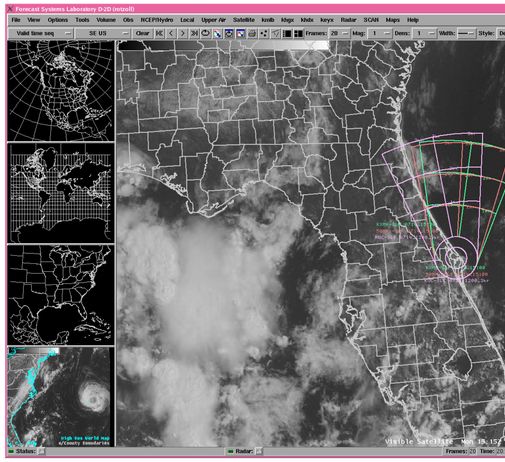
The tool was updated to use the AGRID application to make reading gridded model data easier and faster. AGRID is a package of routines to read or write AWIPS NetCDF files, and is written in the Perl programming language. The AGRID software and user instructions are available from the Local Applications Database (http://www.nws.noaa.gov/mdl/awips). The AMU installed AGRID on a Linux machine running AWIPS client and server software. The AMU then wrote three Perl scripts to read gridded model data with AGRID:

- getModelLevels.pl – Reads the pressure levels that contain wind data,
- getModelData.pl – Read u- and v-wind components at a particular lat/lon, forecast hour, and pressure level, and
- getModelRealUV.pl – Converts the grid-relative u- and v-wind components to north-relative u- and v-wind components.

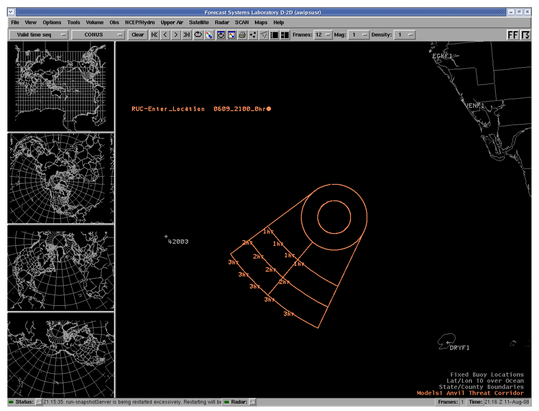
Differences between Phase I and Phase II of the tool.

Feature	*Phase I (uses ncdump utility to read gridded model data)*	*Phase II (uses AGRID to read gridded model data)*
Source code complexity	More complex. The entire NetCDF file must be parsed to get the u- and v-wind components for the lat/lon point.	Less complex. The getModelData.pl script can directly read the u- and v-wind components for the lat/lon point.
Speed	Slower. The entire NetCDF file must be read into memory and then parsed. The amount of time to read the model data is dependent on the size of the file.	Faster. Only the required model data is read from the file. The amount of time to read the model data is independent of the file size; it is related to the number of pressure levels used to calculate the layer-average wind velocity.
Number of center of plot locations in graphic that are allowed	Limited. The center locations are limited to the lat/lon points in which the grid points have already been manually calculated and hard-coded into the tool.	Unlimited. The tool can automatically calculate the corresponding grid point for any lat/lon point in the model domain.
Accuracy of grid point location	Probably less accurate. The grid point corresponding to a lat/lon point is manually calculated by printing out the model domain, then counting the number of grid points in the x- and y-direction.	Probably more accurate. AGRID automatically calculates the grid point corresponding to a lat/lon point. It uses an algorithm that takes the model domain size, projection, and lat/lon as input. The output is the corresponding grid point.
Able to use the nearest grid point to the lat/lon point	Yes. The grid point closest to the lat/lon point is manually calculated.	Yes. AGRID can calculate the grid point closest to a lat/lon point.
Able to interpolate model data from the surrounding four grid points	No. The tool can only read model data from the closest grid point to a lat/lon point.	Yes. AGRID can calculate the four grid points surrounding a lat/lon point, then interpolate the data from the four grid points.
Able to change the model files that are used	No. The manually-calculated grid points cannot be used for other model files, since the model domain size and projection affects the grid point.	Yes. AGRID can calculate the grid point for a lat/lon point, based on the model domain size and projection.
Able to change pressure levels	No. The pressure levels are hard-coded into the source code, since the tool cannot dynamically read which pressure levels are available for u- and v-wind components.	Yes. AGRID can dynamically read which pressure levels are available for u- and v-wind components.

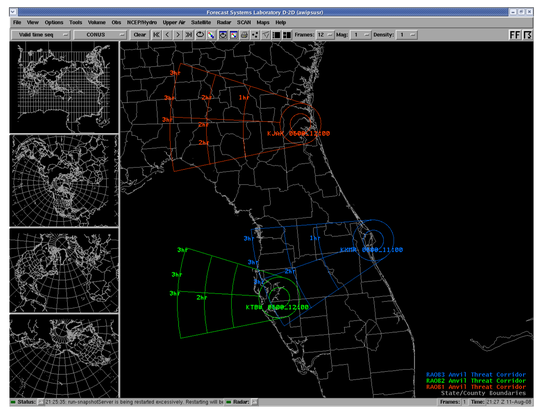
AWIPS ANVIL FORECAST TOOL, PHASE II



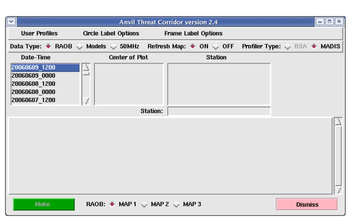
Tool's output displayed in the SMG AWIPS. The graphics are centered over the SLF. The green overlay was created with rawinsonde data, the orange overlay with profiler data, and pink overlay with RUC model data.



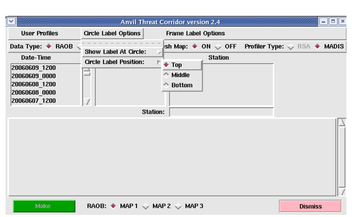
Anvil Forecast Tool graphic, based on the 0-hr forecast of the 2100 UTC run of the RUC model on 9 June 2006 data. The user manually entered a center location of 26.0 North 84.0 West.



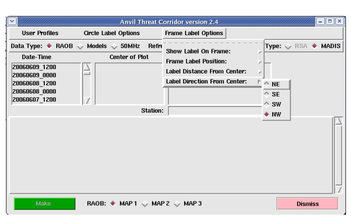
Anvil Forecast Tool graphics based on rawinsonde observations at JAX (red), TBW (green) and XMR (blue) on 8 June 2006.



AWIPS Anvil Forecast Tool GUI at startup.



The Circle Label Options menu in the GUI.



The Frame Label Options menu in the GUI.

REFERENCE

Barrett, J.H., 2008: Anvil Forecast Tool in the Advanced Weather Interactive Processing System, Phase II Final Report. NASA Contractor Report CR-2008-214748, Kennedy Space Center, FL, 26 pp. [http://science.ksc.nasa.gov/amu/final.html]