CREATING INTERACTIVE GRAPHICAL OVERLAYS IN THE ADVANCED WEATHER INTERACTIVE PROCESSING SYSTEM (AWIPS) USING SHAPEFILES AND DGM FILES

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OVERVIEW

Two examples of local AWIPS applications that create graphical overlays interactively are presented here:

1) Anvil Threat Corridor Forecast Tool (Anvil Tool) using shapefiles
2) AMU Trajectory Map Maker (Trajectory Tool) using DGM files.

SHAPEFILE PROPERTIES

- Shapefiles are used by the National Weather Service (NWS) to view background maps in AWIPS. They are also a source of data for creating geographic entity lookup tables (GELT), used by Warngen to describe areas under a warning, watch, or advisory.

- NWS offices usually obtain Shapefiles from the AWIPS map database (http://www.nws.noaa.gov/geodata) and rarely modify or create their own maps.

- Shapefiles can be created or modified with GIS software (e.g. ArcGIS), third-party software libraries (e.g. Shapefile C Library), or a custom program.

- A shapefile stores the geometry and attribute information of the spatial features in a data set. The geometry for each feature is stored as a set of vector coordinates. The feature can be a point, polyline, or polygon.

- A shapefile contains a main file, index file, and a dBASE table.

  - The main file contains a record for each spatial feature (e.g. counties.shp).
  - The index file contains the offset of each record from the beginning of the main file (e.g. counties.shx).
  - The dBASE table contains records for each attribute (e.g. counties.dbf). Attributes are commonly used to describe or label spatial features.

- Each point in a shapefile is represented by two double-precision coordinate values, in the order X Y, where X represents longitude and Y represents latitude.

- A polygon consists of one or more rings. A ring is a sequence of four or more connected points that form a closed loop. The first and last vertex of a ring must be the same.

- A polyline is an ordered set of vertices and consists of one or more parts.
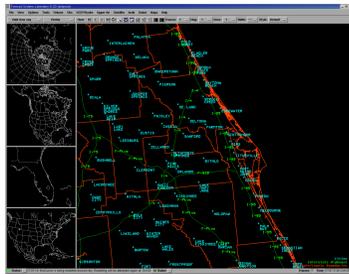
An AWIPS display showing three shapefiles: cities, interstate highways, and state/county boundaries. The cities shapefile consists of points, the interstates shapefile consists of polylines and the state/county boundaries shapefile consists of polygons.

DGM FILE PROPERTIES

- The Denver AWIPS Risk Reduction and Requirements Evaluation (DARE) Graphics Metafile (DGM) was created specifically for AWIPS and is not as well-known.

- DGM files are binary and contain a series of commands stored in two-byte integers.

- The command to set the drawing color is ignored by AWIPS.

- With the exception of color tables, AWIPS graphics colors can only be changed manually in the D2D application. Color tables are used for the "deep graphic" displays, such as profiler time-height displays. Deep graphics cannot be overlaid onto images or have graphics loaded on top of them.

- Each DGM command is represented by a unique "opcode" in hexadecimal format.

- Most useful DGM commands:

  - Draw Linked Vectors: opcode = 0x0100. Draw Unlinked Vectors: opcode = 0x0200.
  - Draw Text: opcode = 0x0300.
  - Select Absolute Addressing: opcode = 0x0CTT (TT = FF for frame addressing, TT = 00 for normal addressing; normal is the default).
  - Select Relative Addressing: opcode = 0x0DTT (TT = FF for frame addressing, TT = 00 for normal addressing).
  - Set Frame Size: opcode = 0x0Fgn (2^n = size of frame) g = 1 for absolute coordinates in minutes of longitude/latitude; when g = 2, a central point is given in minutes and absolute coordinates refer to an offset from the central point in seconds of longitude/latitude.

REFERENCES

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ESRI. *ESRI Shapefile Technical Description*, July 1998. http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf. Accessed September 27, 2007.

NOAA Earth System Research Laboratory, Global System Division. *DARE Graphics Metafile (DGM) Instruction Format.* http://www-sdd.fsl.noaa.gov/~iwake/AWIPS/dgm-doc.html. Accessed September 27, 2007.

Short, D. A. and M.M. Wheeler, 2002: Improved Anvil Forecasting: Phase II Final Report. NASA Contractor Report CR-2002-211170, Kennedy Space Center, FL, 19 pp.

## ANVIL THREAT CORRIDOR FORECAST TOOL

- Purpose: Create a graphical overlay that depicts the location of thunderstorm anvils 1, 2, and 3 hours into the future.

- Users: Since 2002, the 45th Weather Squadron at Cape Canaveral Air Force Station and Spaceflight Meteorology Group at Johnson Space Center have used the tool in the Meteorological Interactive Data Display System (MIDDS). The Applied Meteorology Unit (AMU) ported the tool over to AWIPS in 2007.

- According to a 2002 AMU study, the following properties of the graphical overlay are consistent with the characteristics of anvil clouds over Florida and adjacent coastal waters:

  - 10- and 20-n mi radius standoff circles, centered at the forecast location.
  - 30-degree sector width (In the AMU study, the standard deviation of the difference between upper-tropospheric wind direction and anvil orientation was 25 degrees).
  - Anvil orientation is given by the 300 to 150 mb average wind direction.
  - 1-, 2-, and 3-hour arcs in the upwind direction.
  - Arc distances are calculated from the 300 to 150 mb average wind speed.

- Tool creates polygon features, using utilities in the Shapefile C Library (Shapelib).

If set to "Yes", the tool displays a label describing the graphic over the standoff circles.

Distance (nm) between the frame label and the center location.

Three positions (top, middle, bottom) are available so that labels over standoff circles are not overwritten by other graphical overlays.

When the Make button is selected, the tool creates a new graphical overlay based on the GUI settings.
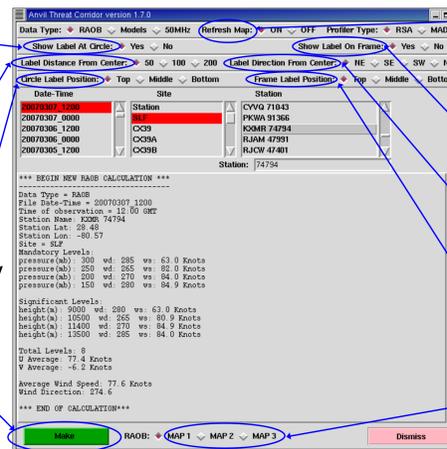
If set to "ON", the current shapefile, if any, is unloaded from the display. The new shapefile is loaded onto the display.

If set to "Yes", the tool displays a label on the screen frame.

Compass direction of frame label from the center location.

Three positions are available so that frame labels are not overwritten by other graphical overlays.

Three shapefile maps are available for each of the three data sources (RAOB, Models, and 50 MHz profiler).

- Installation Instructions:

  - Download Shapelib distribution file, shapelib-1.2.10.tar.gz, from http://dl.maptools.org/dl/shapelib/. Unzip and untar the file in the /usr/local directory on the AWIPS workstation. Build the Shapelib software according to README inside the distribution file.
  - Create soft links in the /usr/local/bin directory to the Shapelib utilities in the /usr/local/shapelib/ directory.
  - Create a new directory for the tool: /awips/fxa/awipsusr/AnvilTool
  - Add the tool to the $FXA_HOME/data/appInfo.txt localization file.
  - Add an application product button to the dataMenus.txt localization file.
  - In the backgroundMenus.txt localization file, add a submenu called "Anvil Threat Corridor 1.7". Inside the submenu, add three submenus for the three RAOB, 50 MHz, and Models data sources. Each of the three submenus should have three product buttons.
  - Add the nine shapefile product buttons (added in previous step) to the productButtonInfo.txt localization file.
  - Add data keys for the nine shapefiles to the dataInfo.manual localization file.
  - Add depict keys for the nine shapefiles to the depictInfo.manual localization file.
  - Run the localization script with the +maps option. Restart the D2D application.
  - In the /awips/fxa/data directory, create soft links to the nine shapefiles in the /awips/fxa/awipsusr/AnvilTool directory.
  - Copy the anviltool.tcl file to the /awips/fxa/bin/ directory. Make sure that the file is executable.

Graphical overlay using KXMR rawinsonde observation at 1200 UTC on 7 March, 2007. The center location is the Shuttle Landing Facility (SLF). The "Show Label At Circle" and "Show Label On Frame" options are set to "Yes".
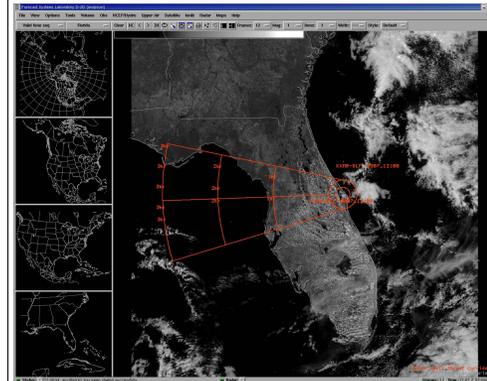
Graphical overlay of all nine shapefiles – three from profiler data, three from rawinsonde data, and three from model data.
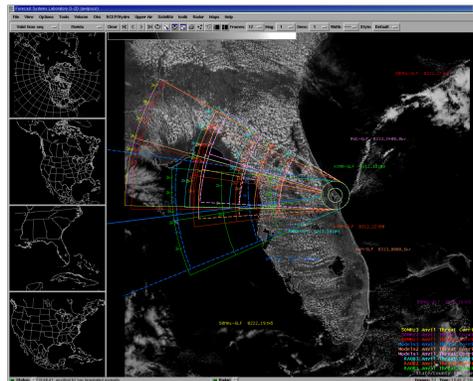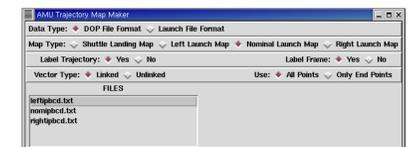

AMU TRAJECTORY MAP MAKER

- Purpose: Overlay the ground trajectories of space vehicles during launch and landing on top of radar products.

- Potential Users: the 45th Weather Squadron and Spaceflight Meteorology Group.

- The tool plots trajectories using a text file of latitude/longitude points as input. The text file can be in either Deorbit Opportunity (DOP) Map file format or Launch file format.

- DOP file format: Each line contains either a latitude/longitude pair or a blank line (east and north are positive). Sequential lines of latitude/longitude pairs are treated as a single linked vector. A blank line causes a new linked vector to start.

- Launch file format: Three separate text files for each launch – for the left and right edges of the expected trajectory and the center of trajectory. Each line contains three decimal numbers – the first is the altitude or time into the flight, the second is the latitude and the third is the longitude.

- Using the tool: If the Data Type is set to DOP format, all the files in DOP format are listed in the FILES listbox. If the Data Type is set to Launch format, all the files in Launch format are listed. The Map Type only determines the directory where the DGM file will be stored – it does not affect the DGM file format.

- How it works: When the user selects a file in the FILES listbox, the tool opens the input file for reading. If the file is in the correct format, the DGM filename is created. The frame size is written to the DGM file with the Set Frame Size command. Either the Draw Linked Vectors or Draw Unlinked Vectors command is then written to the DGM file. The number of points or pairs is written to the DGM file, followed by the longitude/latitude points or pairs. Finally, the frame label, if selected, is written to the DGM file.

- Installation Instructions:

  - Copy the AMUmaptool.tcl and dgmfmt.csh files to the /awips/fxa/bin directory.
  - Create the input directories to hold the input text files:
    - /awips/fxa/awipsusr/AMUMapMaker/DOP
    - /awips/fxa/awipsusr/AMUMapMaker/Launch
  - Create the output directories to hold the DGM files:
    - /data/fxa/dgm/map/left
    - /data/fxa/dgm/map/nominal
   - /data/fxa/dgm/map/right
    - /data/fxa/dgm/map/landing
  - Add the tool to the $FXA_HOME/data/appInfo.txt localization file.
  - Add an application product button to the dataMenus.txt localization file.
  - In the backgroundMenus.txt localization file, add a submenu called "Trajectory Maps". Inside the submenu add three product buttons: "Left Track", "Nominal Track", "Right Track", and "Shuttle Landing".
  - Add the three product buttons to the productButtonInfo.txt localization file.
  - Add data keys for the three DGM products to the dataInfo.manual localization file.
  - Add depict keys for the three DGM products to the depictInfo.manual localization file.
  - Run the localization script with the default options. Restart the D2D application.

Trajectory Tool GUI

Graphical overlay of launch trajectories using all points. Lines look jagged because horizontal resolution is limited to minutes of latitude/longitude.
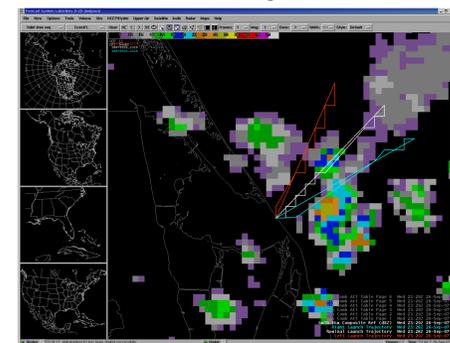
Graphical overlay of launch trajectories using only the end points.
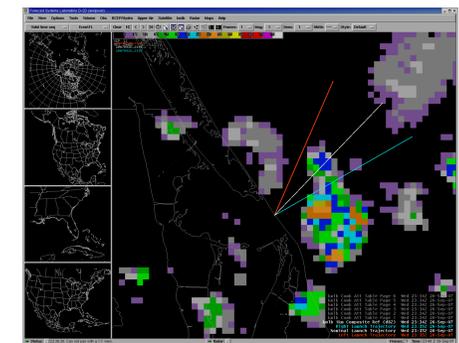
ADVANTAGES OF DGM FILES

- DGM files are easier to create than shapefiles.
- Unlike shapefiles, DGM files are not static and can be looped in D2D just like any other data product.
- Unlike shapefiles, DGM files can be created directly in AWIPS.

ADVANTAGES OF SHAPEFILES

- There is pre-existing software that can be used to create or modify shapefiles.
- There is a large repository of shapefiles for use as maps, such as the AWIPS map database.
- The lines and points in a shapefile can be very precise since latitude/longitude points are stored with double-precision.