

## **General Disclaimer**

### **One or more of the Following Statements may affect this Document**

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.



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



Joe Barrett  
ENSCO, Inc. / Applied Meteorology Unit

Richard Lafosse, Doris Hood, and Brian Hoeth  
Spaceflight Meteorology Group, Houston, TX

## OVERVIEW

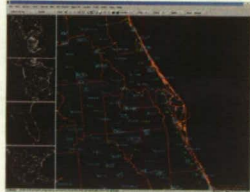
Two examples of local AWIPS applications that create graphical overlays interactively are presented here:

- 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 Warnings 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 = 0x0CXX (TT = FF for frame addressing, TT = 00 for normal addressing; normal is the default).
  - Select Relative Addressing: opcode = 0x0DXX (TT = FF for frame addressing, TT = 00 for normal addressing).
  - Set Frame Size: opcode = 0x0Fgn (2<sup>n</sup> = 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

- Barrett, J.H., W.H. Bauman, J. Keen, 2007. Anvil Tool in the Advanced Weather Interactive Processing System Final Report. NASA Contractor Report CR-2007-214726, Kennedy Space Center, FL, 23 pp.
- ESRI. 2009. 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.ssd.noaa.gov/~wee/AWIPS/dgm-doc.html>. Accessed September 27, 2007.
- Shor, 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

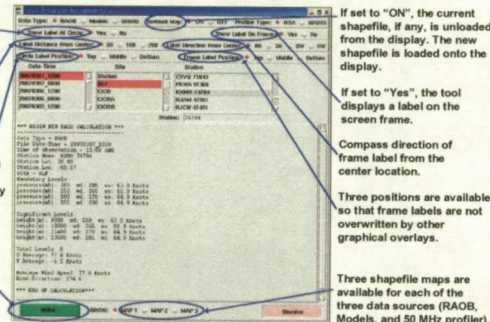
- Purpose: Create a graphical overlay that depicts the location of thunderstorm anvils 1, 2, and 3 hours into the future.
- Users: Since 2002, the 45th Weather Squadron at Cape Canaveral Air Force Station and Spaceflight Meteorology Group at Johnson Space Center have used the tool in the Meteorological Interactive Data Display System (MIDS). 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.

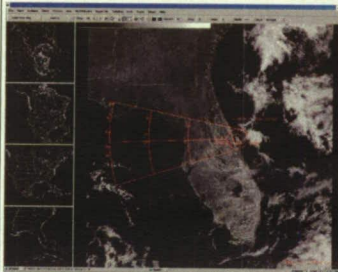
Compass direction of frame label from the center location.

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

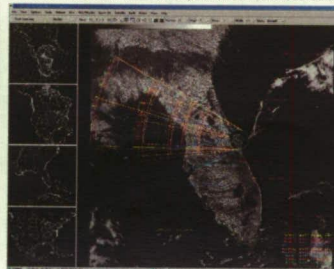
Three shapefile maps are available for each of the three data sources (RAOB, Models, and 50 MHz profiler).

- 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 file 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/xa/awipsusr/AnvilTool
  - Add the tool to the \$FXA\_HOME/data/applinfo.txt localization file.
  - Add an application product button to the dataMenu.txt localization file.
  - In the backgroundMenu.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/xa/data directory, create soft links to the nine shapefiles in the /awips/xa/awipsusr/AnvilTool directory.
  - Copy the anviltool.tcl file to the /awips/xa/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:

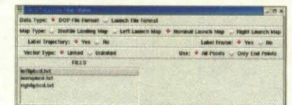
- Copy the AMUmaptool.tcl and dgmmf.csh files to the /awips/xa/bin directory.
- Create the input directories to hold the input text files:
  - /awips/xa/awipsusr/AMUMapMaker/DOP
  - /awips/xa/awipsusr/AMUMapMaker/Launch

Create the output directories to hold the DGM files:

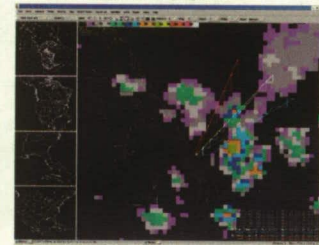
- /data/xa/dgm/map/left
- /data/xa/dgm/map/nominal
- /data/xa/dgm/map/right
- /data/xa/dgm/map/landing

- Add the tool to the \$FXA\_HOME/data/applinfo.txt localization file.
- Add an application product button to the dataMenu.txt localization file.
- In the backgroundMenu.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.

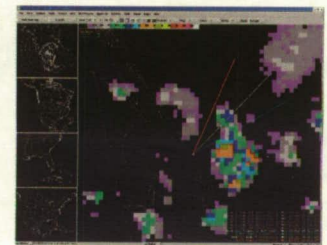
## Trajectory Tool GUI



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.

**REPORT DOCUMENTATION PAGE**

*Form Approved*  
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

**PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

<b>1. REPORT DATE (DD-MM-YYYY)</b> 09-10-2007			<b>2. REPORT TYPE</b> Conference Poster Presentation		<b>3. DATES COVERED (From - To)</b> Apr 2006 - Oct 2007	
<b>4. TITLE AND SUBTITLE</b> Creating Interactive Graphical Overlays in the Advanced Weather Interactive Processing System Using Shapefiles and DGM Files					<b>5a. CONTRACT NUMBER</b> NNK06MA70C	
					<b>5b. GRANT NUMBER</b>	
					<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Joe H. Barrett III Richard Lafosse Doris Hood Brian Hoeth					<b>5d. PROJECT NUMBER</b>	
					<b>5e. TASK NUMBER</b>	
					<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> ENSCO, Inc. 1980 N. Atlantic Ave. Suite 230 Cocoa Beach, FL 32931					<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>	
<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> NASA John F. Kennedy Space Center Code KT-C-H Kennedy Space Center, FL 32899					<b>10. SPONSORING/MONITOR'S ACRONYM(S)</b>	
					<b>11. SPONSORING/MONITORING REPORT NUMBER</b>	
<b>12. DISTRIBUTION/AVAILABILITY STATEMENT</b> Unclassified, Unlimited						
<b>13. SUPPLEMENTARY NOTES</b>						
<b>14. ABSTRACT</b> Graphical overlays can be created in real-time in the Advanced Weather Interactive Processing System (AWIPS) using shapefiles or DARE Graphics Metafile (DGM) files. This presentation describes how to create graphical overlays on-the-fly for AWIPS, by using two examples of AWIPS applications that were created by the Applied Meteorology Unit (AMU). The first example is the Anvil Threat Corridor Forecast Tool, which produces a shapefile that depicts a graphical threat corridor of the forecast movement of thunderstorm anvil clouds, based on the observed or forecast upper-level winds. This tool is used by the Spaceflight Meteorology Group (SMG) and 45th Weather Squadron (45 WS) to analyze the threat of natural or space vehicle-triggered lightning over a location. The second example is a launch and landing trajectory tool that produces a DGM file that plots the ground track of space vehicles during launch or landing. The trajectory tool can be used by SMG and the 45 WS forecasters to analyze weather radar imagery along a launch or landing trajectory. Advantages of both file types will be listed.						
<b>15. SUBJECT TERMS</b> Advanced Weather Interactive Processing System (AWIPS), Shapefiles, thunderstorm anvil clouds						
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b>	
<b>a. REPORT</b>	<b>b. ABSTRACT</b>	<b>c. THIS PAGE</b>			Dr. Francis J. Merceret	
	U	U	UU	1	<b>19b. TELEPHONE NUMBER (Include area code)</b> (321) 867-0818	