P2.1 THE WEATHER EVENT SIMULATOR AND OPPORTUNITIES FOR THE SEVERE STORMS COMMUNITY

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1. Introduction

The Weather Event Simulator (WES) is the primary data playback and simulation tool for National Weather Service forecast offices. The WES contains an operational build of the Advanced Weather Interactive Processing System (AWIPS) software along with WES software (Fig. 1) to facilitate playback of AWIPS data sets on a Linux workstation. The WES software contains a simulation mode where data sets can be played back as if in real time, allowing warning operations to be simulated.

The first version of WES (WES1.0) was released in 2001 (Magsig and Page 2002). WES1.0 contained AWIPS software, WES software, and a copy of the Informix database software necessary for issuing warnings. The Informix software needed to be purchased prior to WES installation, which limited the growth of the WES. In 2003, a cost-free version of WES (WES1.3) was developed (Magsig 2004). WES1.3 featured a flat-file version of the AWIPS text database access software that wrote warnings and other text information to flat files rather than the Informix database. While the WES software has been freely available for almost a year, it has been slow to be used in the academic and research communities. This paper will outline the WES program, and illustrate opportunities for the severe storms community to use this software and to collaborate with local NWS offices.

2. Archived Data

AWIPS utilizes netCDF format (http://my.unidata.ucar.edu/content/software/netcdf/) as the primary data format for numerical model data, satellite data, upper air data, surface observation data, and more. Radar data is left in the standard level III format that is centrally distributed distributed by the NWS (http://www.nws.noaa.gov/tg/rpccds.html). The

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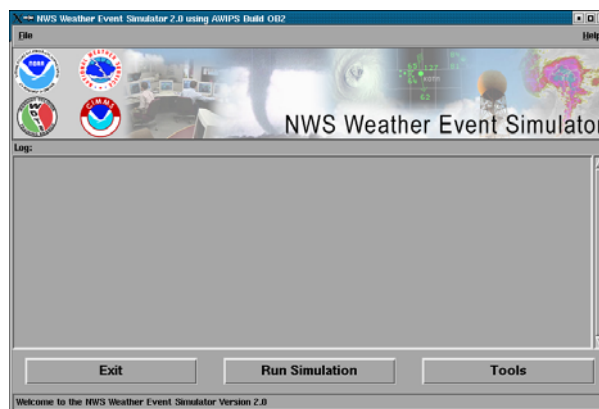
Fig. 1. WES2.0 graphical user interface.

AWIPS netCDF data are created by AWIPS decoders in real time at each NWS office using the NOAAPORT data stream (http://www.nws.noaa.gov/om/marine/noaaport.htm).

After the WES became integrated into NWS operations nation wide, local AWIPS archiving capabilities became a standard part of the configuration managed AWIPS baseline. Currently, local offices archive the processed AWIPS datasets, including satellite, radar, model grids, surface and upper air observations, and other national and local datasets. The data are stored in a primary data location (specified by the AWIPS $FXA_DATA variable) under directories called Grid, sat, radar, point, etc. On WES, the data location has been specified to be in a case directory located under /data/awips. The archived data sets are fairly comprehensive, and they are a valuable resource for research and training.

The archived data sets are compressed and bundled using standard tar and compress utilities available on Linux before they are archived. A day's worth of compressed archive data typically fits on a DVD, which makes a convenient media to share data sets. Although there is no national archive of daily AWIPS data (input or output), the processed AWIPS data are archived at the local level for most significant events. Data are archived shortly following events for static review, and they are used for many other purposes, including damage surveys, media interviews, training
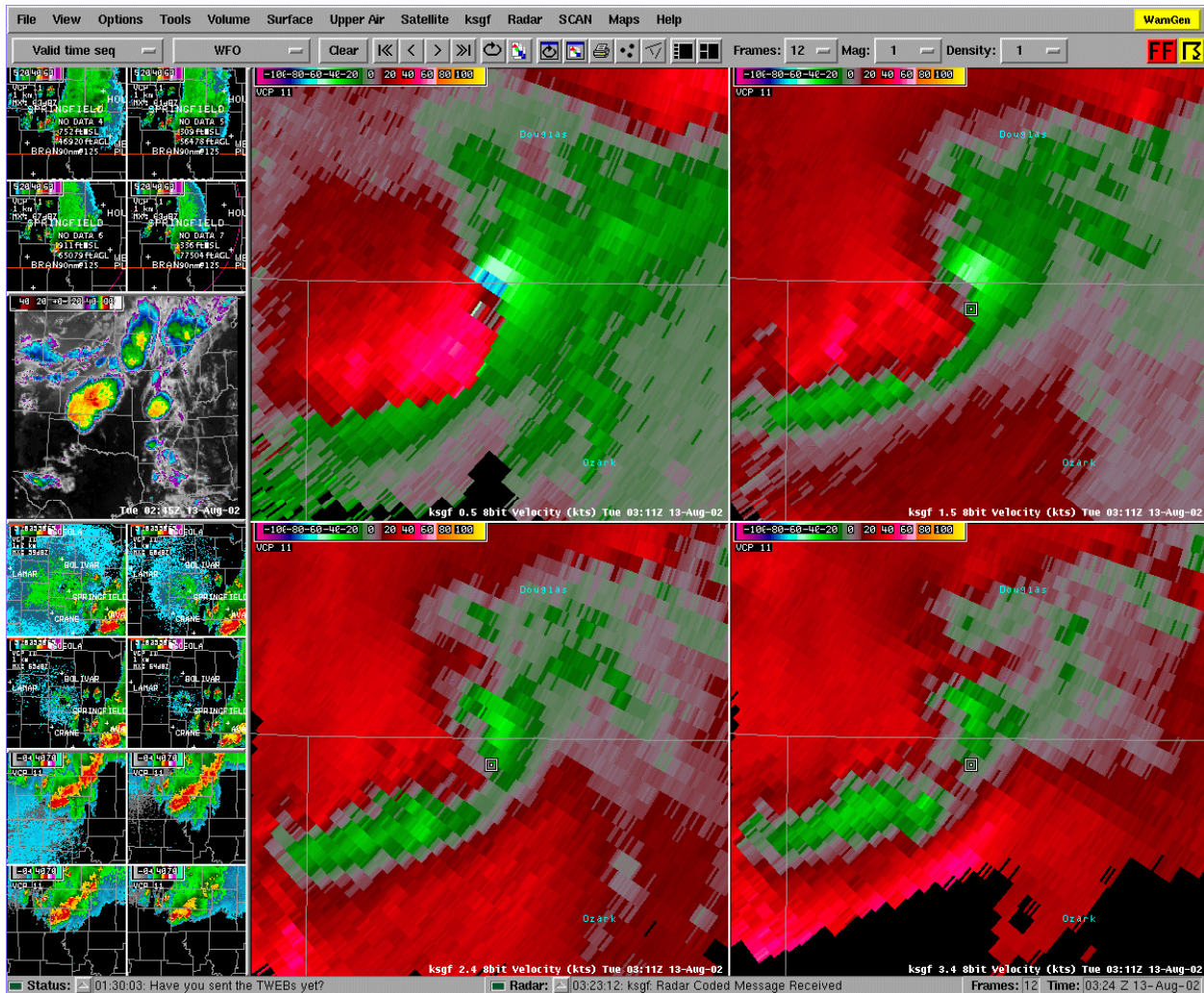
Fig. 2. AWIPS D2D software used to display data and create warnings.

simulations, and more (Ferree et al 2002). In addition to the local archives at NWS offices, the Science and Operations Officer Science & Training Resource Center (SOO/STRC) has established a case study library of AWIPS data sets contributed by NWS offices and the NWS Training Division. The data cases are described at http://strc.comet.ucar.edu/shared/cgi-bin/strc/csl/case_library.pl .

3. Displaying Archived Data Sets

Before a data case should be installed, the WES needs to be installed following the WES installation instructions (Magsig 2004). The WES install instructions contain the requirements for running WES. Although WES runs on Redhat Linux 7.2, many other Linux distributions have

been used with only slight modifications being required. The WES web site at http://strc.comet.ucar.edu/wes/index.htm contains useful information about the WES and many of the frequently asked questions.

A test case is included on the install CD in order to verify a successful installation. Once the WES installation instructions have been completed, and the test case has been used to verify a successful installation, an archived data set can be installed and viewed.

Extracting data from locally archived DVDs involves uncompressing and untarring data into the data case directory, which has been standardized to be /data/awips on the WES machine. Case names are specified in yyyyMmmdd format, such as 2004Jul01.

Once the data is extracted from the DVD into the case, a few directories must be created, and an AWIPS localization typically needs to be built in order to display the data using the AWIPS Display in Two Dimensions (D2D) software (Fig. 2). The few steps to be able to view a new case include: 1) creating a "procs" directory in the data case, 2) creating a symbolic link in the data case called "userPrefs" that points to the procs directory, 3) creating a "customFiles" directory in the data case, and 4) creating a "localizationDataSets" directory in the data case.

AWIPS creates most of the geographical information needed for display and processing of data in what is called a localization data set. The localization data set for a given county warning area (CWA) is typically given the name of the three letter CWA identifier (e.g. BMX for Birmingham, AL). To create a default localization for data display, the user runs the mainScript.csh program with the following syntax: "/awips/fxa/data/localization/scripts/mainScript.csh XXX XXX", where XXX is the three-letter CWA id of the office for which the case was archived. This will create a localization data set, /data/awips/<casename>/localizationDataSets/XXX, where XXX is the three letter id of the CWA. Localization data sets can be created locally, or they can be shared from forecast offices (along with other configuration files).

AWIPS is customized extensively in NWS offices. Some of the customizations include color tables, maps, menus, warning templates, and more. For documentation on AWIPS customization, see the html files in /awips/fxa/data/localization/documentation.

To view a data set, the user runs the /awips/fxa/DRT/start_awips program, and selects the appropriate case and localization data set. The AWIPS menu structure is relatively straightforward in the D2D, though menu items are scale dependent (e.g. most radar data default settings are set to display on wfo and state scale). If an invalid scale is selected, the data will not load, and the submenu entries will turn grey instead of black.

To load in loops at different times the user can select a reference time in the "Set Time" submenu from the "Options" menu. Another way to launch the clock entry tool is to double click on the clock on the lower-right part of the D2D display. D2D loads in a loop of data backward from the time entered (default 12 frames, which is modifiable up to 32 frames in the D2D frame count pull down menu). The D2D clock tool allows data sets to be perused in a static mode, where data isn't being
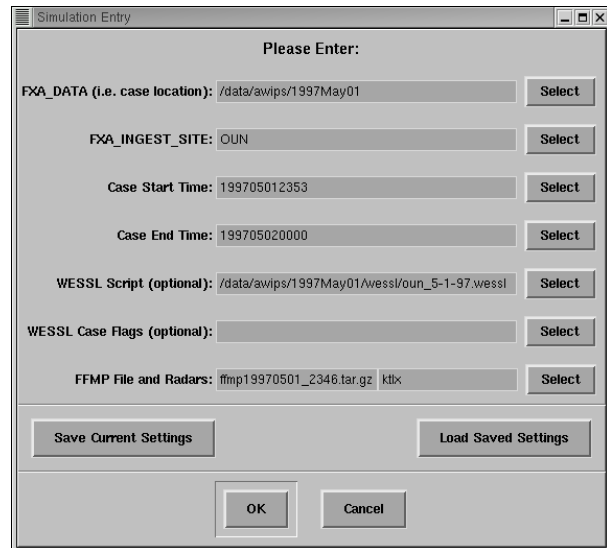

Fig. 3. WES software simulation entry window.

processed, and AWIPS data decoders are not running.

4. WES

The WES is composed of two primary components, the AWIPS software and the WES software. The WES software is installed in the /awips/fxa/DRT directory, and the AWIPS software is installed in the /awips/fxa directory. The WES software was primarily written in Tcl/Tk, although there are some supplemental executables. There are two main programs in the WES software, start_awips and start_simulator. The start_awips program is used to display case data using D2D (see section 3), and the start_simulator program is used to run a simulation using archived data. For instructions on how to run a simulation, please consult the installation instructions on the install CD and the help menu on the start_simulator graphical interface.

In order to run a simulation where data is processing as if in real time, the data needs to be converted to "DRT format" once using the WES "Tools" button. Conversion to DRT format involves renaming the files to be invisible to the display, and it involves creating an indexing scheme for data processing (Magsig and Page 2002). A simulation entry window allows for the details of a simulation to be entered (Fig. 3). After the data are renamed, symbolic links are used to make data visible each minute during the simulation.

When the simulation is started, some AWIPS decoders are also started, and the system clock on the machine is reset to the date and time of the
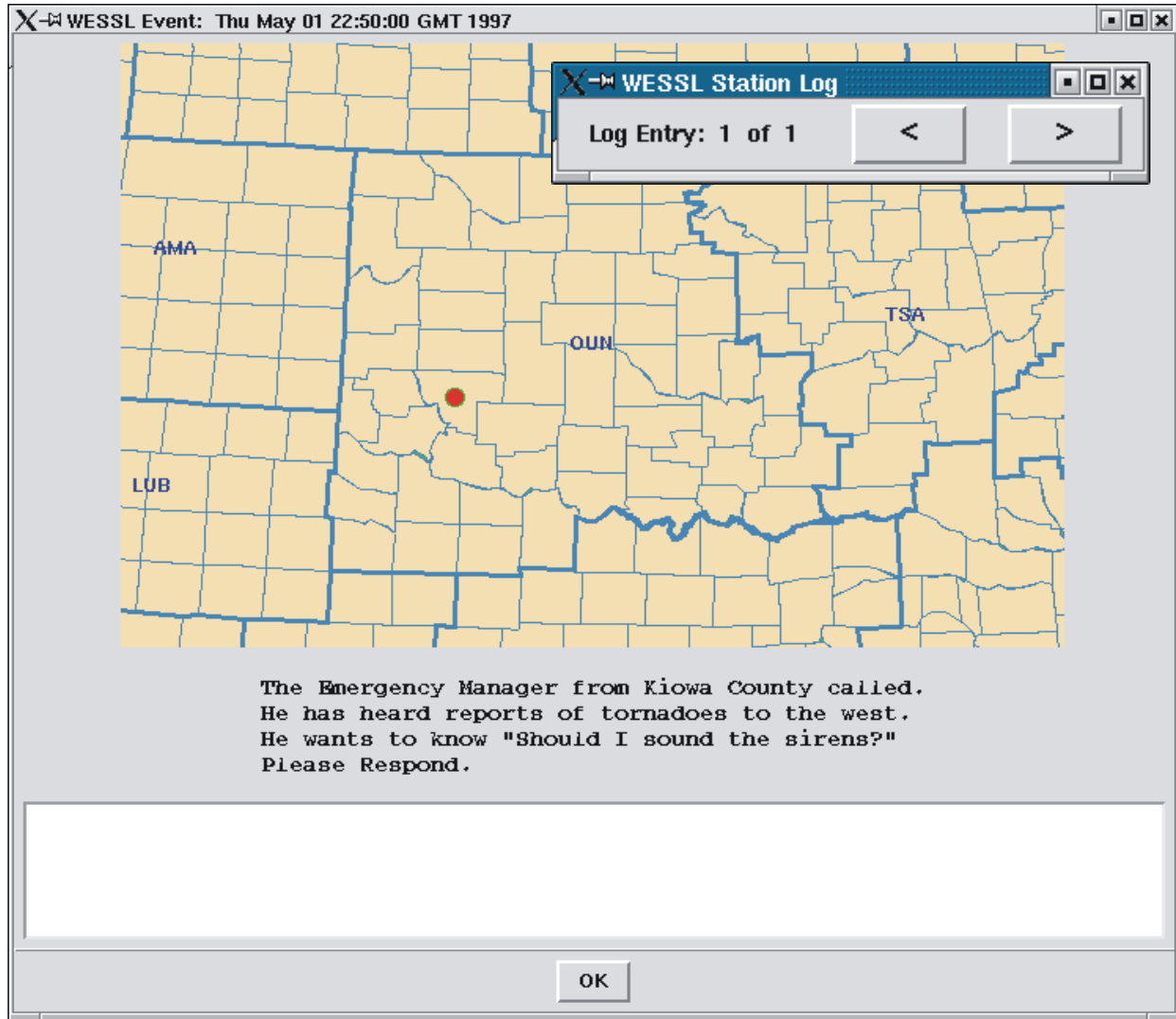
Fig. 4. Example of a WESSL query box that is launched during a simulation.

simulation. As files are made visible every minute, the AWIPS decoders are notified of the faked product arrival, which triggers the image loops in D2D to update. During a simulation, many of the warning components of AWIPS behave as in real time operations, allowing the analyzing of data and issuing of warnings using the operational AWIPS software. This "train as you fight" concept has been utilized by many other markets for performance improvement (Ferree et al 2002).

The simulation mode also has a pause feature, which stops the data processing and allows in depth discussion of warning decision making. In addition to case study review and training benefits, the WES has provided a platform to begin to conduct research into the warning decision making process and the cognitive processes of experts (Jones et al 2003).

5. WESSL

A WES Scripting Language (WESSL) has been developed to facilitate the timed release of non-AWIPS data sources during a simulation such as spotter reports, Storm Prediction Center products, query boxes (Fig. 4), images, audio files, and video files. WESSL is written in Tcl/Tk, and it has a script building tool called builder.tcl (Fig. 5), and a runtime script called wessl.tcl. The builder.tcl program can be used to generate maps and text, or run external applications at pre-set times during a simulation. Wessl.tcl is run by start_simulator during a simulation to issue the commands in the WESSL file built using builder.tcl.
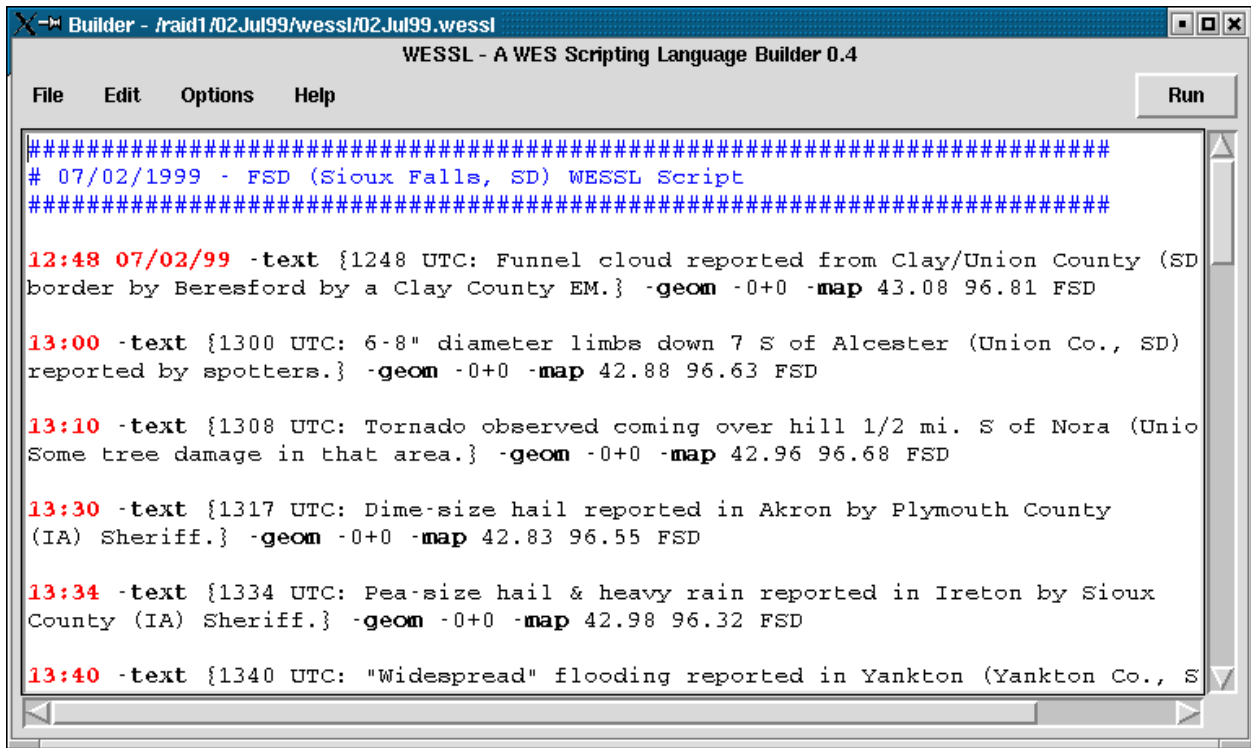
Builder - /raid1/02Jul99/wessl/02Jul99.wessl

WESSL - A WES Scripting Language Builder 0.4

File   Edit   Options   Help   Run

```
################################################################
# 07/02/1999 - FSD (Sioux Falls, SD) WESSL Script
################################################################

12:48 07/02/99 -text {1248 UTC: Funnel cloud reported from Clay/Union County (SD
border by Beresford by a Clay County EM.} -geom -0+0 -map 43.08 96.81 FSD

13:00 -text {1300 UTC: 6-8" diameter limbs down 7 S of Alcester (Union Co., SD)
reported by spotters.} -geom -0+0 -map 42.88 96.63 FSD

13:10 -text {1308 UTC: Tornado observed coming over hill 1/2 mi. S of Nora (Unio
Some tree damage in that area.} -geom -0+0 -map 42.96 96.68 FSD

13:30 -text {1317 UTC: Dime-size hail reported in Akron by Plymouth County
(IA) Sheriff.} -geom -0+0 -map 42.83 96.55 FSD

13:34 -text {1334 UTC: Pea-size hail & heavy rain reported in Ireton by Sioux
County (IA) Sheriff.} -geom -0+0 -map 42.98 96.32 FSD

13:40 -text {1340 UTC: "Widespread" flooding reported in Yankton (Yankton Co., S
```

Fig. 5. Builder.tcl interface that is used to generate data and specify release times in a simulation.

Warning Threat Assessment

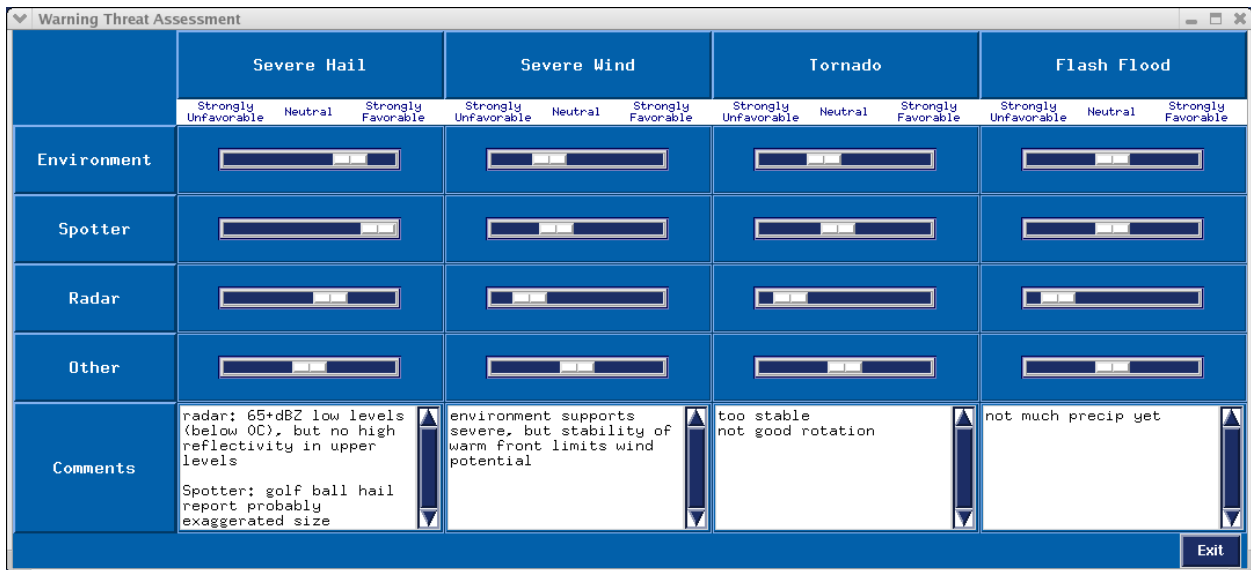|	Severe Hail	Severe Wind	Tornado	Flash Flood
	Strongly Unfavorable — Neutral — Strongly Favorable	Strongly Unfavorable — Neutral — Strongly Favorable	Strongly Unfavorable — Neutral — Strongly Favorable	Strongly Unfavorable — Neutral — Strongly Favorable
Environment				
Spotter				
Radar				
Other				
Comments	radar: 65+dBZ low levels (below 0C), but no high reflectivity in upper levels Spotter: golf ball hail report probably exaggerated size	environment supports severe, but stability of warm front limits wind potential	too stable not good rotation	not much precip yet

Exit

Fig. 6 Threat Assessment Log that is used to document forecaster's synthesis of warning inputs.

WESSL has begun to open the door for the development of new training and evaluation tools. One of the new tools being developed for simulation research and training is the Threat Assessment Log (Fig. 6). The Threat Assessment Log is designed to document how a forecaster is synthesizing warning decision making inputs (radar, environment, spotter, and other) for severe weather threats (tornado, severe hail, severe wind, and flash flooding). Understanding how forecasters and experts synthesize the primary warning inputs is a critical part of simulation training and evaluation. This new tool is currently
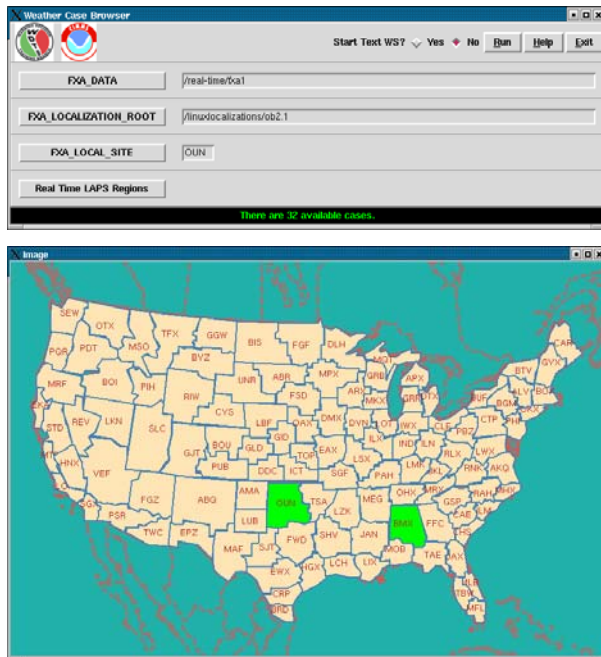
Fig. 7. Weather Case Browser that is used to organize data cases and allow for the easy selection of CWAs to view in D2D.

under development, and it is planned on being released in subsequent versions of WES.

6. Real-time Ingest

With some extra effort, the AWIPS in WES can be configured to ingest some commonly available data feeds. At the WDTB and CIMMS, NIDS radar data, satellite data, and model grid data have been configured to run in real time. Configuring a real-time ingest involves running AWIPS decoders and converting real-time data feeds to the AWIPS raw input format. The programs and techniques to do this are currently being refined and documented for external use. When these programs are ready they will be posted on the WES website at http://strc.comet.ucar.edu/wes/index.htm .

AWIPS input data feeds come from the NOAAPORT Satellite Broadcast System. While these data are commercially available, typically a user needs access to an expensive satellite download system to access the full national data sets used at NWS forecast offices. The AWIPS input data is usually directed to a "raw" subdirectory under each data directory (e.g. /data/awips/<case_name>/radar/raw), where the AWIPS decoders can be notified to look for data to process. As in the WES, the data decoding

process needs to be faked by issuing commands to the AWIPS processes to process data. Some of the AWIPS input data such as radar and grid data can be found from other data sources such as the Unidata Internet Data Distribution service (http://my.unidata.ucar.edu/content/software/idd).

At the WDTB and CIMMS, a single program sets the environment and restarts the AWIPS decoders on a daily basis in a cron job. Some of the AWIPS decoders are triggered to look for data in regular cron jobs, while others are triggered with event driven notifications using LDM software. In order to display radar data from anywhere in the country, localizations have been built for every CWA (~ 15 GB total). The cases and localizations are managed by a Weather Case Browser (Fig. 7), that allows the user to select the data (either archived or real-time) as well as the CWA to view in D2D.

7. Support

Currently there is no centralized support for WES outside of the NWS. The WES website contains troubleshooting tips and frequently asked question that are relevant for all WES users (http://strc.comet.ucar.edu/wes/index.htm). Users are encouraged to collaborate with the local forecast offices on installing WES and obtaining data cases.

8. Conclusions

The Weather Event Simulator offers a unique tool for viewing data sets from NWS operations, and it provides a means for collaboration between NWS offices and their partners. With the relatively recent development of a cost-free solution of WES, the ground is ripe for research, training, and collaboration with NWS offices. While WES is used extensively in NWS operations, it has been relatively slow to expand into academia and other NWS partners. One of the potential areas for widespread use is at Universities, where students can be exposed to NWS data sets, analysis techniques, and warning issues. It is hoped that with the future development of instructions over the real-time ingest of data feeds, that interest in using AWIPS and WES will grow, and accelerate the use of this new tool. WES has a unique potential to bring together NWS operations, research, and training on a large scale.

9. Acknowledgements

10. References

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