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WEATHERSCOPE: A STREAMLINED DISPLAY
APPLICATION FOR GEOGRAPHIC WEATHER DATA

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1.   INTRODUCTION

WeatherScope is a software package developed at the Oklahoma Climatological Survey (OCS) for viewing weather data. A primary design goal is to let the customer's machine render the content rather than rendering images on a server. Once located on the users machine, the data can be zoomed and panned, and data levels can be toggled on or off. Data are served to the customer in a more timely fashion because a server is not required to render a large number of permutations of possible data choices.

Another design goal of WeatherScope is its tight focus on the display of weather data. Although WeatherScope will display georeferenced weather data, it does not attempt to perform complex spatial queries like what would be found in traditional geographic information system (GIS) packages.

Another goal is for WeatherScope to be cross-platform. OCS customers utilize primarily Apple Macintosh computers or Intel-based computers. So WeatherScope is written to run on these two platforms.

2.   HISTORY

Now in its third incarnation, WeatherScope (then called WxScope; McPherson and McPherson 1994) was created in the early to mid 1990's as a tool to visualize data from the Oklahoma Mesonet. At the time the target audience was participants in two outreach programs of the OCS: K-12 teachers in project EarthStorm (McPherson and Crawford 1996), and emergency first responders in OK-First (Morris et. al. 2001).

The first WxScope had the ability to produce maps of data in a station model format, contours, and wind barbs and vectors. WxScope also had the

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ability to produce simple time-series graphs. Its development was along two separate tracks at the time – one for MS-DOS and the other for Apple Mac!OS.

A separate, but complimentary, program called WxImage was written for Mac OS. WxImage could display several image formats common for weather graphics. However, WxImage's main accomplishments were its ability to read and display raw NIDS data (NEXRAD Level 3) and to produce color-filled gradients of Mesonet data.

The second incarnation of WeatherScope, developed in the latter 1990's, was in the form of a web-browser plugin called WxScope Plugin (Wolfinbarger et. al. 1998), with the separate tracks of software development merged into one. The plugin was developed to work under Mac OS and MS Windows 95/98 in Netscape Communicator or Microsoft Explorer. The WxScope Plugin gave web developers the ability to embed weather data within any web page.

3.   CURRENT INCARNATION

The present WeatherScope application is a stand-alone web-based display and analysis system and is available for Windows 2000 and XP and Apple Mac OS X operating systems. Written in C++ and employing OpenGL visualization tools, WeatherScope can be used for many applications in meteorology, geosciences, and geography. Using WeatherScope, users can produce georeferenced maps tailored to their needs, applying a variety of point data and geographic overlays. This differs from WxScope Plugin in that the user now has control of the content and look of the map, whereas before the web designer controlled the content and the user only had control of zooming, panning, and toggling on or off certain predefined products and overlays.

WeatherScope can display geographical weather data as a continuous field in either vector, gradient, or grid point data displays. Data, network, and geographic overlays can be changed by the

network administrator and are updated dynamically by all users when they connect to the web server. WeatherScope also has the ability to produce time-series graphs of data.

Weatherscope has language localization support for the user interface and configuration files. Currently, Weatherscope is configured for English and French. Unicode also is supported.

3.1 *Configuration*

The defining of data, network, and geographic overlay sources is straightforward and highly configurable. A network is defined by a set of XML configuration files. A point-source network such as the Oklahoma Mesonet has three configuration files. The first is a general configuration file describing where the program can find information on the internet. This file includes the location of data files, the location of updates to the configuration files, URLs for information on the data and its producer, and an e-mail address to correspond with the data manager. The file also includes information on the frequency of the data as well as how often the program should check for new data, and when the data becomes too old.

A second configuration file provides site information. This file includes the geographic location of sites, the site names and ID's, and site-specific configuration information. For example, the Oklahoma Mesonet configuration file includes the calibration indices for soil moisture probes.

A third configuration file defines the variables supplied by the network. This file includes a variable ID and name, data representation type (e.g., float or integer), and units. Also, derived variables are defined in terms of provided variable ID's. The order of inclusion in the file determines the order of variables presented in the user's menu.

Radar data have similar configuration files except that the variable information file is replaced by a product information file. This file contains information defining the number of ordinal data levels, radial vs. cartesian grid, pixel or bin size, and units.

Geographic overlays have a main configuration file similar to those previously mentioned. In addition, a shape information file defines the various shapes available. Geographic overlays currently are in a format specific to WeatherScope, but later versions will allow data to be read directly from ESRI Shapefiles.

Configuration of all the file types is straightforward, making new data sources easy to include. And data sources are not limited to weather data. To date, data has been incorporated from the Oklahoma Mesonet, the Agricultural Research Services Little Washita River Basin Micronet, the Atmospheric Radiation Measurement Project's network in the Southern Great Plains, Météo Québec, the West Texas mesonet, the Georgia Automated Environmental Monitoring Network, USGS earthquake activity, and synoptic surface networks for the United States, Canada, Mexico, and Europe. Map overlays have been produced for political boundaries (national, state, province, county) and transportation boundaries (airport runway, road, railroad, city streets).

3.2 *Maps*

WeatherScope allows the user to produce weather maps according to individual needs. Several kinds of map features are available.

A station model map can be produced with values located at the site location or at one of eight positions adjacent to the site location. The user defines this location as well as the color of the text. Wind barbs can be created based on wind speed and direction or U and V wind components, also with user defined colors. Several symbols are available to indicate site location (e.g., open circle, filled square).

Other data features include continuous color gradients and line contours of variables. This visualization is accomplished by performing an objective analysis on the point data. Wind vectors also may be created using objective analysis. Radar data can be displayed on the map along with the station model and gradient data.

The map projection is chosen by the user and the map is rendered on-the-fly. Currently available projections include Mercator, Polar Stereographic, Lambert Conformal Conic, Albers Conic, Orthographic, and flat-earth. The user also has control of the map background color.

Map overlays may be produced from any line or polygon source, although only lines are displayed in the current version for either type. Overlays and data layers can be arranged in the legend such that a layer can be above or below another layer. Overlays can be used as "masks" to limit the area of data viewing. Hence, if an overlay mask is above a gradient layer, then only the data within the extent of the overlay will be shown.

The translucency of layers is user configurable. For example, radar data may overlay point data, but if translucency is set to less than 100%, then the point data are allowed to show through. Translucency is not restricted to radar and gradient data. It can be defined for most features, though some cannot be set in the current user interface.

Weatherscope has the ability to update data in real-time as it becomes available. Alternatively, the user may specify the date and time of the map. Once data for a certain time has been downloaded to the users computer it does not need to be retrieved again, though Weatherscope will check periodically for updated data files. The user may set the program to work off-line using only data located on the user's computer.

Figures 1 through 5 show examples of map output from WeatherScope.

3.3 *Time Series*

To make a time series graph, the user defines starting and ending times, the variables to be displayed, and the sites to display. Multiple variables and/or multiple sites can be displayed on a single graph. For variables with matching units, such as temperature and dewpoint, a single axis is displayed. For each variable with different units, a new axis is created. The data range for each axis can be set by the user or will be determined by the software according to the range of data selected. Also, the color and thickness of the plots are user-controlled. Figure 6 shows an example of a time-series graph.

4. FUTURE DEVELOPMENT

This incarnation of the WeatherScope application still is early in its development. Current development is focused on attaining feature parity with WxScope Plugin. Afterward, a host of new features are planned. These include polygon support, attribute support for geographic objects, support for ESRI Shapefiles, animation, data queries (e.g., sites with temperatures below freezing), a syntax for user-defined derived variables, color palette control, multiple linked windows, XML-based data formats, and georeferenced image files. Priorities for feature inclusion and development will depend on OCS users' needs and available resources.

5. ACKNOWLEDGMENTS

6. REFERENCES

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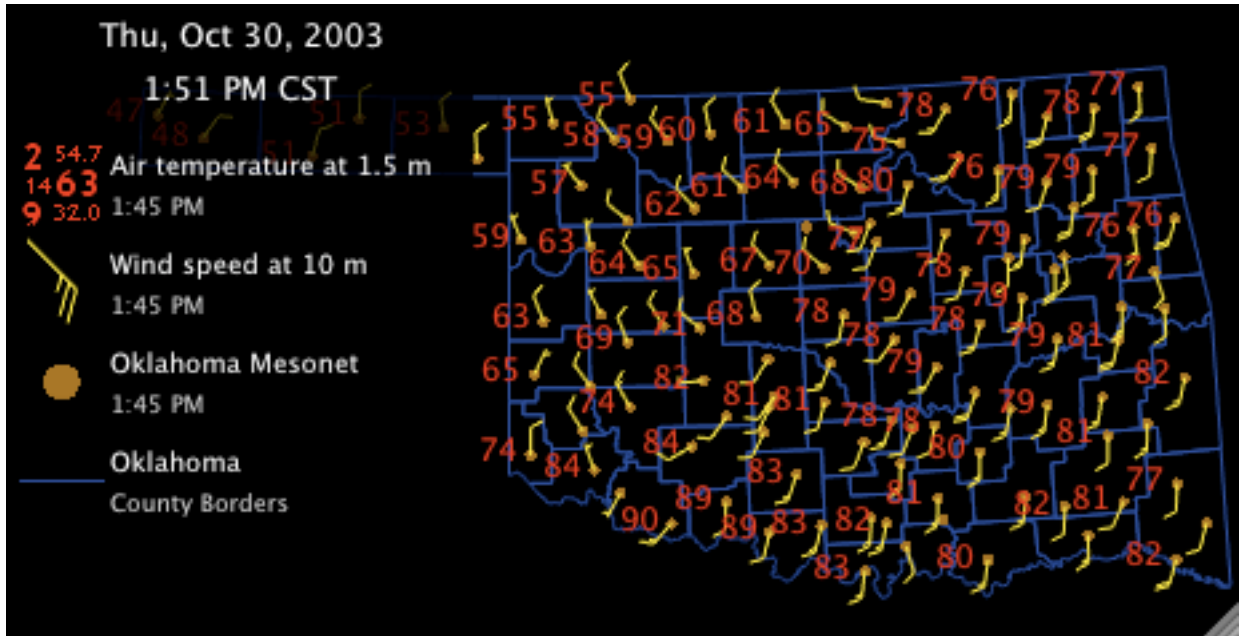
Figure 1. Oklahoma Mesonet map. The sites are represented as filled circles with air temperature located to the left in red. Wind barbs are in yellow. The projection is polar stereographic.
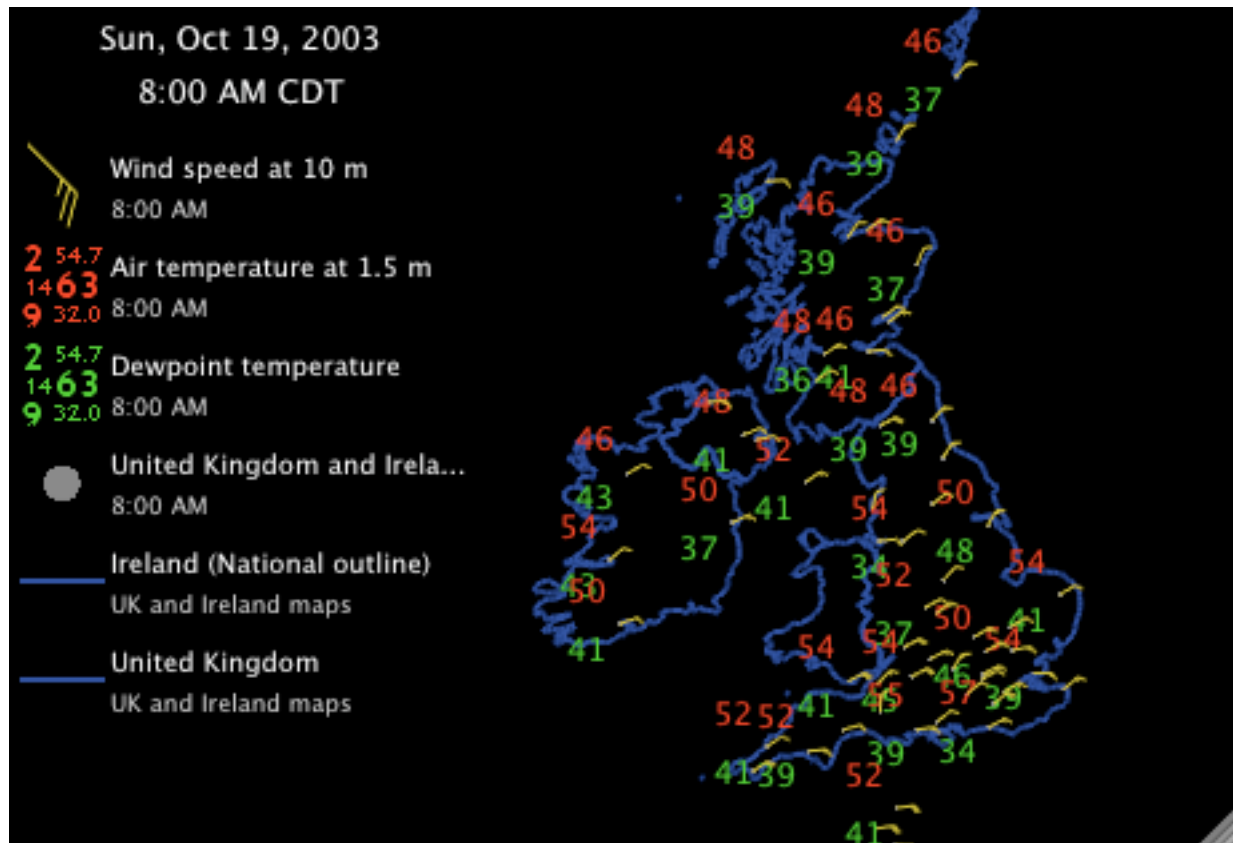

Figure 2. Surface data for the United Kingdom and Ireland. Site locations are gray filled circles. Air temperature is upper-left in red and dewpoint lower-left in green. Wind barbs are in yellow. Map was produced with clock set to local time zone (US central), so the time represented actually is at 13 UTC.
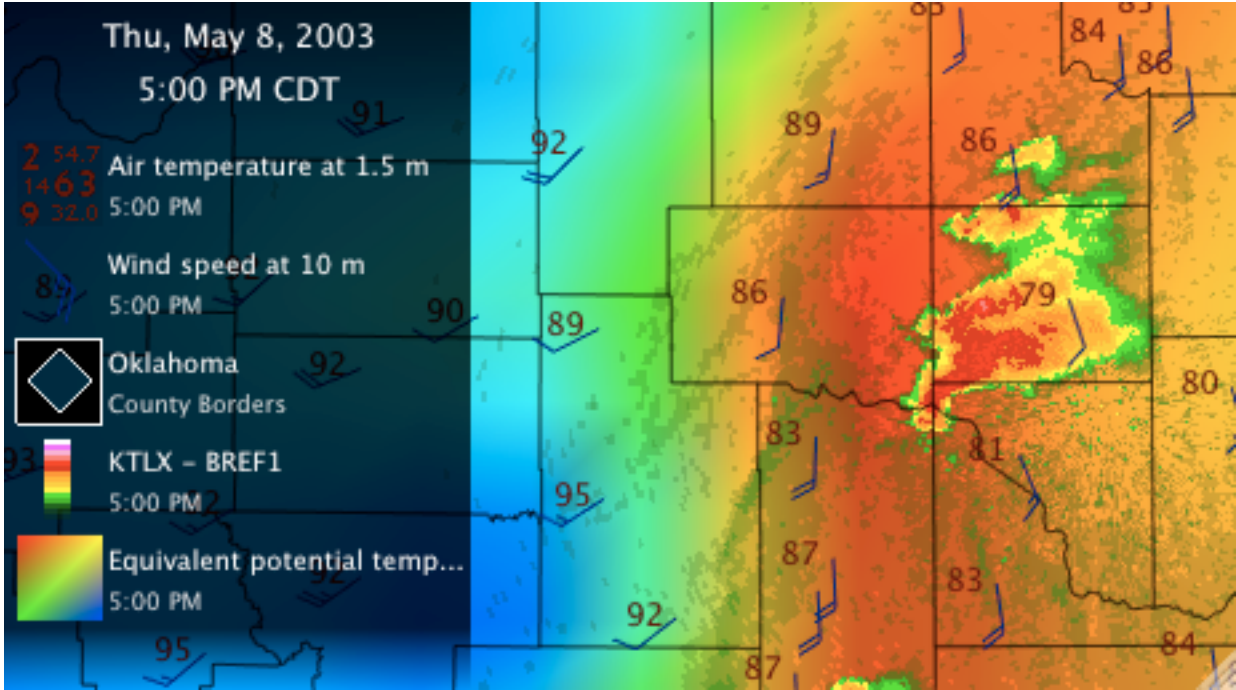
Figure 3. Central Oklahoma radar display for the 2003 May 8 tornadic storm. Air temperature and winds from the Oklahoma mesonet are represented in a station model. Mesonet equivalent potential temperature is shown as a color gradient. Projection is Lambert Conformal.
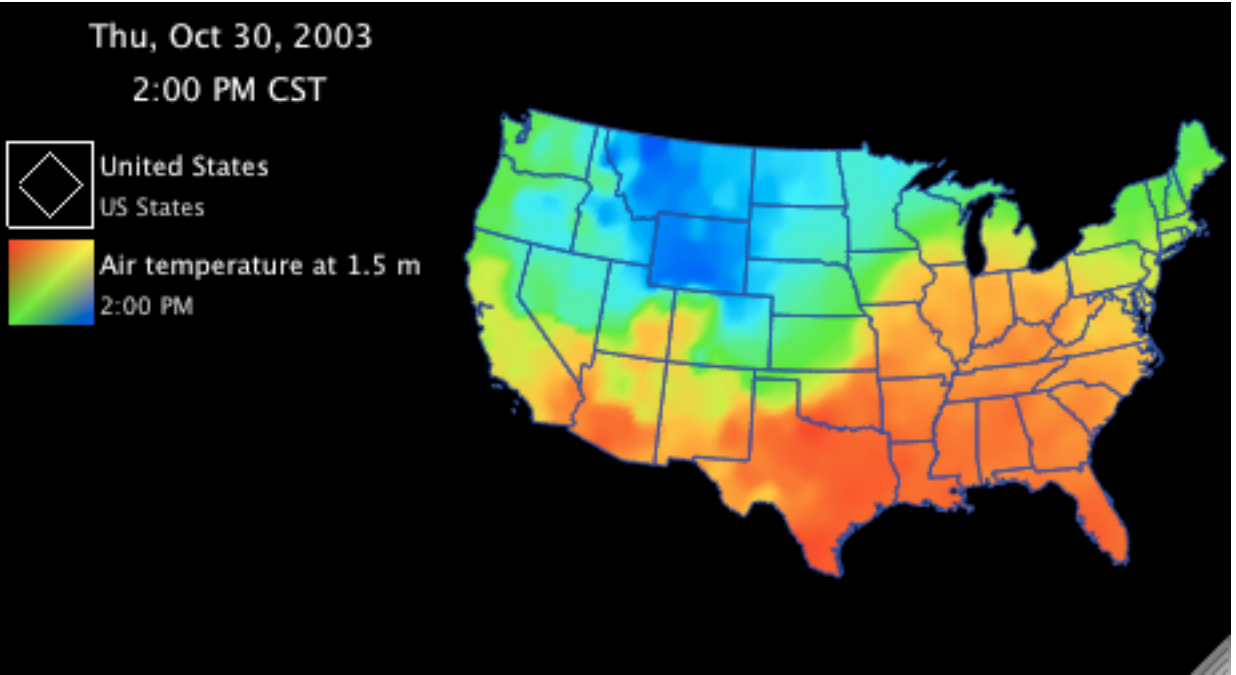

Figure 4. Gradient of surface temperature from the CONUS NWS synoptic network. US states map overlays the gradient and masks anything outside of the extent of the shape. Projection is Lambert Conformal.
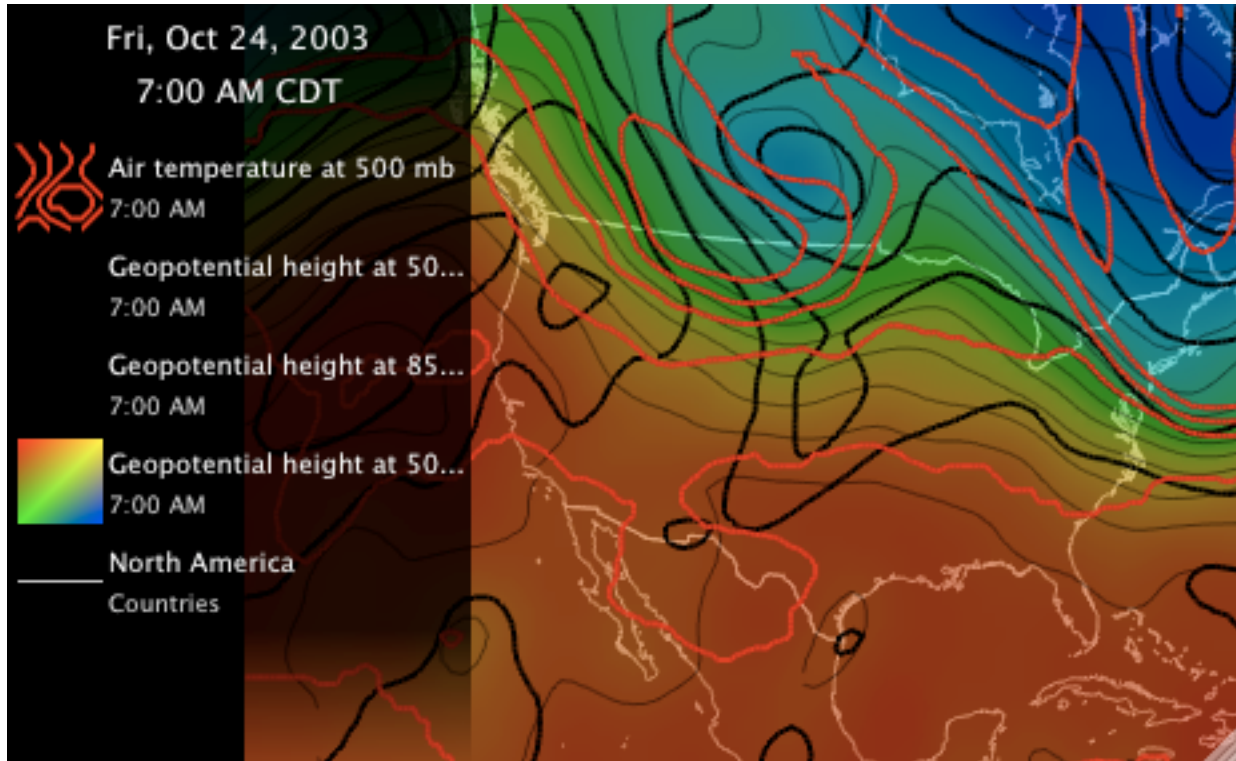
Figure 5. Gridded field (not yet implemented in current version) of ETA model surface initialization data. Map shows contours of 500 mb temperatures in red with line thickness of 2, contours of 850 mb heights in black with line thickness of 2, contour of 500 mb heights in black with thickness of 1 and translucency of 50%, color gradient of 500 mb heights with translucency of 50%, and a basemap of North American national boundaries in white. Note that the white map background is below the gradient and is allowed to "show through" because of the translucency setting of the gradient.
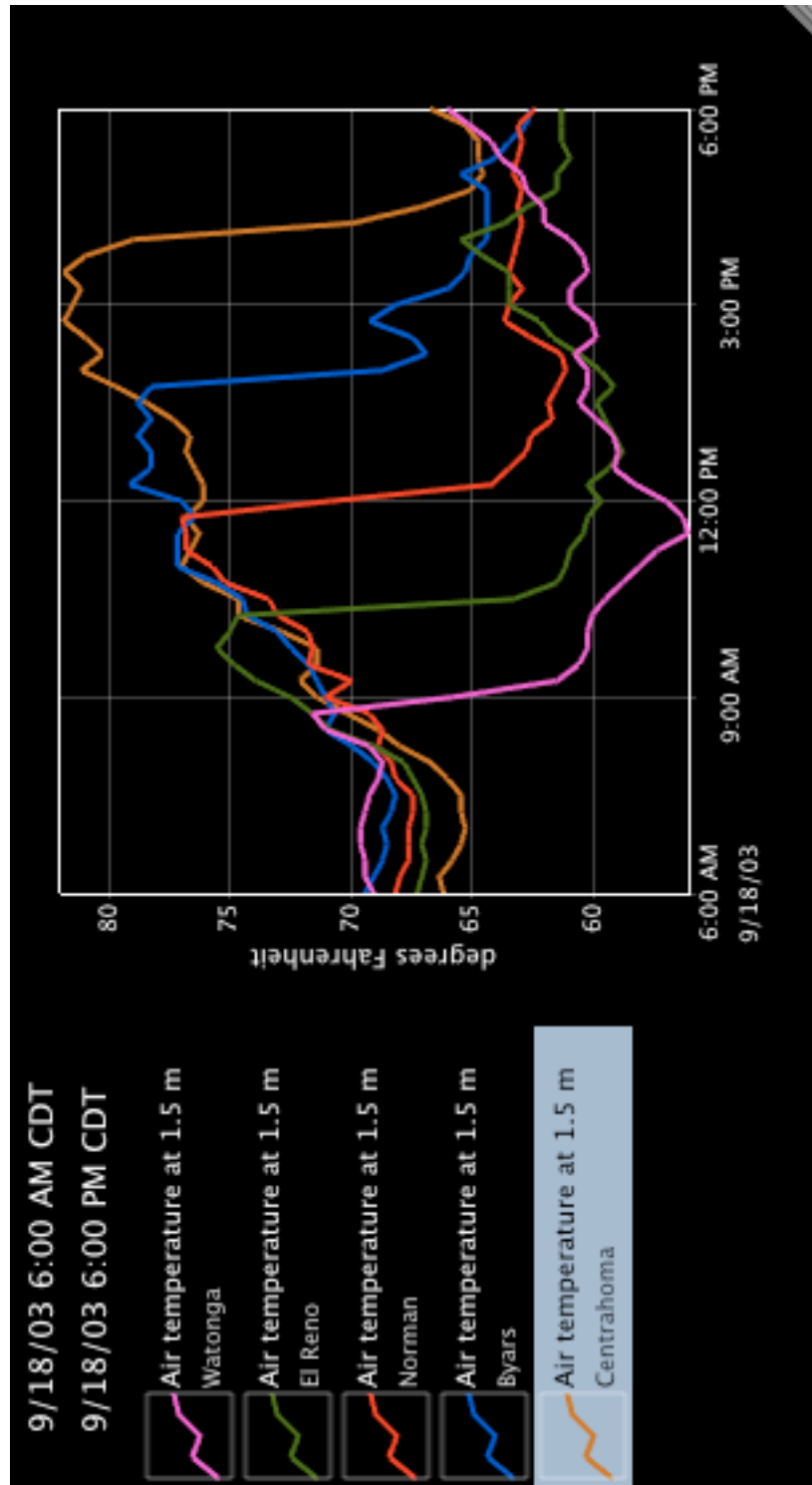
Figure 6. Time-series graph showing 12 hours of air temperature data for five Oklahoma Mesonet sites.