

J4.8 A MODERN, PC/MAC VISUALIZATION TOOL FOR K-20 STUDENTS

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1. INTRODUCTION

The Oklahoma Climatological Survey (OCS) works with K-12 schools as well as undergraduate and graduate students at the University of Oklahoma (OU) to develop high-quality, easy to use software for displaying real-time and archived weather data. Called WeatherScope, this software includes visualization of surface observations, radar data, gridded data, lightning, and other GIS datasets. WeatherScope can be downloaded freely for non-profit use at <http://sdg.ocs.ou.edu>.

2. WEATHERSCOPE OVERVIEW

To aid customers in viewing weather information on their personal computers (PC), OCS software engineers have developed WeatherScope, based on C++ and OpenGL. WeatherScope is a stand-alone HTTP-based display and analysis tool that operates on Microsoft Windows 2000/XP and Apple Macintosh OS X. Originally designed to display Oklahoma weather information, WeatherScope can display weather and geographical information as data plots, wind vectors, color contours, or line contours from sources both within and outside Oklahoma. WeatherScope can update data automatically in real-time, or the user may specify the date and time of the map to examine archived datasets.

A primary design goal for OCS's software development group is to generate visual displays on the customer's PC rather than generating static images on a server. Once data are downloaded to the user's computer, images are created via an XML file that can be customized by the decision maker. Geographic overlays and data are displayed, layered, and colored according to the XML file. The file also contains information about the map projection, font type and size, line or symbol size, zoom level, translucency of the map layer, refresh rate, and the data source.

2.1 Data

WeatherScope displays point data with known latitude-longitude pairs (Fig. 1), such as surface observations from the Oklahoma Mesonet (Brock et al. 1995), Automated Surface Observing System (ASOS) measurements from the National Weather Service (NWS), radiosonde observations, and lightning strikes. ASCII data files can reside on a remote server or the client's machine.

Radar data from the NWS's NEXt generation RADar (NEXRAD) can be displayed using either Level II or Level III (formerly called "NIDS") data or regional/national mosaics. Level II data in NetCDF format, as distributed by the National Climatic Data Center, includes 256 color bins and 16 tilt angles for base reflectivity and base velocity. Level III data includes 16 color bins and four tilts for base reflectivity and two tilts of base velocity. In addition, Level III products include storm-relative velocity, echo tops, 1-h and 3-h precipitation estimates, storm-total rainfall, composite reflectivity, and vertically integrated liquid. Figure 2 demonstrates the visible difference between the Level II and III data for the lowest tilt of base reflectivity at 5:05 PM CDT on 8 May 2003 near Oklahoma City, OK.

Storm attributes are displayed when the user selects the Level III composite reflectivity product (e.g., file in which attributes are embedded by the NWS) and holds the cursor over storm locations (Fig. 3). Similarly, an "inspector window" shows the dBZ value of the base reflectivity when the user selects this product and scrolls the cursor over the region of interest.

Geographic overlays, in ESRI shapefile format, available for every state in the U.S. include state and county borders, highways (limited access, principle, and other), urban areas, and U.S. Congressional districts. Currently, WeatherScope supports line shapefiles only (Fig. 4). Point data, such as locations of power plants, communications towers, or schools, can be displayed via an XML-based file format. As geographic information has become more distributed on the Internet, users have expanded the types of spatial features they incorporate into their personal weather maps.

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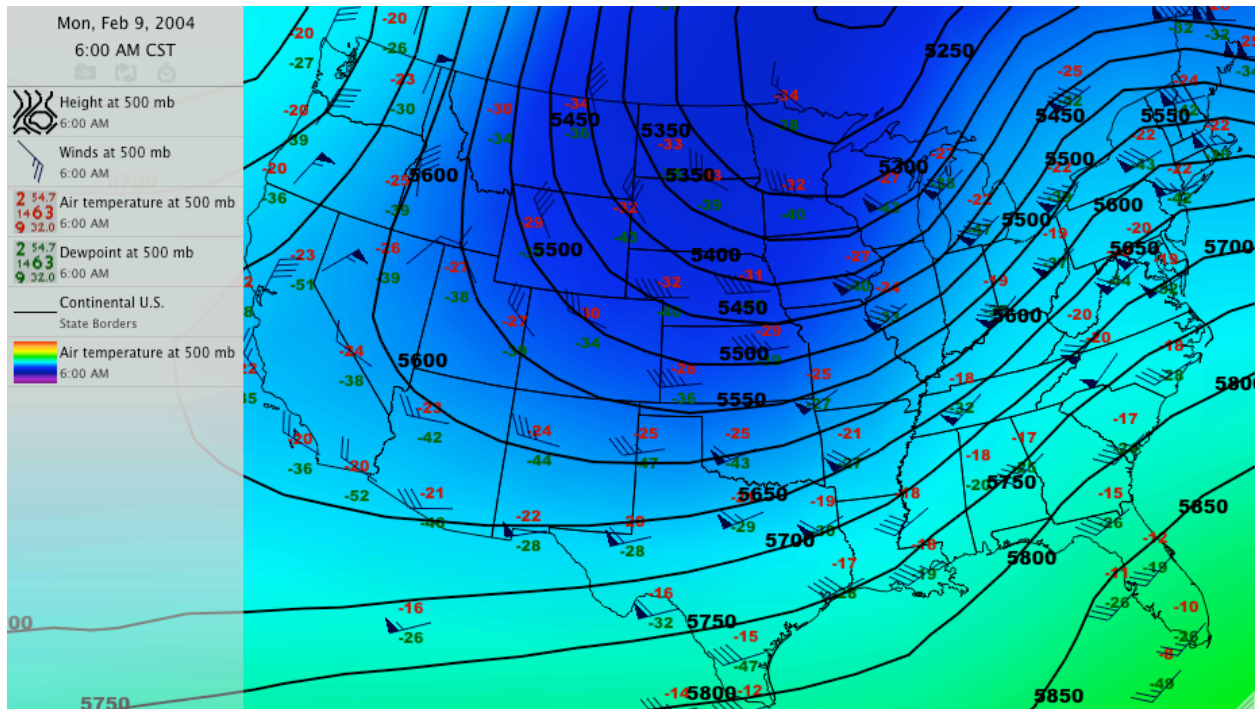


FIG. 1. Example of WeatherScope display of radiosonde observations at 500 mb for 1200 UTC on 9 February 2004. Air temperature (in $^{\circ}\text{C}$) appears as a plotted observation (red, upper left on station model) and color-filled gradient. Dewpoint temperatures (in $^{\circ}\text{C}$) and winds (in m/s) are plotted as green numbers and black barbs, respectively. 500-mb heights (in m) appear as labeled line contours in black.

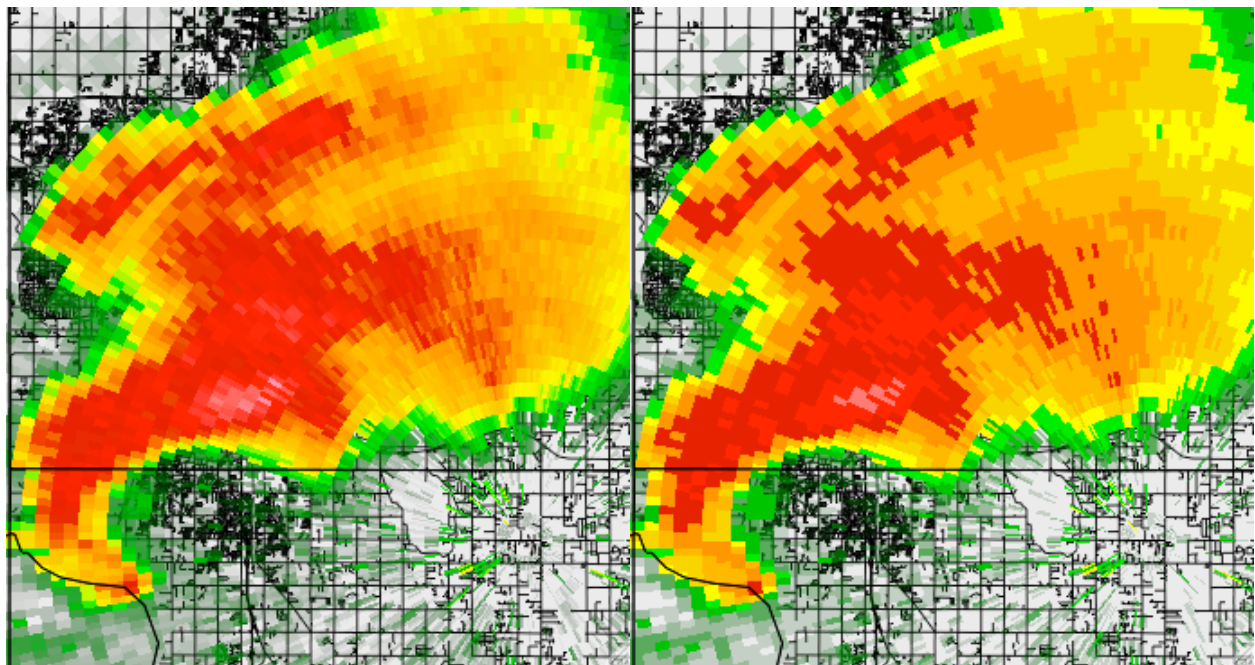


FIG. 2. Example of WeatherScope display of Level II (left) and Level III (right) NEXRAD radar data from KTLX (near Oklahoma City, OK) at 5:05 PM CDT on 8 May 2003. Radar data are displayed with 100% opacity below the county boundaries and above the city streets.

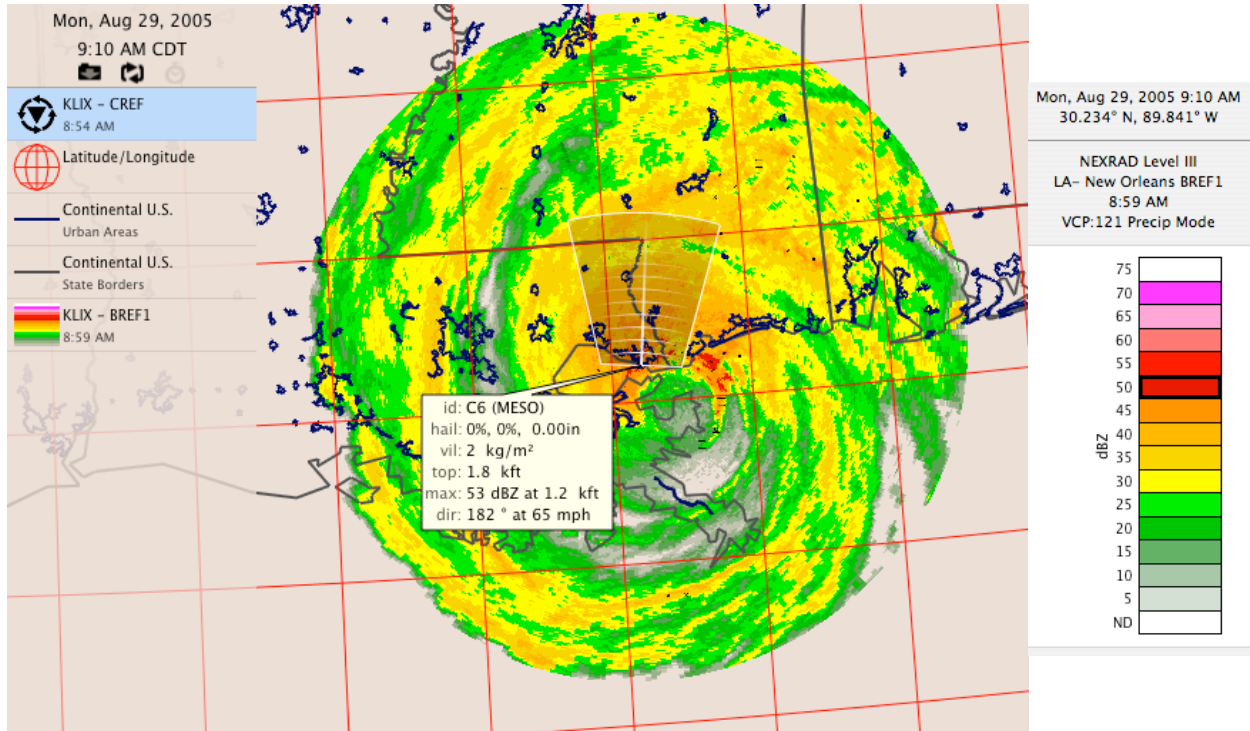


FIG. 3. Example of storm attributes information (middle of map) and WeatherScope inspector window (right of map) for Hurricane Katrina on 29 August 2005. Storm attributes include the storm ID, storm motion, maximum reflectivity (in dBZ), percent chance of hail (and associated size, if appropriate), and whether the storm has a mesocyclone (MESO) or tornado vortex signature (TVS), as determined by NWS algorithms. Level III radar data from KLIX (New Orleans, LA) are overlain by state borders (grey), urban areas (dark blue), and latitude/longitude lines (red).

2.2 Customization

Users can customize WeatherScope maps or graphs by selecting items through the user interface or by generating their own overlays and data sources. Options in the user-interface menus include New Map (or Graph), Save As (e.g., as a PNG, JPEG, TIFF, QuickTime Movie, Photoshop document), animation controls (e.g., play, pause, next frame, first frame), projection (e.g., Lambert Conformal, Mercator, Albers Conic Ellipse), Date/Time, Zoom In/Out, Start/Stop Archiving, Track Real Time, New Product (e.g., Radar, Shape, Symbol, Observation, Image), product properties (e.g., data set, network or station, color, line thickness, opacity), Hide/Show product, layer arrangement (e.g., Move to Front), and Show Inspector, Animator, or Data Manager.

For data sources not served by the Oklahoma Climatological Survey, users can generate their own datasets by creating three properly formatted XML files that describe the dataset configuration,

site information, and variable information. The dataset configuration includes name of the dataset (e.g., NEXRAD Level II), data provider, location of the data (via a web address), data resolution in time, and refresh rate. Site information typically includes the station name, station number, station ID, latitude, longitude, and elevation. Variable information includes the variable name, variable ID, variable type (e.g., floating point value, integer, string), and units of measurement. Figure 5 shows a map generated from storm reports issued by the NWS's Storm Prediction Center. This dataset and its display capabilities within WeatherScope were developed by a user, independent of the OCS software development group.

In a similar manner, users with access to point data or ESRI shapefiles that describe geographic features can create new overlays for display on their custom maps. For example, the city streets displayed in Fig. 2 result from shapefiles available at a government website and incorporated into WeatherScope by a user.

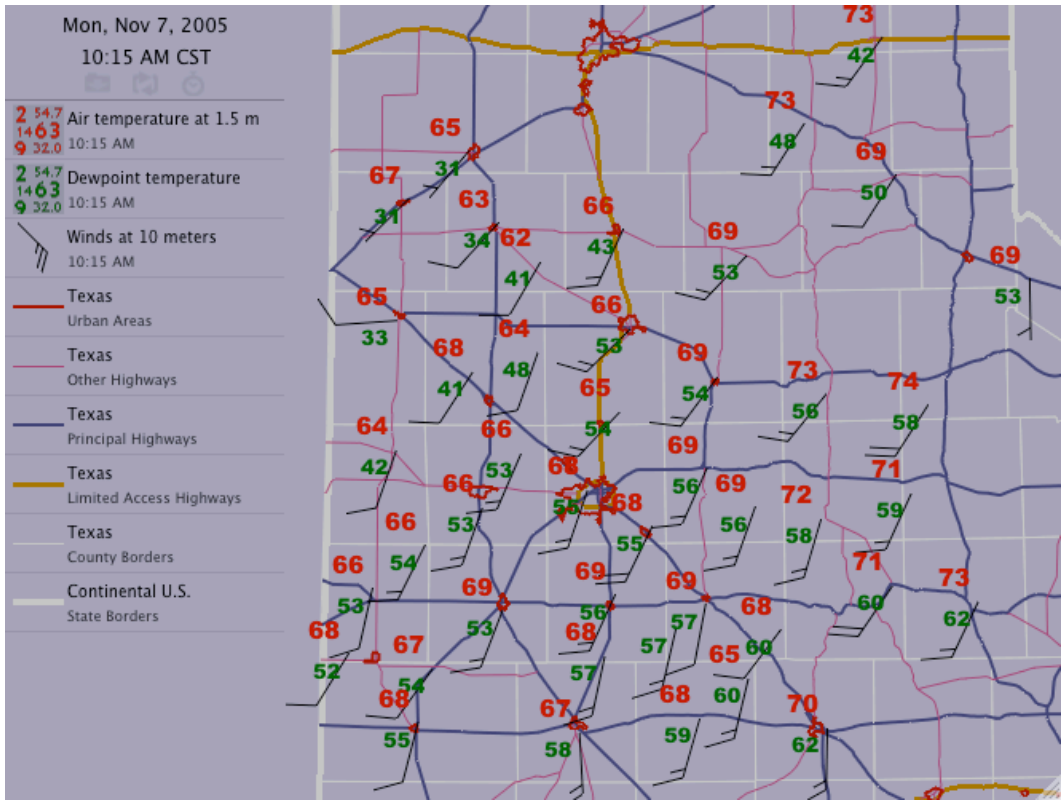


FIG. 4. Example of a WeatherScope map with various geographic overlays, including highways, urban area outlines, and governmental borders. West Texas Mesonet data are plotted for 10:15 AM CST on 7 November 2005.

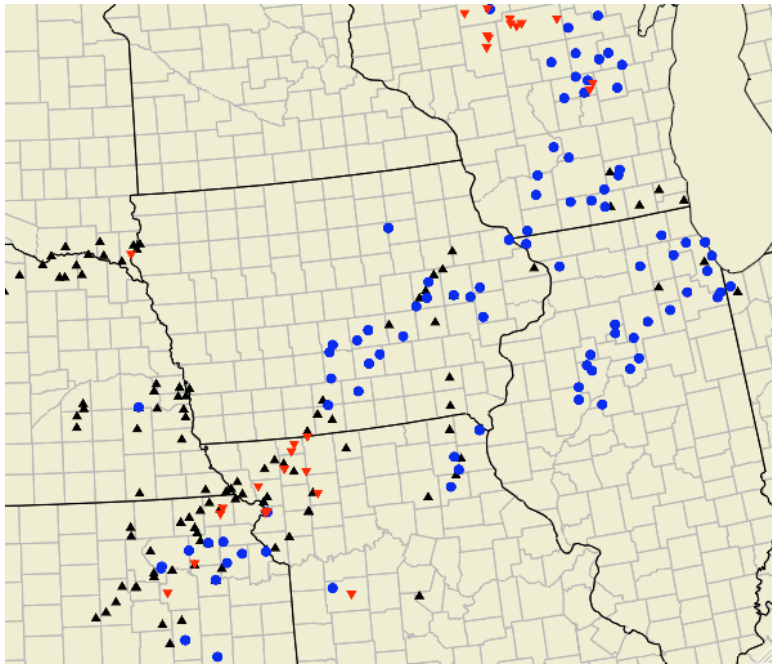


FIG. 5. Example of a WeatherScope map with tornado (red triangles), hail (black triangles), and severe wind (blue circles) reports for 5 June 2005 from the NWS Storm Prediction Center in Norman, OK.

3. EDUCATIONAL USES

The WeatherScope software has been used by educators and students in a host of situations. K-12 students keep track of current weather in their classrooms by using the Track Real Time feature, resulting in automatic updates of the data. These students also use archived data for science fair projects and other experiments.

University undergraduate and graduate students use the software for laboratory exercises (e.g., Oklahoma Climatological Survey 2005), forecast contests (e.g., <http://wxchallenge.com/>), and research projects (e.g., Morgan 2005). Most of the features added to each version of the software result from feedback of university students, especially those who push the limits of the software while working on thesis or dissertation research.

4. SUMMARY

WeatherScope is an easy-to-use display package that takes advantage of the graphics capabilities of the current generation of personal computers. It can be downloaded freely for non-profit use at <http://sdg.ocs.ou.edu>.

5. ACKNOWLEDGMENTS

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