

## THE TRANSITION FROM AN INFORMATION-SUPPORT SYSTEM TO A DECISION-SUPPORT SYSTEM FOR PUBLIC-SAFETY AGENCIES

Dale A. Morris\* and Kevin A. Kloesel  
Oklahoma Climatological Survey,  
The University of Oklahoma  
Norman, OK

### 1. INTRODUCTION

In 1980, the Oklahoma Legislature created the Oklahoma Climatological Survey (OCS) with a mandate to "acquire, archive, process and disseminate, in the most cost-effective way possible, all climate and weather information which is or could be of value to policy and decision makers in the state." Over the years, OCS, along with several partners, has initiated several programs and projects to be consistent with this mandate. Many of these programs were built upon the Oklahoma Mesonet (Brock *et al.* 1995), which currently acquires and disseminates data from 114 automated weather stations across the state in real-time. Perhaps one concept that separated the Oklahoma Mesonet from other state and regional observing networks was that it was designed to be multipurpose and that several user groups were targeted to be beneficiaries of the Mesonet from the network's inception. These user groups included K-12 education, agricultural interests, government agencies, and public safety including emergency management. In 1992, OCS began its first formal outreach program based on the Mesonet known as EARTHSTORM to serve K-12 education (McPherson and Crawford 1996).

Based upon lessons learned in developing the Mesonet and EARTHSTORM, OCS began an initiative to serve public-safety (fire, law enforcement, and emergency management) agencies in 1996. Known as OK-FIRST, this program began by sharing weather information with 65 public-safety agencies; instructing officials from these agencies in the acquisition and use of the data; and providing follow-up support. Because of stable support from the Oklahoma Legislature and the Oklahoma Department of Public Safety, OK-FIRST serves over 110 agencies (Fig. 1), with a majority of users from rural areas (65% of the participants are from towns with populations less than 10,000). Each of these participants routinely access real-time WSR-88D data from 15 regional radar sites via a NIDS (NEXRAD Information Dissemination Service) feed, data from \*Corresponding author address: Dale A. Morris, Oklahoma Climatological Survey, 100 E. Boyd, Suite 1210, Norman OK 73019; e-mail: dmorris@ou.edu; <http://okfirst.ocs.ou.edu>.

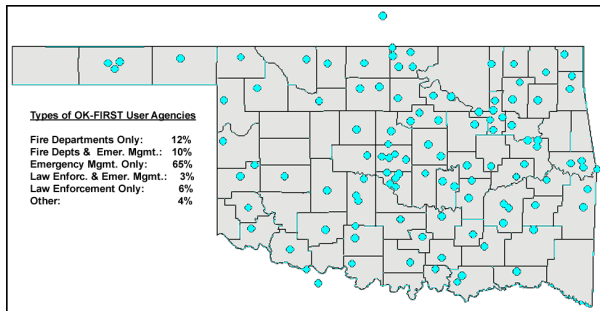
the Oklahoma Mesonet, and information from the National Weather Service (NWS) and apply this information resource to a wide variety of weather-impacted situations.

In 1999, OCS and the NWS began a cooperative pilot program to investigate the portability of OK-FIRST as a national prototype. This pilot program, known as ONALERT (Kloesel *et al.* 2000), began a transition from a pure "information-support" system towards a "decision-support" system. This manuscript discusses these concepts relative to the public safety user. The motivation behind this discussion is that OK-FIRST has convincingly demonstrated the need to provide meteorological data services to the public safety community in Oklahoma (*e.g.*, Morris *et al.* 2000; James *et al.* 2000). Because weather threats do not recognize state boundaries, the need for this type of information does not stop at political borders; yet, OCS can only legitimately serve Oklahoma agencies. Perhaps the lessons learned in Oklahoma can be utilized by other public and private sector groups to provide these services to the public safety community.

### 2. THE ORIGINAL OK-FIRST SYSTEM: INFORMATION-SUPPORT

Since the popularity of the World Wide Web exploded in the late 1990s, more people have accessed weather data than ever before. The sheer number of successful web sites devoted to providing weather data indicates the potential for citizens to apply this data to their individual situations. While the organization and presentation of the data differs among these sites, the concept is basically the same: relatively unprocessed weather data is provided, permitting little user interaction with the data.

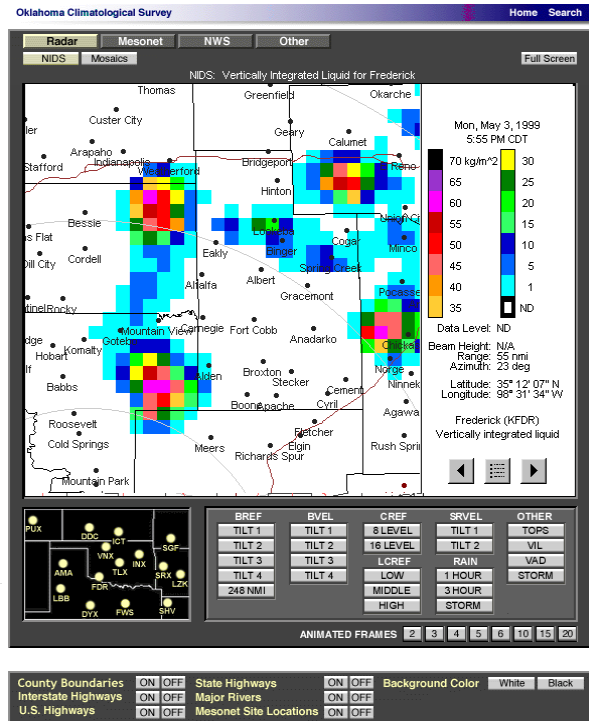
In this section, the original OK-FIRST site is shown to be like many weather-related web sites in that a great deal of weather data is presented to users. However, the provision of this data is not without certain challenges. First, the raw weather data needs to be available and accessible. For example, a user might be able to access and view a radar map of base reflectivity on a web site. Second, the user must be able to correctly interpret the *data* and make the conversion to useful *information*. In this step, the user should examine the radar echoes near his/her



**Figure 1.** Locations of communities served by OK-FIRST as of September 2000.

area and decide if they are representative of his/her location in space and/or time. Third, the weather information must be assimilated with other types of information in order to make a beneficial decision. In other words, the user takes the reflectivity pattern and any available NWS guidance into account with the fact that a little league tournament is in progress, and advises the league officials as to the projected arrival of a thunderstorm. This example outlines the steps one performs when making a decision based upon environmental conditions. This simple example also assumes that the user already knows what specific threat he or she might be under because the user knew about the possibility of a thunderstorm and retrieved the appropriate radar reflectivity image.

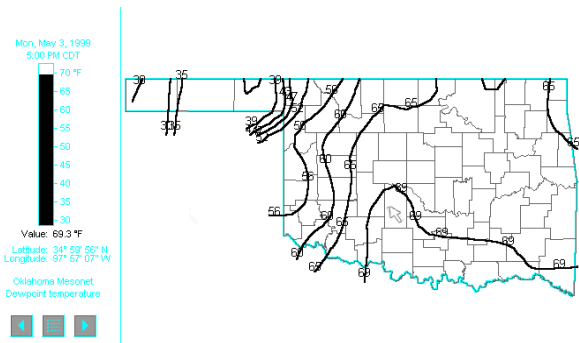
The original OK-FIRST web site (Fig. 2) basically provided data organized in four broad categories. First, approximately 20 NIDS radar products were available from each of 15 radars around Oklahoma. A mechanism was also provided whereby each user could have a set of default preferences. Thus, a user in northeast Oklahoma would default to the Tulsa radar, and a western Oklahoma user could default to the Frederick radar. Second, data from the Oklahoma Mesonet was presented in the form of station plots, contour maps and time series graphs. Third, National Weather Service products (e.g., forecasts, watches, and warnings) were available. Fourth, a section of "Other" data sources were included to provide access to derived products from the Oklahoma Mesonet such as the Oklahoma Fire Danger Model (Carlson and Engle 1998) and the Oklahoma Rainfall Update, used during rainy episodes and for real-time drought monitoring. The "Other" category also provided links to other useful weather-related web sites. Thus, in terms of data availability, this site was fairly analogous to many of the other web sites available today. Perhaps one primary difference between the OK-FIRST site and other weather sites was that OK-FIRST was designed to bring a comprehensive suite of localized data products to rural users with very little time delay.



**Figure 2.** From any of the data sources available in the original OK-FIRST web site, like the radar view of vertically integrated liquid from the Frederick WSR-88D on 3 May 1999, the user could change to any of the other data categories.

This original OK-FIRST web site began to bridge the gap from data to information by providing tools to aid the user in basic interpretation. For example, the NIDS and Mesonet data were presented using custom web-browser "plug-in" software (Wolfenbarger *et al.* 1998a,b). This software allowed the user to interact with the data by making queries through an interactive cursor-tracking feature (Fig. 3). In addition, the plug-in and CGI software on the web site allowed each user to specify a set of geographic overlay preferences (town locations, various levels of highways, etc.) to display and their colors. Thus, the original OK-FIRST web site allowed a user to know with relative certainty a wide variety of environmental conditions in their specific county (e.g., surface conditions like temperature, humidity, rainfall, and winds; and radar parameters like reflectivity, vertically integrated liquid, radial- and storm-relative velocity).

The original OK-FIRST web site also provided a great deal of online training materials, including comprehensive sets of data from ten case studies. For example, over 450 NEXRAD radar images from the 26 April 1991 Oklahoma/Kansas tornado outbreak were available in the case study material. During the



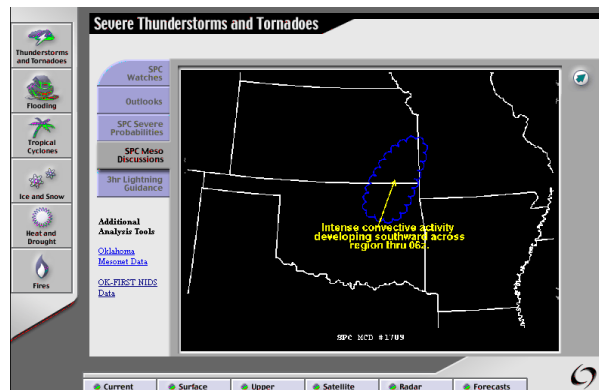
**Figure 3.** Example of WxScope™ plug-in display of dew point temperature from the Oklahoma Mesonet at 5:00 p.m. local time on 3 May 1999. The plug-in software took "raw" data files from the Oklahoma Mesonet and the WSR-88D units, merged the files with geographic information contained on the user's local computer, and allowed the user to interact with the data display. In this case, the vertical bar in the legend moved with the cursor, and indicated that the dew point temperature near the mouse pointer was 69.3.

mandatory workshops each OK-FIRST participant completed, examples of radar signatures like mesocyclones, hook echoes, and hail cores were presented. Yet, to effectively use this case study after returning to their home jurisdictions, the users still needed to know which of the 450 images indicated which signature. In addition, the users also needed to remember which of the available products were most appropriate to use in particular situations. While these concerns are appropriately classified as training issues, and while an independent evaluator (James *et al.* 2000) determined that OK-FIRST staff "enhanced significantly the knowledge and skills of the project participants in a very short period of time," both OCS staff and OK-FIRST users recognized that improvements could be made.

### 3. ONALERT: TOWARDS DECISION-SUPPORT

The ONALERT web site introduced a new concept to Oklahoma's public safety users. Besides including data organized by source, ONALERT also organized additional data sources according to six specific weather hazards (Fig. 4). For example, the section on severe weather included links to outlooks from the Storm Prediction Center (SPC), and the flooding section included outlooks and guidance products from the Hydrometeorological Prediction Center (HPC), the Arkansas-Red Basin River Forecast Center (ABRFC) in Tulsa, and the Climate Prediction Center (CPC). Thus, ONALERT enabled the user to determine the current weather threat much more easily.

The ONALERT web site included many new products and outlooks that were not available on the original OK-FIRST web site. While the ONALERT system allowed the users to more easily diagnose a specific threat, the users needed to know which of



**Figure 4.** Layout of the ONALERT web page. Six data categories (radar, surface, upper-air, satellite, forecasts, and current data) are available from the buttons at the bottom of the page. Products for each of six hazard categories (thunderstorms/tornadoes, flooding, tropical, winter weather, heat/drought, fire weather) are accessible through the buttons on the far left. This page displays the mesoscale discussion from the Storm Prediction Center issued at 0124 UTC on 12 September 2000, which is one of the products available in the thunderstorms/tornadoes category.

the analysis tools along the bottom of the screen were appropriate to use during a specific threat. In addition, users also had to be able to remember specific data threshold values or signature patterns for comparison with current data so correct decisions could be made.

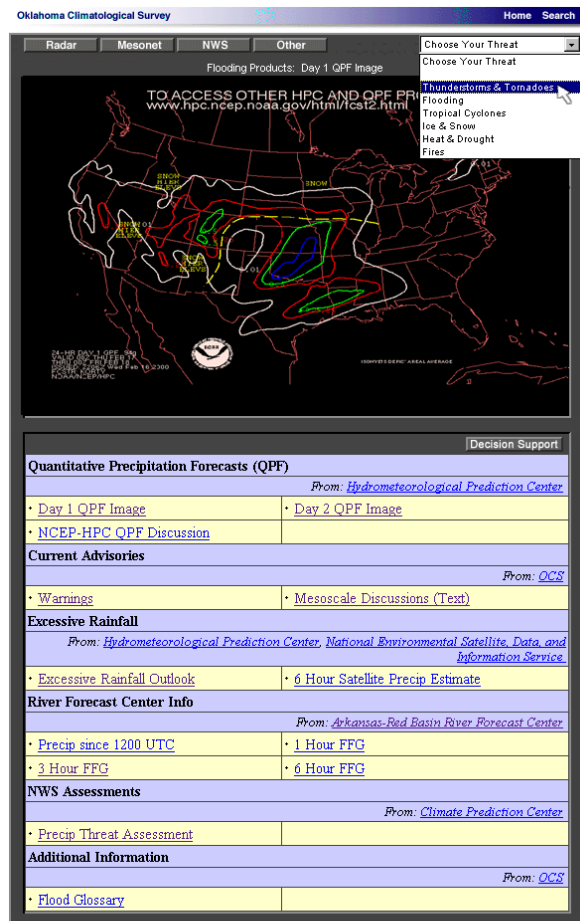
### 4. OK-FIRST 2000: A DECISION-SUPPORT SYSTEM

In 2000, the OK-FIRST site was upgraded to include all of the products introduced by ONALERT. It was also recognized that additional material could be integrated into the new site to aid in data interpretation in a decision-support mode.

The OK-FIRST 2000 site included each weather hazard available with ONALERT (Fig. 5). In addition, a new decision-support page was included with each threat page except the tropical page. The products on the the decision-support pages were organized by their usefulness before or during an event (Fig. 6; Table 1). Products useful during an event were further stratified by specific sub-threats (*e.g.*, radar products for hail were base and composite reflectivity and vertically integrated liquid), and were displayed dynamically using the user's preferences. Annotated examples of specific signatures were included to assist with data interpretation of hail cores, tornadoes, flooding, fire danger (Fig. 7), etc. In other words, the OK-FIRST 2000 site integrated current, dynamic, weather data with static training materials appropriate for specific weather hazards.

### 5. CONCLUSION

Because Oklahoma regularly faces nearly all environmental hazards except hurricanes and



**Figure 5.** Example of the flooding threat page available in the OK-FIRST 2000 site. The Day 1 Quantitative Precipitation Forecast from the Hydrometeorological Prediction Center issued at 2206 UTC on 16 February 2000 is shown. Any of the weather threats can be accessed by from the menu at the top right of the page plus the four original data sources are available from the buttons at the top left of the page. The Decision Support button provides the user with a new decision-support page for the specific threat.

earthquakes, an Oklahoma public safety official must be prepared to deal with the impacts of these conditions upon the public safety. Perhaps the first relationship between public safety and meteorology that comes to mind to a meteorologist in the Great Plains is the role the emergency manager should play in the warning process during severe weather (e.g., Doswell *et al.* 1999). In this case, the emergency manager can act as a coordinator of storm spotters to relay critical information to the NWS prior to a severe weather warning, and implement a resulting NWS warning locally by using local notification systems and directing any local evacuations that might be necessary.



**Figure 6.** Decision-support page for fire weather in the OK-FIRST 2000 site.

Through the implementation and support phases of OK-FIRST, OCS staff quickly learned that the trained public safety official can apply local weather information to a wide variety of situations and jurisdictions. The OK-FIRST user community is comprised of representatives from municipal, county, and state emergency management agencies; municipal and county fire departments; the Oklahoma Highway Patrol (state police); city police departments; and county sheriff's offices. While each of these agencies is committed to protecting the public safety, their respective roles and missions are somewhat different, even among similar agencies in neighboring jurisdictions. Therefore, the information needs of these agencies are not exactly the same. The requirements of decision-support systems appropriate for the public safety user must have a broader focus than simply severe weather and flooding. By adding decision-support components to the OK-FIRST site, the training and support phases of the program can expand to emphasize the use and application of the available products in addition to simple data interpretation and pattern recognition.

This manuscript has documented the evolution of an information system focused on the needs of the public safety user. When the original OK-FIRST site debuted in 1997, many of the users heralded it as "fantastic tool". During a September 2000 refresher workshop, after this transition occurred, the near-unanimous opinion of the users was that OK-

Severe Weather (Before the Event)	
SPC Day 1 & Day 2 Outlooks	Example
SPC Mesoscale Discussion	
SPC Probabilistic Outlooks	
NWS Zone & Area Forecasts	
Surface Temp. & Dew point Contours	Thunderstorm Initiation
Equivalent Potential Temperature	Thunderstorm Initiation & Propagation
Base Reflectivity	Dry Lines; Outflow Boundaries; Intersections of Boundaries
Surface Temperature Contours	Cold Front
Surface Dew Point Contours	Cold Front; Dry Line
Severe Weather (During the Event, Hail)	
Base Reflectivity	Hail Cores
Composite Reflectivity	Hail Algorithm
Vertically Integrated Liquid	Oklahoma VIL/Hail Climatology
Severe Weather (During the Event, Tornadoes)	
Base Reflectivity	Hook Echoes; V-notch; Bounded Weak Echo Region
Composite Reflectivity	Mesocyclone Algorithm; Tornado Detection Algorithm
Base Velocity	Mesocyclones
Storm-Relative Velocity	Rotation Couplets
Severe Weather (During the Event, High Winds)	
Base Reflectivity	Bow Echo
Base Velocity	
Fire Weather (Before the Event)	
Oklahoma Fire Danger Model	Burning Index; Spread Component; KBDI Example
SPC Fire Weather Outlook	
Oklahoma Red Flag Fire Alert	
CPC 6-10 Day Temp. & Precip. Outlook	
CPC National Threat Assessment	
NGM MOS Forecasts (reprocessed)	
Fire Weather (During the Event)	
Mesonet 2-m & 10-m Winds	Wind Shift Example
Base Reflectivity	Thin Lines
Mesonet Fire Weather Plot	
Temperature & Heat Index	
Mesonet Stability (1.5 vs 9 m Temperature)	Stability Example
Oklahoma Dispersion Model	

**Table 1.** Products (left column) and associated examples (right column) for the severe weather and fire weather decision-support pages from the OK-FIRST 2000 site.

FIRST had so changed their approach to their jobs that they could not easily function without having this information system at their disposal. It is the hope of the authors that government agencies and/or private sector companies can learn from the experience gained in Oklahoma to extend these capabilities elsewhere.

## 6. REFERENCES

Brock, F.V., K.C. Crawford, R.L. Elliott, G.W. Cuperus, S.J. Stadler, H.L. Johnson, and M.D. Eilts, 1995: The Oklahoma Mesonet: A technical overview. *J. Atm. Ocean. Tech.* **12**, 5-19.

Carlson, J.D., and D.M. Engle, 1998: Recent developments in the Oklahoma Fire Danger Model, a mesoscale fire danger rating system for Oklahoma. *2nd Symposium on Fire and Forest Meteor.*, Amer. Meteor. Soc., Phoenix, AZ.

Doswell, C.A., III, A.R. Moller, and H.E. Brooks, 1999: Storm spotting and public awareness since the first tornado forecasts of 1948. *Wea. and Fore.*, **14**, 544-557.

James, T.E., P.O. Long, and M.A. Shafer, 2000: An independent evaluation of the OK-FIRST decision-support system. *Preprints, 2nd Symp. on Env. Appl.* Amer. Meteor. Soc., Long Beach, CA., 40-47.

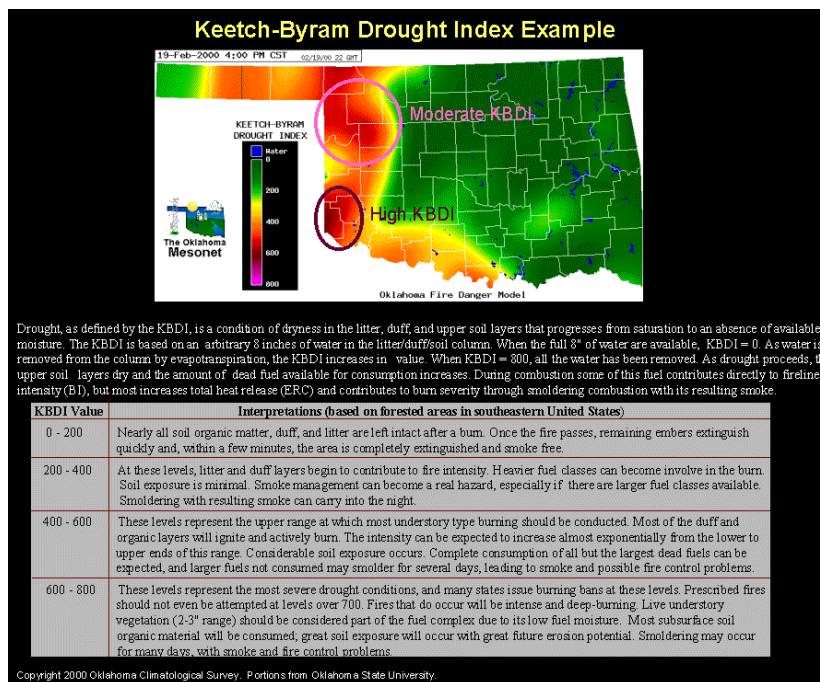
Kloesel, K.A., K.C. Crawford, R.A. McPherson, D.A. Morris, R. Jesuroga, and C. Subramaniam, 2000: Applying environmental data to aid decision-making during hazardous weather events. *Preprints, 2nd Symp. on Env. Appl.* Amer. Meteor. Soc., Long Beach, CA., 38-39.

McPherson, R.A. and K.C. Crawford, 1996: The EARTHSTORM Project: Encouraging the use of data from the Oklahoma Mesonet in K-12 classrooms. *Bull. Amer. Meteor. Soc.* **77**, 749-762.

Morris, D.A., J. Lewis, B. Springfield, and M. Honigsberg, 2000: Collaborations between meteorologists and emergency managers. Part 2: Rural applications of modern weather information during a disaster. *Preprints, 2nd Symp. on Env. Appl.* Amer. Meteor. Soc., Long Beach, CA., 25-31.

Wolfinbarger, J.M., R.A. Young, and T.B. Stanley, 1998a: Interactive software for viewing NEXRAD Level 3 data on the World Wide Web. *Preprints, 14th Intl. Conf. on Inter. Info. and Proc. Sys. for Meteor., Ocean., and Hydro.* Amer. Meteor. Soc., Phoenix, AZ., 208-212.

Wolfinbarger, J.M., R.A. Young, and T.B. Stanley, 1998b: Delivering real-time interactive data from the Oklahoma Mesonet via the World Wide Web. *Preprints, 14th Intl. Conf. on Inter. Info and Proc. Sys. for Meteor., Ocean., and Hydro.* Amer. Meteor. Soc., Phoenix, AZ., 213-217.



**Figure 7.** Interpretation aid for the Keetch-Byram Drought Index, which is a component of the Oklahoma Fire Danger Model.