P1.10 AN EVALUATION OF THE USE OF REAL-TIME WEATHER DATA BY PUBLIC-SAFETY AGENCIES

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1. INTRODUCTION

In 1996, the Oklahoma Climatological Survey (OCS) began an initiative known as OK-FIRST (Crawford *et al.* 1998) to improve access to timely weather information for the state's public-safety agencies (fire, police, and emergency man-agement). Initially funded by the U.S. Department of Commerce, the OK-FIRST program developed a decision-support system for program participants.

Sixty-five participants joined the program in three phases. Each participant received free access to a plethora of real-time weather data, including NEXRAD data from 15 regional radars plus regional and national mosaics (NIDS data; Crawford *et al.* 1999; Klazura and Imy 1993), Oklahoma Mesonet data (Brock *et al.* 1995), derived products like the Oklahoma Fire Danger Model (Carlson and Engle 1998) plus links to products from the National Weather Service (NWS). Each user participated in a three-day computer training workshop followed by an intensive, week-long data-interpretation workshop. Additional refresher courses were offered to improve interpretation skills. All dissemination of data and project materials (*e.g.,* case studies) has been accomplished via the World Wide Web (Morris 1998).

This paper summarizes the use of OK-FIRST and how user feedback affected the evolution of the system. Survey results document the system's usefulness. Finally, this experience base is offered to aid the nationwide deployment of the LDAD (Local Data Acquistion and Dissemination; Jesuroga *et al.* 1998) component of AWIPS by the NWS.

2. SYSTEM EVOLUTION

The dissemination and display of NEXRAD and Oklahoma Mesonet data through the OK-FIRST system occurs through two strategies. The primary method involves the use of web-browser plug-in software (Wolfinbarger *et al.* 1998a,b). Raw, or unprocessed, data files are made available to a web server immediately upon receipt by the NIDS and Mesonet ingest systems. After a user requests data through a web page, common-gateway interface (CGI) software residing on the web server interprets incoming requests for data. It creates a new web page "on the fly" with instructions for the appropriate plug-in including how to obtain the most recent data. The plug-in then requests and decodes the raw data, renders a graphical representation of the data, and meshes the graphic display with locally-stored geographical information. Finally, the plug-in waits for user input, which might consist of commands to zoom or scroll around a map, to save the graphic image or raw data file to disk, or to print. The use of plug-in software means that most of the processing required to make a graphical display of the data has been shifted to the user's computer. As a result, the efficient distribution of hundreds of data products has been achieved. For example, users often receive a radar file *within one minute* of its creation by the radar. This small time-delay is the time required to transmit a file from the radar to our NIDS vendor, from the vendor to our ingest system via satellite, and dissemination over the web.

The second, more traditional, method of disseminating data involves a variety of plots and animations of Mesonet data produced by OCS servers. These plots consist of standard synoptic-type station plots, change-charts of parameters over three-hour periods, maxima and minima of various parameters, meteograms, and color-filled contour plots. In addition, animations of a three-hour sequence of color-filled contour maps are produced in both animated .GIF and QuickTime formats.

Developed for Windows '95/NT and Macintosh by OCS staff, the plug-in software is scheduled for regular updates every six months. A primary release occurs in the fall with a secondary spring release that often includes internal infrastructure improvements. After each software release, OK-FIRST participants were asked for suggestions on future improvements.

With this disciplined approach to software development and release, the participants saw many of their comments incorporated into subsequent builds. For example, after the NIDS Viewer plug-in debuted, an initial comment was, "Does it loop?" Within a year, animation capabilities were available.

The first set of web pages designed for the NIDS Viewer plug-in automatically refreshed every six minutes. Thus the web browser requested

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relatively current NIDS data if its update cycle was synchronized with the radar's update cycle. Even so, this method of refreshing images sometimes resulted in data delays of up to 10 minutes. Moreover, the refreshed web page and accompanying NIDS image did not preserve the zoom level that the user had specified. Several users noted that while updated images could always be manually requested, more frequent updates were desirable.

To support animation, the *plug-in* required the ability to request new data after some specified time interval. In addition, new handshaking between the plug-in and the CGI software allowed the plug-in (rather than the web browser) to refresh the NIDS image. This new communication between the plug-in and re-designed CGI software allowed the CGI software to return a null response if a more recent NIDS file had not been received. The time interval for refreshing could then be shortened, for more timely updates. Equally as important, because the plug-in made the request, all zooming and centering options initially made by the user were preserved.

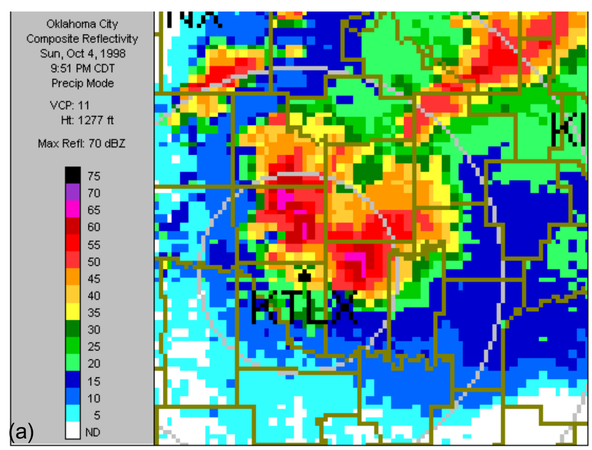
A third example of the incorporation of user feedback involved the storm attribute table included with the composite reflectivity (CREF) product. The initial release of the NIDS Viewer plug-in simply displayed the CREF product (Fig. 1a). Our NIDS vendor also produced a separate text file of the storm attributes (Fig. 1b). Thus the user had to manually match a given storm attribute with its reflectivity signature to decide if the storm attribute information applied to the user's location. Several users inquired if an easier method to use the storm table could be developed. This concern was addressed in a later build of the NIDS Viewer plug-in that interpreted the table in the CREF product and provided a "hot" cursor-tracking feature. A graphical overlay of the attributes was produced and specific information on a given storm appeared in the legend as the cursor moved over the storm centroid (Fig. 2).

Numerous improvements were made to the software. These include better rendering of the image data and geographic overlays in the NIDS Viewer plug-in (compare Fig. 1a with Fig. 2). The ability of the Mesonet WxScope plug-in was extended to produce time-series graphs on-the-fly, cursor-tracking and interactive legends (in both plug-ins), and easier methods to format Mesonet data.

3. SYSTEM USAGE

OK-FIRST participants came "on-line" in three phases: June 1997 (Class 1), October 1997 (Class 2), and March 1998 (Class 3). To help guide future product development and to find possible training deficiencies, usage statistics were compiled for both NIDS and Mesonet after the initial training workshop. Accesses were totaled by training class. A frequency distribution of accesses of NIDS data (Fig. 3; products listed in Table 1) revealed that the lowest-elevation slice of base reflectivity was the overwhelming choice of radar data viewed by OK-FIRST users. Yet, among the other NIDS products, public-safety users in Oklahoma downloaded a variety of NIDS products (including those known as BREF2, BREF248, BVEL1, CREF16, RAINS, SRVEL1, VIL, and STORMS). According to an independent project evaluator, the delivery of training generally improved from Class 1 to Class 3. Consequently, members of Class 3 typically used a wider variety of products to make their local decisions than did the other classes.

A similar analysis was performed on Mesonet products downloaded. Maps constructed using the plug-in software (in the forms of station, line contour, and wind vector plots) were the most common use of Mesonet data. Even so, plotted (*i.e.,* non-interactive) maps of parameters such as maximum/minimum temperatures and 24-hour rainfall accumulation found favor with OK-FIRST users. Two types of time-series graphs of Mesonet data (pre-processed



STM ID	AZ/RAN	TVS	MESO	POSH/POH/MX SIZE	VIL	DBZM	HT	TOP	FCST MVMT
V8	82/ 17	YES	YES	80/100/ 2.25	48	64	34.5	>36.5	269/ 36
M7	349/ 26	NO	YES	70/100/ 1.50	66	65	21.3	>43.8	267/ 29
V1	61/ 27	NO	YES	30/100/ 1.00	34	57	16.2	49.4	251/ 50
J2	356/ 28	NO	YES	40/100/ 1.00	29	61	13.3	36.3	275/ 44
J5	72/ 18	NO	NO	90/ 90/ 2.25	50	66	23.3	26.7	266/ 30
M1	41/ 78	NO	NO	60/100/ 1.25	41	59	24.3	49.0	NEW
W1	303/ 8	NO	NO	0/ 0/ 0.00	5	50	15.5	>15.6	NEW
G3	5/ 13	NO	NO	70/ 80/ 1.75	26	65	20.7	>26.6	NEW
C8	1/ 18	NO	NO	60/ 70/ 1.25	42	66	12.1	23.7	236/ 39
L2	331/ 62	NO	NO	40/100/ 1.00	41	60	18.7	38.6	239/ 38

(b)

Figure 1. Composite reflectivity (a) and an excerpt from the accompanying storm attribute table (b) from KTLX at 0251 UTC on October 4, 1998. Radar image is the depiction by NIDS Viewer, version 1.0 and has been zoomed to focus on the storm (V8) just east of the radar site. OK-FIRST users with this early version of the software could have viewed the image in one window and the attribute table in a second window to manually match attributes with the corresponding storm.

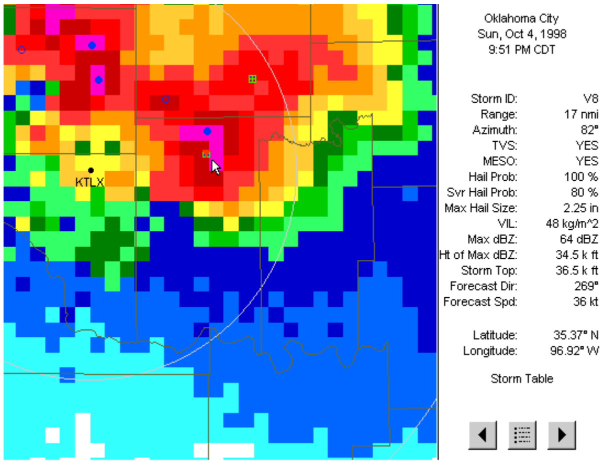


Figure 2. Composite reflectivity image from the same data as in Fig. 1, but with version 3.0 of the software. The storm attribute data for storm V8 (designated by the mouse pointer) is shown in the legend. Various symbols are used to denote storm attributes (open blue circle = probable non-severe hail; filled blue circle = probable severe hail; green box with + sign = mesocyclone; inverted red triangle = TVS). The buttons near the bottom of the interactive legend allow the user to toggle between various legend panes (e.g., storm attributes, various overlays, and image legend).

meteograms and plug-in graphs) received about equal amounts of use. The QuickTime format of animations received slightly more use than did animated .GIF files, probably because the user has some control of the animation of QuickTime files.

As with NIDS, Class 3 exhibited more diversity of the type of Mesonet product requested than Classes 1 and 2. In addition, monthly analysis of Mesonet use indicated that each class generally increased their overall usage of Mesonet data after about six months. Many users reported receiving requests for current weather conditions after knowledge spread of their participation in OK-FIRST.

4. PARTICIPANT SURVEY

An objective survey was conducted to gain feedback from OK-FIRST participants. Most questions dealt with issues regarding data access; other questions focused on programmatic details. Responses were collected from 24 participants (Table 2), with more comprehensive results anticipated.

When asked about the necessity of training before one could adequately use the system, the response was nearly unanimous. In addition, 92% rated the on-going training going training as "Important" or "Very Important".

Nearly every respondent agreed that local, real-time data is very important. NIDS data were considered to be most important, while satellite, fire danger, hydrological, and numerical model data were less important. However, all data categories were regarded as having some importance. These results mostly agreed with a previous survey with national scope (Kelsch 1996). In particular, much importance was expressed in both surveys for radar data, watches and warnings. Both surveys indicated that satellite data was somewhat less important. However, the national survey hinted that temperature, wind,

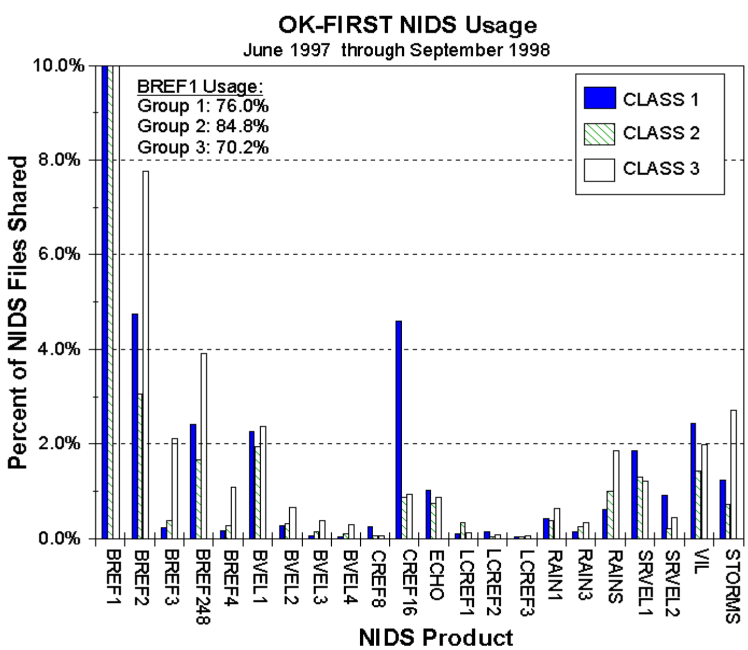


Figure 3. Accesses of NIDS products by OK-FIRST participants for June 1997 through September 1998 (a period of relatively inactive weather with a significant drought).

Table 1. NIDS products available via OK-FIRST (22 products per radar per volume scan)

BREF1	Base Reflectivity (Tilt 1; 0.5 deg)
BREF2	Base Reflectivity (Tilt 2; 1.5 deg)
BREF3	Base Reflectivity (Tilt 3; 2.4 deg)
BREF248	Base Refl. (Tilt 1; 248 nmi range)
BREF4	Base Reflectivity (Tilt 4; 3.4 deg)
BVEL1	Base Velocity (Tilt 1; 0.5 deg)
BVEL2	Base Velocity (Tilt 2; 1.5 deg)
BVEL3	Base Velocity (Tilt 3; 2.4 deg)
BVEL4	Base Velocity (Tilt 4; 3.4 deg)
CREF8	Composite Refl. (8 Data Levels)
CREF16	Composite Refl. (16 Data Levels)
ECHO	Echo Tops
LCREF1	Layer Comp. Refl. (0 - 24 kft)
LCREF2	Layer Comp. Refl (24 - 33 kft)
LCREF3	Layer Comp. Refl. (33 - 60 kft)
RAIN1	One-Hour Rain Accumulation
RAIN3	Three-Hour Rain Accumulation
RAINS	Storm-Total Rain Accumulation
SRVEL1	Storm-Relative Mean Velocity (Tilt 1)
SRVEL2	Storm-Relative Mean Velocity (Tilt 2)
VIL	Vertically Integrated Liquid
STORMS	Storm Attribute Table

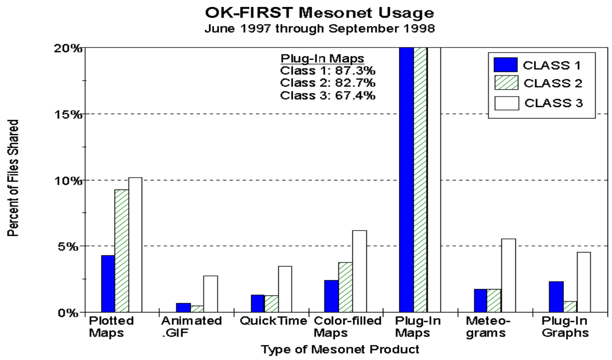


Figure 4. Usage of Mesonet products by OK-FIRST participants.

and rainfall data were less important than did OK-FIRST users (see their response about Mesonet data).

5. SUMMARY AND CONCLUSIONS

OCS is near the end of an initial "demonstration" stage of an outreach project for public-safety agencies. OK-FIRST has been judged as a success by most accounts. Indeed, the horizon is bright as the Oklahoma Legislature authorized additional funding.

Throughout the project, user input was solicited on various issues. As users witnessed their suggestions implemented through disciplined software development, they began to take ownership in subsequent software releases and the project in general.

Some of the results presented herein are unique to Oklahoma (*i.e.,* use of Mesonet data). Yet, much evidence suggests that OK-FIRST users mirror public-safety officials around the country in their need of timely and local weather data. More importantly, success stories continue to accumulate about the application by trained official of real-time weather data to local emergencies (Morris *et al.* 1999). Hopefully similar successes will occur nationwide after the implementation of LDAD by the NWS.

Table 2. Overview of survey results. Values are percentages of responses on a five-point scale (1 = "Not Very Much"; 3 = "No Opinion"; 5 = "Very Much".)

Question	1	2	3	4	5
How important is it for you to have adequate training to use the program?	0	0	0	4	96
How reliable has the OK-FIRST program been for you?	0	0	0	46	54
How much has OK-FIRST increased your ability to inform and advise the public about potentially dangerous weather-related situations?	0	0	0	25	75
How necessary is ongoing training in order to maintain and enhance your ability to use and interpret products available through OK-FIRST?	4	4	0	29	63
How important is it for you to have access to:					
local data?	0	0	0	8	92
real-time data?	0	0	0	4	96
NIDS data?	0	0	0	4	96
Mesonet data?	0	0	0	8	92
Satellite data?	0	0	8	50	42
Fire Danger data?	0	0	16	42	42
Hydrological data?	0	0	17	33	50
Watches & Warnings?	0	0	0	12	88
NWS forecast data?	0	0	4	25	71
Forecast data from NWS computer models?	0	0	9	56	35

6. REFERENCES

Brock, F.V., K.C. Crawford, R.L. Elliott, G.W. Cuperus, H.L. Johnson, and M.D. Eilts, 1995: The Oklahoma Mesonet: a technical overview. *J. Atmos. 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.

Crawford, K.C., D.A. Morris, R.A. McPherson, H.L. Johnson, M.A. Shafer, J.M. Wolfinbarger, and T.W. Hughes, 1998: OK-FIRST: A decision-support system for public-safety agencies. *14th Intl. Conf. on IIPS for Meteor., Ocean., and Hydro.,* Amer. Meteor. Soc., 5-9.

Crawford, K.C., D.A. Morris, and D.E. Lewis, 1999: OK-FIRST: A NIDS success story: *15th Intl. Conf. on IIPS for Meteor., Ocean., and Hydro.,* Amer. Meteor. Soc., in press.

Jesuroga, R.T., C. Subramaniam, and P. Miller, 1998: The AWIPS local data acquisition and dissemination system. *14th Intl. Conf. on IIPS for Meteor., Ocean., and Hydro.,* Amer. Meteor. Soc., 368-370.

Kelsch, M., 1996: Severe weather information for emergency management decisionmaking. *18th. Conf. on Severe Local Storms,* Amer. Meteor. Soc., 597-601.

Morris, D.A, L. Rowe, M. Honigsberg, J. Lewis, D. King, and C. Conaghan, 1999: OK-FIRST in the field: how public-safety agencies use and apply real-time weather data. *15th Intl. Conf. on IIPS for Meteor., Ocean., and Hydro.,* Amer. Meteor. Soc., in press.

Morris, D.A., 1998: The design and implementation of a web-based decision-support system for public-safety agencies. *14th Intl. Conf. on IIPS for Meteor., Ocean., and Hydro.,* Amer. Meteor. Soc., 10-14.

Wolfinbarger, J.M., R.A. Young, and T.B. Stanley, 1998a: Interactive software for viewing NEXRAD level 3 data on the World Wide Web. *14th Intl. Conf. on IIPS for Meteor., Ocean., and Hydro.,* Amer. Meteor. Soc., 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. *14th Intl. Conf. on IIPS for Meteor., Ocean., and Hydro.,* Amer. Meteor. Soc., 213-217.