P1.4 **OK-FIRE: A WEATHER-BASED DECISION SUPPORT SYSTEM FOR WILDLAND FIRE MANAGEMENT IN OKLAHOMA**

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1. INTRODUCTION

Wildland fire, as in many locations around the world, is an important issue in Oklahoma. It is estimated that about 810,000 ha (2 million acres) are burned annually across the state, about 10% by wildfire and 90% by prescribed fire. During certain fire seasons, however, wildfire can become particularly problematic, as was the case during November 2005 through September 2006, when over 16,000 wildfires burned almost 607,000 ha (1.5 million acres). On the positive side, prescribed fire is becoming an increasing practice across the state with beneficial impacts for the landscape.

Weather plays an important role in both fire behavior and the dispersal of smoke resulting from fires. To aid wildland fire managers in their activities, operational fire and smoke management systems, based on recent, current, and forecasted weather conditions, are critical. With respect to wildfire, benefits include better anticipation of severe wildfire conditions, the ability to determine optimal staffing levels, and better suppression strategies during the wildfire itself. With respect to prescribed fire, benefits include better pre-burn planning and management during the burn. With both types of fire, the potential to save lives and structures is there as well.

2. THE "OK-FIRE" PROJECT

Over the past three years, a sophisticated weather-based decision support system for wildland fire managers in Oklahoma has been developed called "OK-FIRE". This project is funded through a $321K grant from the federal Joint Fire Sciences Program (Project #05-2-1-81). OK-FIRE has a three-fold focus:

(1) an expanded suite of **real-time products for fire weather, fire danger, and smoke dispersion**

(2) a **dedicated web site** to act as the delivery mechanism

(3) **regional training and customer support** for the user groups involved

Our current user groups are mainly federal agencies with responsibilities for land management in Oklahoma; we also have one state agency and a private organization. The user groups include: USDA Forest Service, Bureau of Indian Affairs, US Army Corps of Engineers, National Park Service, US Fish & Wildlife Service, Natural Resources Conservation Service, National Weather Service, Oklahoma Forestry Services, and The Nature Conservancy. Currently, about 150 personnel are involved.

OK-FIRE is a joint effort between Oklahoma State University (Stillwater) and the Oklahoma Climatological Survey (Norman), which provides programming, web site, and operational support.

2.1 *Data Sources*

OK-FIRE utilizes Oklahoma's automated weather station monitoring network, the **Oklahoma Mesonet**, to provide current and recent weather data for incorporation into products. Operational since 1994, the Oklahoma Mesonet features 10-m towers transmitting weather data every 5 minutes (Figure 1). Currently consisting of 120 sites, the network has an average station separation of only 30 km (19 miles) (Figure 2). Using data from the Oklahoma Mesonet, fire weather products are updated every 5 minutes, dispersion model products every 15 minutes, and fire danger products every hour.

Figure 1. *Oklahoma Mesonet tower at Clayton, Oklahoma.*

OK-FIRE also utilizes 84-h forecast output from the **North American Model** (NAM), which uses the 12-km WRF non-hydrostatic mesoscale model. This forecast output is incorporated four times a day, using the 00Z, 06Z, 12Z, and 18Z runs of the NAM.

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Figure 2. *Locations of Oklahoma Mesonet stations*

In addition to the Mesonet and NAM forecast inputs, OK-FIRE also uses weekly NDVI satellite imagery to assess vegetation greenness at 1-km resolution. This information is used in the Oklahoma Fire Danger Model (Carlson *et al*., 2002; Carlson and Burgan, 2003).

2.2 *Products*

OK-FIRE products utilize a browser plug-in (WeatherScope) developed at the Oklahoma Climatological Survey. Three venues are available for both current/recent products and forecast products: (1) **dynamic maps** of Oklahoma, capable of zooming, animation, and overlays; (2) **site-specific charts** (e.g., meteograms, firegrams); and (3) **site-specific tables**. Currently, these products extend from five days back in time through the end of the latest 84-h forecast period.

Fire danger products (Figures 3-5) are based on the **Oklahoma Fire Danger Model** (Carlson *et al*., 2002; Carlson and Burgan, 2003), which is an implementation of the National Fire Danger Rating System (NFDRS) to an automated weather station network platform. The next-generation **"Nelson" model** for dead fuel moisture (Carlson *et al*., 2007) provides input to the fire danger model and is run using 15-minute Mesonet data and hourly forecast data.

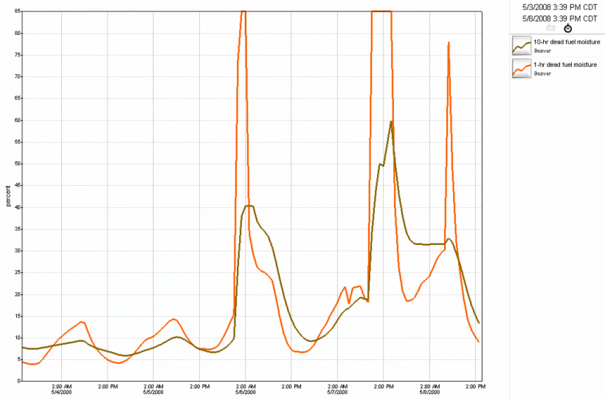

Figure 3. *Forecast chart for 1- and 10-hour dead fuel moisture at Beaver, Oklahoma.*

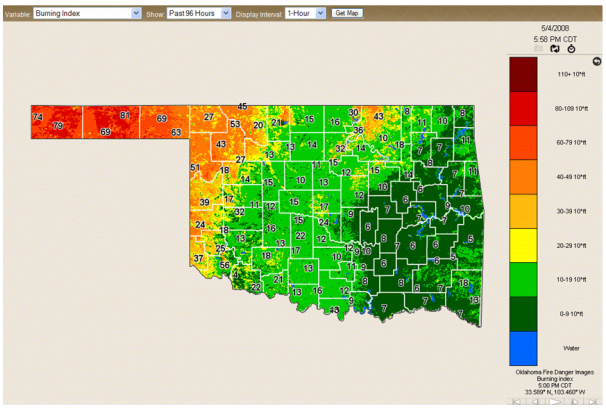

Figure 4. *Burning index map showing high fire danger in the Oklahoma panhandle.*

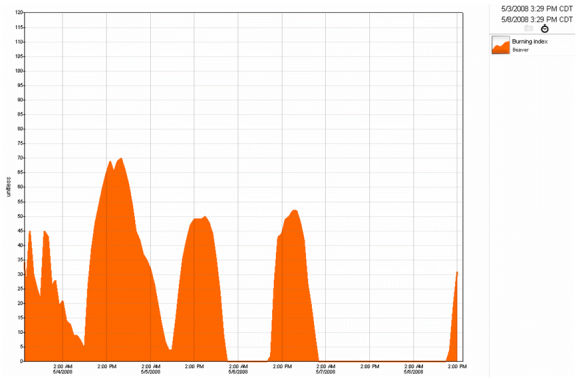

Figure 5. *Forecast chart for burning index at Beaver, Oklahoma.*

Smoke dispersion products (Figures 6-8) utilize output from the **Oklahoma Dispersion Model** (Carlson and Arndt, 2008) for estimates of near-surface dispersion conditions; wind vector products are also available for smoke transport direction.

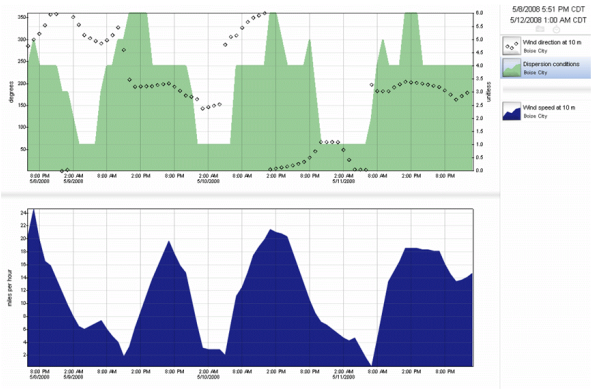

Figure 6. *Forecast chart for dispersion and wind conditions at Boise City, Oklahoma.*

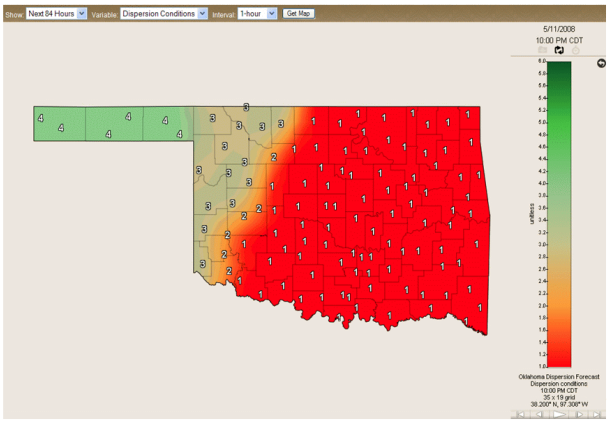

Figure 7. *Forecast map for dispersion conditions.*

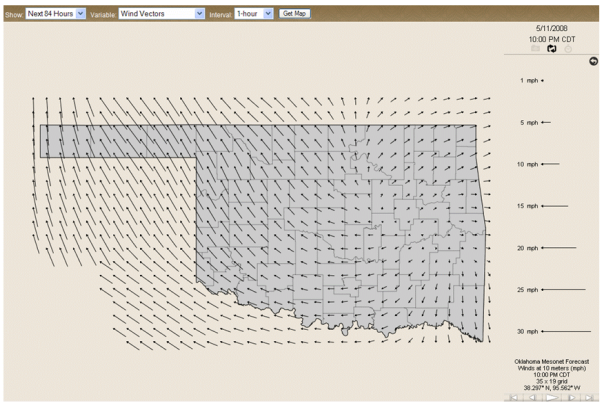

Figure 8. *Wind vector forecast map.*

A popular new product on OK-FIRE is the **"Fire Prescription Planner"**. This product allows the fire manager to specify lower and/or upper limits for various variables pertaining to weather, dispersion conditions, dead fuel moisture, and fire danger. After the prescribed values are entered, the user selects a Mesonet site. Then, using output from the latest 84-h forecast, a table is produced for each hour of the forecast period showing for which hours the prescription is met (both for the individual prescribed variables and for all of them). In the example depicted, a user near Durant, Oklahoma is considering a possible prescribed burn over the next three days. He specifies relative humidity between 30 and 60%, wind speeds between 5 and 20 mph, a lower limit on dispersion conditions of "Moderately Good", 1-h dead fuel moisture (DFM) between 8 and 20%, and 10-h DFM between 8 and 15% (Figure 9). After Durant is selected (not shown), the resulting table indicates a suitable period (green shaded cells) for such a burn between 11 a.m. and 8 p.m. the next day (Figure 10). Since this forecast table is based solely on the latest output from the NAM model, users are encouraged to compare its hourly weather output with official National Weather Service forecasts for their area, as no one model forecast is "perfect".

2.3 Web Site

The OK-FIRE web site is currently password-protected for exclusive use and beta-testing by our user groups. However, in fall 2008 the site will be opened to the general public. The site is located at:

http://okfire.mesonet.org

The web site is designed solely for wildland fire management and is clearly arranged into main subject areas of WEATHER, FIRE, and SMOKE, with additional menu items for SATELLITE, RADAR, AIR QUALITY, and BURN SITE products (Figure 11).

Figure 11. *Home page of OK-FIRE web site.*

The debut of the OK-FIRE web site occurred in September 2006. Beta-testing by our user groups occurred during the first part of 2007 along with further development of models, products, and the web site. Another round of beta-testing took place during early 2008 along with continued development this year.

The site has been successful, especially given the limited number of users up to this point. During calendar year 2007 there were an average of 110 unique visitors (IP addresses) per month with 843,762 hits for the year. During the first four months of 2008, there were an average of 318 unique visitors per month with 1,131,449 hits, which is already more than in 2007. Thus, the web site is experiencing good growth in usage.

2.4 Training

One-day workshops at regional technology centers around the state of Oklahoma were offered in the fall of 2006 and 2007 to our user groups (Figure 12). These workshops were held in computer labs and were broken into topical segments (e.g., weather, fire, smoke) with each segment consisting of both instruction and computer lab exercises based on the material just taught (Figure 13). As of 2008, there are about 150 trained OK-FIRE users from our cooperator groups.

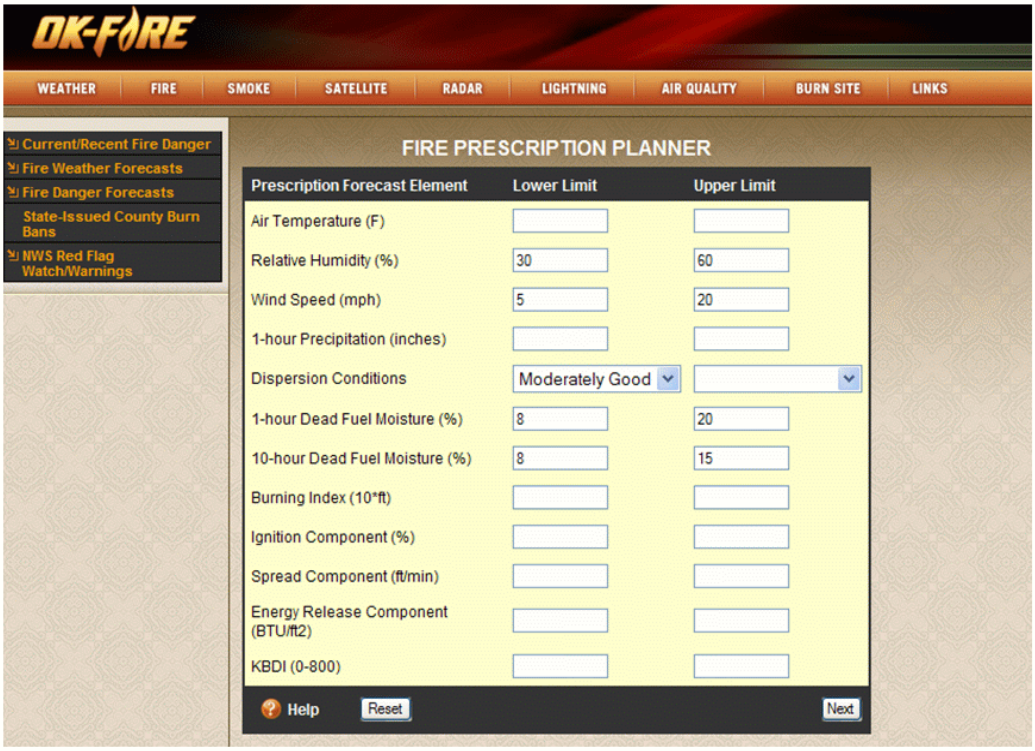

Figure 9. *Entry of values into the Fire Prescription Planner*.

Fire Prescription Table for Durant

DATE TIME	Criteria Met?	RELH	WSPD	DISPERSION	1h DFM	10h DFM	WDIR	TAIR	RAIN_1H	BI	IC	SC	ERC	KBDI
May 29, 2008 2:00 pm CDT	No	69%	8 mph	6 (EX)	13%	15%	SE	83°F	0.00 in.	7	2%	3	2	212
May 29, 2008 3:00 pm CDT	No	64%	8 mph	6 (EX)	12%	14%	SE	86°F	0.00 in.	8	3%	4	2	212
May 29, 2008 4:00 pm CDT	Yes	59%	8 mph	6 (EX)	11%	13%	SE	88°F	0.00 in.	9	4%	4	3	212
May 29, 2008 5:00 pm CDT	Yes	60%	9 mph	5 (G)	11%	12%	SE	88°F	0.00 in.	10	4%	4	3	226
May 29, 2008 6:00 pm CDT	Yes	60%	10 mph	5 (G)	11%	12%	SE	87°F	0.00 in.	10	4%	5	3	226
May 29, 2008 7:00 pm CDT	No	61%	10 mph	5 (G)	11%	11%	SE	87°F	0.00 in.	10	4%	5	3	226
May 29, 2008 8:00 pm CDT	No	68%	10 mph	4 (MG)	12%	12%	SE	85°F	0.00 in.	10	3%	5	3	226
May 29, 2008 9:00 pm CDT	No	74%	9 mph	3 (MP)	13%	12%	SE	82°F	0.00 in.	8	3%	4	2	226
May 29, 2008 10:00 pm CDT	No	80%	9 mph	3 (MP)	15%	13%	SE	80°F	0.00 in.	7	1%	3	2	226
May 29, 2008 11:00 pm CDT	No	84%	9 mph	3 (MP)	16%	14%	SE	78°F	0.00 in.	5	1%	3	1	226
May 30, 2008 12:00 am CDT	No	87%	9 mph	3 (MP)	18%	15%	SE	77°F	0.00 in.	4	0%	2	1	226
May 30, 2008 1:00 am CDT	No	90%	9 mph	3 (MP)	19%	16%	SE	76°F	0.00 in.	1	0%	0	0	226
May 30, 2008 2:00 am CDT	No	89%	9 mph	3 (MP)	21%	17%	SSE	75°F	0.00 in.	0	0%	0	0	226
May 30, 2008 3:00 am CDT	No	89%	10 mph	3 (MP)	21%	17%	SSE	75°F	0.00 in.	0	0%	0	0	226
May 30, 2008 4:00 am CDT	No	88%	11 mph	3 (MP)	21%	17%	S	74°F	0.00 in.	0	0%	0	0	226
May 30, 2008 5:00 am CDT	No	89%	10 mph	3 (MP)	21%	17%	S	74°F	0.00 in.	0	0%	0	0	226
May 30, 2008 6:00 am CDT	No	89%	10 mph	3 (MP)	21%	18%	S	73°F	0.00 in.	0	0%	0	0	226
May 30, 2008 7:00 am CDT	No	89%	10 mph	4 (MG)	21%	18%	S	73°F	0.00 in.	0	0%	0	0	226
May 30, 2008 8:00 am CDT	No	81%	11 mph	5 (G)	19%	18%	S	76°F	0.00 in.	1	0%	0	0	226
May 30, 2008 9:00 am CDT	No	73%	13 mph	4 (MG)	17%	17%	S	78°F	0.00 in.	5	1%	4	1	226
DATE TIME	Criteria Met?	RELH	WSPD	DISPERSION	1h DFM	10h DFM	WDIR	TAIR	RAIN_1H	BI	IC	SC	ERC	KBDI
May 30, 2008 10:00 am CDT	No	65%	14 mph	4 (MG)	15%	16%	S	81°F	0.00 in.	9	2%	6	2	226
May 30, 2008 11:00 am CDT	Yes	60%	15 mph	4 (MG)	13%	14%	S	83°F	0.00 in.	11	4%	7	2	226
May 30, 2008 12:00 pm CDT	Yes	55%	15 mph	5 (G)	11%	13%	S	86°F	0.00 in.	13	5%	8	3	226
May 30, 2008 1:00 pm CDT	Yes	49%	15 mph	5 (G)	10%	12%	S	88°F	0.00 in.	14	7%	9	3	226
May 30, 2008 2:00 pm CDT	Yes	48%	15 mph	5 (G)	9%	11%	S	89°F	0.00 in.	15	9%	9	4	226
May 30, 2008 3:00 pm CDT	Yes	47%	15 mph	4 (MG)	8%	10%	S	89°F	0.00 in.	16	9%	9	4	226
May 30, 2008 4:00 pm CDT	Yes	45%	16 mph	4 (MG)	8%	9%	S	90°F	0.00 in.	16	10%	9	4	226
May 30, 2008 5:00 pm CDT	Yes	46%	15 mph	4 (MG)	8%	9%	S	89°F	0.00 in.	16	10%	9	4	241
May 30, 2008 6:00 pm CDT	Yes	47%	14 mph	4 (MG)	8%	9%	S	89°F	0.00 in.	16	9%	8	4	241
May 30, 2008 7:00 pm CDT	Yes	47%	14 mph	4 (MG)	9%	9%	S	88°F	0.00 in.	15	8%	8	4	241
May 30, 2008 8:00 pm CDT	Yes	50%	12 mph	4 (MG)	9%	9%	S	85°F	0.00 in.	13	7%	6	4	241
May 30, 2008 9:00 pm CDT	No	52%	10 mph	3 (MP)	10%	9%	SSE	82°F	0.00 in.	12	6%	5	4	241
May 30, 2008 10:00 pm CDT	No	54%	9 mph	3 (MP)	10%	9%	SSE	80°F	0.00 in.	10	4%	4	4	241

Figure 10. *Resulting forecast table for Durant, Oklahoma from the Fire Prescription Planner*.

Figure 12. *Kiamichi Technology Center at Talihina, Oklahoma.*

Figure 13. *Instruction at OK-FIRE workshop at Woodward, Oklahoma.*

3. IMPACT OF OK-FIRE

Based on the web site statistics earlier discussed, personal correspondence, and feedback, OK-FIRE is having an impact on those in the program. Following is a small portion of the positive feedback we have had thus far:

"The OK-FIRE system is just as important as a drip torch and backpack fire pumps. Even with all my experience, I won't even consider burning before using the information that is now available to us"

- Steve Sanders, US Army Corps of Engineers

"The OK-FIRE web site is by far the most informative and user friendly fire danger/forecast site I've seen. Great instruction, very thorough. OK-FIRE is the premiere web-based fire information system in the U.S."

-Chris Hise, The Nature Conservancy

"The OK-FIRE web site has been invaluable to personnel at all levels of our organization, in terms of firefighter and public safety .. These products are utilized on a daily basis for decision-making. Thanks for making this useful web site available to us."

- Mark Masters, Bureau of Indian Affairs

"I think OK-FIRE is a great tool in the use of forest fire suppression activities and planning the next days' needs for manpower and equipment."

- Rick Chambless, Oklahoma Forestry Services

"Very useful in determining where and when to do our prescribed burns."

- Shannon Hudgens, US Forest Service

"OK-FIRE helps me as a manager plan what staffing level I need during moderate-high fire danger days."

- Sam McFarland, US Forest Service

"I've attended numerous fire training sessions over the last 25 years and you by far did the best .. this program provides today's fire managers with all the information in one spot."

- Dennis Weiland, National Park Service

4. FUTURE PLANS

The OK-FIRE program has up until now focused mainly on federal land managers, since that was a major focus of the granting agency. However, OK-FIRE has great application for city and rural fire departments across the state (some 950+), as well as the numerous private landowners who conduct prescribed burns. This represents an increase in potential users from the several hundred who are now in the program to users numbering in the thousands.

As we open the OK-FIRE web site up to the public this fall, alternate strategies for training will need to be developed. Aside from computer workshops (either full or half-day), large-group presentations will become a priority as will the development of on-line training resources.

We also will seek additional funding to replace the funds from the expiring grant. Aside from maintaining the existing program, such funding is needed to expand OK-FIRE over the coming years, in terms of model, product, and web site development as well as outreach efforts.

5. ACKNOWLEDGEMENTS

The authors would like to acknowledge the Joint Fire Science Program for funding OK-FIRE (Project #05-2-1-81). Their web site is located at:

http://www.firescience.gov

6. REFERENCES

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