

Howard L. Johnson, Derek S. Arndt *, Gary D. McManus and Mark A. Shafer
Oklahoma Climatological Survey, Norman, Oklahoma

1. INTRODUCTION

The Oklahoma Mesonet (Mesonet), developed through a partnership between the University of Oklahoma and Oklahoma State University, is a permanent mesoscale weather observation network. The Mesonet operates 114 stations on a continuous basis. Atmospheric variables (including rainfall) are recorded every 5 minutes at each site, producing 288 observations per variable per station per day (Brock et al. 1995).

Since the the Mesonet was commissioned in March 1994, three short but intense dry episodes impacted Oklahoma's residents and economy. These occurred during winter 1995-96, summer 1998, and late-summer 2000, with durations varying from ten weeks to ten months. Significant wildfire outbreaks accompanied each episode, and each dry spell severely damaged one or more of Oklahoma's crops. However, because rainfall during the interim periods was well above normal, the episodes were masked by normal and above-normal annual rainfall statistics.

Oklahoma Mesonet data allowed the real-time observation of these events on the mesoscale, including the advent of real-time soil moisture data by the third episode. Mesonet information was incorporated into the state's drought response plan, which was written in the wake of the 1995-96 episode. With improvements in the dissemination of Mesonet data, confidence grew in the instrumentation and in the interpretation of data. As a result, state officials were able to monitor the evolution of successive episodes increasingly well. This enabled quicker recognition of, and response to, drought conditions across the state.

2. WINTER/SPRING 1995-96

The first extended dry spell observed by the Oklahoma Mesonet occurred during the winter and spring of 1995-96 (Table 1). From October through May, statewide-averaged precipitation was

* Corresponding author address: Derek S. Arndt, Oklahoma Climatological Survey, 100 E. Boyd, Suite 1210, Norman, OK 73019.

TABLE 1

Drought 1995-96 October 1, 1995 through May, 1996			
Climate Division	Total Rainfall	Departure from Normal	Percentage of Normal
Panhandle	5.38"	-4.42"	55 %
North Central	6.03"	-9.35"	39 %
Northeast	11.45"	-13.41"	46 %
West Central	5.33"	-9.42"	36 %
Central	9.95"	-11.08"	47 %
East Central	20.17"	-8.92"	69 %
Southwest	6.88"	-9.49"	42 %
South Central	13.21"	-11.32"	54 %
Southeast	23.42"	-10.51"	69 %
Statewide	11.12"	-9.78"	53 %

53% of normal, marking the driest October-May period in Oklahoma's climate history (since 1895). Counties in northern and western Oklahoma observed a more severe deficit.

This eight-month period coincided with the growing months of the state's winter wheat crop. As a result, this major component of the state's economy was decimated. The statewide-averaged winter wheat yield of 19.0 bu/acre was the smallest in years.

Massive sell-offs depressed prices in the cattle industry, another large component of the state's economy. Fire danger rose throughout the winter, as soils and dormant vegetation became increasingly dry. Wildfire ravaged prairie and forest landscape in February 1996.

Beginning midway through the drought, the Oklahoma Climatological Survey made use of the real-time nature of Mesonet data and the emerging importance of the internet. A rainfall update featuring graphics and tables was made available to the public via facsimile, then later on the worldwide web (Fig. 1). This "Oklahoma Drought Update" was updated manually on a weekly basis. Although public use was limited, state agencies such as the Oklahoma Water Resources Board (OWRB) and the Oklahoma Dept. of Agriculture's Forestry Division (OFD) did consume the data.

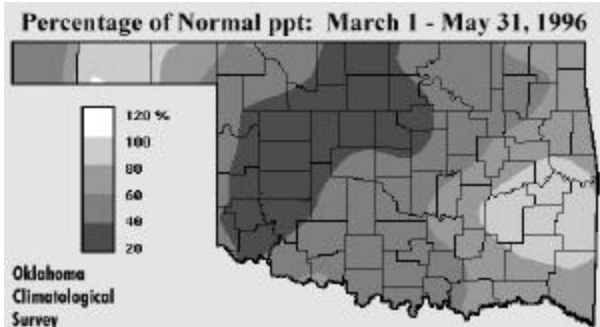


Figure 1. Percentage of normal rainfall, March-May, 1996. Graphics similar to this were issued weekly by OCS during the drought of 1995-96.

Oklahoma participated with other states during the early 1990s to establish a drought preparedness plan. However, the impacts of the 1995-96 episode crystallized the need for stronger drought management. An executive order from the governor's office established a standing Oklahoma Drought Management Team representing several state agencies.

3. SUMMER 1998

The first three months, and the last three months, of 1998 were very wet relative to normal. However, the intervening six months ranked among Oklahoma's driest April-September periods of the 20th century (Table 2). The statewide-averaged rainfall was the third-least since 1895. While all of Oklahoma suffered from heat and lack of rainfall, conditions were particularly severe in parts of western, central, and all of southern Oklahoma. Three climate divisions (west-central, southwest and south-central) observed their driest such period. The period tied for the warmest in state history, and five climate divisions observed record-breaking average temperatures.

Because the episode began after the major winter wheat growth period, the 1998 winter wheat harvest was not adversely affected by this episode. In fact, Oklahoma's 1998 winter wheat yields were among the highest recorded. However, summer crops, such as peanuts, cotton and watermelon were severely impacted.

By 1998, OCS had automated and renamed the Oklahoma Drought Update. The "Oklahoma Rainfall Update", part of the regular OCS suite of products, was updated on a daily basis. The graphics were larger and more detailed than those used in 1996 (Fig. 2). Tabular information was added to the graphical presentation, along with a limited number of water resources links. Soil

TABLE 2

Summer 1998 Episode April 1, 1998 through September 30, 1998			
Climate Division	Total Rainfall	Departure from Normal	Percentage of Normal
Panhandle	11.29"	-3.28"	78 %
North Central	15.40"	-3.46"	82 %
Northeast	21.87"	-2.47"	90 %
West Central	8.58"	-9.42"	48 %
Central	13.33"	-8.25"	62 %
East Central	18.35"	-6.09"	75 %
Southwest	5.54"	-13.03"	30 %
South Central	10.58"	-12.31"	46 %
Southeast	18.30"	-8.55"	68 %
Statewide	13.83"	-8.55"	65 %



Figure 2. Percentage of normal rainfall, April-September 1998.

moisture sensors were installed at about 50 Mesonet sites by the end of the 1998 dry episode, but they played no role in drought management and mitigation decisions.

This was the first episode to be addressed by the state's standing Drought Management Team. To avoid the massive cattle sell-offs that occurred in 1996, Operation Haymaker was initiated. This project involved state-subsidized transport of hay from surplus regions to hay-depleted regions. The operation was hampered by logistical and implementation challenges, as both supply and demand exceeded expectations.

4. LATE SUMMER 2000

The late-summer dry episode of 2000 was relatively short, but extreme in its lack of rainfall. August and September 2000 was the driest in Oklahoma's climate history for four of the state's nine climate divisions (Table 3). The statewide-averaged rainfall was one-sixth the normal value, and represented the lowest such total in

Oklahoma's recorded climate history. The accompanying heat wave was intense, as record maximum temperatures were exceeded into the first week of October.

Unlike the previous two episodes, the most severe effects occurred across the northwestern half of Oklahoma. West-central Oklahoma was particularly hard hit. Its two-month rainfall total of 0.04" averaged across the climate division was not only less than one percent of normal; it was less than ten percent of the previous record.

By summer 2000, soil moisture sensors had been installed at 100 of the Mesonet's 114 sites. Mesonet soil moisture observations revealed that portions of Oklahoma had not fully recovered from the effects of the summer of 1998 by the onset of the summer 2000 episode. In those regions, the impacts of drought and heat were established more quickly and severely than in other regions of Oklahoma. Soil moisture observations were used daily by the OWRB in their role as the lead agency in Oklahoma's Drought Management team (Fig. 4).

In addition to the Oklahoma Rainfall Update, OCS established the "Drought 2000 Update". This product contained additional tables and graphics relative to the Rainfall Update. It also featured a more comprehensive set of links to national and state drought management/mitigation resources.

5. REFERENCES

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



Figure 3. Percent of normal rainfall, August-September 2000.

TABLE 3

Summer 2000 Episode August 1, 2000 through September 30, 2000			
Climate Division	Total Rainfall	Departure from Normal	Percentage of Normal
Panhandle	0.66"	-4.01"	14 %
North Central	0.38"	-6.01"	6 %
Northeast	1.24"	-7.03"	15 %
West Central	0.04"	-5.93"	1 %
Central	1.15"	-5.74"	17 %
East Central	2.43"	-5.19"	32 %
Southwest	0.84"	-5.19"	14 %
South Central	0.90"	-6.20"	13 %
Southeast	2.66"	-5.13"	34 %
Statewide	1.13"	-5.63"	17 %

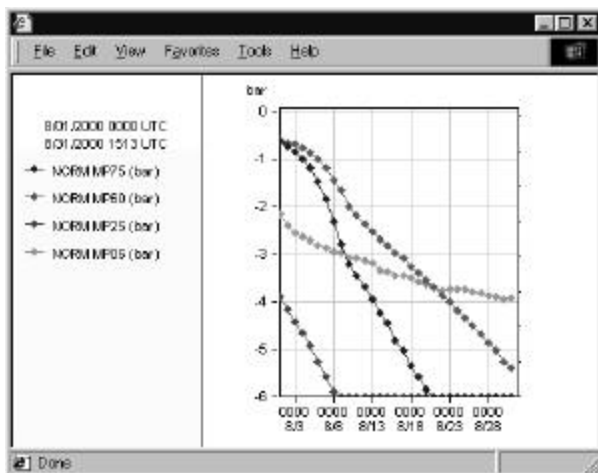


Figure 4. Soil Moisture (matric potential) at the Norman Mesonet site during August 2000. This data was available to the Oklahoma Water Resources Board during Oklahoma's late summer 2000 dry episode.