NWS FORM E-5 (11-88) (PRES. by NWS Instruction 10-924)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL WEATHER SERVICE	HYDROLOGIC SERVICE AREA (HSA) Tulsa, Oklahoma (TSA)
MONTHLY REPORT OF RIVER AND FLOOD CONDITIONS		REPORT FOR: MONTH: **June** YEAR: **2016**
TO: Hydrometeorological Information Center, W/OH2 NOAA / National Weather Service 1325 East West Highway, Room 7230 Silver Spring, MD 20910-3283		SIGNATURE: **Steven F. Piltz** (Meteorologist-in-Charge) DATE: **July 5, 2016**

When no flooding occurs, include miscellaneous river conditions, such as significant rises, record low stages, ice conditions, snow cover, droughts, and hydrologic products issued (NWS Instruction 10-924)

[X] An "X" in the box indicates no flood stages were reached in this Hydrologic Service Area (HSA) during the month above.

June 2016 was a hot and dry month, with all of eastern OK and northwest AR receiving below normal rainfall. Normal rainfall in the month of June ranges from 3.9 inches in McIntosh County to 5.9 inches in Wagoner County. The Ozark region of northwest Arkansas averages 5.1 inches for the month. This report, past E-5 reports, and monthly hydrology and climatology summaries can be found at http://www.srh.noaa.gov/tsa/?n=hydro-monthly-summary.

Monthly Summary

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 1a), the heavier rain in June formed a "ring of fire" around eastern OK and west central AR, leaving well below normal rainfall for much of the area. Rainfall totals for June 2016 ranged from a measly 0.25" to around 6". A large portion of the HSA received 0.50"-2" of rain this month. This corresponds to 5%-50% of the normal June rain across most of the region (Fig. 1b). Only small areas received 75% to around 125% of the normal June rain this month.

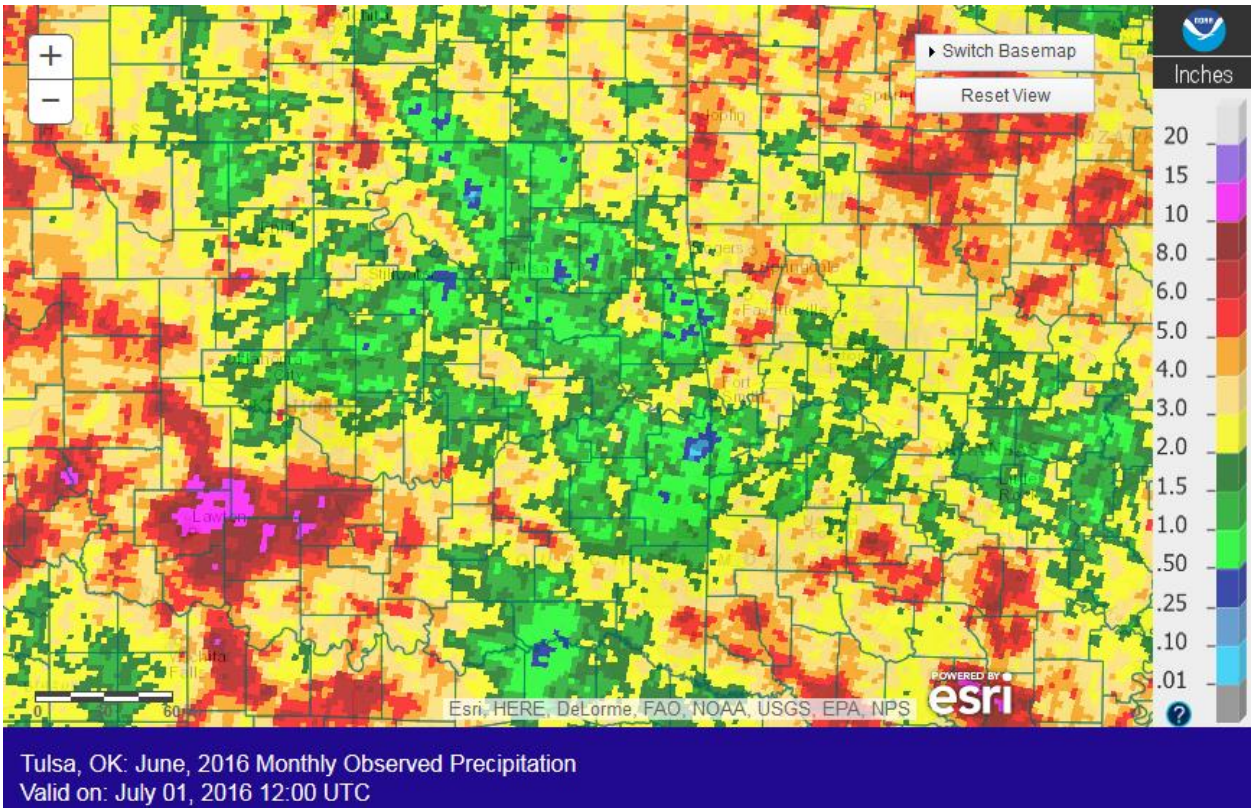


Fig. 1a. Estimated Observed Rainfall for June 2016

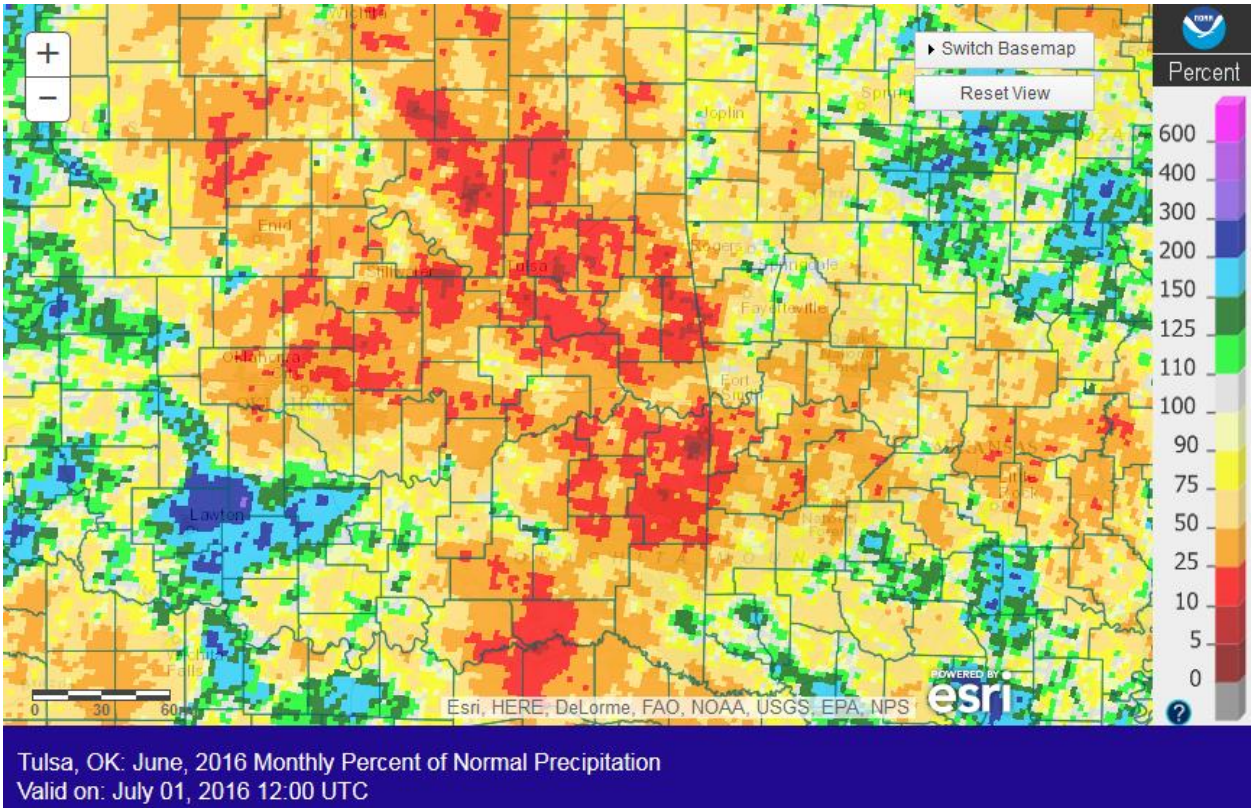


Fig. 1b. Estimated % of Normal Rainfall for June 2016

In Tulsa, OK, June 2016 ranked as the 6th warmest June (82.5°F, tied 1980; since records began in 1905) and the 6th driest June (0.77"; since records began in 1888). Fort Smith, AR had the 13th warmest June (81.6°F; since records began in 1882) and the 27th driest June (1.91"; since records began in 1882). Fayetteville, AR had the 13th warmest (75.9°F) and the 20th driest (2.87") June since records began in 1950.

Some of the larger precipitation reports (in inches) for June 2016 included:

Springdale 5.8ENE, AR (coco)	7.05	Winslow 7NE, AR (coop)	5.62	Miami, OK (coop)	4.71
Riverdale 4.2E, AR (coco)	4.32	Elkins 10.6SSE, AR (coco)	4.20	Ozark 4.6S, AR (coco)	4.09
Hindsville 7.1NW, AR (coco)	3.95	Krebs 0.3WNW, OK (coco)	3.91	Rogers 2.1SE, AR (coco)	3.85

Some of the lowest precipitation reports (in inches) for June 2016 included:

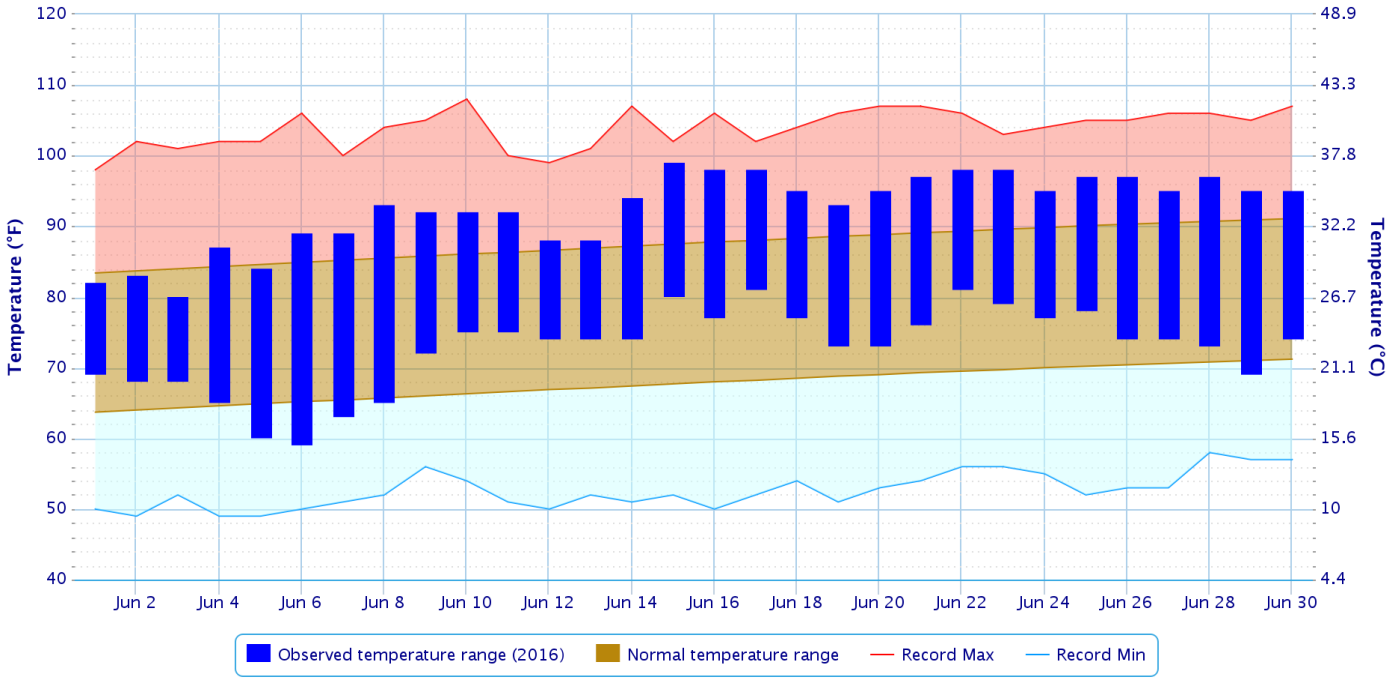
Tulsa 5.9S, OK (coco)	0.36	Oilton, OK (meso)	0.36	Pawnee, OK (meso*)	0.53
Westville 0.2ENE, OK (coco)	0.56	Nowata, OK (meso)	0.59	Ralston, OK (coop)	0.62
Talihina, OK (meso)	0.64	Ochelata 5.6N, OK (coco)	0.69	Porter, OK (meso)	0.74

According to statistics from the Oklahoma Climatological Survey (OCS) Mesonet:

Rank since 1921	June 2016	Last 60 Days (May 2 – Jun 30)	Last 90 Days (Apr 2 – Jun 30)	Warm Growing Season (Mar 1 – Jun 30)	Year-to-Date (Jan 1 – Jun 30)	Water Year-to-Date (Oct 1 – Jun 30)	Last 365 Days (Jul 2, 2015-Jun 30, 2016)
Northeast OK	**3rd driest**	16th driest	27th driest	27th driest	15th driest	18th wettest	19th wettest
East Central OK	14th driest	21st driest	36th driest	44th driest	22nd driest	**10th wettest**	**4th wettest**
Southeast OK	13th driest	20th driest	39th wettest	21st wettest	43rd wettest	**3rd wettest**	**9th wettest**
Statewide	35th driest	30th driest	33rd wettest	34th wettest	48th wettest	12th wettest	12th wettest

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

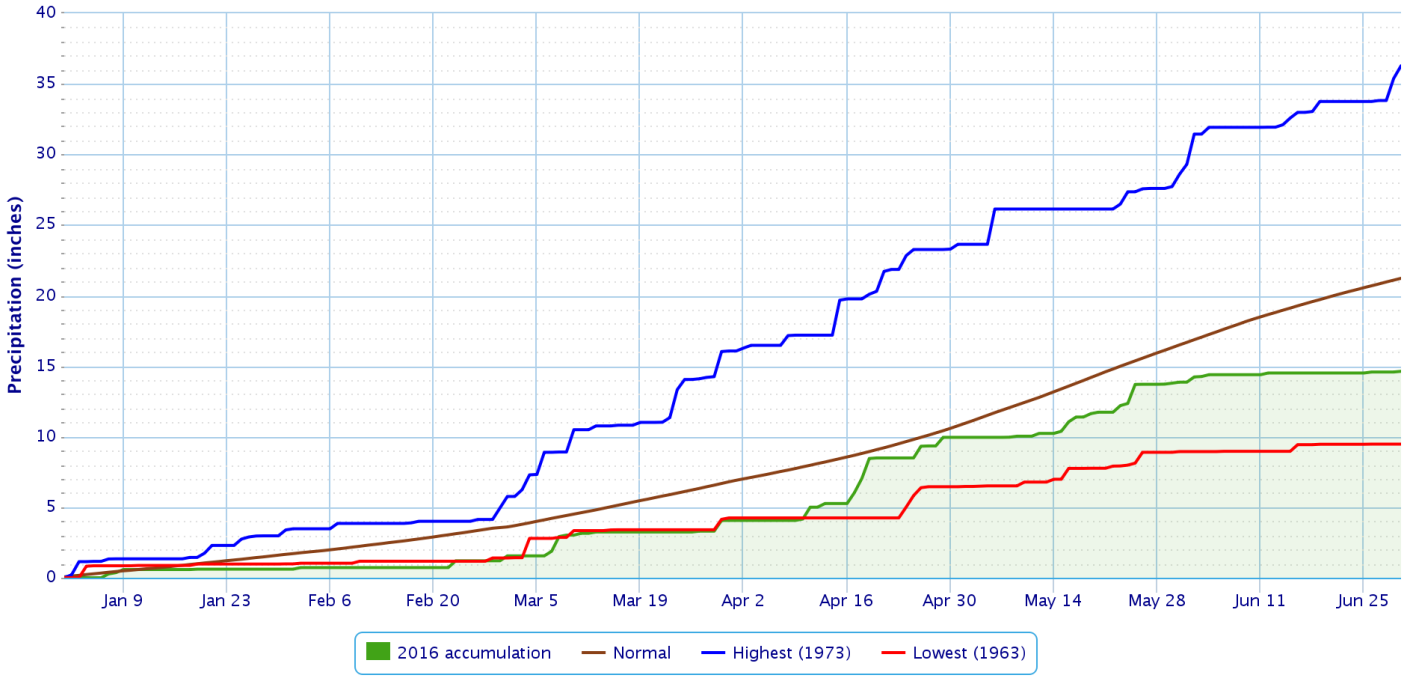
Period of Record – 1905-01-06 to 2016-06-30. Normals period: 1981-2010. Click and drag to zoom chart.



Powered by ACIS

Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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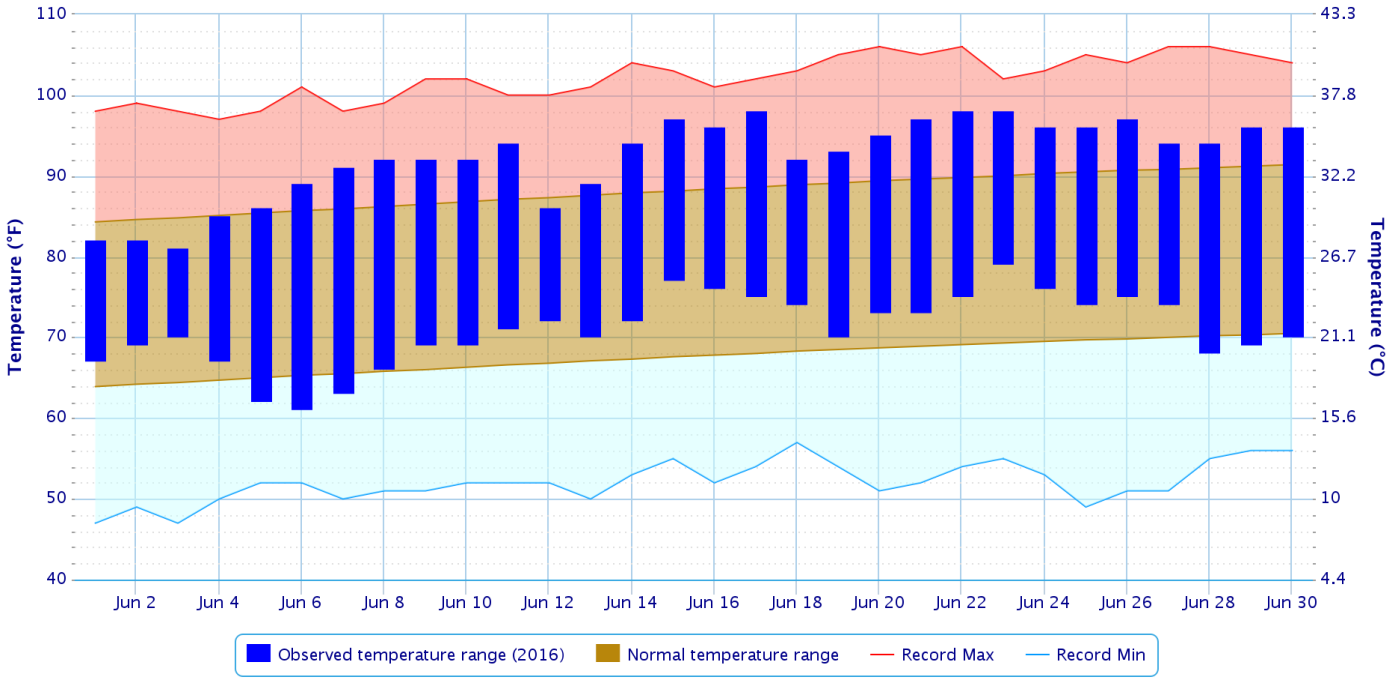
Daily Temperature Data – Fort Smith Area, AR (ThreadEx)

Period of Record - 1882-06-01 to 2016-06-30. Normals period: 1981-2010. Click and drag to zoom chart.



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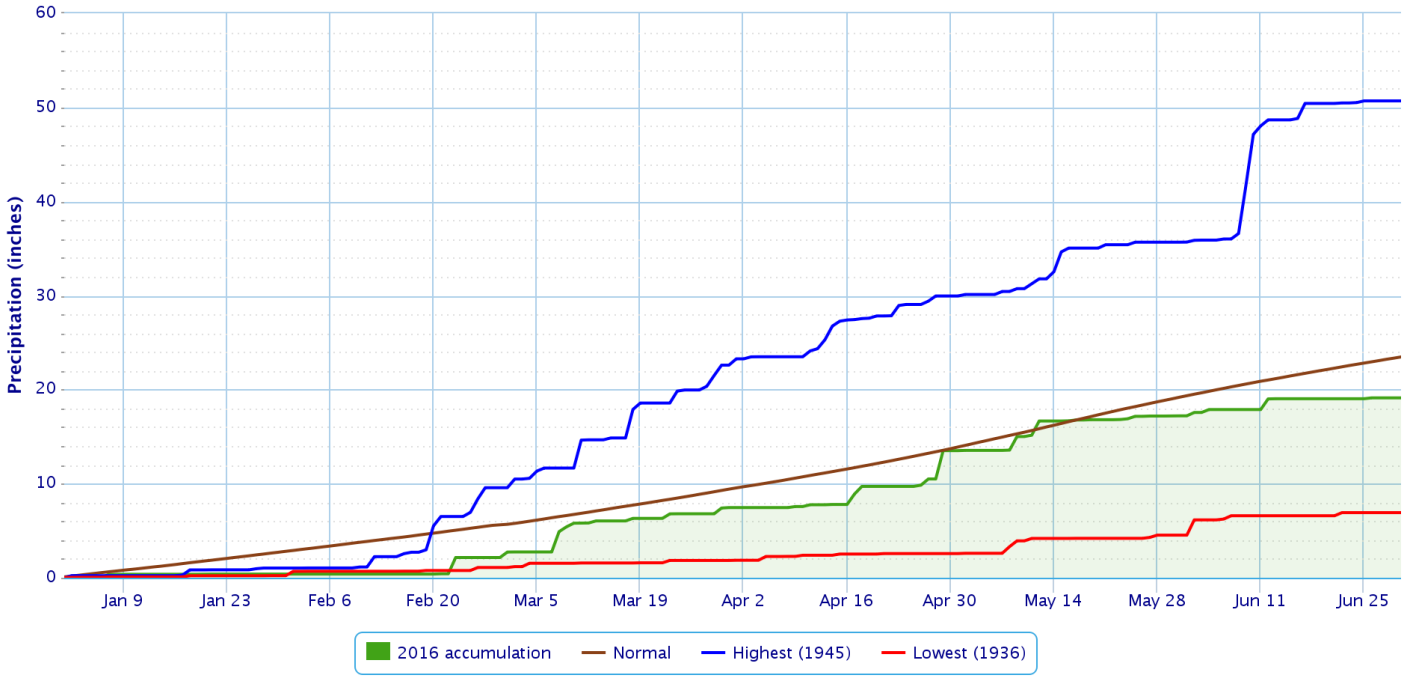
Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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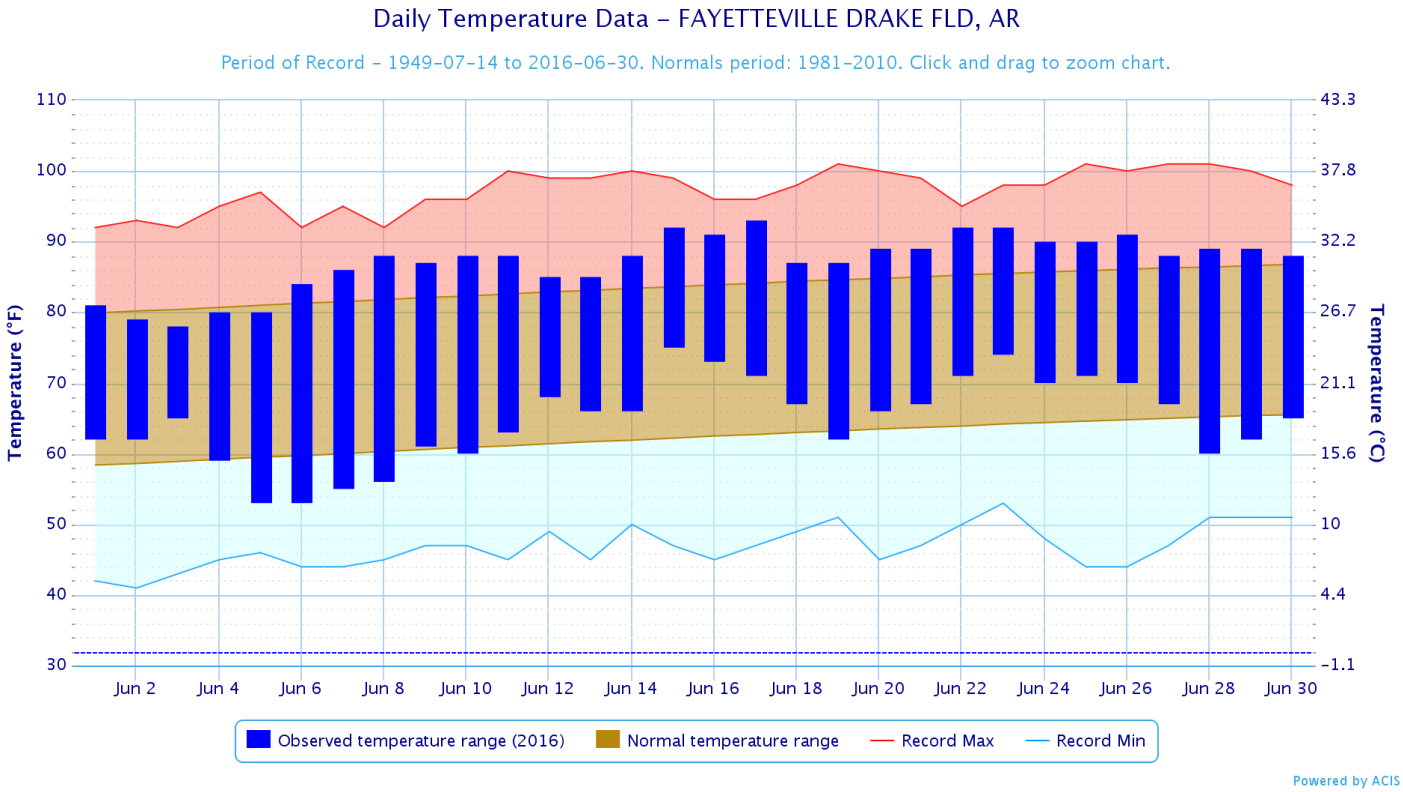
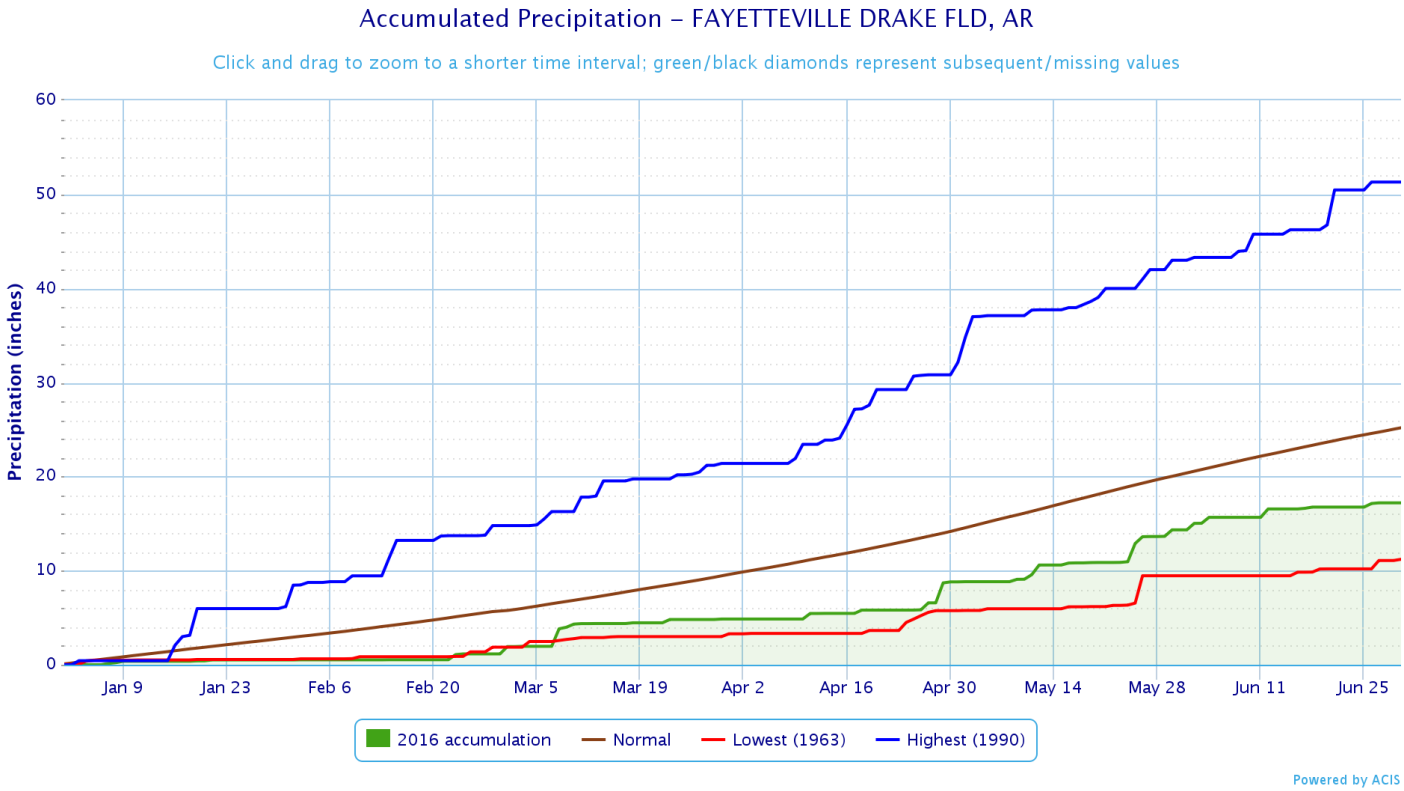




Drought

According to the U.S. Drought Monitor (USDM) from June 28, 2016 (Figs. 2, 3), D1 (Moderate Drought) conditions had developed over Pawnee County and adjacent parts of Osage and Creek Counties in northeast OK. While there were no drought conditions elsewhere in eastern OK and northwest AR, abnormally dry conditions were present across portions of Osage, Washington, Nowata, Creek, Tulsa, Wagoner, Rogers, Muskogee, Craig, Ottawa, Pittsburg, Haskell, Latimer, and Le Flore Counties in OK, and Franklin, Washington, Benton, Carroll, and Madison Counties in AR.

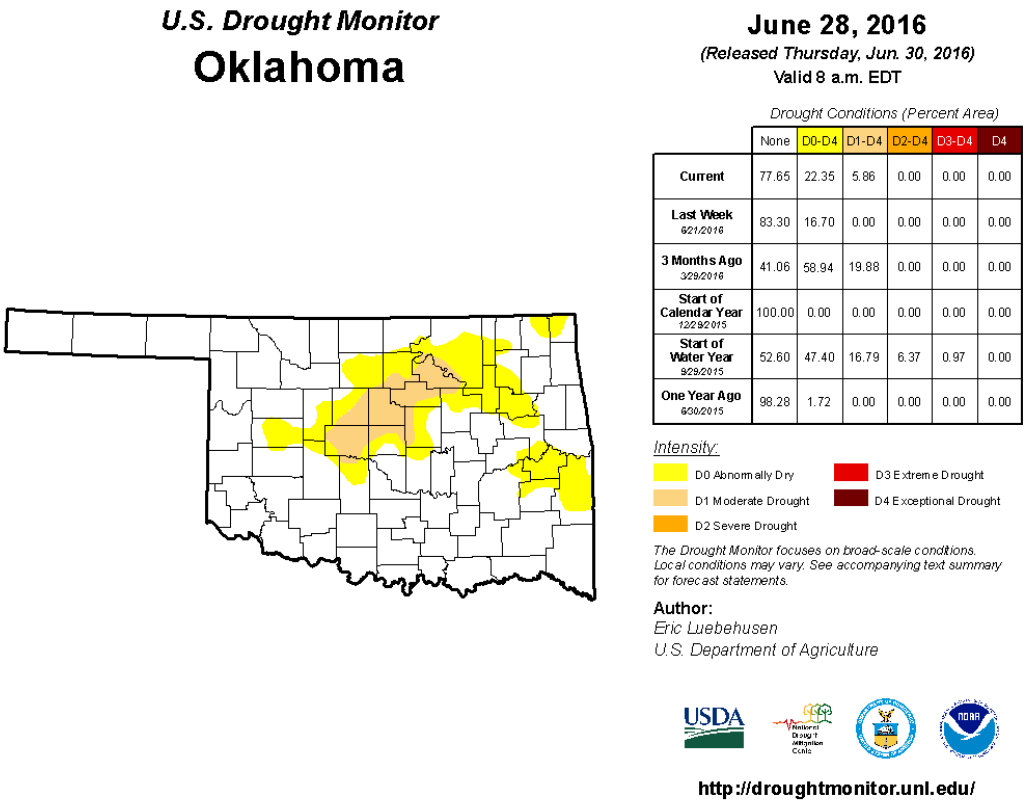


Fig. 2. Drought Monitor for Oklahoma

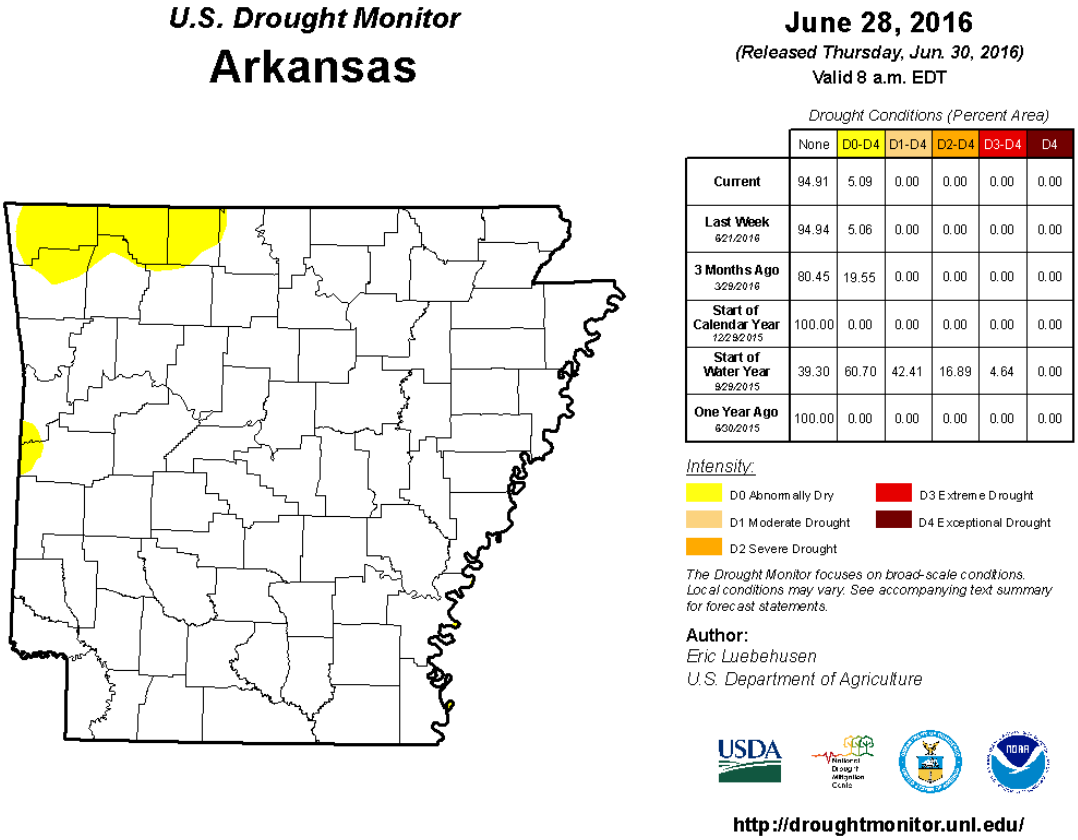
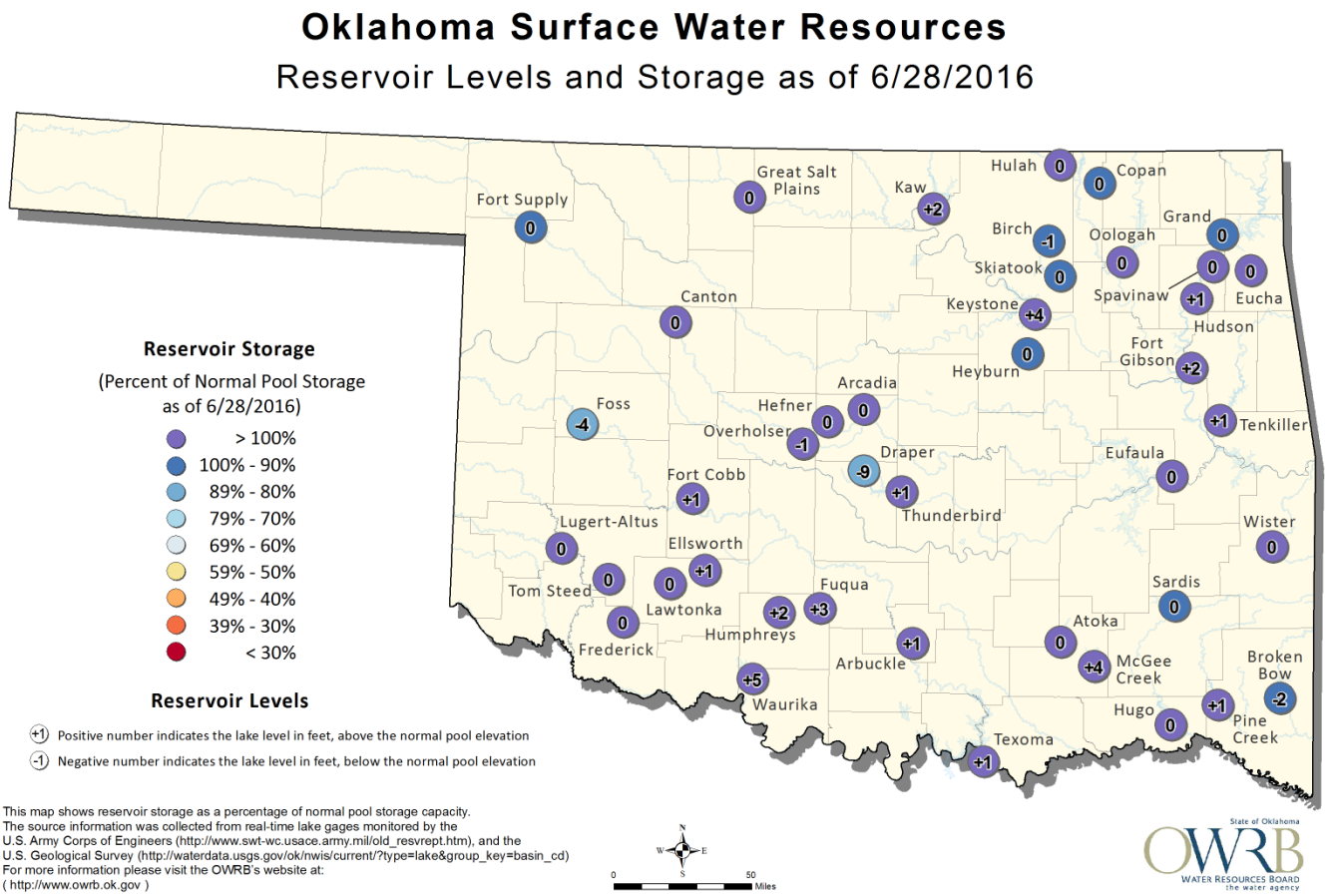


Fig. 3. Drought Monitor for Arkansas



Reservoirs

According to the USACE, all of the major reservoirs in the HSA were operating near their conservation pool levels as of 07/1/2016. Only one reservoir was operating above 5% of the top of its conservation level, Keystone Lake at 106%; and one reservoir was below 5% of its conservation level, Birch Lake at 93%.

Outlooks

The Climate Prediction Center (CPC) outlook for July 2016 (issued June 30, 2016) indicates an enhanced chance of above normal temperatures across all of eastern OK and northwest AR. This outlook also calls for equal chances for above, near, and below median precipitation across eastern OK and northwest AR. This outlook is based on both short- and extended-range weather forecasts. Considerations for the Madden-Julian Oscillation and ENSO neutral conditions were not taken into account.

For the 3-month period July-August-September 2016, CPC is forecasting an equal chance for above, near, and below median precipitation and a slightly enhanced chance for above normal temperatures across all of eastern OK and northwest AR (outlook issued June 16, 2016). According to CPC, Pacific sea surface temperatures along the equator are near to slightly below average. This outlook is based primarily on both statistical and dynamical forecast tools and soil moisture conditions. Outlooks beyond July-August-September include impacts due to the transition to La Niña. The chance of La Niña conditions by August-September-October is 70%, with probabilities persisting above 70% through the 2016-17 Winter.

Summary of Precipitation Events Daily quality controlled rainfall maps can be found at: http://water.weather.gov/precip/index.php?location_type=wfo&location_name=tsa

June 1-15

Bands of scattered, slow moving showers and thunderstorms moved north across the area on June 1st as a boundary sagged south into northeast OK. While several locations saw little to no rainfall, those places that did received 0.25"-1.5" of rain. Some of the rainfall rates with this activity were 1"-2" per hour due to the high precipitable water content of the atmosphere.

An upper-level low then moved into central/northern TX on the 2nd, allowing the front to shift further south. The majority of the shower and thunderstorm activity remained along and south of Hwy 412, with rainfall totals ranging from around 0.10" to near 3" (Fig. 4). The heaviest rain fell over south central OK/north central TX, just west of the Tulsa HSA. However, the heavy rain along the Red River did not result in flooding near Arthur City. The first two days of the month resulted in widespread 0.25"-1.5", with isolated higher totals (Fig. 5).

As the upper low continued to move slowly over TX, scattered showers and thunderstorms continued over eastern OK and northwest AR the 3rd-4th. Rain first developed during the heat of the afternoon and evening hours of the 3rd. A complex of storms moved south out of KS during the morning hours of the 4th and moved south across eastern OK, while a line of showers and thunderstorms blossomed from northwest AR southwest into southeast OK. All of this activity moved south, and had exited the region or dissipated by early afternoon. A few isolated storms continued into the evening hours as a cold front moved south across the HSA. Some locations had rainfall totals of 1"-2" over the two days, while most of the HSA received less than 0.75".

A complex of thunderstorms developed over south central OK during the early morning hours of the 12th as a weak upper-level low moved into the area. These storms moved east into southeast OK shortly after sunrise and continued east northeast through the morning hours. Before noon, additional scattered showers and thunderstorms popped up across the remainder of eastern OK and northwest AR. These storms became more widespread by early afternoon and continued moving northeast before exiting the area by early evening. Additional storms developed over southeast OK during the late afternoon hours along the northern periphery of a storm complex in TX. These storms became more scattered as they moved northward through the overnight hours. Rainfall totals were highest over southern Pittsburg and northwest Pushmataha Counties, where 2"-5" of rain fell. Elsewhere, rainfall totals ranged from around 0.25" to near 3" in isolated locations (Fig. 6).

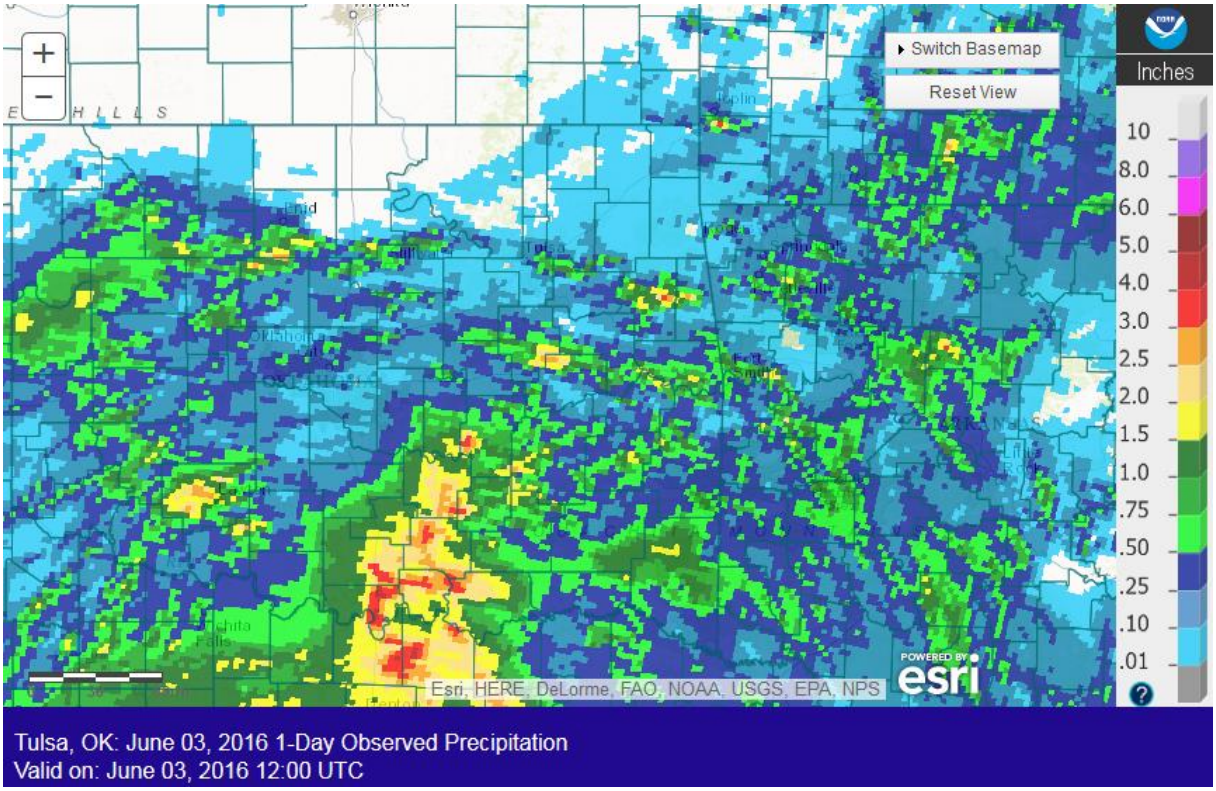


Fig. 4. 24-hour Estimated Observed Rainfall ending at 7am CDT 6/03/2016.

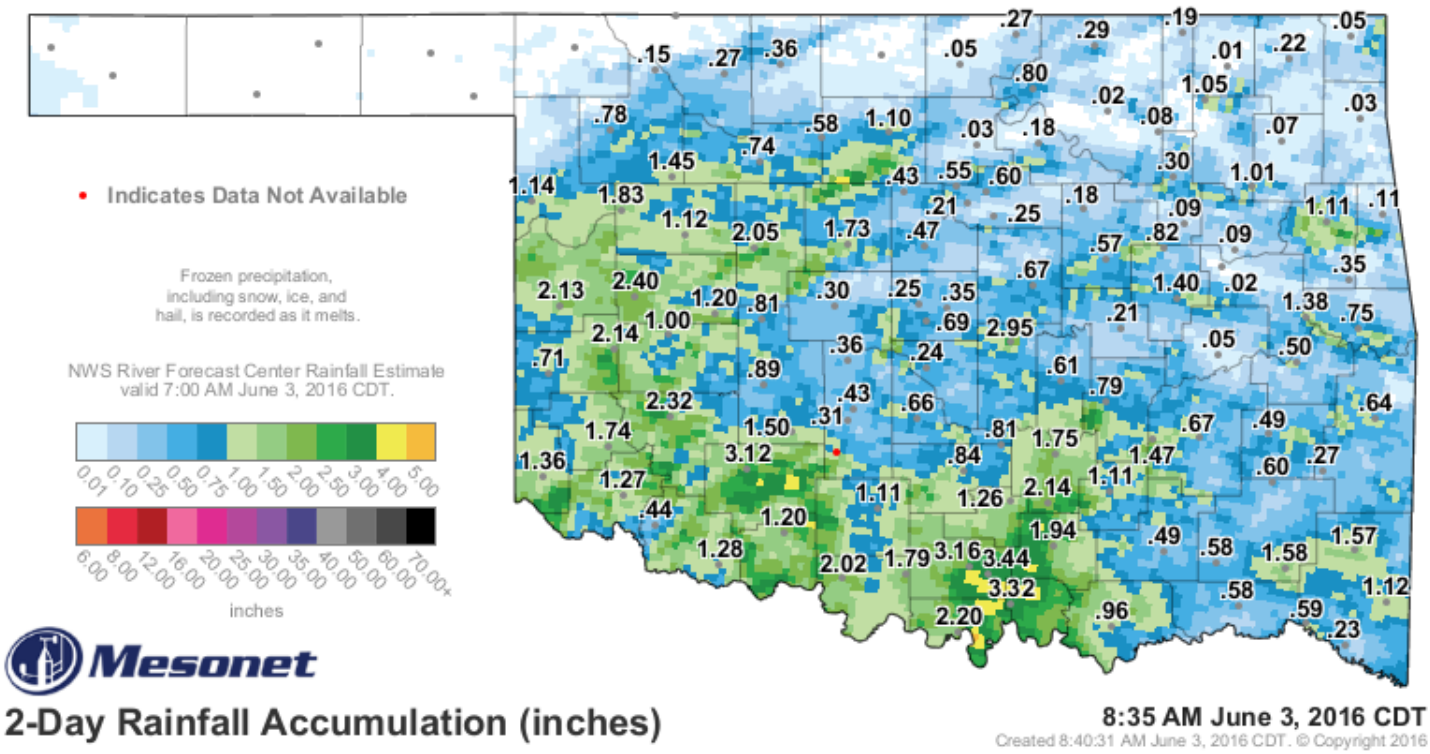


Fig. 5. 2-day Estimated Observed Rainfall (image) and OK Mesonet measurements ending at 8:35am CDT 06/03/2016.

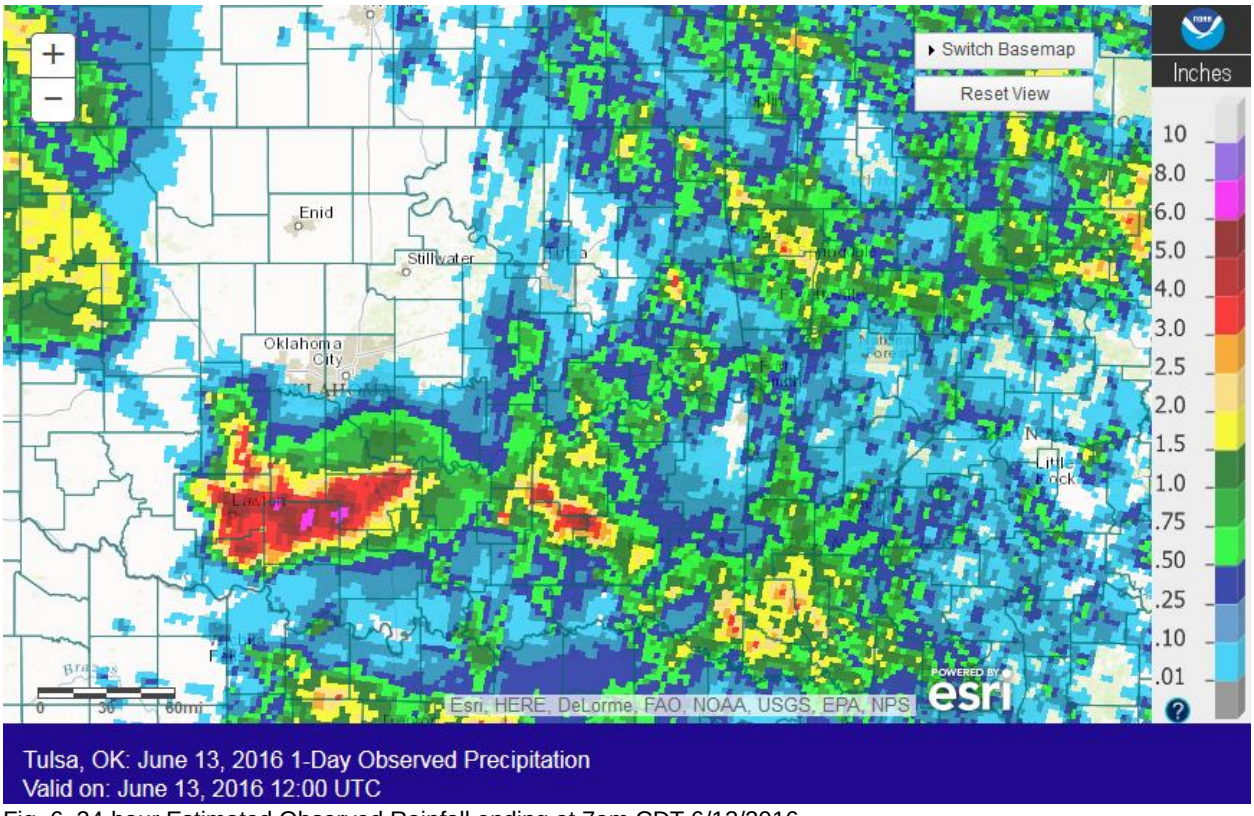


Fig. 6. 24-hour Estimated Observed Rainfall ending at 7am CDT 6/13/2016

June 16-30

A convective complex moving out of north central OK dissipated just as it began to enter the far northeast corner of the HSA during the morning hours of the 18th. A few additional storms affected northeast OK and northwest AR east of the complex along various outflow boundaries. This activity all came to an end by late morning. Scattered showers and thunderstorms redeveloped during the heat of the late afternoon across eastern OK. These storms developed into a westward propagating line during the evening, exiting the HSA by midnight. Rainfall totals ranged from around 0.25" to around 1.5" in those locations that saw storm activity.

A surface boundary stretched from the OK/TX Panhandles to eastern on the 23rd. Thunderstorms that developed along the front moved southeast into northeast OK during the evening, affecting mainly Osage County and locations near the KS/OK state line. Additional storms developed over northwest and west central AR during the late evening hours, ending a few hours after midnight. Isentropic lift along a remnant outflow boundary resulted in repeated showers and thunderstorms over north central OK late on the 23rd through the early morning hours of the 24th. 3"-5" of rain fell in this area (Fig. 7), leading to flash flooding in eastern Kay County. A pickup truck was washed off of Hwy 77 by high water a few miles north of Newkirk. Kaw Lake was able to hold the heavy rain water, and no river flooding occurred downstream along the Arkansas River. More storms developed around sunrise near the OK/KS/MO state lines, but were short-lived. Outside of Kay County, rainfall totals ranged from around 0.50" to around 2" (Fig. 7). Storms then developed further south out of MO and into northwest AR during the morning of the 24th. This activity primarily affected Carroll and far eastern Benton Counties, bringing 0.25" to 1.5" of rain.

Shortly after noon on the 26th, an area of showers and thunderstorms developed over west central AR and dissipated by early evening. At the same time, a second area of thunderstorms developed from north central OK into southwest MO along a cold front. These storms formed a broken line and moved southeast across northeast OK and northwest AR, affecting locations along and north of I-40. This activity exited the region during the early morning hours of the 27th, with some lingering showers over northeast OK and northwest AR through mid-morning. Rainfall totals ranged from around 0.25" to near 2.5" in isolated locations (Fig. 8). Isolated showers and thunderstorms then developed over northeast OK and northwest AR in the afternoon and evening of the 27th in view of a weak surface boundary stretching across central OK to central AR. This activity dissipated by midnight with the loss of daytime heat. Rainfall amounts were localized, from 0.10" to near 1.5".

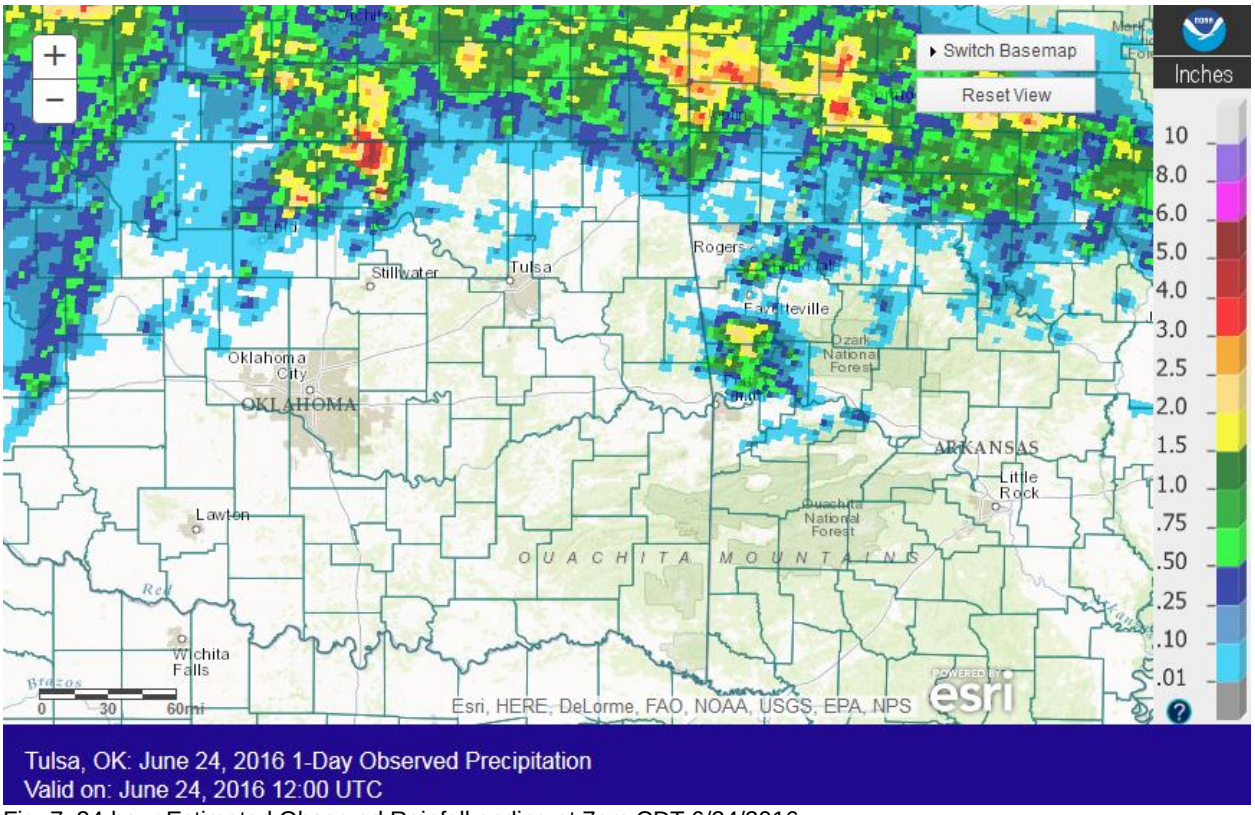


Fig. 7. 24-hour Estimated Observed Rainfall ending at 7am CDT 6/24/2016.

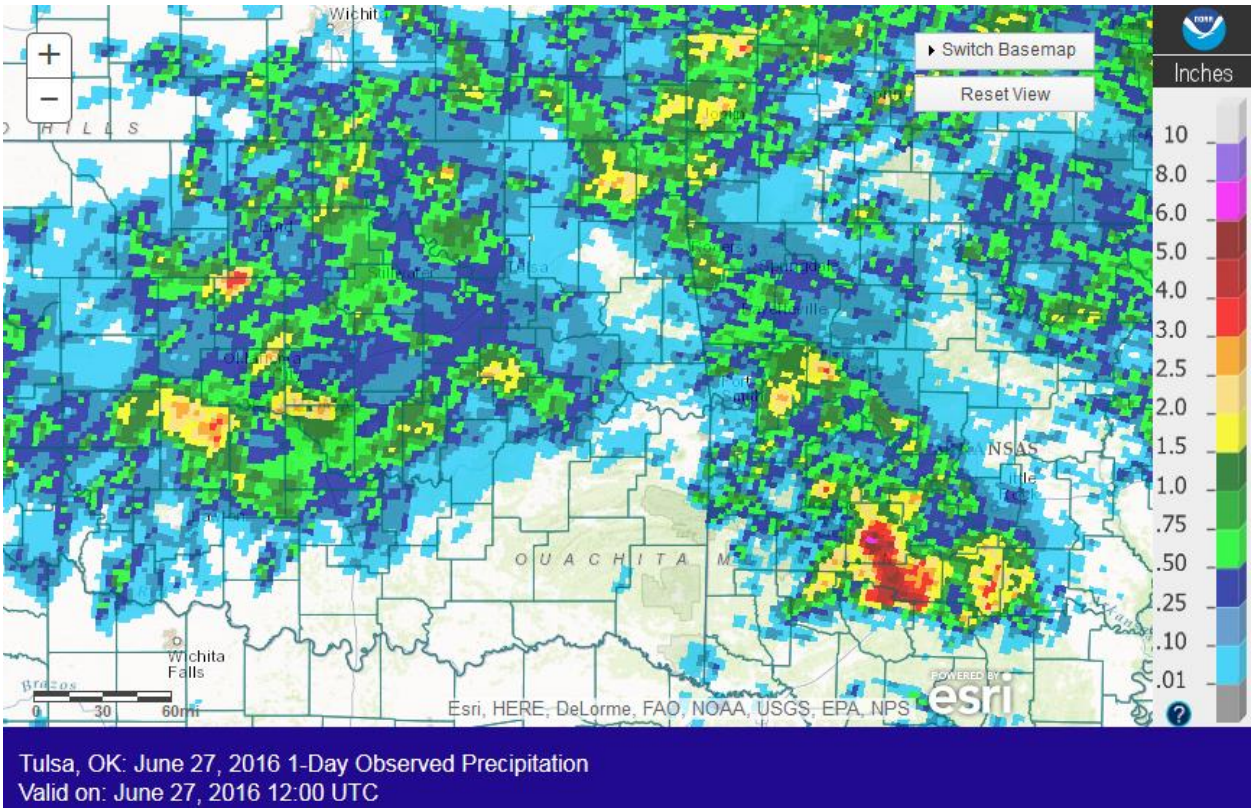


Fig. 8. 24-hour Estimated Observed Rainfall ending at 7am CDT 6/27/2016.

Subtle forcing over the region led to periods of showers and thunderstorms on the 29th-30th. Thunderstorms affected Carroll County during the afternoon of the 29th. Isolated thunderstorms then developed mid-evening near the KS/OK border, in Washington County AR, and southeast OK. A few small isolated showers affected northeast OK in the pre-dawn hours of the 30th. Around sunrise, a small cluster of storms moved across far northeast OK/southeast KS/southwest MO/northwest AR, and continued into northwest AR through the morning hours before dissipating. All of this activity resulted in 0.10" to around 1" of rain.

Thunderstorms moved out of KS and MO and into northeast OK and northwest AR during the afternoon of the 30th. These storms moved south and dissipated in the early evening before reaching I-40 in eastern OK. However, the showers and thunderstorms lingered later into the evening hours over northwest and west central AR. Additional activity developed along and north of a diffuse boundary in northeast OK during the early morning hours of July 1st. Training storms with heavy rain produced 5"-8" of rain over Pawnee and southern Osage through the morning (Figs. 9, 10). The Oklahoma Mesonet site in Pawnee measured 5.78". This resulted in high water over roadways and flooded a portion of the Pawnee Public Library. The Pawnee rainfall occurred after midnight, but mostly before 7am on July 1st. Prior to this rainfall, the Pawnee Mesonet station had only recorded 0.53" for the month of June, ranking as the second driest Mesonet station this month. (Note: the NWS will count rainfall through 7am July 1st as June rain, while other agencies, such as the Oklahoma Climatological Survey/Mesonet, will count it in July.) Elsewhere, rainfall totals ranged from around 0.25" to near 1.5" (Fig. 9).

Highest rainfall measurements ending 7am CDT 7/01/2016 include:

Pawnee, OK	5.35	Pawnee 3ENE, OK	3.83	Ralston, OK	2.65
Bella Vista 0.6 WSW, AR	2.15	Ralston 1ENE, OK	2.01		

Fig. 9. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/01/2016.

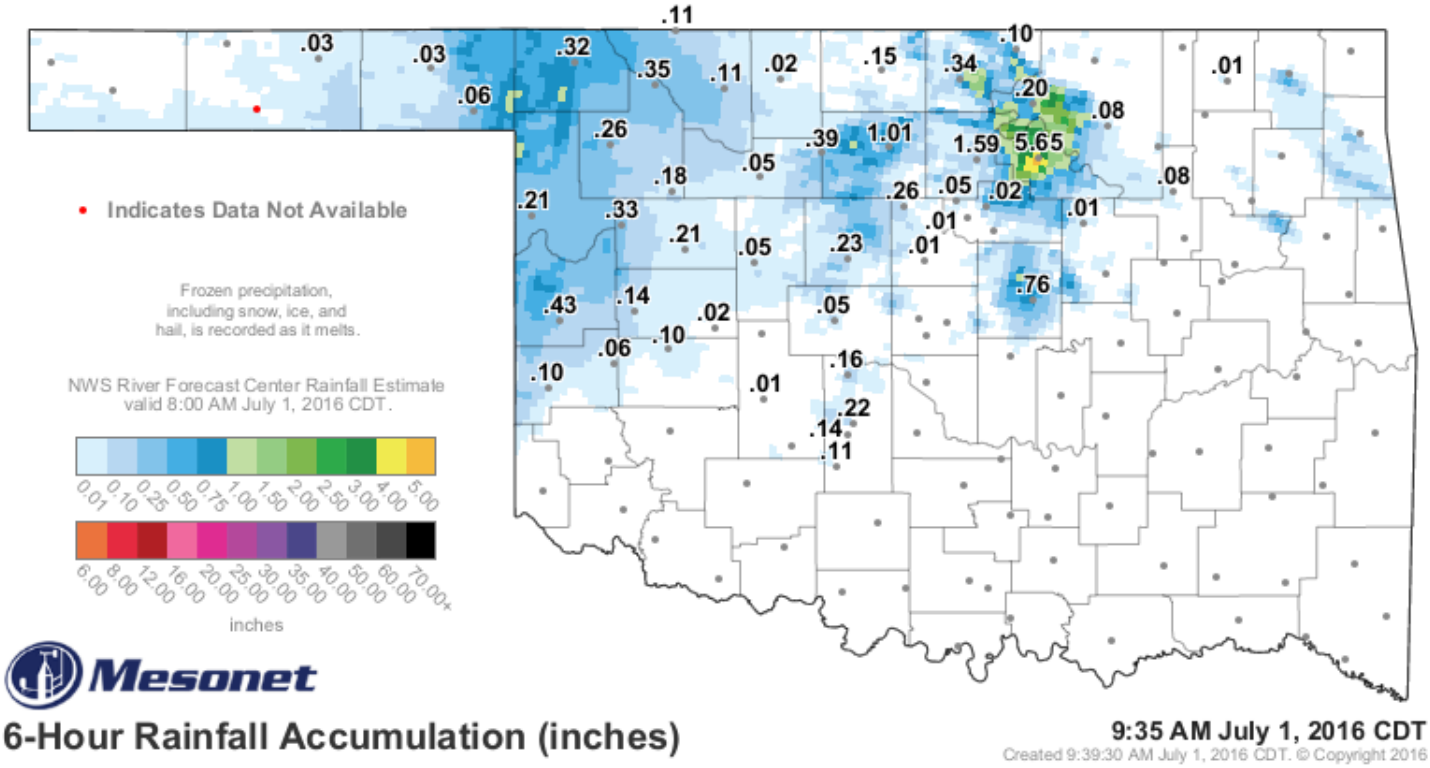


Fig. 10. 6-hr Estimated Observed Rainfall (image) and OK Mesonet measurements ending at 9:35am CDT 07/01/2016.

Written by:
Nicole McGavock
Service Hydrologist
WFO Tulsa

Products issued in June 2016:

*MLBA4 and OZGA4 transferred to NWS Tulsa HSA February 5, 2014
*Mixed case River Flood products began July 31, 2013

1 Flash Flood Warnings (FFW)
2 Flash Flood Statements (FFS)
1 Flash/Areal Flood Watches (FFA) (6 Watch FFA CON/EXT/EXA/EXB/CAN)
14 Urban and Small Stream Advisories (FLS)
1 Areal Flood Warnings (FLW)
0 Areal Flood Statements (FLS)
0 River Flood Warnings (FLW)
0 River Flood Statements (FLS)
0 River Flood Advisories (FLS) (0 Advisory FLS CON/EXT/CAN)
0 River Flood Watches (FFA) (0 Watch FFA CON/EXT/CAN)
0 River Statements (RVS)
0 Hydrologic Outlooks (ESF)
0 Drought Information Statements (DGT)

Preliminary Hydrographs:

None