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: **October** 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: **November 3, 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)

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

October 2016 was a very wet month with some river flooding along the Oklahoma-Kansas state line, while it was a very dry month across southeast OK and west central AR. Normal rainfall for October ranges from 2.9 inches in Pawnee County to 4.4 inches in Sequoyah County. 3.7 inches is normal across the Ozark region of northwest Arkansas. West central Arkansas averages just under 4 inches, while southeast Oklahoma averages slightly higher amounts of 4.5 inches. This report, past E-5 reports, and monthly hydrology and climatology summaries can be found at http://www.weather.gov/tsa/hydro-monthly-summary.

Monthly Summary

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 1a), rainfall totals for October 2016 ranged from a measly 0.10" to an excessive 10"! The highest rainfall totals of 5"-10" affected the counties that border KS, with 2"-6" elsewhere northwest of a McAlester to Fayetteville line. Portions of Franklin and Sebastian Counties only received 0.10" to 0.25", while the remainder of southeast OK and west central AR saw 0.25" to around 2.5". This corresponds to 150% to 250% of the normal October rain for the KS border counties, and around 5% to 25% for southeast OK and west central AR (Fig. 1b). The remainder of the area was generally below normal as well.

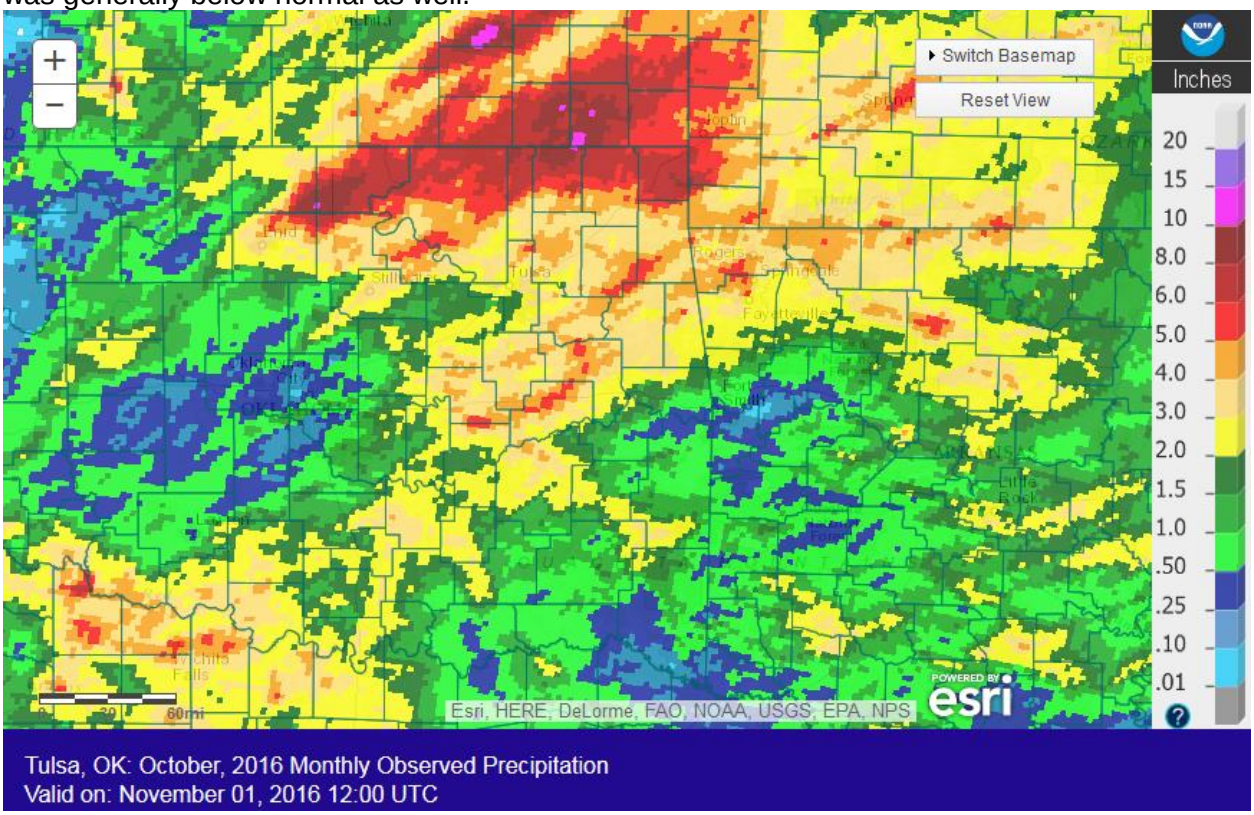


Fig. 1a. Estimated Observed Rainfall for October 2016

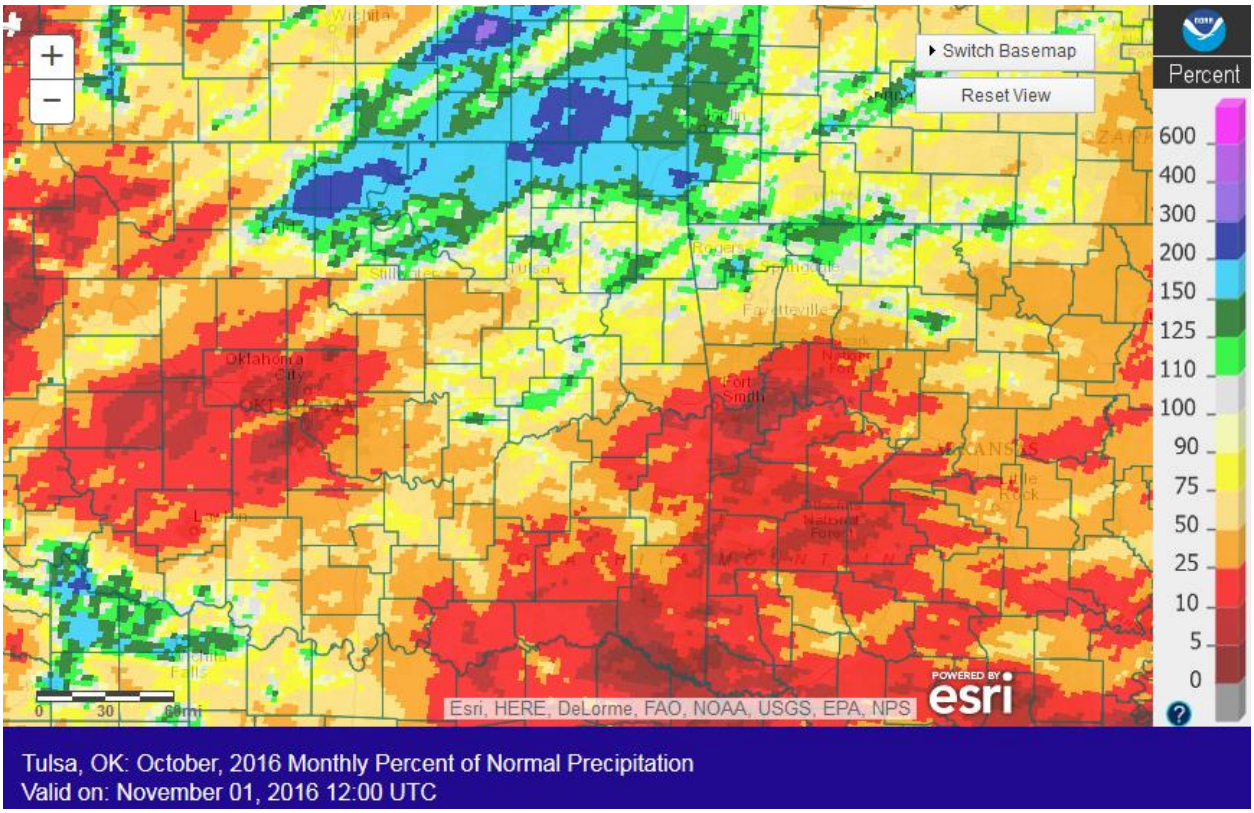


Fig. 1b. Estimated % of Normal Rainfall for October 2016

In Tulsa, OK, October 2016 ranked as the 5th warmest October (68.5°F; since records began in 1905) and the 61st wettest October (2.86", tied 1942; since records began in 1888). Fort Smith, AR had the 2nd warmest October (69.7°F; since records began in 1882) and the 8th driest October (0.40", tied 1966; since records began in 1882). Fayetteville, AR had the 2nd warmest (63.8°F, tied 1950) and the 28th driest (2.97") October since records began in 1949.

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

Copan, OK (meso)	7.69	Miami, OK (meso)	6.95	Busch 0.4E, AR (coco)	6.92
Hulah 5.3WSW, OK (coco)	6.70	Bartlesville, OK (ASOS)	6.39	Ochelata 5.6N, OK (coco)	6.37
Bartlesville, OK (coop)	6.31	Pawhuska 9.4ENE, OK (coco)	6.13	Foraker, OK (meso)	6.05

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

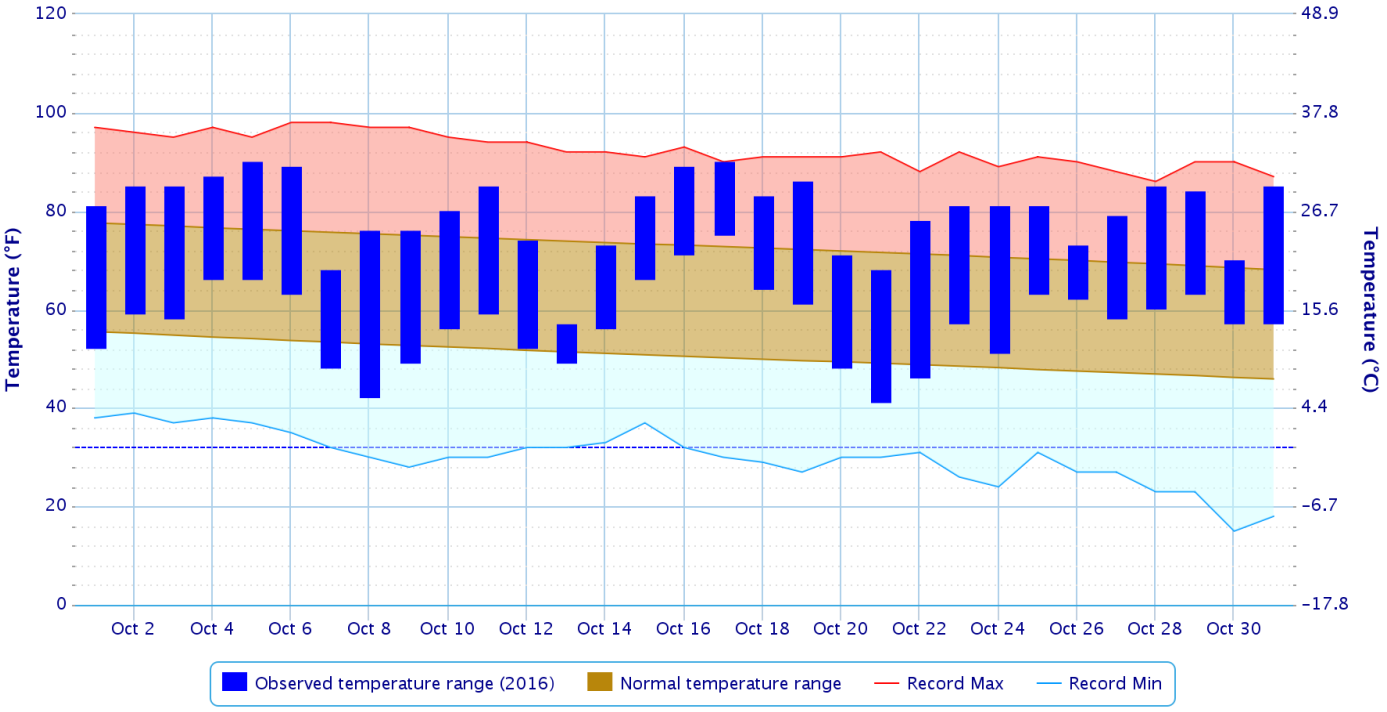
Ozark, AR (coop)	0.21	Charleston 1.7E, AR (coco)	0.34	Fort Smit, AR (ASOS)	0.40
Antlers, OK (meso)	0.53	Van Buren 2.1NNW, AR (coco)	0.69	Antlers, OK (coop)	0.74
Hugo, OK (meso)	0.76	Uniontown 2.1ESE, AR (coco)	0.79	Wister, OK (meso)	0.80

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

Rank since 1921	October 2016	Autumn-to-Date (Sep 1 – Oct 31)	Last 90 Days (Aug 3 – Oct 31)	Last 120 Days (Jul 4 – Oct 31)	Last 180 Days (May 5 – Oct 31)	Year-to-Date (Jan 1 – Oct 31)	Last 365 Days (Nov 2, 2015–Oct 31, 2016)
Northeast OK	28th wettest	45th wettest	34th driest	37th driest	36th driest	28th driest	16th wettest
East Central OK	38th driest	19th driest	17th driest	25th driest	23rd driest	25th driest	15th wettest
Southeast OK	12th driest	12th driest	35th driest	35th driest	20th driest	45th driest	**5th wettest**
Statewide	29th wettest	29th driest	33rd driest	36th driest	38th driest	43rd driest	11th wettest

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

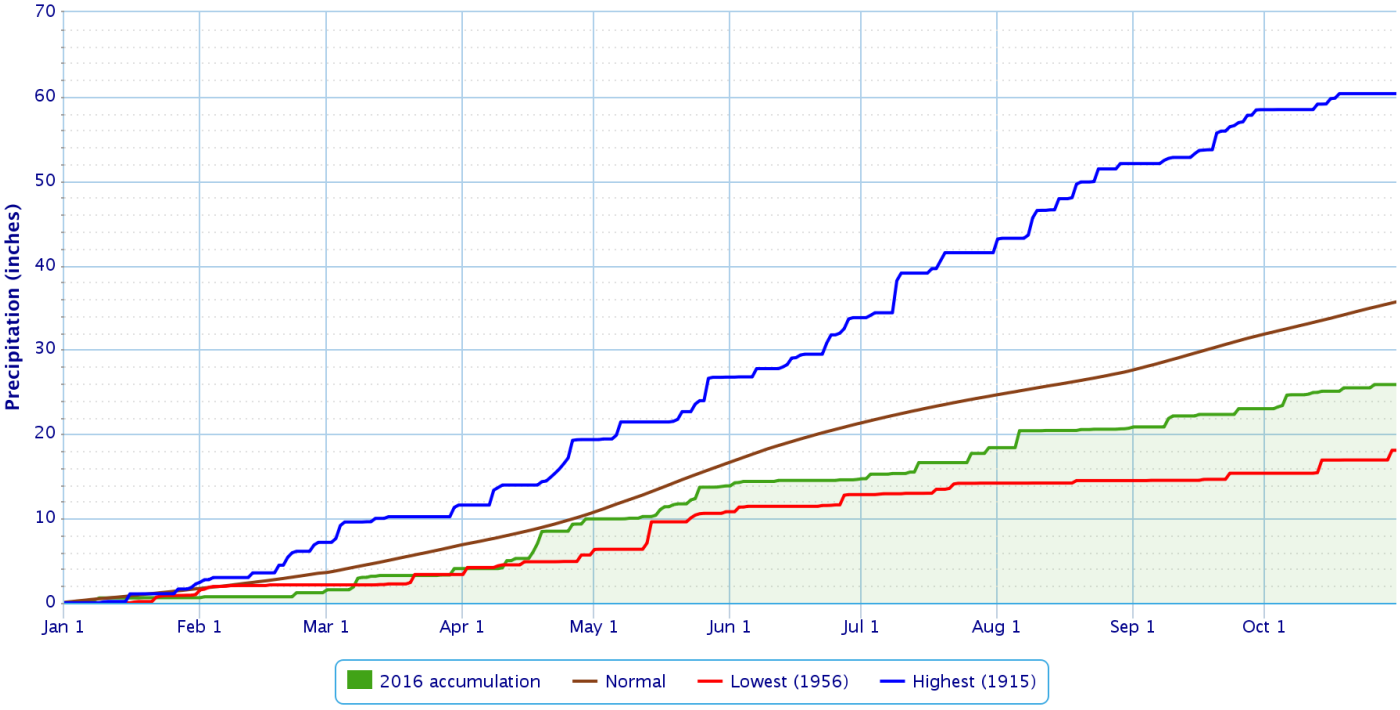
Period of Record – 1905-01-06 to 2016-11-02. Normals period: 1981-2010. Click and drag to zoom chart.



Powered by ACIS

Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

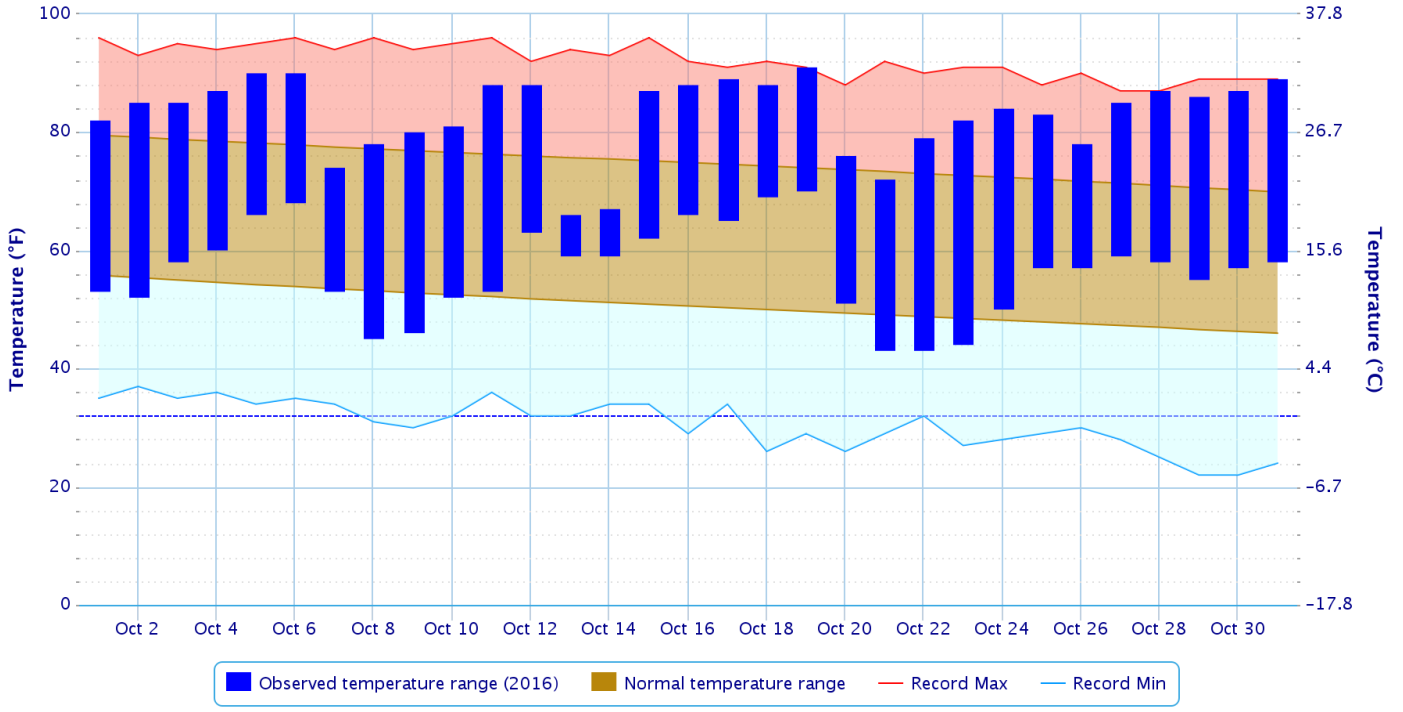
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

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

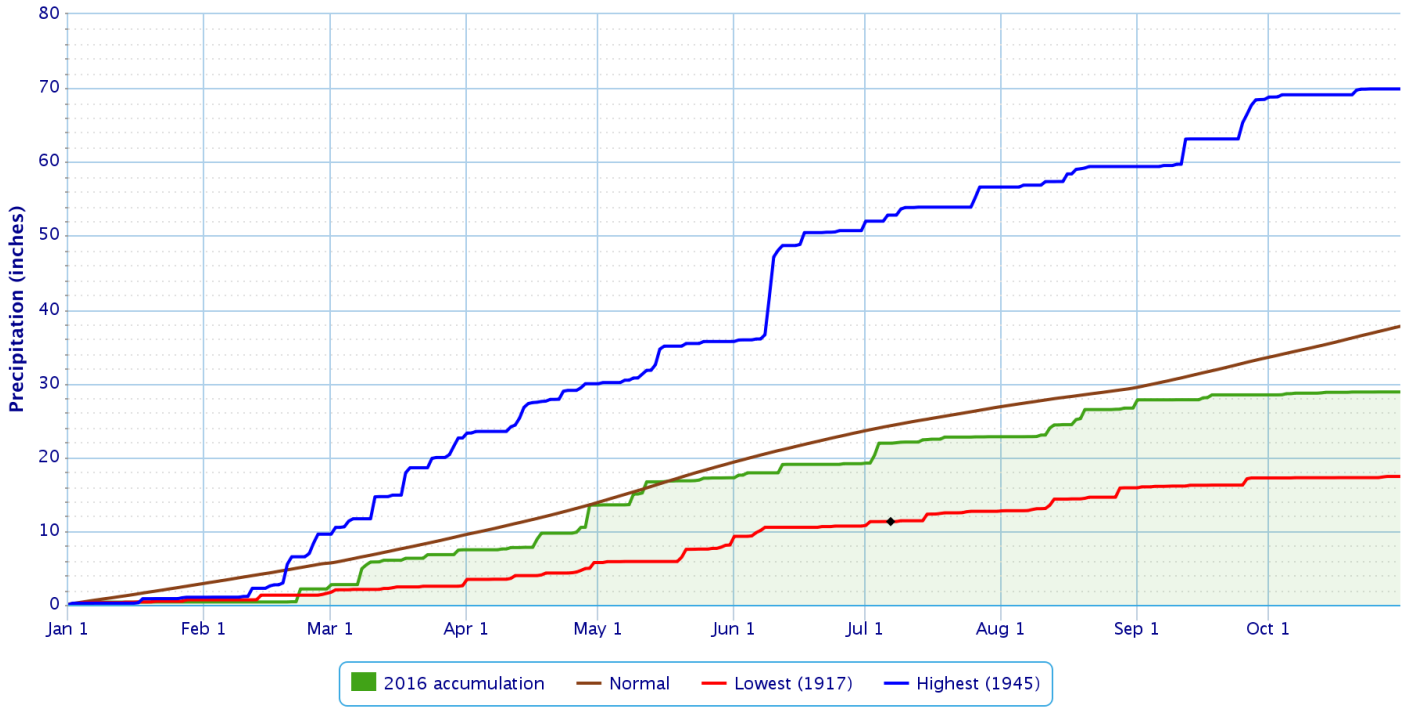
Period of Record – 1882-06-01 to 2016-11-02. Normals period: 1981-2010. Click and drag to zoom chart.



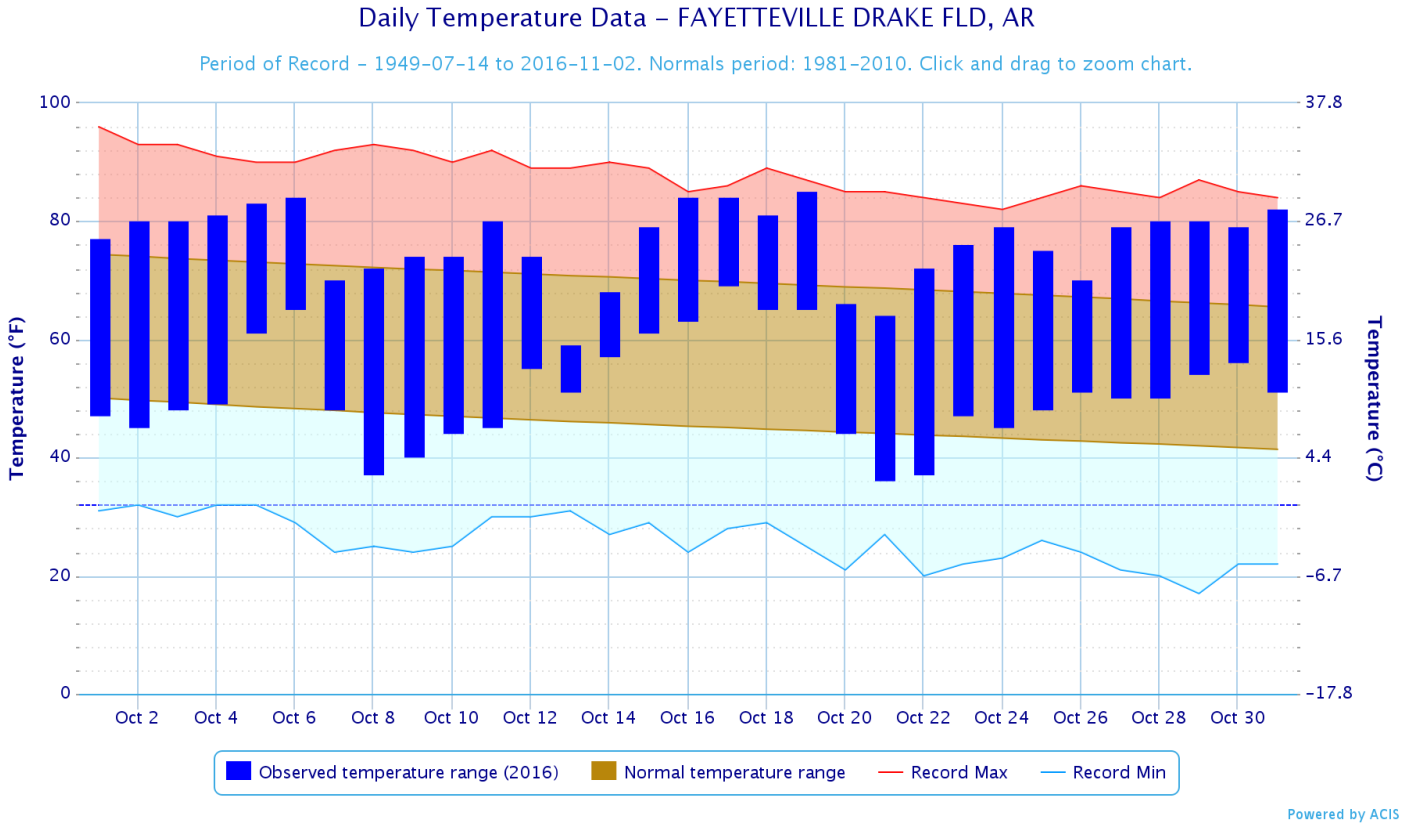
Powered by ACIS

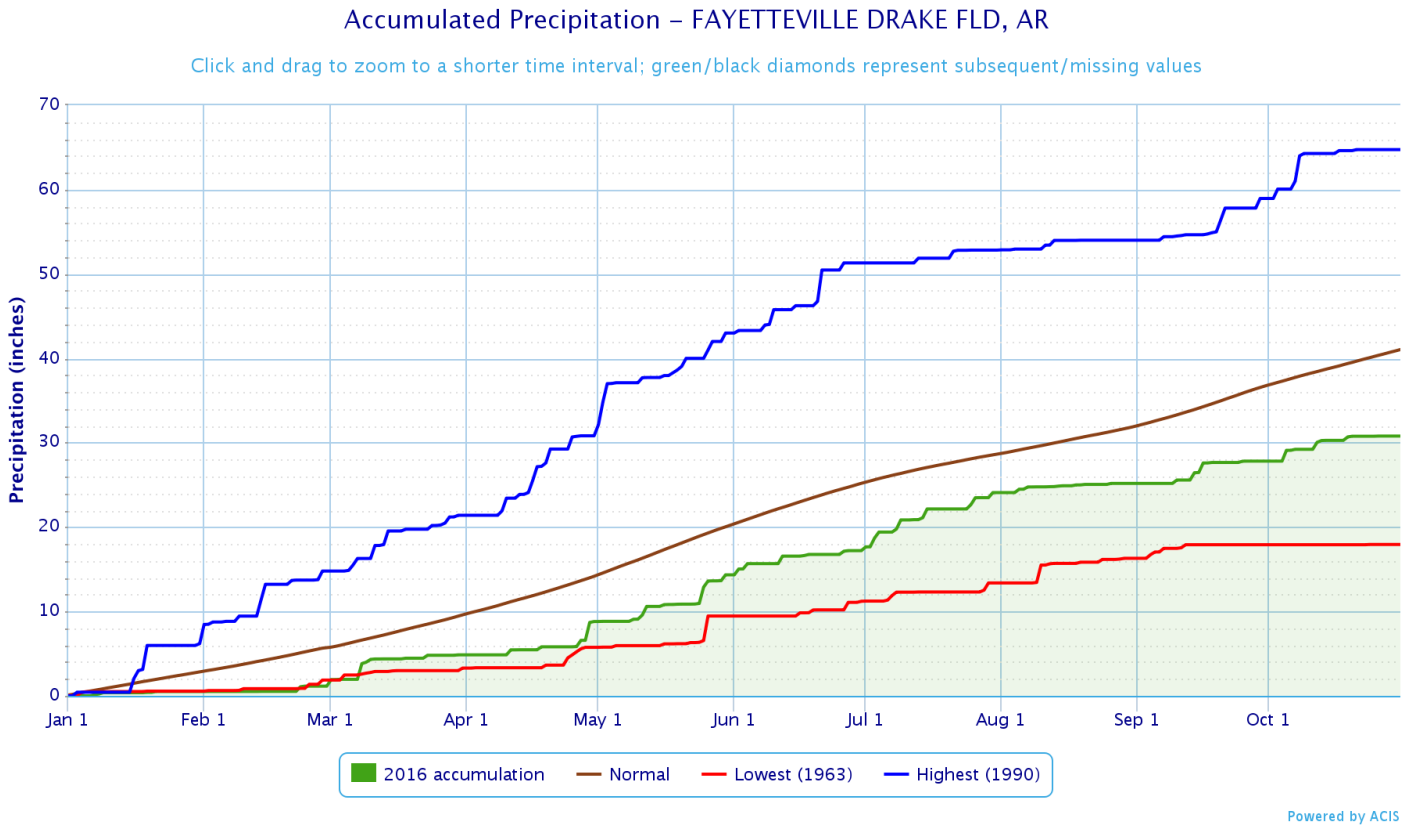
Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

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



Powered by ACIS





Drought

According to the U.S. Drought Monitor (USDM) from November 1, 2016 (Figs. 2, 3), D2 (Severe Drought) developed over Choctaw and southwest Pushmataha Counties. D1 (Moderate Drought) conditions existed over portions of Tulsa, Okmulgee, McIntosh, Wagoner, Muskogee, Cherokee, Adair, Sequoyah, Haskell, Le Flore, Latimer, Pittsburg, and Pushmataha Counties in eastern OK, and Crawford, Sebastian, and Franklin

Counties in west central AR. D0 (abnormally dry conditions but not in drought) were present across portions of Creek, Okfuskee, Tulsa, Washington, Rogers, Mayes, Delaware, and Adair in eastern OK, and Benton, Washington, Crawford, Madison, Franklin Counties in northwest AR.

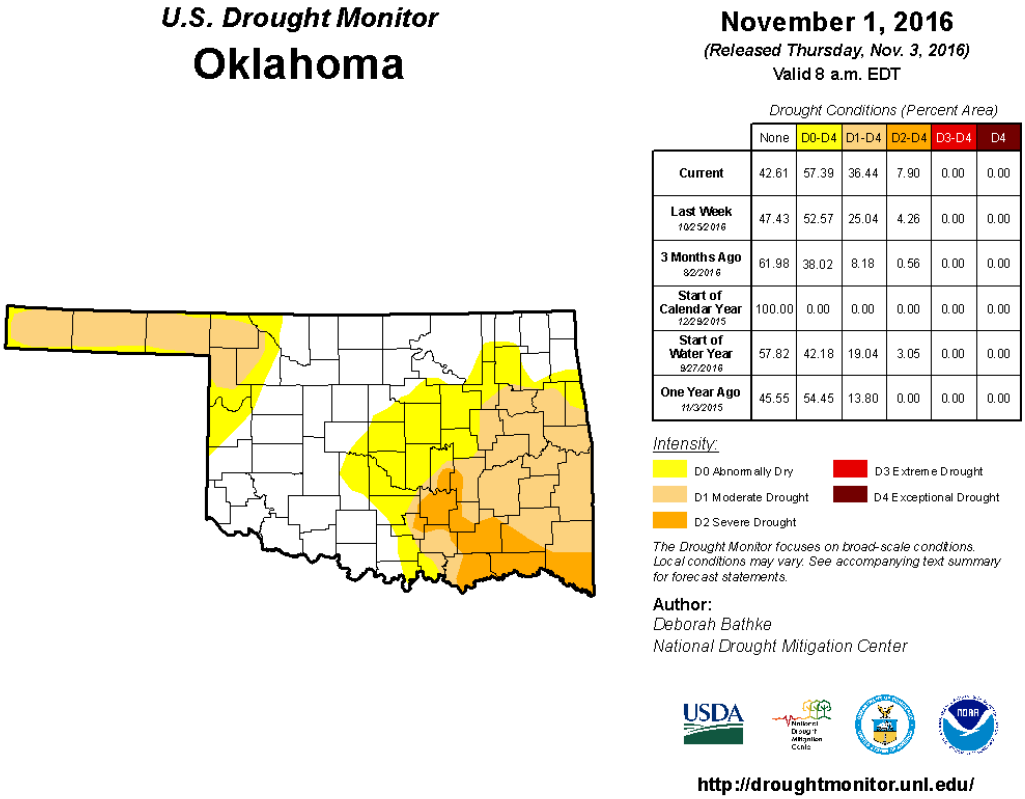


Fig. 2. Drought Monitor for Oklahoma

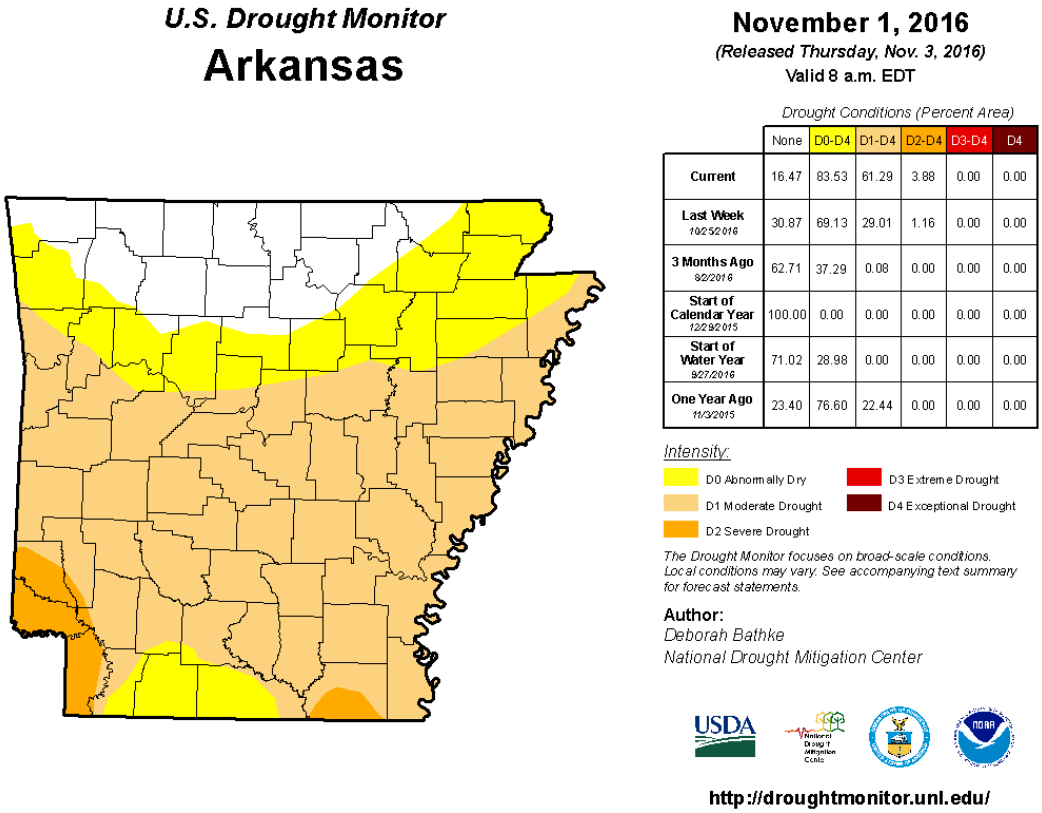
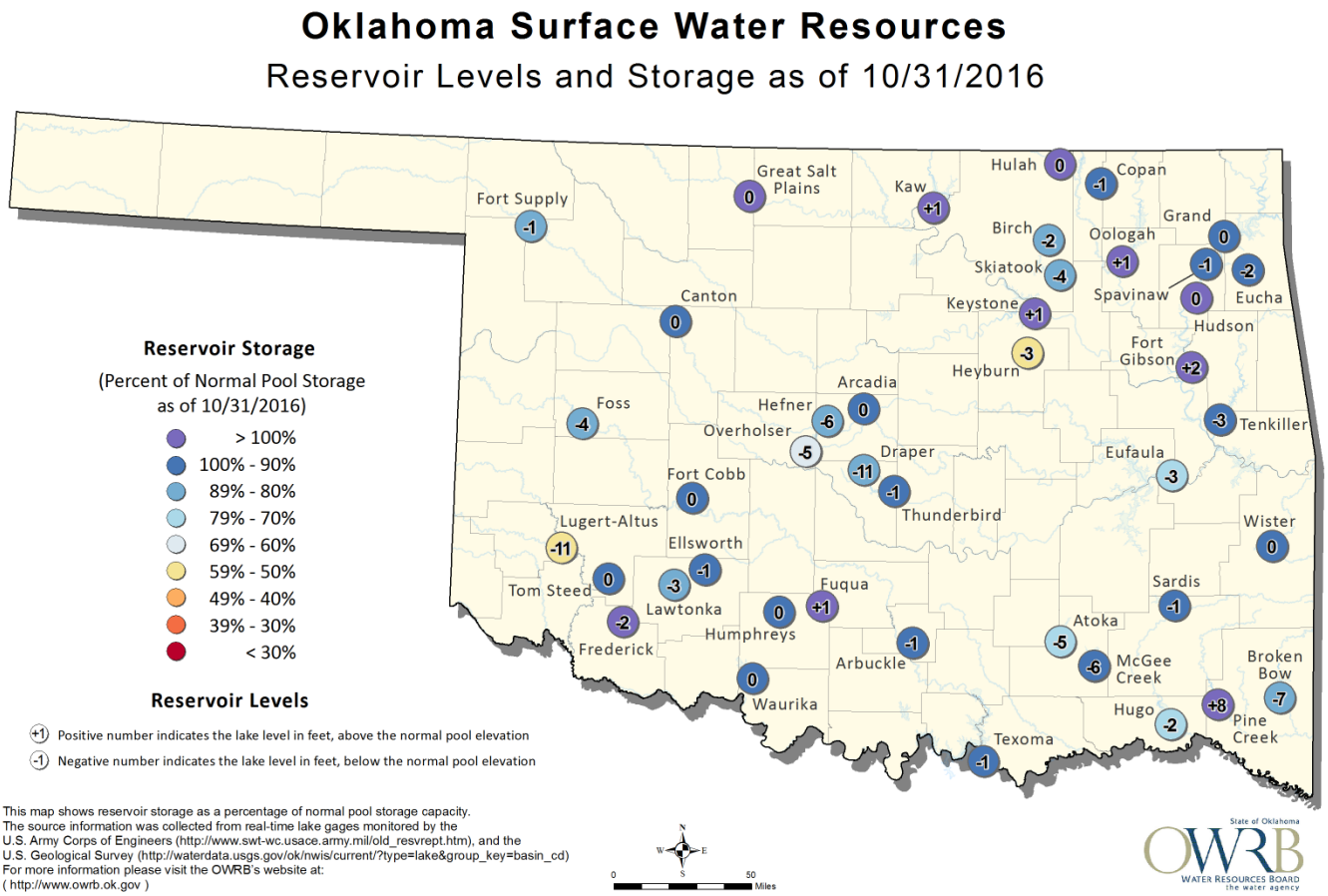


Fig. 3. Drought Monitor for Arkansas

Reservoirs



According to the USACE, several lakes in the HSA were well below the top of their conservation pool levels as of 10/31/2016. Reservoirs operating more than 5% below of the top of their conservation level include: Heyburn Lake 50%, Hugo Lake 76%, Eufaula Lake 79%, Beaver Lake 84%, Birch Lake 85%, Skiatook Lake 88%, Tenkiller Lake 90%, and Copan Lake 92%.

Outlooks

The Climate Prediction Center (CPC) outlook for November 2016 (issued October 31, 2016) indicates a significantly enhanced chance of above normal temperatures across all of eastern OK and northwest AR. This outlook also calls for a slightly enhanced chance for below median rainfall over southeast OK through northwest AR and equal chances for above, near, and below median precipitation elsewhere across northeast OK. This outlook takes into account weather conditions forecast over the next 1-2 weeks, as well as subseasonal climate signals in the weeks 2-4 time frame. An amplified ridge is forecast to dominate the circulation pattern over the U.S. for the first 7-10 days of November, with much above normal temperatures forecast over nearly the entire CONUS. An amplified Madden-Julian Oscillation (MJO) event is forecast in the first two weeks of November, which could result in below normal temperatures and below median rainfall at the end of November over the central U.S. However, the warmth at the beginning of the month will likely be greater than the cooling at the end of the month, tilting the odds for a warmer than normal November.

For the 3-month period November-December-January 2016, CPC is forecasting an enhanced chance for above normal temperatures and an enhanced chance for below median precipitation across all of eastern OK

and northwest AR (outlook issued October 20, 2016). According to CPC, Pacific sea surface temperatures along the equator reflect ENSO-neutral conditions (near average), but observations in both the atmosphere and ocean have trended toward La Niña in recent weeks. This outlook is based on La Niña impacts, both statistical and dynamical forecast tools, and decadal timescale climate trends. CPC has reissued the La Niña Watch. The probability of a weak La Niña is near 70% during Autumn 2016 and remains a consideration in the NDJ outlook. La Niña has a 55% chance to continue into the 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

October 1-15

A line of thunderstorms moved into northeast OK during the late evening hours of the 4th. This activity continued to move east across northeast OK and northwest AR, affecting areas along and north of I-40 through the overnight and morning hours. Thunderstorms developed just south of a stalled cold front late on the 5th. These storms then moved into northeast OK shortly after midnight on the 6th, affecting locations along the OK/KS line through most of the overnight hours. By sunrise, the storms had developed further south, brining rain to northeast OK along and north of I-44 through the noon hour. For the third evening in a row, a line of thunderstorms developed along a cold front to the northwest of the HSA, and moved southeast into the area mid-evening on the 6th. These storms brought rain to the majority of eastern OK and northwest AR through mid-morning on the 7th, though lesser amounts were seen over west central AR and southeast OK as the storms weakened. The three rounds of rainfall resulted in 1.5" to 8" of rain north of I-40, and a few hundredths to less than 1.5" south of I-40 (Figs. 4, 5). The northeast Kay and the northern portions of Osage, Washington, and Nowata Counties (plus the adjacent counties in KS), received 5"-8" of rain. This heavy rain fell over the Caney, Verdigris, and Neosho River Basins, and led to minor flooding along the Verdigris River near Lenapah and moderate flooding along the Neosho River near Commerce (see preliminary hydrographs at the end of this report).

24-hour rainfall measurements (inches) ending at 7am CDT Oct. 7, 2016:

Bartlesville 1NE, OK	4.29	Copan 3ENE, OK	4.27	Pawhuska 1ESE, OK	4.26
Bartlesville 2W, OK	3.99	Wynona 2S, OK	3.98	Hominy 4NNE, OK	3.81
Hulah Dam, OK	3.66	Barnsdall 2S, OK	3.58	Lenapah 3E, OK	3.23

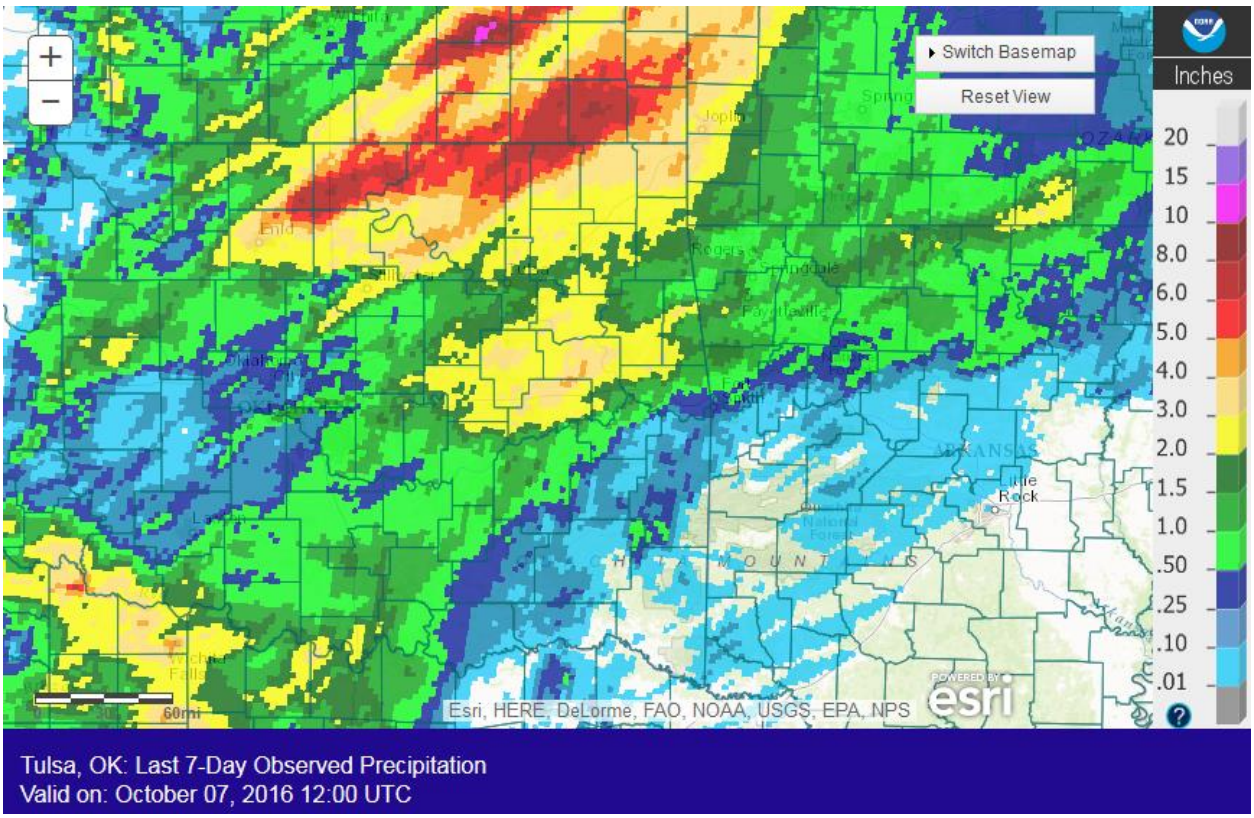


Fig. 4. 7-day Estimated Observed Rainfall ending at 7am CDT 10/07/2016.

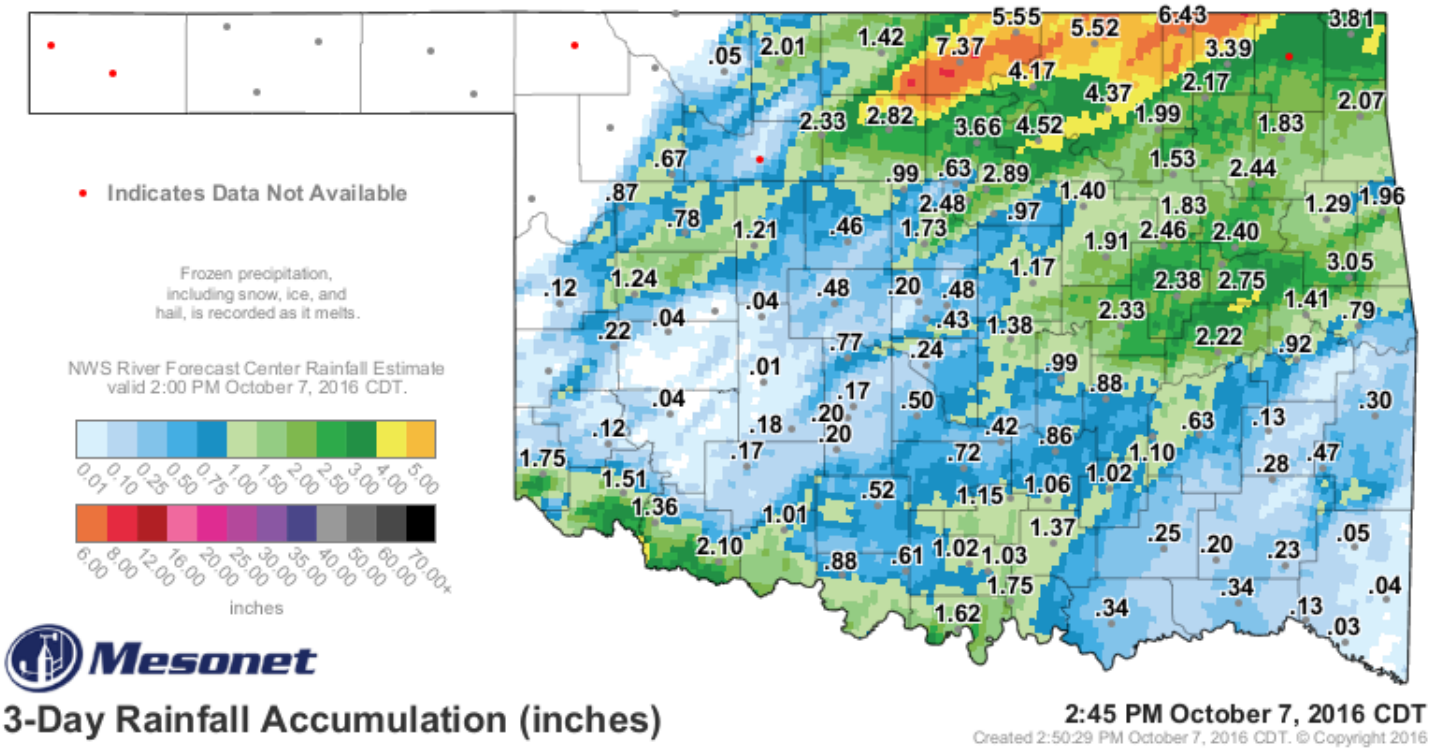


Fig. 5. 3-day Estimated Observed Rainfall (image) and OK Mesonet measurements ending at 2:45pm CDT 10/07/2016

During the evening of the 11th, a few showers and thunderstorms developed over northwest OK east of a dryline and south of an approaching cold front in a ribbon of higher dew point air. These storms moved into northeast OK by late evening and expanded in coverage due to warm air advection as they continued eastward along and north of Hwy 412 through sunrise on the 12th. As a cold front moved south into the area, additional scattered showers and thunderstorms developed during the morning, and continued through the remainder of the day north of I-40. 2"-3" of rain fell over portions of Craig, Ottawa, Benton, and Carroll Counties. Elsewhere, rainfall totals ranged from a few hundredths to around 1.5".

Scattered showers and thunderstorms moved into southeast OK during the evening of the 13th ahead of an approaching upper-level wave. Additional activity developed through the overnight hours over the remainder of eastern OK and northwest AR as the wave moved east. The rain finally dissipated by mid-morning of the 14th. Rainfall totals were light overall, ranging from a few hundredths to around 0.75".

October 16-31

A surface front was located along I-44 on the 19th. Enhanced lift associated with an upper-level shortwave moving across the Central Plains combined with afternoon heating allowed thunderstorms to develop along the front during the late afternoon. The line of showers and thunderstorms then moved southeast across eastern OK and northwest AR through the evening and overnight hours. This activity exited the HSA around sunrise on the 20th. Rainfall totals south of I-44 ranged from around 0.10" to around 3" (Fig. 6). No rain fell north of I-44.

Just before sunrise on the 26th, a line of thunderstorms moved southeast out of KS and into northeast OK. The line continued to move southeast across eastern OK and northwest AR through the morning, before beginning to weaken during the afternoon. By late afternoon, a few storms flared back up across southeast OK, finally exiting the area shortly after sunset. Rainfall totals ranged from a few hundredths to around 1.5".

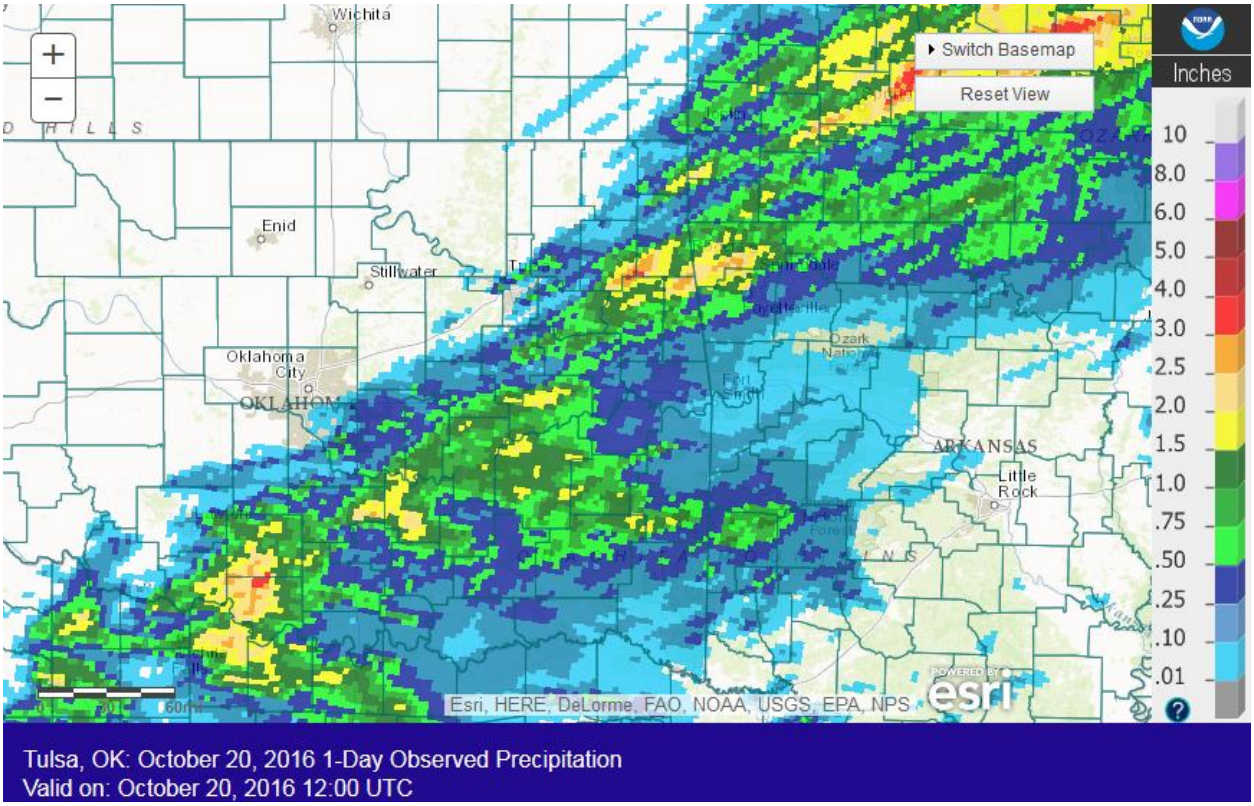


Fig. 6. 24-hr Estimated Observed Rainfall ending at 7am CDT 10/20/2016.

Written by:

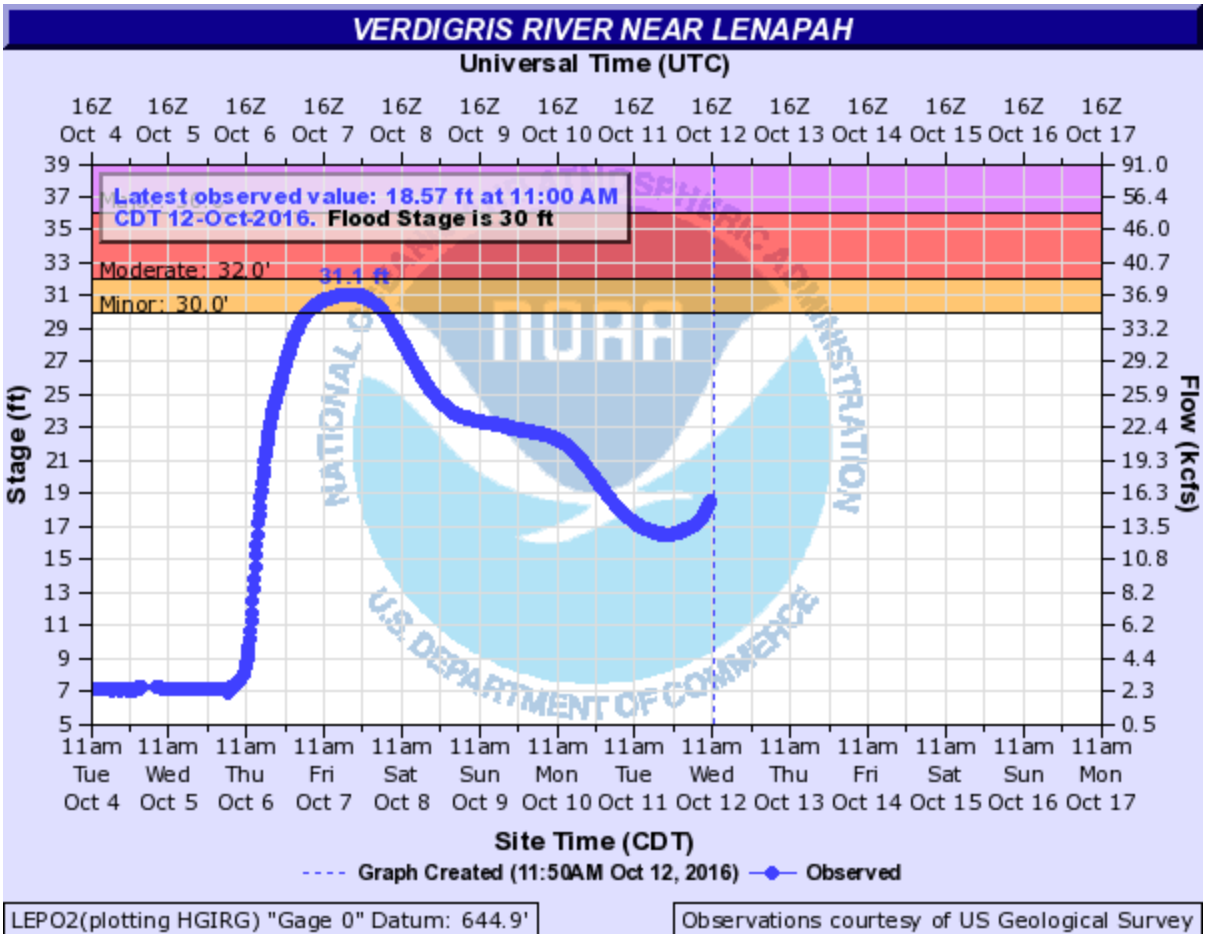
Nicole McGavock
Service Hydrologist
WFO Tulsa

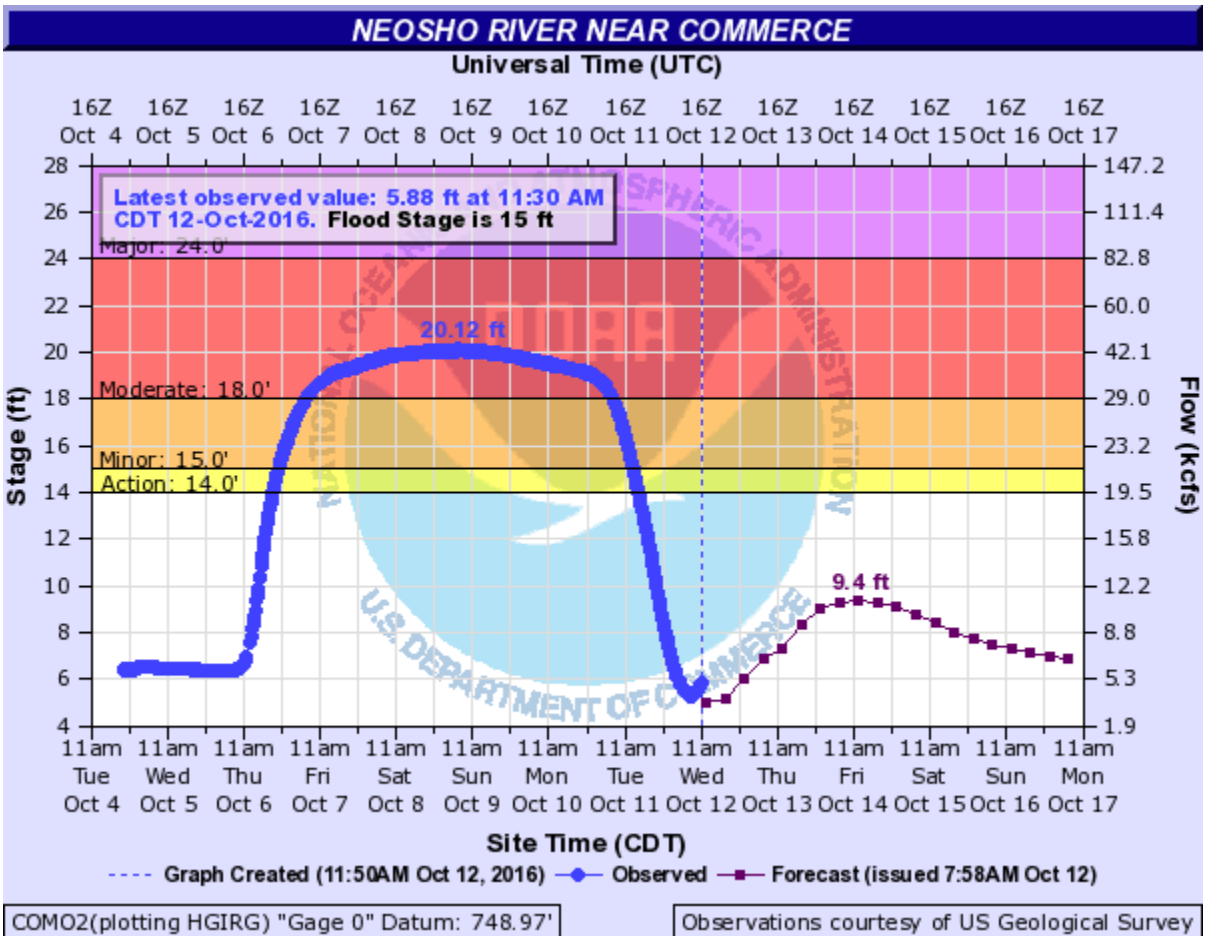
Products issued in October 2016:

*CWYO2 became a daily river forecast point September 7, 2016
*MLBA4 and OZGA4 transferred to NWS Tulsa HSA February 5, 2014
*Mixed case River Flood products began July 31, 2013

2 Flash Flood Warnings (FFW)
0 Flash Flood Statements (FFS)
1 Flash/Areal Flood Watches (FFA) (1 Watch FFA CON/EXT/EXA/EXB/CAN)
8 Urban and Small Stream Advisories (FLS)
0 Areal Flood Warnings (FLW)
0 Areal Flood Statements (FLS)
3 River Flood Warnings (FLW)
28 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)
1 Drought Information Statements (DGT)

Preliminary Hydrographs:


VERDIGRIS RIVER NEAR LENAPAH
Universal Time (UTC)
Latest observed value: 18.57 ft at 11:00 AM CDT 12-Oct-2016. Flood Stage is 30 ft
Moderate: 32.0'
Minor: 30.0'
31.1 ft
Stage (ft)
Flow (kcfs)
Site Time (CDT)
Graph Created (11:50AM Oct 12, 2016)
Observed
LEPO2(plotting HGIRG) "Gage 0" Datum: 644.9'
Observations courtesy of US Geological Survey


NEOSHO RIVER NEAR COMMERCE
Universal Time (UTC)
Latest observed value: 5.88 ft at 11:30 AM CDT 12-Oct-2016. Flood Stage is 15 ft
Major: 24.0'
Moderate: 18.0'
Minor: 15.0'
Action: 14.0'
20.12 ft
9.4 ft
Stage (ft)
Flow (kcfs)
Site Time (CDT)
Graph Created (11:50AM Oct 12, 2016)
Observed
Forecast (issued 7:58AM Oct 12)
COMO2(plotting HGIRG) "Gage 0" Datum: 748.97'
Observations courtesy of US Geological Survey