

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 March	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 April 6, 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.

Despite several rounds of storms, much of eastern OK and northwest AR ending March 2016 with below normal rainfall. Several tornadoes also occurred this month, and one river forecast point exceeded flood stage. The average temperature for March 2016 was well above normal across the area. Normal precipitation for March ranges from 3.1 inches in Pawnee County to 4.3 inches in Le Flore County. In the Ozark region of northwest Arkansas, the normal precipitation for the month is 4.4 inches. 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), rainfall totals for March 2016 ranged from 1" to around 8". Most of the HSA received 2"-5" of rain this month. This corresponds to 25%-90% of the normal March rain northwest of a McAlester to Fayetteville line (Fig. 1b). Southwest of this line, most of southeast OK and west central AR received 110% to near 200% of the normal March rain.

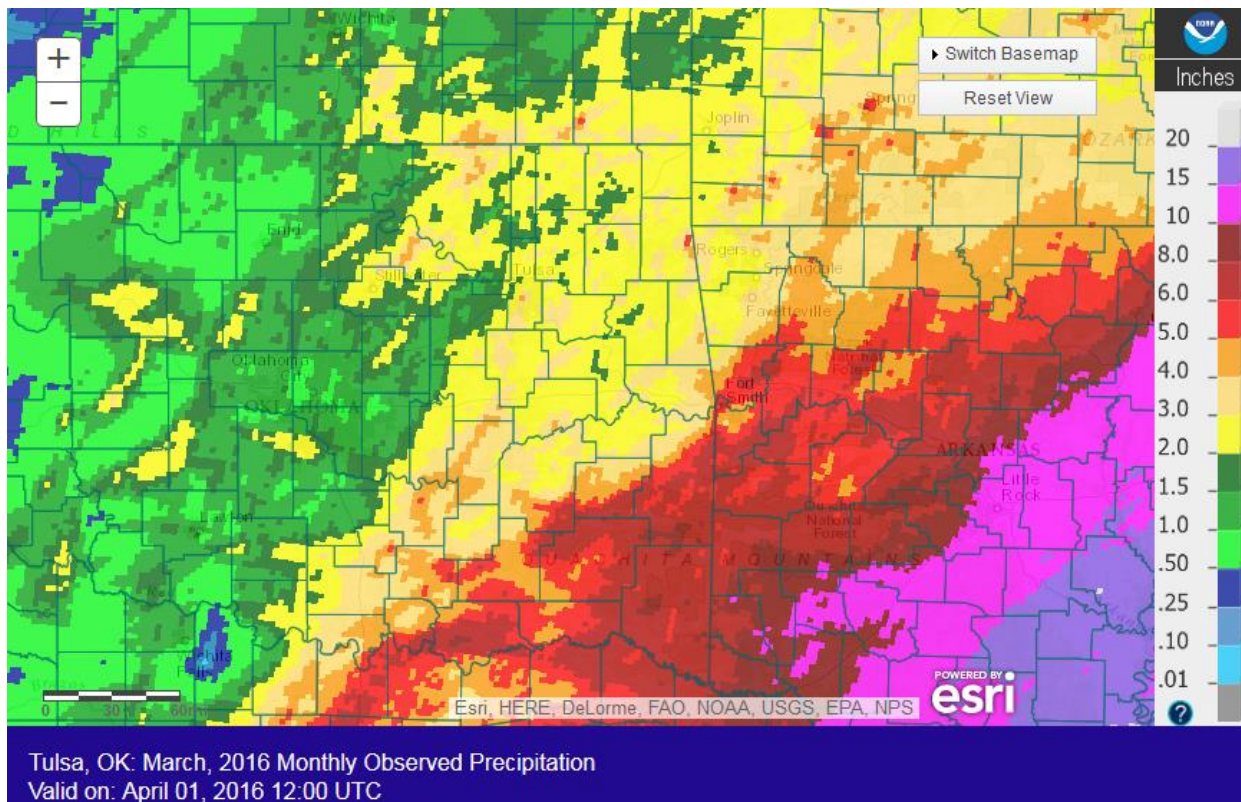


Fig. 1a. Estimated Observed Rainfall for March 2016

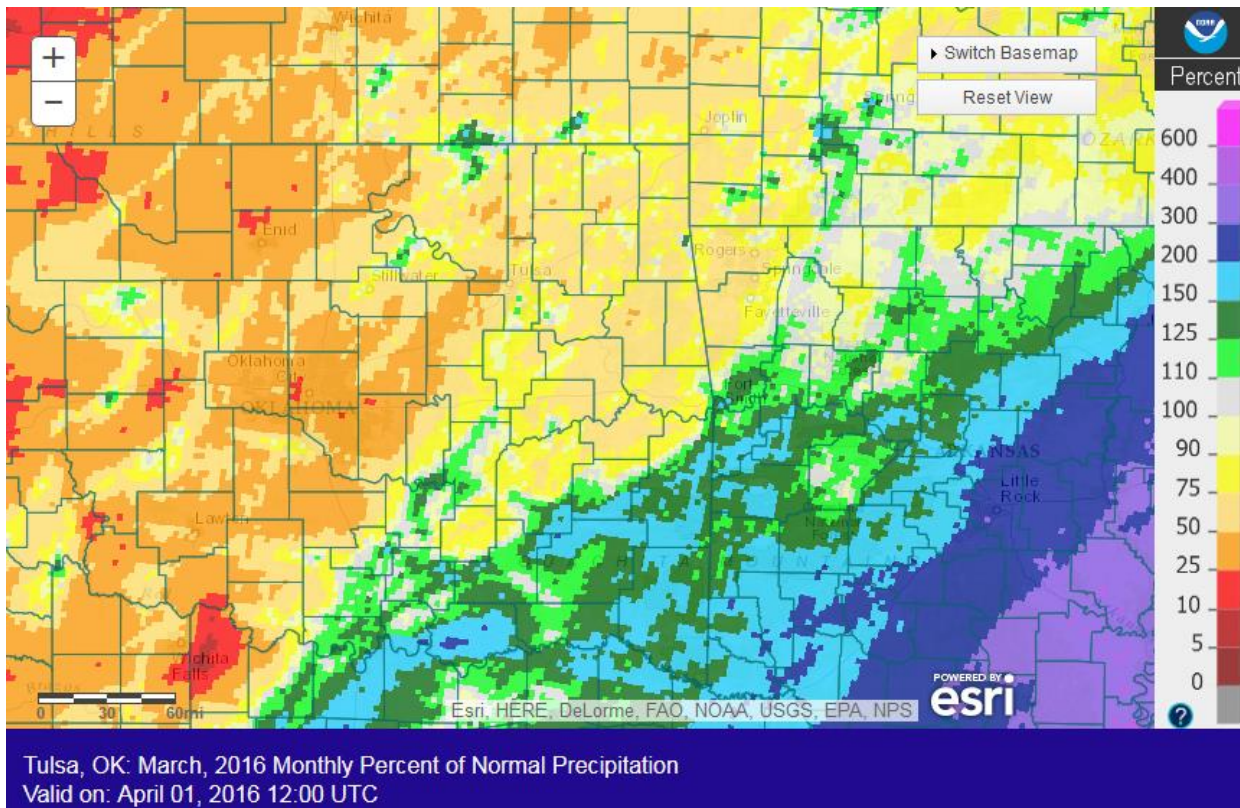


Fig. 1b. Estimated % of Normal Rainfall for March 2016

In Tulsa, OK, March 2016 ranked as the 12th warmest March (56.5°F; since records began in 1905) and the 62nd wettest March (2.86"; since records began in 1888). Fort Smith, AR had the 16th warmest March (56.4°F, tied 1974, 1939, 1935, 1911; since records began in 1883) and the 20th wettest March (5.31", tied 2006; since records began in 1883). Fayetteville, AR had the 14th warmest (51.1°F, tied 1995) and the 33rd wettest (3.63") March since records began in 1950.

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

Clayton, OK (meso)	7.94	Van Buren 0.7SSE, AR (coco)	7.14	Fanshawe, OK (coop)	6.96
Greenwood 1.4W, AR (coco)	6.86	Wister, OK (meso)	6.81	Charleston 1.7E, AR (coco)	6.72
Van Buren 2.1 NNW, AR (coco)	6.54	Talihina, OK (meso)	6.44	Cloudy, OK (meso)	6.38

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

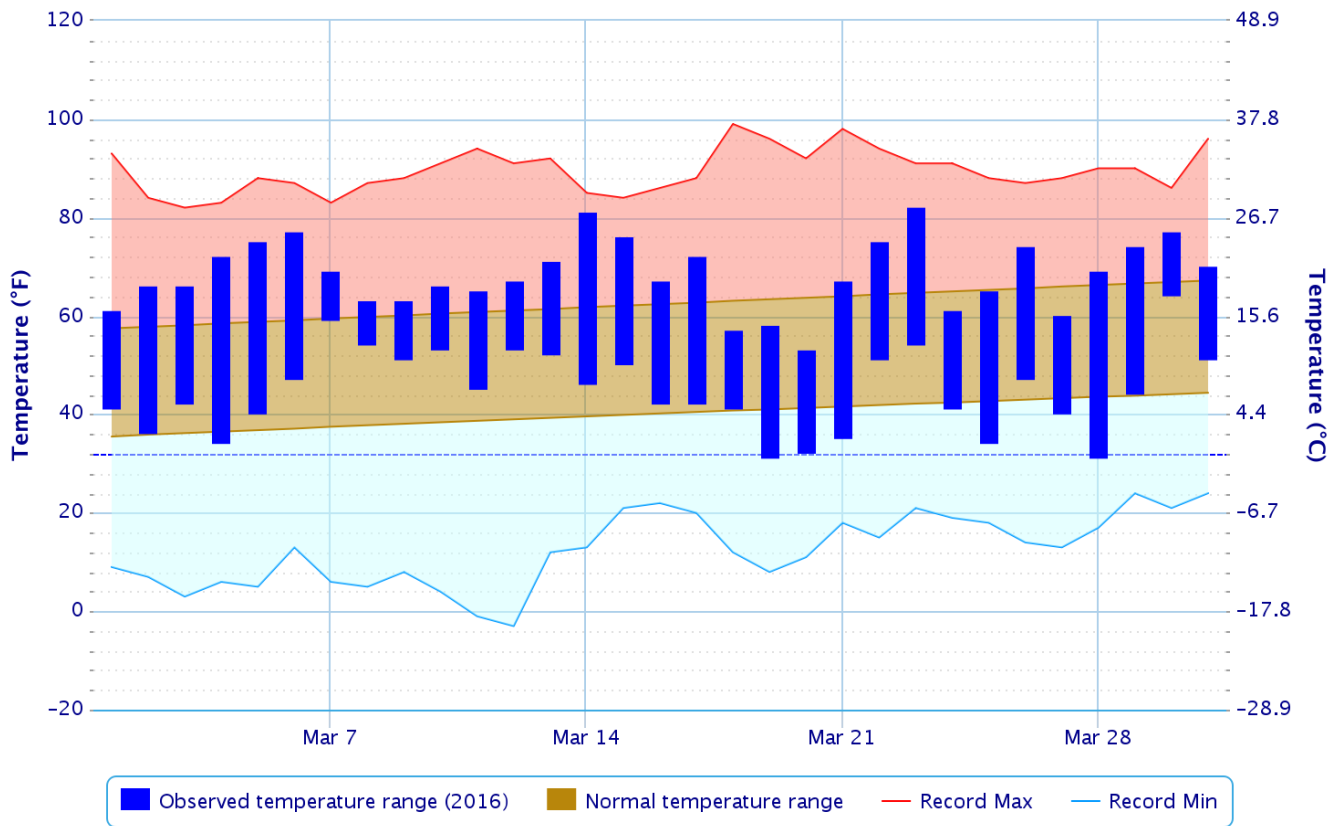
Oilton, OK (meso)	1.48	Burbank, OK (meso)	1.75	Vinita, OK (meso)	1.89
Bartlesville, OK (ASOS)	1.94	Talala, OK (meso)	2.07	Sand Springs 2.1 ENE, OK (coco)	2.20
Copan, OK (meso)	2.28	Wynona, OK (meso)	2.30	Sperry 6.7 WNW, OK (coco)	2.40

According to statistics from the [Oklahoma Climatological Survey \(OCS\)](#) Mesonet:

Rank since 1921	March 2016	Last 60 Days (Feb 1 – Mar 31)	Year-to-Date (Jan 1 – Mar 31)	Last 120 Days (Dec 3 – Mar 31)	Water Year-to-Date (Oct 1 – Mar 31)	Last 365 Days (Apr 2, 2015-Mar 31, 2016)
Northeast OK	44 th driest	29 th driest	17 th driest	12 th wettest	7 th wettest	3 rd wettest
East Central OK	39 th wettest	41 st driest	24 th driest	6 th wettest	3 rd wettest	1 st wettest
Southeast OK	12 th wettest	27 th wettest	43 rd driest	4 th wettest	1 st wettest	1 st wettest
Statewide	47 th driest	37 th driest	24 th driest	17 th wettest	6 th wettest	1 st wettest

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

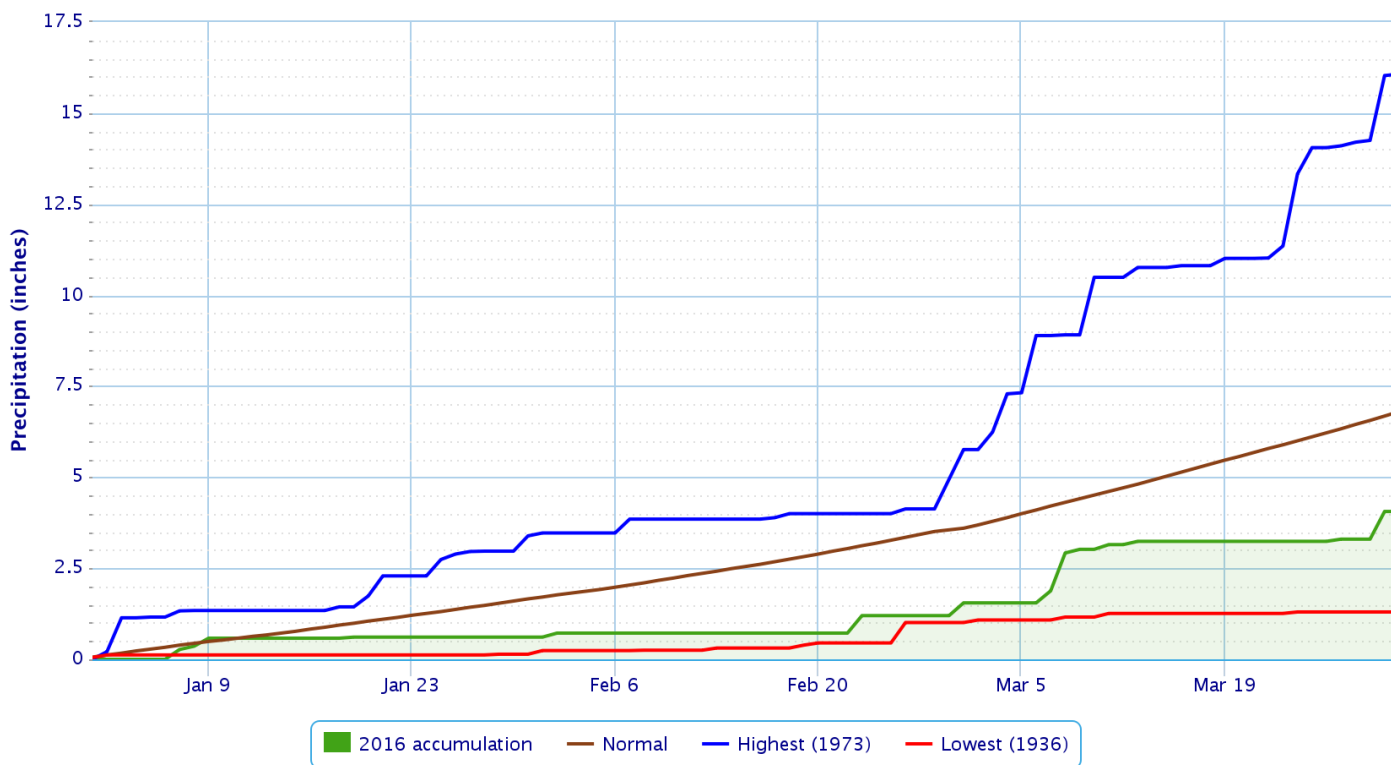
Period of Record – 1905-01-06 to 2016-03-31. Normals period: 1981-2010. Click and drag to zoom chart.



Powered by ACIS

Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

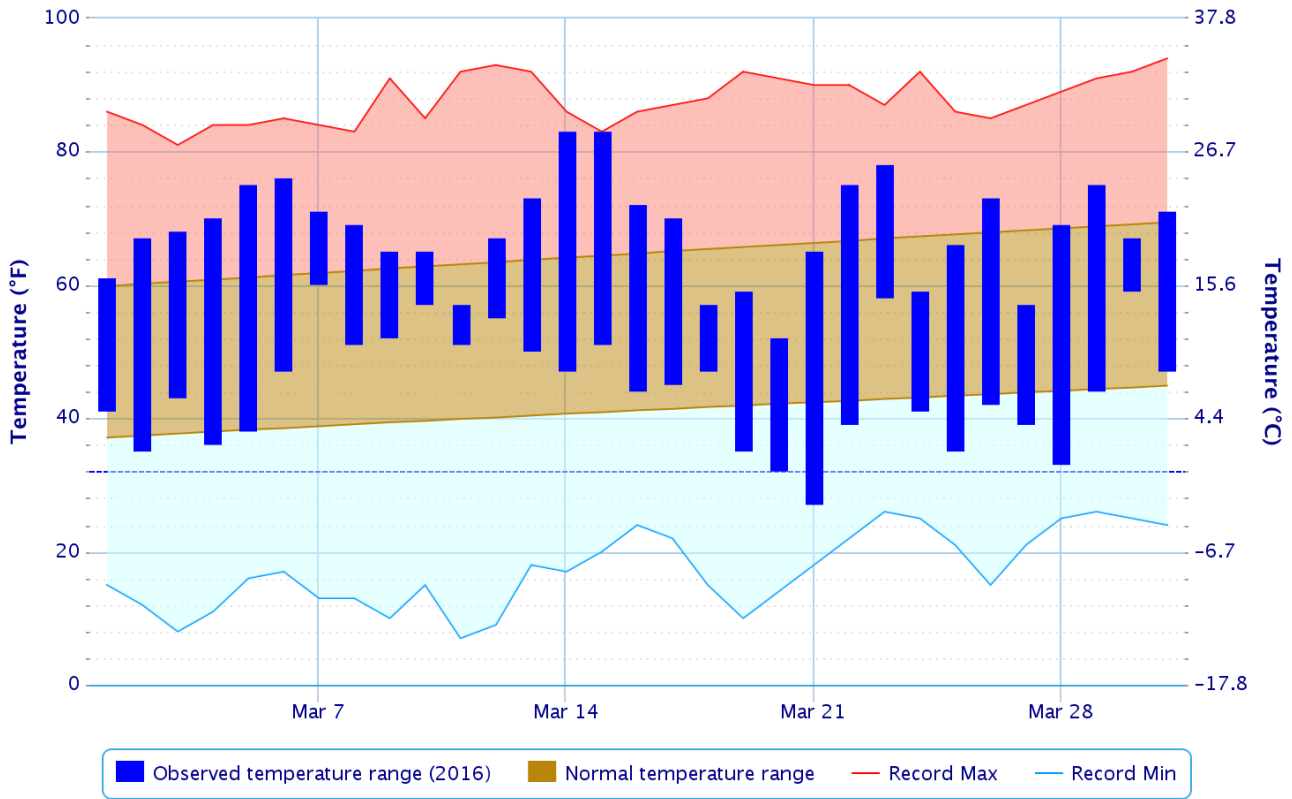
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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

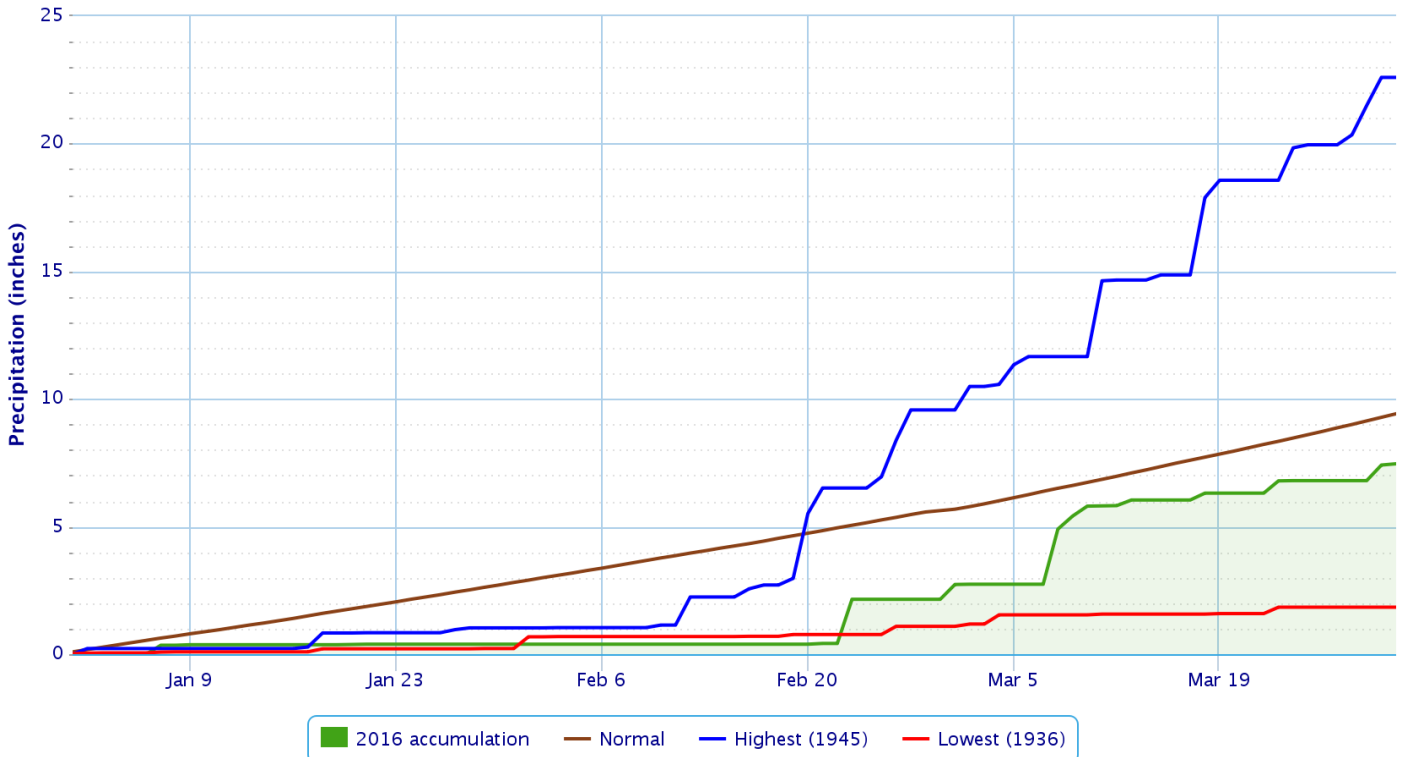
Period of Record – 1882-06-01 to 2016-03-31. Normals period: 1981-2010. Click and drag to zoom chart.



Powered by ACIS

Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

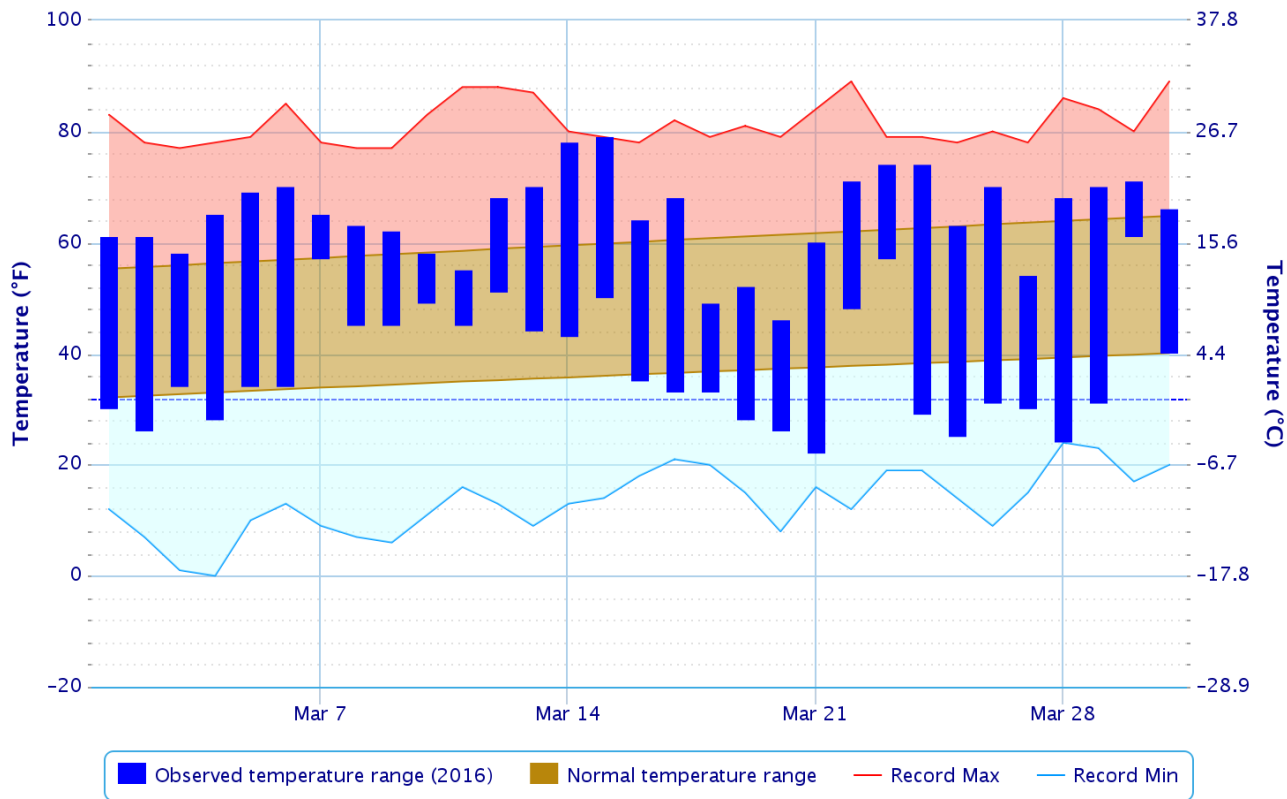
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

Daily Temperature Data – FAYETTEVILLE DRAKE FLD, AR

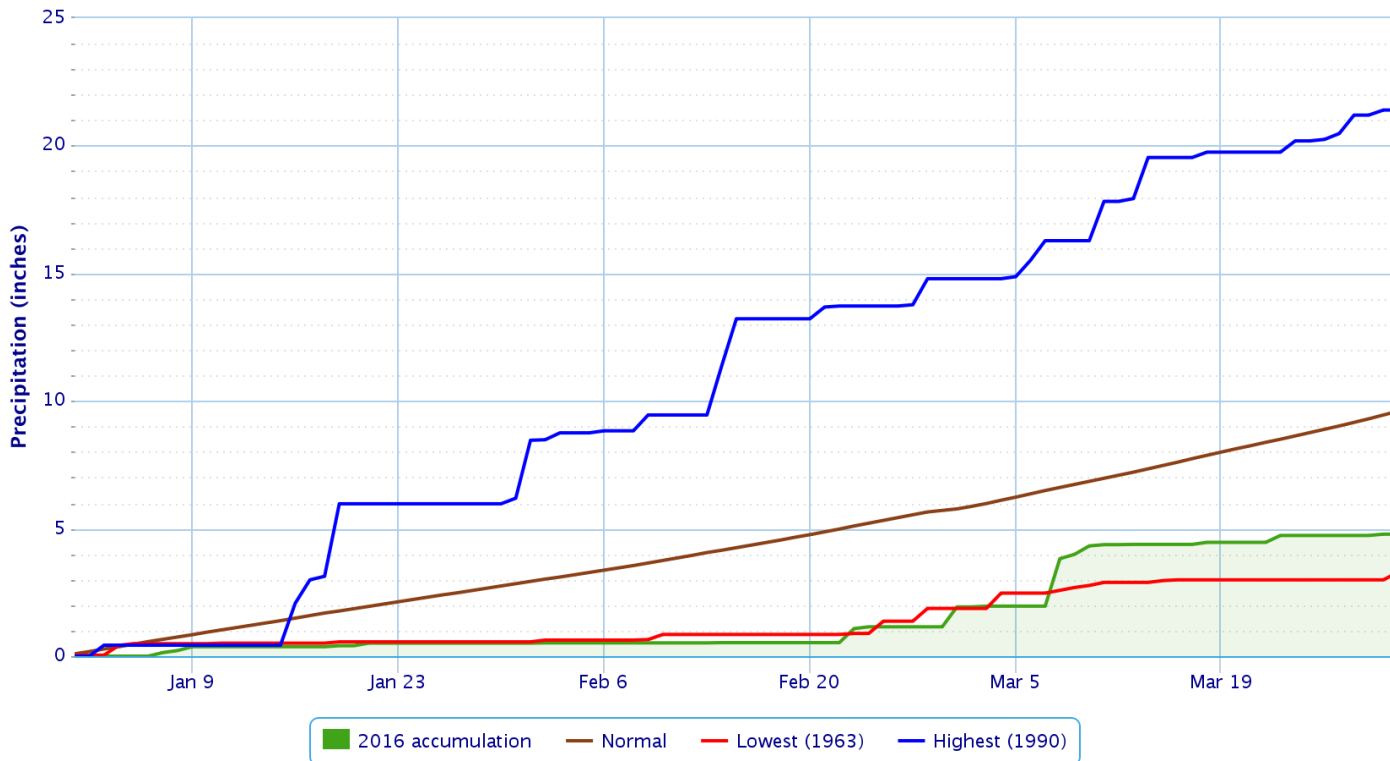
Period of Record – 1949-07-14 to 2016-03-31. Normals period: 1981-2010. Click and drag to zoom chart.



Powered by ACIS

Accumulated Precipitation – FAYETTEVILLE DRAKE FLD, AR

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 March 29, 2016 (Figs. 2, 3), there were no drought conditions present in eastern OK and northwest AR. However, abnormally dry conditions were present across portions of Creek, Pawnee, Osage, Tulsa, Washington, Nowata, Rogers, Craig, Ottawa, Mayes, Delaware, Adair, Cherokee, Muskogee, Wagoner, and Sequoyah Counties in Oklahoma and Crawford, Washington, Benton, Carroll, Madison, and Franklin Counties in Arkansas.

**U.S. Drought Monitor
Oklahoma**

March 29, 2016

(Released Thursday, Mar. 31, 2016)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	41.06	58.94	19.88	0.00	0.00	0.00
Last Week 3/22/2016	65.15	34.85	14.26	0.00	0.00	0.00
3 Months Ago 12/29/2015	100.00	0.00	0.00	0.00	0.00	0.00
Start of Calendar Year 12/29/2015	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 9/29/2015	52.60	47.40	16.79	6.37	0.97	0.00
One Year Ago 3/31/2015	14.36	85.64	68.62	50.68	37.38	8.41

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Brad Rippey
U.S. Department of Agriculture



<http://droughtmonitor.unl.edu/>

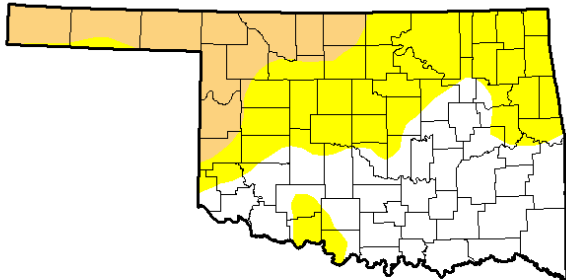


Fig. 2. Drought Monitor for Oklahoma

**U.S. Drought Monitor
Arkansas**

March 29, 2016

(Released Thursday, Mar. 31, 2016)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	80.45	19.55	0.00	0.00	0.00	0.00
Last Week 3/22/2016	100.00	0.00	0.00	0.00	0.00	0.00
3 Months Ago 12/29/2015	100.00	0.00	0.00	0.00	0.00	0.00
Start of Calendar Year 12/29/2015	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 9/29/2015	39.30	60.70	42.41	16.89	4.64	0.00
One Year Ago 3/31/2015	95.38	4.62	0.00	0.00	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Brad Rippey
U.S. Department of Agriculture



<http://droughtmonitor.unl.edu/>

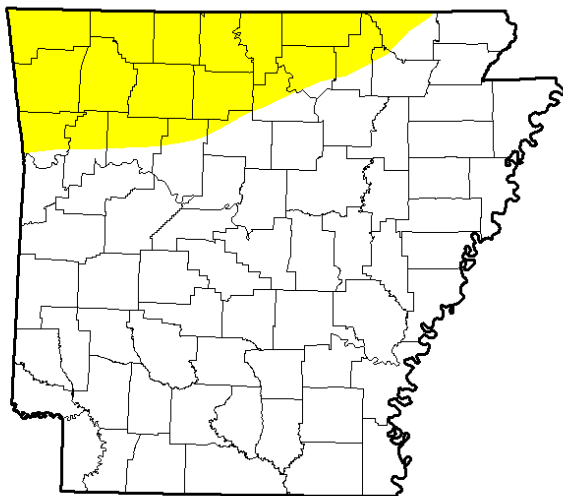
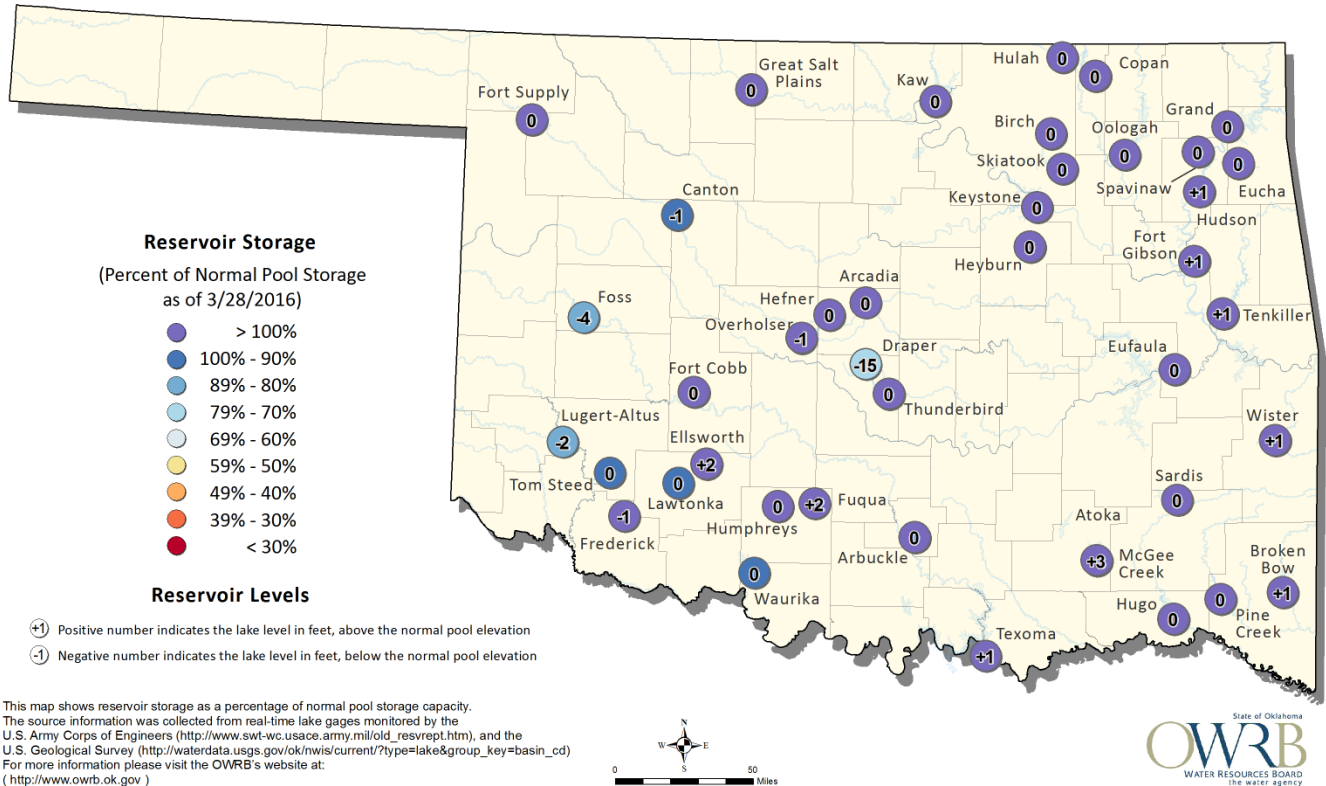


Fig. 3. Drought Monitor for Arkansas

Reservoirs

According to the USACE, all of the major reservoirs in the HSA were operating within 5% of the top of their conservation level as of 4/01/2016.

Oklahoma Surface Water Resources Reservoir Levels and Storage as of 3/28/2016



Outlooks

The [Climate Prediction Center](#) (CPC) outlook for April 2016 (issued March 31, 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 from the ongoing strong El Niño, Madden-Julian Oscillation (MJO) activity, and recent soil moisture conditions.

For the 3-month period April-May-June 2016, CPC is forecasting an equal chance for above, near, and below normal temperatures and a slightly enhanced chance for above median precipitation across all of eastern OK and northwest AR (outlook issued March 17, 2016). According to CPC, strong El Niño conditions remain in place, but the El Niño peaked in late 2015. The 2015-16 El Niño is one of the strongest on record. This event is still expected to transition to neutral conditions during the late spring or early summer 2016. Therefore, this outlook is based primarily on both statistical and dynamical forecast tools, with a reliance on typical circulation response to El Niño conditions. The chance of developing La Nina conditions exceeds 50% beginning in Autumn 2016.

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

March 1-15

A line of showers and thunderstorms moved into east out of central OK during the late evening of the 29th, generally affecting locations of along and south of Hwy412 in eastern OK and northwest AR. Scattered thunderstorms developed behind the initial line of storms near a cold front after 1am on March 1st, affecting much of the HSA as they tracked eastward through the overnight and early morning hours. Most of the rain had exited the area by 8am on the 1st. There were numerous reports of pea and dime-sized hail with the storms. Rainfall totals ranged from around 0.10" to around 2" (Fig. 4).

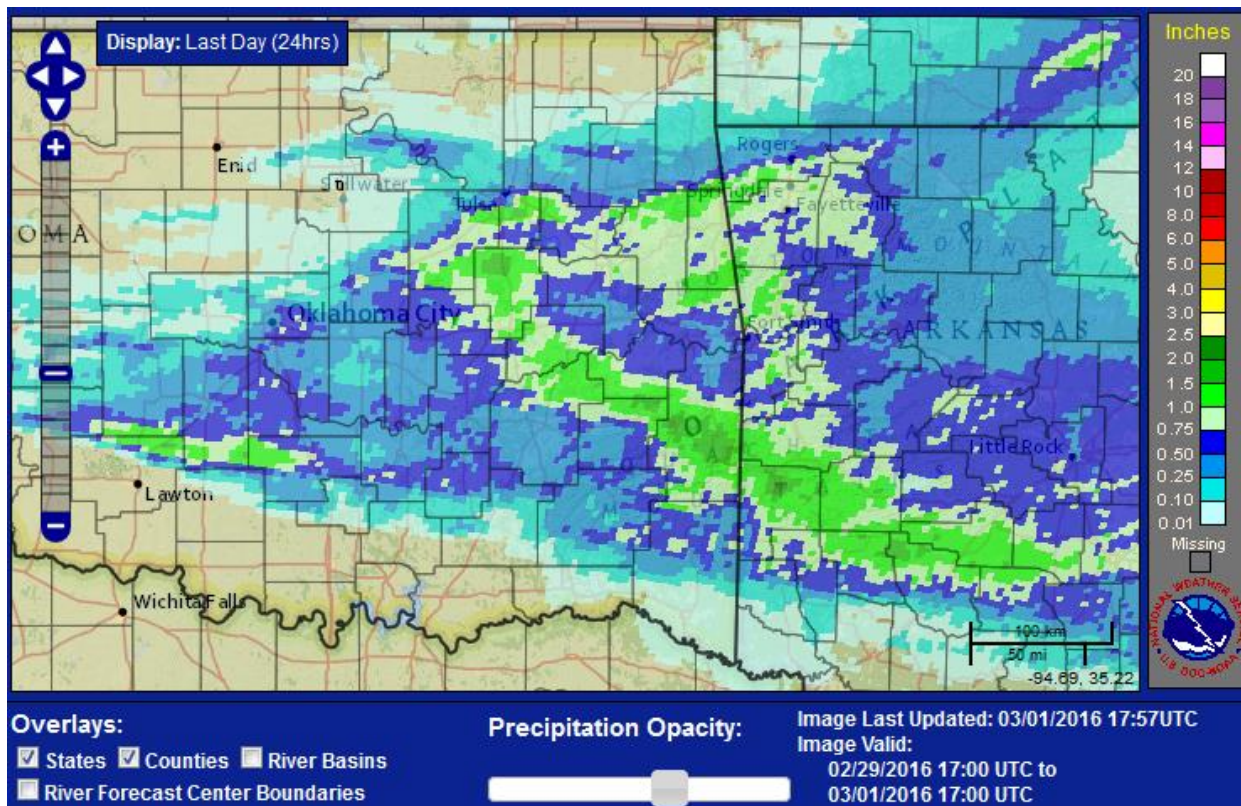


Fig. 4. 24-hour Estimated Observed Rainfall ending at 11am CST 3/01/2016.

A short wave moved into the region, with an associated surface low and triple point, on the 2nd. A small area of storms developed over central OK and expanded in coverage as they moved southeast across southeast OK and west central AR during the late evening hours of the 2nd as the low and frontal boundaries moved through the HSA. The showers and thunderstorms remained south of I-40 and brought around 0.10" to near 2" of rain (Fig. 5), with the highest rainfall totals over southern Pittsburg, northern Pushmataha, and southern Le Flore Counties. A second area of showers moved southeast out of KS as the upper-level portion of the storm system continued to move east, bringing light rain to far northeast OK and northwest AR through the morning hours. While most locations saw less than 0.25" of rain, north central Benton County received around 0.50".

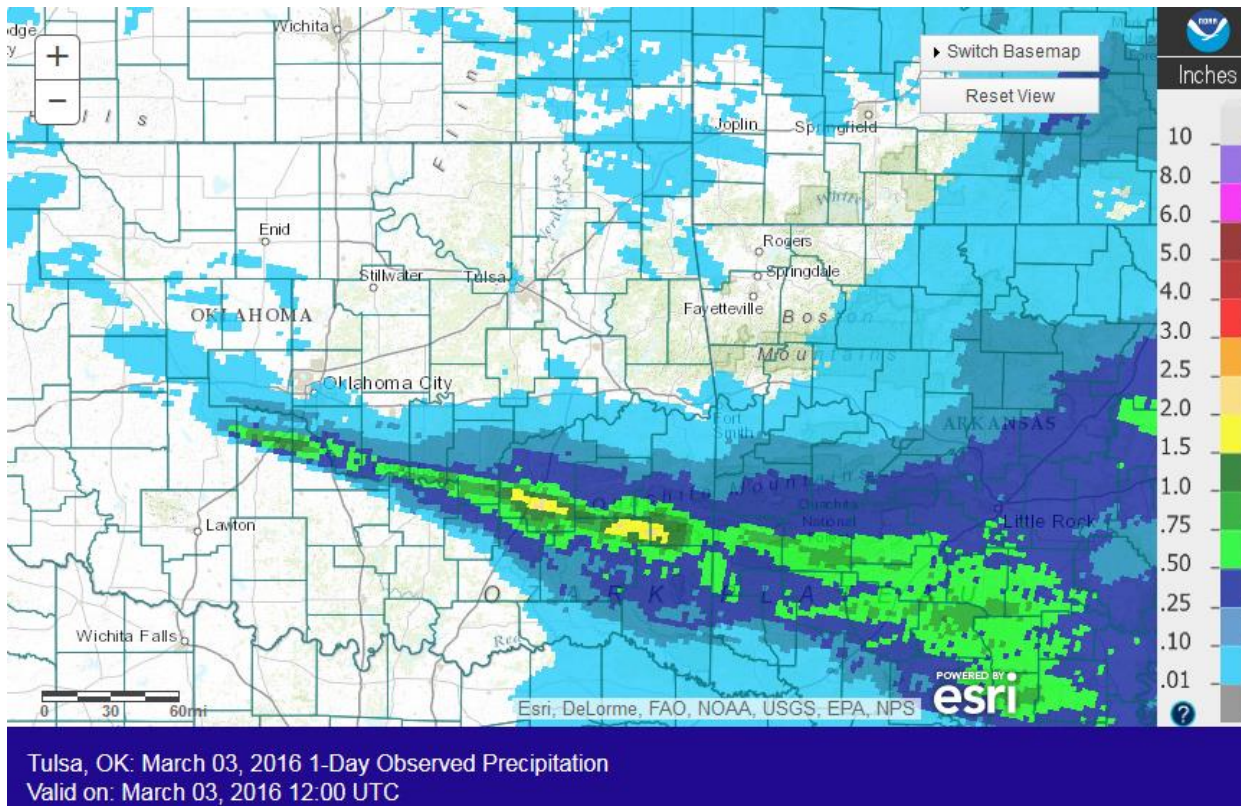


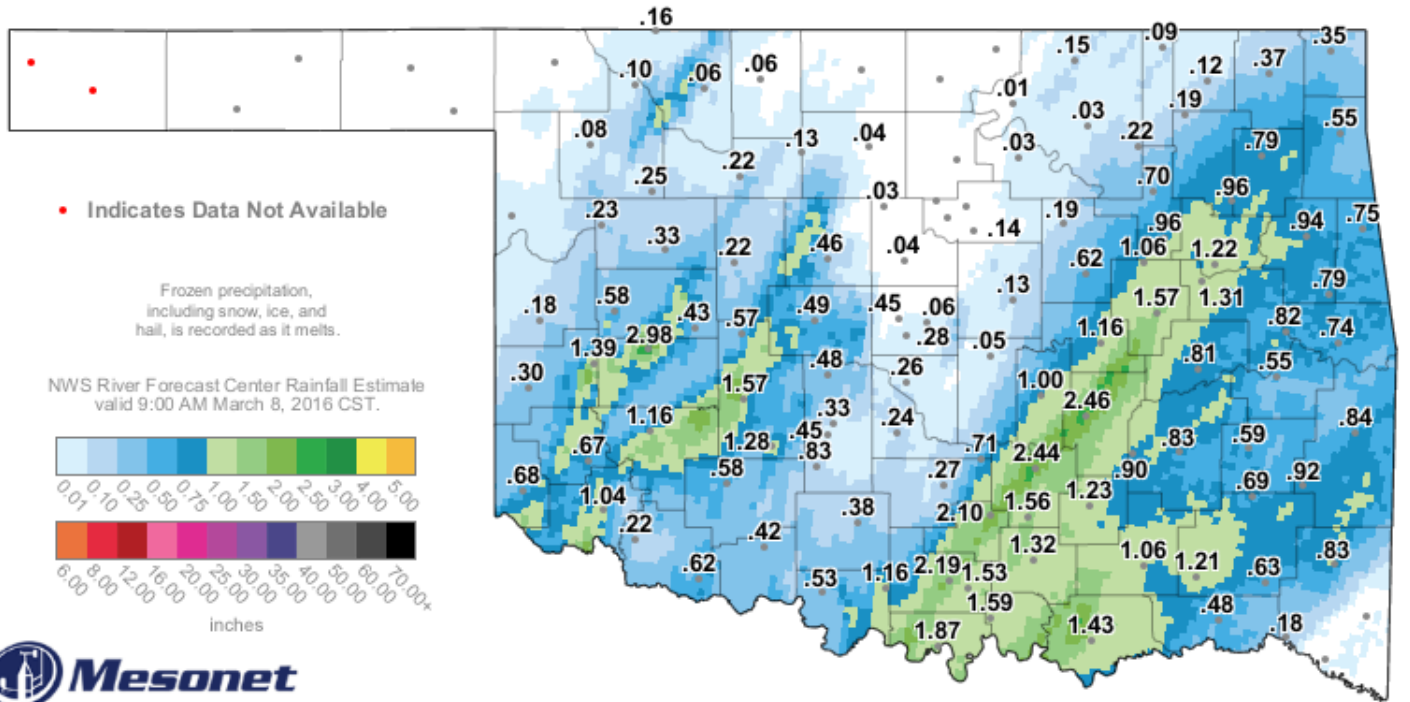
Fig. 5. 24-hour Estimated Observed Rainfall ending at 6am CST 3/03/2016.

Several waves of rain and storms traversed the region the 7th-12th within largely meridional flow aloft downstream from an upper-level low over northern Mexico. Showers and isolated thunderstorms first moved northeast out of south central OK and into northeast OK during the afternoon of the 7th. This activity mainly affected locations from central OK through northeast OK. The rain became more widespread during the evening as a second round of precipitation moved into the region, with showers and thunderstorms affecting much of eastern OK and western AR along and southeast of I-44. This round of rain weakened significantly during the morning of the 8th, while additional showers redeveloped over eastern OK. Rainfall totals by 6am CST ranged from around 0.10" to around 1.5". Far southern Okmulgee and far southeastern Okfuskee Counties received the highest totals of 1.5" to near 2.5" (Figs. 6, 7). Further west, a large area of showers and thunderstorms moved out of southwest TX into western OK during the morning of the 8th. These storms continued eastward and began affecting eastern OK by mid-morning and western AR by early afternoon. These widespread storms affected all of eastern OK and northwest AR before exiting the area during the evening hours. The next round of rain moved north out of northeast TX shortly after midnight on the 9th. These showers and thunderstorms affected most locations southeast of a McAlester to Bentonville line through the morning and afternoon hours. By 6 am CST March 9, the previous 24-hr rainfall total ranged from around 0.50" to around 2" (Fig. 8). The 2-day rainfall total ending at 2 pm CST March 9 was 0.50" to near 3.5" (Fig. 9). This rainfall resulted in minor flooding along the Poteau River near Panama.

After a brief break in the rain during the evening hours and late night hours, rain once again moved north out of northeast TX into southeast OK during the early morning hours of the 10th. Additional short-lived showers developed just south of I-44 in far northeast OK and far northwest AR at the same time. The showers from TX continued to expand northeast across northwest and west central AR through the morning, before dissipating mid-afternoon. There was another break in the precipitation before rain increased again from south to north during the afternoon and evening on the 11th, and lingering through overnight hours, as the upper-level low slowly lifted north into south TX. Rainfall remained light overall, with the majority of the HSA receiving around 0.10" to near 0.50" of rain (Fig. 10). The 5-day rainfall total ending at 8am on the 11th ranged from around 0.50" to near 4" (Fig. 11).

A compact but strong wave ejected out of a long wave trough off the West Coast, igniting showers and thunderstorms over far eastern OK and western AR on the 13th. Scattered showers and thunderstorms brought generally 0.25" to 1" of rain to the affected locations mainly in northeast and east central OK and west

central and far northwest AR, with isolated totals of 1.5"-2" (Fig. 12). Daylight savings time began at 2am on the 13th. Finally, the wet week came to an end during the late evening hours of the 13th. The 7-day rainfall total ranged from just under 1" to around 4" across eastern OK and northwest AR (Fig. 13).



24-Hour Rainfall Accumulation (inches)

9:30 AM March 8, 2016 CST

Created 9:35:27 AM March 8, 2016 CST. © Copyright 2016

Fig. 6. 24-hour Estimated Observed Rainfall (image) and OK Mesonet measurements ending at 9:30am CST 03/08/2016.

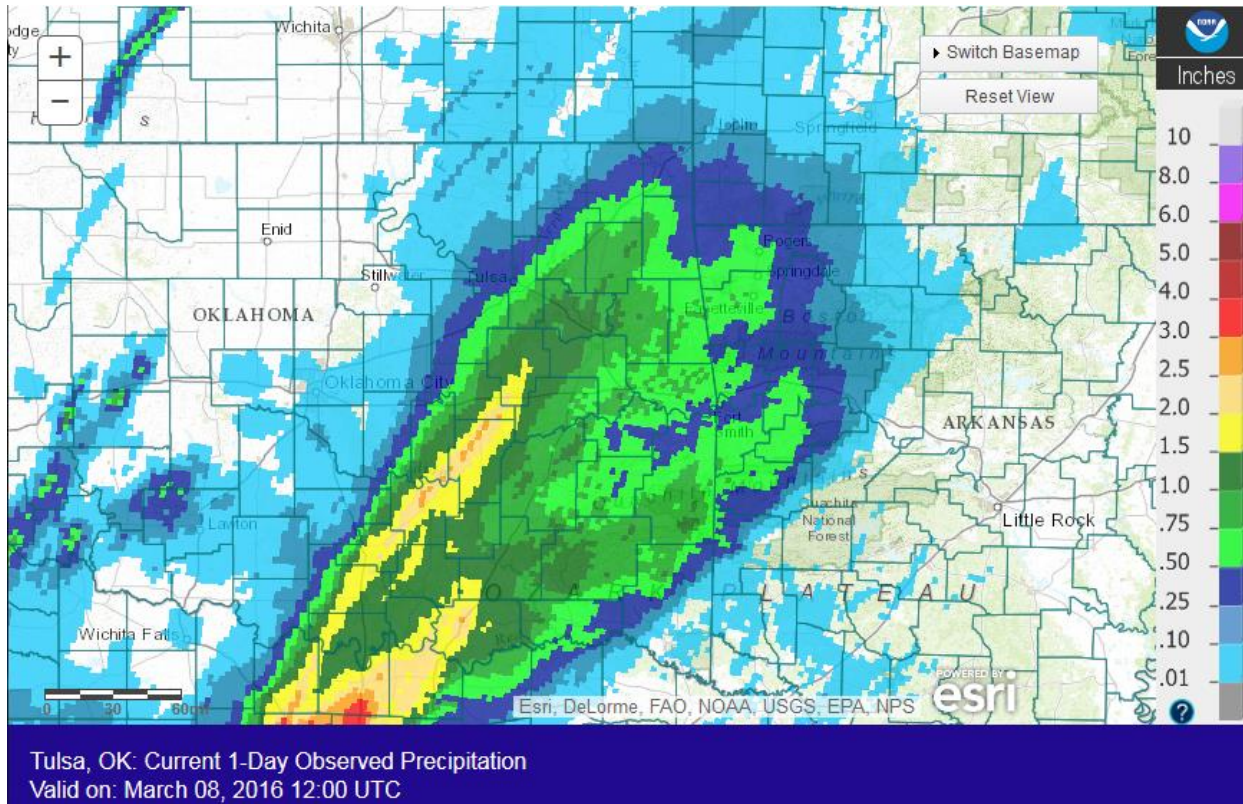


Fig. 7. 24-hour Estimated Observed Rainfall ending at 6am CST 3/08/2016.

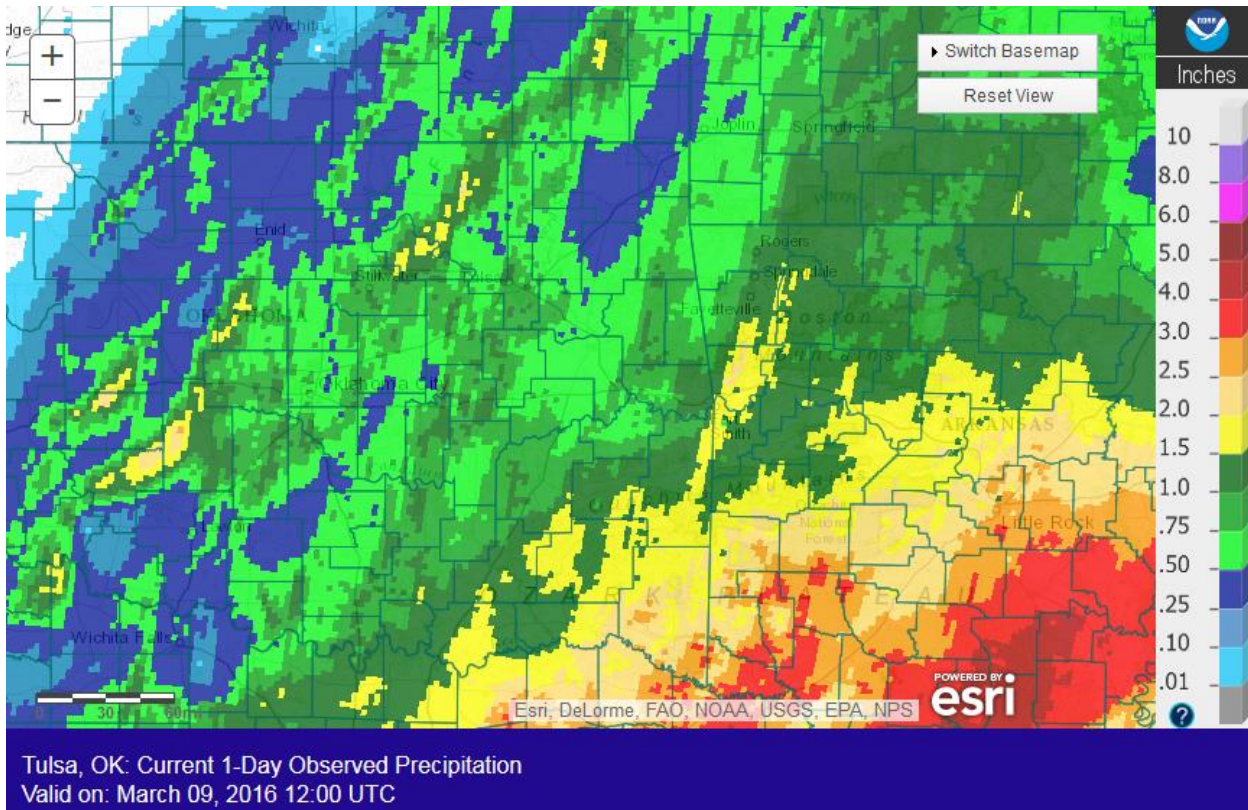


Fig. 8. 24-hour Estimated Observed Rainfall ending at 6am CST 3/09/2016.

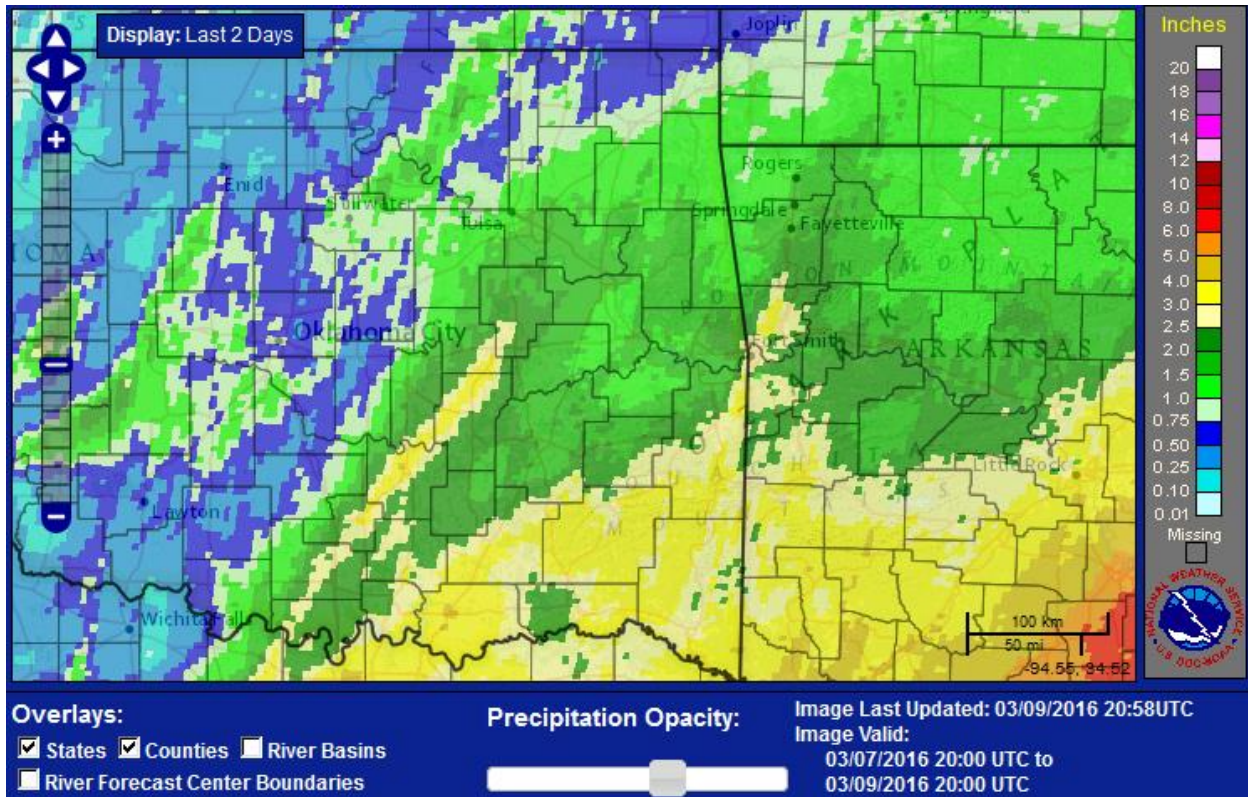


Fig. 9. 2-day Estimated Observed Rainfall ending at 2pm CST 3/09/2016.

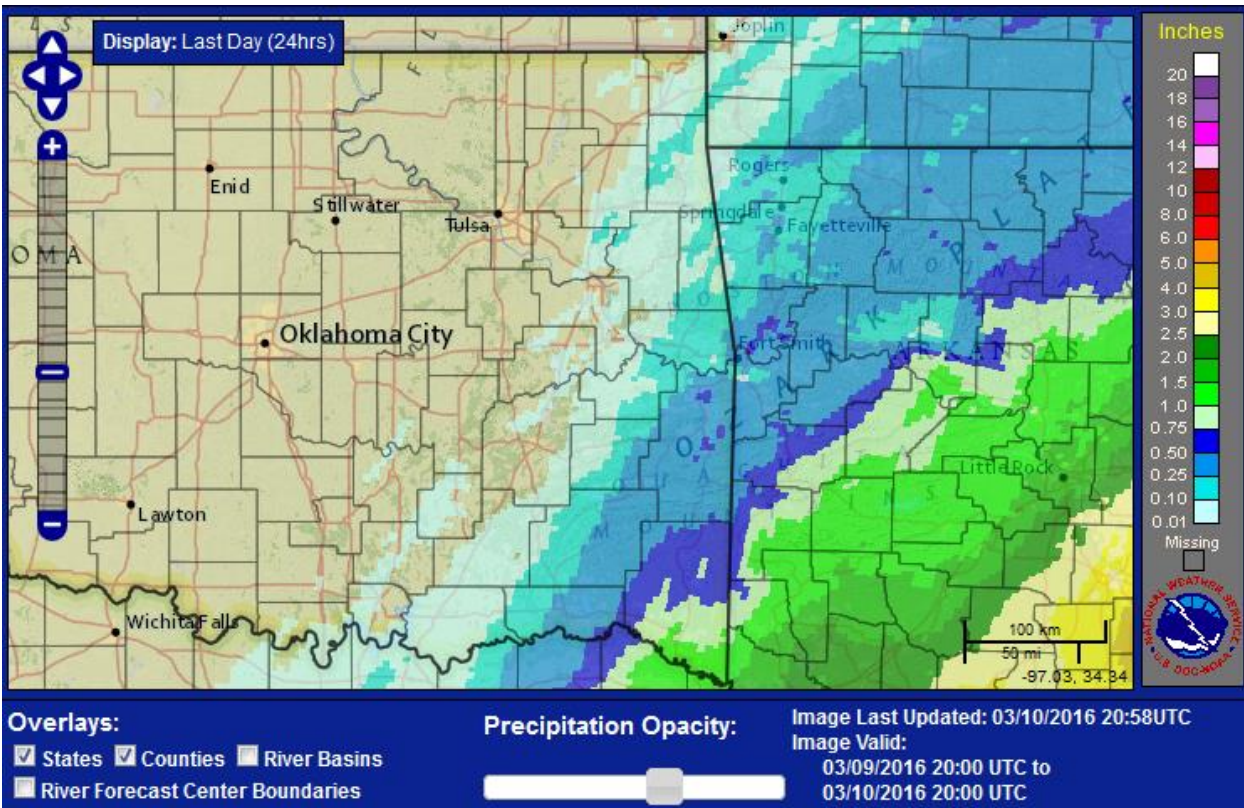


Fig. 10. 24-hour Estimated Observed Rainfall ending at 2pm CST 3/10/2016.

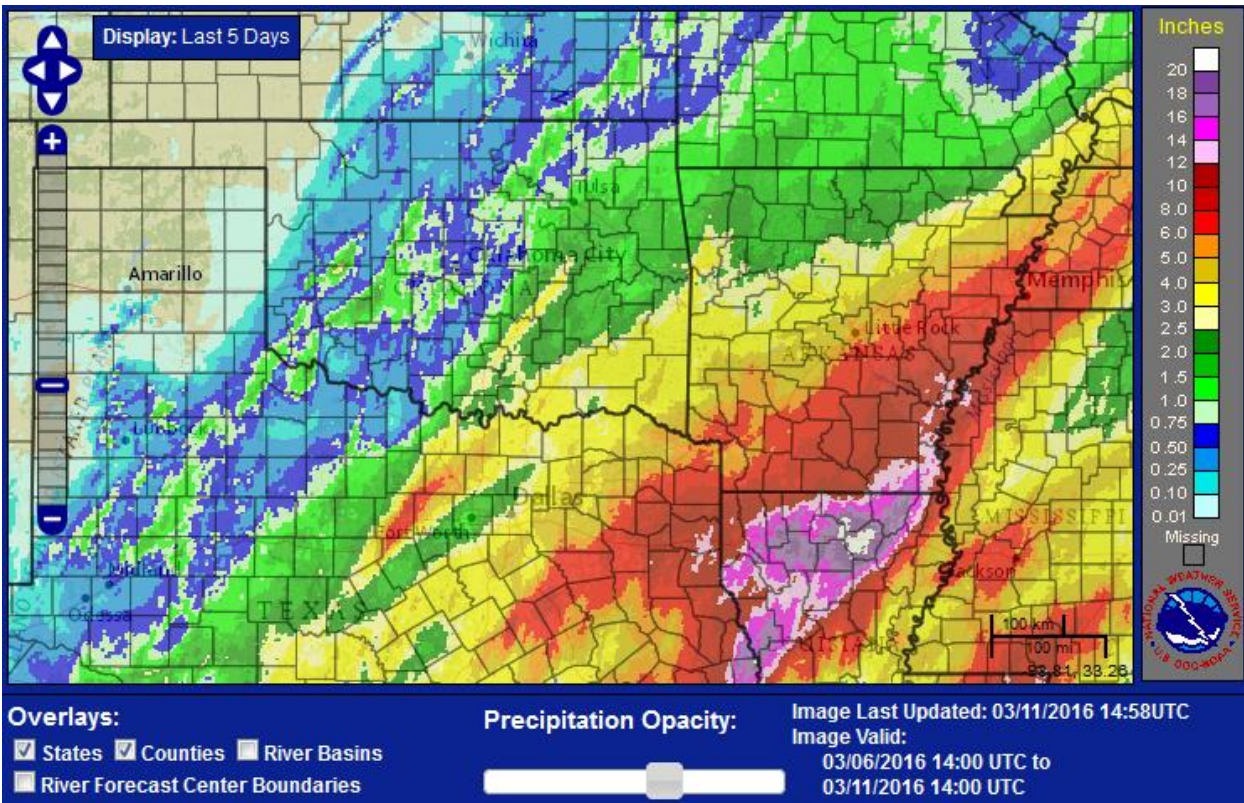
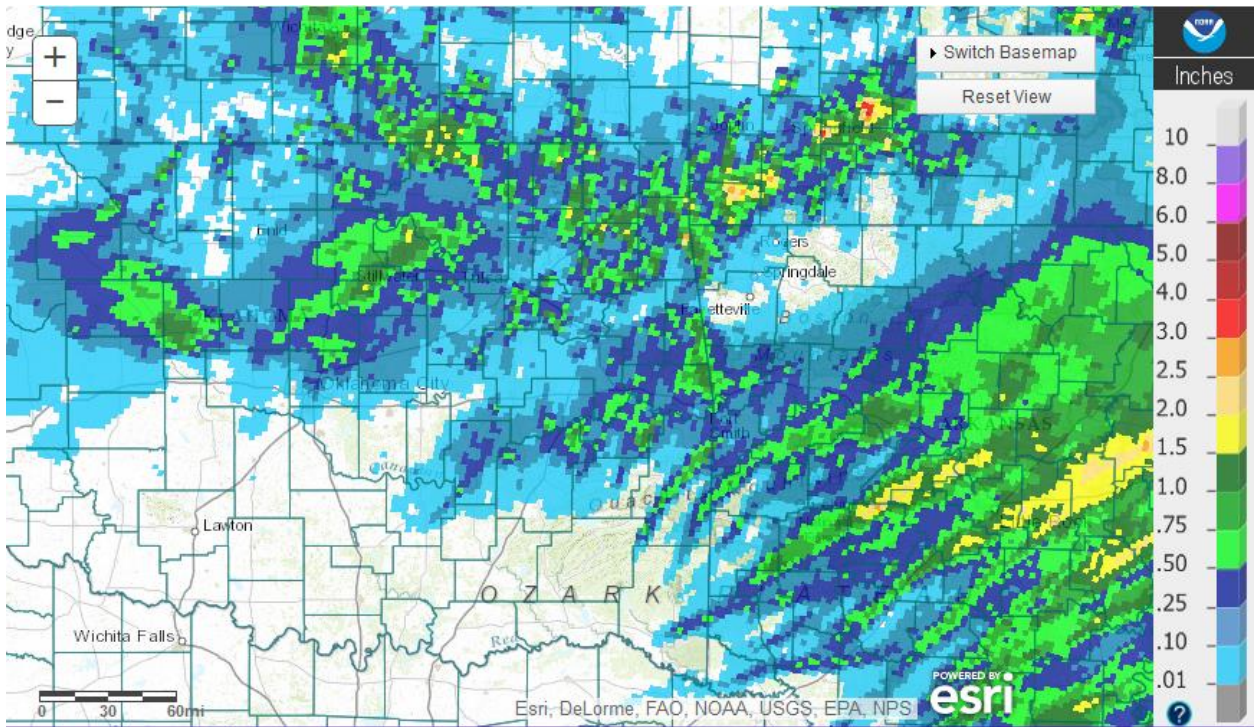
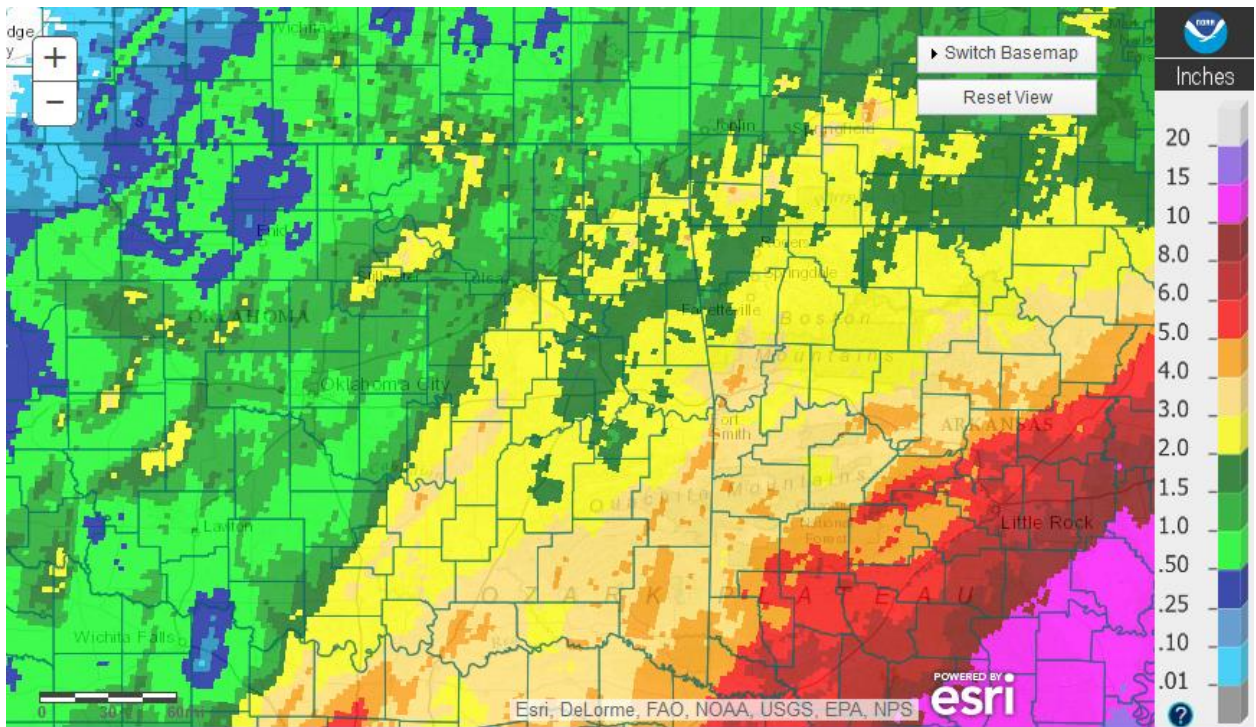


Fig. 11. 5-day Estimated Observed Rainfall ending at 8am CST 3/11/2016.



Tulsa, OK: Current 1-Day Observed Precipitation
Valid on: March 14, 2016 12:00 UTC

Fig. 12. 24-hour Estimated Observed Rainfall ending at 7am CDT 3/14/2016.



Tulsa, OK: Last 7-Day Observed Precipitation
Valid on: March 14, 2016 12:00 UTC

Fig. 13. 7-day Estimated Observed Rainfall ending at 6am CST 3/14/2016.

March 16-31

A frontal boundary over central TX moved north to just south of the Red River. Warm air advection over the front generated elevated showers and thunderstorms over south central OK into southeast OK and west central AR during the morning hours of the 17th. A passing upper-level wave initiated additional thunderstorm activity during the afternoon over southeast OK and west central AR. Widely scattered to isolated showers persisted over southeast OK through the evening hours. Rainfall totals were light, ranging from a few hundredths to near 0.50”.

Showers developed from near the OK/MO/AR border to south central OK on the morning of the 18th as a cold front moved through the region. This activity increased in coverage through the morning hours and pushed eastward through the afternoon and early evening hours. Rainfall totals were generally around 0.50” or less for much of the affected area. However, higher totals of 0.50” to around 1.5” occurred across Choctaw and far southern Pushmataha Counties where the thunderstorms occurred.

Severe thunderstorms developed over eastern OK along and ahead of a dry line during the evening of the 23rd. The storms then moved into northwest AR during the late evening hours. Several of the storms evolved into supercells, producing hail up to around 2” in diameter. One of the supercells also produced a tornado near Evansville, AR. Most of the rain occurred southeast of an Okmulgee to Miami line, with rainfall totals of a few hundredths to just over 2.5” (Fig. 14). More information on this tornado event can be found at <http://arcg.is/1RNkyDs>

Showers developed over northeast OK around sunrise on the 26th and dissipated by noon as an upper-level wave passed through the region. Rainfall remained light, with less than 0.25” of accumulation northwest of I-44. Around 3am on the 27th, another round of showers and isolated thunderstorms moved into northeast OK in association with a cold front and second upper-level wave. This activity moved eastward through the mid-morning hours before exiting northeast of the HSA. Around 0.50” or less of rainfall accumulation occurred northwest of a McAlester to Springdale line.

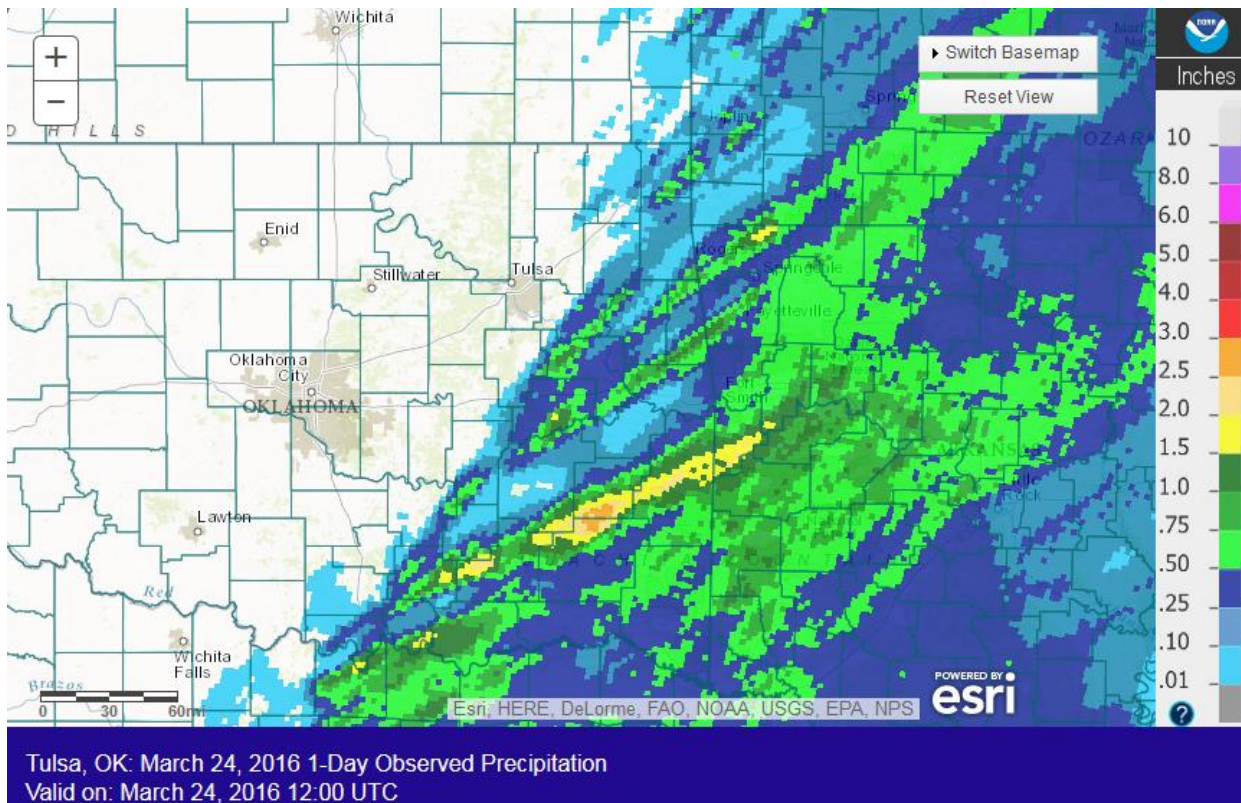
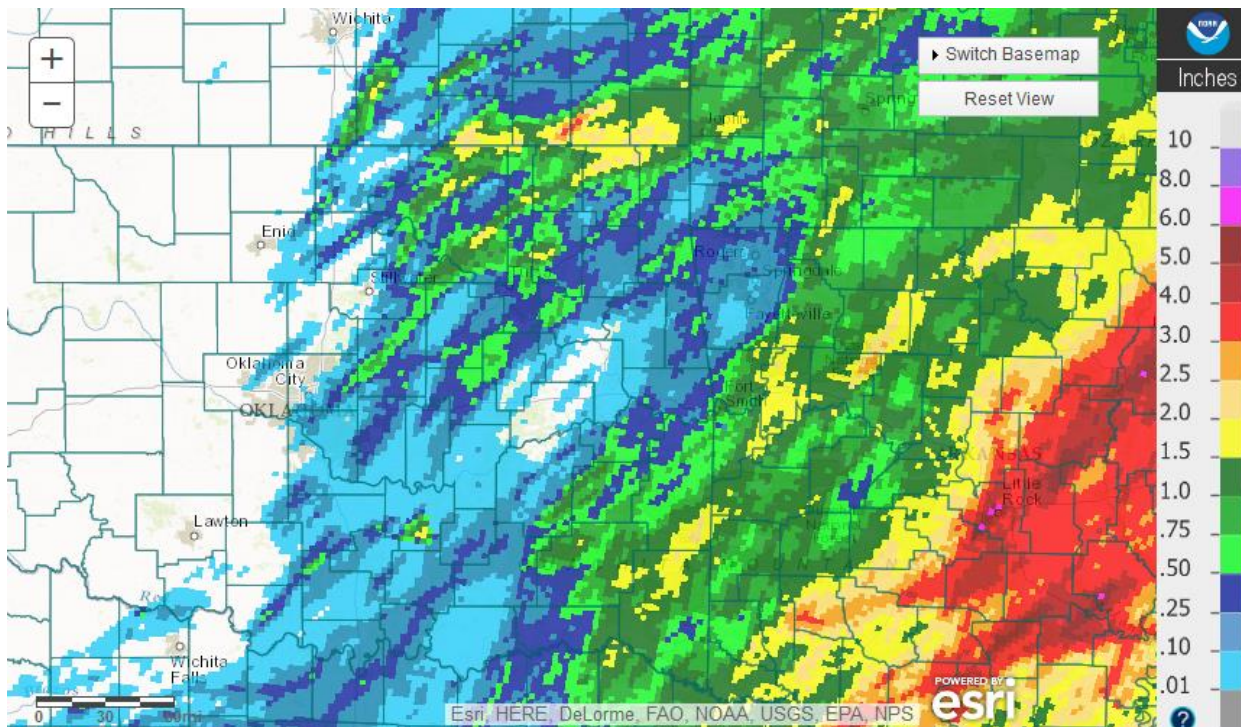


Fig. 14. 7-day Estimated Observed Rainfall ending at 6am CST 3/24/2016.

Elevated showers and thunderstorms affected eastern OK and northwest AR during the morning and early afternoon hours on the 30th with numerous reports of small hail. By mid-afternoon, a dryline and cold front moved to near I-35 in central OK. Clearing skies allowed temperatures to warm immediately east of the dry line which helped to destabilize the atmosphere after the morning storms. Isolated supercells developed on the boundary during the afternoon and evening hours, as a wave was lifting into the Central Plains. A tornado developed from a supercell over north Tulsa. The tornado tracked eastward to near Verdigris before dissipating. The supercell then produced a second tornado near Claremore. A second storm also produced two weak tornadoes, one near Nowata and one near Centralia. Hail of 1" to 1.75" was reported with the afternoon supercells in northeast OK. While the supercells were active in northeast OK, the earlier convection continued across far southeast OK and western AR through the afternoon and evening hours. All of the showers and thunderstorms had pushed east of the HSA shortly after midnight, with just isolated showers remaining during the overnight through early morning hours. Rainfall totals from all of storms ranged from around 0.10" to around 2" (Fig. 15). More information on this tornado event can be found at <http://arcg.is/1RNkyDs>



Tulsa, OK: March 31, 2016 1-Day Observed Precipitation
Valid on: March 31, 2016 12:00 UTC

Fig. 15. 7-day Estimated Observed Rainfall ending at 6am CST 3/31/2016.

Written by:
Nicole McGavock
Service Hydrologist
WFO Tulsa

Products issued in March 2016:

*MLBA4 and OZGA4 transferred to NWS Tulsa HSA February 5, 2014

*Mixed case River Flood products began July 31, 2013

- 0 Flash Flood Warnings (FFW)
- 0 Flash Flood Statements (FFS)
- 1 Flash/Areal Flood Watches (FFA) (5 Watch FFA CON/EXT/EXA/EXB/CAN)
- 4 Urban and Small Stream Advisories (FLS)
- 0 Areal Flood Warnings (FLW)
- 0 Areal Flood Statements (FLS)
- 5 River Flood Warnings (FLW)
- 23 River Flood Statements (FLS)
- 5 River Flood Advisories (FLS) (9 Advisory FLS CON/EXT/CAN)
- 5 River Flood Watches (FFA) (8 Watch FFA CON/EXT/CAN)
- 0 River Statements (RVS)
- 1 Hydrologic Outlooks (ESF)
- 0 Drought Information Statements (DGT)

Preliminary Hydrographs:

