

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
		YEAR	March
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 1, 2019

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.

After a wet winter, the spring season started off with below normal rainfall and below normal temperatures across most of eastern OK and northwest AR. Heavy rain in KS resulted in flooding along the Neosho River near Commerce this month. 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.weather.gov/tsa/hydro-monthly-summary>.

Monthly Summary

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 1a), rainfall totals for March 2019 ranged from 1" to around 5" across eastern OK and northwest AR, with the largest area of low rainfall occurring across Osage Co. These rainfall totals correspond to only 25% to 90% of the normal March rainfall for most of eastern OK and northwest AR (Fig. 1b). A few places across the region were near normal, and isolated areas in Tulsa, Rogers, Wagoner, Craig, and Ottawa Counties were around 125% for the normal March rainfall.

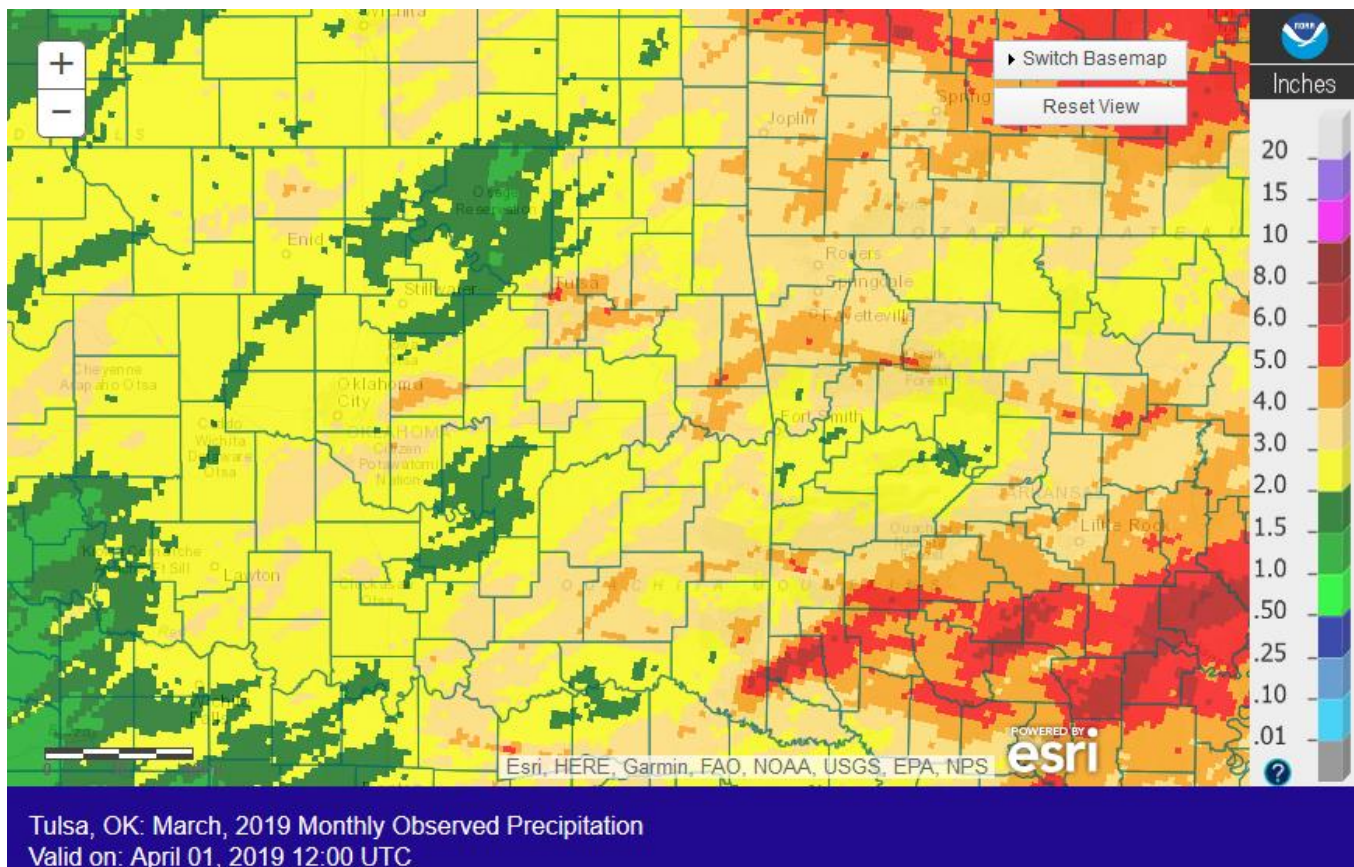


Fig. 1a. Estimated Observed Rainfall for March 2019

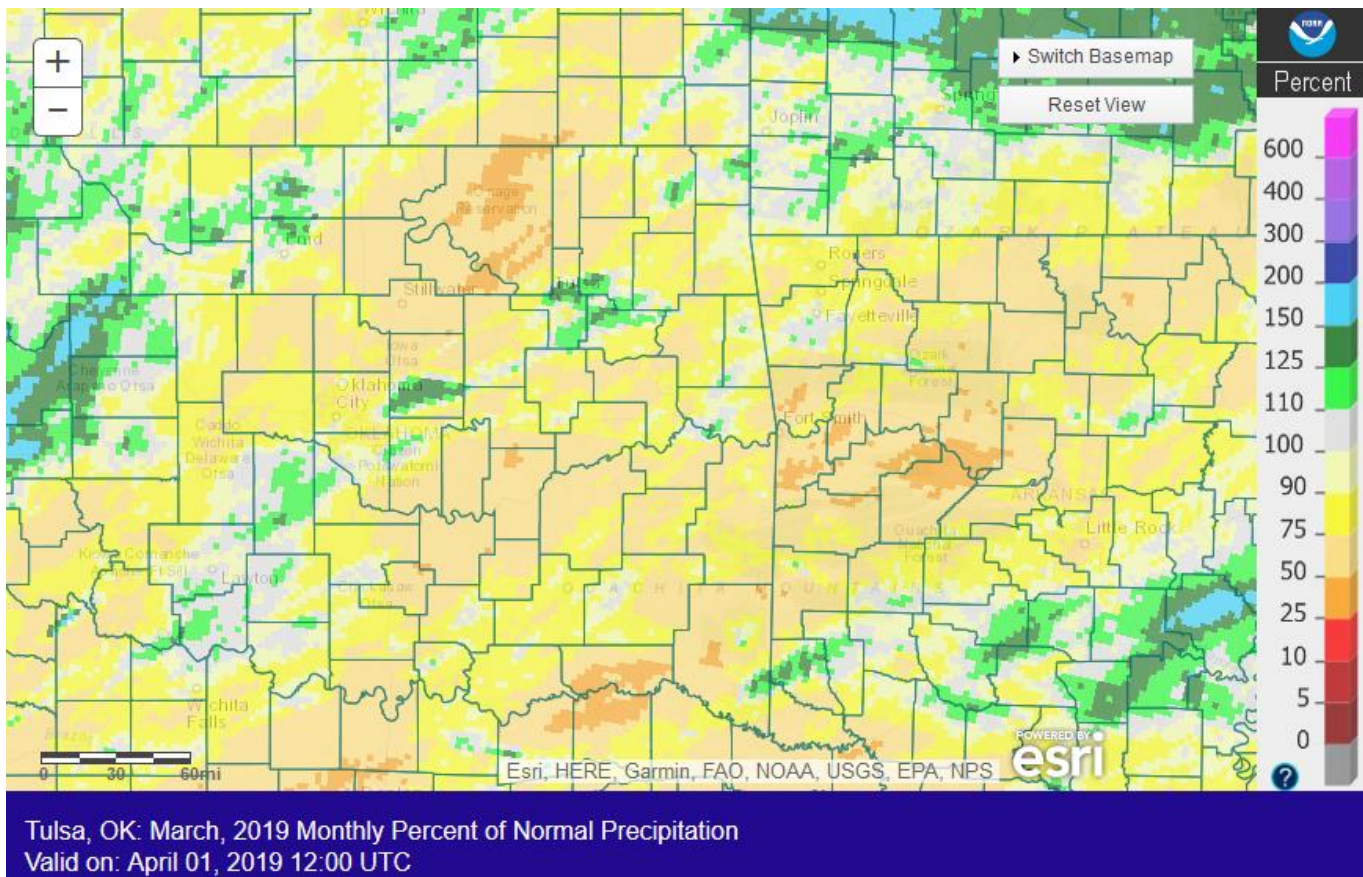


Fig. 1b. Estimated % of Normal Rainfall for March 2019

In Tulsa, OK, March 2019 ranked as the 32nd coldest March (47.8°F; since records began in 1905), the 36th wettest March (3.80", tied 1929; since records began in 1888), and the 28th snowiest March (1.0", tied 1931, 1914; since records began in 1900). Fort Smith, AR had the 47th coldest March (50.4°F, tied 1983; since records began in 1883), the 63rd driest March (2.86"; since records began in 1883), and the 41st snowiest March (Trace, tied 17 other years; since records began in 1884). Fayetteville, AR had the 14th coldest (44.9°F, tied 1980), the 28th wettest (4.32"), and 19th snowiest (0.8") March since records began in 1950.

Some of the larger precipitation reports (in inches) for March 2019 included:

Bunch 0.8N, OK (coco)	5.11	Winslow 7NE, AR (coop)	4.99	Westville 0.2ENE, OK (coco)	4.90
Tulsa 3.4ENE, OK (coco)	4.81	Cookson, OK (meso)	4.66	Kingston 2S, AR (coop)	4.62
Upper Spavinaw Port, OK (coop)	4.59	Fayetteville 1.0E, AR (coco)	4.56	Sallisaw 1.0SE, OK (coco)	4.49

Some of the lowest precipitation reports (in inches) for March 2019 included:

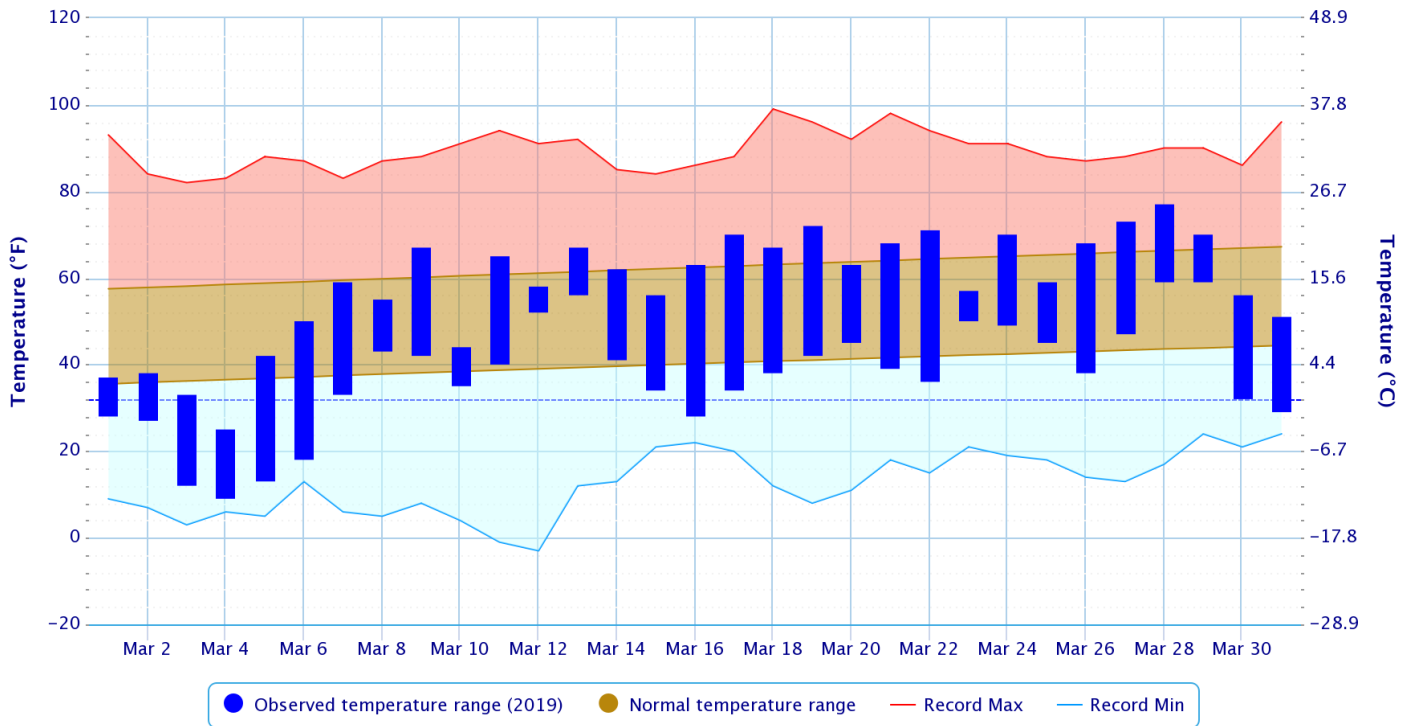
Foraker, OK (meso)	1.33	Skiatook, OK (meso)	1.69	Oilton, OK (meso)	1.74
Wynona, OK (meso)	1.90	Burbank, OK (meso)	2.09	Pawnee, OK (meso)	2.24
Bartlesville, OK (ASOS)	2.26	Nowata, OK (meso)	2.31	Haskell, OK (meso)	2.31

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

Rank since 1921	March 2019	Last 60 Days (Jan 31 – Mar 31)	Year-to-Date (Jan 1 – Mar 31)	Last 120 Days (Dec 2 – Mar 31)	Water Year-to-Date (Oct 1 – Mar 31)	Last 365 Days (Apr 1, 2018– Mar 31, 2019)
Northeast OK	48 th wettest	48 th driest	22 nd wettest	14 th wettest	20 th wettest	43 rd driest
East Central OK	49 th driest	46 th wettest	21 st wettest	14 th wettest	24 th wettest	33 rd wettest
Southeast OK	32 nd driest	45 th driest	46 th driest	23 rd wettest	16 th wettest	26 th wettest
Statewide	46 th wettest	48 th driest	41 st wettest	19 th wettest	15 th wettest	16 th wettest

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

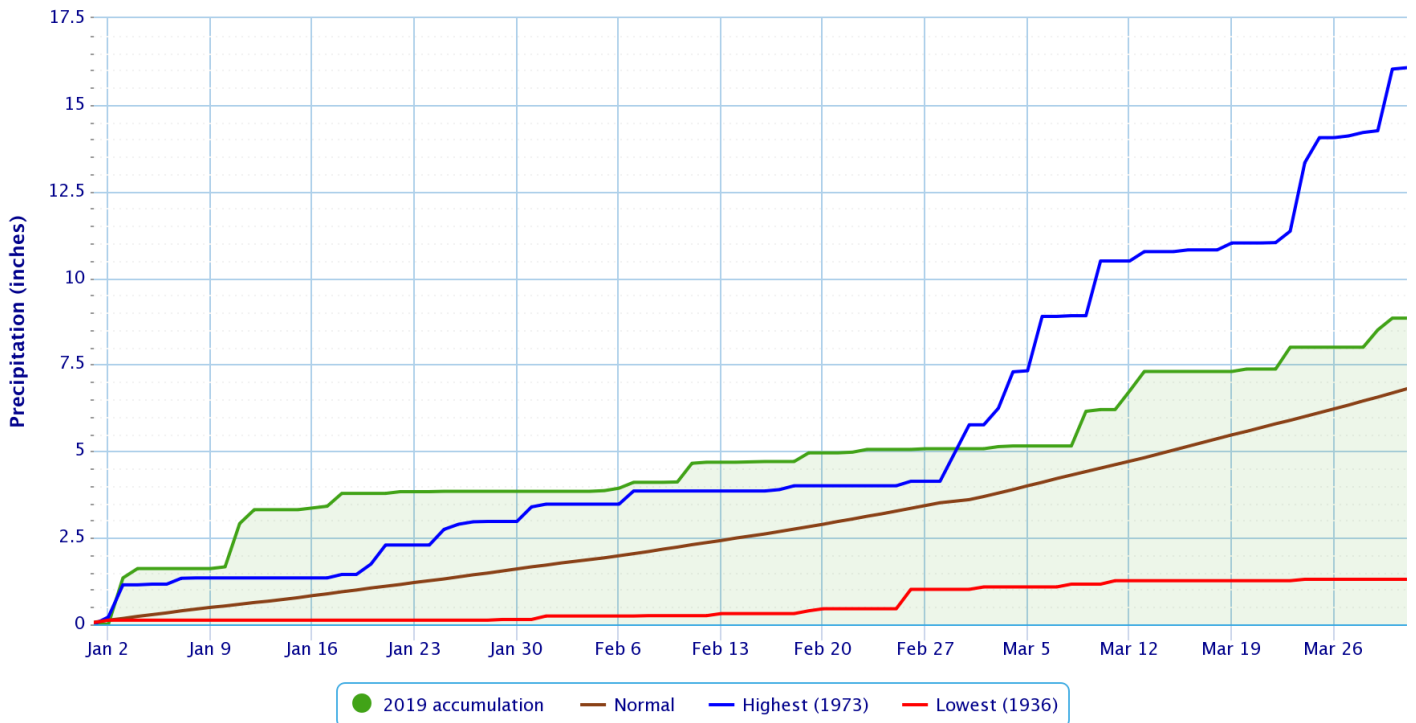
Period of Record – 1905-01-06 to 2019-03-31. Normals period: 1981-2010. Click and drag to zoom chart.



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Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

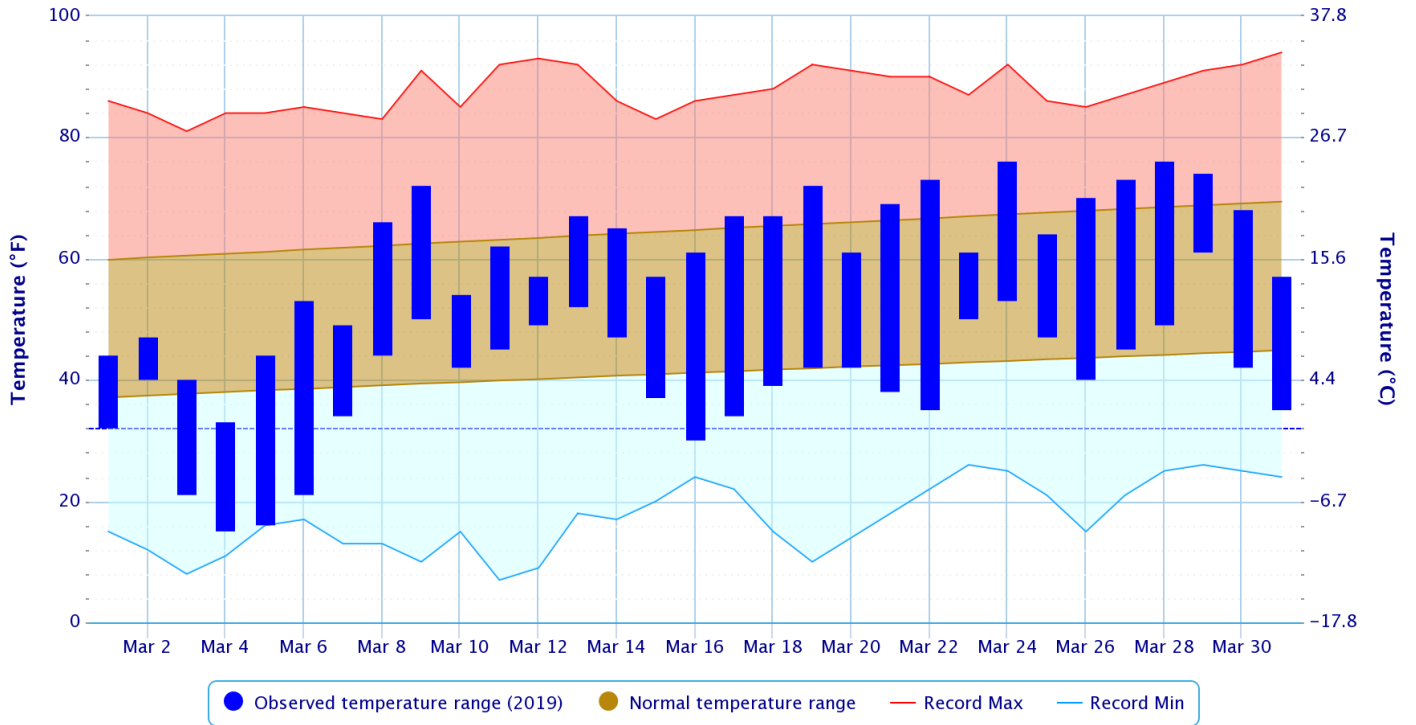
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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

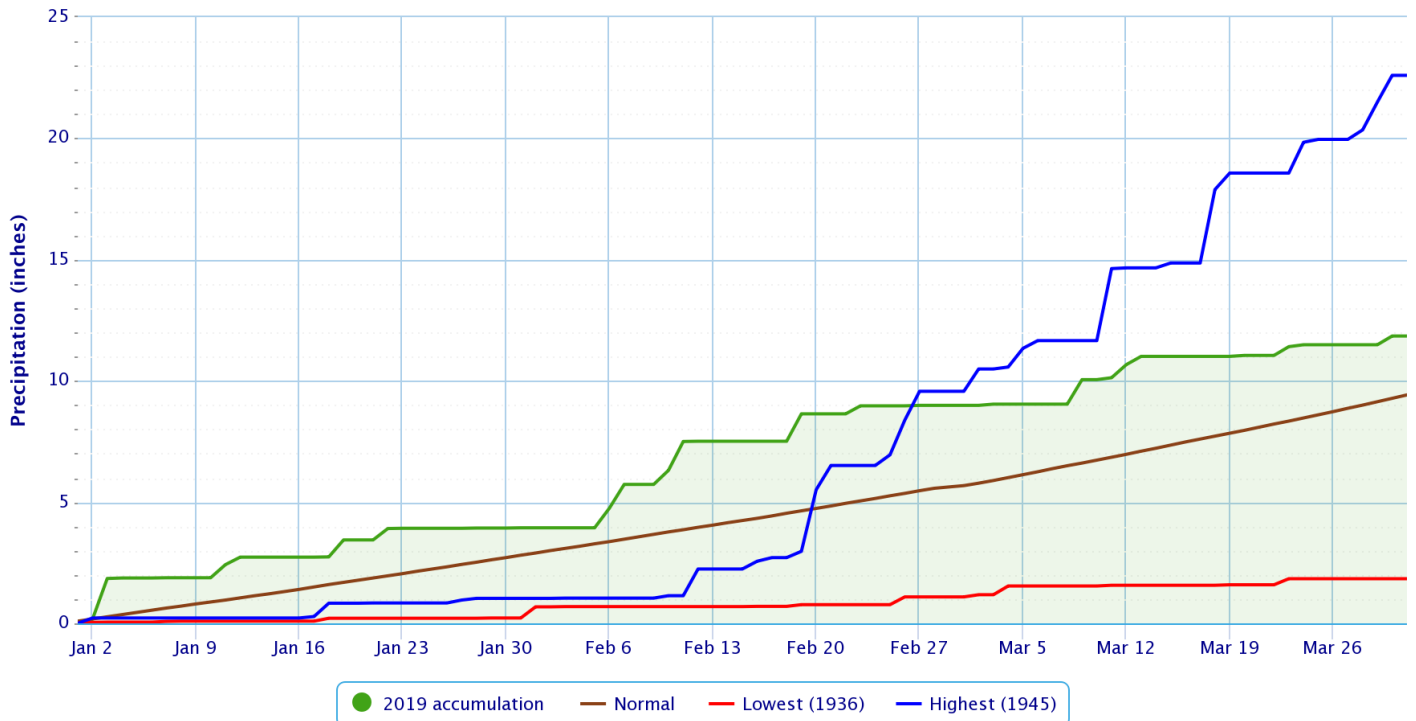
Period of Record – 1882-06-01 to 2019-03-31. Normals period: 1981-2010. Click and drag to zoom chart.



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Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

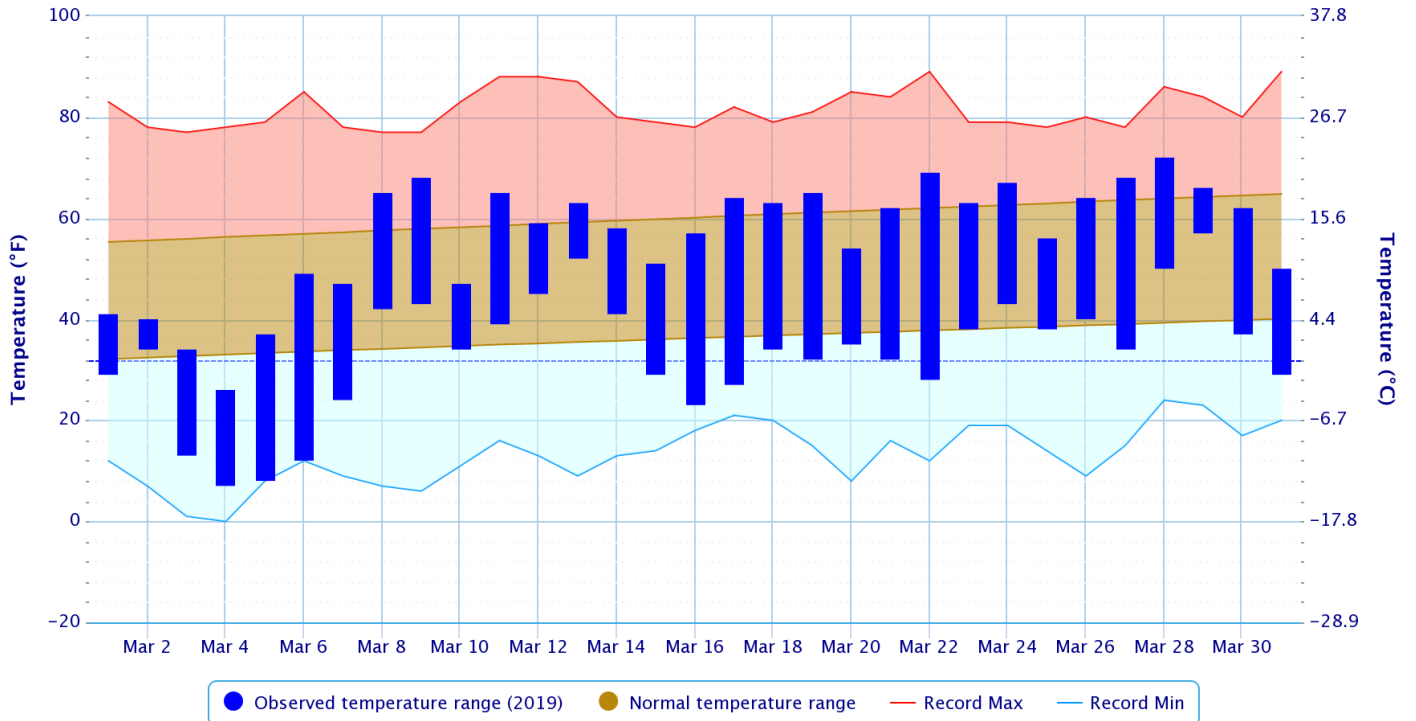
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

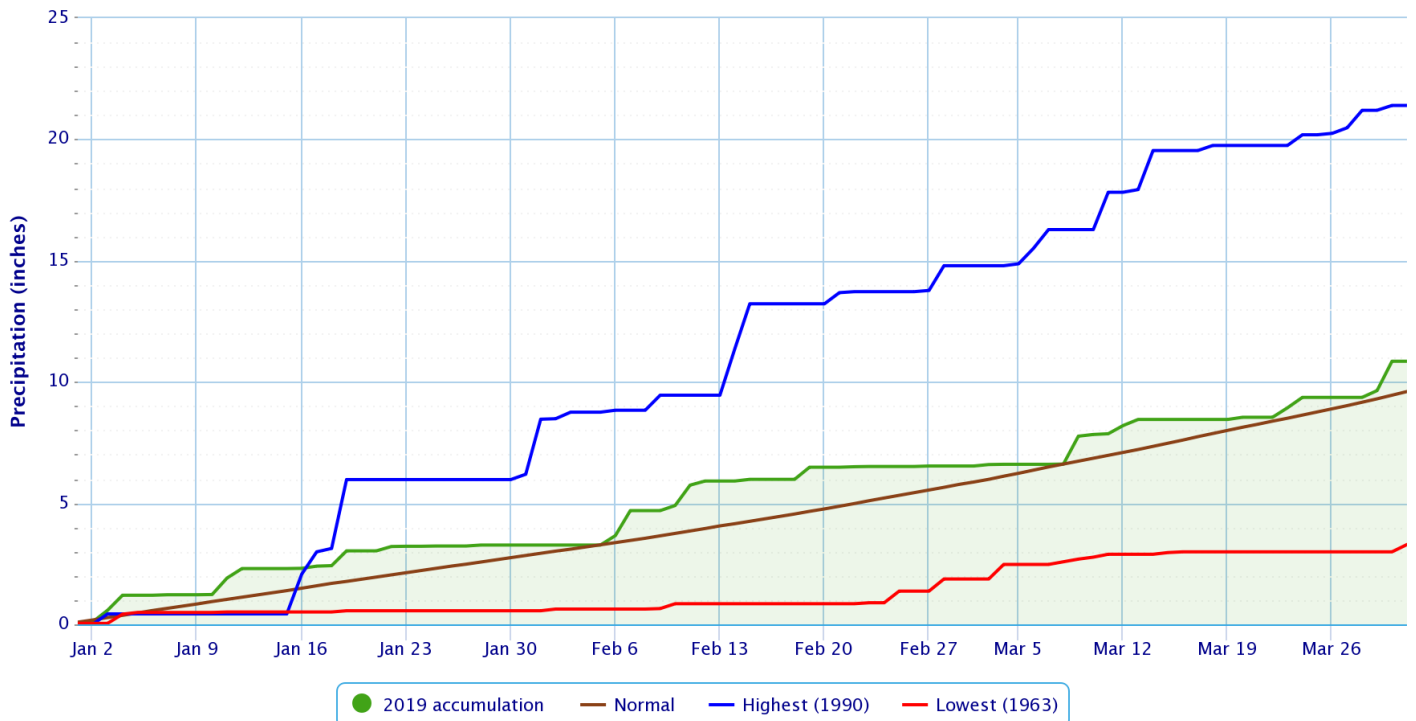
Period of Record – 1949-07-14 to 2019-03-31. Normals period: 1981-2010. Click and drag to zoom chart.



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Accumulated Precipitation – FAYETTEVILLE DRAKE FIELD, AR

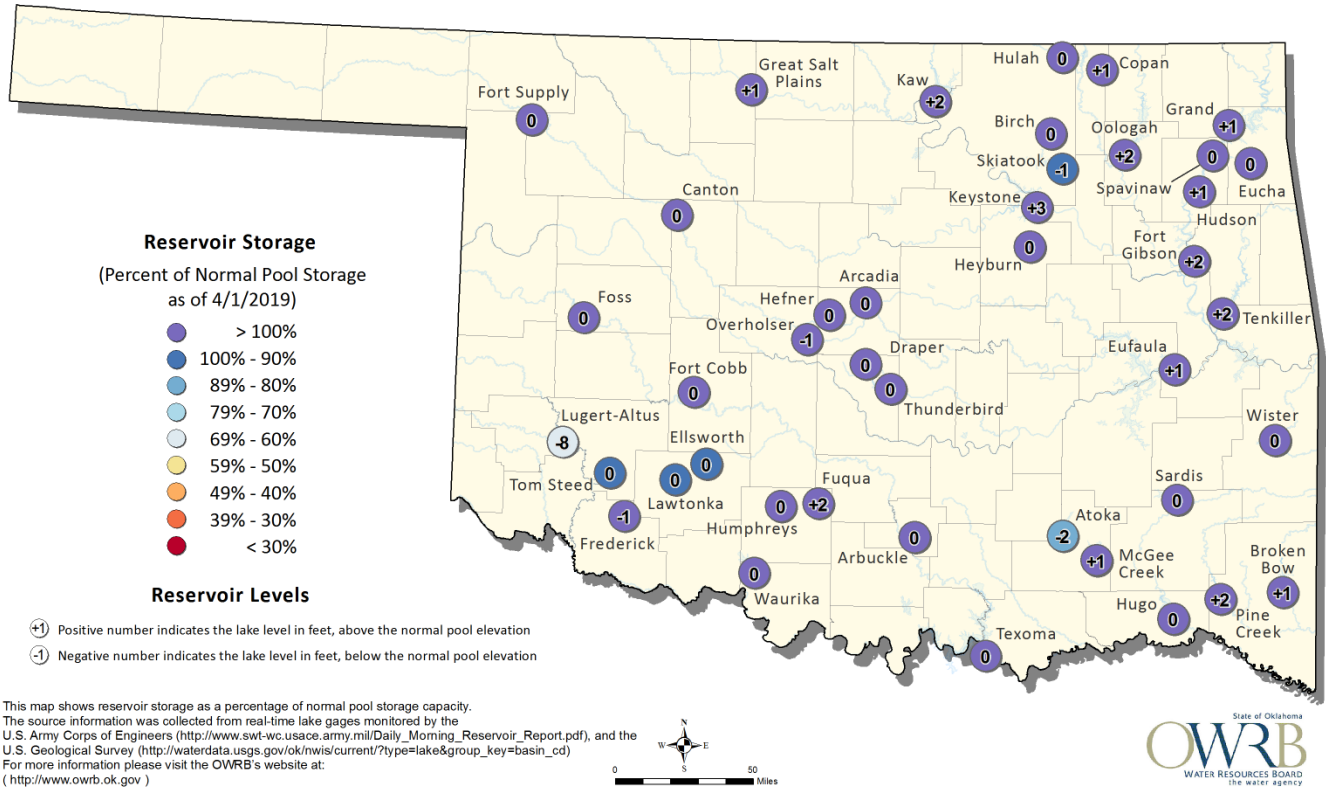
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Reservoirs

Oklahoma Surface Water Resources Reservoir Levels and Storage as of 4/1/2019



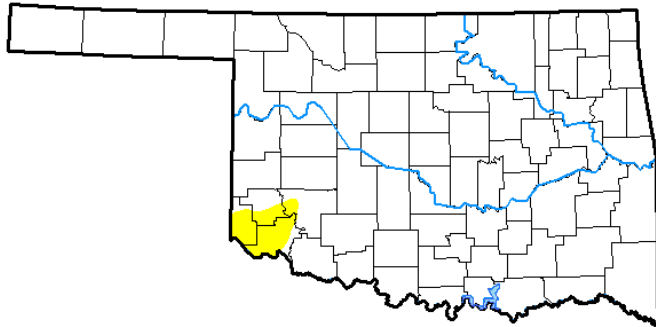
According to the USACE, several lakes in the HSA were slightly above $\pm 3\%$ of their conservation pool level as of 4/01/2019: Grand Lake/Pensacola 106%, Beaver Lake 105%, Tenkiller Lake 105%, Eufaula Lake 105%, Hudson Lake 105%, Oologah Lake 105%, Ft. Gibson Lake 104%, and Keystone Lake 104%. Only one reservoir was below 3% of its conservation pool storage as of 4/01/2019: Skiatook Lake 96%.

Drought

According to the [U.S. Drought Monitor](#) (USDM) from March 26, 2019 (Figs. 2, 3), no drought or abnormally dry conditions were present across eastern OK and northwest AR.

U.S. Drought Monitor Oklahoma

March 26, 2019
(Released Thursday, Mar. 28, 2019)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	97.87	2.13	0.00	0.00	0.00	0.00
Last Week 03-19-2019	99.36	0.64	0.00	0.00	0.00	0.00
3 Months Ago 12-25-2018	50.34	49.66	5.08	0.00	0.00	0.00
Start of Calendar Year 01-01-2019	94.85	5.15	0.00	0.00	0.00	0.00
Start of Water Year 09-25-2018	72.93	27.07	9.11	4.16	0.00	0.00
One Year Ago 03-27-2018	40.71	59.29	47.60	42.29	34.93	14.79

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:

Eric Luebehusen
U.S. Department of Agriculture

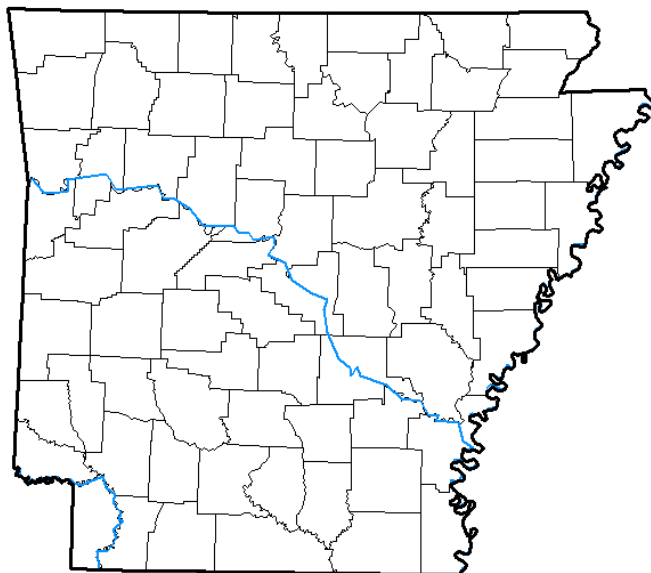


<http://droughtmonitor.unl.edu/>

Fig. 2. Drought Monitor for Oklahoma

U.S. Drought Monitor Arkansas

March 26, 2019
(Released Thursday, Mar. 28, 2019)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	100.00	0.00	0.00	0.00	0.00	0.00
Last Week 03-19-2019	100.00	0.00	0.00	0.00	0.00	0.00
3 Months Ago 12-25-2018	93.04	6.96	1.22	0.00	0.00	0.00
Start of Calendar Year 01-01-2019	98.79	1.21	0.00	0.00	0.00	0.00
Start of Water Year 09-25-2018	93.15	6.85	2.59	0.00	0.00	0.00
One Year Ago 03-27-2018	100.00	0.00	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:

Eric Luebehusen
U.S. Department of Agriculture



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

Fig. 3. Drought Monitor for Arkansas

Outlooks

The [Climate Prediction Center](#) (CPC) outlook for April 2019 (issued March 31, 2019) indicates a slightly enhanced chance for above normal temperatures and slightly increased odds for above median precipitation across all of eastern OK and northwest AR. This outlook takes into account weather conditions forecast over the first two weeks of April, the weeks 3-4 outlook, and the above normal soil moisture over the central and southern Plains, which will make above normal temperatures less likely. El Niño conditions were not heavily considered.

For the 3-month period April-May-June 2019, CPC is forecasting a slightly enhanced chance for below normal temperatures northwest of I-44 in northeast OK and an equal chance for above, near, and below normal temperatures elsewhere across eastern OK and northwest AR. This outlook as indicates a slightly enhanced chance for above median precipitation across all of eastern OK and northwest AR (outlook issued March 21, 2019). This outlook is based on both statistical and dynamical forecast tools, decadal timescale climate trends, current soil moisture conditions, and influence from El Niño. The lag correlation for high soil moisture is a driver for the odds favoring below normal temperatures in northeast OK. The enhanced odds for above median rainfall in primarily based on dynamical models and El Niño influence. According to CPC, the combined effect of the ocean-atmosphere system is consistent with the continuation of weak El Niño conditions. A continuation of the weak El Niño is expected, though there is considerable spread among the various predictive models as the year progresses. There is an 80% chance that El Niño conditions will continue through spring 2019 and a 60% chance it will continue through summer 2019. CPC continues the El Niño Advisory.

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

During the late evening hours of the 2nd, patchy rain and drizzle began to develop across northeast OK as a compact and potent shortwave moved out of the Sierras and into the Plains. As the shortwave moved into KS, a more widespread area of precipitation moved west to east across eastern OK and northwest AR during the early morning hours of the 3rd. At the same time, a surge of very cold Arctic air also moved into the region, causing a changeover to sleet and snow during the early morning hours of the 3rd primarily north of I-40. The precipitation quickly shifted east of the area shortly after sunrise. The highest snowfall accumulation of 0.5"-2" was across northeast OK, where the cold temperatures and precipitation overlapped the longest (Fig. 4). Elsewhere, snowfall totals were a trace to around half an inch. Rainfall and liquid equivalent totals were around 0.25" or less.

Showers and thunderstorms developed over eastern OK near a warm front after midnight on the 9th and progressed eastward through the early morning hours. The rain moved east of the area by mid-morning as the main upper-level system swept through the region. Rainfall totals ranged from around 0.25" to 1.5" across a large portion of eastern OK and northwest AR, and isolated areas of 1.5"-2" (Figs 5, 6).

A band of showers with embedded thunderstorms, associated with isentropic ascent, tracked northeast across eastern OK and northwest AR from midnight to sunrise on the 12th. While most of the region received a few hundredths to around one third of an inch of rain, heavier rain from around 0.50" to around 1" fell across Choctaw, Pushmataha, and southern Le Flore Counties in southeast OK. Scattered showers and thunderstorms continued across northeast OK and northwest AR, with more widespread activity across southeast KS, during the remainder of the morning. By late afternoon, a large area of showers and thunderstorms moving east out of north central OK/south central KS affected southeast KS and locations along the KS/OK state line through the evening hours. A squall line developed over west TX around midnight on the 13th, which then trekked east across OK, while weakening, during the overnight hours. This activity made it into eastern OK in the pre-dawn hours, and continued to move east across eastern OK and northwest AR through late afternoon. An anomalously deep surface cyclone lifted through western KS during the afternoon, resulting in strong southerly wind gusts of 35-50 mph (Fig. 10). For the 24-hour period ending at 7 am CDT March 13, rainfall totals ranged from 0.25" to near 1.5" across portions of northeast OK, northwest AR, and southeast KS (Figs. 7, 9). An additional 0.10" to 1" of rain fell after 7 am (Figs. 8, 9). The higher rainfall totals across southeast KS resulted in flooding along the Neosho River upstream of Grand Lake (see preliminary hydrographs at the end of this report; see E3 Report for details).

Estimated Snow Amount (in)

Weather Forecast Office
Tulsa OK



Sun Mar 3 Midnight To Sun Mar 3 8AM

Updated: Sun Mar 03 2019 10:36 AM CDT

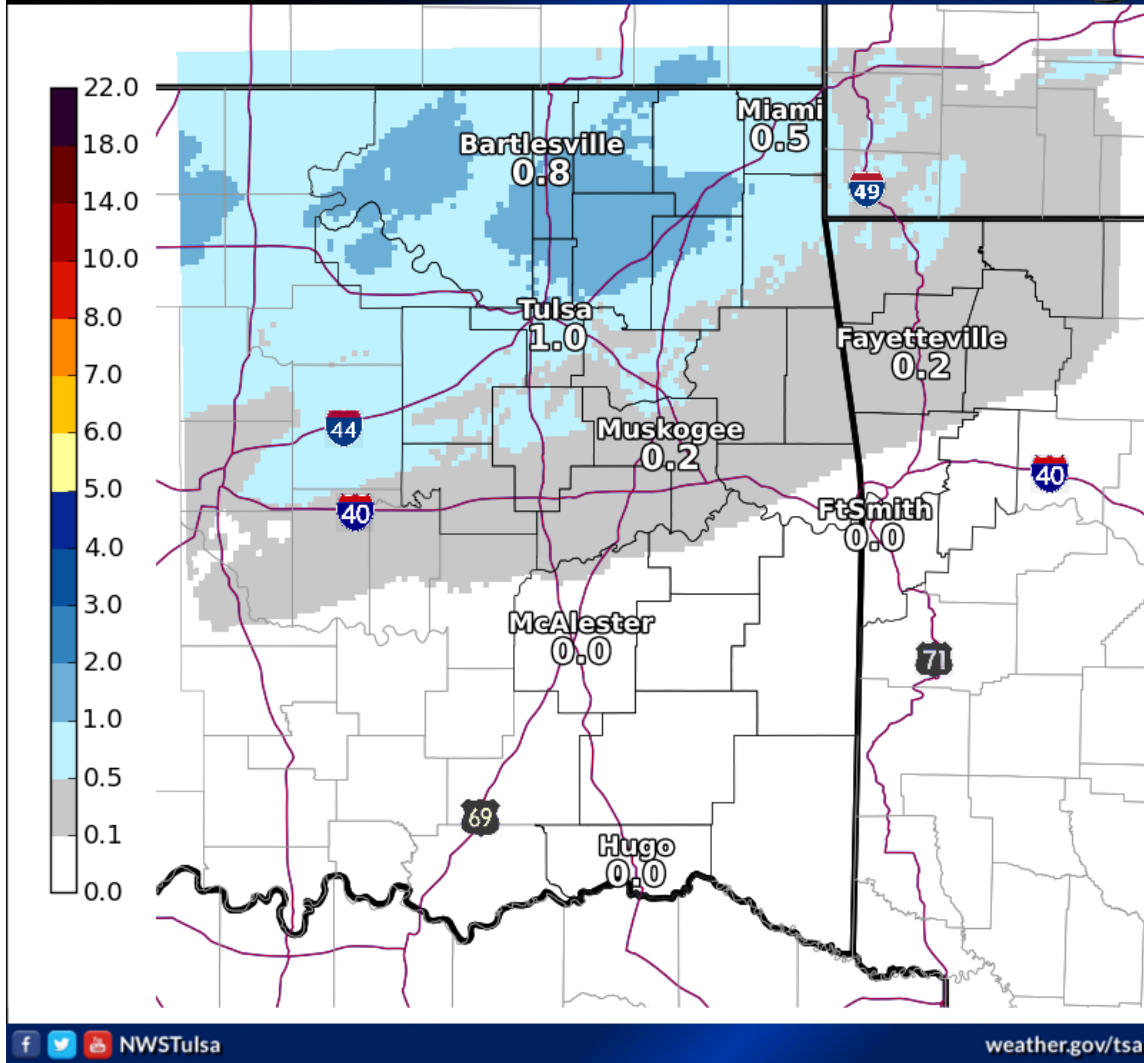
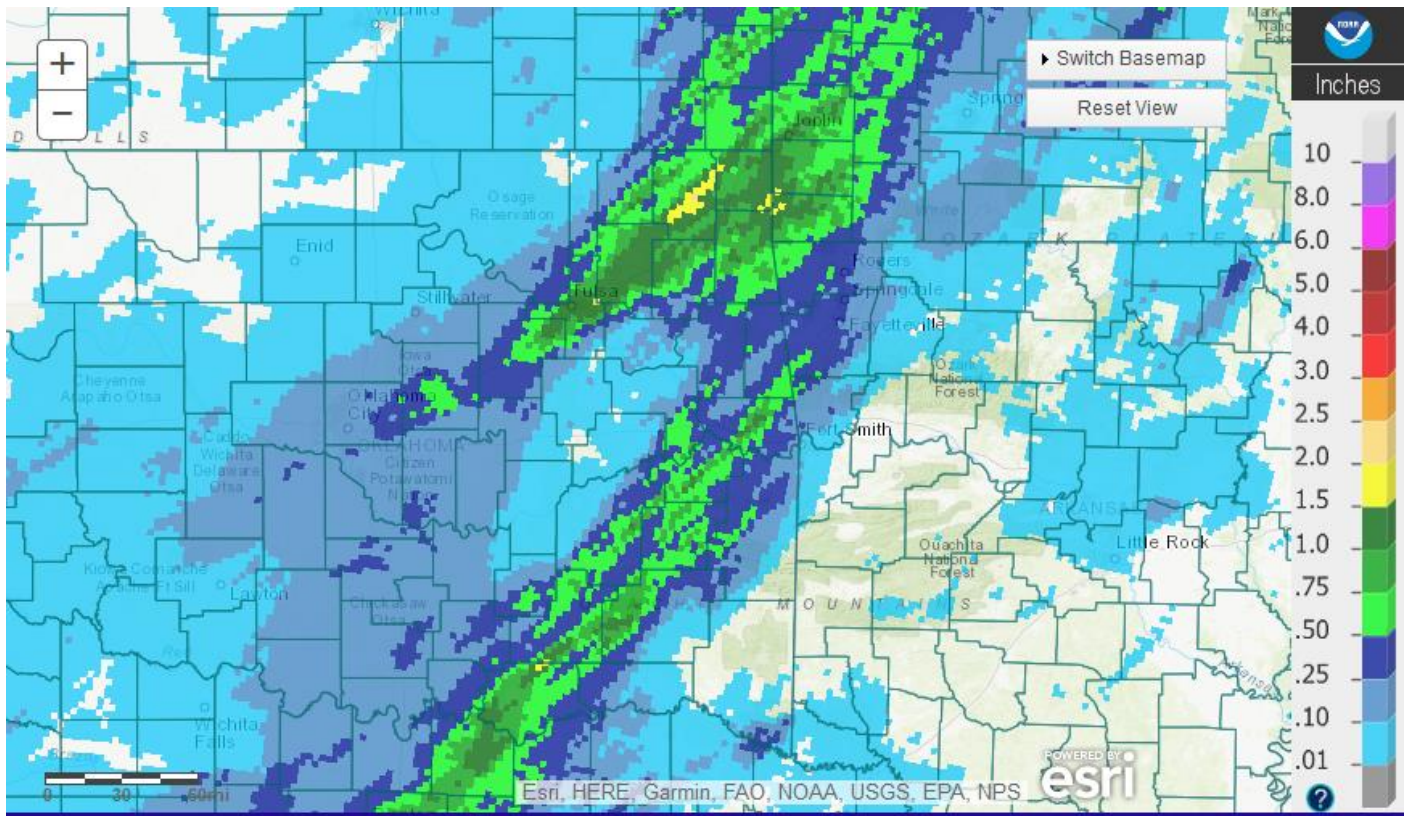
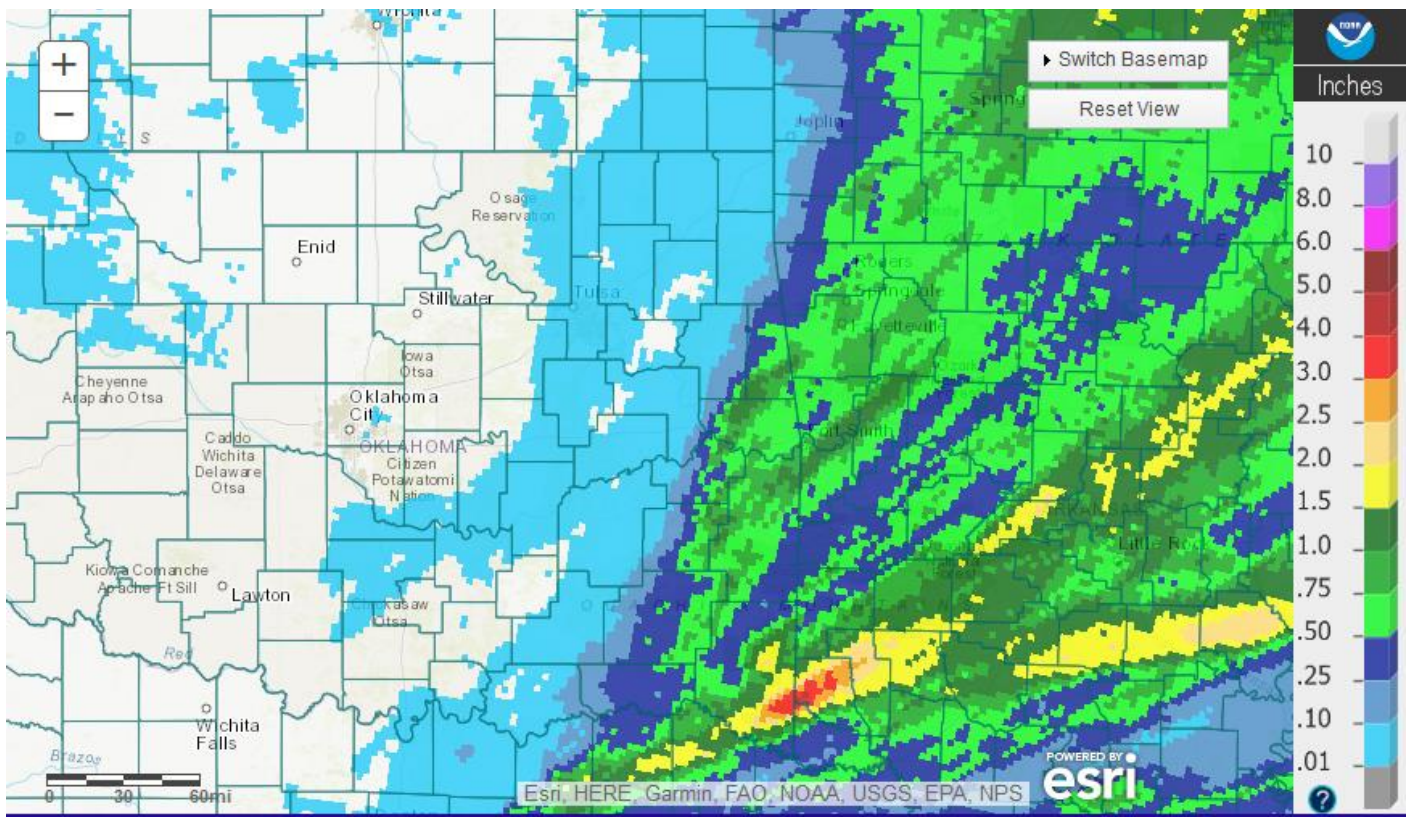


Fig. 4. Estimated storm total snow/sleet ending at 8 am CST 3/03/2019.



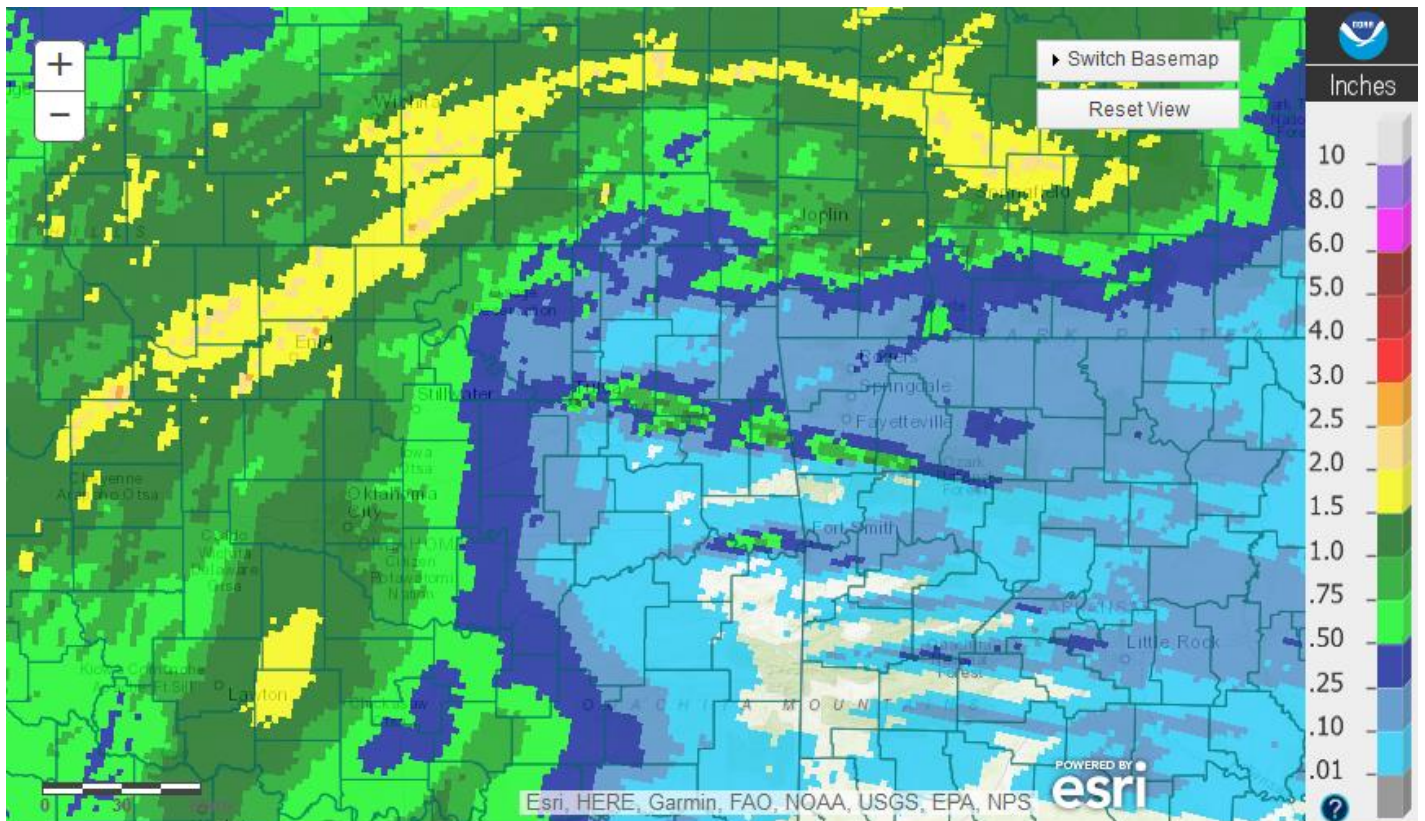
Tulsa, OK: March 09, 2019 1-Day Observed Precipitation
Valid on: March 09, 2019 12:00 UTC

Fig. 5. 24-hour Estimated Observed Rainfall ending at 6am CST 3/09/2019.



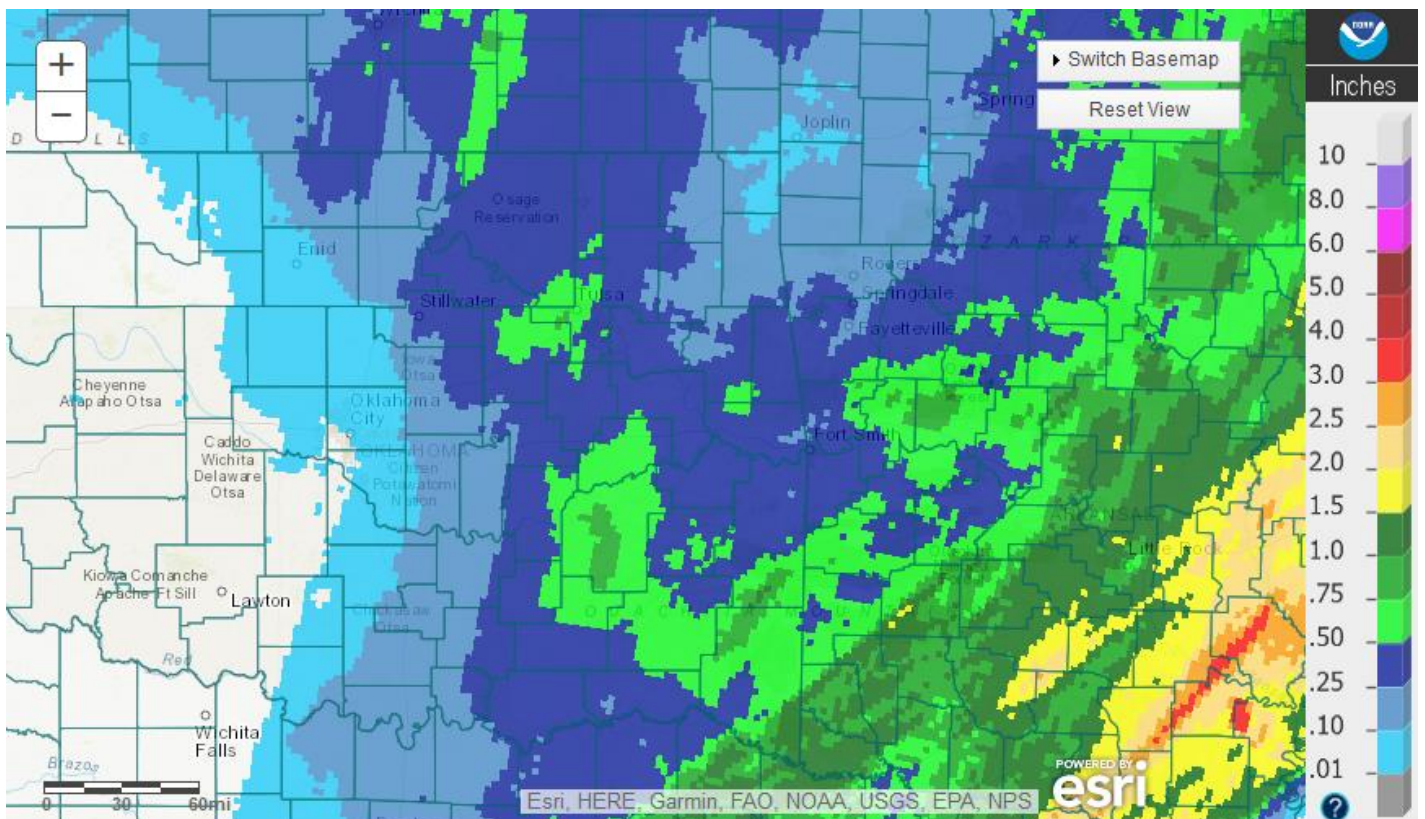
Tulsa, OK: March 10, 2019 1-Day Observed Precipitation
Valid on: March 10, 2019 12:00 UTC

Fig. 6. 24-hour Estimated Observed Rainfall ending at 7am CDT 3/10/2019.



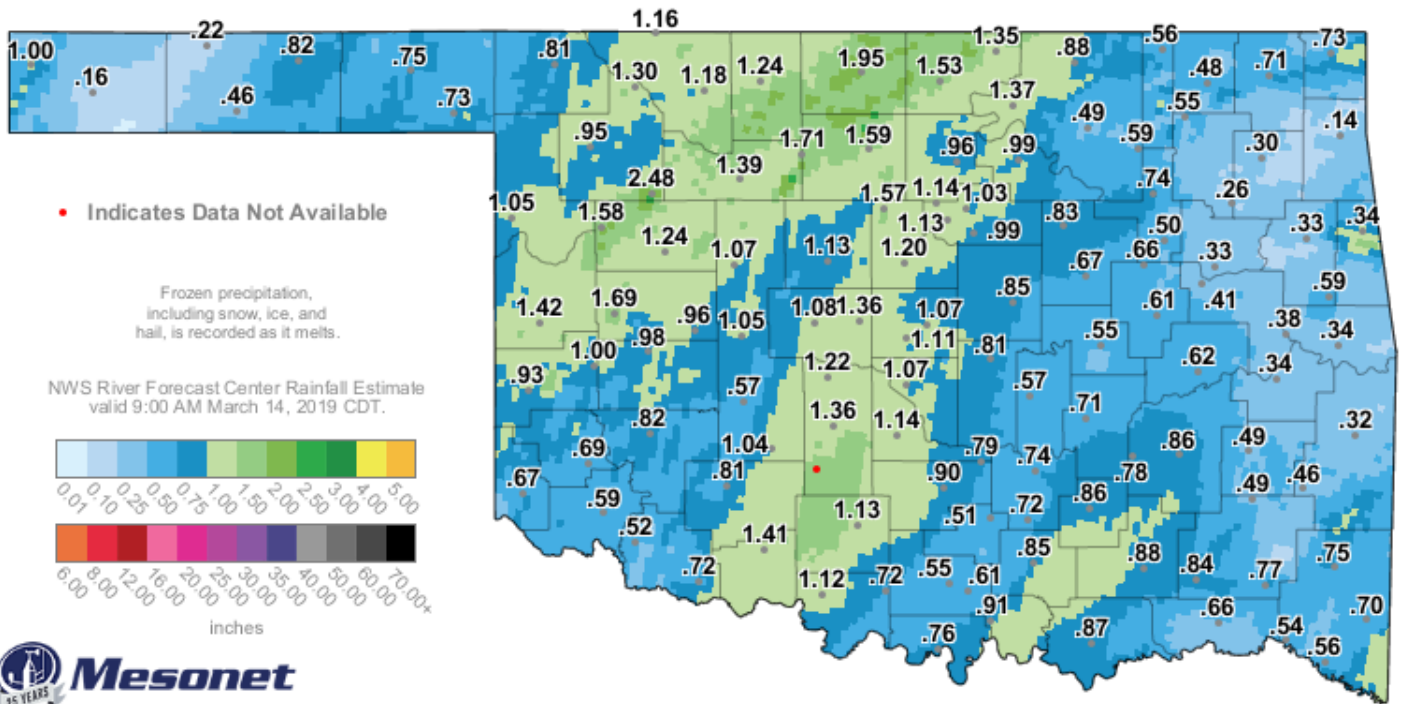
Tulsa, OK: March 13, 2019 1-Day Observed Precipitation
Valid on: March 13, 2019 12:00 UTC

Fig. 7. 24-hour Estimated Observed Rainfall ending at 7am CDT 3/13/2019.



Tulsa, OK: March 14, 2019 1-Day Observed Precipitation
Valid on: March 14, 2019 12:00 UTC

Fig. 8. 24-hour Estimated Observed Rainfall ending at 7am CDT 3/14/2019.

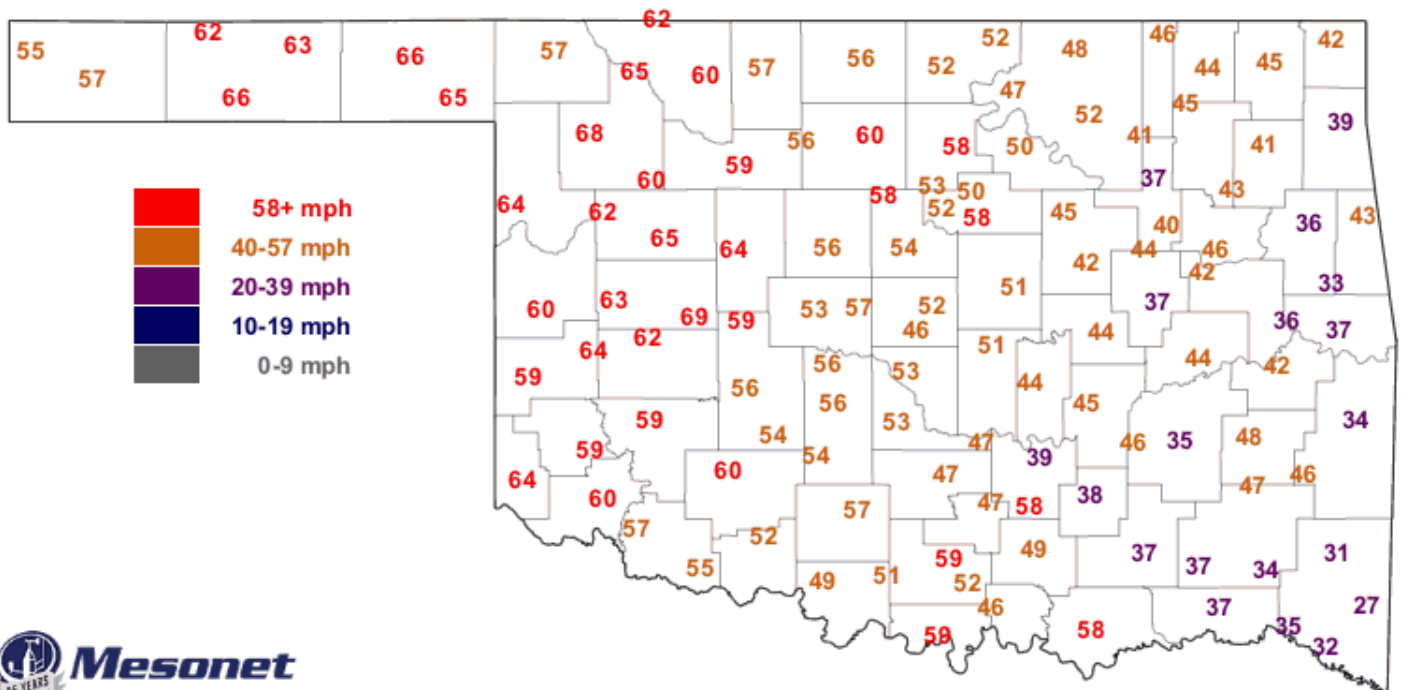


2-Day Rainfall Accumulation (inches)

10:40 AM March 14, 2019 CDT

Created 10:45:51 AM March 14, 2019 CDT. © Copyright 2019

Fig. 9. OK Mesonet (values) and NWS RFC rainfall estimate (image) 2-day rainfall ending at 10:40 am CDT 03/14/2019.



Maximum Wind Gusts (mph)

March 13, 2019

Created 7:30:14 AM March 14, 2019 CDT. © Copyright 2019

Fig. 10. OK Mesonet maximum wind gust (mph) 3/13/2019.

A complex of showers and thunderstorms spread into eastern OK during the pre-dawn hours of the 23rd and continued eastward into northwest AR through the afternoon hours. While most of this first round of rain moved east of the area by mid-evening, additional isolated to scattered thunderstorms developed in central and eastern OK, in the vicinity of a dryline, through the evening. This activity also moved east into northwest AR just before midnight, and continued during the night as the low-level jet increased the isentropic lift over the region. These storms finally dissipated during the early morning hours of the 24th. Rainfall totals ranged from around 0.25" to around 2" across much of eastern OK and northwest AR (Fig. 11).

A cold front moved across the region on the 24th, sparking thunderstorm development across southeast OK into northwest AR in the late afternoon. This activity continued through the evening hours before the cold front and associated storms moved east of the area by midnight. Large hail occurred with these storms, with several reports of golf ball (1.75") sized hail. There were a few reports of 2" hail stones, but the largest hail was baseball size (2.75") reported in Howe, OK and 5 miles south southeast of Poteau, OK (both in Le Flore Co.). Rainfall totals were 0.10" to 1.5" (Fig. 12).

A line of showers and thunderstorms developed along I-35 near a stationary front just before sunrise on the 29th, and moved east across northeast OK through the morning hours. This activity reached northwest AR by noon, and moved east out of the area a few hours later. The front then moved across eastern OK and northwest AR generating a broken line of light showers during the evening. A little after midnight on the 30th, another area of showers and thunderstorms developed over northwest OK, behind the front, as an upper-level wave moved into the region. These storms moved quickly into eastern OK and northwest AR during the early morning hours, and were east of the area by mid-morning. Rainfall totals from the two rounds of storms ranged from around 0.10" to around 1.5" of rain (Fig. 13).

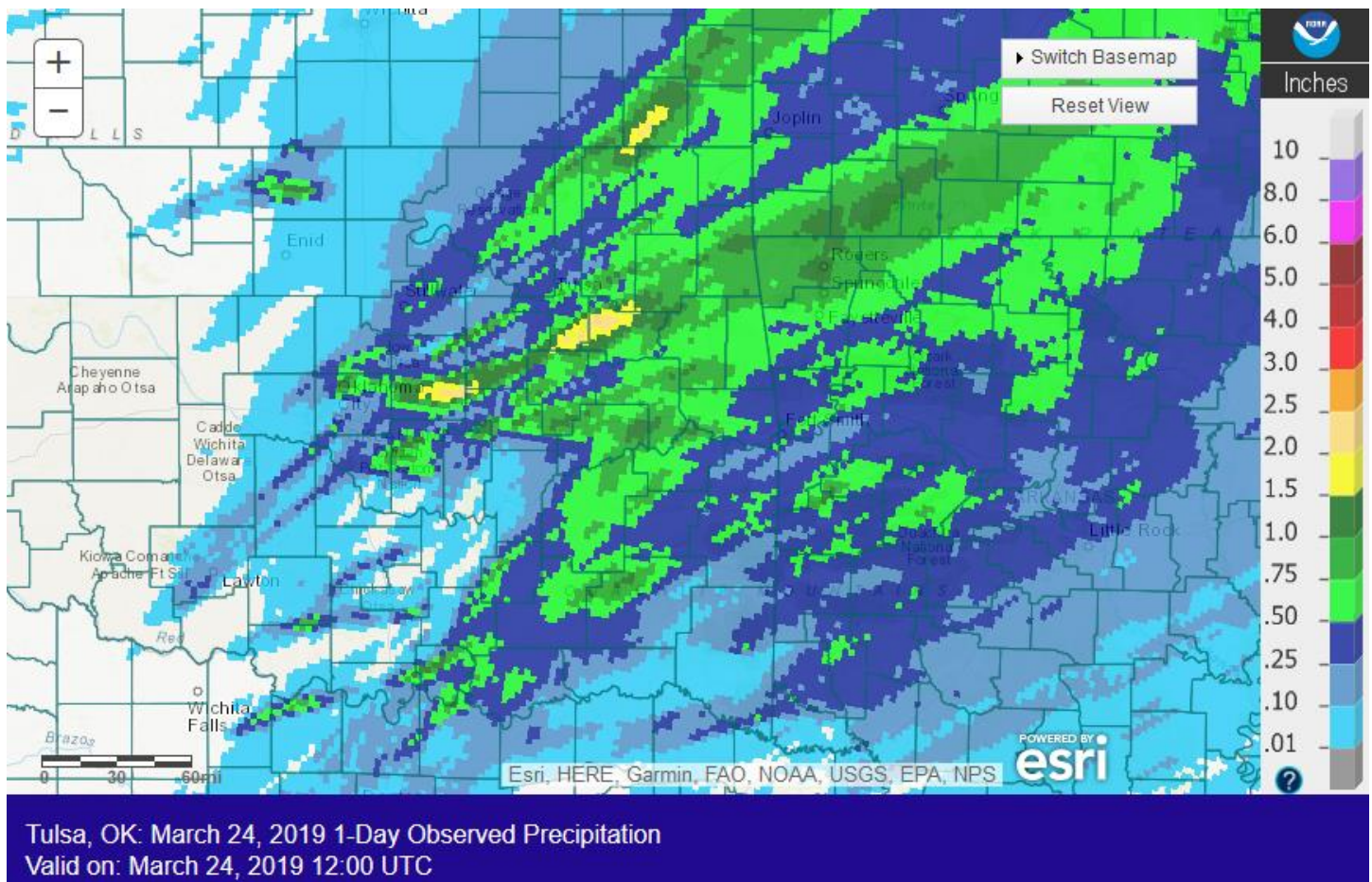
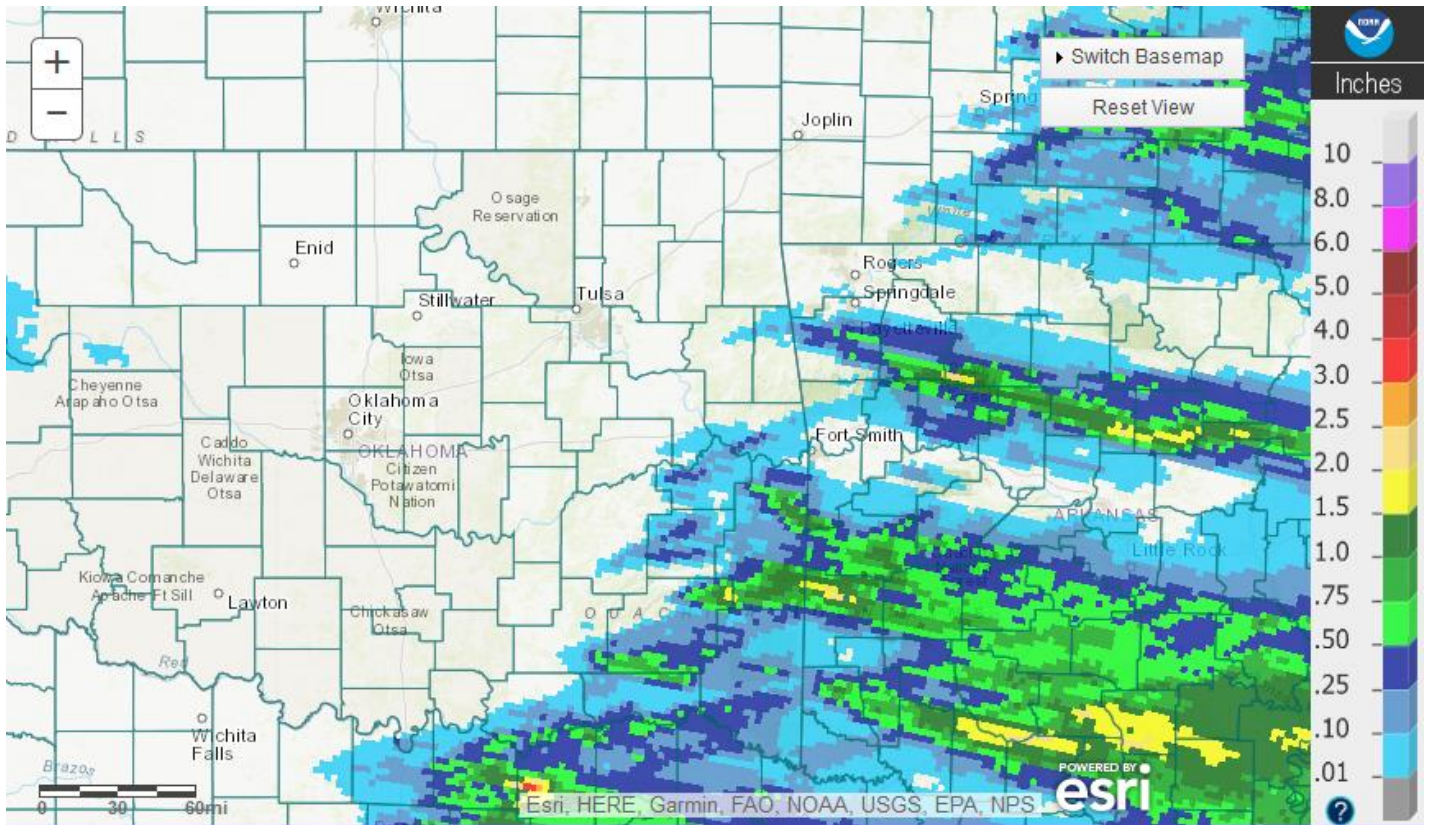
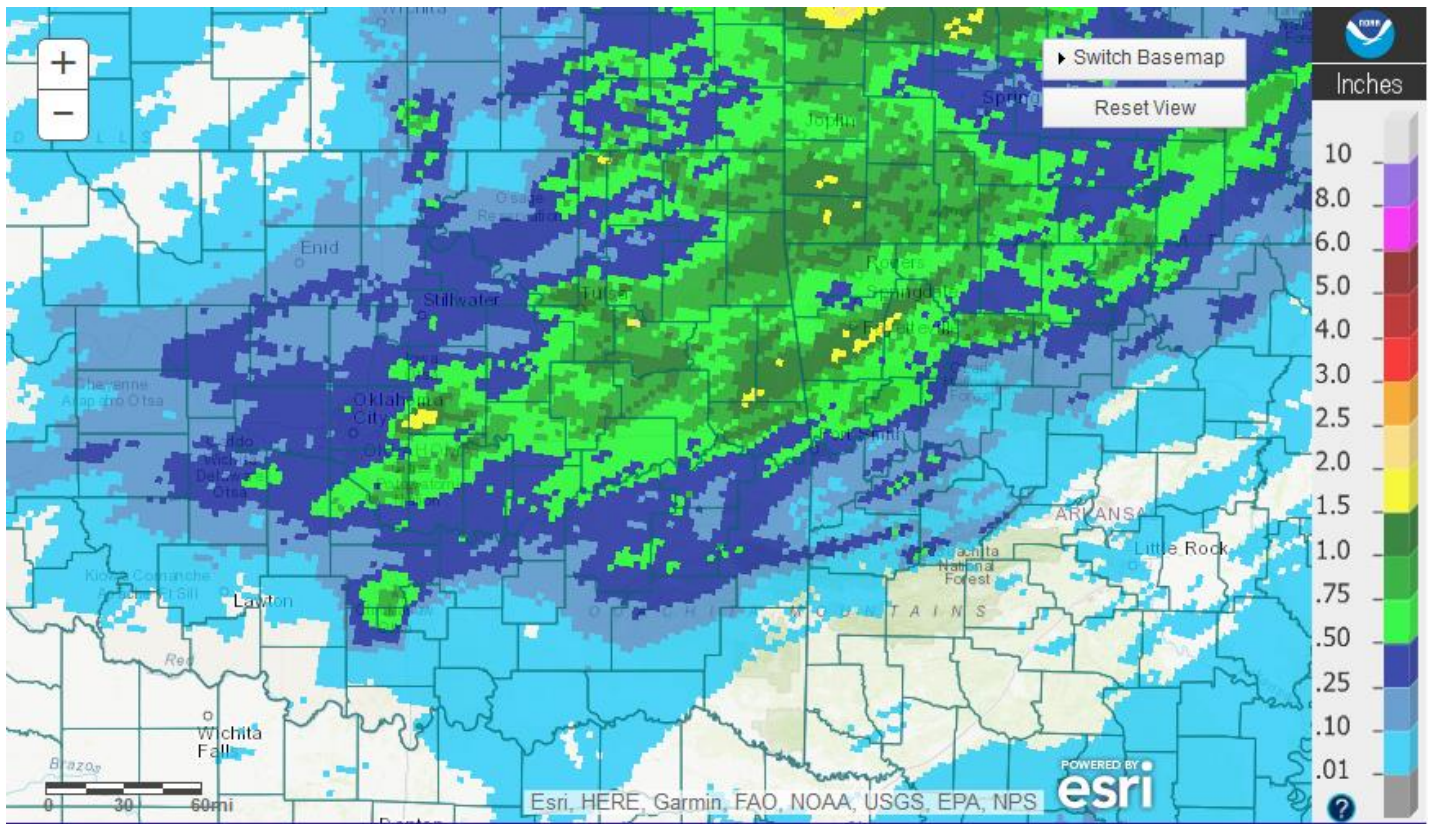


Fig. 11. 24-hour Estimated Observed Rainfall ending at 7am CDT 3/24/2019.



Tulsa, OK: March 25, 2019 1-Day Observed Precipitation
Valid on: March 25, 2019 12:00 UTC

Fig. 12. 24-hour Estimated Observed Rainfall ending at 7am CDT 3/25/2019.



Tulsa, OK: March 30, 2019 1-Day Observed Precipitation
Valid on: March 30, 2019 12:00 UTC

Fig. 13. 24-hour Estimated Observed Rainfall ending at 7am CDT 3/30/2019.

Written by:
 Nicole McGavock
 Service Hydrologist
 WFO Tulsa

Products issued in March 2019:

- *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

- 0 Flash Flood Warnings (FFW)
- 0 Flash Flood Statements (FFS)
- 0 Flash/Areal Flood Watches (FFA) (0 Watch FFA CON/EXT/EXA/EXB/CAN)
- 0 Urban and Small Stream Advisories (FLS)
- 0 Areal Flood Warnings (FLW)
- 0 Areal Flood Statements (FLS)
- 1 River Flood Warnings (FLW) (includes category increases)
- 15 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)
- 1 Hydrologic Outlooks (ESF)
- 0 Drought Information Statements (DGT)

Preliminary Hydrographs:

