

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 September	YEAR 2023
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 October 12, 2023	

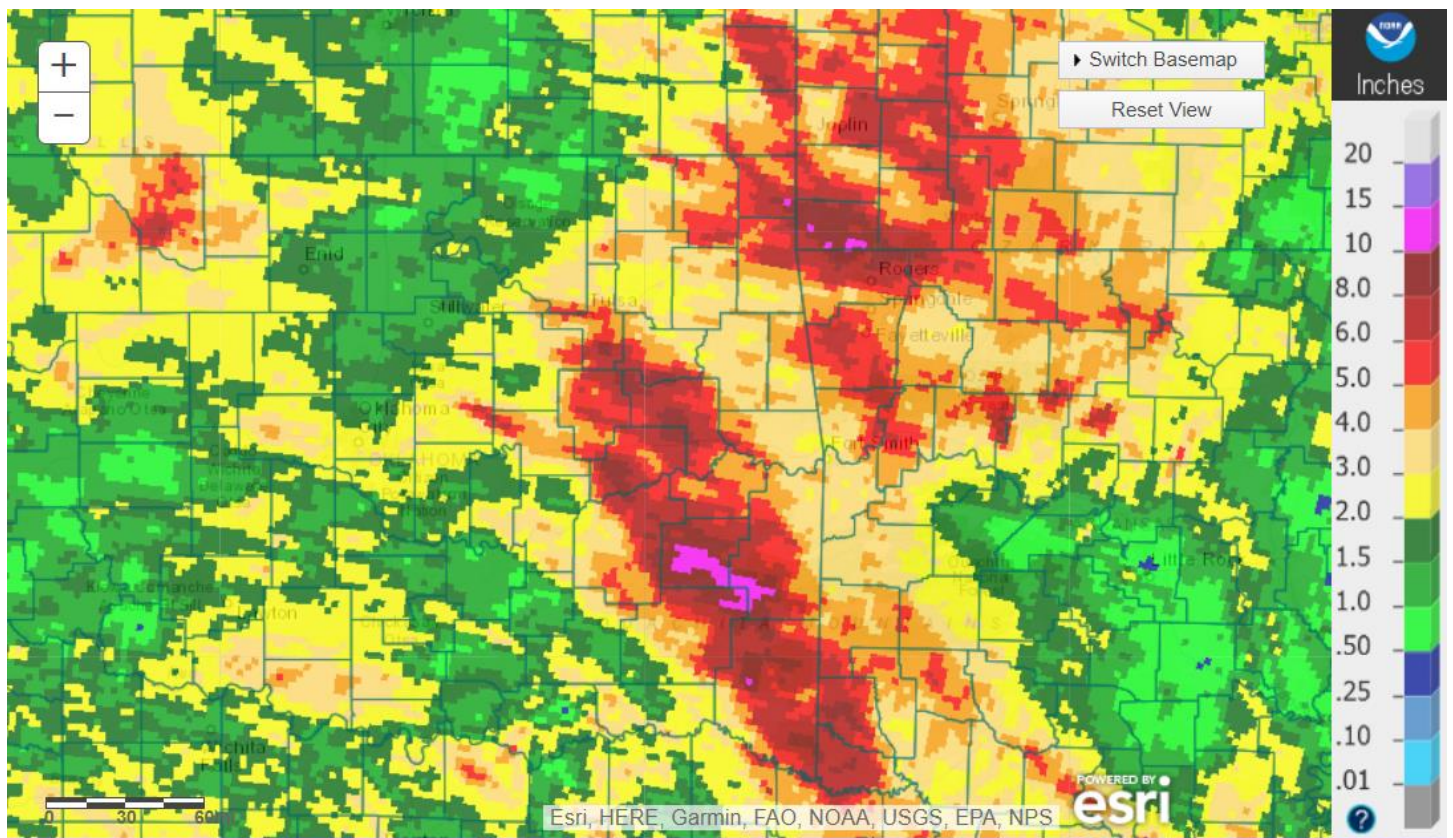
When no flooding occurs, include miscellaneous river conditions, such as significant rises, record low stages, ice conditions, snow cover, droughts, and hydrologic products issued (NWS Instruction 10-924)

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

September 2023 was overall dry for much of the region, though a period of unsettled weather brought some heavy rain during the second half of the month. Normal rainfall for September ranges from 4.2 inches in Okmulgee County to 5.4 inches in Delaware County. In the Ozark region of northwest Arkansas, rainfall averages 4.5 inches for the month. This report, past E-5 reports, and monthly hydrology and climatology summaries can be found at https://www.weather.gov/tsa/climo_summary_e5list.

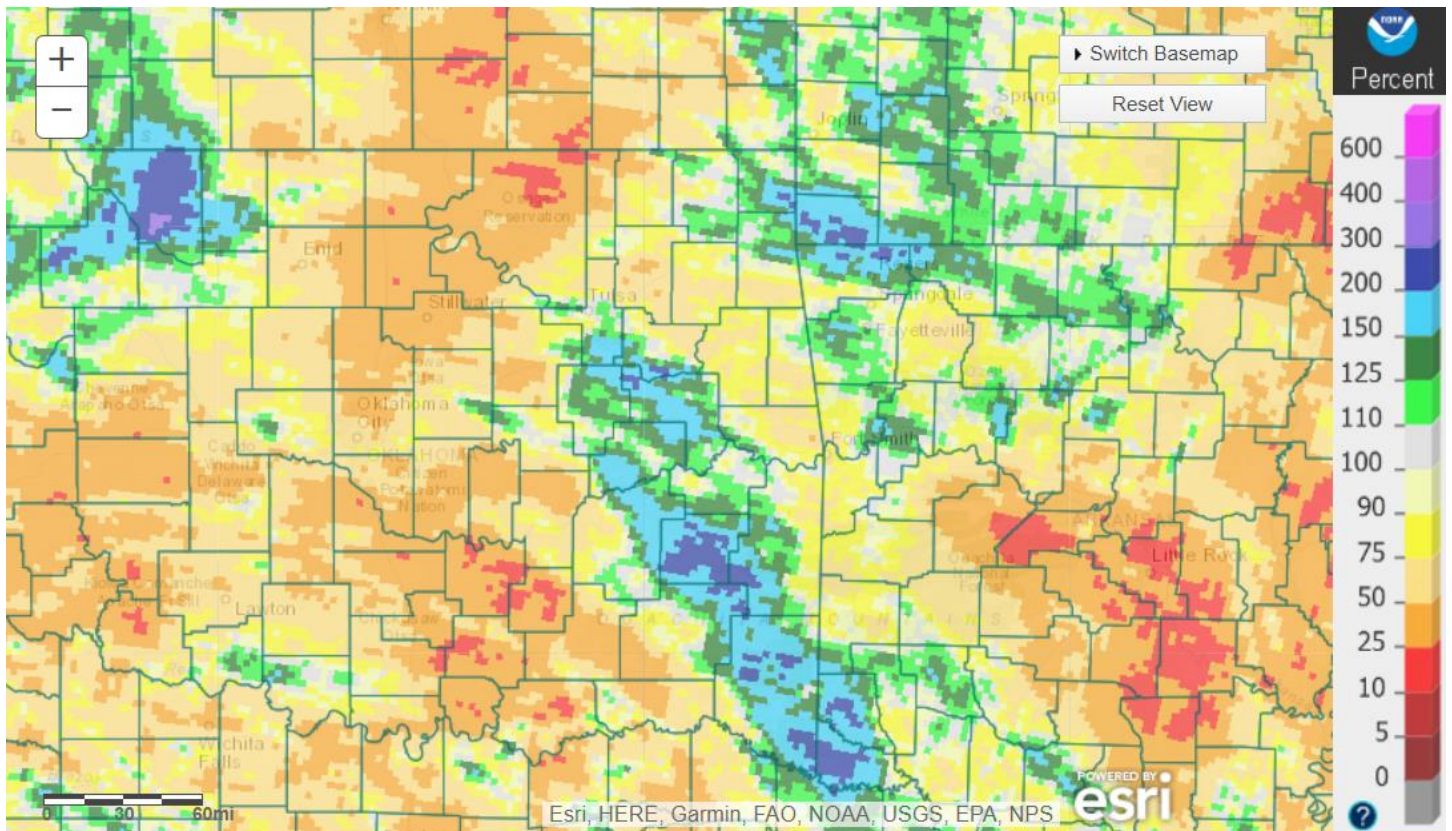
Monthly Summary

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 1a), rainfall totals for September 2023 ranged from 0.50" to around 12" across eastern OK and northwest AR, with much of the area receiving 2"-5". These rainfall totals correspond to 10% to 300% of the normal September rainfall (Fig. 1b).



Tulsa, OK: September, 2023 Monthly Observed Precipitation
 Valid on: October 01, 2023 12:00 UTC

Fig. 1a. Estimated Observed Rainfall for September 2023



Tulsa, OK: September, 2023 Monthly Percent of Normal Precipitation
 Valid on: October 01, 2023 12:00 UTC

Fig. 1b. Estimated % of Normal Rainfall for September 2023

In Tulsa, OK, September 2023 ranked as the 21st warmest September (77.0°F, tied 2016; since records began in 1905) and the 50th wettest September (3.92"; since records began in 1888). Fort Smith, AR had the 16th warmest September (78.4°F, tied 2021; since records began in 1882) and the 66th wettest September (3.40"; since records began in 1882). Fayetteville, AR had the 9th warmest (73.0°F) and the 17th wettest (5.45") September since records began in 1949.

Some of the larger precipitation reports (in inches) for September 2023 included:

Garfield 3.9E, AR (coco)	10.50	Bella Vista 2.2E, AR (coco)	10.19	Talihina, OK (meso)	9.96
Wilburton, OK (meso)	9.31	Bella Vista 2.5SSE, AR (coco)	8.87	Glade 1.9WSW, AR (coco)	8.71
Bella Vista 0.6WSW, AR (coco)	8.32	Viney Grove 2.4NW, AR (coco)	8.28	Eureka Springs 4.0NNW, AR (coco)	8.07

Some of the lowest precipitation reports (in inches) for September 2023 included:

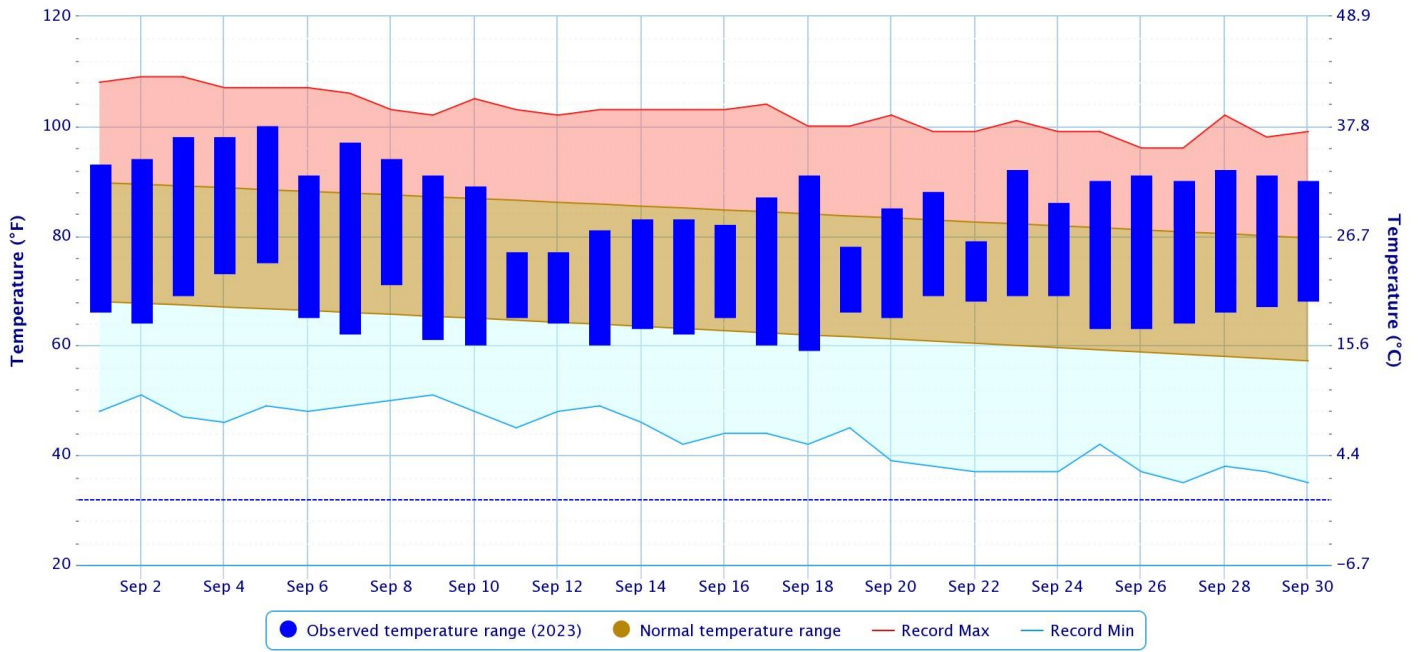
Foraker, OK (meso)	0.78	Bartlesville, OK (ASOS)	1.23	Burbank, OK (meso)	1.39
Antlers, OK (meso)	1.42	Copan, OK (meso)	1.49	Wynona, OK (meso)	1.55
Pawnee, OK (meso)	1.55	Antlers 6.3SE, OK (coco)	1.60	Bristow, OK (meso)	1.76

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

Rank since 1921	September 2023	Last 60 Days (Aug 2 – Sep 30)	Last 90 Days (Jul 3 – Sep 30)	Last 180 Days (Apr 4 – Sep 30)	Year-to-Date (Jan 1 – Sep 30)	Water Year 2022-23 (Oct 1, 2022 – Sep 30, 2023)
Northeast OK	49 th driest	37 th wettest	31 st wettest	33 rd driest	45 th driest	41 st driest
East Central OK	38 th wettest	44 th wettest	22 nd wettest	35 th driest	38 th wettest	33 rd wettest
Southeast OK	30 th wettest	40 th wettest	37 th wettest	29 th driest	28 th wettest	25 th wettest
Statewide	48 th driest	34 th driest	31 st wettest	49 th driest	46 th wettest	44 th wettest

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

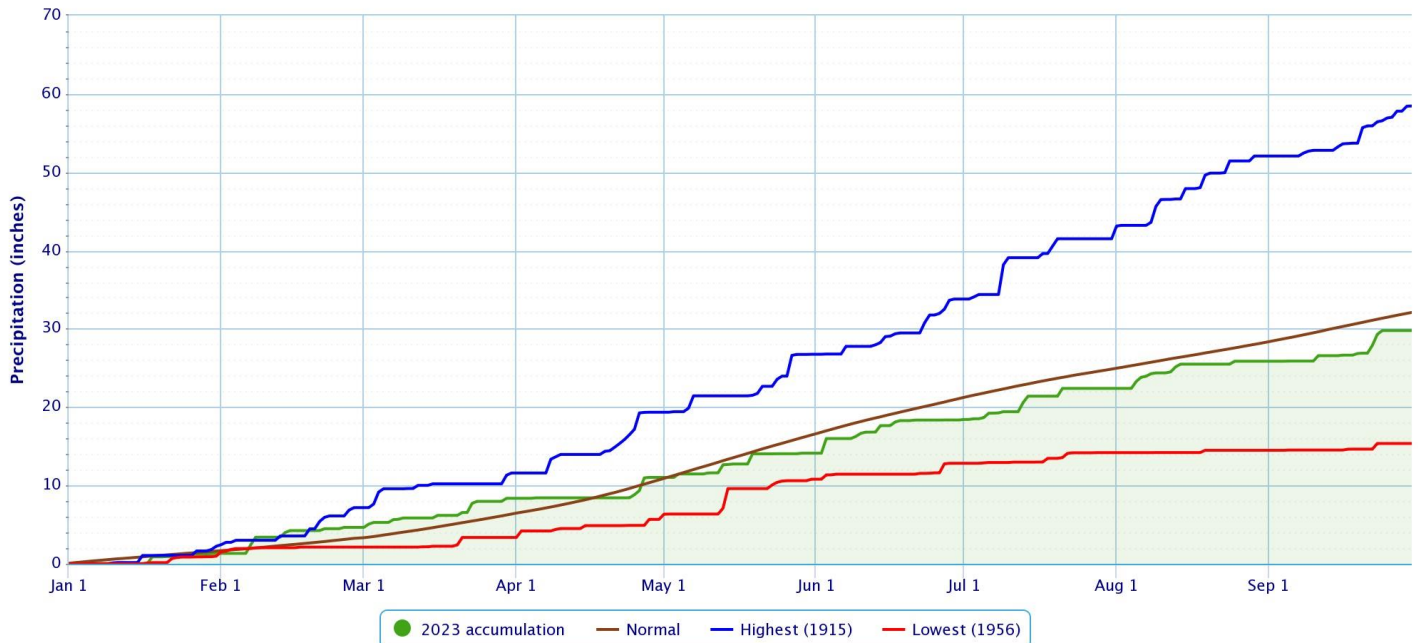
Period of Record – 1905-01-06 to 2023-10-02. Normals period: 1991-2020. Click and drag to zoom chart.



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Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

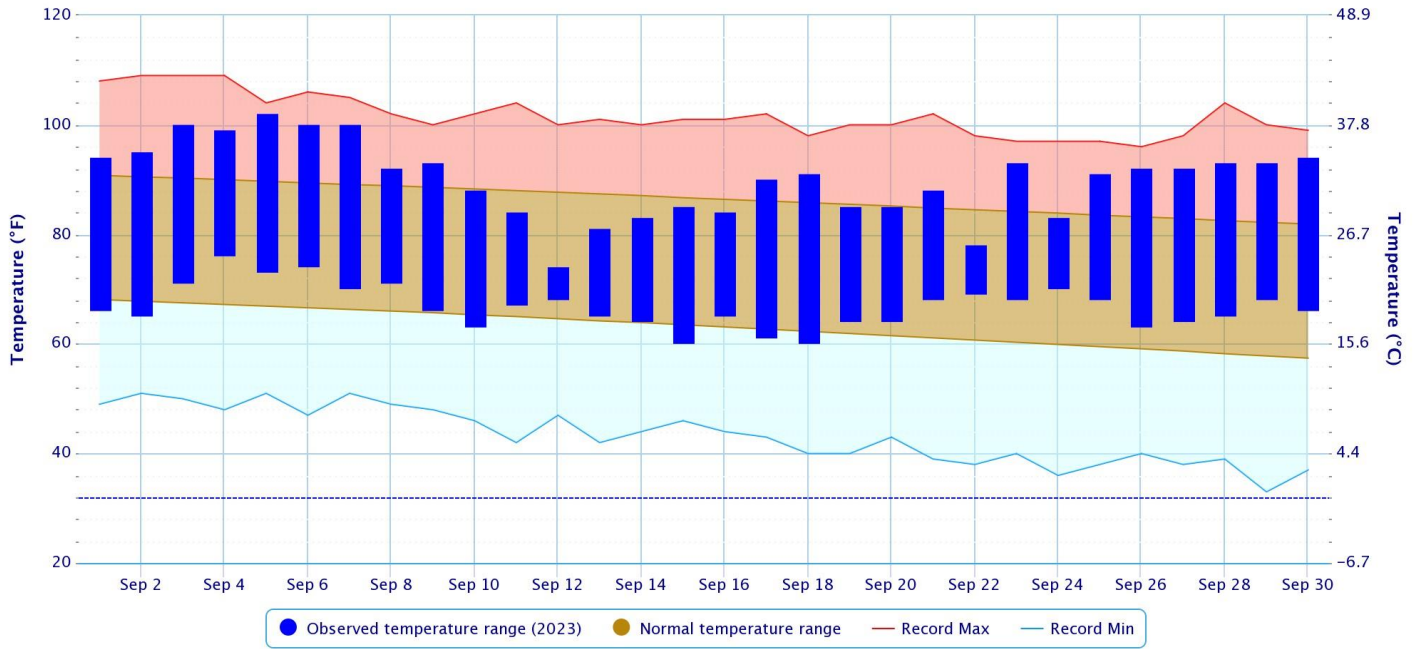
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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

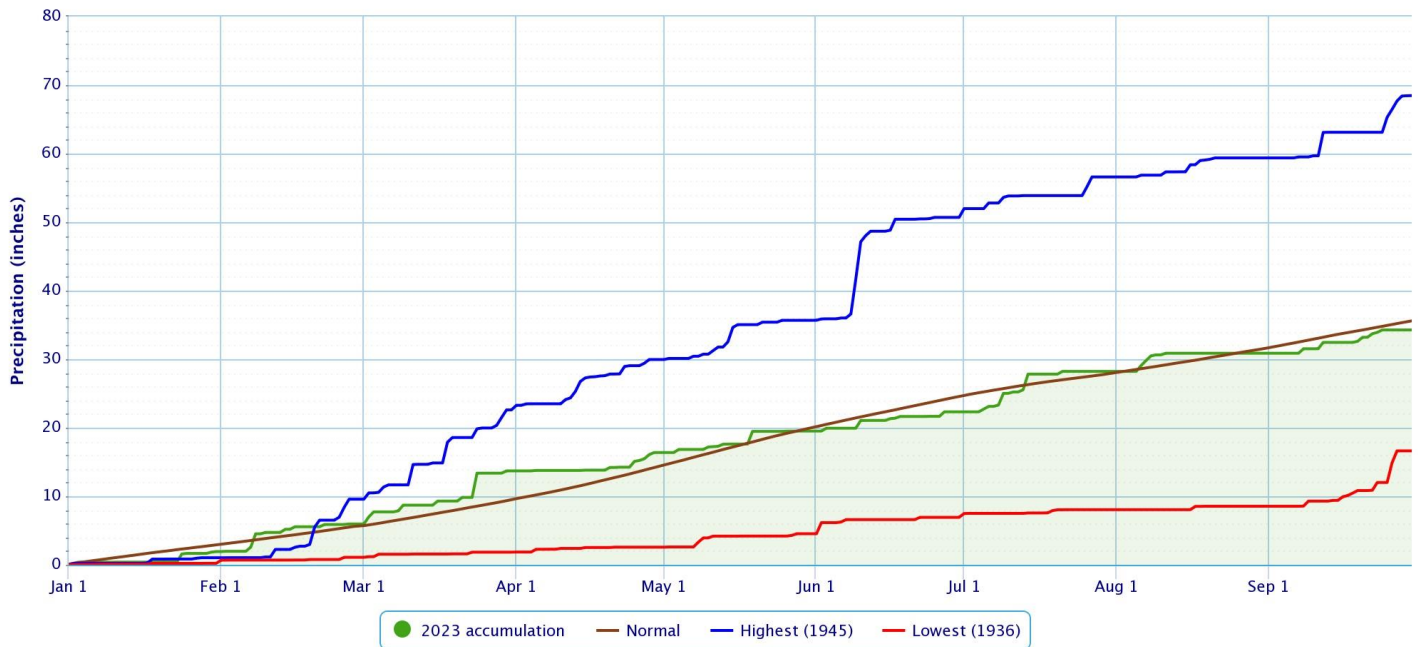
Period of Record – 1882-06-01 to 2023-10-02. Normals period: 1991-2020. Click and drag to zoom chart.



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Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

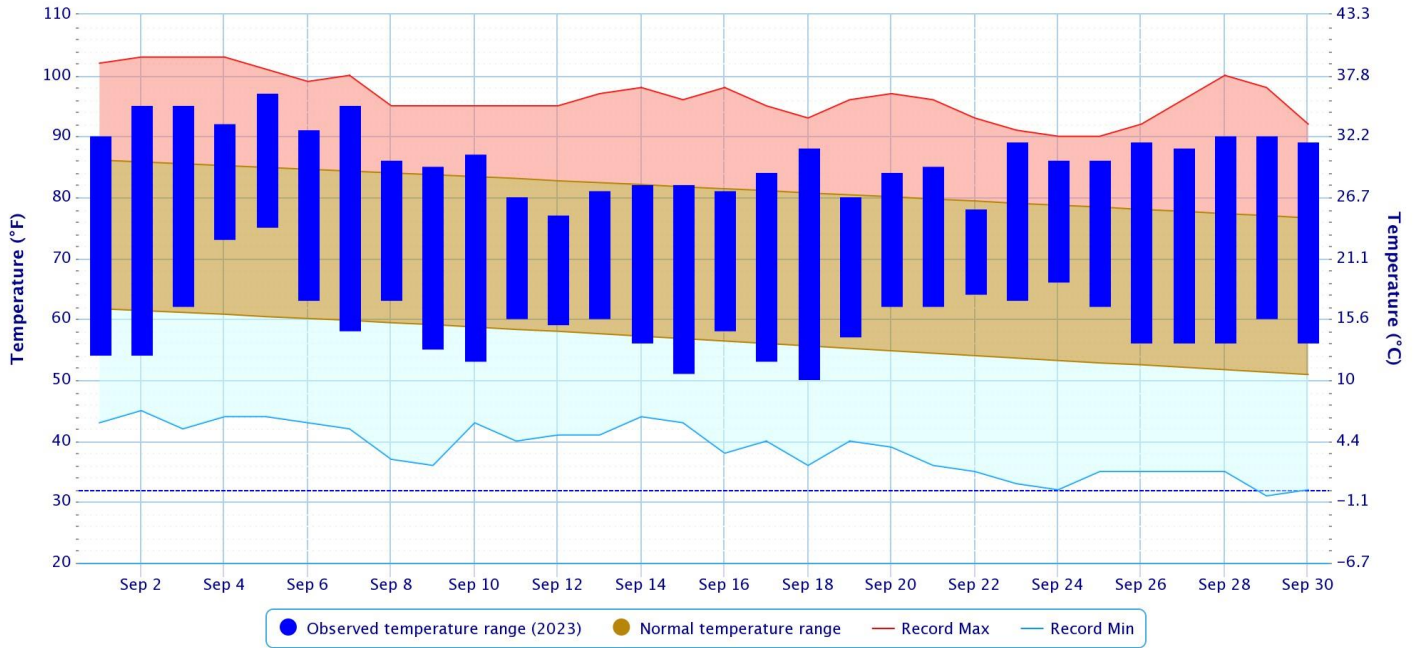
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

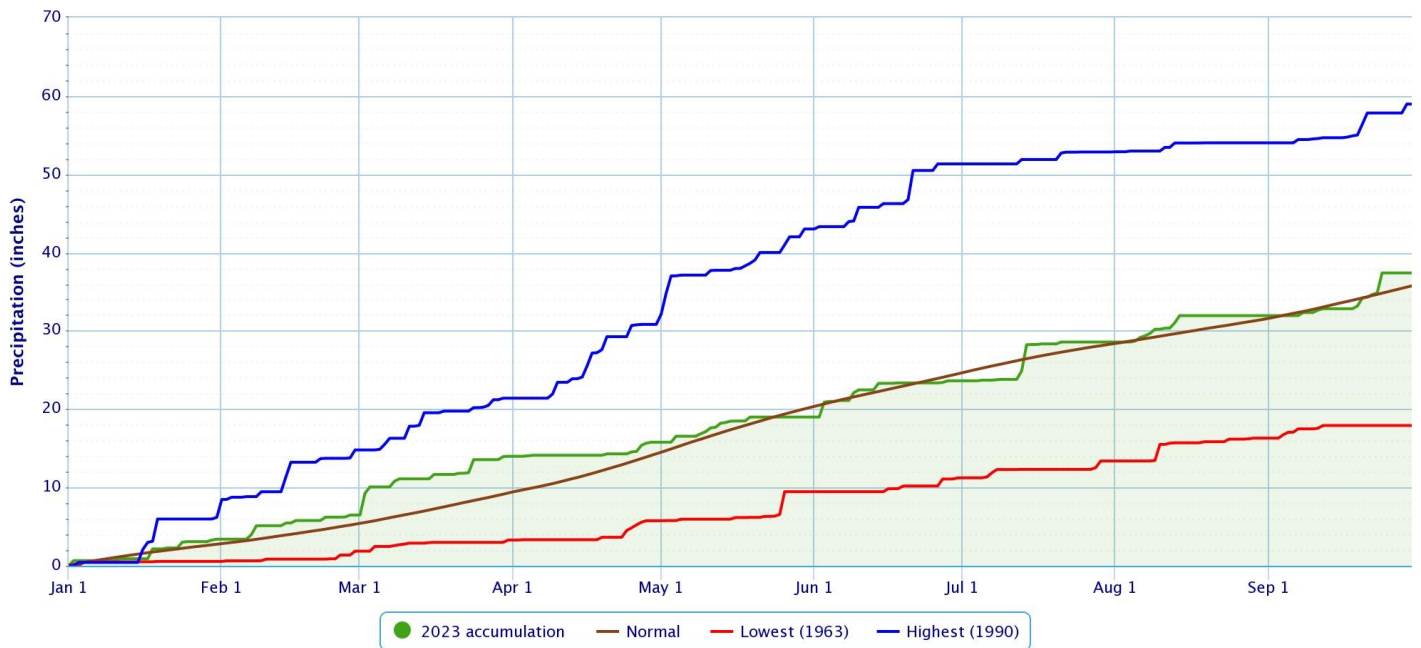
Period of Record – 1949-07-14 to 2023-10-02. Normals period: 1991-2020. Click and drag to zoom chart.



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Accumulated Precipitation – FAYETTEVILLE DRAKE FIELD, AR

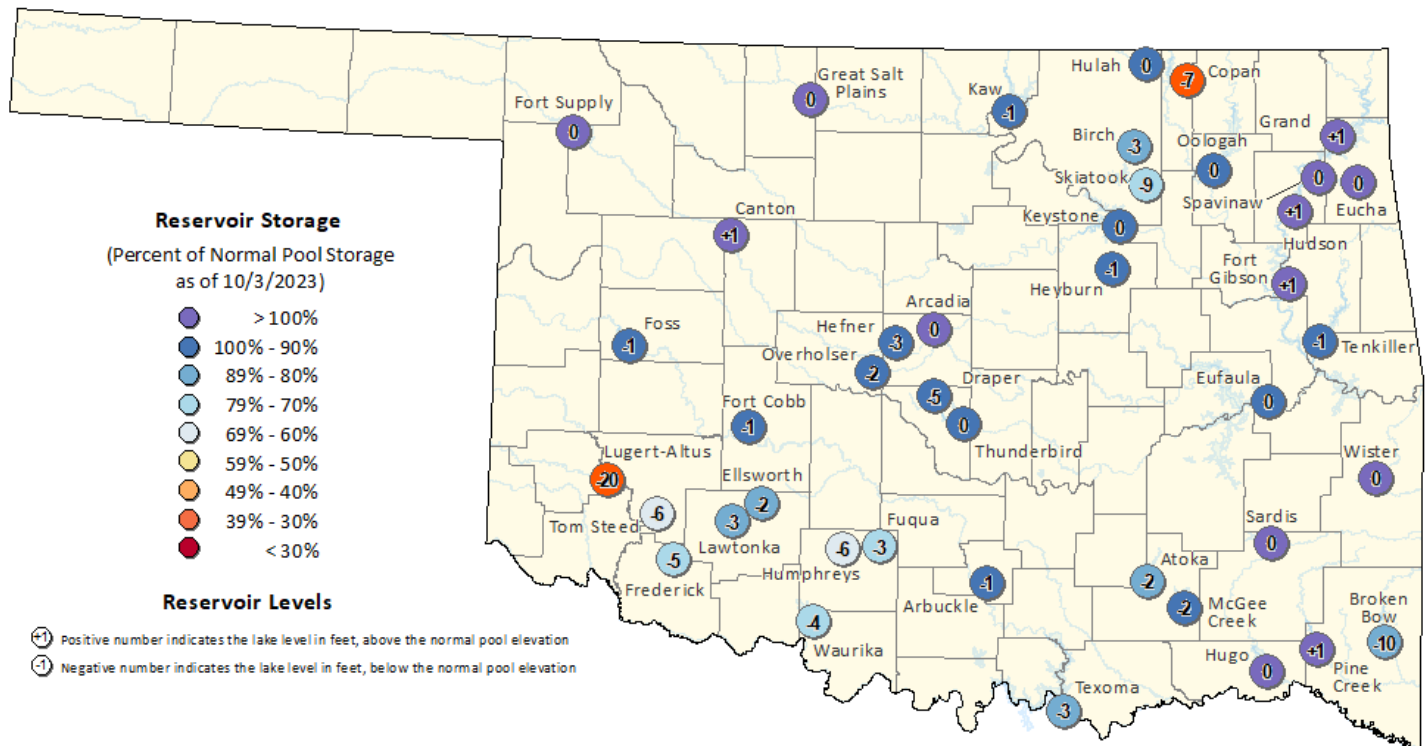
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Reservoirs

Oklahoma Reservoir Levels and Storage as of 10/2/2023



This map shows reservoir storage as a percentage of normal pool storage capacity. The source information was collected from real-time lake gages monitored by the U.S. Army Corps of Engineers (https://www.swt-wc.usace.army.mil/Daily_Morning_Reservoir_Report.pdf), and the U.S. Geological Survey (https://waterdata.usgs.gov/ok/nwis/current/?type=lake&group_key=basin_0d). For more information please visit the OWRB's website: (<https://www.owrb.ok.gov>).



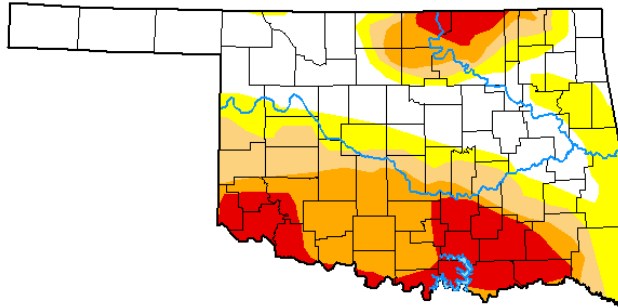
According to the USACE, several of the lakes in the HSA were below 3% of top of their conservation pools as of 10/01/2023: Copan Lake 38%, Skiatook Lake 73%, Birch Lake 78%, Beaver Lake 83%, Heyburn Lake 85%, and Hulah Lake 93%. Two lakes were above 3% of the top of their conservation pools: Hudson Lake 6% and Pensacola Lake 4%.

Drought

According to the [U.S. Drought Monitor](#) (USDM) from October 3, 2023 (Figs. 2, 3), Extreme (D3) Drought conditions were occurring in portions of eastern Kay, Osage, Washington, Pushmataha, and Choctaw Counties in eastern Oklahoma. Severe (D2) Drought conditions exist in portions of Nowata, Washington, Osage, Pawnee, Pittsburg, Choctaw, and Pushmataha Counties in eastern Oklahoma. Moderate (D1) Drought conditions were present in portions of Craig, Nowata, Washington, Osage, Pawnee, Pittsburg, Latimer, and Pushmataha Counties in eastern Oklahoma. Abnormally Dry (D0) but not in drought conditions were occurring in Craig, Nowata, Washington, Rogers, Tulsa, Osage, Pawnee, Okfuskee, Pittsburg, Latimer, Le Flore, Sequoyah, Adair, Cherokee, Muskogee, Wagoner, Mayes, and Pushmataha Counties in eastern OK, and Washington, Madison, Crawford, Sebastian, and Franklin Counties in northwest AR.

U.S. Drought Monitor Oklahoma

October 3, 2023
(Released Thursday, Oct. 5, 2023)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	36.71	63.29	45.30	32.40	14.34	0.00
Last Week 09-26-2023	34.29	65.71	46.76	30.93	12.91	0.00
3 Months Ago 07-04-2023	26.23	73.77	35.88	14.26	4.79	0.52
Start of Calendar Year 01-03-2023	1.82	98.18	89.73	80.92	56.13	11.65
Start of Water Year 09-26-2023	34.29	65.71	46.76	30.93	12.91	0.00
One Year Ago 10-04-2022	0.00	100.00	99.97	99.51	75.77	17.78

Intensity:

- None
- 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. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Brad Pugh
CPC/NOAA

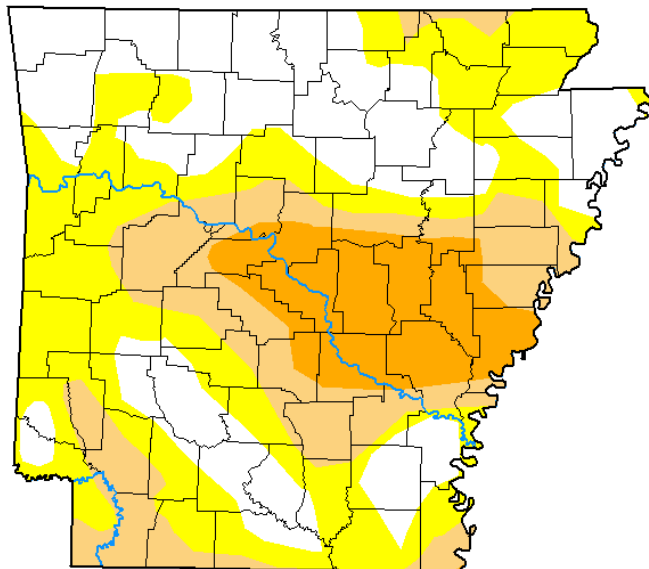


droughtmonitor.unl.edu

Fig. 2. Drought Monitor for Oklahoma

U.S. Drought Monitor Arkansas

October 3, 2023
(Released Thursday, Oct. 5, 2023)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	32.24	67.76	33.18	13.23	0.00	0.00
Last Week 09-26-2023	38.45	61.55	25.37	3.70	0.00	0.00
3 Months Ago 07-04-2023	64.15	35.85	2.47	0.00	0.00	0.00
Start of Calendar Year 01-03-2023	53.09	46.91	2.26	0.00	0.00	0.00
Start of Water Year 09-26-2023	38.45	61.55	25.37	3.70	0.00	0.00
One Year Ago 10-04-2022	2.84	97.16	78.76	56.96	9.53	0.00

Intensity:

- None
- 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. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Brad Pugh
CPC/NOAA



droughtmonitor.unl.edu

Fig. 3. Drought Monitor for Arkansas

Water Year 2023 Summary

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 4a), rainfall totals for Water Year 2023 ranged from 25" to 70" from northwest to southeast across eastern OK and northwest AR, with much of the area receiving 40"-50". These rainfall totals correspond to 50% to around 125% of the normal Water Year rainfall (Fig. 4b).

Some of the larger precipitation reports (in inches) for Water Year 2023 included:

Bella Vista 2.2E, AR (coco)	64.83	Jay 3.3NNE, OK (coco)	60.91	Wister 3.0NNE, OK (coco)	60.30
Garfield 3.9E, AR (coco)	59.32	Berryville 0.9E, AR (coco)	59.20	Bella Vista 2.5SSE, AR (coco)	58.41
Glade 1.9WSW, AR (coco)	58.35	Holiday Island 1.3SSW, AR (coco)	57.95	Pea Ridge 0.2, AR (coco)	57.83

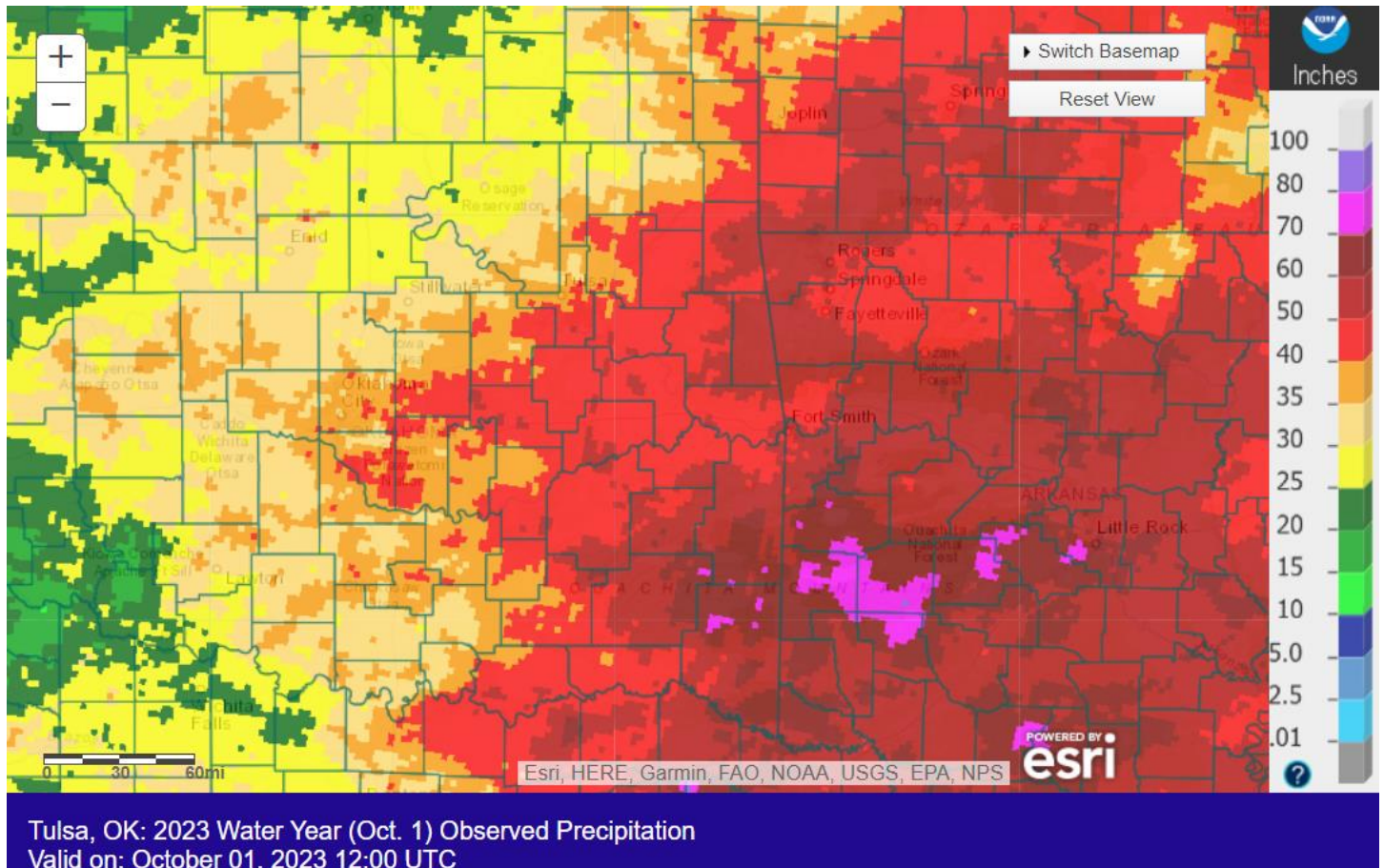
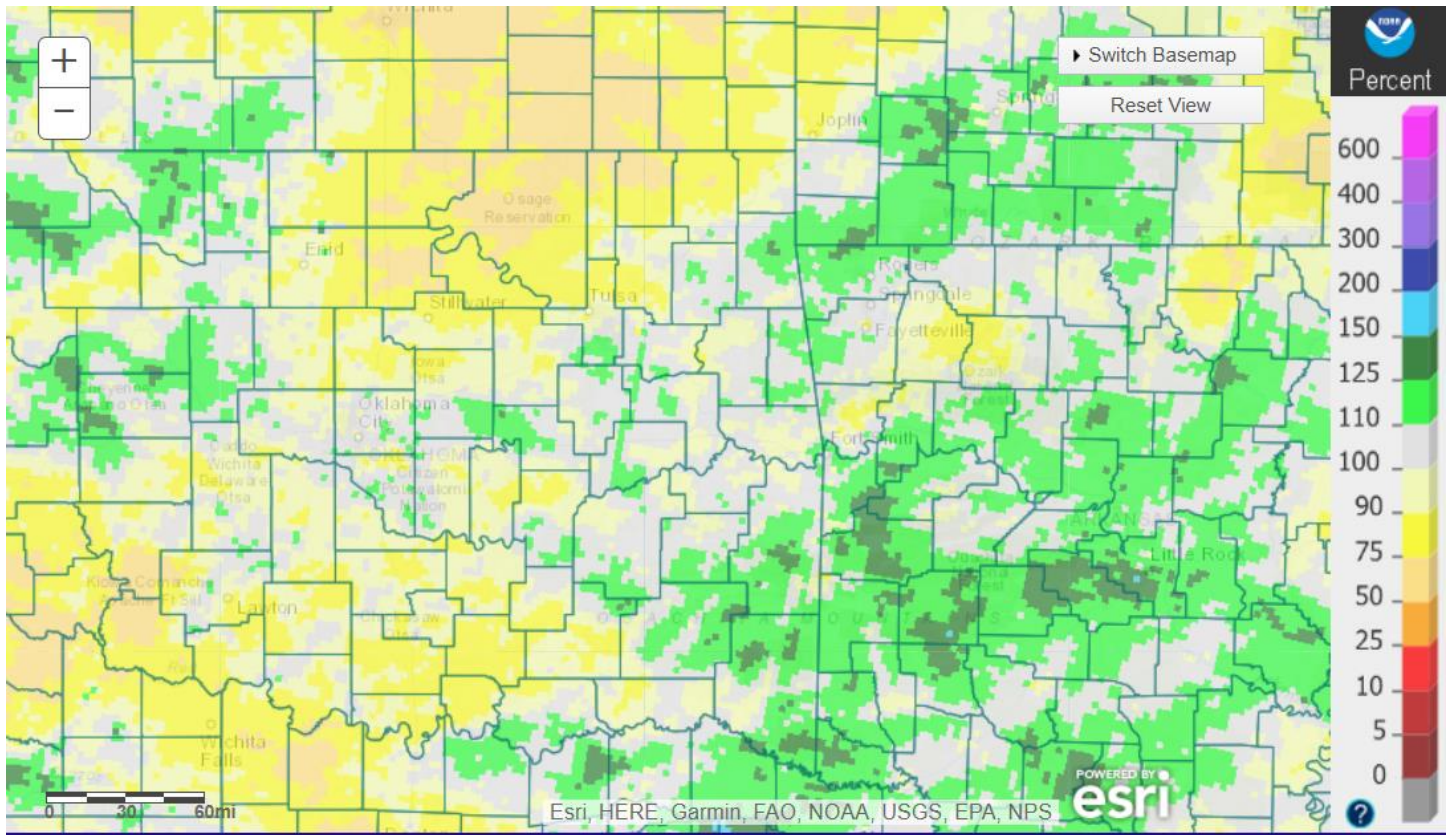


Fig. 4a. Estimated Observed Rainfall for Water Year 2023

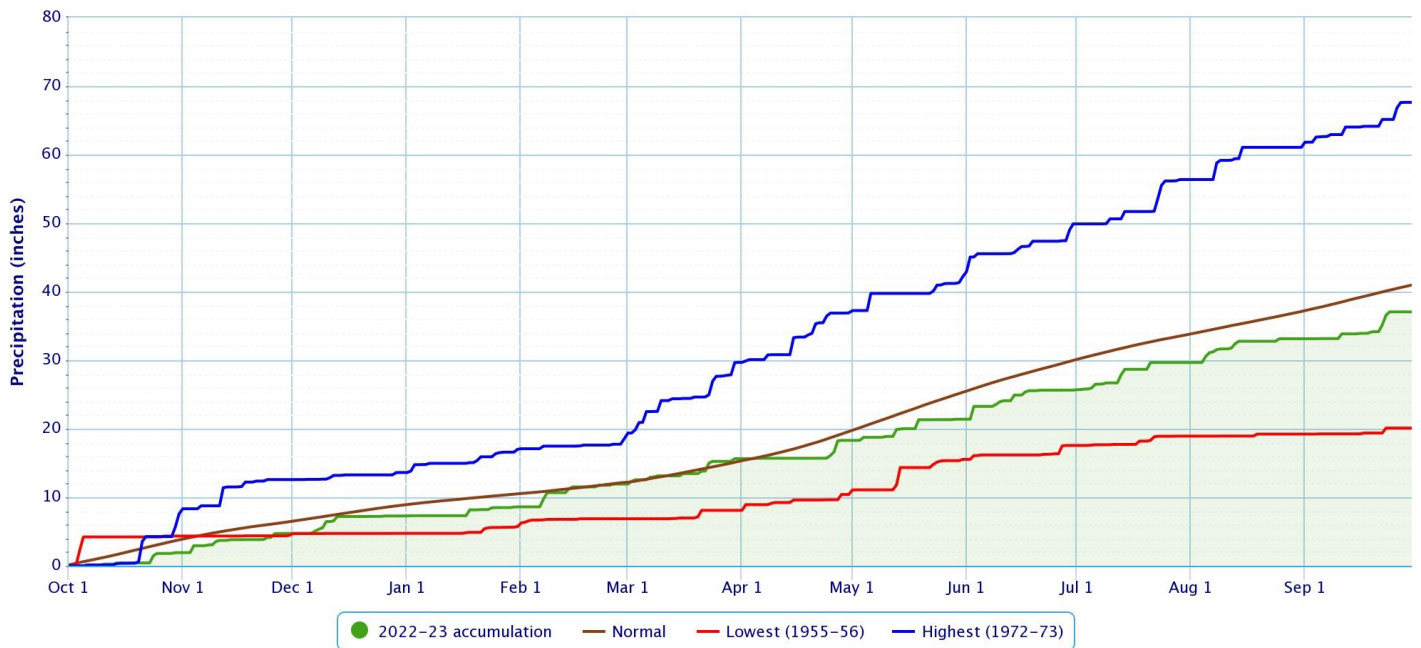


Tulsa, OK: 2023 Water Year (Oct. 1) Percent of Normal Precipitation
 Valid on: October 01, 2023 12:00 UTC

Fig. 4b. Estimated % of Normal Rainfall for Water Year 2023

Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

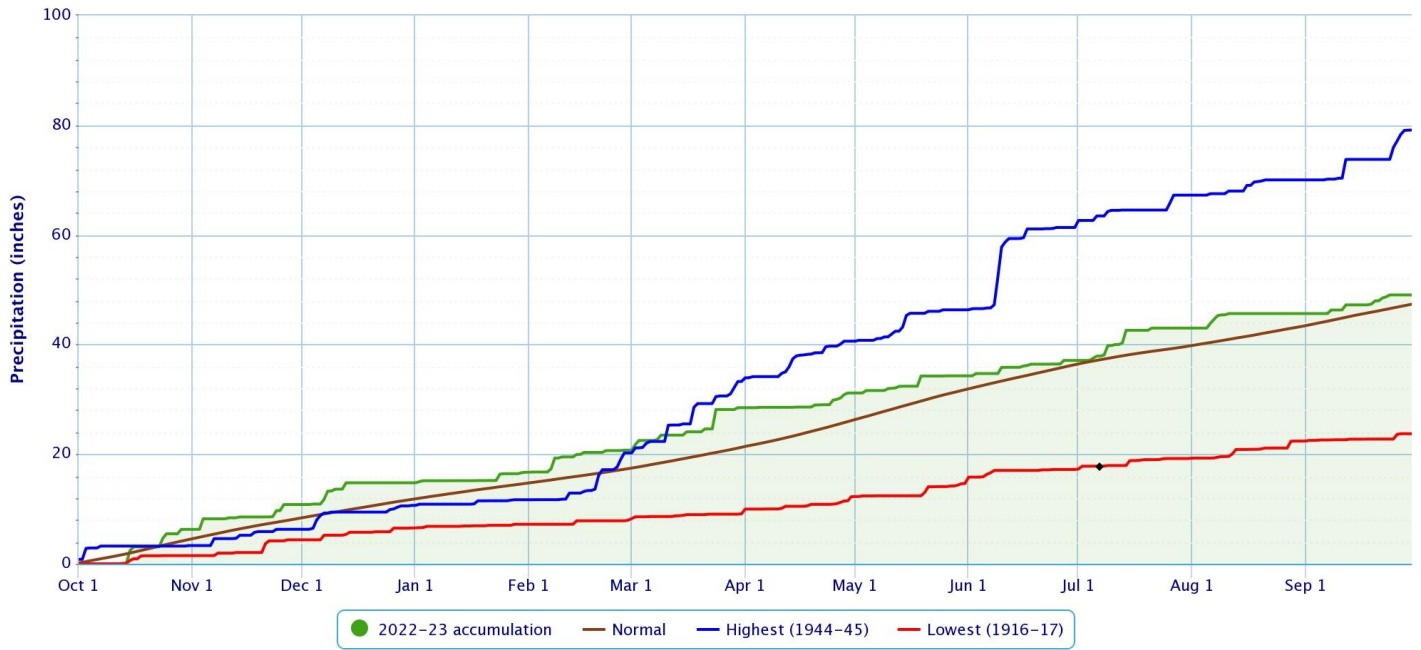
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

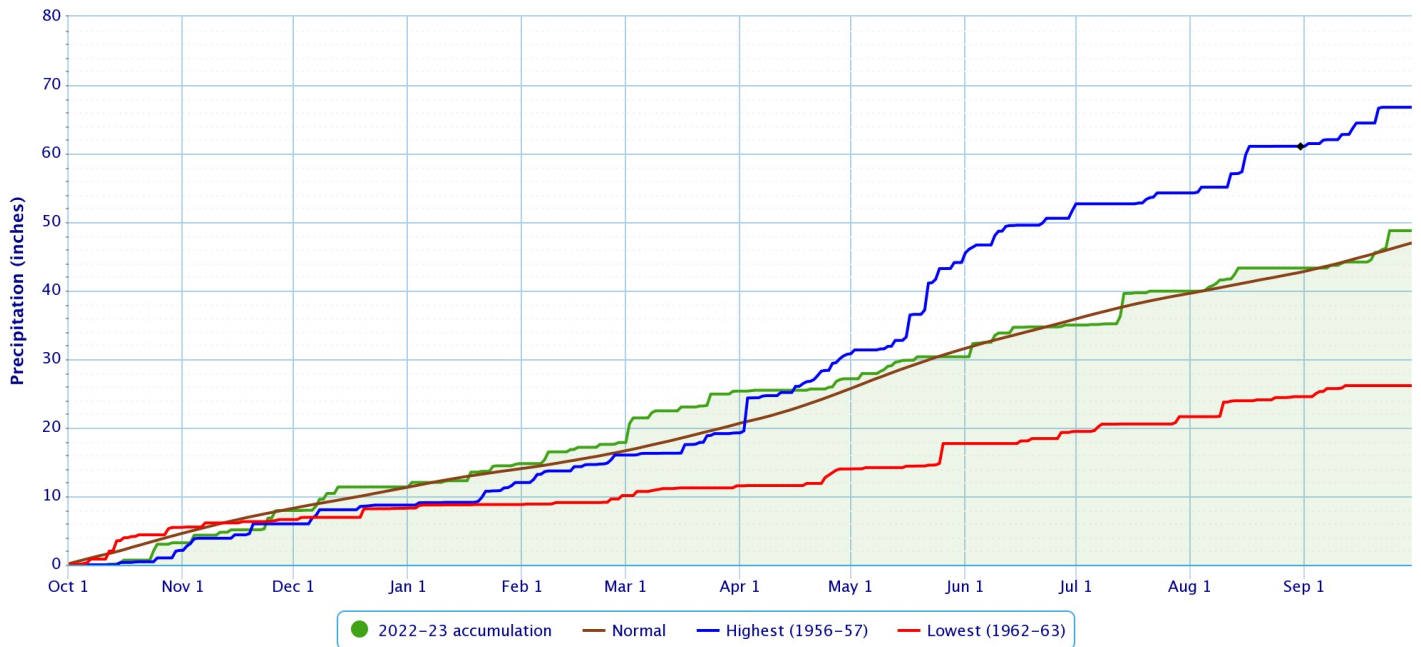
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

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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Outlooks

The [Climate Prediction Center](#) (CPC) outlook for October 2023 (issued September 30, 2023) indicates an enhanced chance for above normal temperatures and an equal chance for above, near, and below median precipitation across all of eastern OK and northwest AR. This outlook was based on dynamical model output and ENSO this month.

For the 3-month period October-November-December 2023, CPC is forecasting an equal chance for above, near, and below normal temperatures and an enhanced chance for above median precipitation across eastern OK and northwest AR (outlook issued September 21, 2023). This outlook is based on long-term trends, ENSO state, soil moisture, and incorporates both statistical and dynamical forecast tools. El Niño would favor cooler than normal temperatures across the Southern Plains, but the longer-term trends favor warmer than normal temperatures. Due to these competing factors, there is not a strong signal to tilt the odds one way or the other. The odds for above median precipitation are primarily due to the influence of El Niño. According to CPC, El Niño conditions are present in the equatorial Pacific Ocean, and El Niño is expected to strengthen and persist through the winter 2023-24. There is a greater than 95% chance of El Niño continuing through the winter and a 70% chance of a strong El Niño event. 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

A line of thunderstorms developed along a weak cold front that stretched from southeast KS to central OK during the evening of the 5th. While the southern end of the convective line dissipated quickly, the storms along the northern portion of the line continued across far northeast OK and far northwest AR. Most of these storms ended around midnight, but convection lingered across far northwest AR until just before sunrise on the 6th. Rainfall totals ranged from 0.50" to 3.5" across far northeast OK and northwest AR (Fig. 5).

Around midnight of the 8th, showers and thunderstorms began to develop over northeast OK as an upper-level disturbance was sliding southeast through the region. This activity continued to increase as the storms progressed east. By 4 am, numerous showers and thunderstorms were impacting locations in OK near the eastern border and across most of northwest and west central AR. The storms became less numerous after sunrise as they shifted to the southeast and east. Rainfall totals along and east of the OK/AR state line ranged from around 0.25" to near 2" (Fig. 6).

A period of unsettled weather began on the 19th. While there were some isolated showers and thunderstorms across eastern OK during the morning hours of the 19th, the activity became more scattered during the afternoon as a shortwave and vorticity maximum were sliding east southeast along the OK/KS border. The rain continued to shift slowly eastward, entering northwest AR during the early evening. As the low-level jet increased during the evening, so did the convection. While storms affected much of eastern OK and northwest AR during the night, the storms were most continuous over far northeast OK and far northwest AR. Also during this time, low-level moisture was streaming northward, and the precipitable water (PWAT) values were in excess of 1.5". By 7 am on the 20th, rainfall totals ranged from around 0.25" to 6", with widespread 1.5"-5" across far northeast OK and far northwest AR (Figs. 7, 8). The convection began to shift southeast mid-morning, and finally dissipated or shifted east of the region by noon. However just an hour later, a line of convection redeveloped over southeast OK in association with a band of mid-level warm advection trailing behind the departing vorticity maximum. This activity continued across east central and southeast OK during the overnight hours, before ending mid-morning on the 21st. PWAT values remained around 1.5" across the region, resulting in some locations of higher rainfall totals of 1"-3" (Fig. 9).

Much of the Southern Plains remained under an enhanced southwesterly to westerly mid-level flow as the area was sandwiched between deep layer ridging to the south across Mexico and troughing over the Intermountain West, resulting in continued periods of convection. A steady stream of Pacific moisture was also streaming into the region within an enhanced subtropical jet anchored overhead. This plume of moisture interacted with deepening low-level moisture streaming north from the Gulf of Mexico and into eastern OK and northwest AR. A cluster of showers and thunderstorms developed during the afternoon and moved east into southeast OK during the early evening hours of the 21st. These storms continued to trek eastward, while also developing further north. By midnight, these storms had moved across east central and southeast OK as well as much of

northwest AR, and were exiting the area to the east. During the overnight hours, another round of widespread showers and thunderstorms developed along the nose of the low-level jet and increasing warm air advection aloft. By sunrise of the 22nd, rain was impacting a large portion of eastern OK and northwest AR. 24-hour rainfall totals through 7am ranged from 0.25" to 3" (Fig. 10). The convection continued across the region through the morning hours, primarily east of Hwy 75, while a MCS moving south out of KS also affected northeast OK. All of this activity began to shift southeast and weaken during the early afternoon, and the rain came to an end by evening. An additional widespread 0.25" to 5" of rain fell from these storms, with the highest totals of 1.5"-5" occurring over southeast OK (Fig. 11).

Low-level moisture continued to stream northward into the region on the 23rd as an upper-level storm system approached, resulting in PWAT values around 2". By afternoon, isolated thunderstorms developed over Creek and Okfuskee Counties and moved to the southeast. These storms produced 2.5"-4" hail stones. A cold front then moved into northeast OK, resulting in the development of numerous thunderstorms across northeast OK by early evening. Scattered thunderstorms then continued across eastern OK and northwest AR through the evening and overnight hours. Flash flooding and high water rescues were reported in east central OK. In the pre-dawn hours of the 24th, the storms began to shift to the southeast and finally exited the region around 7am. Rainfall totals ranged from 0.50" to 6" across much of eastern OK and northwest AR (Figs. 12, 13).

After the several days of rain, a large portion of eastern OK and northwest AR had received 2"-10" of rain (Fig. 14). With dry antecedent conditions, no mainstem river flooding occurred at any of the NWS Tulsa river forecast points.

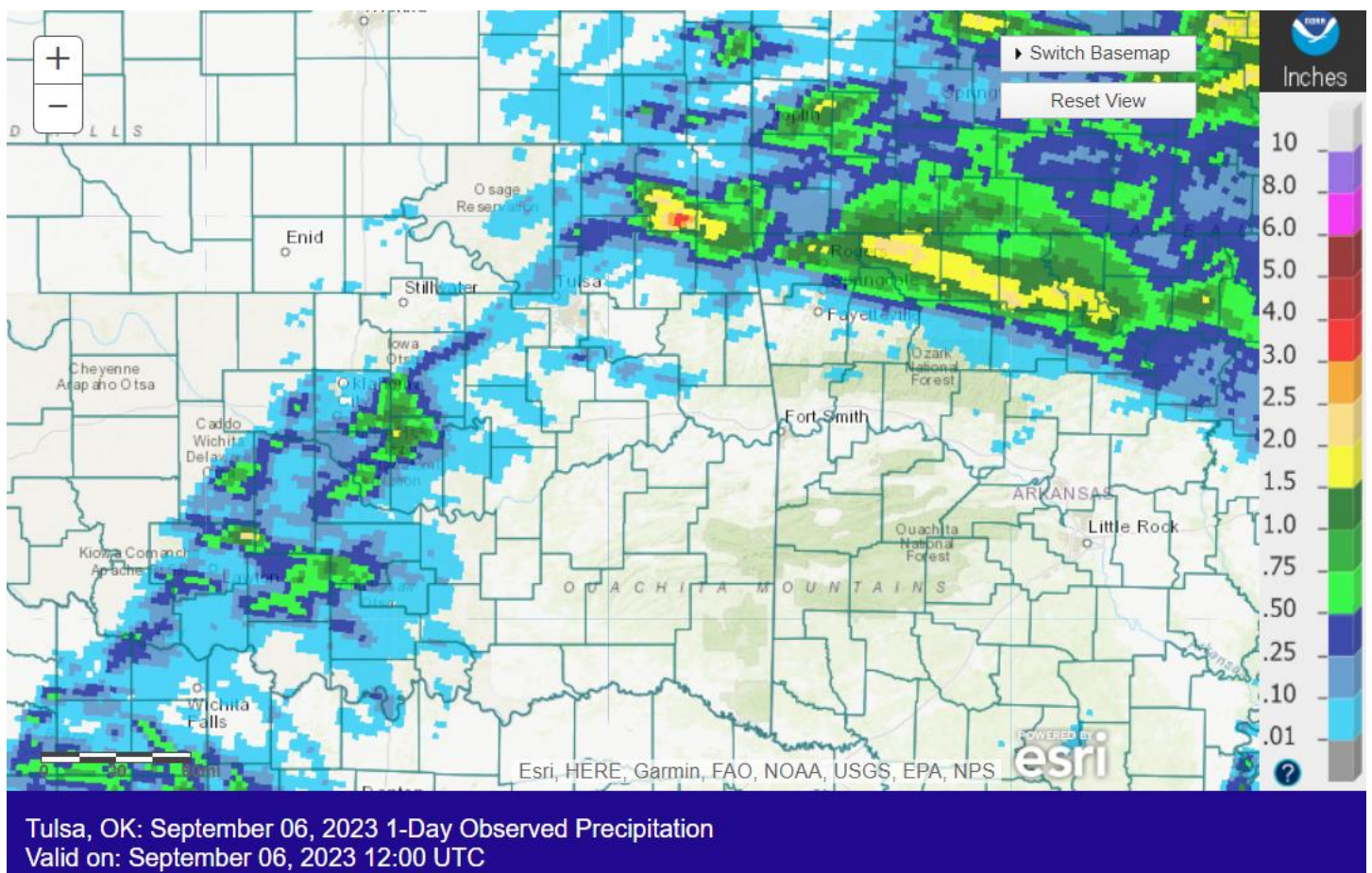
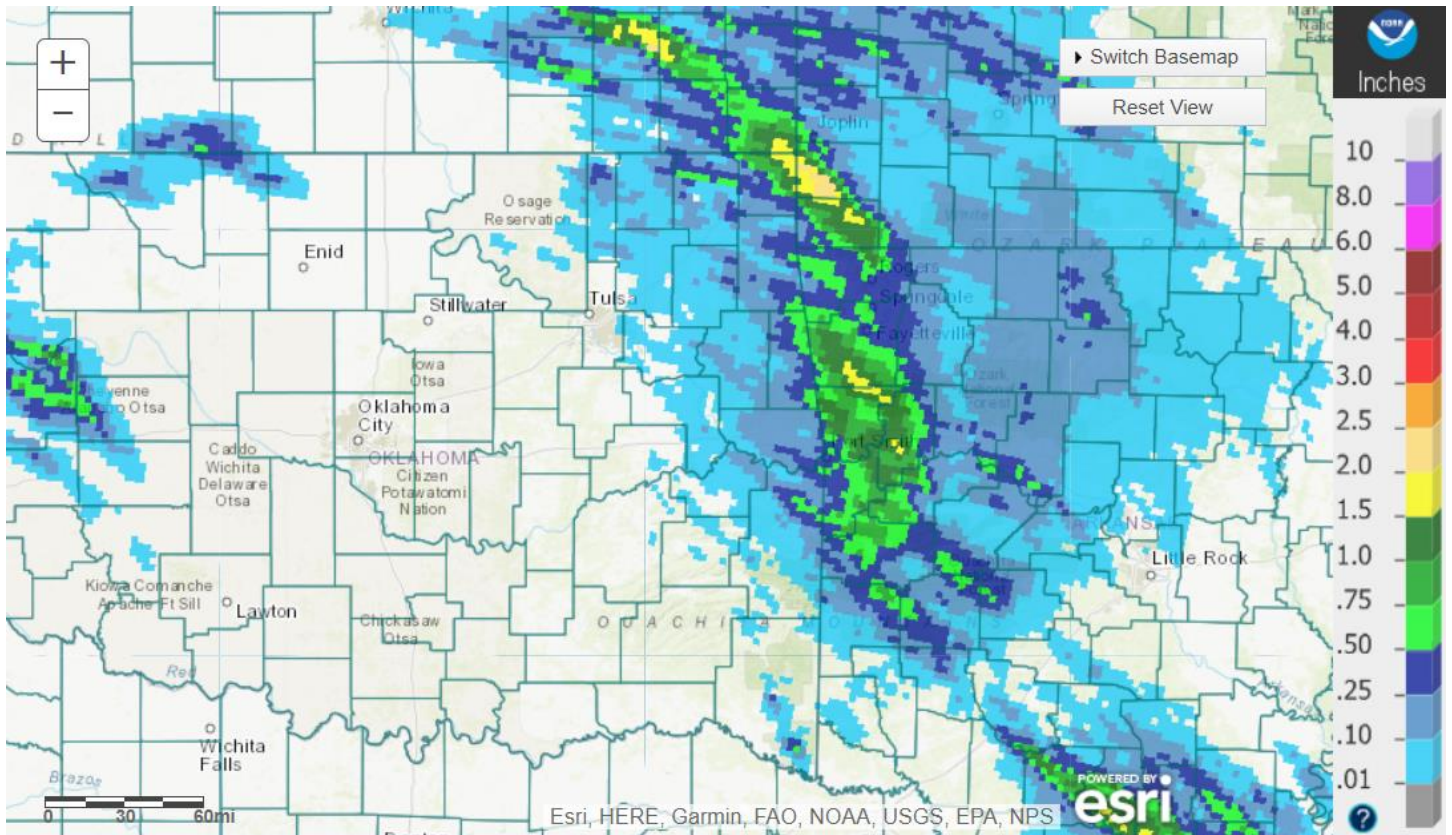


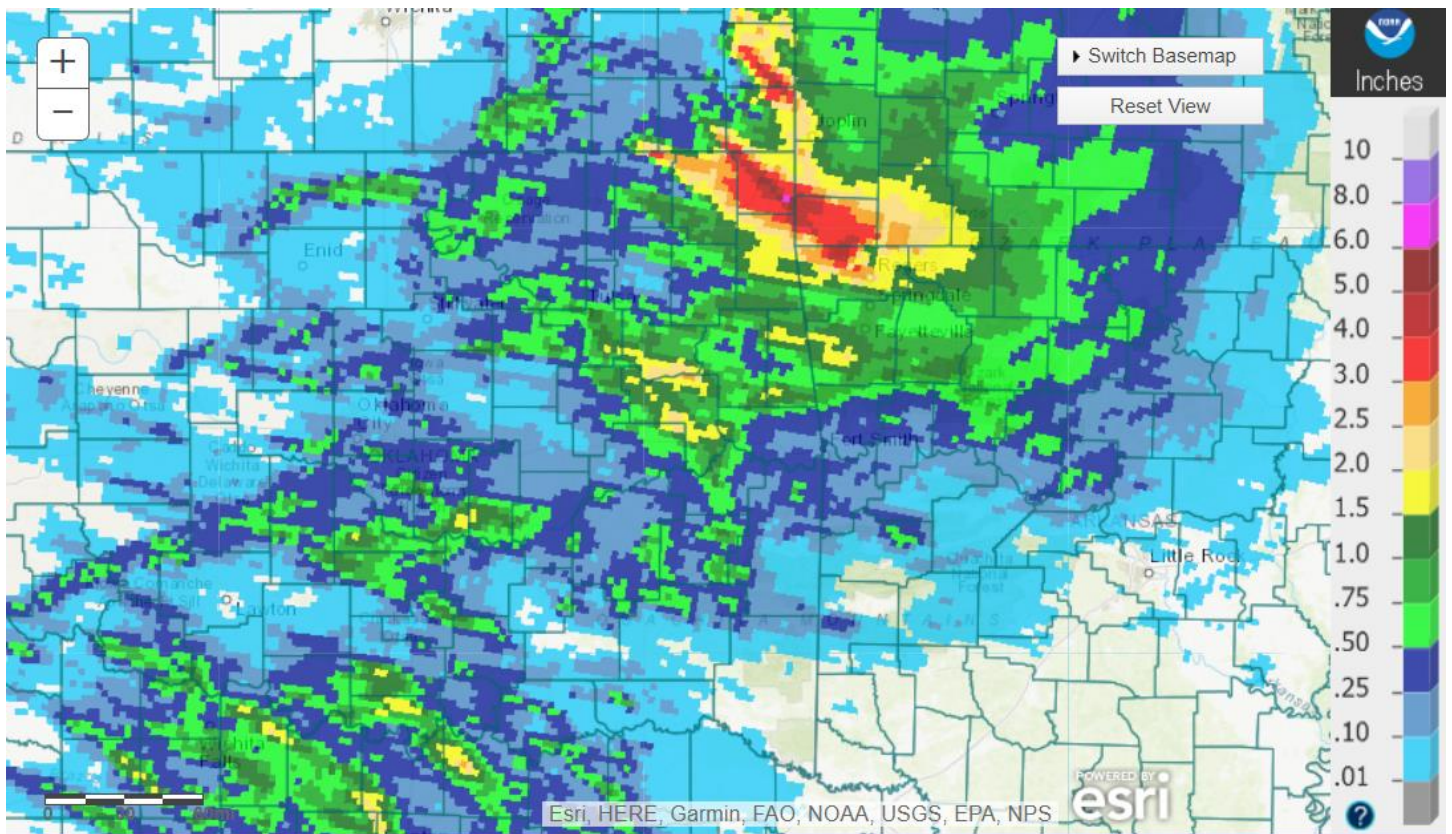
Fig. 5. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/06/2023.



Tulsa, OK: September 08, 2023 1-Day Observed Precipitation

Valid on: September 08, 2023 12:00 UTC

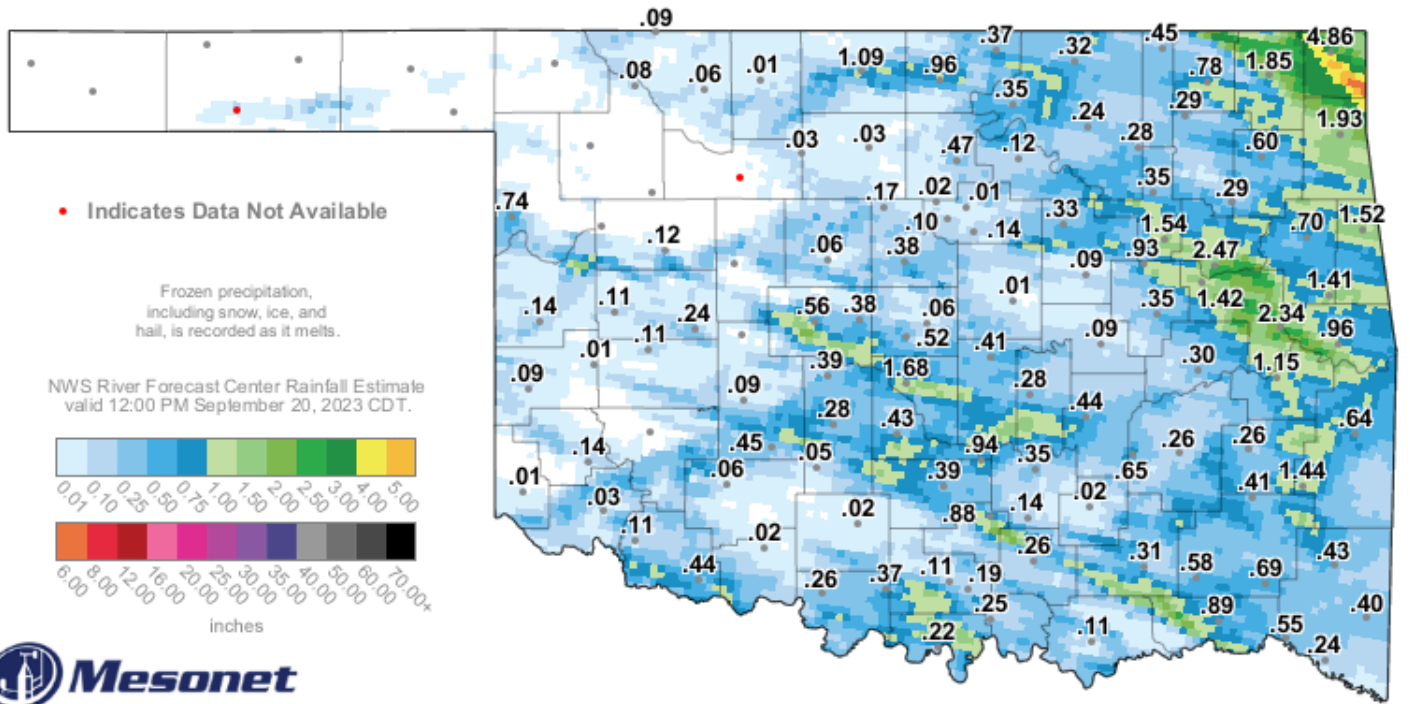
Fig. 6. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/08/2023.



Tulsa, OK: September 20, 2023 1-Day Observed Precipitation

Valid on: September 20, 2023 12:00 UTC

Fig. 7. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/20/2023.

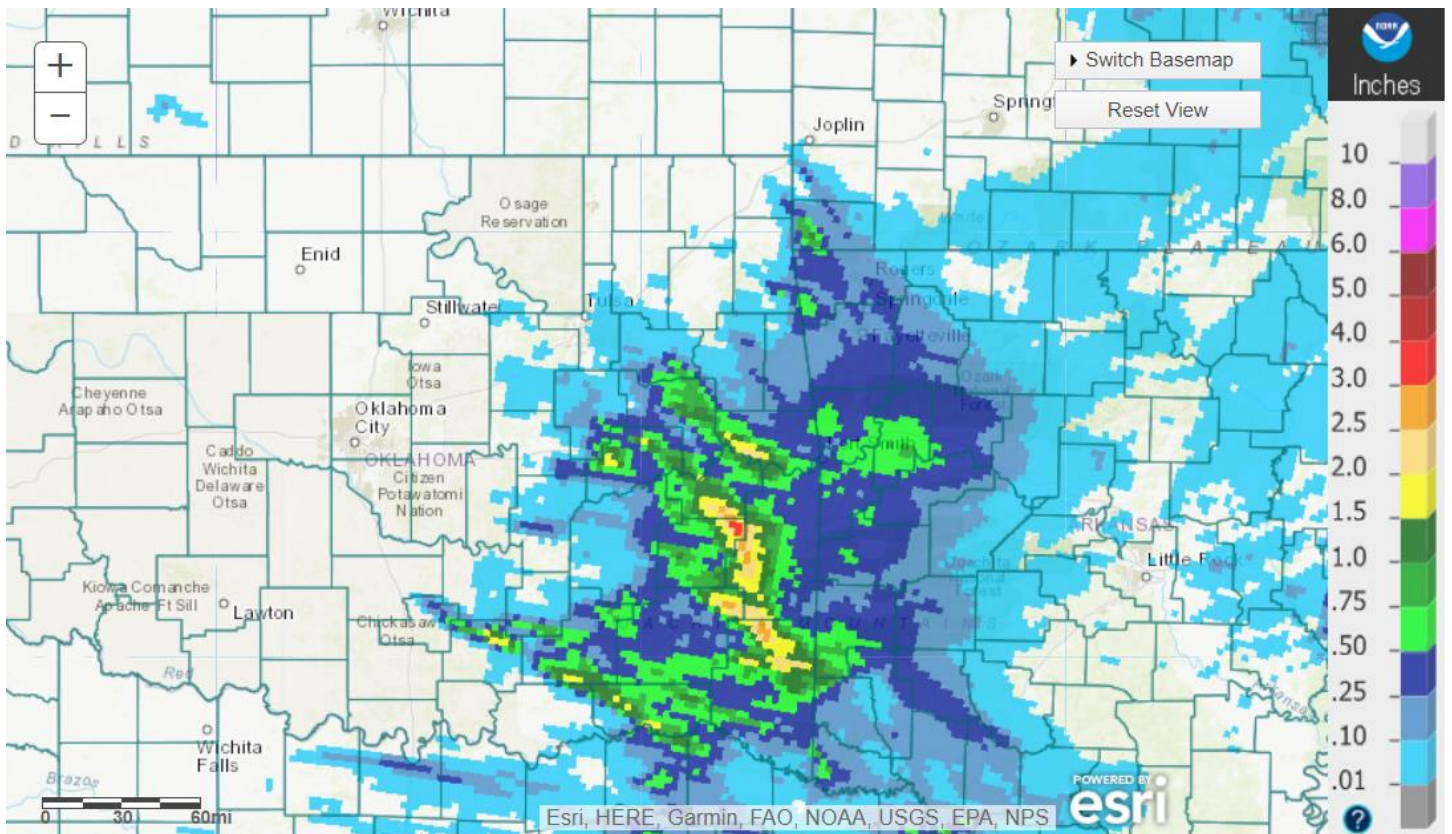


2-Day Rainfall Accumulation (inches)

12:50 PM September 20, 2023 CDT

Created 12:55:47 PM September 20, 2023 CDT. © Copyright 2023

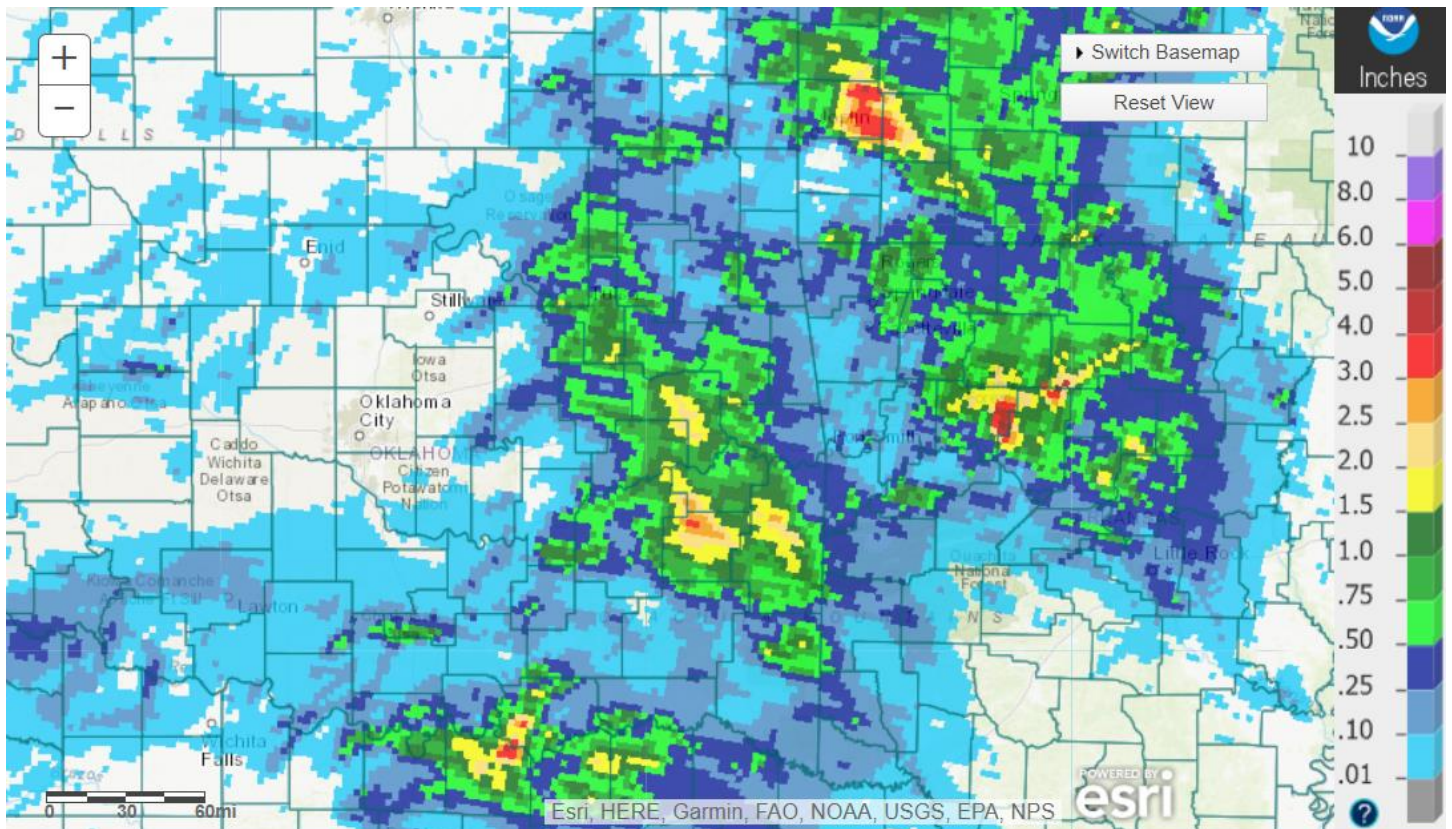
Fig. 8. OK Mesonet (values) and NWS RFC rainfall estimate (image) 48-hour rainfall ending at 12:50 pm CDT 09/20/2023.



Tulsa, OK: September 21, 2023 1-Day Observed Precipitation

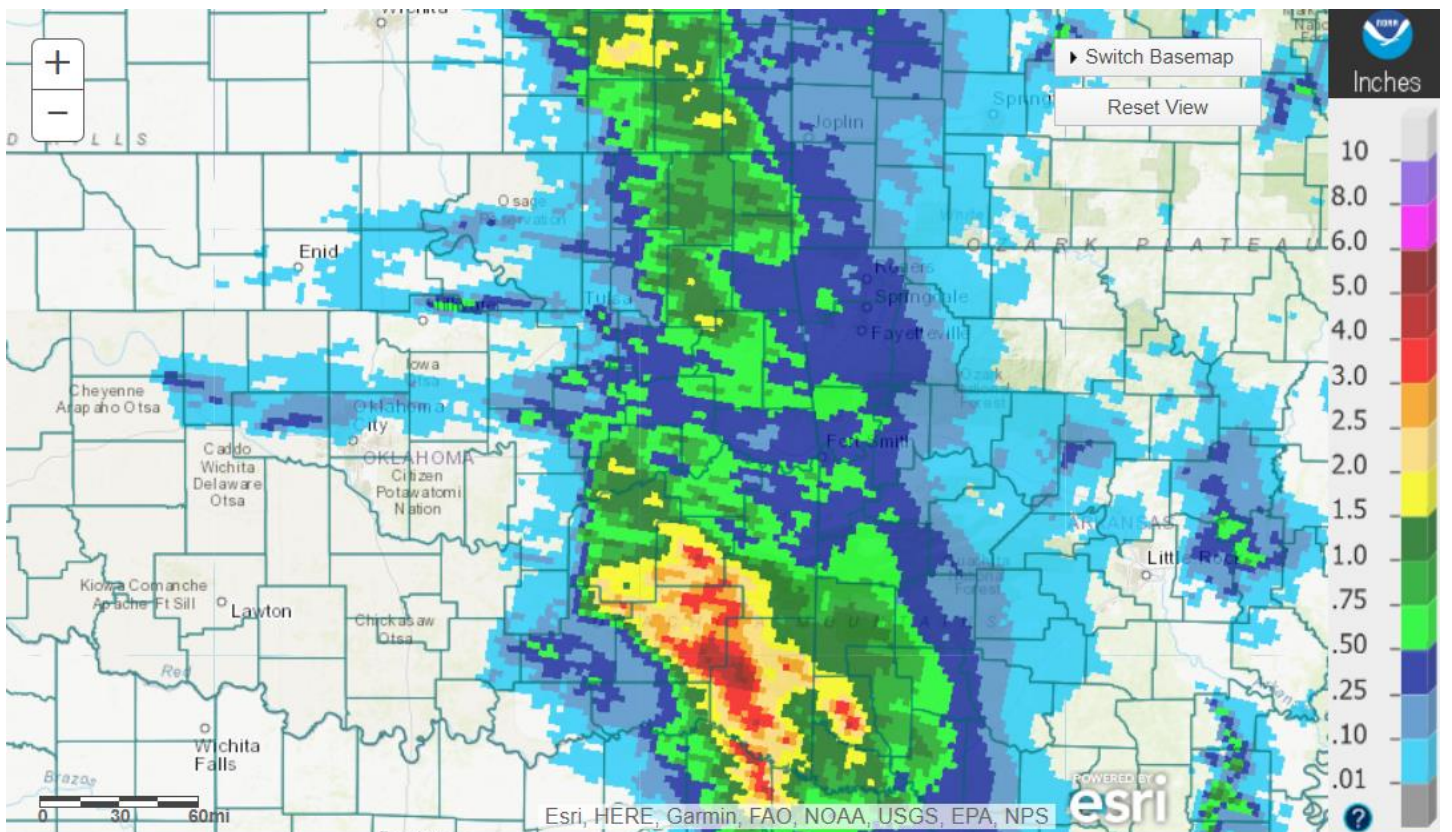
Valid on: September 21, 2023 12:00 UTC

Fig. 9. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/21/2023.



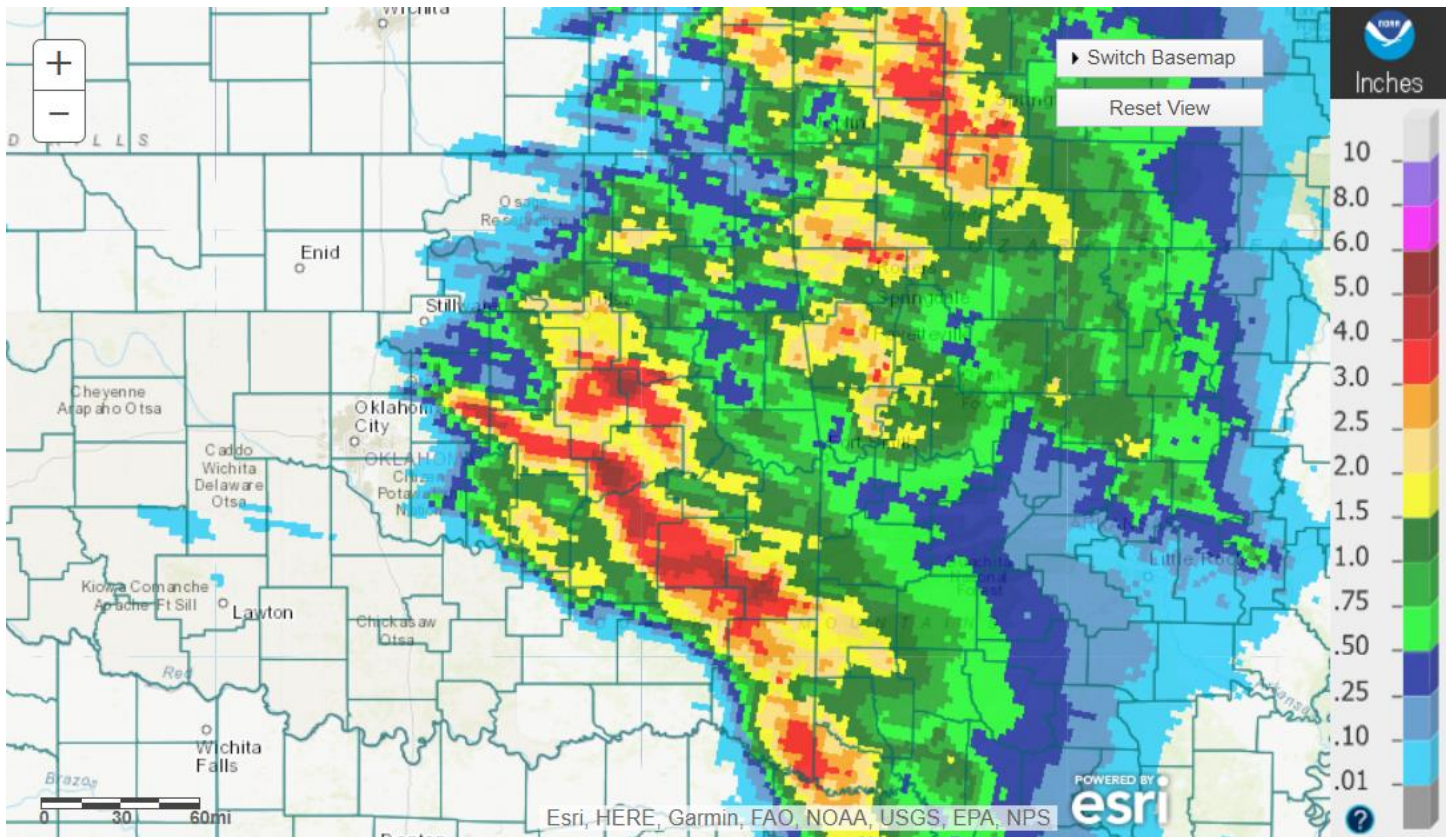
Tulsa, OK: September 22, 2023 1-Day Observed Precipitation
 Valid on: September 22, 2023 12:00 UTC

Fig. 10. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/22/2023.



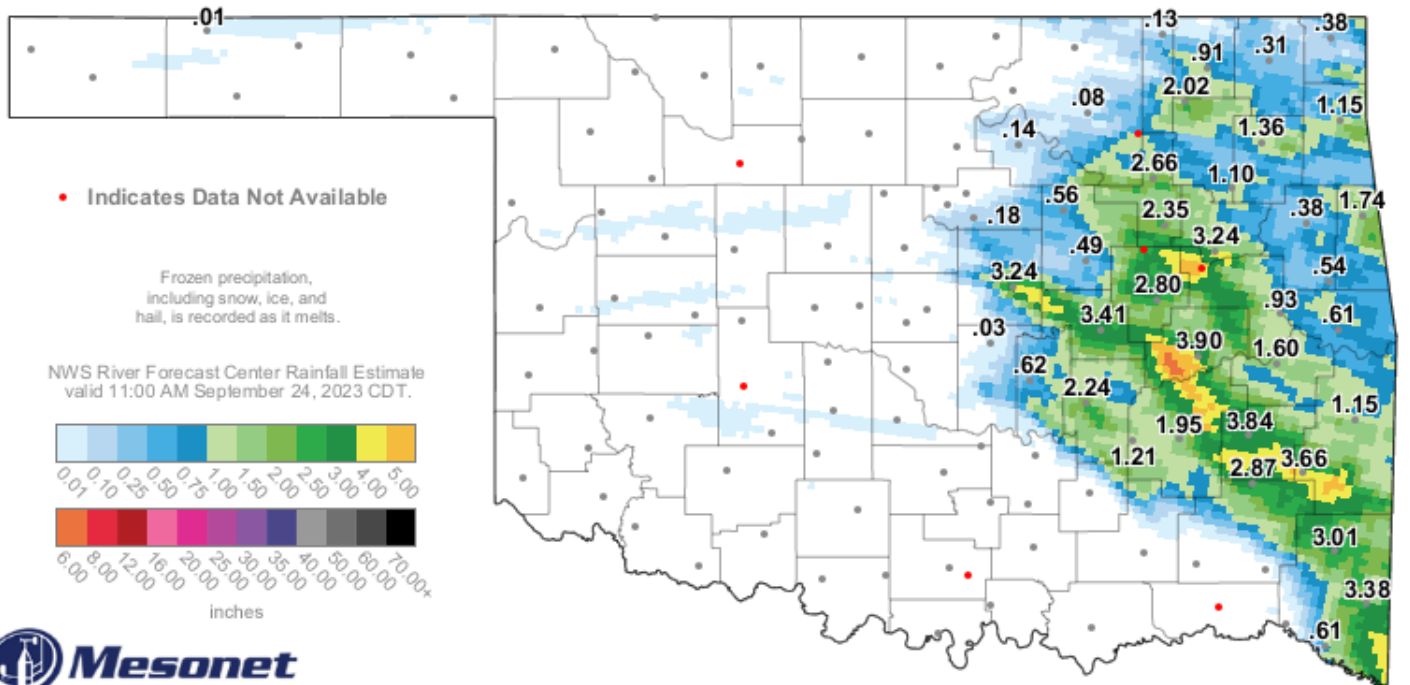
Tulsa, OK: September 23, 2023 1-Day Observed Precipitation
 Valid on: September 23, 2023 12:00 UTC

Fig. 11. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/23/2023.



Tulsa, OK: September 24, 2023 1-Day Observed Precipitation
 Valid on: September 24, 2023 12:00 UTC

Fig. 12. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/24/2023.

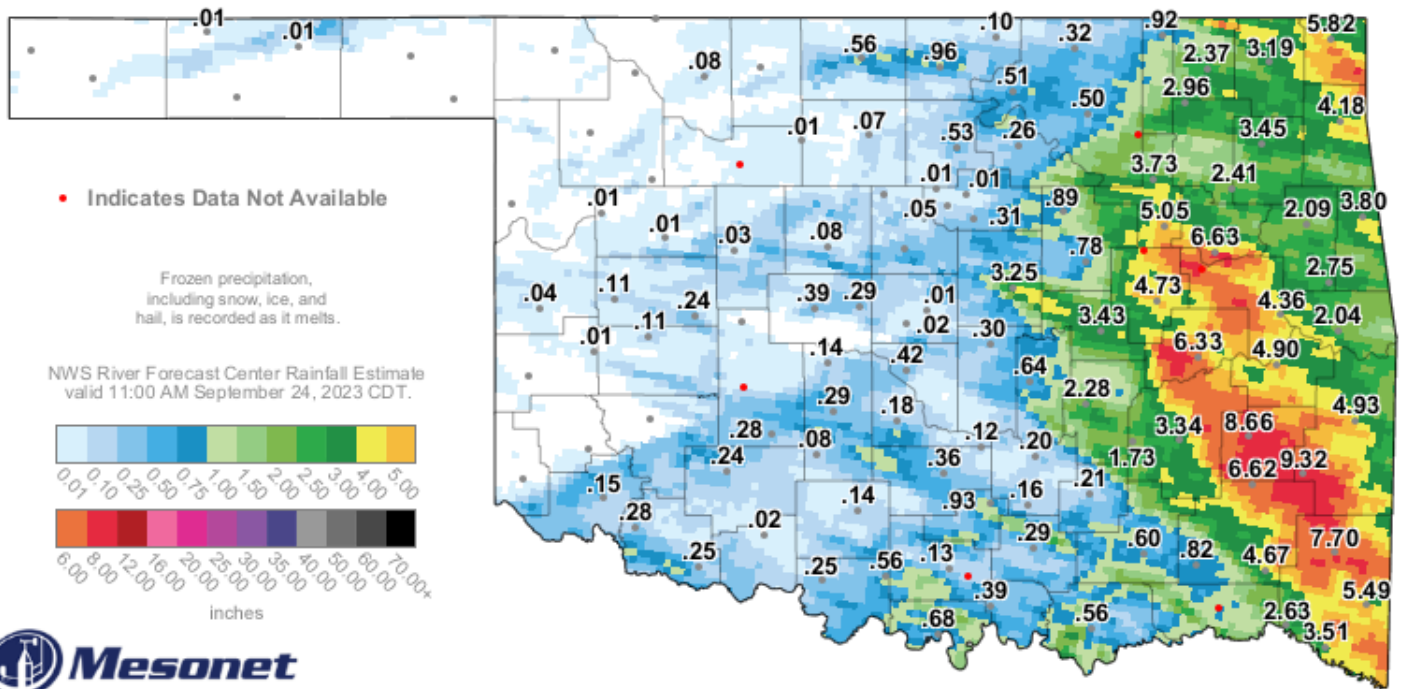


24-Hour Rainfall Accumulation (inches)

12:15 PM September 24, 2023 CDT

Created 12:21:22 PM September 24, 2023 CDT. © Copyright 2023

Fig. 13. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 12:15 pm CDT 09/24/2023.



5-Day Rainfall Accumulation (inches)

12:15 PM September 24, 2023 CDT

Created 12:21:22 PM September 24, 2023 CDT. © Copyright 2023

Fig. 14. OK Mesonet (values) and NWS RFC rainfall estimate (image) 5-day rainfall ending at 12:15 pm CDT 09/24/2023.

Written by:

Nicole McGavock
Service Hydrologist
WFO Tulsa

Products issued in September 2023:

- 15 Flash Flood Warnings (FFW)
- 10 Flash Flood Statements (FFS)
- 2 Flash/Areal Flood Watches (FFA) (6 Watch FFA CON/EXT/EXA/EXB/CAN)
- 17 Urban and Small Stream Advisories (FLS)
- 1 Areal Flood Warnings (FLW)
- 0 Areal Flood Statements (FLS)
- 0 River Flood Warnings (FLW) (includes category increases)
- 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)
- 1 Drought Information Statements (DGT)

Preliminary Hydrographs:

None