

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 July	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 August 3, 2023	

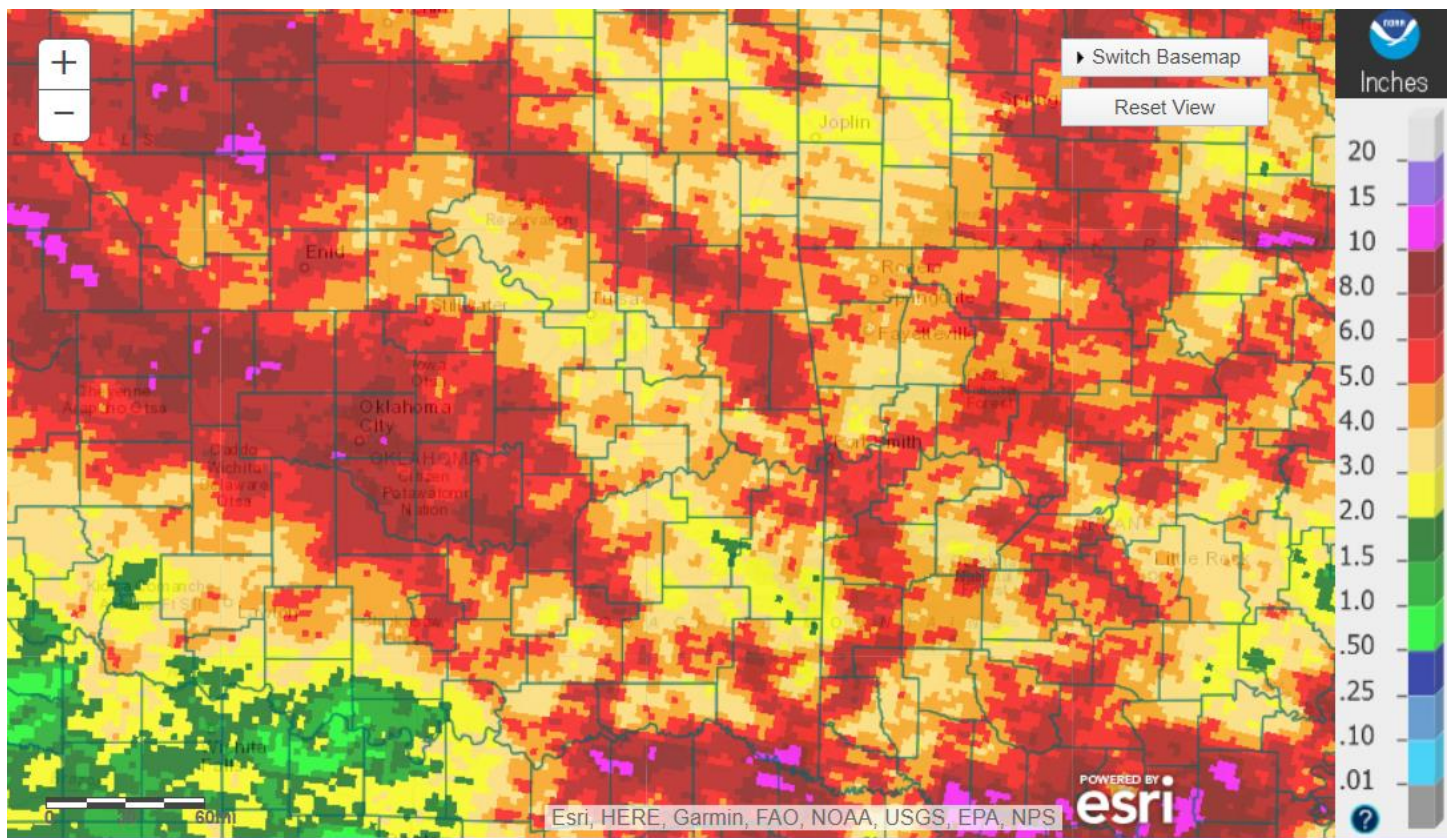
When no flooding occurs, include miscellaneous river conditions, such as significant rises, record low stages, ice conditions, snow cover, droughts, and hydrologic products issued (NWS Instruction 10-924)

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

Numerous MCSs brought several rounds of rain to the region during the first half of the month, helping to ease drought conditions, while the end of the month was hot and humid. Normal rainfall for the month of July ranges from 2.6 inches in McIntosh County to 3.4 inches in Ottawa County. The Ozark region of northwest Arkansas averages 3.1 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.

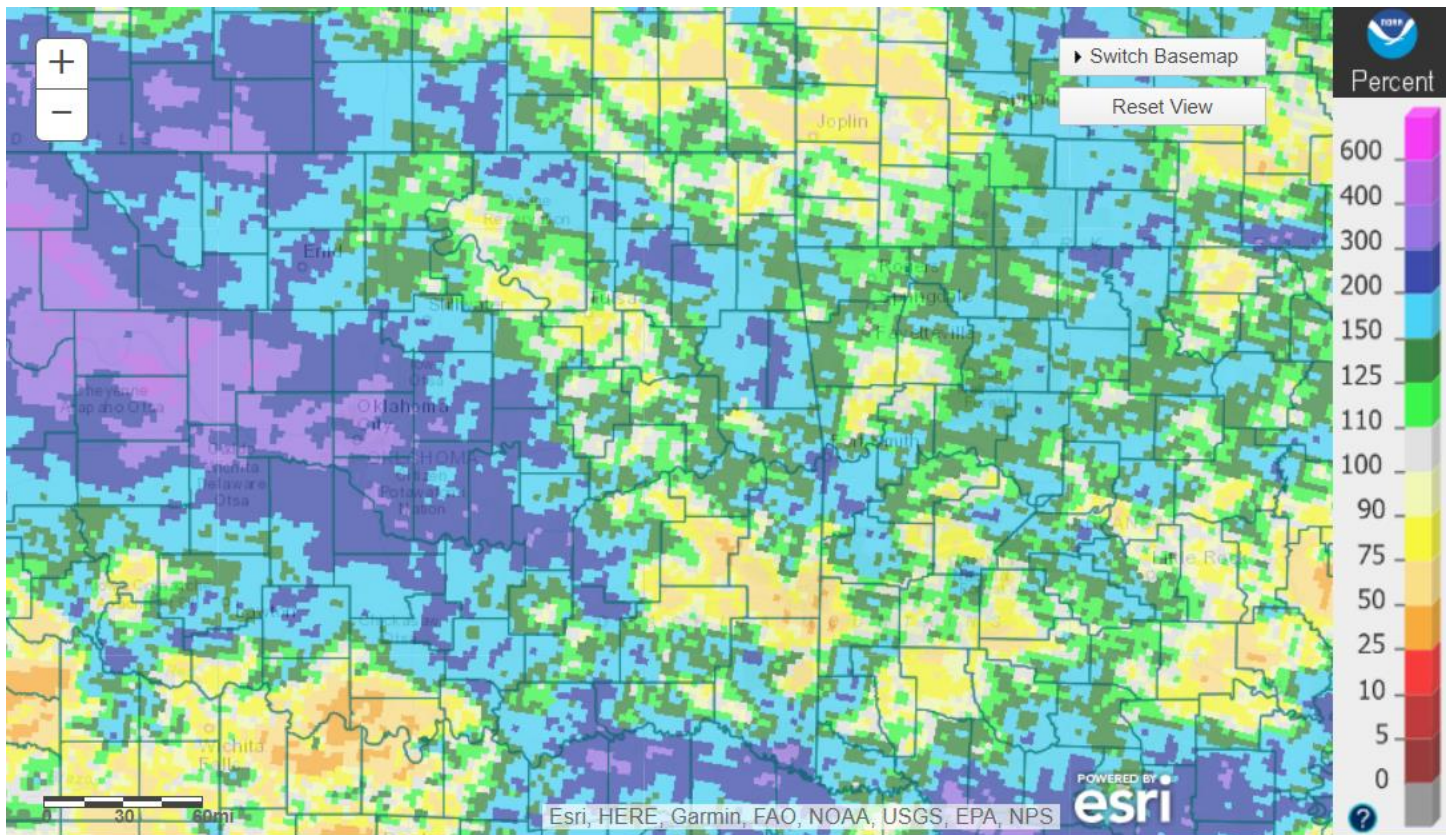
Monthly Summary

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 1a), rainfall totals for July 2023 ranged from around 2" to 10" across eastern OK and northwest AR, with much of the area receiving 3"-5". These rainfall totals correspond to 50% to 300% of the normal July rainfall (Fig. 1b).



Tulsa, OK: July, 2023 Monthly Observed Precipitation
 Valid on: August 01, 2023 12:00 UTC

Fig. 1a. Estimated Observed Rainfall for July 2023



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

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

In Tulsa, OK, July 2023 ranked as the 56th warmest July (83.1°F; since records began in 1905) and the 48th wettest July (4.03"; since records began in 1888). Fort Smith, AR had the 30th warmest July (84.1°F, tied 1933, 1932, 1919; since records began in 1882) and the 20th wettest July (5.90", tied 1945; since records began in 1882). Fayetteville, AR had the 13th warmest (80.1°F) and the 18th wettest (4.95") July since records began in 1950.

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

Pryor 6.9ESE, OK (coco)	10.07	Bunch 0.8N, OK (coco)	8.05	Ochelata 5.6N, OK (coco)	7.81
Cookson, OK (meso)	7.59	Foraker, OK (meso)	7.53	Bartlesville, OK (ASOS)	7.50
Tahlequah, OK (meso)	7.39	Pryor, OK (meso)	7.33	Stuart, OK (meso)	7.05

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

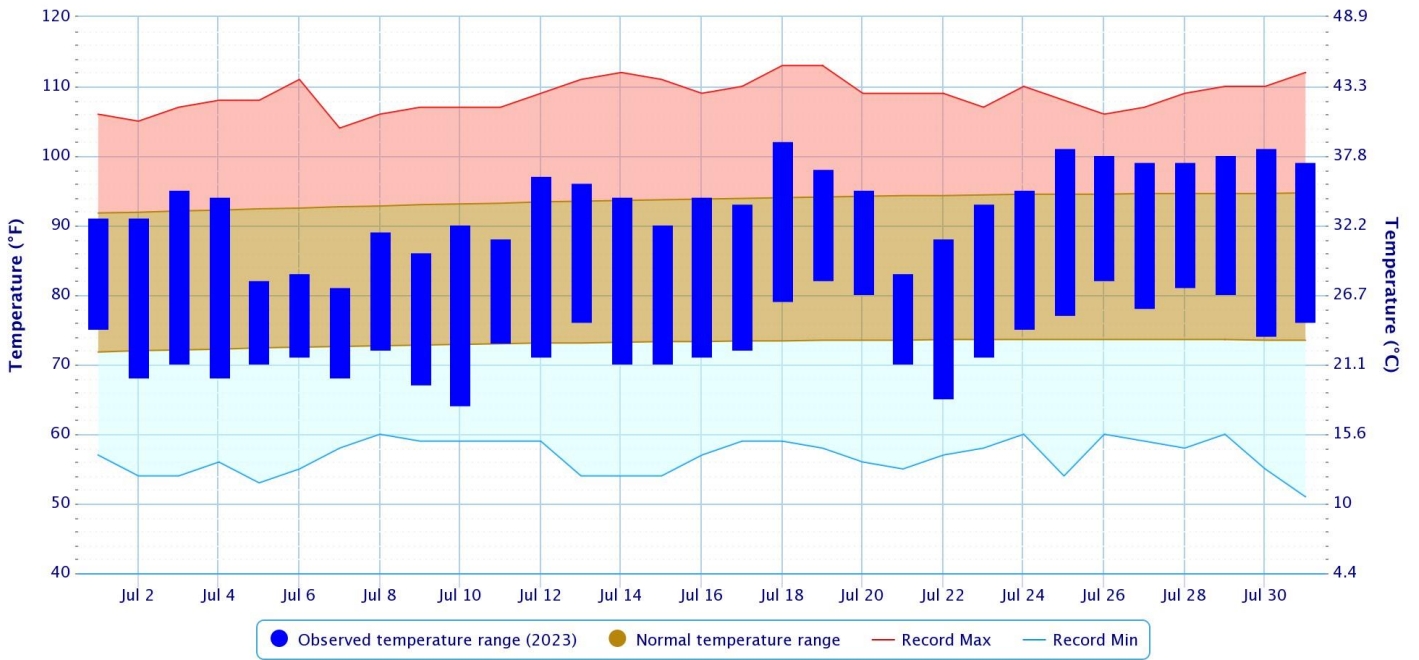
Haskell, OK (meso)	2.54	Jenks Riverside Arprt, OK (ASOS)	2.69	Talihina, OK (meso)	2.78
Porter, OK (meso)	2.91	Clayton, OK (meso)	3.04	Burbank, OK (meso)	3.04
Wilburton, OK (meso)	3.28	Miami, OK (meso)	3.29	Muskogee, OK (ASOS)	3.55

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

Rank since 1921	Last 30 Days (July 2 – 31)	Growing Season (Mar 1 – Jul 31)	Summer-to-Date (Jun 1 – Jul 31)	Year-to-Date (Jan 1 – Jul 31)	Last 120 Days (Apr 3 – Jul 31)	Water Year-to-Date (Oct 1 – Jul 31)	Last 365 Days (Aug 1, 2022 – Jul 31, 2023)
Northeast OK	28 th wettest	26 th driest	50 th wettest	38 th driest	20 th driest	39 th driest	18 th driest
East Central OK	18 th wettest	46 th driest	46 th wettest	44 th wettest	23 rd driest	36 th wettest	51 st driest
Southeast OK	30 th wettest	41 st wettest	42 nd wettest	24 th wettest	25 th driest	26 th wettest	38 th wettest
Statewide	9th wettest	41 st wettest	21 st wettest	39 th wettest	45 th wettest	35 th wettest	45 th driest

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

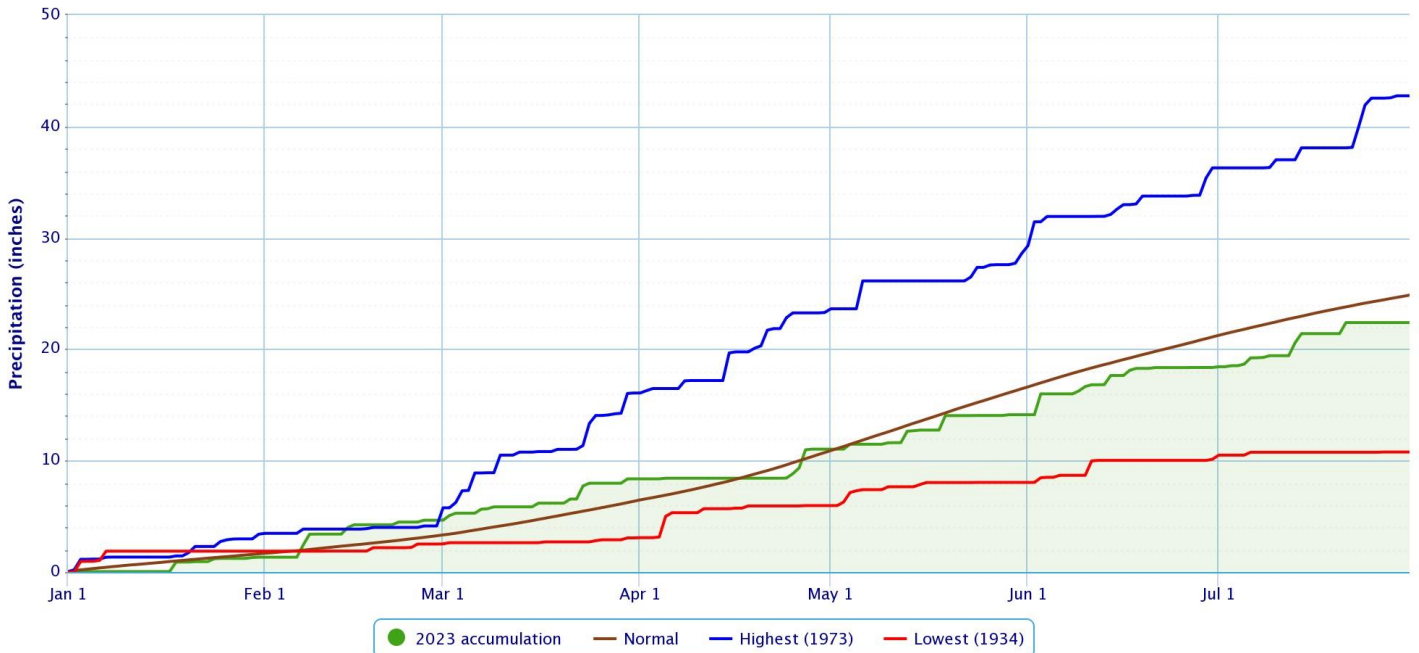
Period of Record – 1905-01-06 to 2023-07-31. Normals period: 1991-2020. Click and drag to zoom chart.



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Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

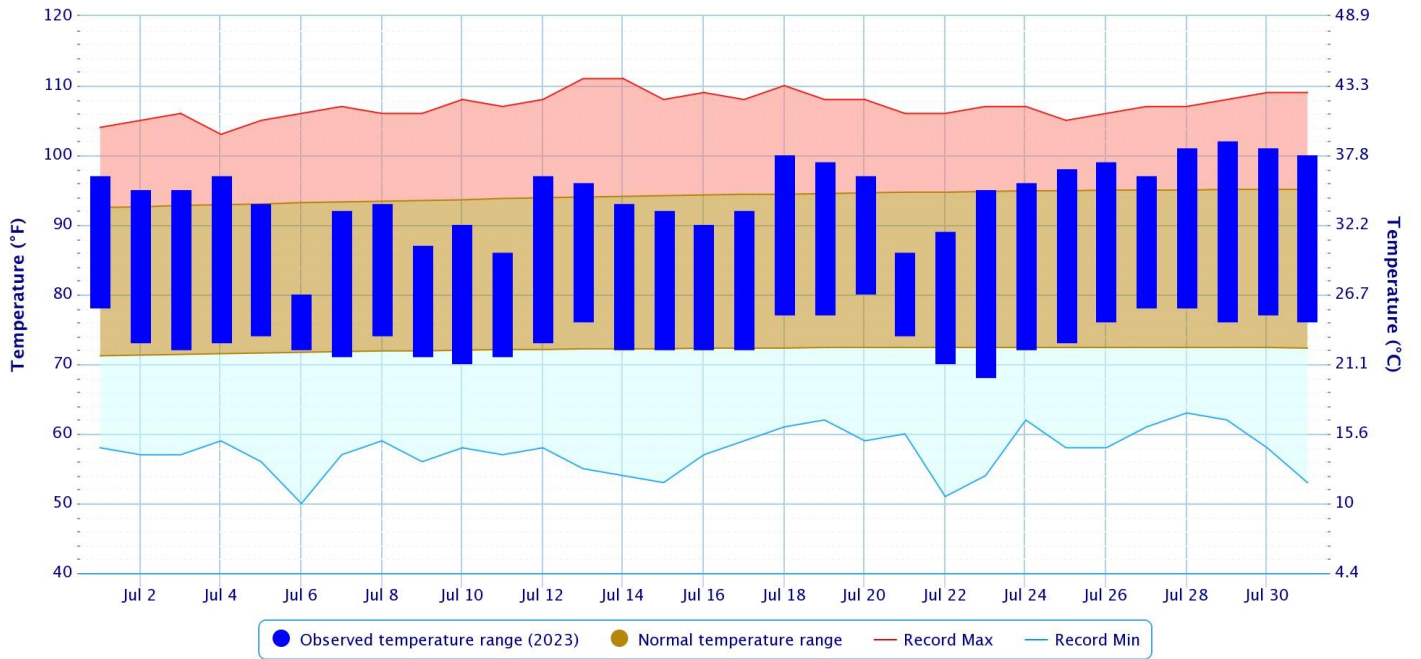
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

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

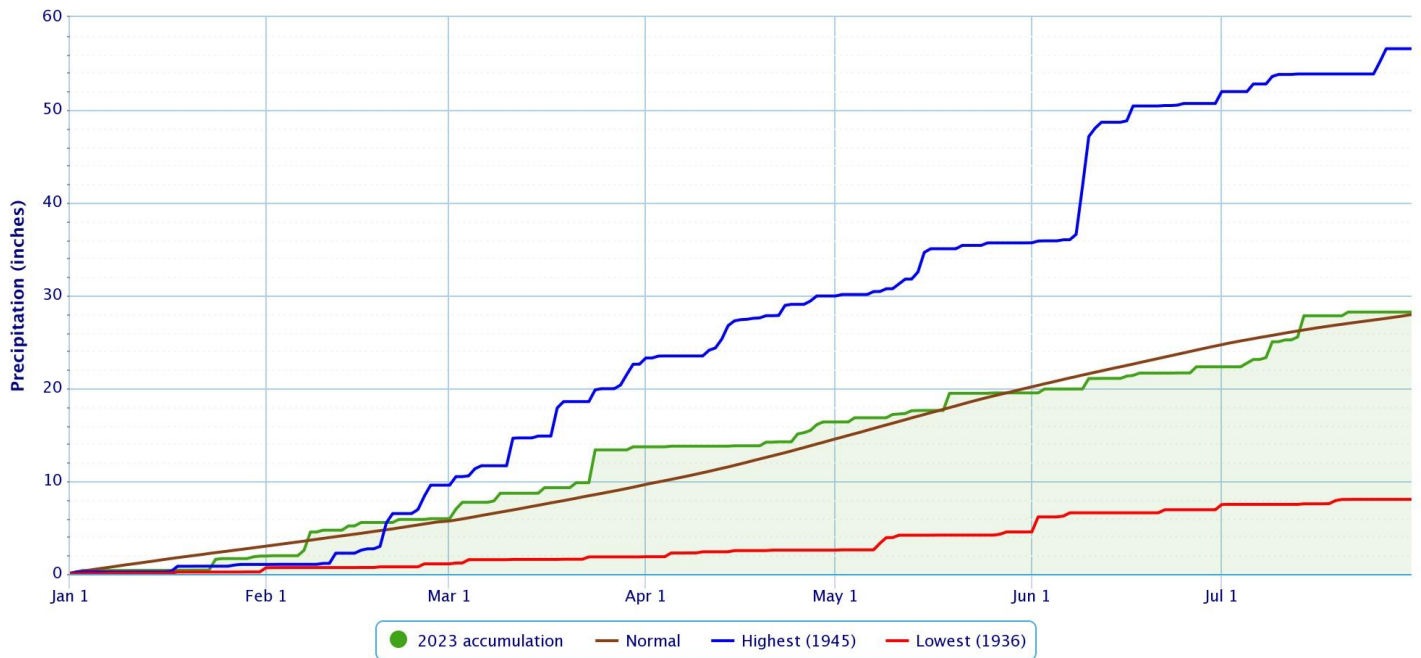
Period of Record – 1882-06-01 to 2023-07-31. Normals period: 1991–2020. Click and drag to zoom chart.



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Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

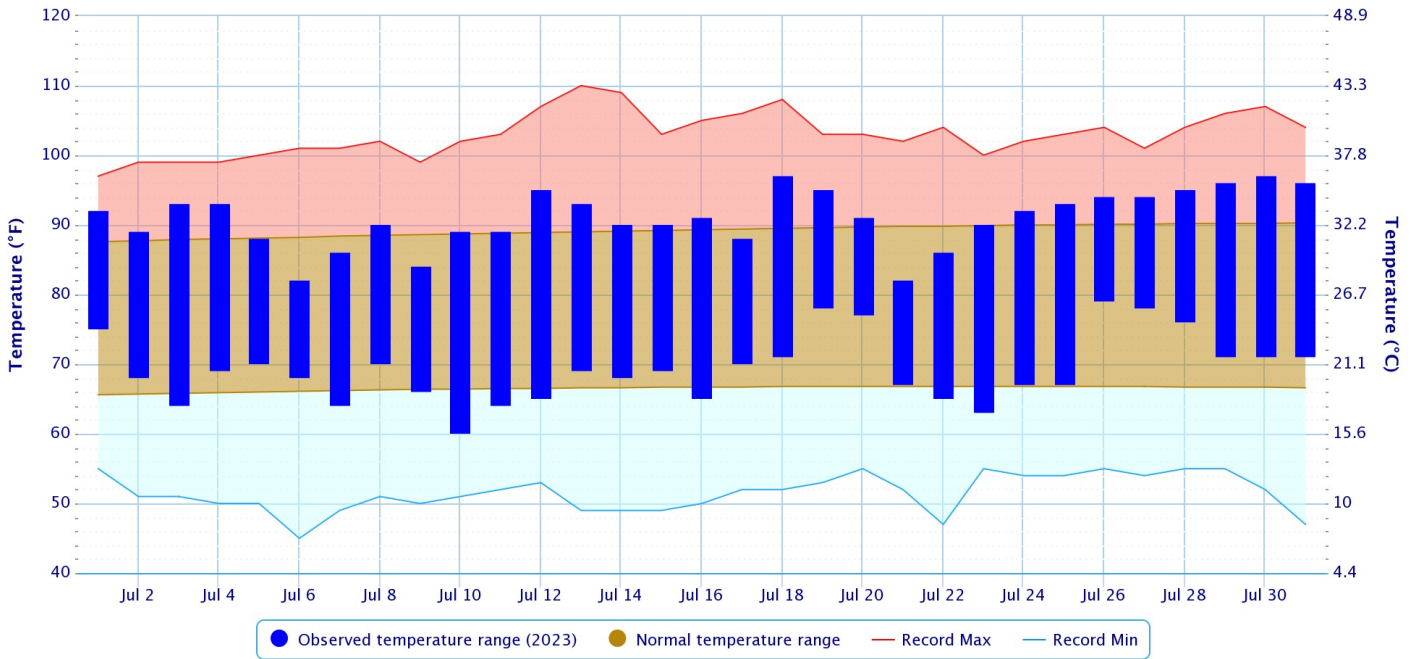
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

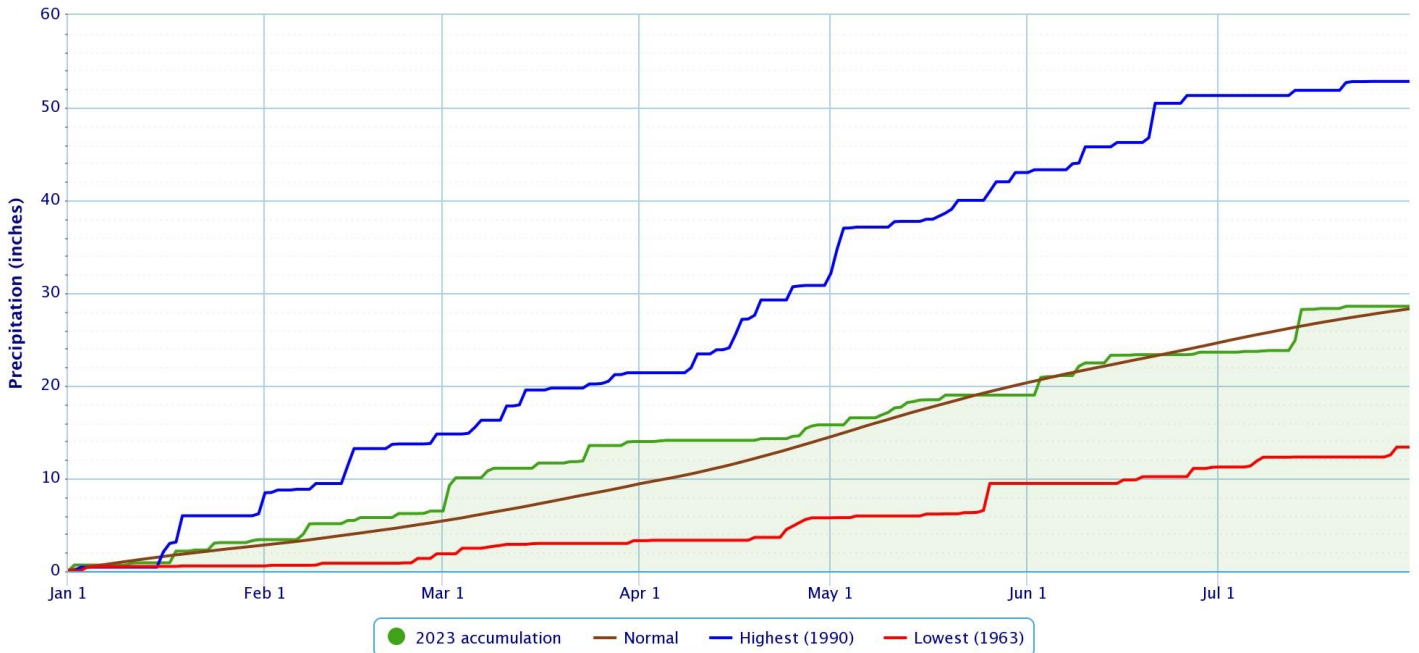
Period of Record – 1949-07-14 to 2023-07-31. Normals period: 1991-2020. Click and drag to zoom chart.



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Accumulated Precipitation – FAYETTEVILLE DRAKE FIELD, AR

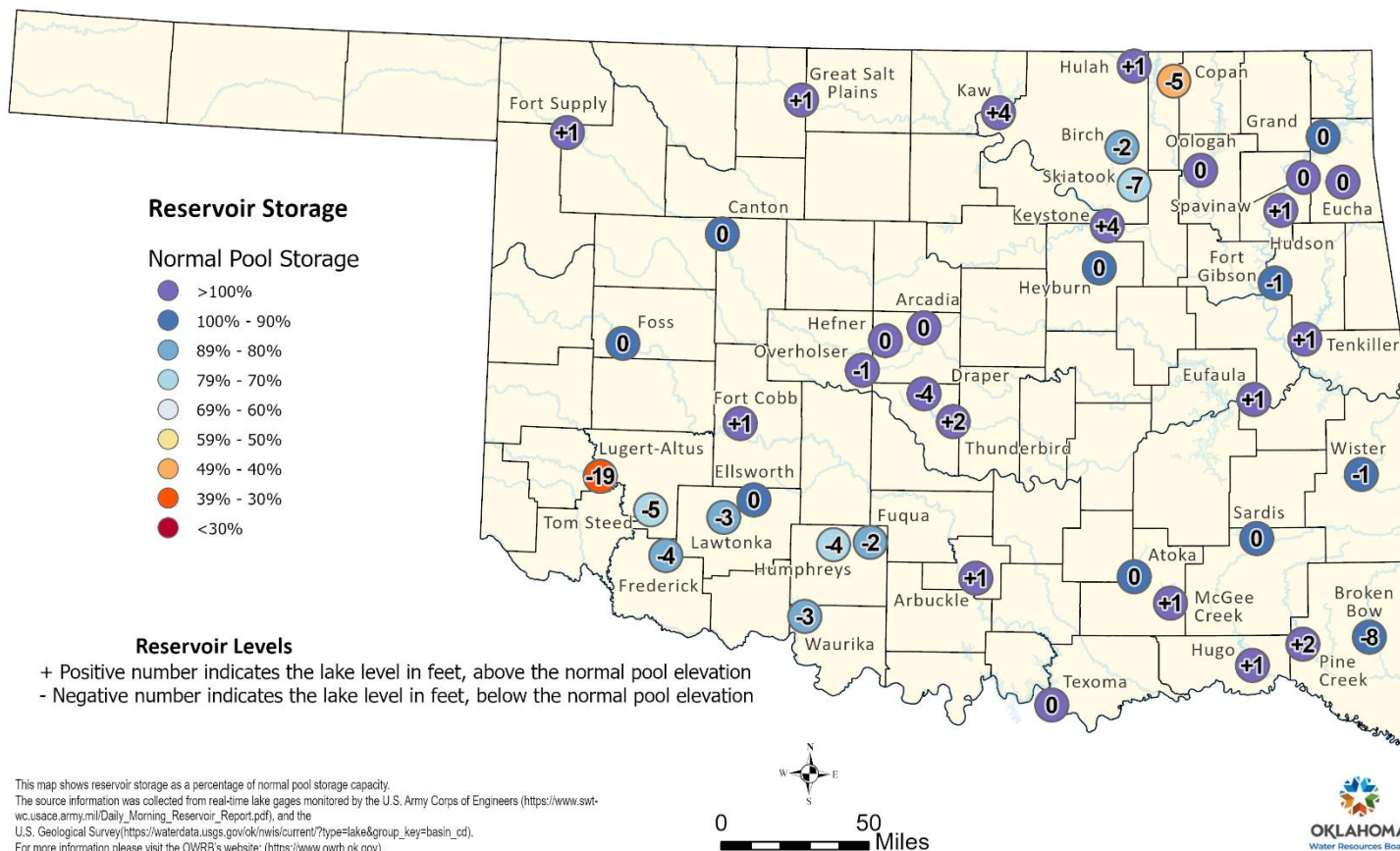
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Reservoirs

Oklahoma Reservoir Levels and Storage as of 8/2/2023



According to the USACE, several of the lakes in the HSA were below 3% of top of their conservation pools as of 08/01/2023: Copan Lake 47%, Ft. Gibson Lake 71%, Skiatook Lake 78%, Birch Lake 87%, Beaver Lake 91%, Wister Lake 91%, and Heyburn Lake 95%. A few lakes were above 3% of the top of their conservation pool: Eufaula Lake 9%, Kaw Lake 7%, Keystone Lake 7%, and Hudson Lake 5%.

Drought

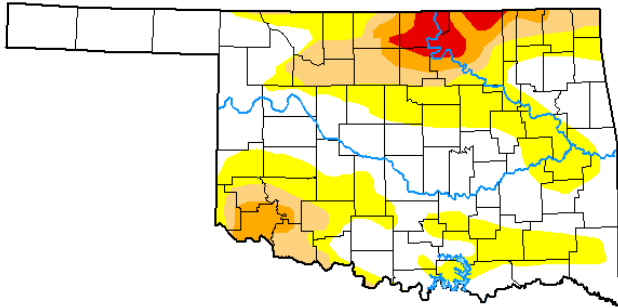
According to the [U.S. Drought Monitor](#) (USDM) from August 1, 2023, Extreme (D3) Drought conditions were occurring in portions of eastern Kay, Osage and Pawnee Counties in eastern Oklahoma. Severe (D2) Drought conditions exist in portions of Craig, Nowata, Washington, Osage, and Pawnee Counties in eastern Oklahoma. Moderate (D1) Drought conditions were present in portions of Ottawa, Craig, Nowata, Washington, Osage, and Pawnee Counties in eastern Oklahoma, and Carroll County in northwest Arkansas. Abnormally Dry (D0) conditions were occurring in portions of Ottawa, Delaware, Craig, Mayes, Nowata, Rogers, Tulsa, Washington, Osage, Pawnee, Creek, Okmulgee, Wagoner, Muskogee, McIntosh, Pittsburg, Haskell, Sequoyah, Latimer, Le Flore, Pushmataha, and Choctaw Counties in eastern Oklahoma, and Benton, Carroll, Washington, and Madison Counties in northwest Arkansas.

U.S. Drought Monitor Oklahoma

August 1, 2023

(Released Thursday, Aug. 3, 2023)

Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	52.33	47.67	17.90	7.58	2.58	0.00
Last Week 07-25-2023	52.39	47.61	17.76	6.64	2.58	0.00
3 Months Ago 05-02-2023	40.58	59.42	52.47	48.90	33.47	10.09
Start of Calendar Year 01-03-2023	1.82	98.18	89.73	80.92	56.13	11.65
Start of Water Year 09-27-2022	0.00	100.00	99.88	94.44	64.44	17.25
One Year Ago 08-02-2022	0.00	100.00	99.15	91.72	31.75	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:

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National Drought Mitigation Center



droughtmonitor.unl.edu

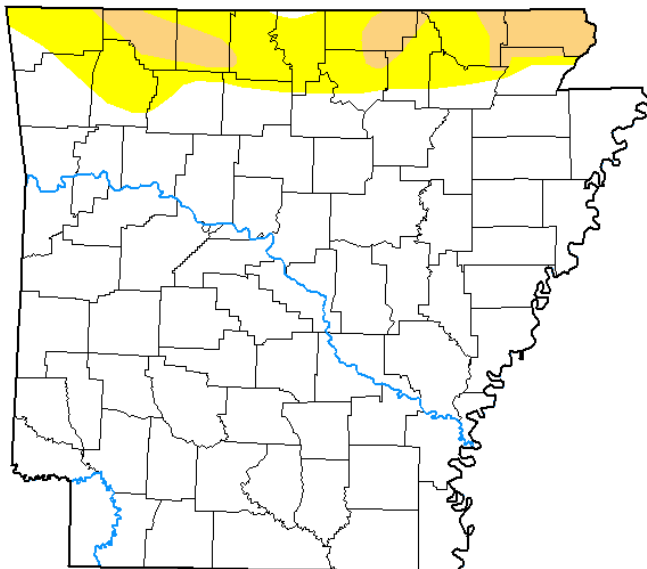
Fig. 2. Drought Monitor for Oklahoma

U.S. Drought Monitor Arkansas

August 1, 2023

(Released Thursday, Aug. 3, 2023)

Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	85.42	14.58	4.18	0.00	0.00	0.00
Last Week 07-25-2023	85.42	14.58	4.18	0.00	0.00	0.00
3 Months Ago 05-02-2023	100.00	0.00	0.00	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 09-27-2022	4.99	95.01	69.68	39.30	2.96	0.00
One Year Ago 08-02-2022	7.06	92.94	82.33	49.49	3.29	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>

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National Drought Mitigation Center

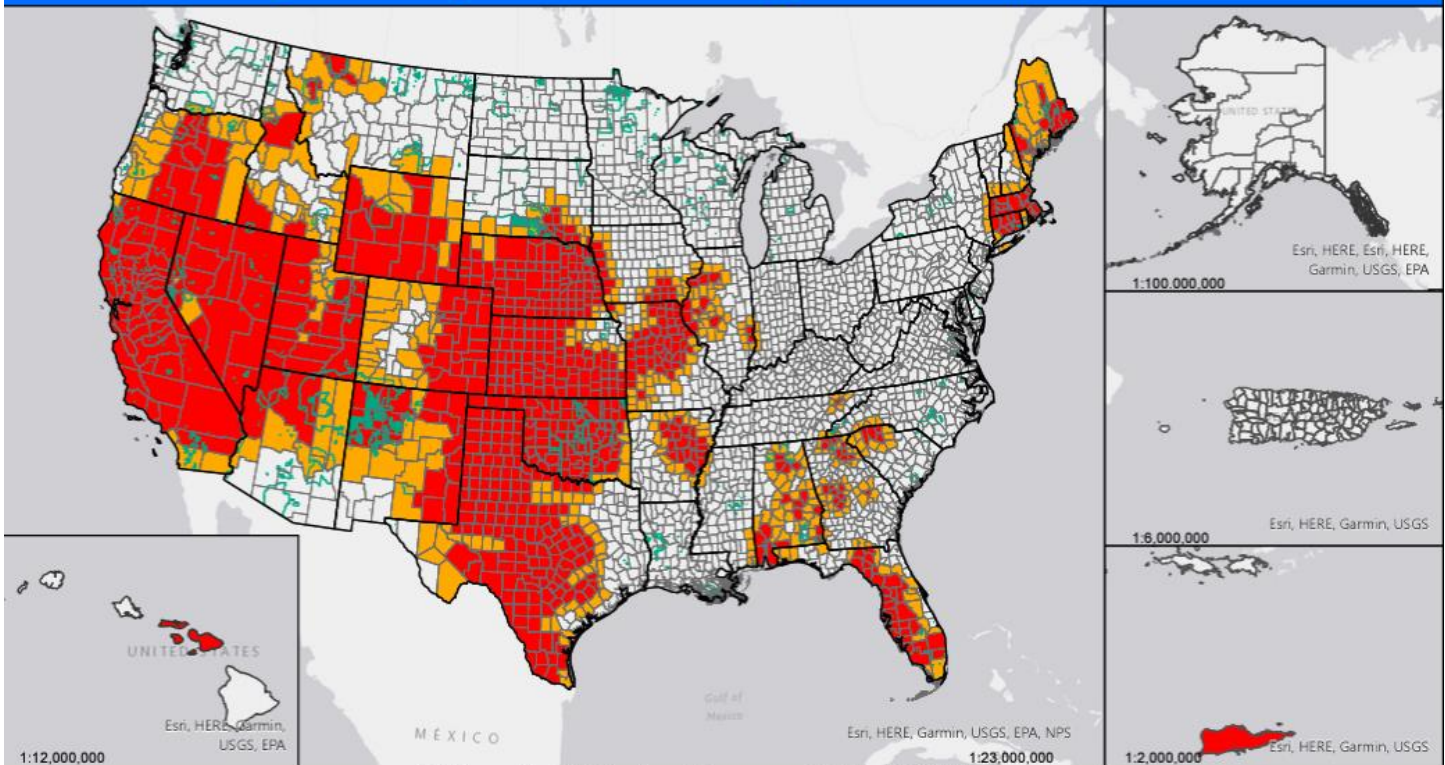


droughtmonitor.unl.edu

Fig. 3. Drought Monitor for Arkansas

Secretarial Disaster Designations - CY 2023

Primary and Contiguous Counties Designated for Crop Disaster Losses



All Secretarial Designations as of July 5, 2023

Total All Crop Approval Designations

-  State Boundary
-  County Boundary
-  Tribal Lands
-  Primary Counties: 746
-  Contiguous Counties: 466



United States Department of Agriculture
Farm Service Agency
Program Delivery/Safety Net Division
July 5, 2023

The long-term drought has impacted agriculture across eastern OK. This map shows counties with USDA Secretarial Disaster Declarations through July 5, 2023. These designations are created based on input from the weekly US Drought Monitor. Eight consecutive weeks of D2 status in the USDM or one week in D3 makes a county eligible for designation.

Outlooks

The [Climate Prediction Center](#) (CPC) outlook for August 2023 (issued July 31, 2023) indicates an enhanced chance for above normal temperatures across all of eastern OK and northwest AR. This outlook also indicates an enhanced chance for above median rainfall across far northern OK, and an equal chance for above, near, and below median rainfall elsewhere. This outlook was largely based on dynamical model output and El Niño influence, as the Madden-Julian Oscillation (MJO) is not expected to have much influence this month.

For the 3-month period August-September-October 2023, CPC is forecasting an enhanced chance for above median precipitation across eastern OK and northwest AR (outlook issued July 20, 2023). This outlook also shows an equal chance for above, near, and below normal temperatures for northeast OK and far northwest AR and an enhanced chance for above normal temperatures across east central and southeast OK and west central AR. This outlook is based on long-term trends, ENSO state, soil moisture, and incorporates both statistical and dynamical forecast tools. 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 90% chance of El Niño continuing through the winter, peaking as a moderate to strong event, and a 20% chance of an "historically strong" El Niño event.

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 cluster of thunderstorms moved into Osage and Pawnee Counties during the late morning of the 3rd and continued to slowly progress to the southeast during the afternoon hours. Additional scattered showers and thunderstorms developed in the afternoon across a more unstable airmass over southeast OK in response to a passing shortwave trough. Most of the showers and thunderstorms dissipated during the evening, though some storms remained near the Red River until midnight. With precipitable water (PWAT) values of 1.6"-1.7", some areas received 1.5"-2.5" of rain from these storms (Fig. 4).

Shortly after sunrise on the 4th, an area of thunderstorms developed over southeast OK, where deeper moisture was present, as a subtle mid-level wave moved through the area. These storms then dissipated around noon after bringing around 0.50" to near 3" of rain to southwest Pittsburg, western Pushmataha, and western Choctaw Counties (Fig. 5).

A mesoscale convective system (MCS) moved south out of KS and into northeast OK at 3 am CDT on the 5th. These storms rapidly weakened over the next few hours and brought 0.10" to around 1" of rain to a portion of northeast OK (Fig. 5). A second MCS then moved into the area from the northwest at mid-morning. The MCS moved southeast across the area, while weakening and becoming more of a scattered line of showers and thunderstorms during the afternoon. Elevated scattered convection developed during the early morning hours of the 6th as the low-level jet increased. By 7 am, these storms had become widespread across northeast and east central OK. 24-hour rainfall totals at 7 am ranged from around 0.10" to around 3" (Fig. 6). This activity continued through the morning hours, spreading east into northwest AR. Meanwhile, additional showers and thunderstorms in central OK also moved eastward into the area. This activity continued to shift to the southeast by noon and exited the area by mid-afternoon. The additional rainfall totals after 7 am ranged from 0.10" to near 4" (Fig. 7).

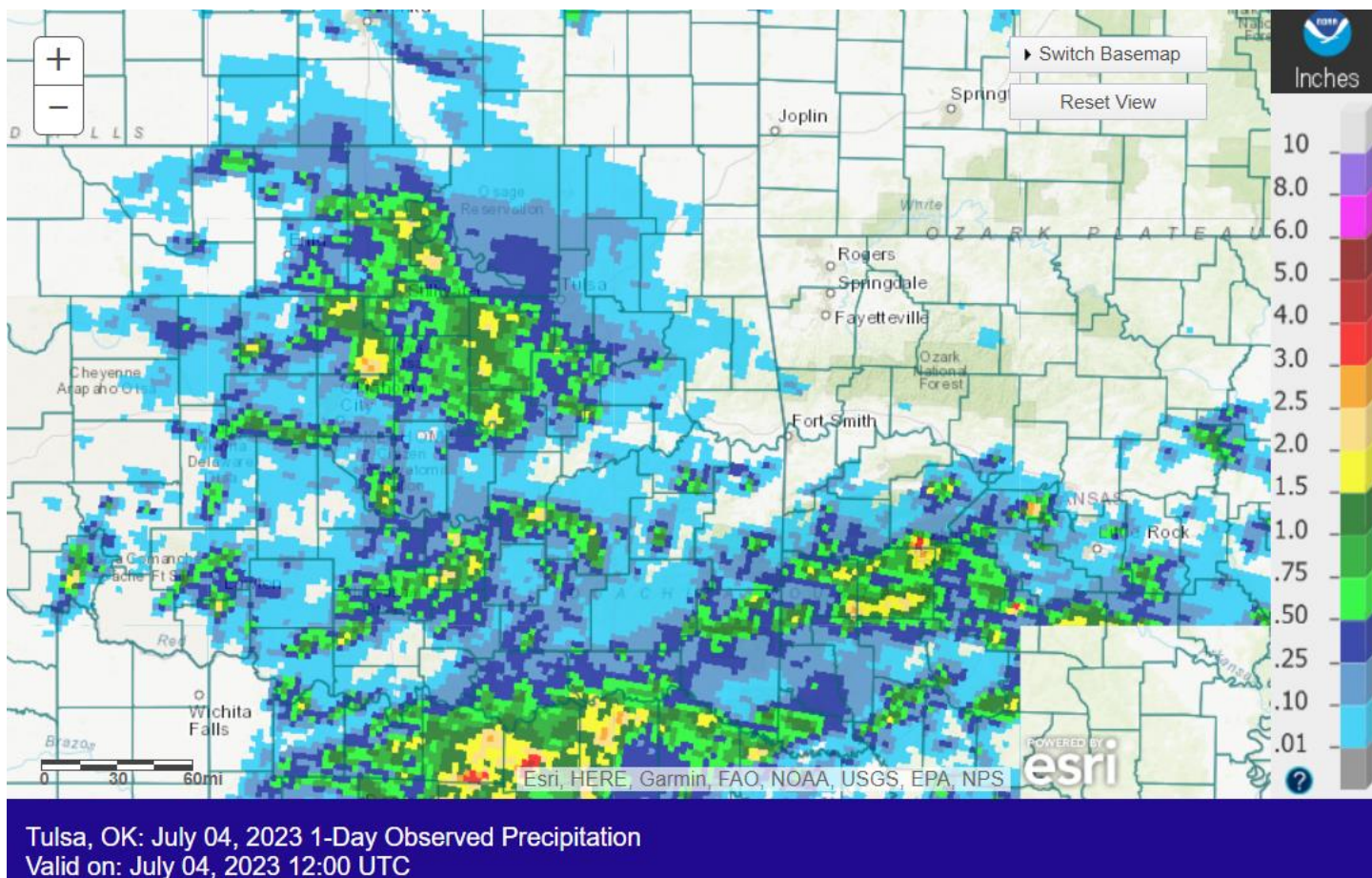
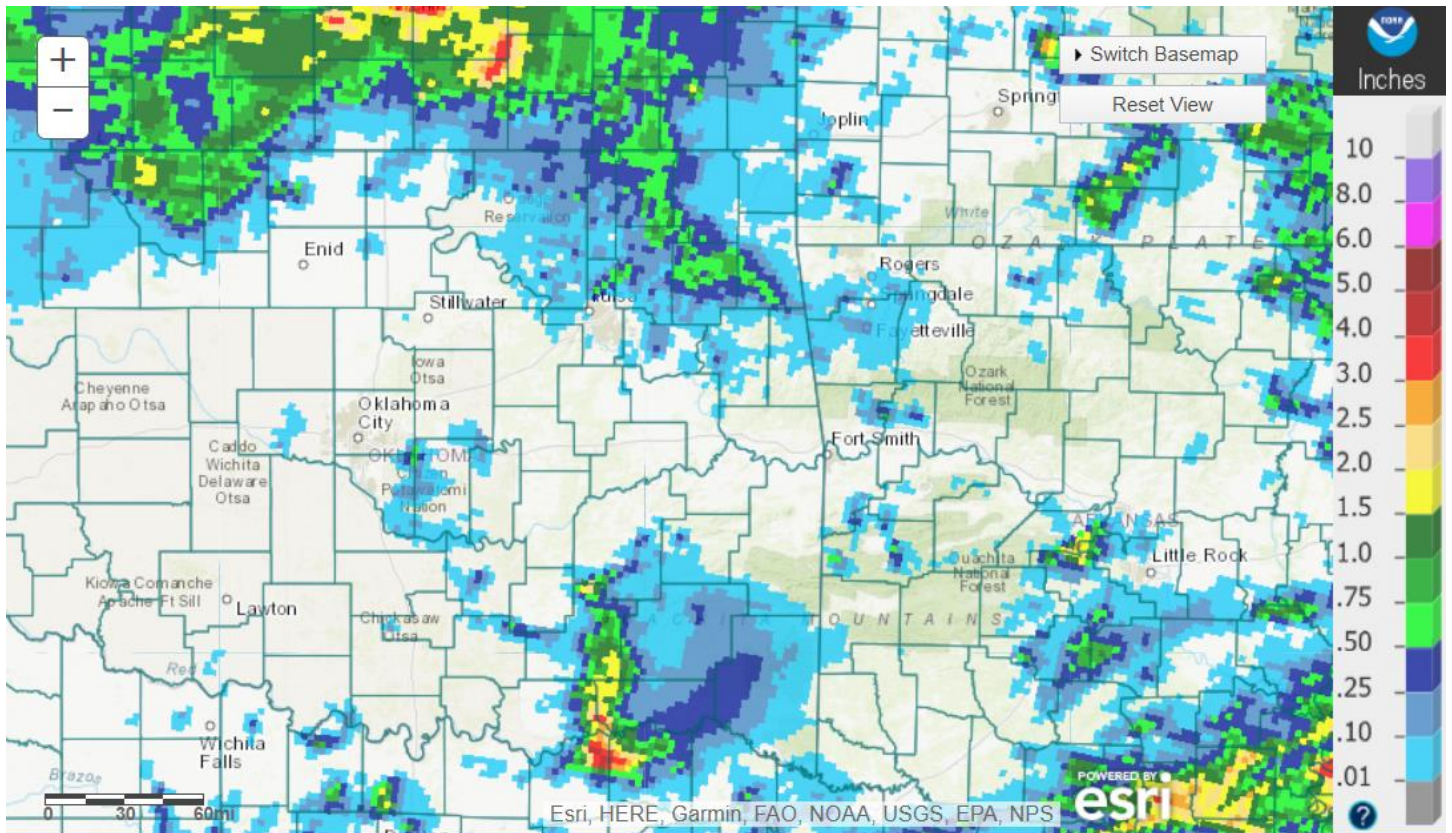


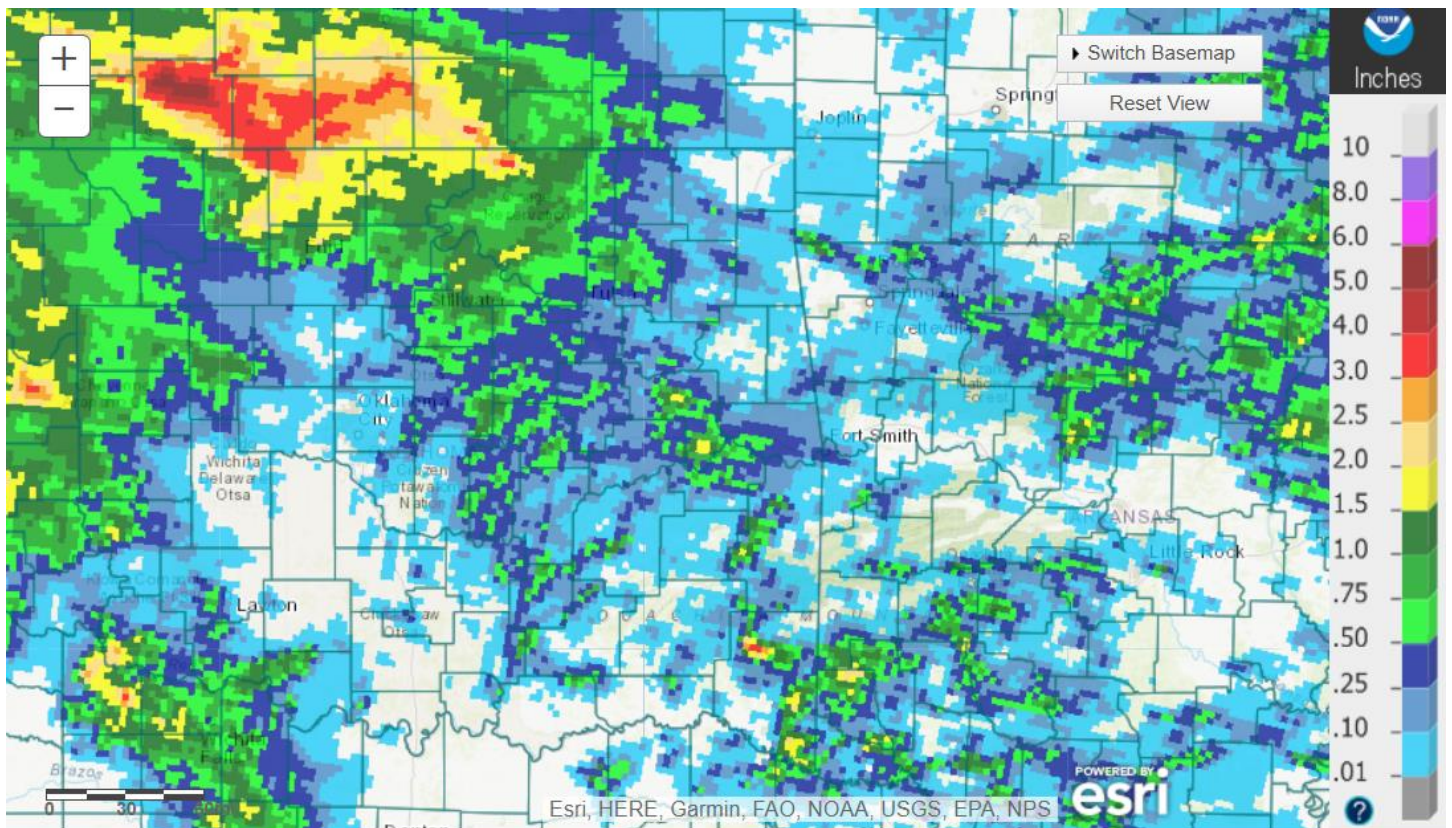
Fig. 4. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/04/2023.



Tulsa, OK: July 05, 2023 1-Day Observed Precipitation

Valid on: July 05, 2023 12:00 UTC

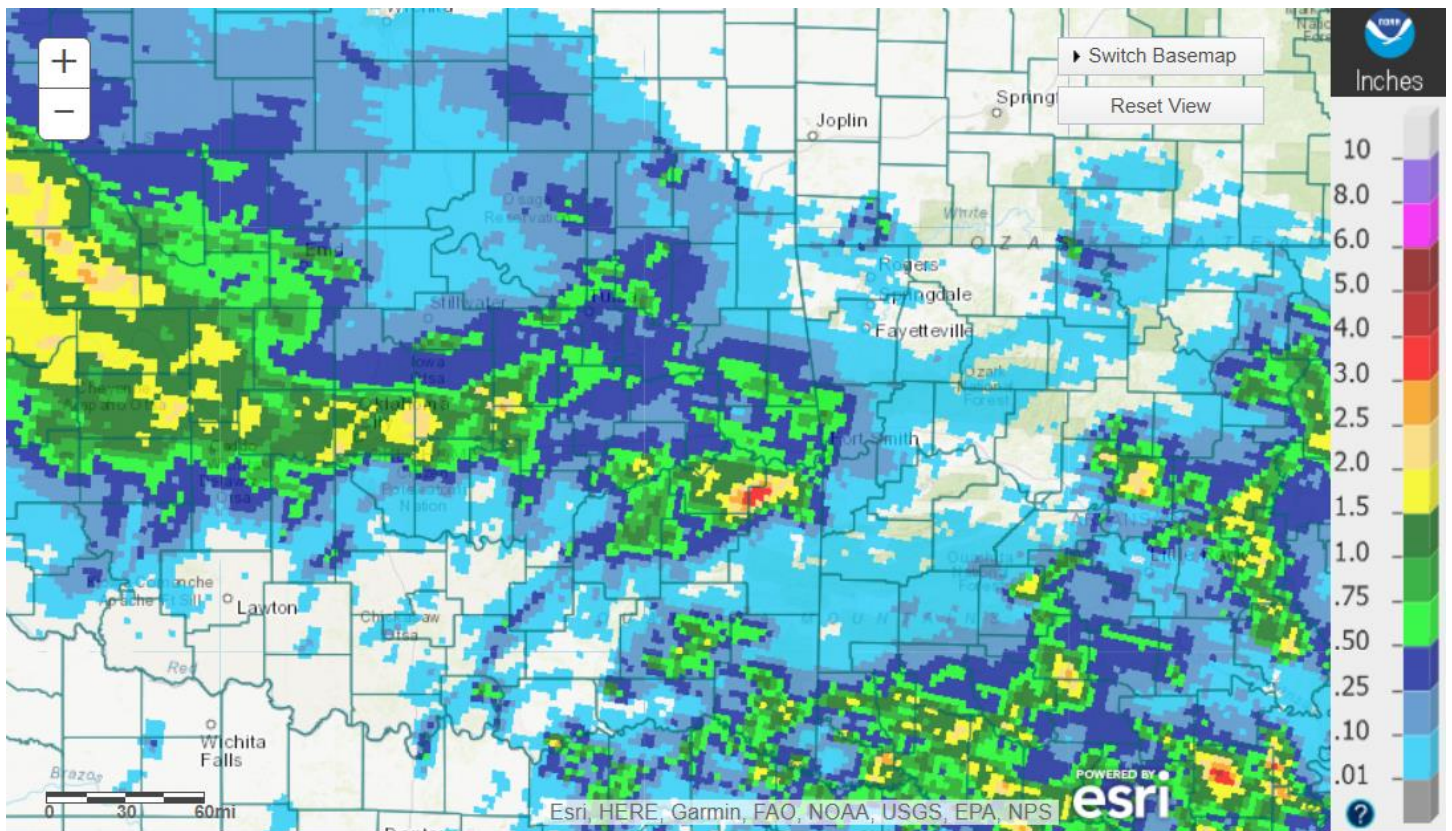
Fig. 5. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/05/2023.



Tulsa, OK: July 06, 2023 1-Day Observed Precipitation

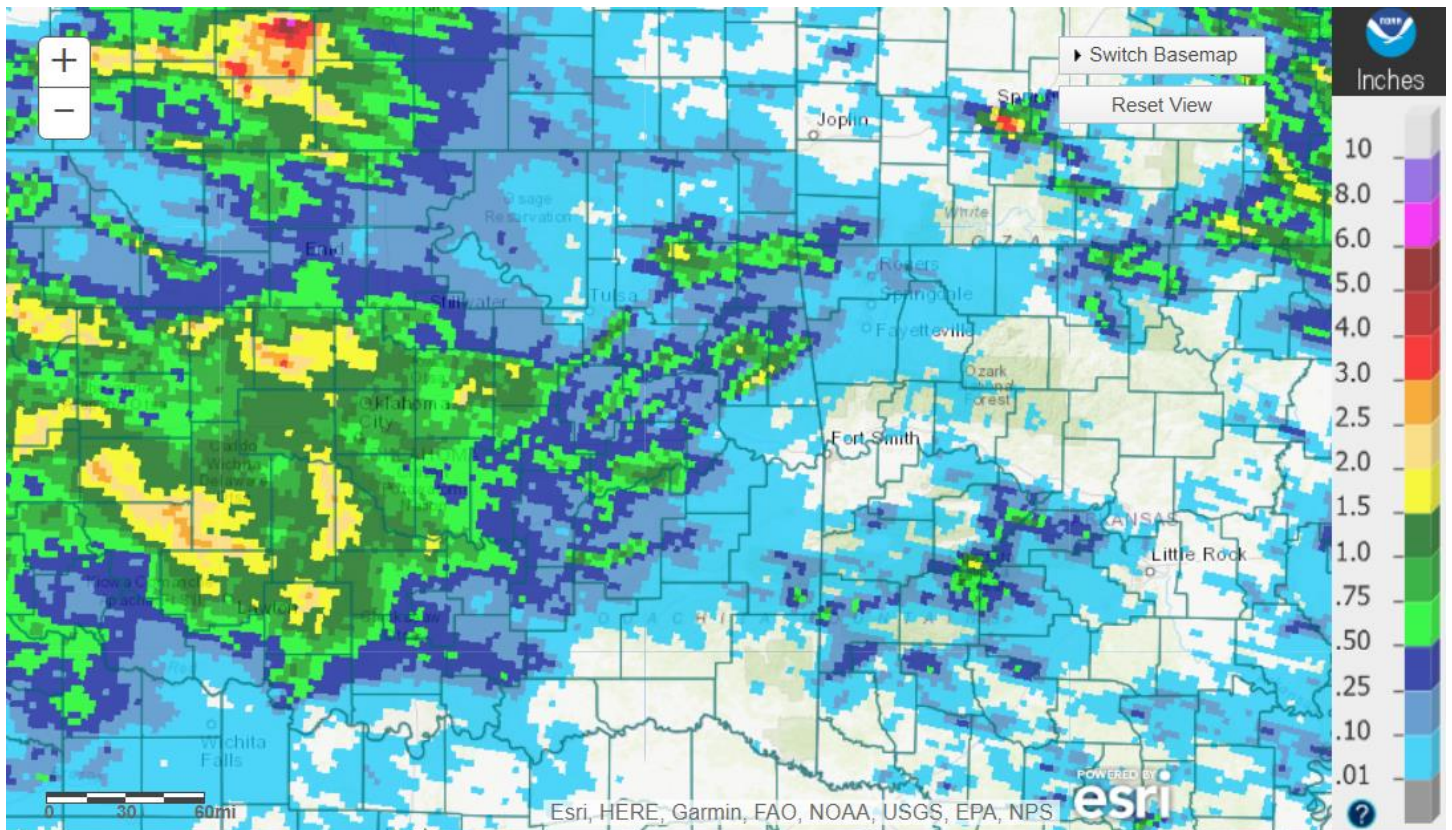
Valid on: July 06, 2023 12:00 UTC

Fig. 6. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/06/2023.



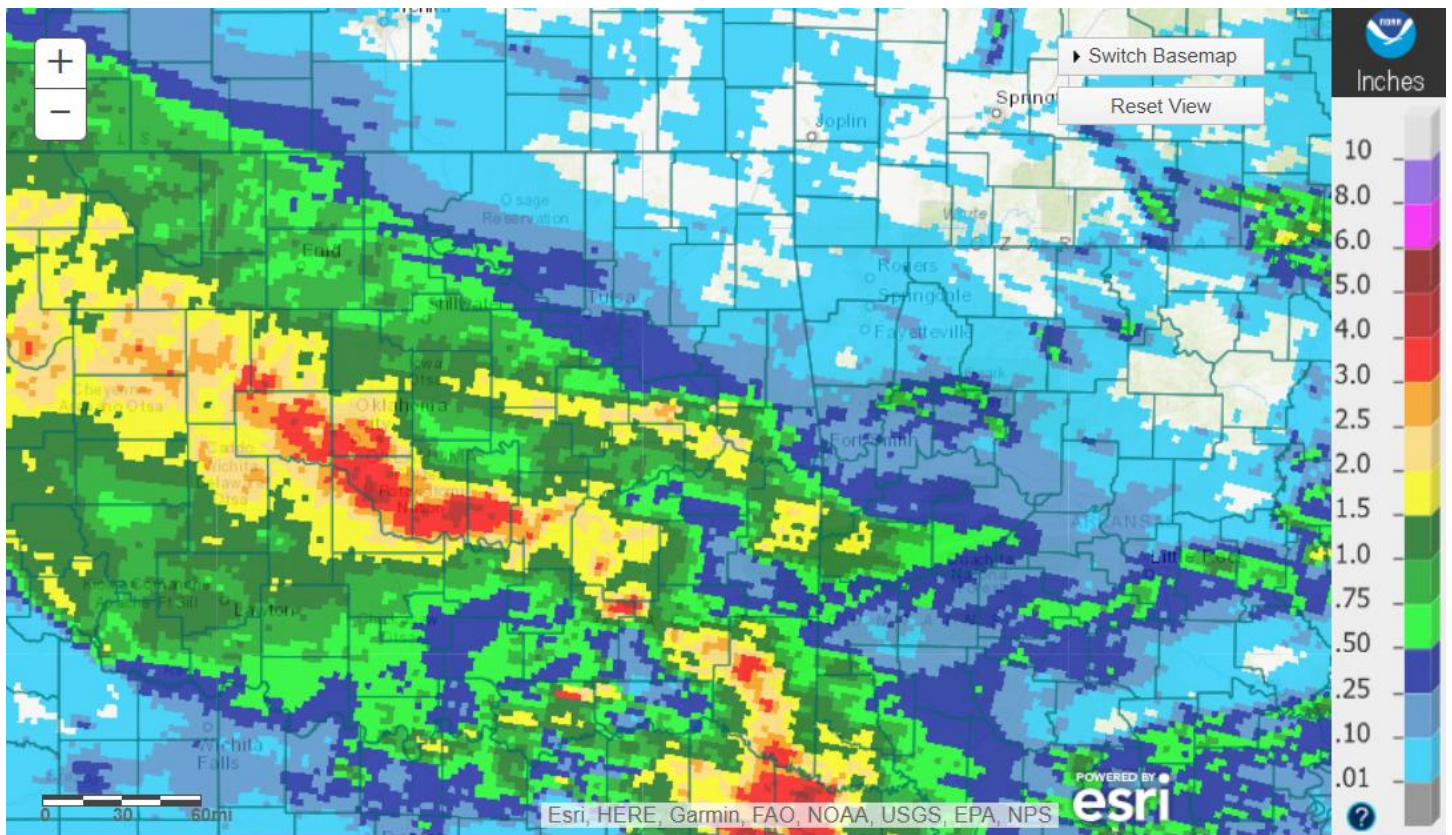
Tulsa, OK: July 07, 2023 1-Day Observed Precipitation
Valid on: July 07, 2023 12:00 UTC

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



Tulsa, OK: July 08, 2023 1-Day Observed Precipitation
Valid on: July 08, 2023 12:00 UTC

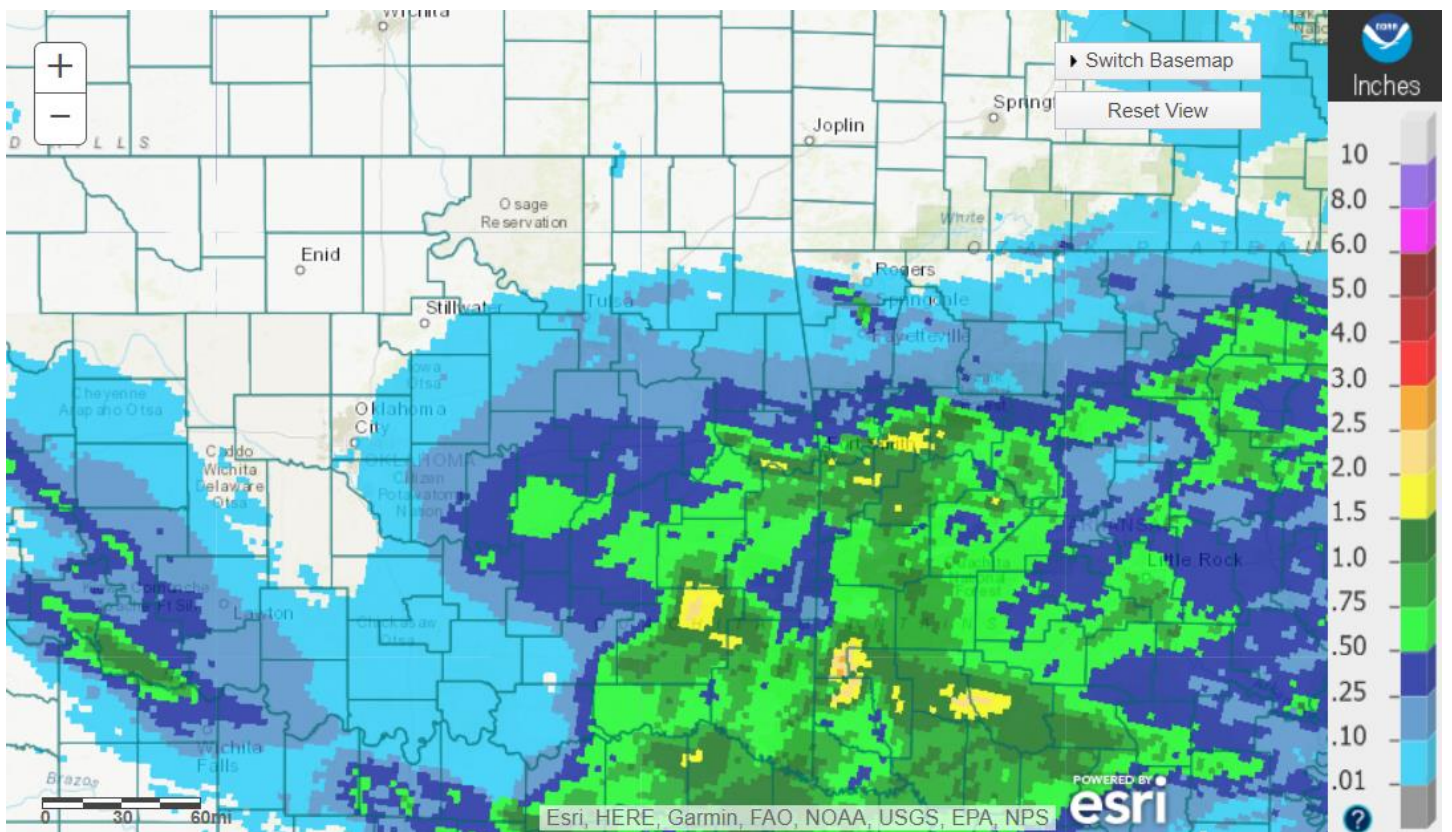
Fig. 8. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/08/2023.



Tulsa, OK: July 09, 2023 1-Day Observed Precipitation

Valid on: July 09, 2023 12:00 UTC

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



Tulsa, OK: July 10, 2023 1-Day Observed Precipitation

Valid on: July 10, 2023 12:00 UTC

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

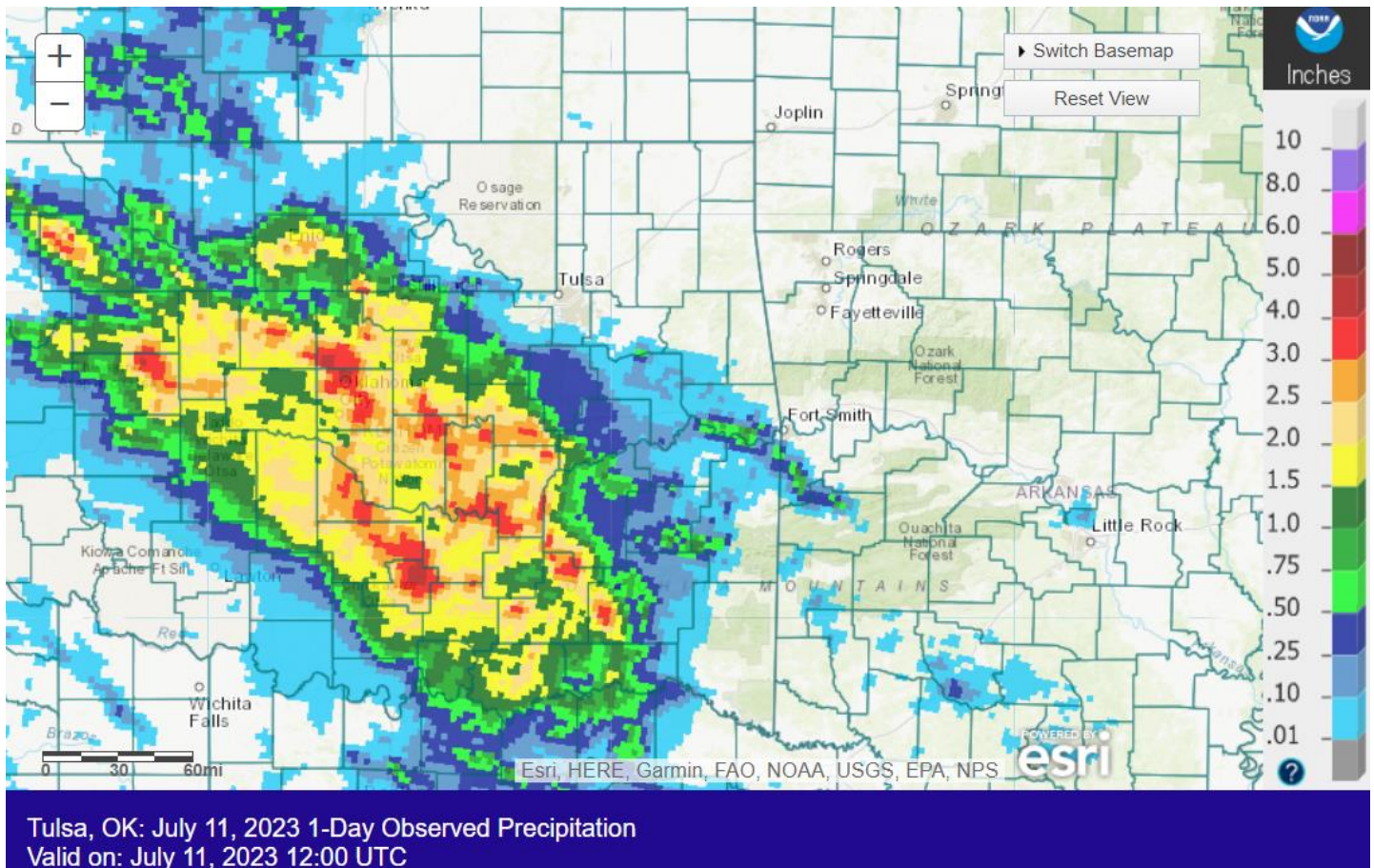


Fig. 11. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/11/2023.

A decaying MCS from central OK brought showers and thunderstorms to portions of east central and southeast OK during the late morning hours of the 7th. Another weakening cluster of storms moved into northeast OK during the afternoon and dissipated with the loss of heating during the evening. A third, much larger, MCS then approached eastern OK from the west soon after midnight. This MCS became less organized as it slowly moved east across the area. By 7 am on the 8th, rain was falling across far eastern OK and western AR. The 24-hour rainfall totals through 7 am ranged from a few hundredths to 2" (Fig 8). These storms became more robust across east central and southeast OK, before exiting the region to the southeast by noon. New convection developed along the leftover outflow boundary across southeast OK during the afternoon, with thunderstorms impacting far southern Le Flore, Pushmataha, and Choctaw Counties. A little after midnight of the 9th, a large MCS moving south out of the central Plains arrived in eastern OK. This complex moved southeast through the early morning hours and was affecting a large portion of eastern OK and northwest AR by 7 am. The 24-hour rainfall totals through 7 am ranged from 0.10" to around 3", however far northeast OK missed out on these storms and remained mostly dry (Fig. 9). The MCS continued its southeast trek and brought an additional 0.10" to around 2" of rain (Fig. 10) before it exited the region by noon.

Soon after midnight on the 11th, thunderstorms developed over central OK, just west of the Indian Nation Turnpike/Hwy 75, within an axis of elevated instability. These storms rapidly developed into an MCS, which then spread east across eastern OK and west central AR. By 7am, widespread showers and thunderstorms were affecting locations southwest of a Tulsa, OK to Fort Smith, AR line and had produced 0.10" to 4" of rain (Fig. 11) due to PWAT values of around 1.5". The MCS continued its southeast trek through the morning, ending from northwest to southeast by noon, and produced an additional 0.10" to 2.5" of rain (Fig. 12).

Another cluster of showers and thunderstorms moved south out of eastern KS and southwest MO into northeast OK and northwest AR after midnight of the 13th. These storms continued to move south across a large portion of eastern OK and northwest AR during the early morning hours. By 7am, the storms stretched from southeast OK into northwest AR and had produced around 0.25" to 2.5" of rain (Fig. 13). This activity finally shifted southeast of the area by late morning. The recent moisture from the storms resulted in widespread dewpoints over 80°F (which doesn't happen very often) (Fig. 14), and combined with hot

temperatures, produced very high heat index values of 107°F to 118°F on the 13th (Fig. 15). By midnight on the 14th, new convection developed from central into northeast OK along a diffuse front as a weak disturbance aloft moved over the region. These storms continued to increase overnight as the low-level jet increased. PWAT values were as high as 2" in places, and combined with some training of storms, resulted in heavy rainfall from northeast OK into west central AR through the overnight and early morning hours. These storms produced an EF-1 tornado in Mansfield, AR (see <https://arcg.is/8jKij> for details). As these storms were shifting east of the area around sunrise, additional thunderstorms were moving into northeast OK. By 7 am, rainfall totals were 0.25" to near 6", with the highest rainfall axis stretching from near Bartlesville, to Tahlequah, to Fort Smith (Fig. 16). The second round of thunderstorms moved southeast across northeast OK and northwest AR, weakening through the morning hours and exiting the area by noon. Yet another MCS from KS moved southeast into the region mid-evening of the 14th. This MCS quickly moved across eastern OK and northwest AR, exiting the area by midnight. However, widely scattered showers and thunderstorms lingered for a few more hours in the wake of the MCS. Rainfall totals ranged from a few hundredths to around 2.5" (Fig. 17).

According to the Oklahoma Mesonet, the first half of July was the wettest on record for the state of Oklahoma. While much of this rain fell across western and central OK, 2"-7" of rain fell across eastern OK (Fig. 18). The near daily storm activity came to an end for the second half of July, but the region then became plagued by high heat and humidity.

An MCS that was moving eastward across northern OK arrived in northeast OK just before sunrise on the 21st. The MCS continued to move east across northeast OK and northwest AR, affecting locations primarily along and north of I-40 through the remainder of the morning. Despite the high PWATs, the fast movement of the storm complex kept rainfall amounts from being excessive, with totals ranging from around 0.25" to 2" (Figs. 19-21).

Thunderstorms that developed over southwest MO moved southeast across Carroll and eastern Madison Counties during the early- to mid-evening hours of the 30th. Just before midnight, an MCS from eastern KS/western MO also moved southeast into northwest AR, and also clipped far northeast OK. While the leading edge quickly exited the area, some scattered showers and thunderstorms lingered into the pre-dawn hours. Rainfall totals were around 0.10" to 1.5" (Fig. 22).

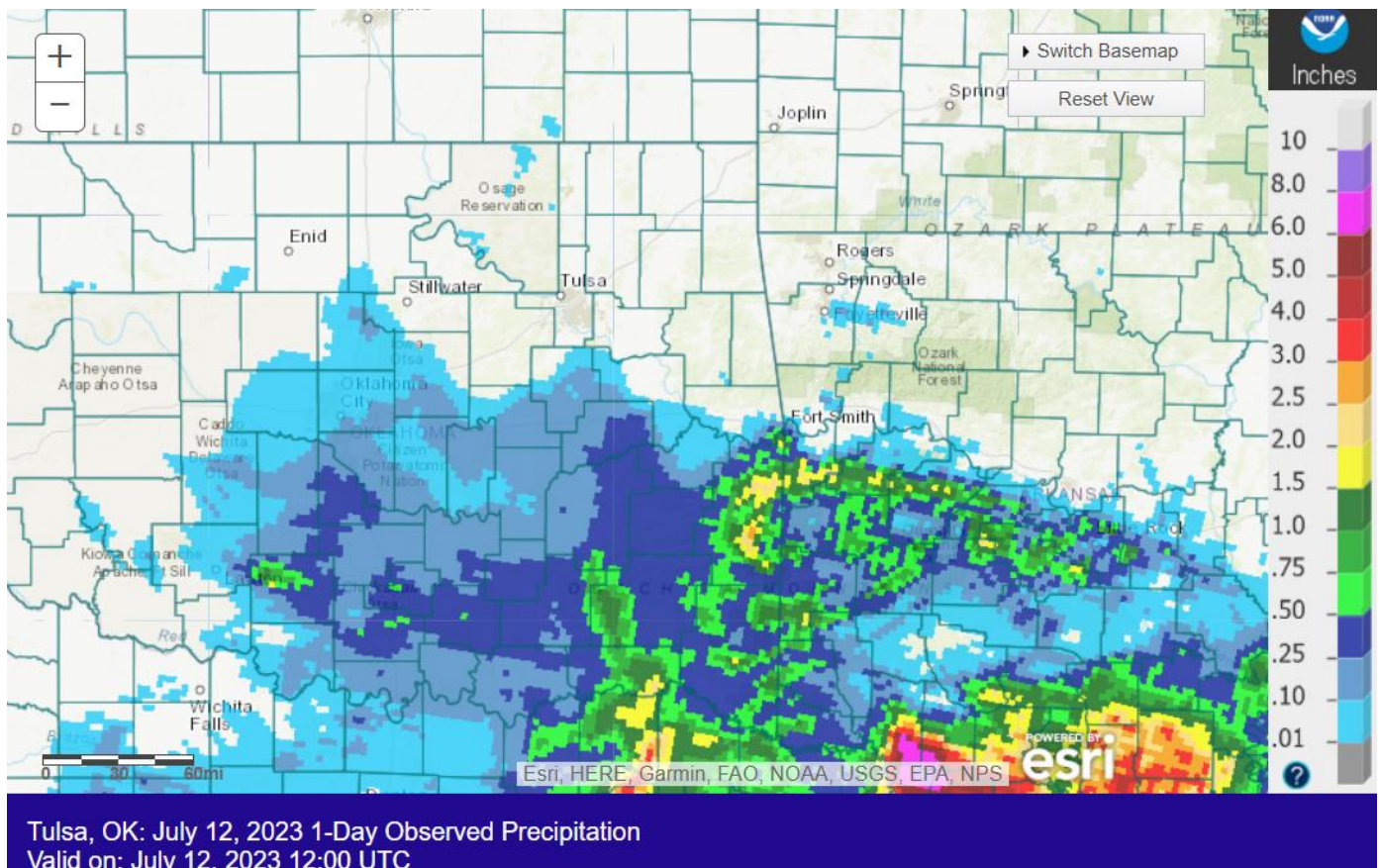
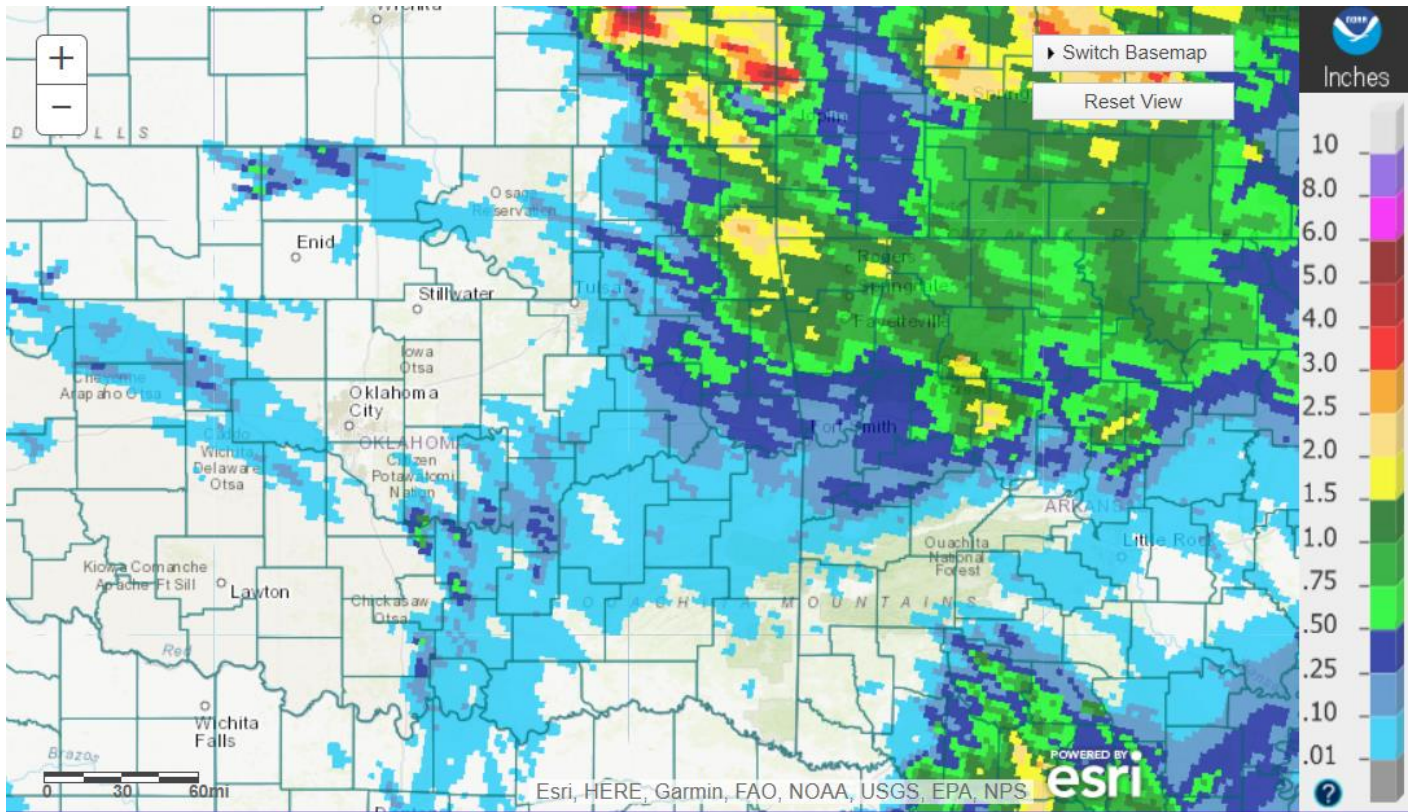
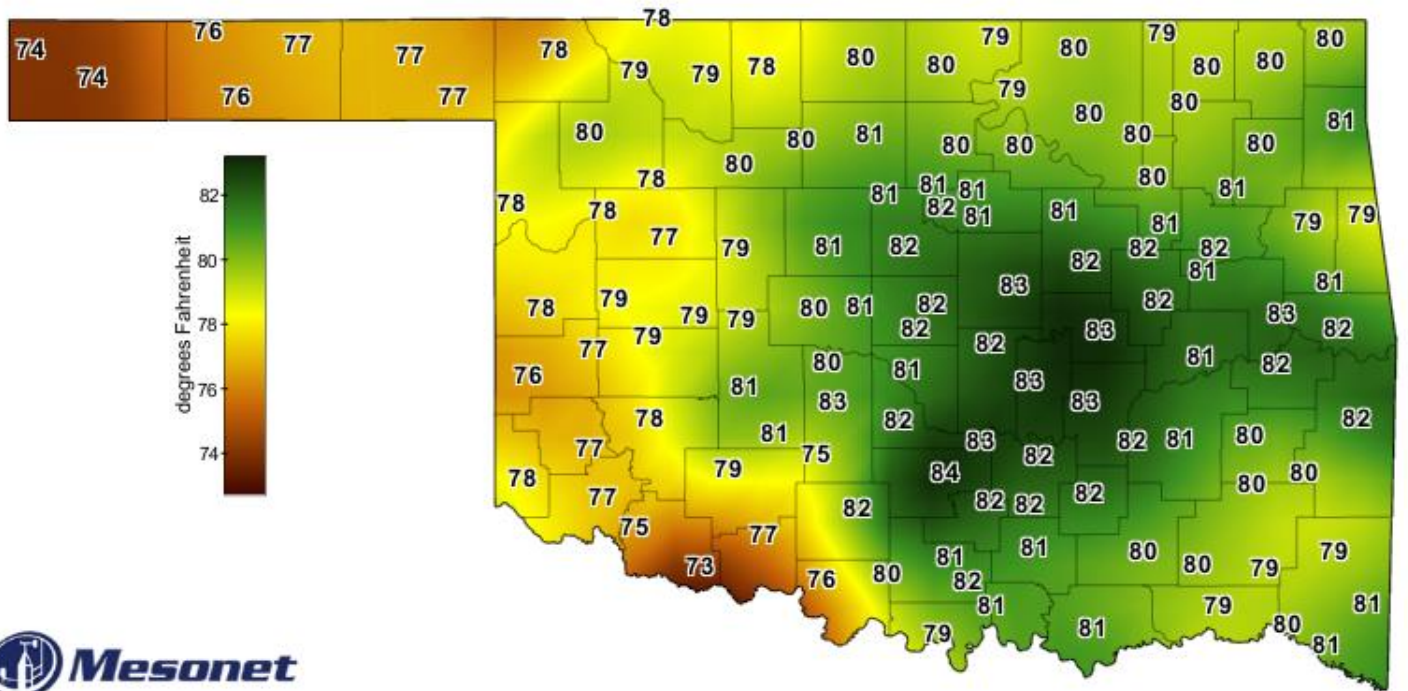


Fig. 12. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/12/2023.



Tulsa, OK: July 13, 2023 1-Day Observed Precipitation
Valid on: July 13, 2023 12:00 UTC

Fig. 13. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/13/2023.

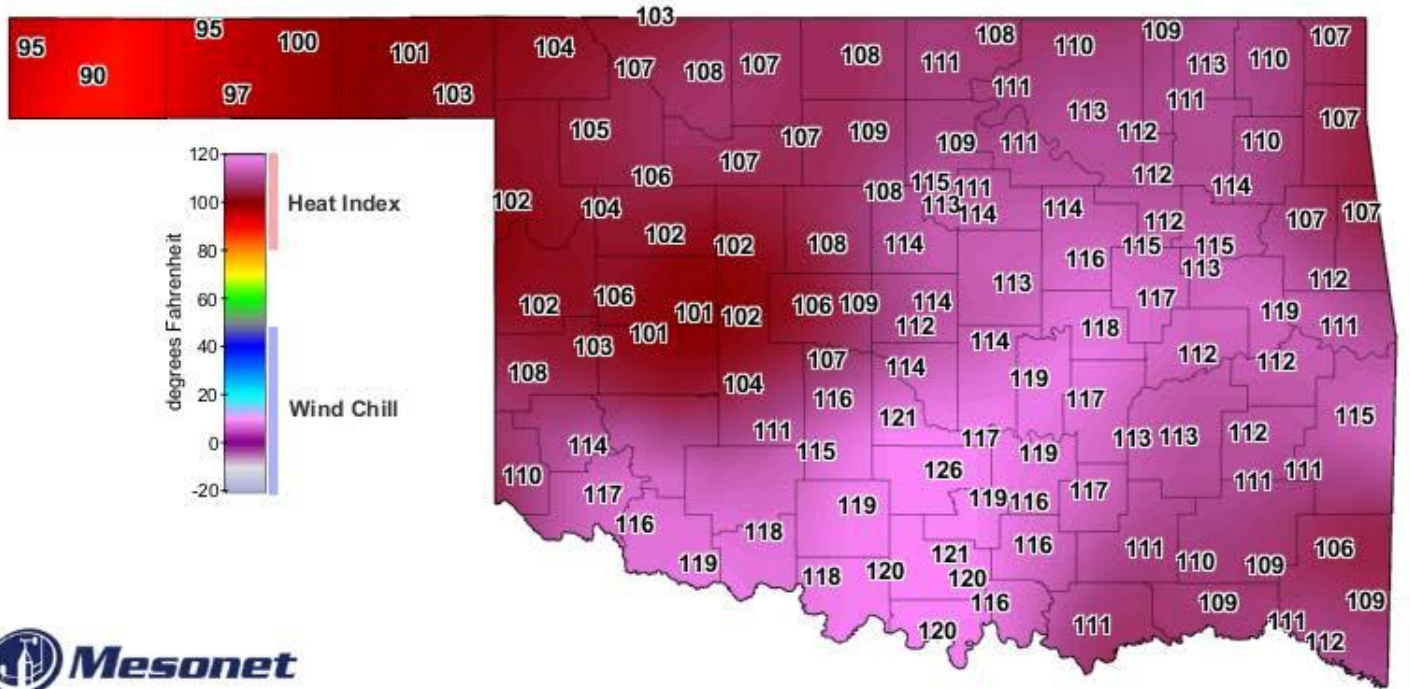


Mesonet
24-hour Maximum Dewpoint Temperature (°F)

12:00 AM July 14, 2023 CDT

Created 12:05:48 AM July 14, 2023 CDT. © Copyright 2023

Fig. 14. OK Mesonet 24-hour Maximum Dew Point Temperatures ending at 12:00 am CDT 7/14/2023.

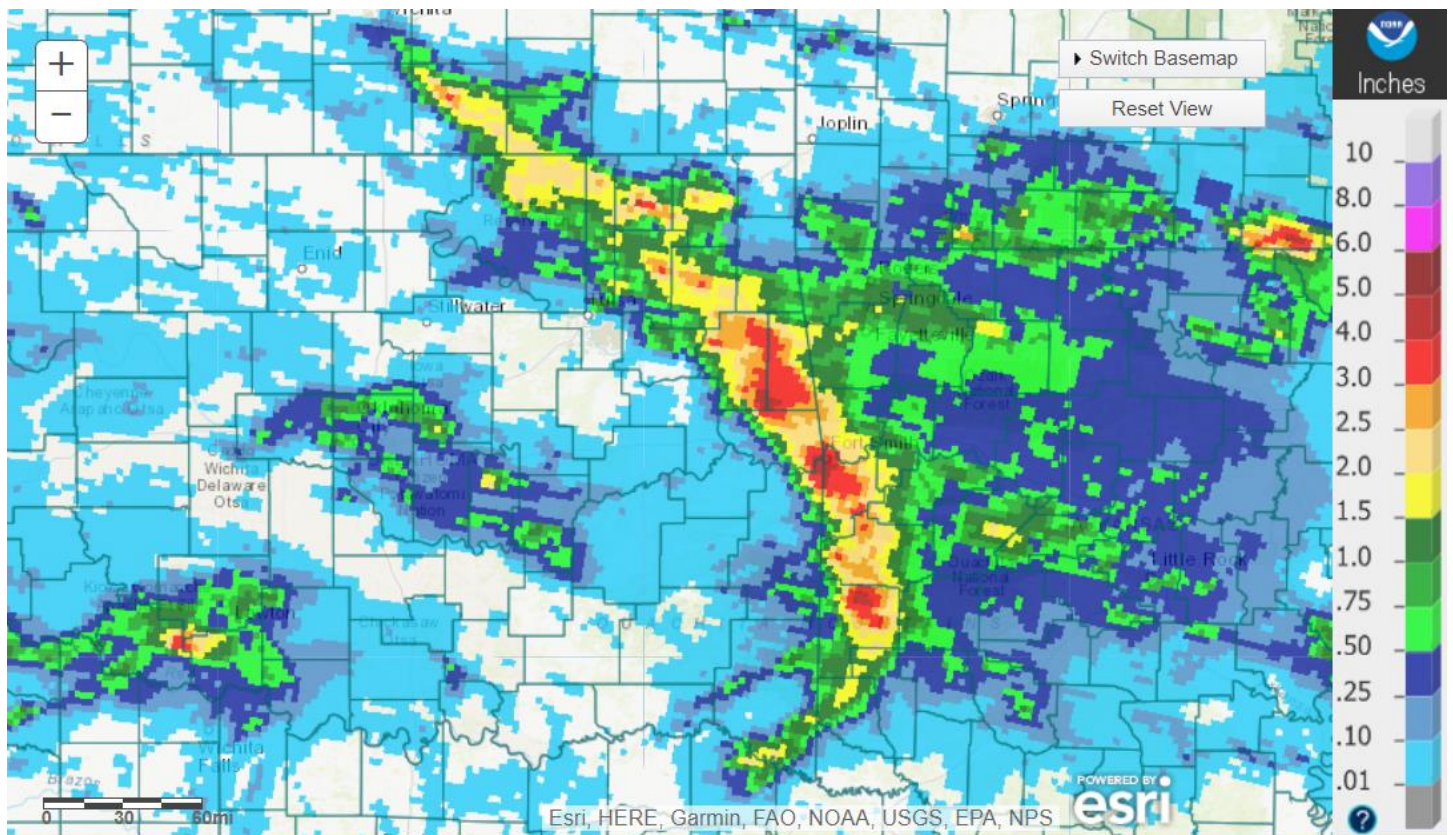


Today's Maximum Wind Chill / Heat Index (°F)

5:15 PM July 13, 2023 CDT

Created 5:20:50 PM July 13, 2023 CDT. © Copyright 2023

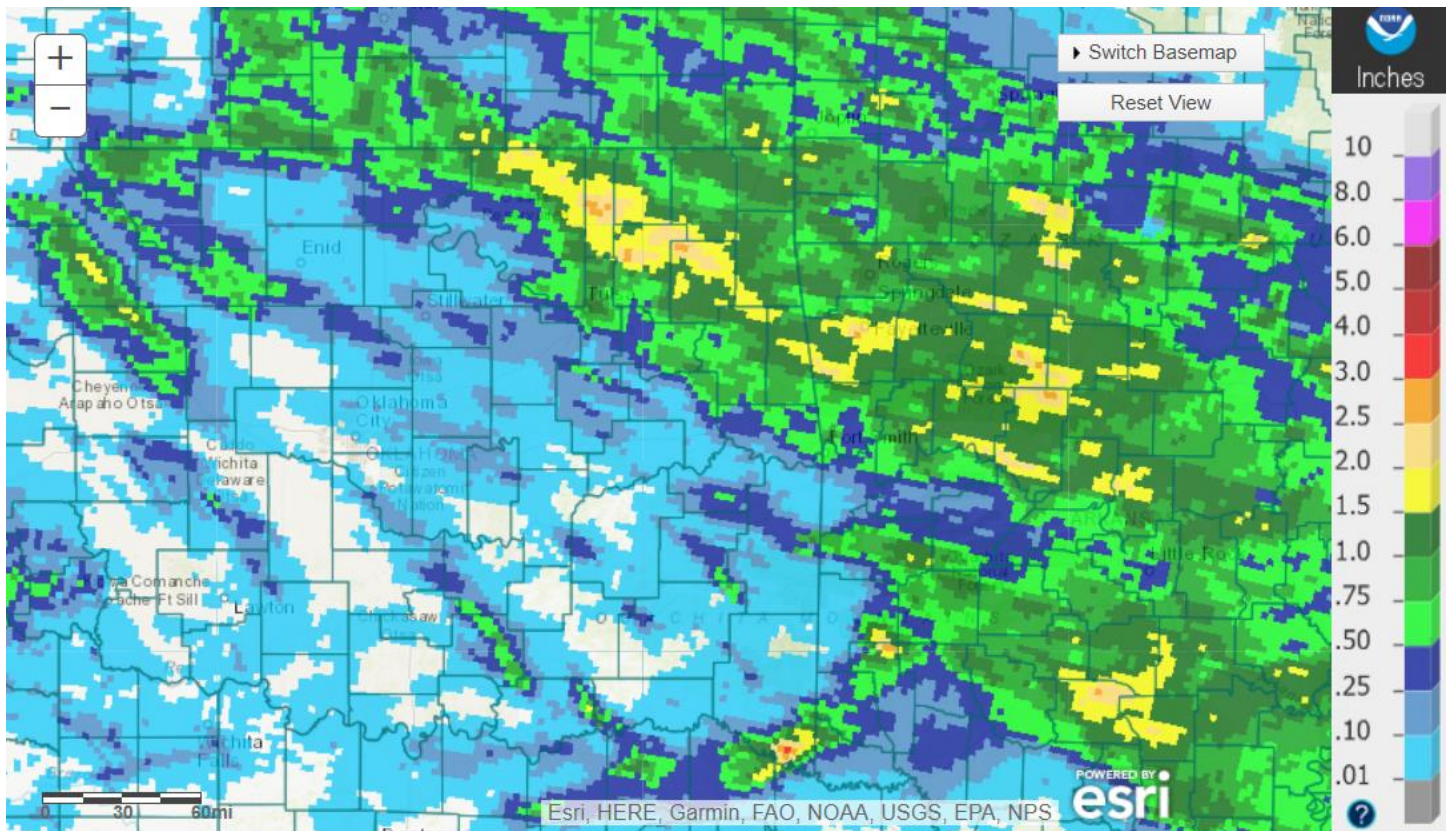
Fig. 15. OK Mesonet Maximum Heat Index values at 5:15 pm CDT 7/13/2023.



Tulsa, OK: July 14, 2023 1-Day Observed Precipitation

Valid on: July 14, 2023 12:00 UTC

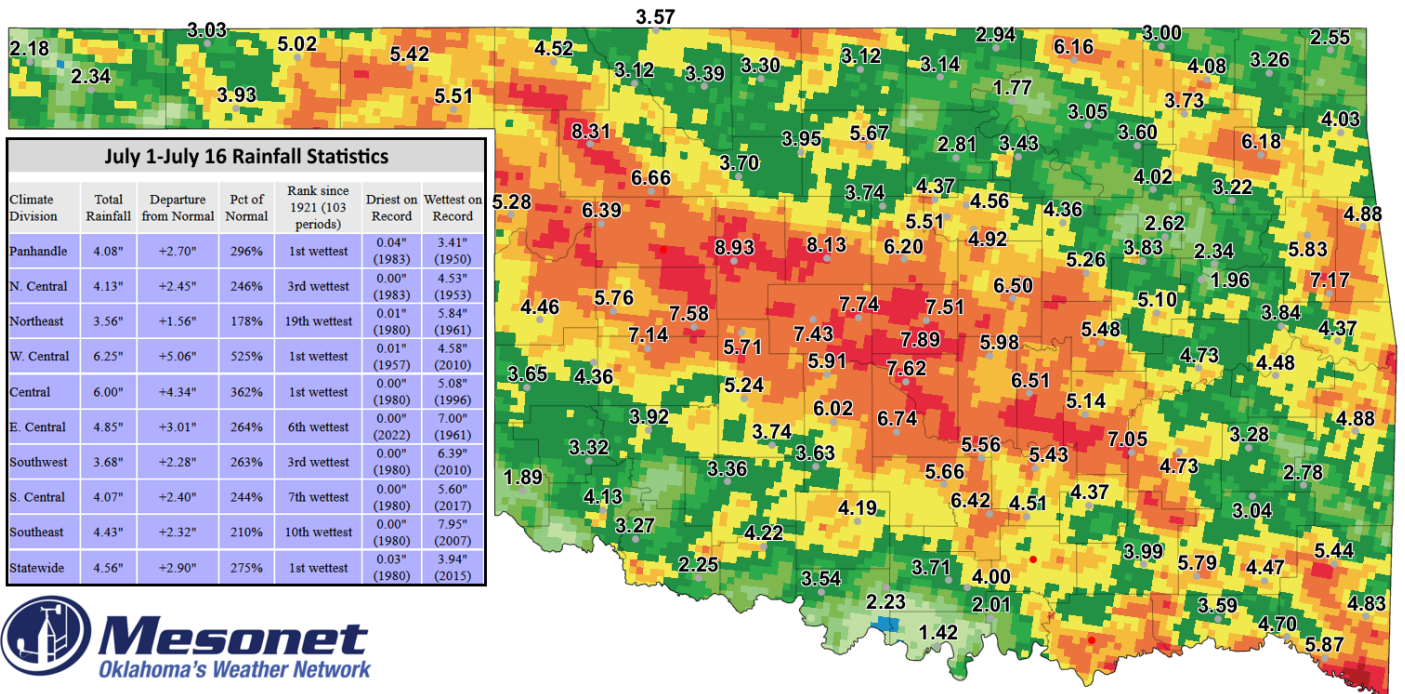
Fig. 16. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/14/2023.



Tulsa, OK: July 15, 2023 1-Day Observed Precipitation
Valid on: July 15, 2023 12:00 UTC

Fig. 17. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/15/2023.

FIRST HALF OF JULY: WETTEST IN LAST 100 YEARS

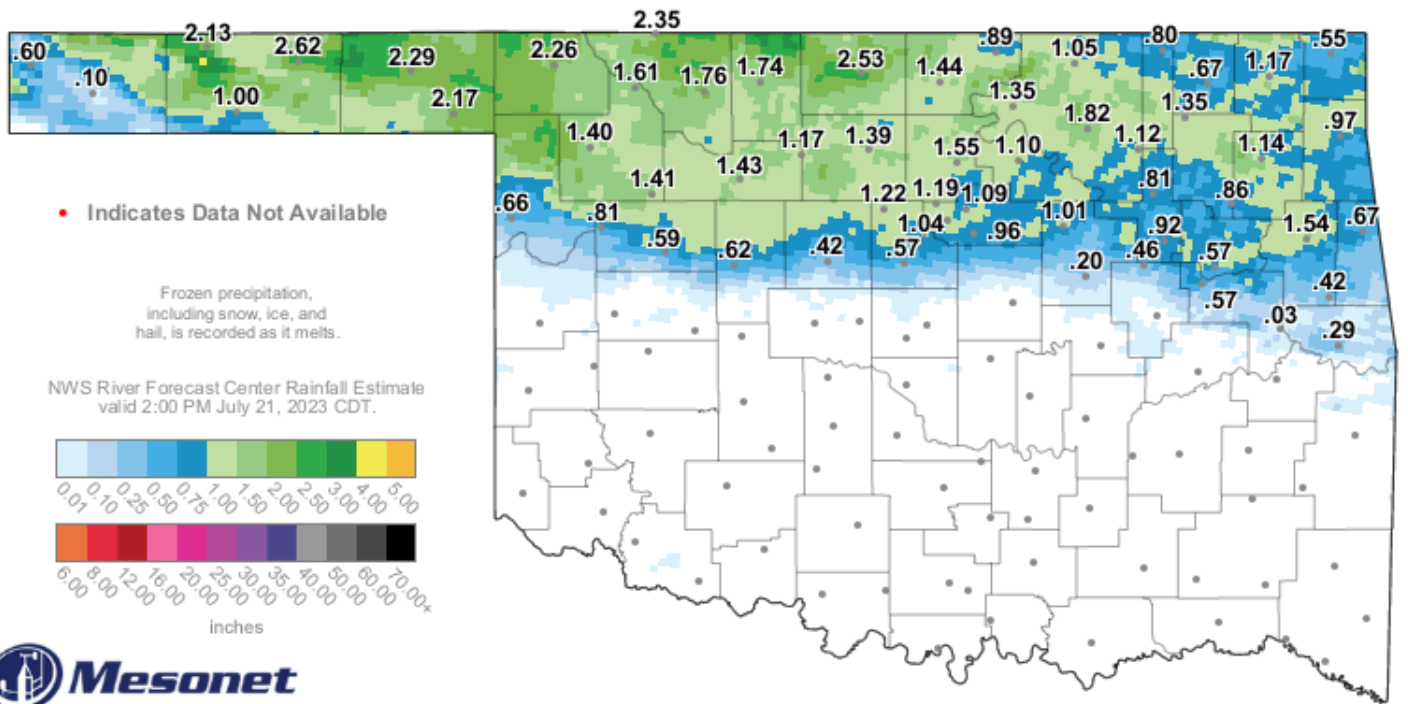


16-Day Rainfall Accumulation (inches)

July 1-July 16, 2023

Created 8:01:41 AM July 17, 2023 CDT. © Copyright 2023

Fig. 18. OK Mesonet (values) and NWS RFC rainfall estimate (image) 16-Day rainfall for July 1-16, 2023.

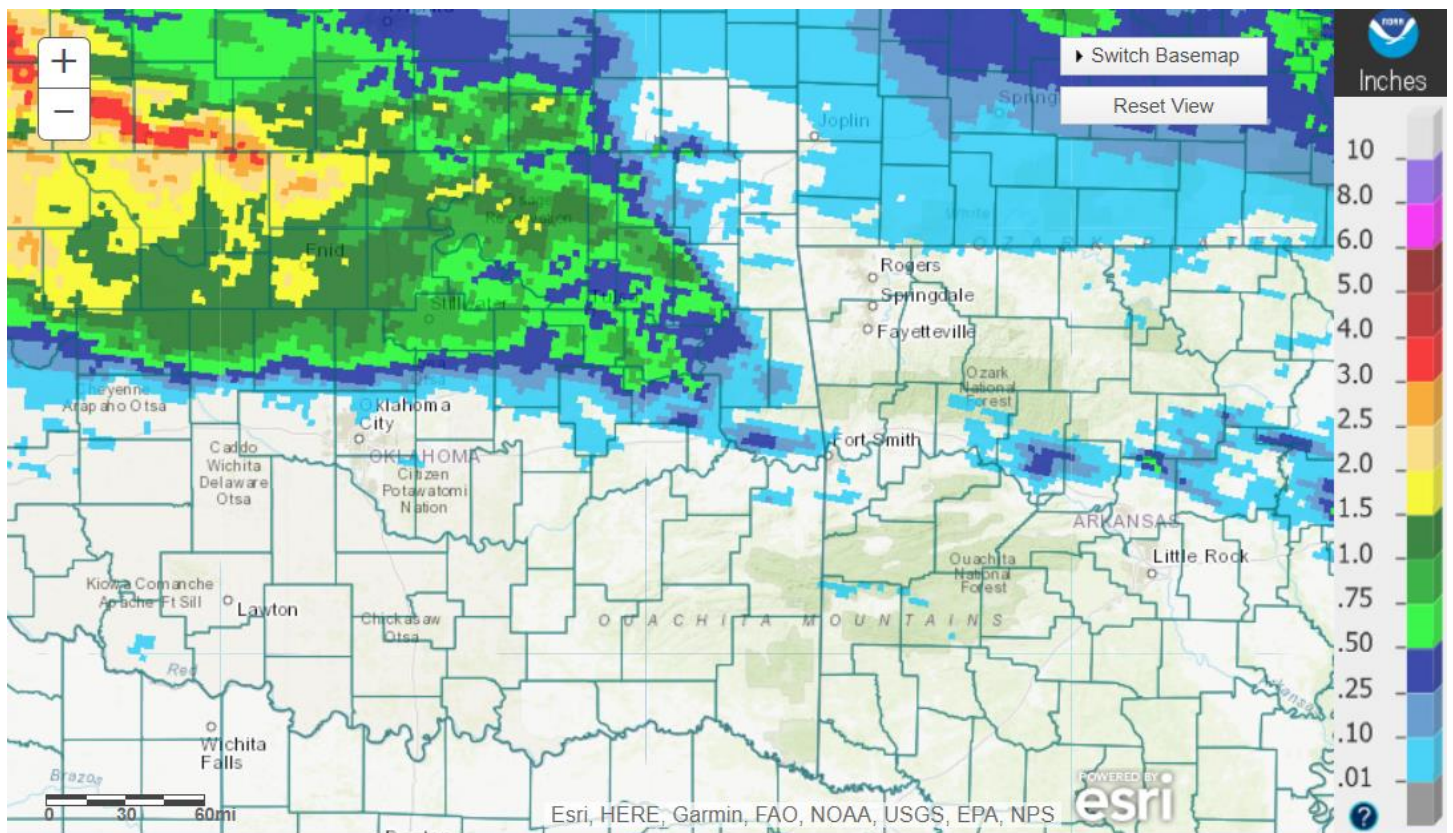


24-Hour Rainfall Accumulation (inches)

2:45 PM July 21, 2023 CDT

Created 2:49:48 PM July 21, 2023 CDT. © Copyright 2023

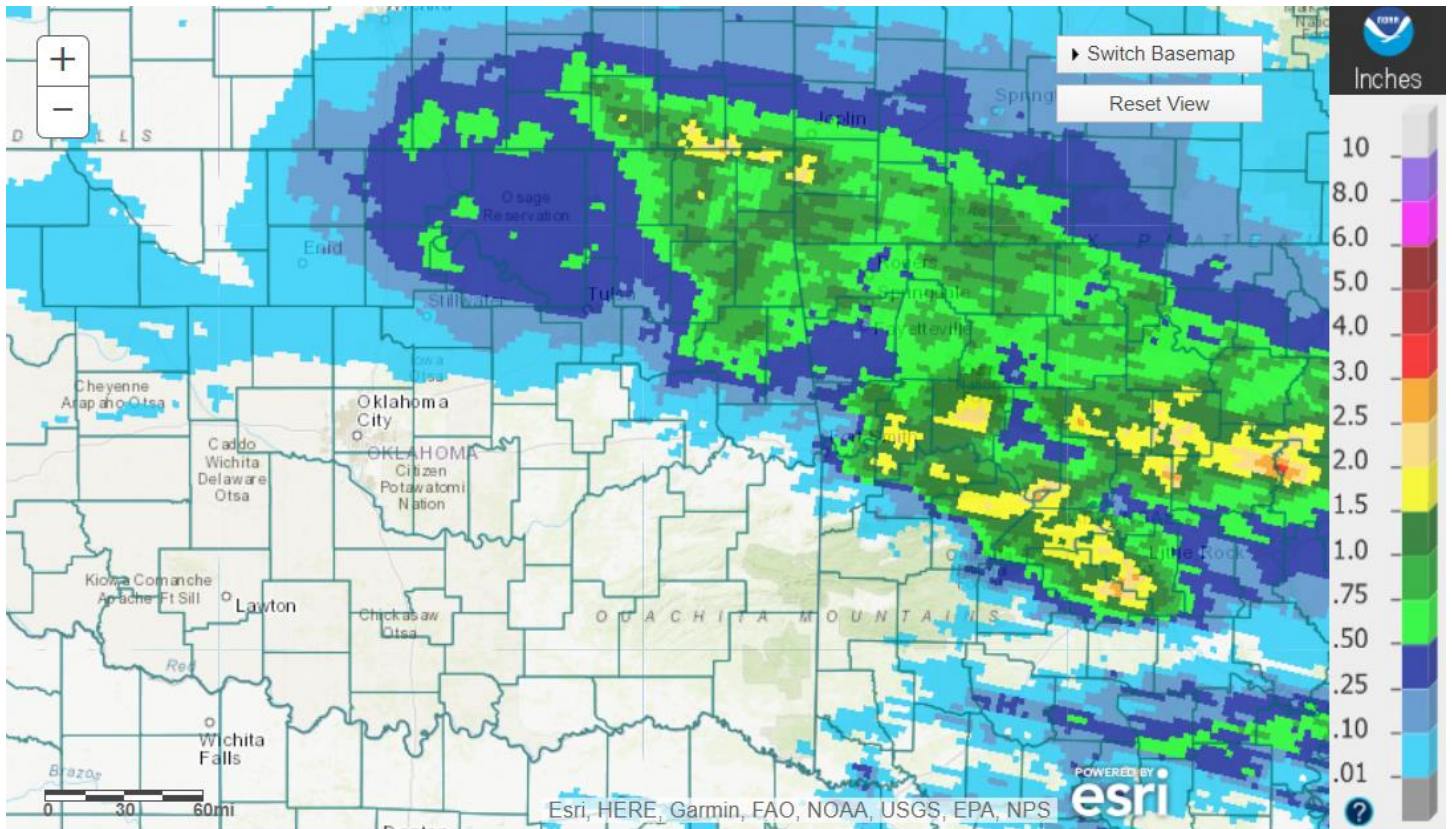
Fig. 19. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 2:45 pm CDT 7/21/2023.



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

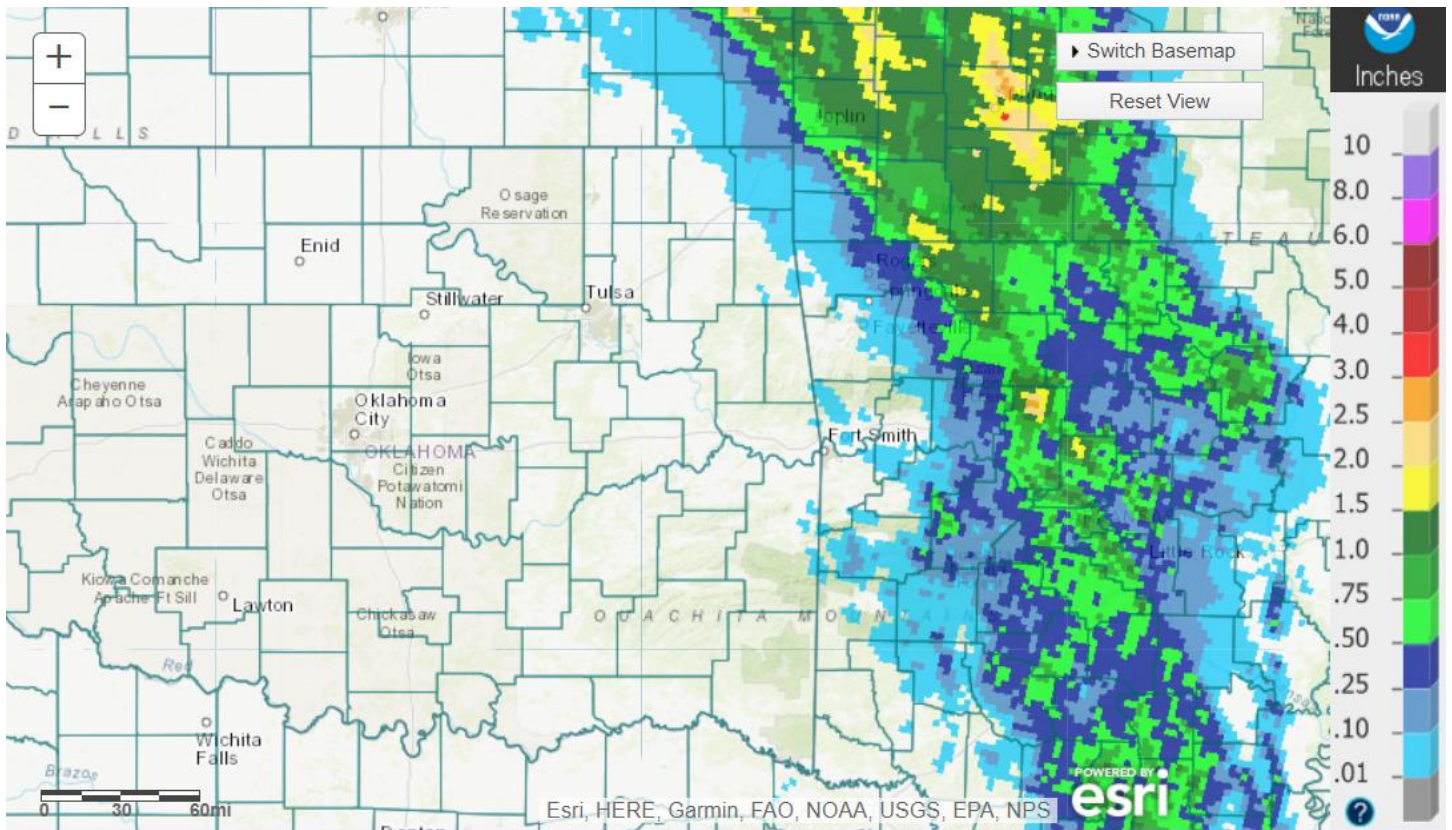
Valid on: July 21, 2023 12:00 UTC

Fig. 20. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/21/2023.



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

Fig. 21. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/22/2023.



Tulsa, OK: July 31, 2023 1-Day Observed Precipitation
Valid on: July 31, 2023 12:00 UTC

Fig. 22. 24-hour Estimated Observed Rainfall ending at 7am CDT 7/31/2023.

Written by:

Nicole McGavock
Service Hydrologist
WFO Tulsa

Products issued in July 2023:

- 3 Flash Flood Warnings (FFW)
- 2 Flash Flood Statements (FFS)
- 2 Flash/Areal Flood Watches (FFA) (5 Watch FFA CON/EXT/EXA/EXB/CAN)
- 19 Urban and Small Stream Advisories (FLS)
- 1 Areal Flood Warnings (FLW)
- 1 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