

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 2021
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 13, 2021	

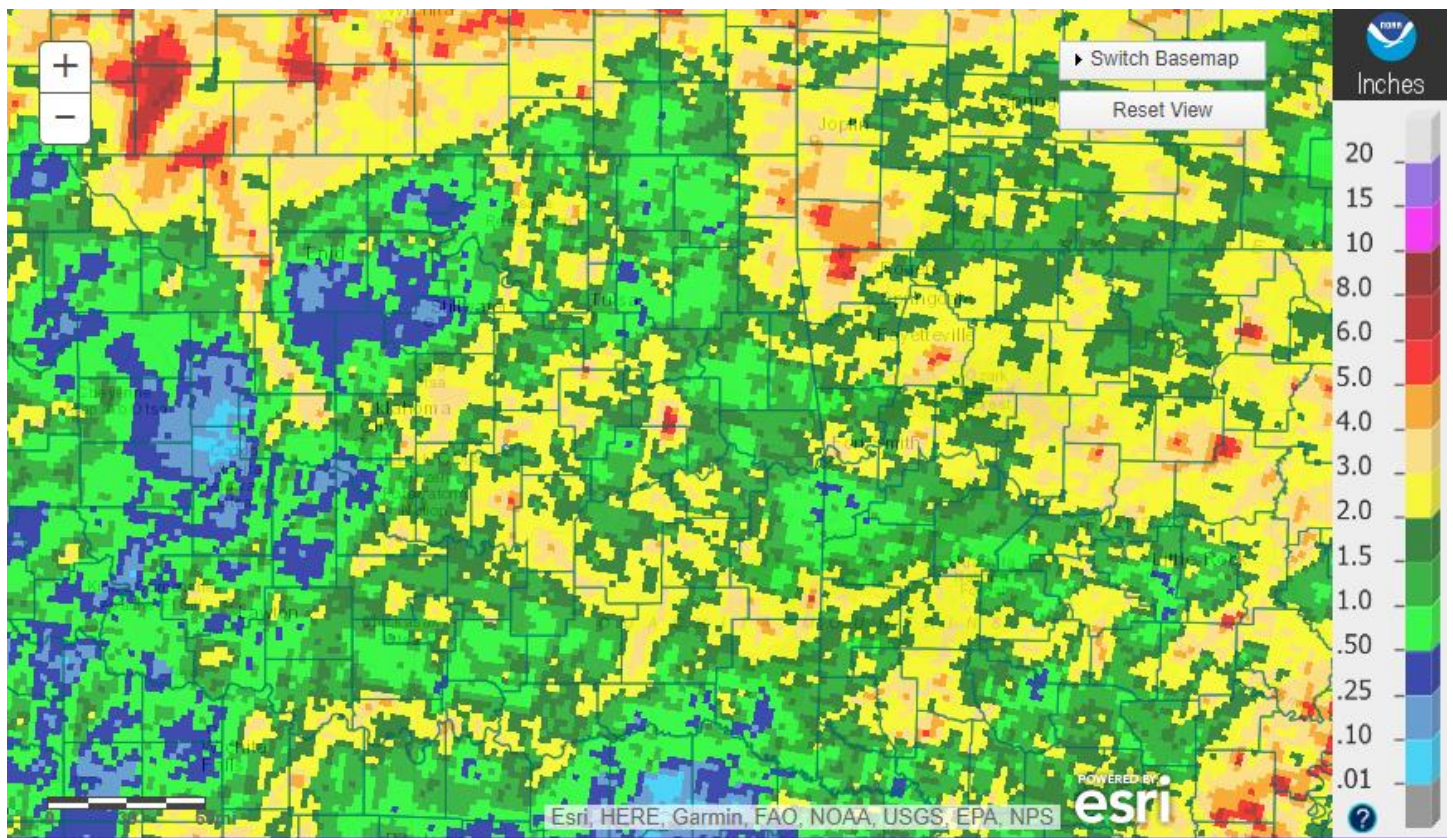
When no flooding occurs, include miscellaneous river conditions, such as significant rises, record low stages, ice conditions, snow cover, droughts, and hydrologic products issued (NWS Instruction 10-924)

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

September 2021 was a hot and dry month across eastern OK and northwest AR. 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 <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 September 2021 ranged from around 0.5" to around 6" across eastern OK and northwest AR, with much of the area receiving 0.5"-2". These rainfall totals correspond to only 5% to 75% of the normal September rainfall across nearly all of eastern OK and northwest AR (Fig. 1b).



Tulsa, OK: September, 2021 Monthly Observed Precipitation
 Valid on: October 01, 2021 12:00 UTC

Fig. 1a. Estimated Observed Rainfall for September 2021

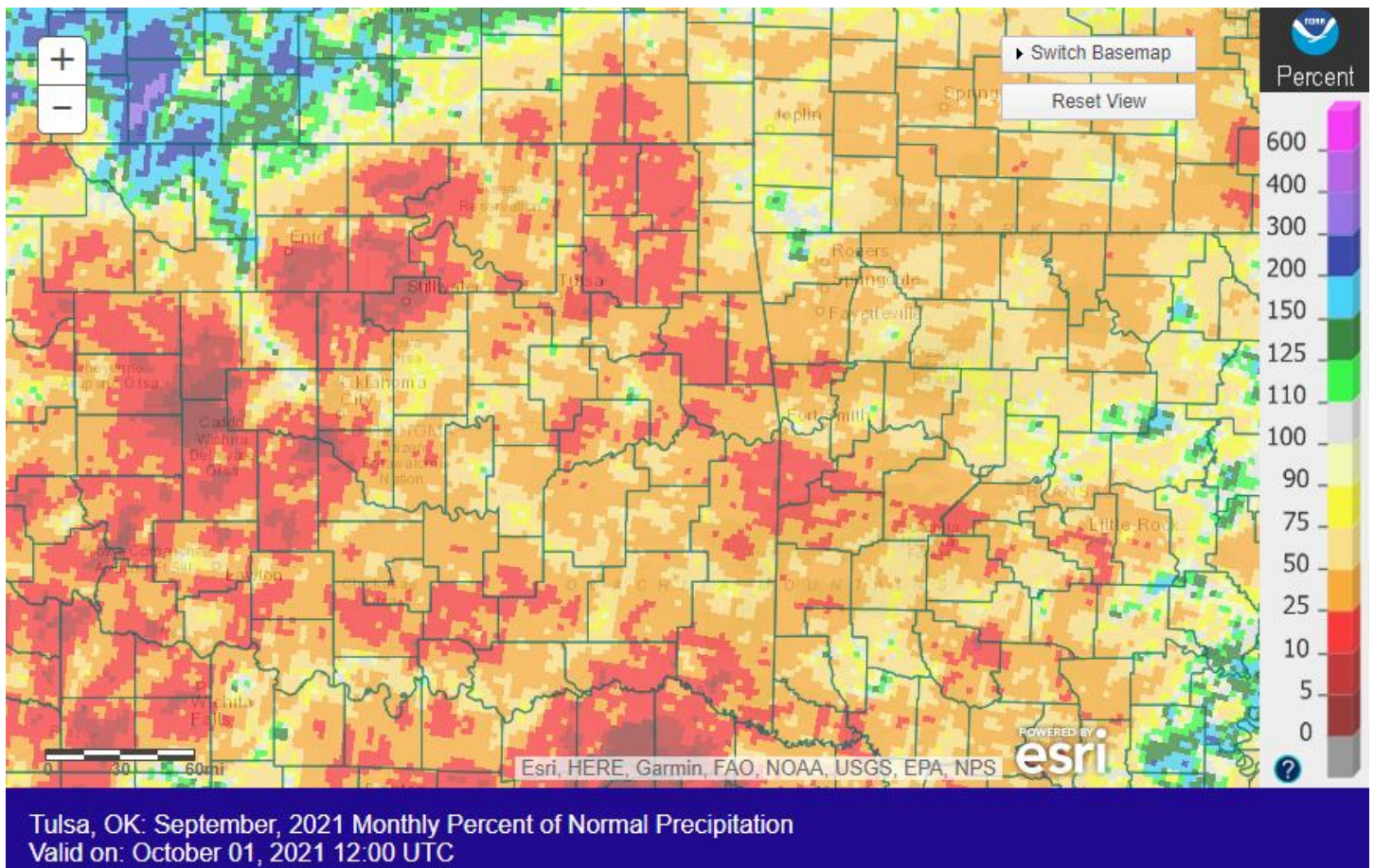


Fig. 1b. Estimated % of Normal Rainfall for September 2021

In Tulsa, OK, September 2021 ranked as the 8th warmest September (79.3°F; since records began in 1905) and the 24th driest September (1.32"; since records began in 1888). Fort Smith, AR had the 16th warmest September (78.4°F; since records began in 1882) and the 42nd driest September (1.88", tied 1981, 1912; since records began in 1882). Fayetteville, AR had the 7th warmest (73.5°F) and the 15th driest (1.93") September since records began in 1949.

Some of the larger precipitation reports (in inches) for September 2021 included:

Gravette, AR (coop)	5.61	Bella Vista 2.2E, AR (coco)	5.29	Bentonville, AR (AWOS)	4.87
Hectorville, OK (meso)	4.49	Pea Ridge 0.2WSW, AR (coco)	3.90	Centerton 1.0E, AR (coco)	3.87
Bella Vista 0.6WSW, AR (coco)	3.85	Miami, OK (meso)	3.78	Wilburton, OK (meso)	3.68

Some of the lowest precipitation reports (in inches) for September 2021 included:

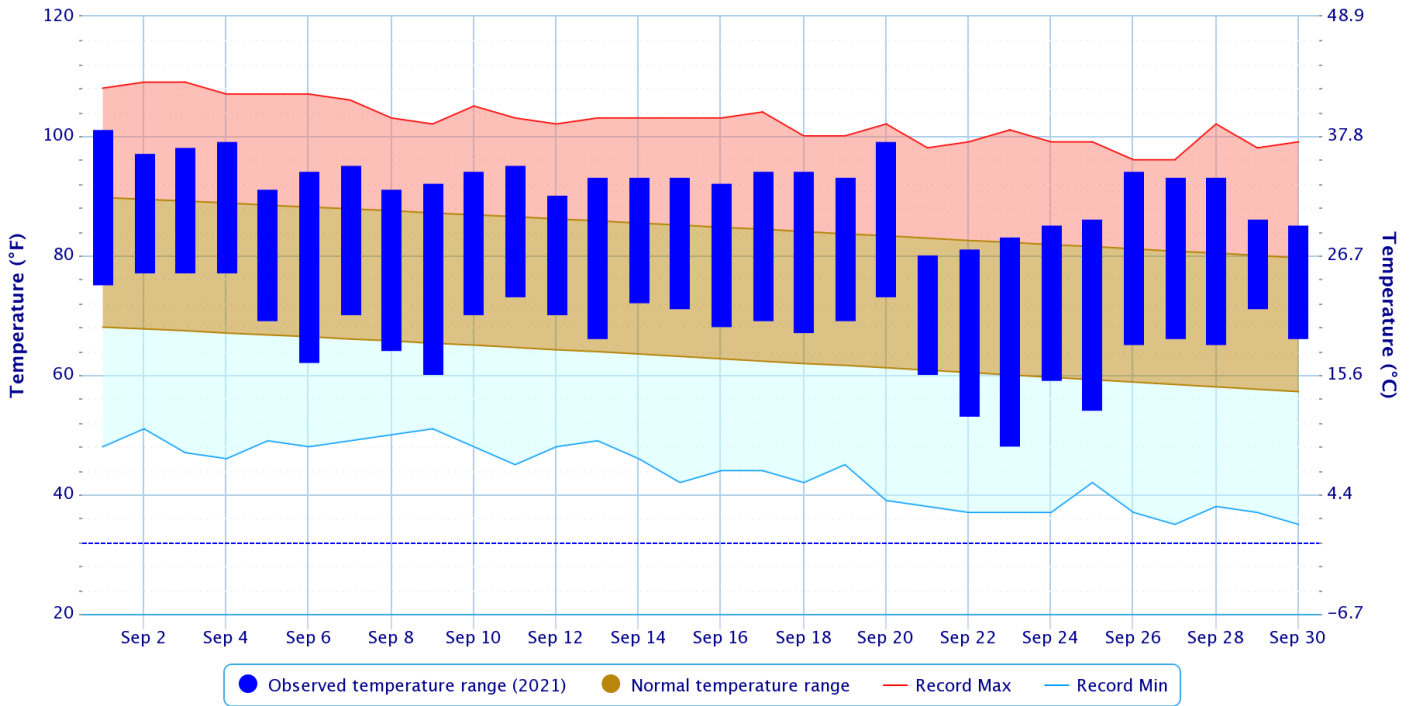
Tulsa 7.7SSE, OK (coco)	0.09	Claremore 7.5W, OK (coco)	0.10	Owasso 1.5ESE, OK (coco)	0.15
Vinita 8.6ESE, OK (coco)	0.22	Sand Springs 4.6WNW, OK (coco)	0.34	Antlers 6.3SE, OK (coco)	0.36
Burbank, OK (meso)	0.37	Broken Arrow 2.2SW, OK (coco)	0.41	Hugo 1.9ENE, OK (coco)	0.57

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

Rank since 1921	Sept. 2021	Last 60 Days (Aug 2 – Sep 30)	Last 90 Days (Jul 3 – Sep 30)	Last 120 Days (Jun 3 – Sep 30)	Year-to-Date (Jan 1 – Sep 30)	Water Year 2021 (Oct 1, 2020 – Sep 30, 2021)	Last 180 Days (Apr 4 – Sep 30, 2021)
Northeast OK	13 th driest	6th driest	17 th driest	47 th driest	43 rd wettest	32 nd wettest	46 th wettest
East Central OK	21 st driest	20 th driest	17 th driest	22 nd driest	47 th driest	47 th driest	41 st wettest
Southeast OK	16 th driest	46 th driest	45 th driest	44 th wettest	31 st wettest	44 th wettest	19 th wettest
Statewide	11 th driest	11 th driest	16 th driest	37 th driest	50 th driest	49 th wettest	48 th wettest

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

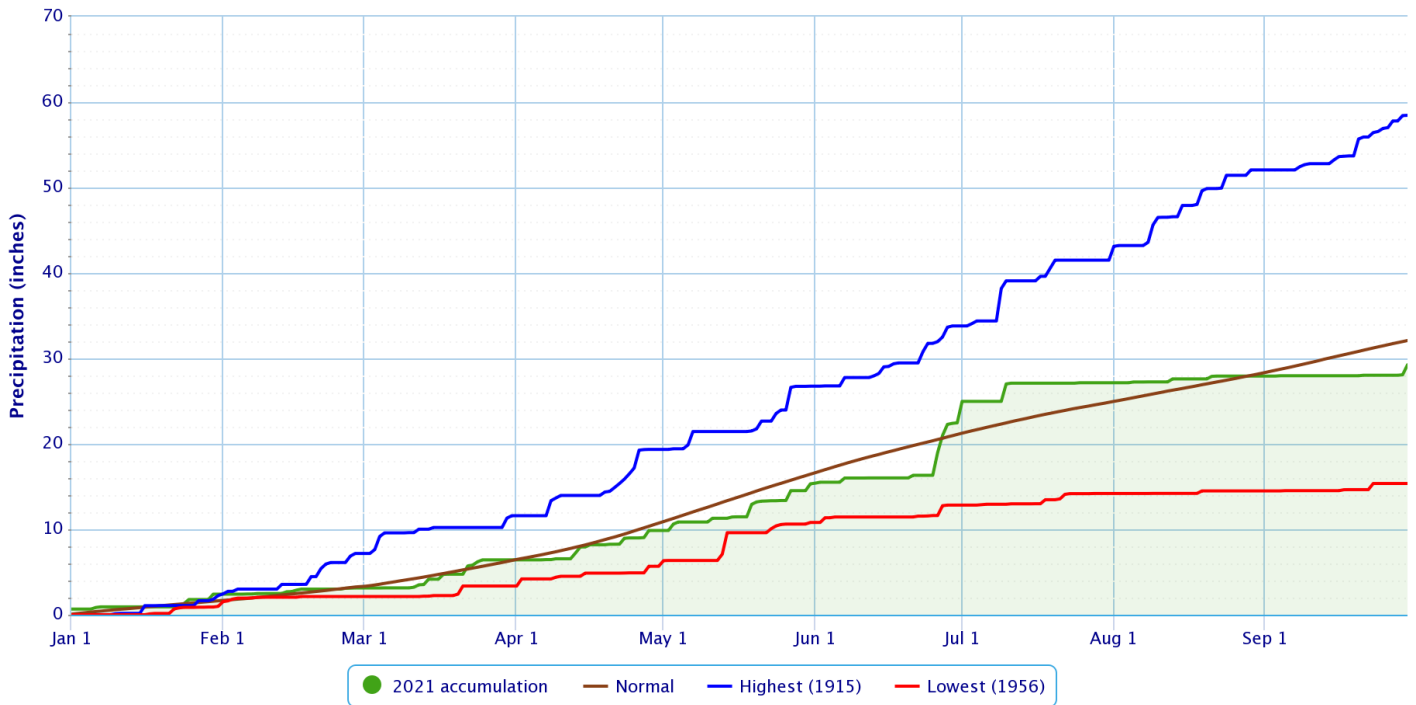
Period of Record – 1905-01-06 to 2021-10-12. Normals period: 1991-2020. Click and drag to zoom chart.



Powered by ACIS

Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

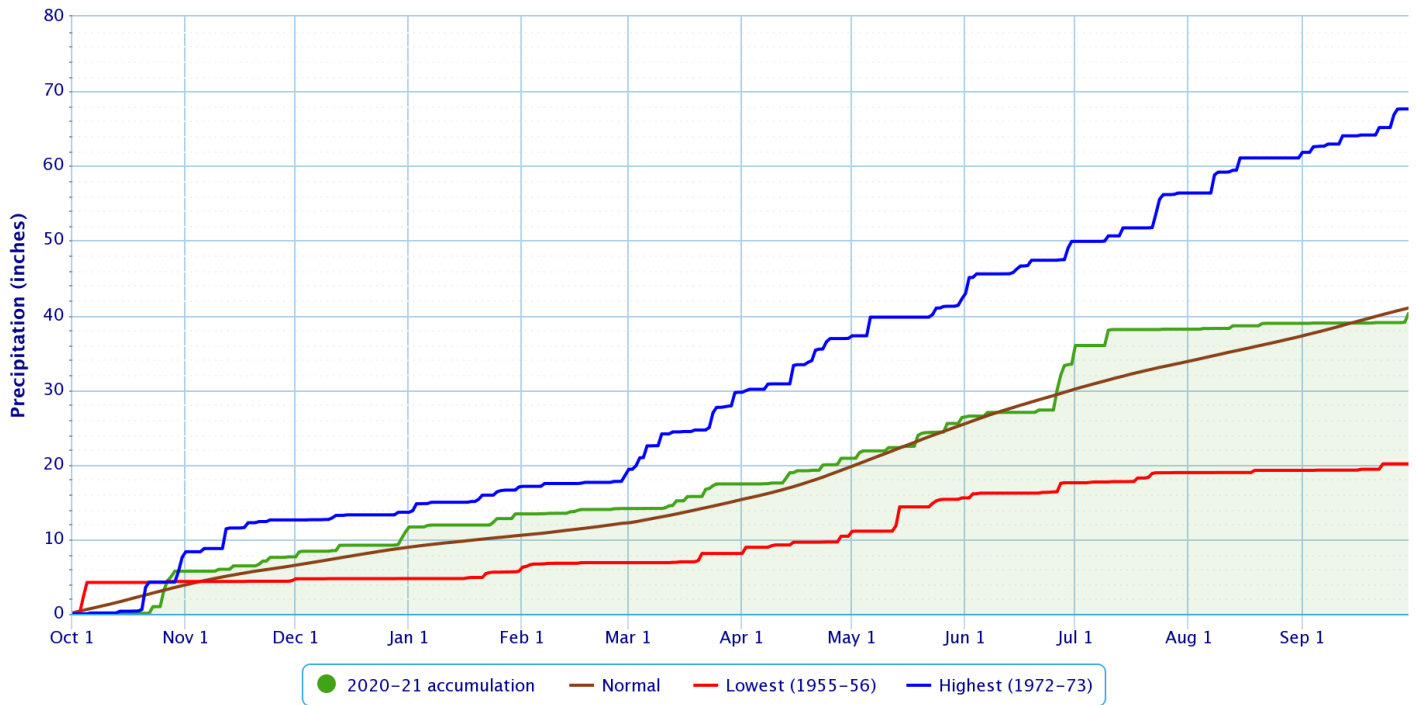
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

Accumulated Precipitation - Tulsa Area, OK (ThreadEx)

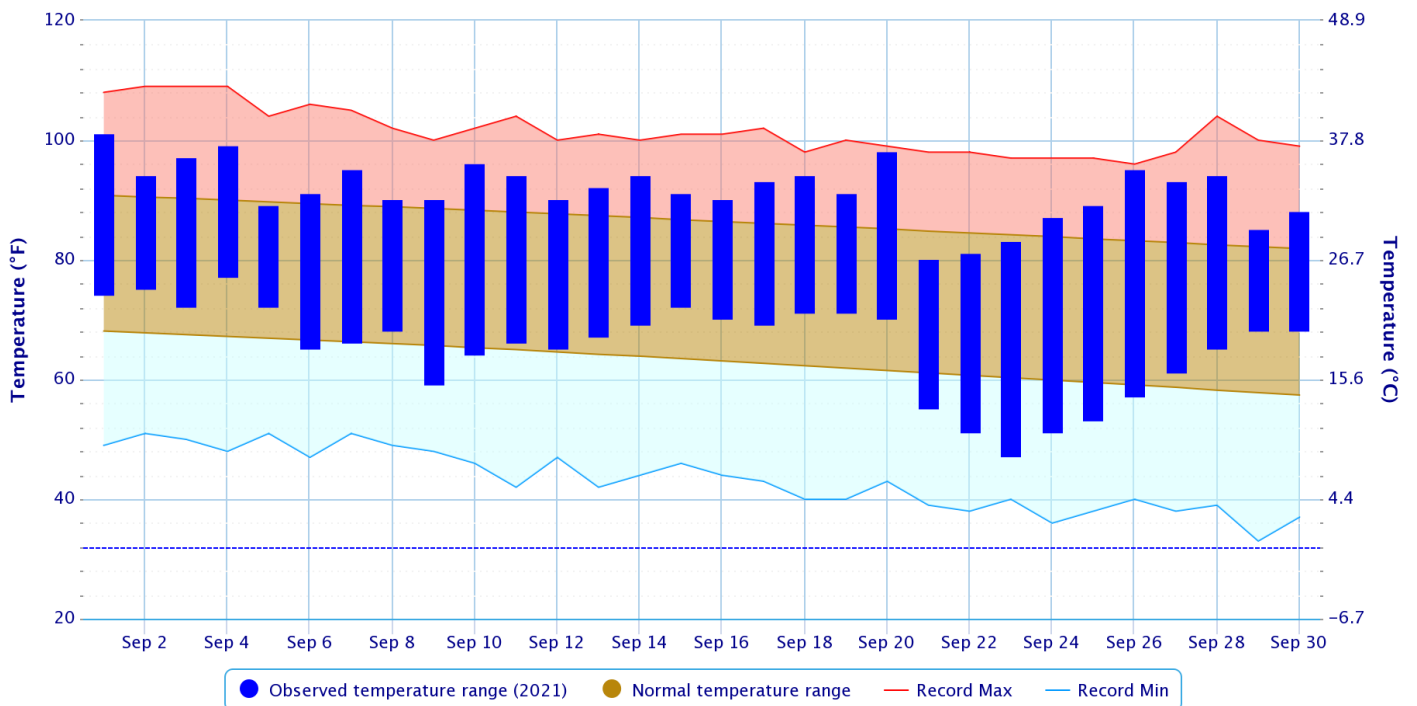
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

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

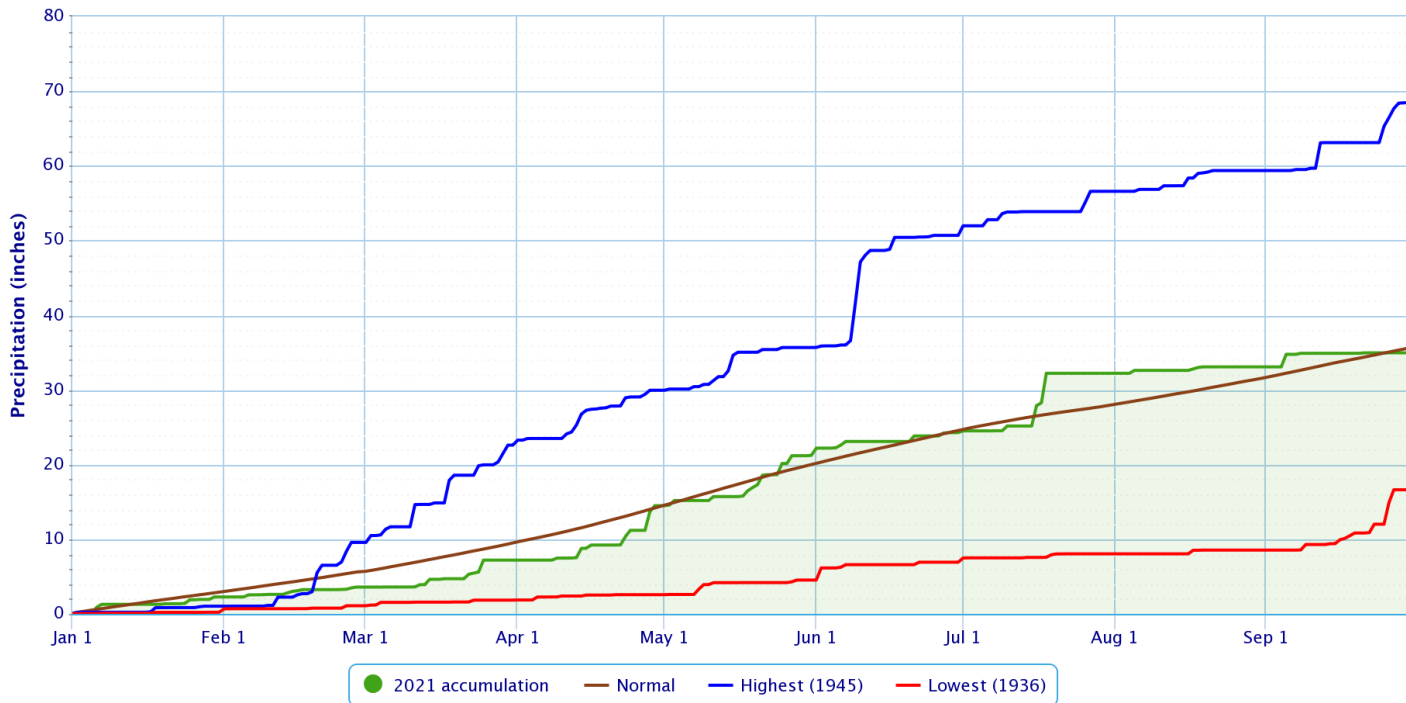
Period of Record - 1882-06-01 to 2021-10-12. Normals period: 1991-2020. Click and drag to zoom chart.



Powered by ACIS

Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

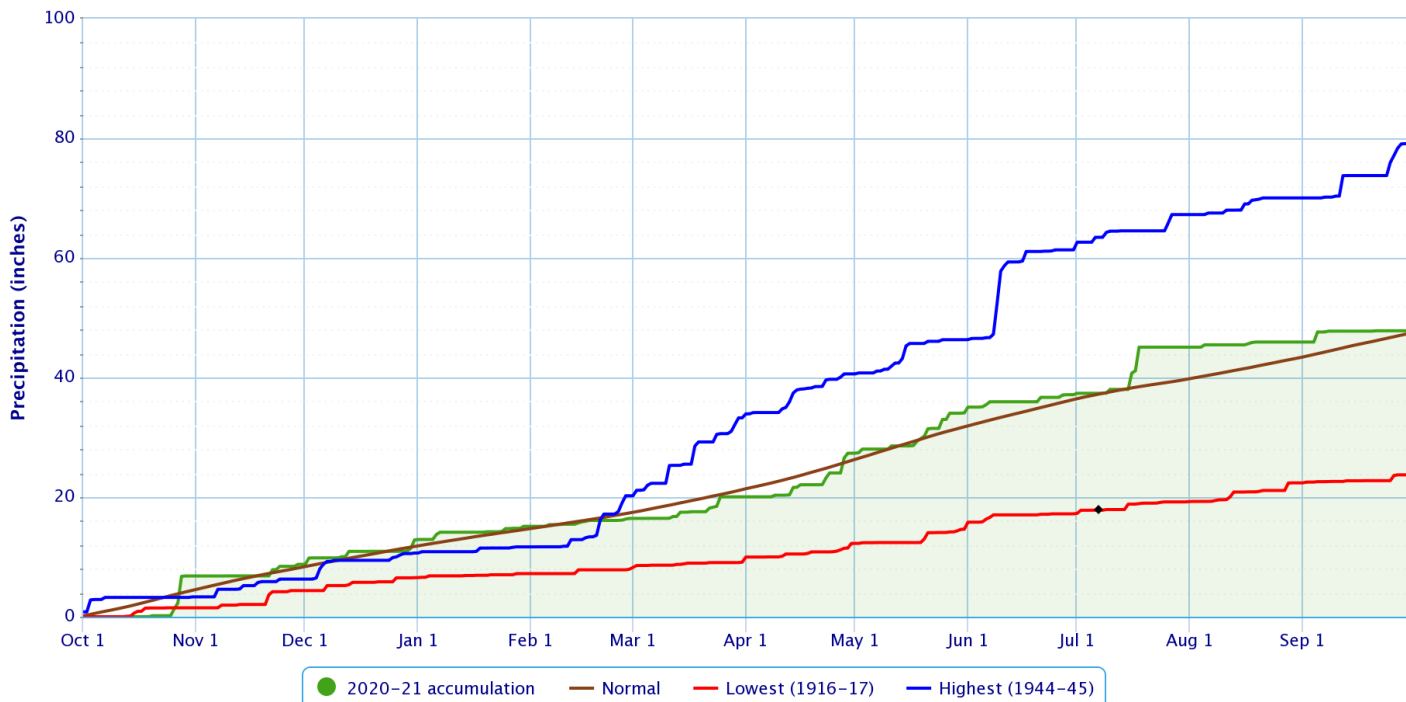
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

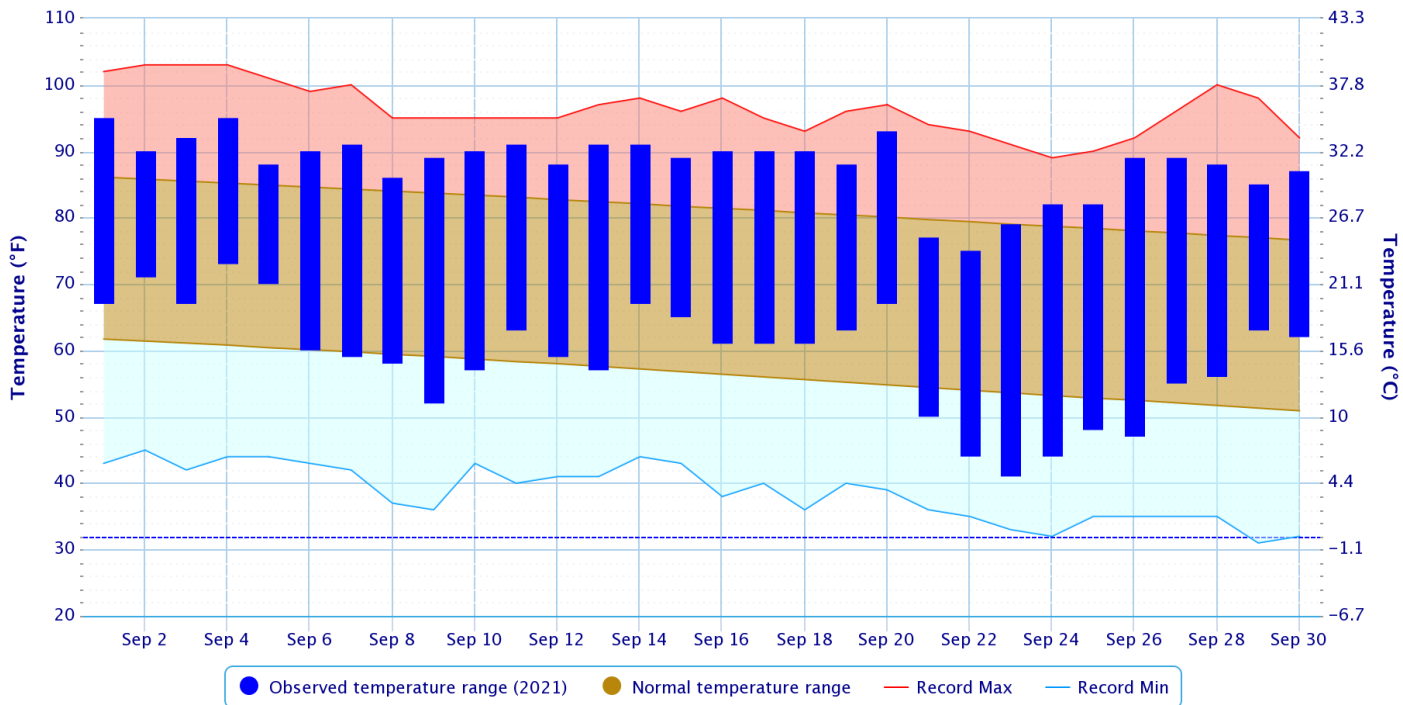
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

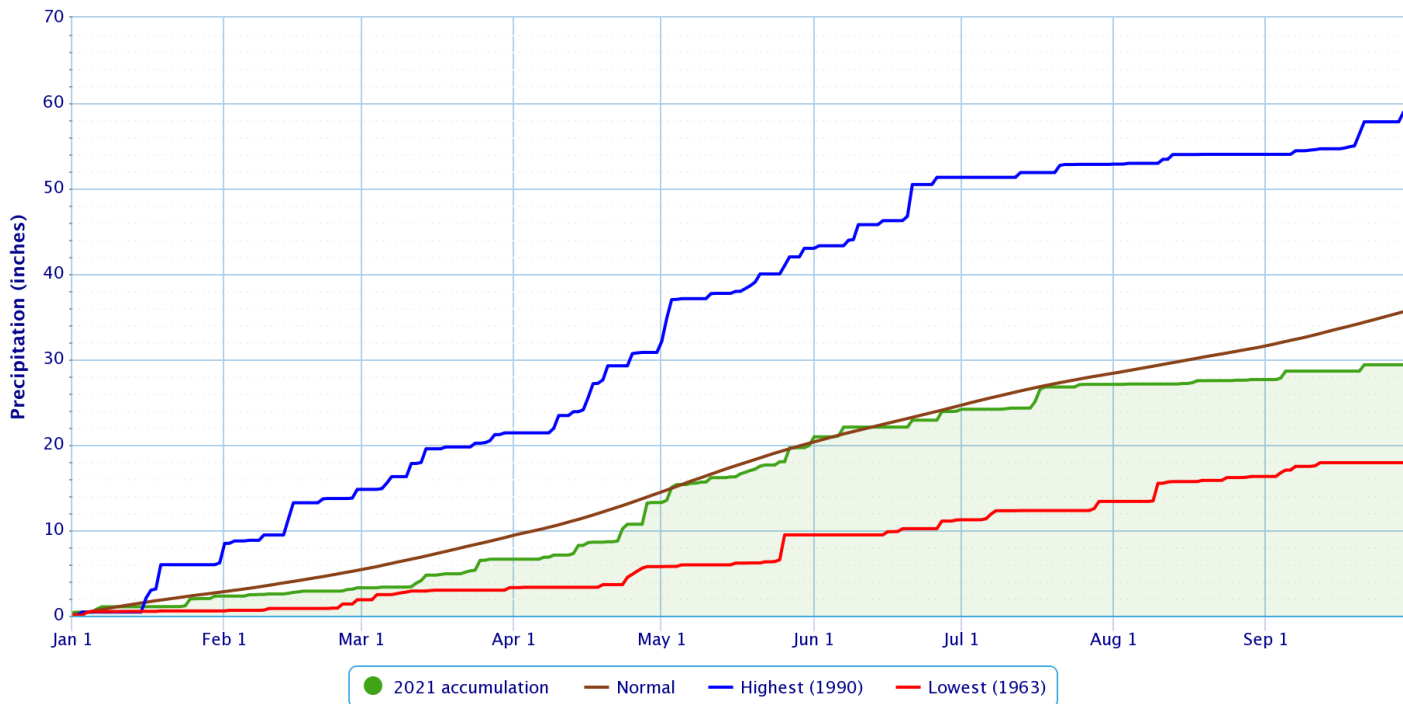
Period of Record – 1949-07-14 to 2021-10-12. Normals period: 1991-2020. Click and drag to zoom chart.



Powered by ACIS

Accumulated Precipitation – FAYETTEVILLE DRAKE FIELD, AR

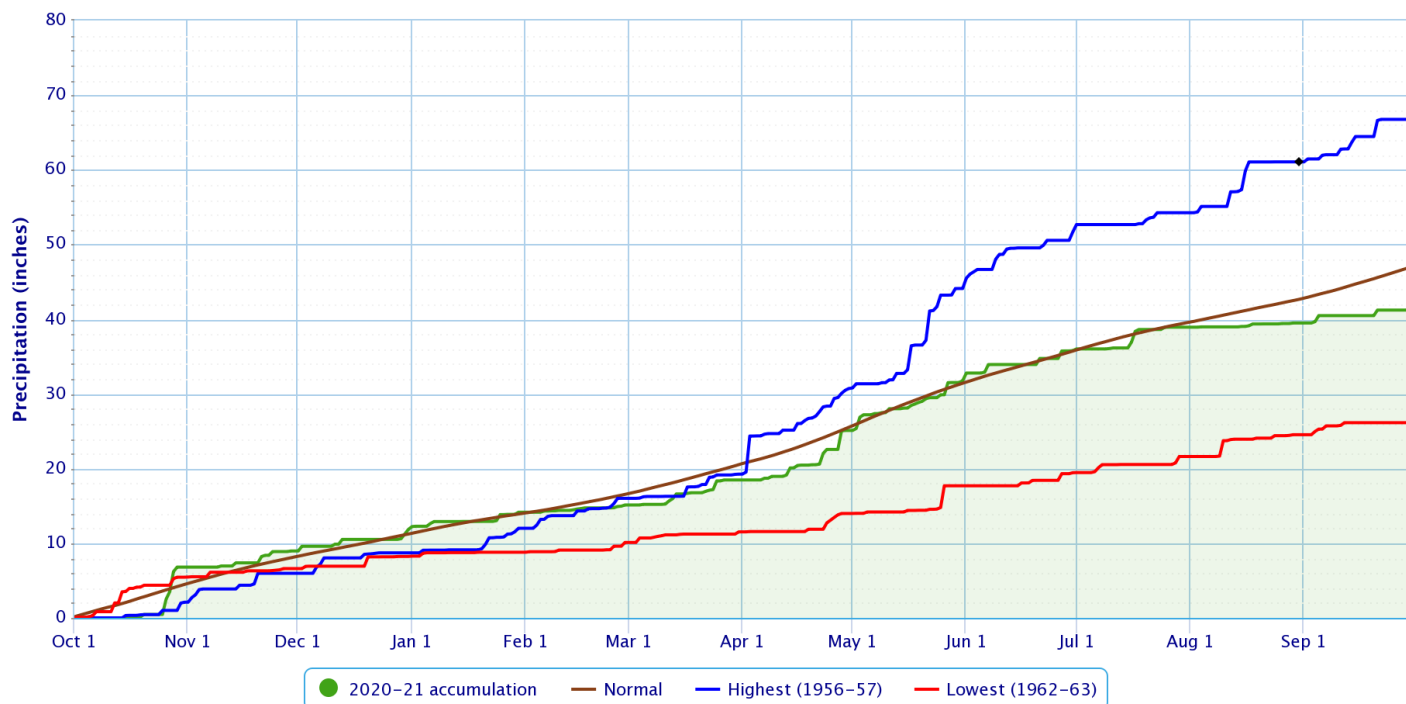
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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



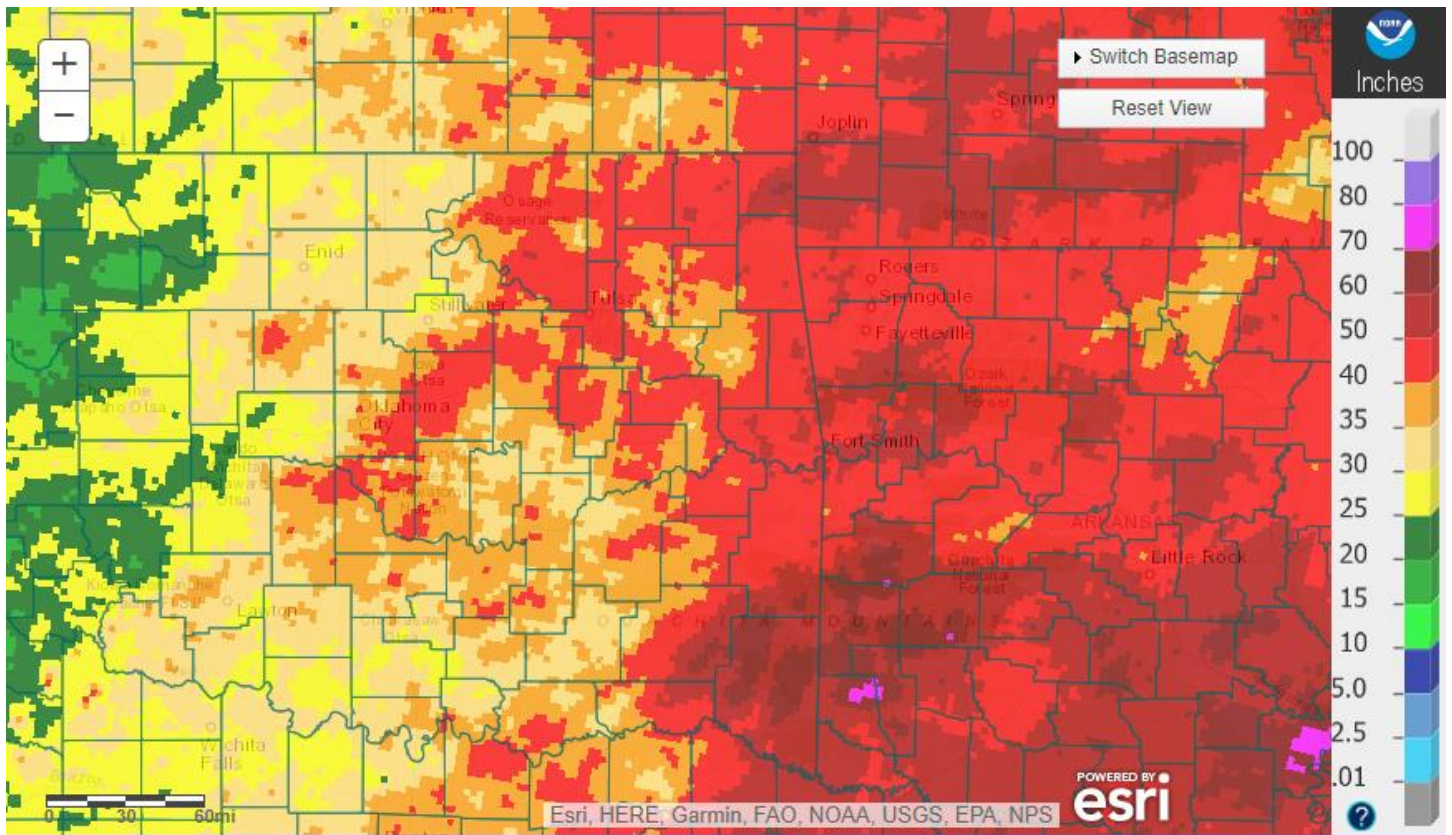
Powered by ACIS

Water Year 2021 (Oct. 1, 2020 – Sep. 30, 2021)

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 2a), rainfall totals for Water Year 2021 ranged from 30" to 65" generally west to east across eastern OK and northwest AR, with much of the area receiving 40"-50". These rainfall totals correspond to 50% to 150% of the normal water year rainfall across eastern OK and northwest AR, with most of the region receiving 75%-110% (Fig. 2b).

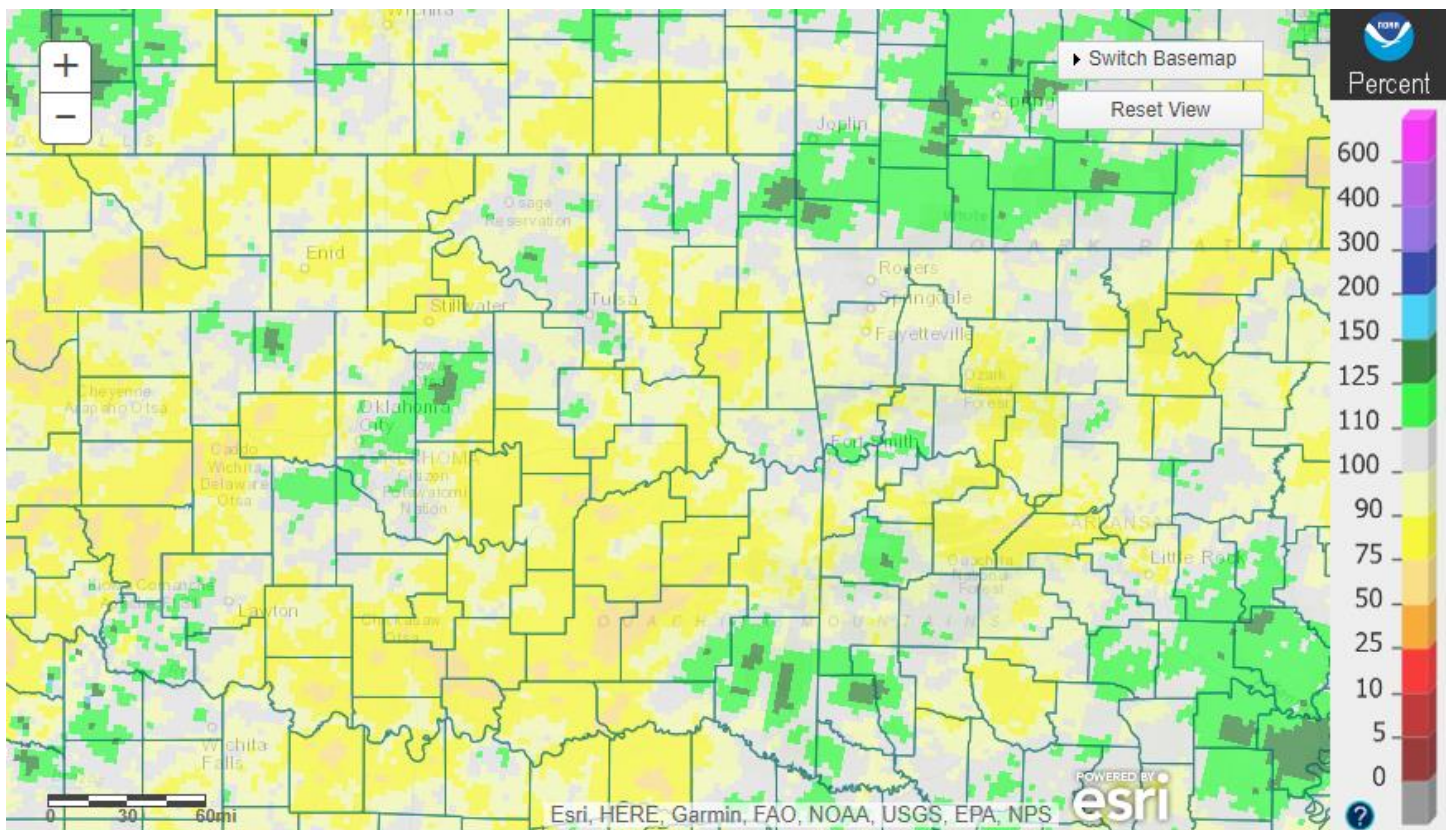
Some of the larger precipitation reports (in inches) for Water Year 2021 included:

Winslow 7NE, AR (coop)	60.06	Rogers 2.4SSW, AR (coco)	56.86	Wyandotte 7.3NE, OK (coco)	55.58
Uniontown 2.1ESE, AR (coco)	55.40	Elkins 10.6SSE, AR (coco)	55.16	Ozark, AR (coop)	54.94
Hugo 1.9ENE, OK (coco)	54.85	Westville 3.0SSW, OK (coco)	54.39	Van Buren 2.1NNW, AR (coco)	54.16



Tulsa, OK: 2021 Water Year (Oct. 1) Observed Precipitation
Valid on: October 01, 2021 12:00 UTC

Fig. 2a. Estimated Observed Rainfall for Water Year 2021



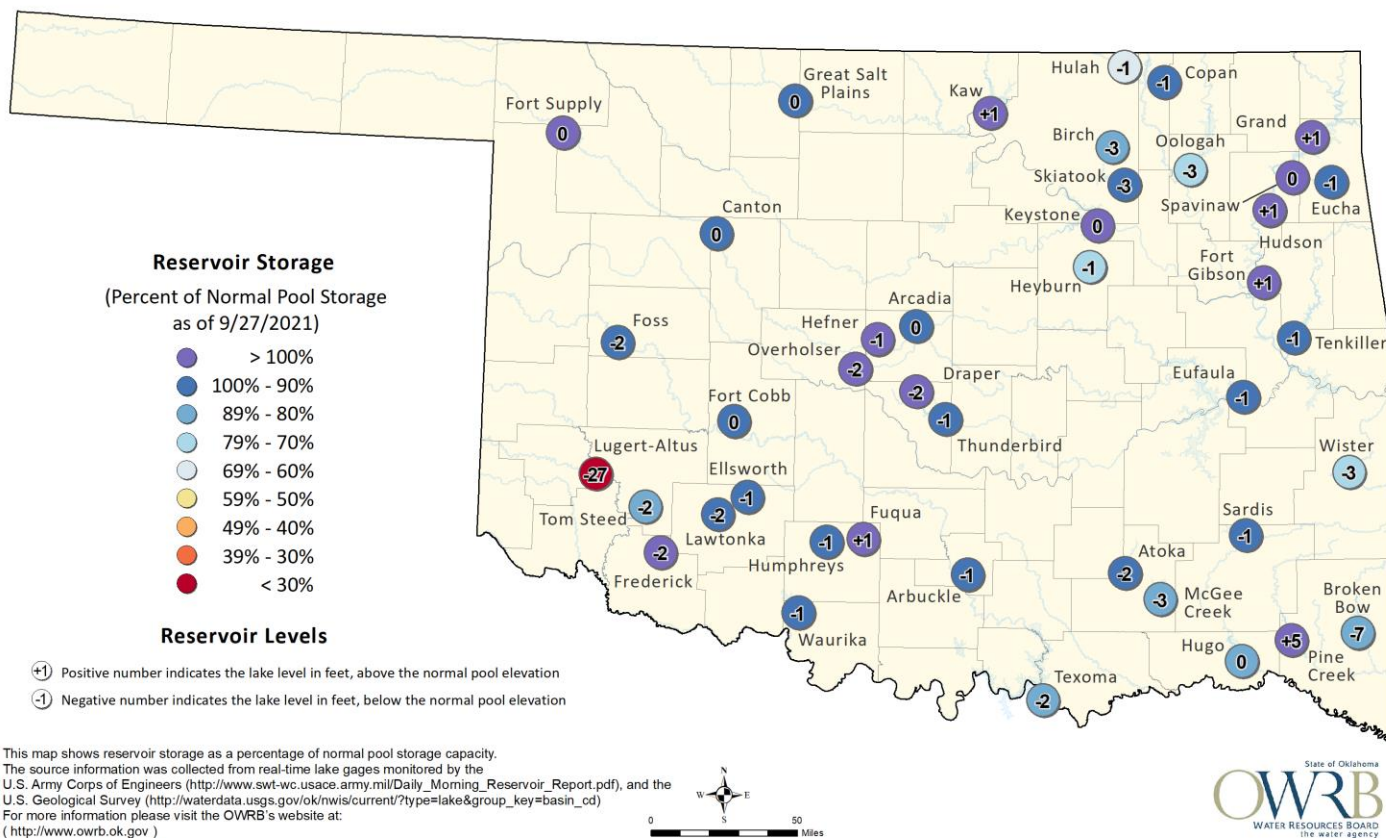
Tulsa, OK: 2021 Water Year (Oct. 1) Percent of Normal Precipitation
Valid on: October 01, 2021 12:00 UTC

Fig. 2b. Estimated % of Normal Rainfall for Water Year 2021

Reservoirs

Oklahoma Surface Water Resources

Reservoir Levels and Storage as of 9/27/2021



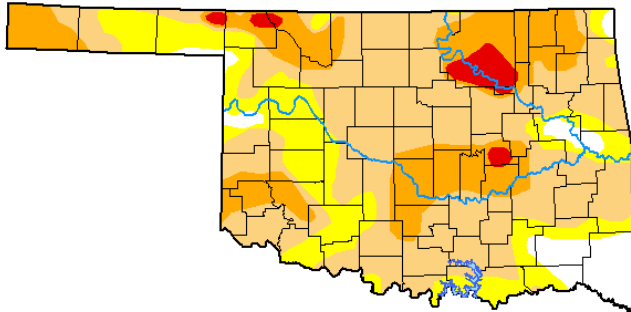
According to the USACE, most of the lakes in the HSA were below 3% of top of their conservation pools as of 9/30/2021: Wister Lake 70%, Heyburn Lake 76%, Birch Lake 82%, Oologah Lake 83%, Hulah Lake 89%, Copan Lake 91%, Skiatook Lake 92%, Lake Eufaula 92%, Sardis Lake 94%, Hugo Lake 94%, Beaver Lake 94% and Tenkiller Lake 95%. Two lakes remained more than 3% above the top of their conservation pools: Hudson Lake 7% and Grand Lake 6%.

Drought

According to the [U.S. Drought Monitor](#) (USDM) from September 28, 2021 (Figs. 3a, 3b), drought conditions were present across a large portion of eastern OK and northwest AR. Extreme (D3) Drought conditions were occurring in parts of Osage, Pawnee, Tulsa, and Okfuskee Counties in eastern OK. Severe (D2) Drought conditions were present over parts of Osage, Pawnee, Creek, Washington, Tulsa, Nowata, Rogers, Craig, Mayes, McIntosh, Okfuskee, and Pittsburg Counties in eastern OK. Moderate (D1) Drought conditions were occurring across portions of Craig, Ottawa, Delaware, Mayes, Rogers, Creek, Tulsa, Wagoner, Cherokee, Adair, Okfuskee, Okmulgee, Muskogee, McIntosh, Pittsburg, Haskell, Latimer, Pushmataha, and Le Flore Counties in eastern OK, as well as Benton, Washington, Madison, Crawford, and Sebastian Counties in northwest AR.

U.S. Drought Monitor Oklahoma

September 28, 2021
(Released Thursday, Sep. 30, 2021)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	6.45	93.55	73.23	23.72	2.65	0.00
Last Week 09-21-2021	20.56	79.44	39.37	4.62	0.17	0.00
3 Months Ago 06-29-2021	84.11	15.89	1.77	0.24	0.00	0.00
Start of Calendar Year 12-29-2020	56.83	43.17	25.21	7.75	1.45	0.00
Start of Water Year 09-29-2020	66.79	33.21	17.71	11.97	1.55	0.00
One Year Ago 09-29-2020	66.79	33.21	17.71	11.97	1.55	0.00

Intensity:
 None (White) D2 Severe Drought (Orange)
 D0 Abnormally Dry (Yellow) D3 Extreme Drought (Red)
 D1 Moderate Drought (Light Orange) D4 Exceptional Drought (Dark Red)

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:
Brian Fuchs
National Drought Mitigation Center

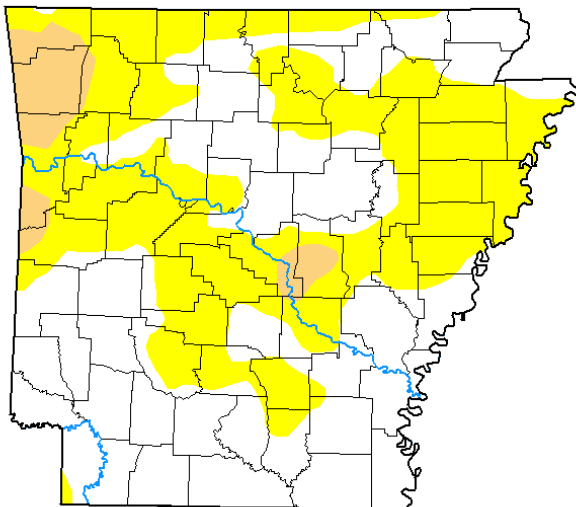


droughtmonitor.unl.edu

Fig. 3a. Drought Monitor for Oklahoma

U.S. Drought Monitor Arkansas

September 28, 2021
(Released Thursday, Sep. 30, 2021)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	51.41	48.59	5.17	0.00	0.00	0.00
Last Week 09-21-2021	55.08	44.92	2.34	0.00	0.00	0.00
3 Months Ago 06-29-2021	100.00	0.00	0.00	0.00	0.00	0.00
Start of Calendar Year 12-29-2020	16.45	83.55	6.87	0.00	0.00	0.00
Start of Water Year 09-29-2020	96.07	3.93	0.62	0.00	0.00	0.00
One Year Ago 09-29-2020	96.07	3.93	0.62	0.00	0.00	0.00

Intensity:
 None (White) D2 Severe Drought (Orange)
 D0 Abnormally Dry (Yellow) D3 Extreme Drought (Red)
 D1 Moderate Drought (Light Orange) D4 Exceptional Drought (Dark Red)

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:
Brian Fuchs
National Drought Mitigation Center



droughtmonitor.unl.edu

Fig. 3b. Drought Monitor for Arkansas

Outlooks

The [Climate Prediction Center](#) (CPC) outlook for October 2021 (issued September 30, 2021) indicates an enhanced chance for above normal temperatures and precipitation across all of eastern OK and northwest AR. This outlook was largely based on dynamical model output. According to CPC, "Model guidance favors troughing at times entering the CONUS and impacting portions of the western and central U.S. This pattern and evolution should create a favorable environment in these regions during periods of the first half of October for elevated odds for above-normal monthly total precipitation amounts from eastern areas of the Southwest northward and eastward to include much of the High and Great Plains as well as much of the Mississippi Valley."

For the 3-month period October-November-December 2021, CPC is forecasting a slightly enhanced chance for above normal temperatures and a slightly enhanced chance for below median precipitation across all of eastern OK and northwest AR (outlook issued September 16, 2021). This outlook is based on long-term trends, La Niña impacts, and incorporates both statistical and dynamical forecast tools. According to CPC, the combined effect of the ocean-atmosphere system is consistent with ENSO neutral conditions. The transition from ENSO neutral to La Niña is expected over the next couple of months and there is a 70%-80% chance for La Niña conditions during winter 2021-22. CPC continues the La Niña Watch.

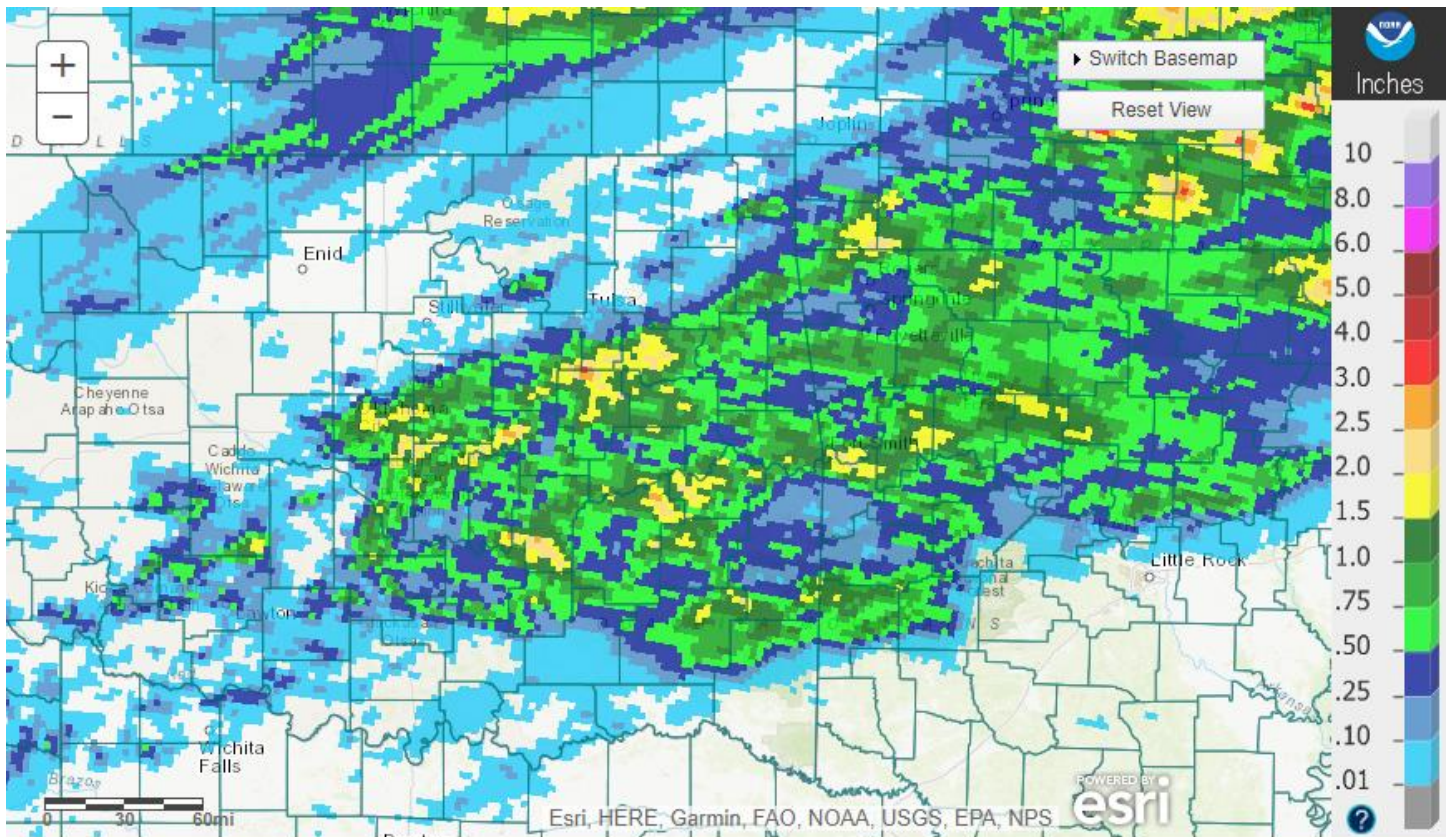
Summary of Heavy Precipitation Events Daily quality-controlled rainfall maps can be found at: http://water.weather.gov/precip/index.php?location_type=wfo&location_name=tsa

A broken line of storms developed along a cold front northwest of I-44 in northeast OK during the afternoon of the 4th. This line moved to the southeast through the evening, with the thunderstorms expanding across a larger area of east central OK and northwest AR. Around midnight on the 5th, a wave approached the area, renewing the convection across east central OK. This second round of showers and thunderstorms also tracked to the southeast through the overnight and early morning hours, before exiting the region mid-morning. With precipitable water (PWAT) values of 2"-2.5" (above the 90th percentile and near record values for this time of year), this convection was able to produce pockets of heavy rain. Rainfall totals for much of the region southeast of I-44 ranged from around 0.25" to near 3" (Fig. 4).

During the very early morning hours of the 8th, showers and thunderstorms developed across east central OK and west central AR ahead of another cold front. This activity quickly moved southwest across southeast OK before exiting the region by mid-morning. Rainfall totals ranged from around 0.10" to 2.5", with the heaviest rain impacting Pushmataha County (Fig. 5).

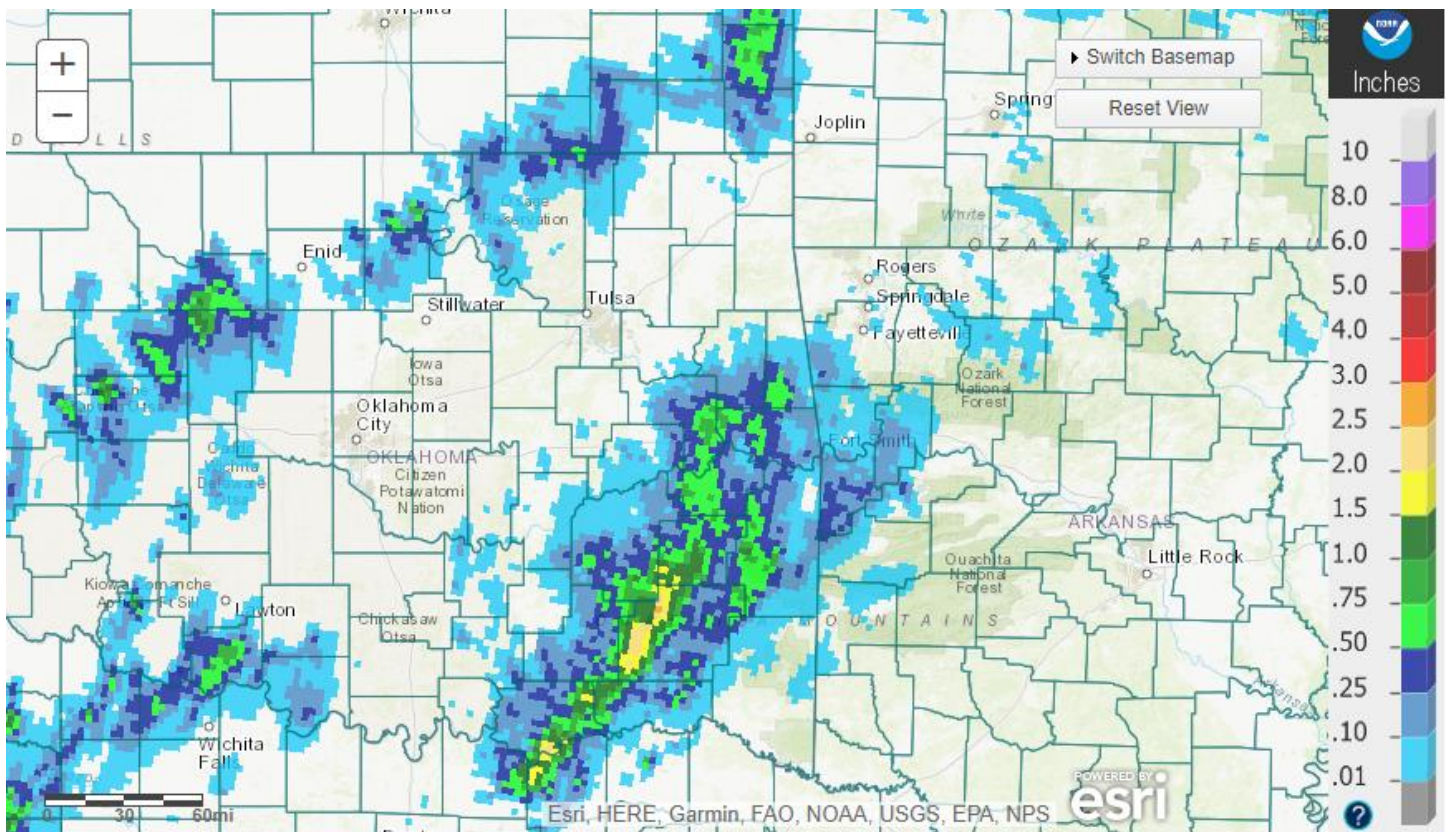
A thunderstorm complex moving across southeast KS crossed the far northeast corner of OK during the early morning hours of the 15th. This activity quickly dissipated soon after sunrise as it was moving into northwest AR. Rainfall totals from around 0.50" to around 1.5" occurred across Ottawa and northern Delaware Counties in northeast OK (Fig. 6). Prior to this rain event, the Oklahoma Mesonet stations in Ottawa County had gone 24 days without receiving 0.10" of rain, and 24 days without 0.25" of rain in both Ottawa and Delaware Counties (Figs. 7, 8).

Thunderstorms developed across southeast KS, southwest MO, and northeast OK during the late evening of the 20th along a cold front. This activity moved southeast, entering northwest AR just before midnight. A secondary area of showers and thunderstorms developed across northeast OK northwest of I-44 during the early morning hours in association with the main upper-level trough. This activity moved east southeast across northeast OK and northwest AR. All of this convection moved east out of the area by mid-morning of the 21st. These storms were efficient at producing rain due to PWATs near 2". Rainfall totals across northeast OK and northwest AR ranged from 0.25" to 3", with the highest totals occurring over Ottawa, Benton, and Madison Counties (Fig. 11). This rainfall helped to end a long streak of consecutive number of days without 0.10" and 0.25" of rain in portions of northeast OK (Figs. 9, 10).



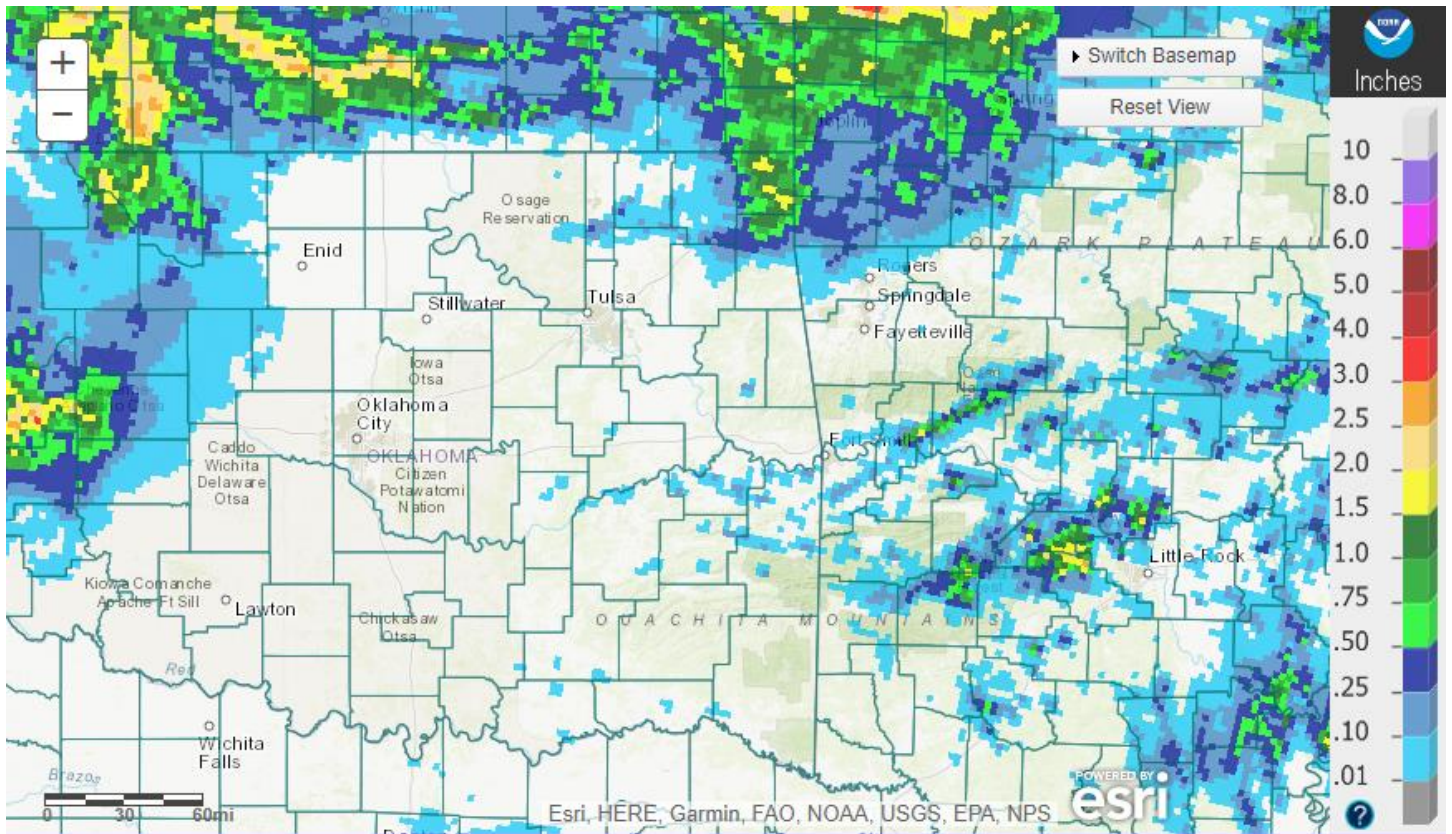
Tulsa, OK: September 05, 2021 1-Day Observed Precipitation
 Valid on: September 05, 2021 12:00 UTC

Fig. 4. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/05/2021.



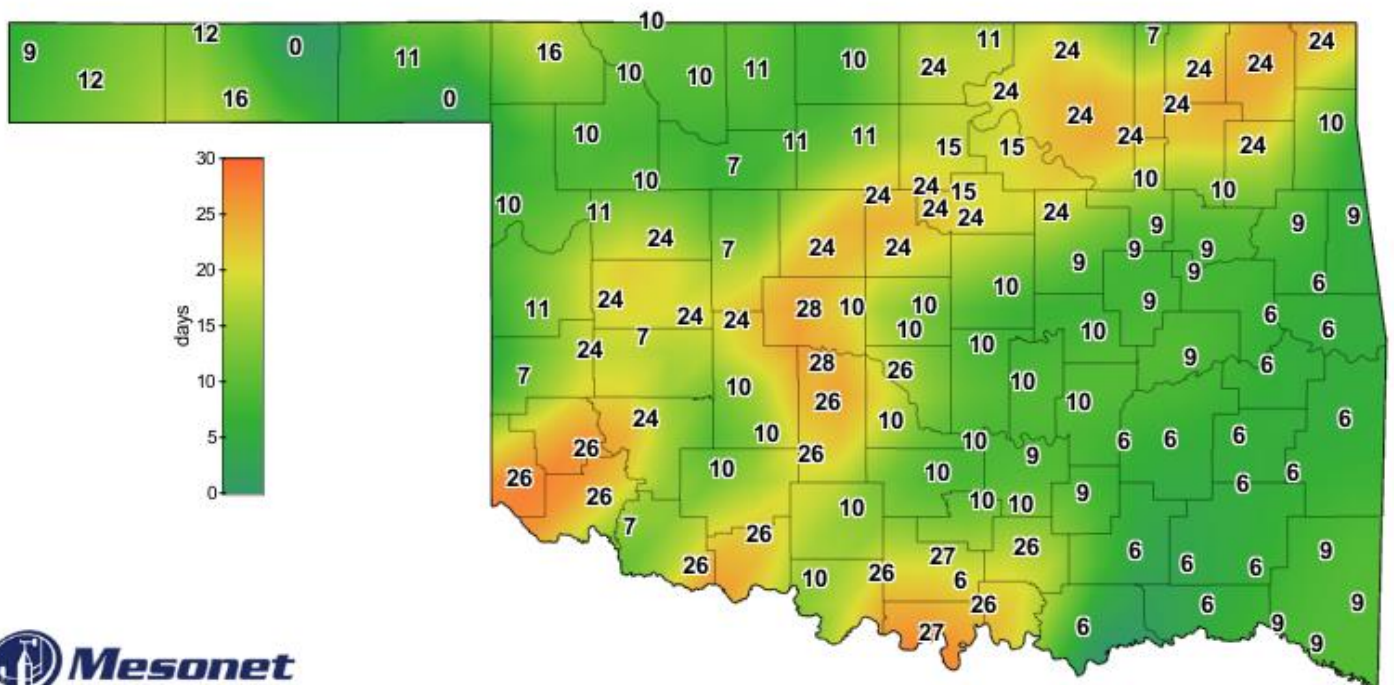
Tulsa, OK: September 08, 2021 1-Day Observed Precipitation
 Valid on: September 08, 2021 12:00 UTC

Fig. 5. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/08/2021.



Tulsa, OK: September 15, 2021 1-Day Observed Precipitation
 Valid on: September 15, 2021 12:00 UTC

Fig. 6. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/15/2021.

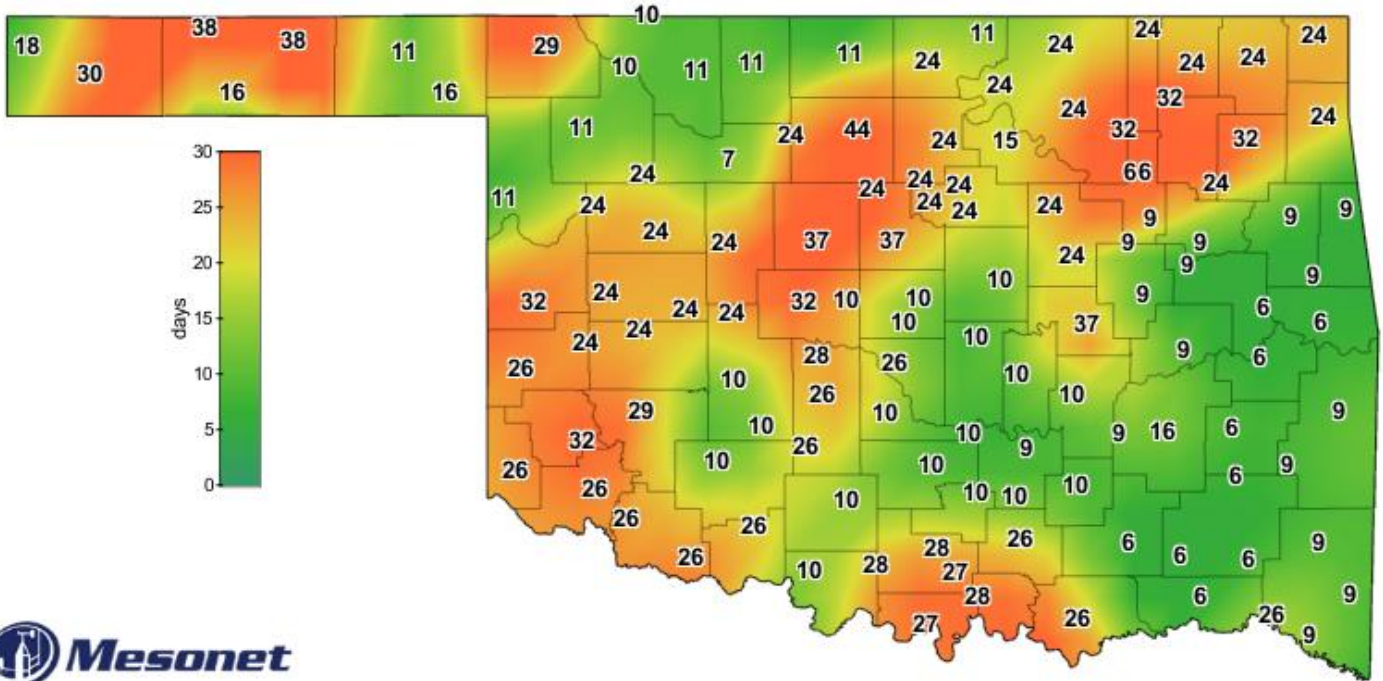


Consecutive Days With Less Than 0.10" Rainfall

September 14, 2021

Created 8:15:02 AM September 15, 2021 CDT. © Copyright 2021

Fig. 7. OK Mesonet consecutive number of days with less than 0.10" of rain through 9/14/2021.

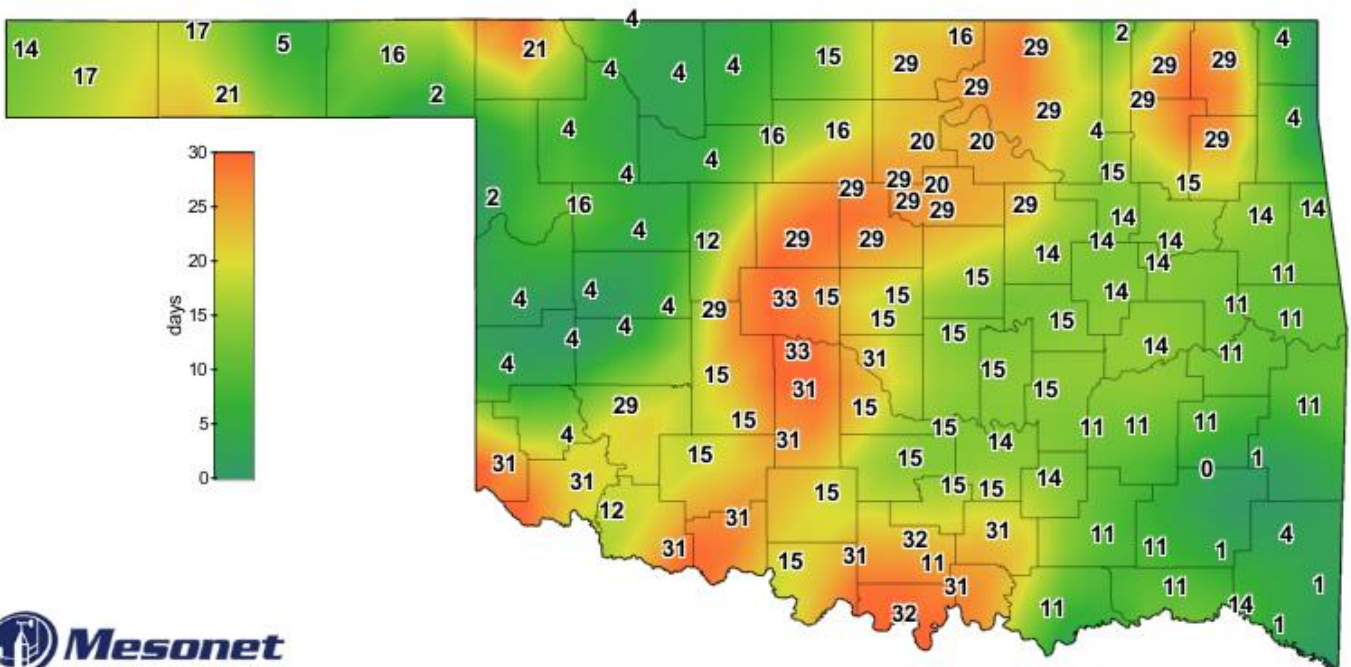


Consecutive Days With Less Than 0.25" Rainfall

September 14, 2021

Created 8:15:02 AM September 15, 2021 CDT. © Copyright 2021

Fig. 8. OK Mesonet consecutive number of days with less than 0.25" of rain through 9/14/2021.

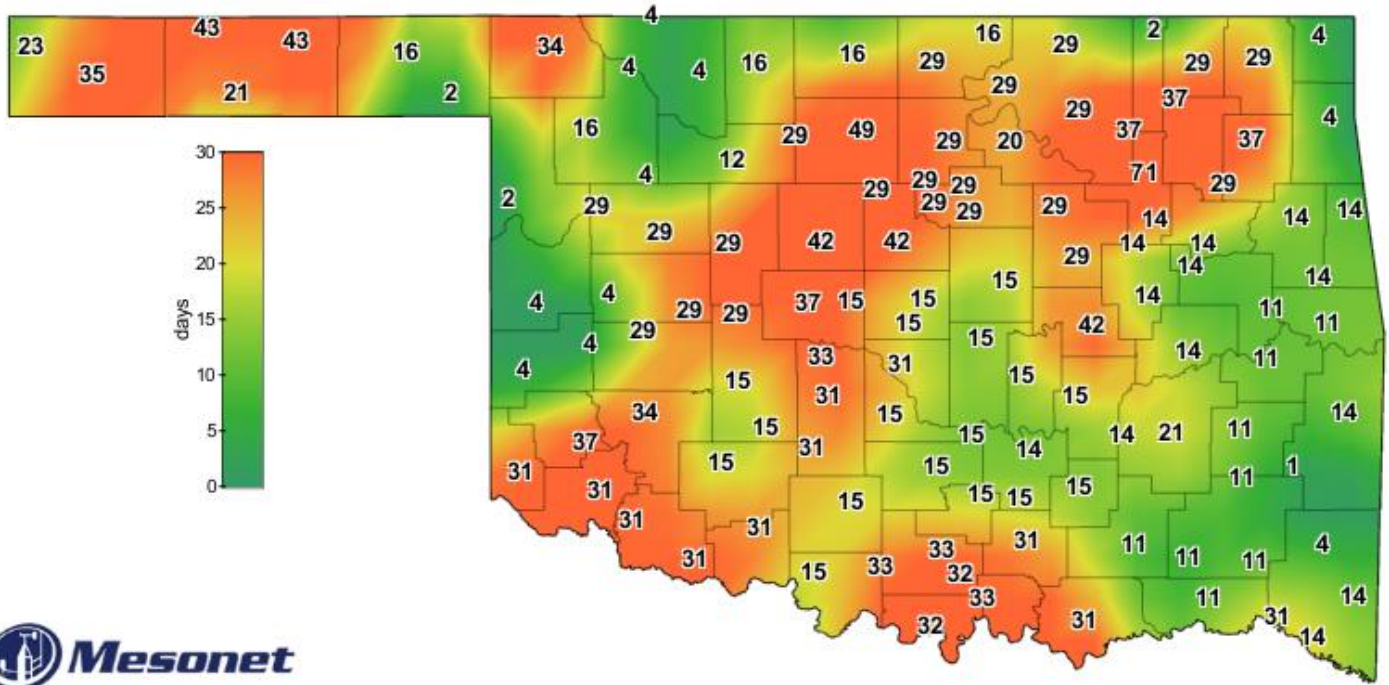


Consecutive Days With Less Than 0.10" Rainfall

September 19, 2021

Created 8:15:03 AM September 20, 2021 CDT. © Copyright 2021

Fig. 9. OK Mesonet consecutive number of days with less than 0.10" of rain through 9/19/2021.

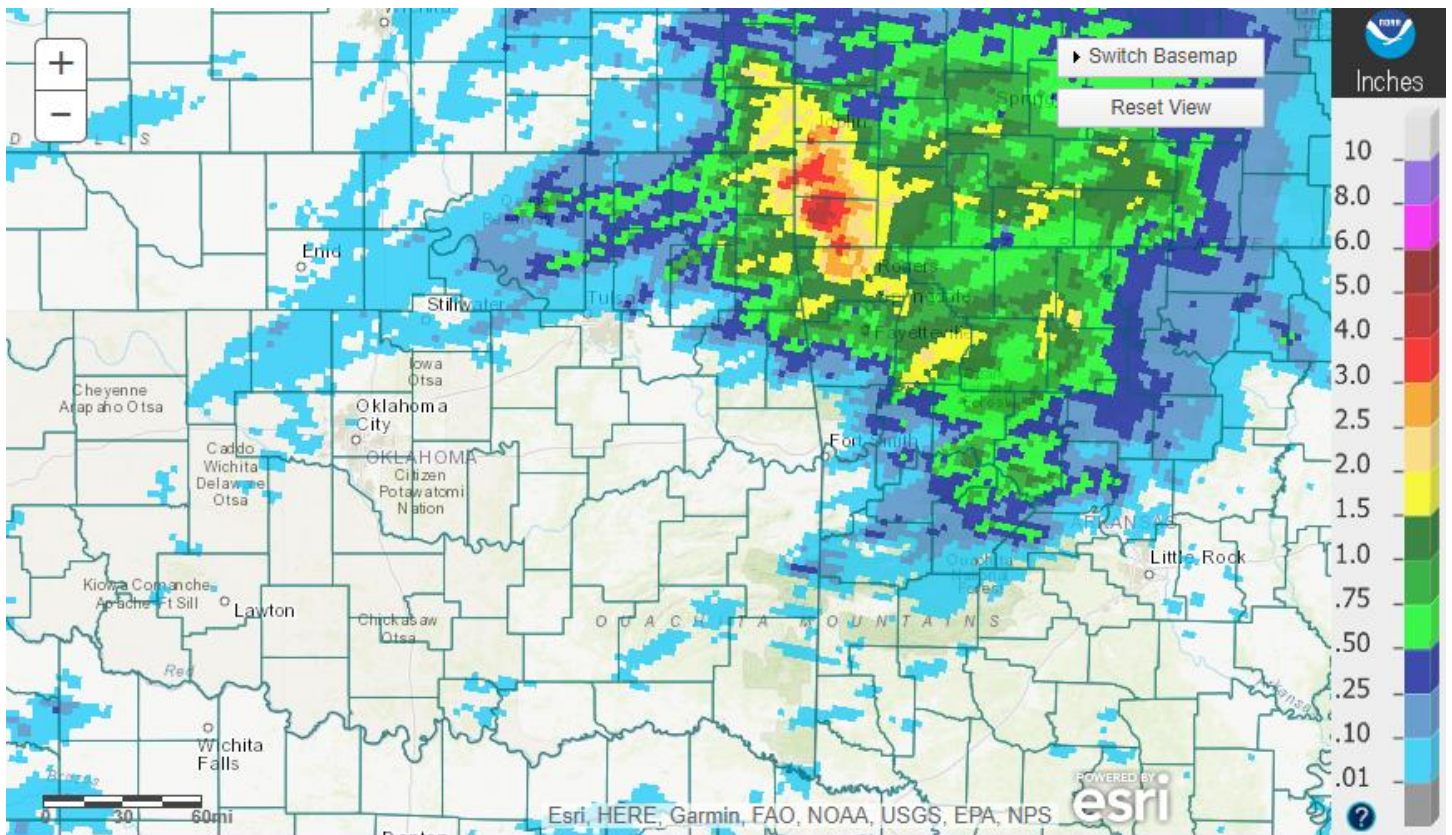


Consecutive Days With Less Than 0.25" Rainfall

September 19, 2021

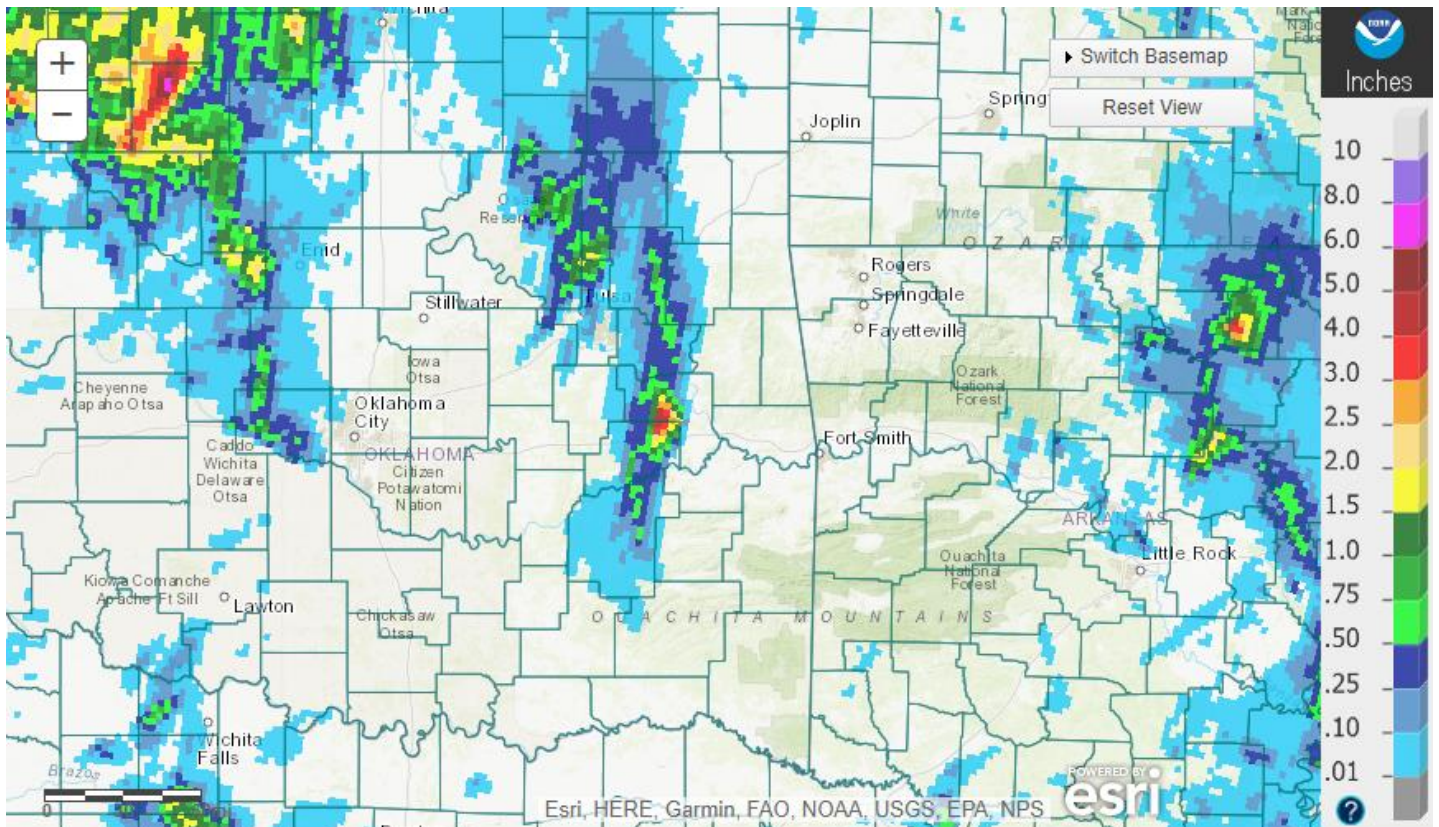
Created 8:15:02 AM September 20, 2021 CDT. © Copyright 2021

Fig. 10. OK Mesonet consecutive number of days with less than 0.25" of rain through 9/19/2021.



Tulsa, OK: September 21, 2021 1-Day Observed Precipitation
Valid on: September 21, 2021 12:00 UTC

Fig. 11. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/21/2021.



Tulsa, OK: September 30, 2021 1-Day Observed Precipitation
Valid on: September 30, 2021 12:00 UTC

Fig. 12. 24-hour Estimated Observed Rainfall ending at 7am CDT 09/30/2021.

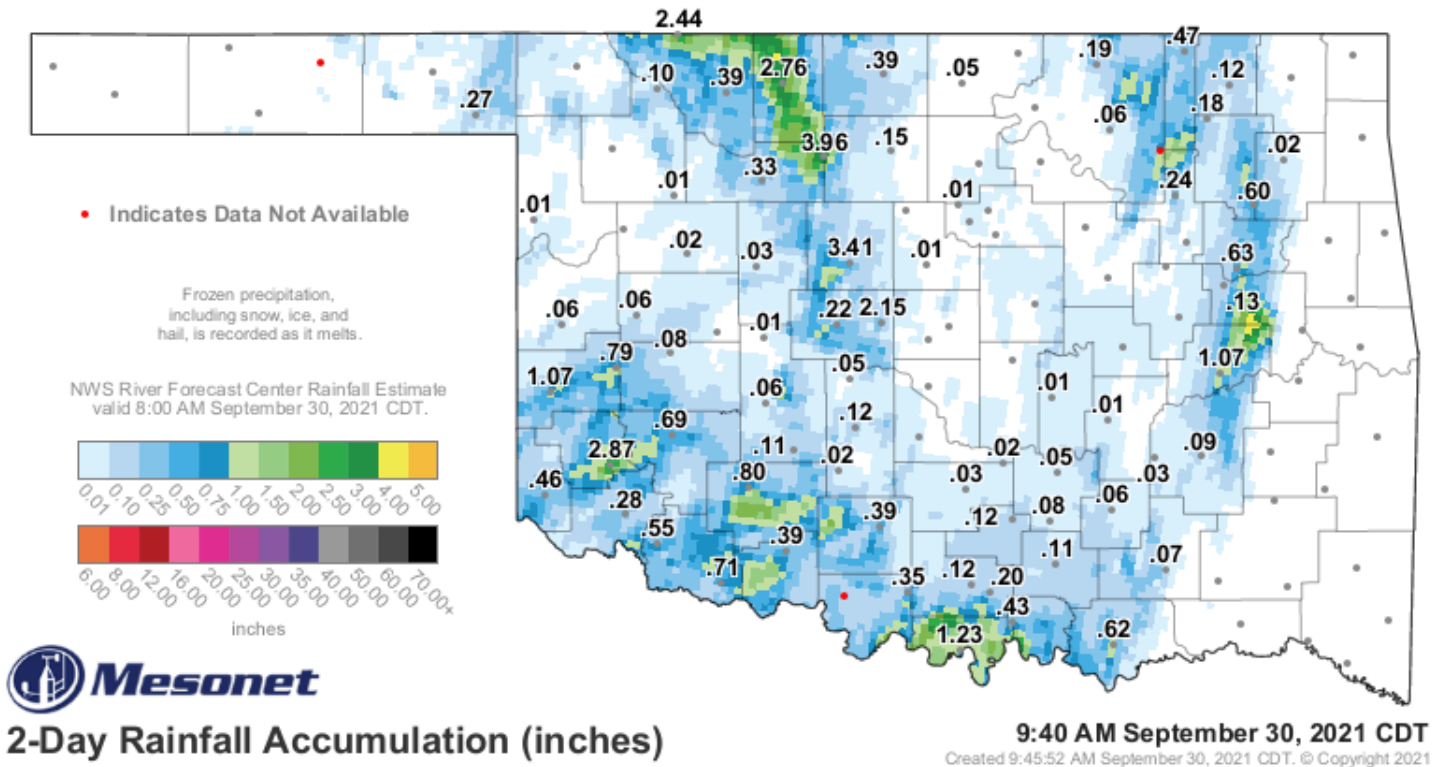
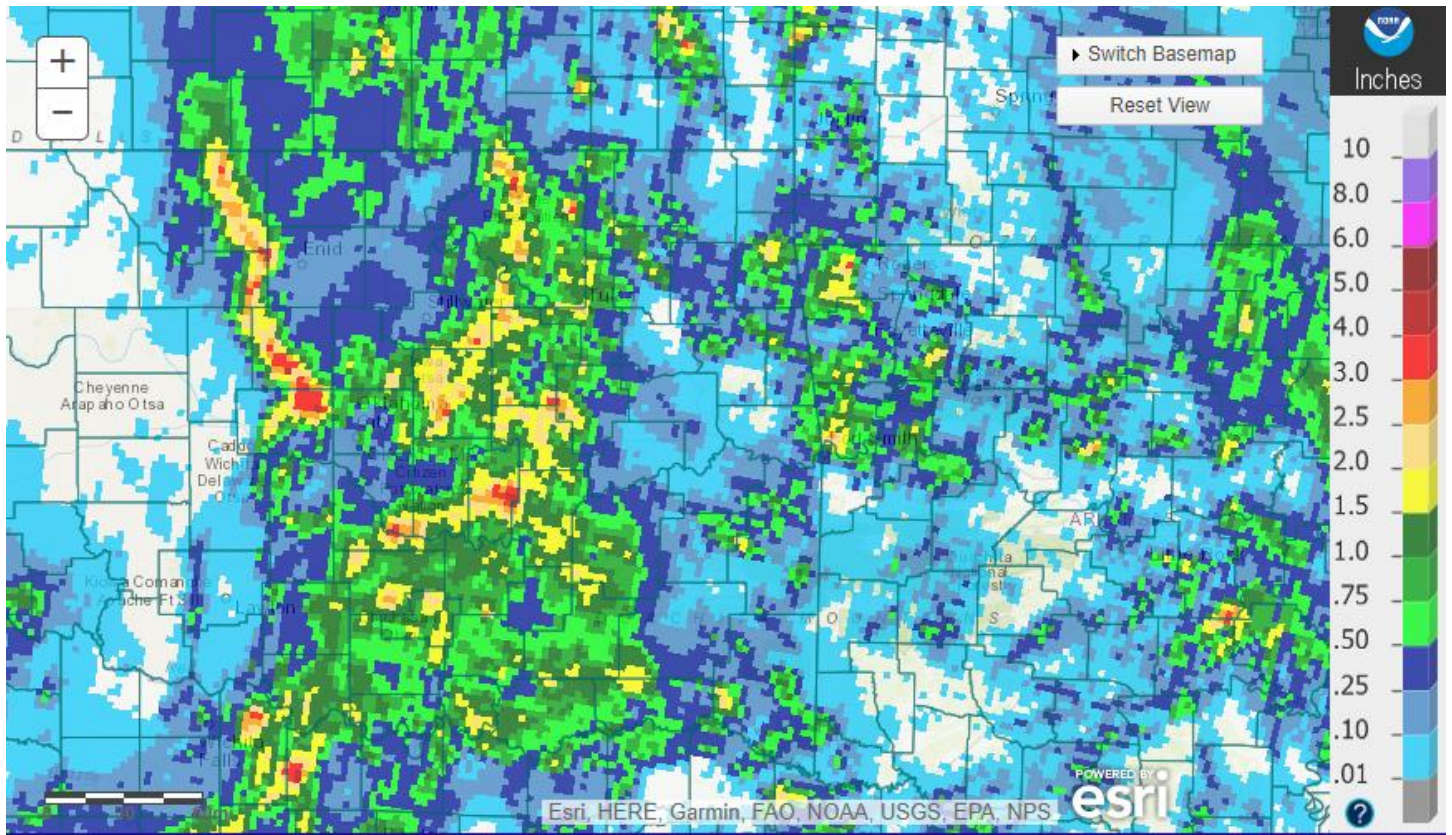
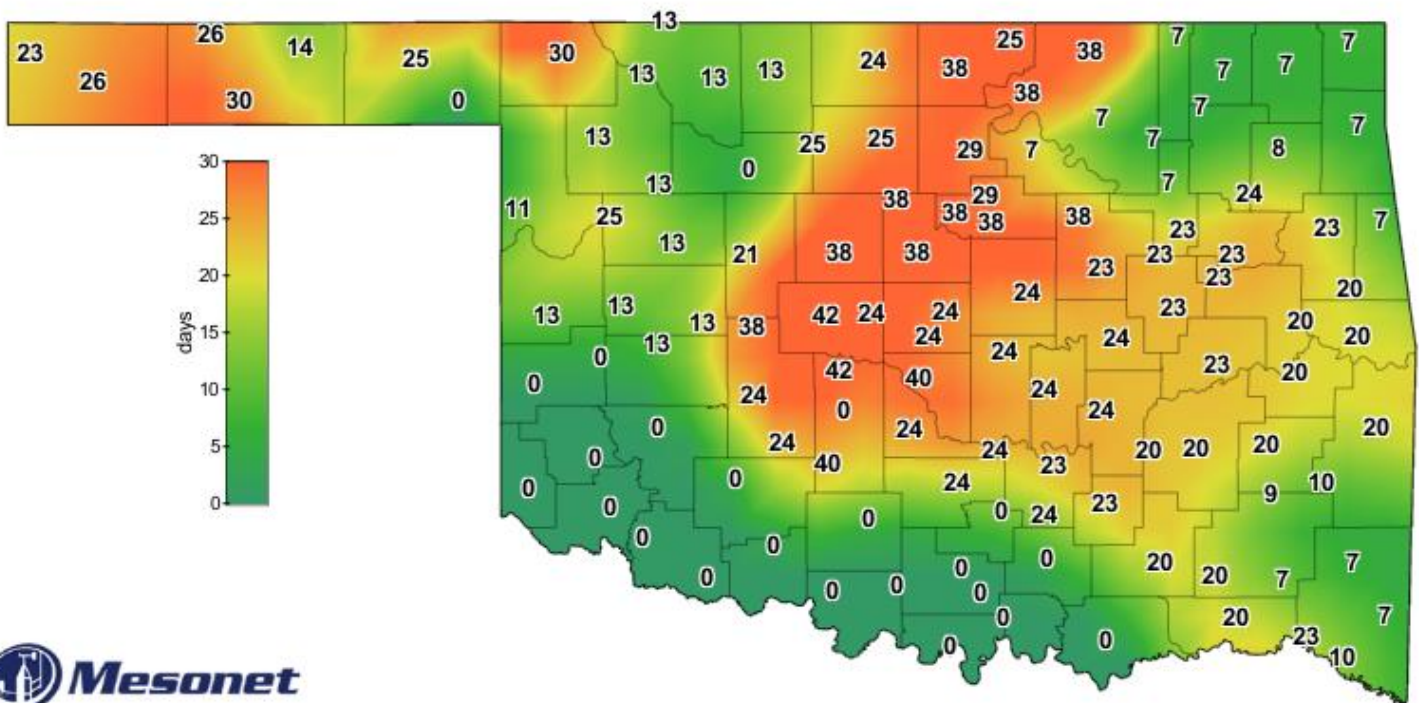


Fig. 13. OK Mesonet (values) and NWS RFC rainfall estimate (image) 2-day rainfall ending at 09:40 am CDT 9/30/2021.



Tulsa, OK: October 01, 2021 1-Day Observed Precipitation
Valid on: October 01, 2021 12:00 UTC

Fig. 14. 24-hour Estimated Observed Rainfall ending at 7am CDT 10/01/2021.



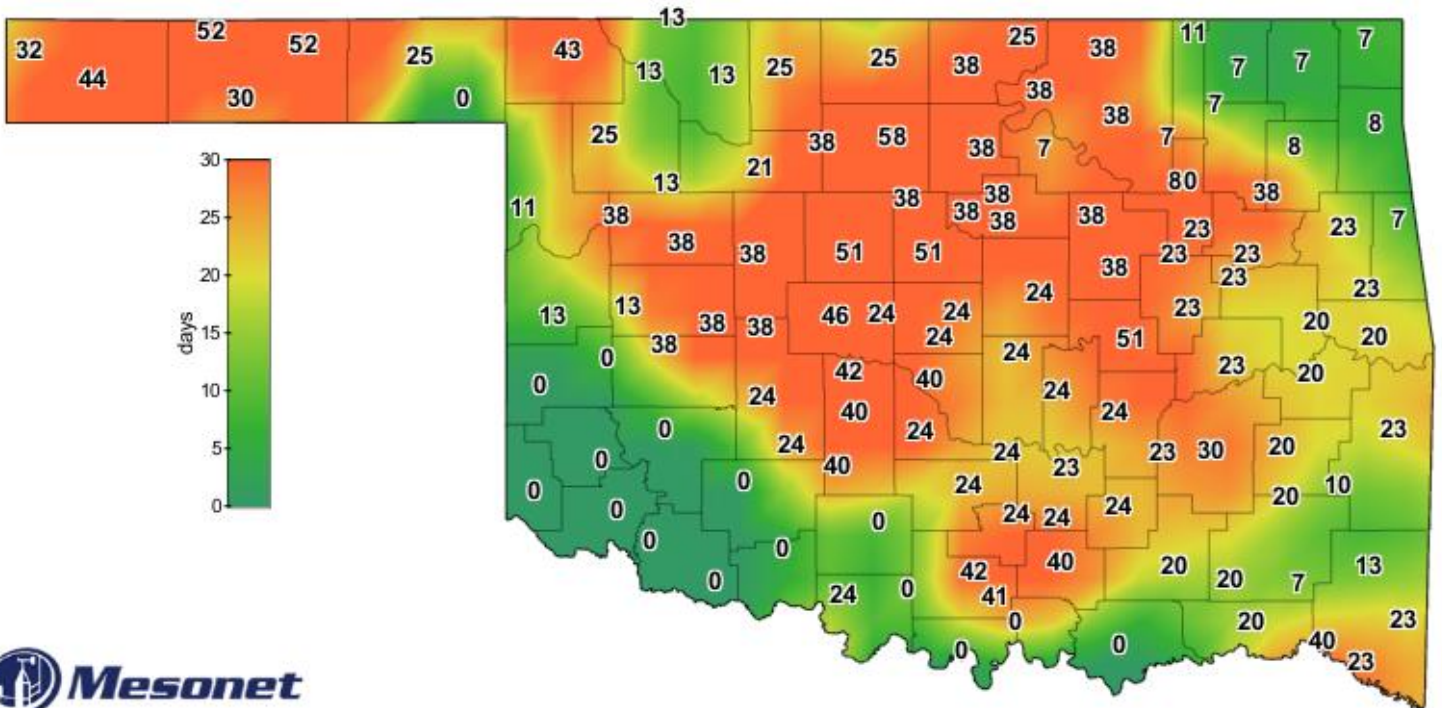
Mesonet

Consecutive Days With Less Than 0.10" Rainfall

September 28, 2021

Created 6:15:03 AM September 29, 2021 CDT. © Copyright 2021

Fig. 15. OK Mesonet consecutive number of days with less than 0.10" of rain through 9/28/2021.

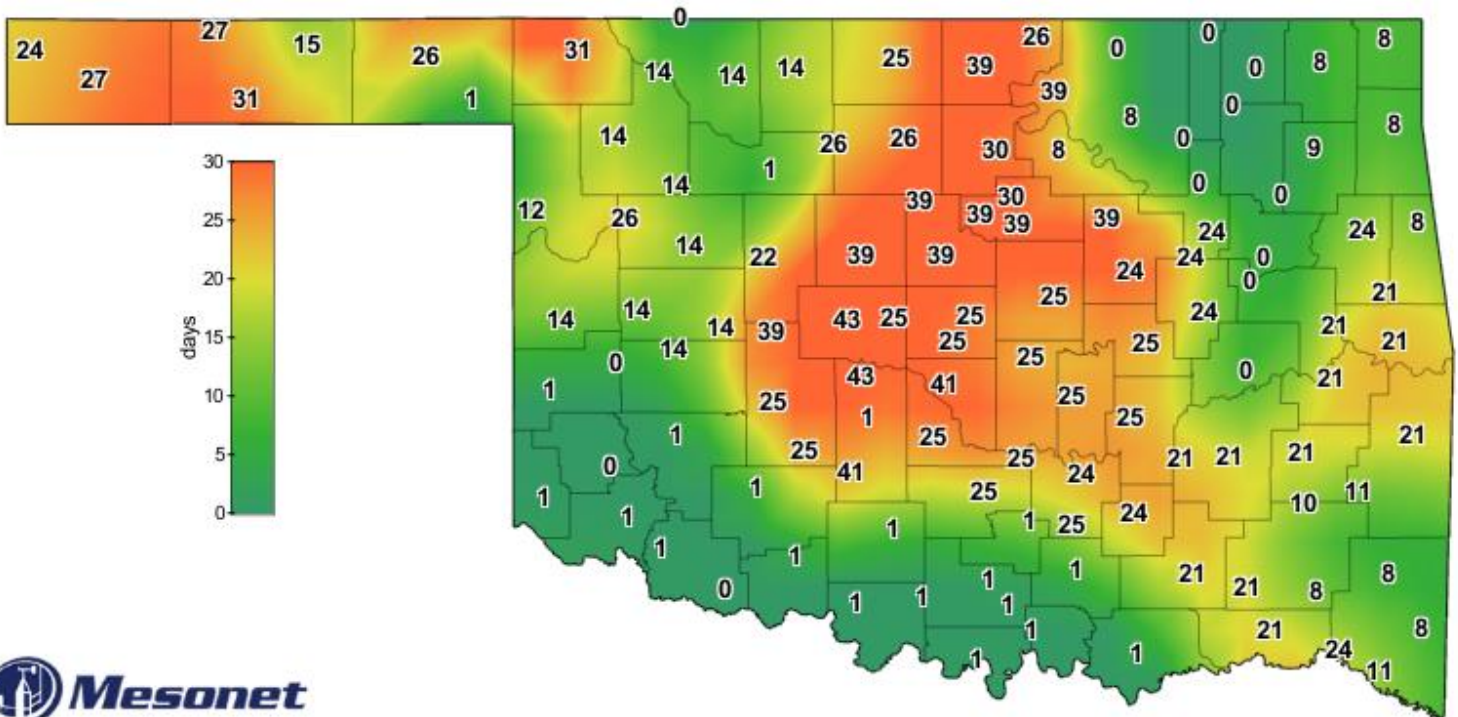


Consecutive Days With Less Than 0.25" Rainfall

September 28, 2021

Created 6:15:03 AM September 29, 2021 CDT. © Copyright 2021

Fig. 16. OK Mesonet consecutive number of days with less than 0.25" of rain through 9/28/2021.

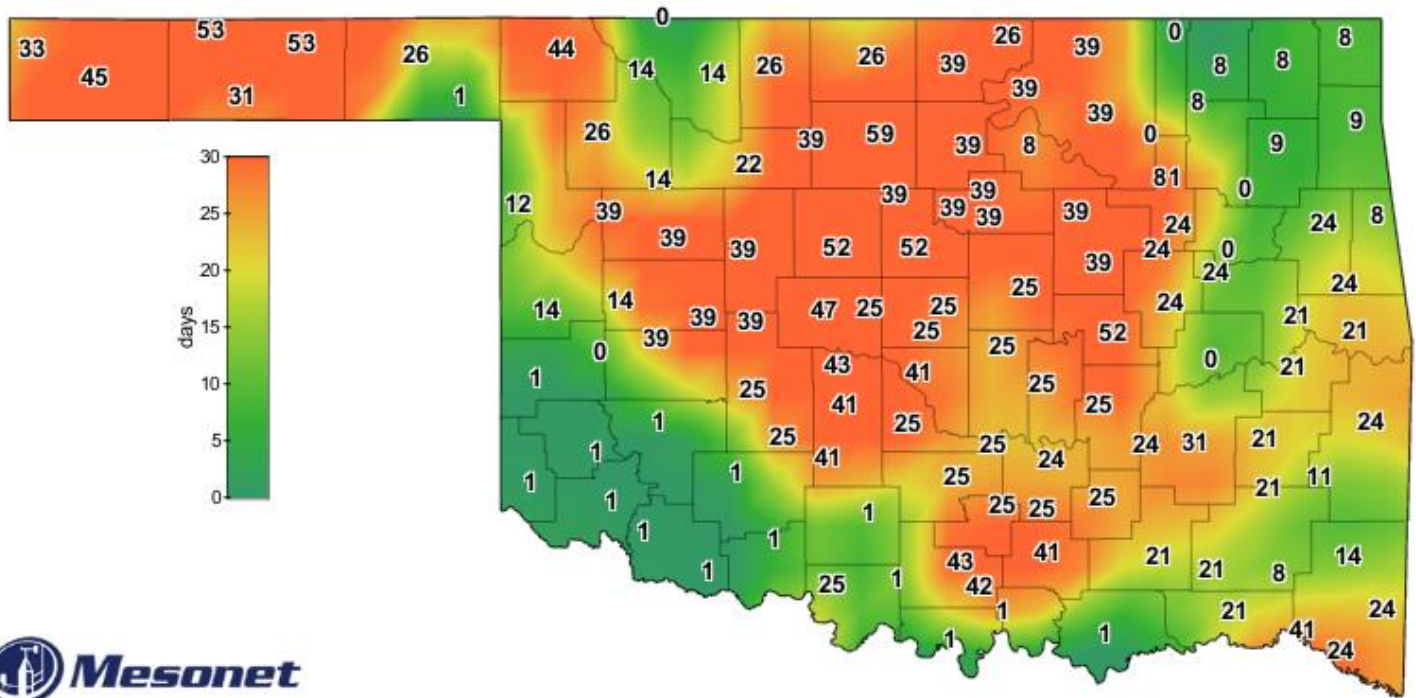


Consecutive Days With Less Than 0.10" Rainfall

September 29, 2021

Created 8:15:03 AM September 30, 2021 CDT. © Copyright 2021

Fig. 17. OK Mesonet consecutive number of days with less than 0.10" of rain through 9/29/2021.



Consecutive Days With Less Than 0.25" Rainfall

September 29, 2021

Created 8:15:03 AM September 30, 2021 CDT. © Copyright 2021

Fig. 18. OK Mesonet consecutive number of days with less than 0.25" of rain through 9/29/2021.

A shortwave moved into the region on the morning of the 29th, sparking scattered showers and thunderstorms across northeast OK during the morning and early afternoon hours. Thunderstorms trained across northeast McIntosh County into central Muskogee County, resulting in an area of 1.5" to near 5" of rainfall (Figs. 12, 13). Flash flooding of roads was reported.

A complex of storms moved into eastern OK from the west at mid-morning of the 30th. This line of storms slowly marched eastward, reaching western AR by late afternoon. This complex began to break up during the evening hours, but scattered convection continued through the evening before completely dissipating by midnight. Rainfall totals ranged from a few hundredths to 3" across eastern OK and northwest AR (Fig. 14).

The rainfall at the end of the month finally brought an end to a long period of consecutive number of days with rainfall totals less than 0.10" and less than 0.25" according to the Oklahoma Mesonet (Figs. 15-18). The Mesonet station at Tulsa went 81 days with less than 0.25" of rainfall through September 29 (Fig. 18).

Written by:

Nicole McGavock
Service Hydrologist
WFO Tulsa

Products issued in September 2021:

*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

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

Preliminary Hydrographs:

None