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|---|---|--|-------------|
| 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: | YEAR |
| | | MONTH July | 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 August 3, 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.

As is typical of summer time convection, some areas of eastern OK and northwest AR received well above normal rainfall in July 2021, while many other areas received well below normal rainfall. Both flash flooding and river flooding did occur. Overall, temperatures this month were below normal, though hot and humid conditions did show up during the latter half of the month. 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 <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 July 2021 ranged from 1" to around 12" across eastern OK and northwest AR, with much of the area receiving 2"-5". These rainfall totals correspond to 25% to near 400% of the normal July rainfall (Fig. 1b).

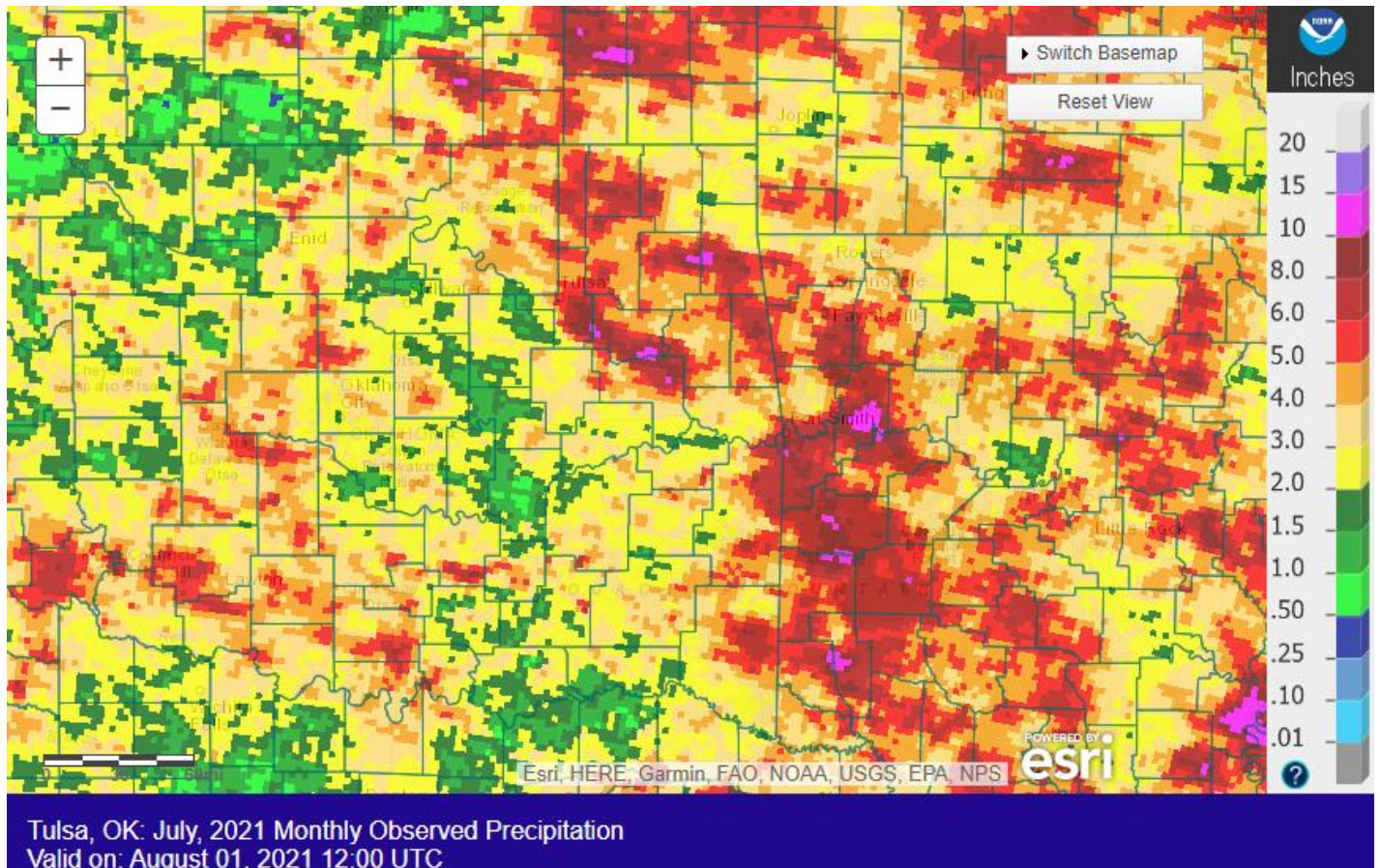


Fig. 1a. Estimated Observed Rainfall for July 2021

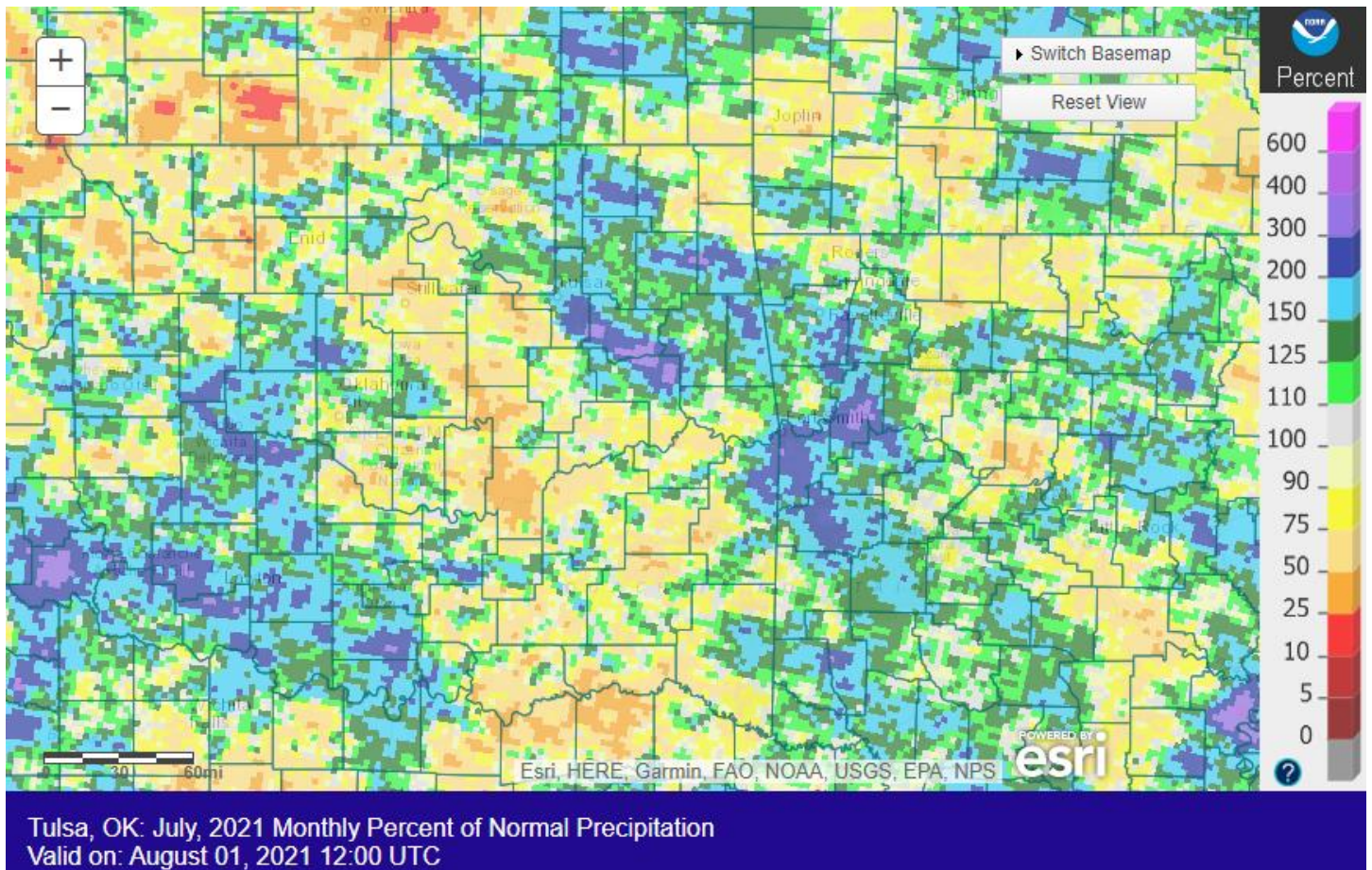


Fig. 1b. Estimated % of Normal Rainfall for July 2021

In Tulsa, OK, July 2021 ranked as the 38th coldest July (81.5°F, tied 1996, 1962, 1949, 1907; since records began in 1905) and the 32nd wettest July (4.69"; since records began in 1888). Fort Smith, AR had the 47th coldest July (81.1°F, tied 1953, 1928; since records began in 1882) and the 9th wettest July (7.94"; since records began in 1882). Fayetteville, AR had the 23rd coldest (77.1°F, tied 1979, 1973) and the 32nd wettest (3.14") July since records began in 1950.

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

| | | | | | |
|--------------------------------|-------|--------------------------|-------|-------------------------------|------|
| Broken Arrow 4.6SSW, OK (coco) | 10.73 | Ozark 4.6S, AR (coco) | 10.00 | Broken Arrow 2.2SW, OK (coco) | 9.62 |
| Bixby, OK (meso) | 9.38 | Talala 0.5W, OK (coco) | 9.37 | Ozark, AR (coop) | 9.31 |
| Westville 3.0SSW, OK (coco) | 9.03 | Vinita 8.6ESE, OK (coco) | 8.90 | Greenwood 0.9S, AR (coco) | 8.41 |

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

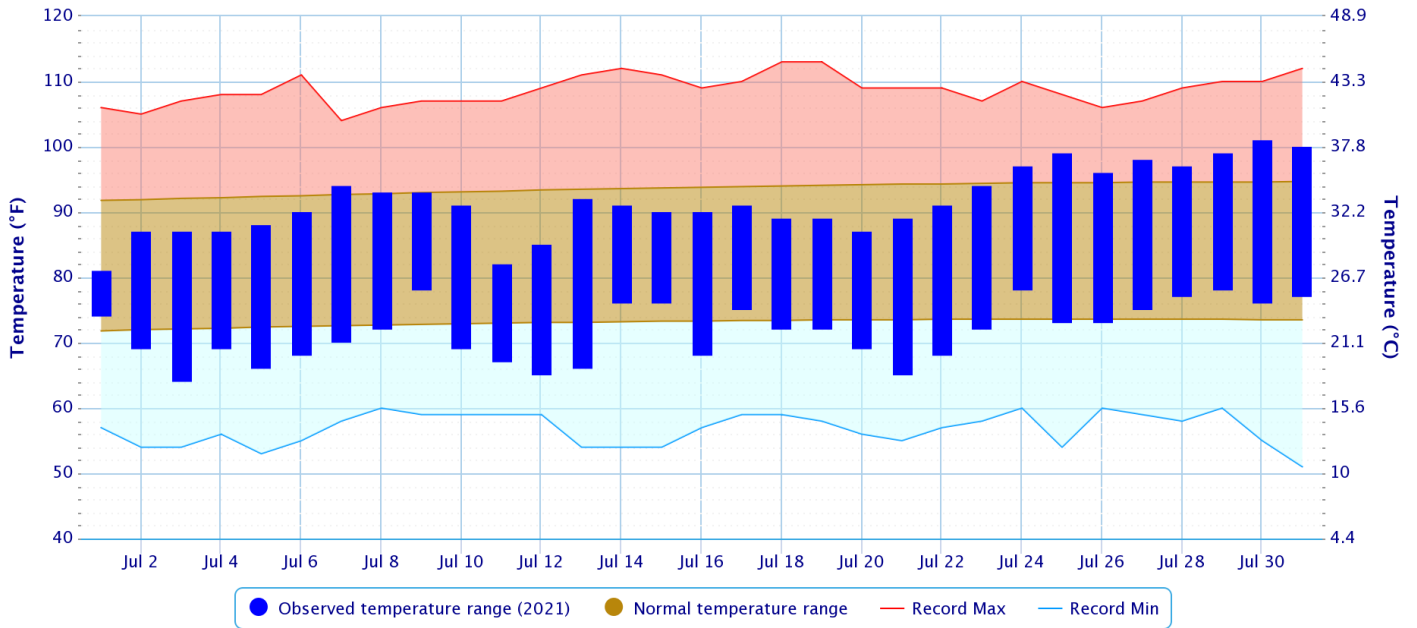
| | | | | | |
|--------------------|------|------------------------|------|---------------------|------|
| Clayton, OK (meso) | 1.51 | Okemah, OK (meso) | 1.82 | Talihina, OK (meso) | 1.85 |
| Stigler, OK (meso) | 1.93 | Burbank, OK (meso) | 1.99 | Bristow, OK (meso) | 2.03 |
| Pawnee, OK (meso) | 2.13 | Hectorville, OK (meso) | 2.37 | Okmulgee, OK (meso) | 2.52 |

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

| Rank since 1921 | Last 30 Days July 2-31 | Summer-to-Date (Jun 1 – Jul 31) | Last 90 Days (May 3 – Jul 31) | Warm Growing Season 2021 (Mar 1 – Jul 31) | Year-to-Date (Jan 1 – Jul 31) | Water Year-to-Date (Oct 1, 2020 – Jul 31, 2021) | Last 365 Days (Aug 1, 2020 – Jul 31, 2021) |
|-----------------|--------------------------|---------------------------------|-------------------------------|---|-------------------------------|---|--|
| Northeast OK | 37 th wettest | 16 th wettest | 16 th wettest | 17 th wettest | 17 th wettest | 16 th wettest | 26 th wettest |
| East Central OK | 36 th driest | 47 th driest | 41 st wettest | 29 th wettest | 37 th wettest | 40 th wettest | 32 nd wettest |
| Southeast OK | 47 th driest | 35 th driest | 15 th wettest | 19 th wettest | 25 th wettest | 40 th wettest | 19 th wettest |
| Statewide | 46 th driest | 31 st wettest | 21 st wettest | 21 st wettest | 34 th wettest | 34 th wettest | 32 nd wettest |

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

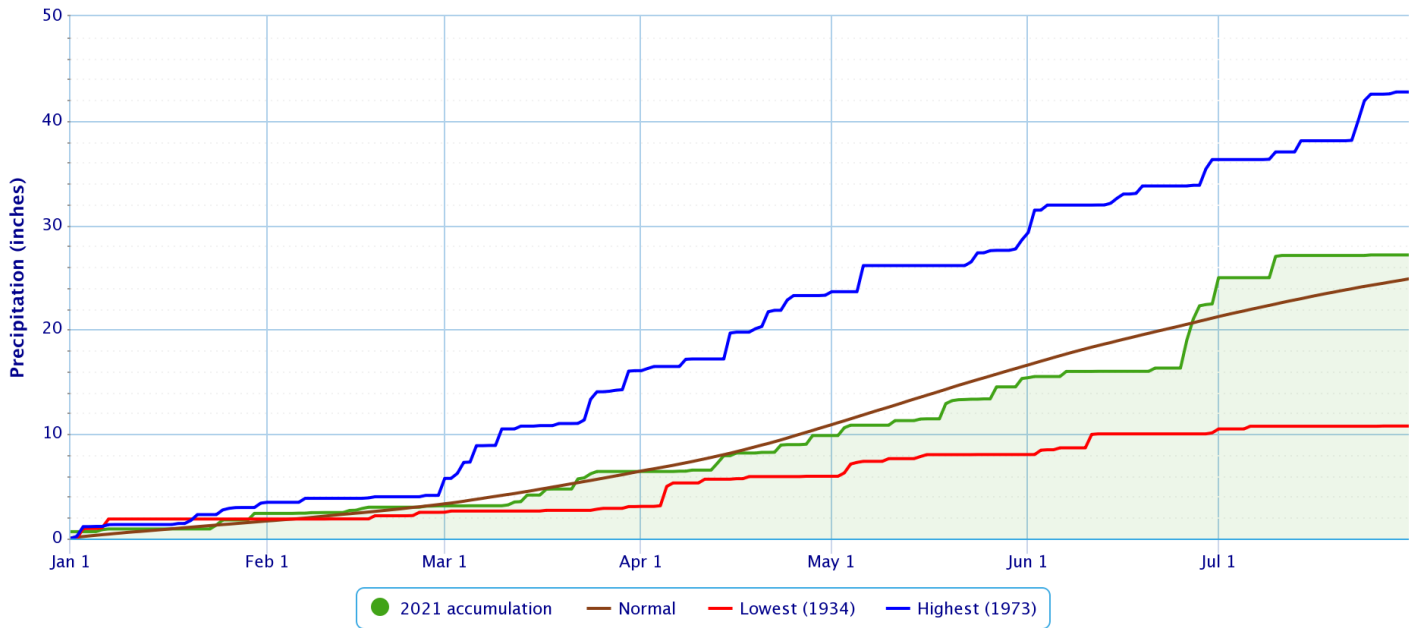
Period of Record – 1905-01-06 to 2021-08-01. Normals period: 1991-2020. Click and drag to zoom chart.



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Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

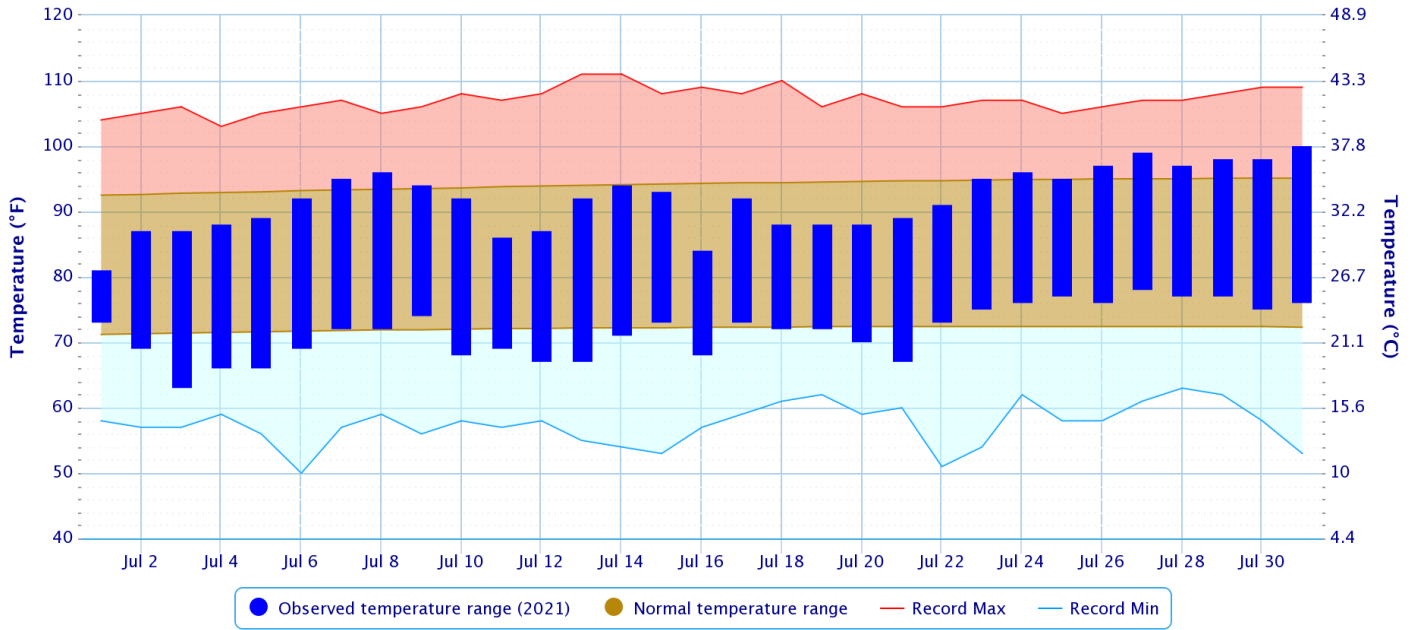
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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

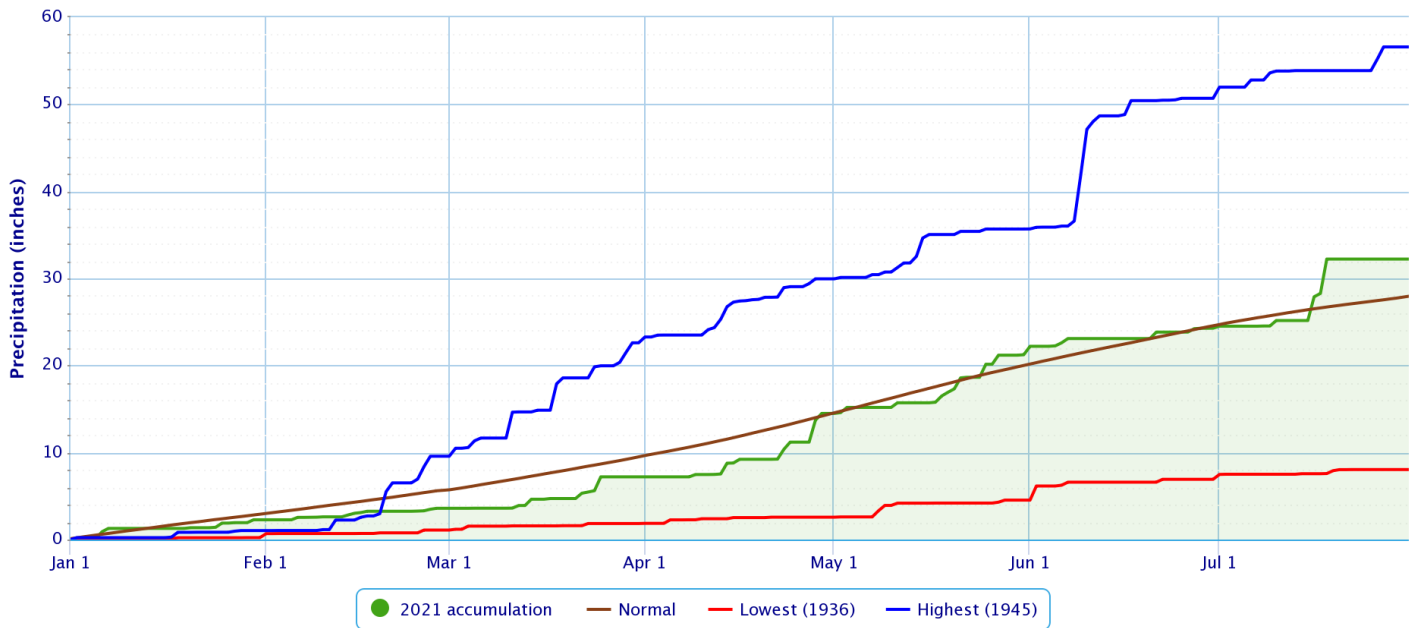
Period of Record – 1882-06-01 to 2021-08-01. Normals period: 1991-2020. Click and drag to zoom chart.



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Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

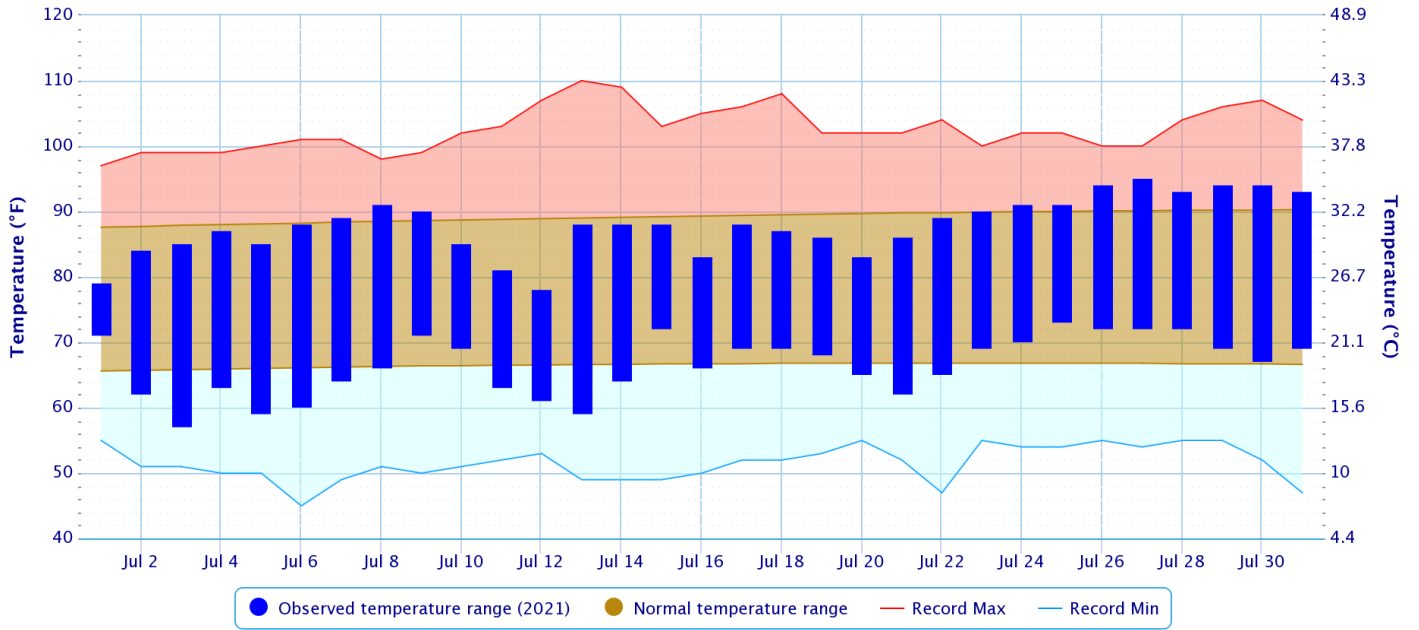
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

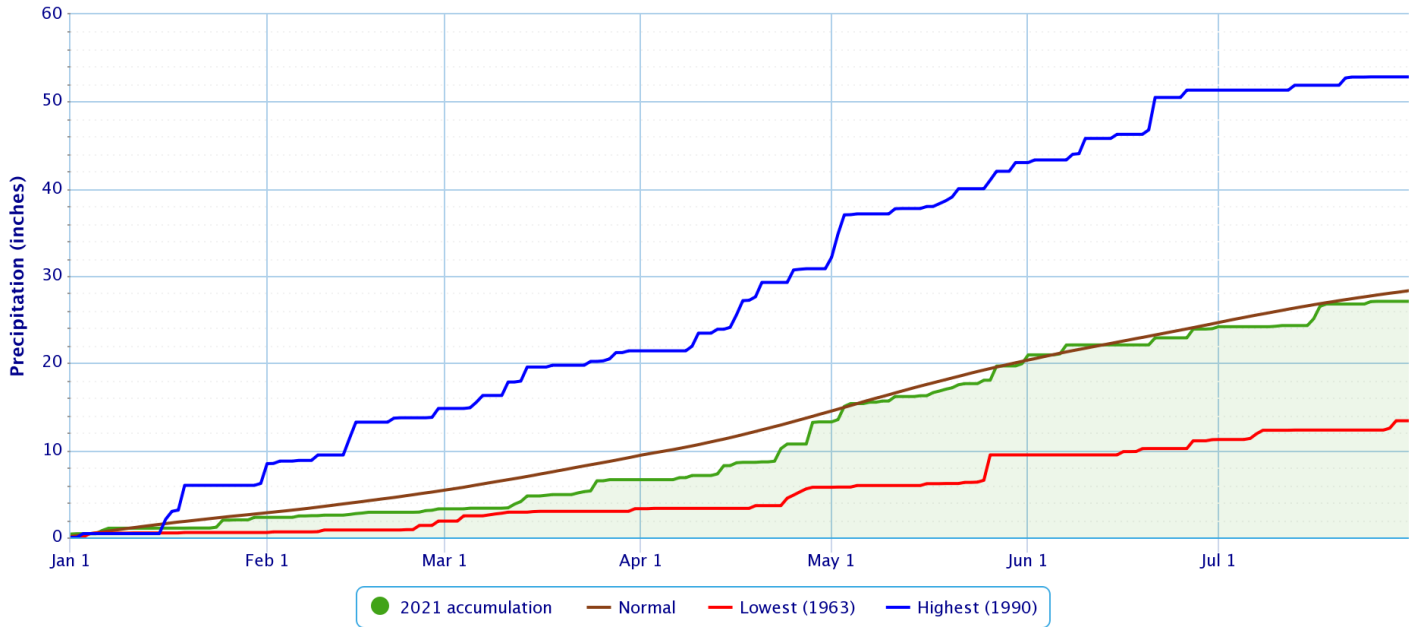
Period of Record – 1949-07-14 to 2021-08-01. Normals period: 1991-2020. Click and drag to zoom chart.



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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

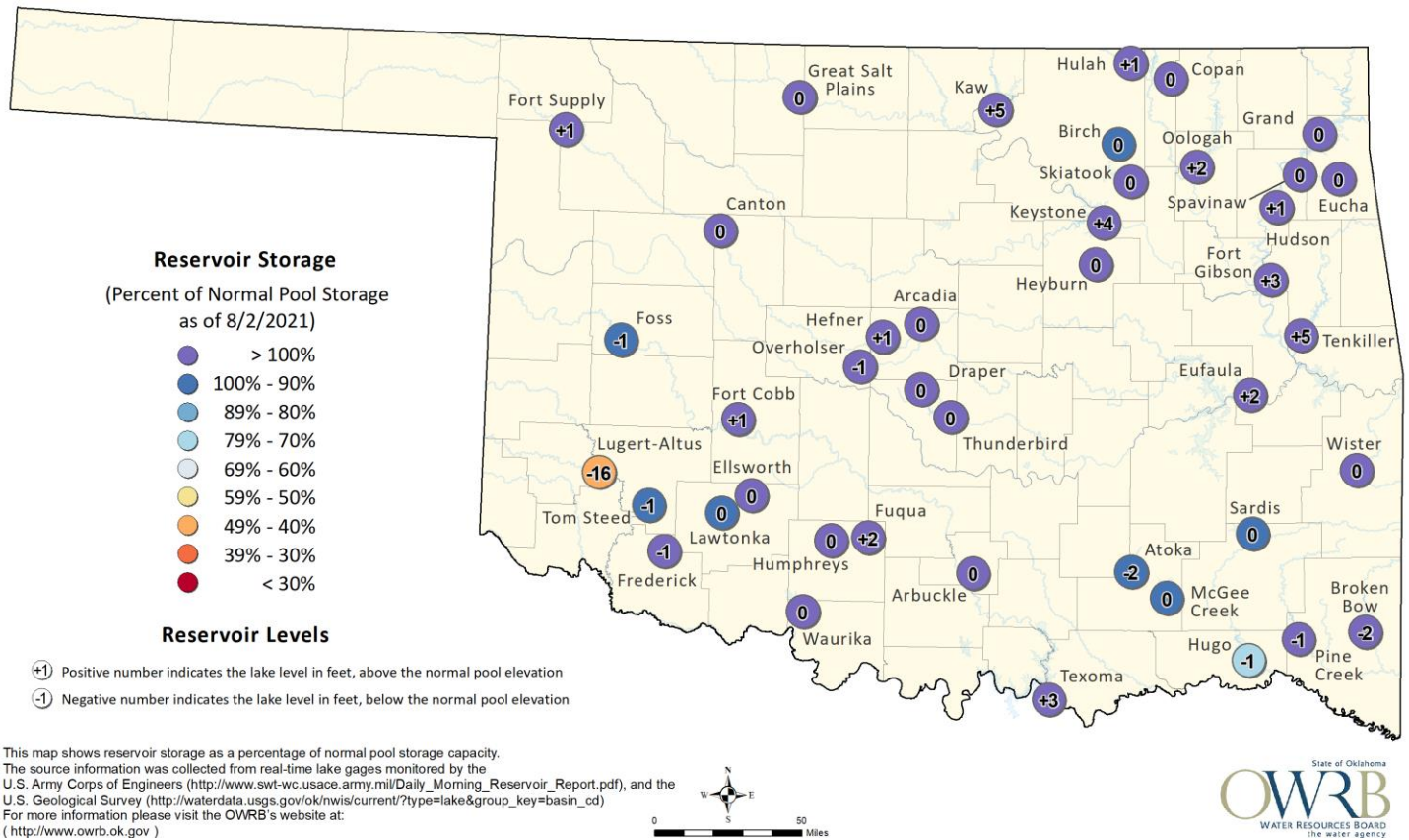


Powered by ACIS

Reservoirs

Oklahoma Surface Water Resources

Reservoir Levels and Storage as of 8/2/2021



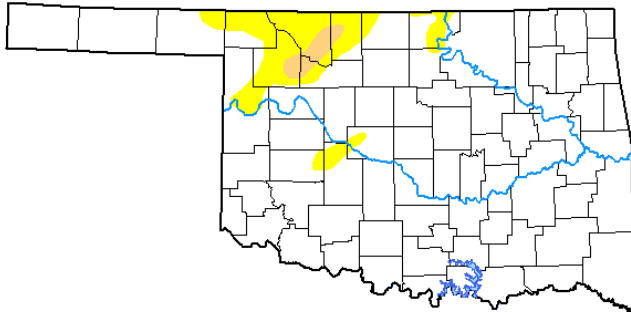
According to the USACE, several of the lakes in the HSA were higher than 3% of top of their conservation pools as of 8/01/2021: Beaver Lake 47%, Lake Eufaula 18%, Tenkiller Lake 12%, Kaw Lake 9%, Oologah Lake 9%, Keystone Lake 7%, Fort Gibson Lake 6%, and Hudson Lake 4%. One reservoir was more than 3% below the top of its conservation pool as of 8/01/2021: Hugo Lake 92%.

Drought

According to the [U.S. Drought Monitor](#) (USDM) from July 27, 2021 (Figs. 3a, 3b), no drought conditions were present across eastern OK and northwest AR. Abnormally Dry (but not in drought) conditions were occurring in a portion of far western Osage and eastern Kay Counties in eastern OK.

U.S. Drought Monitor Oklahoma

July 27, 2021
(Released Thursday, Jul. 29, 2021)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

| | None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|-------|-------|-------|-------|-------|------|
| Current | 91.45 | 8.55 | 1.13 | 0.00 | 0.00 | 0.00 |
| Last Week 07-20-2021 | 91.45 | 8.55 | 1.13 | 0.00 | 0.00 | 0.00 |
| 3 Months Ago 04-27-2021 | 43.60 | 56.40 | 20.02 | 6.30 | 0.08 | 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 07-28-2020 | 39.83 | 60.17 | 25.96 | 10.26 | 2.79 | 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 Rippey
U.S. Department of Agriculture



droughtmonitor.unl.edu

Fig. 3a. Drought Monitor for Oklahoma

U.S. Drought Monitor Arkansas

July 27, 2021
(Released Thursday, Jul. 29, 2021)
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 07-20-2021 | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 Months Ago 04-27-2021 | 99.34 | 0.66 | 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 07-28-2020 | 76.91 | 23.09 | 0.00 | 0.00 | 0.00 | 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 Rippey
U.S. Department of Agriculture



droughtmonitor.unl.edu

Fig. 3b. Drought Monitor for Arkansas

Outlooks

The [Climate Prediction Center](#) (CPC) outlook for August 2021 (issued July 31, 2021) indicates an enhanced chance for below normal temperatures along and southeast of I-44 in eastern OK and northwest AR, and an equal chance for above, near, and below normal temperatures northwest of I-44. This outlook also indicates an enhanced chance for above median precipitation across southeast OK and west central AR and an equal chance for above, near, and below median precipitation elsewhere across eastern OK and northwest AR. This outlook was largely based on dynamical model output combined with soil moisture and a cool start to the month.

For the 3-month period August-September-October 2021, CPC is forecasting an equal chance for above, near, and below normal temperatures and precipitation across all of eastern OK and northwest AR (outlook issued June 15, 2021). This outlook is based on long-term trends, as well as incorporating both statistical and dynamical forecast tools. The equal chances for temperatures are due to weaker signals among temperature tools coupled with abnormally wet soil moisture conditions across most of this region and represents a reduction in above normal temperature probabilities. According to CPC, the combined effect of the ocean-atmosphere system is consistent with ENSO neutral conditions. ENSO-neutral conditions are favored through early fall, followed by a 66% chance for a return of La Niña conditions during the September-November season and lasting through winter 2021-22. CPC has issued a 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

An active weather pattern affected the region at the end of June. As a very moist airmass remained in place with precipitable water values at or above 2", scattered convection developed across much of eastern OK and northwest AR around noon on June 30th. While much of this activity ended by evening, storms persisted across northeast OK and far northwest AR during the evening hours. The weak surface boundary across KS then sagged into northeast OK overnight, and convection renewed near it in the pre-dawn hours of July 1st as the low-level jet strengthened. Scattered showers and thunderstorms continued to spread southward across eastern OK and northwest AR through the morning and afternoon hours of the 1st. This activity weakened and dissipated by late evening, finally marking an end to the active weather pattern. Rainfall totals over the two days ranged from around 0.25" to around 5" across the region, with the highest totals once again over northeast OK (Figs. 4-6). Rises occurred along Bird Creek, with minor flooding near Owasso-Mingo (see preliminary hydrographs at the end of this report and the E3 Report for details). 2"-10" of rain fell over the Deep Fork River basin over a 7-day period (Figs. 7, 8), with near major flooding occurring along the Deep Fork River near Beggs (see preliminary hydrographs at the end of this report and the E3 Report for details).

Thunderstorms developed along a leftover outflow boundary during the afternoon in southeast KS and moved south into northeast OK by early evening. These storms continued to increase as a robust upper-level wave moved into the region, eventually forming a line as they moved south across most of eastern OK and western AR during the evening hours. The last of the rain crossed the Red River in the pre-dawn hours of the 11th. Damaging winds occurred with this line of storms, and with precipitable water amounts around 2", some of the thunderstorms produced locally heavy rain. Rainfall totals ranged from around a few hundredths of an inch to around 4" across eastern OK and northwest AR (Fig. 9).

Persistent, pre-frontal convection occurred across the Neosho River basin in southeast KS during the afternoon and evening hours of the 15th. As a shortwave trough and the low-level jet interacted with the outflow from these storms, additional thunderstorms developed into an MCS over southeast KS, which moved into northeast OK shortly after midnight of the 16th. By 7 am CDT on the 16th, 24-hour rainfall totals were 1"-3" across far northeast OK, and 1.5"-10" across southeast KS (Fig. 10). This heavy rain in southeast KS caused rapid rises along the Neosho and Verdigris Rivers. Moderate flooding eventually occurred along the Neosho River near Commerce (see preliminary hydrographs at the end of this report and the E3 Report for details). The MCS continued to move to the southeast during the morning and afternoon hours, affecting far eastern OK and western AR. Precipitable water values were once again around 2", allowing for efficient rain production and locally heavy rainfall. Just before midnight of the 17th, slow moving, heavy rain producing thunderstorms developed across northeast OK and northwest AR along an 850 mb warm front. The 24-hour rainfall totals at 7 am CDT on the 17th ranged from 0.50" to 8" across northeast and far eastern OK and western AR (Fig. 11). A large area Mayes and Delaware Counties received 5"-8" of rain (Fig. 11). This additional rainfall caused a

higher rise on the Verdigris River, but the river remained just below flood stage. These storms began to fade during the late morning hours of the 17th as the low-level jet weakened. However, slow moving scattered convection redeveloped during the afternoon and evening hours across eastern OK and northwest AR as a mesoscale convective vortex (MCV) interacted with outflow boundaries from the early morning storms. These storms remained within an axis of anomalously high moisture that stretched from central AR into northern OK, resulting in additional pockets of very high rainfall. Convection remained active during the night as low-level warm air advection persisted. Most of this rain finally came to an end by mid-morning on the 18th. 24-hour rainfall totals by 7 am CDT on the 18th were once again 0.5"-8" (Fig. 12), with areas of 5"-8" impacting portions of Wagoner, Muskogee, and Franklin Counties. Street flooding was reported in Bixby, OK, where 3.96" of rain fell in just under two hours at the OK Mesonet site. A personal weather station in Bixby measured 1.84" of rain in 40 minutes during the afternoon of the 17th, followed by another 5.08" in 3 hours during the late evening hours. Another personal weather station reported nearly 5.5" of rain in just over two hours in Okay, OK. Flooding damaged homes in Ozark, AR and roadways in southwest Franklin County, AR. Street flooding also occurred in Muskogee, OK, and at least one swift water rescue was reported. Rises occurred along the Illinois River, making recreation dangerous, but the river remained below flood stage.

The moisture axis finally shifted south, and scattered showers and thunderstorms developed across primarily southeast OK and west central AR during the afternoon of the 18th. This activity festered through the evening and into the early morning hours of the 19th. Rainfall totals ranged from 0.25"-3" (Fig. 13).

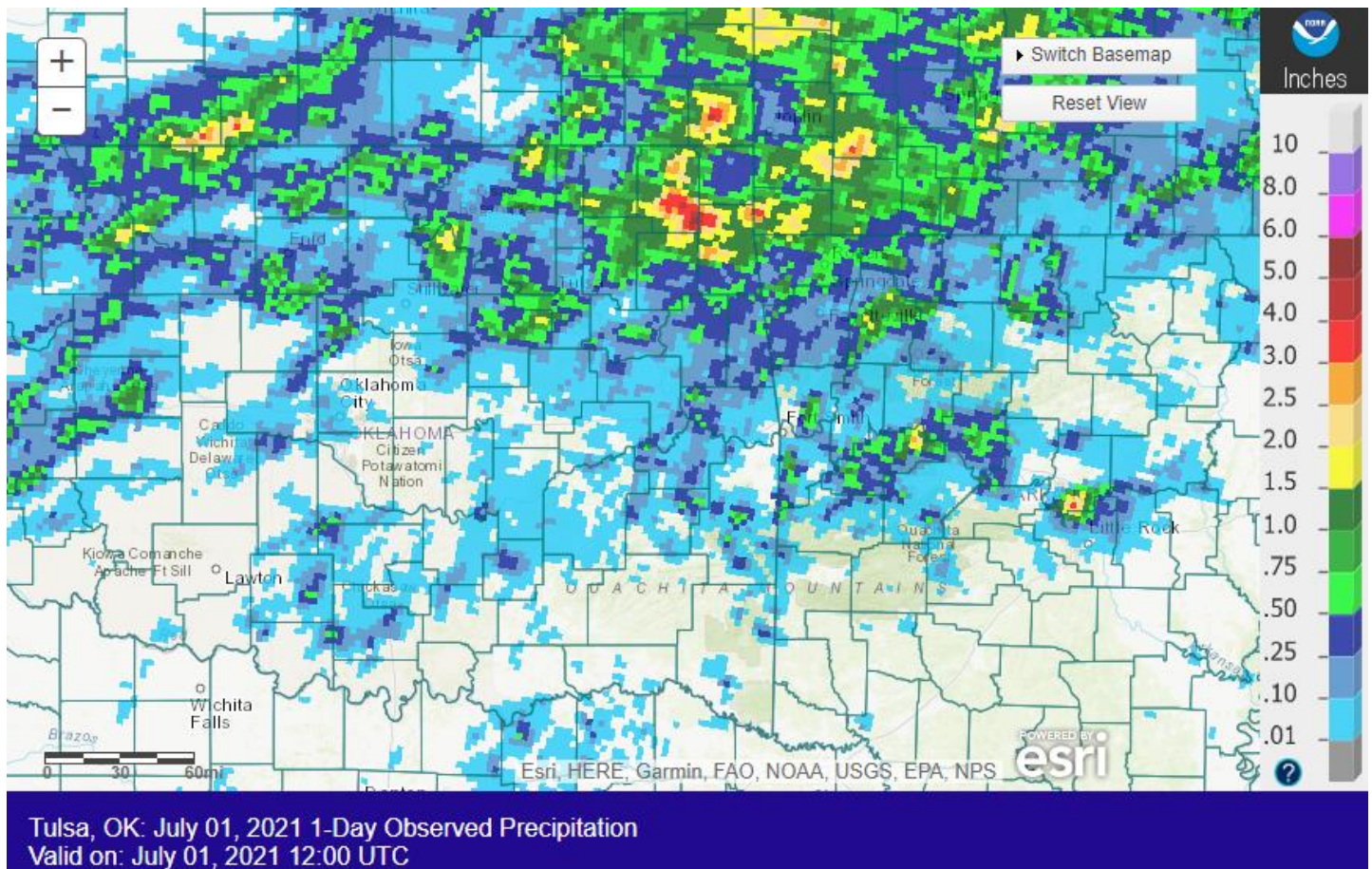
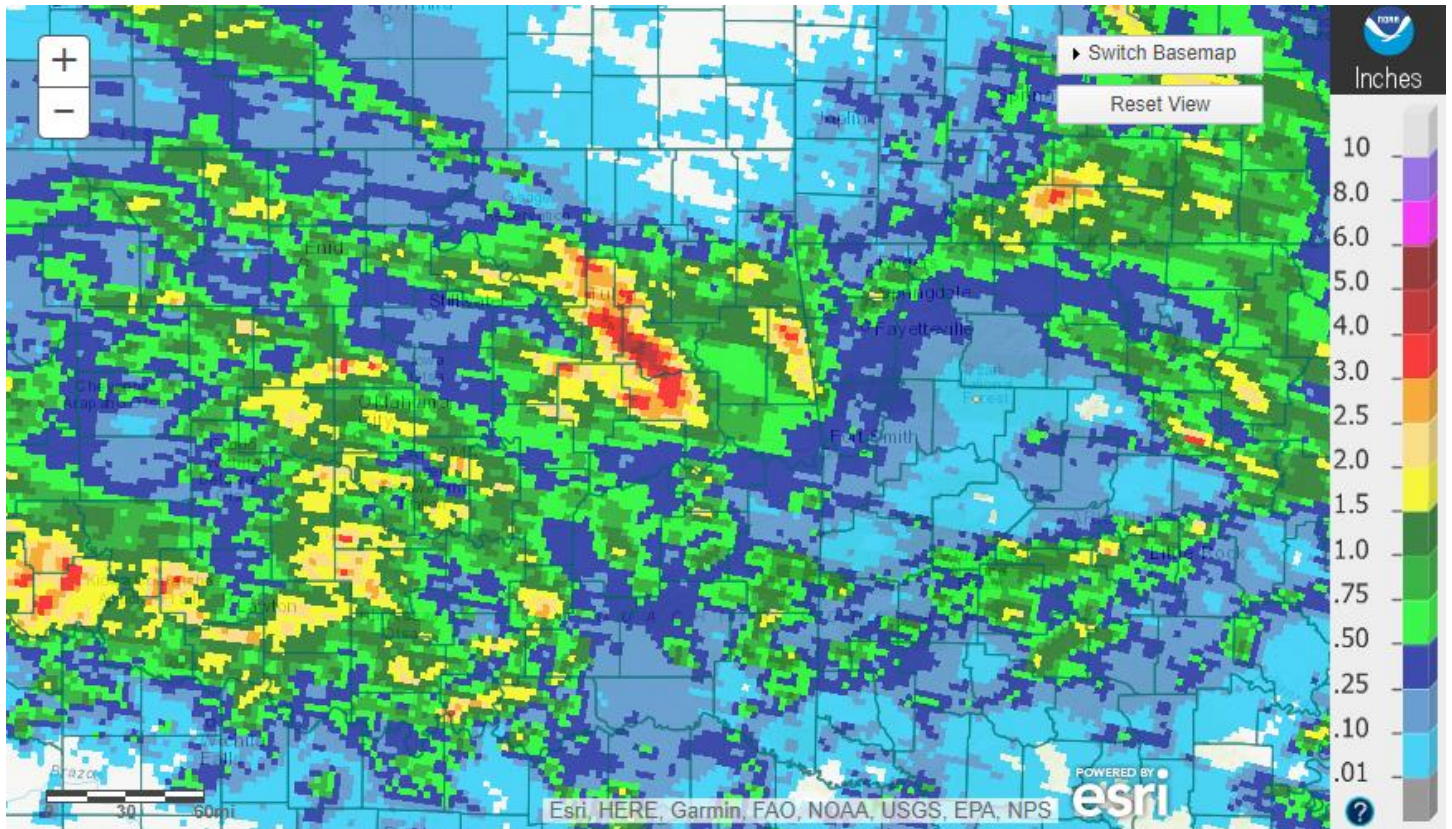
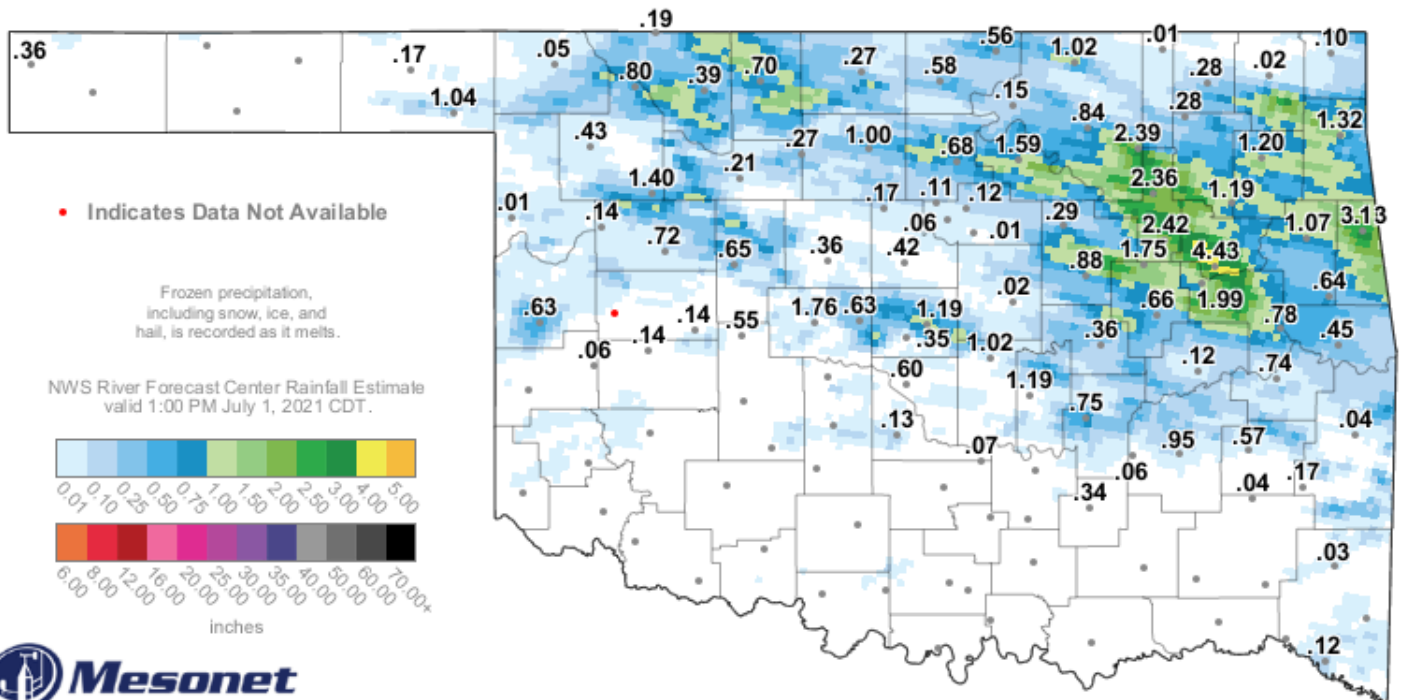


Fig. 4. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/01/2021.



Tulsa, OK: July 02, 2021 1-Day Observed Precipitation
Valid on: July 02, 2021 12:00 UTC

Fig. 5. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/02/2021.

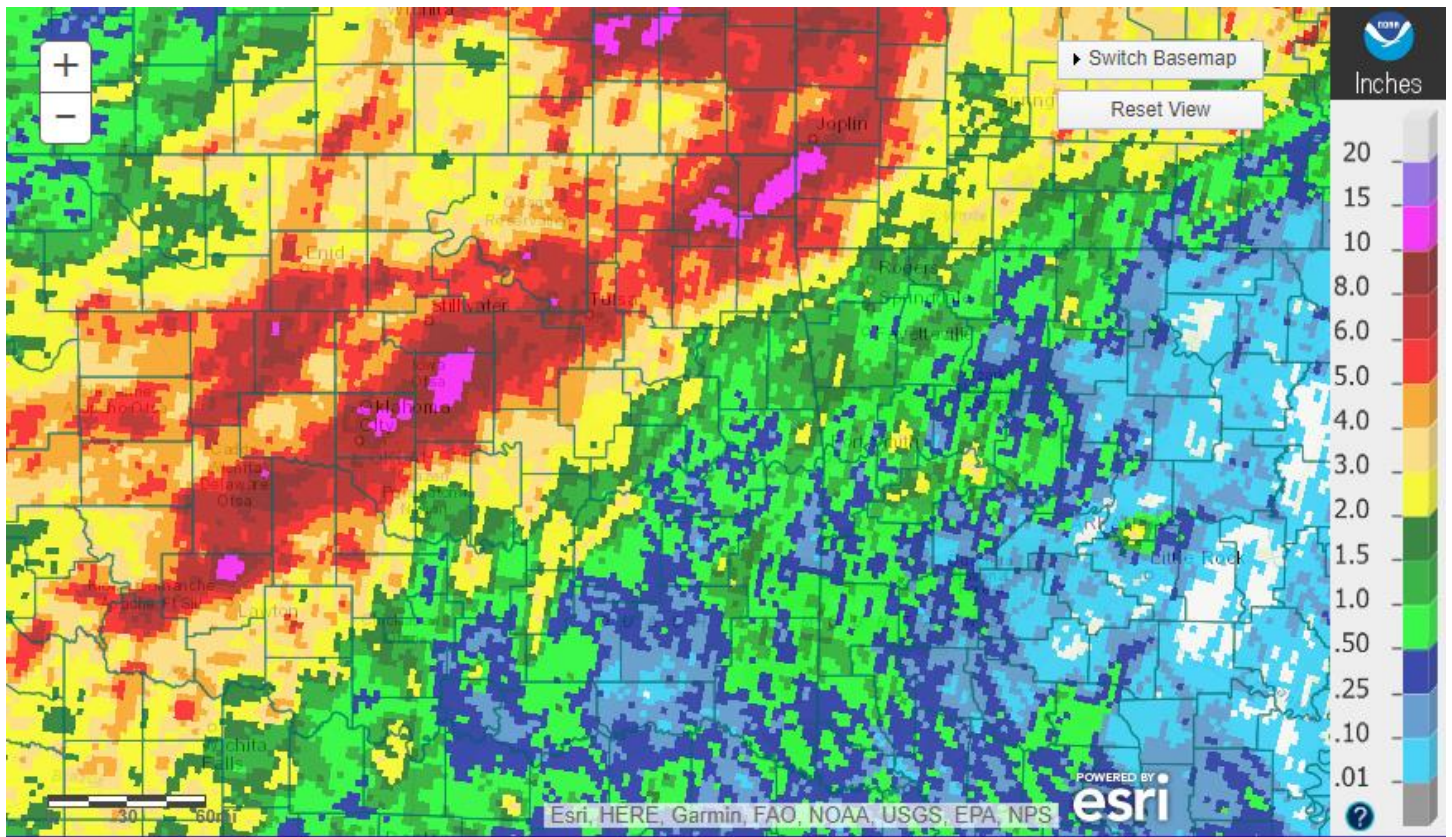


12-Hour Rainfall Accumulation (inches)

2:40 PM July 1, 2021 CDT

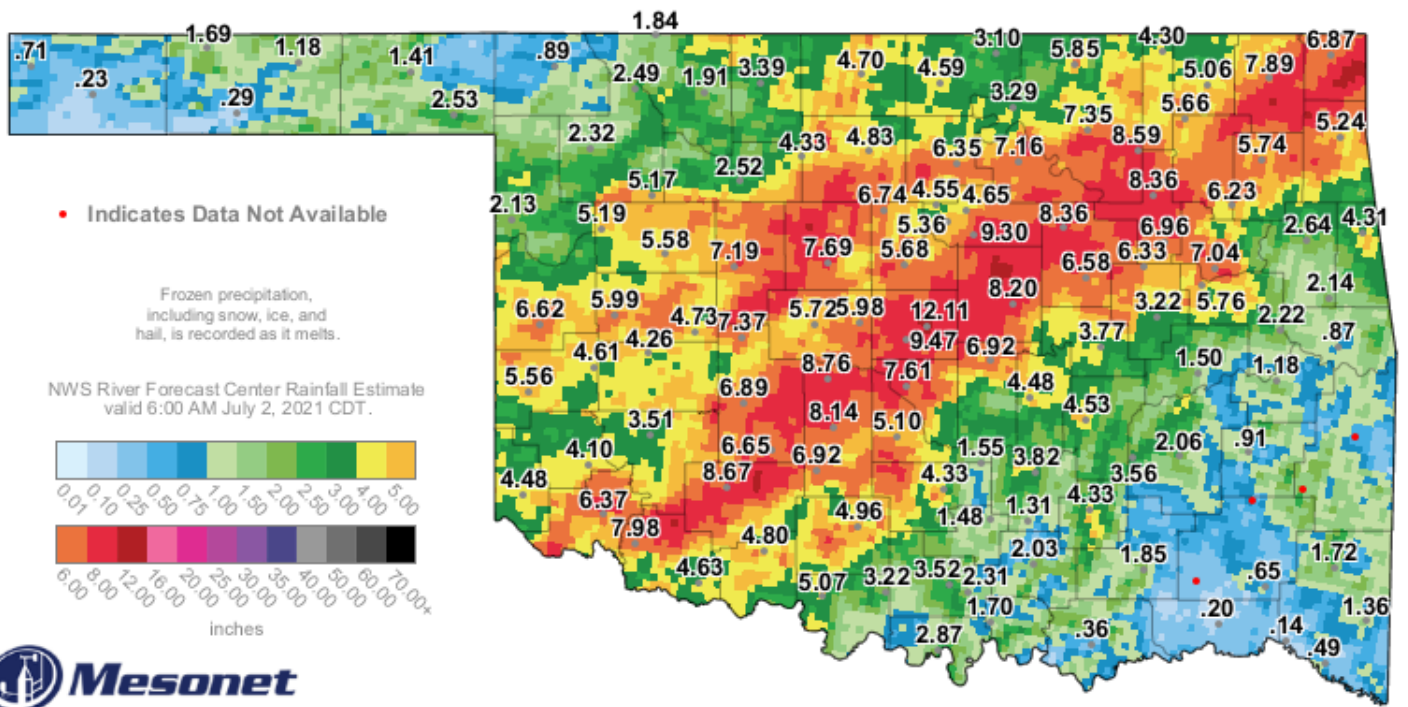
Created 2:45:53 PM July 1, 2021 CDT. © Copyright 2021

Fig. 6. OK Mesonet (values) and NWS RFC rainfall estimate (image) 12-hour rainfall ending at 02:40 pm CDT 7/01/2021.



Tulsa, OK: Last 7-Day Observed Precipitation
Valid on: July 01, 2021 12:00 UTC

Fig. 7. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/01/2021.

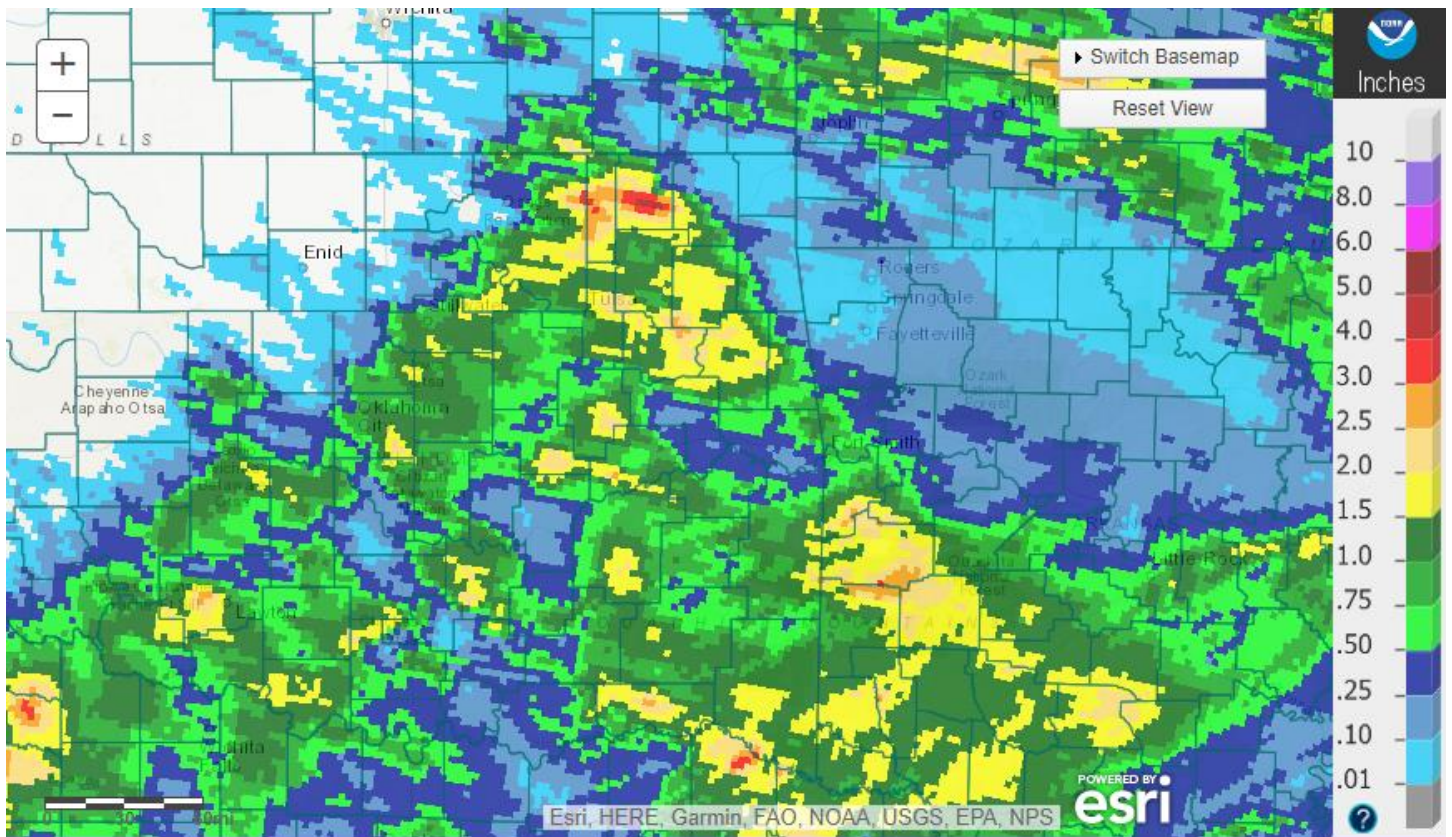


7-Day Rainfall Accumulation (inches)

7:35 AM July 2, 2021 CDT

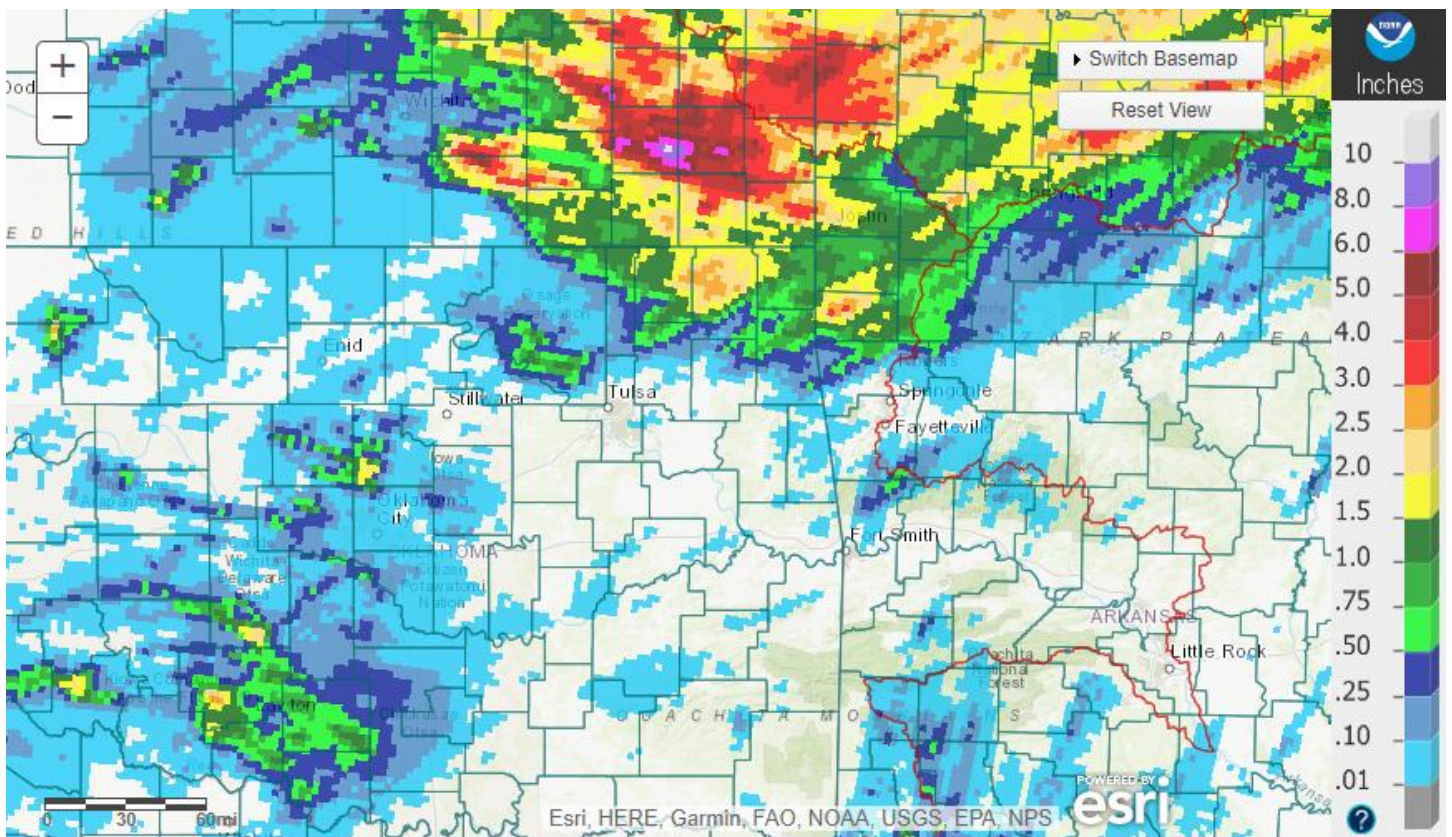
Created 7:41:00 AM July 2, 2021 CDT. © Copyright 2021

Fig. 8. OK Mesonet (values) and NWS RFC rainfall estimate (image) 7-day rainfall ending at 07:35 am CDT 7/02/2021.



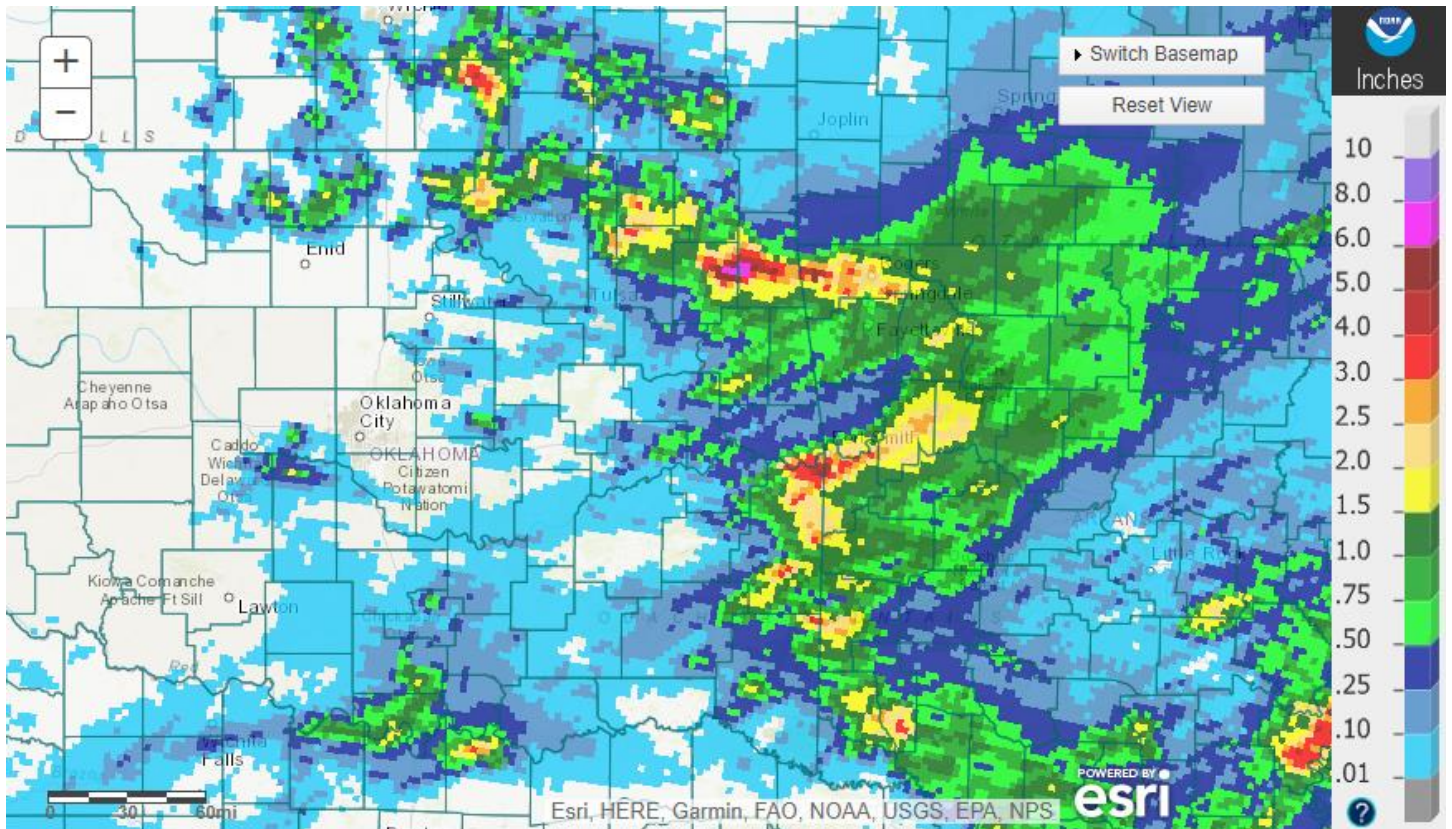
Tulsa, OK: July 11, 2021 1-Day Observed Precipitation
Valid on: July 11, 2021 12:00 UTC

Fig. 9. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/11/2021.



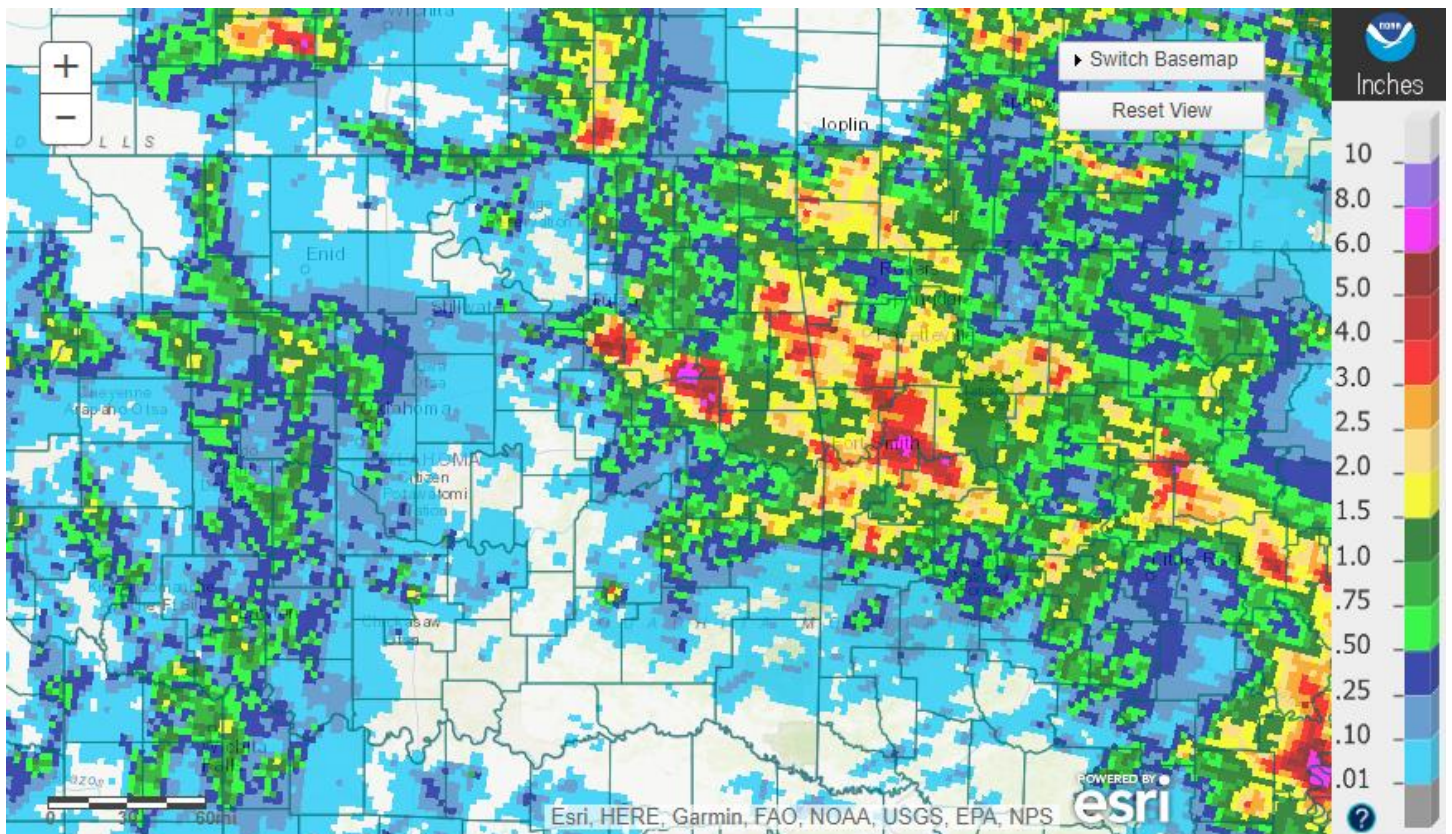
Tulsa, OK: July 16, 2021 1-Day Observed Precipitation
Valid on: July 16, 2021 12:00 UTC

Fig. 10. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/16/2021.



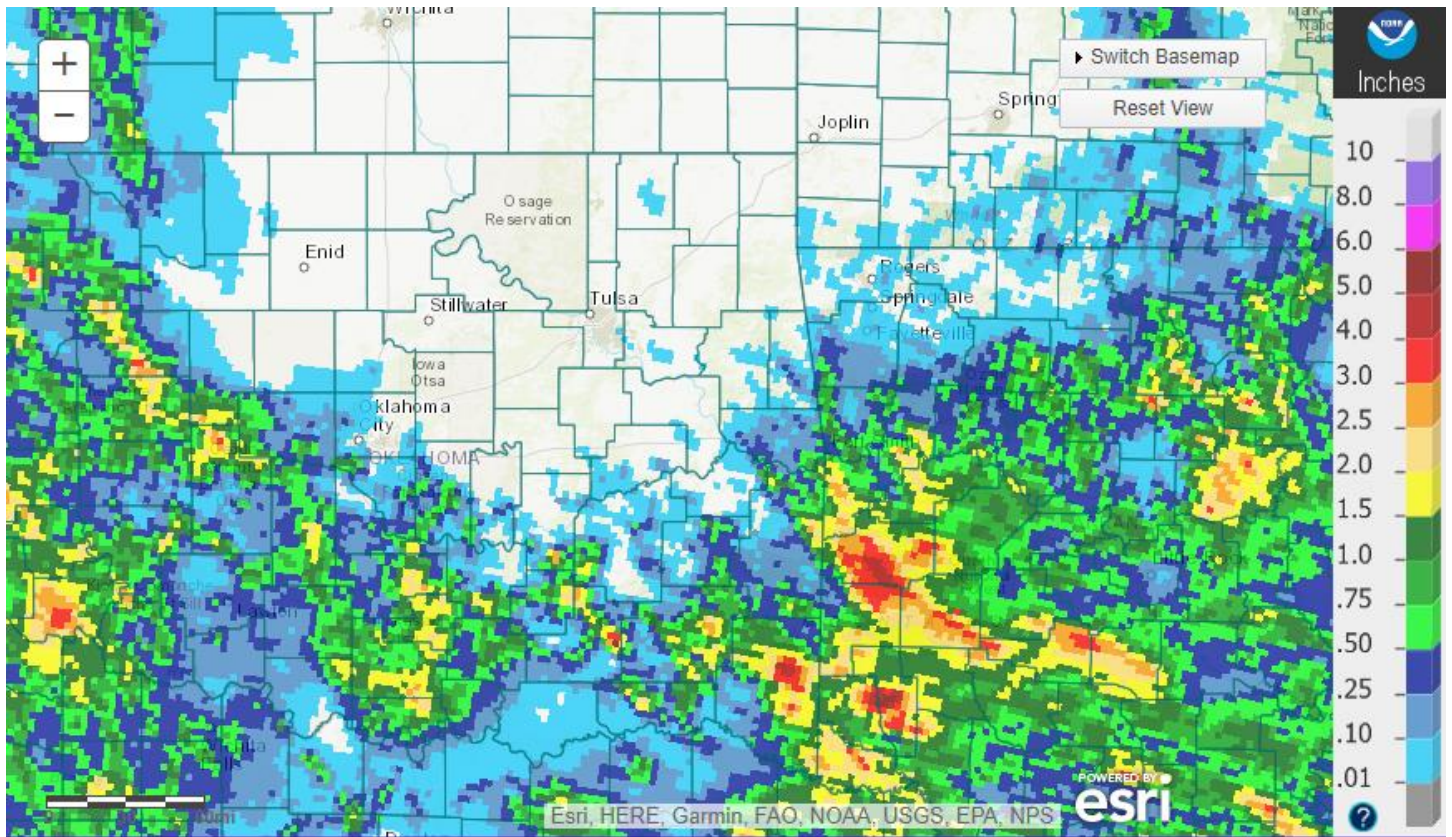
Tulsa, OK: July 17, 2021 1-Day Observed Precipitation
Valid on: July 17, 2021 12:00 UTC

Fig. 11. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/17/2021.



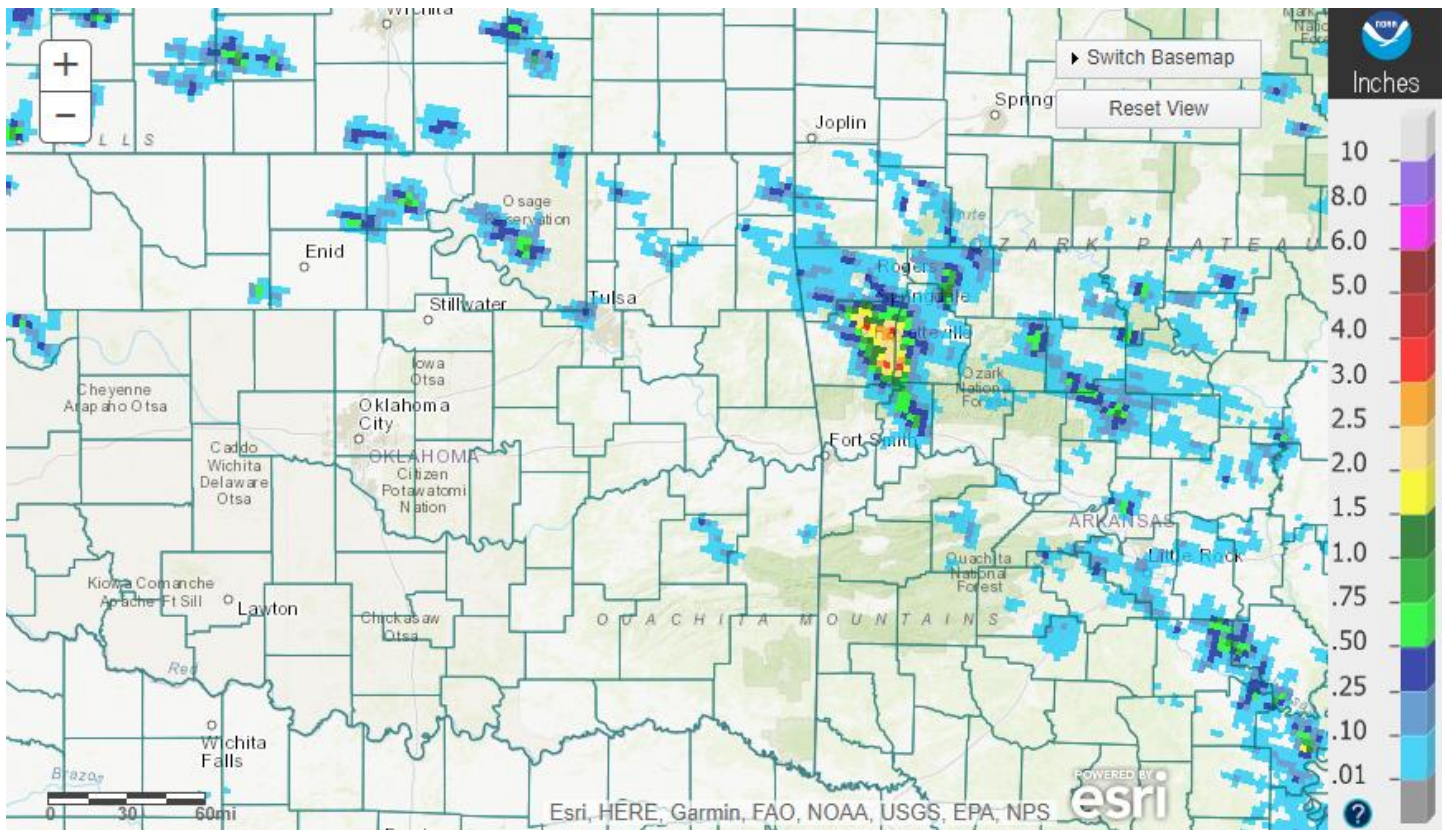
Tulsa, OK: July 18, 2021 1-Day Observed Precipitation
Valid on: July 18, 2021 12:00 UTC

Fig. 12. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/18/2021.



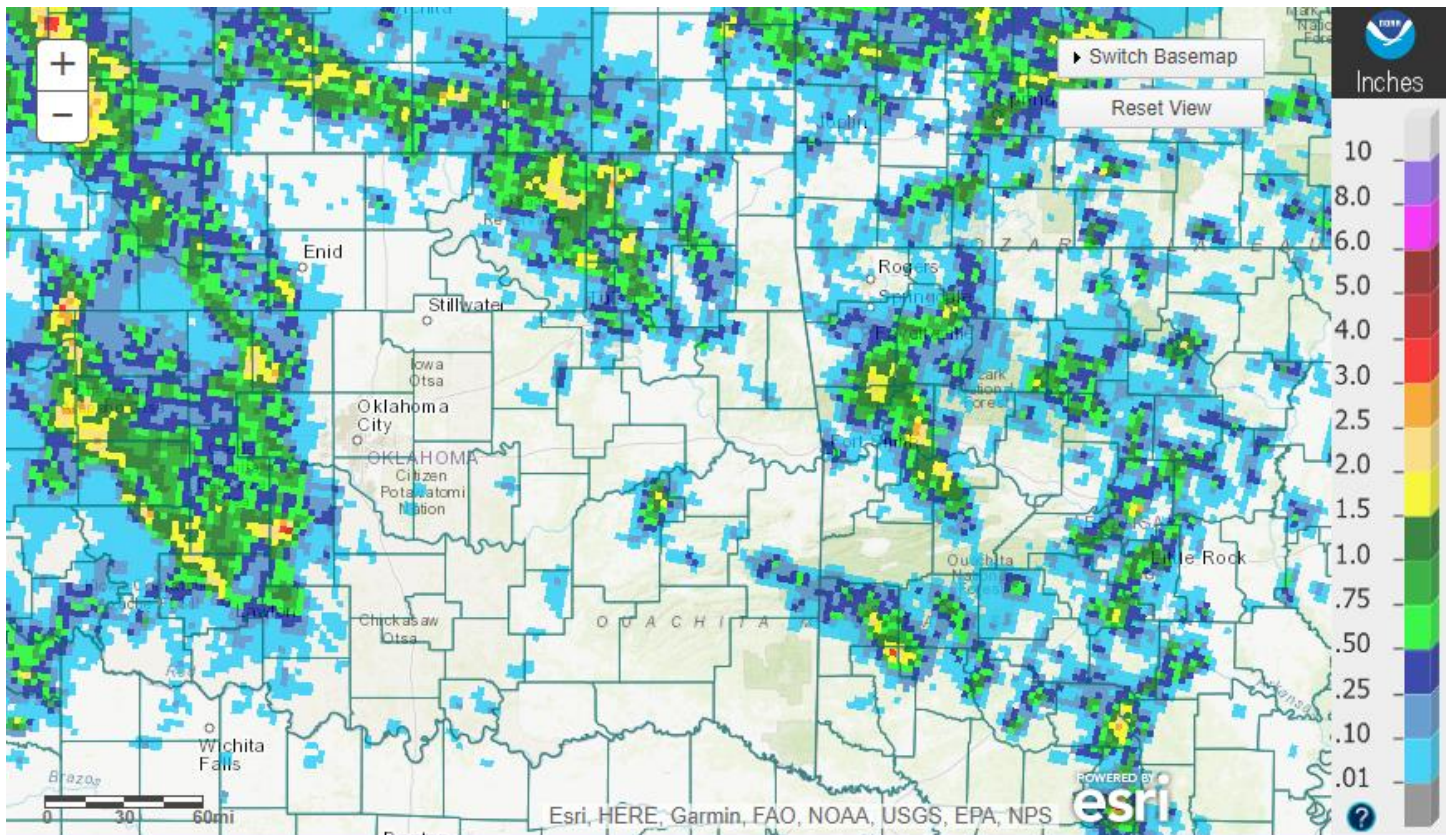
Tulsa, OK: July 19, 2021 1-Day Observed Precipitation
Valid on: July 19, 2021 12:00 UTC

Fig. 13. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/19/2021.



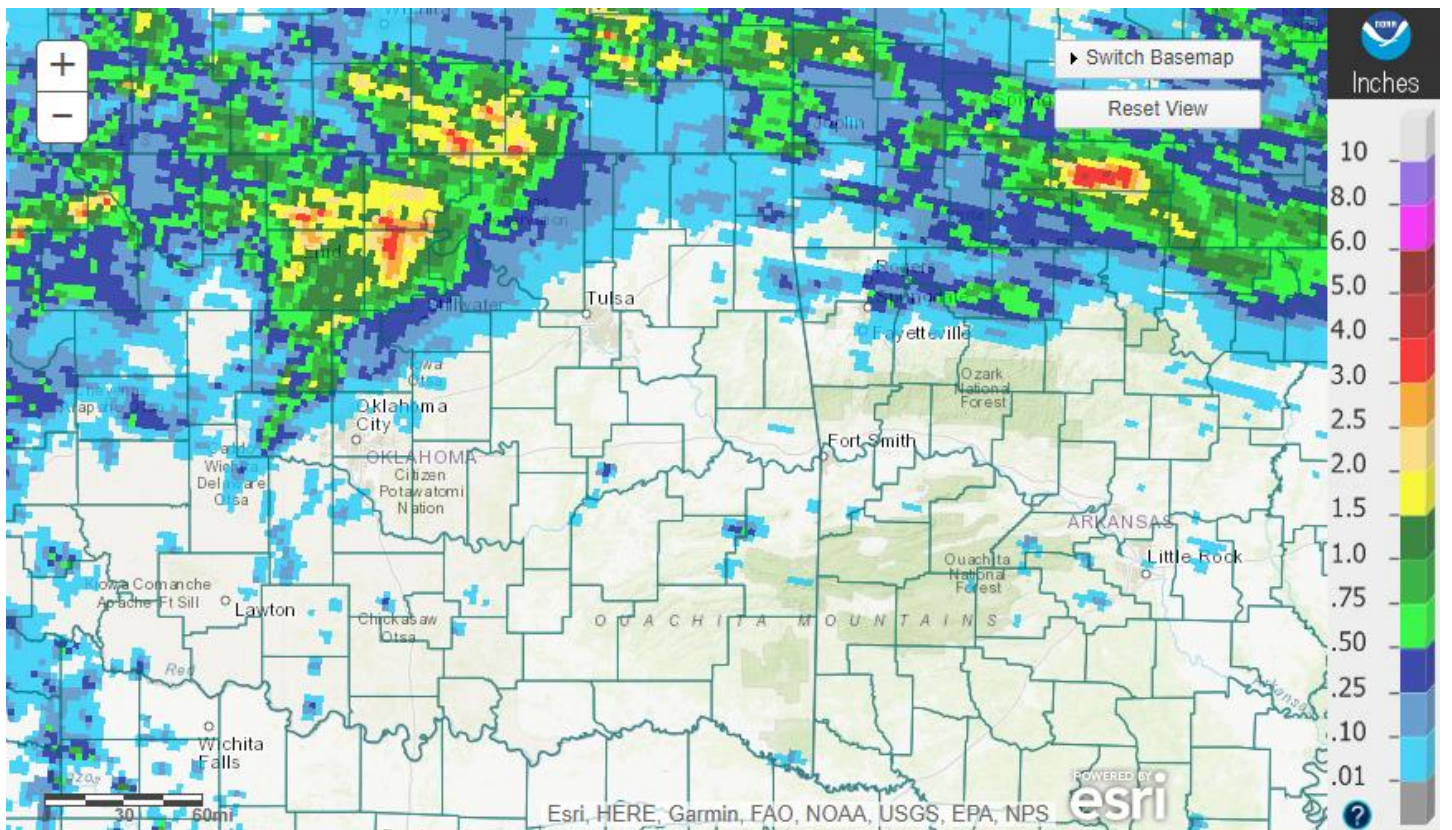
Tulsa, OK: July 25, 2021 1-Day Observed Precipitation
Valid on: July 25, 2021 12:00 UTC

Fig. 14. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/25/2021.



Tulsa, OK: July 26, 2021 1-Day Observed Precipitation
Valid on: July 26, 2021 12:00 UTC

Fig. 15. 24-hour Estimated Observed Rainfall ending at 7am CDT 07/26/2021.



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

Fig. 16. 24-hour Estimated Observed Rainfall ending at 7am CDT 08/01/2021.

Showers and thunderstorms developed during the early morning hours of the 25th across northwest AR. These storms slowly drifted south through the morning, before finally dissipating during the early afternoon. Rainfall from this activity ranged from around 0.50" to around 3" across northwest and west central AR (Figs. 14, 15). Thunderstorms then developed along an outflow boundary, where 80°F dewpoints had pooled, that was moving south into northeast OK during the afternoon. Some of these storms were severe, producing damaging winds in Tulsa, Collinsville, Owasso, and Broken Arrow. The Tulsa ASOS measured a peak wind gust of 63 mph. This activity quickly dissipated during the early evening hours. Rainfall totals were primarily around 0.50" to 2.5" (Fig. 15).

Late on the 31st, thunderstorms that had developed along a cold front in southern KS moved south into north central and northeast OK. This activity continued into the early morning hours as the front moved southward. Precipitable water values were near 2", and heavy rain fell across Osage, Pawnee, and eastern Kay Counties where the biggest storms were. Rainfall totals in this area were around 0.50" to around 3" (Fig. 16).

Written by:

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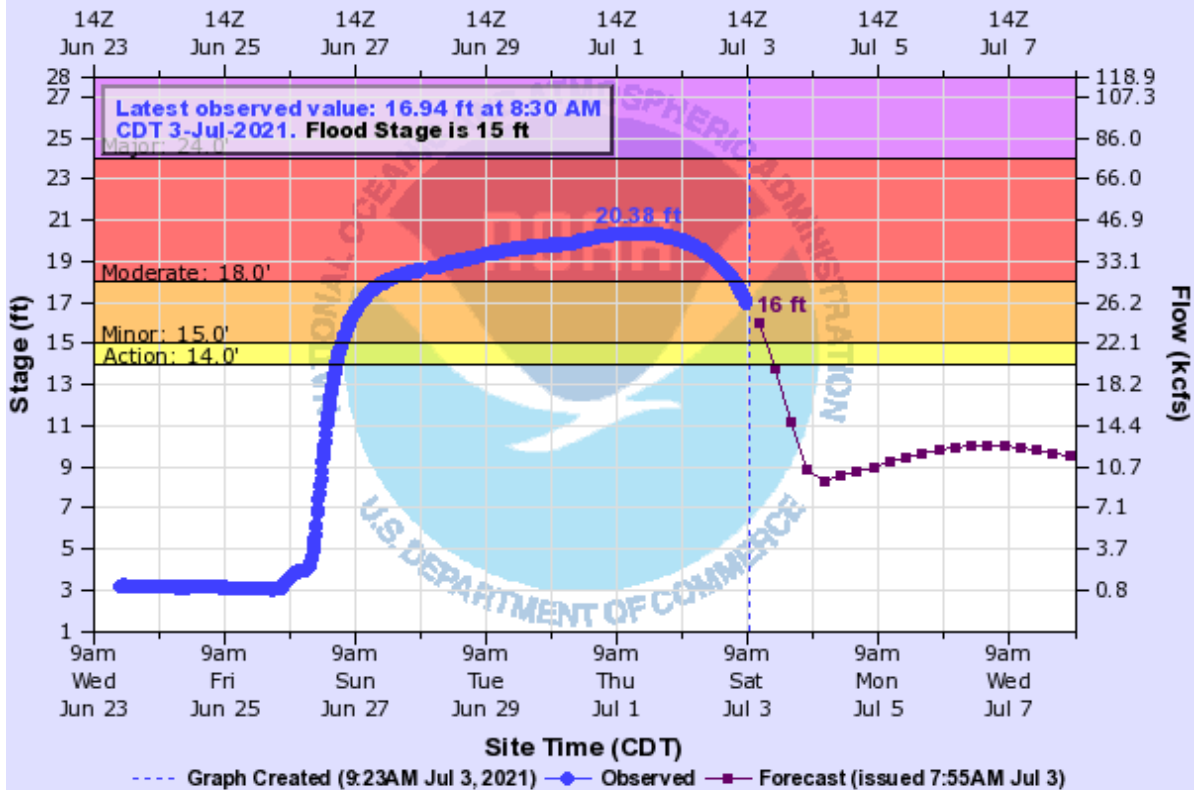
Products issued in July 2021:

- 21 Flash Flood Warnings (FFW)
- 15 Flash Flood Statements (FFS)
- 2 Flash/Areal Flood Watches (FFA) (14 Watch FFA CON/EXT/EXA/EXB/CAN)
- 46 Urban and Small Stream Advisories (FLS)
- 10 Areal Flood Warnings (FLW)
- 4 Areal Flood Statements (FLS)
- 5 River Flood Warnings (FLW) (includes category increases)
- 61 River Flood Statements (FLS)
- 4 River Flood Advisories (FLS) (21 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:

NEOSHO RIVER NEAR COMMERCE

Universal Time (UTC)

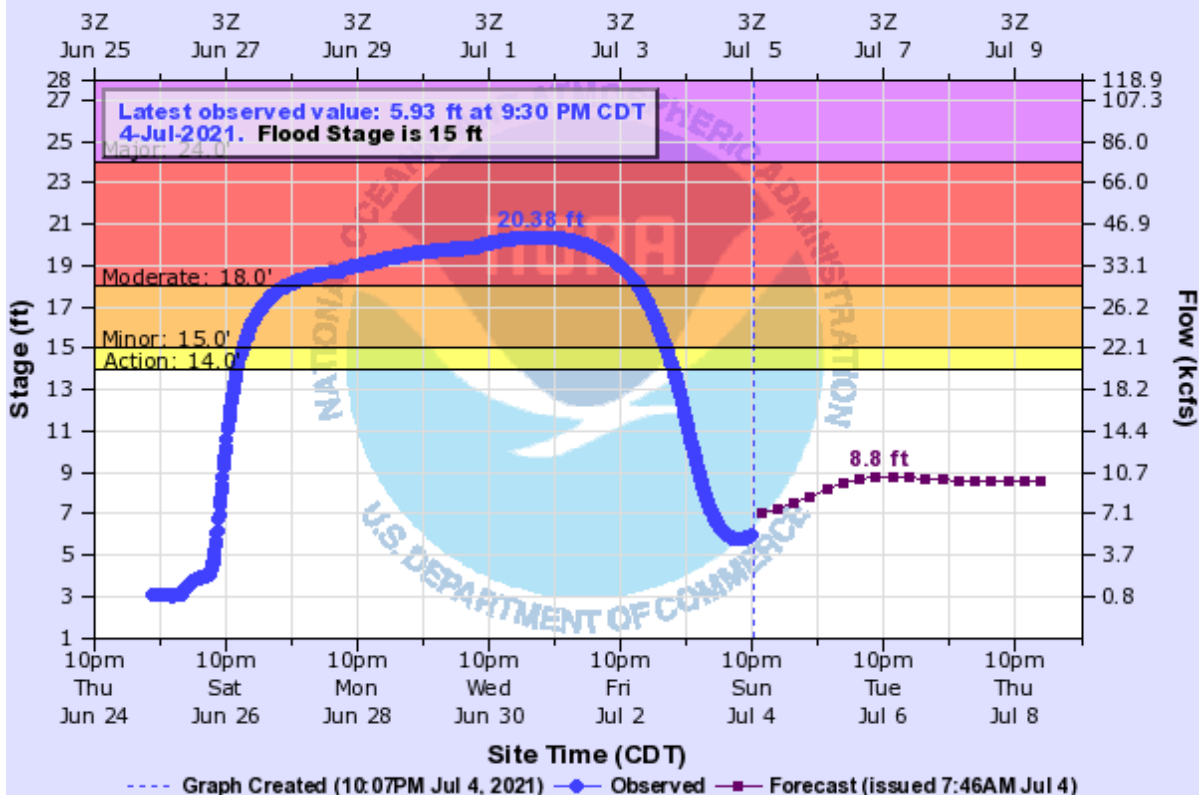


COMO2(plotting HGIRG) "Gage 0" Datum: 748.97'

Observations courtesy of US Geological Survey

NEOSHO RIVER NEAR COMMERCE

Universal Time (UTC)

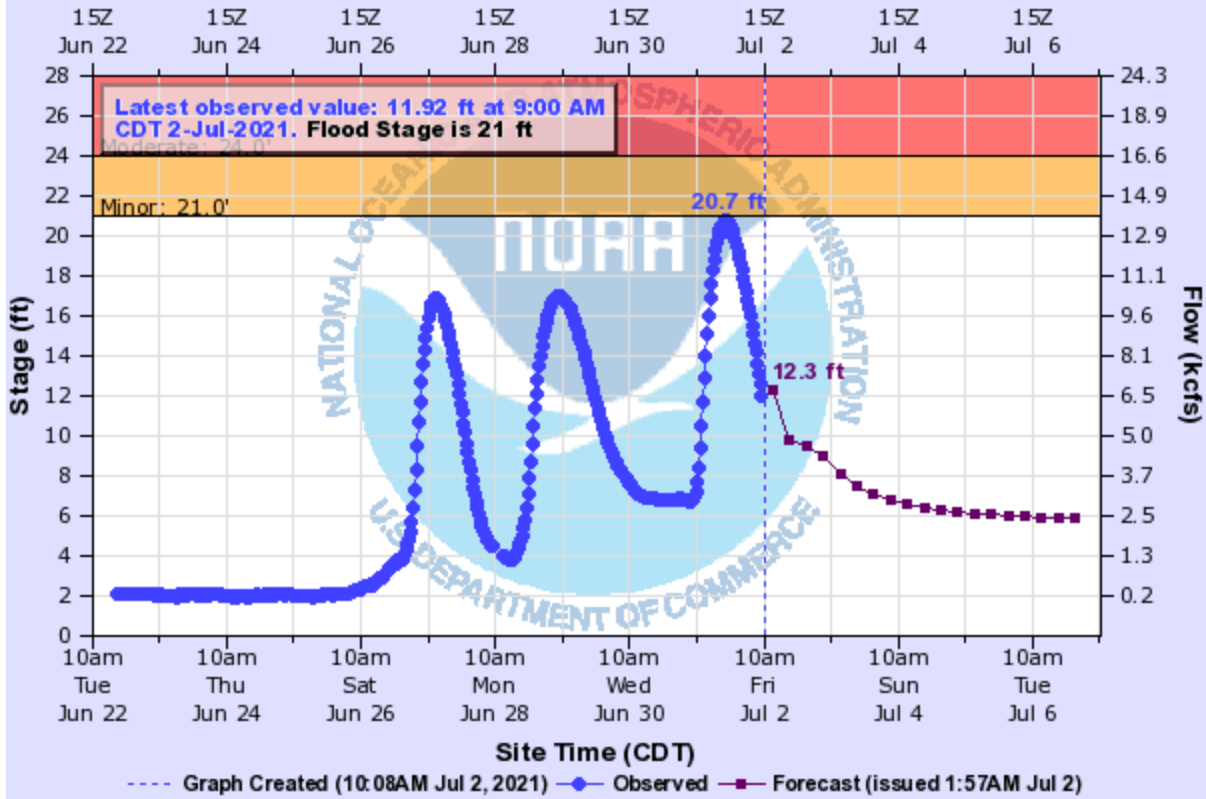


COMO2(plotting HGIRG) "Gage 0" Datum: 748.97'

Observations courtesy of US Geological Survey

BIRD CREEK NEAR SPERRY

Universal Time (UTC)

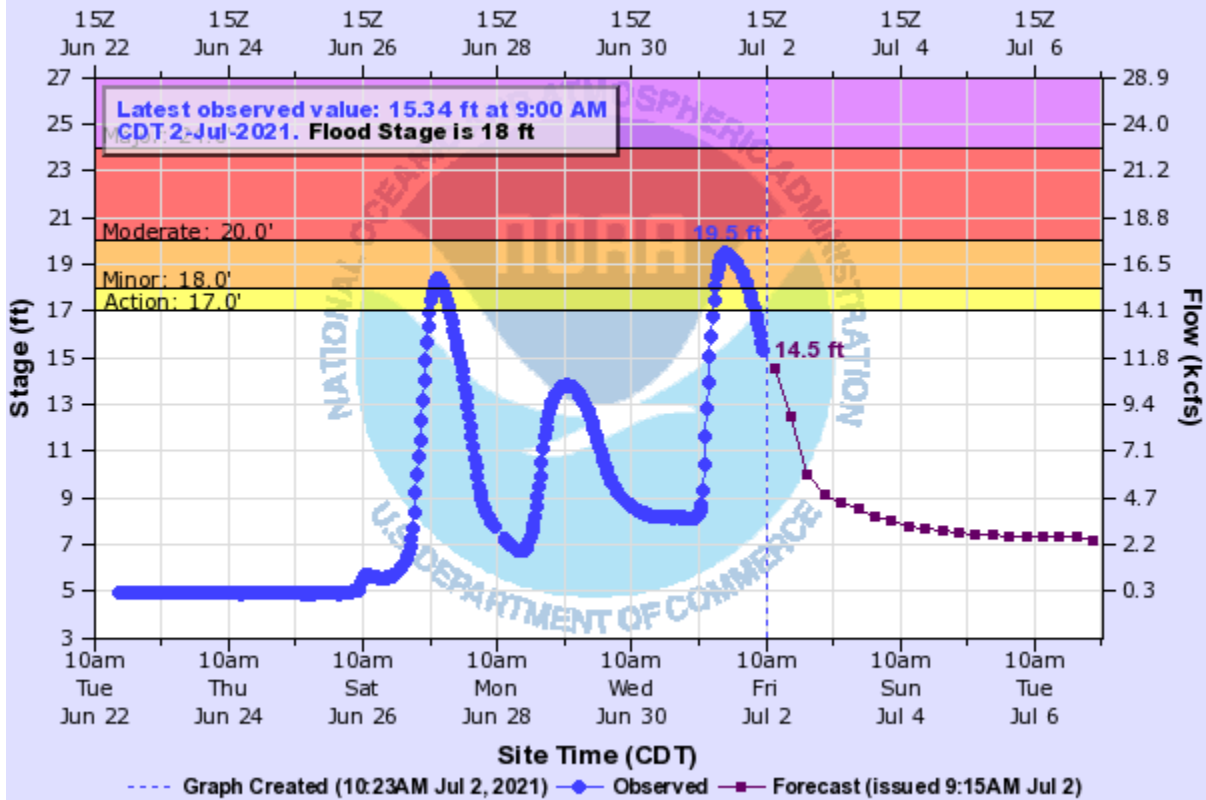


SPEO2(plotting HGIRG) "Gage 0" Datum: 579.43'

Observations courtesy of US Geological Survey

BIRD CREEK NEAR OWASSO

Universal Time (UTC)

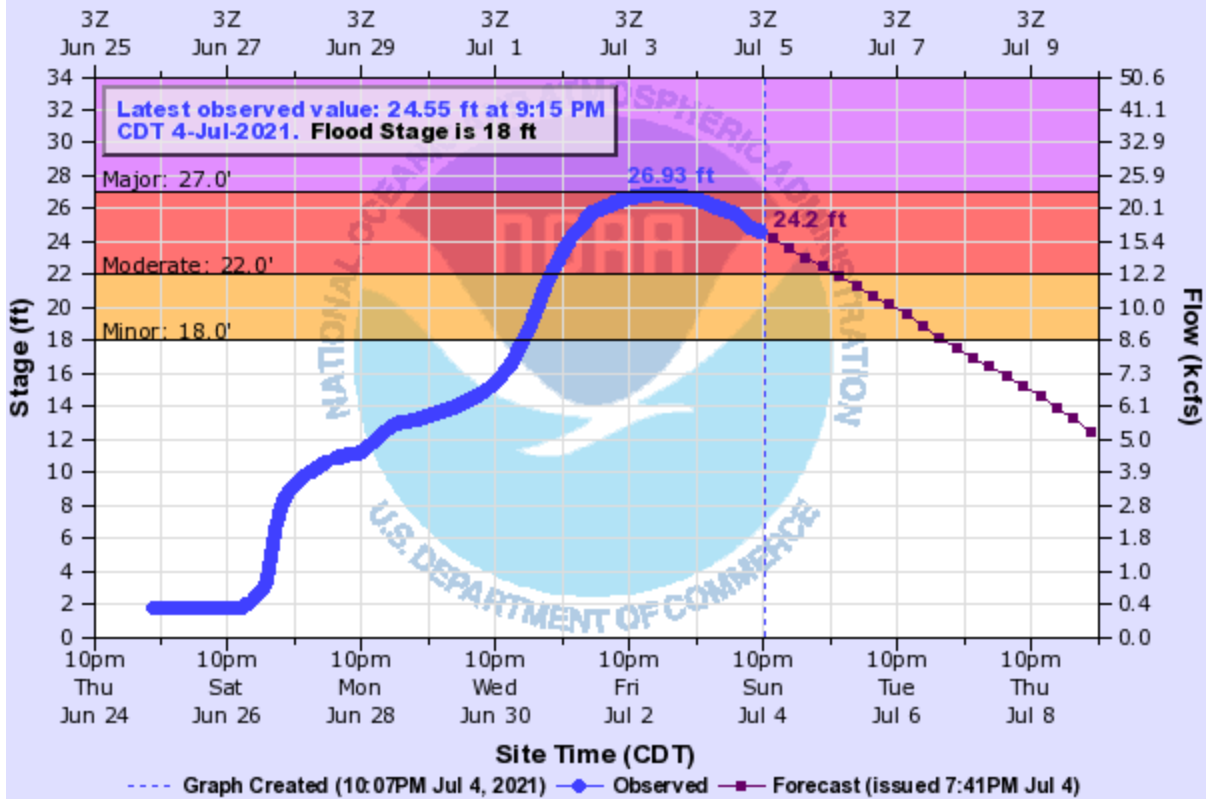


OWSO2(plotting HGIRG) "Gage 0" Datum: 560.17'

Observations courtesy of US Geological Survey

DEEP FORK RIVER NEAR BEGGS

Universal Time (UTC)

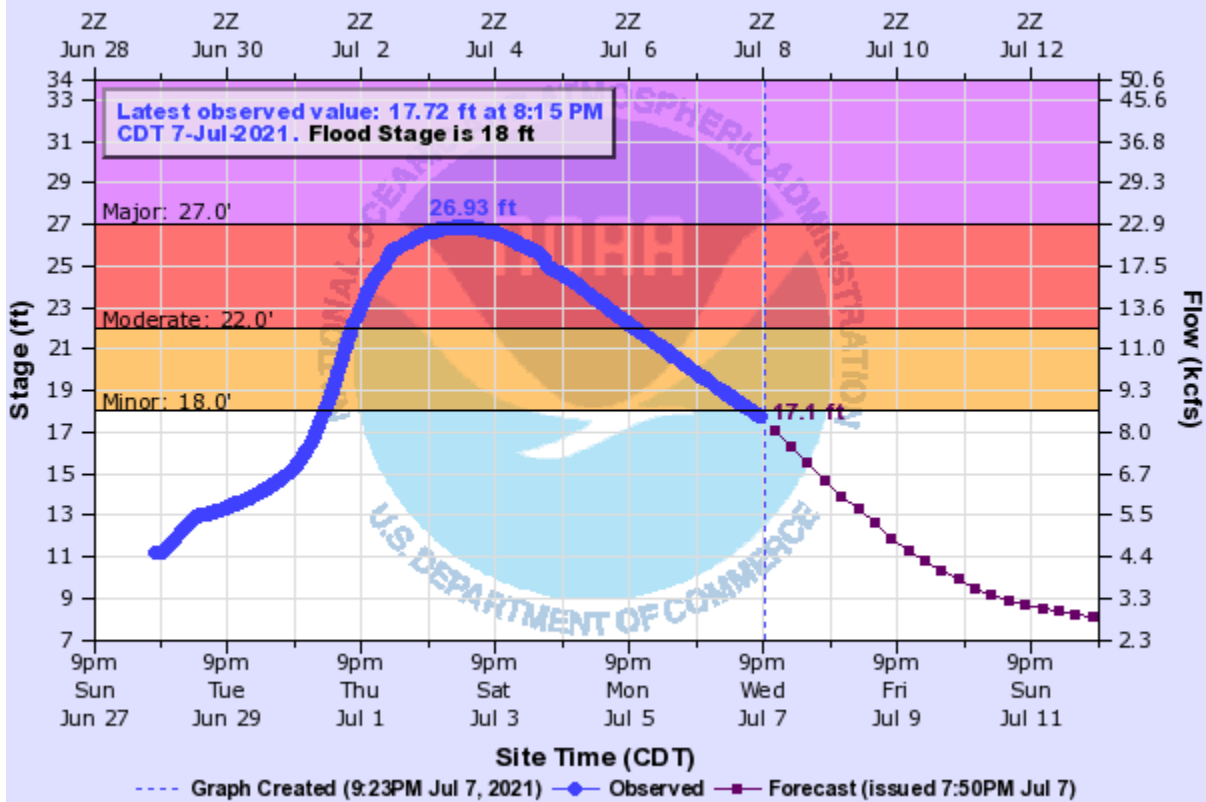


BGSO2(plotting HGIRG) "Gage 0" Datum: 632.55'

Observations courtesy of US Geological Survey

DEEP FORK RIVER NEAR BEGGS

Universal Time (UTC)

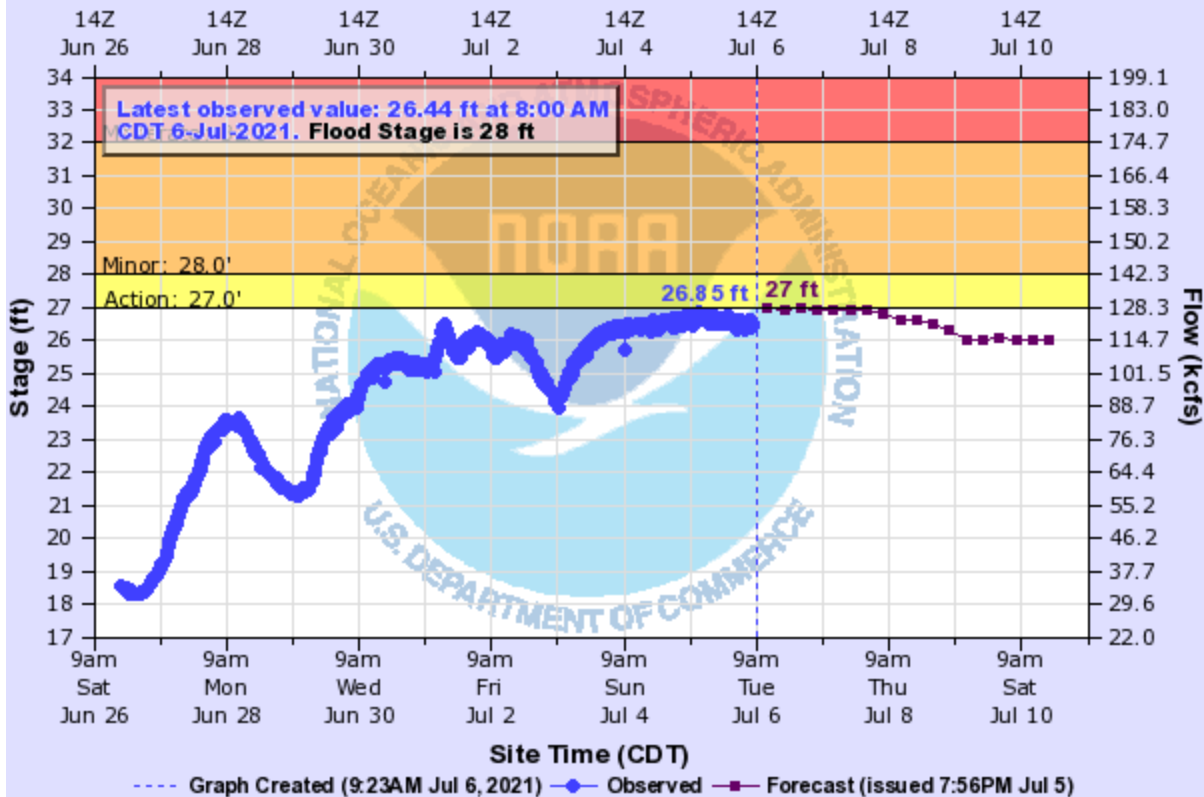


BGSO2(plotting HGIRG) "Gage 0" Datum: 632.55'

Observations courtesy of US Geological Survey

ARKANSAS RIVER NEAR MUSKOGEE

Universal Time (UTC)

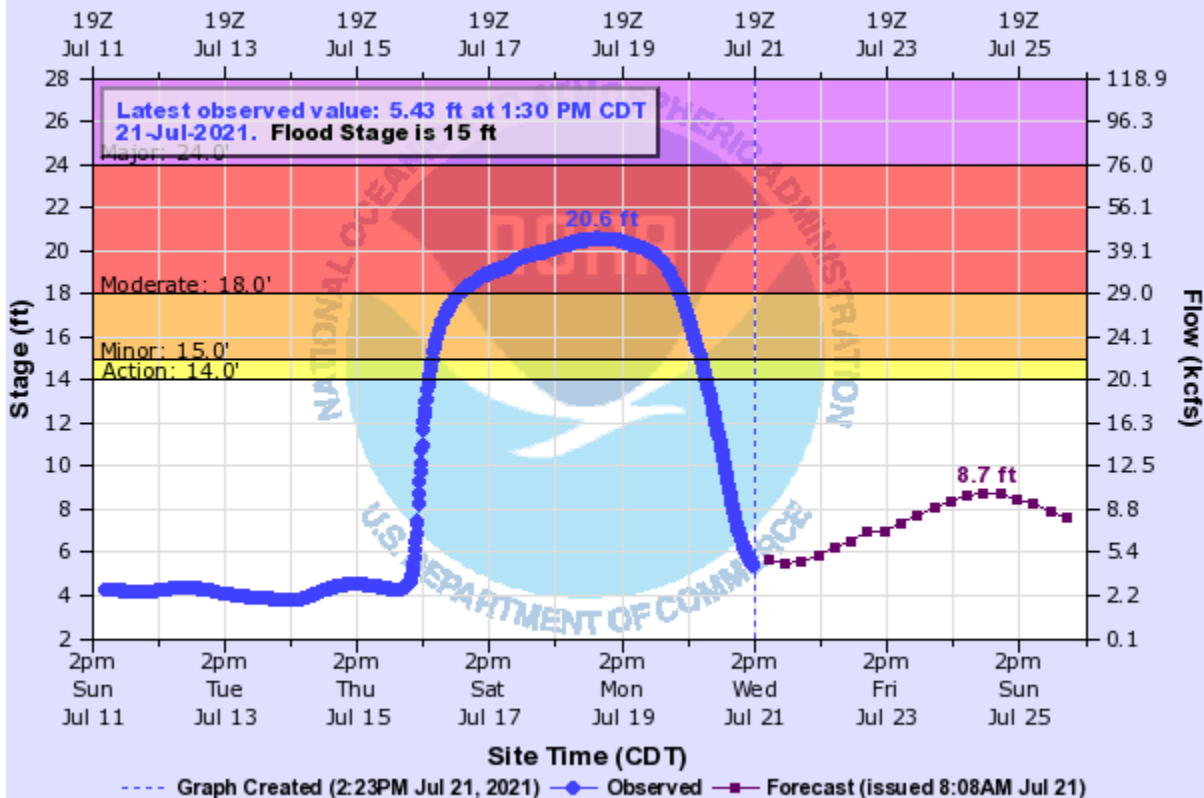


MKGO2(plotting HGIRG) "Gage 0" Datum: 471.38'

Observations courtesy of US Geological Survey

NEOSHO RIVER NEAR COMMERCE

Universal Time (UTC)

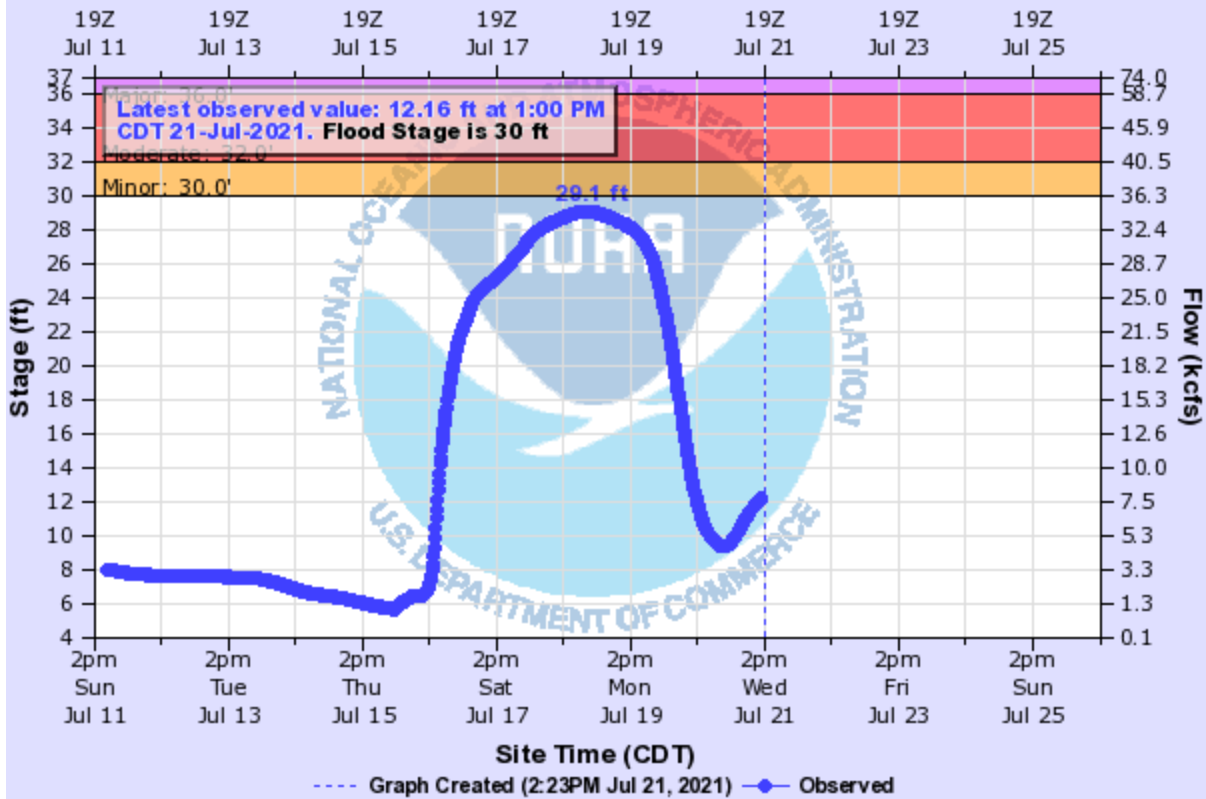


COMO2(plotting HGIRG) "Gage 0" Datum: 748.97'

Observations courtesy of US Geological Survey

VERDIGRIS RIVER NEAR LENAPAH

Universal Time (UTC)



LEPO2(plotting HGIRG) "Gage 0" Datum: 644.9'

Observations courtesy of US Geological Survey

ILLINOIS RIVER (AR OK) NEAR TAHLEQUAH

Universal Time (UTC)

