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 **August** YEAR **2020**
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 **September 11, 2020**

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)

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

There was a very large rainfall gradient from north to south across the HSA in August 2020: The Northwest AR Regional Airport measured 0.88" of rain, while Fort Smith, AR measured 9.98". The Bartlesville Airport measurement of 0.35" was lowest while the RFC estimates 20" in southeast Le Flore County. Several rounds of heavy rain at the end of the month resulted in a Flash Flood Emergency and Major flooding along the Poteau River near Panama at the start of September. Normal rainfall for August ranges from 2.6 inches in McIntosh County to 3.8 inches in Ottawa County. In the Ozark region of northwest Arkansas, rainfall averages 3.7 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 August 2020 was one of extremes, ranging from around 0.35" to around 20" across eastern OK and northwest AR, with most of the area receiving 2"-8". These rainfall totals correspond to 10% to 90% of the normal August rainfall for north east OK and far northwest Arkansas, and 150%-600% of the normal August rainfall across east central and southeast OK and west central AR (Fig. 1b).

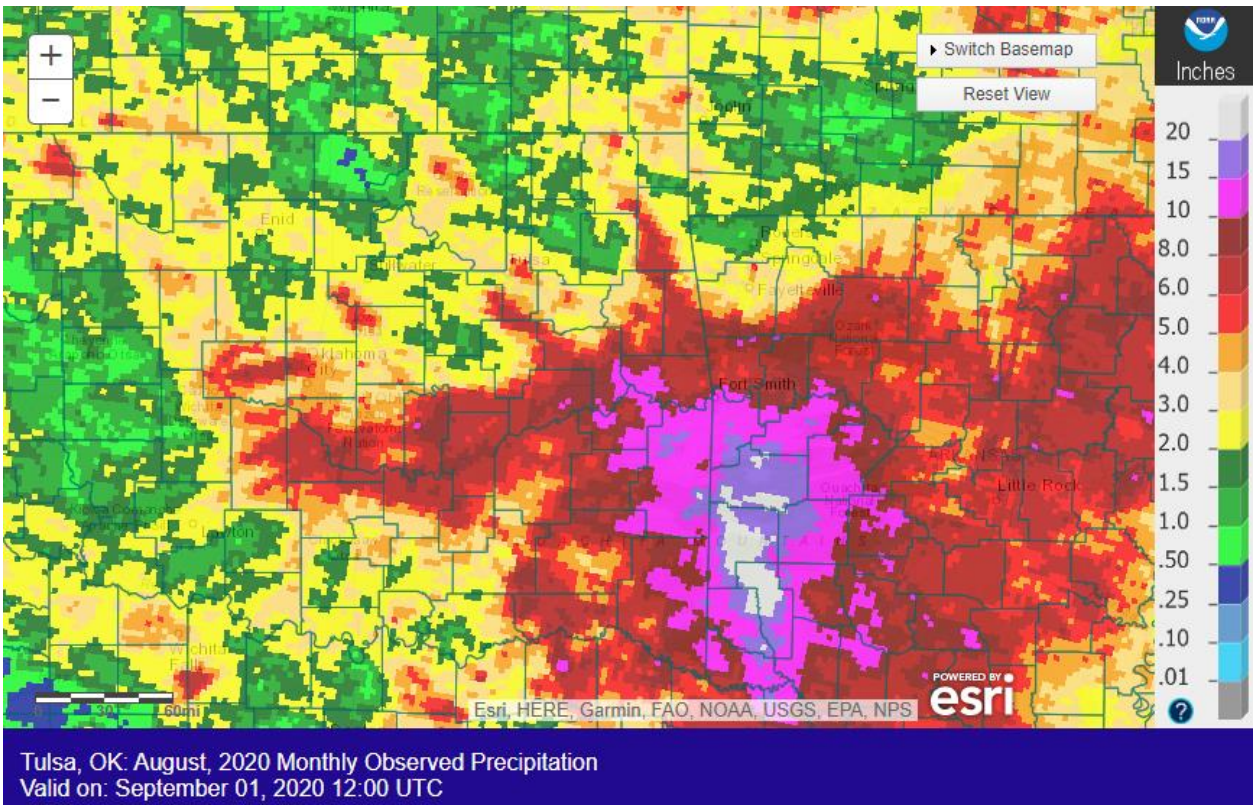


Fig. 1a. Estimated Observed Rainfall for August 2020

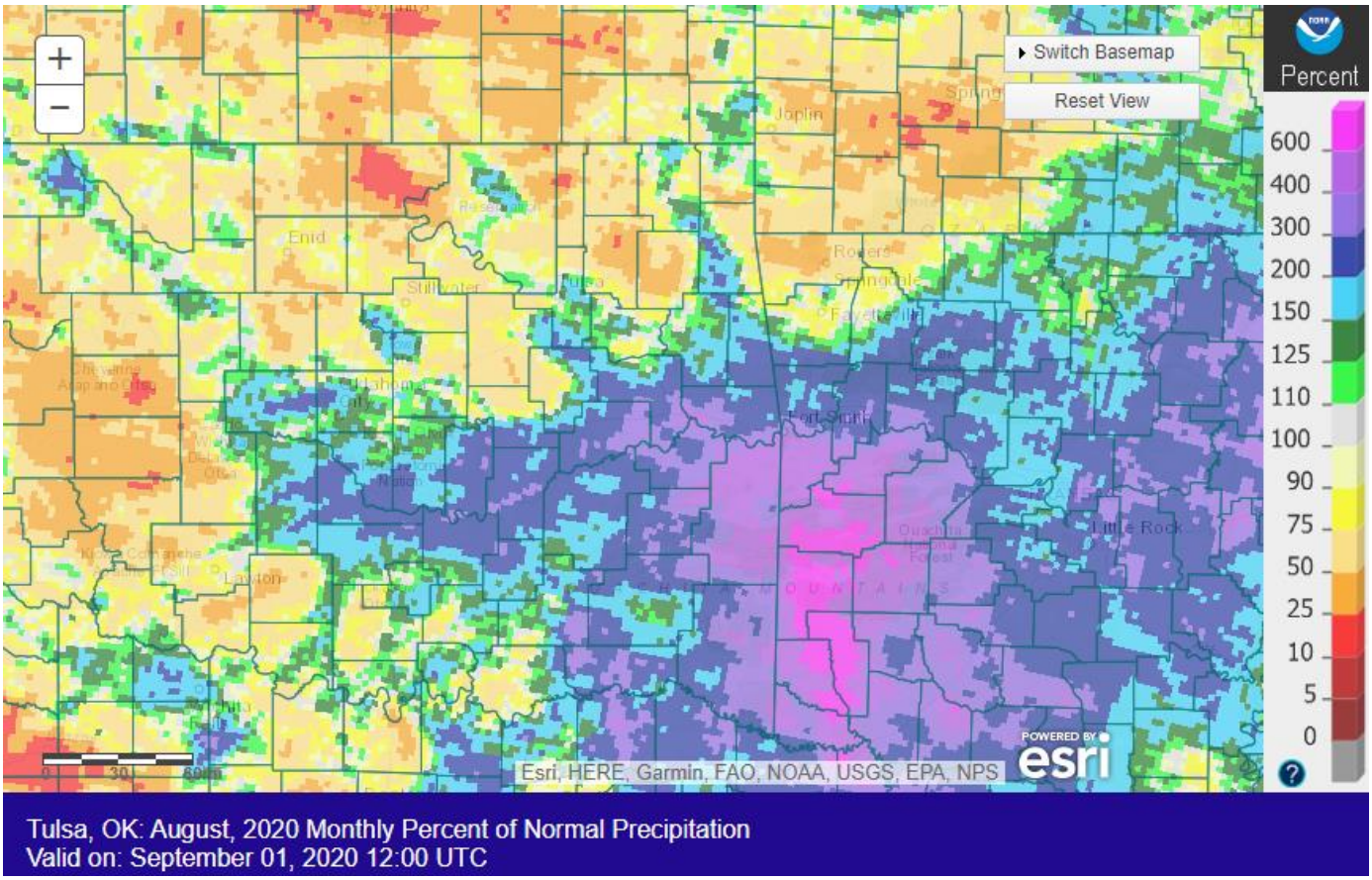


Fig. 1b. Estimated % of Normal Rainfall for August 2020

In Tulsa, OK, August 2020 ranked as the 25th coldest August (79.4°F, tied 2015, 2009, 1981; since records began in 1905) and the 37th wettest August (4.26"; since records began in 1888). Fort Smith, AR had the 48th coldest August (79.8°F; since records began in 1882) and the 3rd wettest August (9.98"; since records began in 1882). Fayetteville, AR had the 19th coldest (75.3°F) and the 11th driest (1.14") August since records began in 1949.

Some of the larger precipitation reports (in inches) for August 2020 included:

Webbers Falls, OK (meso)	10.81	Fort Smith, AR (ASOS)	9.98	Bunch 0.8N, OK (coco)	8.79
Sallisaw 1.0SE, OK (coco)	8.66	Hugo, OK (meso)	8.23	Van Buren 0.7SSE, AR (coco)	7.34
Antlers, OK (meso)	7.33	Wister, OK (meso)	7.06	Vinita 8.6ESE, OK (coco)	7.02

Some of the lowest precipitation reports (in inches) for August 2020 included:

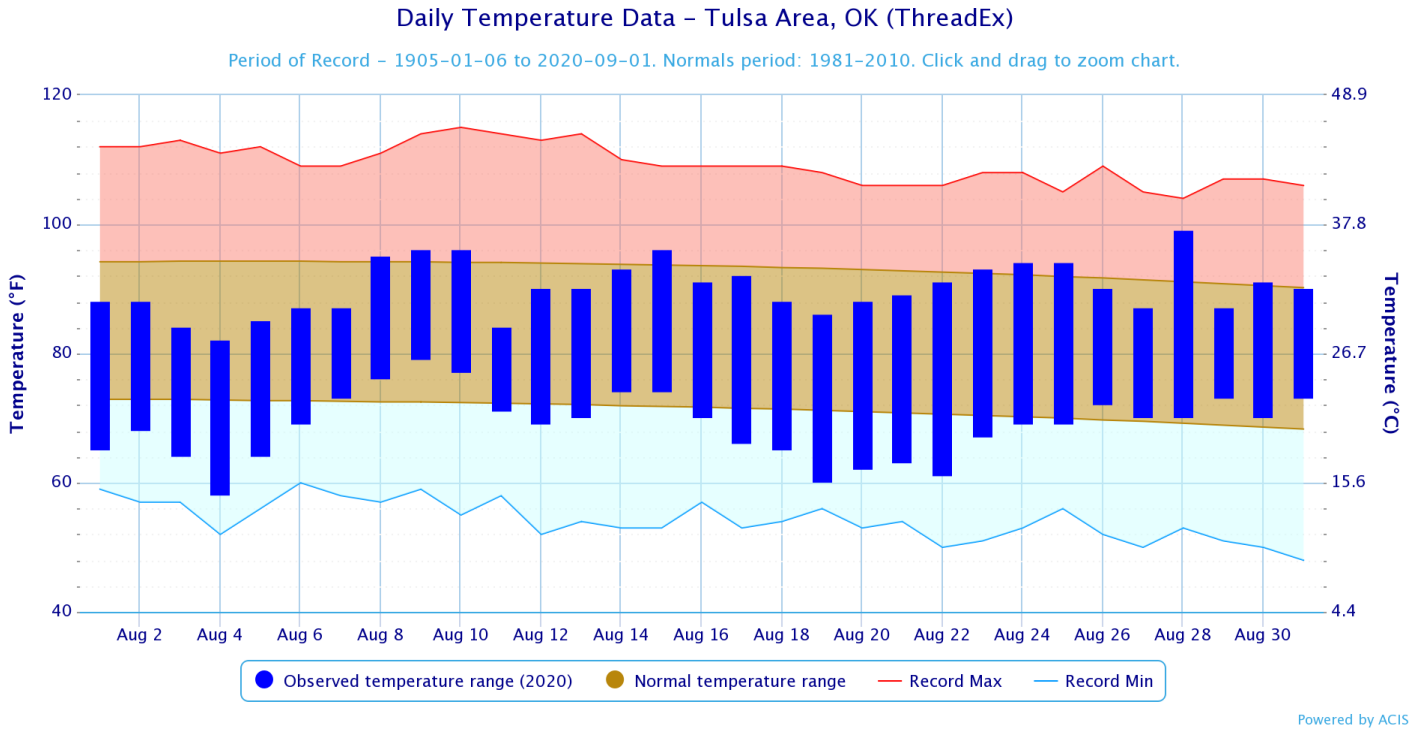
Bartlesville, OK (ASOS)	0.35	NW AR Regional Arpt (ASOS)	0.88	Decatur 2.6ESE, AR (coco)	0.88
Ochelata 5.6N, OK (coco)	0.91	Bristow, OK (meso)	0.99	Bentonville 6.6SSW, AR (coco)	1.01
Rogers 2.4SSW, AR (coco)	1.02	Siloam Springs, AR (AWOS)	1.03	Claremore 7.5W, OK (coco)	1.14

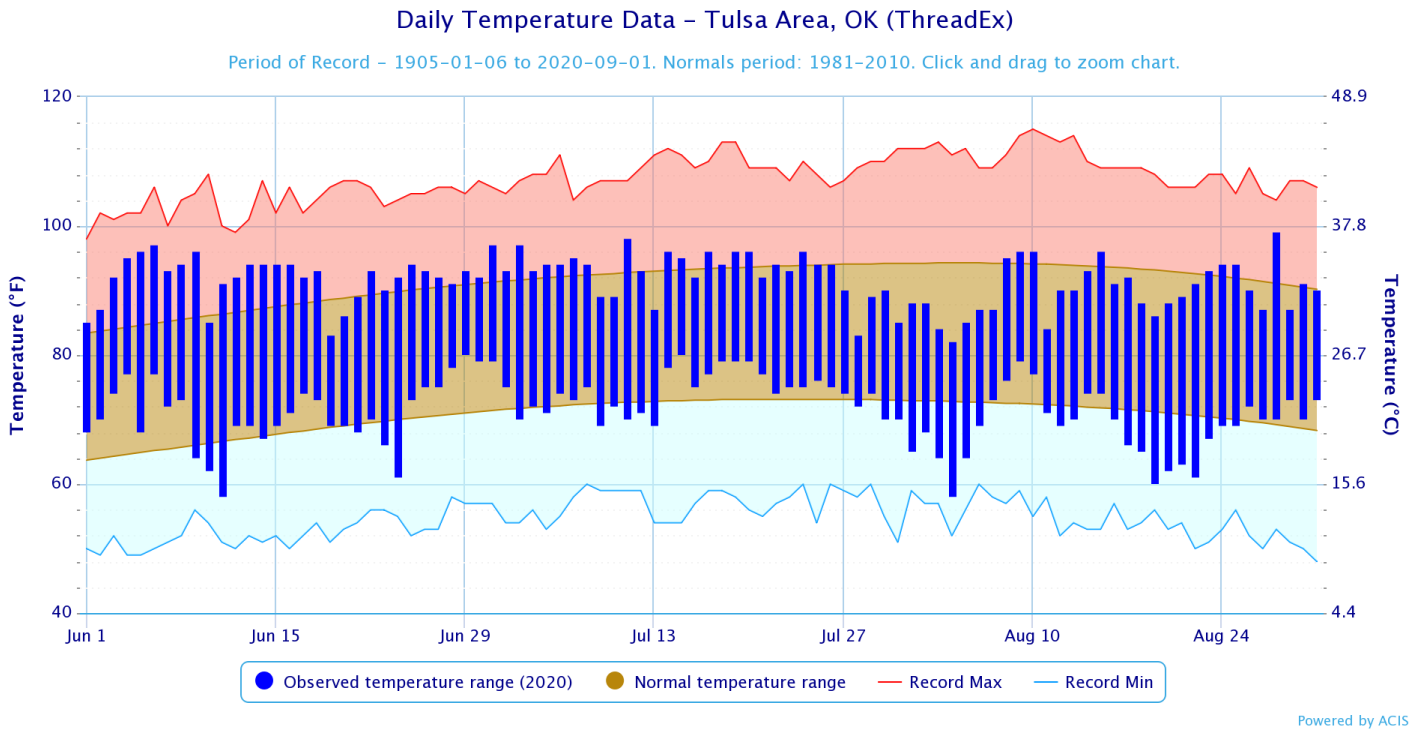
According to statistics from the Oklahoma Climatological Survey (OCS) Mesonet:

Rank since 1921	Last 30 Days (Aug 2 – Aug 31)	Last 60 Days (Jul 3 – Aug 31)	Summer 2020 (Jun 1 – Aug 31)	Warm Growing Season 2020 (Mar 1 – Aug 31)	Year-to-Date (Jan 1 – Aug 31)	Water Year-to-Date (Oct 1 – Aug 31)	Last 365 Days (Sep 2, 2019 – Aug 31, 2020)
Northeast OK	46th driest	17th wettest	37th driest	25th wettest	17th wettest	14th wettest	**10th wettest**
East Central OK	13th wettest	**6th wettest**	34th wettest	11th wettest	**6th wettest**	**4th wettest**	**5th wettest**
Southeast OK	4th wettest	11th wettest	32nd wettest	**9th wettest**	**6th wettest**	**4th wettest**	**3rd wettest**
Statewide	46th wettest	19th wettest	44th driest	37th wettest	23rd wettest	22nd wettest	22nd wettest

Summer (June-July-August) 2020

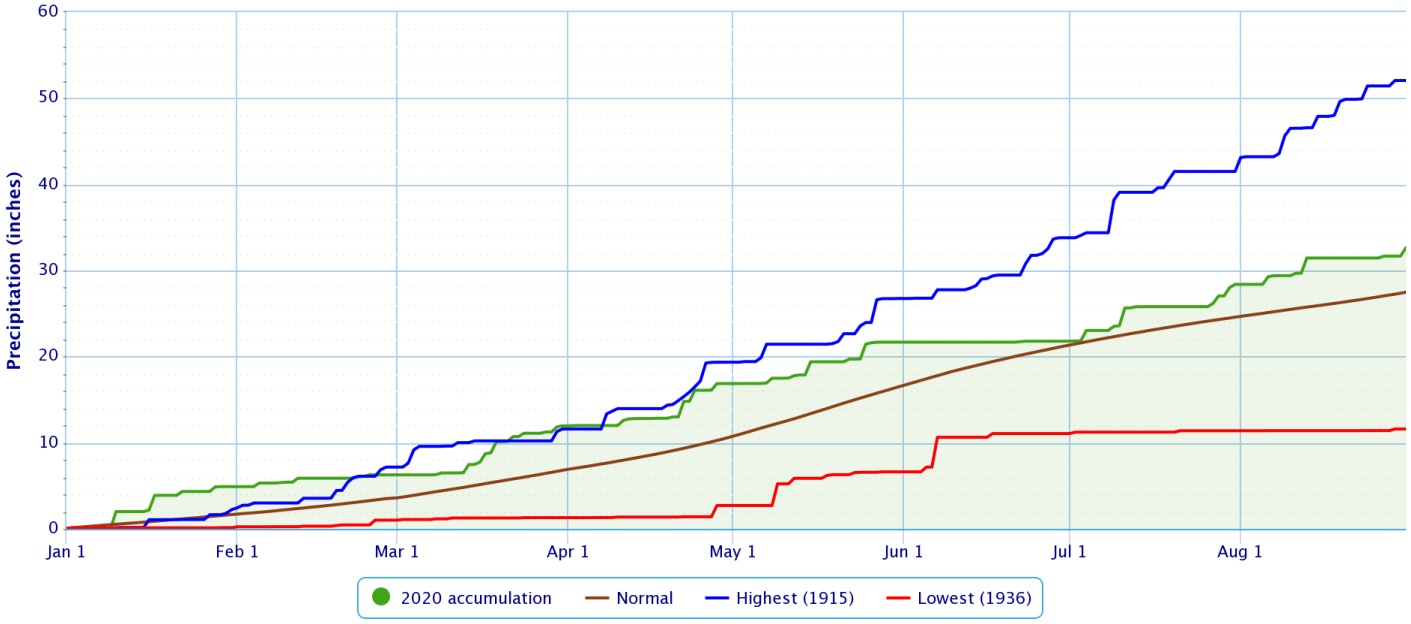
In Tulsa, OK, Summer 2020 ranked as the 51st warmest Summer (81.4°F, tied 2002, 1953, 1909; since records began in 1905) and the 59th wettest Summer (10.97"; since records began in 1888). Fort Smith, AR had the 50th warmest Summer (81.2°F, tied 1911; since records began in 1882) and the 25th wettest Summer (14.28"; since records began in 1882). Fayetteville, AR had the 29th warmest (76.6°F, tied 1999, 1970, 1964) and the 13th driest (7.82") Summer since records began in 1950.





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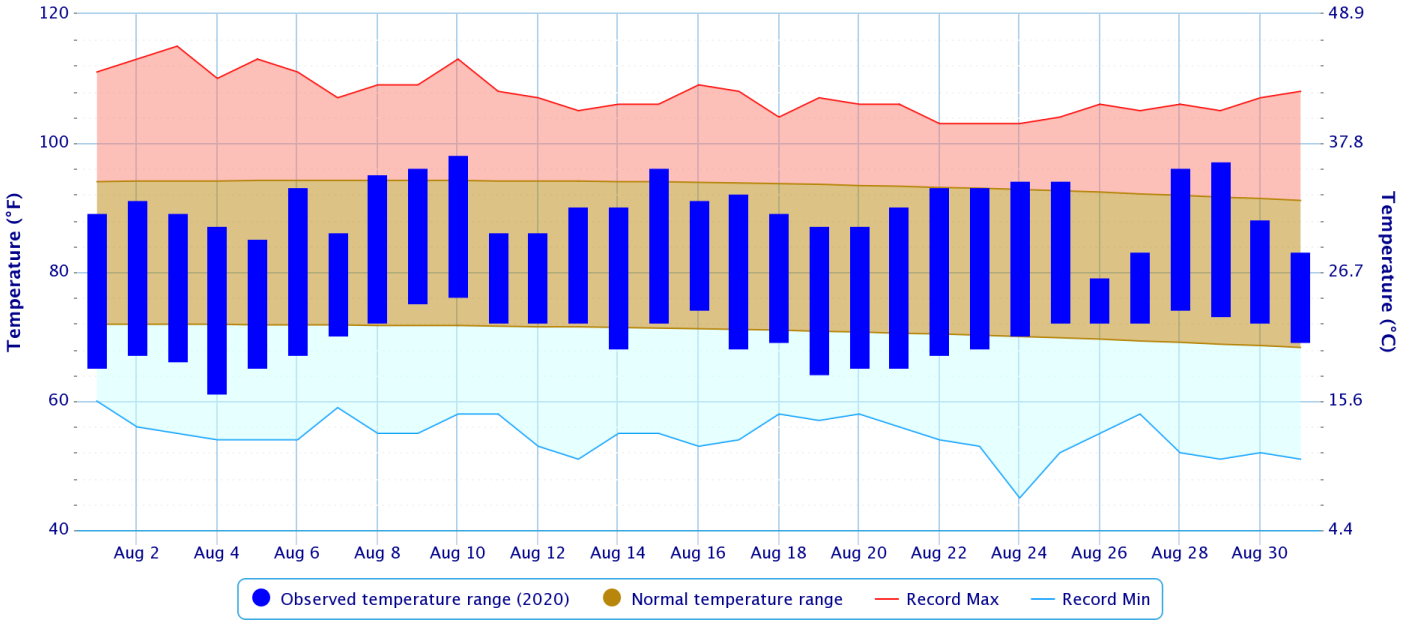
Daily Temperature Data – Fort Smith Area, AR (ThreadEx)

Period of Record – 1882-06-01 to 2020-09-01. Normals period: 1981-2010. Click and drag to zoom chart.



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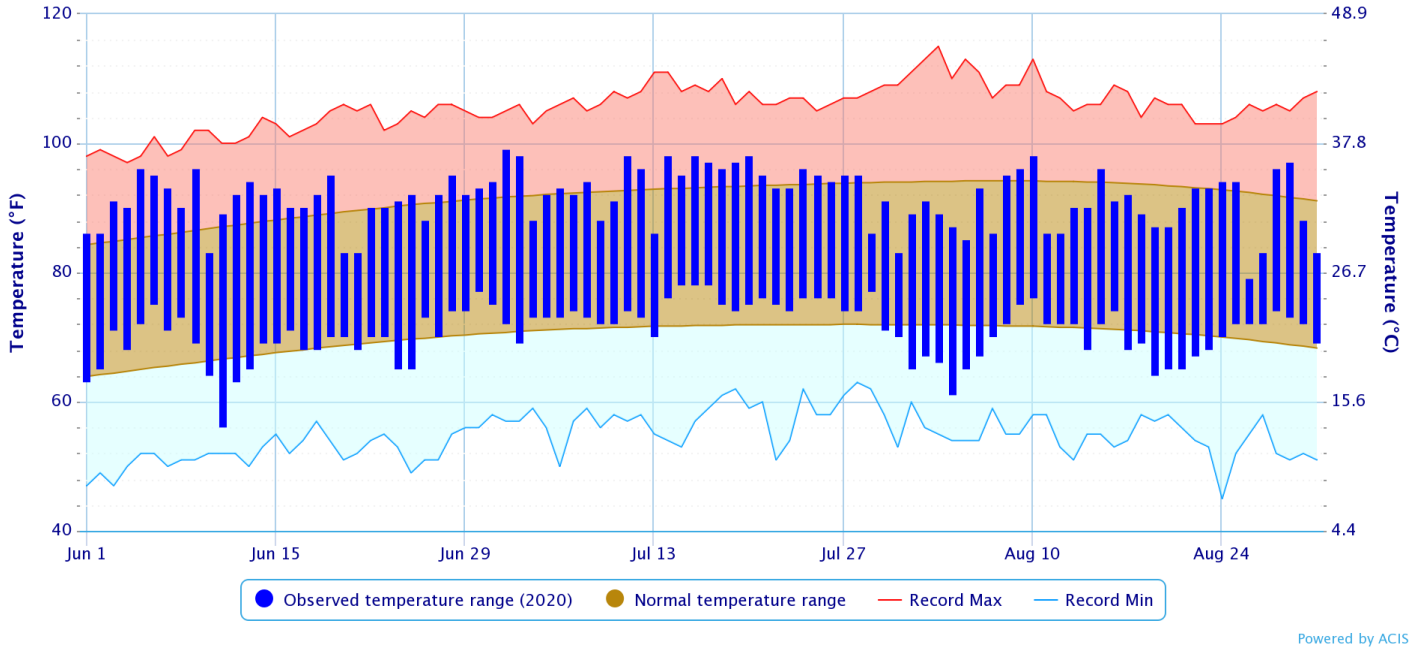

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Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

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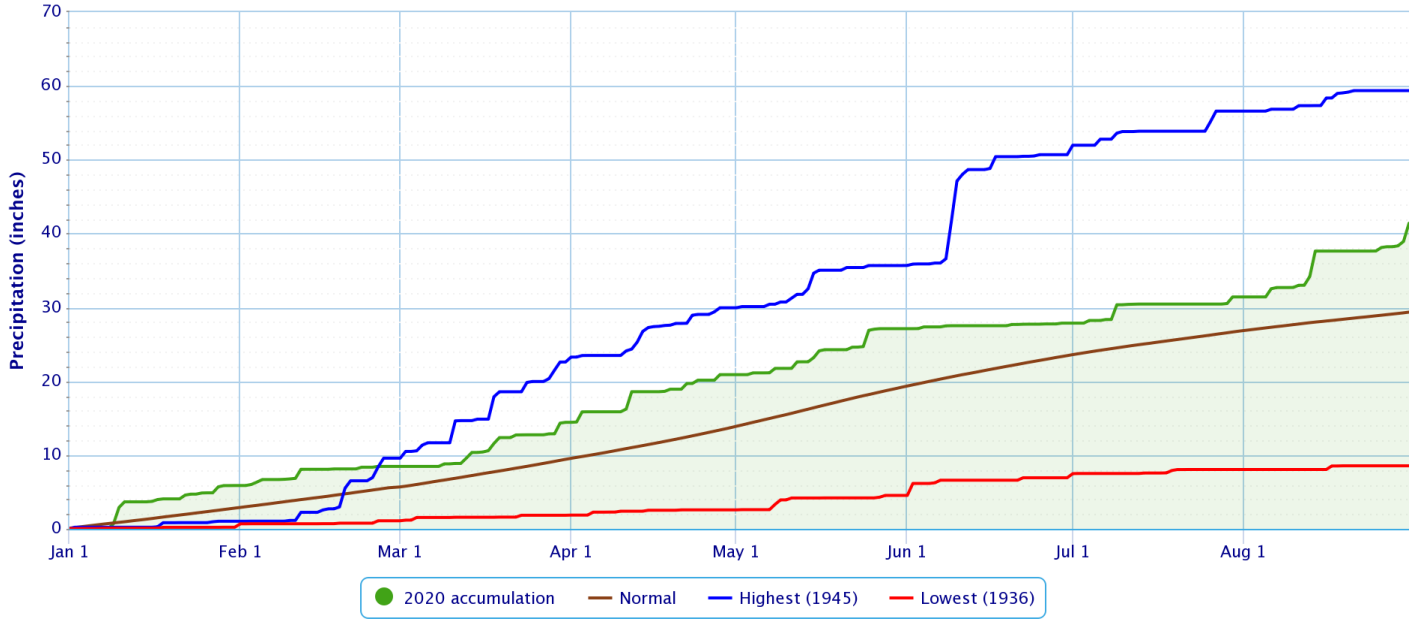

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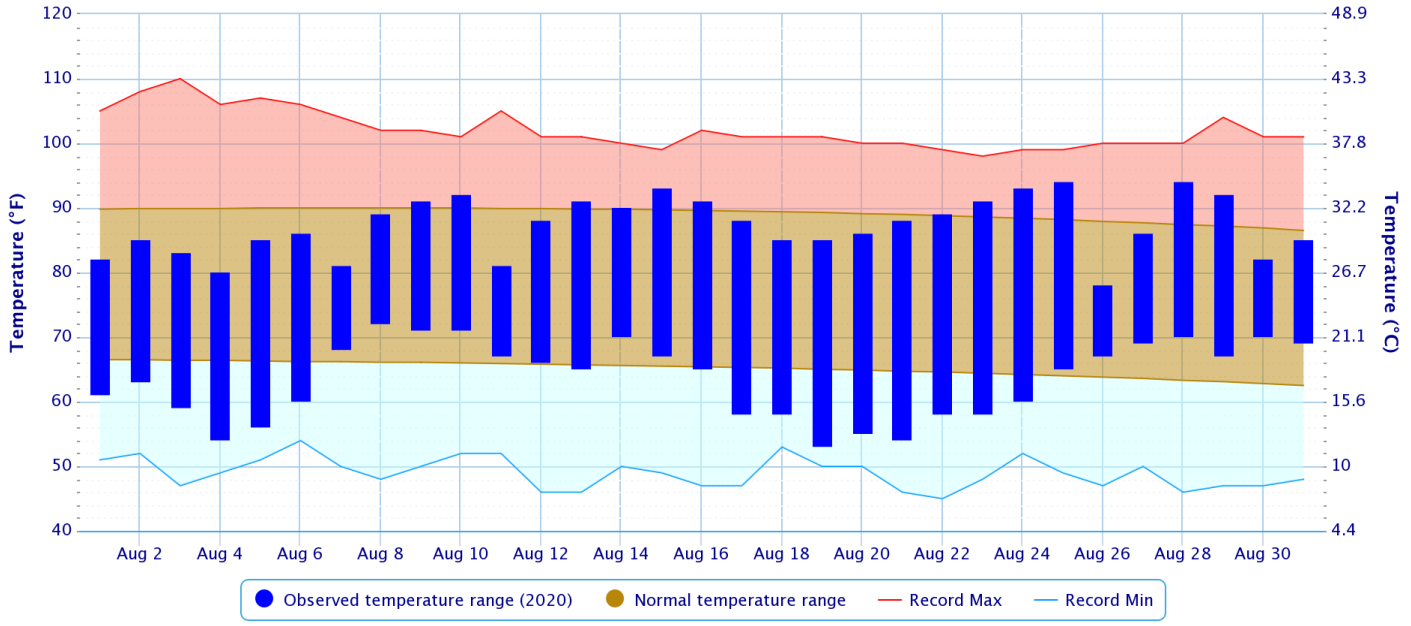
Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

Period of Record – 1949-07-14 to 2020-09-01. Normals period: 1981-2010. Click and drag to zoom chart.



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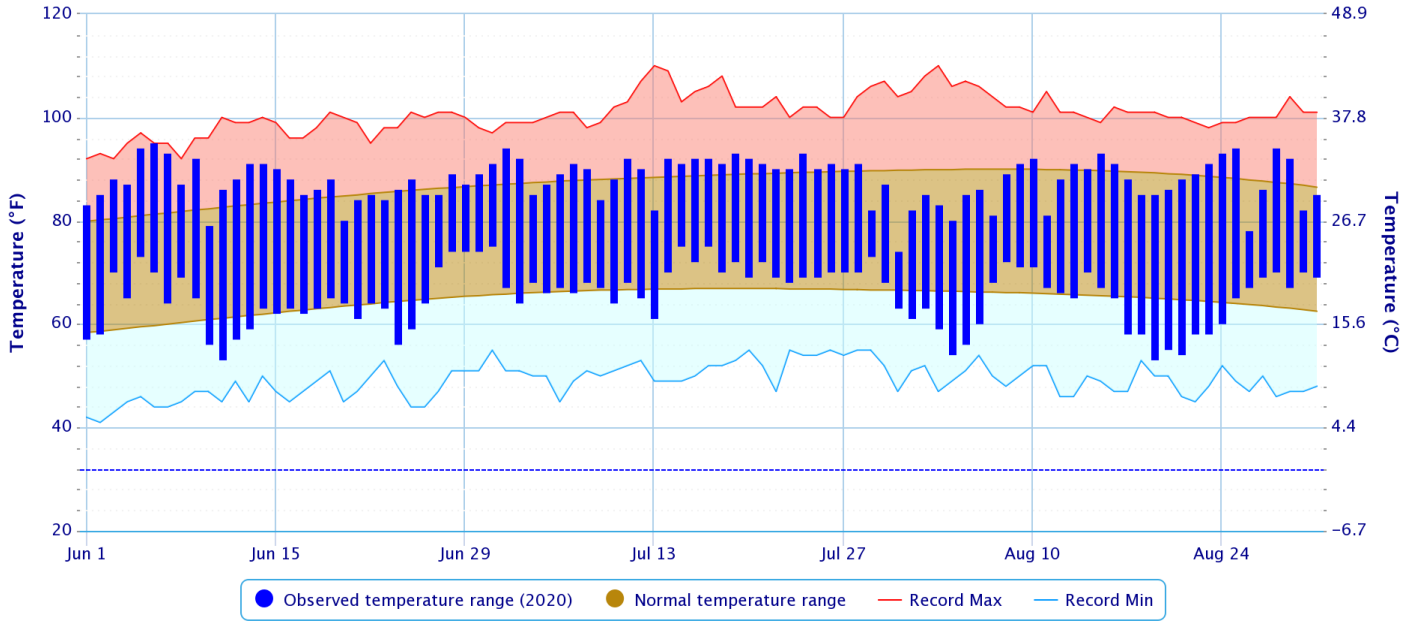
Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

Period of Record – 1949-07-14 to 2020-09-01. Normals period: 1981-2010. Click and drag to zoom chart.



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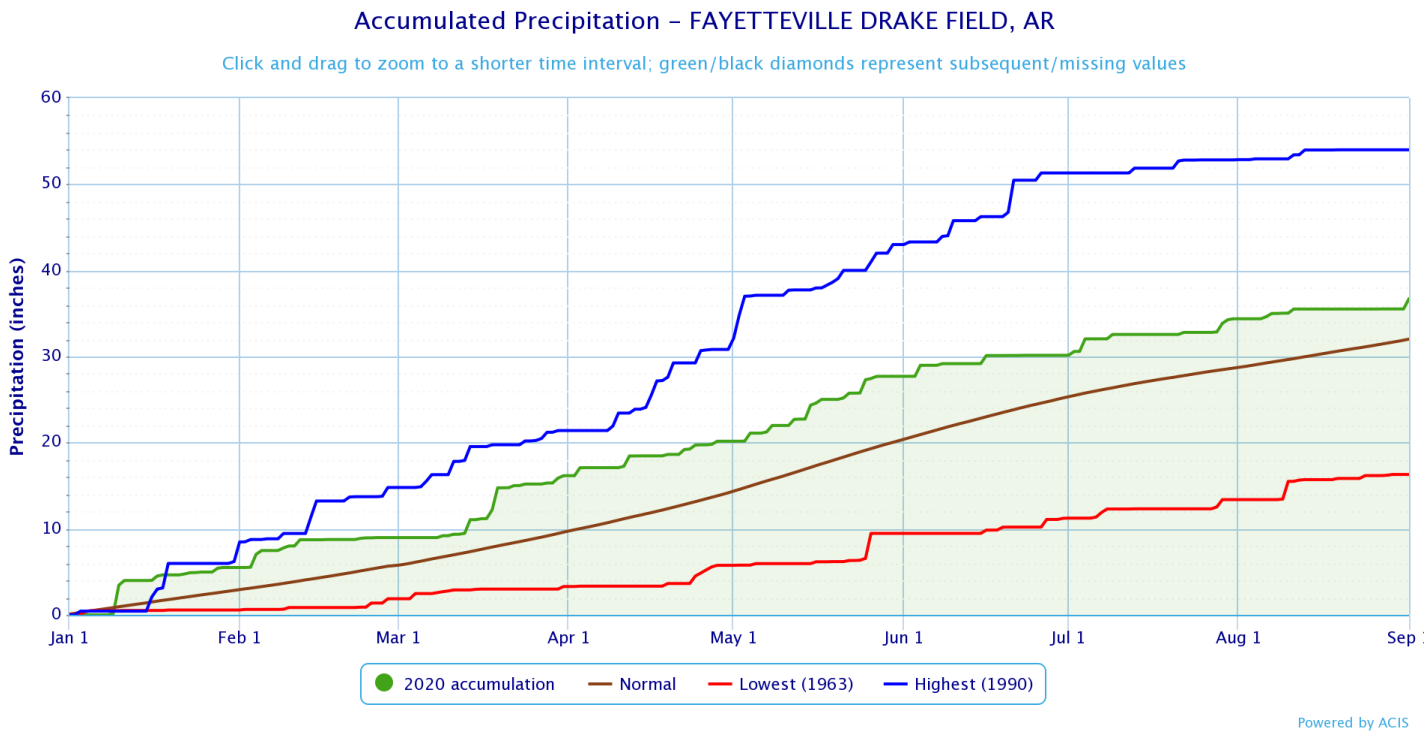
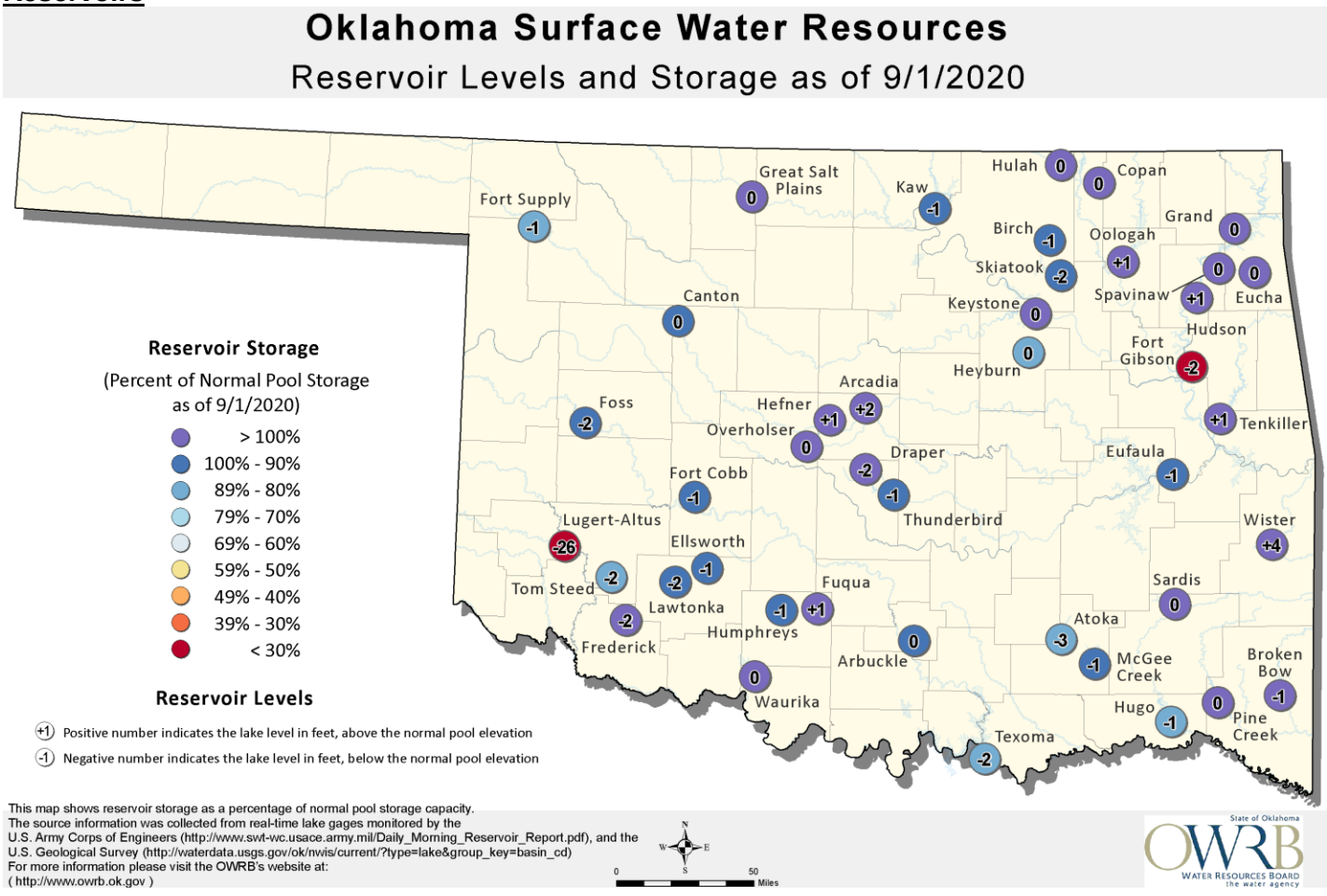


Reservoirs



According to the USACE, most of the lakes in the HSA were within ±3% of top of their conservation pools as of 9/02/2020. However, a few lakes were using a higher percentage of their flood control pools: Wister Lake 35%, Sardis Lake 28%, Beaver Lake 8%, and Hudson Lake 4%. Some lakes in northeast OK were operating below 3% of the top of their conservation pools: Kaw Lake 96%, Birch Lake 94%, Skiatook Lake 93%, Heyburn Lake 90%, and Ft. Gibson Lake 24%.

Drought

According to the U.S. Drought Monitor (USDM) from September 1, 2020 (Figs. 2, 3), eastern OK and northwest AR were drought free. However, Abnormally Dry (but not in drought) conditions were occurring in northwest Ottawa County in eastern OK.

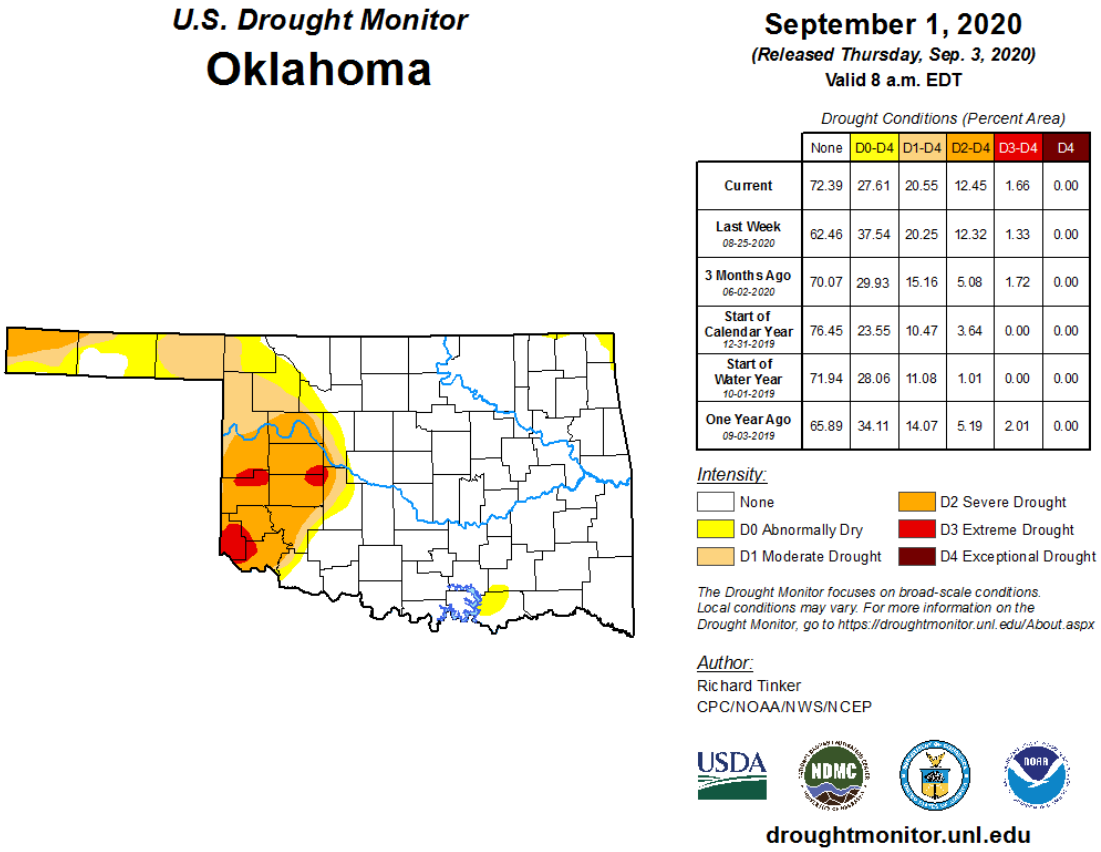


Fig. 2. Drought Monitor for Oklahoma

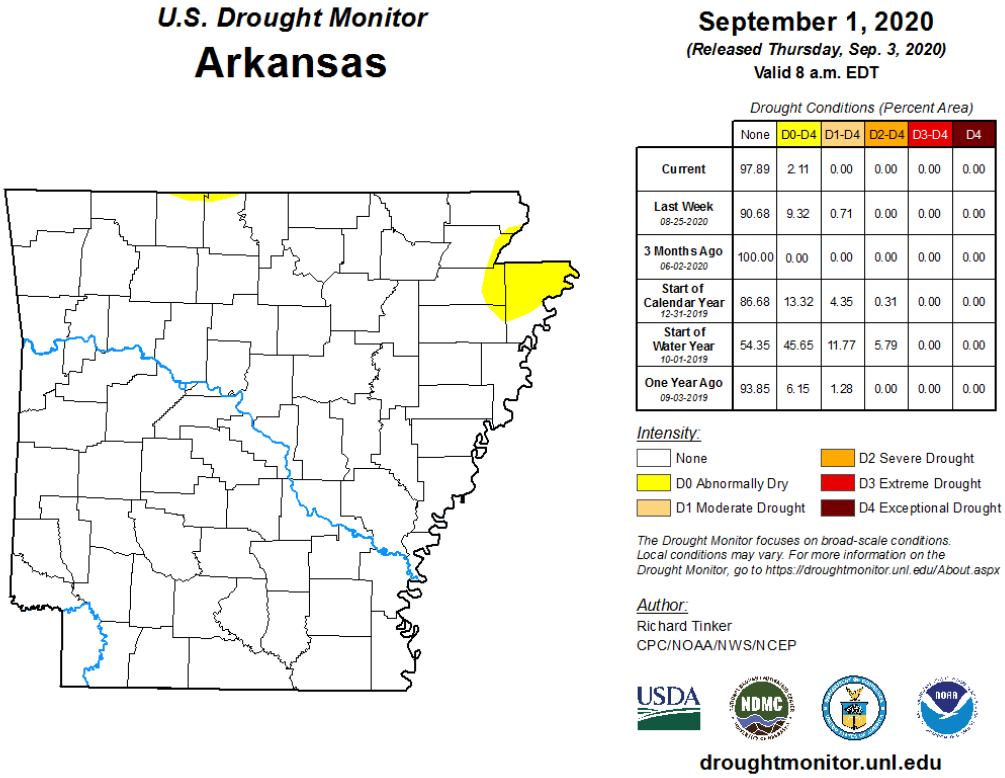


Fig. 3. Drought Monitor for Arkansas

Outlooks

The Climate Prediction Center (CPC) outlook for September 2020 (issued August 31, 2020) indicates an enhanced chance for below normal temperatures and a greatly enhanced chance for above median precipitation across eastern OK and northwest AR. From CPC, “below normal temperatures are favored for a large part of the central and east-central CONUS in September, associated with an expected prolonged period of anomalously cold temperatures. The forecast magnitude of this cold air anomaly will have a dominant impact on this region for at least the first 2-3 weeks of the month, and is expected to carry the month as a whole.” This enhanced above median precipitation outlook “is associated with a mean baroclinic zone that stretches across much of this region. The predicted rainfall bulls-eye over southeastern OK and western AR is forecast to receive 5-7 inches of rain just within the first week of September. Chances of above normal precipitation exceed 70% over the vicinity of the Ozark Mountains.”

For the 3-month period September-October-November 2020, CPC is forecasting an enhanced chance for above normal temperatures and an enhanced chance for below median precipitation across eastern OK and northwest AR (outlook issued August 20, 2020). This outlook is based on both statistical and dynamical forecast tools, current soil moisture, and decadal timescale climate trends. According to CPC, the combined effect of the ocean-atmosphere system is consistent with La Niña conditions, and there is a 75% chance of La Niña conditions continuing through winter 2020-21. Therefore, CPC issued a La Niña Advisory on September 10, 2020.

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 thunderstorm complex moved south southeast from central into southeast OK during the morning of the 5th. A small portion of the HSA was affected by these storms and received around 0.25” to around 1.5” of rain. However, higher totals of 1.5” to 3” of rain impacted western Choctaw County (Fig. 4).

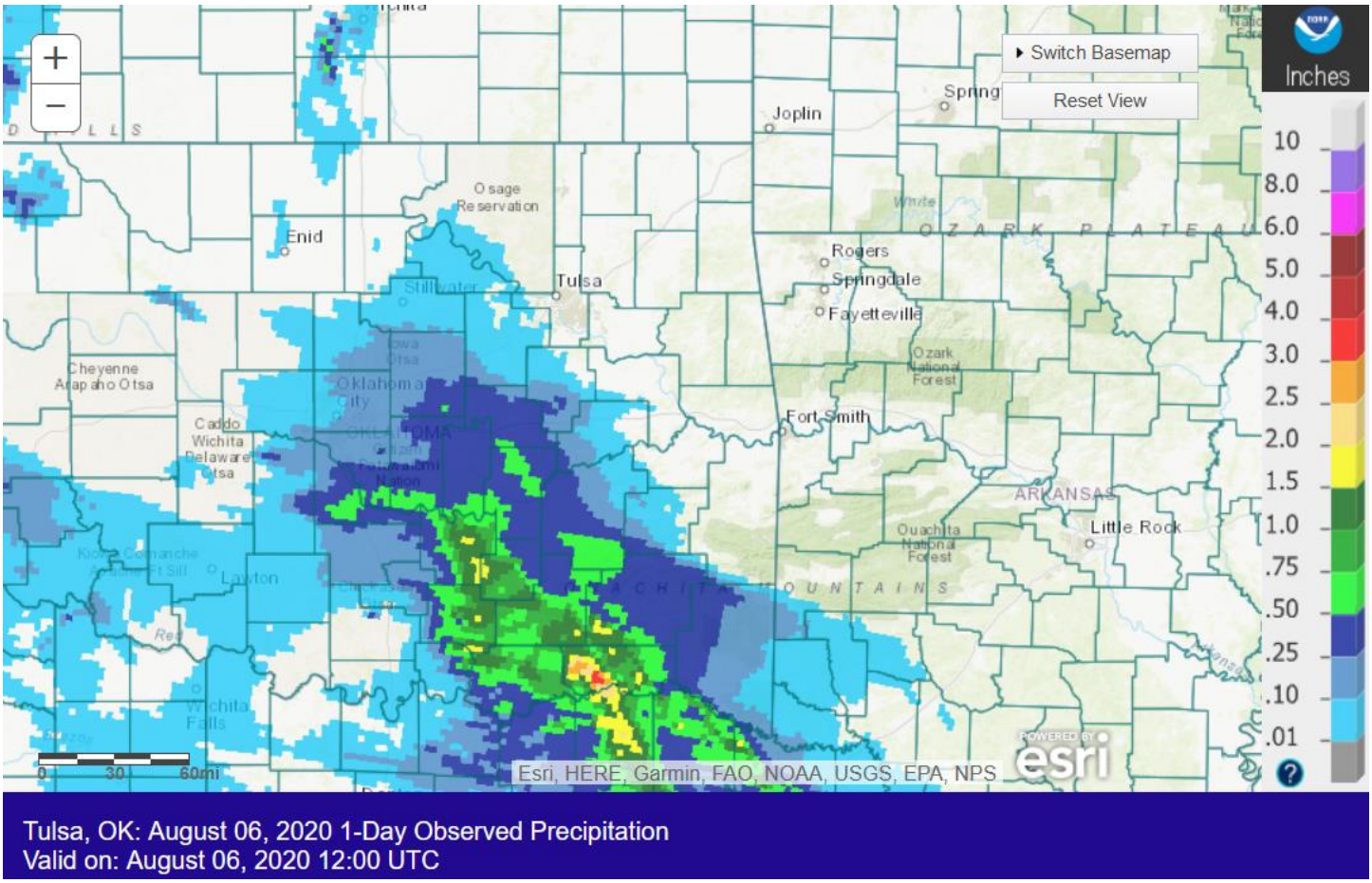


Fig. 4. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/06/2020.

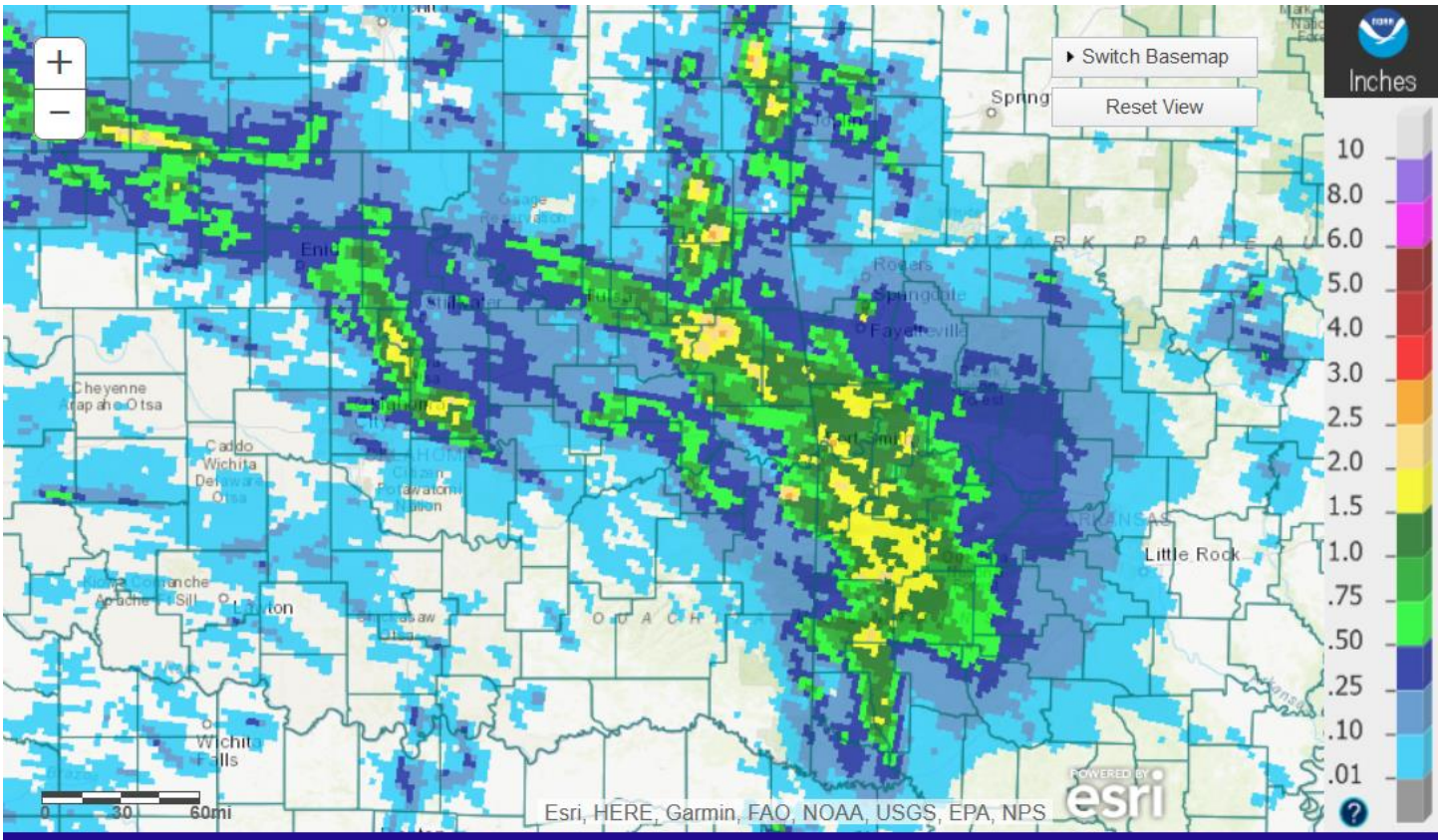


Fig. 5. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/07/2020.

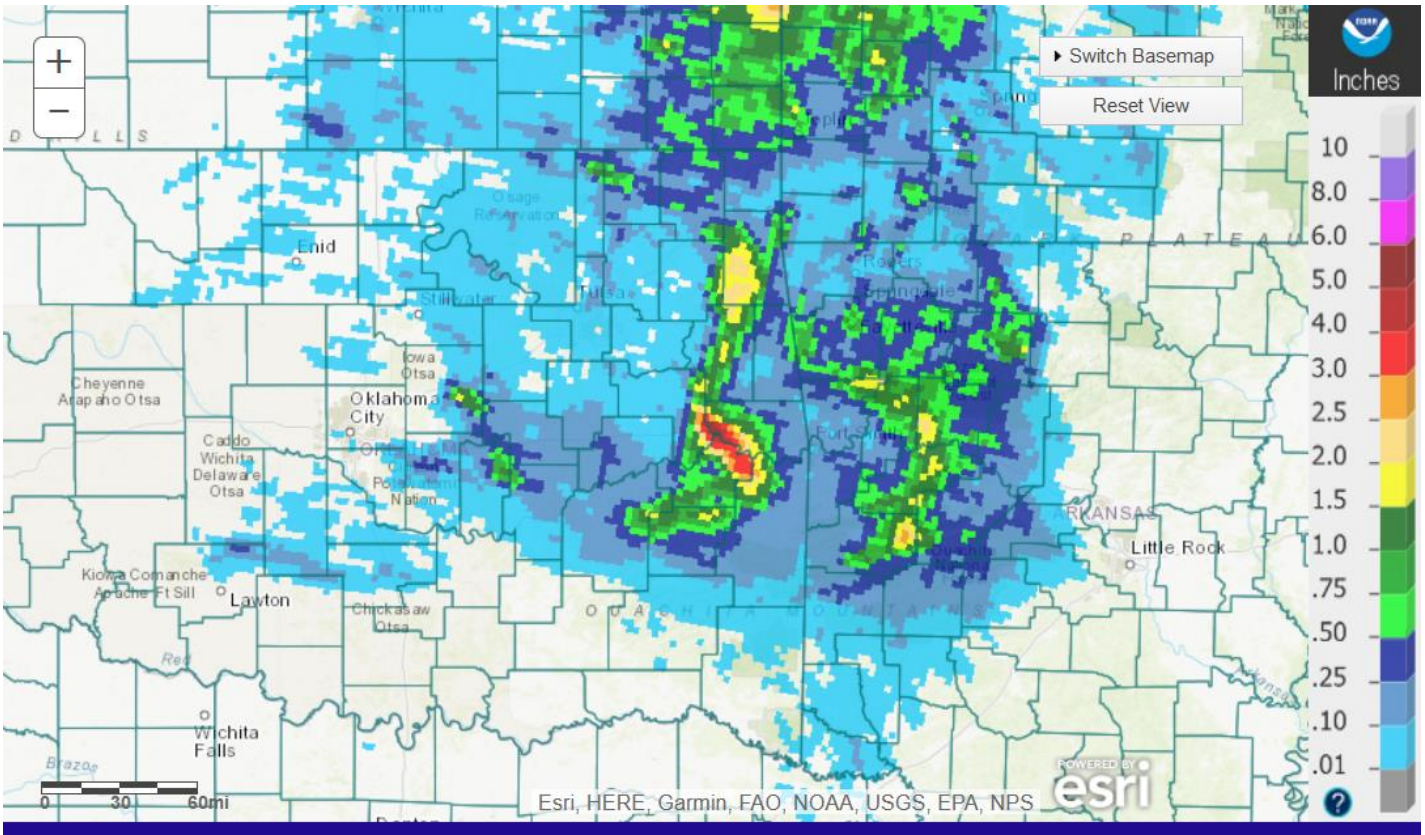


Fig. 6. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/08/2020.

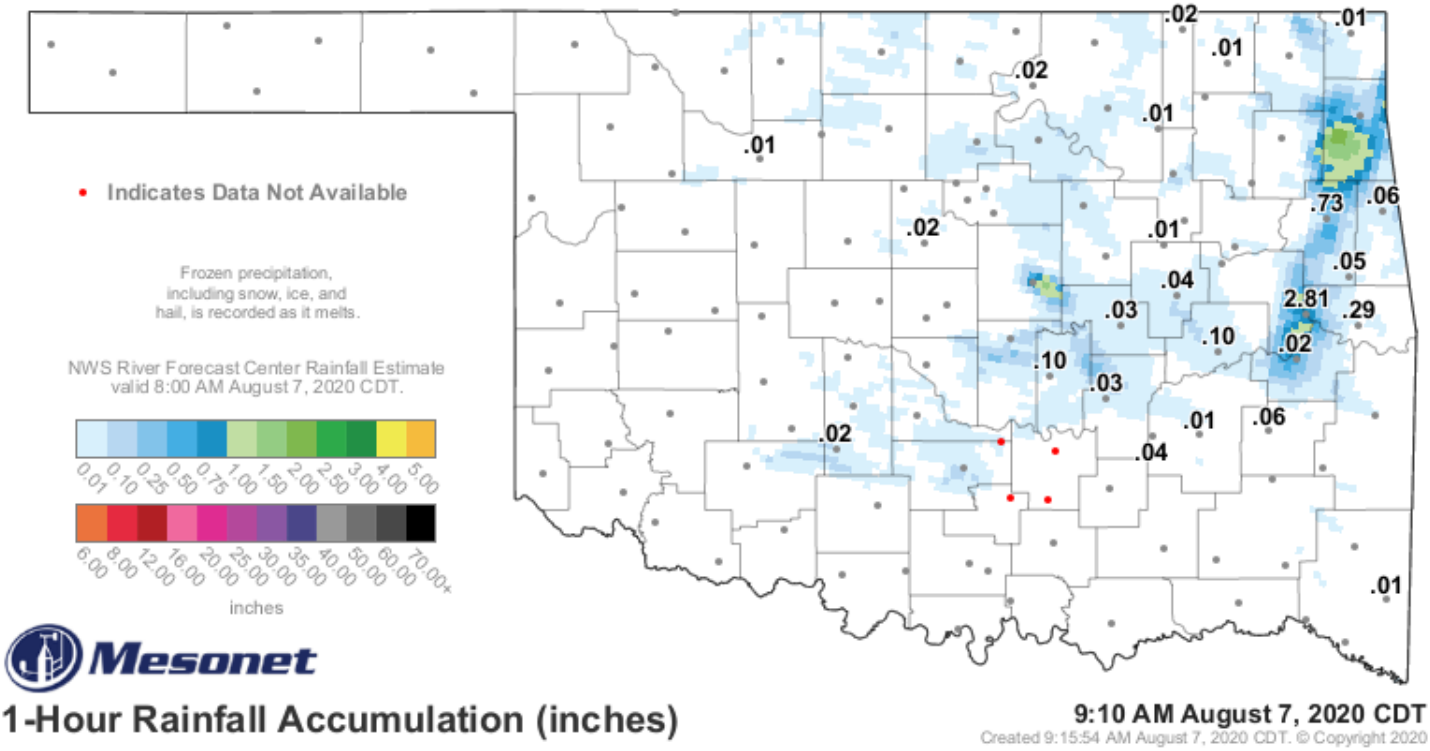


Fig. 7. OK Mesonet (values) and NWS RFC rainfall estimate (image) 1-hour rainfall ending at 9:10 am CDT 8/7/2020.

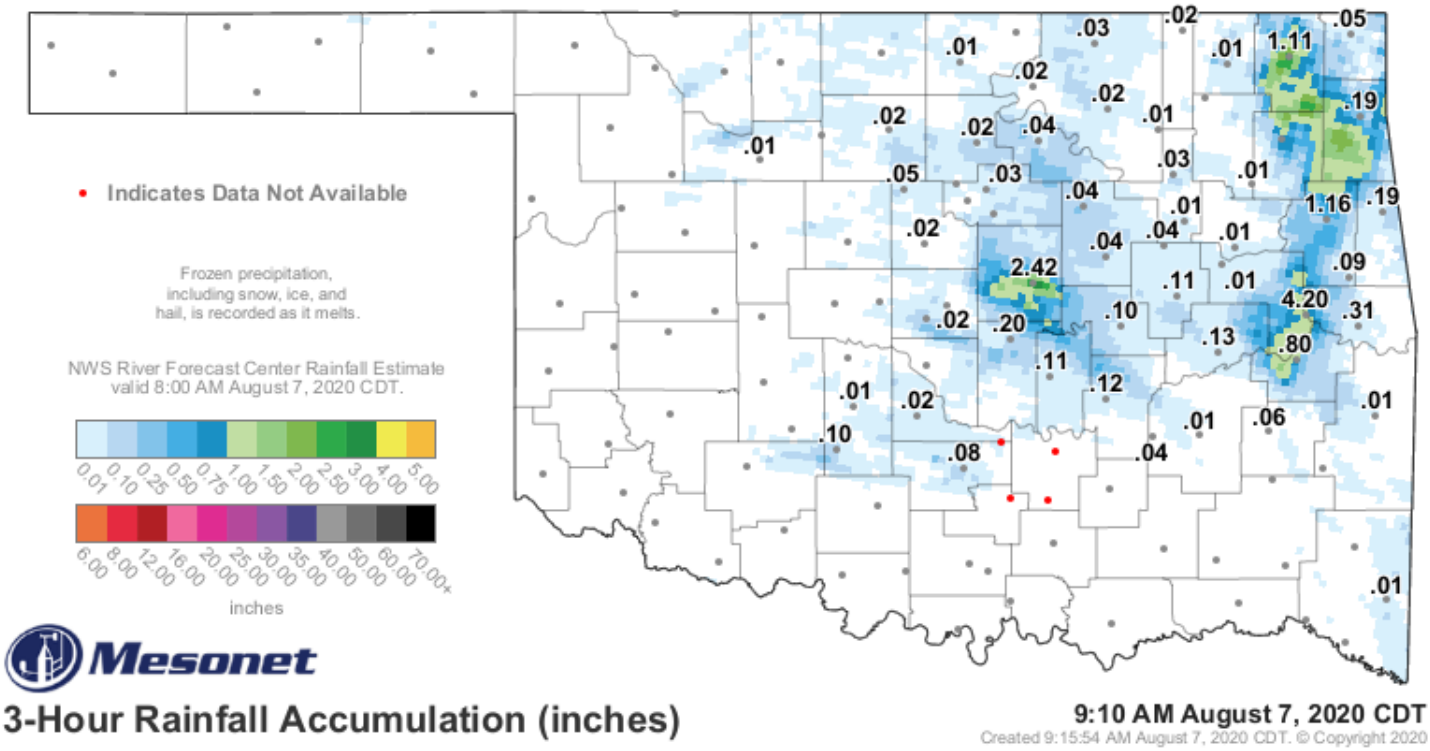


Fig. 8. OK Mesonet (values) and NWS RFC rainfall estimate (image) 3-hour rainfall ending at 9:10 am CDT 8/7/2020.

From mid-afternoon through mid-evening of the 6th, showers and thunderstorms tracked southeast across northeast OK and northwest AR within an area of deep layer moisture and warm air advection. Isolated to widely scattered showers and thunderstorms then continued across eastern OK and northwest AR through the remainder of the overnight hours. Convection continued to increase just before sunrise on the 7th in response to a 35-40 knot low-level jet and increasing warm air advection. Precipitable water (PWAT) values were around 2", resulting in efficient rain production. Rainfall totals ranged from around 0.10" to around 1.5" for most locations, with isolated spots receiving 1.5" to near 2.5" through 7 am on the 7th (Fig. 5). Showers and thunderstorms continued to move southeast through northeast OK and northwest AR through early afternoon before dissipating. Thunderstorms trained over the Arkansas River from near Webbers Falls Lock and Dam downstream to Kerr Lock and Dam, with locations in this vicinity receiving 1.5"-5" of rain (Fig. 6). The OK Mesonet station in Webbers Falls measured 2.81" in just one hour (Fig. 7) and 4.20" in 3 hours (Fig. 8)! A large area of 1.5"-2.5" of rain, most of which also fell within one hour, also impacted Delaware County (Fig. 7).

A mid-level mesoscale convective vortex (MCV) and outflow boundary from early morning storms resulted in showers and thunderstorms from late morning through late evening of the 11th across a large portion of eastern OK and northwest AR. Some isolated to widely-scattered activity then persisted through the overnight hours across far southeast OK and west central AR. PWAT values were once again around 2", resulting is high rainfall rates. Locations impacted by this activity received around 0.75" to around 4", with the highest totals occurring over southeast OK (Fig. 9).

Around midnight of the 13th, a line of showers and thunderstorms developed from near Wichita, KS to near Stillwater, OK in an area of a strengthening low-level jet and warm air advection. These storms increased in intensity and coverage, with some becoming severe, as they shifted eastward into northeast OK. Hail of 1.75" diameter was reported in both Burbank, OK and Hominy, OK. By sunrise, this thunderstorm complex began to move southward into southeast OK and northwest AR. The storms began to wane my late morning and ended by mid-afternoon of the 13th. Rainfall totals ranged from around 0.75" to near 1.5", with isolated 1.5"-2.5" amounts (Figs. 10, 11).

Shortly after midnight on the 14th, a thunderstorm complex once again developed and quickly increased in intensity and coverage. This time, however, the storms developed over far eastern OK and northwest AR along an 850 mb moisture axis and 850 mb frontogenetic forcing. Some of these storms became severe, with several wind damage reports in west central AR. Storms continued to train across the OK/AR border counties, with rainfall rates of over 1" per hour at times. A large area from Delaware County through Sebastian County received 1.5"-4" of rain, with 4"-8" falling over northeast Cherokee/southern Delaware/northwest Adair Counties (Figs. 12, 13), where flash flooding was reported. This activity dissipated by noon.

Tropical moisture increased across the area on the 26th, in advance of Hurricane Laura. As a mid-level low over western OK interacted with this tropical moisture, showers and thunderstorms developed over southeast OK and west central AR at mid-morning. This activity became more widespread during the afternoon, with some isolated storms occurring elsewhere over eastern OK. By evening, the rainfall waned across most of the area. However, scattered showers continued over southeast OK and west central AR through the overnight hours as Hurricane Laura made landfall near Lake Charles, LA and moved northward. Rainfall totals of around 0.50" to around 5" were primarily confided to locations along and south of an Antlers, OK to Fort Smith, AR line (Fig. 14).

The remnants of Hurricane Laura moved north across central AR on the 27th, with just a glancing blow to the eastern portion of the NWS Tulsa HSA, where 0.50" to 2.5" of rain fell (Fig. 15). Some far outer bands produced scattered showers and thunderstorms across eastern OK. These storms brought up to around 2" in isolated locations (Fig. 15).

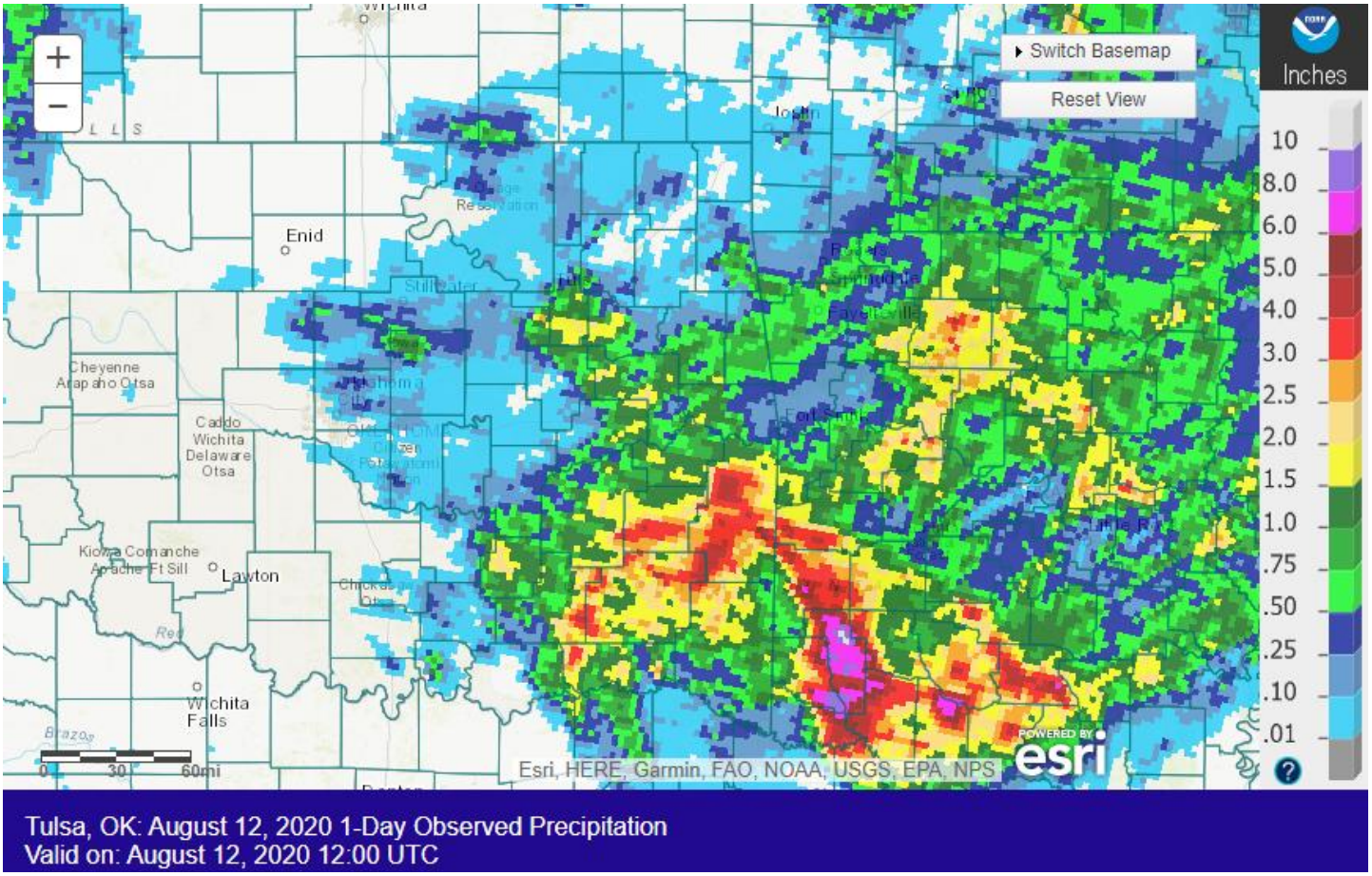


Fig. 9. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/12/2020.

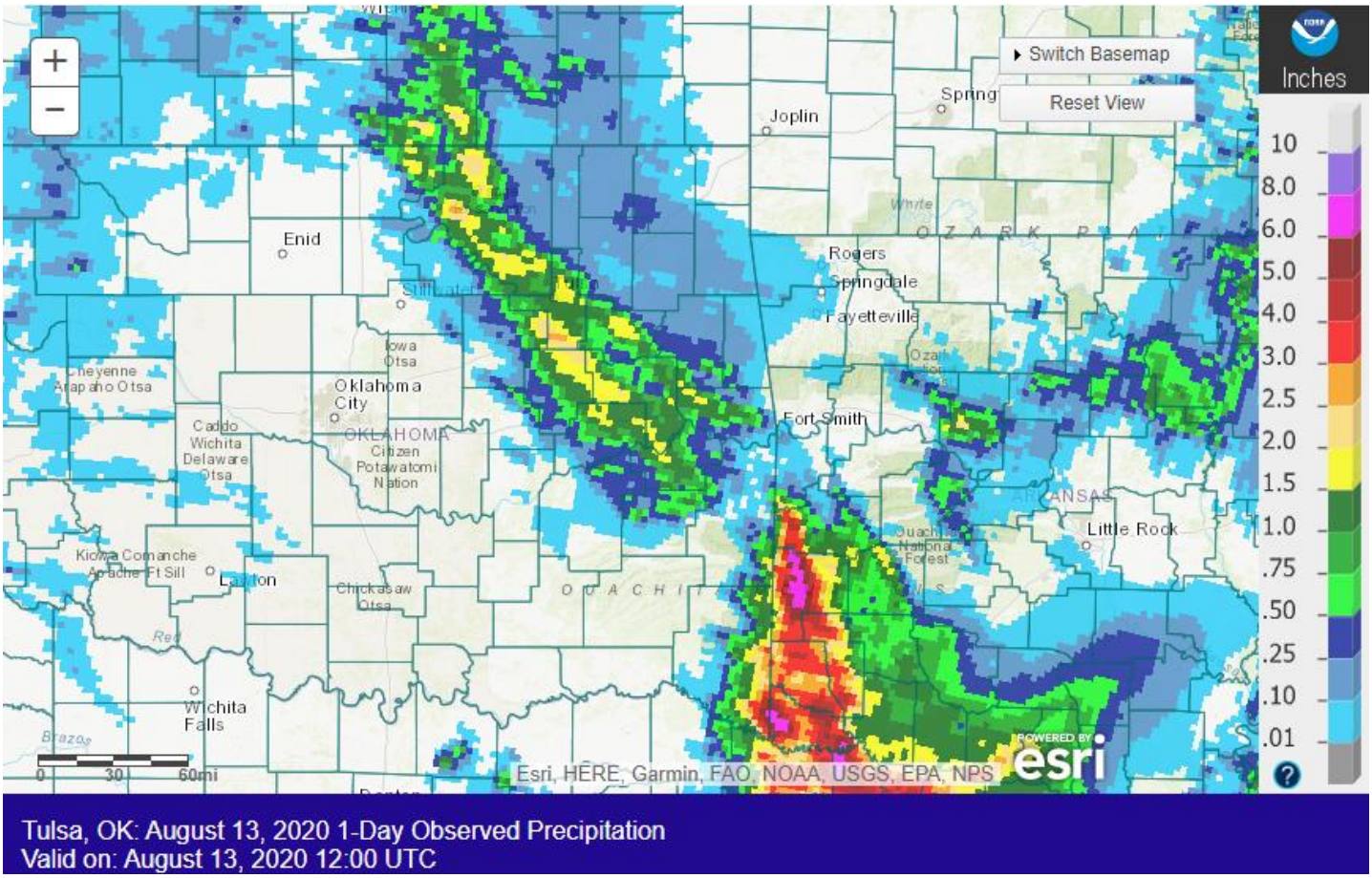


Fig. 10. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/13/2020.

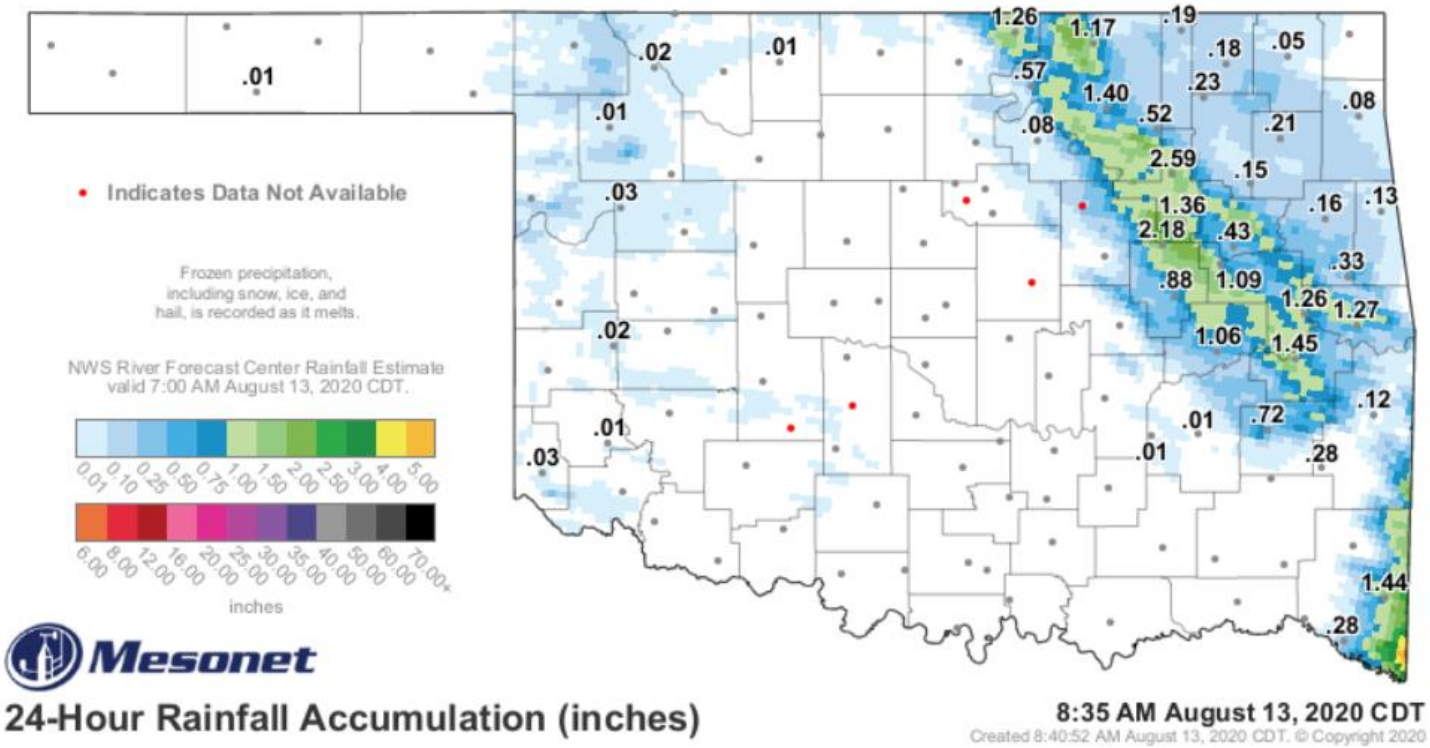


Fig. 11. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 8:35 am CDT 8/13/2020.

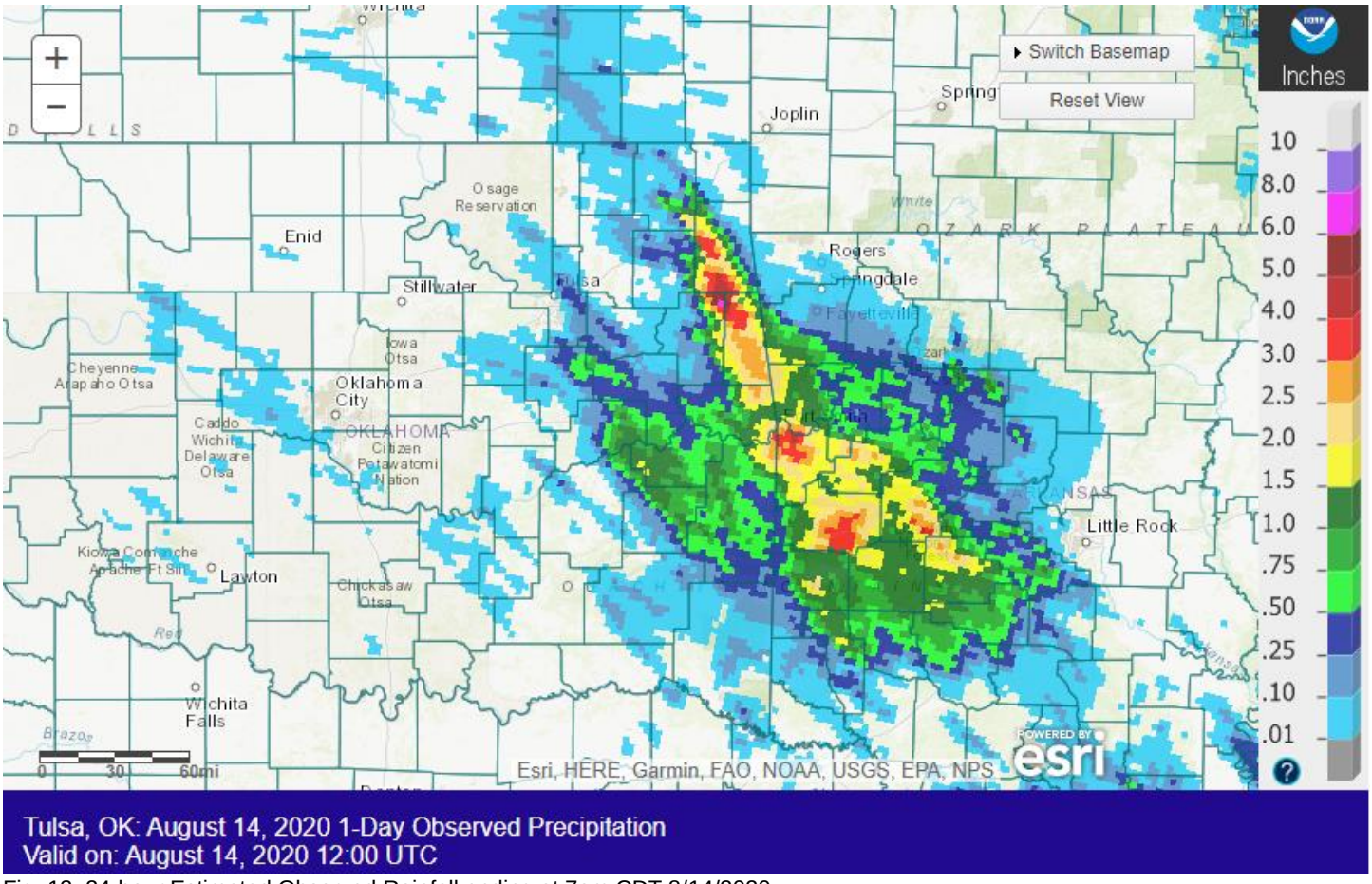


Fig. 12. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/14/2020.

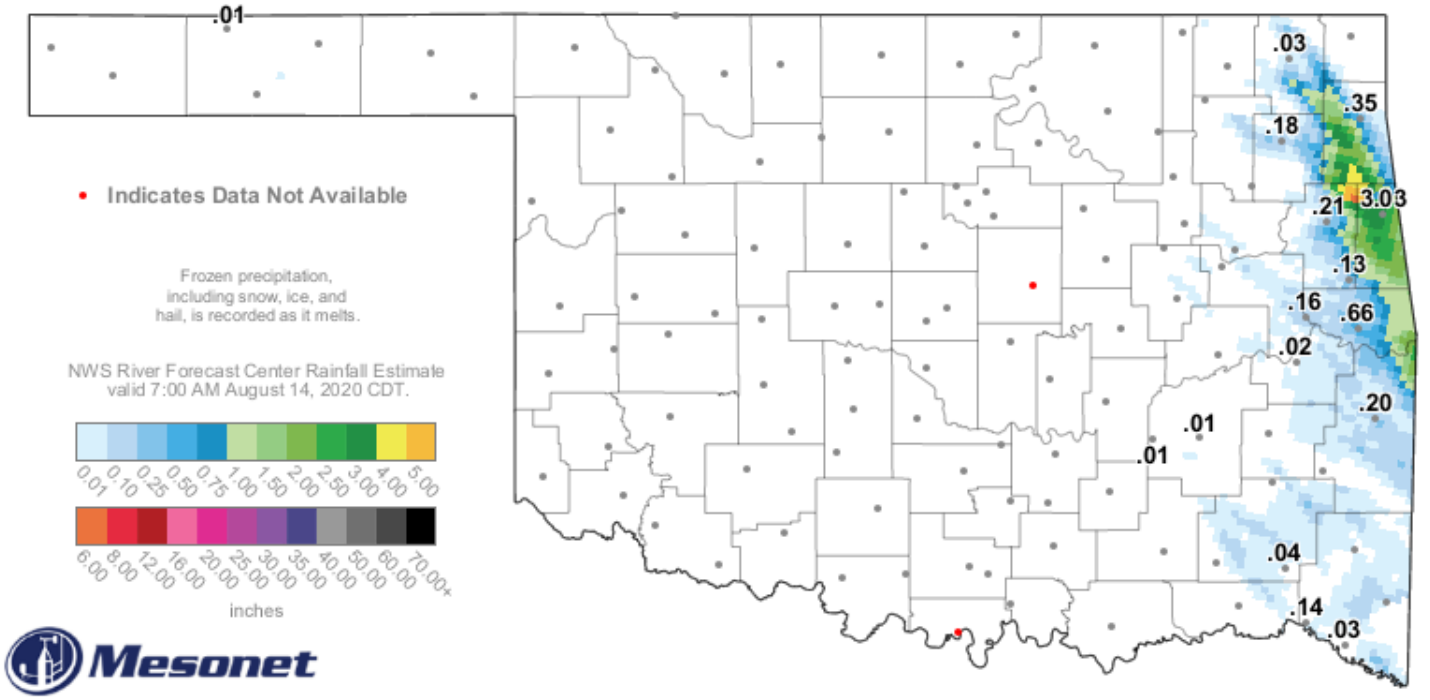


Fig. 13. OK Mesonet (values) and NWS RFC rainfall estimate (image) 12-hour rainfall ending at 7:50 am CDT 8/14/2020.

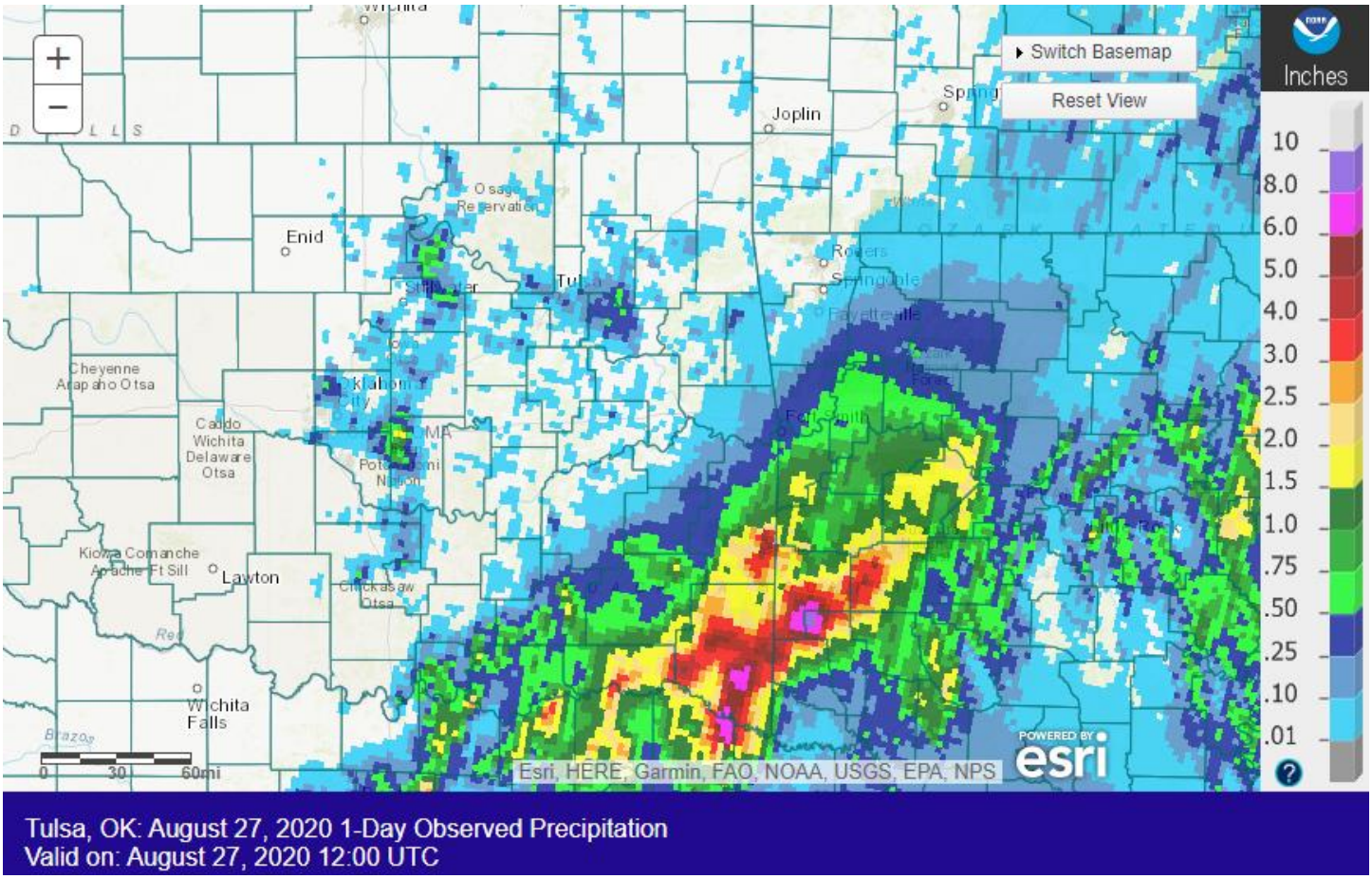


Fig. 14. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/27/2020.

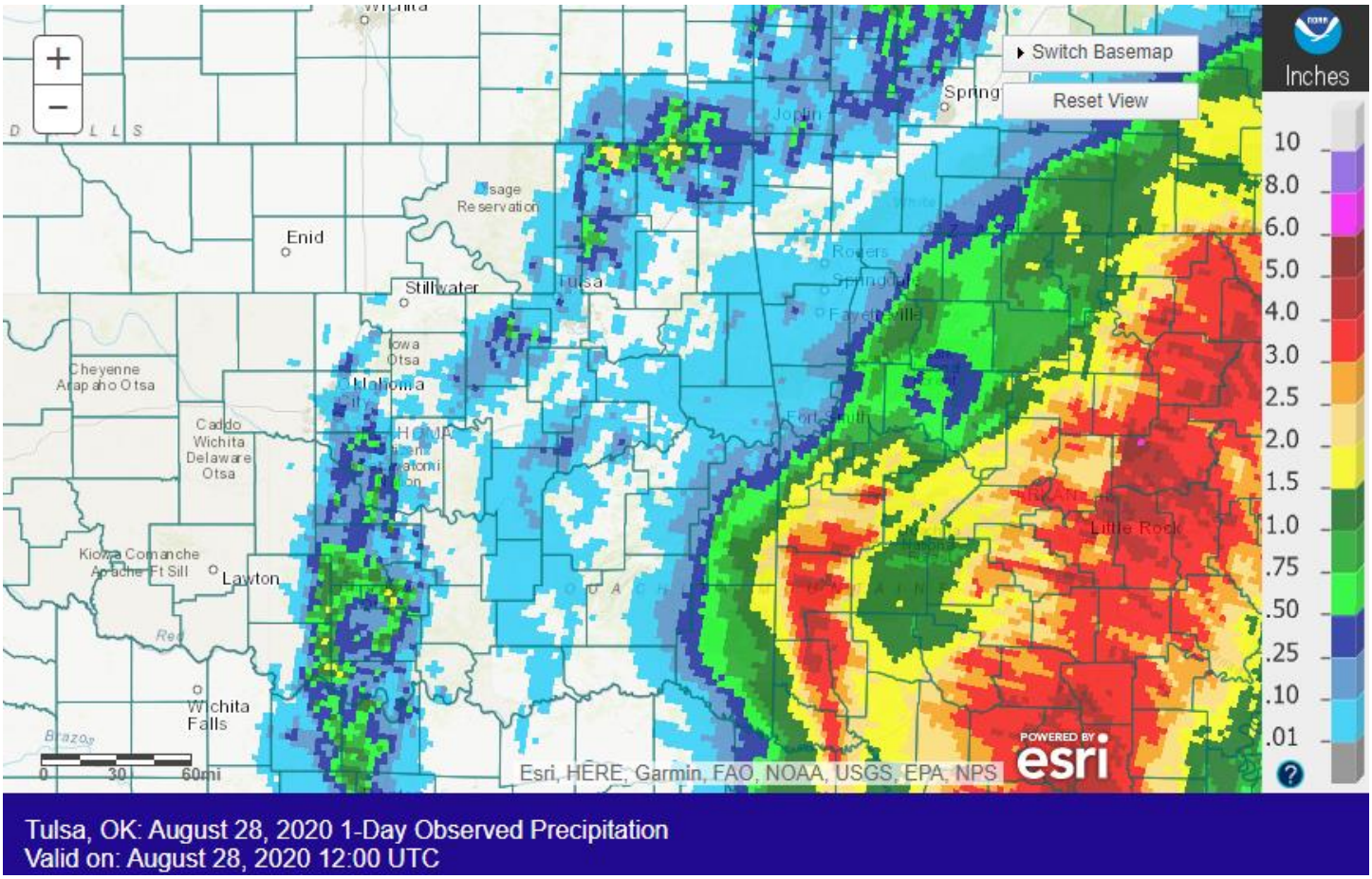


Fig. 15. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/28/2020.

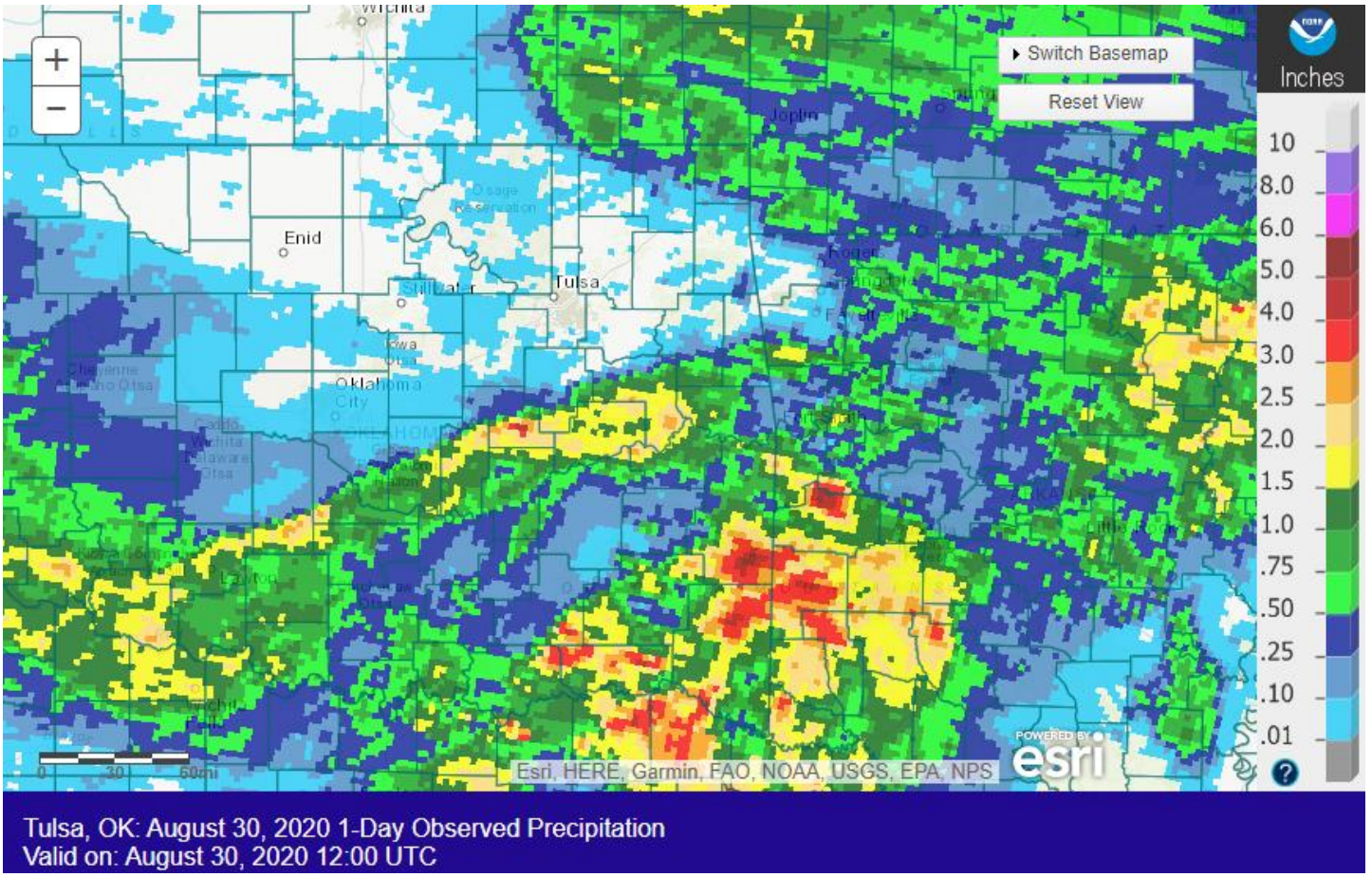


Fig. 16. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/30/2020.

During the morning of the 29th, a line of thunderstorms moved across southern KS and southern MO, bringing rain to the adjacent counties in northeast OK and northwest AR. A cold front then moved south through the region and was located near I-40 by the afternoon. A very unstable airmass resided south of the front, and thunderstorms developed over northwest AR and southeast OK during the mid-evening hours. As the low-level jet strengthened, the storms increased in coverage across southeast OK and west central AR before waning around midnight. Scattered showers and thunderstorms continued over southeast OK and west central AR during the overnight hours, while another thunderstorm complex approached from central OK. This MCS moved into east central and southeast OK just before sunrise on the 30th and continued to push eastward into northwest AR through the morning before dissipating before noon. PWAT values near 2.5", which is around 3 standard deviations from normal, allowed for efficient rain production. By 7 am on the 30th, rainfall totals ranged from around 0.50" to around 5" (Fig. 16).

PWAT values remained near 2" during the early morning hours of the 31st as showers and thunderstorms developed between Highway 412 and I-40 in response to an approaching upper-level wave and stronger low-level jet axis. These storms continued to expand in coverage, with scattered showers and thunderstorms across eastern OK and northwest AR by sunrise. Rainfall totals at 7am ranged from around 0.50" to around 2" from Creek County through west central AR (Fig. 17). The scattered showers and thunderstorms continued through the morning, finally dissipating by late afternoon. A cold front then moved into the region, with thunderstorms rapidly developing during the early evening hours across central into northeast OK. Widespread showers and thunderstorms continued across primarily northeast and east central OK through the evening hours as additional lift moved in from the west. This activity then expanded into western AR and southeast OK after midnight, continuing across much of the HSA through the overnight and morning hours of September 1. By 7am on Sep. 1, a large portion of east central and southeast OK and west central AR had received 1.5" to around 6" of rain, with a large area from northeast Latimer County into northern Le Flore County receiving 6"-8" of rain (Figs. 18, 19). Flash flooding occurred from this heavy rain, and numerous reports of swift water rescues and people needing evacuation from their homes prompted a Flash Flood Emergency for northern Le Flore County during the early morning of the 1st. Widespread showers and thunderstorms continued through much of the day, slowly ending from north to south during the afternoon and evening. By 5 pm on the 1st, widespread 4"-10" had fallen over portions of southeast OK, with the OK Mesonet station at Clayton measuring 7.77" (Fig. 20). This rainfall caused major flooding along the Poteau River near Panama, with moderate flooding upstream near Poteau (see preliminary hydrographs at the end of this report and the E3 Report for details).

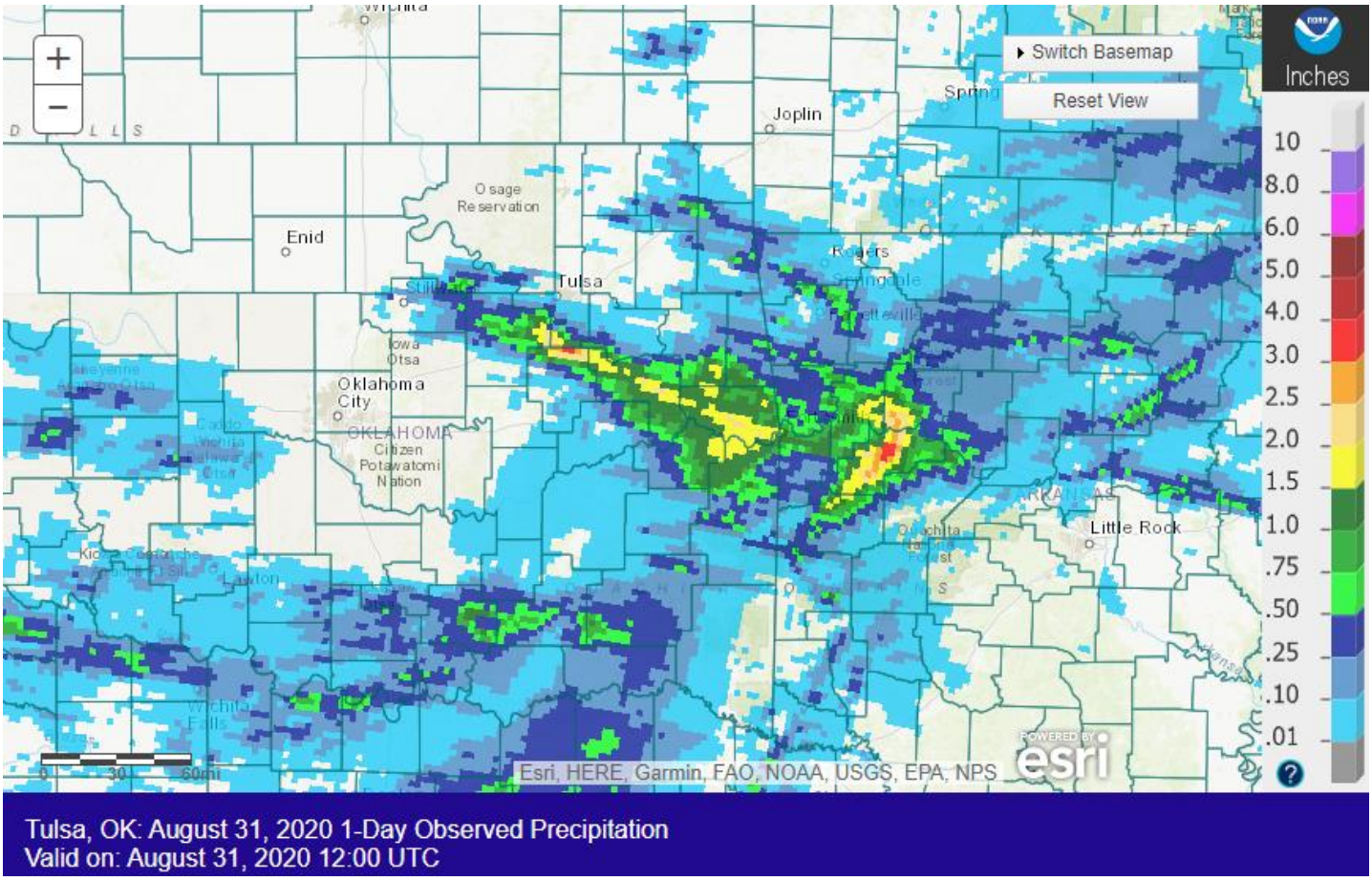


Fig. 17. 24-hour Estimated Observed Rainfall ending at 7am CDT 8/31/2020.

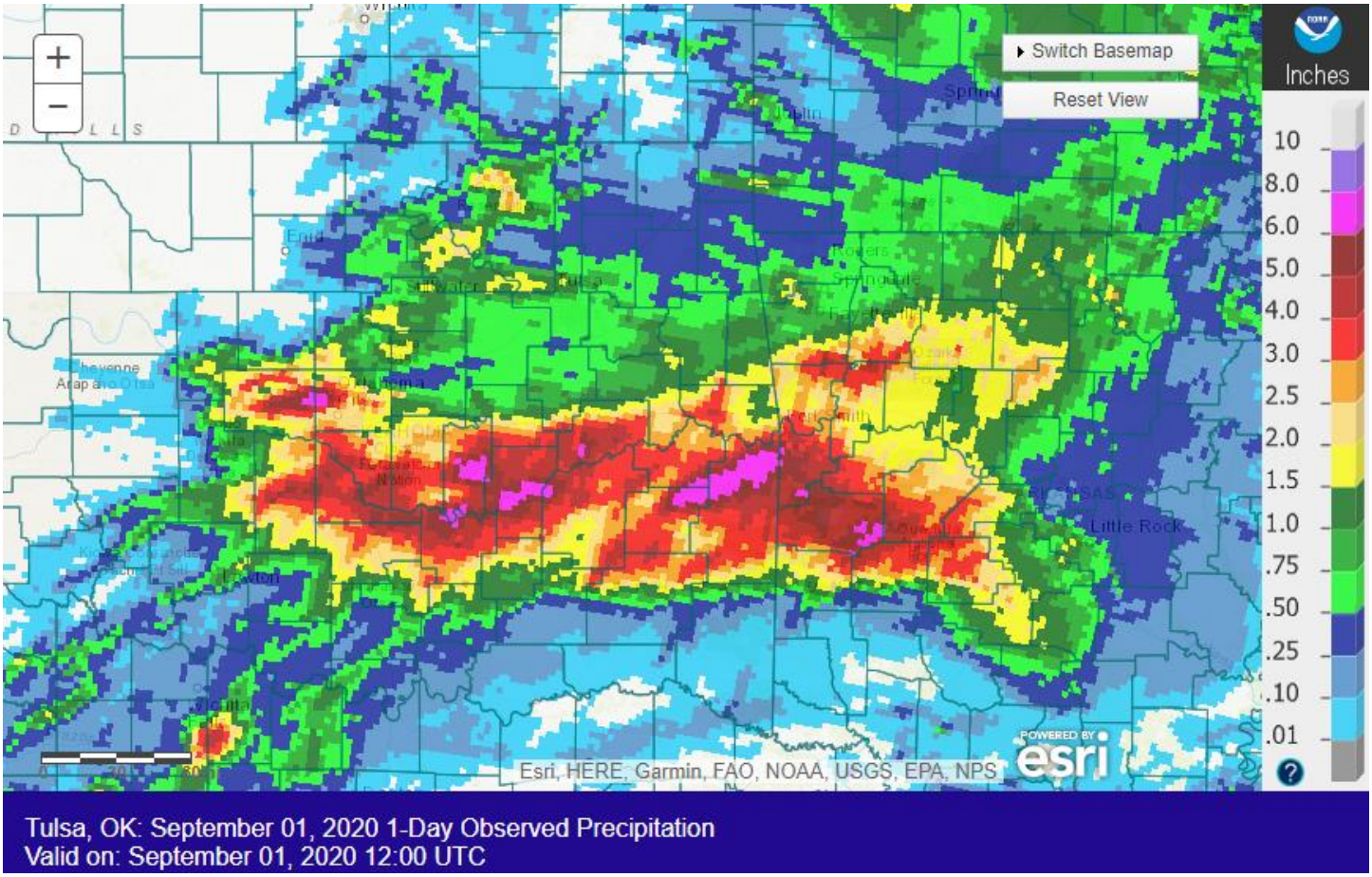


Fig. 18. 24-hour Estimated Observed Rainfall ending at 7am CDT 9/01/2020.

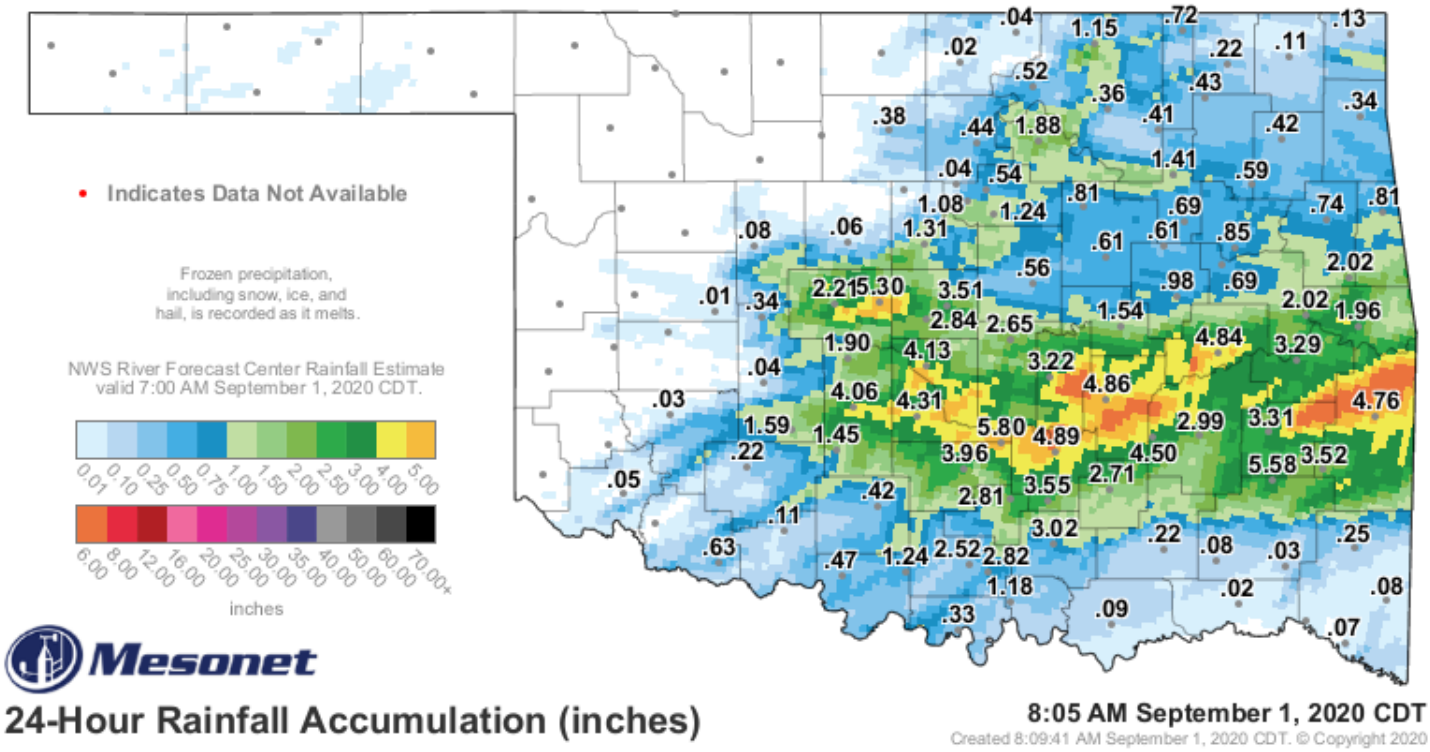


Fig. 19. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 8:05 am CDT 9/01/2020.

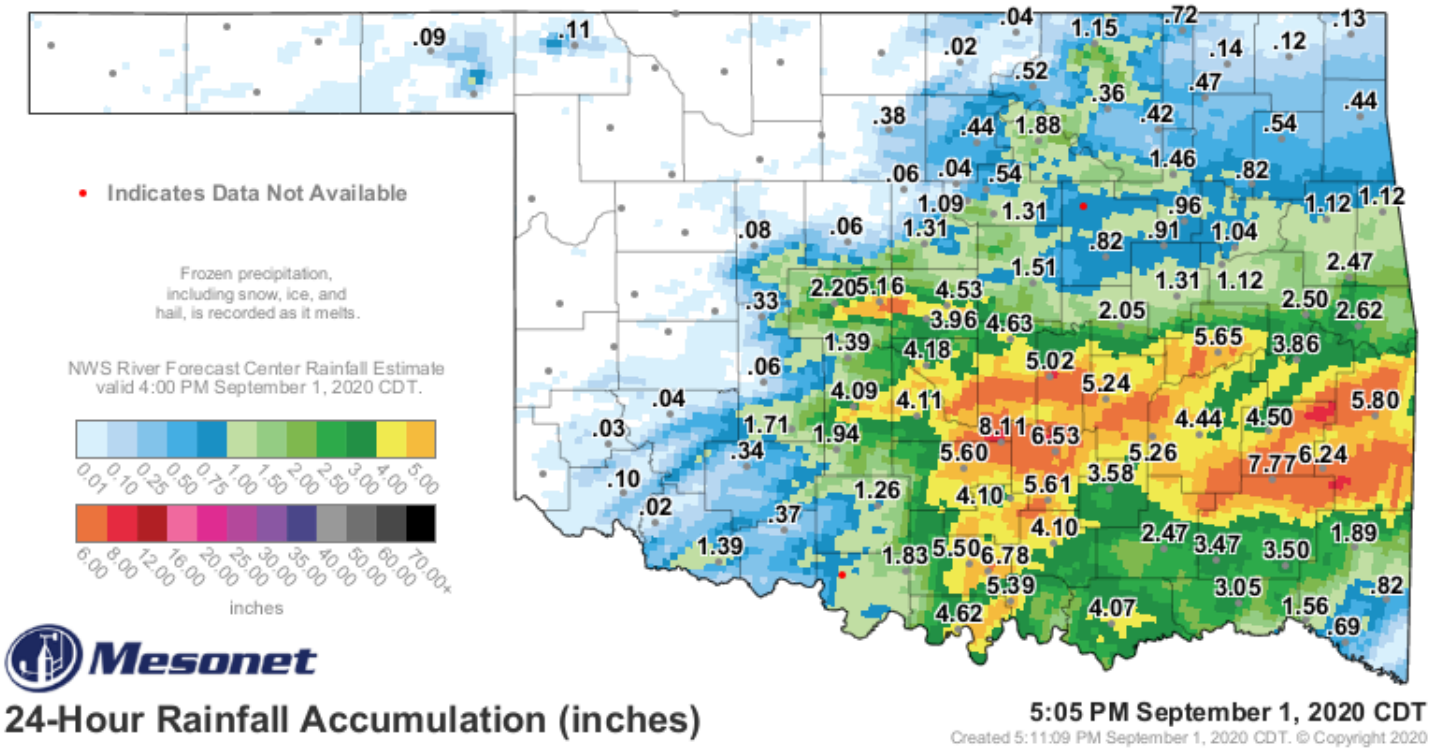


Fig. 20. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 5:05 pm CDT 9/01/2020.

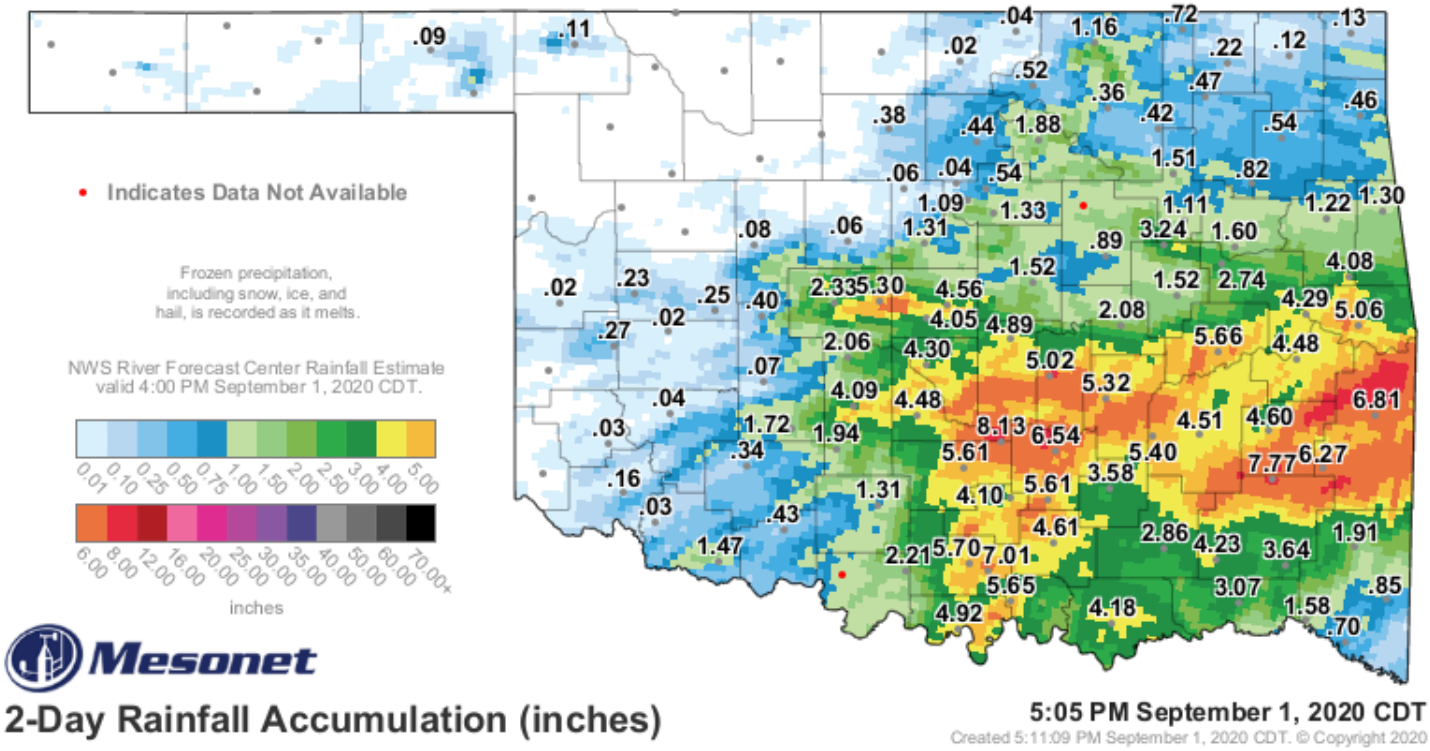


Fig. 21. OK Mesonet (values) and NWS RFC rainfall estimate (image) 2-day rainfall ending at 5:05 pm CDT 9/01/2020.

Written by:
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WFO Tulsa

Products issued in August 2020:

*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

14 Flash Flood Warnings (FFW)
18 Flash Flood Statements (FFS)
4 Flash/Areal Flood Watches (FFA) (12 Watch FFA CON/EXT/EXA/EXB/CAN)
32 Urban and Small Stream Advisories (FLS)
3 Areal Flood Warnings (FLW)
0 Areal Flood Statements (FLS)
1 River Flood Warnings (FLW) (includes category increases)
1 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: