

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)
		REPORT FOR: MONTH December YEAR 2020
MONTHLY REPORT OF RIVER AND FLOOD CONDITIONS		SIGNATURE Steven F. Piltz (Meteorologist-in-Charge)
TO: Hydrometeorological Information Center, W/OH2 NOAA / National Weather Service 1325 East West Highway, Room 7230 Silver Spring, MD 20910-3283		DATE January 15, 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.

The last month of 2020 brought snow and ice to portions of eastern OK and northwest AR, with a heavy rain event at the end of the month resulting in minor flooding for the start of the new year. Normal precipitation for December ranges from 1.5 inches in Pawnee County to 3.2 inches in Haskell County. Normal precipitation for the Ozark region of northwest Arkansas averages 3.2 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 December 2020 ranged from around 2" to around 6" across eastern OK and northwest AR. These rainfall totals correspond to 75% to 200% of the normal December rainfall for eastern OK and northwest AR (Fig. 1b).

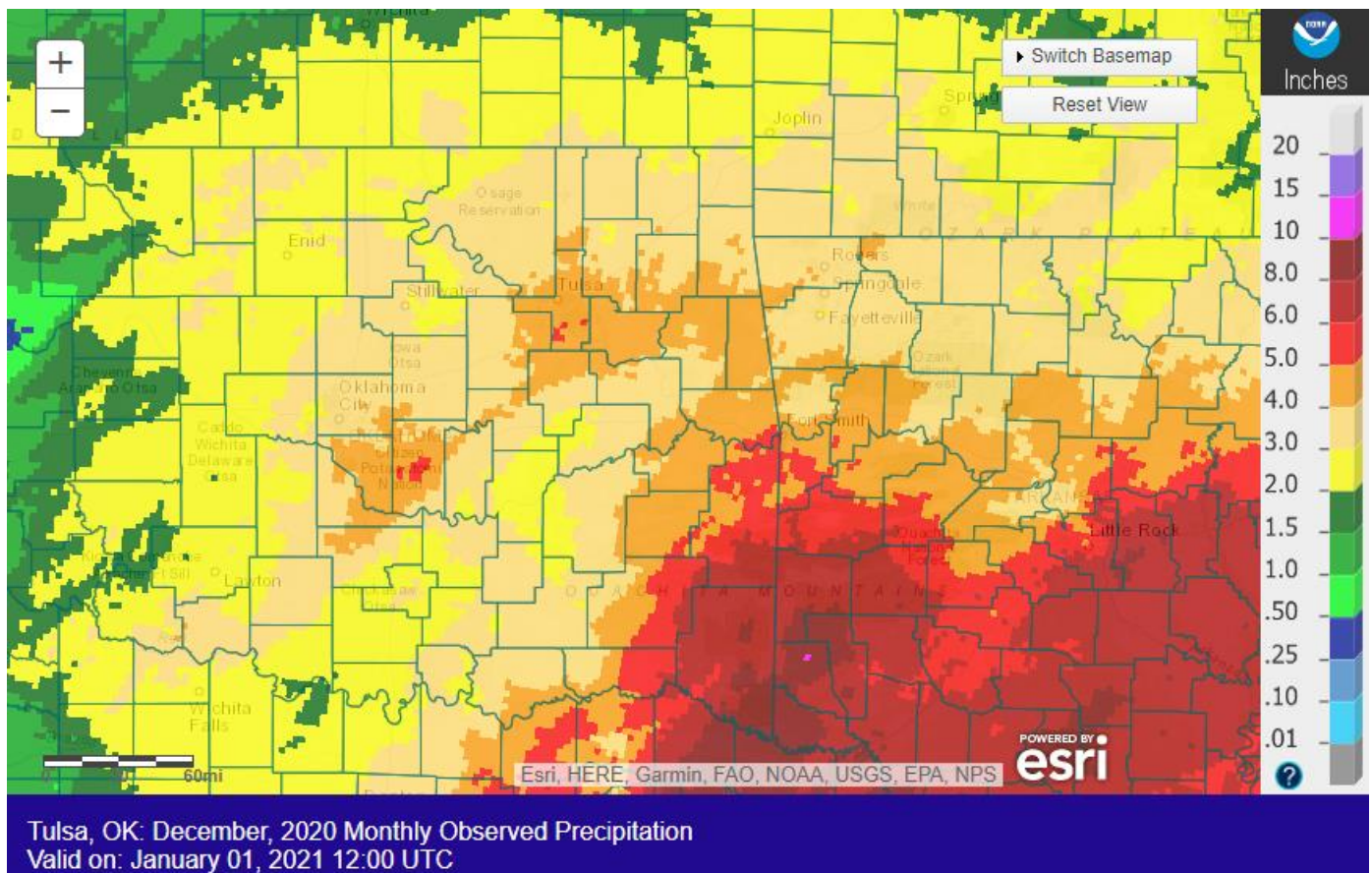


Fig. 1a. Estimated Observed Rainfall for December 2020

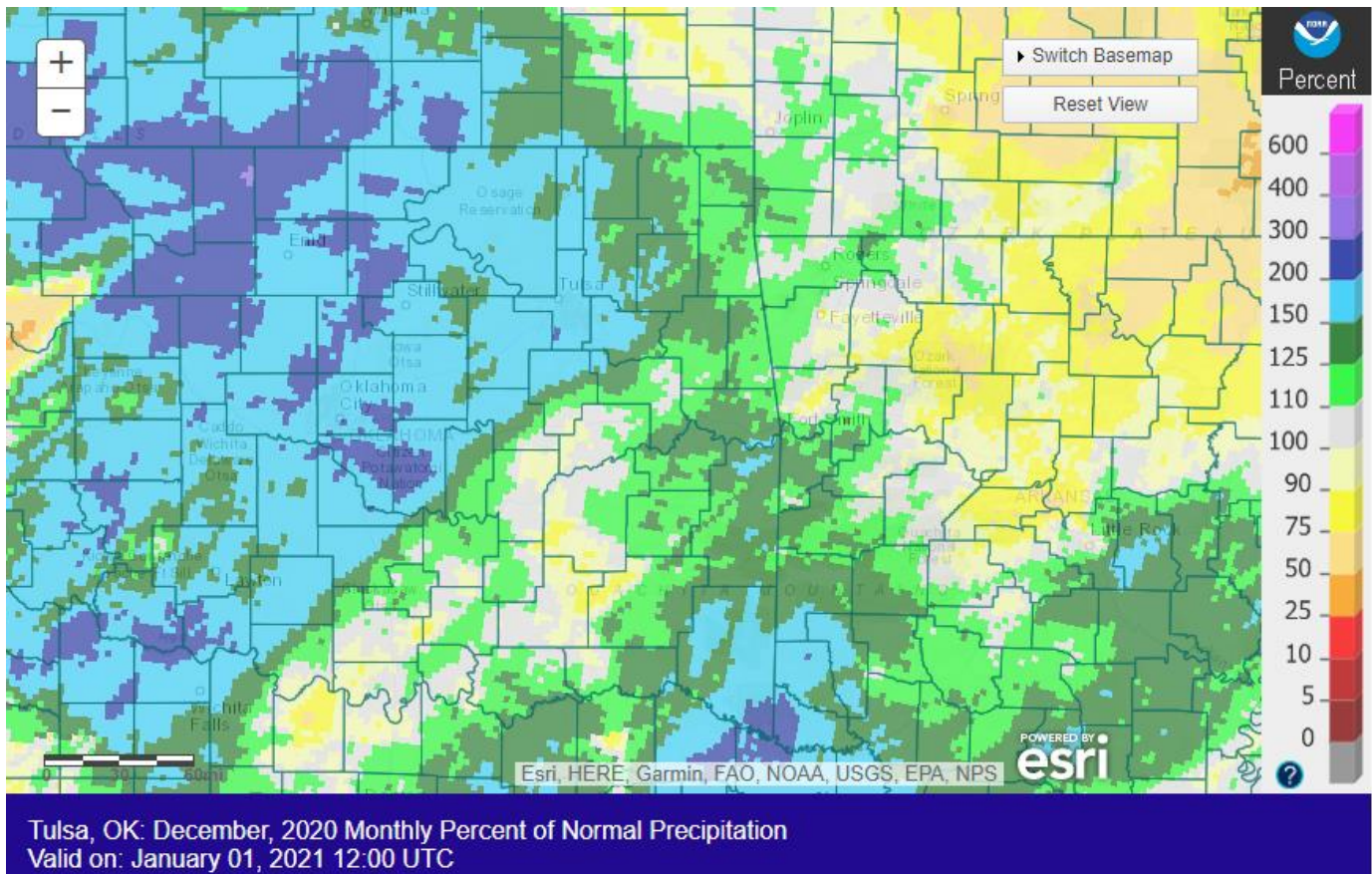


Fig. 1b. Estimated % of Normal Rainfall for December 2020

In Tulsa, OK, December 2020 ranked as the 44th warmest December (42.1°F; since records began in 1905), the 27th wettest December (3.34"; since records began in 1888), and the 12th snowiest December (5.7"; since records began in 1900). Fort Smith, AR had the 57th warmest December (42.9°F, tied 2017; since records began in 1882), the 39th wettest December (4.09"; since records began in 1882), and the 43rd snowiest December (0.5", tied 1988, 1987, 1932; since records began in 1883). Fayetteville, AR had the 26th warmest (39.8°F, tied 2007, 1987, 1980), the 32nd wettest (2.89", tied 1959), and the 16th snowiest December (2.8") since records began in 1949.

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

Cloudy, OK (meso)	5.41	Hugo, OK (meso)	5.21	Wister, OK (meso)	5.11
Talihina, OK (meso)	4.90	Antlers, OK (meso)	4.54	Sallisaw, OK (meso)	4.51
Stigler, OK (meso)	4.51	Clayton, OK (meso)	4.48	Bixby, OK (meso)	4.36

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

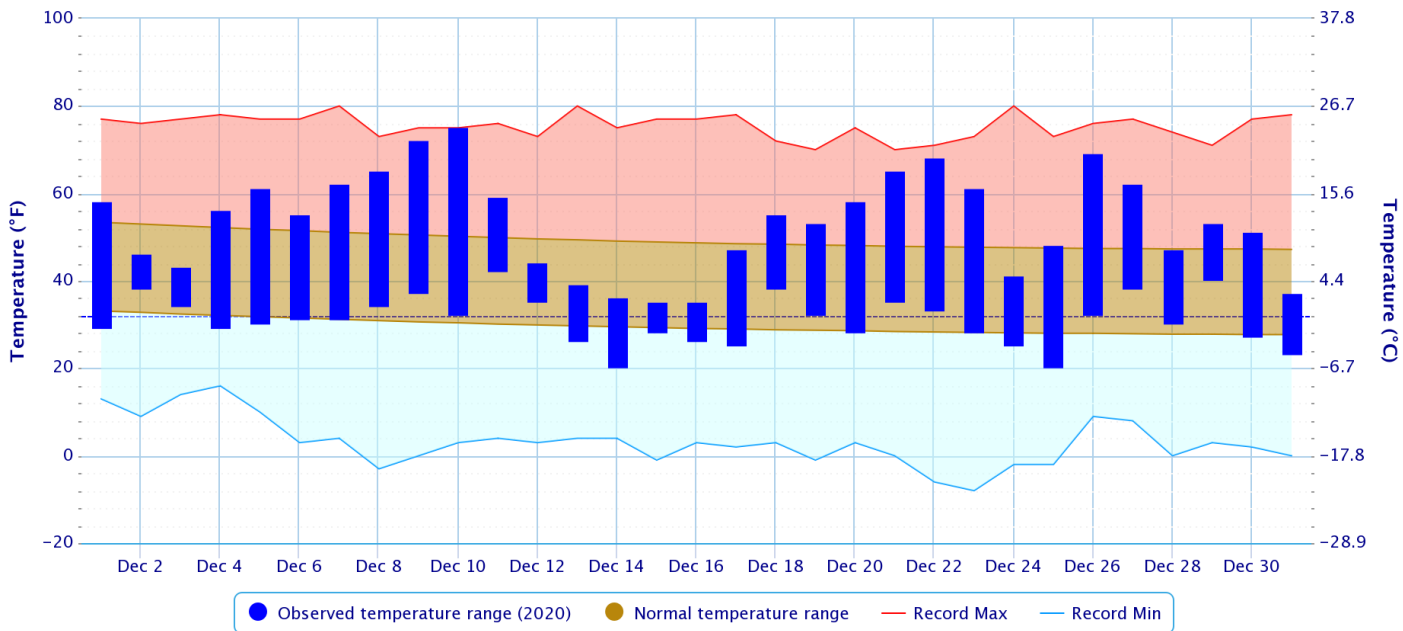
Gentry 5.6ENE, AR (coco)	1.71	Metalton 3.5W, AR (coco)	1.99	Kingston 2S, AR (coop)	2.10
Owasso 1.4NNW, OK (coco)	2.14	Oologah 2.8NE, OK (coco)	2.17	Spavinaw, OK (coop)	2.22
Tulsa 7.7SSE, OK (coco)	2.22	Vinita 8.6ESE, OK (coco)	2.23	Foraker, OK (meso)	2.23

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

Rank since 1921	December 2020	Last 60 Days (Nov 2 – Dec 31)	Water Year-to-Date (Oct 1, 2020 – Dec 31, 2020)	Cool Growing Season (Sep 1 – Dec 31)	Last 180 Days (Jul 5 – Dec 31)	Year 2020
Northeast OK	17 th wettest	34 th wettest	29 th wettest	43 rd wettest	19 th wettest	18 th wettest
East Central OK	21 st wettest	48 th wettest	49 th wettest	41 st wettest	21 st wettest	8 th wettest
Southeast OK	17 th wettest	49 th wettest	39 th driest	35 th wettest	15 th wettest	8 th wettest
Statewide	21 st wettest	44 th wettest	45 th wettest	43 rd wettest	25 th wettest	27 th wettest

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

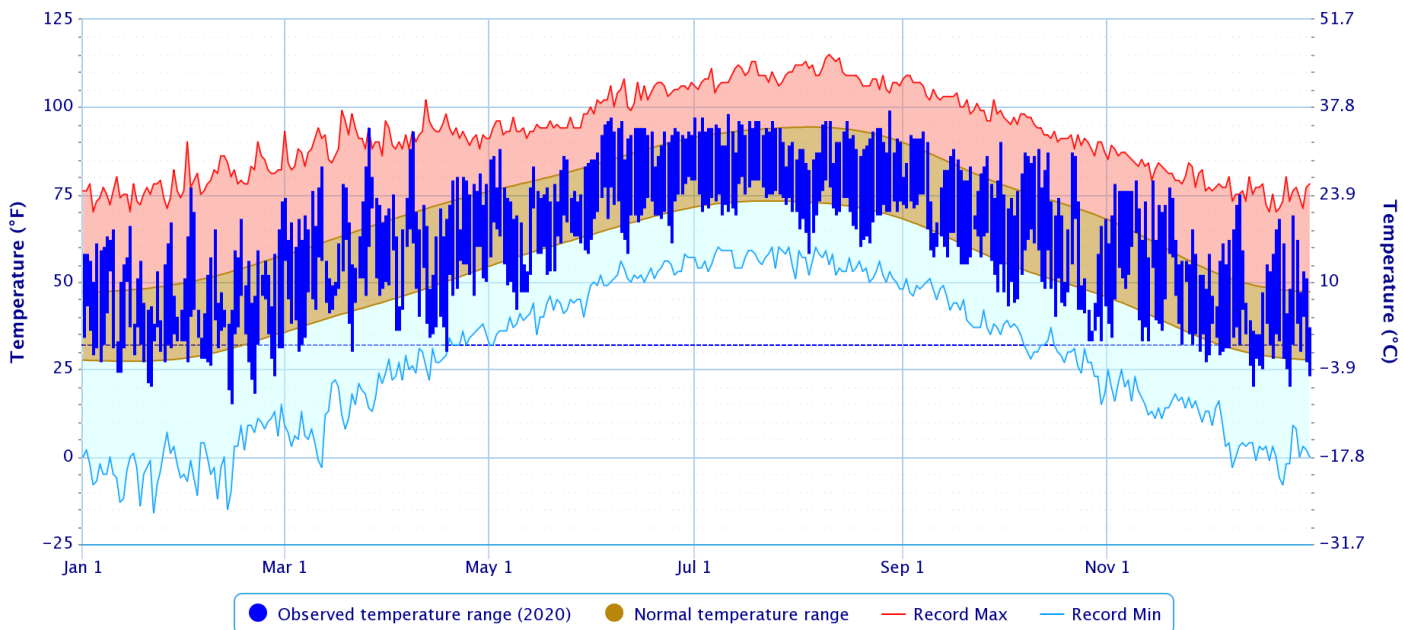
Period of Record – 1905-01-06 to 2021-01-04. Normals period: 1981-2010. Click and drag to zoom chart.



Powered by ACIS

Daily Temperature Data – Tulsa Area, OK (ThreadEx)

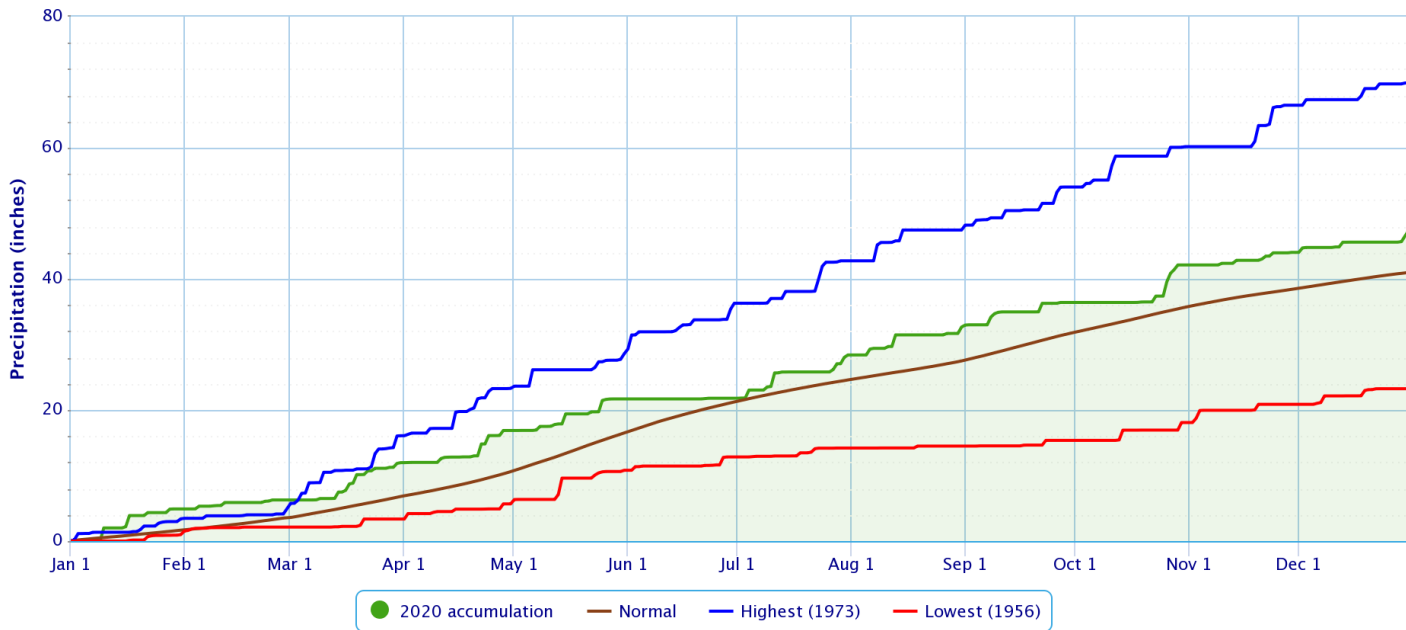
Period of Record – 1905-01-06 to 2021-01-04. Normals period: 1981-2010. Click and drag to zoom chart.



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Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

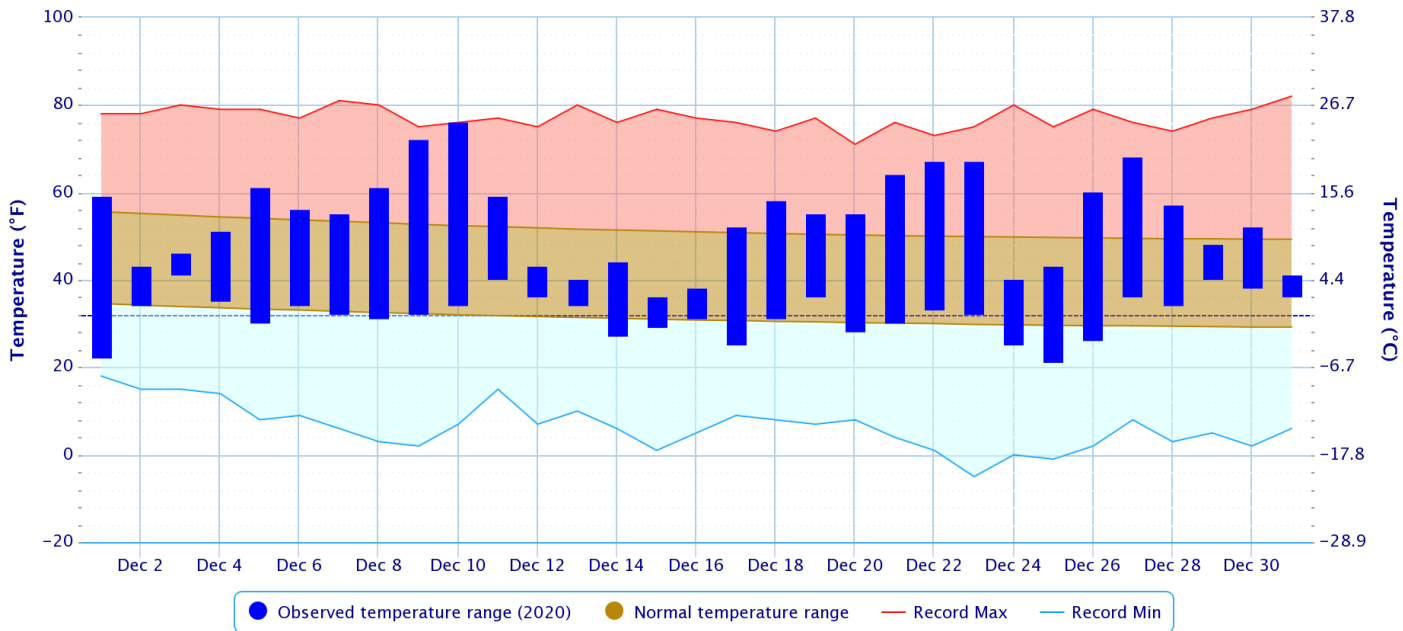
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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

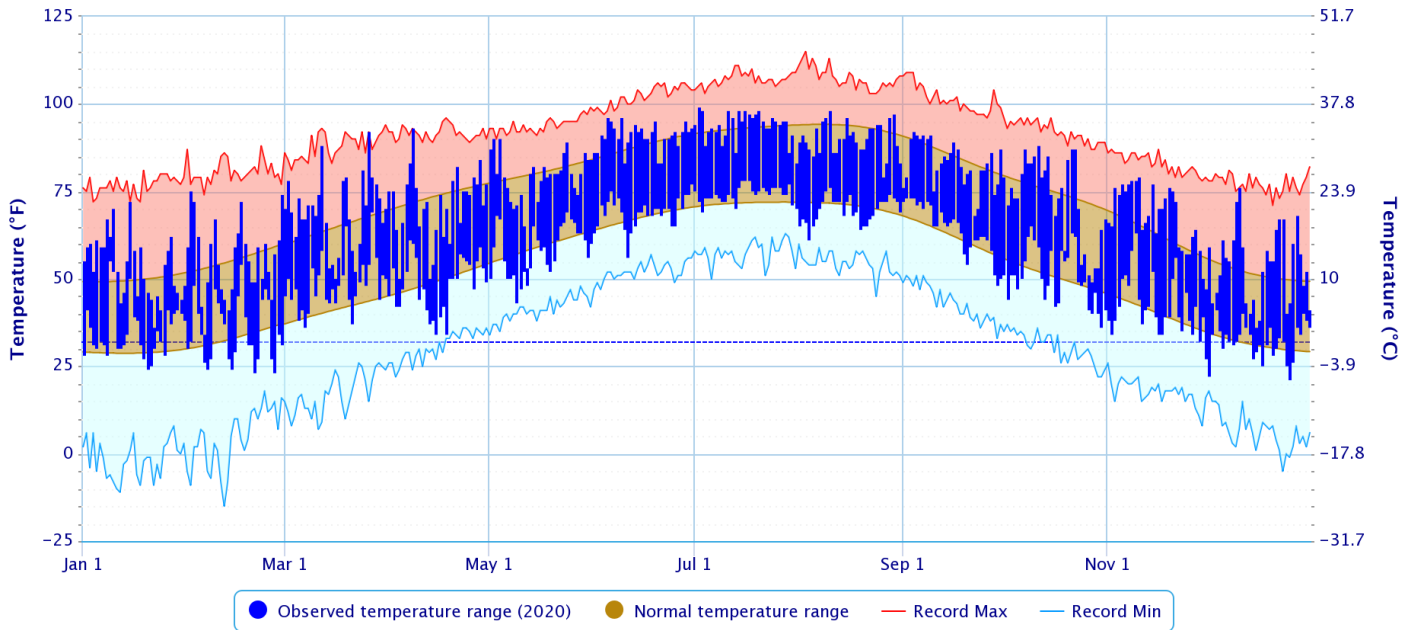
Period of Record – 1882-06-01 to 2021-01-14. Normals period: 1981-2010. Click and drag to zoom chart.



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

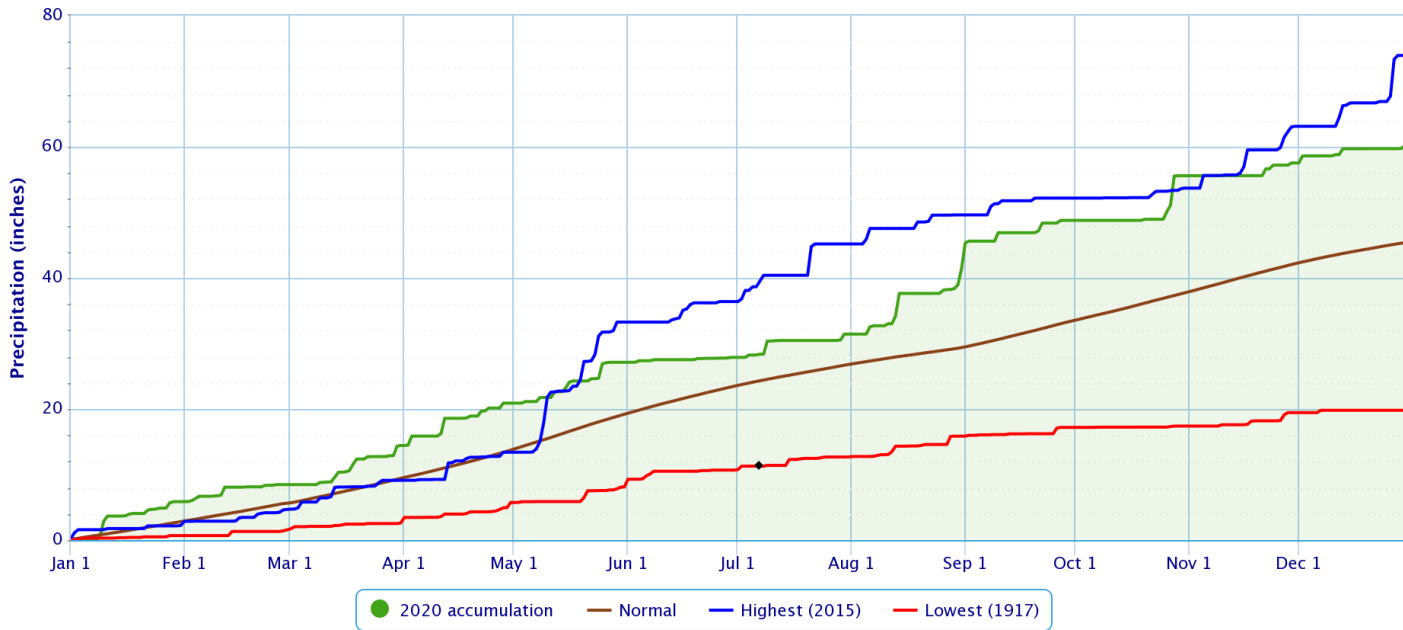
Period of Record – 1882-06-01 to 2021-01-04. Normals period: 1981-2010. Click and drag to zoom chart.



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Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

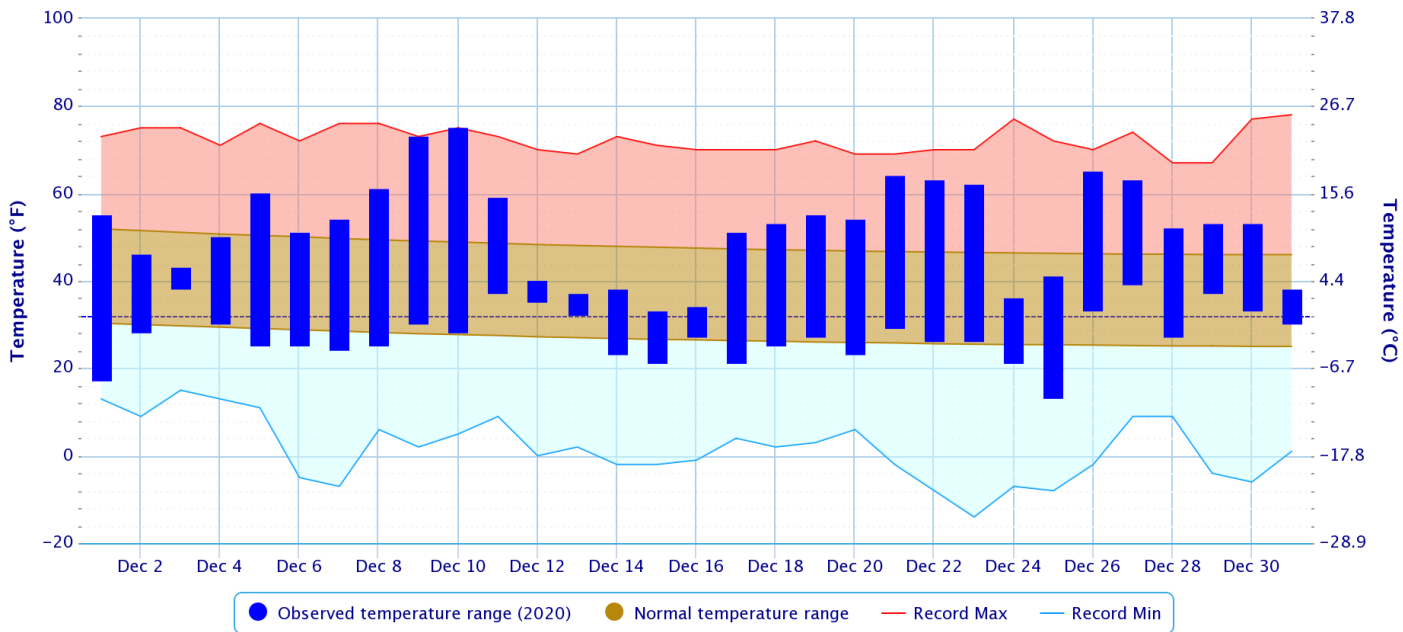
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



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Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

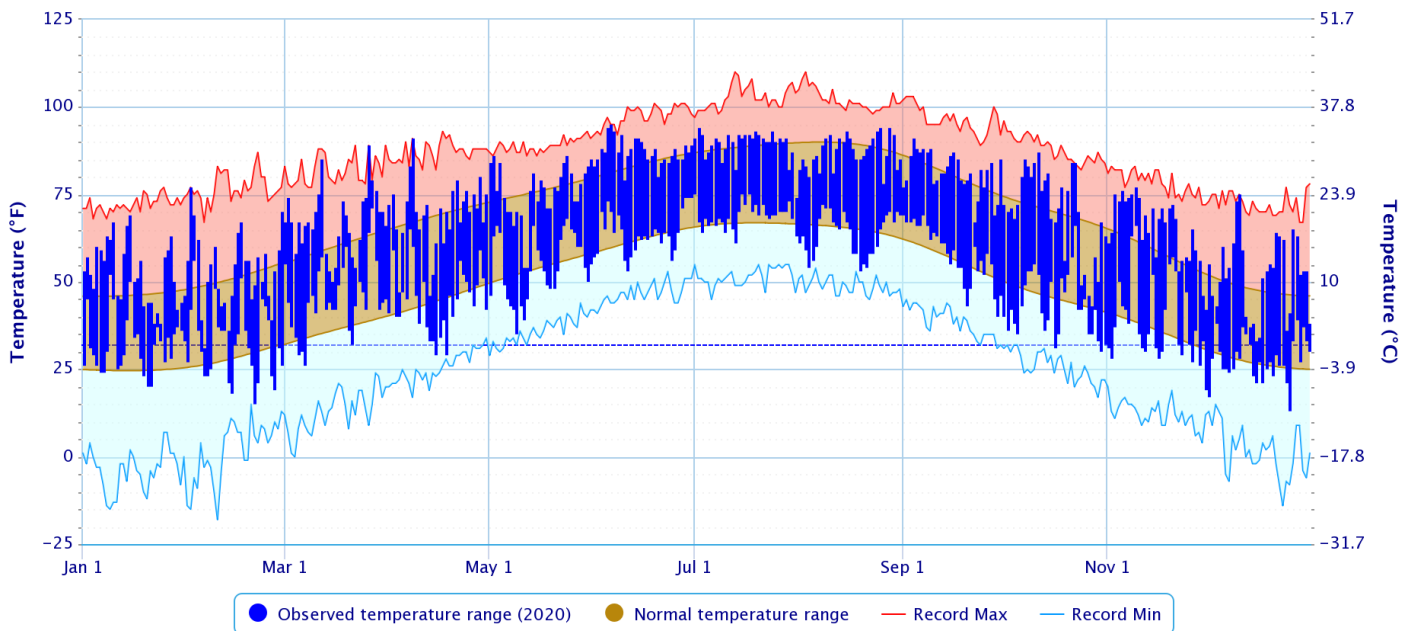
Period of Record – 1949-07-14 to 2021-01-04. Normals period: 1981-2010. Click and drag to zoom chart.



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Daily Temperature Data – FAYETTEVILLE DRAKE FIELD, AR

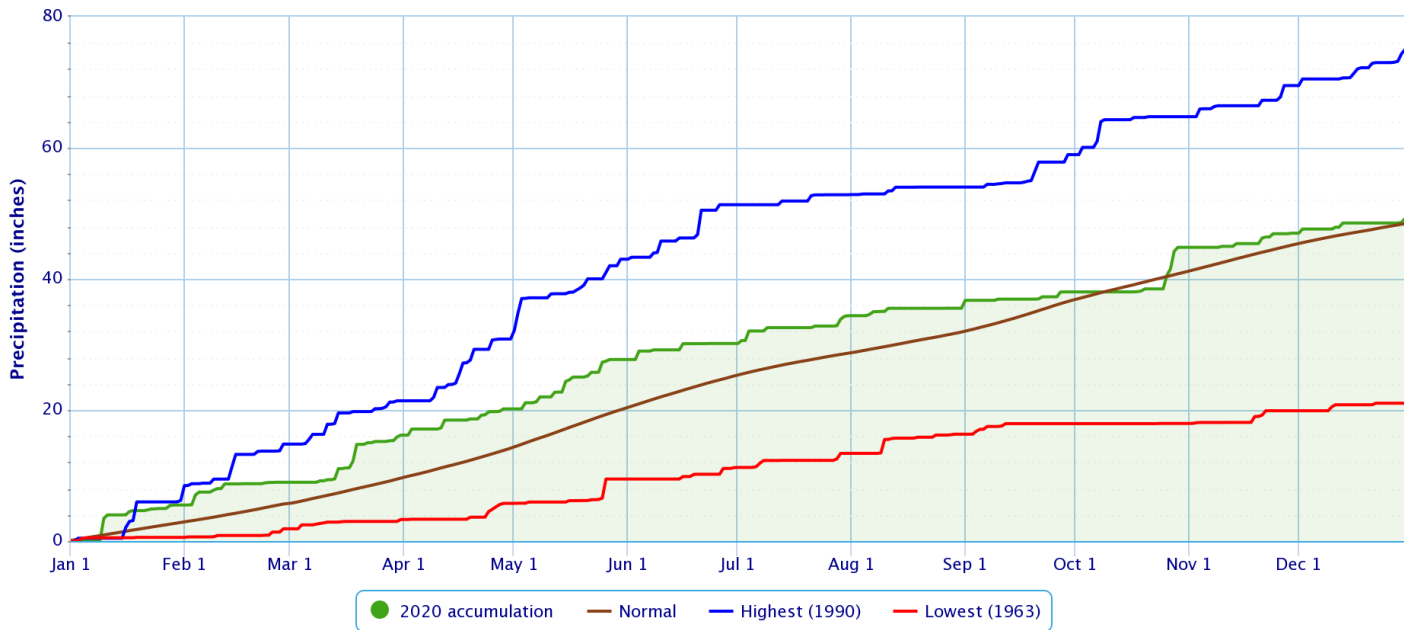
Period of Record – 1949-07-14 to 2021-01-04. Normals period: 1981-2010. Click and drag to zoom chart.



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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

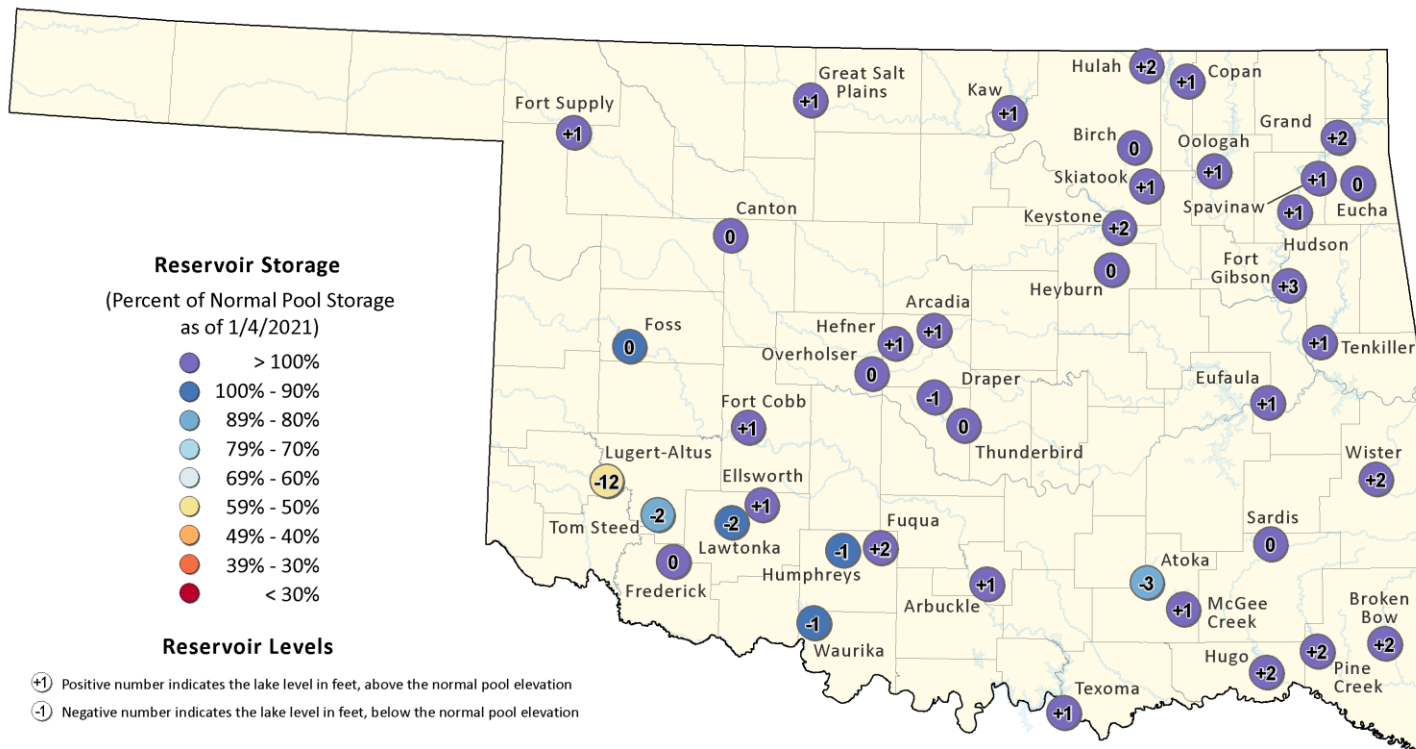


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Reservoirs

Oklahoma Surface Water Resources

Reservoir Levels and Storage as of 1/4/2021



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



According to the USACE, several of the lakes in the HSA were using over 3% of top of their flood control pools as of 01/01/2021, with the remainder of the lakes within $\pm 3\%$. Lakes using a higher percentage of their flood control pools are: Wister Lake 11%, Sardis Lake 8%, Birch Lake 8%, Fort Gibson Lake 7%, Hudson Lake 5%, Copan Lake 4%, Heyburn Lake 4%, Hugo Lake 4%, Tenkiller Lake 4%, and Eufaula Lake 4%.

Year 2020

In Tulsa, OK, the Year 2020 ranked as the 29th warmest year (61.7°F, tied 2007, 1977; since records began in 1905), the 21st wettest year (47.38"; since records began in 1888), and the 50th snowiest year (8.7", tied 2013; since records began in 1900). Fort Smith, AR had the 23rd warmest year (62.8°F, tied 2018, 2007, 1927, 1925; since records began in 1883), the 5th wettest year (61.62"; since records began in 1882), and the 24th least snowy year (1.0", tied 2019; since records began in 1884). Fayetteville, AR had the 6th warmest (59.2°F), the 22nd wettest (49.86"), and the 17th least snowy year (3.2") since records began in 1950.

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

Miami, OK (meso)	81.64	Jay, OK (meso)	80.67	Pryor, OK (meso)	75.31
Vinita, OK (meso)	74.87	Cookson, OK (meso)	73.96	Talala, OK (meso)	73.79
Tahlequah, OK (meso)	73.32	Nowata, OK (meso)	72.85	Inola, OK (meso)	70.87

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

Bartlesville, OK (ASOS)	40.80	Broken Arrow 1.5WSW, OK (coco)	44.02	Jenks Riverside Arpt, OK (ASOS)	45.17
Tulsa, OK (ASOS)	47.38	Muskogee, OK (ASOS)	48.13	Foraker, OK (meso)	48.33
Claremore 7.5W, OK (coco)	48.49	Tulsa 1.4S, OK (coco)	48.85	Okemah, OK (meso)	49.42

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 2a), rainfall totals for the year 2020 ranged from 30" in north central OK to around 80" in southeast OK and west central AR, with most of the area receiving 40"-60". These rainfall totals correspond to 75% to 150% of the normal annual rainfall for eastern OK and northwest AR, though most of the area had 100% to 125% of the normal annual rainfall (Fig. 2b).

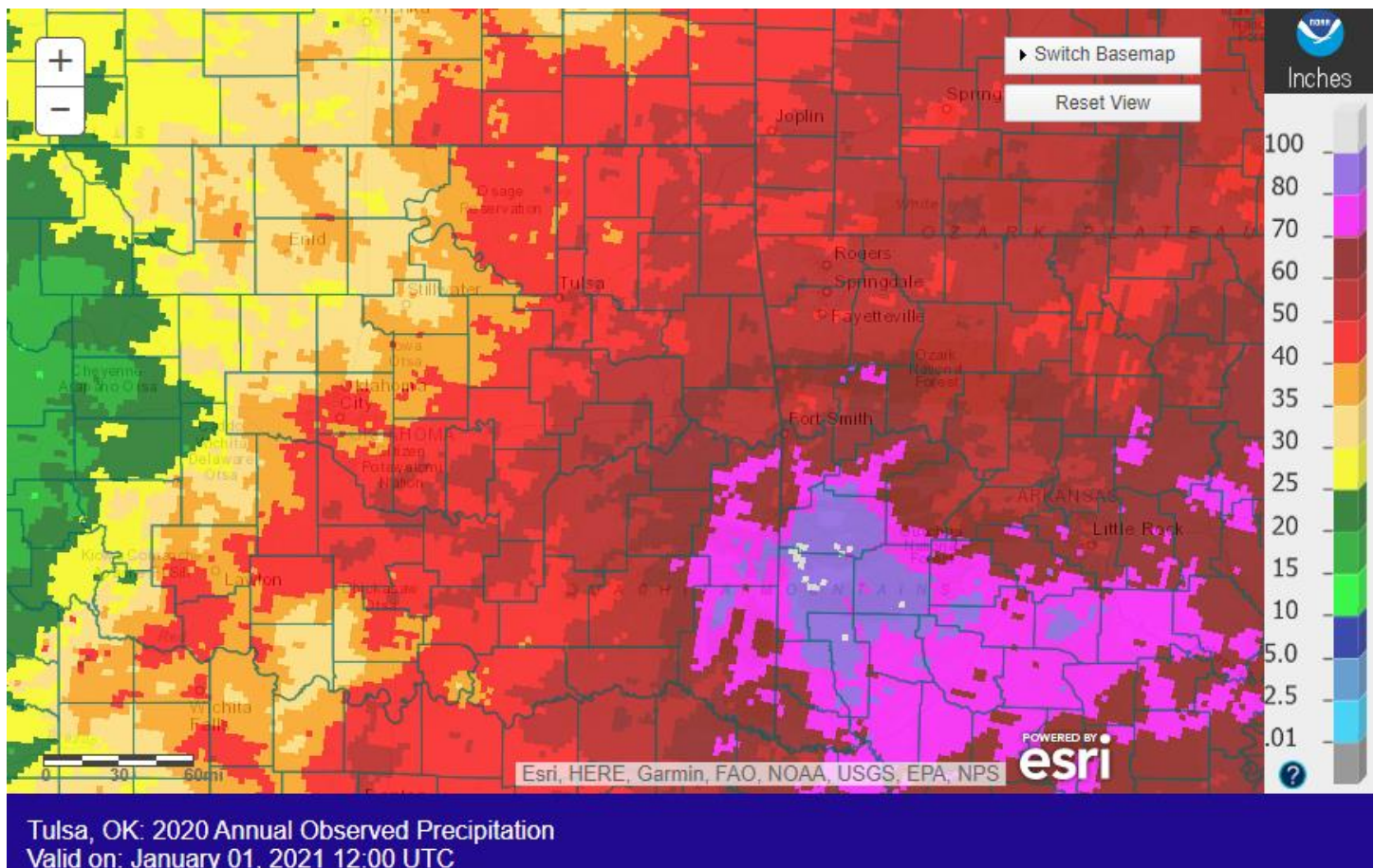
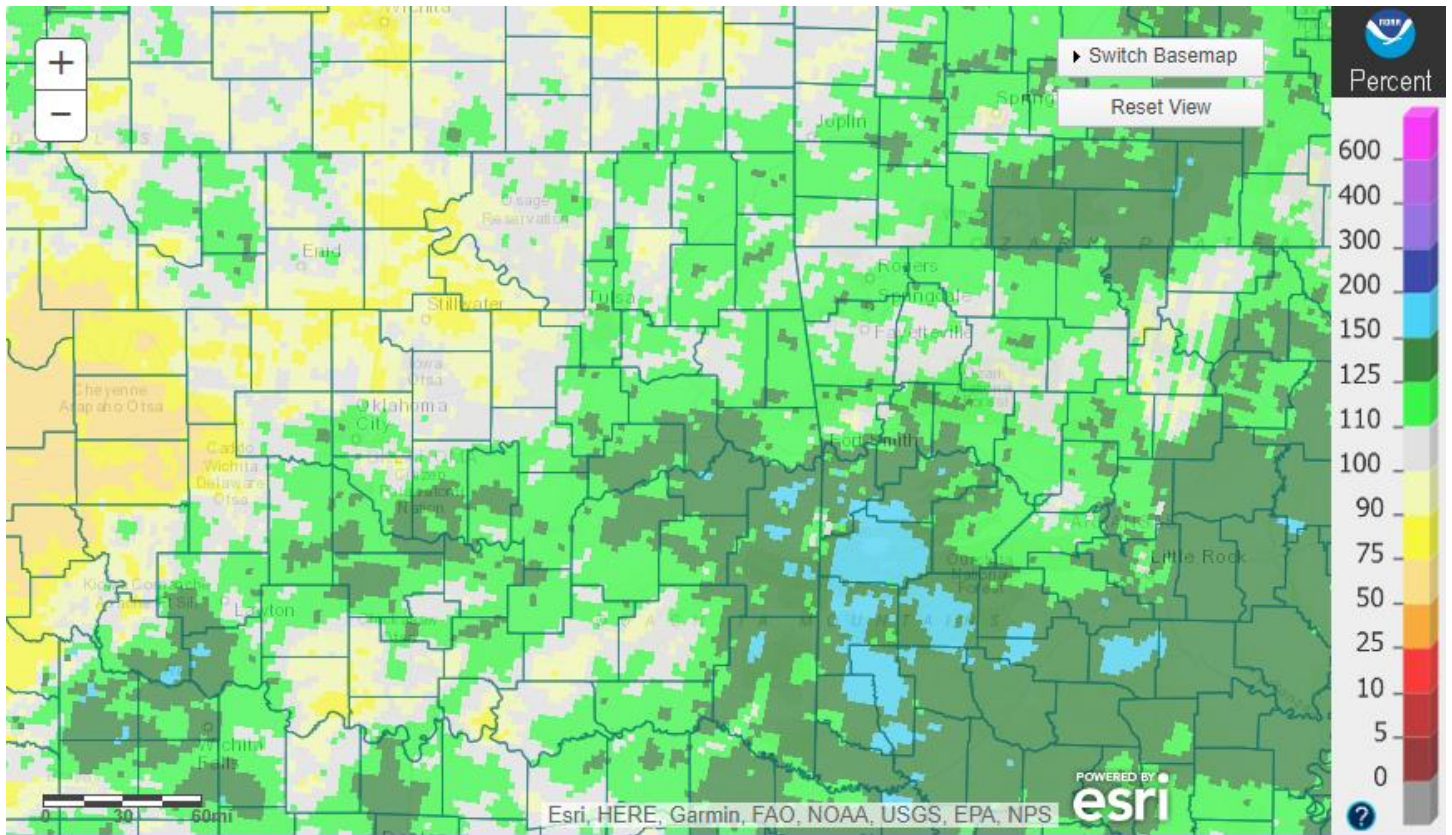


Fig. 2a. Estimated Observed Rainfall for Year 2020



Tulsa, OK: 2020 Annual Percent of Normal Precipitation
 Valid on: January 01, 2021 12:00 UTC

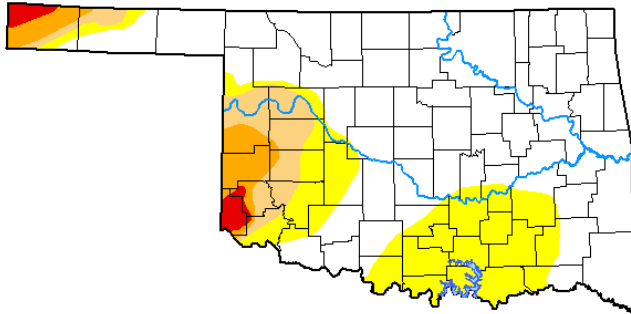
Fig. 2b. Estimated % of Normal Rainfall for Year 2020

Drought

According to the [U.S. Drought Monitor](#) (USDM) from December 5, 2020 (Figs. 3a, 3b), drought conditions were not depicted across eastern OK and northwest AR. However, Abnormally Dry (but not in drought) conditions remained over a portion of Pittsburg, Pushmataha, and Choctaw Counties in eastern OK.

U.S. Drought Monitor Oklahoma

January 5, 2021
(Released Thursday, Jan. 7, 2021)
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	67.30	32.70	11.99	5.58	1.45	0.00
Last Week 12-29-2020	56.83	43.17	25.21	7.75	1.45	0.00
3 Months Ago 10-06-2020	54.86	45.14	21.84	12.03	2.56	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 01-07-2020	76.26	23.74	10.50	3.64	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:
Deborah Bathke
National Drought Mitigation Center

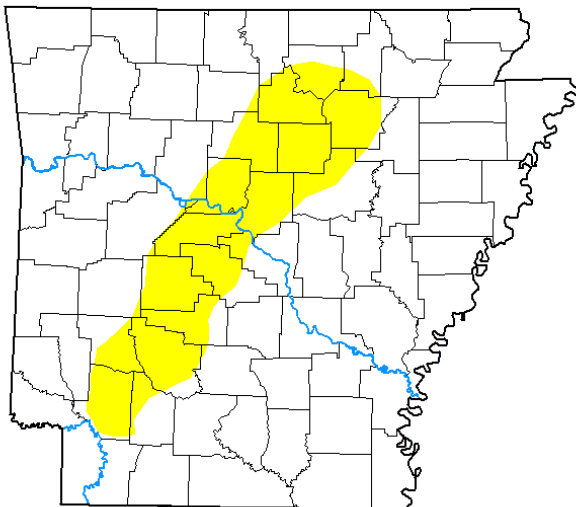


droughtmonitor.unl.edu

Fig. 3a. Drought Monitor for Oklahoma

U.S. Drought Monitor Arkansas

January 5, 2021
(Released Thursday, Jan. 7, 2021)
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	83.35	16.65	0.00	0.00	0.00	0.00
Last Week 12-29-2020	16.45	83.55	6.87	0.00	0.00	0.00
3 Months Ago 10-06-2020	96.00	4.00	0.98	0.17	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 01-07-2020	85.36	14.64	4.96	0.31	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>

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National Drought Mitigation Center



droughtmonitor.unl.edu

Fig. 3b. Drought Monitor for Arkansas

Outlooks

The [Climate Prediction Center](#) (CPC) outlook for January 2021 (issued December 31, 2020) indicates an enhanced chance for above normal temperatures and an enhanced chance for above median precipitation across all of eastern OK and northwest AR. This outlook was largely based on dynamical model output combined with the influence from La Niña. The enhanced chance for above median precipitation is due to increase Gulf moisture at the beginning of the month, as well as a possible influence from the Madden-Julian Oscillation (MJO).

For the 3-month period January-February-March 2021, CPC is forecasting an enhanced chance for above normal temperatures across all of eastern OK and northwest AR, an equal chance for above, near, and below median precipitation across northwest AR and far northeast/east central OK, and an enhanced chance for below median precipitation across the remainder of eastern OK (outlook issued December 17, 2020). This outlook is based strongly on La Niña impacts, as well as incorporating both statistical and dynamical forecast tools. According to CPC, the combined effect of the ocean-atmosphere system is consistent with moderate La Niña conditions. La Niña is expected to continue through the Northern Hemisphere winter and there is a 50% chance of a transition to ENSO-neutral during the spring. CPC continues the La Niña Advisory.

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

Scattered showers developed across southeast OK during the early morning of the 2nd as moisture increased ahead of an upper-level low over the TX/OK panhandles. This activity expanded northward through the morning hours, with scattered showers across a large portion of eastern OK and northwest AR by noon. The main area of showers began to shift eastward during the late afternoon through evening hours as the upper-level low and the associated dry slot approached. However, precipitation continued along the KS/OK border and across northwest AR during the overnight hours. Temperatures fell below freezing in the highest terrain areas of northwest AR, causing the rain to switch over to snow. A trace to 2" of snow accumulation occurred in the higher terrain of northwest AR, with rainfall totals of around 0.10" to around 2" across eastern OK and northwest AR (Fig. 4).

Showers increased over southeast OK a couple of hours before sunrise on the 13th ahead of an upper-level wave. This activity quickly spread northeast, with precipitation occurring across all of eastern OK and northwest AR by mid-morning. The thermal profile of the atmosphere promoted moderate to occasionally heavy snow across northeast OK and northwest AR, despite surface temperatures near freezing. Snowfall rates of 1.5"-2" occurred at times, with large clumps of snowflakes falling. A corridor of heavy snow set up along and just south of I-44 by mid-morning, then shifted into east central OK and northwest AR during the afternoon. The precipitation then ended from northwest to southeast during the afternoon through mid-evening hours. Snowfall totals ranged from a trace to around 6", with the highest snowfall of 4"-6" occurring from northeast OK into northwest AR roughly along Highway 412 (Figs. 5, 6). Tulsa officially measured 5.0" of snow, breaking the streak of 2,563 days (just over 7 years) without 3 or more inches of snow. Rainfall/liquid equivalent totals from this winter storm system ranged from around 0.25" to around 1.5" (Fig. 7).

Another round of light wintry precipitation occurred on the 15th as a mid-level low swept across the Plains. The precipitation started off as a mix of rain and snow, before changing over to all snow. Some locations across northeast OK and northwest AR received snowfall accumulations of a trace to around 0.25", with liquid equivalent/rainfall totals of less than 0.10".

A line of moderate showers with embedded thunderstorms developed along and behind a cold front, which moved into northeast OK during the mid-evening hours of the 29th. The cold front continued to push southeast through the overnight hours. Showers with isolated embedded thunderstorms continued across most of eastern OK and northwest AR along and behind the front. By 6 am CST on the 30th, much of northeast OK and northwest AR had received 0.50" to near 1.5" of rain, with lesser amounts of around 0.10" to around 0.50" across southeast OK and west central AR (Figs. 8, 9). Temperatures behind the front remained above freezing, though enough cold air interacted with the northern edge of the precipitation to set up a band of rain mixed with moderate snow during the mid-morning hours of the 30th along and just south of I-44 (Fig 10). A trace to 2.5" of snow fell in this area. A few bands of light snow mixed with rain continued south of I-44 during the afternoon, but coverage decreased as the initial upper-level disturbance lifted northeast of the region. An

axis of mid-level frontogenetic forcing remained across southeast OK into west central AR during the afternoon and evening hours. Showers continued in this area before shifting south by midnight. Rainfall/liquid equivalent totals were 0.25" to around 0.75" along and just south of I-44, and 0.25" to near 2" across far southeast OK into west central AR (Fig. 11). Elsewhere, rainfall totals were less than 0.25".

A strong upper-level low lifted northeast from northern Mexico across TX on the 31st, resulting in rainfall spreading north out of TX into southeast OK by late morning. This area of showers continued to expand northward through the afternoon and evening, with precipitation occurring across all of eastern OK and western AR by mid-evening. By late evening, the freezing line was near to just north of I-44 and sub-freezing temperatures were also occurring across the higher terrain areas of northwest AR, allowing for some ice accumulation of a trace to 0.2" (Fig. 13). Far southeast Madison County received around 0.25" of ice. As the upper-low moved across OK, the precipitation continued to shift north, coming to an end from south to north around midnight through the mid-morning hours of the 1st. The upper-low also helped to cool the atmosphere aloft, allowing for a change over to snow across portions of northeast OK. 1" to 2" of snow, with isolated areas of 2"-5" of snow, occurred north of I-44 (Fig. 12). 1"-2" of rain/liquid equivalent fell across nearly all of eastern OK and northwest AR, with the highest totals across southeast OK (Figs. 14, 15). The 3-day rainfall total ranged from 1.5" to 3.5" across eastern OK and northwest AR (Fig. 16). This heavy rain resulted in rises along area streams and rivers. Minor flooding occurred along the Poteau River near Panama (see preliminary hydrographs at the end of this report and the E3 Report for details), but the other rivers remained within their banks.

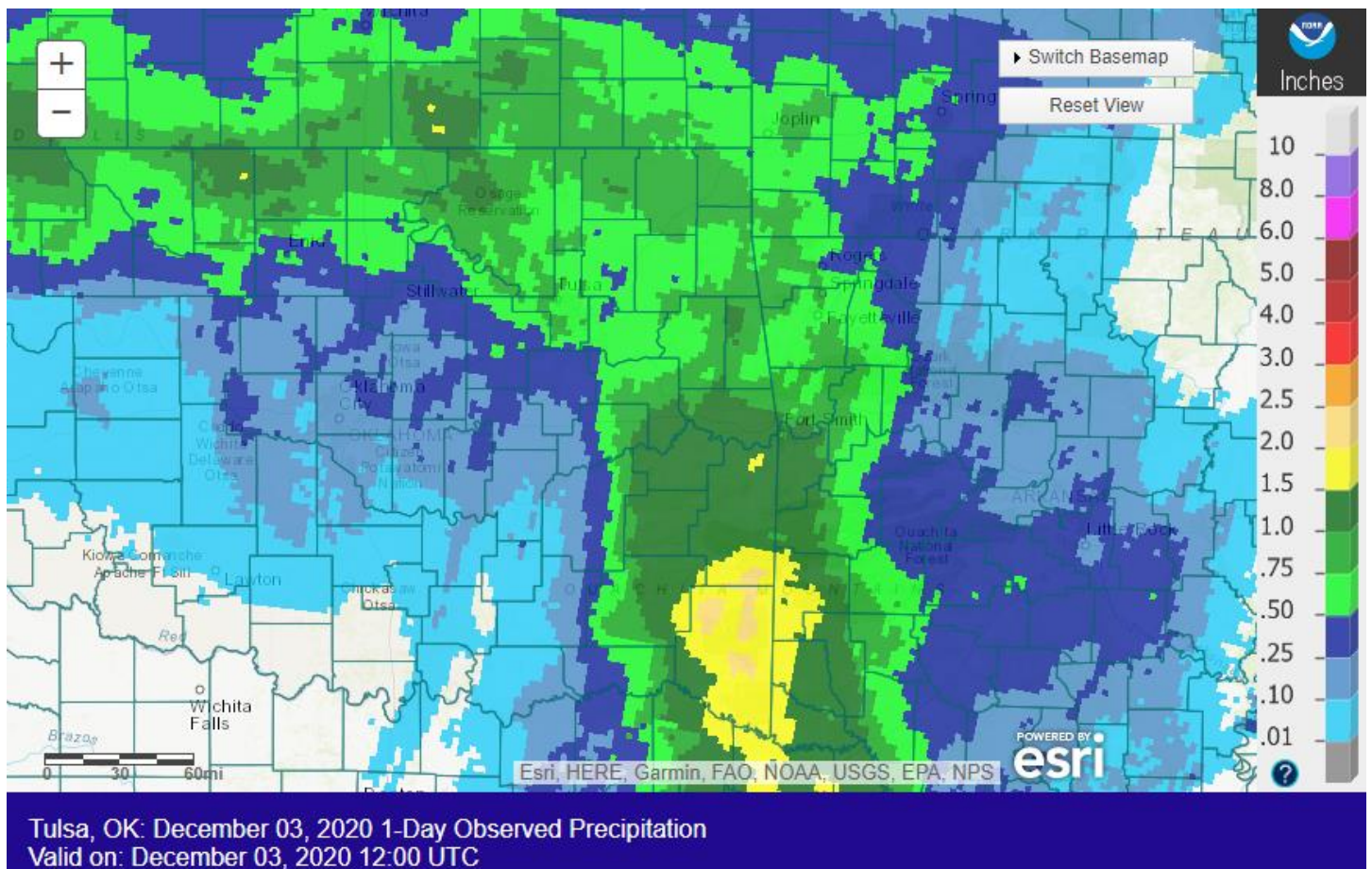


Fig. 4. 24-hour Estimated Observed Rainfall ending at 6am CST 12/03/2020.

Estimated Snowfall Accumulation Sunday

Weather Forecast Office
Tulsa, OK



From Radar Precipitation Estimates and YOUR Reports - As of 7 PM

Issued Dec 13, 2020 7:05 PM CST



Fig. 5. Estimated snowfall totals based on snow measurement reports for the 12/13/2020 winter storm event.

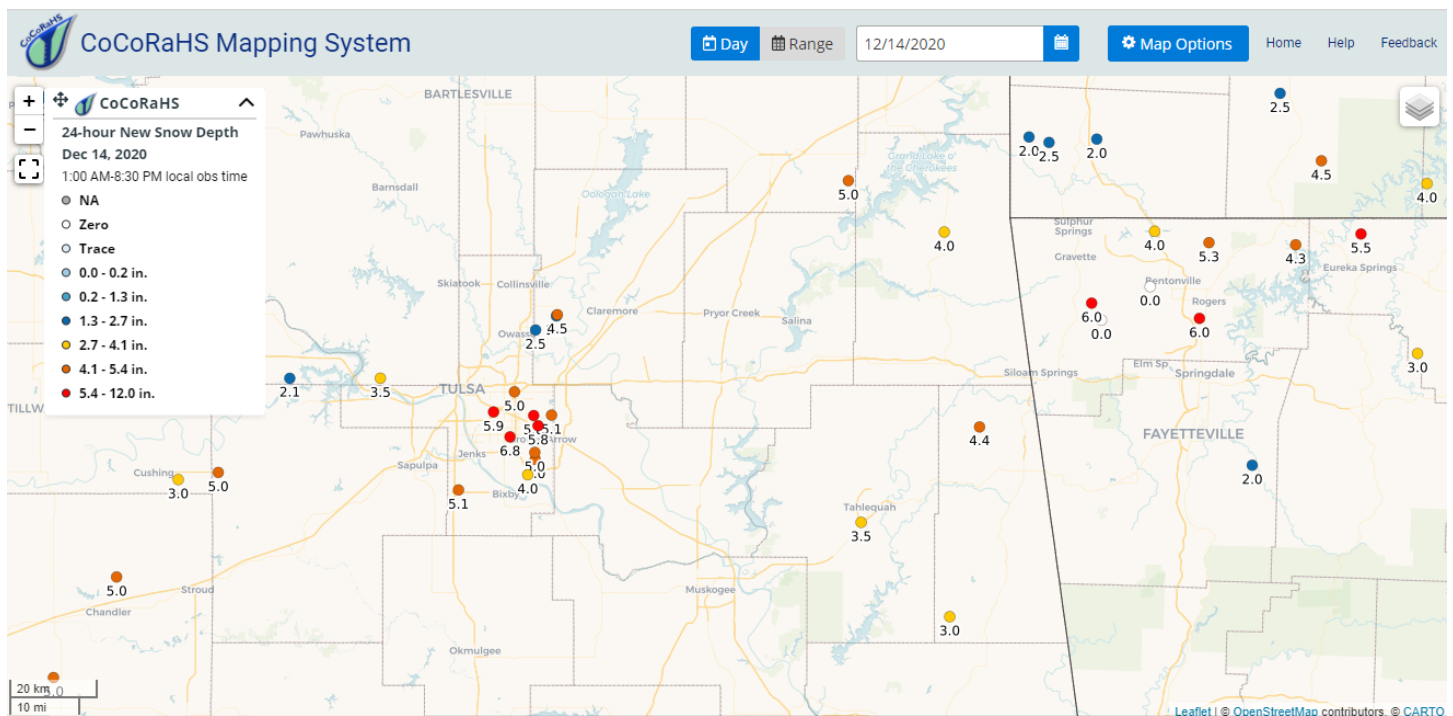
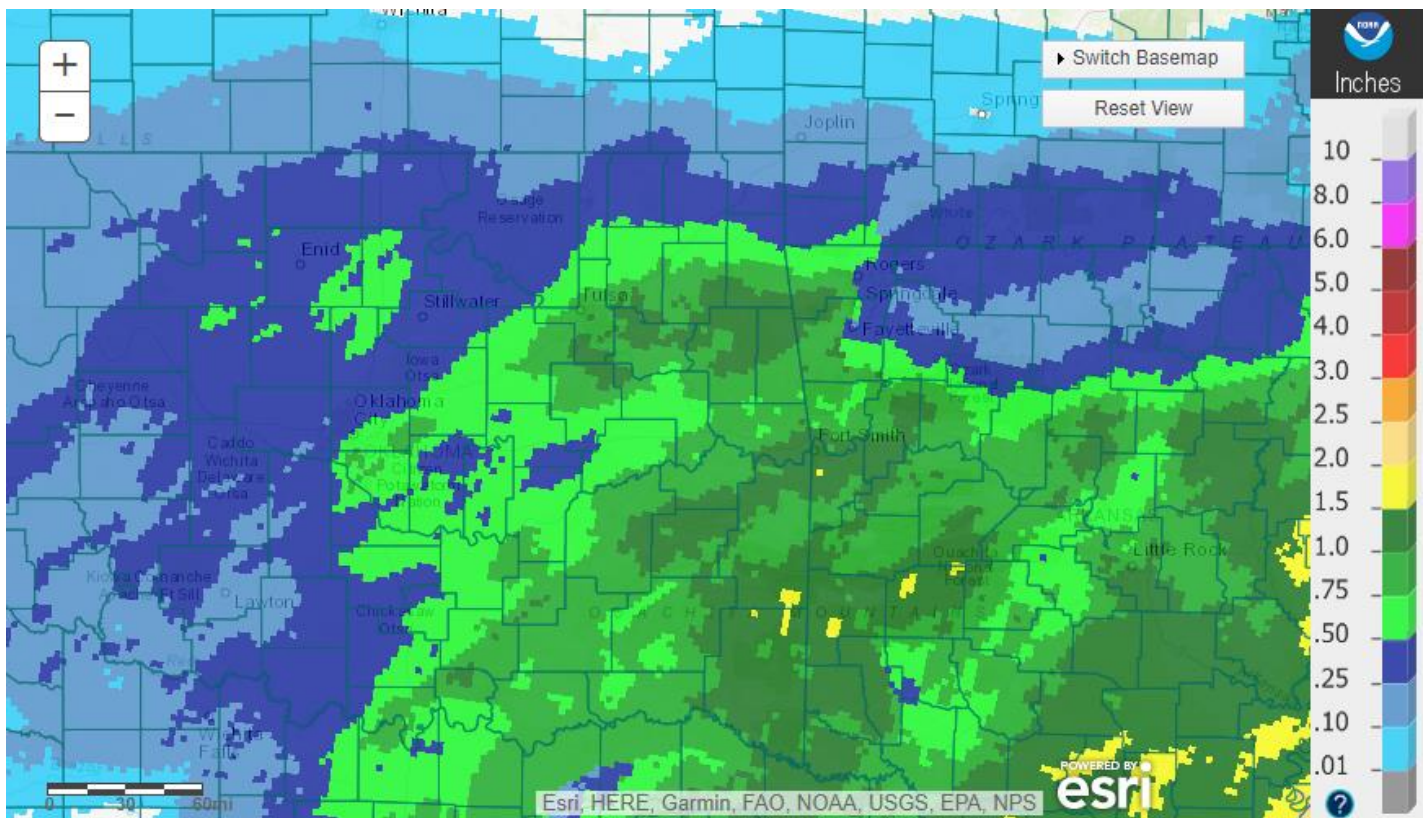
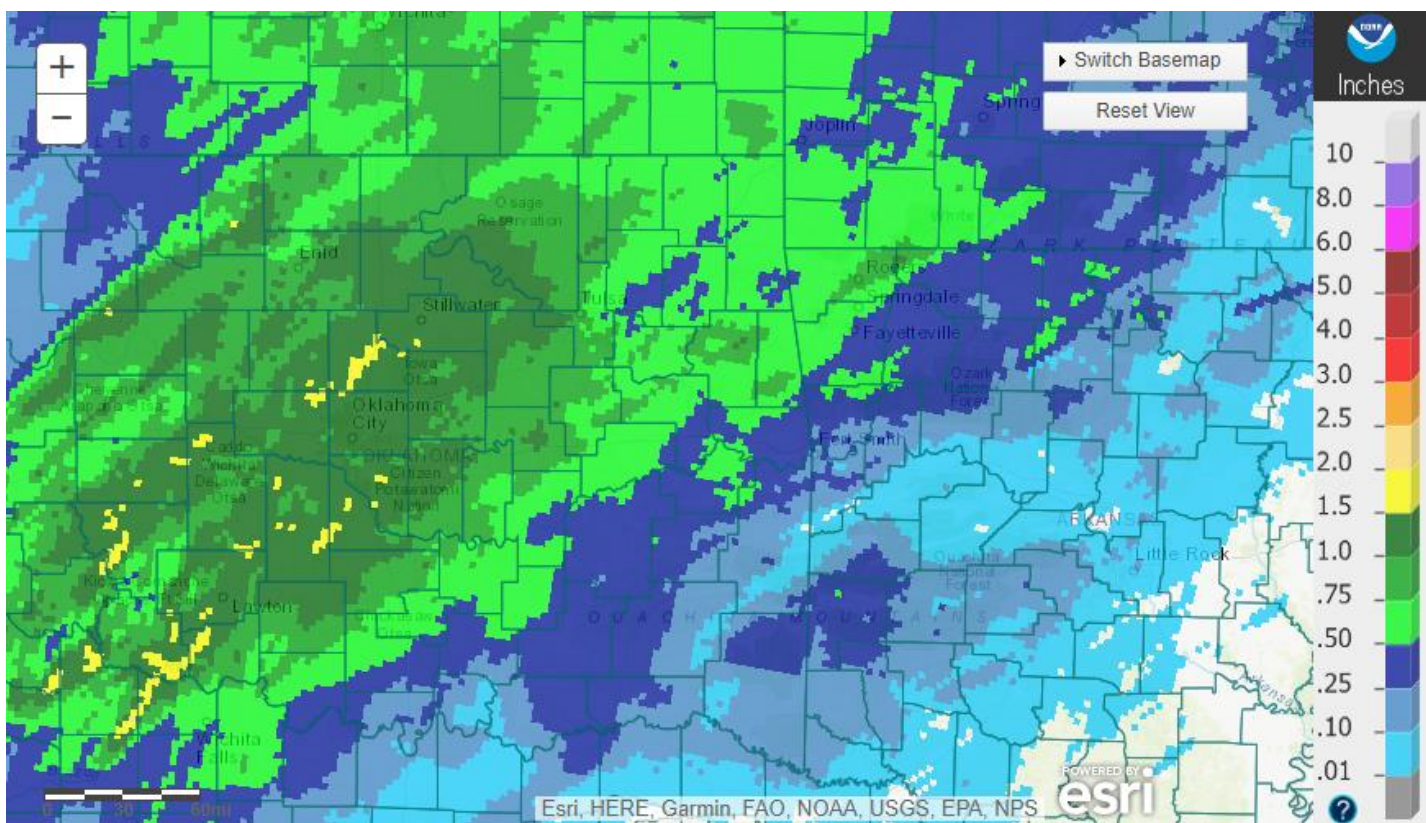


Fig. 6. 24-hour snowfall measurements by CoCoRaHS observers ending on 12/14/2020.



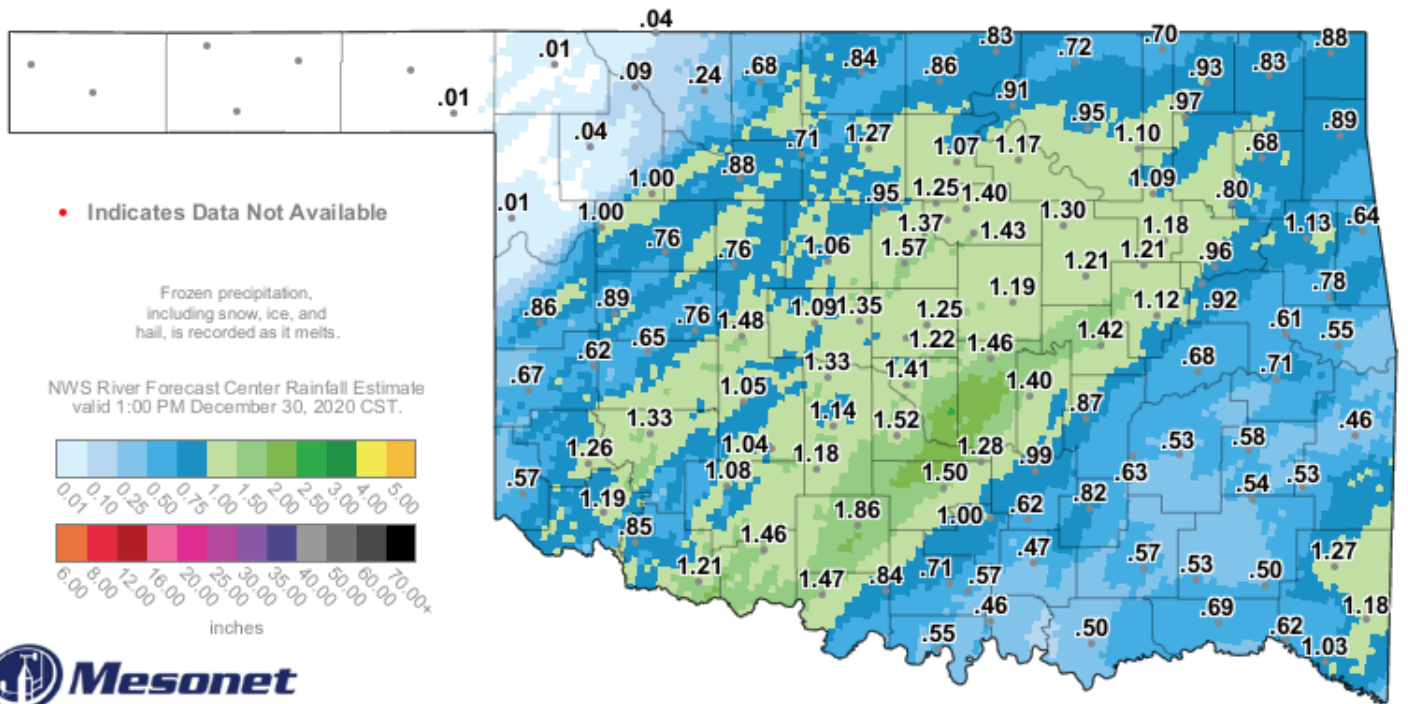
Tulsa, OK: December 14, 2020 1-Day Observed Precipitation
Valid on: December 14, 2020 12:00 UTC

Fig. 7. 24-hour Estimated Observed Rainfall ending at 6am CST 12/14/2020.



Tulsa, OK: December 30, 2020 1-Day Observed Precipitation
Valid on: December 30, 2020 12:00 UTC

Fig. 8. 24-hour Estimated Observed Rainfall ending at 6am CST 12/30/2020.



24-Hour Rainfall Accumulation (inches)

2:35 PM December 30, 2020 CST

Created 2:40:01 PM December 30, 2020 CST. © Copyright 2020

Fig. 9. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 2:35 pm CST 12/30/2020.

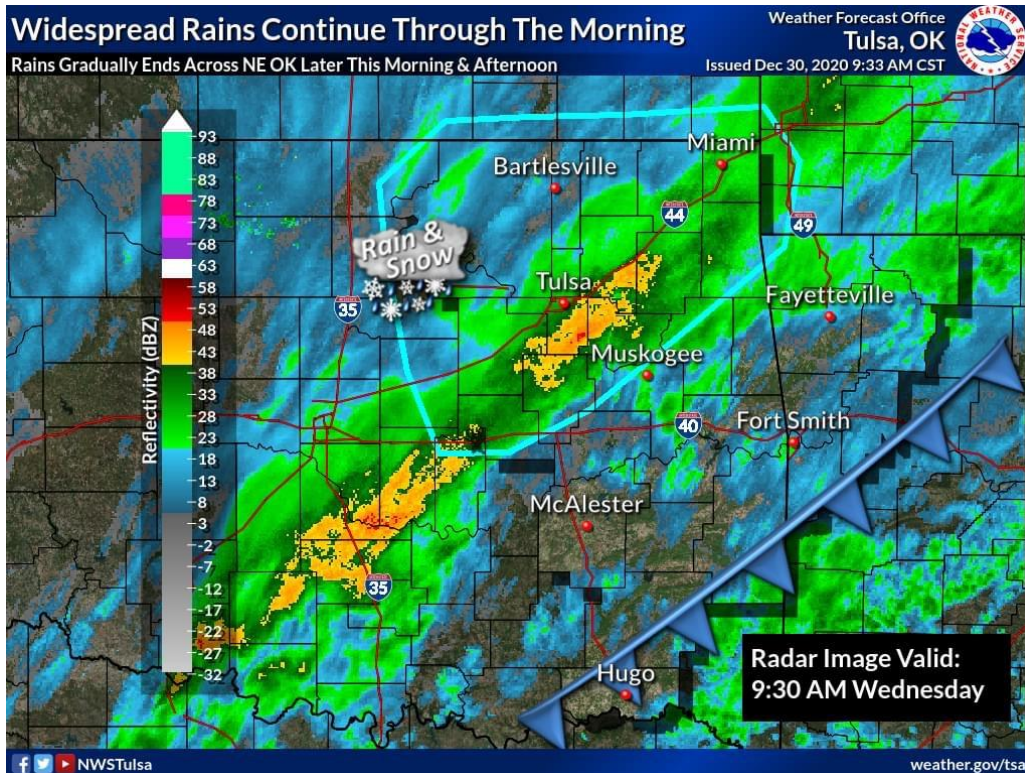
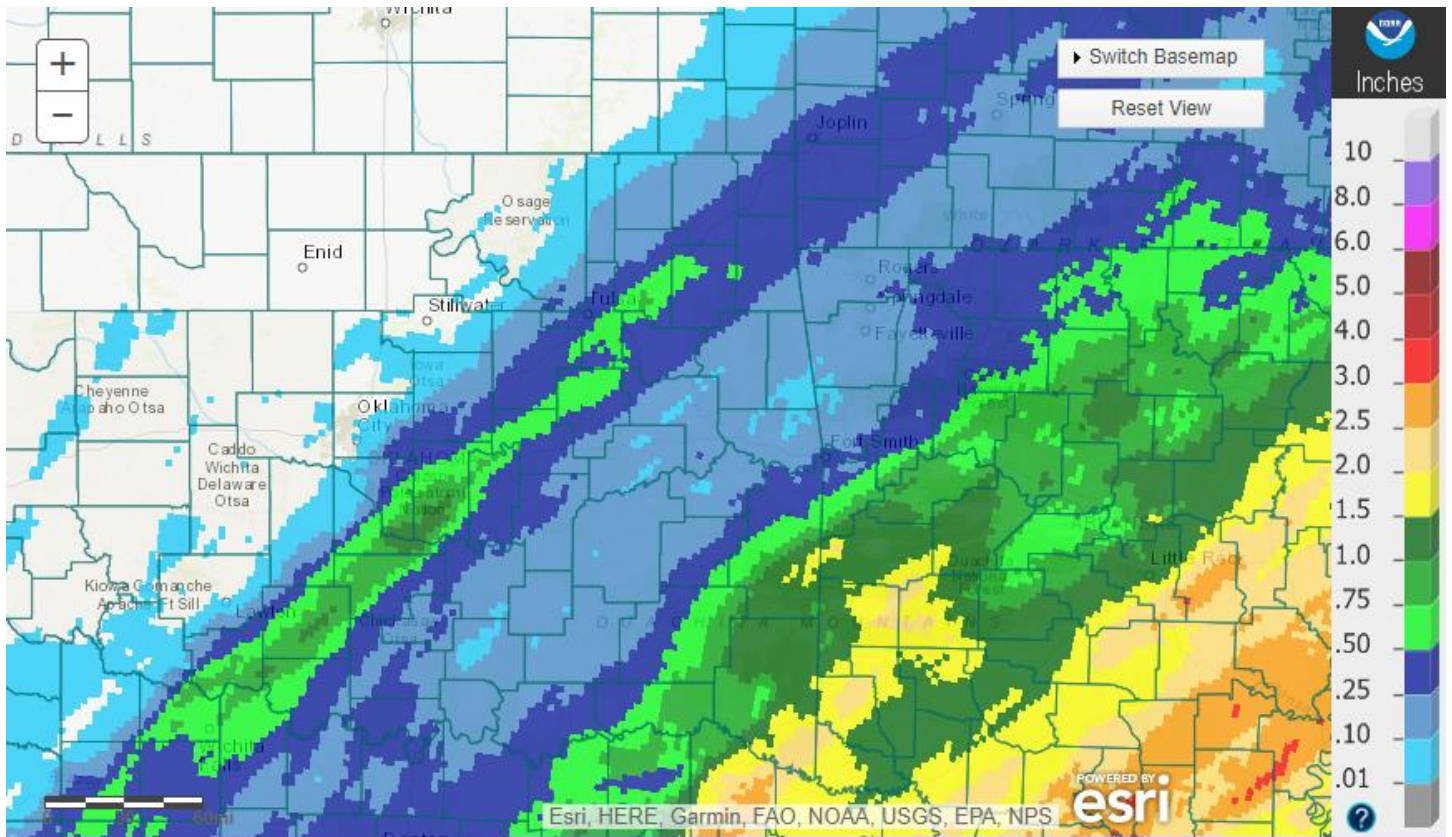


Fig. 10. Radar image at 9:30 am CST 12/30/2020 showing band of rain and moderate snow mix near I-44.



Tulsa, OK: December 31, 2020 1-Day Observed Precipitation
Valid on: December 31, 2020 12:00 UTC

Fig. 11. 24-hour Estimated Observed Rainfall ending at 6am CST 12/31/2020.

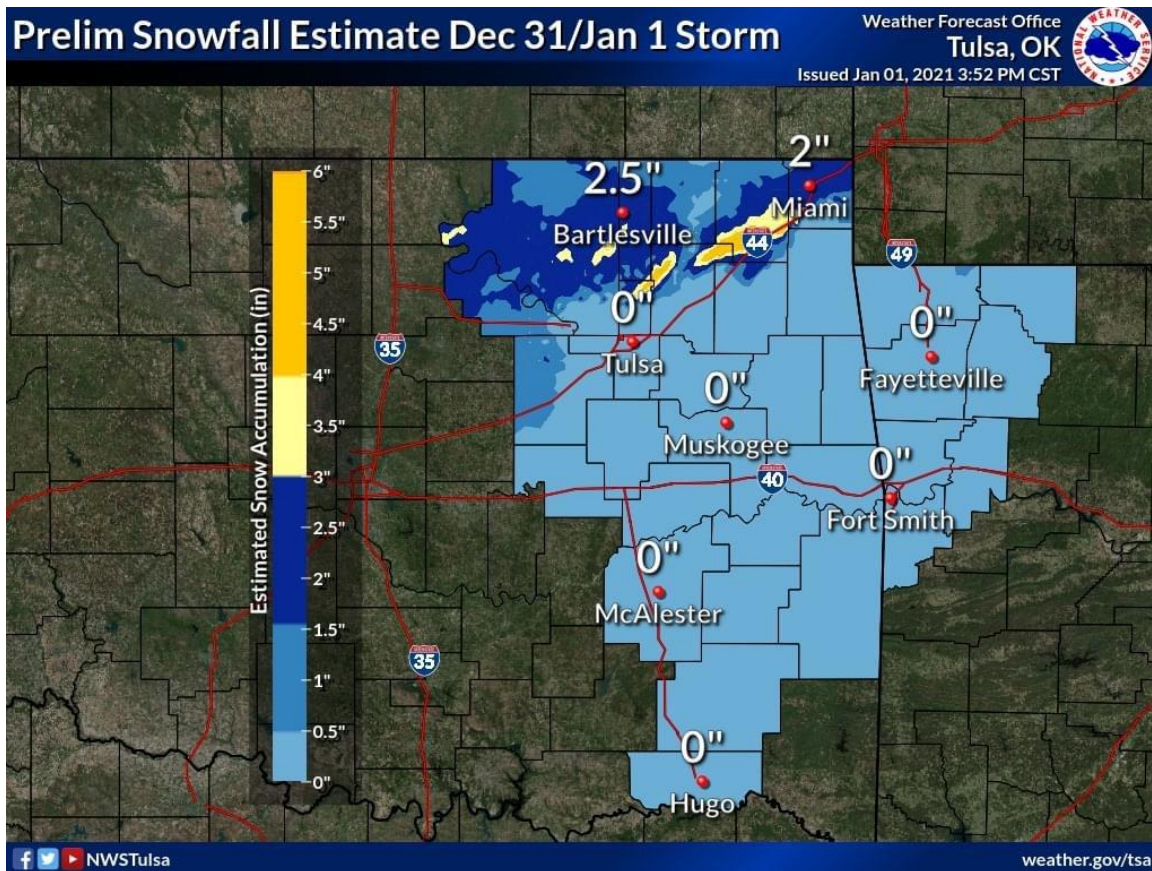


Fig. 12. Estimated snowfall totals for December 31, 2020-January 1, 2021.

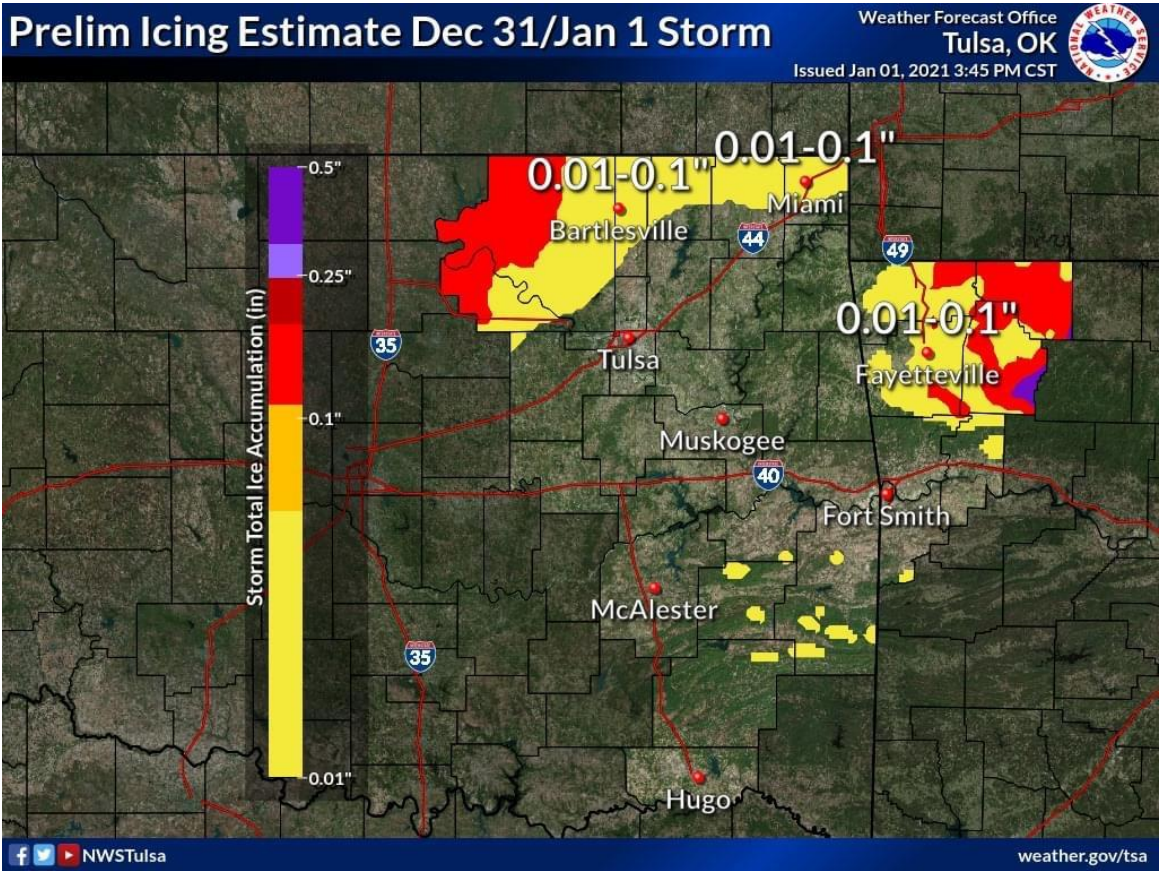


Fig. 13. Estimated ice accumulation totals for December 31, 2020-January 1, 2021.

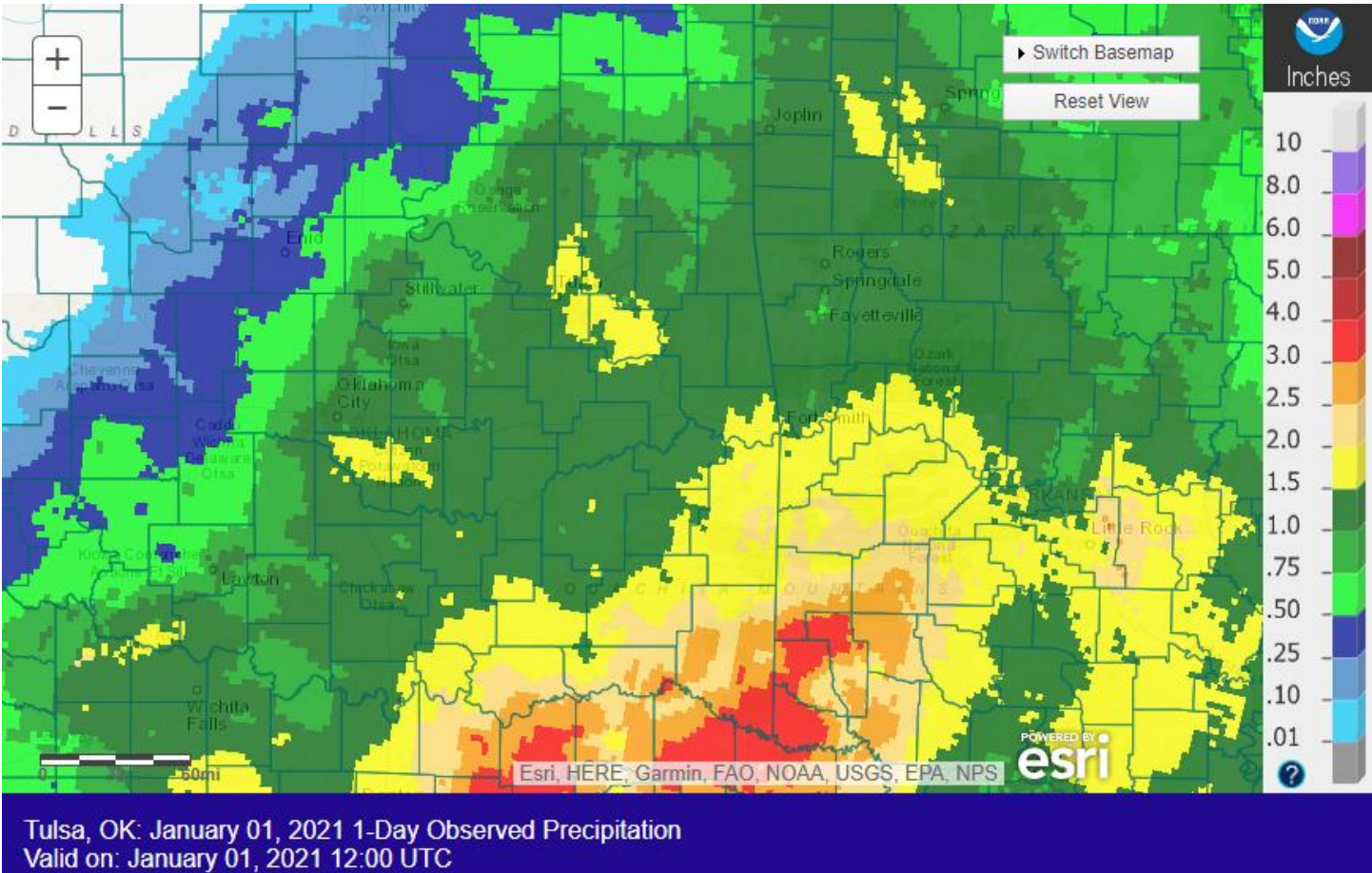


Fig. 14. 24-hour Estimated Observed Rainfall ending at 6am CST 01/01/2021.

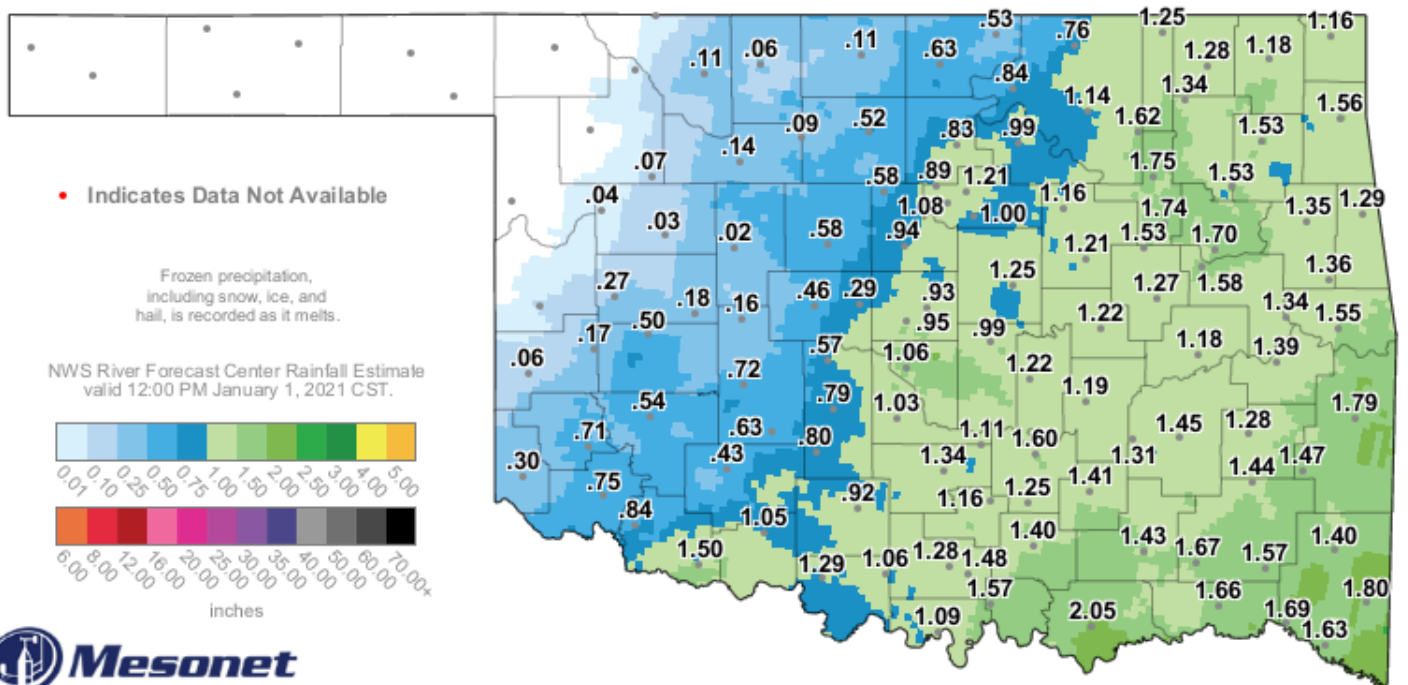


Fig. 15. OK Mesonet (values) and NWS RFC rainfall estimate (image) 24-hour rainfall ending at 1:05 pm CST 01/01/2021.

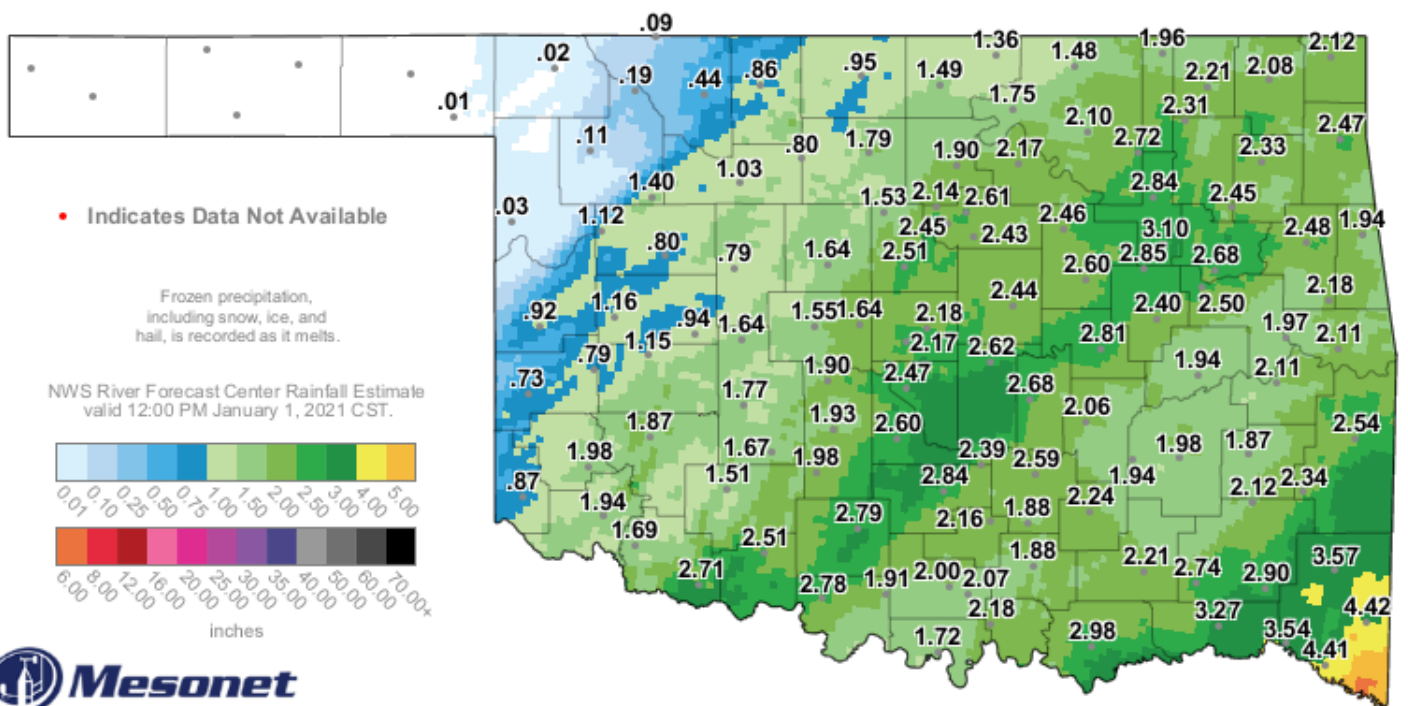


Fig. 16. OK Mesonet (values) and NWS RFC rainfall estimate (image) 3-Day rainfall ending at 1:05 pm CST 01/01/2021.

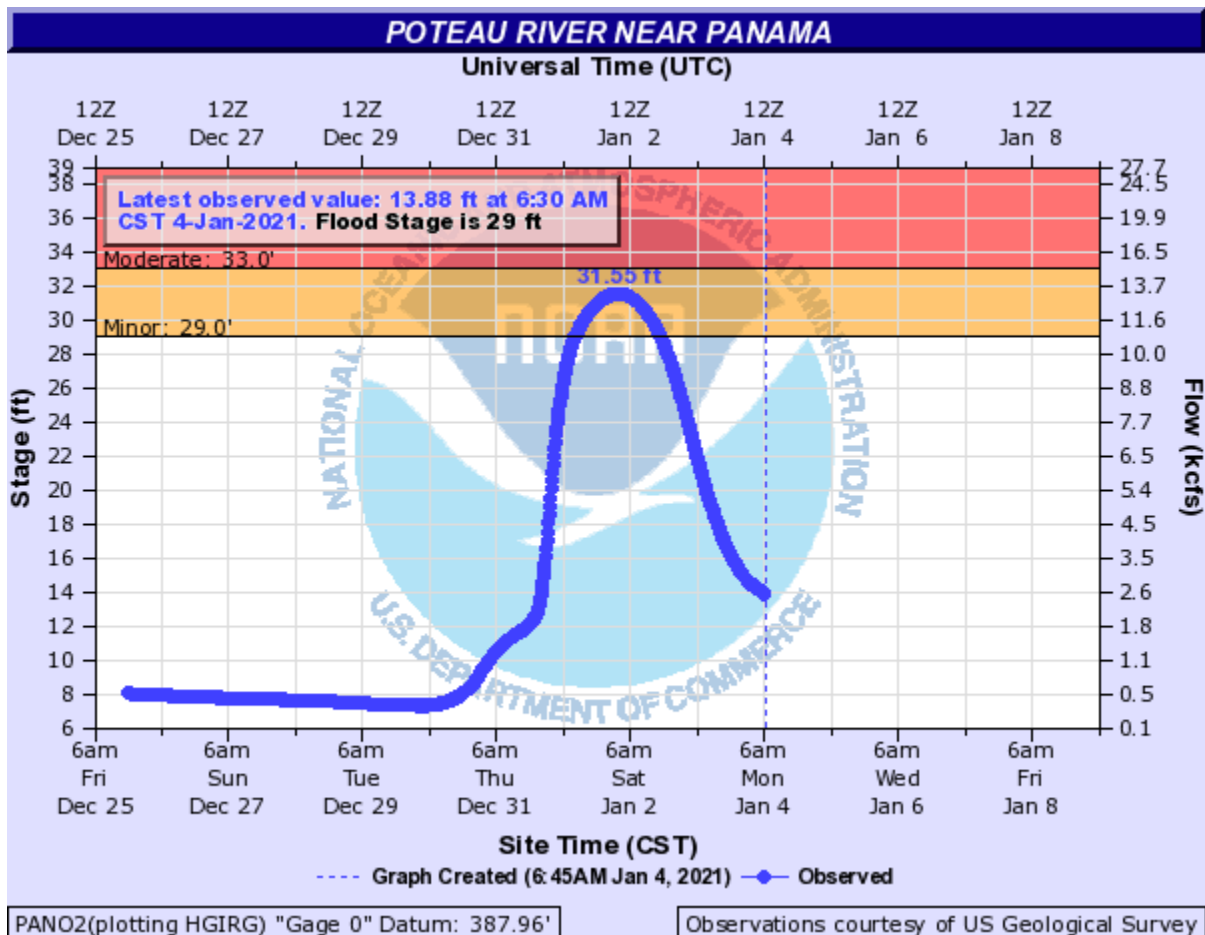
Written by:
Nicole McGavock
Service Hydrologist
WFO Tulsa

Products issued in December 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

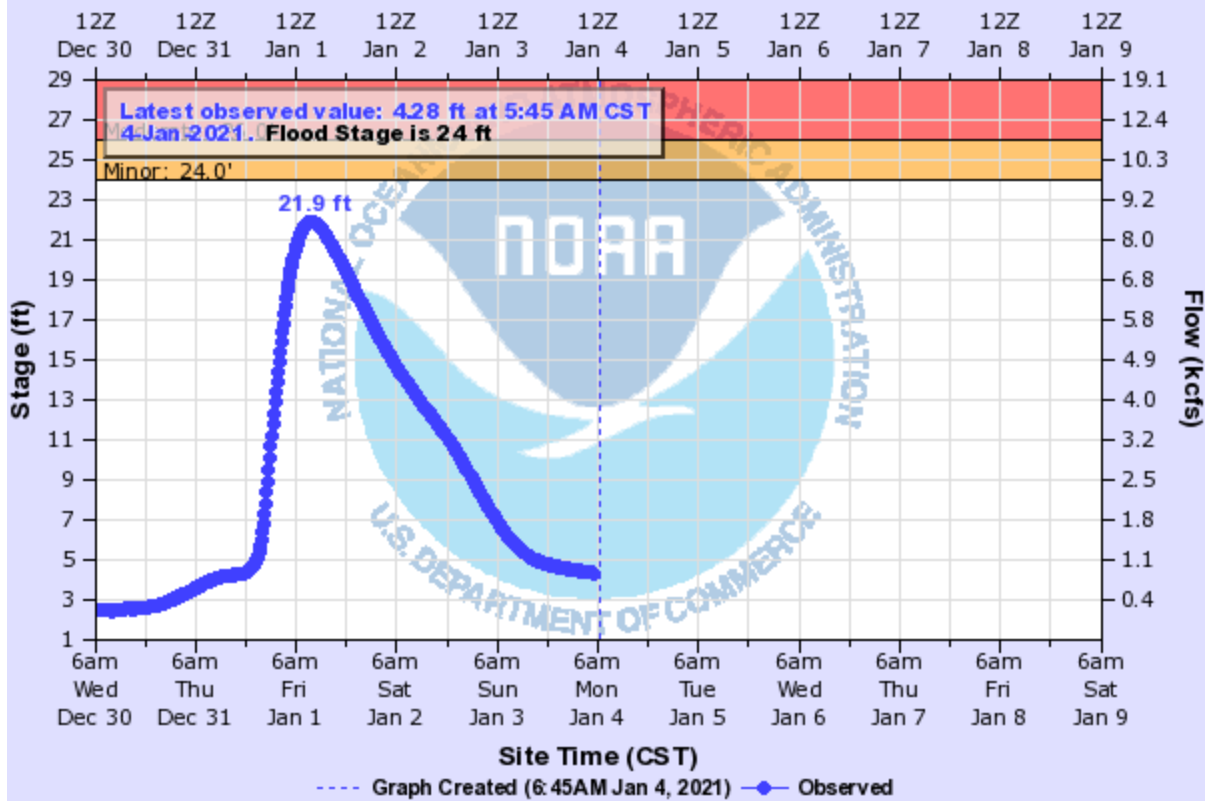
- 0 Flash Flood Warnings (FFW)
- 0 Flash Flood Statements (FFS)
- 1 Flash/Areal Flood Watches (FFA) (4 Watch FFA CON/EXT/EXA/EXB/CAN)
- 0 Urban and Small Stream Advisories (FLS)
- 0 Areal Flood Warnings (FLW)
- 0 Areal Flood Statements (FLS)
- 0 River Flood Warnings (FLW) (includes category increases)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



POTEAU RIVER NEAR POTEAU

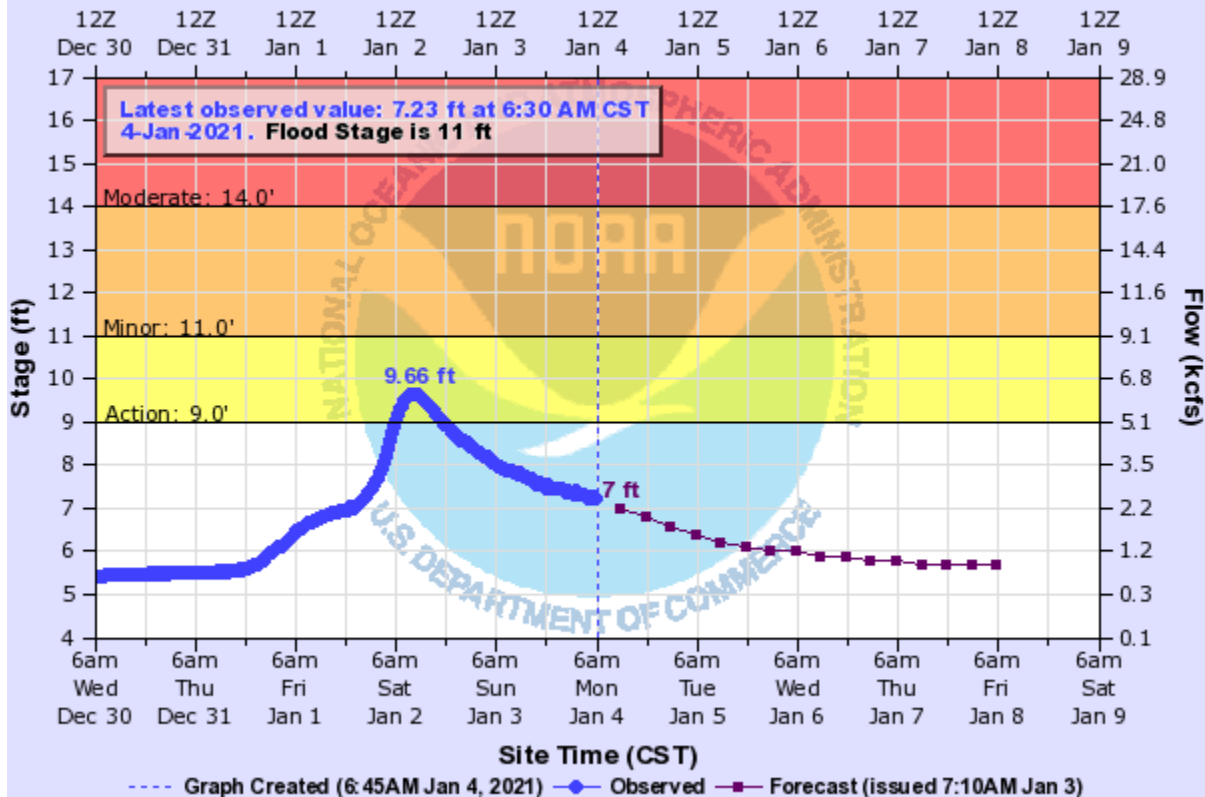
Universal Time (UTC)



PTAO2(plotting HGIRG) "Gage 0" Datum: 409.4'

ILLINOIS RIVER (AR OK) NEAR TAHLEQUAH

Universal Time (UTC)



TALO2(plotting HGIRG) "Gage 0" Datum: 664.14'

Observations courtesy of US Geological Survey