

|   |   |  |                     |
|---|---|--|---------------------|
| <b>NWS FORM E-5</b><br>(11-88)<br>(PRES. by NWS Instruction 10-924)   | <b>U.S. DEPARTMENT OF COMMERCE</b><br>NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION<br>NATIONAL WEATHER SERVICE | HYDROLOGIC SERVICE AREA (HSA)                                    |                     |
|   |   | <b>Tulsa, Oklahoma (TSA)</b>                                     |                     |
| <b>MONTHLY REPORT OF RIVER AND FLOOD CONDITIONS</b>   |   | REPORT FOR:  |                     |
|   |   | MONTH<br><b>December</b>   | YEAR<br><b>2016</b> |
| TO: Hydrometeorological Information Center, W/OH2<br>NOAA / National Weather Service<br>1325 East West Highway, Room 7230<br>Silver Spring, MD 20910-3283 |   | SIGNATURE<br><b>Steven F. Piltz</b><br>(Meteorologist-in-Charge) |                     |
|   |   | DATE<br><b>January 10, 2017</b>                                  |                     |

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.

It was very dry across eastern OK and northwest AR during December 2016. Large temperature swings brought periods of very cold and very warm weather to the region, with the net result being near normal average temperature for the month as a whole. 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 2016 ranged from 0.25" to around 2". This corresponds to only 10%-50% of the normal December rainfall for the majority of eastern OK and northwest AR (Fig. 1b). A small area of northwest AR received a little over 50% of the normal December rainfall this month, while many locations received less than 25%.

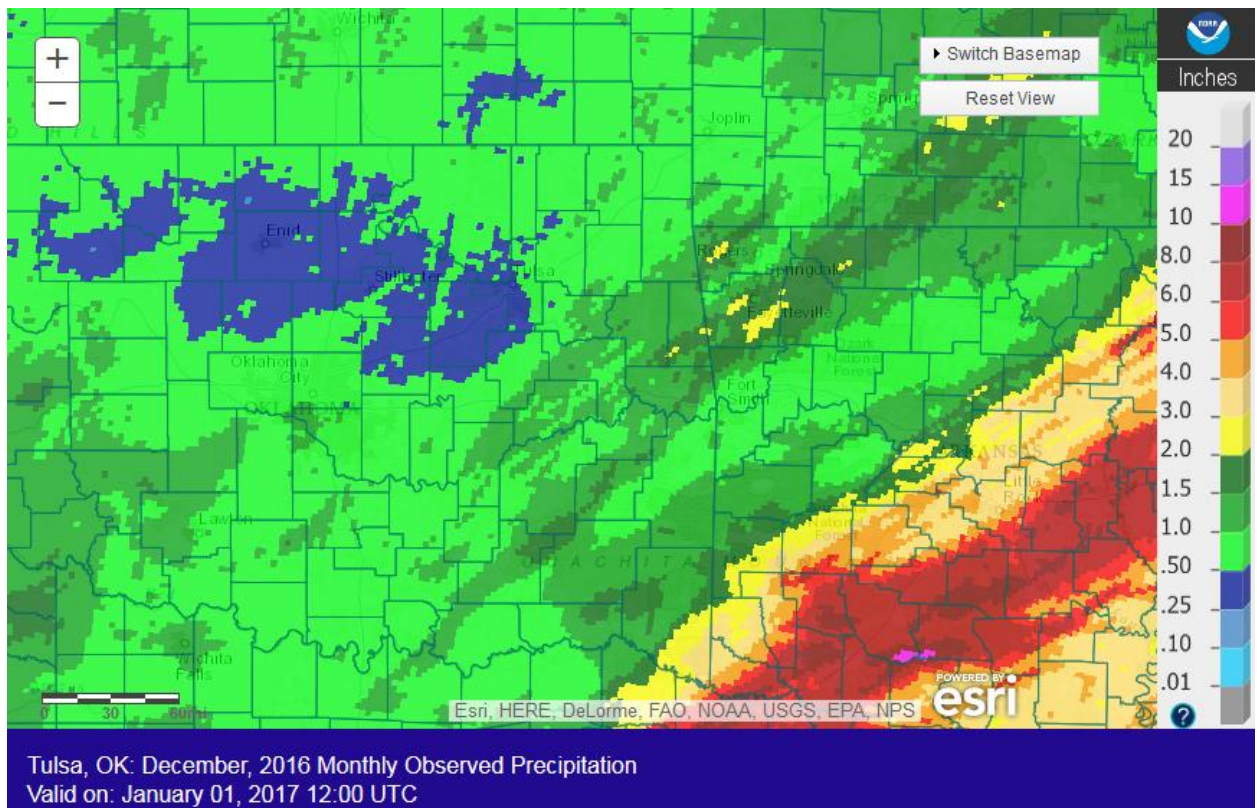


Fig. 1a. Estimated Observed Rainfall for December 2016

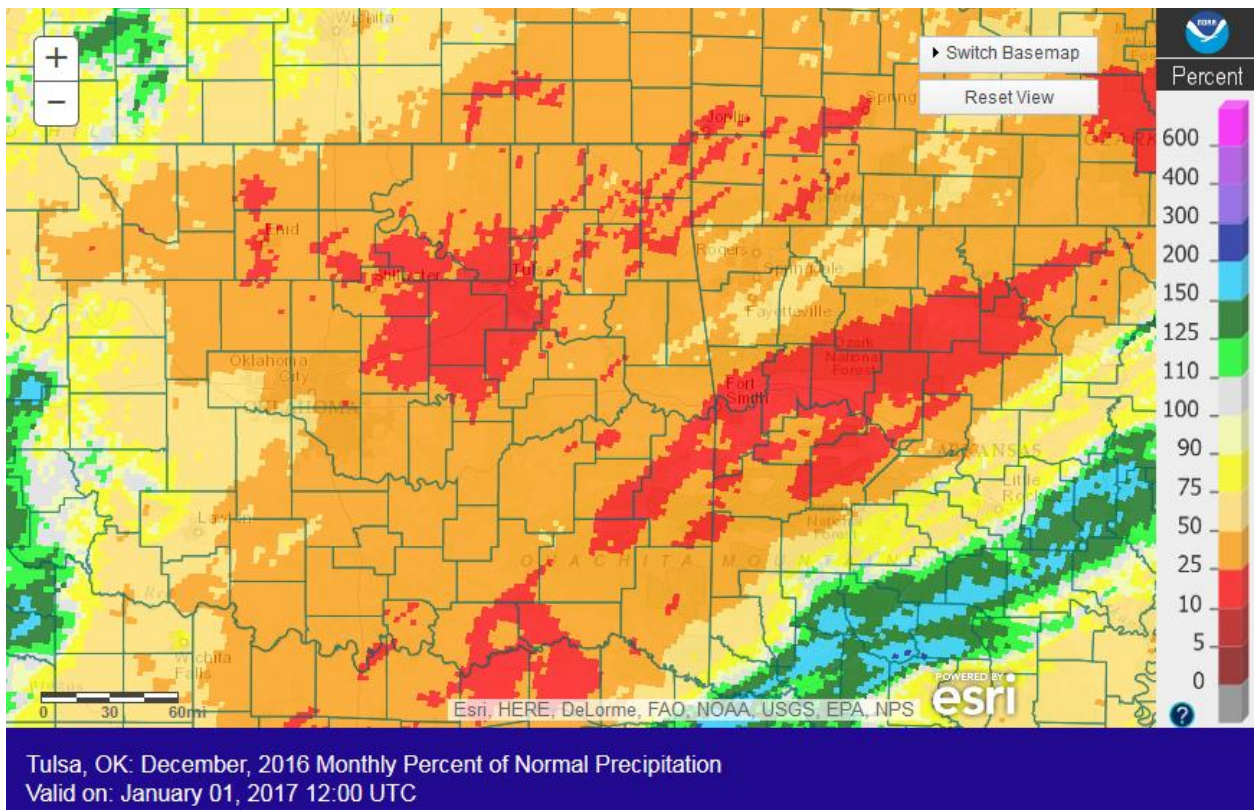


Fig. 1b. Estimated % of Normal Rainfall for December 2016

In Tulsa, OK, December 2016 ranked as the 44<sup>th</sup> coldest December (39.4°F, tied 2008, 1995); since records began in 1905), the 17<sup>th</sup> driest December (0.44"; since records began in 1888), and the 49<sup>th</sup> snowiest December (0.5", tied 2015, 2007, 1918, 1912; since records began in 1900). Fort Smith, AR had the 55<sup>th</sup> warmest December (42.4°F, tied 2007, 1988, 1980; since records began in 1882) and the 15<sup>th</sup> driest December (0.77"; since records began in 1882). Only a trace of snow fell in Fort Smith in December 2016. Fayetteville, AR had the 24<sup>th</sup> coldest (37.7°F, tied 1953), the 22<sup>nd</sup> driest (1.83"), and the 29<sup>th</sup> snowiest (0.3") December since records began in 1949.

Some of the larger precipitation reports (in inches) for December 2016 included:

|                              |      |                              |      |                                     |      |
|------------------------------|------|------------------------------|------|-------------------------------------|------|
| Winslow 7NE, AR (coop)       | 2.54 | Farmington 0.6WSW, AR (coco) | 2.16 | Upper Spavinaw Port, OK (coop)      | 2.13 |
| Hindsville 10NNE, AR (coop)  | 2.00 | Miami, OK (coop)             | 1.84 | Fayetteville Drake Field, AR (ASOS) | 1.83 |
| Decatur 2.6ESE, AR (coco)    | 1.81 | Wilburton, OK (meso)         | 1.71 | Kingston, AR (coop)                 | 1.69 |
| Berryville 0.8SSW, AR (coco) | 1.69 |                              |      |                                     |      |

Some of the lowest precipitation reports (in inches) for December 2016 included:

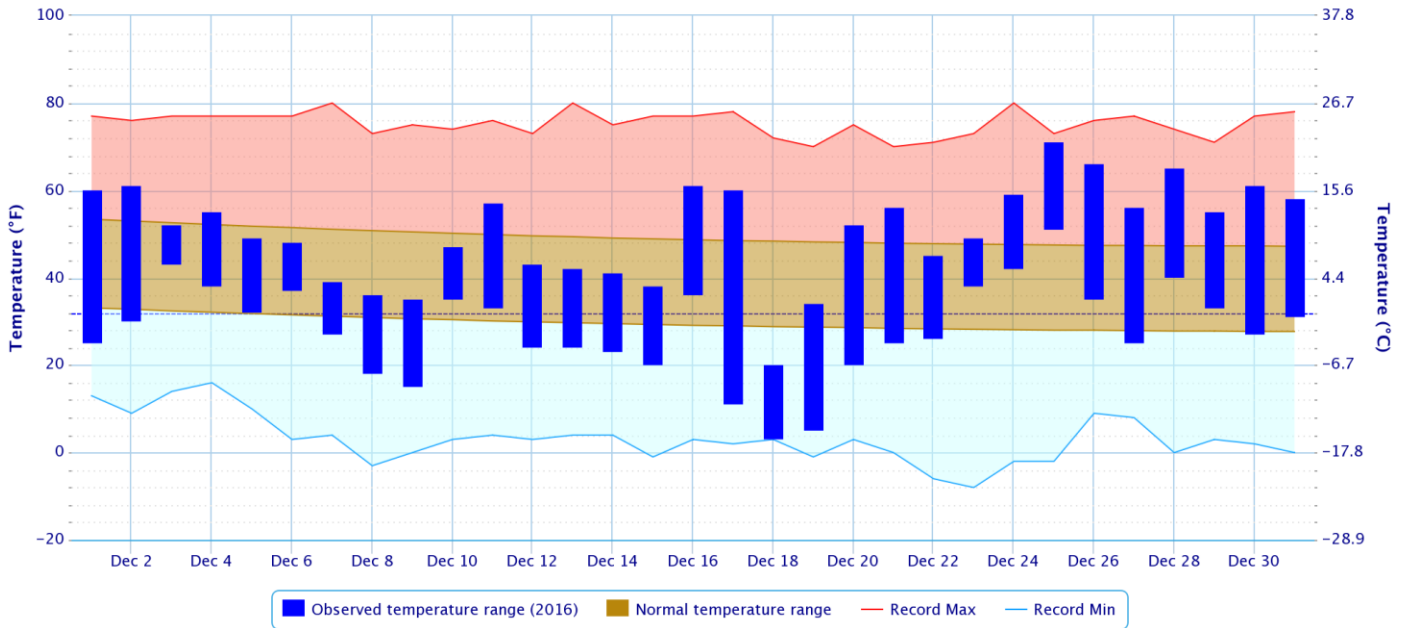
|                                 |      |                         |      |                        |      |
|---------------------------------|------|-------------------------|------|------------------------|------|
| Jenks Riverside Arpt, OK (ASOS) | 0.27 | Tulsa 2.6SSW, OK (coco) | 0.33 | Bristow, OK (meso)     | 0.33 |
| Pawnee, OK (meso)               | 0.34 | Burbank, OK (meso)      | 0.38 | Tulsa 1.4S, OK (coco)  | 0.40 |
| Sand Springs 4.6 WNW, OK (coco) | 0.42 | Bartlesville, OK (ASOS) | 0.42 | Hectorville, OK (meso) | 0.42 |

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

| Rank since 1921 | December 2016           | Water Year-to-Date (Oct 1 – Dec 31) | Cool Growing Season (Sep 1 – Dec 31) | Last 60 Days (Nov 2 – Dec 31) | Last 180 Days (Jul 5 – Dec 31) | 2016 (Jan 1 – Dec 31)   |
|-----------------|-------------------------|-------------------------------------|--------------------------------------|-------------------------------|--------------------------------|-------------------------|
| Northeast OK    | 11 <sup>th</sup> driest | 28 <sup>th</sup> driest             | 19 <sup>th</sup> driest              | 7 <sup>th</sup> driest        | 19 <sup>th</sup> driest        | 17 <sup>th</sup> driest |
| East Central OK | 16 <sup>th</sup> driest | 12 <sup>th</sup> driest             | 8 <sup>th</sup> driest               | 7 <sup>th</sup> driest        | 9 <sup>th</sup> driest         | 11 <sup>th</sup> driest |
| Southeast OK    | 9 <sup>th</sup> driest  | 7 <sup>th</sup> driest              | 7 <sup>th</sup> driest               | 20 <sup>th</sup> driest       | 19 <sup>th</sup> driest        | 32 <sup>nd</sup> driest |
| Statewide       | 17 <sup>th</sup> driest | 15 <sup>th</sup> driest             | 16 <sup>th</sup> driest              | 15 <sup>th</sup> driest       | 19 <sup>th</sup> driest        | 32 <sup>nd</sup> driest |

### Daily Temperature Data – Tulsa Area, OK (ThreadEx)

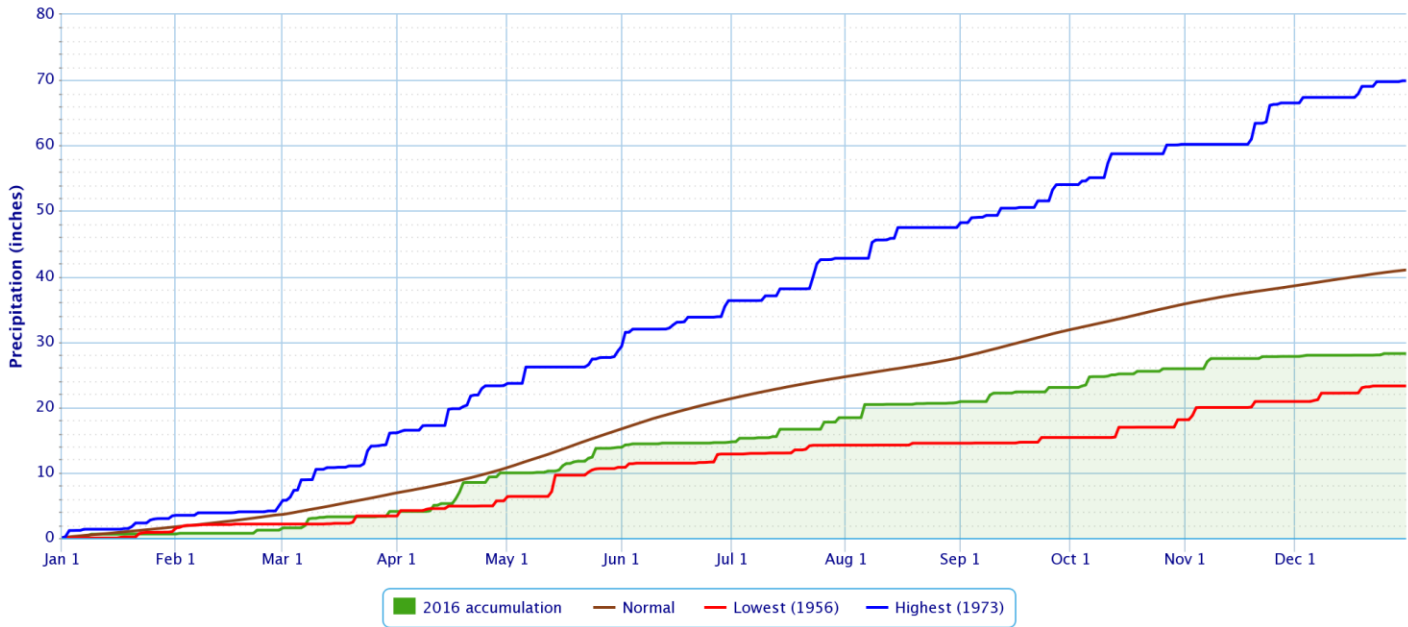
Period of Record – 1905-01-06 to 2017-01-03. Normals period: 1981-2010. Click and drag to zoom chart.



Powered by ACIS

### Accumulated Precipitation – Tulsa Area, OK (ThreadEx)

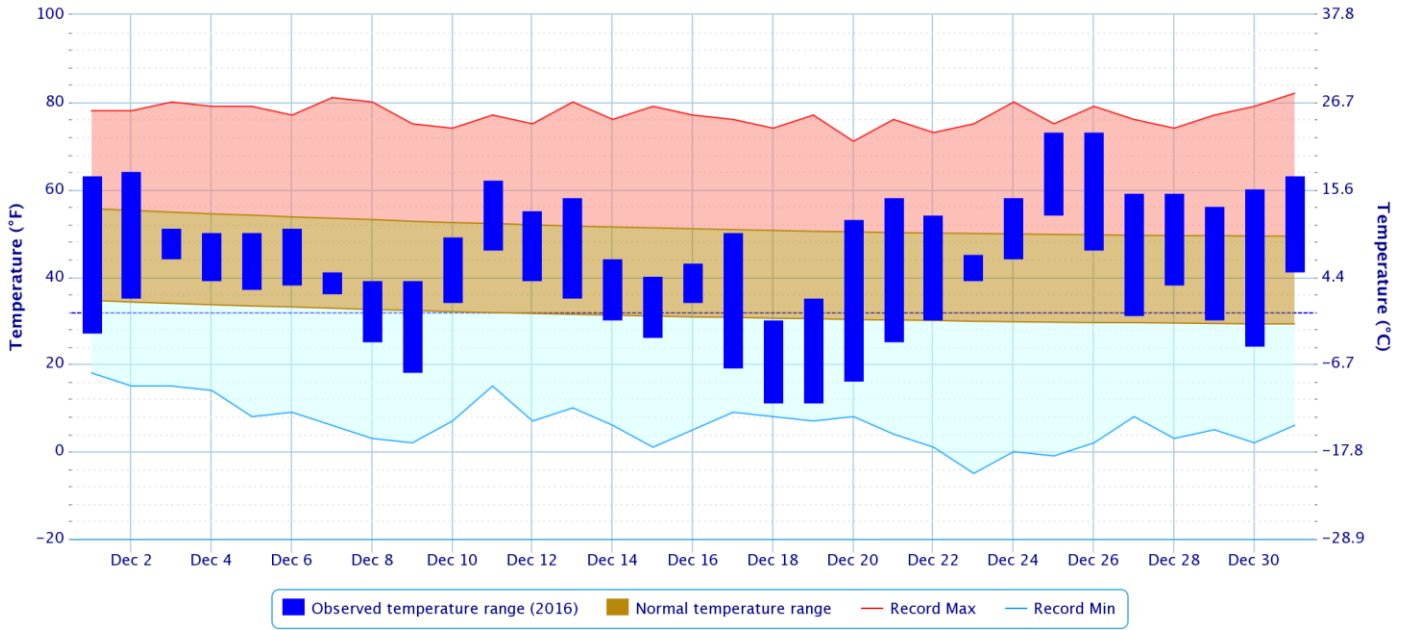
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

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

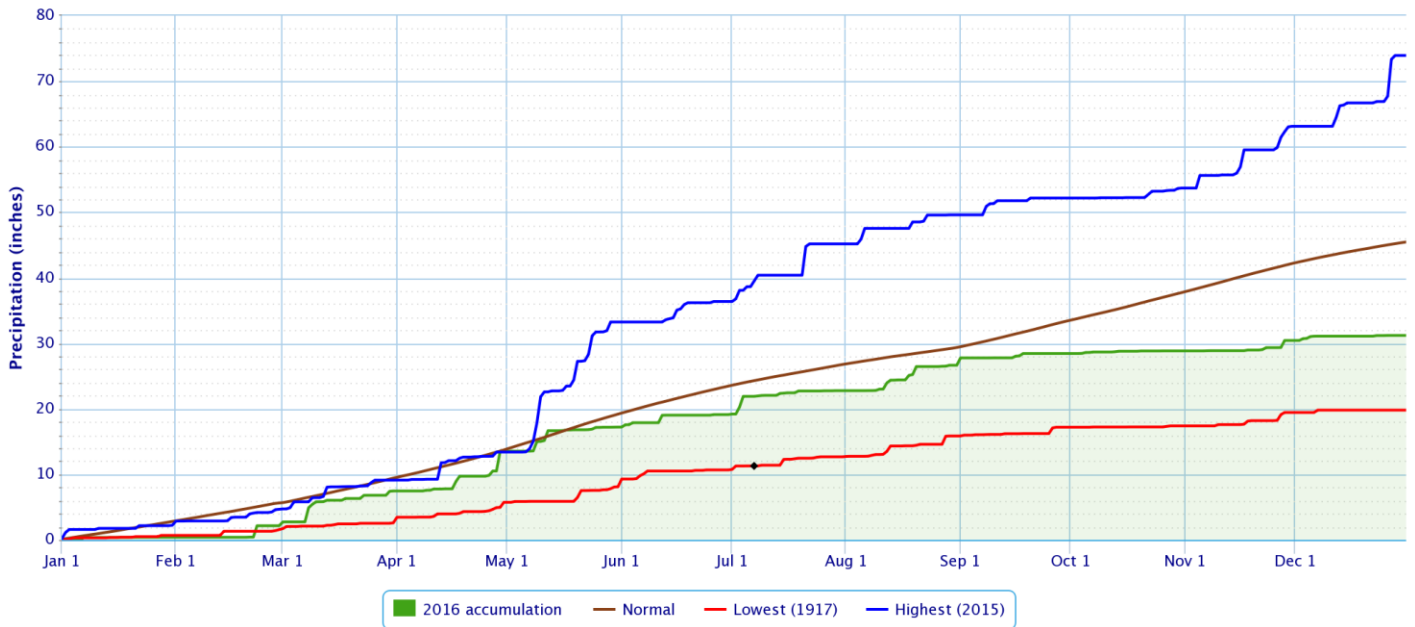
Period of Record – 1882-06-01 to 2017-01-03. Normals period: 1981-2010. Click and drag to zoom chart.



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### Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

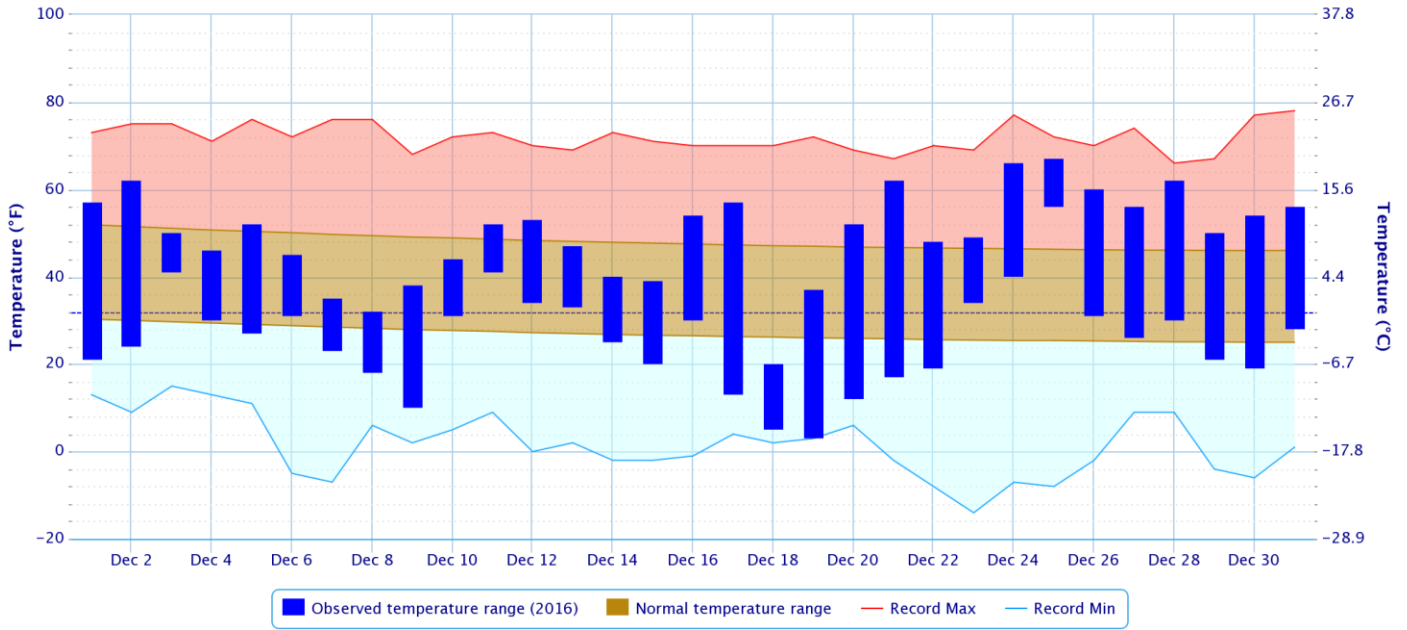
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

### Daily Temperature Data – FAYETTEVILLE DRAKE FLD, AR

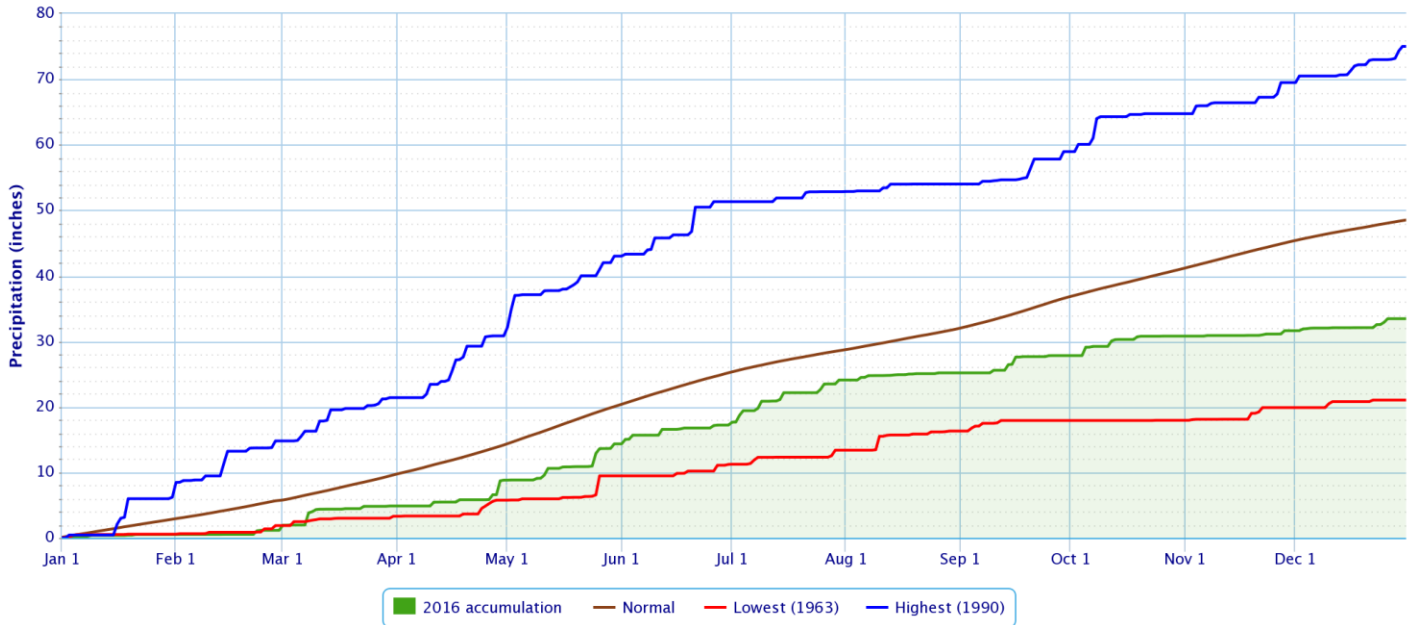
Period of Record – 1949-07-14 to 2017-01-03. Normals period: 1981-2010. Click and drag to zoom chart.



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### Accumulated Precipitation – FAYETTEVILLE DRAKE FLD, AR

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



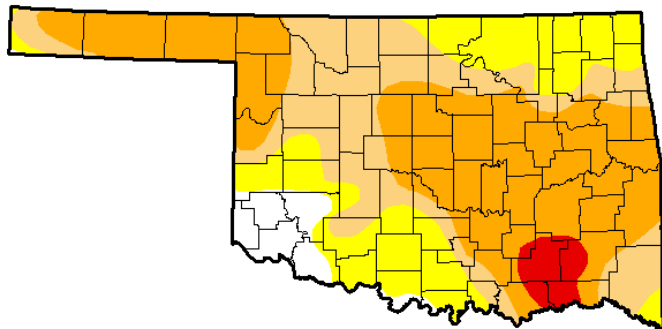
Powered by ACIS

## Drought

According to the [U.S. Drought Monitor](#) (USDM) from December 27, 2016 (Figs. 2, 3), D3 (Extreme Drought) conditions continued over western Pushmataha and western Choctaw Counties in southeast OK. D2 (Severe Drought) encompassed portions of Creek, Tulsa, Wagoner, Cherokee, Adair, Muskogee, Okfuskee, Okmulgee, McIntosh, Pittsburg, Haskell, Sequoyah, Latimer, Le Flore, Choctaw, and Pushmataha Counties in eastern OK, and Washington, Madison, Sebastian, Crawford, and Franklin Counties in west central AR. D1 (Moderate Drought) conditions existed over portions of Pawnee, Osage, Tulsa, Wagoner, Mayes, Delaware, Cherokee, and Adair Counties in eastern OK and Benton, Carroll, Washington, and Madison Counties in northwest AR. D0 (abnormally dry conditions but not in drought) were present across portions of Osage, Tulsa, Washington, Nowata, Rogers, Mayes, Delaware, Craig and Ottawa Counties in eastern OK, and Carroll County in northwest AR.

# U.S. Drought Monitor Oklahoma

**December 27, 2016**  
(Released Thursday, Dec. 29, 2016)  
Valid 7 a.m. EST



Drought Conditions (Percent Area)

|   | None   | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4   |
|---|--------|-------|-------|-------|-------|------|
| <b>Current</b>                              | 5.63   | 94.37 | 72.32 | 45.73 | 3.14  | 0.00 |
| <b>Last Week</b><br>12/20/2016              | 11.94  | 88.06 | 72.83 | 42.47 | 3.14  | 0.00 |
| <b>3 Months Ago</b><br>9/27/2016            | 57.82  | 42.18 | 19.04 | 3.05  | 0.00  | 0.00 |
| <b>Start of Calendar Year</b><br>12/29/2015 | 100.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 |
| <b>Start of Water Year</b><br>9/27/2016     | 57.82  | 42.18 | 19.04 | 3.05  | 0.00  | 0.00 |
| <b>One Year Ago</b><br>12/29/2015           | 100.00 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00 |

**Intensity:**  
 D0 Abnormally Dry      D3 Extreme Drought  
 D1 Moderate Drought      D4 Exceptional Drought  
 D2 Severe Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

**Author:**  
Brad Rippey  
U.S. Department of Agriculture

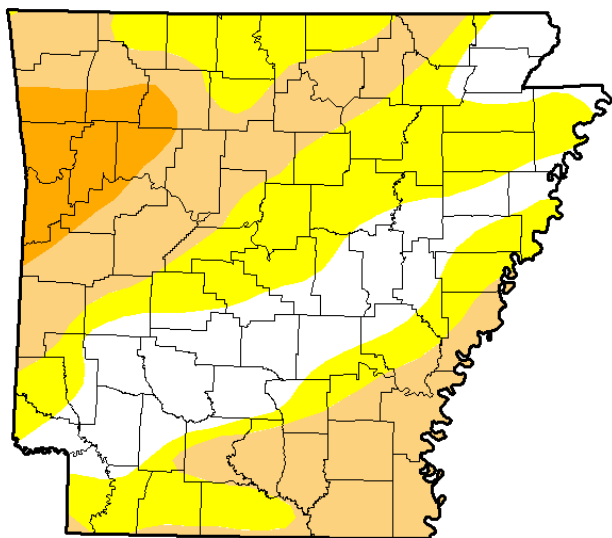


<http://droughtmonitor.unl.edu/>

Fig. 2. Drought Monitor for Oklahoma

# U.S. Drought Monitor Arkansas

**December 27, 2016**  
(Released Thursday, Dec. 29, 2016)  
Valid 7 a.m. EST



Drought Conditions (Percent Area)

|   | None   | D0-D4  | D1-D4 | D2-D4 | D3-D4 | D4   |
|---|--------|--------|-------|-------|-------|------|
| <b>Current</b>                              | 23.75  | 76.25  | 40.46 | 7.21  | 0.00  | 0.00 |
| <b>Last Week</b><br>12/20/2016              | 0.00   | 100.00 | 89.36 | 5.81  | 0.00  | 0.00 |
| <b>3 Months Ago</b><br>9/27/2016            | 71.02  | 28.98  | 0.00  | 0.00  | 0.00  | 0.00 |
| <b>Start of Calendar Year</b><br>12/29/2015 | 100.00 | 0.00   | 0.00  | 0.00  | 0.00  | 0.00 |
| <b>Start of Water Year</b><br>9/27/2016     | 71.02  | 28.98  | 0.00  | 0.00  | 0.00  | 0.00 |
| <b>One Year Ago</b><br>12/29/2015           | 100.00 | 0.00   | 0.00  | 0.00  | 0.00  | 0.00 |

**Intensity:**  
 D0 Abnormally Dry      D3 Extreme Drought  
 D1 Moderate Drought      D4 Exceptional Drought  
 D2 Severe Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

**Author:**  
Brad Rippey  
U.S. Department of Agriculture

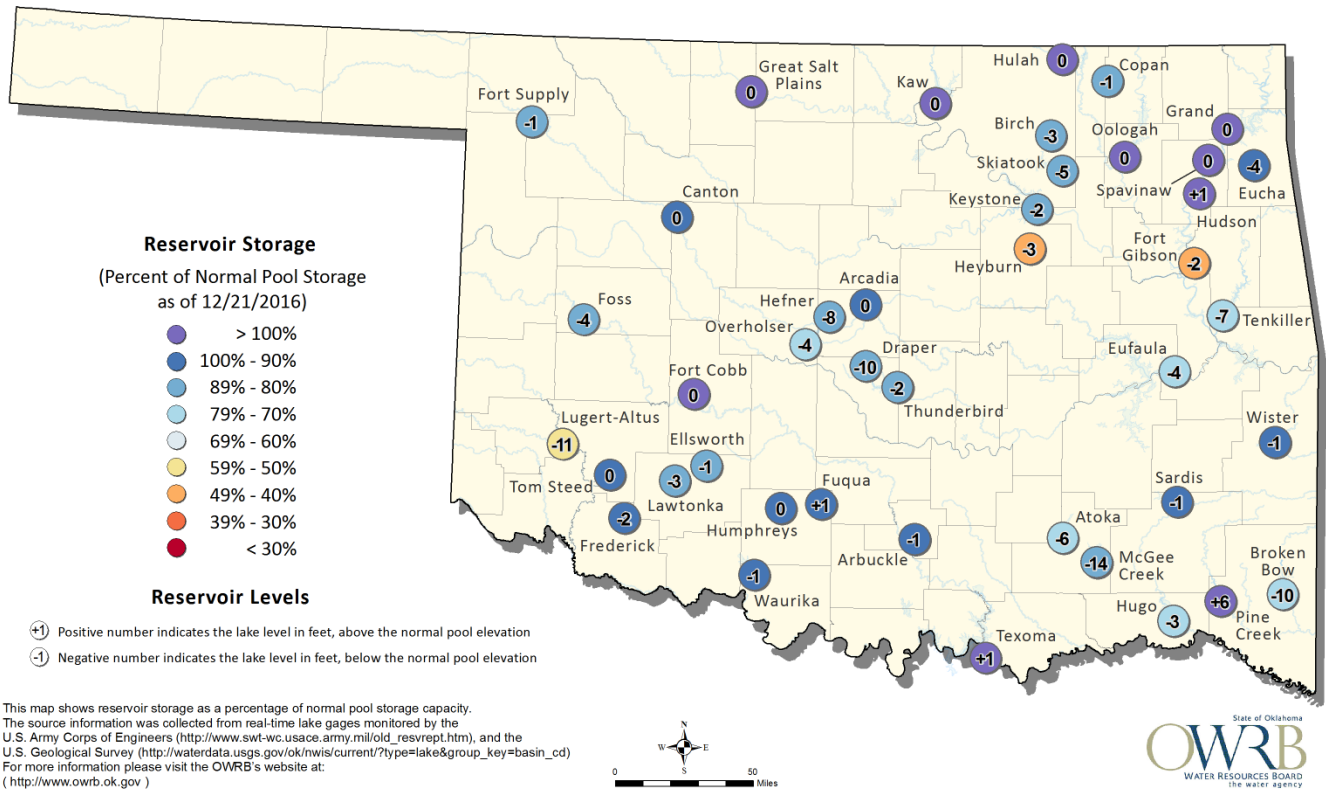


<http://droughtmonitor.unl.edu/>

Fig. 3. Drought Monitor for Arkansas

## Oklahoma Surface Water Resources

### Reservoir Levels and Storage as of 12/21/2016



According to the USACE, several lakes in the HSA were well below the top of their conservation pool levels as of 1/04/2017. Reservoirs operating more than 3% below of the top of their conservation level include: Eufaula Lake 71%, Tenkiller Lake 73%, Beaver Lake 74%, Hugo Lake 76%, Birch Lake 80%, Skiatook Lake 85%, Copan Lake 90%, Kaw Lake 86%, Keystone Lake 88%, Wister Lake 89%, Copan Lake 89%, Ft. Gibson 91%, and Sardis Lake 95%.

### **Annual Summary 2016**

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 4a), rainfall totals for 2016 ranged from a measly 20" to 60" across eastern OK and northwest AR. The majority of the region received 25"-40", with the lowest values occurring along the Arkansas River valley from north central OK into west central AR. This corresponds to 90% to 50% of the normal annual rainfall for the entire area for 2016 (Fig. 4b). Only a few isolated locations received near normal rainfall this year. After one of the wettest years on record in 2015, dry conditions prevailed and drought conditions deteriorated in 2016 as an El Niño waned at the beginning of the year and a weak La Niña developed at the end of the year.

In Tulsa, OK, 2016 ranked as the 2<sup>nd</sup> warmest Year (63.9°F, record is 64.7°F in 2012; since records began in 1905), the 13<sup>th</sup> driest Year (28.19"; since records began in 1888), and the 26<sup>th</sup> least snowy Year (3.0"; since records began in 1900). Fort Smith, AR had the 3<sup>rd</sup> warmest Year (64.4°F, tied 2011; since records began in 1883), the 19<sup>th</sup> driest Year (31.20"; since records began in 1882), and the 4<sup>th</sup> least snow (Trace, tied 2005, 2002, 1998, 1992, 1991, 1957; since records began in 1884). Fayetteville, AR had the 7<sup>th</sup> warmest (58.8°F), the 7<sup>th</sup> driest (33.45"), and the 4<sup>th</sup> least snow (0.3") Year since records began in 1950.

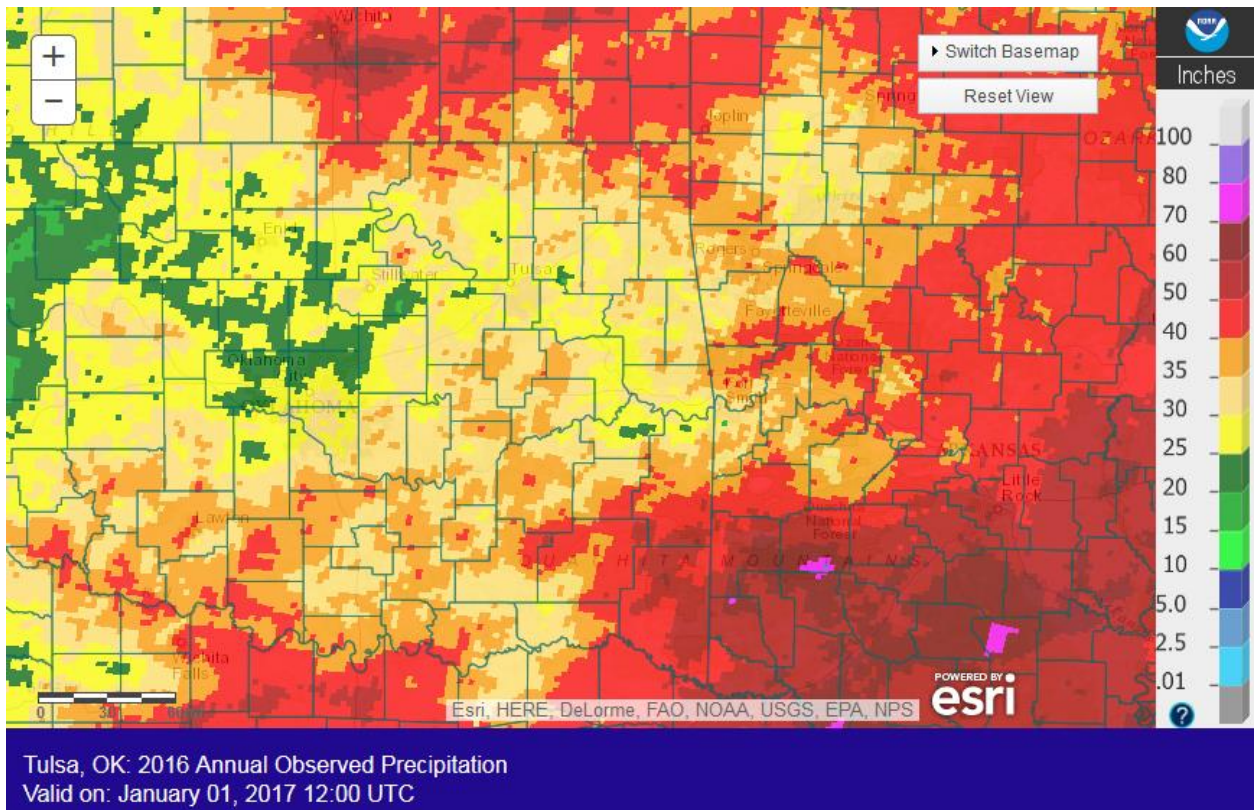


Fig. 4a. Estimated Observed Rainfall for 2016

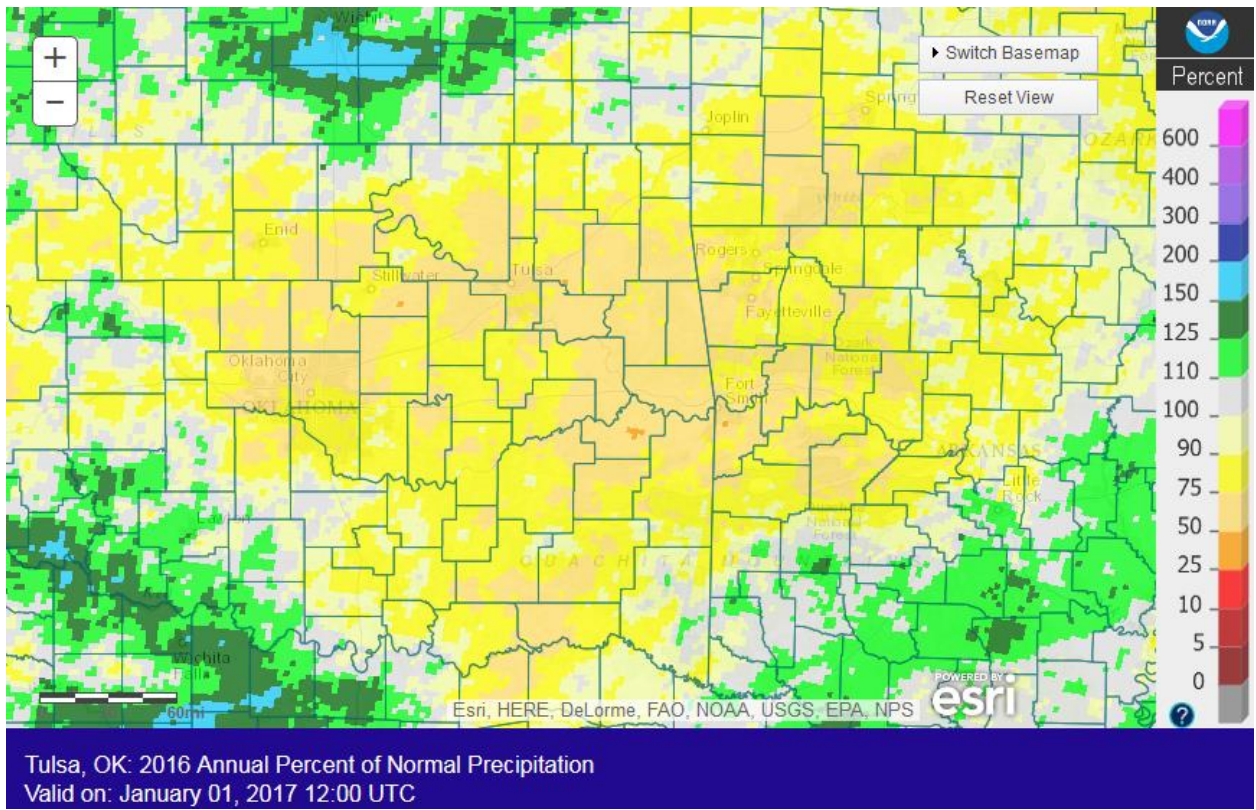


Fig. 4b. Estimated % of Normal Rainfall for 2016

Some of the larger precipitation reports (in inches) for 2016 included:

|                        |       |                             |       |                                |       |
|------------------------|-------|-----------------------------|-------|--------------------------------|-------|
| Winslow 7NE, AR (coop) | 51.21 | Cloudy, OK (meso)           | 45.70 | Upper Spavinaw Port, OK (coop) | 45.17 |
| Clayton, OK (meso)     | 43.35 | Hindsville 10NNE, AR (coop) | 42.49 | Cookson, OK (meso)             | 41.90 |
| Miami, OK (coop)       | 41.75 | Bunch 0.8N, OK (coco)       | 41.52 | Springdale 5.8ENE, AR (coco)   | 40.85 |





# Tulsa Oklahoma OK - 2016

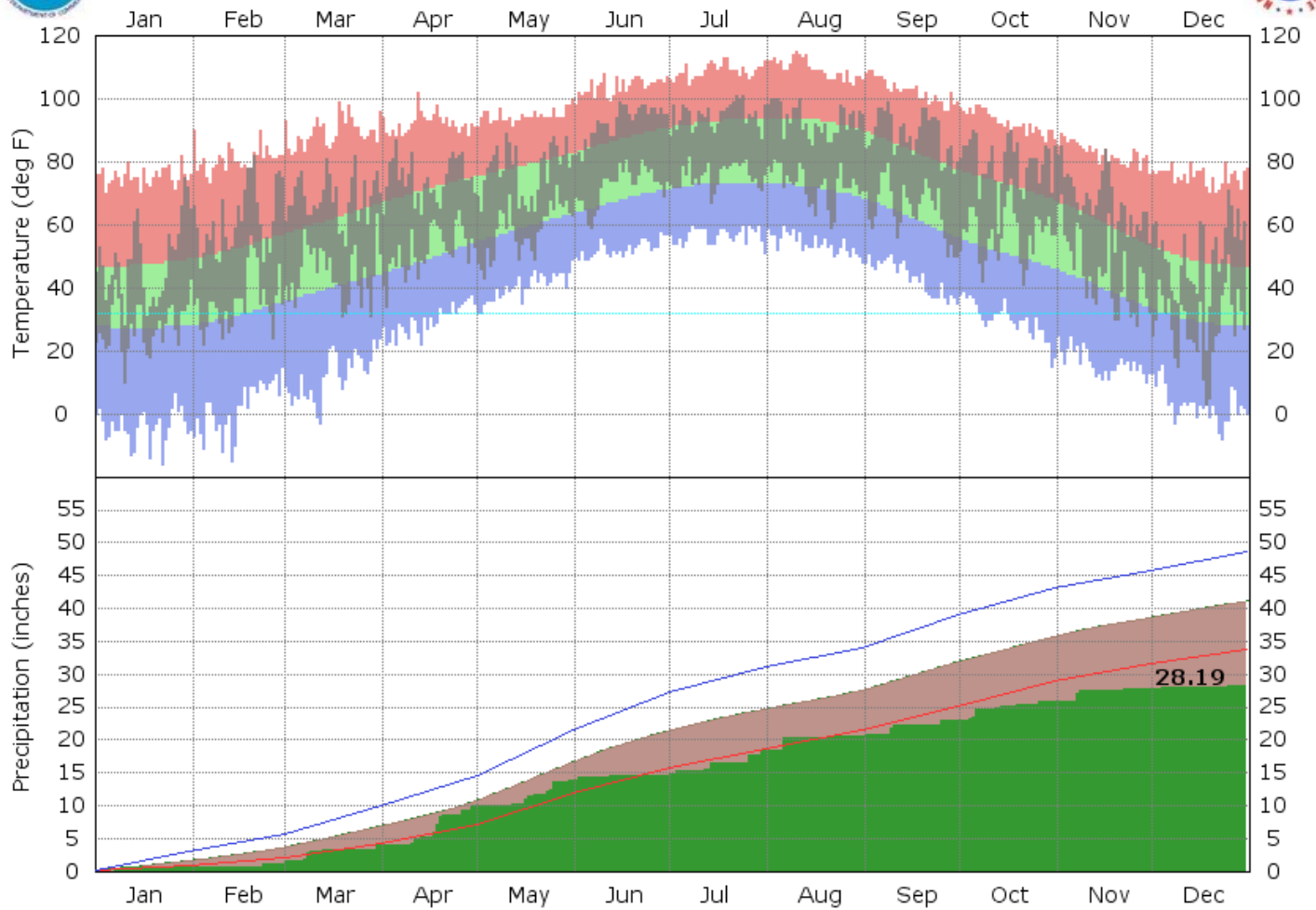


Image created: Sat, 31 Dec 2016 16:00 GMT+00:00



# Fort Smith Arkansas AR - 2016

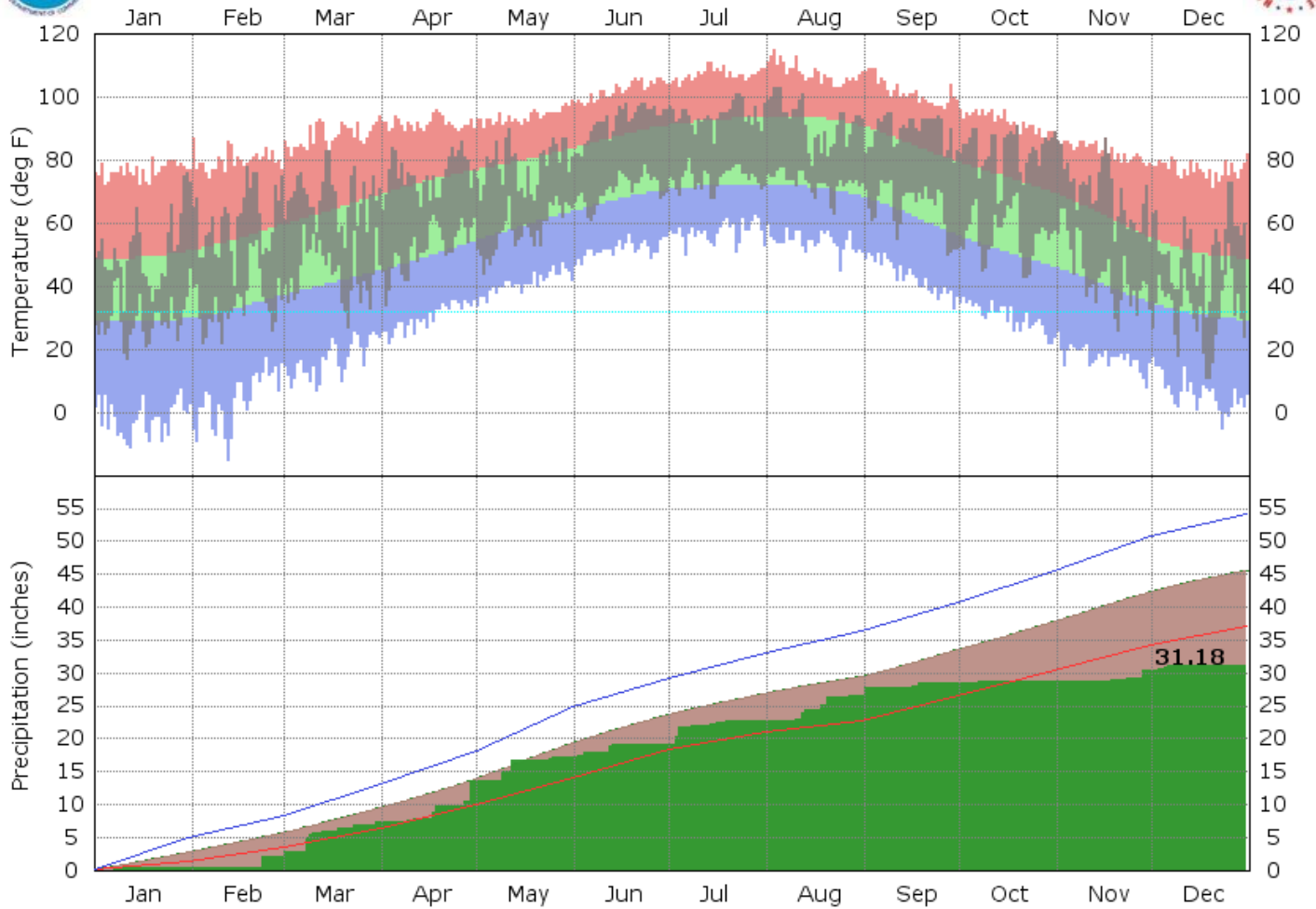


Image created: Sat, 31 Dec 2016 16:00 GMT+00:00



# Fayetteville Arkansas AR - 2016

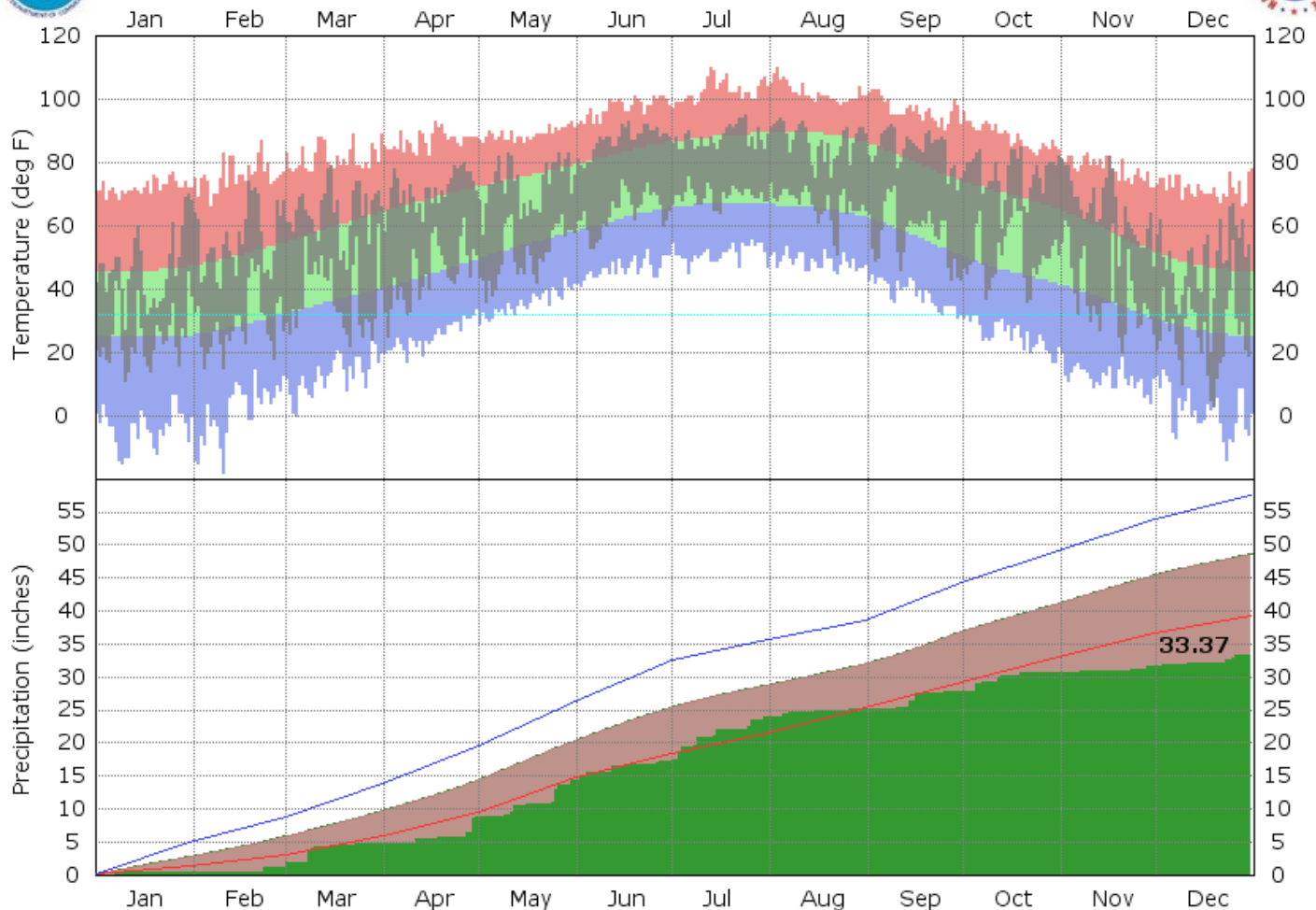


Image created: Sat, 31 Dec 2016 16:00 GMT+00:00

## Outlooks

The [Climate Prediction Center](#) (CPC) outlook for January 2017 (issued December 31, 2016) indicates an equal chance of above, near, and below normal temperatures and precipitation across all of eastern OK and northwest AR. This outlook takes into account weather conditions forecast over the next 1-2 weeks, as well as subseasonal climate signals in the weeks 2-4 time frame. Extratropical modes of variability are likely to dominate the weather pattern over North America. Since these modes have lower levels of predictability beyond two weeks, the uncertainty in the latter half of January reduces the overall confidence in the outlook.

For the 3-month period January-February-March 2017, CPC is forecasting an enhanced chance for above normal temperatures and an equal chance for above, near, and below median rainfall across all of eastern OK and northwest AR (outlook issued December 15, 2016). According to CPC, Pacific sea surface temperatures along the equator continue to reflect weak La Niña conditions. This outlook is based on lingering La Niña impacts, both statistical and dynamical forecast tools, and decadal timescale climate trends. CPC continues the La Niña Advisory. However, a transition to ENSO-neutral conditions is expected to occur during the January-March 2017 period. ENSO-neutral is then favored to persist through the summer.

**Summary of Precipitation Events** Daily quality controlled rainfall maps can be found at: [http://water.weather.gov/precip/index.php?location\\_type=wfo&location\\_name=tsa](http://water.weather.gov/precip/index.php?location_type=wfo&location_name=tsa)

## December 1-15

Scattered light rain affected locations southwest of a Tulsa to Fort Smith line from late evening of the 2<sup>nd</sup> through the early morning of the 3<sup>rd</sup>. The rainfall increased over southeast OK due to increasing warm air advection during the morning hours, then dissipated during the afternoon. Rainfall totals were 0.10" to around 0.50", with eastern Choctaw County receiving around 0.75" of rain.

An area of light showers moved east into northeast OK during the pre-dawn hours of the 4<sup>th</sup> in association with a very strong upper jet streak, quickly moved into northwest AR, and was east of the area by mid-morning. Rainfall totals were around 0.10" or less.

Showers moved north out of TX and into southeast OK during the evening of the 5<sup>th</sup>, and continued into northwest AR through the overnight hours as an upper-level low lifted northeast from south central TX into southern AR. Rainfall totals were 0.10" to around 0.50". The three rounds of showers did not bring much rain to the area, with most locations in eastern OK receiving less than 0.50" (Fig. 5).

Snow flurries occurred across eastern OK and northwest AR on the 7<sup>th</sup> in association with an arctic front, but there was no snow or liquid water equivalent accumulation.

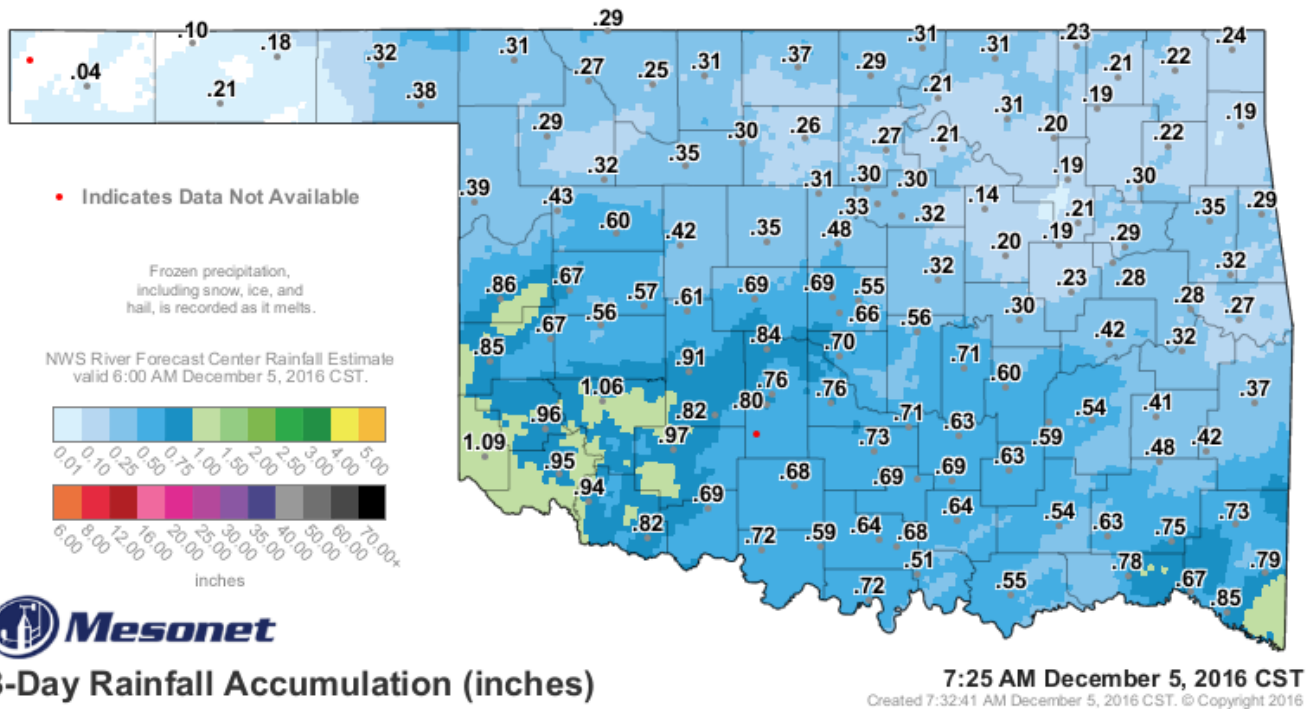


Fig. 5. 3-day Estimated Observed Rainfall (image) and OK Mesonet measurements ending at 7:25am CST 12/05/2016

## December 16-31

By early morning on the 17<sup>th</sup>, an initial push of cold air was located just south of I-44, with a secondary surge of even colder air pressing into southern KS. Temperatures fell through the day as the cold front passed, then dropped more as the secondary arctic airmass moved into eastern OK and northwest AR. Post-frontal precipitation developed, bringing freezing drizzle, sleet, and snow to portions of the area. Freezing drizzle resulted in very hazardous driving conditions across northwest AR and adjacent areas of northeast OK. The accumulating sleet and snow generally fell along and north of Hwy 412, where amounts were generally a few tenths to around 1" (Fig. 6). Light rain and liquid equivalent from the frozen precipitation was less than one tenth of an inch, except near the KS-OK state line, where totals were slightly over 0.10".

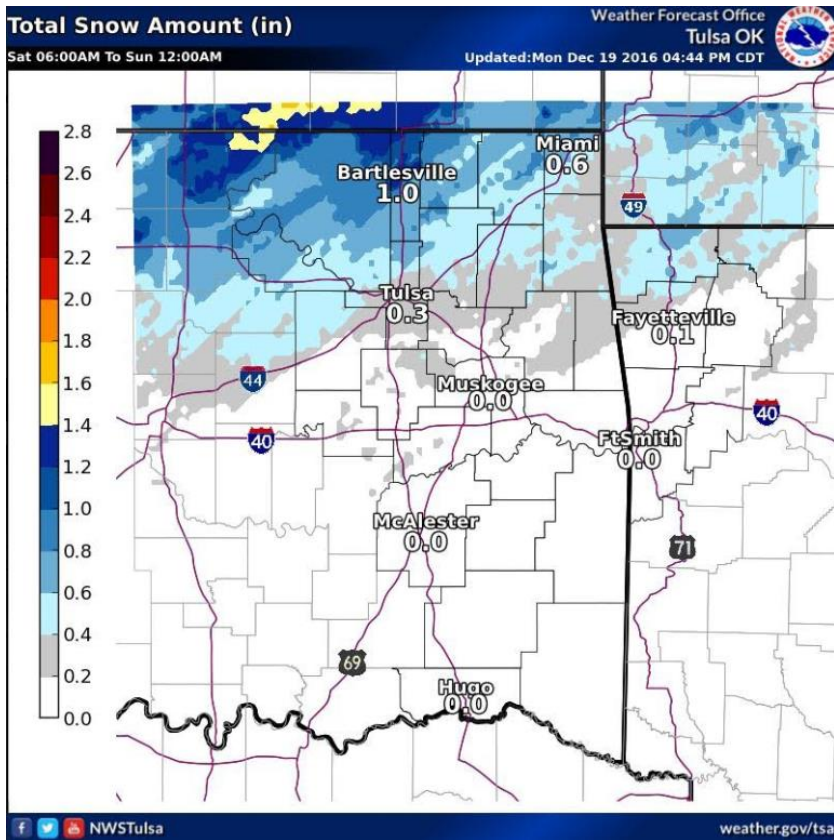


Fig. 6. Storm Total Sleet/Snowfall for Dec. 17, 2016

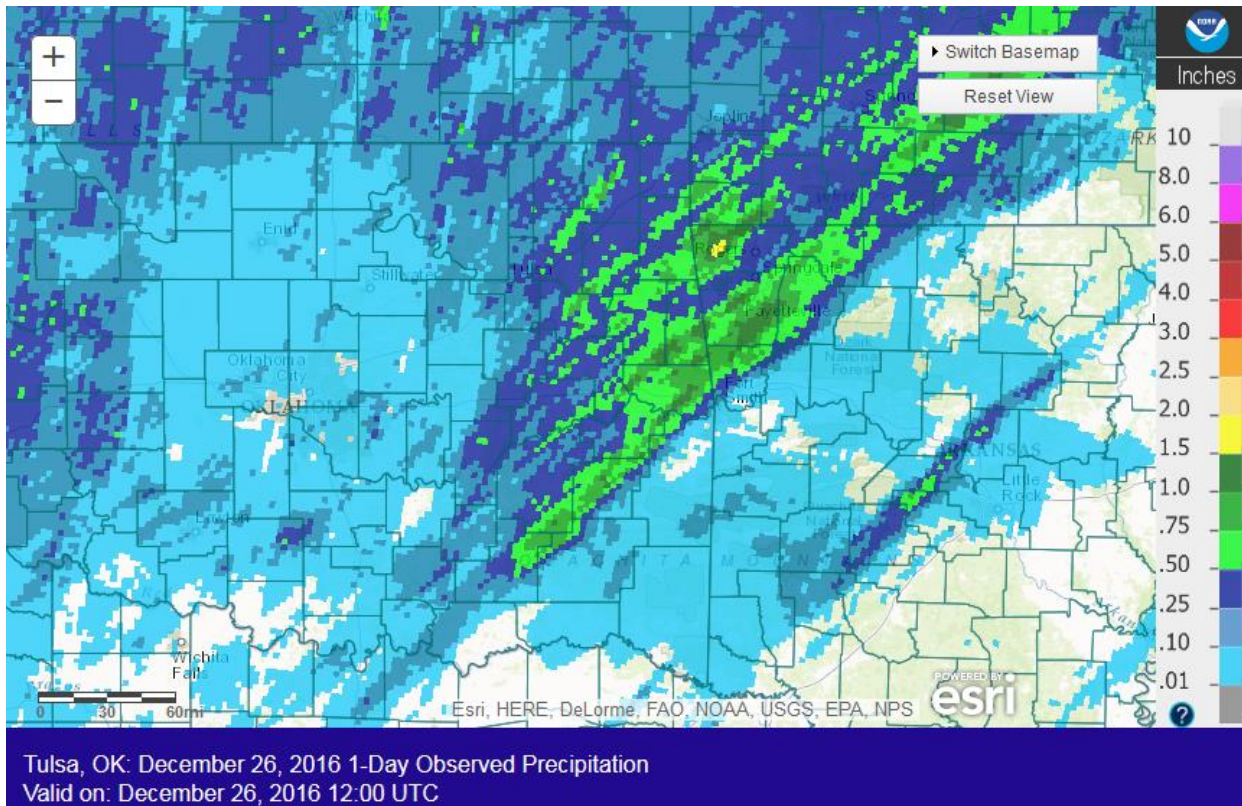


Fig. 7. 24-hr Estimated Observed Rainfall ending at 7am CDT 12/26/2016.

A couple of bands of light rain/sleet occurred in northeast OK during the evening of the 22<sup>nd</sup> as mid-level isentropic lift occurred over the area. Around midnight on the 23<sup>rd</sup>, light rain mixed with some sleet moved east along the OK/KS state line. Then during the early morning hours, additional precipitation moved southeast into northeast OK as synoptic scale lift increases in response to an approaching shortwave and the vicinity of the

right entrance region of the upper-level jet. This activity increased in coverage and intensity through the morning hours as the storms continued to moved southeast. The rain then came to an end by mid-afternoon, dissipating before reaching southeast OK. However, additional light rain redeveloped over southeast OK during the late evening hours. Rainfall totals ranged from just a few hundredths to around 0.50" across eastern OK and northwest AR.

A narrow line of showers and thunderstorms marched west to east across eastern OK and western AR along a front from the afternoon hours of the 25<sup>th</sup> through the early morning hours of the 26<sup>th</sup>. Rainfall totals were around 0.10" to around 1.5" (Fig. 7) Temperatures were very warm on Christmas day, with a new record high temperature set in McAlester.

Written by:

Nicole McGavock  
Service Hydrologist  
WFO Tulsa

**Products issued in December 2016:**

\*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)
- 0 Flash/Areal Flood Watches (FFA) (0 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)
- 0 River Flood Statements (FLS)
- 0 River Flood Advisories (FLS) (0 Advisory FLS CON/EXT/CAN)
- 0 River Flood Watches (FFA) (0 Watch FFA CON/EXT/CAN)
- 0 River Statements (RVS)
- 0 Hydrologic Outlooks (ESF)
- 1 Drought Information Statements (DGT)

**Preliminary Hydrographs:**

None