

<b>NWS FORM E-5</b> (11-88) (PRES. by NWS Instruction 10-924)	<b>U.S. DEPARTMENT OF COMMERCE</b> NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL WEATHER SERVICE	HYDROLOGIC SERVICE AREA (HSA)	
		<b>Tulsa, Oklahoma (TSA)</b>	
<b>MONTHLY REPORT OF RIVER AND FLOOD CONDITIONS</b>		REPORT FOR:	
		MONTH <b>December</b>	YEAR <b>2013</b>
TO: Hydrometeorological Information Center, W/OH2 NOAA / National Weather Service 1325 East West Highway, Room 7230 Silver Spring, MD 20910-3283		SIGNATURE <b>Steven F. Piltz</b> (Meteorologist-in-Charge)	
		DATE <b>January 3, 2014</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)*

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

Two significant ice storms affected eastern Oklahoma and northwest Arkansas in December 2013. Locations northwest of I-44 had below normal precipitation this month, with a mix of above and below normal conditions elsewhere in the HSA. 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.

### Monthly Summary

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 1a), rainfall totals for December 2013 ranged from less than an inch in Osage, Washington, and Nowata Counties in northeast OK to around 6" in southern Le Flore County in southeast OK. Locations northwest of I-44 had below normal precipitation for December 2013, with most of this area receiving only 25%-75% of the normal December rainfall (Fig. 1b). A mix of above and below normal precipitation was observed across the remainder of eastern OK and northwest AR.

Tulsa, OK (TSA): December, 2013 Monthly Observed Precipitation  
 Valid at 1/1/2014 1200 UTC- Created 1/2/14 17:36 UTC

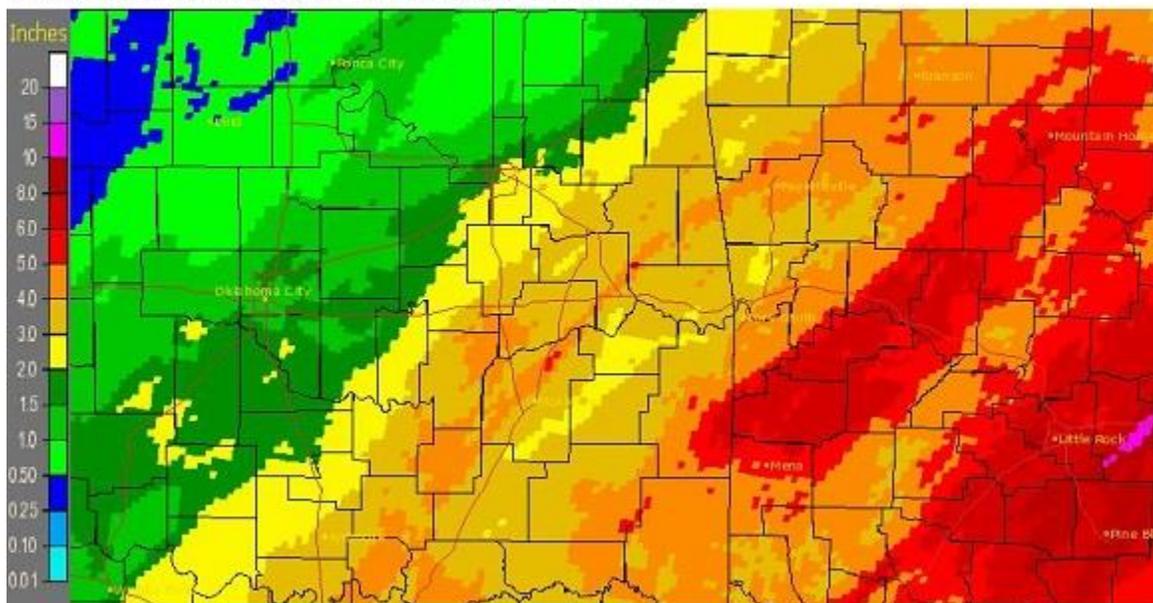


Fig. 1a. Estimated Observed Rainfall for December 2013

Tulsa, OK (TSA): December, 2013 Monthly Percent of Normal Precipitation  
 Valid at 1/1/2014 1200 UTC- Created 1/2/14 17:39 UTC

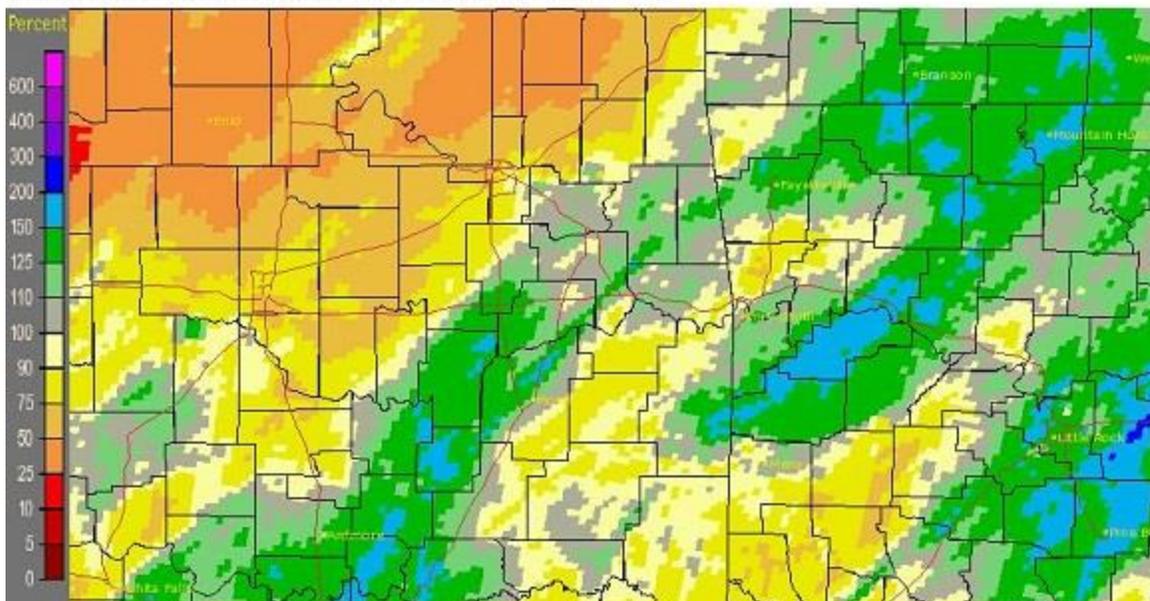


Fig. 1b. Estimated % of Normal Rainfall for December 2013

In Tulsa, OK, December 2013 ranked as the 14<sup>th</sup> coldest December (35.3°F; since records began in 1905), the 53<sup>rd</sup> wettest December (1.78"; since records began in 1888), and the 13<sup>th</sup> snowiest December (5.0", tied 1906; since records began in 1900). Fort Smith, AR was the 21<sup>st</sup> coldest December (39.0°F; since records began in 1882), the 36<sup>th</sup> wettest December (4.10"; since records began in 1882), and the 7<sup>th</sup> snowiest December (5.0", tied 1958; since records began in 1883). Fayetteville, AR was the 8<sup>th</sup> coldest (34.4°F), the 16<sup>th</sup> wettest (4.10"), and the **Record snowiest** (7.0") December since records began in 1949. Fayetteville received its annual normal snowfall of 7.0" in this month alone.

Some of the larger precipitation reports (in inches) for December 2013 included:

Kingston, AR 2S (coop)	6.55	Hindsville 10NNE, AR (coop)	5.06	Berryville 5NW, AR (coop)	4.56
Fanshawe, AR (coop)	4.23	Fort Smith, AR (ASOS)	4.10	Fayetteville, AR (ASOS)	4.10
Cookson, OK (meso)	3.95	Odell, AR (coop)	3.91	Tahlequah, OK (meso)	3.89

Some of the lowest precipitation reports (in inches) for December 2013 included:

Pawnee, OK (coop)	0.57	Ralston, OK (meso)	0.62	Pawnee, OK (meso)	0.64
Wynona, OK (meso)	0.71	Copan, OK (meso)	0.88	Nowata, OK (meso)	1.04
Burbank, OK (meso)	1.06	Foraker, OK (meso)	1.15	Skiatook, OK (meso)	1.18

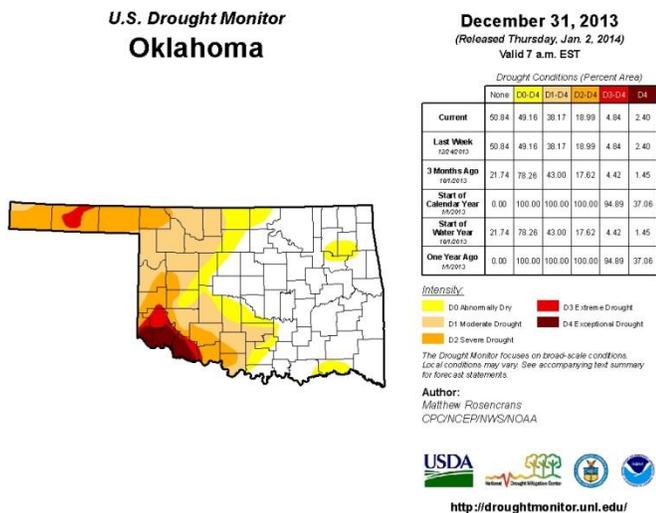


Fig. 2. Drought Monitor for Oklahoma

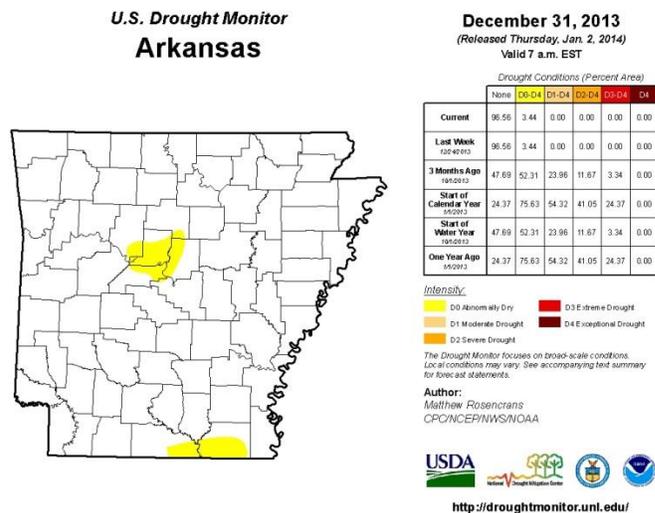


Fig. 3. Drought Monitor for Arkansas

According to the [U.S. Drought Monitor](http://droughtmonitor.unl.edu/) (USDM) from December 31, 2013 (Figs 2, 3), Abnormally Dry (D0), but

not experiencing drought, conditions remained in Choctaw, southern Rogers, Mayes, and northern Wagoner Counties in eastern OK.

According to the USACE, most of the major reservoirs in the HSA were operating within  $\pm 4\%$  of the top of their conservation pools as of 12/31/2013. A couple of lakes were still below normal: Skiatook Lake 75% and Heyburn Lake 81%. Several lakes were utilizing flood control storage: Ft. Gibson Lake 108%, Wister Lake 108%, Sardis Lake 107%, Tenkiller Lake 106%, and Beaver Lake 106%.

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

Rank since 1921	December 2013	Last 60 Days (Nov 2 – Dec 31)	Cool Growing Season (Sep 1 – Dec 31)	Water Year-to-Date (Oct 1 – Dec 31)	Last 180 Days (Jul 5 – Dec 31)	Year 2013 (Jan 1 – Dec 31)
Northeast OK	38 <sup>th</sup> driest	29 <sup>th</sup> driest	34 <sup>th</sup> driest	40 <sup>th</sup> driest	30 <sup>th</sup> wettest	32 <sup>nd</sup> wettest
East Central OK	28 <sup>th</sup> wettest	45 <sup>th</sup> wettest	40 <sup>th</sup> driest	42 <sup>nd</sup> wettest	40 <sup>th</sup> wettest	30 <sup>th</sup> wettest
Southeast OK	46 <sup>th</sup> driest	42 <sup>nd</sup> wettest	37 <sup>th</sup> wettest	27 <sup>th</sup> wettest	31 <sup>st</sup> wettest	38 <sup>th</sup> wettest
Statewide	46 <sup>th</sup> driest	38 <sup>th</sup> driest	29 <sup>th</sup> driest	45 <sup>th</sup> driest	32 <sup>nd</sup> wettest	38 <sup>th</sup> wettest

### Annual Summary

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 4a), rainfall totals for 2013 were 35”-60” across the majority of eastern OK and northwest AR. However, a few areas of Pawnee, Creek, Tulsa, Rogers, Washington (OK), Choctaw, and Crawford Counties received between 25” and 35” of rain. Southeast Le Flore County and northeast Benton County received a little over 60” of rain this year. These rainfall totals ranged from 75% to 150% of the normal annual rainfall, with the 50%-75% of normal in portions of Creek, Crawford, and Choctaw Counties (Fig. 4b).

Tulsa, OK (TSA): Full Year 2013 Observed Precipitation  
Valid at 1/1/2014 1200 UTC- Created 1/2/14 17:40 UTC

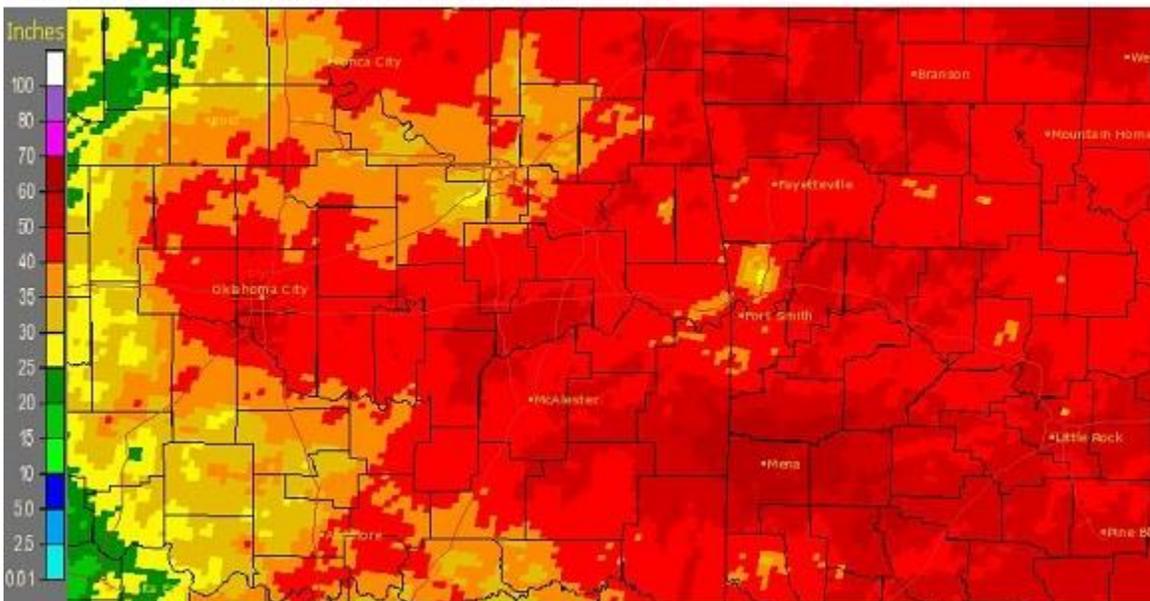


Fig. 4a. Estimated Observed Rainfall for 2013

Tulsa, OK (TSA): Full Year 2013 Percent of Normal Precipitation  
 Valid at 1/1/2014 1200 UTC- Created 1/2/14 17:44 UTC

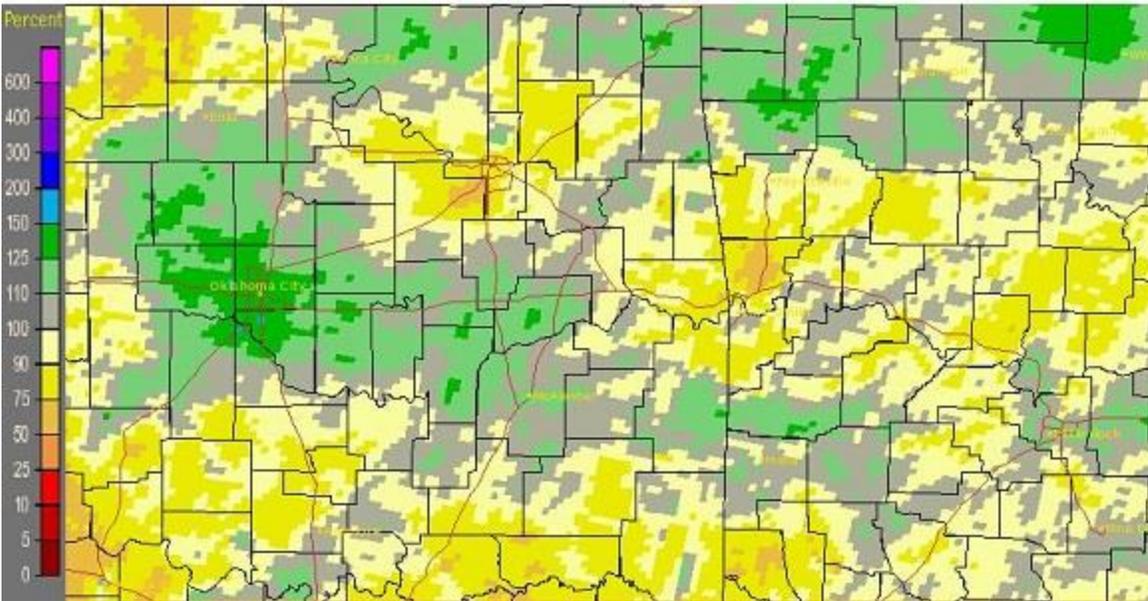


Fig. 4b. Estimated % of Normal Rainfall for 2013

Refer to the end of this report for temperature and rainfall graphs for 2013. In Tulsa, OK, 2013 ranked as the 25<sup>th</sup> coldest year (59.6°F, tied 1985, 1972, 1962; since records began in 1905), the 33<sup>rd</sup> driest year (33.09"; since records began in 1888), and the 49<sup>th</sup> snowiest year (8.7"; since records began in 1900). Fort Smith, AR was the 44<sup>th</sup> warmest year (61.9°F, tied 2000, 1918, 1910, 1890; since records began in 1883), the 34<sup>th</sup> wettest year (47.05"; since records began in 1882), and the 27<sup>th</sup> snowiest year (9.0"; since records began in 1884). Fayetteville, AR was the 6<sup>th</sup> coldest (56.3°F, tied 1966), the 29<sup>th</sup> wettest (46.62"), and the 24<sup>th</sup> snowiest (9.4") year since records began in 1950.

Some of the larger precipitation reports (in inches) for 2013 included:

Wister, OK (meso)	58.75	St Paul, AR (coop)	57.94	Fanshawe, AR (coop)	55.67
Talihina, OK (meso)	55.20	Bengal, OK (coop)	54.73	Winslow 7NE, AR (coop)	53.46
Hindsville 10NNE, AR (coop)	53.35	Eufaula, OK (meso)	52.18	NW AR Reg. Arpt, AR (ASOS)	51.98

Area rivers exceeded flood stage on 27 occasions during 2013, with flooding occurring in each of the major river basins in eastern OK (Verdigris, Grand-Neosho, Lower Arkansas, Canadian, and Lower Red Basins). The Neosho River near Commerce experienced flooding 4 times this year, while the Verdigris River near Lenapah and the Illinois River near Watts and near Tahlequah flooded 3 times each. Flash flooded caused at least \$6.5 million in damage to roads (infrastructure), homes, and businesses in 2013, and resulted in one fatality in Okfuskee County on June 1, 2013.

43 tornadoes occurred in eastern Oklahoma and northwest Arkansas in 2013, compared to an average of about 18 per year since 1950. Tornadoes occurred in January, March, April, May, June, and July. Four were rated EF2, with the strongest being in Broken Arrow on May 30, 2013. These tornadoes caused at least \$8 million in property damage and at least four injuries, though no fatalities. In addition to tornadoes, at least \$400,000 in property damage occurred due to hail. The largest stones reported during the year were 4.25" north of Bigheart in Osage County on May 20, 2013 and 3.00" near Fort Gibson in Muskogee County on March 30, 2013. One fatality occurred in Springdale, AR (Washington County) on May 20, 2013 due to strong thunderstorm winds. The strongest straight-line wind gusts reported this year were 91 mph (measured) in Tulsa, OK on July 23, 2013.

There were several periods of excessive heat in 2013, including June 26-27, July 9-10, and August 6-7, with dozens of heat-related medical calls in Tulsa County. Over 450 heat-related medical calls occurred on August 31, 2013 at the Arkansas Razorbacks home football game in Fayetteville, AR.

## **Outlooks**

The [Climate Prediction Center](#) (CPC) outlook for January 2014 (issued December 31, 2013) indicates equal chances for above, near, and below normal temperatures and precipitation across all of eastern OK and northwest AR. This outlook is based primarily on short term forecasts of expected weather conditions during the first half of the month, as well as longer term climate anomalies.

For the 3-month period Jan-Feb-Mar 2014, CPC is forecasting an enhanced chance for above normal temperatures and equal chances for above, near, and below median rainfall across all of eastern OK and northwest AR (outlook issued December 19, 2013). According to CPC, ENSO neutral conditions remained through December. ENSO neutral conditions are expected to continue into Summer 2014. Therefore, this outlook is based on both statistical and dynamical forecast tools and correlations with the Pacific Decadal Oscillation.

## **Summary of Precipitation Events**

### **December 1-15**

A major winter storm impacted eastern OK and northwest AR, beginning early on the 5<sup>th</sup>, and continued through late on the 6<sup>th</sup>. Significant ice accumulations and sleet and snow accumulations occurred. An arctic cold front pushed through the region during the daylight hours of the 4<sup>th</sup>, dropping temperatures from the 60s in some locations to below freezing in a matter of hours. Precipitation did not develop along the surface front, but instead, waited for a series of upper-level disturbances to move northeastward across eastern OK and northwest AR on the 5<sup>th</sup> and 6<sup>th</sup>.

Freezing rain, mixed with sleet at times, developed through the morning of the 5<sup>th</sup>, primarily to the southeast of the I-44 corridor. Temperatures were warm enough initially in far southeast OK and a small part of west central AR that the precipitation began as rain before quickly transitioning to freezing rain by mid-morning. Cold air gradually deepened from north to south during the afternoon and evening, allowing some of the freezing rain to transition to sleet and finally snow. Additional precipitation blossomed overnight on the 5<sup>th</sup> and into the morning of the 6<sup>th</sup>, bringing some of the first measurable snow or sleet to areas north of the I-44 corridor, as well as locations in southeast OK and west central AR that previously saw significant ice accumulation.

Far southeast OK and west central AR were hardest hit with ice accumulation and related impacts. Areas from Hugo to Antlers, Poteau, and toward Greenwood and Ozark saw between a 0.50" and 1" of ice accumulation (see Fig. 6). Widespread power outages occurred. Snow and sleet accumulated to 3"-6" across a large part of northeast OK, east central OK, and northwest AR (see Fig. 5). The largest snow and sleet accumulations, a foot or more, were recorded in far northwest AR across Benton and Carroll counties. Officially, Tulsa, OK received 4.9", Fort Smith, AR 5.0", and Fayetteville, AR 7.0" of sleet and snow during this event. Liquid equivalent estimates ranged from a few hundredths in Osage and Washington Counties in northeast OK to around 3" in Le Flore and Sebastian Counties in southeast OK and west central AR (see Fig. 7). More information about this event can be found at: [http://www.srh.noaa.gov/tsa/?n=weather-event\\_2013dec05](http://www.srh.noaa.gov/tsa/?n=weather-event_2013dec05)

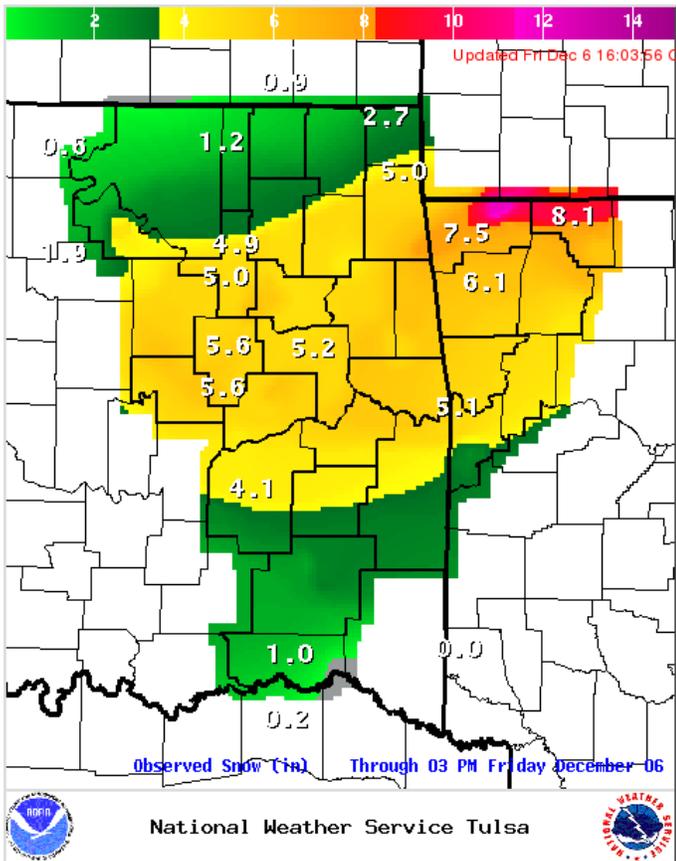


Fig. 5. Snowfall estimate for Dec. 5-6, 2013.

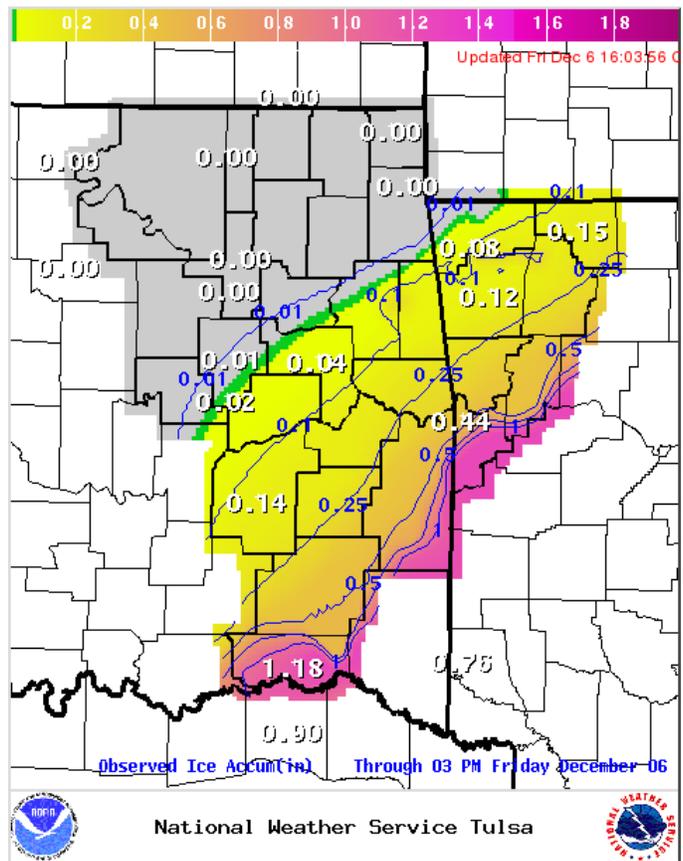


Fig. 6. Ice accumulation estimate for Dec. 5-6, 2013.

Tulsa, OK (TSA): Current 7-Day Observed Precipitation  
Valid at 12/11/2013 1200 UTC - Created 12/11/13 19:54 UTC



Fig. 7. 7-day estimated observed rainfall/ liquid equivalent ending 6am CST 12/11/2013 (Note: this image also includes the precipitation that fell along the OK/KS border on the 9<sup>th</sup>).

On the 9<sup>th</sup>, an upper-level disturbance brought another round of snow to locations along the OK/KS state line and flurries near the AR/MO state line. Snowfall totals generally ranged from 1"-3" in northeast OK, with liquid equivalent totals of a few hundredths to less than 0.25" (see Fig. 8).

Tulsa, OK (TSA): 12/10/2013 1-Day Observed Precipitation  
Valid at 12/10/2013 1200 UTC- Created 12/11/13 21:32 UTC



Fig. 8. 24-hr estimated observed rainfall/ liquid equivalent ending 6am CST 12/10/2013.

As an upper-level low shifted east into the Southern Plains, showers and isolated thunderstorms developed on the 13<sup>th</sup> within an area of strong warm air advection. During the morning hours, temperatures across northwest AR were at or just below freezing, leading to a light glaze of ice. However, temperatures warmed above freezing and no significant ice accumulation occurred. Rainfall totals ranged from around 0.10" just north of I-44 to around 1.5" in portions of east central OK and northwest AR (see Fig. 9).

Tulsa, OK (TSA): 12/14/2013 1-Day Observed Precipitation  
Valid at 12/14/2013 1200 UTC- Created 12/16/13 23:31 UTC

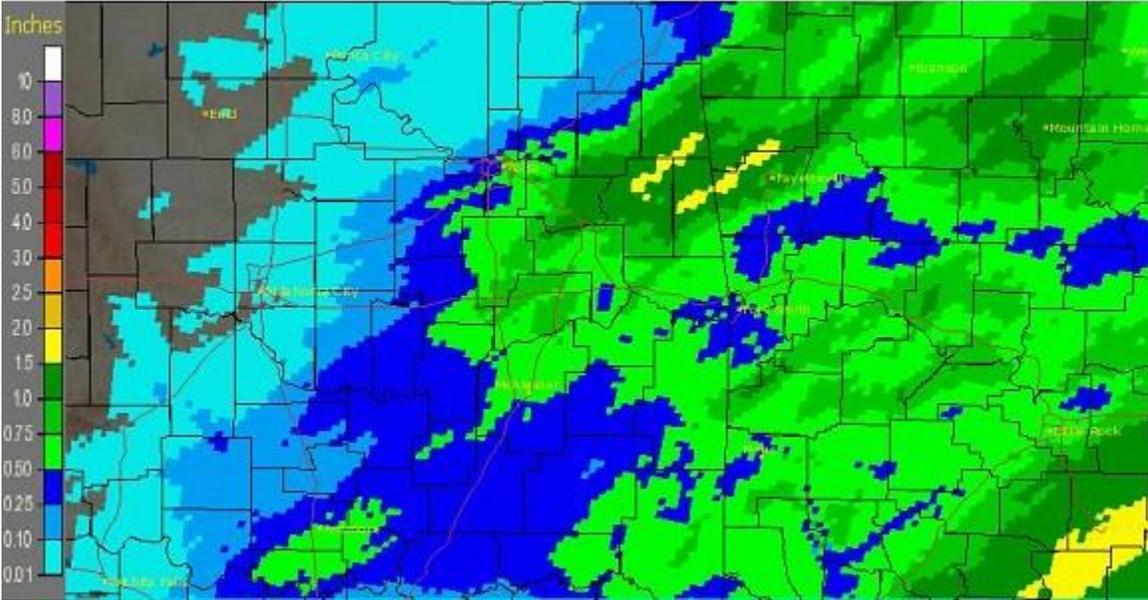


Fig. 9. 24-hr estimated observed rainfall/ liquid equivalent ending 6am CST 12/14/2013.

**December 16-31**

From late on the 20<sup>th</sup> through the 21<sup>st</sup>, a significant ice storm impacted a large portion of OK, extending from the southwestern portions of the state eastward through much of east central and northeast OK. The swath of accumulating ice also reached into extreme northwest portions of Arkansas. The weather event began as a strong cold pushed into northeast Oklahoma during the overnight hours on the 19<sup>th</sup>. The post frontal air was cold; however, the depth of the cold temperatures remained very shallow, generally less than 1500 feet thick.

This forced the cold front to stall upon impacting the higher terrain of northwest AR into southeast OK, with locations south of the front remaining much warmer than locations north of the boundary. The location and magnitude of this cold front was a determining factor in the exact location of the heaviest icing and became a key feature during the forecast process.

A broad region of unseasonably high moisture was located across the Southern Plains ahead of the strong cold front. The upper air balloon launched from Fort Worth, TX on the morning of the 21<sup>st</sup> sampled 1.32" of precipitable water. This is a measure of the total moisture available, and this amount is in the top 5% of precipitable water values observed during December for Fort Worth. This rich moisture was then lifted as a strong storm system tracked toward the region, with precipitation expanding into eastern Oklahoma on the evening of the 20<sup>th</sup>, and increasing in coverage and intensity the night of the 20<sup>th</sup> through the 21<sup>st</sup>. The shallow, yet very cold, nature of the airmass north of the cold front allowed widespread freezing rain to develop, with a swath of heavy icing along the I-44 corridor and also across a portion of Osage County. Ice accumulations of 0.50"-0.75" were reported in these areas (see Fig. 10). Further south, across southeast OK into extreme northwest AR, icing accumulations of 0.25"-0.50" were reported. The extensive icing extended west across much of OK, with the Oklahoma Mesonet reporting many frozen wind anemometers across the state. South of the cold front, temperatures remained warm enough to prevent icing, however localized flooding was reported with the widespread and long duration rainfall.

Rainfall/liquid equivalent totals for this event were 1"-3" southeast of I-44, with a few locations just over 3" (see Fig. 11). Northwest of I-44, the totals were slightly less, from around 0.50" to around 1". The Illinois River near Tahlequah rose above action stage, but remained below flood stage. Rises occurred along several rivers across southeast OK, though none exceeded flood stage. More information about this ice storm can be found at: [http://www.srh.noaa.gov/tsa/?n=weather-event\\_2013dec20](http://www.srh.noaa.gov/tsa/?n=weather-event_2013dec20)

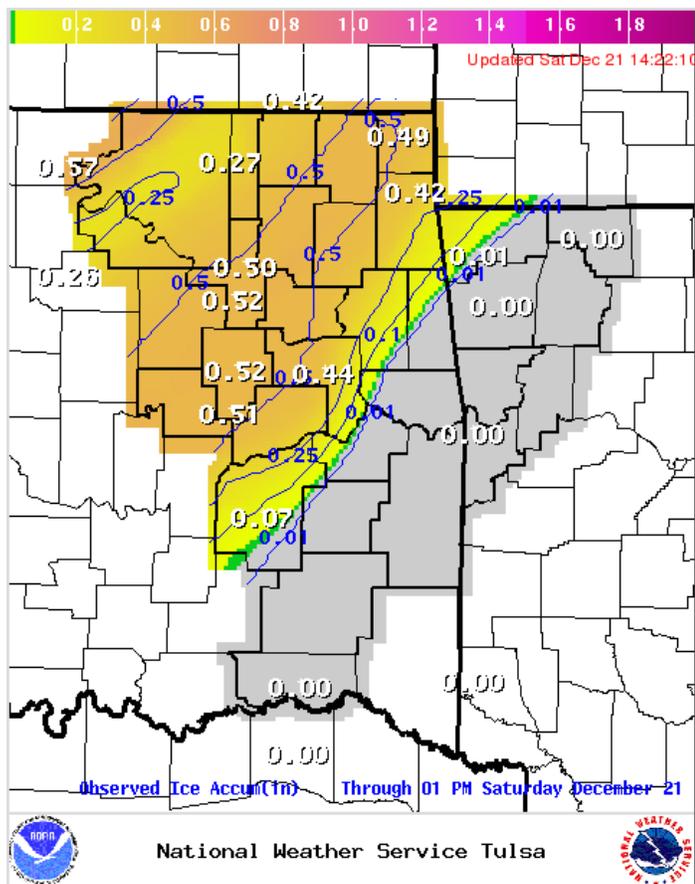


Fig. 10. Storm total ice accumulation estimate for the Dec. 20-21, 2013 ice storm event.

Tulsa, OK (TSA): Current 7-Day Observed Precipitation  
Valid at 12/23/2013 1200 UTC- Created 12/23/13 15:53 UTC

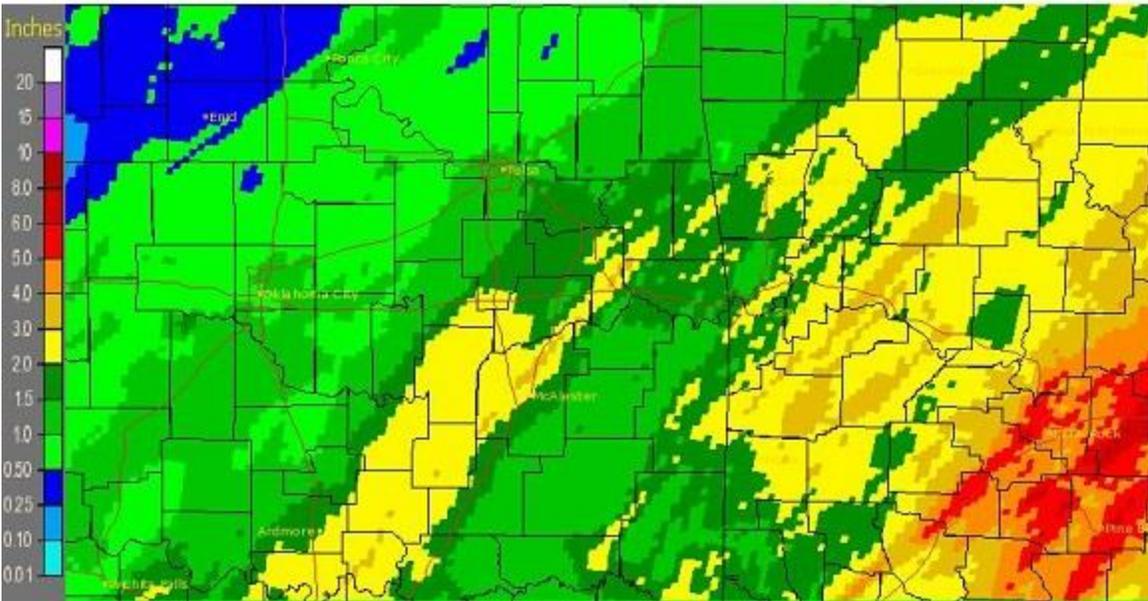


Fig. 11. 7-day estimated observed rainfall/ liquid equivalent ending 6am CST 12/23/2013. This is the storm total for the Dec. 20-21, 2013 ice storm event.

Some light snow fell on the 23<sup>rd</sup> generally north of Hwy 412 in northeast OK and northwest AR as a short-wave trough moved over the area. Most locations only received a flurries or a dusting of snow, but a few locations, including Bartlesville, had 0.50"-1" of snow.

Written by:

Nicole McGavock  
Service Hydrologist  
WFO Tulsa

**Products issued in December 2013:**

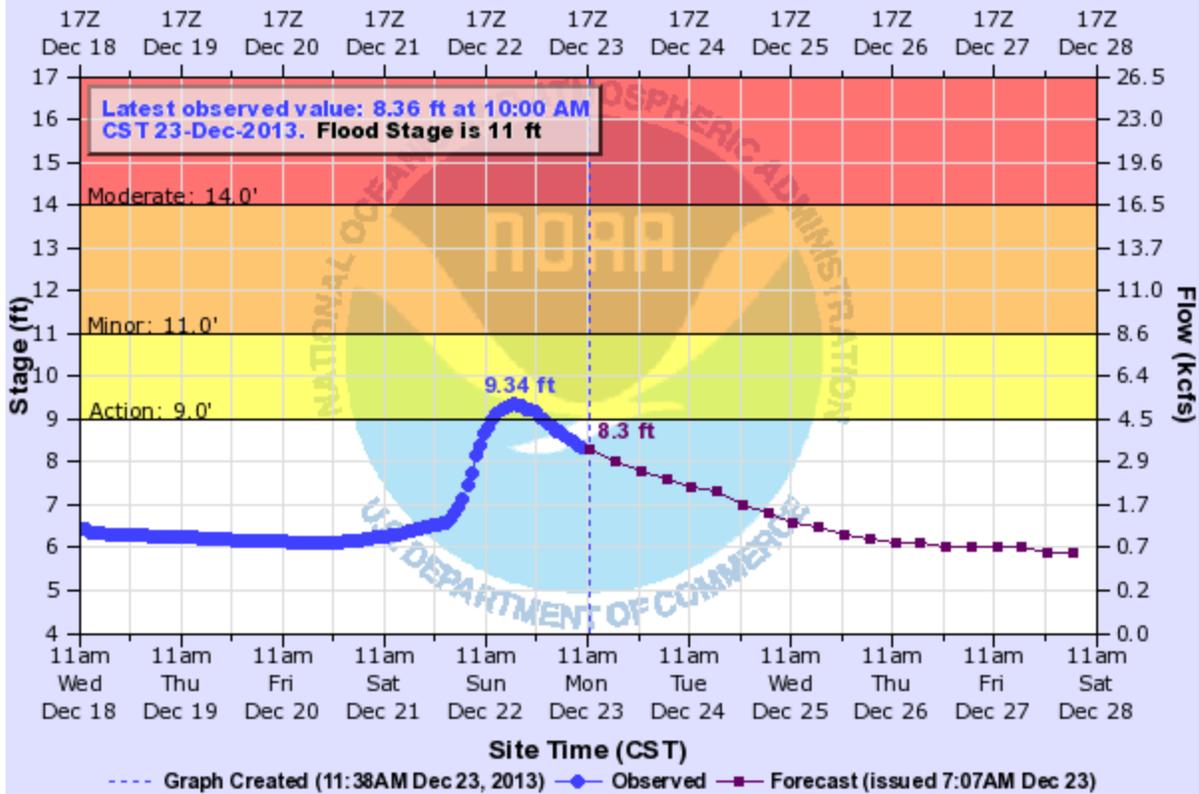
\*Mixed case River Flood products began July 31, 2013

- 0 Flash Flood Warnings (FFW)
- 0 Flash Flood Statements (FFS)
- 1 Flash/Areal Flood Watches (FFA) (6 Watch FFA CON/EXT/CAN)
- 0 Urban and Small Stream Advisories (FLS)
- 1 Areal Flood Warnings (FLW)
- 1 Areal Flood Statements (FLS)
- 1 River Flood Warnings (FLW)
- 1 River Flood Statements (FLS)
- 1 River Flood Advisories (FLS) (6 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:**

## ILLINOIS RIVER NEAR TAHLEQUAH

Universal Time (UTC)

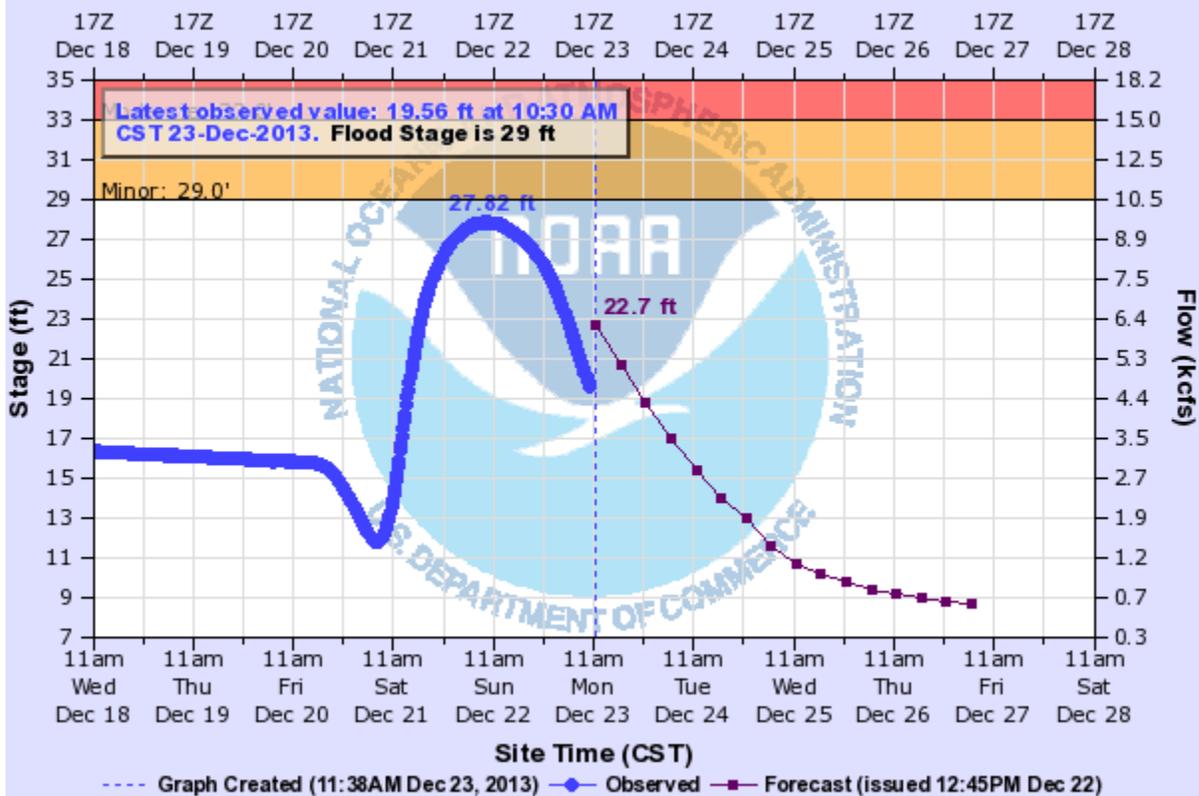


TALO2(plotting HGIRG) "Gage 0" Datum: 664.14'

Observations courtesy of US Geological Survey

## POTEAU RIVER NEAR PANAMA

Universal Time (UTC)



PANO2(plotting HGIRG) "Gage 0" Datum: 387.97'

Observations courtesy of US Geological Survey

**2013 Temperature and Precipitation Graphs:**



# Tulsa Oklahoma OK - 2013

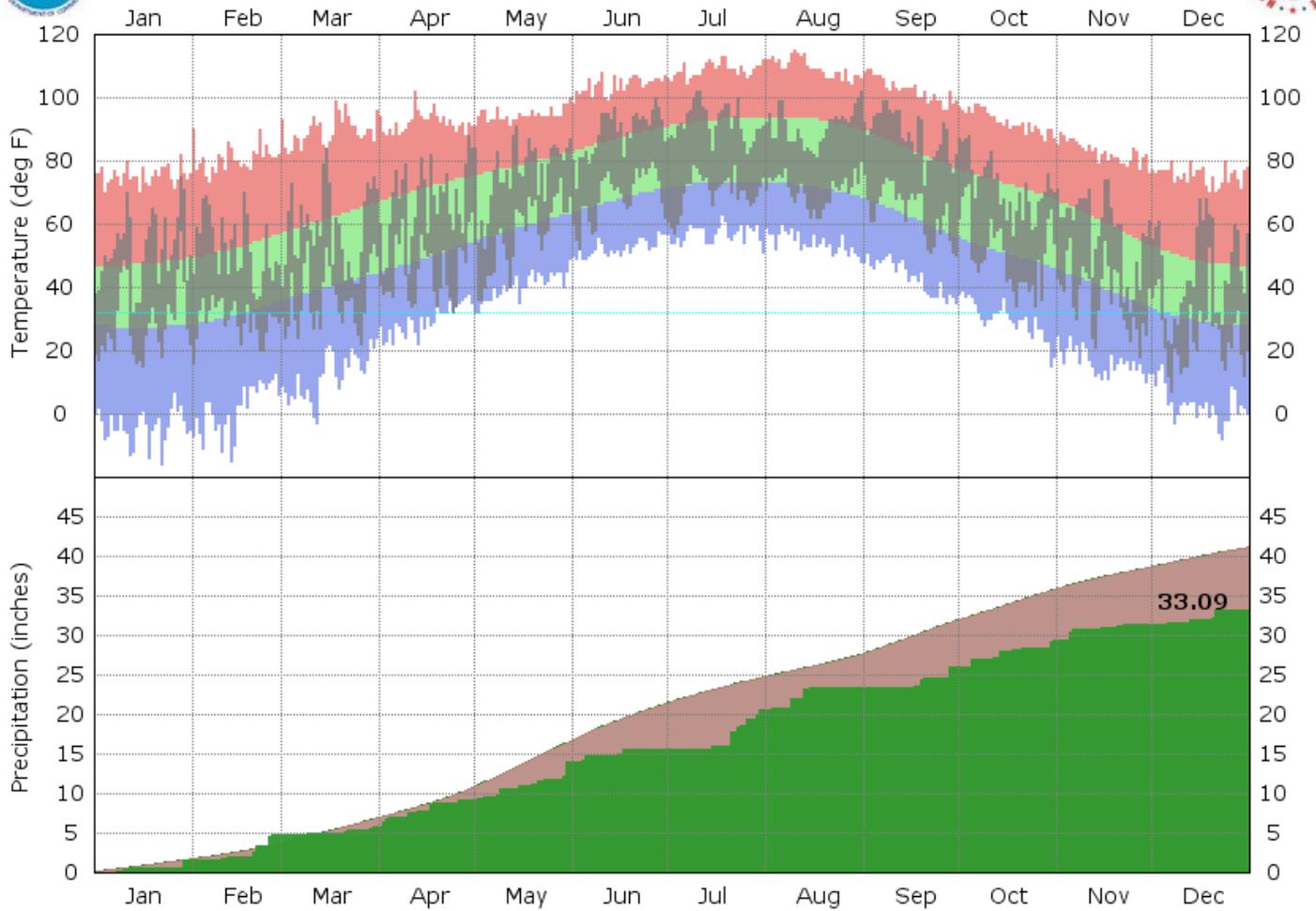


Image created: Wed, 1 Jan 2014 16:00 UTC



# Fort Smith Arkansas AR - 2013

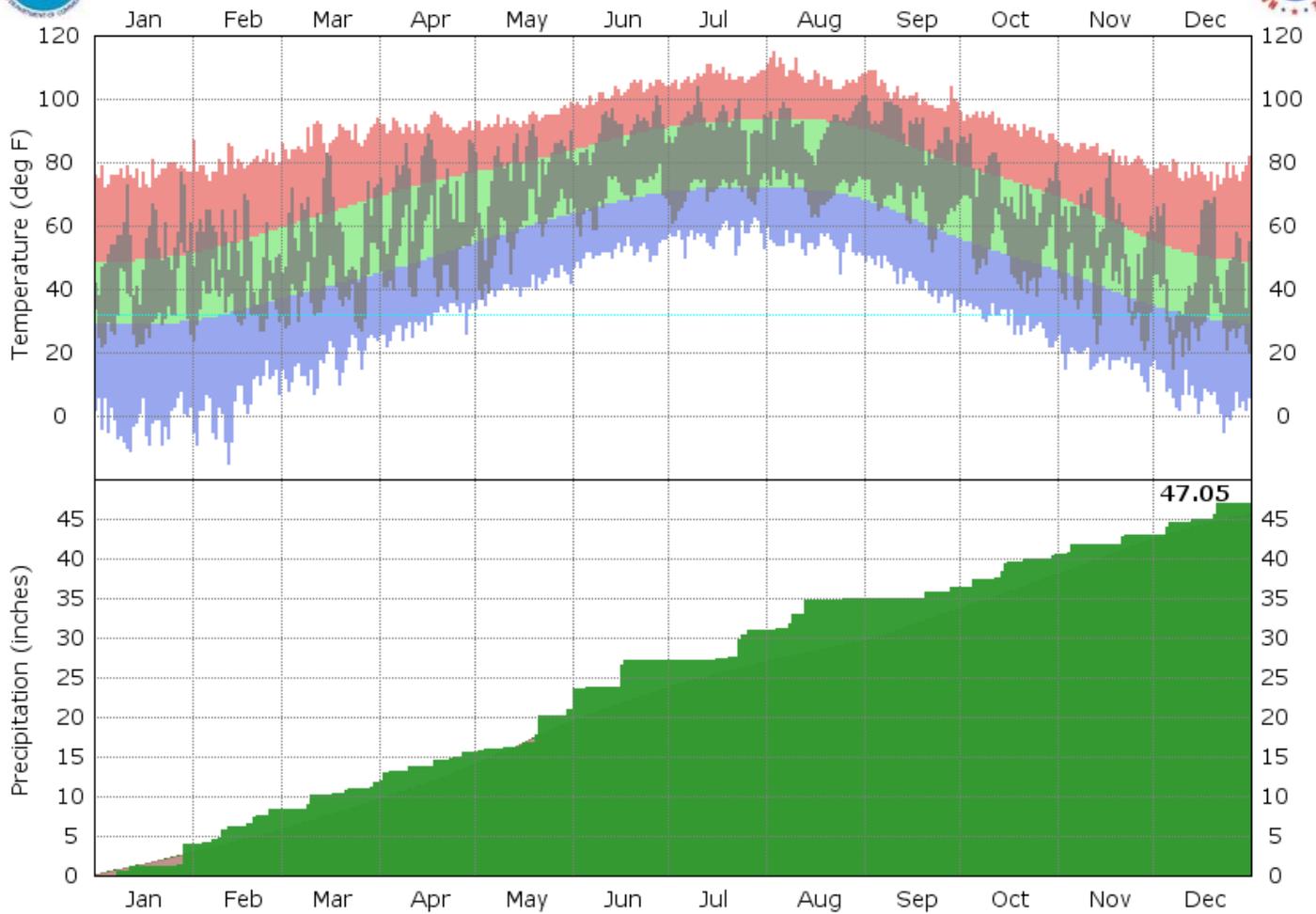


Image created: Wed, 1 Jan 2014 16:00 UTC



# Fayetteville Arkansas AR - 2013

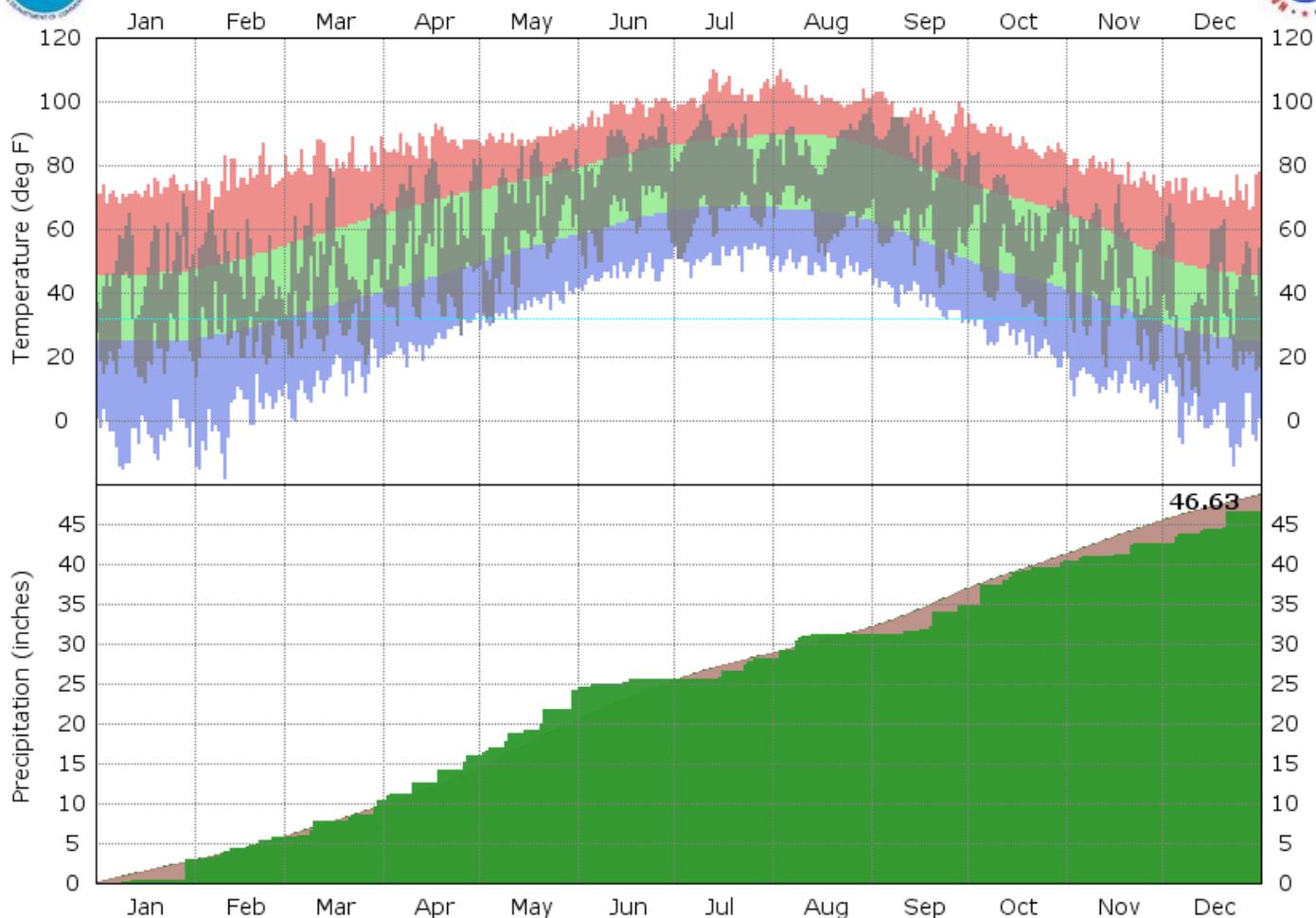


Image created: Wed, 1 Jan 2014 16:00 UTC



# Muskogee Oklahoma OK - 2013

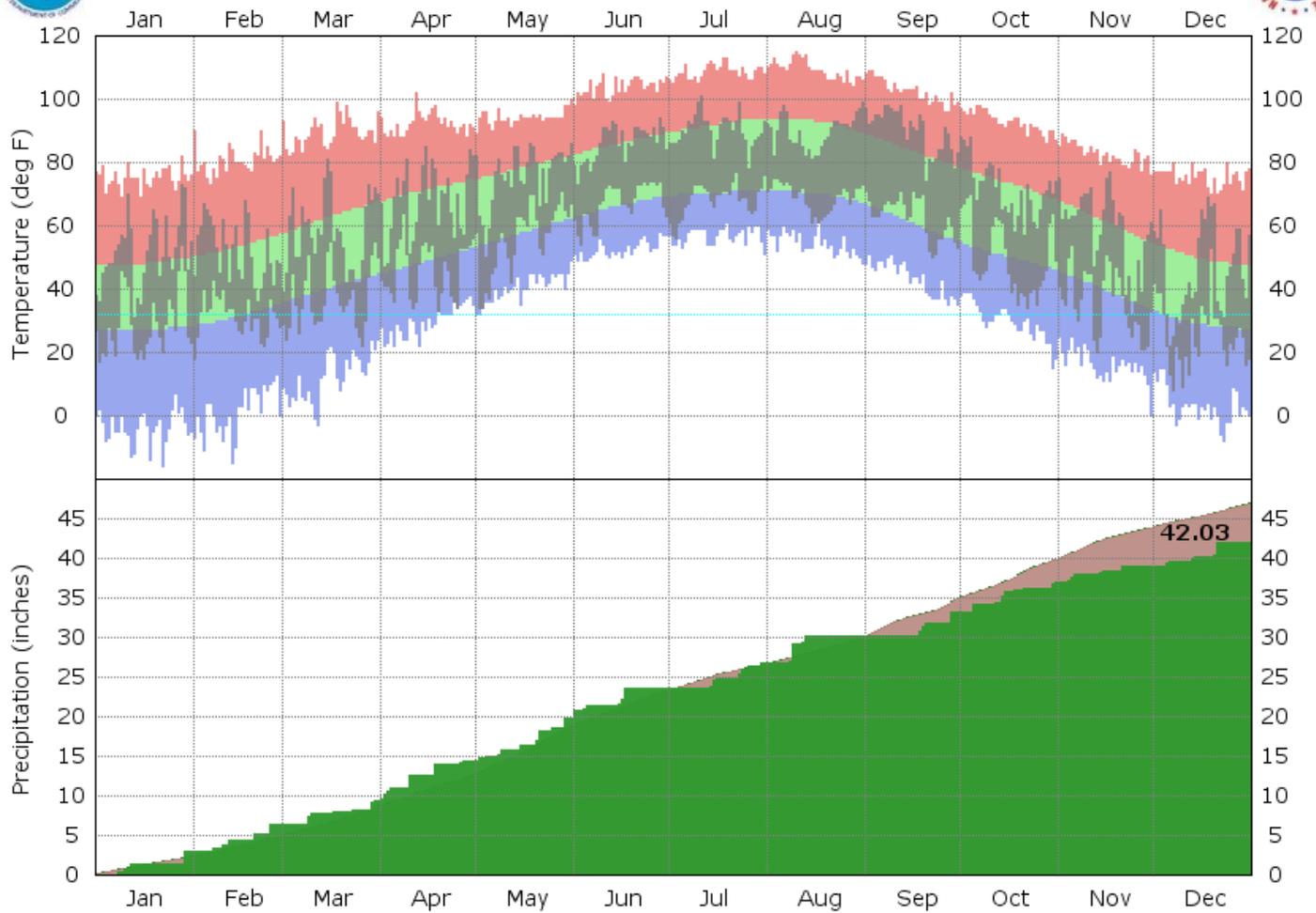


Image created: Wed, 1 Jan 2014 16:00 UTC



# Bartlesville Oklahoma OK - 2013

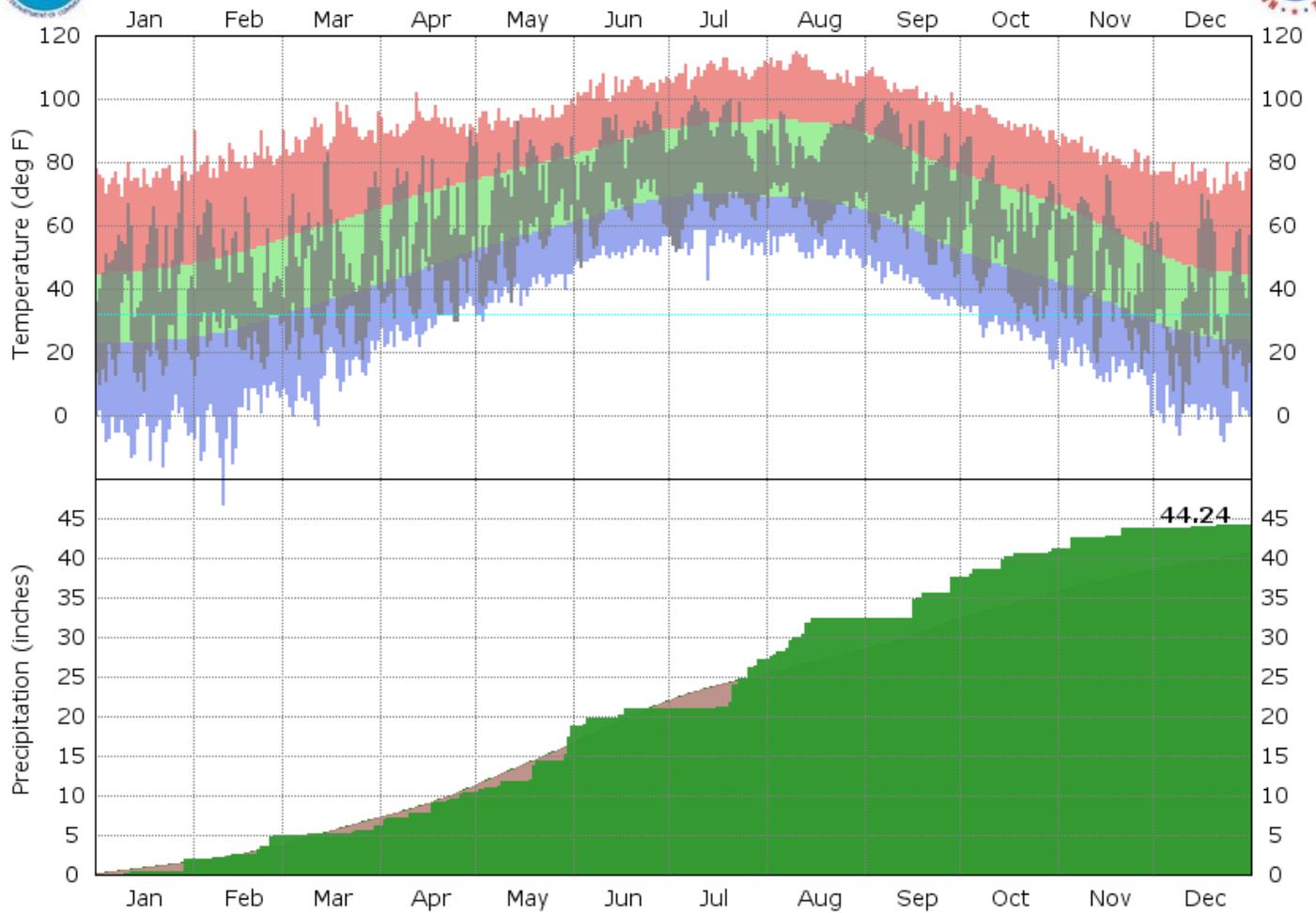


Image created: Wed, 1 Jan 2014 16:00 UTC



# Mcalester Oklahoma OK - 2013

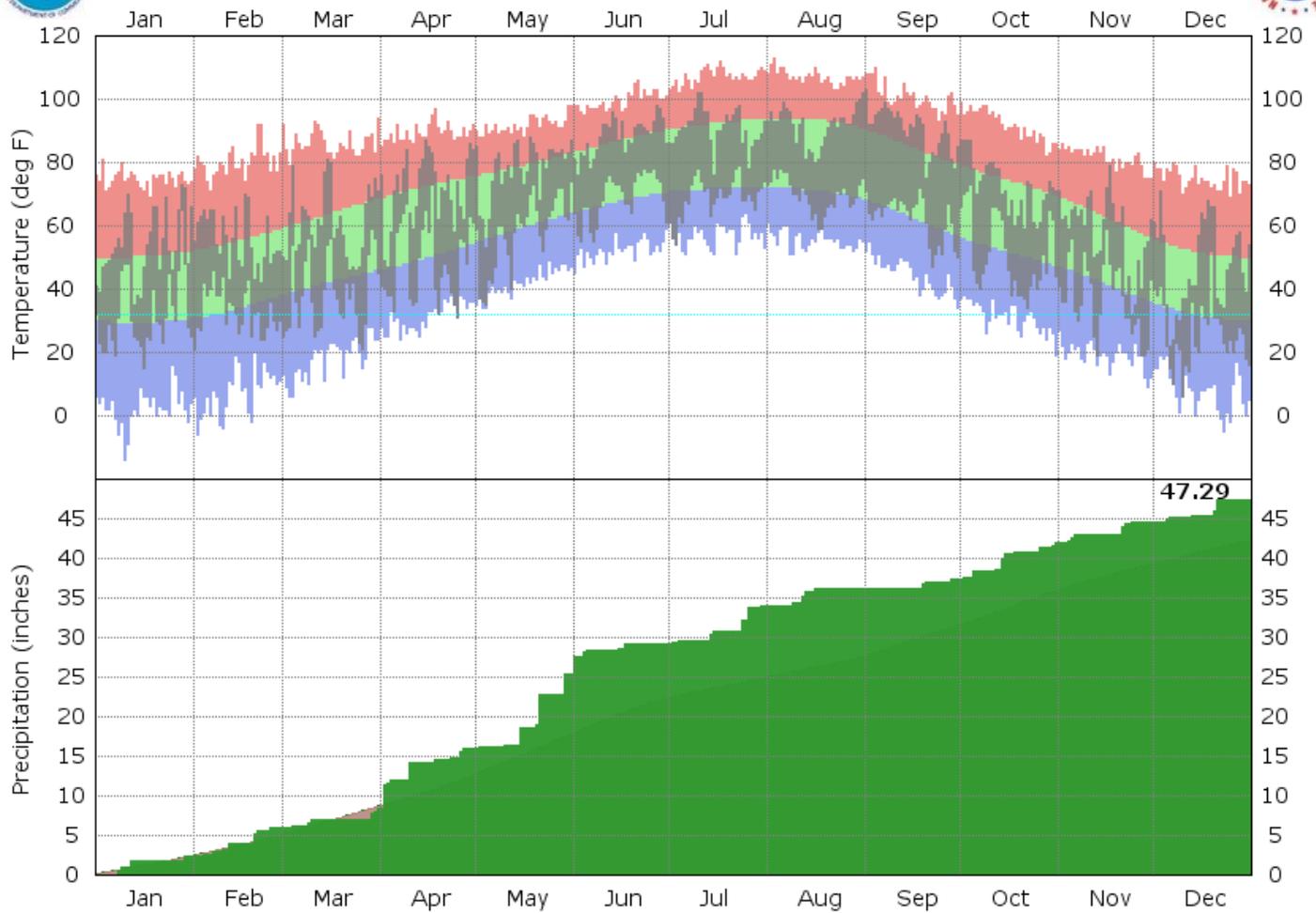


Image created: Wed, 1 Jan 2014 16:00 UTC