

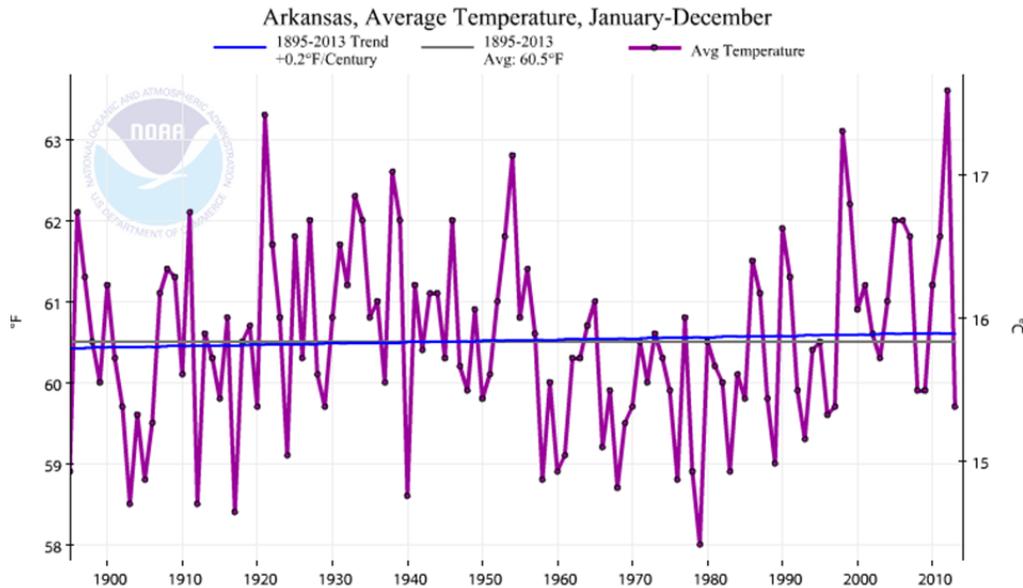
CLIMATE OF ARKANSAS

The Random House Dictionary defines climate as “the composite or generally prevailing weather conditions of a region, such as temperature, air pressure, humidity, precipitation, sunshine, and winds, throughout the year, averaged over a series of years.” Weather refers to conditions of the atmosphere over a short period of time. Climate is also concerned with the variability and probability of weather events.

The climate of Arkansas is classified as “humid subtropical.” Generally, there is a significant amount of precipitation in every month, and temperatures tend to be mild compared with the northern part of the country. Both temperatures and precipitation decrease from south to north. The Ouachita and Ouachita mountains also modify weather and climate. Generally, temperatures are lower in the mountains, and precipitation is higher, especially on windward slopes. The lowest temperatures are often found at the bottom of valleys where cold air drains from mountain tops.

TEMPERATURE

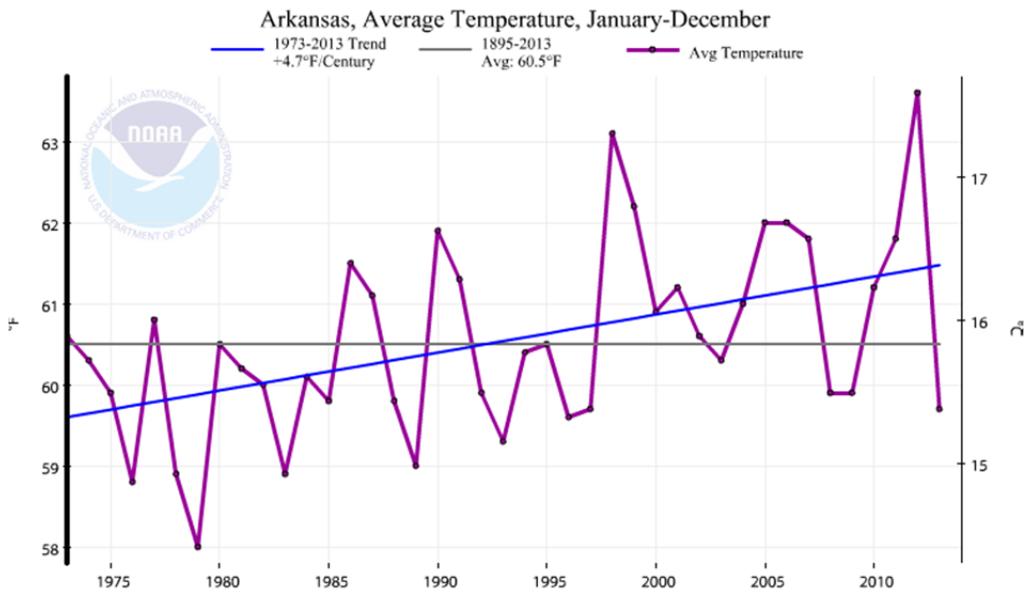
The significance of temperature is often better defined by variability, extremes, and trends rather than averages. Note the graph below shows that there is only a slight increase in temperature per century. Yet there is considerable year to year variability. For the period 1895 through 2013, the statewide average annual temperature in Arkansas varies from 58°F to 63.6°F. The 119 year average is 60.5°F.



Statewide, the coldest month is January, with an average low temperature of 29.3°F. July is the hottest, with an average high of 92.6°F. Monthly and annual averages are shown in the table on the next page.

Arkansas Average Monthly and Annual Temperatures, 1895-2013 (degrees Fahrenheit)													
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Maximum	49.5°	53.6°	62.8°	72.3°	80.0°	87.7°	91.6°	91.1°	84.9°	74.5°	61.4°	51.6°	71.8°
Minimum	29.3°	32.3°	40.0°	49.1°	57.6°	65.6°	69.1°	67.9°	61.0°	49.0°	38.7°	31.5°	49.3°
Average	39.4°	42.9°	51.4°	60.7°	68.8°	76.7°	80.3°	79.5°	72.9°	61.7°	50.1°	41.5°	60.5°

The chart below demonstrates an upward trend in temperature from 1973 through 2013.



Temperature and precipitation averages are often termed “normal”. Every ten (10) years the National Climatic Data Center (NCDC) computes 30-year climate normals. The current “normals” are for the period 1981 through 2010. The long term averages above vary from 0 to 1.0 degrees with the 30-year normals.

For more in-depth comparison across the State, please compare the Fayetteville COOP Experiment Station and the Pine Bluff COOP Station in the table on the next page. This table illustrates the frequency for occurrence for both high and low temperatures. It is not surprising that there are more days with below freezing temperatures in northwest Arkansas than the southeast, or that days exceeding 90° are more numerous in the southeast. And while the average number of days per year exceeding 100°F during this time period may appear relatively small, data outside this table demonstrate that Pine Bluff has experienced at least five years since 1895 with 40 or more days exceeding 100°F.

Extreme Temperature Comparisons for 1901-2013*
Fayetteville COOP Experiment Station and Pine Bluff COOP Station

	Fayetteville		Pine Bluff	
	Number	Year	Number	Year
Average number of days exceeding 90°F	47.4		83.8	
Most days exceeding 90°F	99	1954	124	1925
Average number of days exceeding 100°F	4.2		9.4	
Most days exceeding 100°F	40	1954	56	1954
Average number of days below 32°F	84.2		49.3	
Most days below 32°F	114	1960	84	1903
Average number of days below 10°F	6.5		0.9	
Most days below 10°F	20	1979	8	1983

* Exceeding and below also include "equal to".

The highest statewide summer average maximum temperature was 96.9°F in 1954, followed by 96.2°F in 1934, 95.7°F in 1936, and 94.8°F in 1943 and 2011. The lowest statewide winter average temperature was 24.2°F in 1918, followed by 24.6°F in 1978, 24.9°F in 1905, 25.0°F in 1977, and 25.5°F in 1899.

The record for the lowest temperature in Arkansas is -29°F at Pond in 1905, in northeast Arkansas. The highest temperature was 120°F at Ozark in 1936.

Growing season usually refers to the days between last and first frost, or approximately the last and first occurrence of 32°F. In the case of the Fayetteville Experiment Station, the average growing season is 194 days. The range over the period 1895 through 2003 is 159 to 237 days. The earliest frost free date is March 10, which occurred in 1905, 1995, 2003, and 2012. The earliest frost date in the fall was on November 23 in 2003. While there is a 90% probability of the frost-free period exceeding 174 days, there is only a 10% chance of exceeding 215 days.

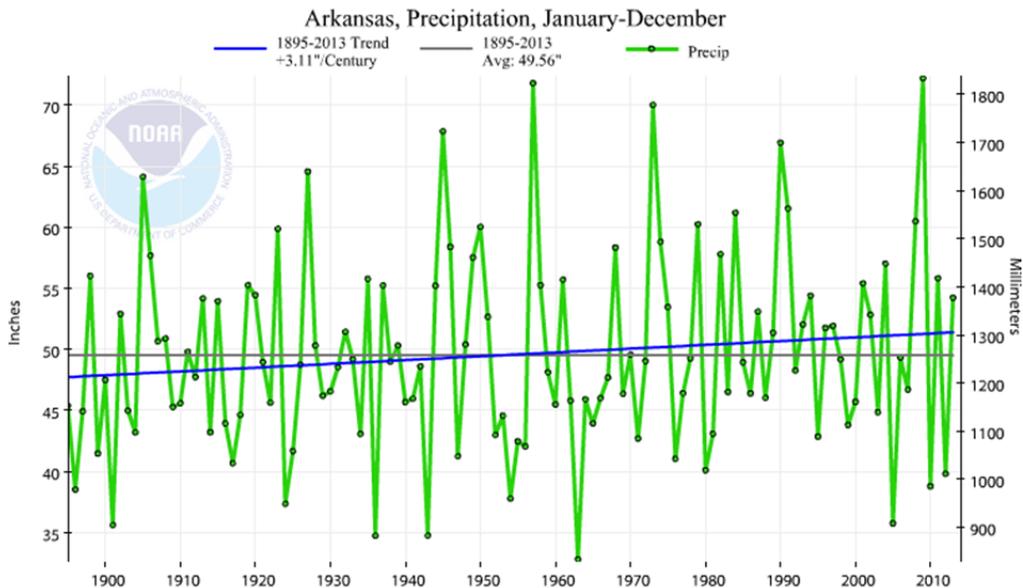
PRECIPITATION

Precipitation results from one or more sources: 1. middle latitude cyclones (lows), with warm, cold and other frontal situations, 2. tropical lows from the Gulf of Mexico, 3. thunderstorms, or 4. orographic uplift caused by hills and mountains. Middle latitude cyclones form at the boundary between cold air masses from the north and warm air masses from the south. While they can occur in any season, they are most common during the fall, winter and spring. They often produce widespread precipitation that does not vary substantially over small areas.

Thunderstorms are more of a warm season phenomena. They can produce intense showers over small areas. Tropical lows are associated with tropical cyclones (storms or hurricanes) that track overland from the Gulf. As air rises over hills and mountains, the lowering of air temperature can trigger condensation and/or instability.

Over the period from 1895 through 1913, the precipitation in Arkansas averaged 49.56 inches per year. The driest year was 1963, when the total precipitation averaged only 32.80 inches statewide. Other “top 5” dry years were 34.74” (1936), 34.76” (1943), 35.61” (1901), and 35.75” (2005). The wettest year was 72.20” (2009), followed by 71.78” (1957), 70.01” (1973), 67.86” (1945), and 66.91” (1990). Some may recognize significant flooding events in these years. For example, the Halloween and Christmas Eve flooding in parts of central Arkansas in 2009, flooding along the Mississippi River in 1973, flooding in Clinton in 1957, and flooding on the Arkansas River in 1990. The single year State record was set in 2009 when Leola in Grant County recorded 101.05 inches of precipitation. The highest average annual precipitation of 60.37 inches was at Big Fork in Polk County.

Below is a graph of the statewide annual precipitation amounts from 1895 through 2013. Note the sloping blue line which indicates an increase in precipitation of 3.11 inches per century, or approximately 1/3 inch per decade.



Arkansas Average Monthly and Annual Precipitation, 1895-2013
(inches)

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Precipitation	4.06	3.69	4.78	4.93	5.15	3.99	3.76	3.36	3.63	3.58	4.25	4.37	49.56

Summer is the driest season, and together with high temperatures and evaporation, produces more severe drought conditions. The driest summer over the 1895-2013 was 3.97” (1930), followed by 4.43” (1954), 4.49” (1980), 5.07” (1943), and 6.17” (1896). 1954 and 1980 were both hot and dry. Overall, summer precipitation shows a slight downward trend, but only 1.2 inches per century.

EVAPORATION

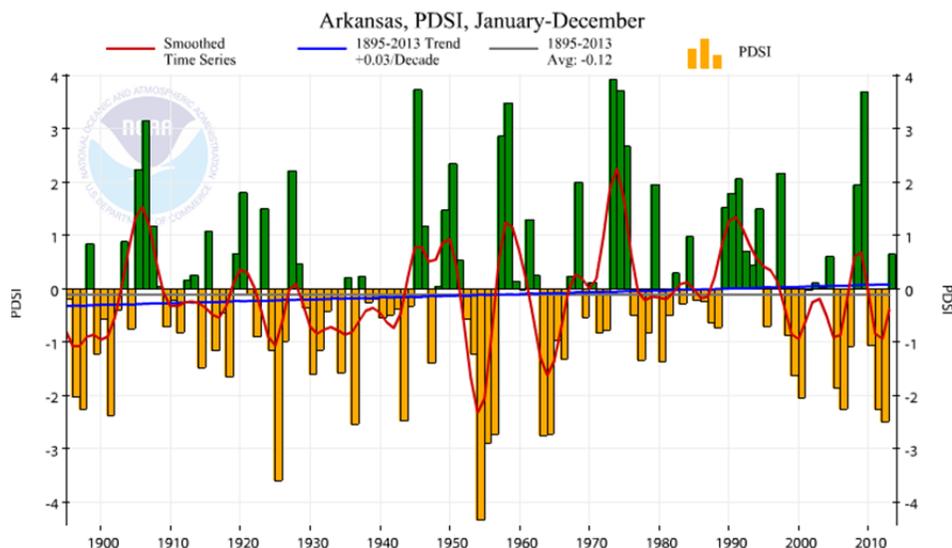
Evaporation is measured using fluctuation of water levels in an evaporation pan. The National Weather Service (NWS) does not maintain many evaporation stations. Only five stations, at Blue Mountain Dam, Blakely Dam, Millwood Dam, Narrows Dam, and Keiser are still in operation. Discontinued stations include Stuttgart, Russellville, Nimrod, Gillham, Hope, Norfolk, and Mountain Home.

Evaporation and evapotranspiration offset precipitation which may lead to serious water shortages, whether for water bodies such as lakes or soil moisture for plant growth. Examples of severe water shortage occurred in the summers of 1954 and 1980. For the entire summer, June through July, the Stuttgart 9 ESE COOP weather station measured only 3.99” and 2.04” of precipitation, respectively. The evaporation pans recorded 24.12” and 29.81” of evaporation. The average annual precipitation and evaporation for these summer months at Stuttgart is 10.15” and 22.23”, respectively. So even in an “average” precipitation and evaporation year, evaporation can far exceed precipitation.

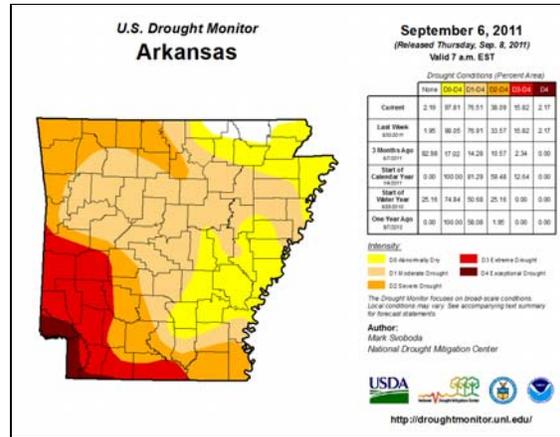
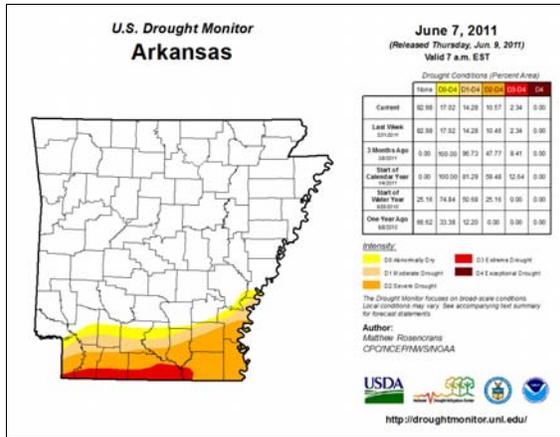
DROUGHT

The Palmer Drought Severity Index, devised in 1965, was the first drought indicator to assess moisture status comprehensively. It uses temperature and precipitation data to calculate water supply and demand, incorporates soil moisture, and is considered most effective for unirrigated cropland. It primarily reflects long-term drought and has been used extensively to initiate drought relief.

One way to compare historic droughts in Arkansas is to compare the PDSI for past years. Negative PDSI indicates drought conditions. While there are several periods of drought over the past 100+ years, some droughts persist over a number of years. Individual years with the highest negative drought index are 1954, 1925, 1955, 1963, and 1956. The drought of 1952-56 is the most intense drought over a 5-year period. The 1929-1944 period was interrupted by minor wet years in 1935 and 1937. More recently, drought episodes from 2005-2007 and 2010-2011 were interrupted by wet years, including the record-setting year of 2009.



Droughts can develop quickly, as occurred in 2011. Most of the State experienced heavy rains and flooding in April and May. The north central climate division recorded an average of nearly 33.5 inches of rainfall during those months. Drought conditions followed from June through October.



SNOWFALL

Snowfall helps recharge soil moisture, groundwater and streams during the winter. In the northern part of the State, there are areas that have annual snowfall averages between 10 and 15 inches. Record one-day totals are between 25 and 30 inches. Typically, a foot of snow has approximately 1 inch of water; therefore, snowfall is not a major contributor to the water balance.

SEVERE WEATHER

Arkansas is frequented by severe weather, especially during the spring. Severe weather events often take the form of ice storms, severe thunderstorms, high winds, hail, lightning, heavy rainfall, and tornadoes. Over the 1950-2013 period, 1,714 (26+per year) tornadoes caused 386 fatalities and \$1,766,880,000.00 in damages. Tornadoes generally track from southwest to northeast.

CLIMATE PREDICTION

Through Climate Prediction Center, the National Oceanographic and Atmospheric Administration (NOAA) tries to predict the weather at time frames from 6 days to 3 months. The prediction or outlook is for temperature, precipitation, hazards, and drought. In the case of temperature and precipitation, the outlook is characterized as the probability that these weather elements will be either below or above the “normal” for that time period. As individual weather systems approach, forecasters can begin to give more details concerning the actual temperatures and precipitation amounts (and type).

One of the factors used in predicting weather is the El Nino – La Nina phenomena. Most attention is given to the more studied El Nino. El Nino occurs when the Equatorial Pacific Ocean temperatures exceed normal conditions over several months. This results in heavy rainfall, including flooding, along the coast of Peru and Ecuador.

During winter El Niño episodes (top map) feature a strong jet stream and storm track across the southern part of the United States, and less storminess and milder-than-average conditions across the North. La Niña episodes (bottom map) feature a wave-like jet stream flow over the United States and Canada, with colder and stormier than average conditions across the North, and warmer and less stormy conditions across the South.

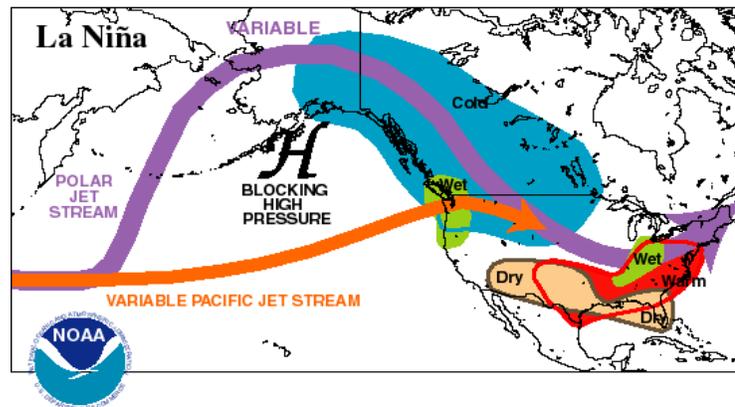
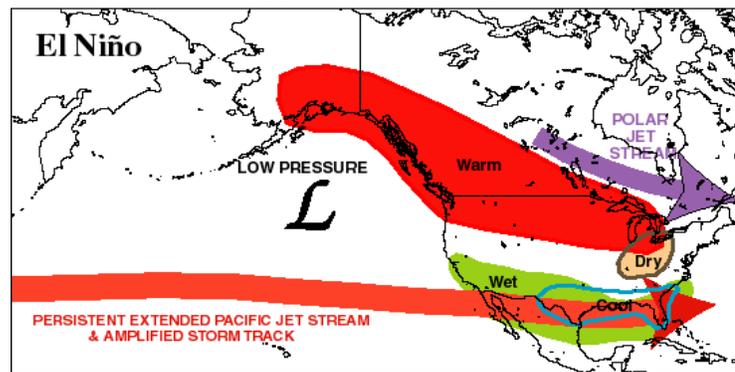
In Arkansas, the El Niño effect produces the most effect during the cooler half of the year. Historically, moderate to strong El Niño episodes in November-December have featured an increased frequency of near normal or above normal precipitation over the northern two-thirds of the State and above normal precipitation over the southern third. From January to March, El Niños result in nearly normal precipitation statewide.

El Niños vary in strength and effect on the weather. For 10 El Niño events from 1915 to 1992, during November-December, climate divisions in Arkansas averaged 119 to 135% of normal precipitation. January-March averages ranged from 87 to 103% of normal. The 1982-83 El Niño illustrates the more extreme potential impact on Arkansas. For the November-December timeframe, precipitation ranged from 194 to 248% of normal; for January-March, precipitation ranged from 45 to 84% of normal.

Other factors such as the Arctic Oscillation can influence weather in Arkansas. The Arctic Oscillation (AO) refers to an atmospheric circulation pattern over the mid-to-high latitudes of the Northern Hemisphere. The most obvious result of this oscillation is the north-to-south location of the storm-steering, mid-latitude jet stream.

The AO's positive phase is characterized by lower-than-average air pressure over the Arctic paired with higher-than-average pressure over the northern Pacific and Atlantic Oceans. The jet stream is farther north than average under these conditions and storms can be shifted northward of their usual paths. Thus, the mid-latitudes generally see fewer cold air outbreaks than usual during the positive phase of the AO.

TYPICAL JANUARY-MARCH WEATHER ANOMALIES AND ATMOSPHERIC CIRCULATION DURING MODERATE TO STRONG EL NIÑO & LA NIÑA



Climate Prediction Center/NCEP/NWS

Conversely, AO's negative phase has higher-than-average air pressure over the Arctic region and lower-than-average pressure over the northern Pacific and Atlantic Oceans. The jet stream shifts toward the equator under these conditions, so the globe-encircling river of air is south of its average position. Consequently, locations in the mid-latitudes are more likely to experience outbreaks of frigid, polar air during winters when the AO is negative.

AO episodes typically last only a few weeks and are difficult to predict more than a week or two in advance. A strong negative AO in mid-January, 2014 was reflected in average January temperatures in Arkansas that were 3 to 6 degrees below normal.

CLIMATE CHANGE

As noted earlier, since the 1970s average annual temperatures have increased, with considerable year-to-year variability. Annual precipitation shows a very small increase over those decades. The National Climate Assessment (NCA) and other studies indicate trends in the climate through the end of this century. Some of the predictions are already taking place.

- Since 1970, average annual temperatures have increased approximately 4.5°F. In the southeastern U.S., temperatures are expected to increase another 5 to 10°F at inland locations.
- The number of days with maximum temperatures exceeding 90°F is expected to increase. That number is expected to increase to up to 150 days. Heat indices are also on the rise.
- Precipitation is expected to increase slightly, but it will be offset by higher evapotranspiration rates.
- There are expected to be fewer below freezing days, and a longer growing season.
- There are expected to be a greater frequency of both intense rainfall (flooding) events and more prolonged heat waves and drought episodes.

Scientists attribute much of the climate change to increases in carbon emissions over the past decades. If their projections are correct, the effects will be widespread, affecting public health, agriculture, water availability, and forestry.

RESOURCES

Information for this climate section was obtained or computed from the following sources, available on the Internet:

- NOAA National Climate Center “Climate at a Glance”
- NOAA Pacific Marine Environmental Laboratory
- Southern Regional Climate Center, CLIMOD
- Tornado History Project
- U.S. Drought Monitor
- Cool Weather (records)