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CLIMATE OF MISSOURI

Missouri has a continental type of climate marked by strong seasonality. In winter, dry-cold air masses, unchallenged by any topographic barriers, periodically swing south from the northern plains and Canada. If they invade, reasonably humid air, snowfall and rainfall result. In summer, moist, warm air masses, equally unchallenged by topographic barriers, swing north from the Gulf of Mexico and can produce copious amounts of rain, either by fronts or by convectional processes. In some summers, high pressure stagnates over Missouri, creating extended droughty periods. Spring and fall are transitional seasons when abrupt changes in temperature and precipitation may occur due to successive, fast-moving fronts separating contrasting air masses.

Missouri experiences regional differences in climates, but these differences do not have obvious geographic boundaries. Regional climates grade inconspicuously into each other. Nevertheless, several basic principles help to understand climatic differences in Missouri.

The basic gradient for most climatic characteristics is along a line diagonally crossing the state from northwest to southeast. Both mean annual temperature and precipitation exhibit gradients along this line.

TEMPERATURE (Based on 1981-2010 Normals)

- Because of its inland location, Missouri is subject to frequent changes in temperature. While winters are cold and summers are hot, prolonged periods of very cold or very hot weather are unusual. Occasional periods of mild, above freezing temperatures are noted almost every winter. Conversely, during the peak of the summer season, occasional periods of dry-cool weather break up stretches of hot, humid weather.

Temperatures over 100° F are rare, but they have occurred in every section of the state. In the summer, temperatures rise to 90° F or higher on an average of 20 to 30 days in the north, central and Ozark Plateau region and 40 to 50 days in the south. Temperatures below zero are infrequent, but have occurred in every county in Missouri. On average there are 5 to 10 days a

year with below zero temperatures in the northern counties, 3 to 5 days in central sections and 1 to 2 days in the southern counties, although there are some winters when temperatures do not go below zero at all.

Mean January minimum temperature follows the northwest-to-southeast gradient, from a low of 13° in the northwest to a high of 26° in the southeast. However, mean July maximum temperature shows hardly any geographic variation in the state. Mean July maximum temperatures have a range of only five or six degrees across the state (86° to 92°), and the central Ozarks averages somewhat cooler July temperatures than other portions of southern Missouri.

All of Missouri experiences freezing temperatures every year. Annually, an average of about 120 days with temperature below 32° F in northern sections, 100 to 110 days across central parts and the Ozark Plateau, 90 to 100 days over southern sections, and about 70 such days in the Bootheel counties.

Missouri's growing season typically runs from April to October and, depending on where you live, can make a big difference when to expect your first or last frost. Missouri's latitudinal variation, the Ozark Plateau, river bottomlands, hills, valleys and populated areas are all factors contributing to frost potential. If you have an established climate record of temperatures for your region, and an idea of how local topography can affect temperature, you can use that knowledge in determining when, on average, to expect your first and last frost.

Typically, the first fall frost (≤ 32°F) occurs over northern and central Missouri by the second and third week of October, respectively. Similarly, the last spring frost occurs over northern and central Missouri by the third and second week of April, respectively. Frosts are more likely to be experienced earlier in the fall or later in the spring over the Ozarks when compared to central Missouri. The reason for this is due to the higher elevation of the Ozark Plateau which causes cooler temperatures in the Ozark region. As the Ozark Plateau transitions to the southeastern lowlands of the Bootheel, the average first fall frost generally occurs between the last week of October and the first week of November. Similarly, the average last spring frost varies from the second week of April to the end of March.

Another item to consider is local terrain where temperatures can be highly variable over small distances due to topography. Minimum temperatures can vary 10°F or higher over a short distance, say, from the bottom of a valley to a nearby hilltop. Cool air, being denser than warm air, moves down the slopes of hills, accumulating in the valleys. This is why low lying areas, such as river bottoms, will likely be colder than their surroundings on clear, calm nights. Therefore, while referring to the data and maps throughout this site, consider your local landscape when determining your average first frost date.

The metropolitan areas of St. Louis and Kansas City exert a significant and measurable effect on their climates. Temperatures are elevated in both regions by a few degrees, an effect known as the "urban heat island." More atmospheric particulates create a "dirtier" atmosphere of less

intense light and a greater abundance of condensation nuclei. Somewhat cloudier skies and more hours of very light precipitation may result, although the total amount of precipitation may not be greater than in non-metropolitan areas.

Minimum-recorded temperatures are lowest in northern and western Missouri. The lowest temperature officially recorded in Missouri is -40° at Warsaw on February 13, 1905. The highest temperature officially recorded in Missouri is 118° at Warsaw and Union on July 14, 1954.

PRECIPITATION (Based on 1981-2010 Normals) - Mean annual precipitation varies along the same gradient as temperature, from a low of 34 inches in the northwest to a high of 52 inches in the southeast. Seasonal climatic variations are more complex. In northwestern Missouri, seasonality in precipitation is very pronounced due to strong continental influences. June precipitation, for example, averages five times greater than January precipitation. In contrast, in southeastern Missouri, seasonality in precipitation is insignificant due to the greater influence of subtropical air masses throughout the year.

Mean January precipitation varies along the gradient from a low of 0.4 inches in the northwest to a high of 3.7 inches in the southeast. However, mean July precipitation is greatest in far northern sections of Missouri, largely the result of high-intensity convectional precipitation (just over 5 inches), and least in southwestern Missouri (3.3 inches). Though much less precipitation falls in northern Missouri in the winter than in the summer, it tends to be seasonally effective precipitation, since temperature and evaporation rates are much lower in winter.

Snow has been known to fall in Missouri as early as October, and as late as May. However, most of it falls in December, January, and February. As one would expect, the northern counties usually get the most snow. For the northern half of Missouri, the winter snowfall averages 15 to 22 inches and the average figure tapers off to 10 to 15 inches in the southern sections to less than 10 inches in the Bootheel. It is unusual for snow to stay on the ground for more than a week or two before it melts. Winter precipitation usually is in the form of rain, or snow, or both. Conditions sometimes are on the borderline between rain and snow, and in these situations freezing drizzle or freezing rain occurs. This does not usually happen more than five times in a winter season.

Spring, summer, and early fall precipitation comes largely in the form of showers or thunderstorms. Thunderstorms have been observed in Missouri during the winter months, but they are most frequent from April to July. Hail also occurs in all regions and may occur throughout the year, but it is much less likely in winter. May has the greatest number of days with hail. Measurable precipitation occurs on an average of about 100 days a year. About half of these will be days with thunderstorms. Occasionally, these produce some very heavy rains.

All of Missouri experiences “extreme” climate events, though infrequent in occurrence and often very geographically restricted, these “disturbances” produce environmental changes that may not otherwise have happened and that may be relatively long lasting in their effect. Among

these extreme climatic events are high-intensity rains, protracted drought, heat waves and cold waves, ice storms, windstorms, and tornadoes. These climatic events, in turn, may lead to other environmental disturbances such as floods, fires, landslides, and abrupt changes in plant and animal populations and distributions.

High-intensity precipitation characterizes all regions of Missouri. The town of Holt in northwestern Missouri holds the world record for a high-intensity rain, having received 12 inches within a 42-minute period on June 22, 1947. Once every two years in southwestern Missouri one should expect one precipitation event to produce at least 3.7 inches of rain in a 24-hour period. Over a five-year period, a ten-year period, a twenty-five-year period, a fifty-year period, and a hundred-year period one should expect one precipitation event to produce at least 4.8 inches, 5.6 inches, 6.6 inches, 7.3 inches, and 8.2 inches of rain respectively in a 24-hour period. Probabilities decline to the north and east away from southwestern Missouri.[+]

Table 1 provides information on state precipitation records and significant events.

Precipitation	**Year/Month(s)**	**State Average Precipitation (In.)**
Wettest Year:	1973	57.13
Driest Year:	1953	25.12
Wettest winter:	1949-50, Dec-Jan-Feb	11.11
Driest winter:	1962-63, Dec-Jan-Feb	2.36
Wettest spring:	1973, Mar-Apr-May	21.61
Driest spring:	1936, Mar-Apr-May	6.07
Wettest summer:	1951, Jun-Jul-Aug	20.17
Driest summer:	1936, Jun-Jul-Aug	3.88
Wettest autumn:	1941, Sep-Oct-Nov	18.90
Driest autumn:	1897, Sep-Oct-Nov	3.97
Wettest month:	1993, September	11.31
Driest month:	1986, January	0.10

Wettest Year:	Individual location: 1957, Portageville; 92.77 inches
Driest Year:	Individual location: 1910, Conception; 14.37 inches
Wettest day:	1965, July 20; 18.18 inches in Edgerton
Snowiest month:	1960, March; State average snowfall: 20.6 inches
Max month snowfall:	1960, March; 38.5 inches in Concordia
Deepest snow depth:	1960, March 19-20; 36 inches in Union
Latest heavy snowfall:	1907, May 3; 8 inches in Fairport
World record rainfall:	1947, June 22; 12 inches in 42 minutes in Holt

Table 1.

Flash flooding along minor streams following heavy thunderstorm rains, occur most frequently in the spring and early summer, April to July, but may occur during any month. Serious flooding occurs less frequently along the main stems of the Missouri and Mississippi Rivers and usually occurs during the spring and early summer. Main stem flooding may be caused by prolonged

periods of heavy rains, ice jams, or upstream flood crests synchronized with high tributary discharge. There are several flood control structures in the Missouri Basin above Kansas City, which may be expected to reduce upstream: flood crests in the future.

The Ozark region gets abundant rainfall in an average year, and has numerous streams and many springs. Several large lakes have been created by damming up streams, and these are centers for a growing tourist and vacation industry, besides providing electric power and flood control. In the northern counties, underground water is not as readily available as in other sections. More use is being made of small dams and farm ponds to impound surface water during seasons with abundant rainfall.

During years when precipitation comes in a fairly normal manner, moisture is stored in the top layers of the soil during the winter and early spring, when evaporation and transpiration are low. During the summer months the loss of water by evaporation and transpiration is high, and if rainfall fails to occur at frequent intervals, drought will result. Nearly every year some areas have short periods of drought in Missouri. There have been occasional years when the soil moisture has been depleted, arid when rains have failed to replace the water lost by evaporation and transpiration for prolonged periods. These conditions have caused widespread distress. With increasing population and more competition for the use of water, wise water management is becoming more important.

Drought may be conceptualized in different ways. Meteorological drought, based on precipitation records, is different from agricultural or soil-moisture drought and the physiological drought of plants. Drought is commonly thought of as a growing season phenomenon, but precipitation deficiency during colder months does affect moisture abundance during the following warmer months. Drought directly affects plant and animal life by limiting water supplies, especially at times of high temperatures and high evaporation rates. Drought indirectly affects life by increasing plant and animal susceptibility to disease and the probability of fire and the severity of any fire.

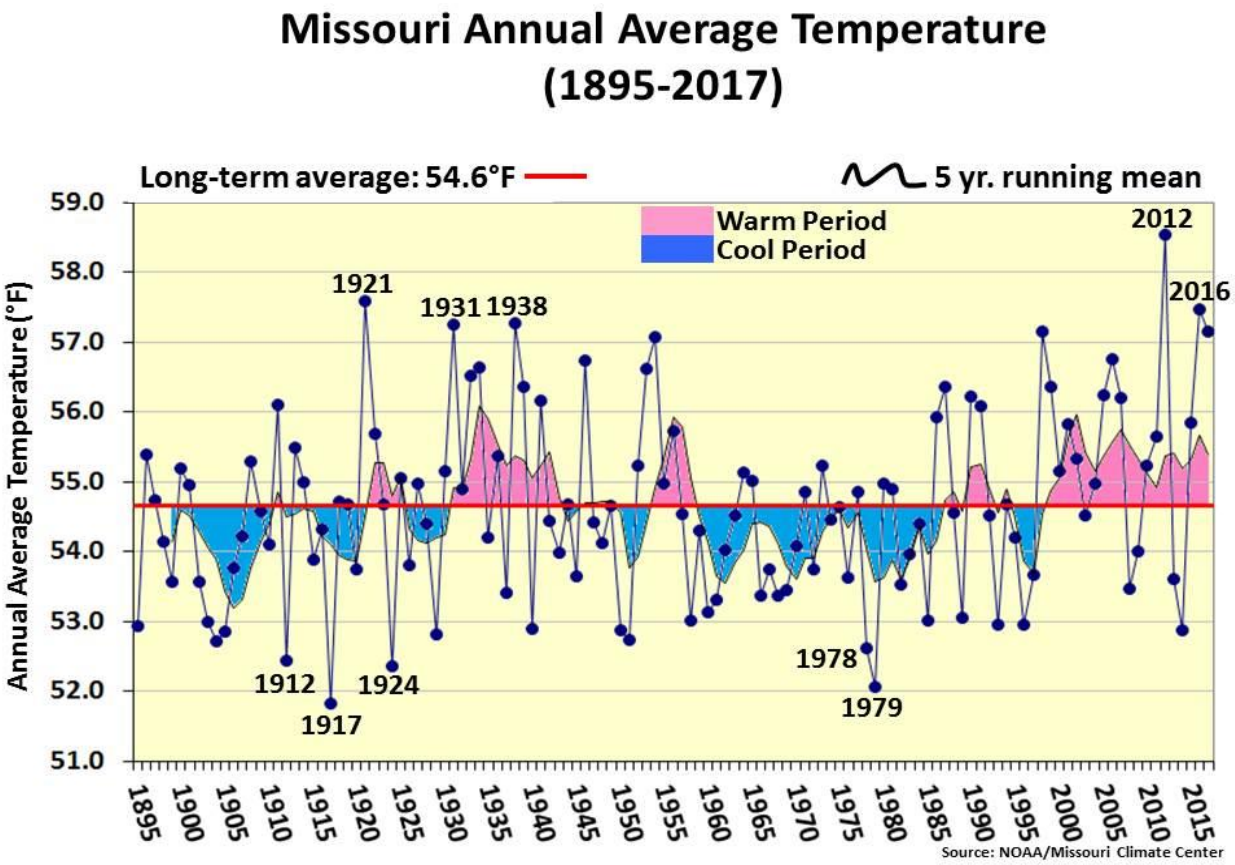
[+]**Reference:** Huff, Floyd A., and James R. Angel. Rainfall Frequency Atlas of the Midwest. Illinois State Water Survey, Champaign, Bulletin 71, 1992.

TOPOGRAPHIC INFLUENCES -Superimposed upon the basic statewide climatic patterns are local topographic influences that create topoclimatic, or microclimatic variations. In regions of appreciable relief, for example, air drainage at nighttime may produce temperatures several degrees lower in valley bottoms than on sideslopes. At critical times during the year, this phenomenon may produce later spring or earlier fall freezes in valley bottoms. Fog, heavy dew, and higher humidities are more common in low-lying areas. Deep sinkholes often have a microclimate significantly cooler, moister, and shadier than surrounding surfaces, a phenomenon that may result in a strikingly different ecology. Microclimate is also expressed by different wind speeds due to differences in the exposure of surfaces such as bluff faces. Higher daytime temperatures of bare rock surfaces and higher albedo (reflectivity) of unvegetated surfaces may create distinctive environmental niches such as glades and balds.

Slope orientation (direction) is an important topographic influence on climate. South-and-west-facing slopes are regularly warmer and drier than adjacent north- and-east-facing slopes. Finally, the climate within a canopied forest is measurably different from the climate of adjacent open areas where most standard weather stations are located.

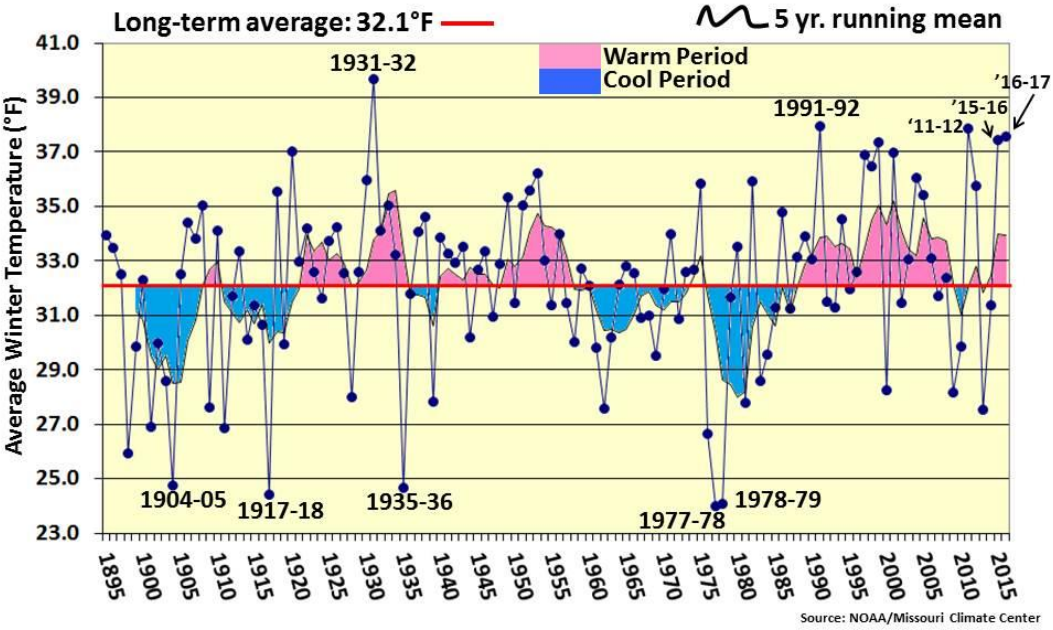
The various combinations of climate, terrain, and soil in Missouri have made possible several major types of farming. In the prairies of northern and west-central Missouri a combination of grain and livestock is most common. In the Ozarks, a large forest products industry is occurring. Farms in the Ozarks are usually small and quite varied in their products. In the southwestern counties there are numerous dairy, fruit, and vegetable-producing areas. The rich deep soil, abundant rain, and warm temperatures of the Bootheel section in southeastern Missouri have made possible a highly intensive kind of farming. Major crops are cotton, corn, and soybean. This area produces a large share of the cash value of all crops in Missouri each year.

MISSOURI CLIMATE CHARTS
Update through December 31, 2017



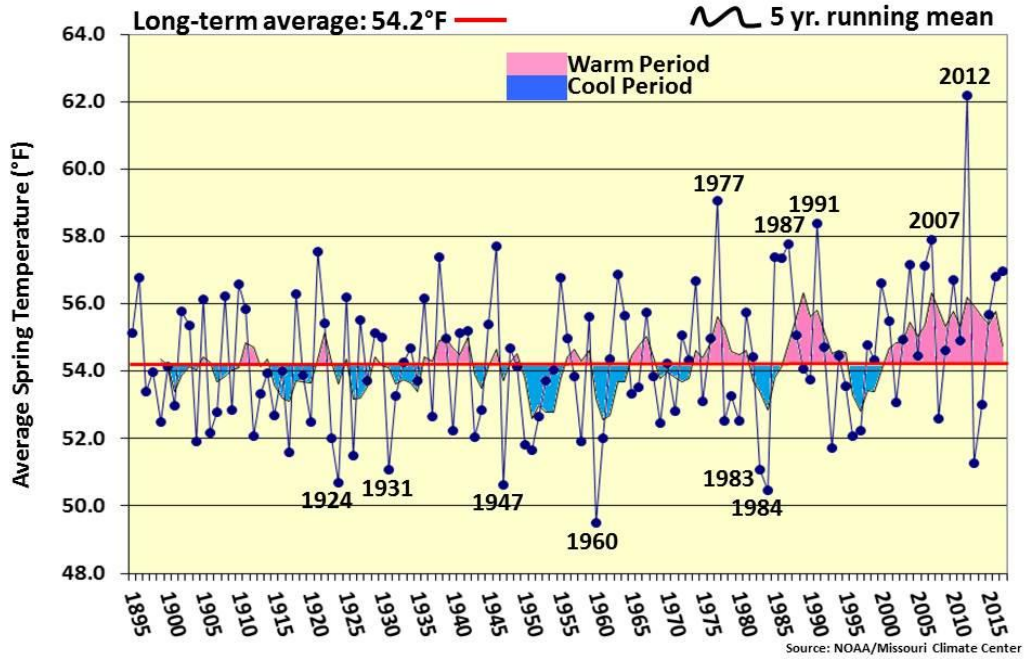
Missouri Average Winter Temperature
(Dec-Jan-Feb, 1895-2017*)

*The winter of 2017 is defined as Dec 2016 and Jan, Feb 2017



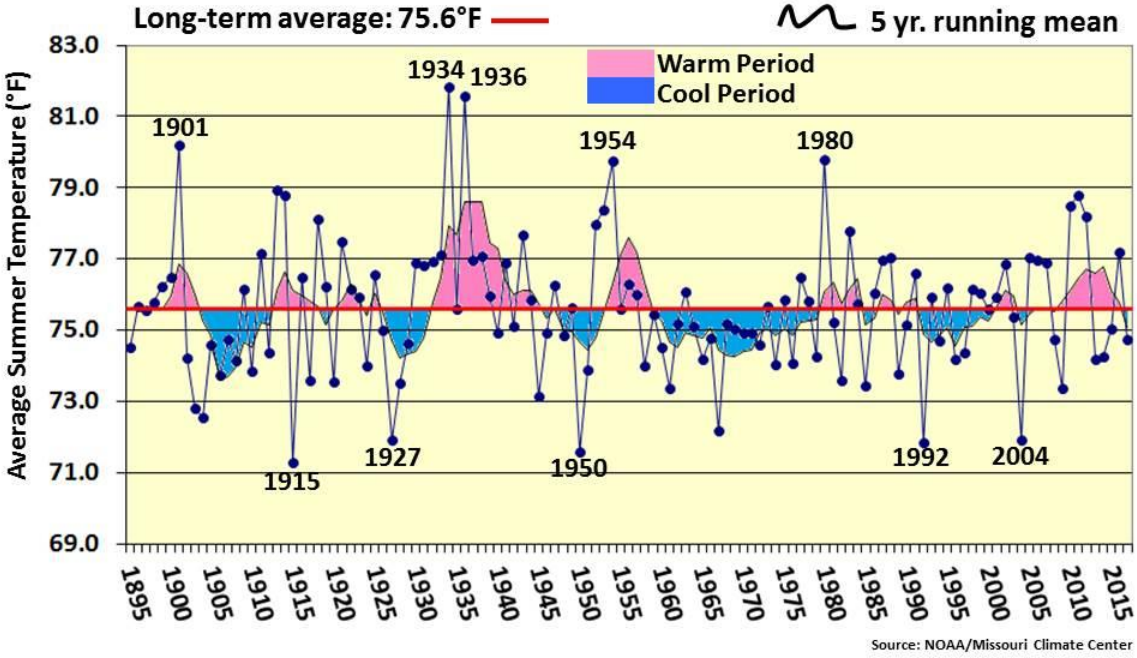
Source: NOAA/Missouri Climate Center

Missouri Average Spring Temperature
(Mar-Apr-May, 1895-2017)

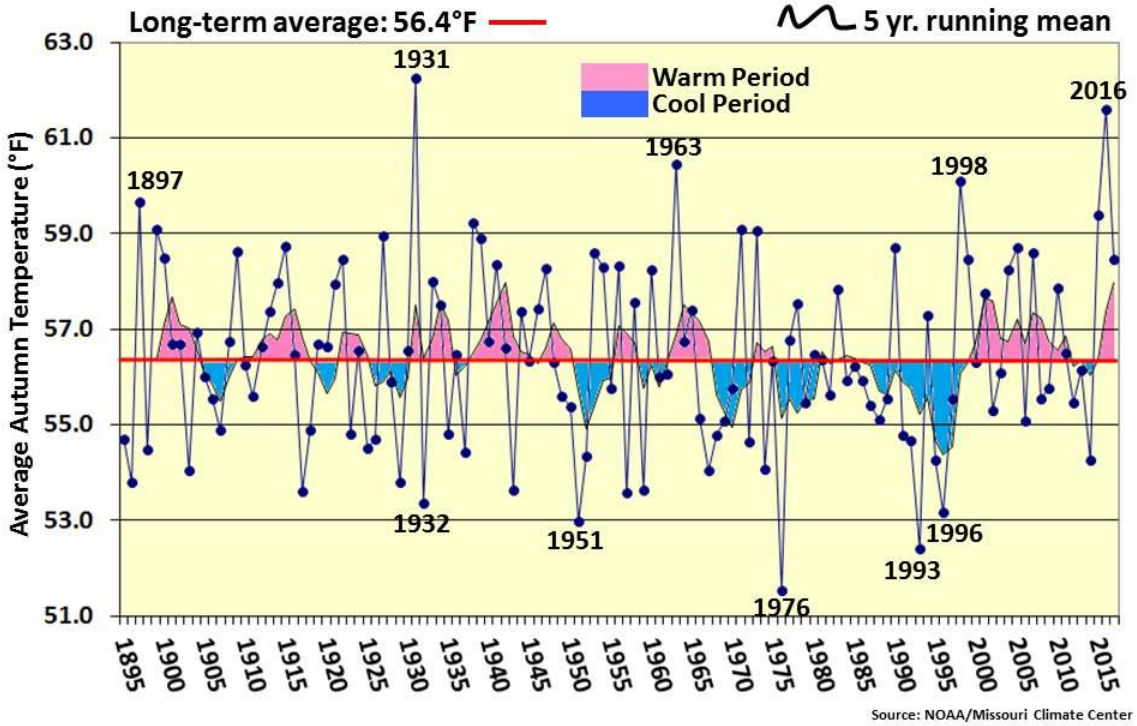


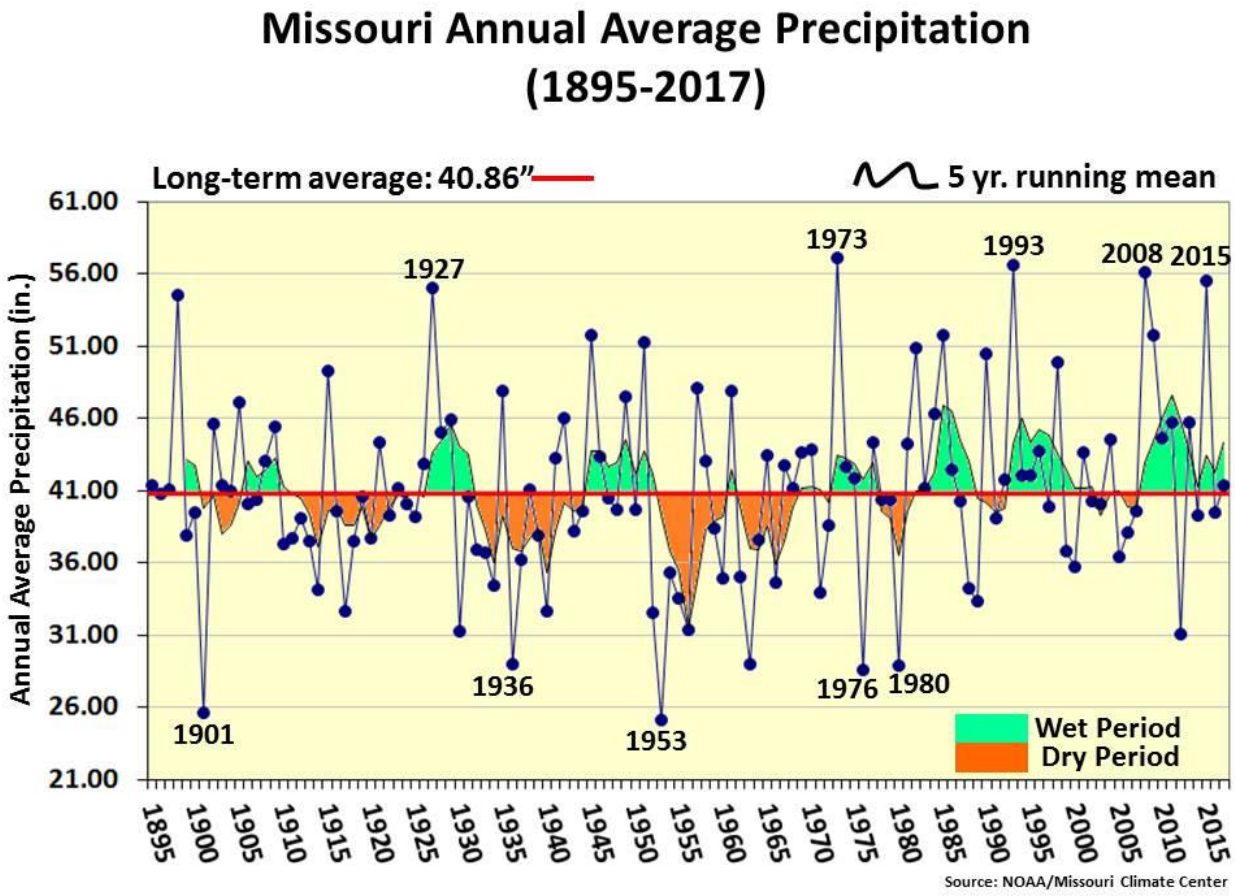
Source: NOAA/Missouri Climate Center

Missouri Average Summer Temperature
(Jun-Jul-Aug, 1895-2017)



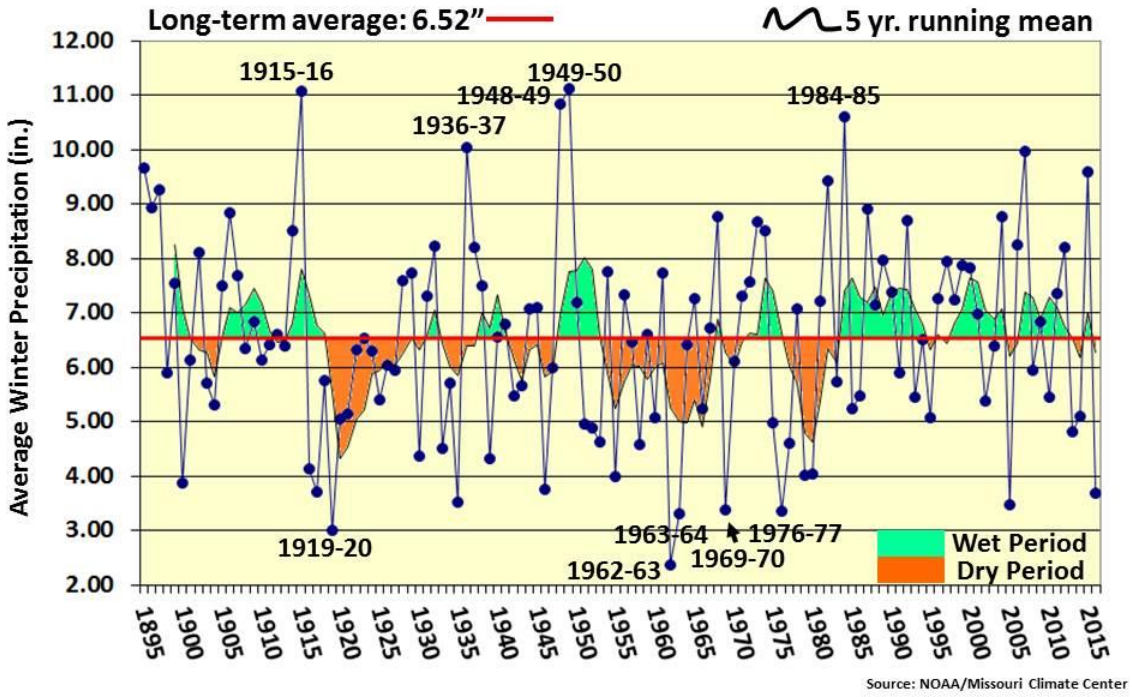
Missouri Average Autumn Temperature
(Sep-Oct-Nov, 1895-2017)




Missouri Annual Average Precipitation
(1895-2017)
Long-term average: 40.86"
5 yr. running mean
Annual Average Precipitation (in.)
61.00
56.00
51.00
46.00
41.00
36.00
31.00
26.00
21.00
1927
1973
1993
2008
2015
1901
1936
1953
1976
1980
Wet Period
Dry Period
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Source: NOAA/Missouri Climate Center

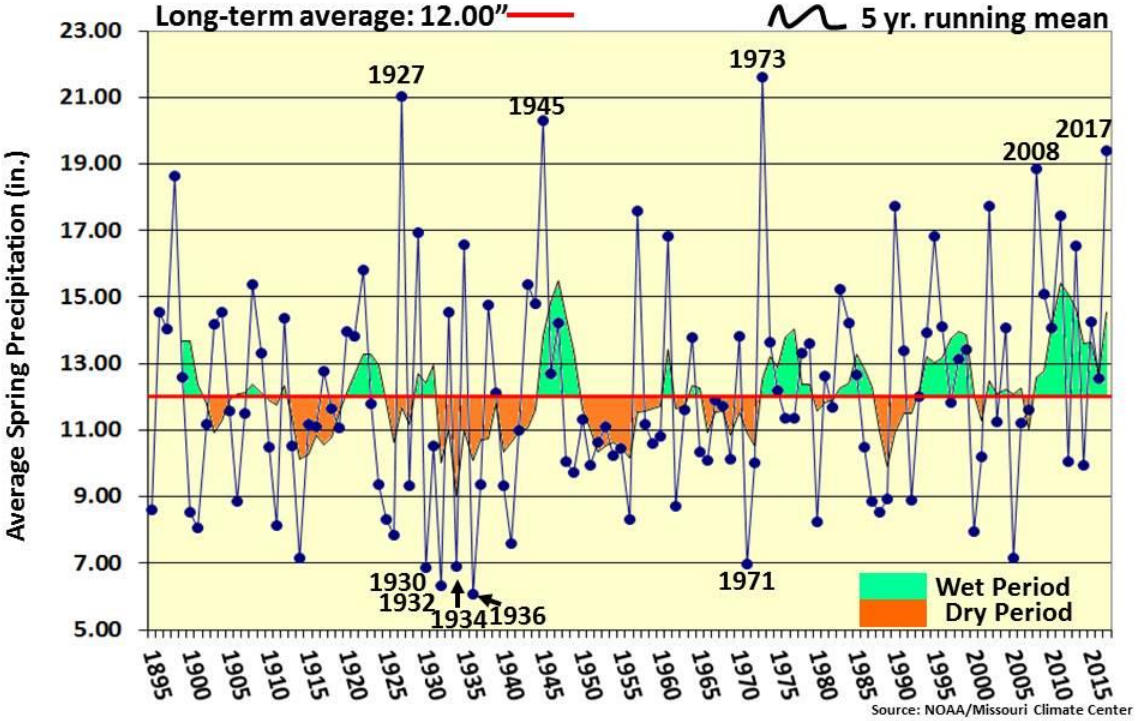
Missouri Average Winter Precipitation
(Dec-Jan-Feb, 1895-2017*)

*The winter of 2017 is defined as Dec 2016 and Jan, Feb 2017



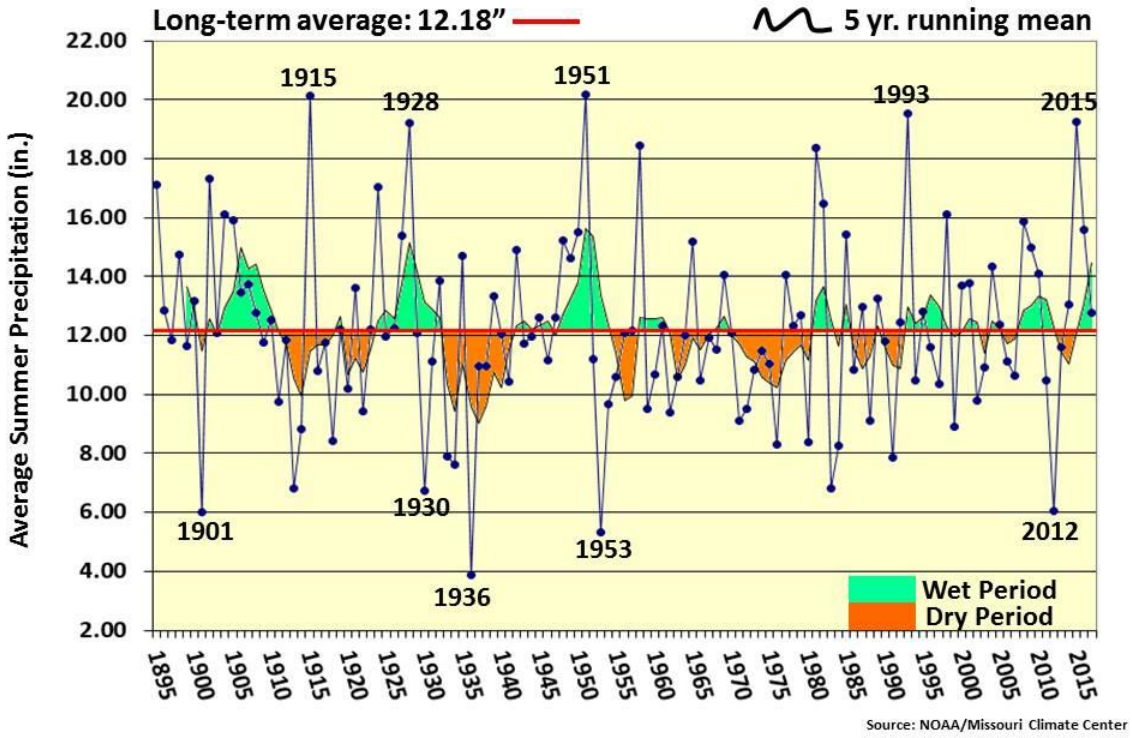
Source: NOAA/Missouri Climate Center

Missouri Average Spring Precipitation
(Mar-Apr-May, 1895-2017)



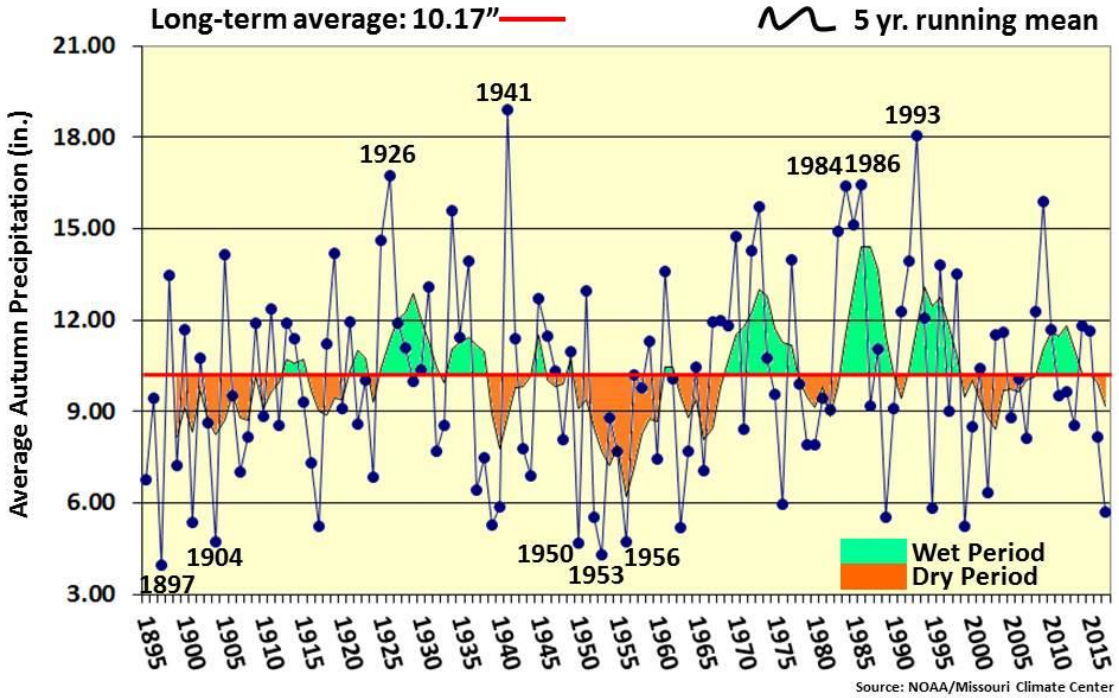
Source: NOAA/Missouri Climate Center

Missouri Average Summer Precipitation
(Jun-Jul-Aug, 1895-2017)



Source: NOAA/Missouri Climate Center

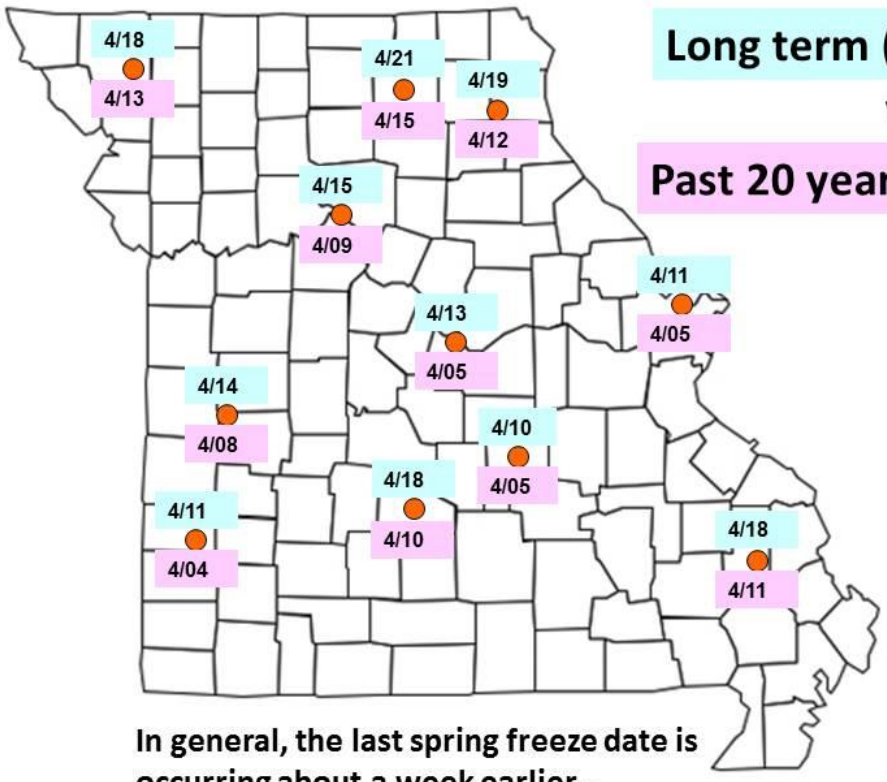
Missouri Average Autumn Precipitation
(Sep-Oct-Nov, 1895-2017)



Source: NOAA/Missouri Climate Center

MISSOURI CLIMATE TRENDS
Updated through December 31, 2017

Median Date of Last Spring Frost (≤ 32°F)



Long term (1895-2017)

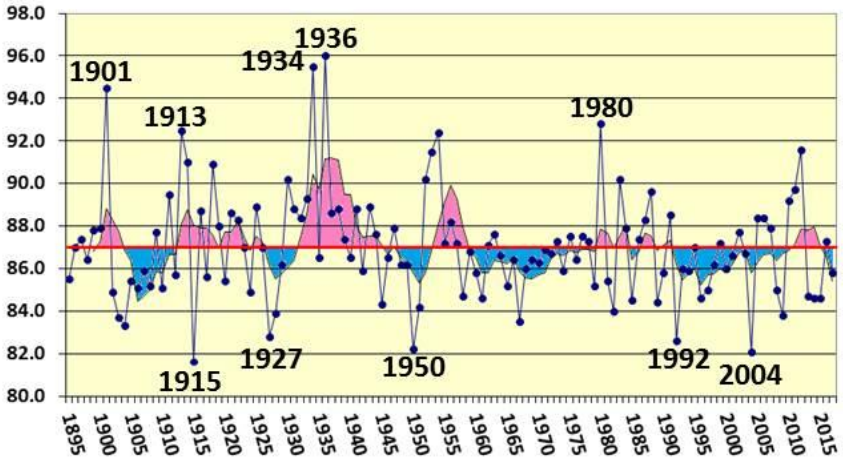
vs.

Past 20 years (1998-2017)

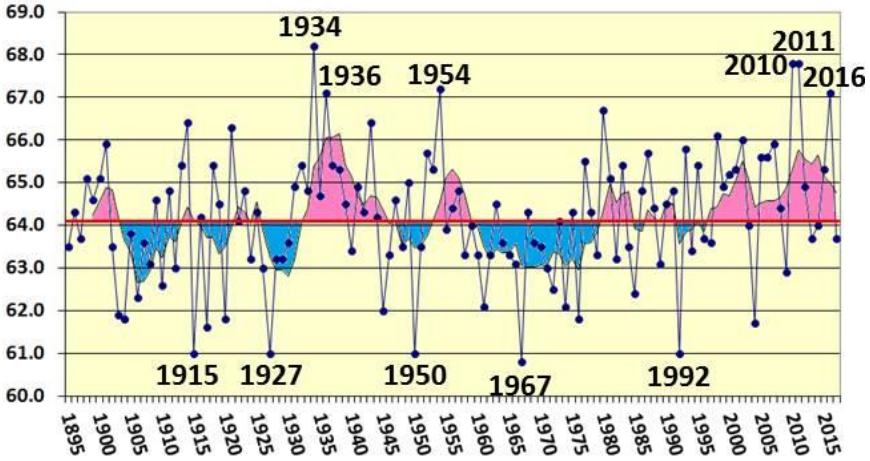
In general, the last spring freeze date is occurring about a week earlier…

Source: NOAA/Missouri Climate Center

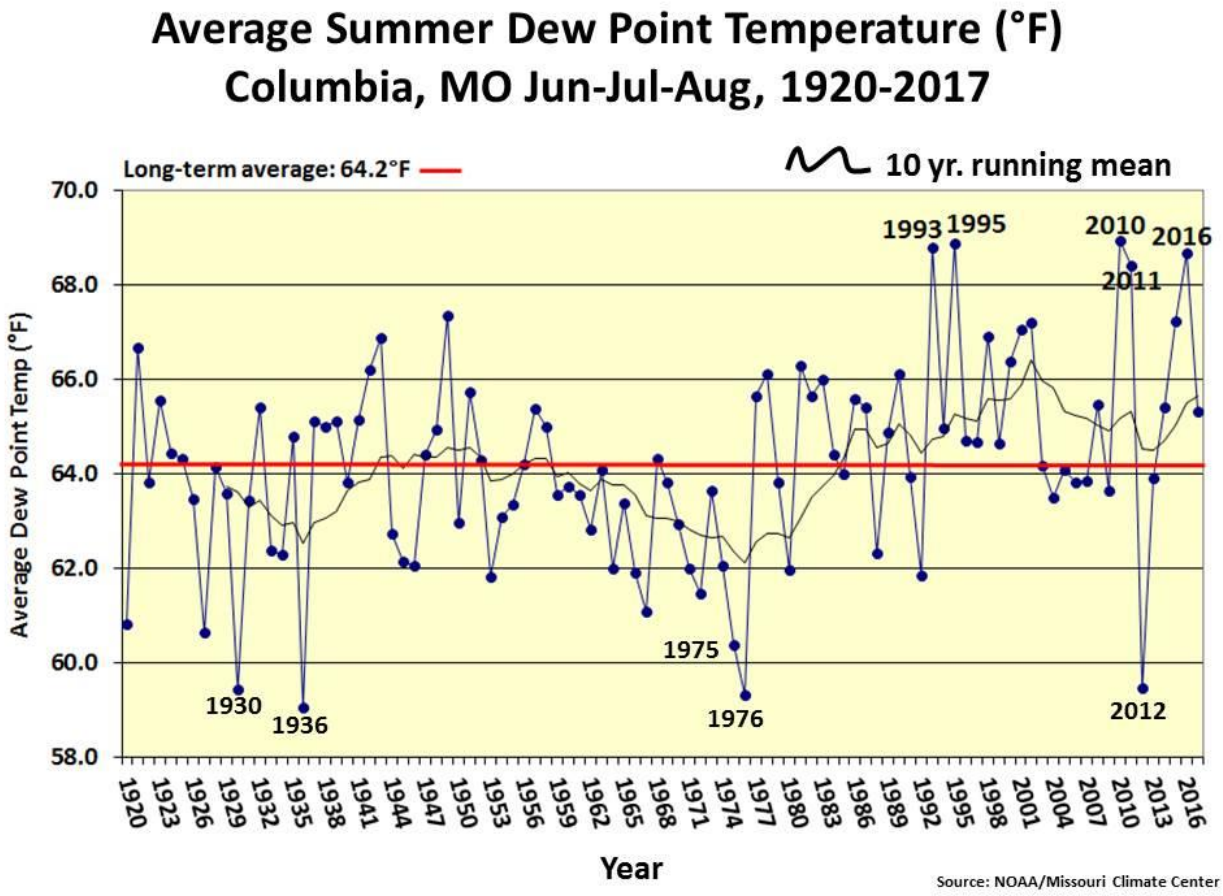
Missouri Average Summer Maximum Temperature (Jun-Jul-Aug, 1895-2017)



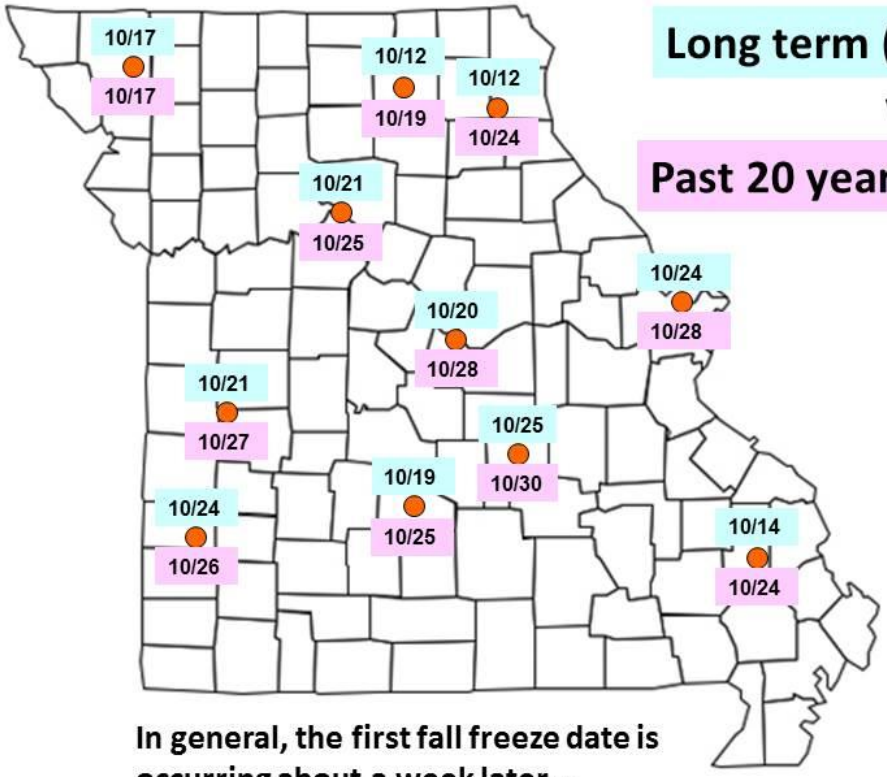
Missouri Average Summer Minimum Temperature (Jun-Jul-Aug, 1895-2017)



Source: NOAA/NCEI/Missouri Climate Center


Average Summer Dew Point Temperature (°F)
Columbia, MO Jun-Jul-Aug, 1920-2017
Long-term average: 64.2°F
10 yr. running mean
Average Dew Point Temp (°F)
70.0
68.0
66.0
64.0
62.0
60.0
58.0
1993
1995
2010
2016
2011
1930
1936
1975
1976
2012
1920 1923 1926 1929 1932 1935 1938 1941 1944 1947 1950 1953 1956 1959 1962 1965 1968 1971 1974 1977 1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016
Year
Source: NOAA/Missouri Climate Center

Median Date of First Fall Frost (≤ 32°F)



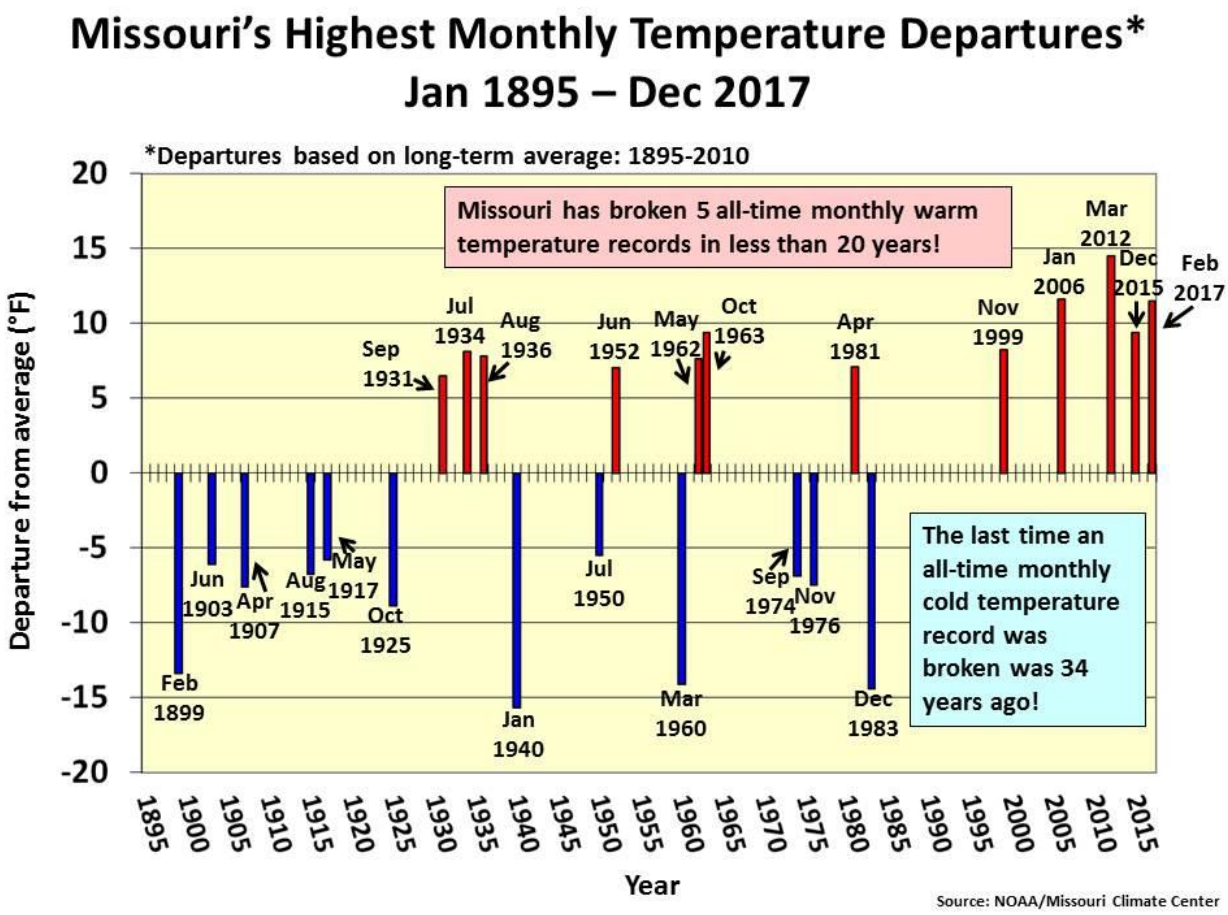
Long term (1895-2017)

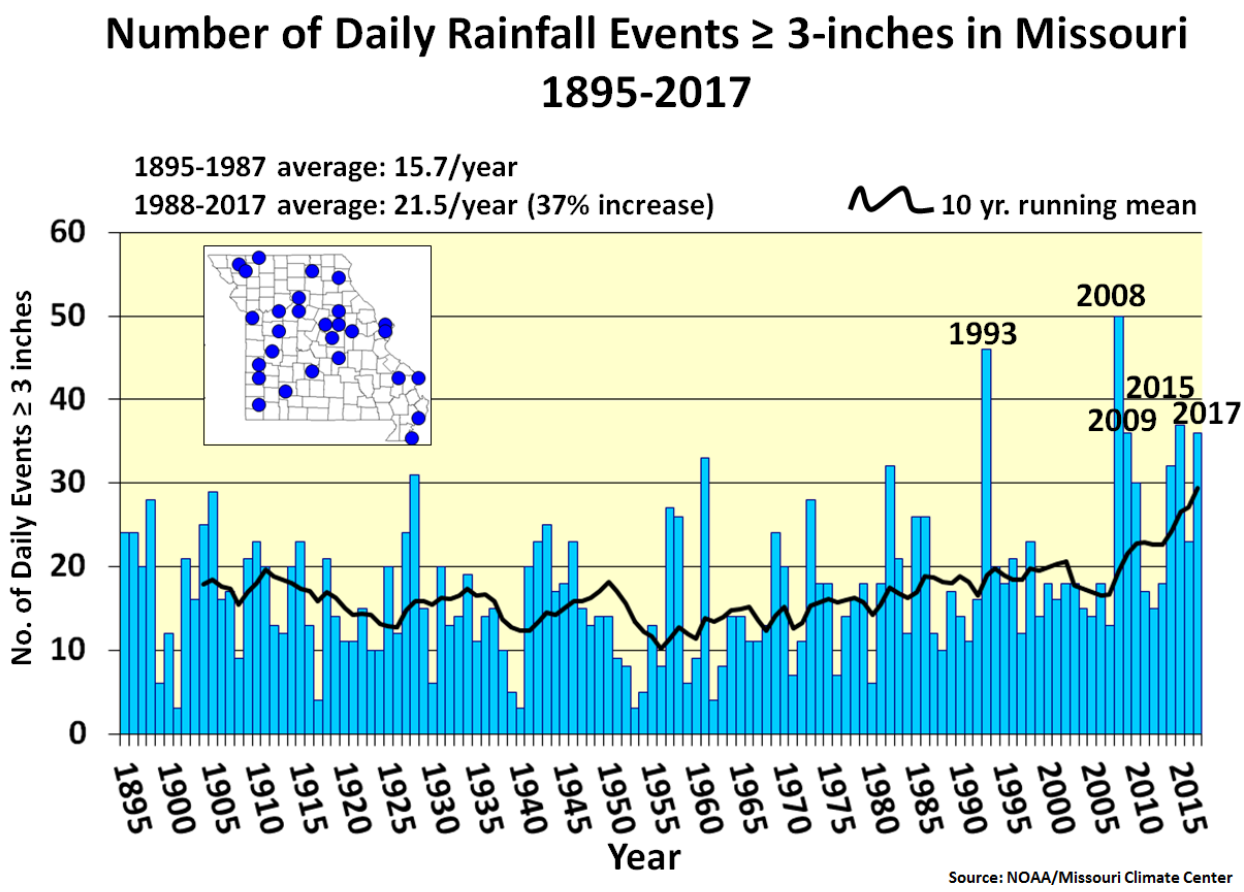
vs.

Past 20 years (1998-2017)

In general, the first fall freeze date is occurring about a week later…

Source: NOAA/Missouri Climate Center


Missouri's Highest Monthly Temperature Departures*
Jan 1895 – Dec 2017
*Departures based on long-term average: 1895-2010
Missouri has broken 5 all-time monthly warm temperature records in less than 20 years!
The last time an all-time monthly cold temperature record was broken was 34 years ago!
Departure from average (°F)
Year
Source: NOAA/Missouri Climate Center
Feb 1899
Jun 1903
Apr 1907
Aug 1915
May 1917
Oct 1925
Sep 1931
Jul 1934
Aug 1936
Jan 1940
Jun 1952
Jul 1950
May 1962
Mar 1960
Oct 1963
Sep 1974
Nov 1976
Apr 1981
Dec 1983
Nov 1999
Jan 2006
Mar 2012
Dec 2015
Feb 2017


Number of Daily Rainfall Events ≥ 3-inches in Missouri
1895-2017
1895-1987 average: 15.7/year
1988-2017 average: 21.5/year (37% increase)
10 yr. running mean
No. of Daily Events ≥ 3 inches
Year
1993
2008
2009
2015
2017
Source: NOAA/Missouri Climate Center

Missouri Climate Trends

Updated through Dec 31, 2017

- Missouri's most recent warm annual temperature trend began in the mid 1980's and most notably, since 1998, where 15 out of the past 20 years (75%) have been above normal; 2012 was the warmest year on record.

- Seasonally, Missouri winters and springs have experienced the greatest warming trend; 19 out of the past 28 winters (68%) and 16 out of the past 20 springs (80%) have been above normal.

- The median last spring frost date in Missouri is occurring about a week earlier over the past 20 years compared to the long-term average.

- Summer and autumn minimum temperature trends have been notably warmer over the past few decades whereas maximum temperature trends have been cooling.

- The median first fall frost date in Missouri is occurring about a week later over the past 20 years compared to the long-term average.

- Dew point temperatures have trended above normal over the past few decades. Since 1981, 68% of the years have had above normal dew points for the Jun-Aug period.

Missouri Climate Trends

Updated through Dec 31, 2017

- Beginning in the early 1980's, and since 1895, an unprecedented wet period has evolved in Missouri. Since 1981, 22 out of 37 years (60%) have had above normal precipitation.

- Over the past few decades, all 4 seasons have witnessed more above normal precipitation years in Missouri; most notably in winter where 21 out the past 36 winters (58%) recorded above normal precipitation. Snowfall trends have been declining.

- Over the past few decades, Missouri has witnessed an above normal trend in heavy (≥ 1") and extreme (≥ 3") daily precipitation events compared to the long-term average.

- Recent historical trends for Missouri indicate an unprecedented multi-decadal wet period beginning in the early 1980's. Conversely, there have been multi-decadal dry periods, i.e. 1950's and 1960's.

- Extended dry and wet patterns can change abruptly and there are numerous occasions, where Missouri transitioned from one extreme to another in a short period of time.

- The 2012 drought resulted in numerous impacts, affecting many sectors in Missouri. However, it was a short-lived drought when compared to other historic droughts, i.e. 1952-56. An important question we all need to consider is how prepared are we when the next 1950's drought affects the Show Me State?

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