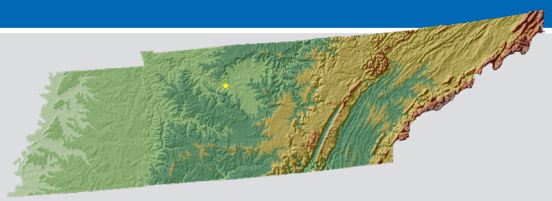
TENNESSEE



Key Messages

Tennessee, like much of the southeastern United States, has experienced little overall warming since the beginning of the 20th century. However, historically unprecedented warming is projected during this century.

Future naturally occurring droughts are projected to be more intense because higher temperatures will lead to more rapid depletion of soil moisture during dry spells.

The number and intensity of extreme heat and precipitation events are projected to increase in the future, while the intensity of cold waves is projected to decrease.

Tennessee's central location in the southeast exposes it to warm and humid air from the Gulf of Mexico and hot and cold air masses from the interior of North America. Its climate is characterized by moderately large variations in temperature and abundant precipitation. For most of the state, summers are warm and humid, while winters are cool with occasional episodes of very cold arctic air. Temperatures decrease across the state as elevation increases, averaging a 3°F decline per 1,000 feet increase in elevation. The higher elevations of the state, such as the Cumberland Plateau (average elevation of 2,000 feet) and the Smoky Mountains (peaks up to 6,000 feet), have noticeably lower average temperatures compared to the Great Valley of East Tennessee (slopes from 1,500 feet in the north to 700 feet in the south). Average (1991–2020 normals) minimum temperatures in January range from 22°F in Mountain City to 33°F in Memphis. Average high temperatures in the summer vary between 85°F and 90°F in western and central Tennessee and between 80°F and 85°F in the eastern portion of the state. Historical observed extreme temperatures for the state range from −32°F in Mountain City in the winter of 1917 to 113°F in Perryville in the summer of 1930.

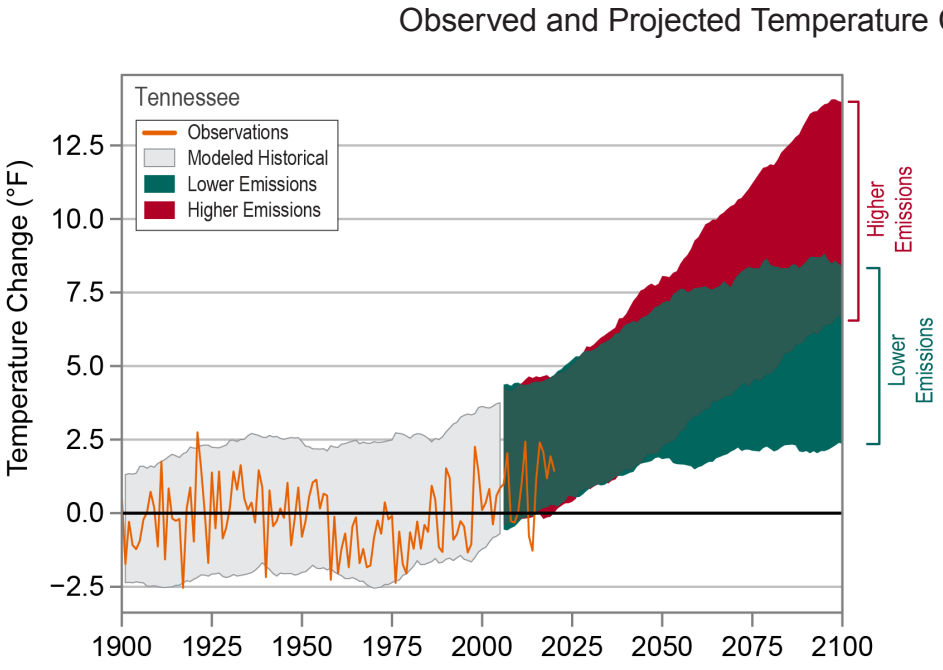


Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Tennessee. Observed data are for 1900–2020. Projected changes for 2015–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Tennessee (orange line) have risen by 0.5°F since the beginning of the 20th century, less than a third of the warming for the contiguous United States, but the warmest consecutive 5-year interval was the most recent, 2016–2020. Shading indicates the range of annual temperatures from the set of models. Observed temperatures are generally within the envelope of model simulations of the historical period (gray shading). Historically unprecedented warming is projected during this century. Less warming is expected under a lower emissions future (the coldest end-of-century projected years being about as warm as the hottest year in the historical record; green shading) and more warming under a higher emissions future (the hottest end-of-century projected years being about 11°F warmer than the hottest year in the historical record; red shading). Sources: CISESS and NOAA NCEI.

Temperatures in Tennessee have risen by 0.5°F since the beginning of the 20th century, less than a third of the warming for the contiguous United States. Temperatures were highest in the 1920s and 1930s, followed by a substantial cooling of about 2°F by the 1960s (Figure 1). Since that cool period, temperatures have risen by more than 2°F, and since 2010, they have been near the highs of the 1920s and 1930s. Because of the significant cooling that occurred in the middle of the 20th century, the southeastern United States is one of the few locations globally that has experienced little to no overall warming since 1900, while the United States as a whole has warmed by about 1.8°F. The United States also cooled from the 1930s into the 1960s, but not by nearly as much as Tennessee. Hypothesized causes for this difference in warming rates include increased cloud cover and precipitation, increased small particles from coal burning, natural factors related to forest regrowth, decreased heat flux due to irrigation, and multidecadal variability in North Atlantic and tropical Pacific sea surface temperatures. However, some recent years have been very warm, including 2012 (2nd warmest), 2016 (3rd warmest), 2017 (5th warmest), and 2019 (7th warmest). The number of extremely hot days was highest in the 1930s and early 1950s. Since then, the number has been mostly near to below average (Figure 2). The number of very warm nights has fluctuated around the long-term average over the last two decades (Figure 3). While the recent trend is toward warmer winters (see Tennessee Supplemental Figures), a historic cold wave affected the state during February 11–20, 2021. In the west, temperatures remained below freezing for 9 consecutive days and fell to around 0°F or below, with the coldest temperature being -5°F at Germantown.

Total annual precipitation has been mostly above average since 1990 (Figure 4). The number of 3-inch extreme precipitation events has also been generally above the long-term average over the same period. The highest 5-year average number of such events occurred during the 2000–2004 period (Figure 5). Total summer precipitation averages 12.6 inches and exhibits no long-term trend, although it has been consistently above average since 2013 (Figure 6). Over the entire historical period (1895–2020), the driest year on record occurred in 1941, with a statewide total of 36.4 inches of precipitation for the year. The wettest year recorded was 2018, with an annual total of 67.1 inches. The driest

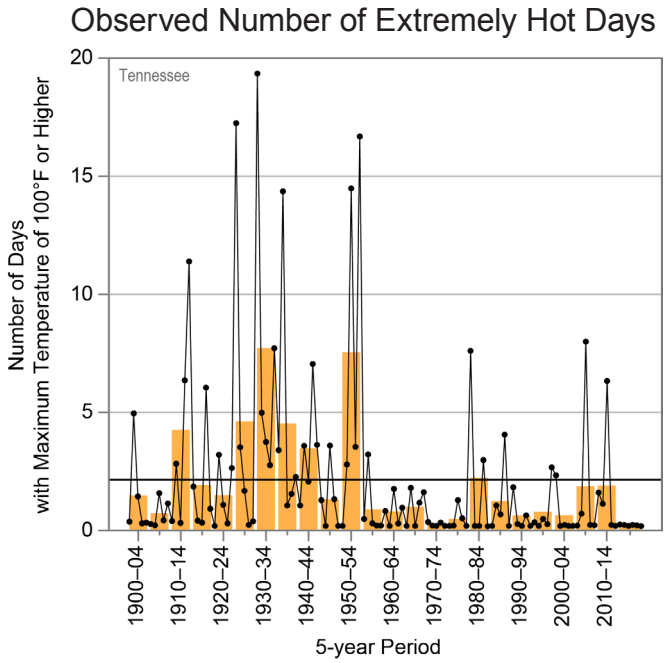


Figure 2: Observed annual number of extremely hot days (maximum temperature of 100°F or higher) for Tennessee from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 2.2 days. These values are averages from 19 long-term reporting stations. The number of extremely hot days has not changed much over the last 70 years. Record high numbers occurred during the droughts of the 1930s and early 1950s. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily.

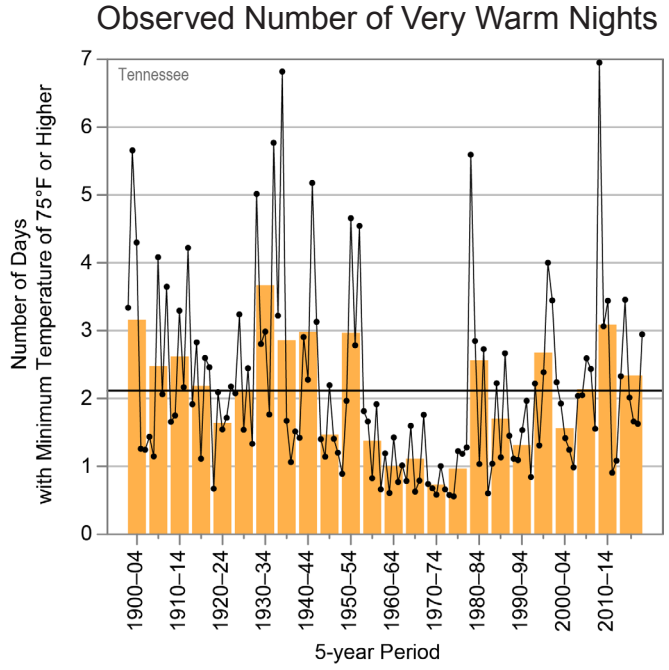


Figure 3: Observed annual number of very warm nights (minimum temperatures of 75°F or higher) for Tennessee from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 2.1 days. These values are averages from 19 long-term reporting stations. The number of very warm nights has generally been near the long-term average since 1980, with slightly above average levels for the last 5 years. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily.

consecutive 5 years was the 1939–1943 interval, with annual average precipitation of about 44 inches, and the wettest was 2016–2020, with an annual average of more than 60 inches per year.

Extreme weather events that frequently occur in Tennessee include severe thunderstorms, flooding, tornadoes, droughts, heat and cold waves, and winter storms. The remnants of hurricanes occasionally track across the state. **Since 2000, the state has received 33 major disaster declarations involving severe storms and flooding.** The Flood of 2010 was caused by record-breaking amounts of rainfall in early May. The National Weather Service reported a new 2-day rainfall record for Nashville on May 1–2, 2010, when 13.6 inches fell, shattering the previous record of 6.7 inches, which was set on September 13–14, 1979. An even more extreme rainfall event occurred in August 2021, when 20.73 inches of rain fell in less than 24 hours in the McEwen area of Middle Tennessee—by far a new state record. Multiple weather stations experienced more than 3 inches of rainfall over 3 consecutive hours. This resulted in deadly flash flooding downstream along the Trace Creek in Waverly. An area of 800–1,000 square miles experienced rainfall totals that would be expected to occur less than once every 1,000 years.

Tennessee experiences a relatively high number of tornadoes, averaging approximately 21 tornadoes and 5 fatalities per year over the period 1985–2019. While tornadoes can occur in any month, they tend to peak in the spring. One of the most active and destructive tornado months on record for the entire United States occurred in April 2011, with a total of 542 tornadoes recorded. Tennessee reported 93 tornadoes for that month, surpassing a historical record of 42 tornadoes in April 1974.

Droughts are a regular occurrence in Tennessee's climate. In about half of the weeks since 2000, at least some portion of the state has been in drought status; in 15% of those weeks, at least half of the state experienced some degree of drought conditions.

Annual average snowfall ranges from a modest 1–4 inches in southern sections to nearly a foot in the northeast, with higher amounts in the Great Smoky Mountains. **Winter weather includes occasional damaging snow and ice storms.** During February

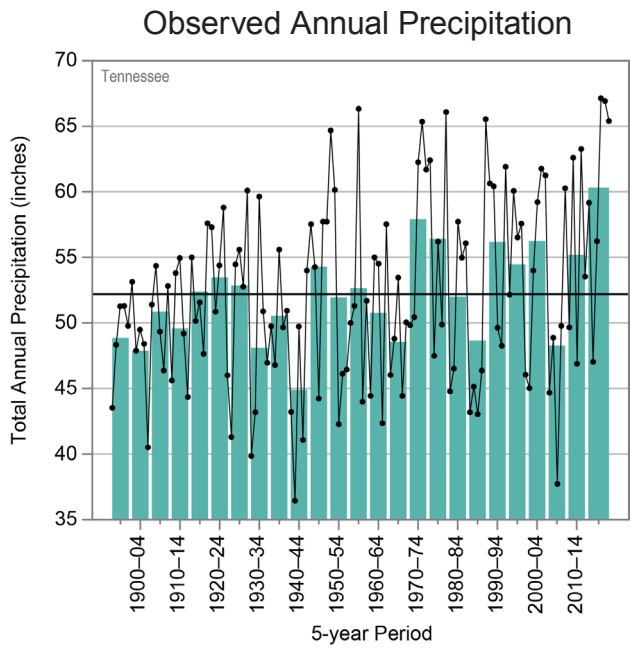


Figure 4: Observed total annual precipitation for Tennessee from 1895 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 52.2 inches. Annual precipitation varies widely from year to year. Since 2010, precipitation has been above the long-term average. Sources: CISESS and NOAA NCEI. Data: nClimDiv.

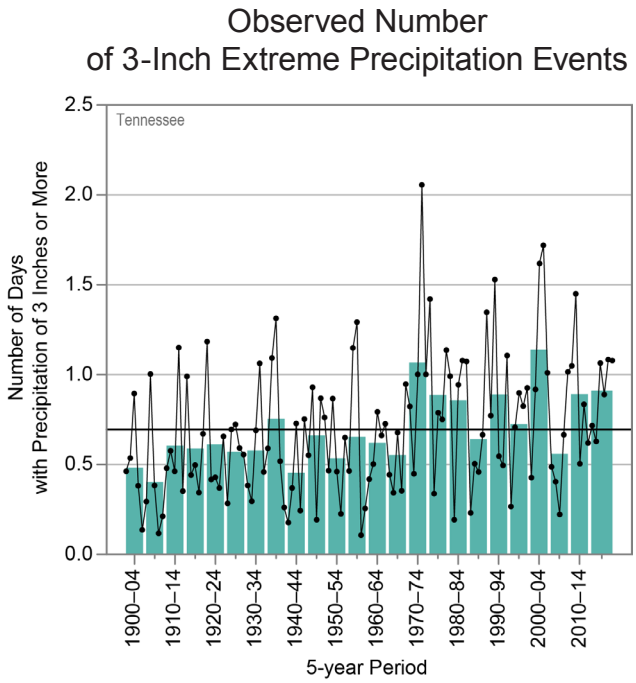


Figure 5: Observed annual number of 3-inch extreme precipitation events (days with precipitation of 3 inches or more) for Tennessee from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 0.7 days. These values are averages from 21 long-term reporting stations. A typical station experiences about 2 events every 3 years. Tennessee has experienced an above average number of extreme precipitation events since 1990, except for the period from 2005 to 2009. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily.

9–13, 1994, a devastating ice storm struck much of the southern United States. In Tennessee, 5–8 inches of rain (much of it freezing) fell in some locations. About 770,000 utility customers lost power (some for up to a month) and damages totaled about $500 million (second behind Mississippi). During January 22–24, 2016, some parts of eastern Tennessee received 6–12 inches of snow, with more than a foot falling in the Great Smoky Mountains. In February 2021, heavy snow (around 10 inches in some locations) and severe icing caused widespread damage.

Historically unprecedented warming is projected during this century (Figure 1). Even under a lower emissions pathway, annual average temperatures are projected to exceed historical record levels in most years by the middle of this century. However, a large range of temperature increases is projected under both pathways, and under the lower pathway, a few projections are only slightly warmer than historical records. Continuation of the post-1980 warming trend would lead to an approximate additional warming of 1°F by 2050 and 3°F by 2100. In this case, the future warming would be on the low end of the model-simulated increases. However, under a high emissions scenario, considerably larger temperature increases are projected. Any substantial increase in temperature will lead to increased heat wave intensity but decreased cold wave intensity.

Winter and spring precipitation is projected to increase by midcentury (Figure 7), while changes in summer and fall precipitation are less distinct. **The intensity of naturally occurring droughts is likely to increase because higher temperatures will increase the rate of loss of soil moisture during dry spells.**

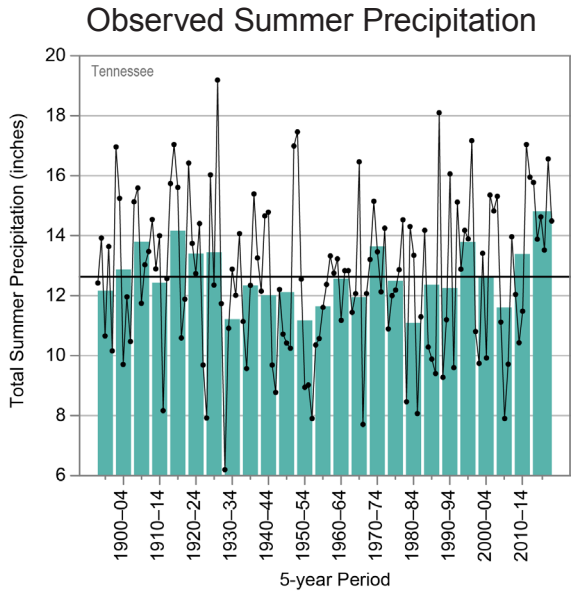


Figure 6: Observed total summer (June–August) precipitation for Tennessee from 1895 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-summer average). The horizontal black line shows the long-term (entire period) average of 12.6 inches. Summer precipitation has been above average since 2010. Sources: CISESS and NOAA NCEI. Data: nClimDiv.

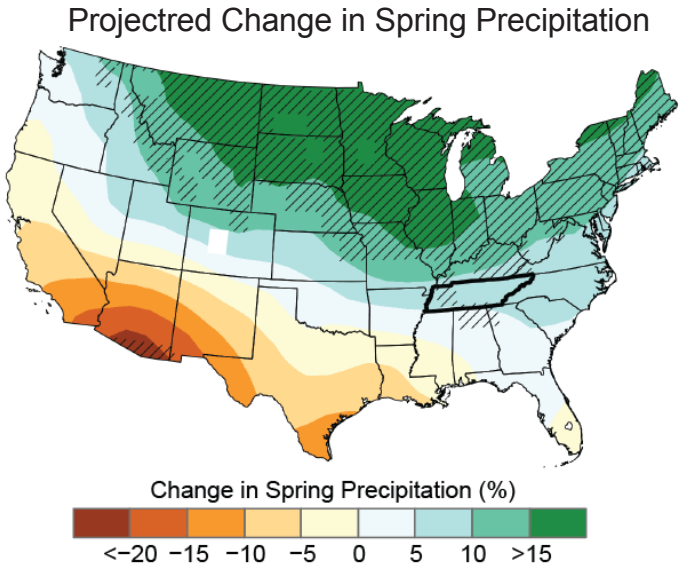


Figure 7: Projected changes in total spring (March–May) precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. The whited-out area indicates that the climate models are uncertain about the direction of change. Hatching represents areas where the majority of climate models indicate a statistically significant change. Precipitation is projected to increase in Tennessee. Sources: CISESS and NEMAC. Data: CMIP5.

Technical details on observations and projections are available online at https://statesummaries.ncics.org/technicaldetails.