KANSAS

Key Messages

Temperatures in Kansas have risen about 1.5°F since the beginning of the 20th century, with greater warming in the winter and spring than in the summer and fall. The number of very cold nights has been below average since 1990. Under a higher emissions pathway, historically unprecedented warming is projected during this century.

Kansas is a region of transition between the humid conditions to the east of the state and the semiarid conditions to the west, and as a result, precipitation in the state varies greatly from year to year. Projected increases in winter precipitation and decreases in summer precipitation may have both positive and negative impacts on the state.

Droughts and heat waves pose a particular risk to Kansas's agricultural economy. Such events occurred in the 1930s, 1950s, and in recent years. Projected increases in temperatures may increase the intensity of future droughts. The frequency and severity of wildfires are also projected to increase throughout the state.

Kansas lies in the central Great Plains, straddling the transition from relatively abundant precipitation (more than 45 inches annually; 1991–2020 normals) in the southeast, supporting forests and rain-fed agriculture, to semiarid conditions (less than 20 inches annually) in the west. The state is located far from the moderating effects of the oceans, and temperatures vary widely across seasons. The statewide average temperature is 33.0°F in the winter and 76.8°F in the summer.

Temperatures in Kansas have risen about 1.5°F since the beginning of the 20th century (Figure 1). Recent multiyear periods have been among some of the warmest on record for Kansas, comparable to the extreme heat of the Dust Bowl era of the 1930s, when intense drought and poor land management likely exacerbated the hot summer conditions. Many record-high temperatures were set during the summer of 2012, which was the hottest year on record with an average temperature of 58.2°F. Recent spring temperatures have been above average (Figure 2a), which may have implications for crop planting. Summer temperatures have been near or above average since 2000 (Figure 2b). There is no long-term trend in very warm nights or extremely hot days, although both were slightly above average during the 2010–2014 period (Figures 3a and 3b). The number of very cold nights has been mostly below average since 1990 (Figure 4). The freeze-free season has also lengthened, especially in eastern Kansas, averaging about 9 days longer in this century than the 20th century average.

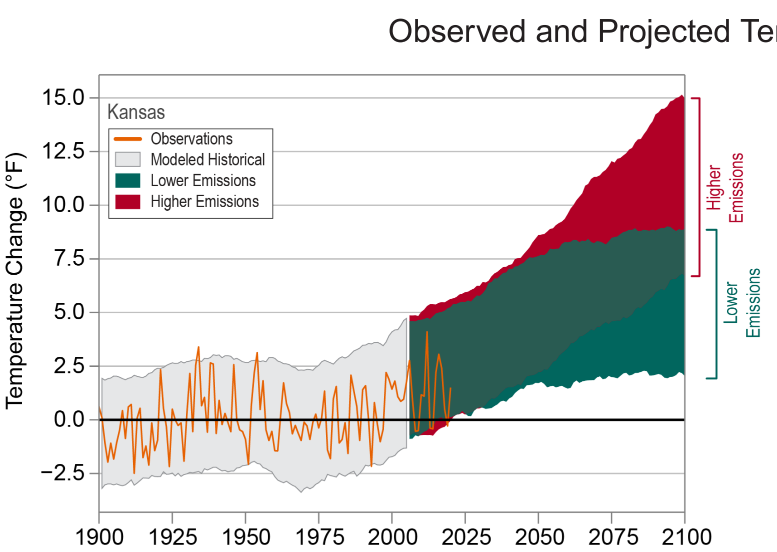

Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Kansas. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Kansas (orange line) have risen about 1.5°F since the beginning of the 20th century. 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 projections being about 2°F warmer than the historical average; green shading) and more warming under a higher emissions future (the hottest end-of-century projections being about 11°F warmer than the hottest year in the historical record; red shading). Sources: CISESS and NOAA NCEI.

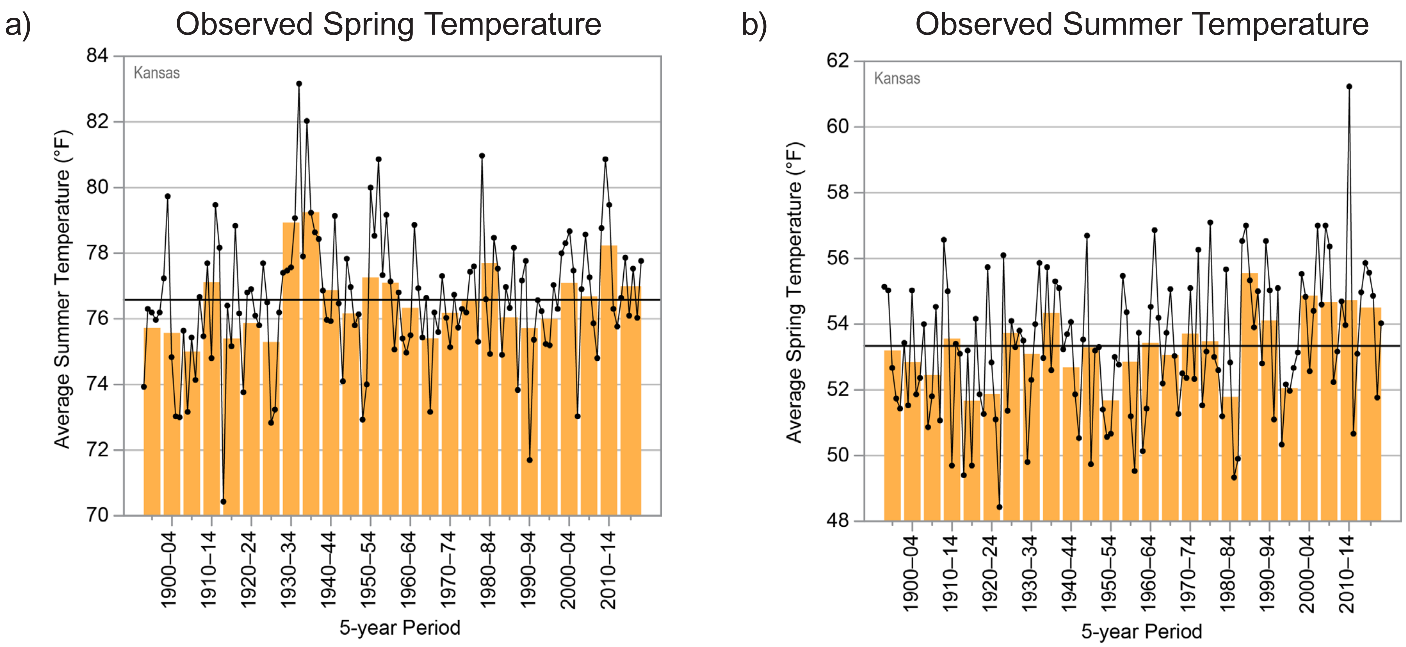

Figure 2: Observed (a) spring (March–May) average temperature and (b) summer (June–August) average temperature for Kansas from 1895 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black lines show the long-term (entire period) averages: (a) 53.3°F and (b) 76.6°F. Since 2000, Kansas has experienced some of the highest springtime temperatures on record, while summer temperatures have been near to above average. The warmest summers on record were 1934 and 1936. Sources: CISESS and NOAA NCEI. Data: nClimDiv.

Precipitation is highly variable from year to year, with the majority of precipitation falling during the warm-season months (Figures 3d and 3e). Throughout the period of record (1895–2020), total annual precipitation has ranged from a low of 15.3 inches in 1956 to a high of 40.6 inches in 1951 and has generally been above average since 1985 (Figure 3c). The driest multiyear periods occurred during the 1910s, 1930s, and 1950s and the wettest during the 1940s, 1990s, and since 2015. The driest consecutive 5-year interval was 1952–1956, and the wettest was 2015–2019. **The frequency of extreme precipitation events has been highly variable but shows a general increase; the number of 2-inch precipitation events was well above average during the 2015–2020 period** (Figure 5). The increase in extreme precipitation events has been more pronounced in the eastern part of the state. Several major floods have occurred since the beginning of the 20th century. The Great Flood of 1951 extended over about half the state, with both rural and urban areas suffering severe losses, including more than $2 billion in total damages and 19 fatalities.

Due to the state's geography, which allows cold, dry air from the north to combine with warm, moist air from the Gulf of Mexico, severe thunderstorms are common in Kansas. **Some of these thunderstorms can produce large hail, high winds, and tornadoes**. During 1991–2010, the state experienced an average of just under 100 tornadoes each year, which occasionally caused major damage and loss of life. The Topeka tornado of June 8, 1966, one of the most destructive in Kansas's history, killed 17 people, injured more than 500, and caused more than $200 million in damages (at the time, it was the costliest tornado in U.S. history, and as of 2015, it was the fourth costliest). Since 1950, Kansas has had six F5/EF5 tornadoes, the third most of any state. The most recent EF5 tornado occurred on May 4, 2007, when nearly 95% of Greensburg was completely destroyed and 11 people were killed.

Droughts pose a particular risk to Kansas's agricultural economy (Figure 6). A multiyear drought impacted the state from late 2010 through late 2015. The peak of the drought occurred in 2012, which was one of the state's driest years on record. The critical growth months of May–July were the driest on record, with a statewide average of only 4.9 inches of rain. By August, nearly 90% of the state was in extreme or exceptional drought status. The drought, combined with the extreme summer heat, had significant negative impacts on crop yields, livestock production, and pasture conditions. Despite the occurrence of this very intense drought, the late 20th and early 21st centuries generally have been characterized by few droughts, either short-term or long-term.

Figure 3: Observed (a) annual number of very warm nights (minimum temperature of 75°F or higher), (b) annual number of extremely hot days (maximum temperature of 100°F or higher), (c) total annual precipitation, (d) total spring (March–May) precipitation, and (e) total summer (June–August) precipitation for Kansas from (a, b) 1900 to 2020 and (c, d, e) 1895 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black lines show the long-term (entire period) averages: (a) 4.7 nights, (b) 13 days, (c) 27.3 inches, (d) 8.1 inches, (e) 10.6 inches. The frequency of very warm nights and extremely hot days peaked during the 1930s Dust Bowl era. All precipitation metrics were above average during the 2015–2020 period. Sources: CISESS and NOAA NCEI. Data: (a, b) GHCN-Daily from 32 long-term stations; (c, d, e) nClimDiv.

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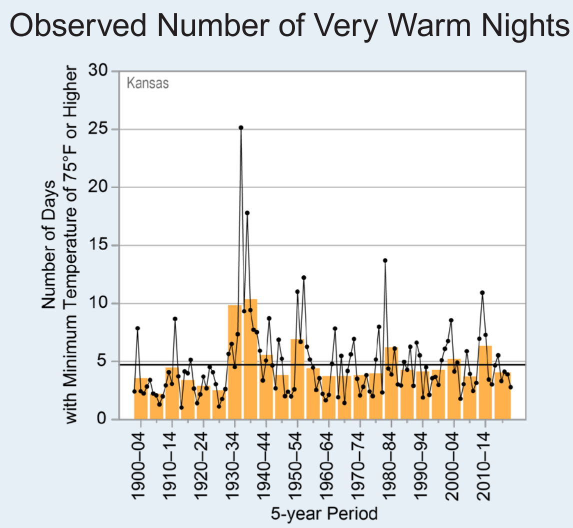

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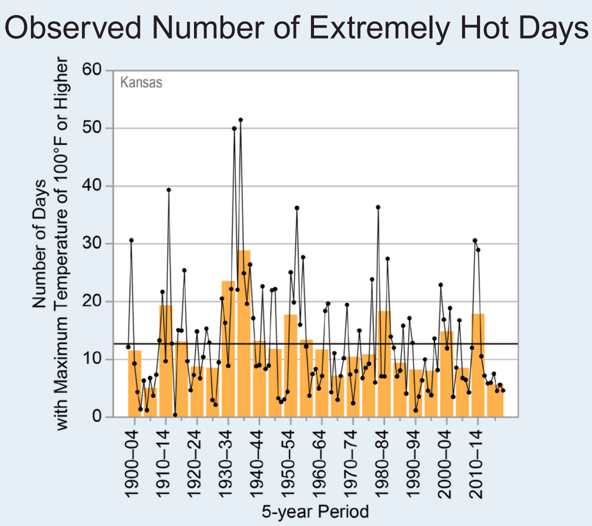

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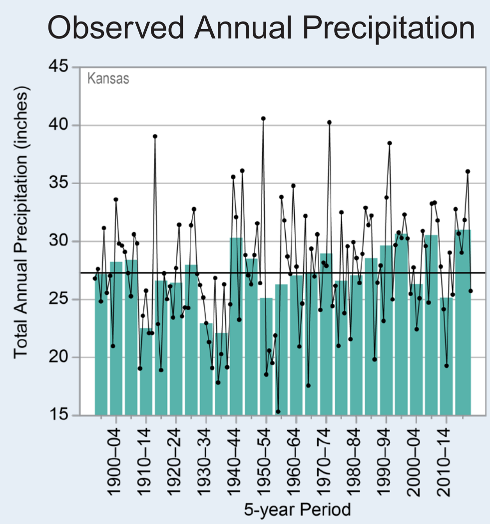

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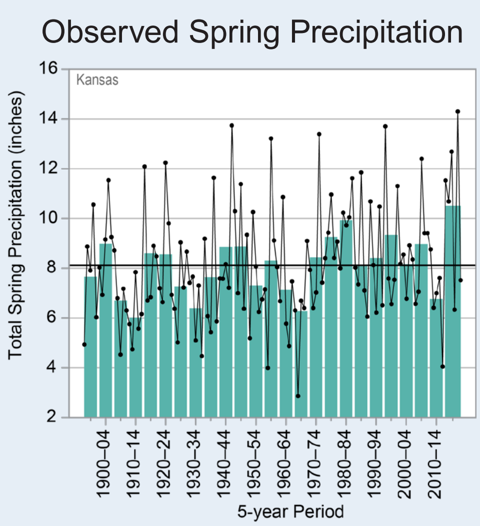

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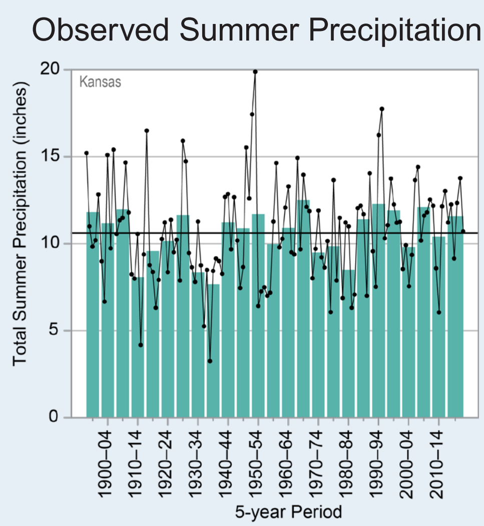

Under a higher emissions pathway, historically unprecedented warming is projected during this century (Figure 1). Even under a lower emissions pathway, temperatures are projected to most likely exceed record levels by the middle of this century. However, a large range of temperature increases is projected under both pathways, and under the lower pathway, a few projections are only slightly warmer than historical records. Heat wave intensity is projected to increase, posing a risk to both livestock and human health, while cold wave intensity is projected to decrease. The freeze-free season is projected to lengthen.

Although projections of overall annual precipitation are uncertain, summer precipitation is projected to decrease across the state (Figure 7), **while winter precipitation is projected to increase**. Winter precipitation increases could benefit winter wheat production, but summer drying would have negative impacts on rain-fed summer crops and rangeland.

The intensity of future droughts is projected to increase. Droughts are a natural part of the climate system. Although projections of overall precipitation are uncertain, higher temperatures will increase the rate of soil moisture loss during dry spells, leading to more serious conditions during future naturally occurring droughts, including an increase in the occurrence and severity of wildfires.

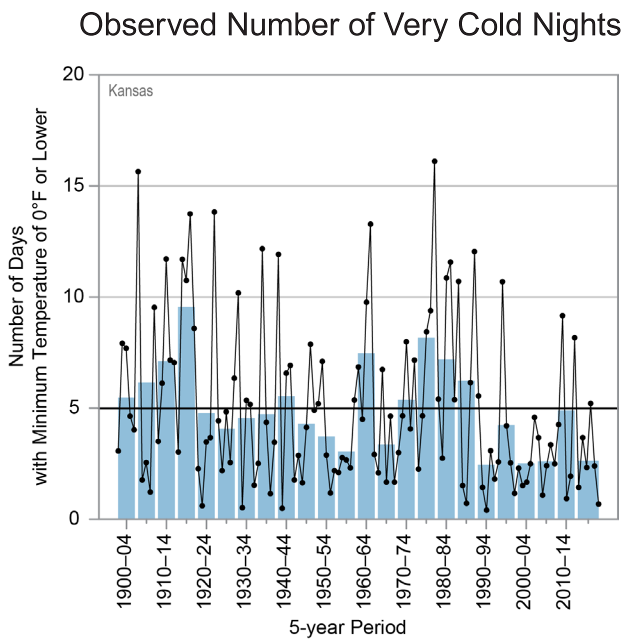

Figure 4: Observed annual number of very cold nights (minimum temperature of 0°F or lower) for Kansas from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 5.0 nights. Since 1990, Kansas has experienced a near to below average number of very cold nights, indicative of overall winter warming in the region. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 32 long-term stations.

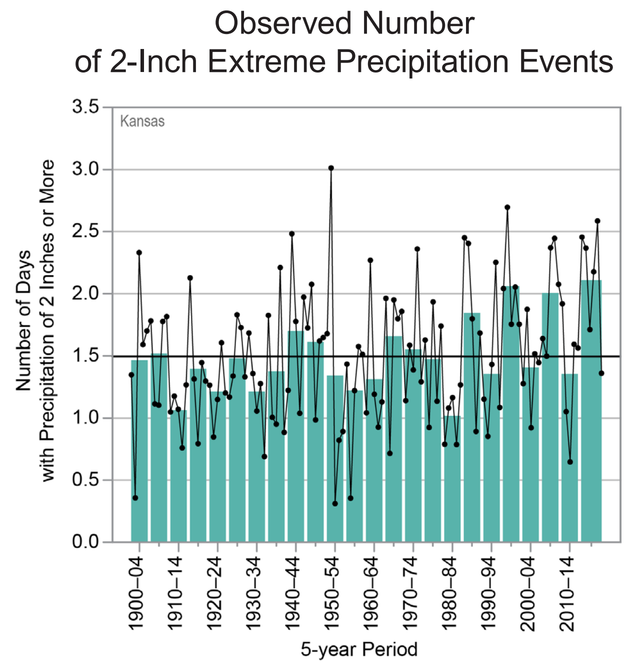

Figure 5: Observed annual number of 2-inch extreme precipitation events (days with precipitation of 2 inches or more) for Kansas from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 1.5 days. A typical reporting station experiences 1 to 2 events per year. The largest number of 2-inch extreme precipitation events occurred during the 2015–2020 period, with an average of 2.1 events per year, followed by the 1995–1999 period, with an average of 2.0 events annually. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 51 long-term stations.

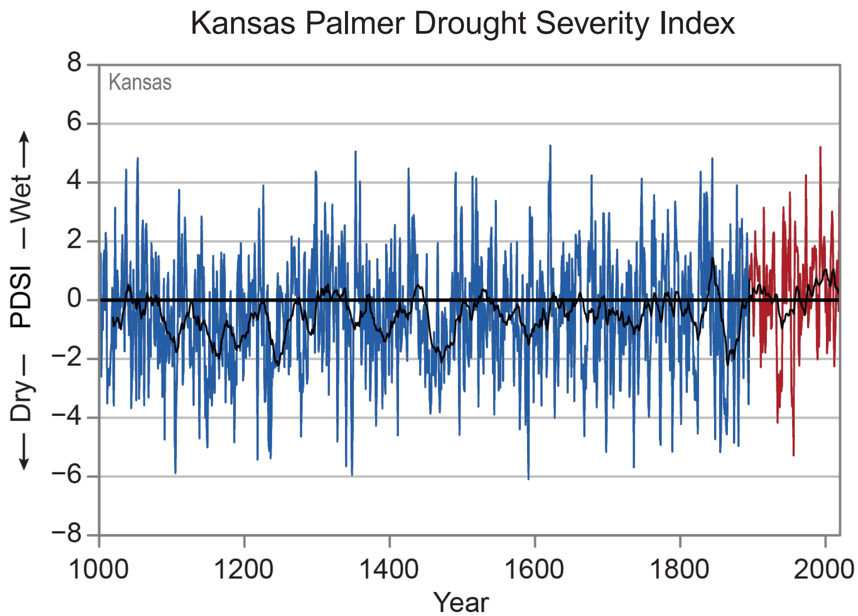

Figure 6: Time series of the Palmer Drought Severity Index for Kansas from the year 1000 to 2020. Values for 1895 to 2020 (red) are based on measured temperature and precipitation. Values prior to 1895 (blue) are estimated from indirect measures such as tree rings. The fluctuating black line is a running 20-year average. In the modern era, the wet periods of the early 1900s and the dry period of the 1930s to 1940s are evident. With the exception of the 2010–2015 drought, Kansas has experienced overall wet conditions since the 1980s. The extended record indicates periodic occurrences of similar extended wet and dry periods. Sources: CISESS and NOAA NCEI. Data: nClimDiv and NADAv2.

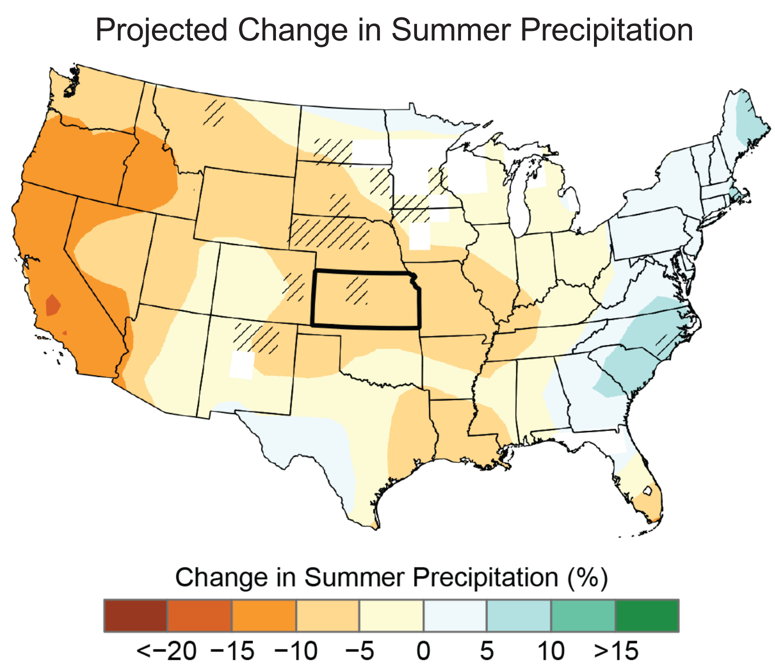

Figure 7: Projected changes in total summer (June–August) precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. Whited-out areas indicate that the climate models are uncertain about the direction of change. Hatching represents areas where the majority of climate models indicate a statistically significant change. In Kansas, summer precipitation is projected to decrease in the range of 5% to 10% by 2050, although the changes are statistically significant only in the central part of the state. Sources: CISESS and NEMAC. Data: CMIP5.

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

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