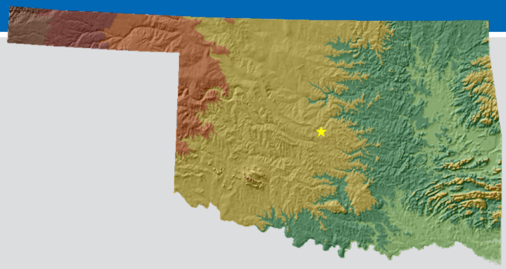

OKLAHOMA

Key Messages

Temperatures in Oklahoma have risen by about 0.6°F since the beginning of the 20th century. Winter warming is evident in the less frequent occurrence of very cold nights since 1990. Historically unprecedented warming is projected during this century.

Oklahoma is in a region of transition from humid to semiarid conditions, and as a result, precipitation can vary greatly from year to year. Extreme precipitation events are projected to increase, which may increase the risk of flooding and the associated soil erosion and nonpoint source runoff into streams and lakes.

Droughts pose a particular risk to the agricultural economy of Oklahoma. Several such events have occurred in recent years. Higher temperatures will increase the rate of soil moisture loss, leading to an increase in the intensity of future naturally occurring droughts.

Oklahoma lies in the central Great Plains, straddling the transition from relatively abundant precipitation (more than 50 inches per year) in the southeast to semiarid conditions (less than 20 inches per year) in the west. Due to its location in the interior of the United States and its distance from the moderating effects of any oceans, the state experiences a wide range of average (1991–2020 normals) daily temperatures, averaging from the upper 30s to low 40s in the winter and the upper 70s to low 80s in the summer. The hottest year on record was 2012, with an average temperature of 63.2°F, which was 3.4°F degrees warmer than the long-term (1895–2020) average. Extreme temperatures for the state range from 120°F, observed at several locations in the summer of 1936, to −31°F, observed in northeastern Oklahoma during the winter of 2011.

Since the beginning of the 20th century, temperatures in Oklahoma have risen by about 0.6°F (Figure 1). Since 2010, temperatures have been higher than they were during the previous 40 years and have approached the levels seen during the 1950s and the 1930s Dust Bowl era, when poor land management likely exacerbated the hot summer temperatures. The recent warming has been concentrated in the winter and spring. While summer average

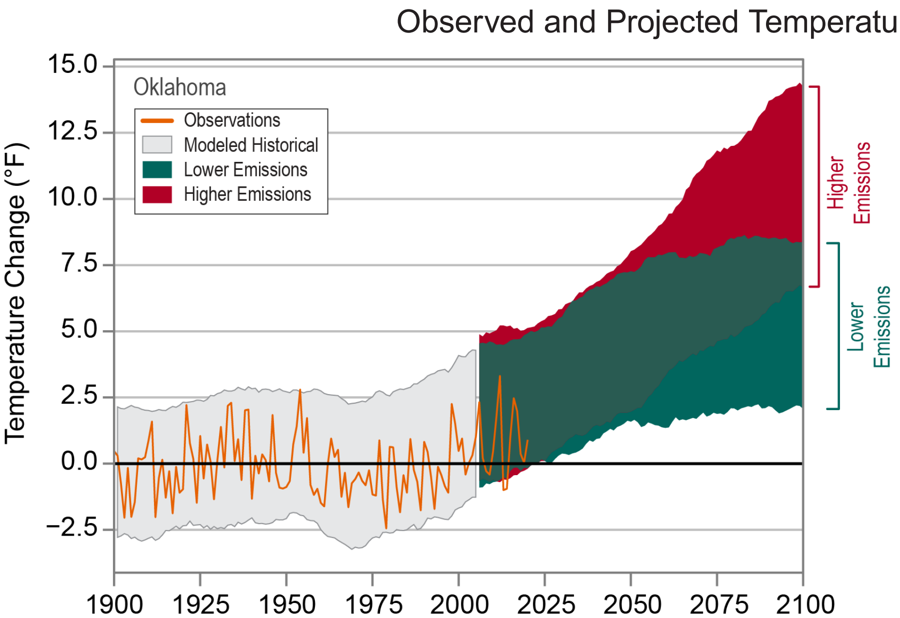

Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Oklahoma. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Oklahoma (orange line) have risen about 0.6°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 the 21st century. Less warming is expected under a lower emissions future (the coldest end-of-century projected years being about 2°F warmer than the historical average; 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.

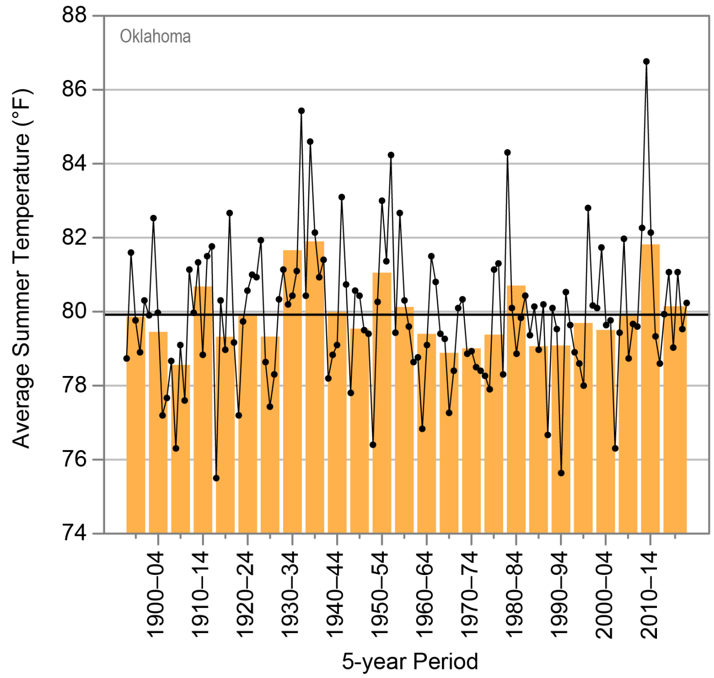

Figure 2: Observed summer (June–August) average temperature for Oklahoma from 1895 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 79.9°F. Summer temperatures during the 2010–2014 period reached about the same level as the record extreme heat of the 1930s Dust Bowl era. Due to extreme drought and poor land management practices, the summers of the 1930s remain the warmest decade-long period on record. Sources: CISESS and NOAA NCEI. Data: nClimDiv.

temperatures were above the long-term average in the 2010s, which included the all-time hottest summer in 2011, they have not reached the levels experienced consistently during the 1930s, a feature characteristic of much of the Great Plains and Midwest (Figure 2). The lack of summer warming is reflected in the mostly below average number of extremely hot days in recent years (Figure 3a) and the lack of a clear trend in extremely warm nights (Figure 3b). The winter warming trend is reflected in a below average number of very cold nights since 1990 (Figure 4). While the recent trend is toward fewer extremely cold nights, a historic cold wave affected the state during February 9–20, 2021. Temperatures remained below freezing for 10 consecutive days and fell to around -20°F in a few locations with the coldest temperature being -21°F at Ralston. The extreme cold temperatures, heavy snow (of more than 10 inches in many locations), severe icing, and accompanying power outages caused considerable damage.

Precipitation is highly variable from year to year, with the statewide annual total ranging from a low of 20.3 inches in 1910 to a high of 53.7 inches in 2015. The driest multiyear periods were in the 1910s, 1950s, and 1960s, and the wettest were the 1990s and late 2010s (Figure 3c). The driest consecutive 5 years was the 1952–1956 interval and the wettest was the 2015–2019 period. The majority of precipitation falls during the spring and summer months. Summer precipitation was well below average during 2011 and 2012 (Figure 3d). Annual snowfall ranges from less than 2 inches in the extreme southeast to almost 30 inches in the Panhandle. Oklahoma regularly experiences freezing rain, particularly in the southeastern part of the state. **The frequency of 2-inch extreme precipitation events has increased since 1985, with the highest number of events occurring in 2015** (Figure 5).

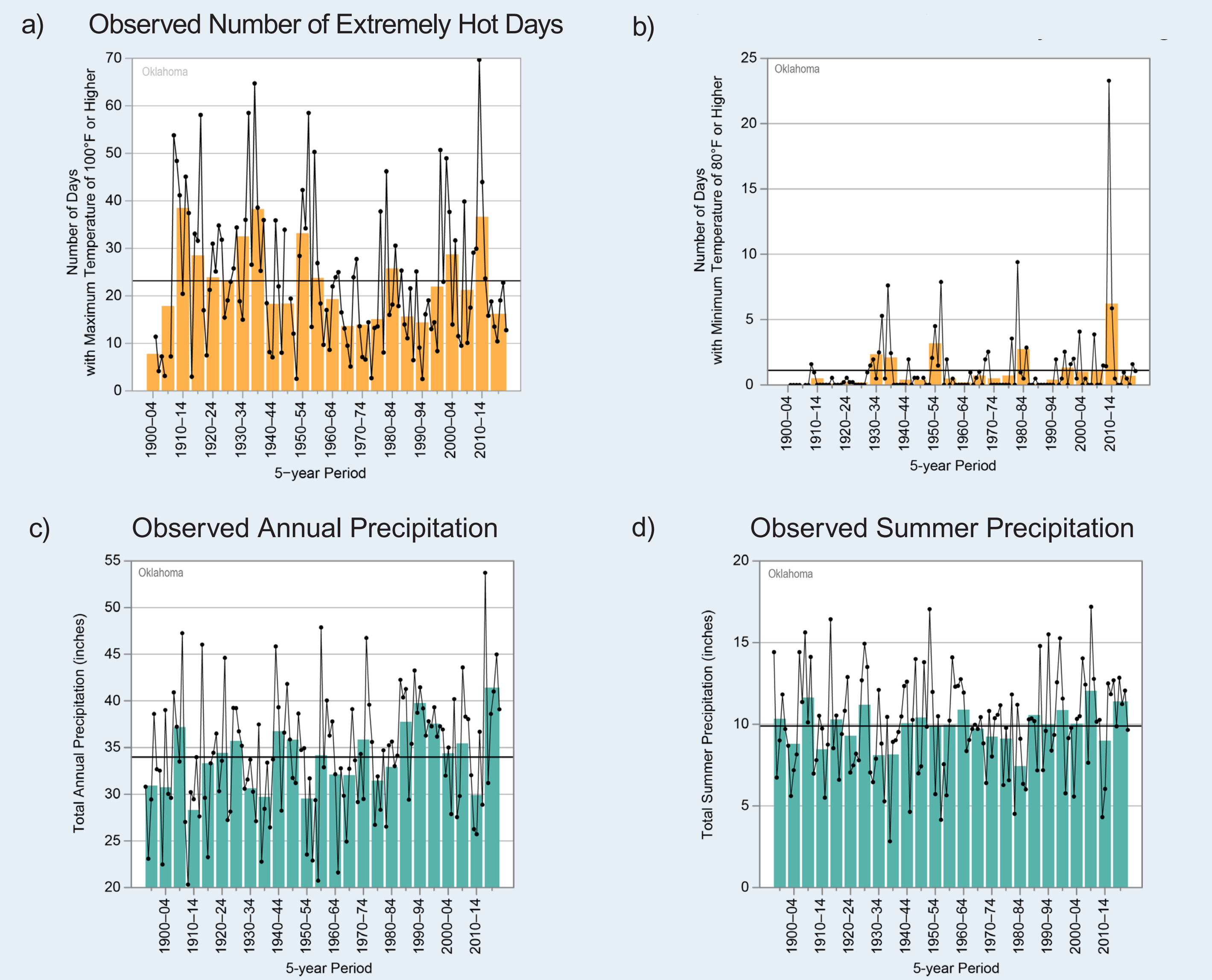

Figure 3: Observed (a) annual number of extremely hot days (maximum temperature of 100°F or higher), (b) annual number of extremely warm nights (minimum temperature of 80°F or higher), (c) total annual precipitation, and (d) total summer (June–August) precipitation for Oklahoma from (a, b) 1903–2020 and (c, d) 1895–2020. 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) 23 days, (b) 1.1 nights, (c) 34.0 inches, (d) 9.9 inches. The number of extremely hot days and extremely warm nights have been primarily below the long-term average, although the 2010 to 2014 period was above average in both categories. Annual and summer precipitation have been above average in recent decades, except for the 2010 to 2014 period, which was drier than normal, reflecting the severe multiyear drought in the state. Sources: CISESS and NOAA NCEI. Data: (a, b) GHCN-Daily from 2 long-term stations; (c, d) nClimDiv.

Severe thunderstorms are common in Oklahoma due to the state's geographical location, which allows cold, dry air from the north and west to clash frequently with warm, moist air from the Gulf of Mexico. Oklahoma locations experience approximately 45 to 60 thunderstorm days each year. These storms frequently produce tornadoes. From 1985 to 2019, Oklahoma averaged 60 tornadoes and 4 fatalities per year. Tornadoes are most frequent during April and May. The state's deadliest tornado occurred on April 9, 1947, killing more than 100 people and injuring more than 700. On May 3, 1999, a supercell thunderstorm spawned more than 60 tornadoes, the largest outbreak ever recorded in the state. One of these tornadoes caused F4–F5 damage in Bridge Creek, Newcastle, Moore, and Oklahoma City, destroying 1,800 homes and causing 36 direct fatalities. On May 20, 2013, the same area was struck by yet another EF5 tornado, which killed 24 people and caused more than $2 billion in damages.

Droughts are a frequent and severe hazard in Oklahoma (Figure 6). In 2011, a severe drought occurred when the state experienced its third driest January–October on record, receiving only 19.4 inches of precipitation—more than 10 inches below the long-term average. Although winter precipitation brought some relief, extremely dry and hot conditions in 2012 once again brought widespread drought conditions to the area. By the end of September 2012, more than 95% of the state was experiencing extreme drought conditions. Since the creation of the United States Drought Monitor Map in 2000, Oklahoma has been completely drought-free for approximately 21% of the time and has had at least 50% or more drought coverage for approximately 28% of the time. **In addition to devastating impacts on the agricultural economy, severe droughts also increase the risk of wildfires.** In 2011, wildfires burned more than 132,000 acres in the state.

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. If large increases in temperature occur, future heat waves are likely to be more intense, while cold waves are projected to become less intense.

Projections of overall annual precipitation do not indicate a clear trend. **Although summer precipitation is projected to decrease slightly across the state** (Figure 7)**, the decreases are smaller than natural variations.** Even if summer precipitation remains the same, higher temperatures will increase evaporation rates and decrease soil moisture, leading to increased intensity of future droughts and increased risk of severe wildfires.

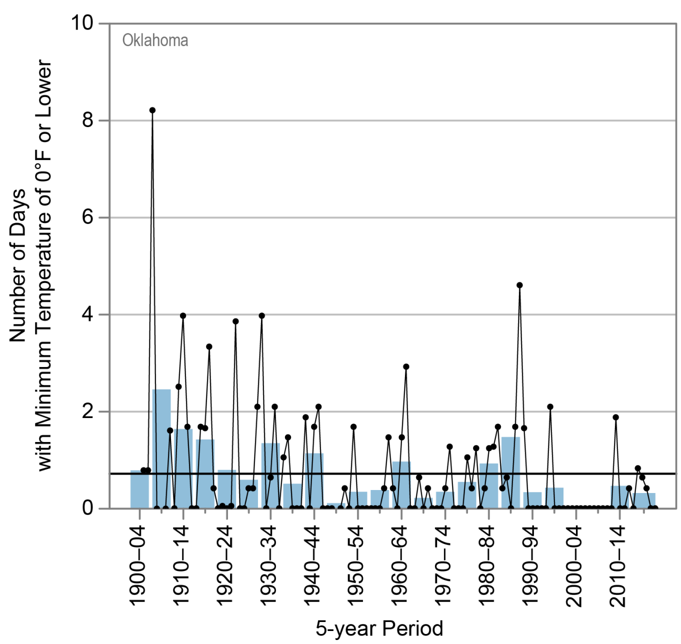

Figure 4: Observed annual number of very cold nights (minimum temperature of 0°F or lower) for Oklahoma from 1903 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 0.7 nights. Since 1990, Oklahoma has consistently experienced a below average number of very cold nights, indicative of winter warming in the region. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 2 long-term stations.

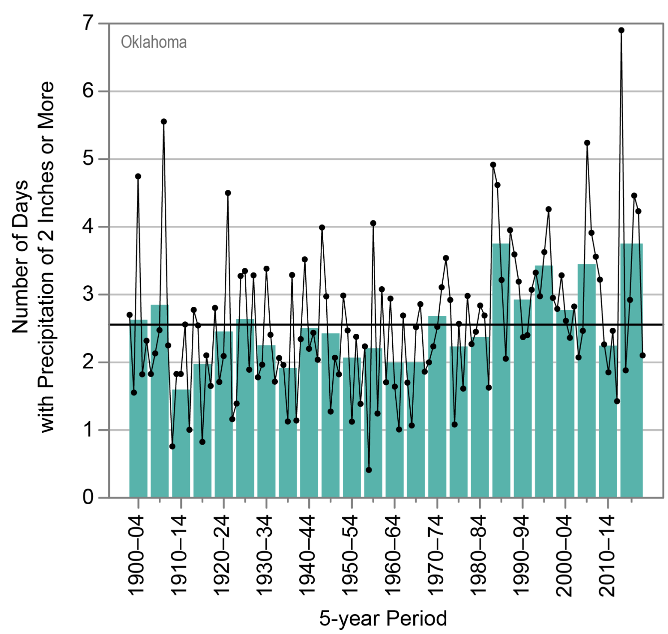

Figure 5: Observed annual number of 2-inch extreme precipitation events (days with precipitation of 2 inches or more) for Oklahoma from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 2.6 days. A typical reporting station experiences 2 to 3 events per year. Oklahoma has experienced an above average number of extreme precipitation events since 1985, with the exception of the 2010–2014 period. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 18 long-term stations.

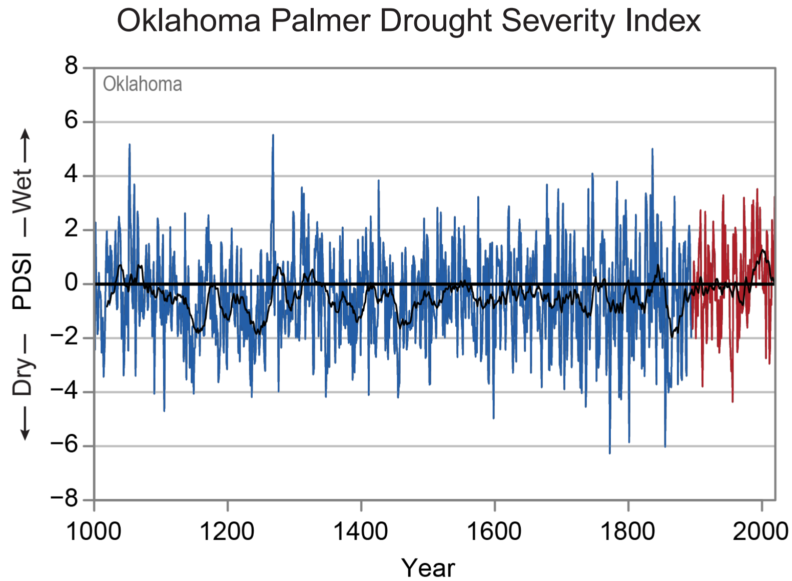

Figure 6: Time series of the Palmer Drought Severity Index for Oklahoma from the year 1000 to 2020. Values for 1895–2020 (red) are based on measured temperature and precipitation. Values prior to 1895 (blue) are estimated from indirect measures such as tree rings. The fluctuating black line is a running 20-year average. In the modern era, the wet periods of the 1980s and 1990s and the dry periods of the 1930s and 1950s are evident. The extended record indicates periodic occurrences of similar extended wet and dry periods. Sources: CISESS and NOAA NCEI. Data: nClimDiv and NADAv2.

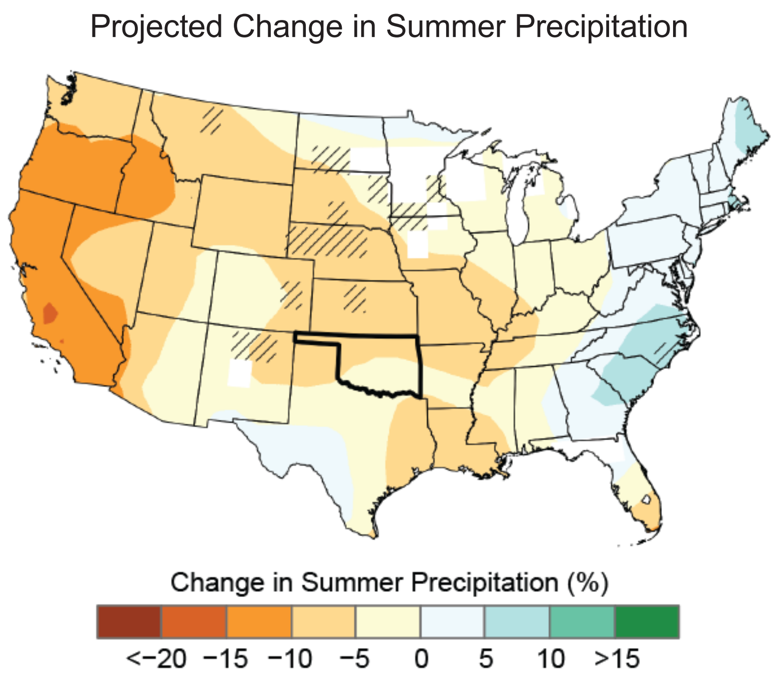

Figure 7: Projected changes in total summer (June–August) precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. Whited-out areas indicate that the climate models are uncertain about the direction of change. Hatching represents areas where the majority of climate models indicate a statistically significant change. Precipitation in the summer is projected to decrease slightly in Oklahoma, but the changes are smaller than natural variations. Sources: CISESS and NEMAC. Data: CMIP5.

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