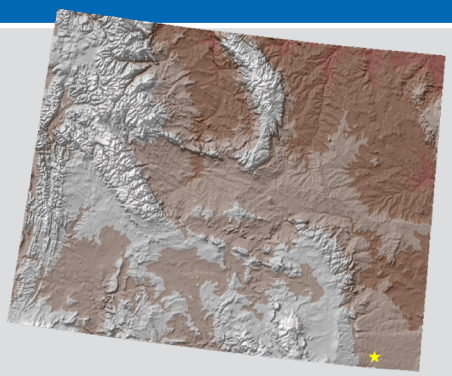
WYOMING



Key Messages

Temperatures in Wyoming have risen about 2.5°F since the beginning of the 20th century. Warming is most evident in winter and is reflected in a generally below average number of very cold days since 2000. Under a higher emissions pathway, historically unprecedented warming is projected during this century.

Winter and spring precipitation is projected to increase. Heavier spring precipitation, combined with a shift from snow to rain, could increase the potential for flooding.

Increases in evaporation rates due to rising temperatures may increase the rate of soil moisture loss and the intensity of naturally occurring droughts. The frequency and severity of wildfires are projected to increase.

Wyoming's climate is largely determined by its mid-latitude location in the interior of the North American continent, far from oceanic moisture sources. While its frequent proximity to the jet stream exposes it to periodic storm systems, its lack of easy access to moisture sources leads to a mostly semiarid climate. Wyoming also has large climatic variations due to its geographic diversity and altitudinal range. The eastern portion of the state lies within the Great Plains, while the central and western portions encompass a series of mountain ranges and basins. **Elevations across the state range from about 3,100 to 13,800 feet, causing wide variations in temperature**. The state has mild to warm (depending on elevation) summers and cold winters. Winter average (1991–2020 normals) minimum temperatures at individual locations are mostly in the range of 5°F to 18°F (depending on elevation and topography), with lower values at higher elevations. For most of the state, summer average maximum temperatures range from 75°F to 89°F, although temperatures are much lower at higher elevations. Due to the state's semiarid climate, temperatures can vary widely from day to night. The hottest year on record was 2012, with a statewide annual average temperature of 44.8°F (3.8°F higher than the long-term [1895–2020] average).

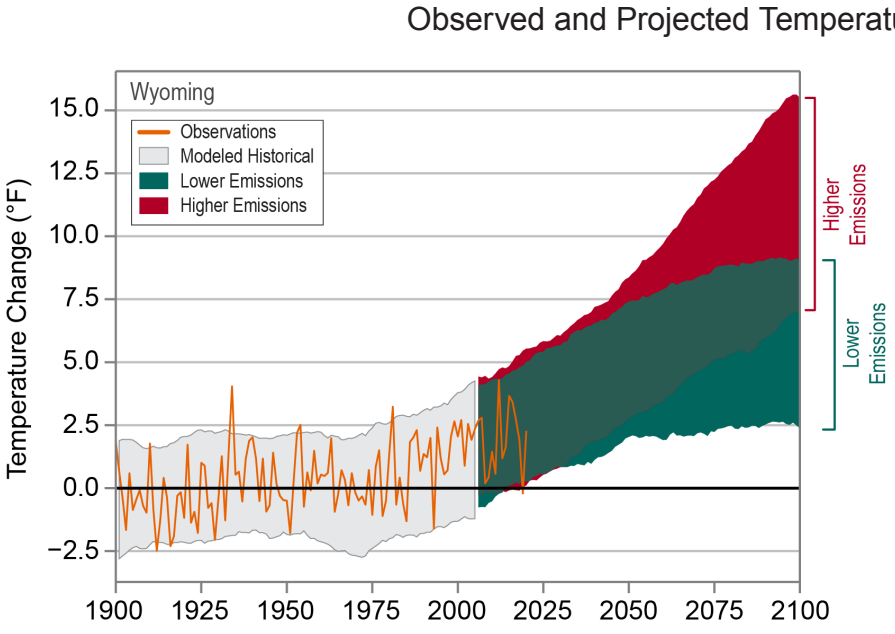


Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Wyoming. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Wyoming (orange line) have risen about 2.5°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.

Temperatures in Wyoming have risen about 2.5°F since the beginning of the 20th century (Figure 1), and nearly every year of this century has been above the long-term average. This warming has been observed in all seasons; since 1995, winter and summer temperatures have averaged 1.9°F and 1.3°F above the historical average, respectively (Figures 4a and 4b). The highest number of very hot days occurred during the 2000s and early 2010s (Figure 2). While warm nights are rare in Wyoming, the number of these nights has generally been above average since 2000 (Figure 3). Another indication of the overall trend of higher average temperatures is a generally below average number of very cold days since 2000 (Figure 4c).

Wyoming's topographic variability causes large regional variations in precipitation across the state. Total annual precipitation at long-term observation stations varies from 5.51 inches in the north-central part of the state to 32.82 inches in Yellowstone National Park. Temporal variability is also large. Statewide precipitation totals have varied from a low of 11.0 inches in 2012 to a high of 20.5 inches in 1927. The driest multiyear periods were in the early 1930s and early 2000s and the wettest in the late 1940s and late 1990s (Figure 4d). The driest consecutive 5-year interval was 1931–1935, averaging 13.4 inches per year, and the wettest was 1995–1999, averaging 18.2 inches per year. Most of the state's precipitation falls during spring and summer, although some areas in the mountains experience a peak during winter. Some mountainous regions receive more than 200 inches of snowfall annually. Since the 2005–2009 period, the number of 1-inch extreme precipitation events has been increasing (Figure 4e).

During the summer months, the state experiences frequent thunderstorms, which can produce hail, lightning, and strong winds. Southeastern Wyoming lies in "Hail Alley," the most hail-prone area in the country. Since 2010, the state has averaged 34 severe hail (1-inch diameter or larger) days annually. On August 1, 1985, a severe thunderstorm in Cheyenne dropped more than 6 inches of rain in just over 3 hours and produced hail of up to 2 inches in diameter. In some areas of the city, the hail piled up in 4- to 8-foot drifts. On June 6, 2020, Wyoming was one of the states

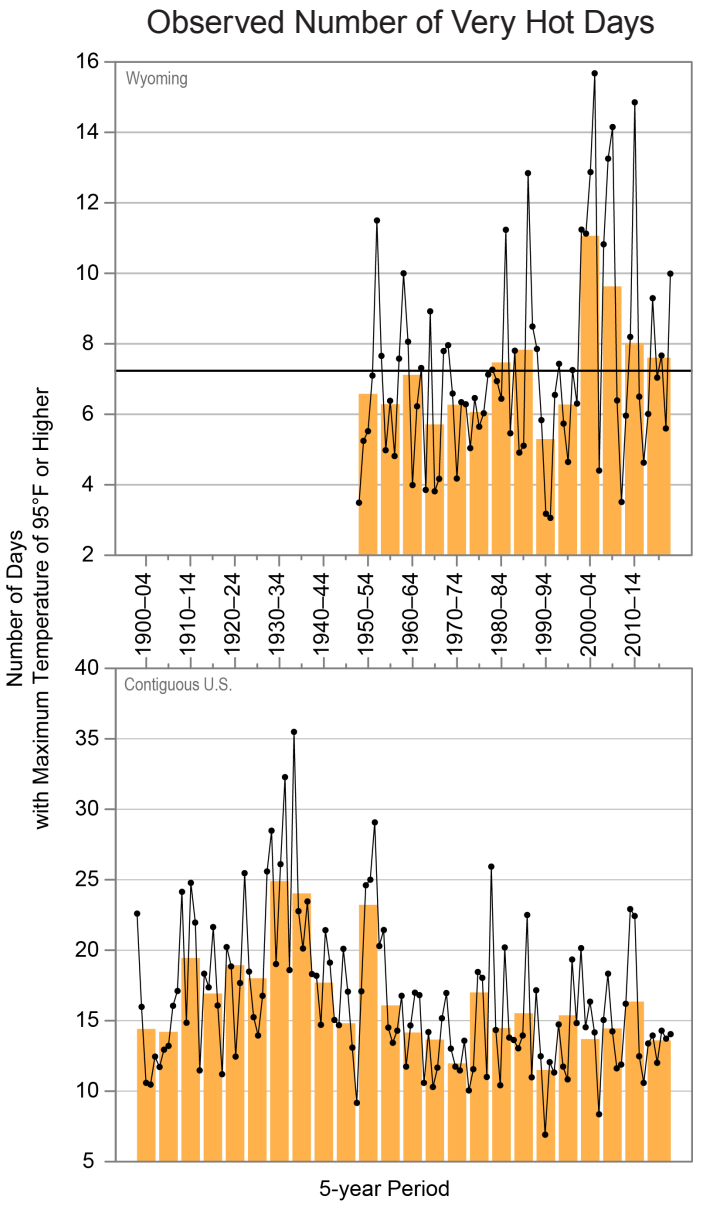


Figure 2: Observed annual number of very hot days (maximum temperature of 95°F or higher) for Wyoming from 1950 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 7.2 days. Values for the contiguous United States (CONUS) from 1900 to 2020 are included to provide a longer and larger context. Long-term stations dating back to 1900 were not available for Wyoming. The highest number of very hot days in Wyoming occurred during the 2000s and early 2010s. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 35 (WY) and 655 (CONUS) long-term stations.

hit by an exceptionally rare western-U.S. derecho. This storm began in eastern Utah and tracked northeast over 750 miles before ending in North Dakota. Of the 339 total wind reports, 55 came from the state of Wyoming. A mesonet station near the Wyoming–South Dakota border measured a wind gust of 85 mph, the highest in the state for that type of event.

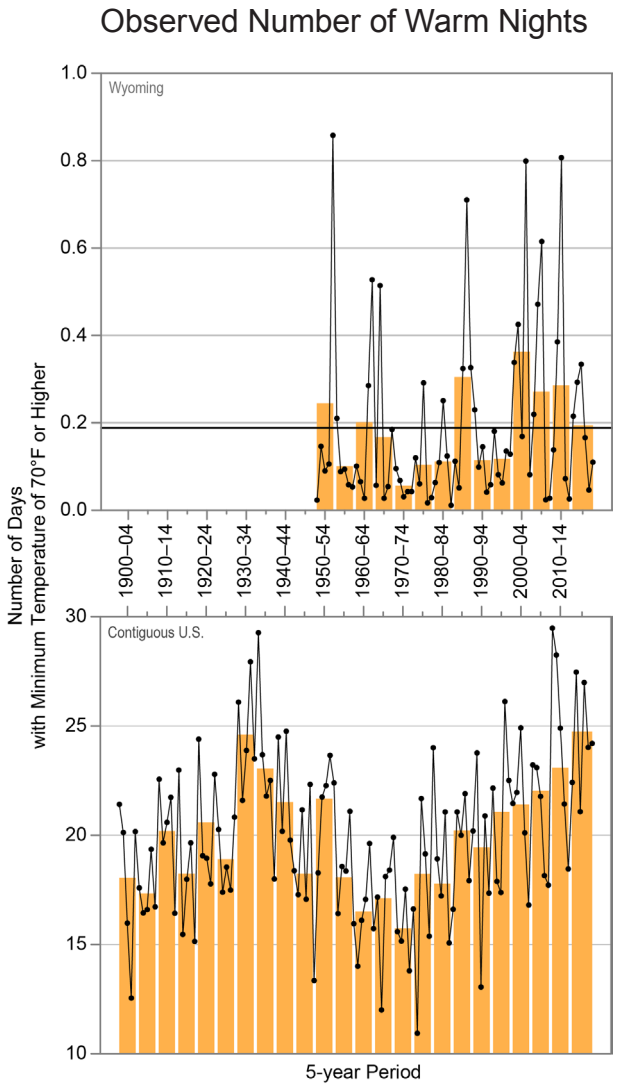


Figure 3: Observed annual number of warm nights (minimum temperature of 70°F or higher) for Wyoming from 1950 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 0.2 nights. Values for the contiguous United States (CONUS) from 1900 to 2020 are included to provide a longer and larger context. Long-term stations dating back to 1900 were not available for Wyoming. Wyoming rarely experiences warm nights due to its semiarid climate and high average elevation. However, since 2000, the number of warm nights has generally been above average. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 35 (WY) and 655 (CONUS) long-term stations.

Wyoming's northern location and associated proximity to the jet stream also make it susceptible to the impacts of winter storm systems, including heavy snows, high winds, and low wind chill temperatures. In early 1949, a series of winter storms devastated the state, killing 17 people and hundreds of thousands of livestock. More recently, eastern Wyoming was hit by an early-season blizzard (October 3–5, 2013) that knocked down power lines and closed many roads. Among long-term weather observing stations, Bates Creek No. 2 reported the highest snowfall amounts of 25 inches over the 3-day period, 20 inches of which fell on October 5th.

Chinook winds—warm and dry downslope winds that occur along the eastern slope of the Rocky Mountains—are a hazard unique to Wyoming and western mountain states. During the winter months, these winds can persist along the eastern slope of the Continental Divide and often bring large temperature increases that lead to rapid snowmelt. Chinook winds can often gust strong enough to cause property damage, as well as flooding due to the rapid melting of snow.

Wyoming is a major source of water for other states, and changes in precipitation can have broad impacts beyond its boundaries. Water from the state's rivers flows into four major river basins: the Missouri–Mississippi, Green–Colorado, Snake–Columbia, and Great Salt Lake. Yearly variations in late-season snowpack depths are large; for example, April 1 snow water equivalent (the amount of water contained within the snowpack) at Lewis Lake Divide has ranged from less than 20 inches to more than 50 inches since 1981 (Figure 5). Such variations have implications for water availability across the West, as snowmelt from the winter snowpack feeds many rivers and streams. **In years with heavy snow cover, heavy rains during the spring thaw can cause rapid melting of the snowpack and lead to severe flooding**.

Wyoming, like the rest of the Great Plains, is susceptible to droughts, which are occasionally severe. From 1999 to 2008, large portions of the state experienced drought conditions. The state then experienced several years of above average precipitation until 2012, which was Wyoming's driest year since historical records began in 1895. By October 2012, almost 90% of the state was in "severe" drought (the U.S. Drought Monitor's third-highest category of drought severity). The drought, along with high temperatures and high winds, resulted in one of Wyoming's worst wildfire seasons, with more than 350,000 acres burned (more than 3 times the yearly average [2002–2020] of 113,000 acres). Another severe wildfire season occurred in 2020; by October 2020, about 60% of the state was in severe drought and almost 340,000 acres had burned.

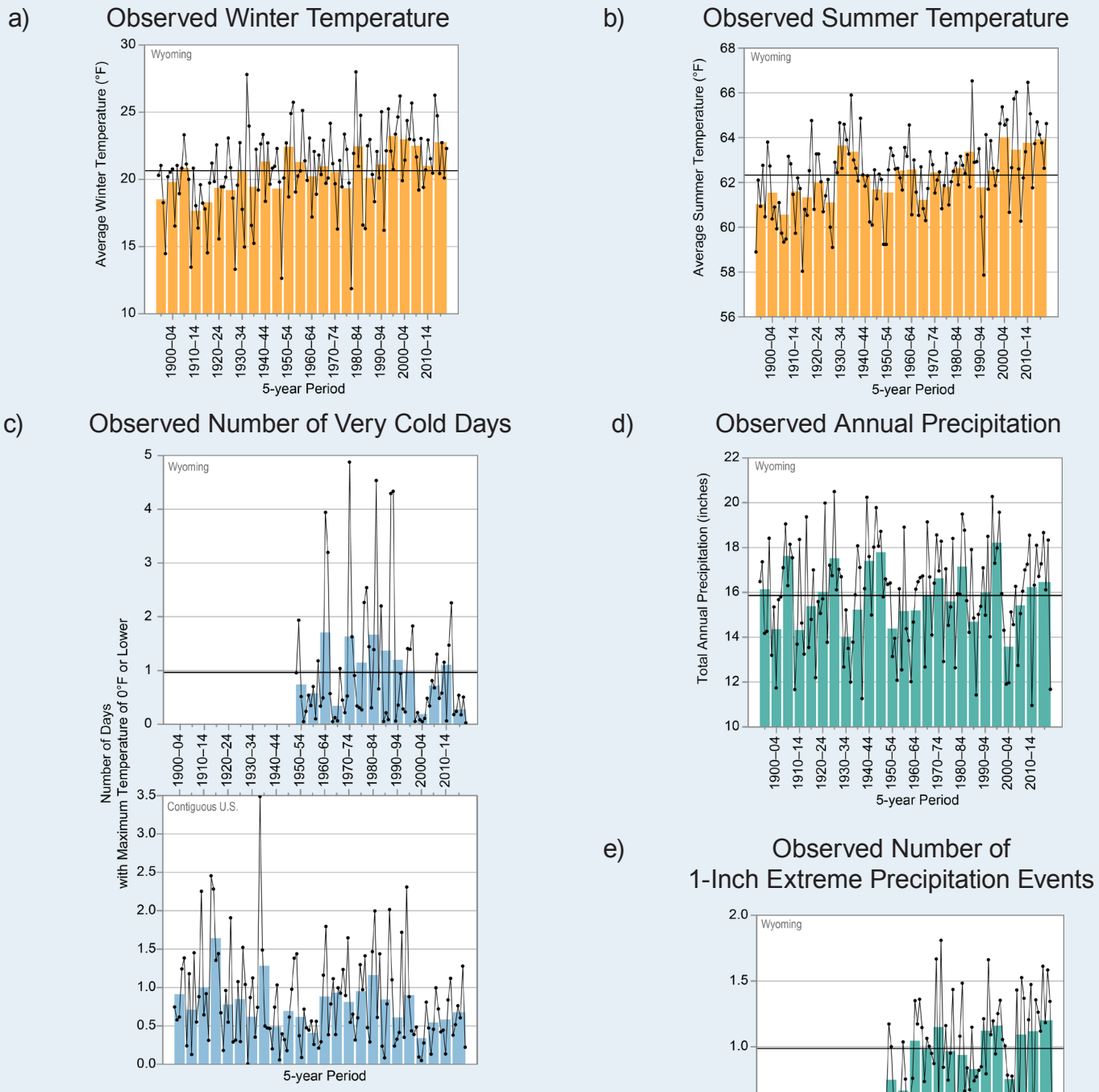


Figure 4: Observed (a) winter (December–February) average temperature, (b) summer (June–August) average temperature, (c) annual number of very cold days (maximum temperature of 0°F or lower), (d) total annual precipitation, and (e) annual number of 1-inch extreme precipitation events (days with precipitation of 1 inch or more) for Wyoming from (a, b, d) 1895 to 2020 and (c, e) 1950 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 for Wyoming: (a) 20.6°F, (b) 62.3°F, (c) 1.0 days, (d) 15.9 inches, (e) 1.0 days. Values for the contiguous United States (CONUS) from 1900 to 2020 are included for Figures 4c and 4e to provide a longer and larger context. Long-term stations dating back to 1900 were not available for Wyoming. The highest multiyear averages for summer and winter average temperatures have occurred since 1995, with summer average temperatures during the early 2000s and 2010s exceeding the extreme heat of the 1930s Dust Bowl era. Since 2000, the number of very cold days in Wyoming has generally been below average, indicative of warming in the region. Total annual precipitation and the number of 1-inch extreme precipitation events have been trending upward since 2000. A typical reporting station experiences about one 1-inch extreme precipitation event per year. Sources: CISESS and NOAA NCEI. Data: (a, b, d) nClimDiv, (c) GHCN-Daily from 35 (WY) and 655 (CONUS) long-term stations, (e) GHCN-Daily from 47 (WY) and 832 (CONUS) long-term stations.

Under a higher emissions pathway, historically unprecedented warming is projected during this century (Figure 1). Even under a lower emissions pathway, annual average temperatures are projected to most likely exceed historical record levels by the middle of the 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. Increases in heat wave intensity are projected, but the intensity of cold waves is projected to decrease.

Winter and spring precipitation is projected to increase (Figure 6). Projected rising temperatures will raise the snow line—the average lowest elevation at which snow falls. This will increase the likelihood that precipitation will fall as rain rather than snow, reducing water storage in the snowpack, particularly at lower mountain elevations that are now on the margins of reliable snowpack accumulation. Higher spring temperatures will also result in earlier melting of the snowpack, further decreasing water availability during the drier summer months. Heavier spring precipitation, combined with a shift from snow to rain, could increase the potential for flooding.

The intensity of future droughts is projected to increase, even if precipitation amounts increase. Increases in evaporation rates due to rising temperatures may increase the rate of soil moisture loss during dry spells. Thus, future summer droughts, a natural part of Wyoming's climate, are likely to become more intense. This in turn will increase the risk of wildfires, which are projected to become more frequent and severe.

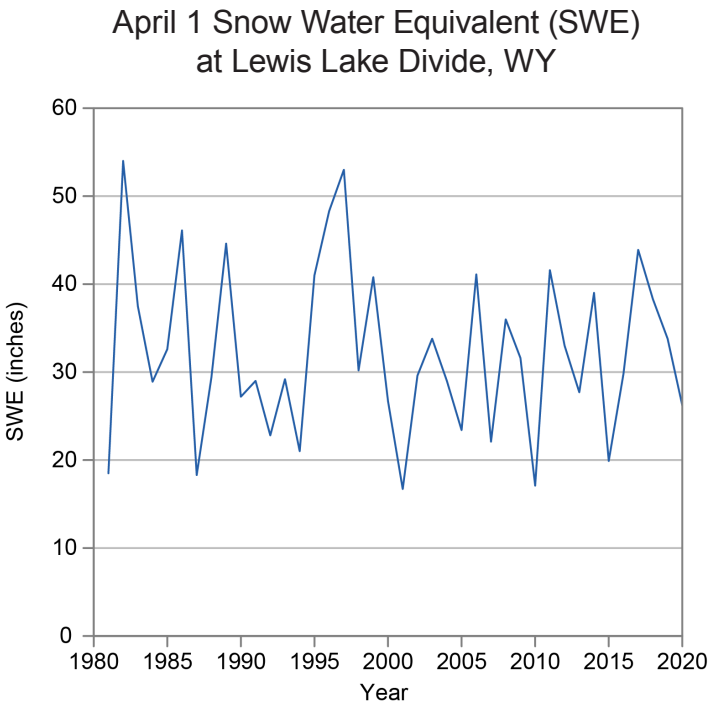


Figure 5: Variations in the April 1 snow water equivalent (SWE) at the Lewis Lake Divide, Wyoming, SNOTEL site from 1981 to 2020. SWE, the amount of water contained within the snowpack, varies widely from year to year. Source: NRCS NWCC.

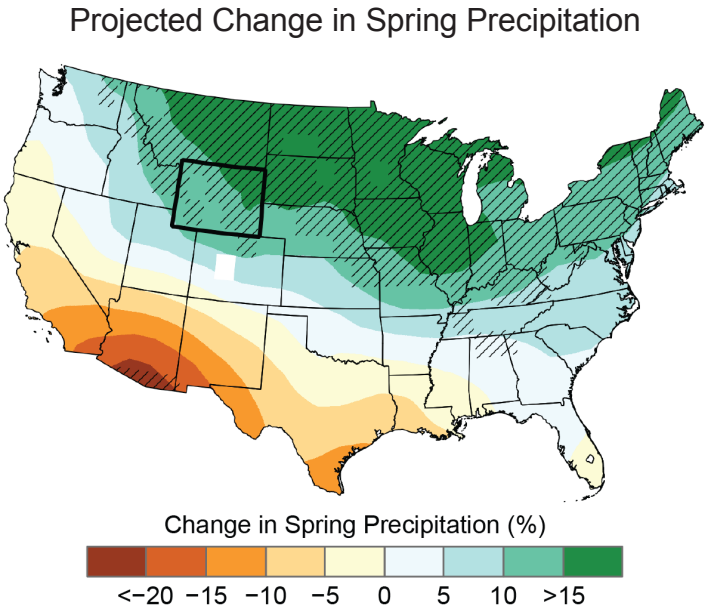


Figure 6: Projected changes in total spring (March–May) precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. The whited-out area indicates that the climate models are uncertain about the direction of change. Hatching represents areas where the majority of climate models indicate a statistically significant change. Wyoming is part of a large area of projected increases across the northern United States. Sources: CISESS and NEMAC. Data: CMIP5.

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