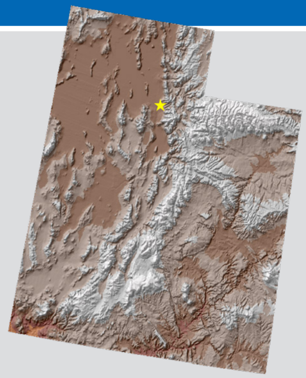

UTAH

Key Messages

Temperatures in Utah have risen more than 2.5°F since the beginning of the 20th century. Warming is particularly evident in the increase of very warm nights and a below average occurrence of very cold nights over the past three decades. Under a higher emissions pathway, historically unprecedented warming is projected to continue through this century.

Droughts are a serious threat in this water-scarce state. The intensity of naturally occurring droughts and the frequency and severity of wildfires are projected to increase in Utah.

It is projected that more winter precipitation will fall as rain instead of snow, which will decrease the snowpack water storage. The number and magnitude of extreme precipitation events are projected to increase, which could increase the risk of flooding.

Utah is a geographically diverse state with forested, mountainous, and desert regions. It has a varied climate due to its inland continental location and wide range of topography. Elevations across the state range from approximately 2,500 feet in the Virgin River Valley to 13,500 feet in the Uinta Mountains. Based on records from long-term stations, average (1991–2020 normals) temperatures in the mountains are around 20°F during the winter months, while lower elevations in the southern portion of the state frequently experience days over 100°F during the summer. In the northern part of the state, the Great Salt Lake has a moderating effect on temperatures in its vicinity. The hottest year on record for Utah was 1934 with an annual average temperature of 51.3°F, followed by 2012 with an annual average temperature of 50.9°F.

Temperatures in Utah have risen more than 2.5°F since the beginning of the 20th century (Figure 1). The period since 2012 has been the warmest on record for Utah, with 8 of the 10 warmest recorded years. The highest number of extremely hot days in the historical record occurred during 2000–2004 (Figure 2). In keeping with the overall trend of higher temperatures, the state has experienced a dramatic increase in the number of very warm nights and a decrease in the number of very cold nights since 1990 (Figures 3 and 4a).

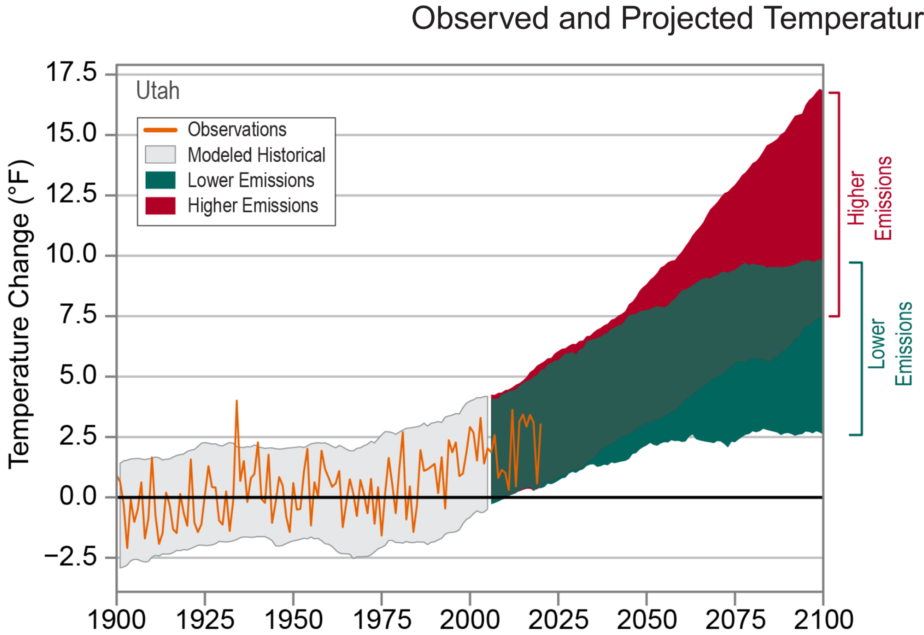

Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Utah. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Utah (orange line) have risen more than 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 to continue through 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 13°F warmer than the hottest year in the historical record; red shading). Sources: CISESS and NOAA NCEI.

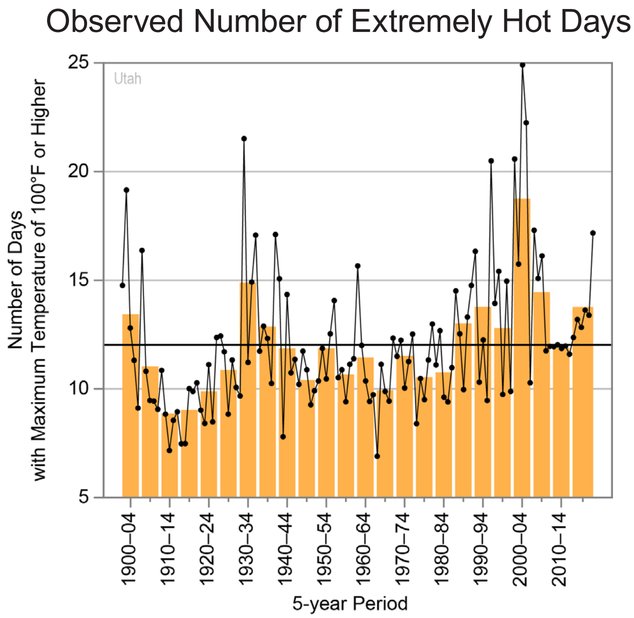

Figure 2: The observed number of extremely hot days (maximum temperature of 100°F or higher) for Utah from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 12 days (note that the average for individual stations varies greatly because of the state's large elevation range). With the exception of the 2010–2014 period, the number of extremely hot days has been above the long-term average since the late 1980s, reaching a peak in 2000–2004. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 15 long-term stations.

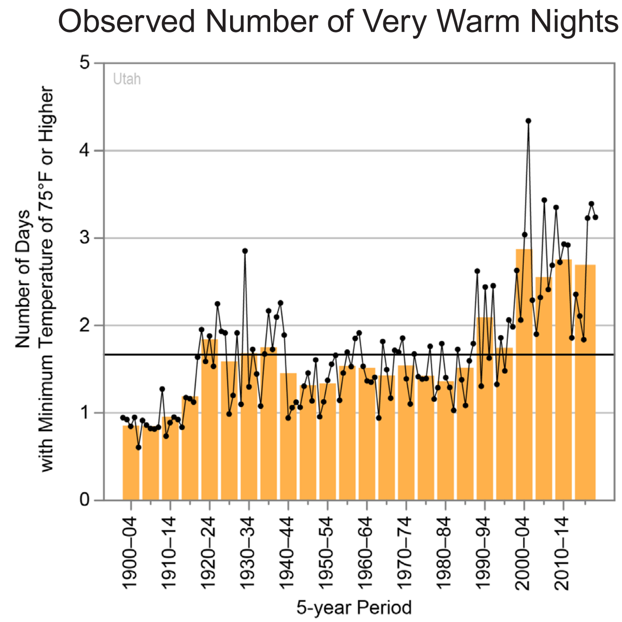

Figure 3: Observed annual number of very warm nights (minimum temperature of 75°F or higher) for Utah from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 1.7 nights (note that the average for individual stations varies greatly because of the state's large elevation range). Due to its semiarid climate and high average elevation, high nighttime temperatures are historically rare for Utah, but the number of very warm nights has risen dramatically since 2000; multiyear averages are nearly double those seen in the 1900s. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 15 long-term stations.

Most of Utah is quite dry because the Sierra Nevada and the Rocky Mountains block moisture from the Pacific Ocean and Gulf of Mexico, respectively. In the northwest part of the state, most precipitation falls during the winter and spring months, while thunderstorms fueled by moisture from the North American Monsoon provide summer precipitation in the east and south. Precipitation is highly variable across the state, with annual totals ranging from less than 5 inches in portions of the Great Salt Lake Desert to more than 40 inches in some portions of the Wasatch Mountains. Statewide total annual precipitation has ranged from 6.2 inches in 2020 to 20.3 inches in 1941. The driest multiyear periods were in the early 1900s and the 1950s to early 1960s, and the wettest periods were the late 1900s and early 1980s (Figure 4b). The driest consecutive 5 years was 1952–1956, with an annual average of 10.7 inches, and the wettest 5-year period was 1980–1984, with an annual average of 17.2 inches. Long-term periods of wet and dry spells can have critical impacts on water supplies.

Snowfall varies widely across the state, with portions of the south receiving less than 10 inches per year and areas in the mountains receiving more than 400 inches per year. The area around the Great Salt Lake can receive significant snowfall due to lake-effect snow events. The lake's high salt content prevents it from freezing, and the open waters can efficiently warm and moisten cold air masses as they pass over the lake, occasionally triggering bands of heavy snowfall over areas to the east and south of the lake. As the state has warmed, the percentage of precipitation falling as snow during the winter has decreased, as have snow depth and snow cover.

Unlike many areas of the United States, Utah and other southwestern states have not experienced an upward trend in the frequency of extreme precipitation events (Figure 4c). **Although floods are rare in the state, both heavy rainfall and snowmelt can result in severe flooding.** Historically, floods of both types have had devastating impacts. In 1983, melting of a large snowpack during the months of April and June caused mudslides and extensive flooding in the Salt Lake Valley (Figure 4d). In January 2005, heavy rains in the Virgin River basin caused severe flooding along the Virgin and Santa Clara rivers in Washington County, resulting in more than $225 million in damage.

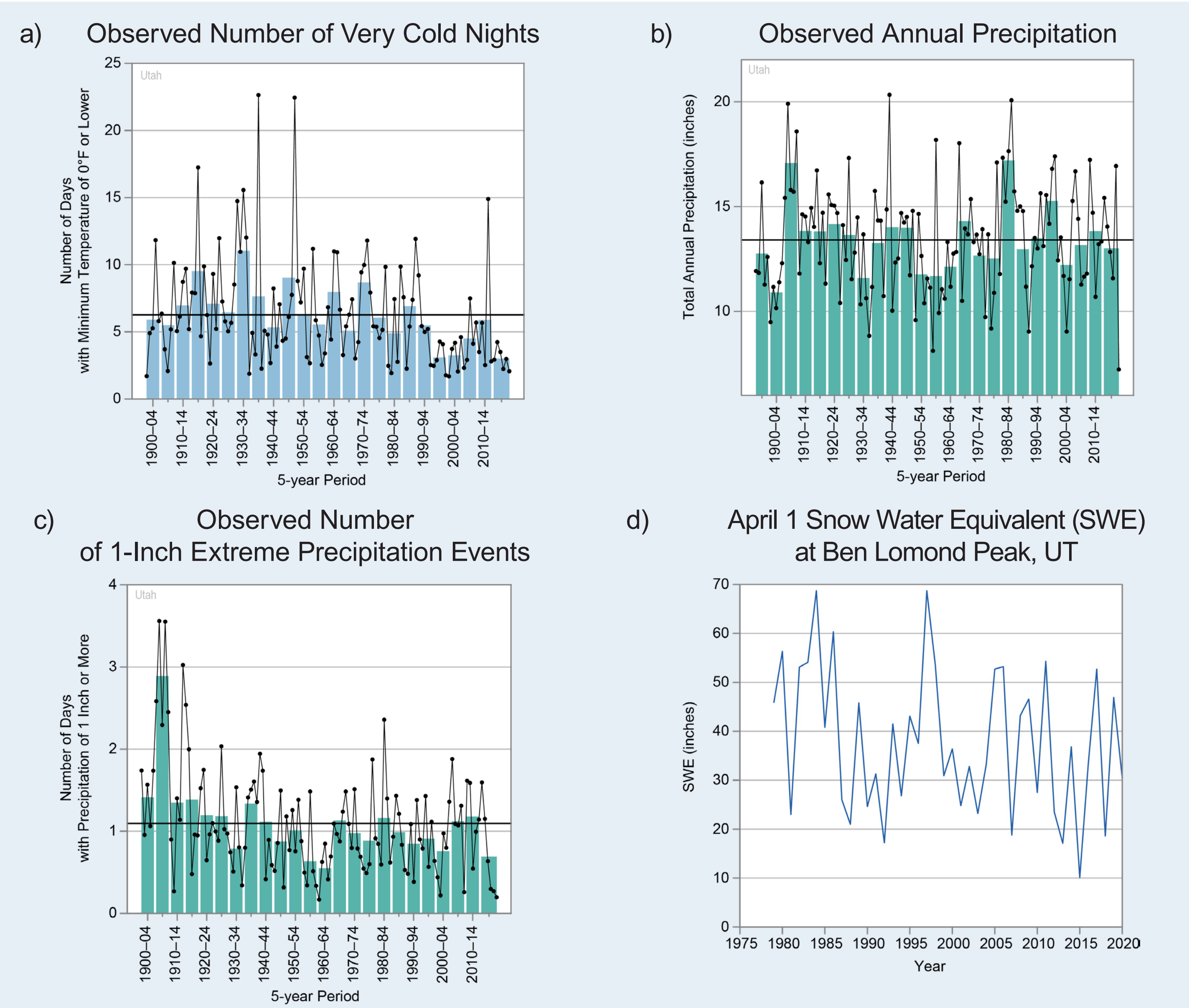

Figure 4: Observed (a) annual number of very cold nights (minimum temperature of 0°F or lower), (b) total annual precipitation, and (c) number of 1-inch extreme precipitation events (days with precipitation of 1 inch or more) for Utah from (a, c) 1900 to 2020 and (b) 1895 to 2020. Dots show annual values. 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) 6.3 nights, (b) 13.4 inches, (c) 1.1 days. (Note that for Figures 4a and 4c, the average for individual reporting stations varies greatly because of the state's large elevation range.) Figure 4d shows variations in the April 1 snow water equivalent (SWE) at the Ben Lomond Peak, Utah, SNOTEL site from 1979–2020. Since 1990, Utah has experienced a below average number of very cold nights, indicative of warming in the region. Annual precipitation during the most recent sixteen years (2005–2020) has been near the long-term average, but 2020 was the driest year on record. There is no long-term trend in the number of 1-inch extreme precipitation events. SWE, the amount of water contained within the snowpack, varies widely from year to year and exhibits a general downward trend; it was well above the long-term average in 2017 and 2019 but was well below that average in 2015 and 2018. Sources: (a, b, c) CISESS and NOAA NCEI; (d) NRCS NWCC. Data: (a) GHCN-Daily from 15 long-term stations; (b) nClimDiv; (c) GHCN-Daily from 8 long-term stations.

Utah frequently experiences droughts. The historical record indicates periodic prolonged wet and dry periods (Figure 5). Since snowmelt from the snowpack provides water for many river basins, abnormally low winter and spring precipitation is often the trigger for drought conditions. In 2012, Utah experienced one of its driest springs since records began in 1895, resulting in severe drought conditions in areas across the entire state. The driest year on record was 2020, and by the end of the year, 90% of the state was in extreme or exceptional drought. Dry conditions since 2000 have resulted in near-record-low water levels in the Great Salt Lake (Figure 6). El Niño and La Niña events can have major effects on precipitation in other parts of the western U.S., but in Utah the effects are not consistent and thus the occurrence of such events cannot be used as a reliable prediction tool.

Under a higher emissions pathway, historically unprecedented warming is projected to continue through 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 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. Increases in average temperatures will be accompanied by increases in heat wave intensity and decreases in cold wave intensity.

Climate models are not consistent in their projections of precipitation for Utah, including winter precipitation (Figure 7). However, projected rising temperatures will also raise the snow line—the average lowest elevation at which snow falls. Continuing recent trends, this will increase the likelihood that precipitation will fall as rain instead of snow, reducing water storage in the snowpack, particularly at lower elevations that are currently on the margins of reliable snowpack accumulation. **In addition, extreme precipitation is projected to increase, potentially increasing the frequency and intensity of floods.**

Droughts, a natural part of Utah's climate, are expected to become more intense. Higher temperatures will amplify the effects of naturally occurring dry spells by increasing the rate of loss of soil moisture. Most of Utah's water is supplied by the snowpack; observed trends toward more winter precipitation falling as rain and less as snow could result in less water storage. Additionally, higher spring temperatures can cause early melting of the snowpack, decreasing water availability during the already dry summer months. The projected increase in the intensity of naturally occurring droughts will increase the occurrence and severity of wildfires.

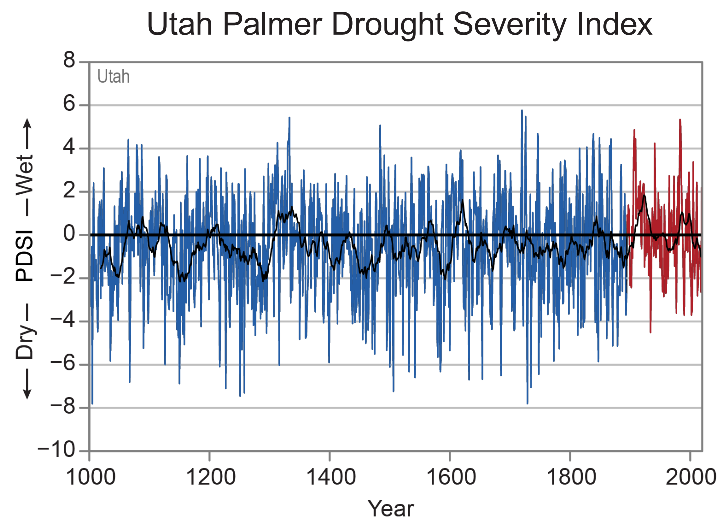

Figure 5: Time series of the Palmer Drought Severity Index for Utah from the year 1000 to 2020. Values for 1895–2020 (red) are based on measured temperature and precipitation. Values prior to 1895 (blue) are estimated from indirect measures such as tree rings. The fluctuating black line is a running 20-year average. In the modern era, the wet periods of the early 1900s and the 1980s–1990s and the dry periods of the 1950s and 2000s are evident. The extended record indicates periodic occurrences of similarly prolonged wet and dry periods. Sources: CISESS and NOAA NCEI. Data: nClimDiv and NADAv2.

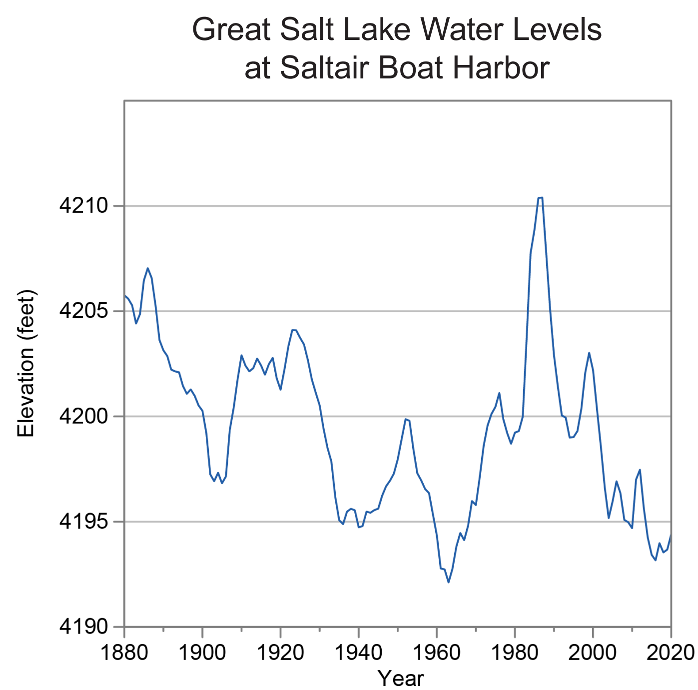

Figure 6: Annual time series of the water level of the Great Salt Lake at Saltair Boat Harbor for 1880–2019. Water levels in the Great Salt Lake have varied widely over the years. Record snowpack levels during the winter of 1982–1983 resulted in severe flooding. Recent years have seen some of the lowest levels in the historical record. Source: USGS.

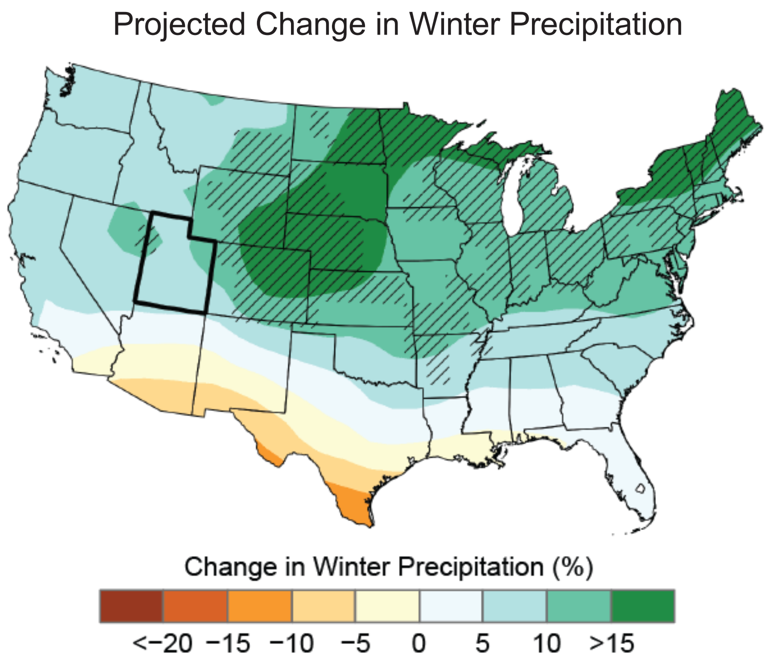

Figure 7: Projected changes in total winter (December–February) precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. Hatching represents areas where the majority of climate models indicate a statistically significant change. Utah is part of a large area across the United States with projected increases in winter precipitation, but the changes in Utah are not statistically significant. Sources: CISESS and NEMAC. Data: CMIP5.

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