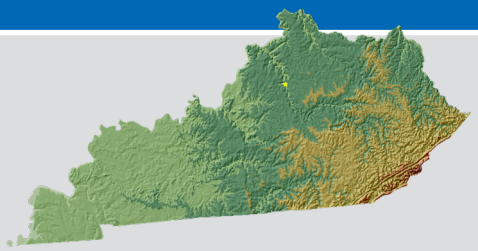
KENTUCKY



Key Messages

Temperatures in Kentucky have risen by 0.6°F, less than half of the warming for the contiguous United States, since the beginning of the 20th century, but the warmest consecutive 5-year interval was 2016–2020. Under a higher emissions pathway, historically unprecedented warming is projected during this century, with associated increases in heat wave intensity and decreases in cold wave intensity.

Total annual precipitation and the number of extreme precipitation events have generally been above average since 2000. Future increases in the frequency and intensity of extreme precipitation events are projected.

Increases in evaporation rates due to rising temperatures may increase the intensity of naturally occurring droughts.

Due to its central location in the eastern half of the United States and the lack of mountain barriers to the interior of the North American continent and south to the Gulf of Mexico, Kentucky's climate is characterized by moderately large variations in temperature and abundant precipitation. Summers vary from warm to hot and humid, while winters are cool with occasional episodes of very cold arctic air. Average (1991–2020 normals) daily high temperatures for July range from 82°F in the east to 91°F in the west, while January highs range from 40°F in the north to 47°F in the south. Temperatures fall below 0°F for more than 3 days per year in the north to less than 1 day in the south. Kentucky's elevation ranges from 400 feet above sea level along the Mississippi River in the west to more than 4,100 feet at the peak of Black Mountain in the southeast, although most of the state is below 1,000 feet. Annual average precipitation ranges from about 38 inches in the northeast to around 58 inches in the southeast. The wettest year on record was 2011, with 64 inches of precipitation, while the driest was 1930, with 29 inches.

Temperatures in Kentucky have risen by 0.6°F, less than half of the warming for the contiguous United States, since the beginning of the 20th century, but the warmest consecutive 5-year interval was 2016–2020 (Figure 1). Very warm temperatures occurred during the 1930s, followed by a substantial cooling of about 2°F in the 1960s. Since then, temperatures have risen about 3°F and have exceeded the highs of the 1930s. The hottest year on record was 1921, but two recent years, 2012 and 1998, rank second and third, respectively. Because of the cooling in the mid-20th century, the southeastern United States is one of the few regions globally that has experienced little to no overall warming since 1900. The contiguous United States as a whole has warmed by about 1.8°F since 1900, although it also cooled from the 1930s into the 1960s but not by nearly as much as Kentucky. 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.

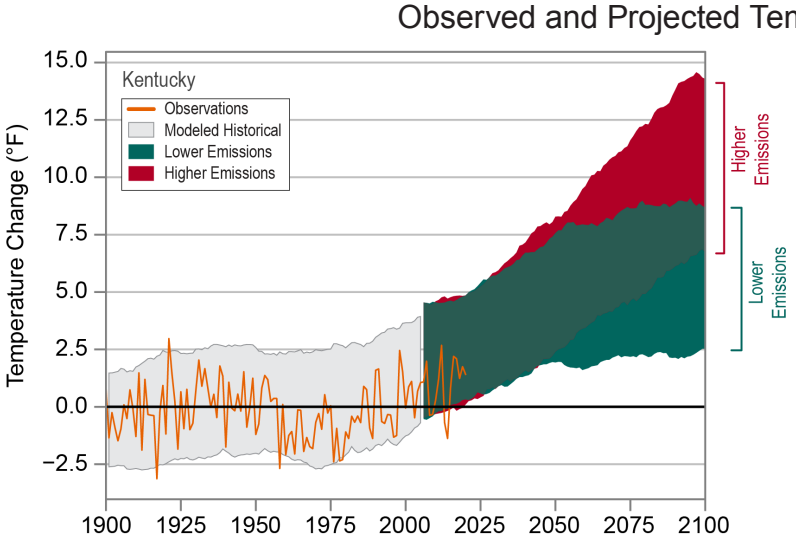
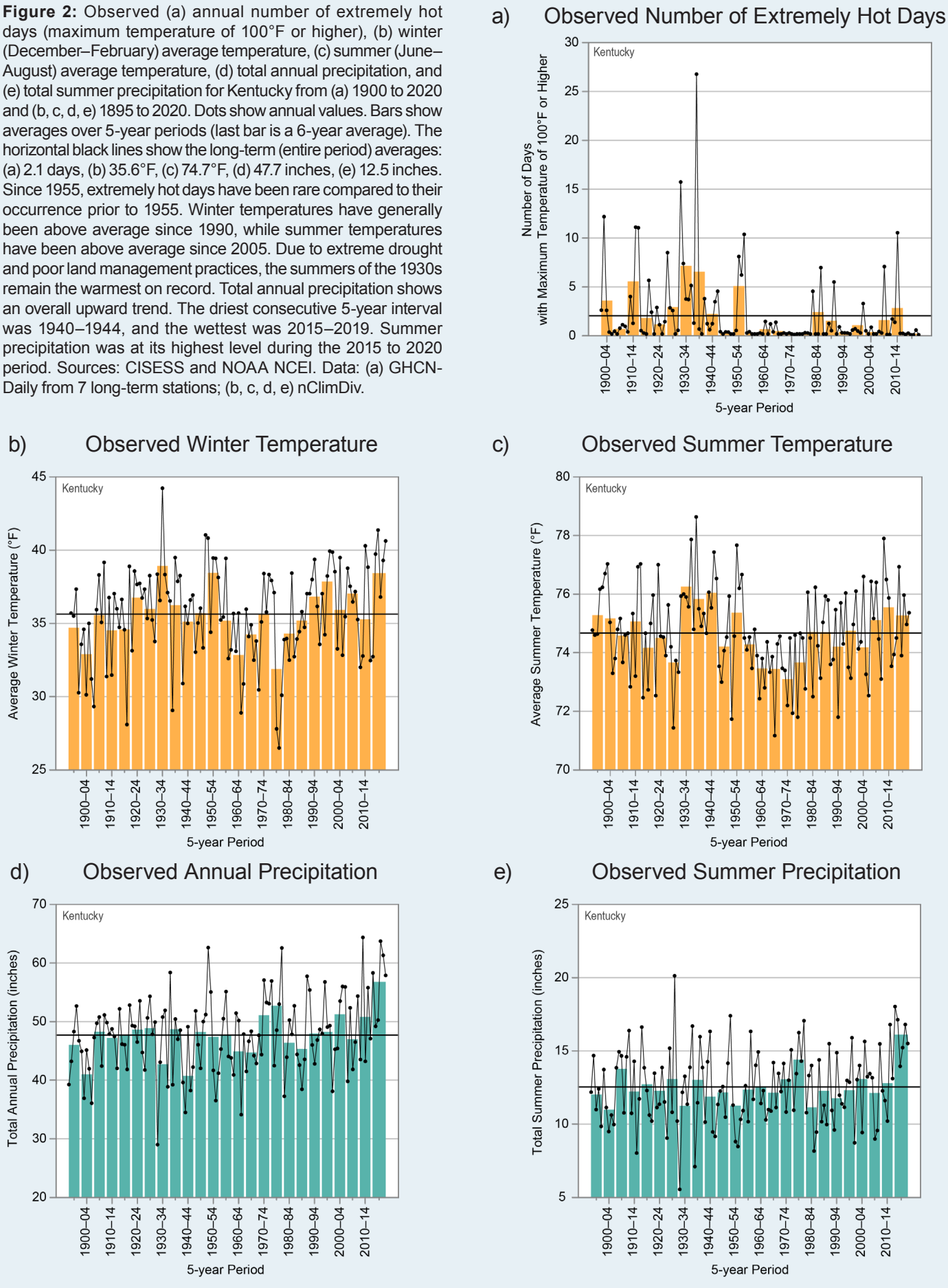


Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Kentucky. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Kentucky (orange line) have risen by 0.6°F, less than half of the warming for the contiguous United States, since the beginning of the 20th century, but the warmest consecutive 5-year interval was 2016–2020. Shading indicates the range of annual temperatures from the set of models. Observed temperatures are generally within, but on the lower end of, 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 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 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) annual number of extremely hot days (maximum temperature of 100°F or higher), (b) winter (December–February) average temperature, (c) summer (June–August) average temperature, (d) total annual precipitation, and (e) total summer precipitation for Kentucky from (a) 1900 to 2020 and (b, 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) 2.1 days, (b) 35.6°F, (c) 74.7°F, (d) 47.7 inches, (e) 12.5 inches. Since 1955, extremely hot days have been rare compared to their occurrence prior to 1955. Winter temperatures have generally been above average since 1990, while summer temperatures have been above average since 2005. Due to extreme drought and poor land management practices, the summers of the 1930s remain the warmest on record. Total annual precipitation shows an overall upward trend. The driest consecutive 5-year interval was 1940–1944, and the wettest was 2015–2019. Summer precipitation was at its highest level during the 2015 to 2020 period. Sources: CISESS and NOAA NCEI. Data: (a) GHCN-Daily from 7 long-term stations; (b, c, d, e) nClimDiv.



The greatest number of extremely hot days occurred in the early 1910s and the Dust Bowl era of the 1930s, with a record high of 27 days in 1936 (Figure 2a). Since 1955, the number of extremely hot days has generally been below average. **The number of extremely cold events has also been below average in recent winters**. The top 10 coldest winters all occurred prior to 1980. Also, since 1990, the number of very cold nights has been below average (Figure 3), and winter average temperatures have generally been near to above average (Figure 2b). For the 2015–2020 period, multiyear averages for both the number of very warm nights (Figure 4) and summer average temperature (Figure 2c) were above average but not as high as the multiyear averages for the 1930s.

Total annual precipitation in Kentucky exhibits an overall upward trend (Figure 2d) **and has averaged 7.4 inches above the long-term (1895–2020) average since 2011**. The annual number of 2-inch extreme precipitation events has been highly variable (Figure 5). The two highest multiyear averages of more than 3 days occurred during the 1975–1979 and 2010–2014 periods. Summer precipitation was well above average during the 2015–2020 period (Figure 2e). Deficient precipitation coupled with hot temperatures during the summer months can result in drought. During the summer of 2012, extreme drought conditions in western Kentucky were exacerbated by a heat wave in late June and early July, when high temperatures rivaled those experienced in the 1930s.

Extreme weather events in Kentucky include ice and snowstorms in the winter and severe thunderstorms in the warmer months. Heavy rain from severe thunderstorms can often lead to flash flooding in low-lying areas and in urban areas where the prevalence of impermeable surfaces (such as roads, roofs, and parking lots) accelerates storm runoff to ditches and streams. High winds, hail, and tornadoes are also associated with severe thunderstorms. From 2010 to 2020, the Federal Emergency Management Agency granted 19 disaster declarations, mostly for severe storms, tornadoes, and flooding. **Kentucky experiences a relatively high number of tornadoes each year**, with an annual average of about 24 tornadoes between 1991 and 2019. On March 2, 2012, eighteen tornadoes touched down in Kentucky, including one of EF4 and four of EF3 intensity, resulting in 22 fatalities. In April 2011, 41 tornadoes were reported, superseding an earlier April record of 29 tornadoes during the Super Outbreak of 1974. The December 10–11, 2021, tornado outbreak is one of the deadliest in Kentucky history, resulting in 76 fatalities. Twenty tornadoes touched down, including one of EF4 and three of EF3 intensity. The EF4 tornado path extended from near Woodland Mills, TN (just across the border from Fulton County, KY), to Breckinridge County (near Falls of Rough, KY), a distance of 165.7 miles. The maximum estimated wind speed was 190 mph.

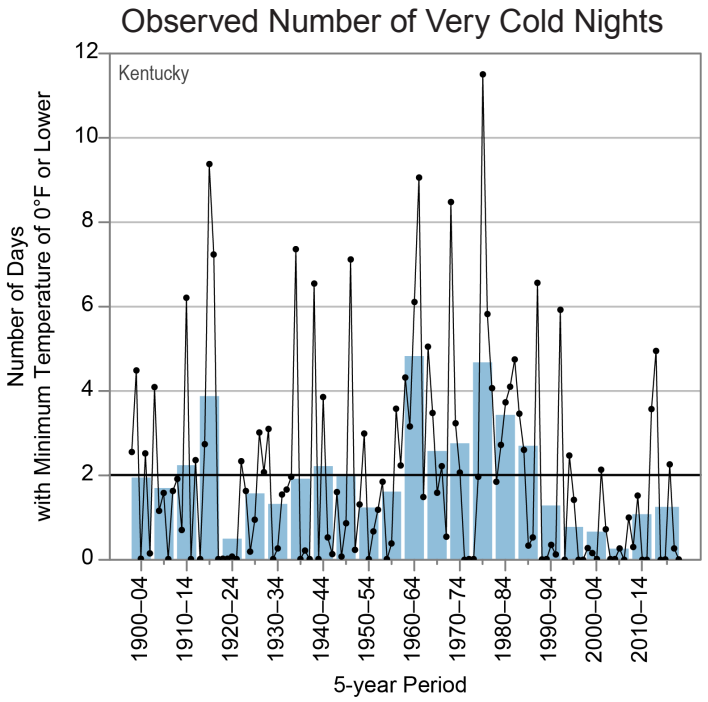


Figure 3: Observed annual number of very cold nights (minimum temperature of 0°F or lower) for Kentucky from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 2.0 nights. The number of very cold nights has been below average since 1990. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 7 long-term stations.

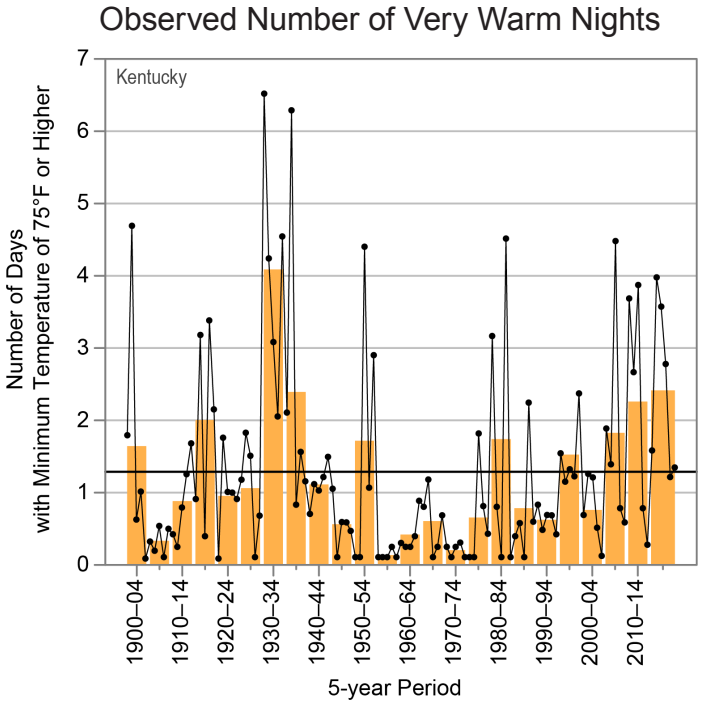


Figure 4: Observed annual number of very warm nights (minimum temperature of 75°F or higher) for Kentucky from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 1.3 nights. The number of very warm nights has been steadily increasing since 2000 but has not exceeded the values of the early 1930s. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 7 long-term stations.

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 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—if observed temperatures continue to follow the lower end of model projections. Heat waves are projected to be more intense in the future, posing increased risks of heat-related illness and deaths, especially for urban residents. Cold waves are projected to be less intense.

Increases in precipitation are projected for Kentucky, most likely during the winter and spring (Figure 6). Changes in summer and fall precipitation are uncertain, however. Continuing increases in the frequency and intensity of extreme precipitation events are also projected, potentially increasing the frequency and intensity of floods. At the same time, the intensity of future droughts is projected to increase because of increases in evaporation rates due to rising temperatures in combination with naturally occurring periods of below average rainfall. These potential increases in the intensity of both floods and droughts will have implications for important sectors of the state's economy, including agriculture, industry, tourism, and natural resource management.

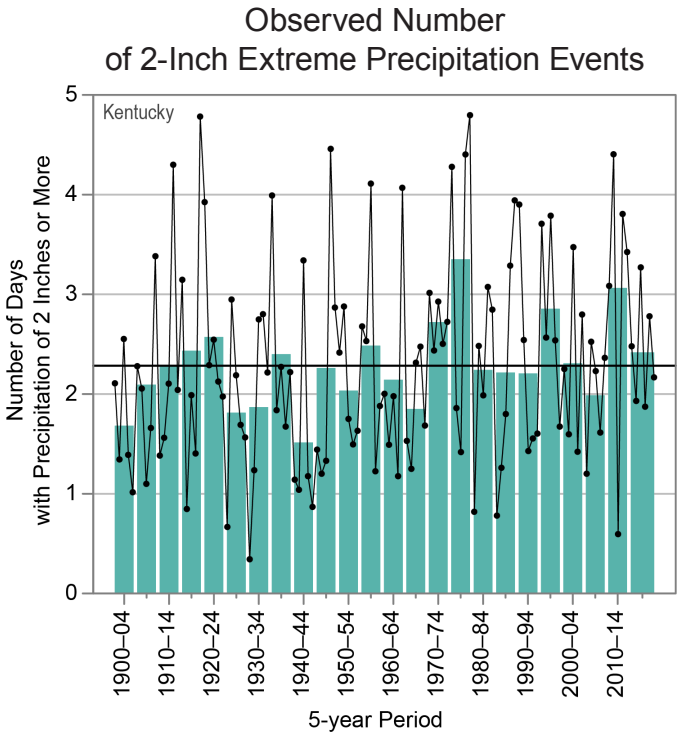


Figure 5: Observed annual number of 2-inch extreme precipitation events (days with precipitation of 2 inches or more) for Kentucky from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 2.3 days. A typical station experiences about 2 events per year. The number of 2-inch extreme precipitation events was mostly below average between 1900 and 1969 but mostly near or above average since then. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 7 long-term stations.

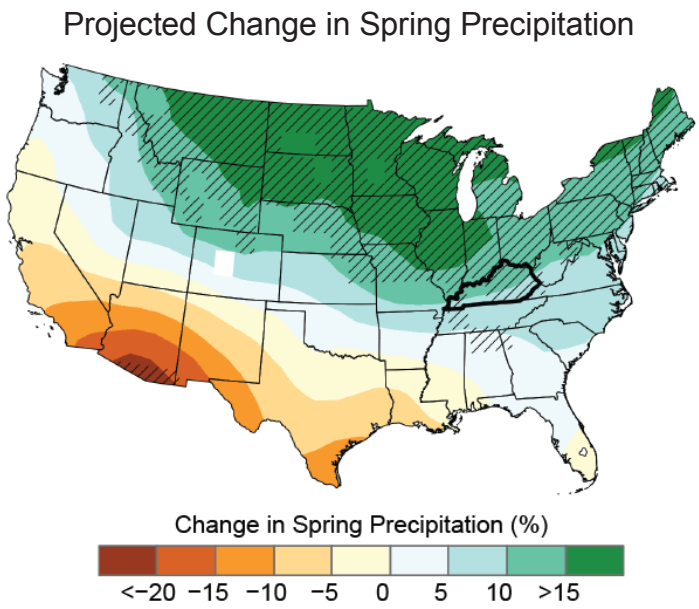


Figure 6: Projected changes in total spring (March–May) precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. The whited-out area indicates that the climate models are uncertain about the direction of change. Hatching represents areas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

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