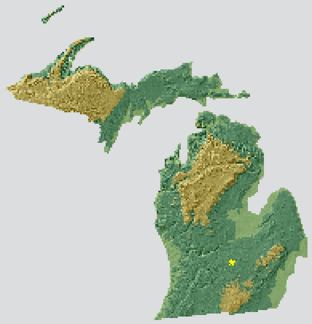
MICHIGAN



Key Messages

Temperatures in Michigan have risen almost 3°F since the beginning of the 20th century. Historically unprecedented warming is projected during this century. Extreme heat is a particular concern for densely populated urban areas such as Detroit, where high temperatures and high humidity can cause dangerous conditions.

Projected increases in winter and spring precipitation raise the risk of springtime flooding, which could delay planting and reduce yields.

Changes in seasonal and multiyear precipitation and increased evaporation rates due to rising temperatures can affect water levels in the Great Lakes, causing serious environmental and socioeconomic impacts.

Michigan experiences large seasonal changes in temperature, with warm, humid summers and cold winters. The Great Lakes play an important role in moderating the state's climate, causing it to be more temperate and moist than other north-central states. The Lower Peninsula is bordered by Lake Michigan to the west and by Lakes Huron and Erie to the east; the Upper Peninsula, by Lake Superior to the north and Lakes Michigan and Huron to the east and south. The moderating effect is most evident along the shores, which are considerably warmer during the winter and cooler in the summer than more inland locations. For example, Lansing and Muskegon have similar latitudes but experience very different frequencies of hot and cold days. Lansing, located in the center of the state, averages 9.0 hot days and 6.9 very cold nights per year. In contrast, Muskegon, located along the western shore of Lake Michigan, averages only 3.4 hot days and 2.5 very cold nights. The moderating effects are even more striking along the shores of the colder waters of Lake Superior in the Upper Peninsula. Sault Ste. Marie averages only 1.4 hot days per year, and there have been only 11 warm nights since 1888.

Temperatures in Michigan have risen almost 3°F since the beginning of the 20th century (Figure 1). Temperatures in the 2000s have been higher than in any other historical period. The year 2012 was the hottest on record, with a statewide annual average temperature of 48.4°F, 4.6°F above the long-term (1895–2020) average.

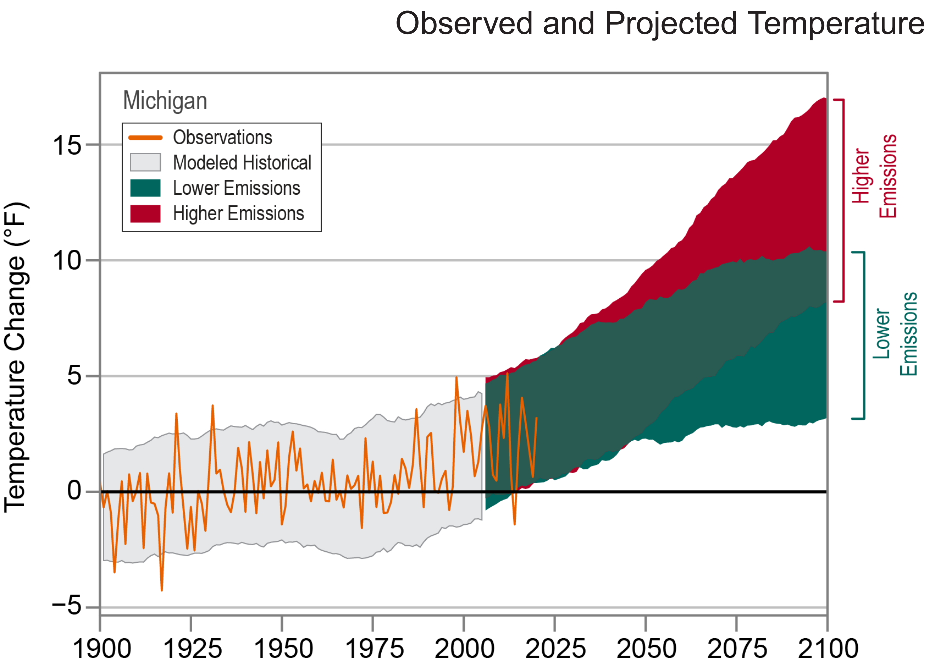


Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Michigan. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Michigan (orange line) have risen almost 3°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 3°F warmer than the historical average; green shading) and more warming under a higher emissions future (the hottest end-of-century projections being about 12°F warmer than the hottest year in the historical record; red shading). Sources: CISESS and NOAA NCEI.

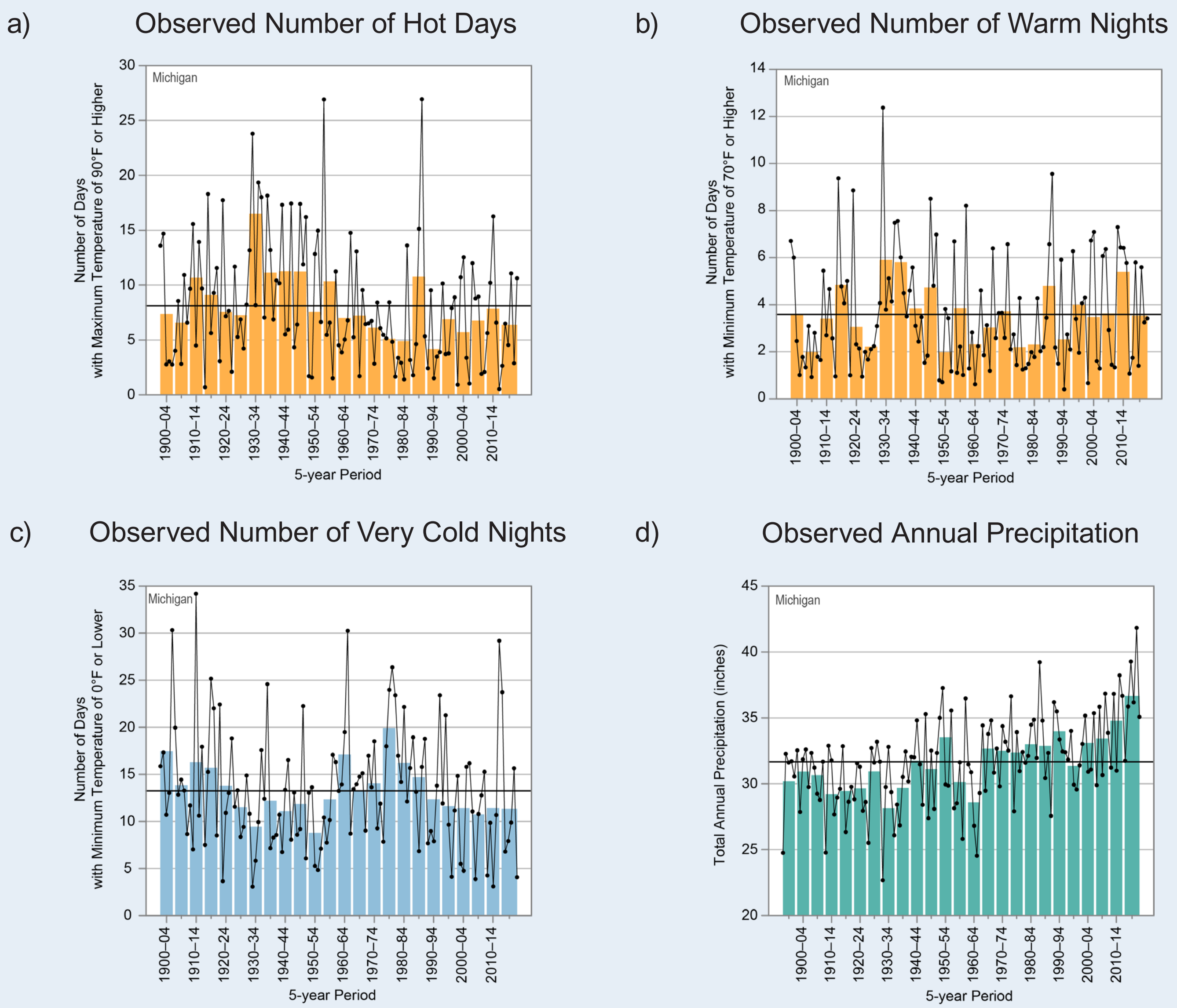


Figure 2: Observed (a) annual number of hot days (maximum temperature of 90°F or higher), (b) annual number of warm nights (minimum temperature of 70°F or higher), (c) annual number of very cold nights (minimum temperature of 0°F or lower), and (d) total annual precipitation for Michigan from (a, b, c) 1900 to 2020 and (d) 1895 to 2020. Dots show annual values. Bars show averages over five-year periods (last bar is a 6-year average). The horizontal black lines show the long-term (entire period) averages: (a) 8.1 days, (b) 3.6 nights, (c) 13 nights, (d) 31.7 inches. The number of hot days has been below average since 1990, while the number of warm nights shows no clear trend. Due to extreme drought and poor land management practices, the summers of the 1930s remain the warmest on record. The number of very cold nights has been below average since 1990. Annual precipitation shows an upward trend since 1995, with the highest multiyear average recorded for the 2015 to 2020 period. Sources: CICESS and NOAA NCEI. Data: (a, b, c) GHCN-Daily from 21 long-term stations, (d) nClimDiv.

Warming has been concentrated in winter and spring, while summers have not warmed substantially, a feature characteristic of much of the Midwest. A lack of summer warming is reflected in a below average number of hot days since 1990 (Figure 2a) and no overall trend in warm nights (Figure 2b). The winter warming trend is reflected in a below average number of very cold nights since 1990 (Figure 2c) and reduced ice cover in the Great Lakes. The 2000–2021 annual average maximum ice coverage was about 47%, compared to the 1973–1999 average of 58%.

Statewide annual precipitation has ranged from a low of 22.7 inches in 1930 to a high of 41.8 inches in 2019. The driest multiyear periods were in the 1930s and early 1960s and the wettest in the early 1950s, early 1990s, and 2010s (Figure 2d). The driest consecutive 5-year interval was 1930–1934, and the wettest was 2016–2020.

The frequency of extreme precipitation events has increased. Multiyear averages for 2-inch extreme precipitation events for the 2010–2014 and 2015–2020 periods are the highest on record (Figure 3). Snowfall is common in the state but varies regionally. Due to their proximity to the Great Lakes, the south shore of Lake Superior in the Upper Peninsula and the eastern shore of Lake Michigan in the Lower Peninsula receive much more snowfall than the rest of the state. Parts of the Upper Peninsula receive more than 180 inches annually.

Water levels in the Great Lakes have fluctuated over a range of 3 to 6 feet since the late 19th century (Figure 4). Higher lake levels were generally noted in the late 19th century, the early 20th century, and the 1940s, 1950s, 1980s, and late 2010s. Lower lake levels were observed in the 1920s and 1930s and again in the 1960s. For Lake Michigan–Huron, lower levels occurred during the first decade of this century. Lake levels have risen rapidly since 2013, with the highest levels since 1886 observed in 2020.

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 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. Extreme heat is a particular concern for Detroit and other urban areas, where high temperatures combined with high humidity can cause dangerous heat index values, a phenomenon known as the urban heat island effect. Higher spring temperatures will lengthen the growing season but also potentially increase the risk of spring freeze damage. In 2012, record-high March temperatures caused Michigan's fruit trees to bloom early. When temperatures dropped back down to below freezing in April, the budding fruit crop was destroyed, causing exceptionally large monetary losses in the hundreds of millions of dollars.

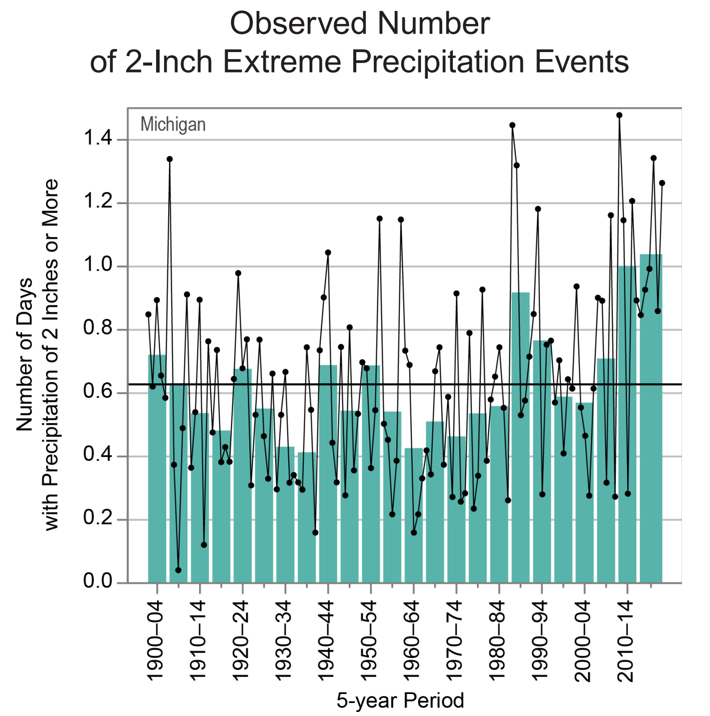


Figure 3: Observed annual number of 2-inch extreme precipitation events (days with precipitation of 2 inches or more) for Michigan from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 0.6 days. A typical reporting station experiences about 1 event every 2 years. The number of 2-inch extreme precipitation events has been increasing since 2000, with record-high multiyear values for the last two periods. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 20 long-term stations.

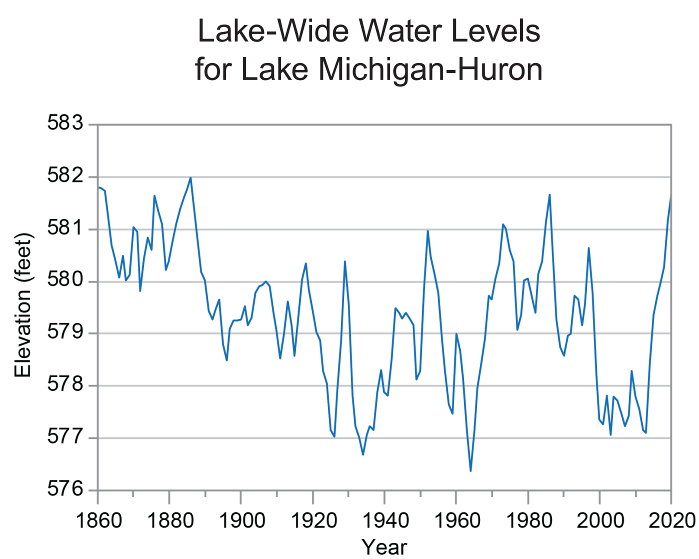


Figure 4: Annual time series of the average water levels for Lake Michigan–Huron from 1860 to 2020. Water levels in the Great Lakes have fluctuated widely over the years. Lake Michigan–Huron levels were very low during 2000–2013 but have since risen rapidly to the highest levels since 1886. Source: NOAA GLERL.

Increases in precipitation are projected for Michigan, most likely during the winter and spring (Figure 5). The frequency and intensity of extreme precipitation are also projected to increase, potentially increasing the frequency and intensity of floods. Springtime flooding, in particular, could pose a threat to Michigan's important agricultural industry by delaying planting and threatening yield losses.

The intensity of future droughts is projected to increase even if precipitation increases. Rising temperatures will increase evaporation rates and the rate of soil moisture loss. Thus, summer droughts, a natural part of Michigan's climate, are likely to be more intense in the future.

Changes in seasonal and multiyear precipitation and increases in evaporation rates due to rising temperatures can affect water levels in the Great Lakes, causing serious environmental and socioeconomic impacts. During the 1980s, high lake levels resulted in the destruction of beaches, erosion of shorelines, and the flooding and destruction of near-shore structures. Low lake levels can affect the supply and quality of water, restrict shipping, and result in the loss of wetlands. Future changes in lake levels are uncertain and the subject of research. Reduced winter ice cover from warmer temperatures also leaves shores vulnerable to erosion and flooding.

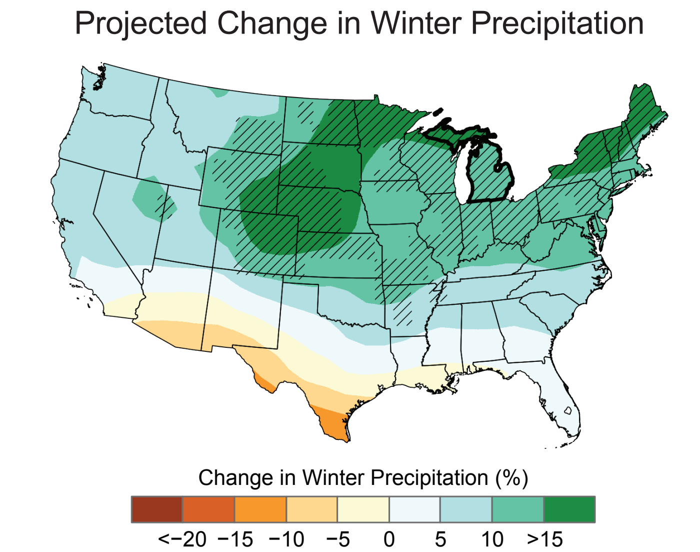


Figure 5: Projected changes in total winter (December–February) precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. Hatching represents areas where the majority of climate models indicate a statistically significant change. Precipitation is projected to increase in Michigan, with the largest increases projected for winter and spring. Sources: CISESS and NEMAC. Data: CMIP5.

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

WWW.NCEI.NOAA.GOV | HTTPS://STATESUMMARIES.NCICS.ORG/CHAPTER/MI/ | LEAD AUTHORS: REBEKAH FRANKSON, KENNETH E. KUNKEL
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