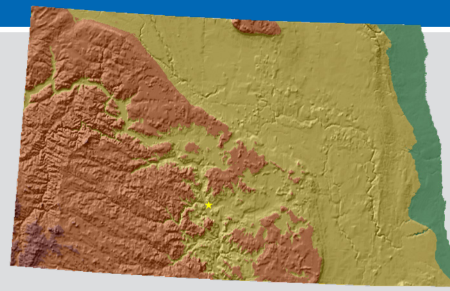
NORTH DAKOTA



Key Messages

Temperatures in North Dakota have risen more than 2.6°F since the beginning of the 20th century. The annual average temperature has increased at a rate of 0.2°F per decade. This warming is most evident in winter and is reflected in a below average number of very cold days since 2000. Under a higher emissions pathway, historically unprecedented warming is projected during this century.

Increases in evaporation rates due to rising temperatures may increase the rate of soil moisture loss and the intensity of naturally occurring droughts.

Precipitation is projected to increase during the colder months. Increases in the frequency and intensity of extreme precipitation events are also projected.

North Dakota lies in the northern Great Plains, straddling the transition from the moist eastern United States to the semiarid West. Due to its location in the center of the North American continent, far from the moderating effects of the oceans, the state experiences large temperature extremes. Average (1991–2020 normals) January temperatures range from about 4°F in the northeast to 18°F in the southwest, while average July temperatures range from 65°F in the northeast to 72°F in the south. Temperatures of 100°F or higher occur nearly every year and are most prevalent in the drier southwestern and south-central regions. The lack of mountain ranges to the north exposes the state to bitterly cold arctic air masses in the winter.

Temperatures in North Dakota have risen more than 2.6°F since the beginning of the 20th century (Figure 1). The first two decades of this century represent one of the warmest periods on record for North Dakota, with several years (2006, 2012, 2015, and 2016) meeting or exceeding the extreme heat of many of the 1930s Dust Bowl years, when intense drought and poor land management likely exacerbated the hot summer temperatures. Over the last 126 years, North Dakota's annual average temperature has increased 0.2°F per decade. Warming has occurred in all four seasons but has been largest in the winter, with warming rates more than double the other seasons and

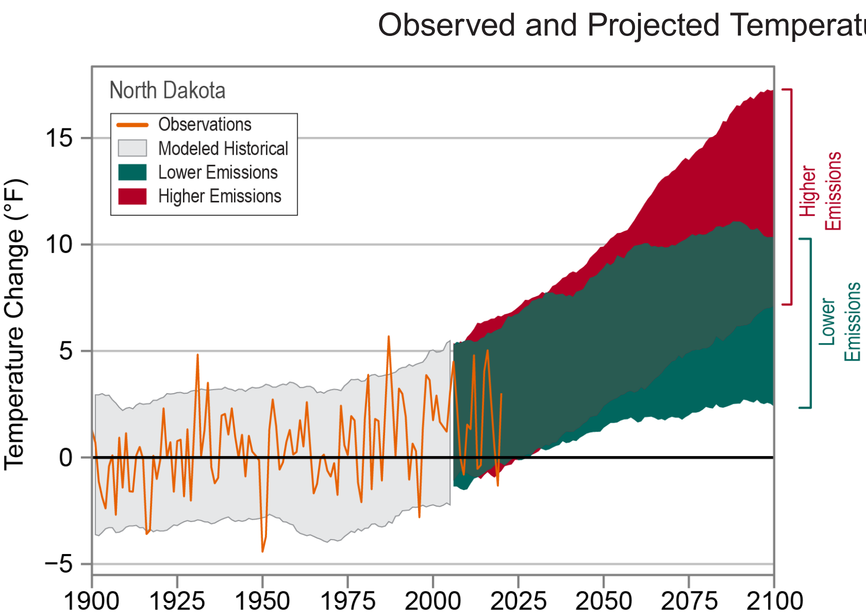


Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for North Dakota. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in North Dakota (orange line) have risen more than 2.6°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 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 12°F warmer than the hottest year in the historical record; red shading). Sources: CISESS and NOAA NCEI.

greater than those for any other state. The relatively small summer warming is reflected in a below average number of very hot days since 1990 (Figure 2) and no overall trend in the number of warm nights since the beginning of the 20th century (Figure 3). Winter warming is reflected in a below average number of very cold days since 2000 (Figure 4). Additionally, over the past 126 years, winter temperatures have increased by 4.5°F per century, more than three times the summer trend of 1.5°F per century.

Annual precipitation ranges from less than 16 inches in the northwest to about 24 inches in the southeast. Statewide total annual precipitation varies from year to year, ranging from a low of 8.8 inches in 1936 to a high of 24.4 inches in 2019 (Figure 5). The wettest multiyear periods were in the early 1940s, 1990s, and early 2010s and the driest in the 1930s. The wettest consecutive 5-year interval was 2007–2011, and the driest was 1933–1937. Most of the state's precipitation falls during the late spring and early summer months, when thunderstorm activity is highest. The most severe thunderstorms can produce hail, tornadoes, or damaging straight-line winds exceeding 75 mph. **The frequency of 2-inch extreme precipitation events has increased** (Figure 6). Since 1990, the number of these events has been above average, peaking during the most recent 6-year period (2015–2020).

Compared to other northern states, North Dakota receives less snowfall, averaging 30 to 55 inches annually. However, due to the state's northern location, winter storm systems can be accompanied by exceptionally severe conditions, including heavy snows, high winds, and low wind chill temperatures. The probability of a blizzard occurring in any given year in North Dakota—greater than 50%—is one of the highest in the Nation. During the winter of 1996–97, North Dakota experienced multiple blizzards and winter storms, which contributed to seasonal snowfalls of more than 100 inches in some parts of the state.

North Dakota is highly prone to both flooding and drought. The Red River Valley is one of the most flood-prone areas in the United States due to the river's low gradient and northward flow. The spring thaw causes snow and river ice in the south to melt prior to the downstream river channel to the north, creating

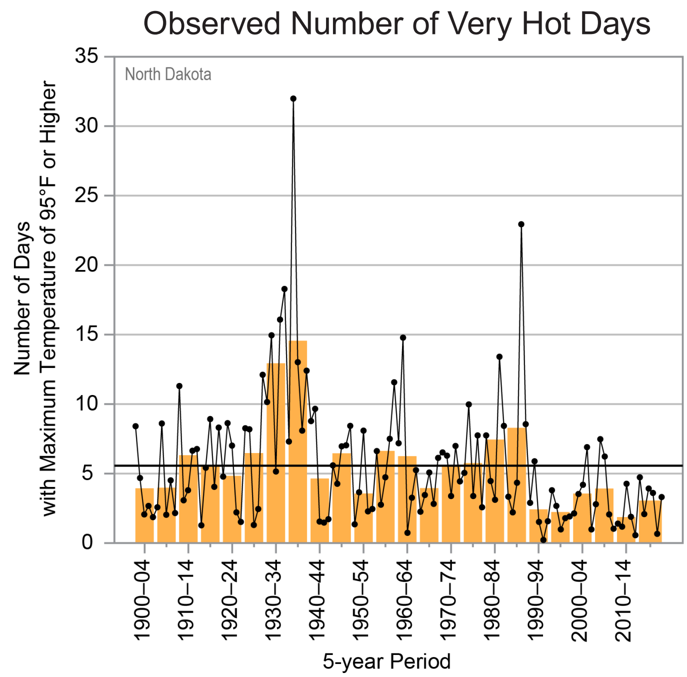


Figure 2: Observed annual number of very hot days (maximum temperature of 95°F or higher) for North Dakota from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 5.6 days. Multiyear averages for the 1930s were the highest on record and more than double the long-term average. Since 1990, however, the number of very hot days has been below average. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 12 long-term stations.

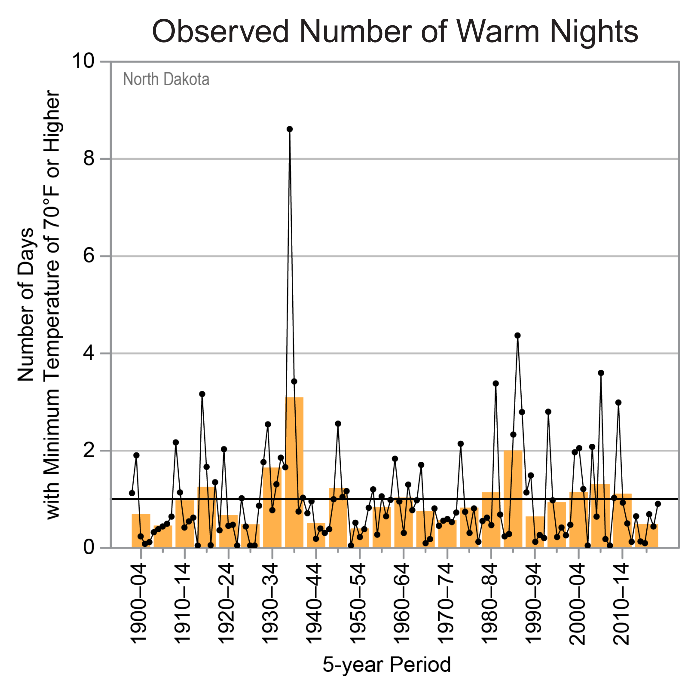


Figure 3: Observed annual number of warm nights (minimum temperature of 70°F or higher) for North Dakota from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 1.0 nights. The late 1930s had the highest number of warm nights, more than three times the long-term average. Since 1990, the number of warm nights has been near or below average. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 12 long-term stations.

natural ice jams, flooding of the upstream river, and backfill of runoff into the river's tributaries. In addition to snowmelt, recharge of soil moisture due to fall precipitation and direct runoff of spring rainfall from saturated soils contribute to spring floods. Based on more than 100 years of river-stage data collected in Fargo, the Red River has exceeded major flood stages 18 times. In the spring of 1997, the melting of record snowfall caused record floods along the river. These records were exceeded by the 2009 floods, when the river at Fargo reached its highest level in recorded history. In June 2011, record-breaking flood levels on the Souris River caused major property damage, including the flooding of 4,000 homes in Minot. Another flood-prone area is Devils Lake, where rapidly rising waters since the early 1990s have destroyed hundreds of homes and businesses and inundated thousands of acres of productive farmland. Since 1993, state and federal funds totaling more than $1 billion have been spent on flood-mitigation efforts in the region. If lake levels were to rise substantially from current levels, an uncontrolled natural spill to the Sheyenne River could occur, potentially causing extensive downstream flooding, channel erosion, and water quality degradation (Figure 7). Drought has been a regular occurrence in the state. The 2017 Northern Plains drought, which primarily impacted North Dakota, South Dakota, and Montana, as well as adjacent Canadian Prairies, was devastating for livestock and agricultural production. The drought emerged in the spring and rapidly spread and intensified throughout the summer, leading to crop failure, the culling of livestock herds, widespread wildfires, low water supplies, and losses exceeding $2.5 billion.

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. Although the frequency of hot summer temperatures has not increased, continued overall warming is expected to intensify heat waves, while cold waves are projected to decrease in intensity.

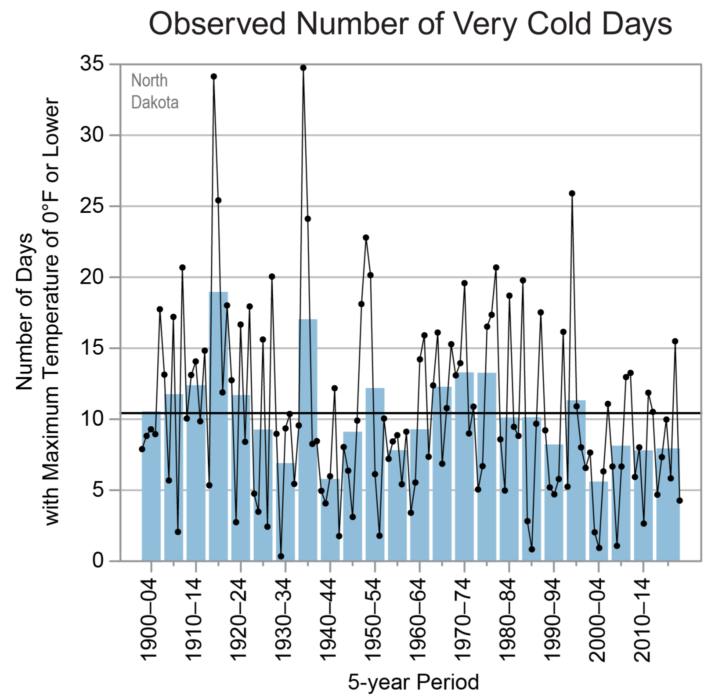


Figure 4: Observed annual number of very cold days (maximum temperature of 0°F or lower) for North Dakota from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 10 days. The number of very cold days has been below average since 2000 and is indicative of overall winter warming in the region. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 12 long-term stations.

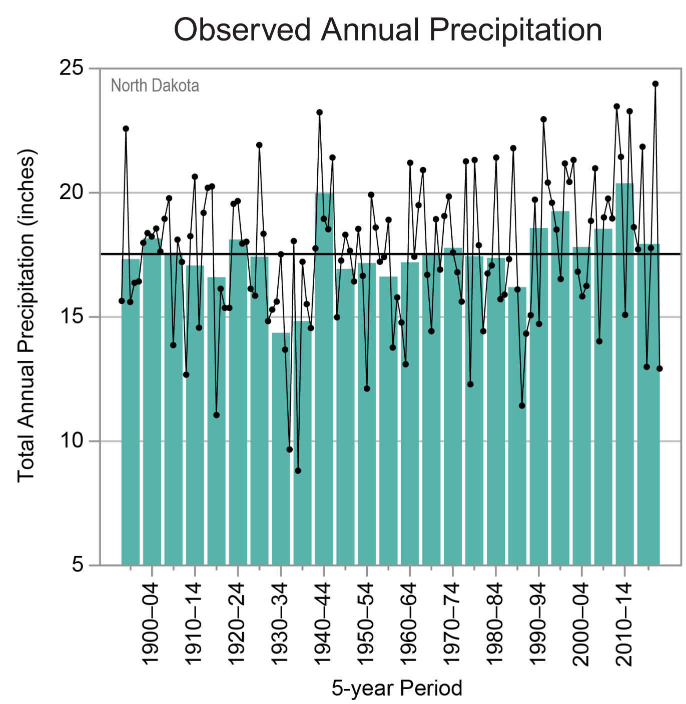


Figure 5: Observed total annual precipitation for North Dakota from 1895 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 17.5 inches. Total annual precipitation varies widely but has been near or above average since 1990. The wettest consecutive 5-year interval on record was 2007–2011, averaging 20.5 inches, while the driest was 1933–1937, averaging 13.5 inches. Sources: CISESS and NOAA NCEI. Data: nClimDiv.

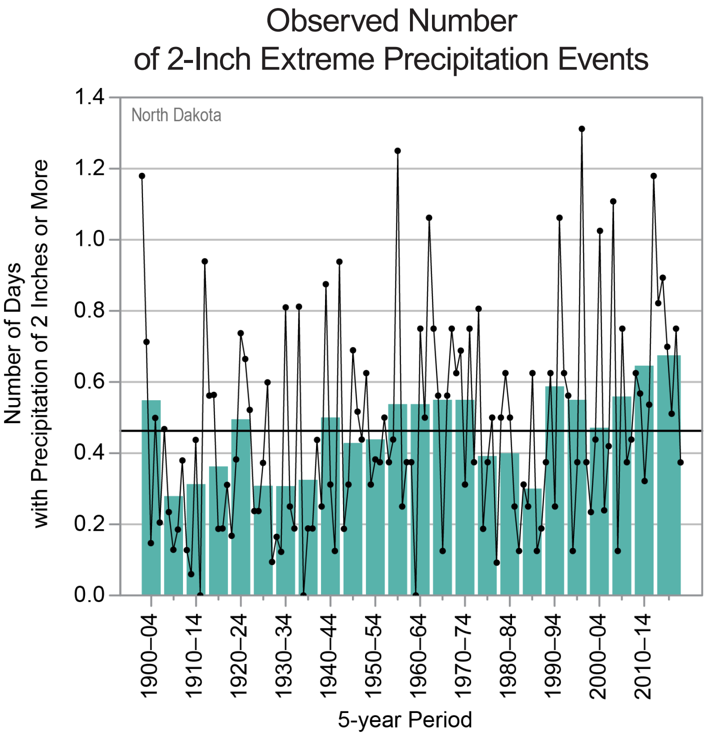


Figure 6: Observed annual number of 2-inch extreme precipitation events (days with precipitation of 2 inches or more) for North Dakota from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 0.5 days. A typical reporting station experiences an event about once every 2 years. The number of 2-inch extreme precipitation events has been near to above average since 1990. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 12 long-term stations.

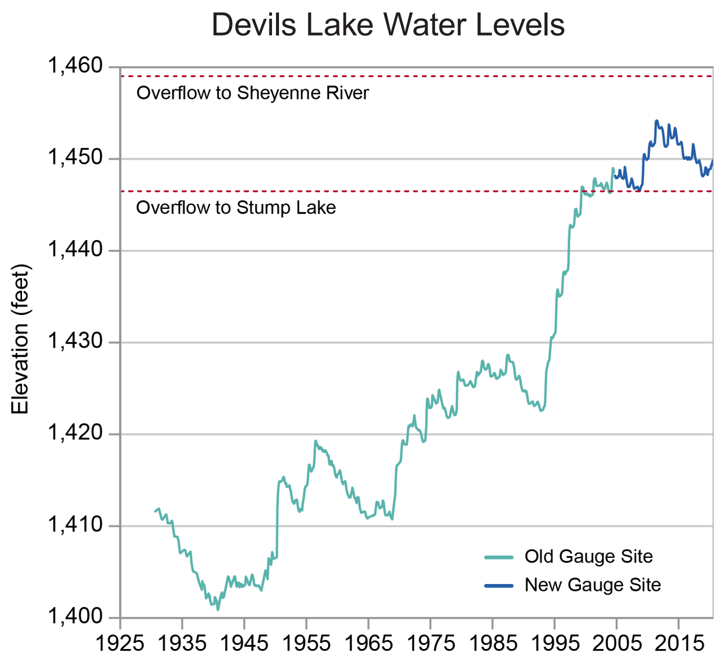


Figure 7: Annual time series of the average water level of Devils Lake at Creel Bay from 1930 to 2020. Lake levels have fluctuated over time but have been steadily rising overall since the 1940s. Water began spilling from Devils Lake to Stump Lake in 1999, and in 2007, Devils Lake and Stump Lake essentially became one continuous body of water. If lake levels were to rise substantially from current levels, an uncontrolled natural spill to the Sheyenne River could occur. Source: USGS NWIS.

Although current observations do not show a positive trend in cold-season precipitation, projections suggest that winter precipitation will increase (Figure 8), even under a lower emissions pathway. Increased cold-season precipitation can impact North Dakota's agricultural economy both positively (increased soil moisture) and negatively (loss of soil nutrients, planting delays, and yield losses). Extreme precipitation events are also projected to increase in frequency and intensity, potentially leading to increased runoff and flooding, which can reduce water quality and erode soils.

The intensity of droughts is projected to increase. Droughts are a natural part of the climate system, and because precipitation increases are projected to occur during the cooler months, North Dakota will remain vulnerable to periodic drought. Increases in evaporation rates due to rising temperatures may increase the rate of soil moisture loss and the intensity of naturally occurring droughts. Wildfires may also become more common from mid-summer through early fall.

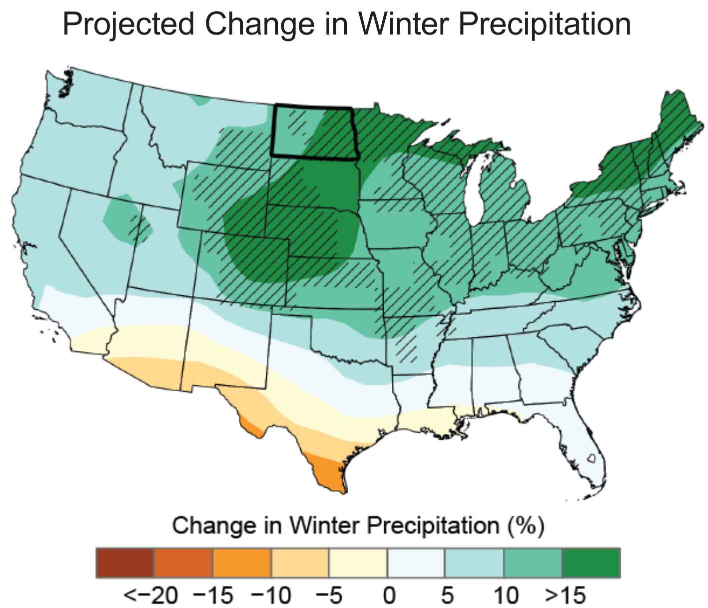


Figure 8: Projected changes in total annual precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. Hatching represents areas where the majority of climate models indicate a statistically significant change. Winter precipitation for North Dakota is projected to increase in the range of 10% to more than 15% by 2050. Spring precipitation is also projected to increase. North Dakota is part of a large area in the northern and central United States with projected increases. 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/ND/ | LEAD AUTHORS: REBEKAH FRANKSON, KENNETH E. KUNKEL
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