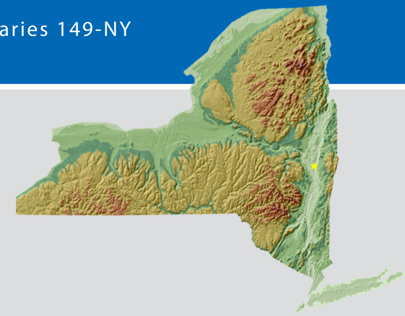


NEW YORK

Key Messages

Mean annual temperature has increased approximately 2°F over the last two decades. Under a higher emissions pathway, historically unprecedented warming is projected by the end of the 21st century. Extreme heat is of particular concern for densely populated urban areas such as New York City, where high temperatures and high humidity can cause dangerous conditions.

Sea level has risen by about 13 inches since 1880 along the coast of New York, more than global rise of 8 inches. Global sea level is projected to rise another 1 to 4 feet by 2100; levels along the coast of New York will likely be higher due to local and regional factors. Sea level rise will increase the frequency, extent, and severity of coastal flooding, a grave risk to the dense, high value development along New York's coastline.

New York has experienced a large increase in heavy rain events and further increases are projected. Projected increased winter and spring precipitation raise the risk of springtime flooding, which could cause delayed planting and reduced yields.

New York encompasses a wide diversity of environments, ranging from the nation's most populous metropolitan area, to large expanses of sparsely populated but ecologically and agriculturally important areas. The state's climate is heavily influenced by several geographic features. The Atlantic Ocean has a moderating effect on the coastal areas, while the Great Lakes and Lake Champlain moderate the northwestern and northeastern parts of the state, respectively. During much of the year, the prevailing westerly flow brings air masses from the North American

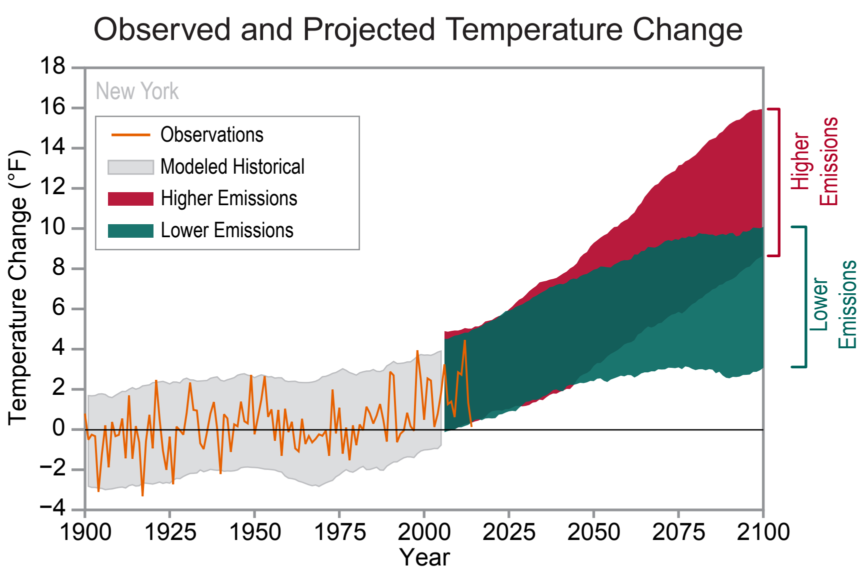
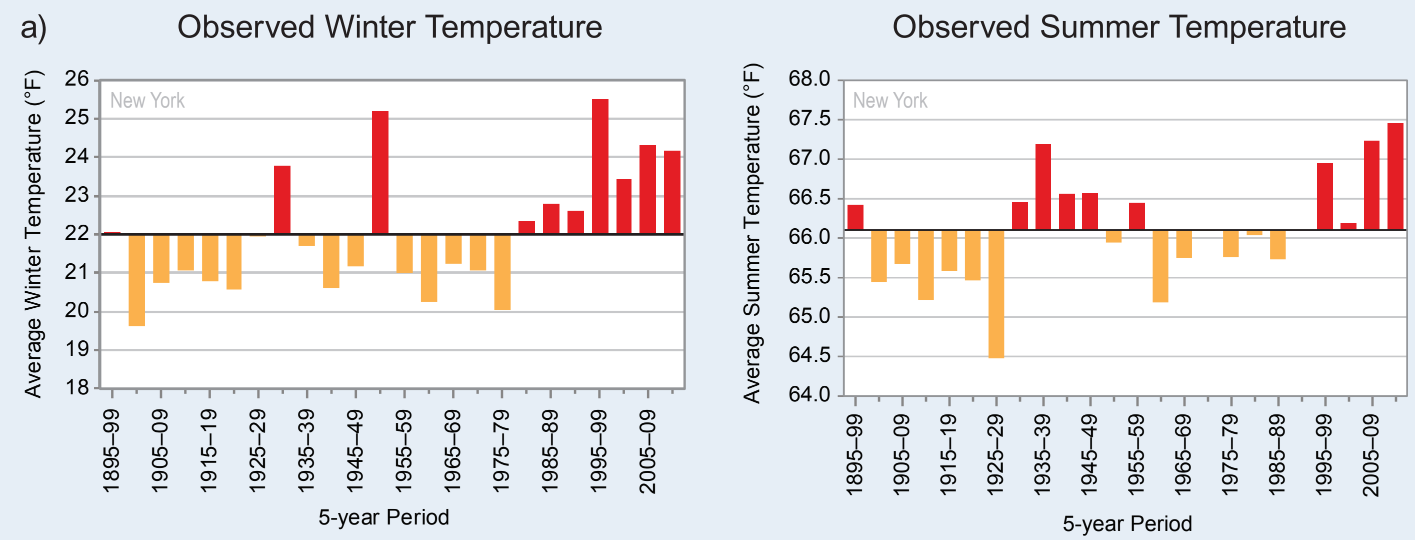
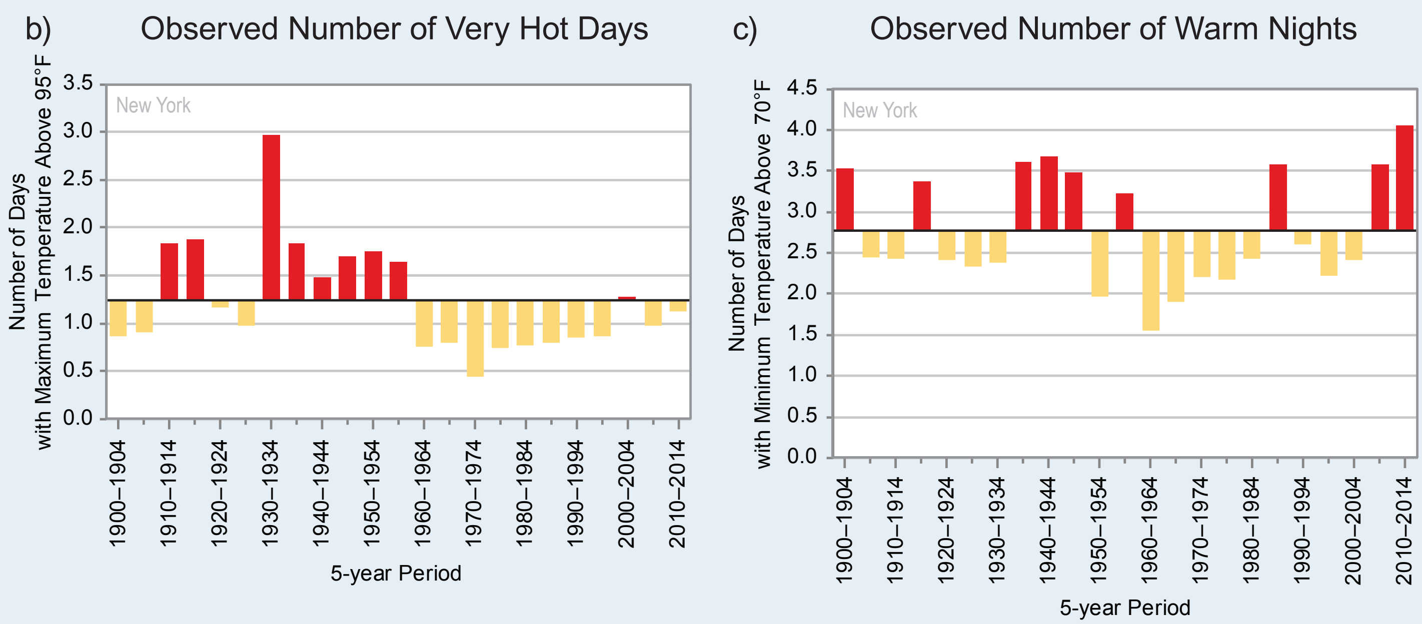


Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for New York. Observed data are for 1900–2014. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions)[1]. Temperatures in New York (orange line) have risen about 2°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 the 21st century. Less warming is expected under a lower emissions future (the coldest years being about as warm as the hottest year in the historical record; green shading) and more warming under a higher emissions future (the hottest years being about 11°F warmer than the hottest year in the historical record; red shading). Source: CICS-NC and NOAA NCEI.

[1]Technical details on models and projections are provided in an appendix, available online at: https://statesummaries.ncics.org/ny





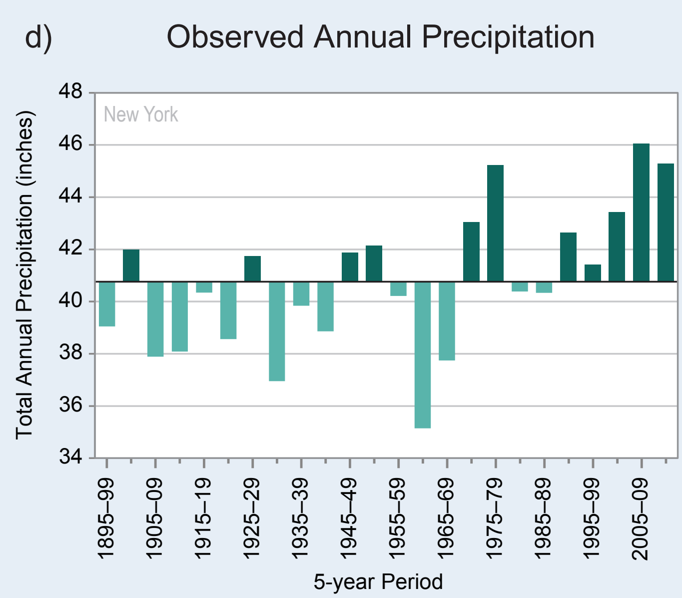


Figure 2: The observed (a) winter and summer temperature, (b) number of very hot days (annual number of days with maximum temperature above 95°F), (c) number of warm nights (annual number of days with minimum temperature above 70°F), and (d) annual precipitation, averaged over 5-year periods. The values for Figures 2a and 2d are from NCEI's version 2 climate division dataset. The values in Figures 2b and 2c are averages from 16 long-term reporting stations. The dark horizontal lines represent the long-term average. Recent years have seen some of the warmest winter and summer temperatures in the historical record. The number of very hot days peaked in 1930–1934, while the number of warm nights was the highest on record during the most recent 5-year period (2010–2014). Annual precipitation amounts have been significantly above the long-term average for the last two decades. Source: CICS-NC and NOAA NCEI.

interior across the entire region, with occasional episodes of bitter cold during winter. The polar jet stream, which is often located near or over the region during the winter, brings frequent storm systems which cause cloudy skies, windy conditions, and precipitation. New York is often affected by extreme events such as floods, droughts, heat waves, hurricanes, nor'easters, and snow and ice storms.

Since the beginning of the 20th century, temperatures have risen approximately 2°F, and temperatures in the 2000s have been higher than any other historical period (Figure 1). As of the year 2015, the year 2012 was the hottest on record for New York, with a statewide average temperature of 48.9°F, more than 4°F above the long-term average (44.5°F). This warming has been concentrated in the winter and spring while summers have not warmed as much (Figure 2a). The lack of summer warming is evident in a below average occurrence of very hot days (days with maximum temperature greater than 95°F) (Figure 2b). However, the state has experienced an increase in the number of warm nights (days with minimum temperature above 70°F) and a decrease in the number of very cold nights (days with minimum temperature below 0°F) (Figures 2c and 3). The increase in winter temperatures has had an identifiable effect on Great Lakes ice cover. Since 1998, the maximum ice cover extents on Lakes Erie and Ontario have been below the long-term average (Figure 4).

Statewide average precipitation is a little over 40 inches annually; this varies regionally, with mountainous regions of the state receiving more than 50 inches per year. Statewide annual precipitation has ranged from a low of 31.56 inches in 1964 to a high of 55.71 inches in 2011. The driest multi-year periods were in the late 1920s and 1950s, and the wettest were during the late 1970s and since 2005 most recently (Figure 2d). The driest 5-year period was 1962–1966 with an average of 35.15 inches and the wettest was 2007–2011 with an average of 46.06 inches. **New York has recently experienced a large increase in the number of extreme precipitation events (days on which precipitation totals are greater than 2 inches)** (Figure 5)**,** peaking during the most recent 5-year period (2010–2014). The annual precipitation record set in 2011 was partially due to extreme precipitation events caused by Hurricane Irene and Tropical Storm Lee in late August and early September. Many areas of eastern New York received more than 7 inches of rain from Hurricane Irene, with some locations in the Catskill Mountains receiving more than 18 inches. Less than two weeks later, Tropical Storm Lee brought additional heavy rainfall, with more

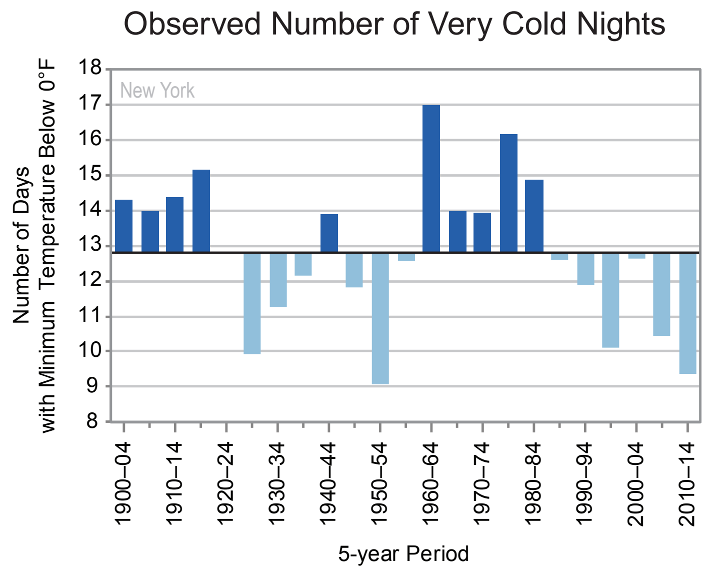


Figure 3: The observed number of very cold nights (annual number of days with minimum temperature below 0°F) for 1900–2014, averaged over 5-year periods; these values are averages from all 16 long-term reporting stations. The number of very cold nights has been below average since 1990s, reflecting a long-term winter warming trend. The dark horizontal line is the long-term average of 13.8 days per year. Source: CICS-NC and NOAA NCEI.

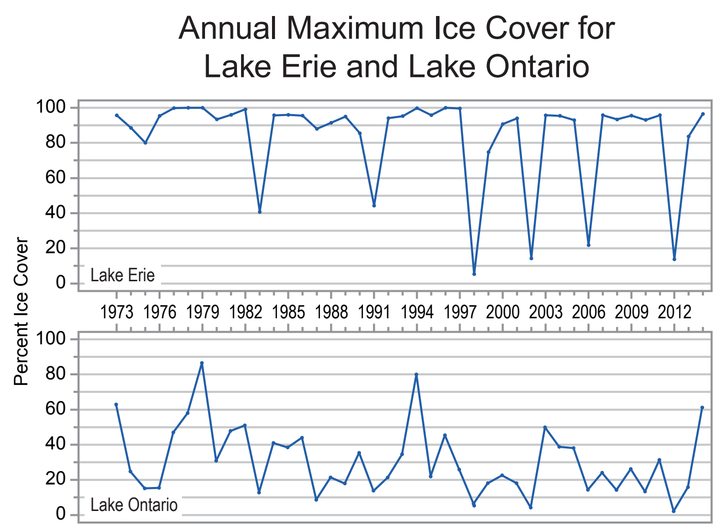


Figure 4: Annual maximum ice cover extent (%) for Lake Erie (top) and Lake Ontario (bottom) for 1973–2014. In most years, Lake Erie becomes nearly frozen over while Lake Ontario is mostly ice-free. In four years, Lake Erie has been mostly ice-free and all of those have occurred since 1998. Since 2006, Lake Ontario has remained below 30% ice-covered except for a higher value during the cold 2013–2014 winter. Source: NOAA Great Lakes Environmental Research Laboratory.

than 12 inches of rain falling in the Susquehanna River Basin. The extreme rainfall from these two events caused devastating flooding and damage.

In addition to causing heavy flooding inland, hurricanes and tropical storms can cause coastal damage from storm surge and flooding. In late October 2012, Superstorm Sandy (a post-tropical storm) caused a massive storm surge in New York City. The extensive flooding from the storm surge inundated subway tunnels, damaged the electrical grid, overwhelmed sewage treatment plants, and destroyed thousands of homes. Superstorm Sandy caused tens of billions of dollars in damages in the state, with an estimated $19 billion of damages to New York City.

Winter storms are a frequent occurrence due to the large temperature contrast between the cold interior of the North American continent and the warm moist air of the western Atlantic. **These storms, popularly known as nor'easters, can produce crippling snowfall, flood-producing rainfall, hurricane-force winds, and dangerous cold.** The Blizzard of 1996 from January 6 to 8, a classic nor'easter, dropped more than 20 inches of snow in New York City and caused an estimated $70 million (in 1996 dollars) of damage across the state. The northern part of the state frequently experiences heavy lake-effect snows due to warming and moistening of arctic air masses as they pass over the Great Lakes. This results in intense bands of heavy snowfall over areas downwind of Lakes Ontario and Erie. On November 17–19, 2014, a lake effect snow storm delivered more than 5 feet of snow just east of Buffalo. A second lake effect event immediately followed, dropping an as much as an additional 4 feet of snow on November 19–20. Snowfall rates as high as 6 inches per hour were reported, with some areas receiving more than 3 feet of snow in less than 12 hours. There were 13 fatalities from these storms; thousands of motorists were stranded, and infrastructure suffered several hundred roof collapses, power outages from downed trees, and food and gas shortages. These two storms were considered a set of unprecedented events, but they were characteristic of lake effect snows that affect the state.

Under a higher emissions pathway, historically unprecedented warming is projected by the end of the 21st century (Figure 1). Even under a pathway of lower greenhouse gas emissions, average annual temperatures are projected to most likely exceed historical record levels by the middle of the 21st century. However, there is a large range of temperature increases under both

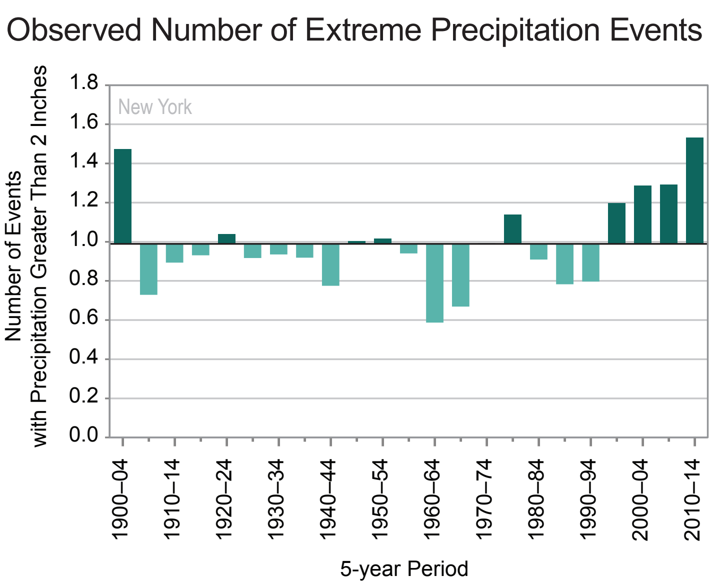


Figure 5: The observed number of days with extreme precipitation events (annual number of days with precipitation above 2 inches) for 1900–2014, averaged over 5-year periods; these values are averages from 16 long-term reporting stations. A typical station experiences one such event each year. Over the past 20 years, New York has experienced an above average number of extreme rain events, with the most recent 5-year period (2010–2014) experiencing the highest frequency in the historical record. The dark horizontal line is the long-term average of about one day per year. Source: CICS-NC and NOAA NCEI.

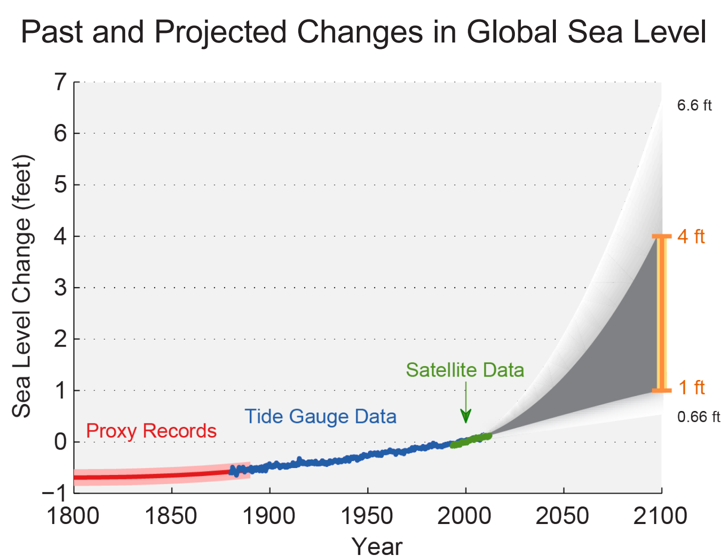


Figure 6: Estimated, observed, and possible future amounts of global sea level rise from 1800 to 2100, relative to the year 2000. The orange line at right shows the most likely range of 1 to 4 feet by 2100 based on an assessment of scientific studies, which falls within a larger possible range of 0.66 feet to 6.6 feet. Source: Melillo et al. 2014 and Parris et al. 2012.

pathways, and under the lower pathway, a few projections are only slightly warmer than historical records. (Figure 1). Heat waves are projected to be more intense. Extreme heat is of particular concern for New York City and other urban areas where the urban heat island effect raises summer temperatures. High temperatures combined with high humidity can create dangerous heat index values. By contrast, cold waves are projected to become less intense.

Increasing temperatures raise concerns for sea level rise in coastal areas. Over the last century, sea level has risen by about 13 inches along the coast of New York, more than the global rise of 8 inches that has occurred since 1880. Global sea level rise is projected to rise another one to four feet by 2100, as a result of both past and future emissions from human activities (Figure 6) and local and regional factors are expected to cause New York sea level to rise more than the global projection. Even if storm patterns remain the same, sea level rise will increase the frequency, extent, and severity of coastal flooding. Sea level rise has caused an increase in tidal floods, a rise in water level above the minor flooding threshold (determined locally by NOAA's National Weather Service) to cause nuisance flooding. Nuisance flooding can damage infrastructure, cause road closures, and overwhelm storm drains. As sea level has risen along the New York coastline, the number of nuisance flooding events has also increased, reaching a peak in 2011 (Figure 7). This is of particular concern in New York due to the dense, high value development along the coastline.

Winter and spring precipitation is projected to increase in New York (Figure 8). This could result in enhanced snowpack at higher elevations, but with warmer temperatures more of the precipitation will fall as rain, particularly at lower elevations. In addition, extreme precipitation is projected to increase, potentially increasing the frequency and intensity of floods. Heavier precipitation raises the risk of springtime flooding. Springtime flooding in particular could pose a threat to New York's agricultural industry by delaying planting and resulting in loss of yield.

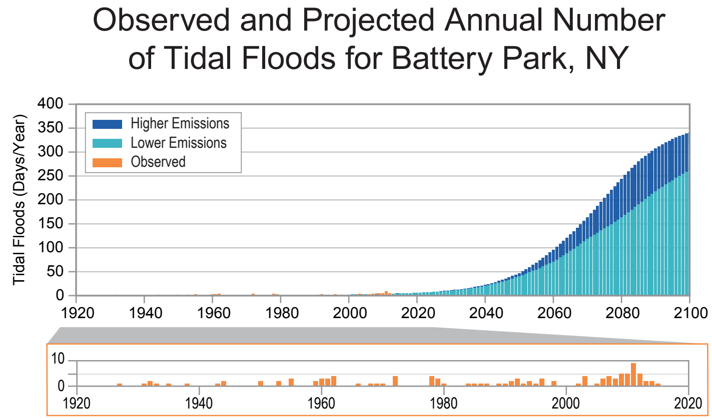


Figure 7: Number of tidal flood days per year for the observed record (orange bars) and projections for two possible futures: lower emissions (light blue) and higher emissions (dark blue) per calendar year for Battery Park, NY. Sea level rise has caused an increase in tidal floods associated with nuisance-level impacts. Nuisance floods are events in which water levels exceed the local threshold (set by NOAA's National Weather Service) for minor impacts, such as road closures and overwhelmed storm drains. The greatest number of tidal flood days (all days exceeding the nuisance level threshold) occurred in 2011 in Battery Park. Projected increases are large even under a lower emissions pathway. Near the end of the century, under a higher emissions pathway, some models (not shown here) project tidal flooding nearly every day of the year. To see these and other projections under additional emissions pathways, please see the supplemental material on the State Summaries website (https://statesummaries.ncics.org/ny). Source: NOAA NOS.

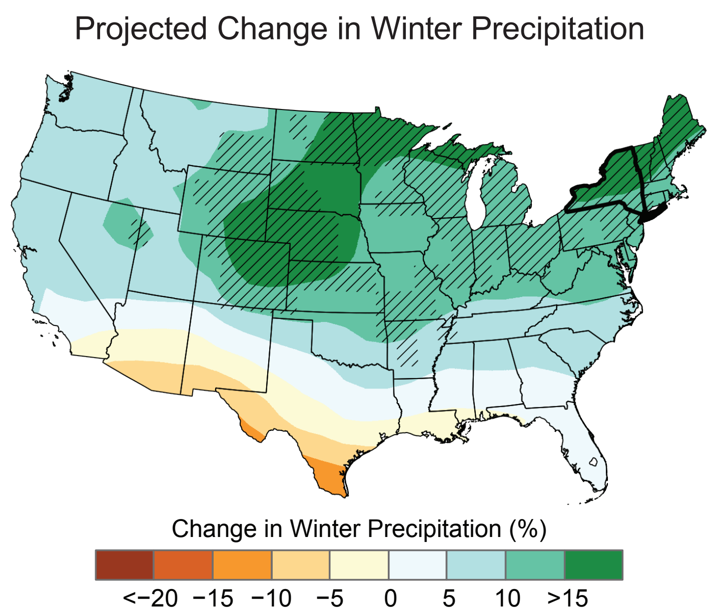


Figure 8: Projected change in winter precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. Hatching represents portions of the state where the majority of climate models indicate a statistically significant change. By the middle of the 21st century, winter precipitation is projected to increase by 10%–15% in southern New York and 15%–20% in northern New York if greenhouse gas emissions continue to rise rapidly. Source: CICS-NC, NOAA NCEI, and NEMAC.