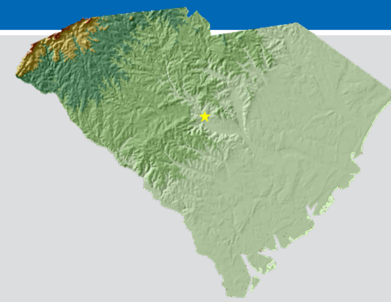

SOUTH CAROLINA

Key Messages

Temperatures in South Carolina have risen more than 1°F since the beginning of the 20th century, less than the warming for the contiguous United States. Under a higher emissions pathway, historically unprecedented warming is projected during this century, including increases in extreme heat events.

Future changes in precipitation are uncertain, but extreme precipitation is projected to increase. In addition, projected increases in temperature will likely increase the intensity of naturally occurring droughts.

Sea level at Charleston has risen by 1.3 inches per decade, nearly double the global sea level rise, since reliable record keeping began in 1921. Global sea level is projected to rise another 1 to 4 feet by 2100, with greater rises projected for South Carolina. Rising sea levels pose widespread and continuing threats to both natural and built environments in coastal South Carolina.

South Carolina's geographic position at subtropical latitudes and adjacent to the Atlantic Ocean gives it a humid climate with hot summers and mild winters. The Appalachian Mountains to the north and west tend to partially shield the state from cold air masses approaching from the northwest, making winters milder than those in locations to the west of the mountains. However, the mountains are not high enough to fully block these air masses, so occasional periods of very cold conditions occur. Clockwise circulation of air around the Bermuda High, a semipermanent high-pressure system in the North Atlantic Ocean, provides a persistent flow of warm, moist air from the Atlantic during the warmer half of the year. The annual average (1991–2020 normals) temperature varies across the state from the mid-50s (°F) in the mountains to the mid-60s (°F) along the coast. During January, average temperatures range from 40°F in the north to around 47°F in the Lowcountry. Similar northwest to southeast temperature gradients also occur in the summer, with average temperatures in July ranging from 76°F in the northwest to 82°F in the Midlands and coastal Lowcountry.

Temperatures in South Carolina have risen more than 1°F since the beginning of the 20th century (Figure 1). The state warmed during the early part of the 20th century and then cooled substantially during the middle of the century. Warming has occurred since then, but only recently have temperatures reached the levels of the 1930s.

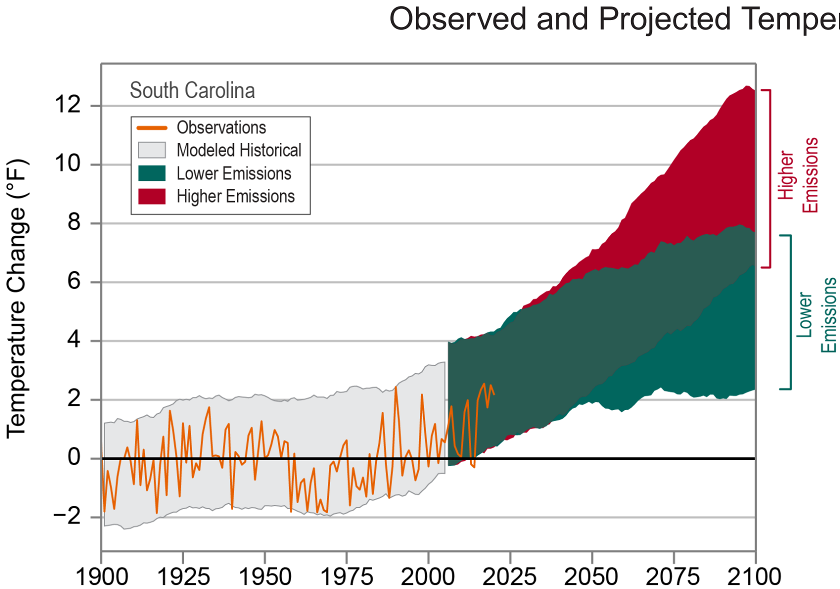

Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for South Carolina. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in South Carolina (orange line) have risen more than 1°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 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 10°F warmer than the hottest year in the historical record; red shading). Sources: CISESS and NOAA NCEI.

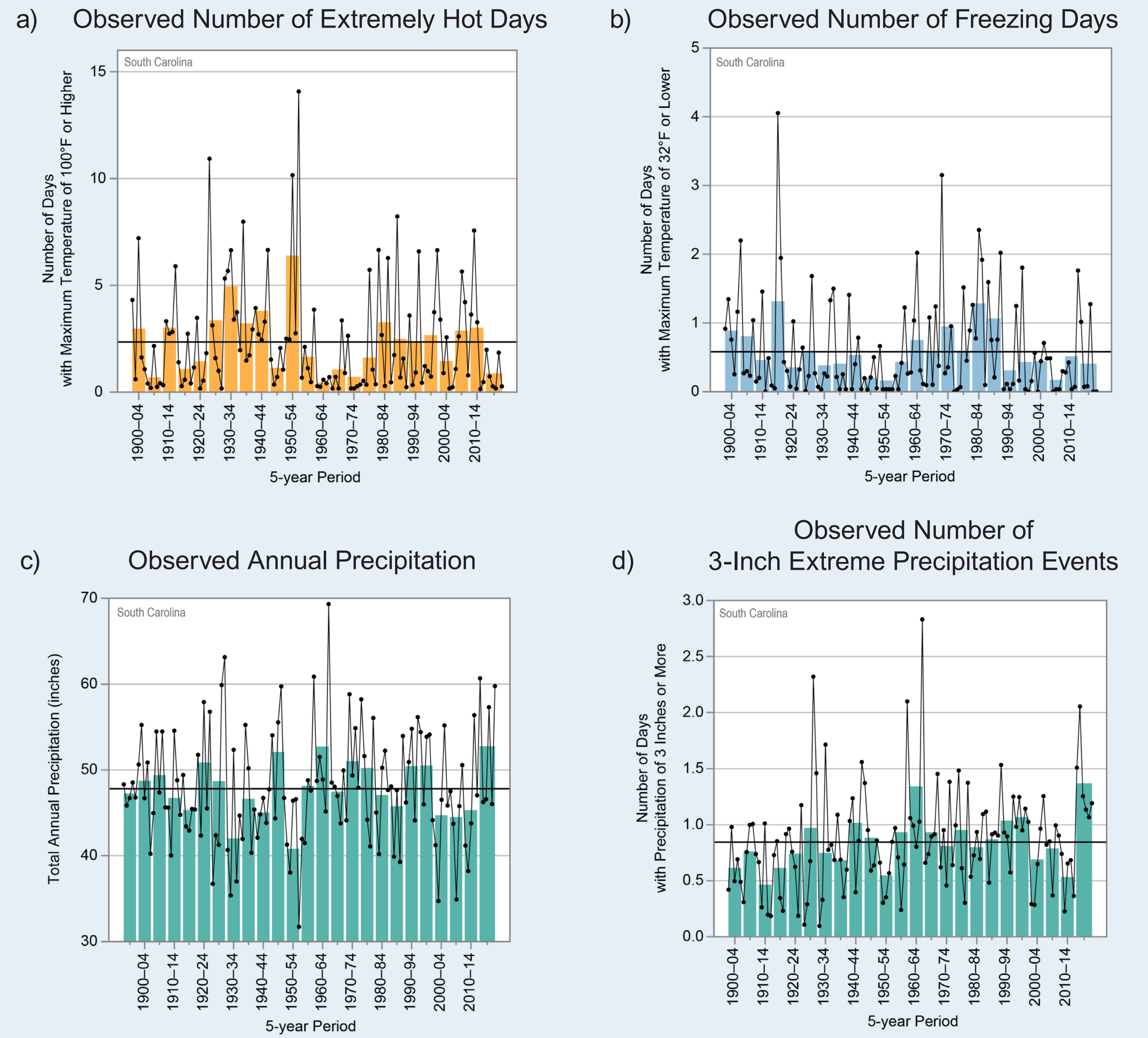

Figure 2: Observed (a) annual number of extremely hot days (maximum temperature of 100°F or higher), (b) annual number of freezing days (maximum temperature of 32°F or lower), (c) total annual precipitation, and (d) annual number of 3-inch extreme precipitation events (days with precipitation of 3 inches or more) for South Carolina from (a, b, d) 1900 to 2020 and (c) 1895 to 2020. 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) 2.3 days, (b) 0.6 days, (c) 47.8 inches, (d) 0.8 days. There is no overall trend in the number of extremely hot days, but they have been rare since 2014. The number of freezing days has been below average since 1990. Annual precipitation and the number of 3-inch extreme precipitation days has generally been above average since 2015. A typical reporting station experiences a 3-inch event about once every year. Sources: CISESS and NOAA NCEI. Data: (a, b) GHCN-Daily from 11 long-term stations; (c) nClimDiv; (d) GHCN-Daily from 17 long-term stations.

The number of extremely hot days has been generally near average since 1980 (Figure 2a), following very high numbers in the early 1930s and early 1950s and a period of below average numbers from the late 1950s to the late 1970s; however, such days have been rare since 2014. Between 1991 and 2020, the state capital of Columbia had an average of 3.5 days per year with temperatures of 100°F or higher, compared to a yearly average of 2.4 days between 1961 and 1990. In the very hot summers of 2015 and 2016, the city experienced 10 and 16 extremely hot days, respectively, well above average. Statewide, very warm nights have generally been above average since 1980, with the highest 5-year average occurring during the 2010–2014 period (Figure 3). The number of freezing days has been below average since 1990 (Figure 2b).

Annual average precipitation ranges from 80 inches near Lake Jocassee in the mountains of the far northwest to less than 39 inches at Wateree in the Midlands, the driest part of the state. While isolated mountain areas receive large precipitation amounts, average precipitation for most of the Upstate is 45 to 55 inches. Average precipitation in the rest of the state is about 45 to 50 inches in the Midlands and 45 to 55 inches in the coastal Lowcountry. The high amounts of precipitation in the far northwest are due to moist air being forced up the mountains to higher elevations, while the slightly higher amounts along the Coastal Plain are due to sea-breeze-front thunderstorms, which occur during the summer months.

Total annual precipitation has been below average during most years since 2000 but was above average during the 2015–2020 period (Figure 2c). There is no overall trend in annual precipitation since the beginning of the 20th century; however, a few recent years (notably 2015, 2018, and 2020) have been very wet. **Between 2000 and 2015, the state experienced a below average number of 3-inch extreme precipitation events, but during the 2015–2020 period, the number was well above average** (Figure 2d). Of the last 21 years in South Carolina, 15 have been characterized by warm-season drought conditions.

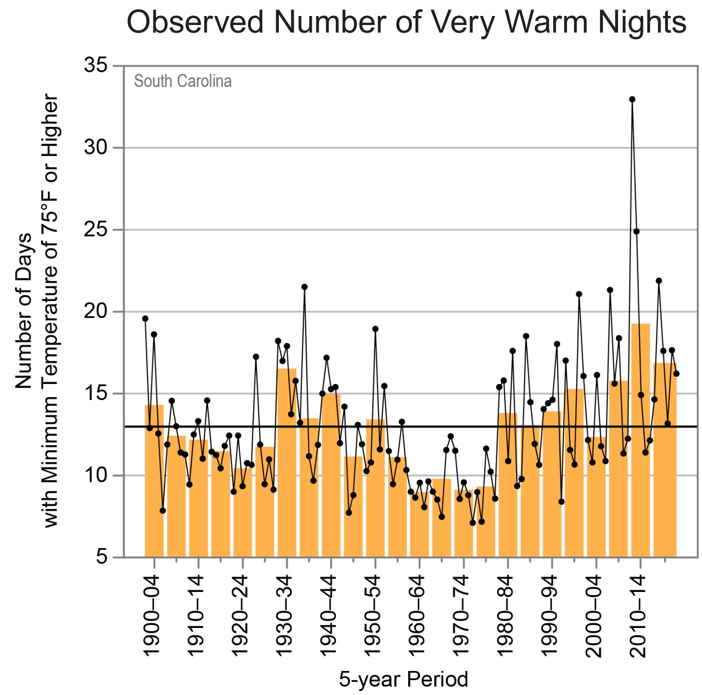

Figure 3: Observed annual number of very warm nights (minimum temperature of 75°F or higher) for South Carolina from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 13 nights. The number of very warm nights has been mostly above average since 1980. The highest number occurred during the 2010–2014 period, with an average of 19 nights per year. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 11 long-term stations.

Major storm threats for South Carolina include hurricanes, which occur in the summer and fall, and severe thunderstorms, which occur in the late winter and spring and are capable of producing tornadoes. The state ranks 23rd in the Nation for annual tornado frequency, with an average of about 23 tornadoes confirmed each year between 2000 and 2019 (compared to Texas, ranked 1st, with an estimated 132 tornadoes each year). Strong and destructive tornadoes occur 2 to 4 times each year. **Over the last decade, the state has experienced numerous billion-dollar disaster events involving severe storms, tornado outbreaks, hurricanes, and droughts.** One notable event was the April 13, 2020, tornado outbreak, which consisted of multiple category EF3 tornadoes and the first EF4 tornado to hit the state since 1995. This outbreak resulted in more than $15 million in damages to the state.

In early October 2015, torrential rainfall caused catastrophic flooding in the central and coastal regions of South Carolina. While relieving the moderate to severe drought conditions of that year's summer, the rainfall shattered numerous 24-hour and 5-day total records. The state's previous 24-hour rainfall record of 14.8 inches (Myrtle Beach, September 16, 1999, during Hurricane Floyd) was broken at White Birch Circle in Columbia, which recorded a total of 17.7 inches on October 4, with 15.1 inches falling in less than 10 hours. The previous 5-day rainfall record of 17.4 inches (Greenville, August 22–26, 1908) was broken at more than 40 locations: 27.2 inches at Mount Pleasant (Park West, October 2–6), 23.8 inches at Charleston (Clark Sound, October 1–5); 23.5 inches at Georgetown County Airport (October 1–5); 22.0 inches at Charleston (James Island, October 2–6); and 21.5 inches at Folly Beach (October 2–6).

Tropical cyclones and hurricanes occur less frequently than severe thunderstorms and tornadoes, but they have more destructive potential. Hurricane Hugo in 1989 was one of the strongest hurricanes (Category 4) in the state's history and, at that time, was one of the costliest Atlantic hurricanes (ranked 9th). Wind speeds of up to 120 mph were observed 200 miles inland, and the storm tide reached 20 feet, resulting in extensive damage, including loss of life, severe residential and commercial flooding, power outages, and other essential infrastructure loss. Damages were estimated at more than $8 billion. Between 1901 and 2020, a total of 19 hurricanes made landfall along the coast of South Carolina. Although hurricanes are rare in coastal South Carolina, Hurricane Hugo demonstrated the state's vulnerability to these events. Climate models project not only an increase in the number of Category 4 and 5 hurricanes but also an increase of 20% more rainfall associated with these storms by the end of this century.

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. Increases in the number of extremely hot days and decreases in the number of extremely cold days are projected to accompany the overall warming.

Little change in total annual precipitation is projected over this century (Figure 4). However, any increases in temperature will cause more rapid loss of soil moisture during dry spells, increasing the intensity of naturally occurring droughts in the future. The resulting decreases in water availability, exacerbated by population growth, will continue to increase competition for water.

Global sea level is projected to rise another 1–8 feet, with a likely range of 1–4 feet, by 2100 as a result of both past and future emissions from human activities (Figure 5). Since 1921, sea level at Charleston has risen by 1.3 inches per decade, nearly double the global sea level rise of 0.7 inches per decade. Sea level rise is an important concern in South Carolina due to the state's extensive coastline, which includes an abundance of salt marshes and estuaries, as well as natural seaports such as Georgetown and Charleston. Today, more than 800 square miles of coastal land near the Charleston area lies less than 4 feet above the high tide line. 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. These events can damage infrastructure, cause road closures, and overwhelm storm drains. As sea level has risen along the South Carolina coastline, the number of tidal flood days (all days exceeding the nuisance level threshold) has also increased, with the greatest number

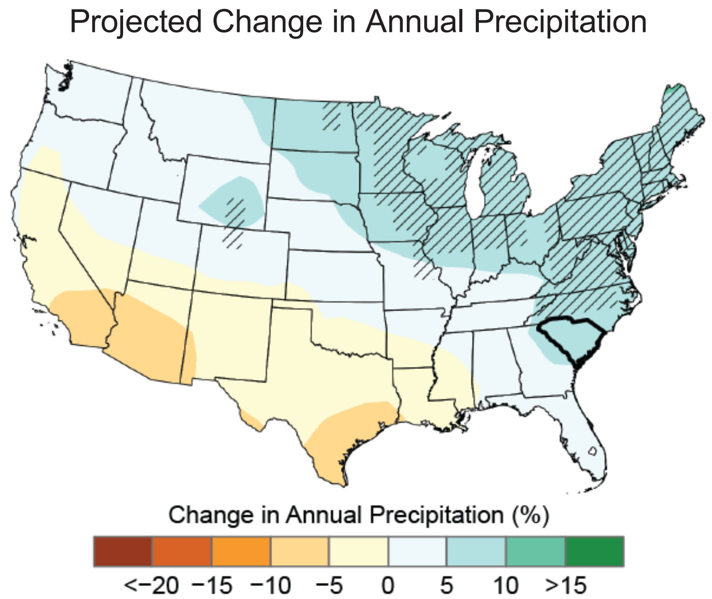

Figure 4: Projected changes in total annual precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. Hatching represents areas where the majority of climate models indicate a statistically significant change. Sources: CISESS and NEMAC. Data: CMIP5.

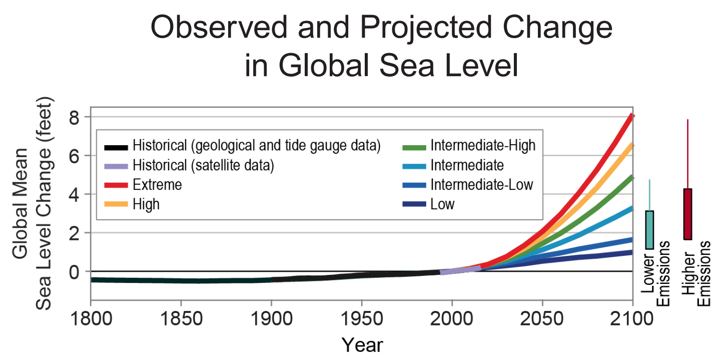

Figure 5: Global mean sea level (GMSL) change from 1800 to 2100. Projections include the six U.S. Interagency Sea Level Rise Task Force GMSL scenarios (Low, navy blue; Intermediate-Low, royal blue; Intermediate, cyan; Intermediate-High, green; High, orange; and Extreme, red curves) relative to historical geological, tide gauge, and satellite altimeter GMSL reconstructions from 1800–2015 (black and magenta lines) and the very likely ranges in 2100 under both lower and higher emissions futures (teal and dark red boxes). Global sea level rise projections range from 1 to 8 feet by 2100, with a likely range of 1 to 4 feet. Source: adapted from Sweet et al. 2017.

(14 days) occurring in 2020 (Figure 6). Even marginal amounts of sea level rise increase the likelihood of less common flooding events by amplifying tide and storm surge. Greater rises are likely for South Carolina, following historical trends. Some state-level estimates project a rise of 3.9 feet by 2100 as compared to 2012, after accounting for local effects of land subsidence. Projected sea level rise will likely result in increased coastal flooding, coastal erosion, and disruptions to coastal and estuarine ecosystems.

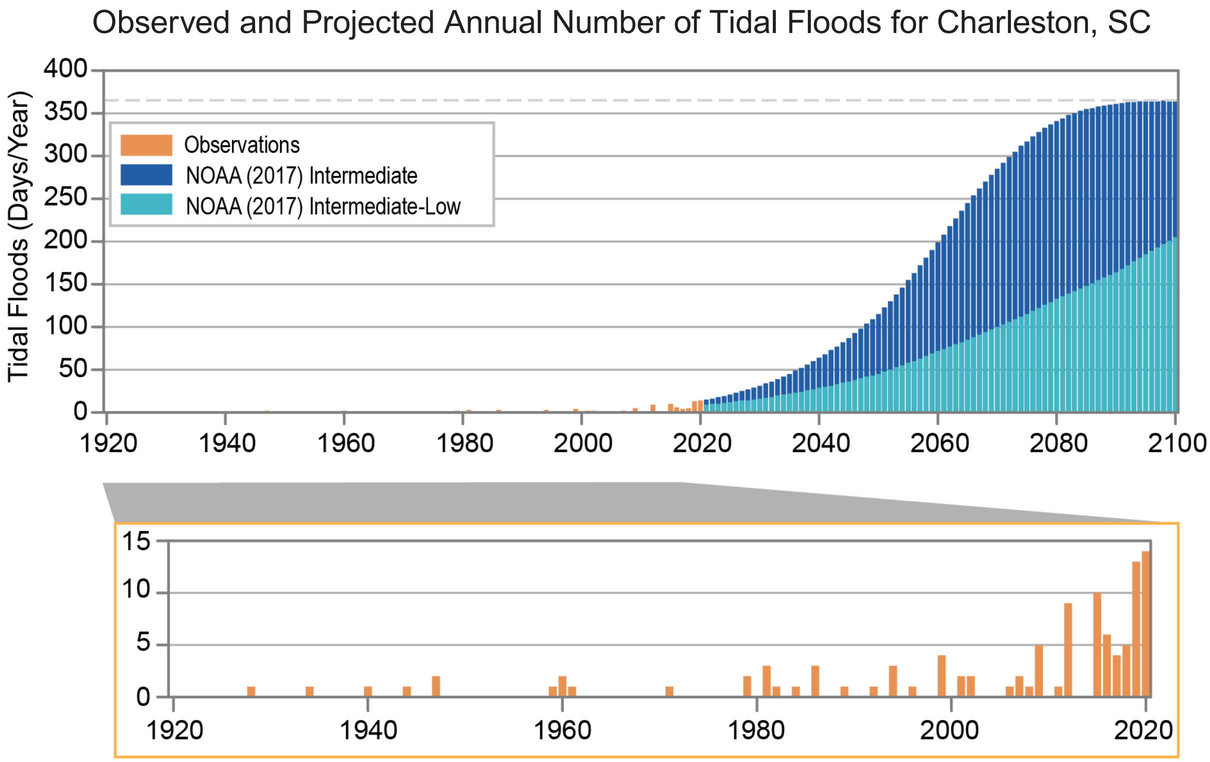

Figure 6: Number of tidal flood days per year at Charleston, SC, for the observed record (1922–2020; orange bars) and projections for two NOAA (2017) sea level rise scenarios (2021–2100): Intermediate (dark blue bars) and Intermediate-Low (light blue bars). The NOAA (2017) scenarios are based on local projections of the GMSL scenarios shown in Figure 5. Sea level rise has caused a gradual increase in tidal floods associated with nuisance-level impacts. The greatest number of tidal flood days (all days exceeding the nuisance-level threshold) occurred in 2020 at Charleston. Projected increases are large even under the Intermediate-Low scenario. Under the Intermediate scenario, tidal flooding is projected to occur every day of the year by the end of the century. Additional information on tidal flooding observations and scenarios is available at https://statesummaries.ncics.org/technicaldetails. Sources: CISESS and NOAA NOS.

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