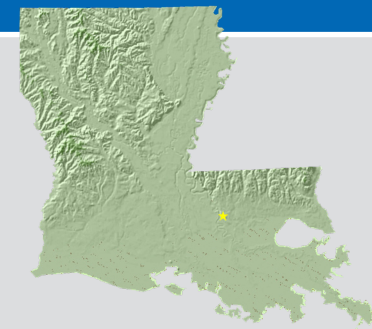


LOUISIANA

Key Messages

Temperatures in Louisiana have risen by 0.5°F since the beginning of the 20th century, less than a third of the warming for the contiguous United States, but the warmest consecutive 5-year interval was the most recent, 2016–2020. Historically unprecedented warming is projected during this century.

Hurricanes strike Louisiana an average of once every three years. As the climate continues to warm, hurricane-associated rainfall rates are projected to increase, and the resulting flooding is a particular concern for the state.

Global sea level is projected to rise, with a likely range of 1–4 feet by 2100. Louisiana's coastline is extremely vulnerable to sea level rise due to coastal subsidence, wetland loss, and low elevation in the southern portion of the state. Projected sea level rise poses widespread and continuing threats to coastal communities.

Louisiana is located between the Gulf of Mexico and the southern end of the vast, relatively flat plains of central North America, which extend from the Arctic Circle to the Gulf of Mexico. The state is therefore exposed to the influences of diverse air masses, including the warm, moist air over the Gulf of Mexico and the drier continental air masses, which are cold in the winter and warm in the summer. Additionally, clockwise circulation of air around a semipermanent high-pressure system in the North Atlantic (known as the Bermuda High) causes a persistent southerly flow of air off the gulf during the warmer half of the year. **Louisiana's climate is characterized by relatively short and mild winters, hot summers, and year-round precipitation**. The Gulf of Mexico helps moderate the climate in the southern portion of the state, while temperatures and precipitation are more variable in the north. Extreme temperatures range from a record high of 114°F at Plain Dealing (August 10, 1936) to a record low of −16°F at Minden (February 13, 1899).

Temperatures in Louisiana have risen by 0.5°F since the beginning of the 20th century, less than a third of the warming for the contiguous United States, but the warmest consecutive 5-year interval was the most recent, 2016–2020 (Figure 1). Temperatures during the 20th century were highest in the first half of the century, followed

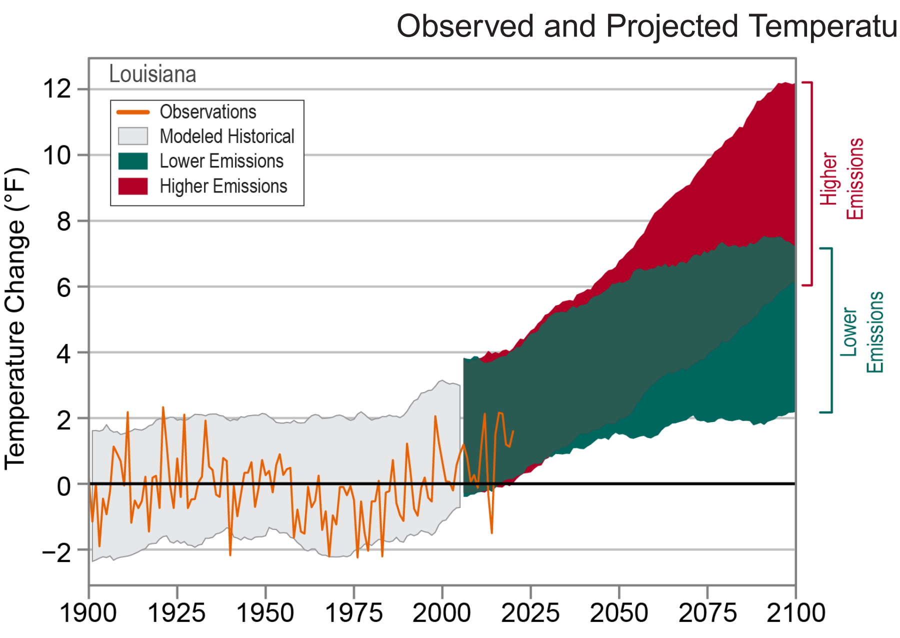
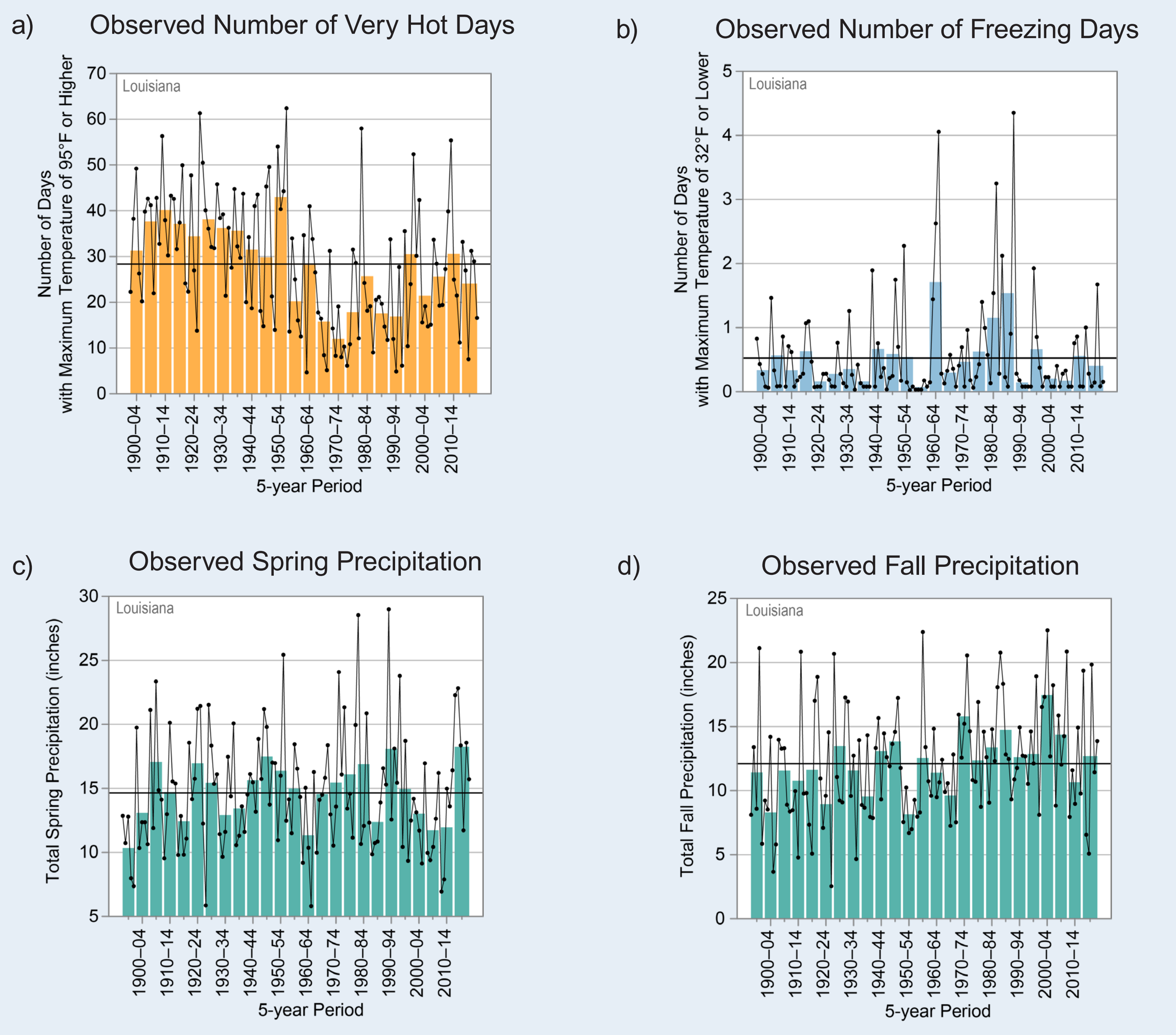


Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Louisiana. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Louisiana (orange line) have risen by 0.5°F since the beginning of the 20th century, less than a third of the warming for the contiguous United States, but the warmest consecutive 5-year interval was the most recent, 2016–2020. 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 projected 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 end-of-century projected years being about 10°F warmer than the hottest year in the historical record; red shading). Sources: CISESS and NOAA NCEI.



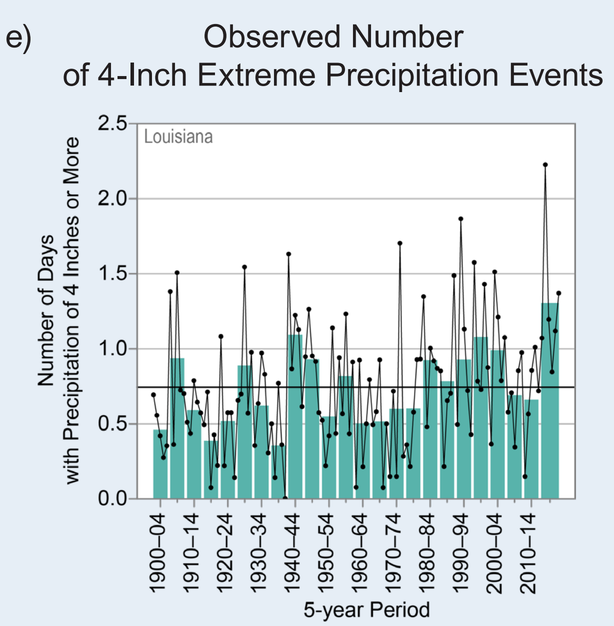


Figure 2: Observed (a) annual number of very hot days (maximum temperature of 95°F or higher), (b) annual number of freezing days (maximum temperature of 32°F or lower), (c) total spring (March–May) precipitation, (d) total fall (September–November) precipitation, and (e) annual number of 4-inch extreme precipitation events (days with precipitation of 4 inches or more) for Louisiana from (a, b, e) 1900 to 2020 and (c, d) 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) 28 days, (b) 0.5 days, (c) 14.7 inches, (d) 12.1 inches, (e) 0.7 days. Since 1965, the number of very hot days has generally been below average. The number of freezing days has generally been below average since 1990. Seasonal precipitation is highly variable from year to year and between seasons. Spring precipitation shows no long-term trend, while fall precipitation has been mostly near or above average since 1970. The number of 4-inch extreme precipitation events has been generally above average since 1980 and was well above average during the 2015–2020 period; a typical reporting station experiences an event every one to two years. Sources: CISESS and NOAA NCEI. Data: (a, b) GHCN-Daily from 10 long-term stations; (c, d) nClimDiv; (e) GHCN-Daily from 12 long-term stations.

by a substantial cooling of almost 2°F from the 1950s to the 1970s. Temperatures have risen since that cool period by more than 2°F, such that the first 21 years of this century have been about as warm as or warmer than early 20th-century levels, with 17 of the 21 years since 2000 being above average. Because of the cooling in the mid-20th century, the southeastern United States is one of the few locations globally that has experienced little to no 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 Louisiana. 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.

In Louisiana, the number of very hot days was above average in the early 20th century but was well below average during the late 1960s and 1970s. Since 1995, the number of very hot days has begun to increase but has generally remained below average (Figure 2a). By contrast, the number of very warm nights has increased steadily since 2000, reaching a record-high level during the 2015–2020 period (Figure 3). The number of freezing days showed wide variability over the 20th century but has generally been below average since 1990 (Figure 2b). While the recent trend is toward fewer extremely cold events, a historic cold wave affected the state during February 11–20, 2021. In the northwest, temperatures remained below freezing for 5 consecutive days and fell into the 0°–10°F range. Severe icing caused widespread damage.

Louisiana receives abundant precipitation throughout the year. Annual precipitation ranges from around 50 inches in the north to around 70 inches at some locations in the southeast. Statewide annual precipitation has ranged from a low of 36.6 inches in 1924 to a high of 79.5 inches in 1991. The driest multiyear periods occurred in the early 1900s and late 1930s and the wettest in the early 1990s and late 2010s (Figure 4). The driest consecutive 5-year interval was 1914–1918, with an annual average of 49.2 inches, and the wettest was 1989–1993, with an annual average of 65.6 inches. Total annual precipitation has generally been above average since 1970. While 2010 and 2011

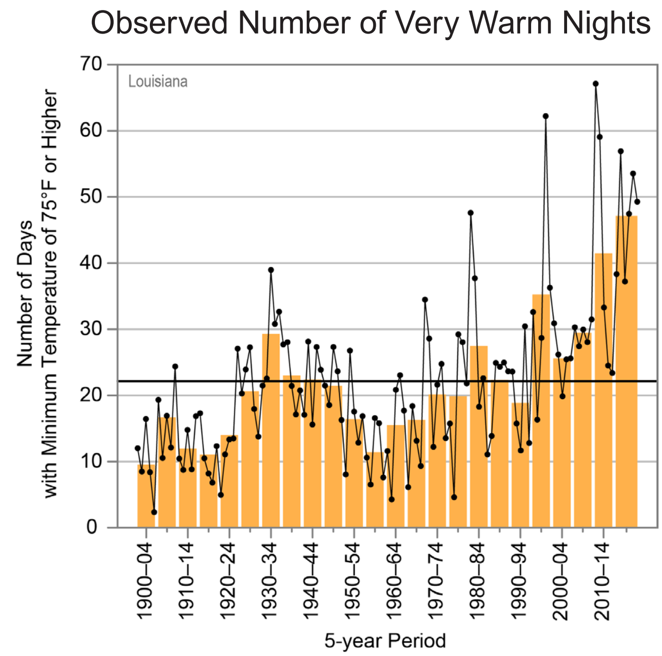


Figure 3: Observed annual number of very warm nights (minimum temperature of 75°F or higher) for Louisiana from 1900 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 22 nights. The number of very warm nights has increased steadily since 2000. The multiyear average for the 2015–2020 period is more than double the long-term average. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 10 long-term stations.

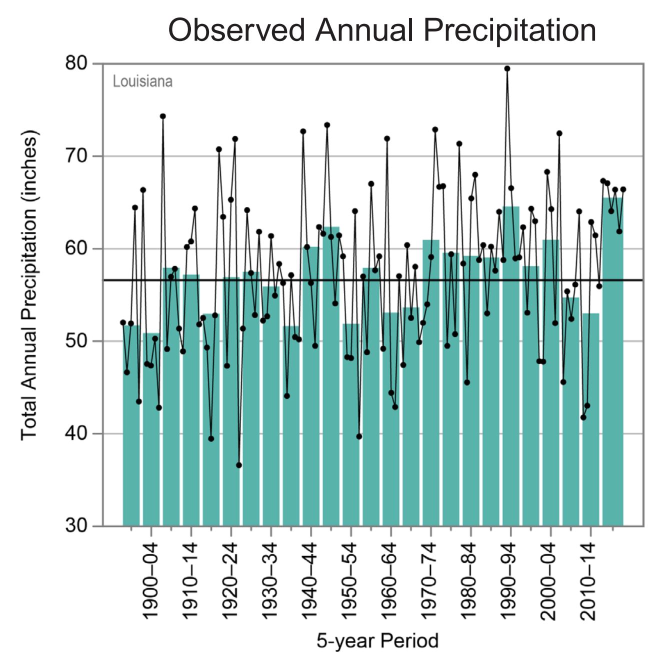


Figure 4: Observed total annual precipitation for Louisiana from 1895 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 57.2 inches. Louisiana receives abundant precipitation throughout the year. The most recent 6-year period (2015–2020) was wetter than average. Sources: CISESS and NOAA NCEI. Data: nClimDiv.

were very dry, 8 of the 9 years since then have been above average. Spring and fall precipitation has been highly variable, with very wet springs in 1991 and 2016 interspersed by very dry springs in 2010 and 2011 and very wet falls in 2009 and 2018 interspersed by very dry falls in 2016 and 2017 (Figures 2c and 2d). The number of 4-inch extreme precipitation events has generally been above average since 1980, reaching a record high during the 2015–2020 period (Figure 2e). After Florida, Louisiana has, on average, the second-highest annual number of thunderstorms in the contiguous United States, with a typical location in the state averaging more than 60 thunderstorms per year. Severe thunderstorms capable of producing tornadoes occur throughout the year but less frequently in the summer months. Snowfall is rare near the Gulf of Mexico but can occur occasionally in the northern part of the state during incursions of polar air masses.

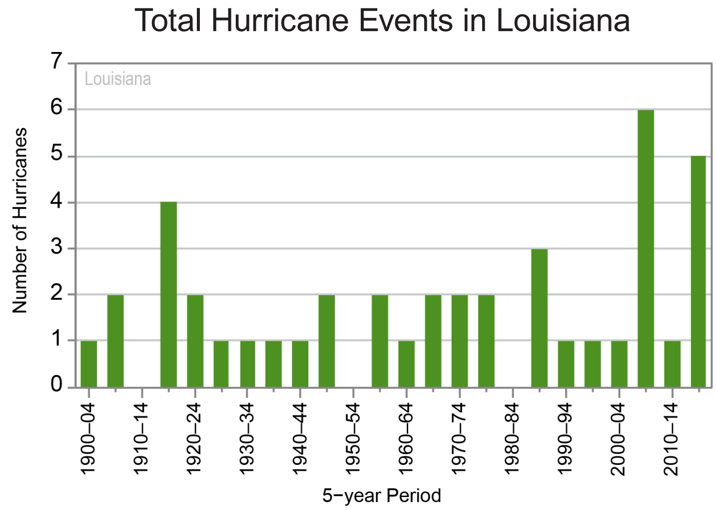


Figure 5: Total number of hurricane events (wind speeds reaching hurricane strength somewhere in the state) for Louisiana from 1900 to 2020. Bars show 5-year totals (last bar is a 6-year total). On average, Louisiana is struck by a hurricane about once every three years. From 2005 to 2009, Louisiana was struck by 6 hurricanes, the largest number during a 5-year period since the beginning of the 20th century. Source: NOAA Hurricane Research Division.

The Louisiana coast is particularly vulnerable to severe flooding from a direct hurricane strike, which occurs about once every three years (Figure 5). In August 2005, Hurricane Katrina (a Category 3 storm at landfall) caused massive damage from storm surge flooding in the eastern part of the state. New Orleans was particularly hard hit, with more than 80% of the city flooded and some areas under as much as 15 feet of water. Hurricane Katrina caused more than 1,500 fatalities in the state and immense property damage. Three hurricanes made landfall in Louisiana in 2020, the strongest being Hurricane Laura (Category 4). Laura was the strongest hurricane making landfall in Louisiana since 1856, with wind speeds of 150 mph and a 15-foot storm surge, causing massive property damage in southwestern Louisiana. The average return period (estimated average time between events) of a 10-foot storm surge is 25 to 50 years along the southwestern coast of Louisiana (Figure 6, top panel). Along the southeastern coast, the geography relative to the general path of tropical cyclones through the central Gulf of Mexico causes a funneling effect of water, leading to greater surge heights, with a 10-foot storm surge having a 10- to 25-year return period (Figure 6, bottom panel).

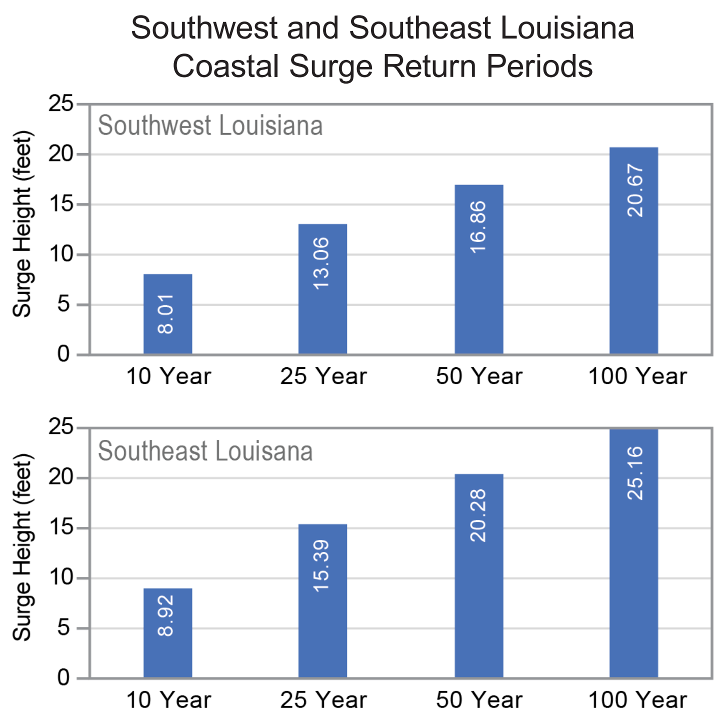


Figure 6: Storm surge heights occurring at selected average return intervals (10, 25, 50, and 100 years) along the Louisiana southwestern (top) and southeastern (bottom) coasts. Sources: CISESS and NOAA NCEI. Data: Needham et al. 2012.

Flooding is also a hazard, particularly for regions along the Mississippi River. In May 2011, one of the worst floods in Louisiana history affected the Lower Mississippi valley. To control the massive flooding, the Morganza Spillway was opened for only the second time (the first was in 1973) to protect levees and prevent flooding downstream in Baton Rouge and New Orleans. Yet despite the massive floodwaters, southern Louisiana was experiencing an extreme drought at the same time. Both the flood and drought were tied to La Niña conditions in the equatorial Pacific Ocean, which caused storm tracks to shift to the north across the Ohio River valley, bypassing Louisiana and producing drought conditions. At the same time, the storm tracks caused the excessive rainfall in the Midwest that then produced the flood wave, which moved downstream along the Mississippi River into the drought-stricken area. Most recently, in August 2016, a historic flooding event produced 20 to more than 30 inches of rainfall over several days and exceeded 500-year flood amounts in some locations. More than 30,000 people were rescued from floodwaters that damaged or destroyed more than 50,000 homes, 100,000 vehicles, and 20,000 businesses. With damages estimated at $10 billion dollars, this was one of the most costly U.S. flood events in history.

Despite the lack of a distinct dry season, Louisiana is vulnerable to drought. Since the creation of the United States Drought Monitor map in 2000, Louisiana has been completely drought-free for approximately 47% of the time (2000–2020), and at least half of the state has been in drought conditions approximately 17% of that time.

Historically unprecedented warming is projected during this century (Figure 1). Even under a lower emissions pathway, annual average temperatures are projected to exceed historical record levels in most years by the middle of the century. Since the 1970s, Louisiana temperatures have generally been within the range, but on the low end, of model-simulated temperatures. Under a lower emissions pathway, a continuation of the post-1980 warming trend would lead to an additional warming of about 1.5°F by 2050 and 3°F by 2100. In this case, the future warming would be on the low end of the model-simulated increases. However, a higher emissions pathway would potentially lead to considerably larger temperature increases. Any overall warming will lead to increasing heat wave intensity but decreasing cold wave intensity.

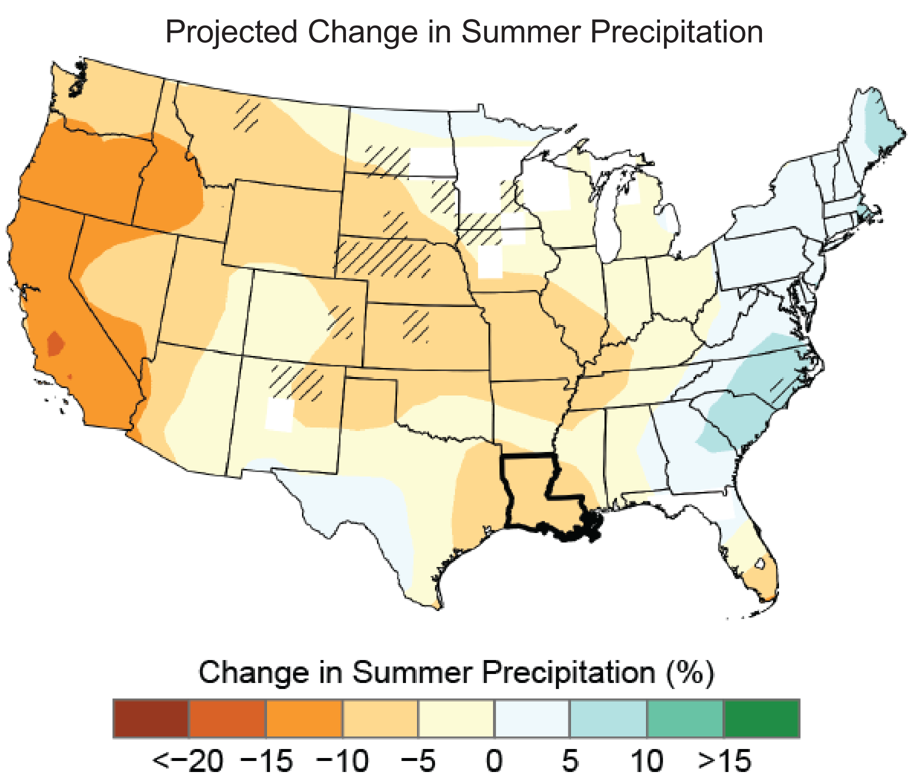


Figure 7: Projected changes in total summer (June–August) precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. Whited-out areas indicate that the climate models are uncertain about the direction of change. Hatching represents areas where the majority of climate models indicate a statistically significant change. Summer precipitation is projected to decrease throughout Louisiana; however, these changes are small relative to the natural variability in this region. Sources: CISESS and NEMAC. Data: CMIP5.

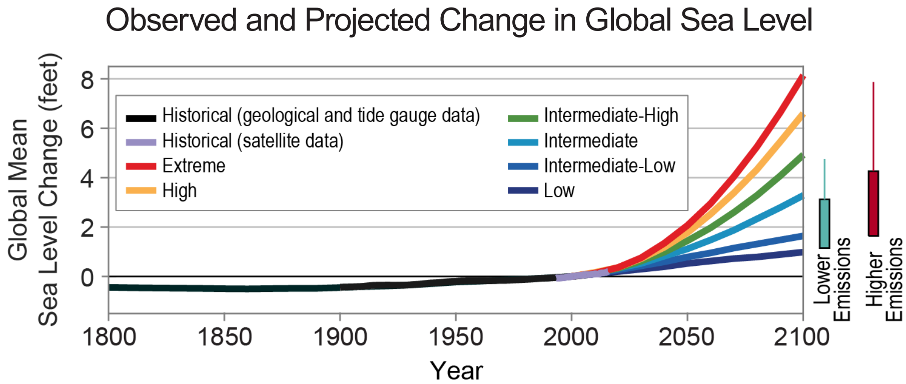


Figure 8: Global mean sea level (GMSL) change from 1800 to 2100. Projections include the six U.S. Interagency Sea Level Rise Task Force GMSL scenarios (Low, navy blue; Intermediate–Low, royal blue; Intermediate, cyan; Intermediate High, green; High, orange; and Extreme, red curves) relative to historical 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.

Summer precipitation is projected to decrease in Louisiana, although the projected decreases are smaller than natural variations (Figure 7). Even if average precipitation remains the same, higher temperatures will increase the rate of soil moisture loss during dry spells, which could increase the intensity of naturally occurring droughts.

Increasing global temperatures raise concerns for sea level rise in coastal areas. Since 1900, global average sea level has risen by about 7–8 inches. It 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 8). 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. Nuisance flooding has increased in all U.S. coastal areas, with more rapid increases along the East and Gulf Coasts. Nuisance flooding events in Louisiana are likely to occur more frequently as global and local sea levels continue to rise. **Much of Louisiana is at extreme risk for sea level rise due to its low elevation, which averages only 3 feet in the southeastern part of the state**. Additionally, the coastline is rapidly sinking due to subsidence (settling of the soil over time), which has already caused the state to lose almost 2,000 square miles of land since the 1930s. Due to subsidence, relative sea level rise at some locations is more than 4 times the global rate. The New Orleans metropolitan area, the most populous in the state, is at particular risk for sea level rise impacts. Sea level rise will present major challenges to Louisiana's existing coastal water management system and could cause extensive economic damage through ecosystem degradation and losses in property, tourism, and agriculture.

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