TECHNICAL BULLETIN *Prepared by the Davey Institute*

Climate Change Projections for the Southeast United States

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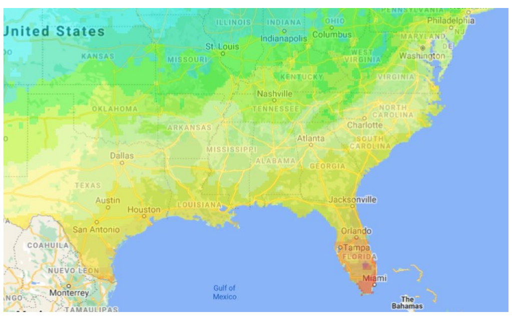
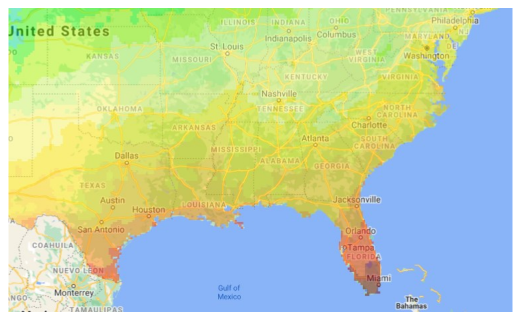
Image from Fourth National Climate Assessment

The Davey Climate Change Fact Sheet Series projects the future impacts of climate change in our industry over the next 30-70 years, with emphasis on changes in temperature, precipitation, storm intensity, tree health, pest pressure, wildfire, and worker stress. Temperatures across the U.S. are expected to increase between 3-11°F by the end of this century, with future patterns of greenhouse gas emissions providing the largest source of uncertainty. The Intergovernmental Panel on Climate Change (IPCC) predicts future climates based on modeling for different emissions scenarios, called "Representative Concentration Pathways (RCP)." This fact sheet focuses on changes expected to occur in the Southeast U.S. based on lower (RCP4.5) and higher (RCP8.5) emission scenarios. Currently, global patterns of fossil fuel consumption correspond most closely with the high emission scenario, while the lower emission scenario will require significant mitigation measures yet to be implemented.



Current winter hardiness zones



Winter hardiness zones projected for end of century under the lower emission scenario

The climate is warming, but unevenly

In the Southeast, nights and winters are warming faster than days and summers. Average daily minimum temperatures have increased three times faster than average daily maximum temperatures, and the number of nights with minimum temperatures greater than 75°F over the last 10 years was almost twice that of the long-term average for 1901–1960. In addition, the length of the freeze-free season has increased by 1.5 weeks throughout the region. Winters are predicted to continue warming throughout the region. By mid-century, USDA plant hardiness zones will increase from 8a to 9a along the Gulf coast and 6b to 7b in central Kentucky. Temperatures greater than 86° F can negatively affect plant photosynthesis and, subsequently, plant growth and health. By mid-century, days above this threshold are expected to increase by an average of 32 and 58 days from the baseline period 1980-2009 under low and high scenarios across the region.

Average daily maximum temperatures in the Southeast have warmed at rates similar to the rest of the country since 1960, while summer heat waves throughout the region are becoming more frequent, intense, and longer. Average temperatures are predicted to continue to increase by 2050 under the lower and higher emission scenarios. Increases are predicted to be much greater under the high emission scenario, with daily maximum temperatures above 95°F becoming the norm and temperatures above 100°F becoming much more frequent during summer. Under the high scenario the frost-free season is predicted to increase by more than a month. In Alabama and Florida, for example, temperatures are predicted to exceed 95°F on 30-60 and 45-90 days each year, for low and high scenarios respectively, by the end of the century, compared with about 15 days today.

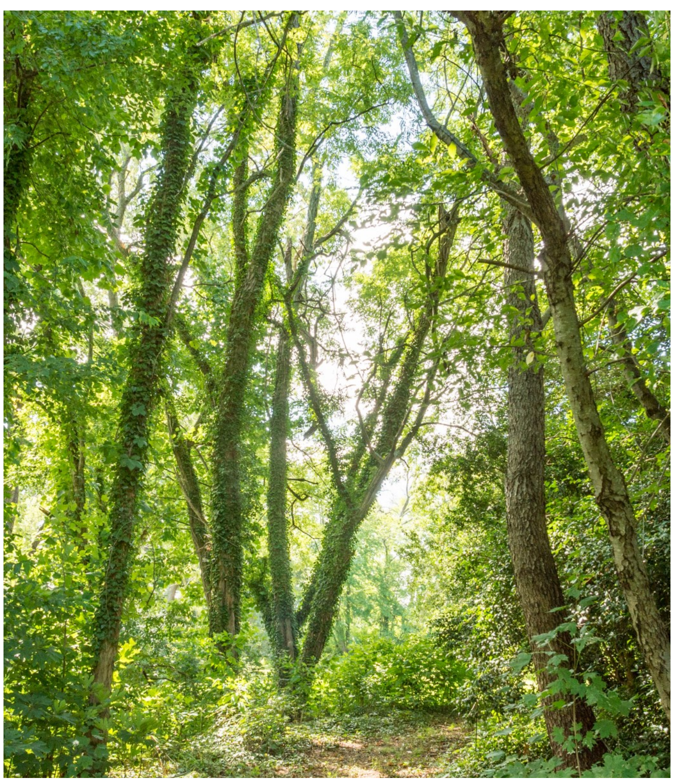
Extreme precipitation events

More rain is falling in heavy downpours, and extreme precipitation events and flooding are predicted to increase by 2050 under the lower emission scenario, and to a much greater degree under the higher emission scenario. Even as total rainfall increases, intermittent summer droughts are predicted to be more frequent and severe as periods without rain become longer, with very hot days more frequent and drier soil as evaporation increases. The number of extreme rainfall events (3 or more inches) has increased over most of the Southeast region since 1950, but have decreased along and southeast of the Appalachian Mountains and in Florida.

Hurricanes, sea level rise, and coastal flooding

Globally, sea level is rising at a rate of 4.5 mm per year and accelerating. The frequency of flooding at high tide has increased 5- to 10-fold over the past 50 years in several Southeast coastal cities, with Wilmington, NC, Charleston, SC, and Miami, FL among those seeing significant impacts.

The number of hurricanes that strike the Southeast each year is highly variable and there is little evidence of change in frequency over time. However, hurricanes draw their energy from the heat of the warming ocean and the frequency of strong hurricanes (class 4 and 5) and associated precipitation and flooding has increased substantially, bringing with it significant economic impact. This trend is predicted to intensify, with major implications for the tree care industry and utilities.



Forest composition is changing

Forest composition will continue to change throughout the region as temperatures continue to increase and patterns of precipitation change. Wildfire ignited by lightning is expected to increase an average of 30% throughout the region by 2060. Effects on forest productivity are uncertain, as negative effects of more intense droughts may be offset by a longer growing season and increased atmospheric CO_2 concentrations.

As the climate warms, oaks are predicted to increase in dominance at the expense of loblolly and shortleaf pines in southern regions of the Southeast. In central Kentucky, beech and maple are predicted to decline as oak and hickory increase in dominance. Saltwater intrusion caused by sea level rise has increased tree mortality in forests along the Atlantic and Gulf coasts.

Insect pest pressure: winners and losers

Cities are generally warmer than surrounding rural areas. This urban heat island effect has amplified warming in urban areas and has provided an opportunity to study impacts of climate change on trees and insects. For example, research at North Carolina State University has found that populations of scale insects are much greater on trees in warmer areas of urban Raleigh than in cooler green areas of the city due to higher insect survival rates.

Spider mite populations also increase more rapidly in warmer areas because they can complete their life cycle faster as temperature increases. These studies indicate that certain pest problems will intensify over time as the climate warms. Wood-borers, vascular wilt, and canker pathogens have an advantage when trees are stressed by high temperatures and intermittent drought.

However, warmer temperatures do not favor all pests. Populations of hemlock woolly adelgid, an invasive insect that has devastated native hemlocks throughout the Appalachian Mountains, are lower, and hemlock survival higher, in warmer, lower altitude areas of Georgia. Research has shown this to be caused by high insect mortality when temperatures exceed 90°F for several days.

Human health: Extreme heat and insect-vectored diseases

Tree care workers will experience increased stress from extreme heat and risk of diseases spread by insects. The frequency of heat waves is predicted to increase substantially throughout the Southeast under both climate change scenarios, and with it the number of days exceeding 95°F and 100°F.

The distribution and abundance of mosquitos that vector viruses such as dengue, chikungunya, West Nile, and Zika are predicted to increase throughout the Southeast as the climate continues to warm. Currently, only the climate of South Florida is suitable for year-round breeding of the yellow fever mosquito (*Aedes aegypti*), although it can spread throughout the Southeast during summer. Thus, as warming continues, the incidence of mosquito-borne diseases is projected to increase throughout the region.

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