Future projections of climate aid decision making by providing realistic scenarios of how the climate of a region may change in the future. Considering results from multiple climate models allows decision makers to examine a range of possible futures — all of which represent plausible futures — and provide appropriate range of risk for planning purposes.

Global climate models use physics to calculate temperature, moisture, wind, pressure, etc. at each point in a grid that covers the globe. These models are not trying to predict the weather on any given day. Rather, they help us understand how weather on average will change given changes in external forcing, such as changing concentrations of carbon dioxide and other greenhouse gases.

In this report, we will examine multiple scenarios. Scenarios are used to show how future trajectories of key greenhouse gases may impact the climate system. The low-end scenario (i.e., representative concentration pathway 2.6 (or RCP 2.6) represents a drastic reduction in global emissions. The high emissions scenario (RCP 8.5) represents a "business as usual” case, where countries continue to increase their emissions. Some graphics presented in this report include a third scenario to represent a possible future with some reductions in global emissions (RCP 4.5). RCP 4.5 represents a future between the high and low emissions extremes — RCP 8.5 and 2.6, respectively. Although nations are currently (as of 2020) on target to equal or surpass the high-end scenario, we strongly recommend consideration of all scenarios, as changes in technologies, governments, business interests, or public opinion may quickly shift the direction of future greenhouse gas emissions from today’s trend.

The projections used in this report were generated using statistical downscaling techniques in partnership with the Geophysical Fluid Dynamics Laboratory of the National Oceanic and Atmospheric Administration (NOAA). Statistical downscaling ensures that large-scale changes from the global climate models are translated to regional or local situations by building mathematical relationships between the historical observations from the region and the large-scale global projections. Assuming that the statistical relationships observed in the past will continue to hold in the future, we can project changes at the regional level based on global climate model output.

The projections shown below (as of October 2020) use three global climate models that are representative of the climate of the south-central U.S. and three statistical downscaling techniques that have been used for many types of decision applications (Wootten et al., 2020).

Unless otherwise stated, the maps and figures on the following pages represent the average change from the historical period (1981–2005).

Temperature Projections

The historical annual average daytime high of Oklahoma City is 71.4 deg F. In central Oklahoma, average annual high temperatures for the period from 2036-2065 are projected to increase by about 2 deg F for the low-end scenario (Fig. 1, left image) to about 5 deg F for the high-end scenario (Fig. 1, right image) above the historical annual average high temperatures from 1981–2005.

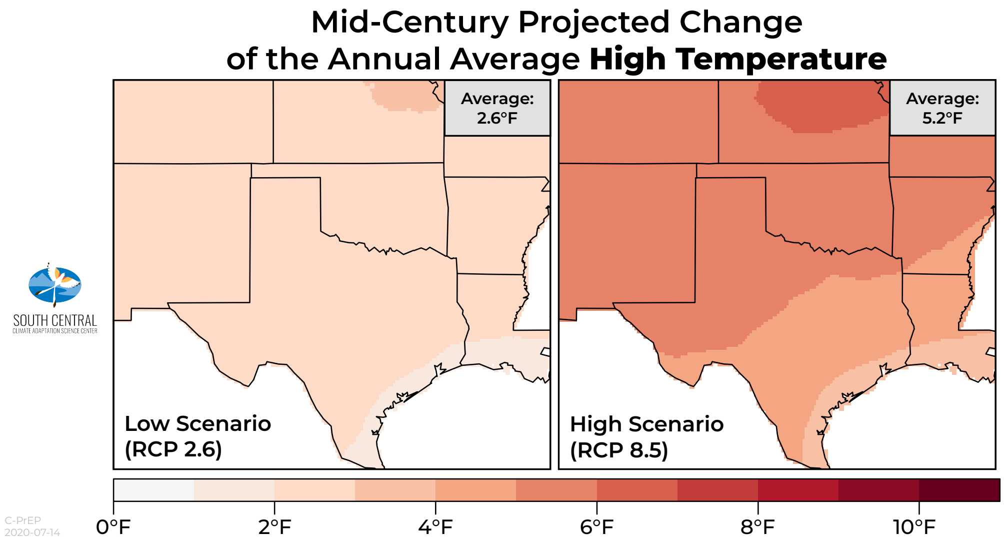


Figure 1. Projected change in the annual average high temperature (degrees) for mid-century (2036–2065) for a low-emissions scenario (left) and a high-emissions scenario (right). The annual average high temperature is calculated by averaging daily high temperatures in a given year.

The historical annual average nighttime low of Oklahoma City is 49.7 deg F. Similar to the average annual high temperature, the average annual low temperatures for the mid-century are projected to increase by about 2 deg F for the low-end scenario (Fig. 2, left image) to about 5 deg F for the high-end scenario (Fig. 2, right image) in central Oklahoma.

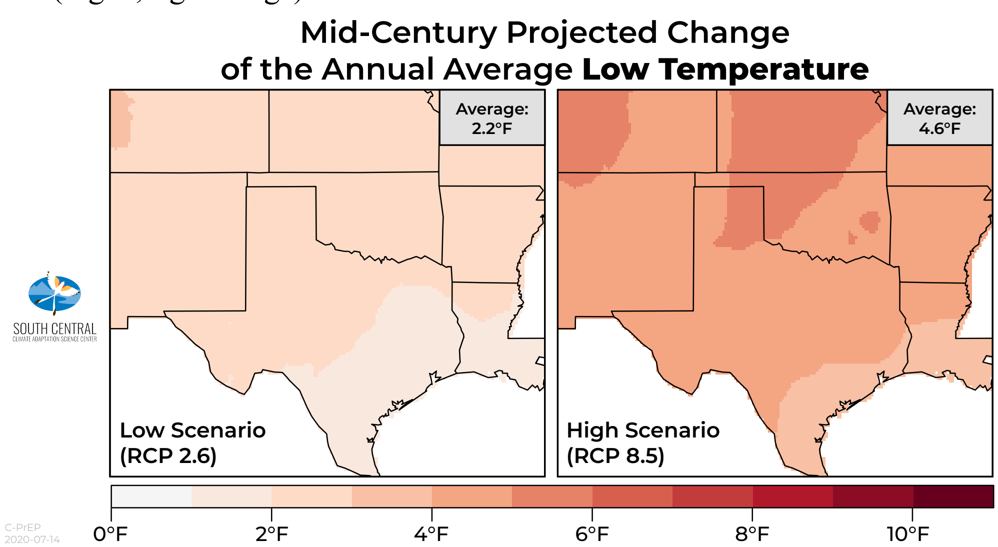


Figure 2. Projected change in the annual average low temperature (degrees) for mid-century (2036-2065) for a low-emissions scenario (left) and a high-emissions scenario (right). The annual average low temperature is calculated by averaging daily low temperatures in a given year.

The overall warming that is projected will lead to changes in the average annual number of very hot days (i.e., days with temperatures above 100 deg F). By mid-century, projections indicate there will be about 13 to 28 more very hot days on average per year for Oklahoma City (Fig. 3). Using bar plots, we can see more of the possible range for each of the three scenarios at a localized scale.[1] On average, OKC currently experiences ~9 very hot days on an annual basis. More very hot days will significantly impact human health and comfort, as well as put strain on city infrastructure such as cooling systems, road surfaces, and water resources (NCA 2014).

Increasing the average annual number of very hot days will lead to more events like the summer of 2011 (NCA 2018). During that extremely hot and dry summer, severe impacts were experienced across the state, including increased heat-related illnesses and death, more brush fires, and low reservoir levels (NWS 2011).

Oklahoma City is expected to see an increase of about 2 to 4 heatwave events on average per year (Fig. 4). Heatwave events are defined as a period of 3 or more days were both the high and low temperatures are on the extreme high end of the temperature distribution for that location (above the 95th percentile). On average, Oklahoma City currently experiences about 1 heatwave event per year.

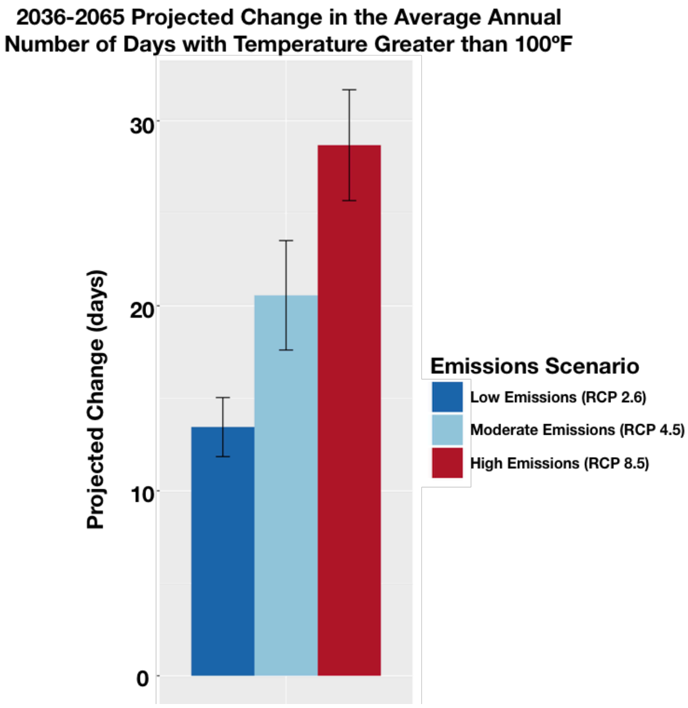


Figure 3. Projected change in the average annual number of very hot days (high temperatures > 100ºF) for mid-century (2036-2065) for a low-emissions scenario (furthest left) and a high-emissions scenario (furthest right).

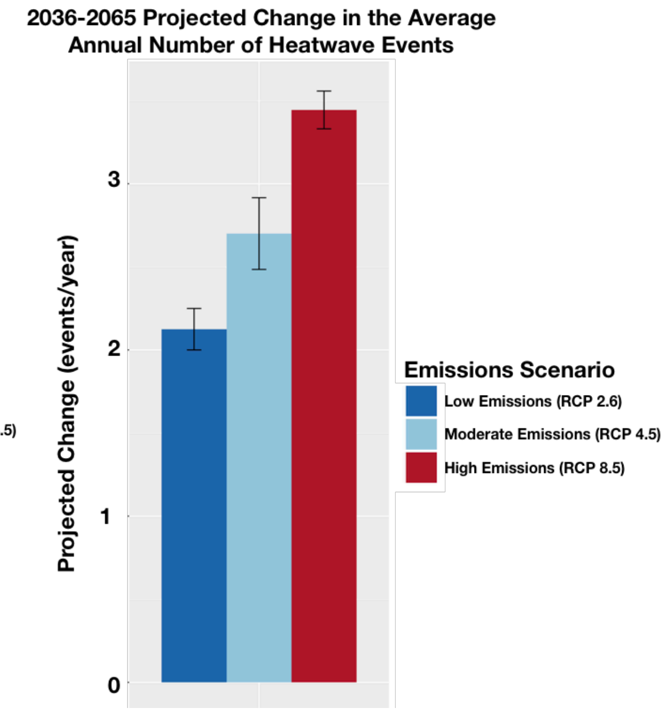


Figure 4. Projected change in the average annual number of heatwave events for mid-century (2036–2065) for a low-emissions scenario (furthest left) and a high-emissions scenario (furthest right).

[1] *Bar plots are generated using several grid boxes across OKC, and should not be viewed as representative of a point location.*

On average, Oklahoma City currently experiences about 69 days with temperatures below 32 deg F. By mid-century, Oklahoma City is expected to have about 11 to 26 fewer days with temperatures below 32 deg F (Fig. 5). A reduction in days below freezing is expected as temperatures on average warm (regardless of emissions scenario). This warming will impact the type of precipitation that falls in the winter and Oklahoma City may ultimately experience less snowfall on average. In addition, as the winter season becomes warmer, it is expected that populations like mosquitos and ticks will become larger since there are fewer days with temperatures below freezing to keep the population numbers in check (NCA 2018). Ticks and mosquitos are known to carry diseases that can be transmitted to humans through their bites.

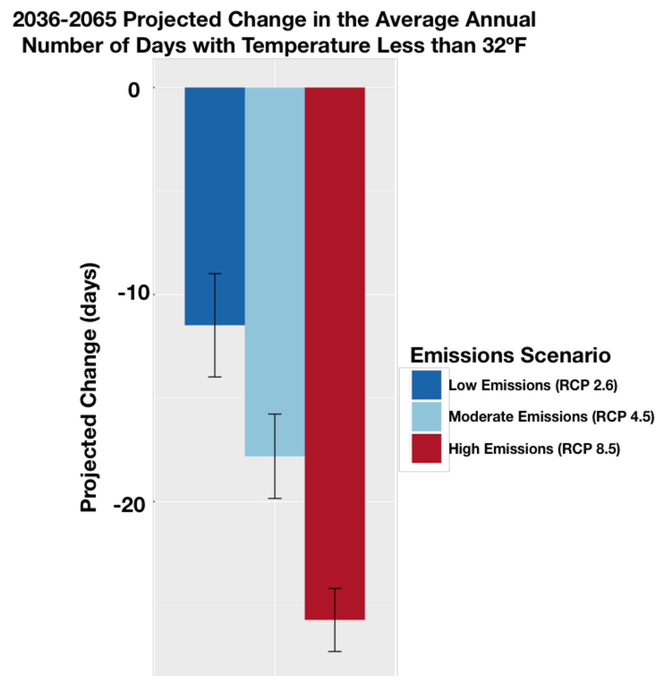


Figure 5, right. Projected change in the average annual number days with temperatures less than 32 deg F (2036–2065) for a low-emissions scenario (furthest left) and a high-emissions scenario (furthest right).

Precipitation Projections

The historical annual average total precipitation of Oklahoma City is 36.7 inches. In central Oklahoma, average annual total precipitation for the period from 2036-2065 is projected to stay about the same in the low-end scenario (Fig. 6, left image), but decrease by 4 to 6 percent in the high-end scenario (Fig. 6, right image) compared to the average annual total precipitation from 1981–2005.

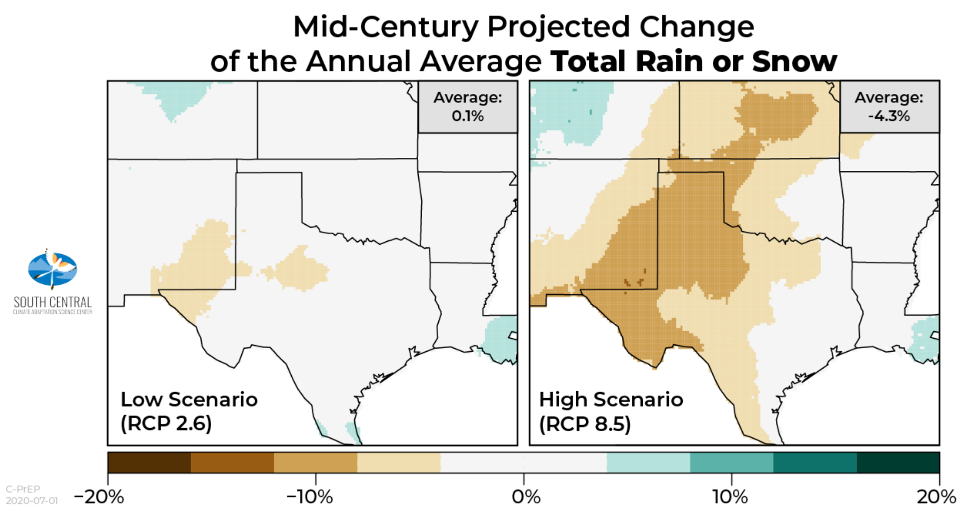


Figure 6: Projected change (percent) in the annual average total precipitation for mid-century (2036-2065) for a low-emissions scenario (left) and a high-emissions scenario (right). The annual average total precipitation is calculated by averaging daily total precipitation in a given year.

Changes in atmospheric circulations at the global scale ultimately influence *where* on Earth precipitation might fall (NCA 2014). In each emissions scenario, the atmospheric circulations are different. As such, we may see different signals (increasing or decreasing) in the same geographic area when looking at different emissions scenarios.

Even with relatively little change in average annual total precipitation, shifts may occur in when and how much precipitation falls at any given time. With warming air temperatures, the atmosphere can hold more water vapor, and results in generally more dry days between precipitation events and generally more intense precipitation events when they occur.

In Oklahoma City, on average, the climate projections show a decrease from about 1 to 4 fewer days with any amount of precipitation (Fig. 7). On average, Oklahoma City currently experiences ~124 days with at least a trace of precipitation.

Heavy precipitation (e.g., heavy rainfall) is also expected to increase for Oklahoma City. Projections show, on average, an increase of about 0.16 in (4 mm) for the average annual maximum 1-day precipitation total (Fig.8). This slight increase means that the heaviest 1-day precipitation event for Oklahoma City will likely increase in the future. Currently, Oklahoma City's average 1-day maximum precipitation total is about 2.4 in (60 mm). An additional 0.16 inches to this 1-day total could result in additional flash flooding or erosion.

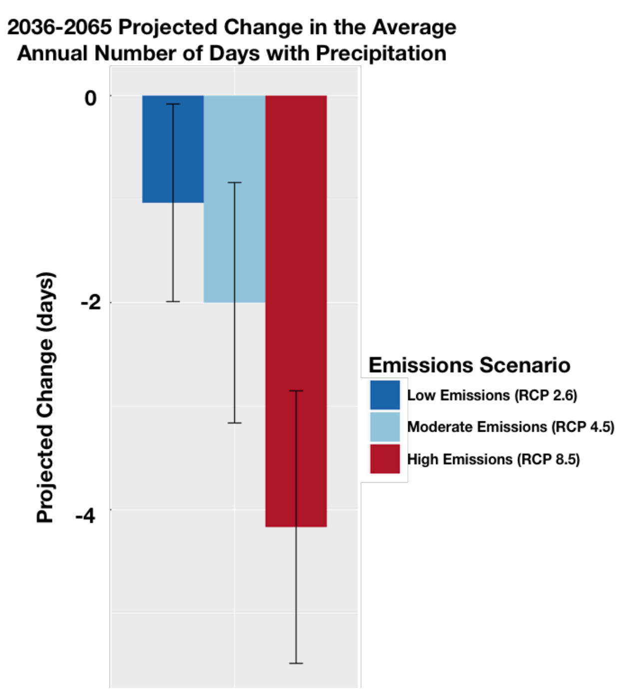


Figure 7: Projected change in the average annual number of days with precipitation measuring greater than a trace for mid-century (2036-2065) for a low-emissions scenario (furthest left) and a high-emissions scenario (furthest right).

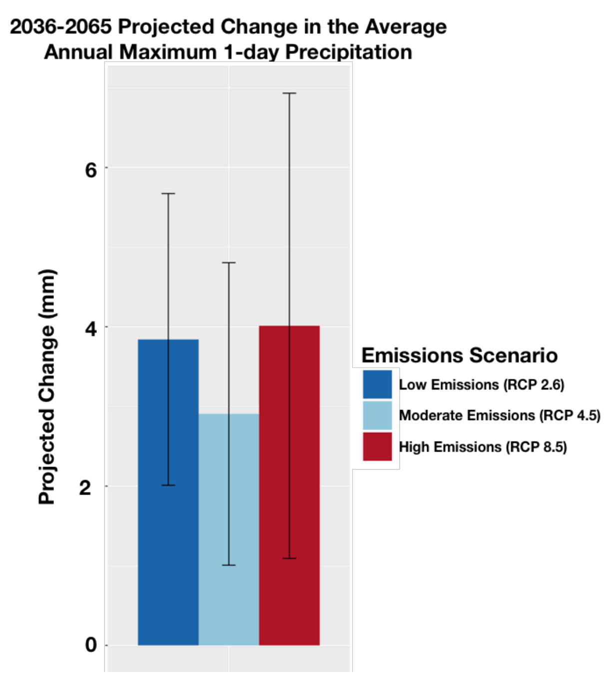


Figure 8: Projected change in the average annual maximum 1-day precipitation total (mm) for mid-century (2036-2065) for a low-emissions scenario (furthest left) and a high-emissions scenario (furthest right).

With a shift in the frequency and intensity of precipitation events, we can expect impacts to soil moisture. As precipitation events become more intense, more runoff will occur and less will have the opportunity to soak into the soils (NCA 2018). Generally drier soils, fewer days with precipitation, and higher temperatures will likely result in drought conditions.

The summer of 2011 not only impacted people through extreme heat, but also through a reduction of water. With little rainfall during that summer, several lakes across the state experienced record low levels (NWS 2011). Low lake levels created dangerous conditions for boaters, and the stagnant water served as the perfect breeding ground for blue-green algae - a health hazard for the public and animals. Impacts such as these may become more frequent in the future as the climate continues to change.

Additional Projections

Growing season length is useful information for those in the agricultural or urban gardening communities. Our growing season length projections are derived from temperature only, so the values shown may not be completely representative. To accurately understand growing season, one must also take into account variables such as soil moisture, first leaf, and precipitation. Our projections, which are calculated as the number of days between the last spring freeze and first fall freeze, are useful in seeing potential trends. It is expected that as temperatures warm, the growing season length will likely increase as well.

In Oklahoma City, the average historical growing season length based solely on temperature is 224 days. On average, this value is expected to increase by about 12 to 26 days. Since this value is solely derived from temperature, the numbers are really larger than reality, but the key takeaway is the positive trend to a longer growing season.

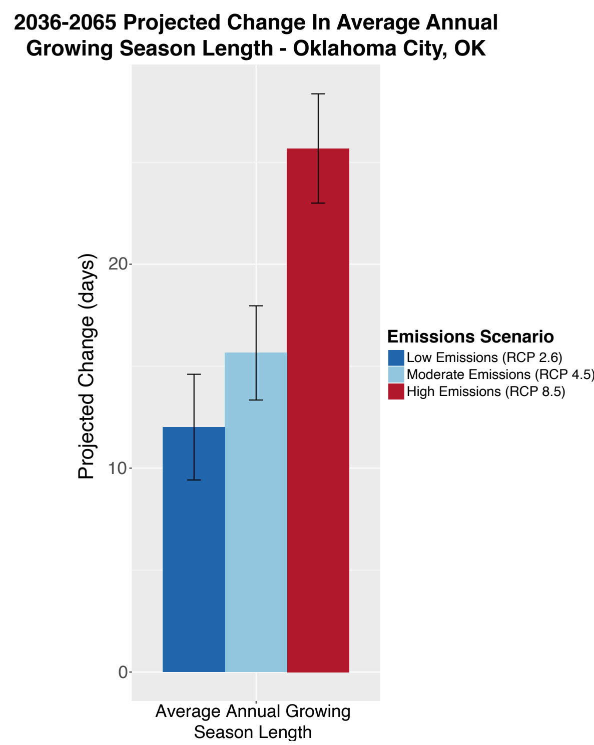


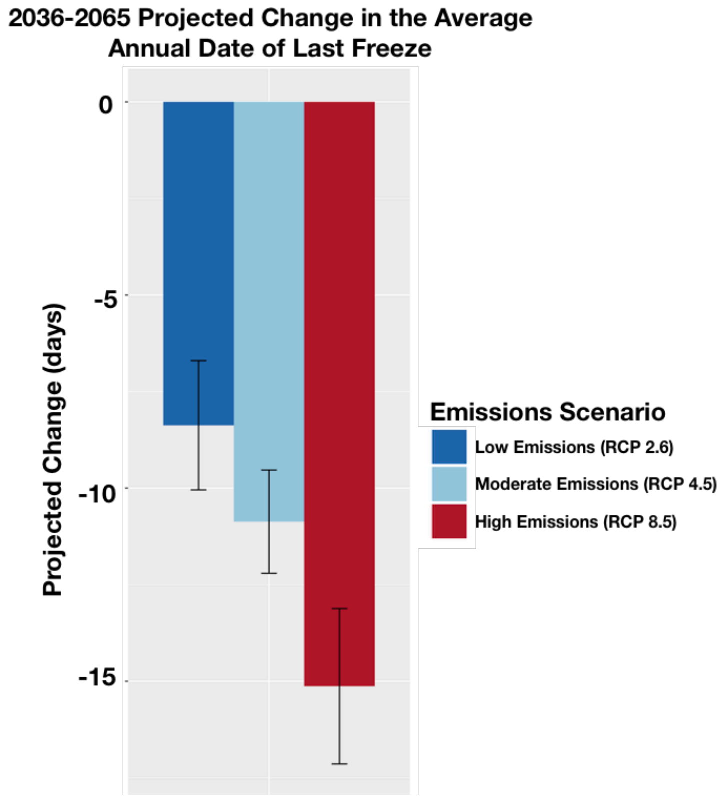
Figure 9, above: Projected change in the average annual growing season length for mid-Century (2036-2065) for a low-emissions scenario (furthest left) and a high-emissions scenario (furthest right).

In Oklahoma, an increase in the growing season length may be seen as a positive. However, the increase in temperatures that result in a longer growing season also often result in the leaf out process starting sooner in the year. When late season frosts and freezes occur after the plants have started leafing out, plant loss typically occurs.

On average, Oklahoma City currently experiences their last freeze towards the end of March (~26th or 27th). According to climate projections, the average annual date of last freeze is expected to happen about 8 to 15 days earlier in the year (i.e., mid- to early March).

While on average the date may change to earlier in the season, this does not mean that a late season frost or freeze can not or will not happen in a given year.

Figure 10, right: Projected change in the average annual date of last freeze for mid-Century (2036-2065) for a low-emissions scenario (furthest left) and a high-emissions scenario (furthest right).



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