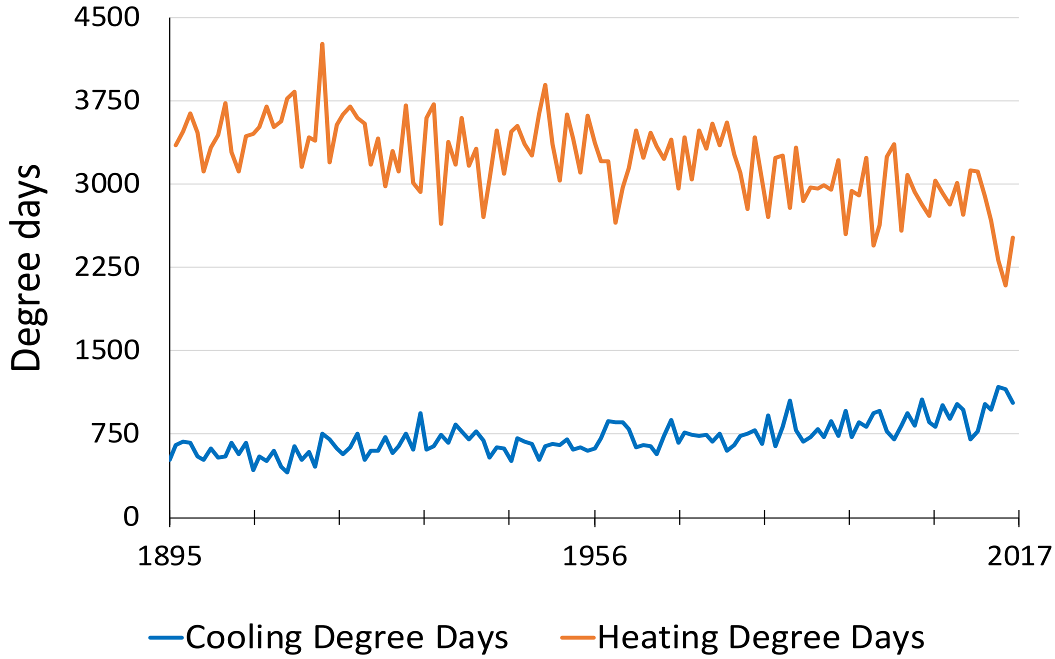
Cooling and Heating Degree Days

Average temperatures have increased in California over the past century. As a result, the energy needed to cool buildings during warm weather — measured by "cooling degree days" — has increased. The energy needed to heat buildings during cold weather — measured by "heating degree days" — has decreased.

Figure 1. Cooling and Heating Degree Days



Note: Degree days measure the difference between the average daily temperature and a reference temperature of 65 degrees Fahrenheit (°F). Cooling degree days measure how much the average daily temperature is higher than 65°F; heating degree days, how much it is lower than 65°F. For example, an average daily temperature of 75°F corresponds to a cooling degree day value of 10. Each value shown in the graph is the sum of degree days for that year.

Source: NOAA, 2017a

What does the indicator show?

Annual cooling degree days (CDD) in California increased between 1895 and 2016, while heating degree days (HDD) decreased over the same time period (Figure 1). Both trends are consistent with national trends (US EPA, 2016). The past few years have seen anomalously high ambient temperatures, as reflected in the unusually high CDDs and unusually low HDDs observed statewide and regionally. Trends in CDD and HDD for the seven California climate divisions as defined by the National Oceanic and Atmospheric Administration (NOAA)[2] are shown in Figures 2-5.

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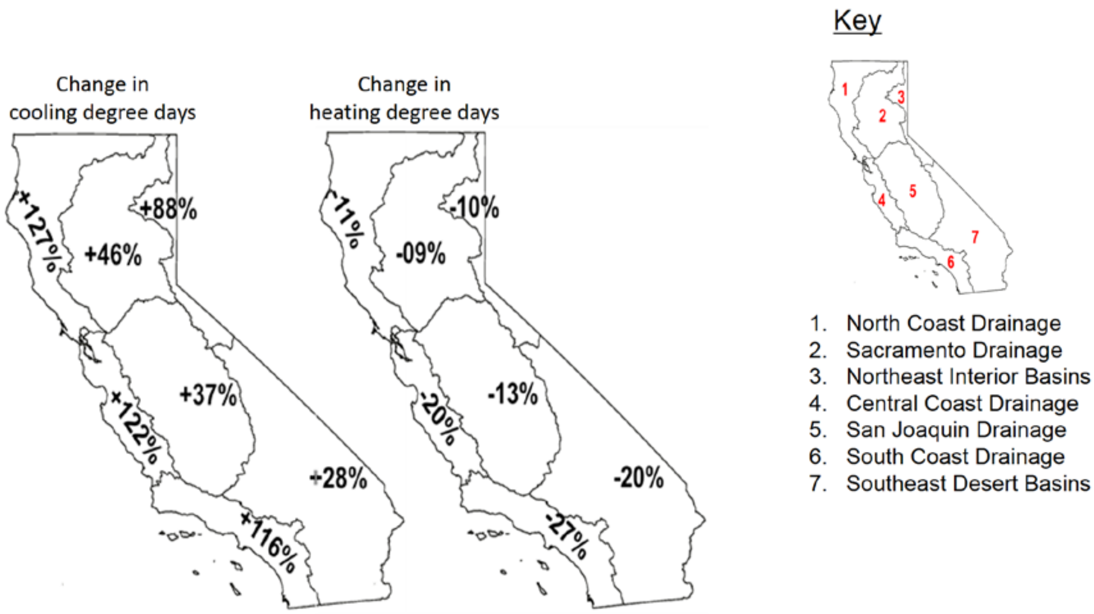
[2] Note: NOAA's climate divisions span the contiguous United States, subdividing each state into ten or fewer climate divisions; other indicators in this report are based on data from the Western Regional Climate Center, which divides California into eleven climate regions.

Figure 2. Percent change in degree days by climate division, 1895-2016



Source: NOAA, 2017a

All seven divisions show an increase in CDD and a decrease in HDD over the last century, but to varying extents (see Figure 2). Interestingly, coastal California shows greater increases in CDD over the last century compared to inland areas of the state. Larger declines in HDD are found in the Central Coast and South Coast, with the latter showing the greatest decrease. Graphs of degree days for each division are provided below in Figure 3 and 4.

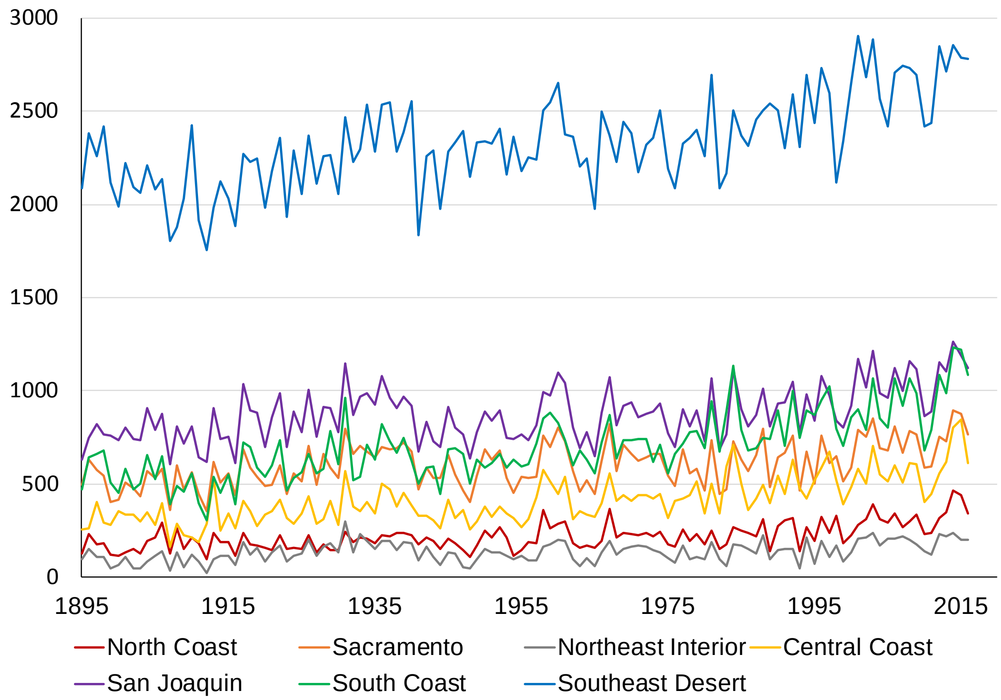
California's 100 million acres encompass diverse terrains and geographies with various climates. Not surprisingly, long-term trends in degree days show regional variations. Table 1 presents these trends in terms of the average annual change in heating and cooling days for the seven climate divisions.

Table 1. Divisional Trends in Cooling and Heating Degree Days

Trend are presented for each of California's climate divisions. Values presented are the slope of linear trends, representing the rate of change in cooling or heating degree days per year.

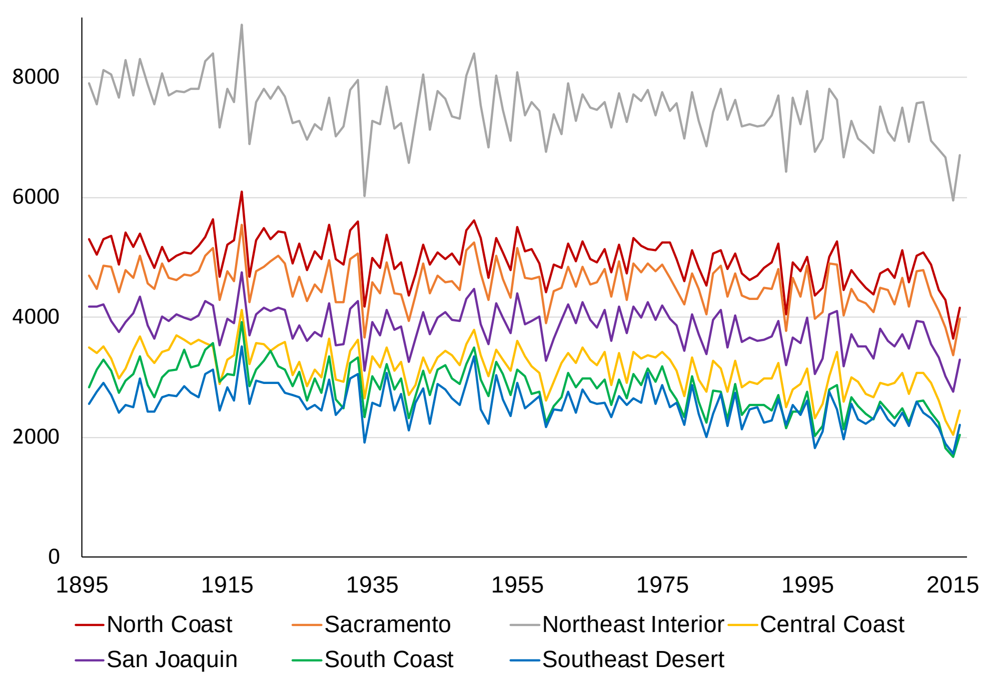
Climate Division	Trends, 1895-2016 (Degree Days per Year)	
	Cooling	Heating
Southeast Desert Basins	+4.7	-4.4
North Coast Drainage	+1.2	-5.1
Central Coast Drainage	+2.5	-6.0
South Coast Drainage	+3.8	-7.4
San Joaquin Drainage	+2.1	-4.3
Sacramento Drainage	+1.6	-3.6
Northeast Interior Basins	+0.6	-6.4

Figure 3. Cooling degree days by Division, 1895-2016



Source: NOAA, 2017a

Figure 4. Heating degree days by Division, 1895-2016



Source: NOAA, 2017a

Why is this indicator important?

The need to cool or heat indoor living spaces depends on the outdoor temperature. Warmer summers increase the need for air conditioning, and warmer winters decrease the need for heating. Measurements of degree days offer a way to track the demand for energy to cool homes and buildings (NOAA, 2005). They inform utility planning and construction decisions (USGCRP, 2014), along with other factors that influence energy demand including energy-efficient heating systems, cooling technologies, home insulation, behavior change, and population shifts (US EPA, 2016).

As the climate continues to warm, energy consumption will shift from cooler months to warmer months (CEC, 2015). Demand for air conditioning electricity will grow and demand for heating sources will shrink (US EPA, 2016). Space heating represents about 18 percent of average total household energy expenditures in California, while air conditioning represents 13 percent (US EIA, 2013).

Meeting a growing demand for air conditioning may require investments in new energy generation and distribution infrastructure and new ways to manage peak demand and system reliability (US EPA, 2016). At the same time, studies suggest climate change may hamper the ability to meet the increased demand in electricity for cooling. Warming temperatures, sea level rise, and wildfires can impact the operation or the efficiency of power plants, transmission networks, and natural gas facilities (US EPA, 2016; CEC, 2009, 2012; Patrick and Fardo, 2009). Climate change can also affect renewable energy, given its dependence on natural resources like water, wind, biomass and available incoming solar radiation which are all influenced by climate variations (CEC, 2009).

The increasing demand for cooling can impact communities in California. Although the state, on average, consumes less electricity per household than most of the nation, the higher electricity prices in California raise household electricity costs closer to the national average (US EIA, 2009). In addition, certain populations in California may face disproportionately greater impacts than other groups. Lower-income households are less likely to own air conditioners, making them more vulnerable to health effects of summer heat extremes. For households that do own air conditioners, the cost of energy associated with cooling represents a greater proportion of household income in lower income groups (CalEPA, 2010).

What factors influence this indicator?

Since heating and cooling degree days reflect trends in temperature, factors that influence temperature affect this indicator. These factors are discussed in the *Annual air temperature* indicator.

Technical Considerations

Data Characteristics

Degree day values were downloaded from an online NOAA database, Climate at a Glance, at https://www.ncdc.noaa.gov/cag/ (NOAA, 2017b).

The values for degree days are derived by NOAA using daily temperature observations at major weather stations in the United States. A mean daily temperature (average of daily maximum and minimum temperatures) of 65ºF serves as the reference temperature for degree day calculations. Cooling degree days are calculated by summing the positive differences between the mean daily temperature and the 65ºF reference temperature. Heating degree days are calculated by summing the negative differences between the mean daily temperature and 65ºF. Heating degree days during July 1 through June 30 and cooling degree days during January 1 through December 31 are added together to calculate total heating degree days per "heating year" and total cooling degree days per "cooling year," respectively.

Long-term trends of degree days over time (1895 to 2016) for each climate division were analyzed with trendlines. Slopes of trendlines provided the rates of change in degree days per year for Table 1.

Strengths and Limitations of the Data

The nCLIMDIV dataset is an improved version of an older climate dataset from NOAA. It goes through quality assurance reviews and temperature bias adjustments and provides more robust values than its predecessor (NOAA, 2017b).

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