Colorado and Climate Change

Colorful Colorado Greener Than Ever

CO2 COALITION

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August 2026

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EXECUTIVE SUMMARY

In 2024, Colorado State University's Colorado Climate Center published the third edition of its *Climate Change in Colorado* report (Bolinger et al., 2024) that discusses recent trends and model-based predictions of the climate and hydrology in Colorado. This report claims that "the evidence that human influences have impacted the global climate system has only strengthened."

Are Colorado and its citizens being negatively impacted by human-driven climate change?

The objective of our report is to compile and analyze scientific data to answer this question. To meet this objective, we gathered data from various sources, including government agencies, universities, and peer-reviewed papers.

Based on these scientific data, the key findings of our study are as follows:

Temperature: Temperatures in Colorado have fluctuated since the late 1800s, alternating between periods of warming and cooling. Since the mid-1970s, Colorado's annual average temperature saw a modest increase, with temperatures during the 2020s comparable to those from past decades and from the late 1800s to the early 1900s, which indicates that Colorado is not warming dangerously. This modest warming can be attributed to the prominent increase in the annual average minimum temperatures during this time, as recent values of the annual average maximum temperatures are comparable to those from past decades and from the late 1800s to the early 1900s, despite its increase since the 1990s. In other words, the annual average temperature in Colorado is increasing because the cold temperatures are becoming less cold, and not because hot temperatures are becoming hotter.

Heat waves and cold waves: The number of hot days in Colorado with temperatures at or above 95 °F (35 °C) has been decreasing since its peak in the 1930s, which means that heat waves are not becoming more frequent in Colorado. Similarly, since its peak in the 1920s, the number of cold days in Colorado with temperatures of or below 0 °F (-17.8 °C) has been decreasing, which means that cold waves are not becoming more frequent. This development is beneficial for people, as there are significantly more deaths from cold than heat, as well as for agriculture, as warming extends the length of growing seasons, allowing for more plantings. Despite the modest warming, Colorado has experienced a slight increase in snowfall.

Precipitation and drought: The annual precipitation in Colorado is dynamic, with significant fluctuations year-to-year, but overall, the annual precipitation in Colorado shows no indication of a decreasing trend, as recent values are comparable to those from past decades. Therefore, Colorado is in no danger of a precipitation-driven drought. Since 1895, Colorado has been alternating between dry and wet periods. Dry periods since 1999 can be partially explained by natural phenomena in the Pacific Ocean, namely El Niño and La Niña.

Natural disasters: Wildfires, tornadoes, and winter storms are not becoming more frequent or severe. Except for a couple of unusual years, overall flood data do not indicate that these events are becoming more frequent or severe.

Air Quality: Air quality in Colorado has improved significantly over the years, with the concentrations of six of the seven criteria air pollutants below the limits specified by the National Ambient Air Quality Standards (NAAQS). In the case of ozone, its concentration is near the limit specified by NAAQS, which means that its concentration is not dangerously high.

Agriculture: Crop productivity is increasing in Colorado and globally due to agricultural innovation, increased carbon dioxide fertilization, longer growing seasons, CO_2-related increased drought resistance, and the use of fossil fuel-based fertilizers and pesticides.

Carbon dioxide: Carbon dioxide (CO_2) is an essential and beneficial gas for life on Earth, as plants cannot produce oxygen and food without it. Exposing plants to increasing CO_2 concentrations allows them to grow taller, produce more food, and better resist drought. CO_2 also contributes 70% to the greening of Earth, as confirmed by NASA. Colorado has enjoyed the benefits of CO_2, with its increasing yield of various crops. Finally, because the radiative forcing that causes greenhouse gas warming is nearly saturated with CO_2 at current concentrations, the warming effect of each newly added CO_2 molecule to the atmosphere is small.

Conclusions: Based on the scientific evidence presented in this report, there is no climate crisis in Colorado. Moreover, CO_2 is essential and beneficial for life on Earth. Therefore, policies to reduce CO_2 emissions are ecologically and economically destructive.

INTRODUCTION

> *The evidence that human influences have impacted the global climate system has only strengthened.* (Bolinger et al., 2024)

> *Anthropogenic climate change is increasing the overall risk of impacts across the various extreme weather and climate events and natural hazards, both globally and in Colorado …* (Bolinger et al., 2024)

> *The most important human drivers of warming are the increases in greenhouse gases, principally carbon dioxide (CO_2) and methane (CH_4) …* (Bolinger et al., 2024)

In 2024, Colorado State University's (CSU's) Colorado Climate Center published the third edition of its *Climate Change in Colorado* report (Bolinger et al., 2024). The CSU report claimed that human-caused climate change in Colorado (Figure 1) is occurring and will exacerbate the risks associated with natural disasters.

Is Colorado being endangered by man-made climate change?

The objective of this report is to answer this question by investigating the climate in Colorado through analysis of scientific data to determine if climate change is harming Colorado. These data include those from government agencies, universities, and peer-reviewed papers. The data indicate that there is no climate crisis in Colorado and that CO_2 is essential and beneficial for life on Earth.

Figure 1: *Map of the United States of America featuring Colorado.*
Image: U.S. CDC (2026)

PHYSICAL SCIENCE BASIS: CLIMATE CHANGE

COLORADO TEMPERATURE STATIONS

To determine if Colorado is experiencing dangerous, human-caused warming, we use data from the National Oceanic and Atmospheric Administration's (NOAA's) U.S. Historical Climatology Network (USHCN) (Menne et al., 2009; NOAA NCEI, 2026g). The USHCN consists of 1,218 stations located in the contiguous United States and is a subset of the NOAA Cooperative

Observer Program (COOP). The sites for these USHCN stations were selected on the basis of "spatial coverage, record length, data completeness, and historical stability."

Across Colorado, there are 24 USHCN stations that record temperature and precipitation data. The locations of these stations are shown in Figure 2.

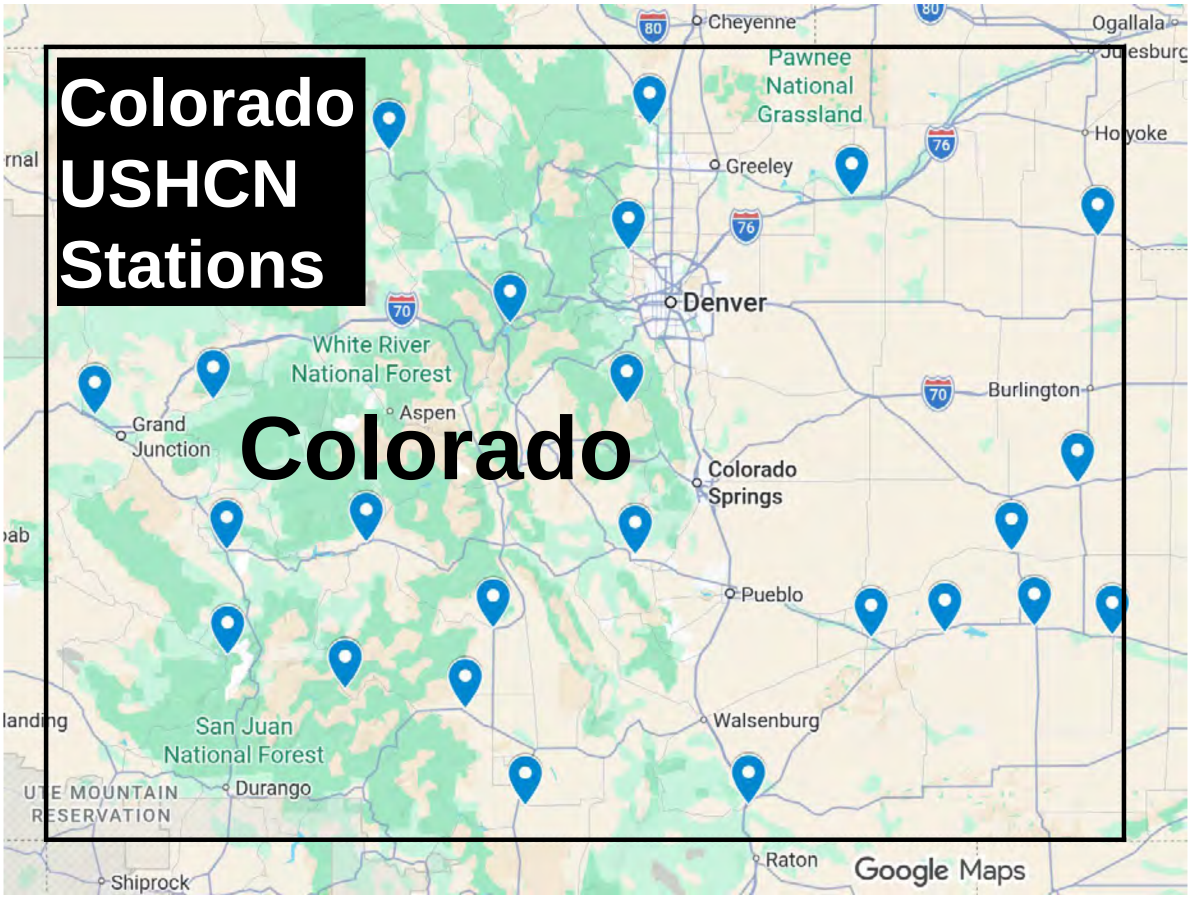


Figure 2: *Locations of the 24 USHCN temperature and precipitation stations in Colorado. NOAA NCEI (2026g)*

Temperature Adjustments and Fabrication of Data

Despite the quality of the long-term temperature data recorded by the USHCN stations, the temperatures recorded by these stations are influenced by several factors, including:

- Urban heat island effect that raises temperature readings (Spencer et al., 2025; Watts, 2022, 2026).
- Adjustments to raw temperature readings (Menne et al., 2009; NOAA NCEI, 2026g).
- Fabricated data for stations that no longer exist or are no longer reporting temperatures (Heller, 2022).

Additional discussions regarding these factors are provided in the Appendix.

Average Temperature in Colorado

According to the *Climate Change in Colorado* report (Bolinger et al., 2024):

> *The most fundamental and pervasive effect of anthropogenic (human-caused) climate change is an overall warming of the climate system.*
>
> *Statewide annual average temperatures warmed by 2.3°F from 1980 to 2022.*

To determine the validity of the above claims and figures, we will start by first discussing the data from the USHCN stations for the annual average temperature in Colorado (Figure 3).

Figure 3 confirms that, from 1980 to 2022, based on a linear regression, temperature warmed about 2.2 °F (1.2 °C), which is similar to the 2.3 °F (1.3 °C) figure by Bolinger et al. (2024). However, it should be noted that during this warming trend, the annual average temperature in Colorado peaked in 2012 and 2017, with temperatures of about 50 °F (10 °C). However, the annual average temperature during the 2020s are comparable to those from past decades and from the late 1800s to the early 1900s.

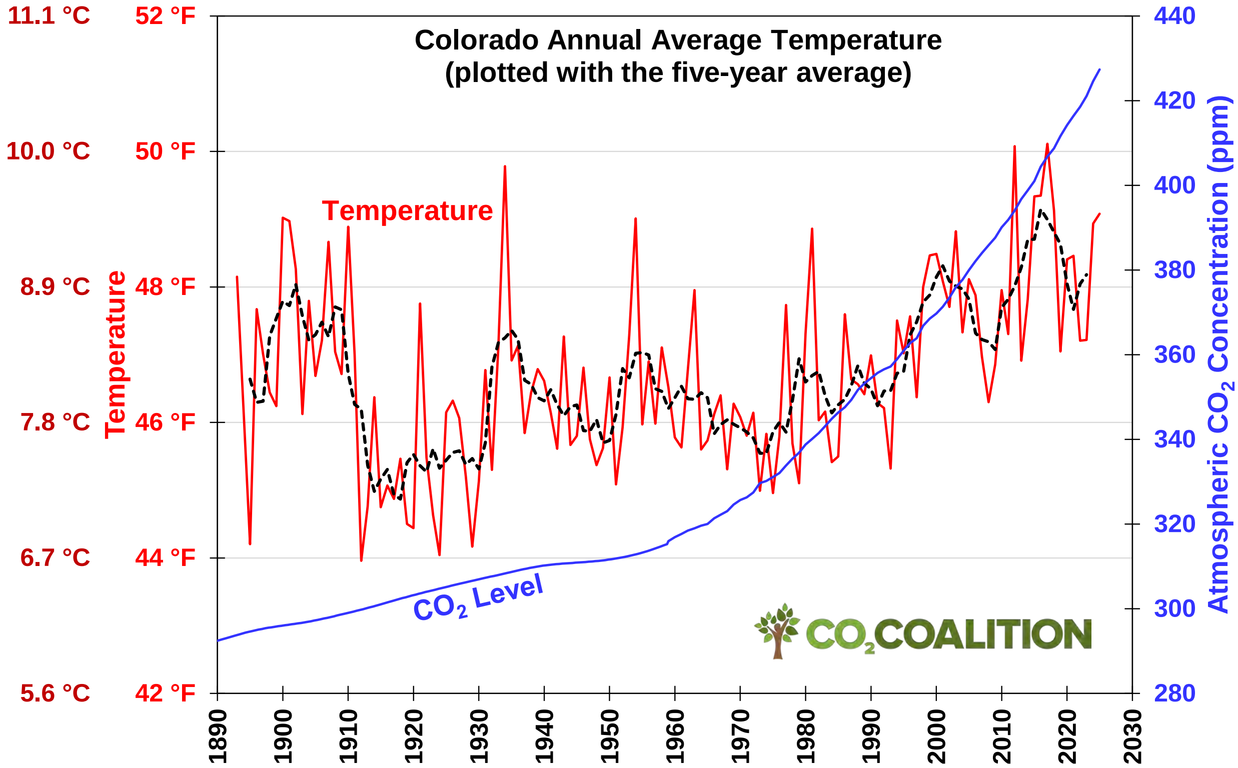


Figure 3: *Colorado annual average temperature vs. atmospheric CO_2. Temperature: NOAA NCEI (2026g); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

Importantly, the report by Bolinger et al. (2024) omits any mention of two strong cooling periods that coincided with increasing CO_2 levels. A cooling of about 4.6 °F (2.5 °C) occurred from 1900 to 1920, while the atmospheric CO_2 concentration increased by about 7 parts per million (ppm). The years 1900 to 1929 saw a temperature difference of -4.9 °F (-2.7 °C), while the atmospheric CO_2 concentration increased by about 11 ppm. A second much longer cooling trend (1934–1975) occurred during a period in which CO_2 levels increased by about 23 ppm, while temperatures dropped by 4.8 °F (2.7 °C).

The fact that these cooling periods occurred as the atmospheric CO_2 concentration increased calls into question the claim that CO_2 is the primary driver of temperature.

Is the recent warming unusual or unprecedented?

Not at all. In fact, the overall warming that Colorado has experienced since the late 1800s can be attributed to the recovery from the cold period known as the Little Ice Age (A.D. 1250 to 1850). For instance, the Central England Temperature (CET) series (Figure 4), the longest instrumental temperature record available (Met Office Hadley Centre for Climate Change, 2026), with data going back as far as the Maunder Minimum, a period of extreme cold within the Little Ice Age, confirm that the current warming trend began more than 300 years ago.

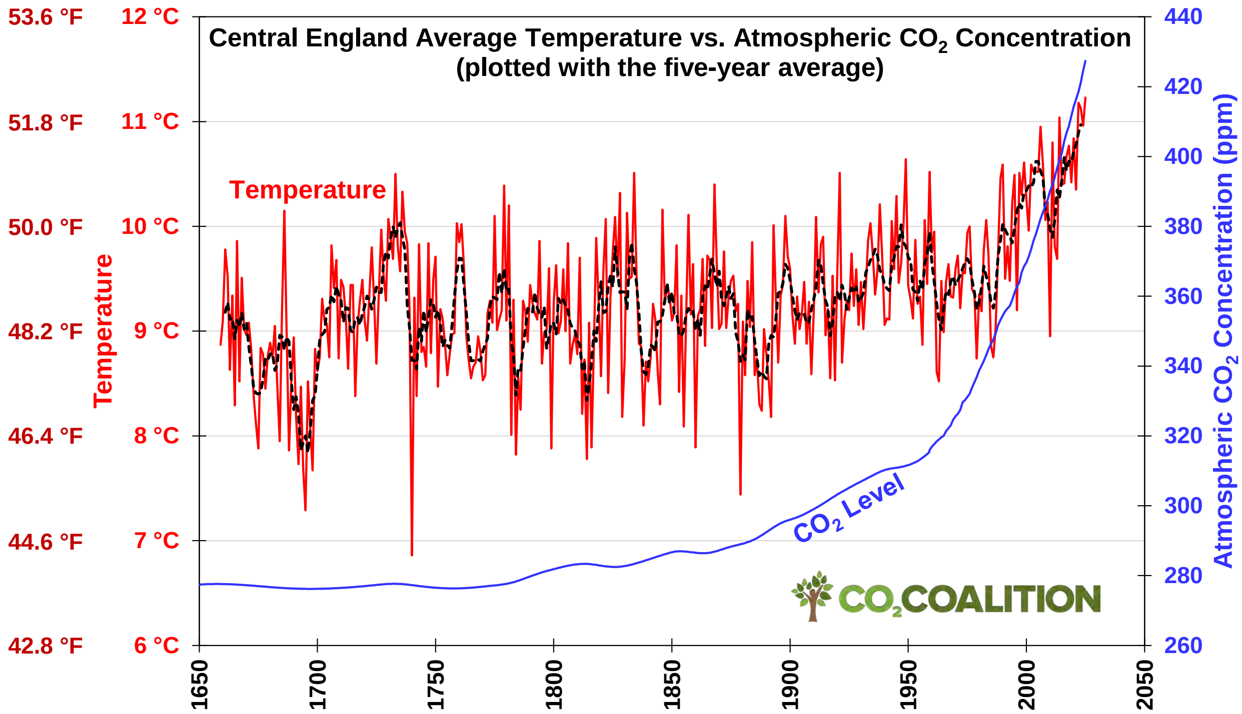


Figure 4: *Annual average temperature in Central England vs. atmospheric CO_2. Temperature: Met Office Hadley Centre for Climate Change (2026); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

The highest rate of warming in the record occurred in the period from 1695 to 1733. Notice that this temperature increase, which can be seen as a foreshadowing of the warming that was to come, occurred during a time when the atmospheric CO_2 concentration was very low, at an average of about 277 ppm, i.e., about more than 150 ppm lower than today's value. Therefore, the modern temperature increase cannot be attributed solely to the rising concentration of atmospheric CO_2 from anthropogenic activities.

To put into perspective the warming that occurred starting in the late 1600s, let us look at longer-term data that span thousands of years. Figure 5 shows the temperature variation for the past 4,000 years in Central Greenland. Before the sharp rise in the atmospheric CO_2 concentration that began during the late 1700s, the atmospheric CO_2 concentration remained below 290 parts per million (ppm) since 2000 B.C. Yet, despite the lower atmospheric CO_2 concentration before the late 1700s, the temperature fluctuated, alternating between warm and cold periods. The fact that periods of warming occurred during times of lower atmospheric CO_2 concentration refutes claims that current warming is unprecedented and that CO_2 is responsible for dangerous warming.

Is the recent warming harmful?

Not at all. If anything, it is beneficial. For starters, history tells us that civilizations thrived during warm periods (Bronze Age, Iron Age, and High Middle Ages) (Figure 5). In fact, historians refer to these warm periods as "climate optima." In contrast, civilizations crumbled during cold periods (Greek Dark Ages, Dark Ages, and Little Ice Age) (Figure 5), as these cold periods brought about "crop failure, famine, pestilence, disease, mass depopulation and societal collapse" (Wrightstone, 2023).

Recent data support historical records that warmth is better than cold. For instance, during 2000–2019, worldwide deaths due to cold exceeded heat-related deaths by more than nine times (Figure 6); while in North America, the number of cold-related deaths are about 8.5 times greater than the number of heat-related deaths. The fact that cold has killed significantly more people than heat suggests that there is no need to fear more warmth. If anything, a cooling temperature would be more concerning.

In addition to potentially reducing the proportion of cold-related deaths, a warming temperature also extends the length of growing seasons (which is affected by temperature, frost days, precipitation, and daylight hours) (U.S. EPA, 2025a). This development benefits agriculture, as killing frosts end earlier during spring seasons and arrive later during fall seasons, giving farmers opportunity for more plantings and a decrease in the risk of late-spring killing frosts.

As shown in Figure 7, the length of the growing season of crops in western United States, which encompasses Colorado, has increased by more than three weeks since 1895. Further discussions regarding agriculture are provided in a later section.

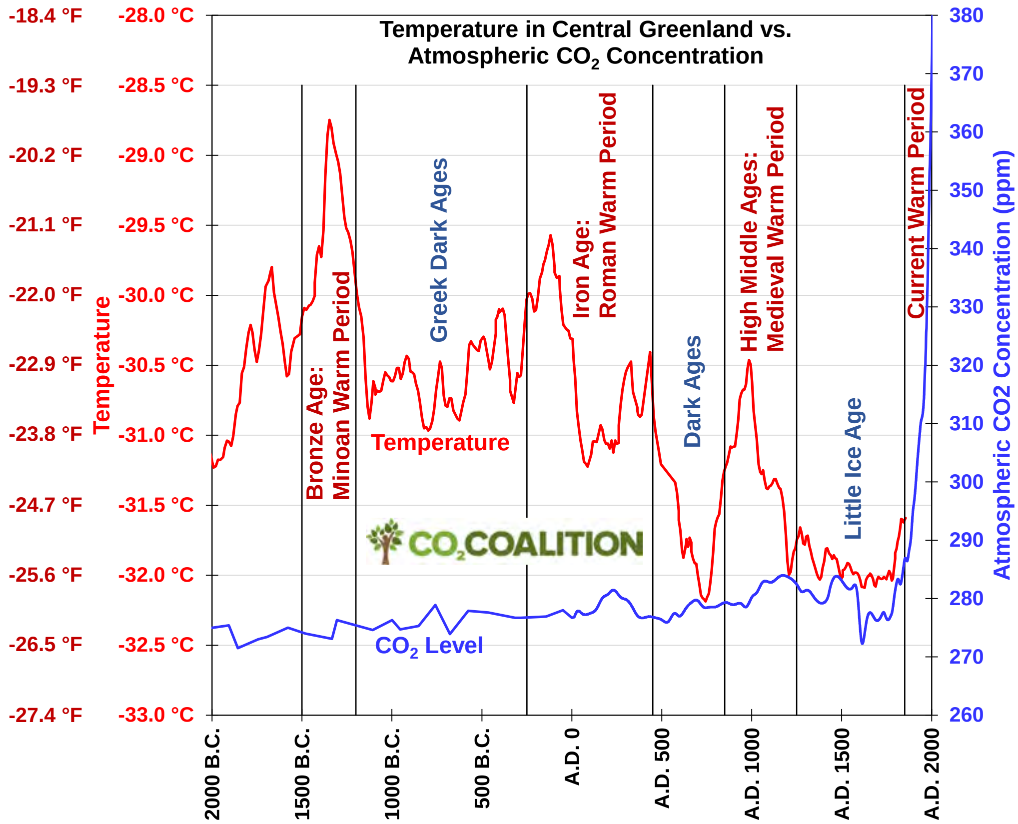


Figure 5: *~ 4,000 years of varying temperature in Central Greenland vs. atmospheric CO_2. Temperature: Alley (2004); CO_2 concentration (A.D. 1 and before): Bereiter et al. (2015a); CO_2 concentration (after A.D. 1 and before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

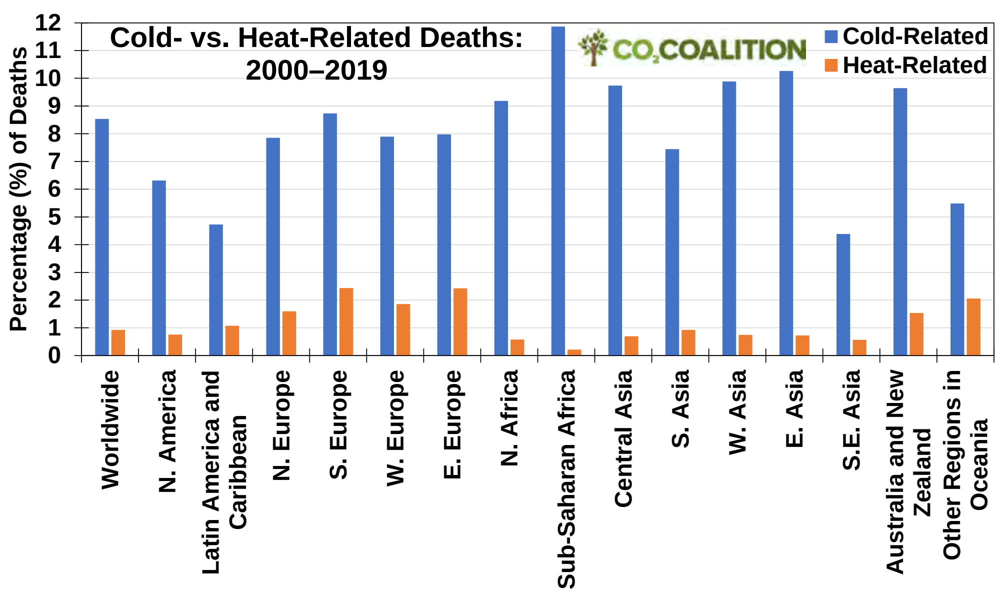


Figure 6: *Worldwide cold-related vs. heat-related deaths during 2000–2019. Zhao et al. (2021)*

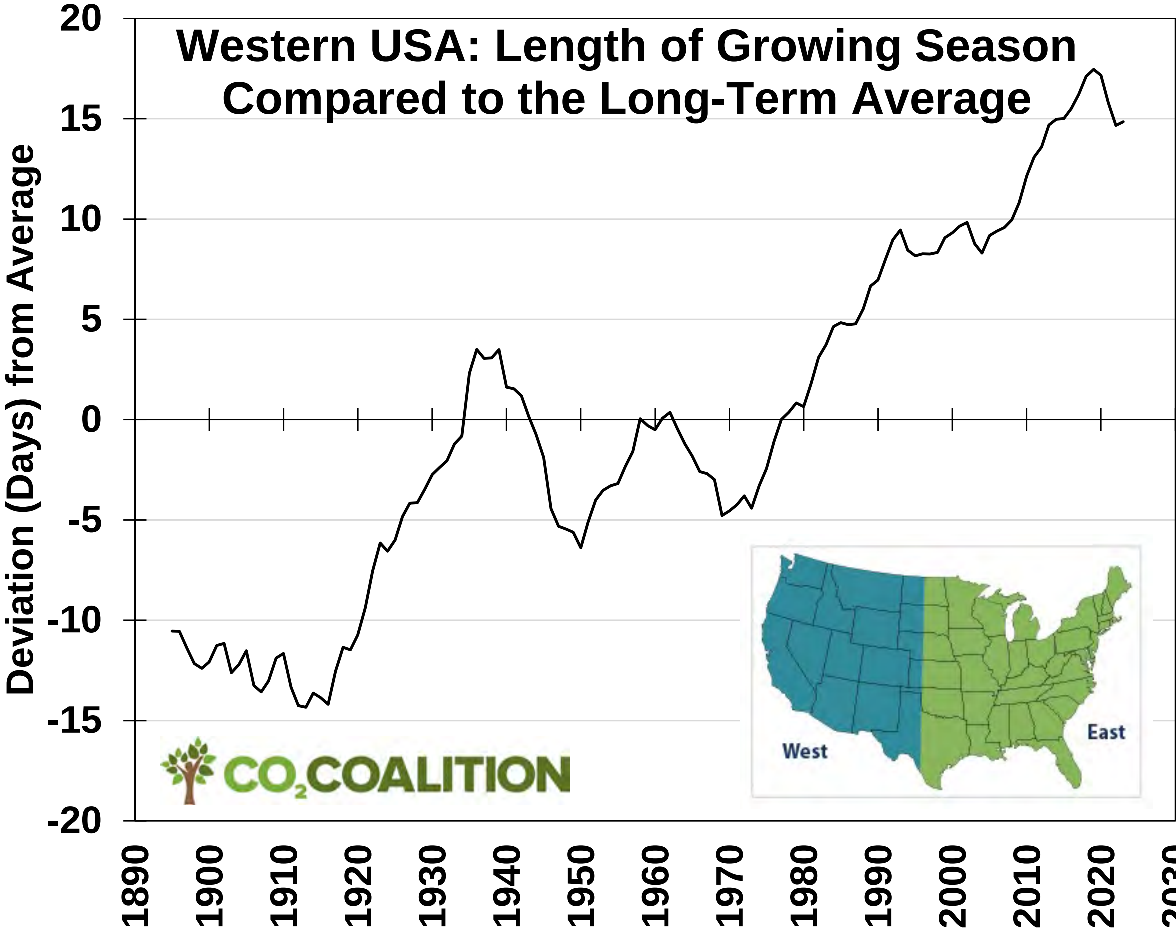


Figure 7: *Length of growing season of crops in western United States. U.S. EPA (2025a)*

Temperatures: Model Predictions vs. Data

> *The observed warming over the last 20 years is comparable to what was projected by earlier climate models run in the 2000s.* (Bolinger et al., 2024)

To determine if climate models are reliable, let us look at a comparison of the model predictions against data. Figures 8 and 9 compare the average worldwide temperature and the average rate of summer temperature increase in the U.S. Corn Belt, respectively, from the 1970s to 2022, against the predictions from 36 climate models. Figure 8 shows that as the years progress, the overestimation produced by the climate models becomes worse, while Figure 9 shows that 34 of the 36 climate models overestimate the warming by more than twice the observed value.

Given that we cannot correctly predict the temperature just days into the future, it is not surprising that climate models cannot accurately predict the temperature decades into the future. Therefore, climate models should not be used to make claims regarding the climate, let alone formulate climate policies.

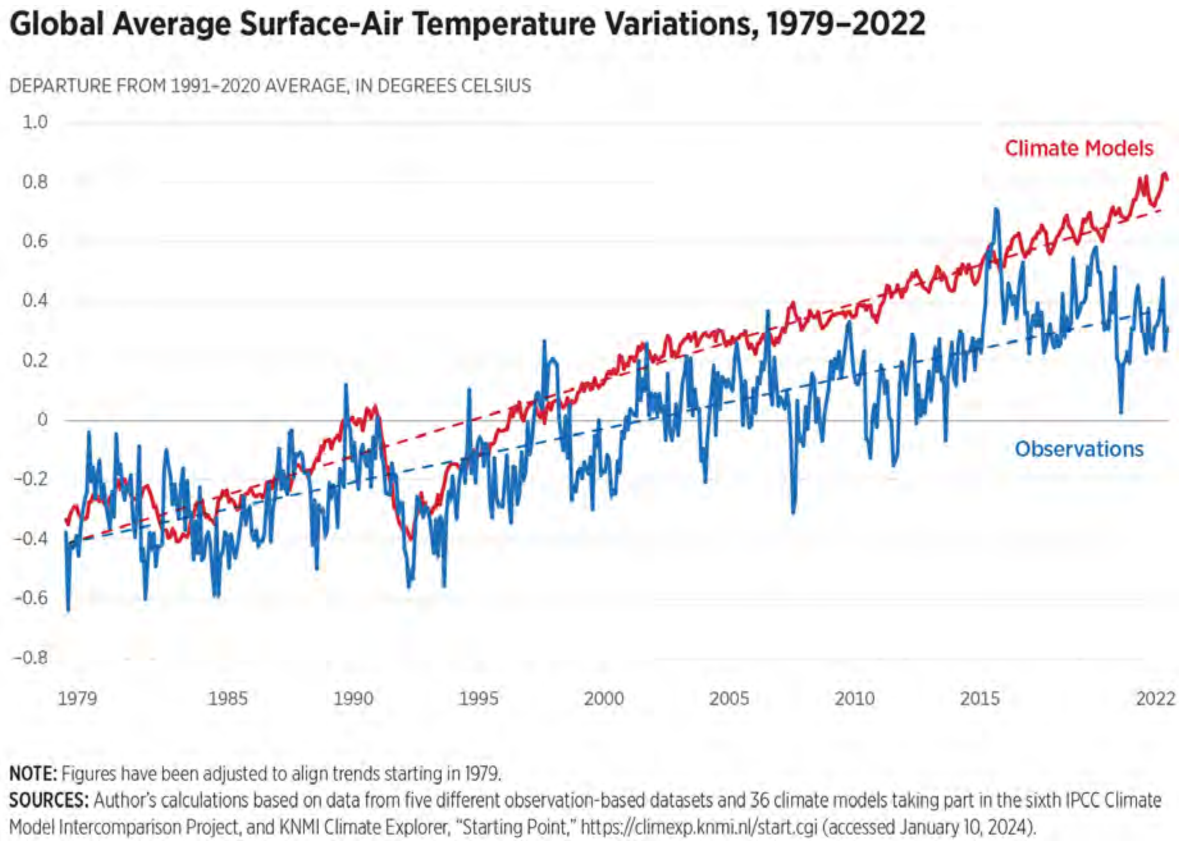


Figure 8: *Average global temperature anomaly during 1979–2022 recorded in five data sets vs. the average predictions from 36 climate models. Spencer (2024)*

Cold and Hot Temperatures in Colorado

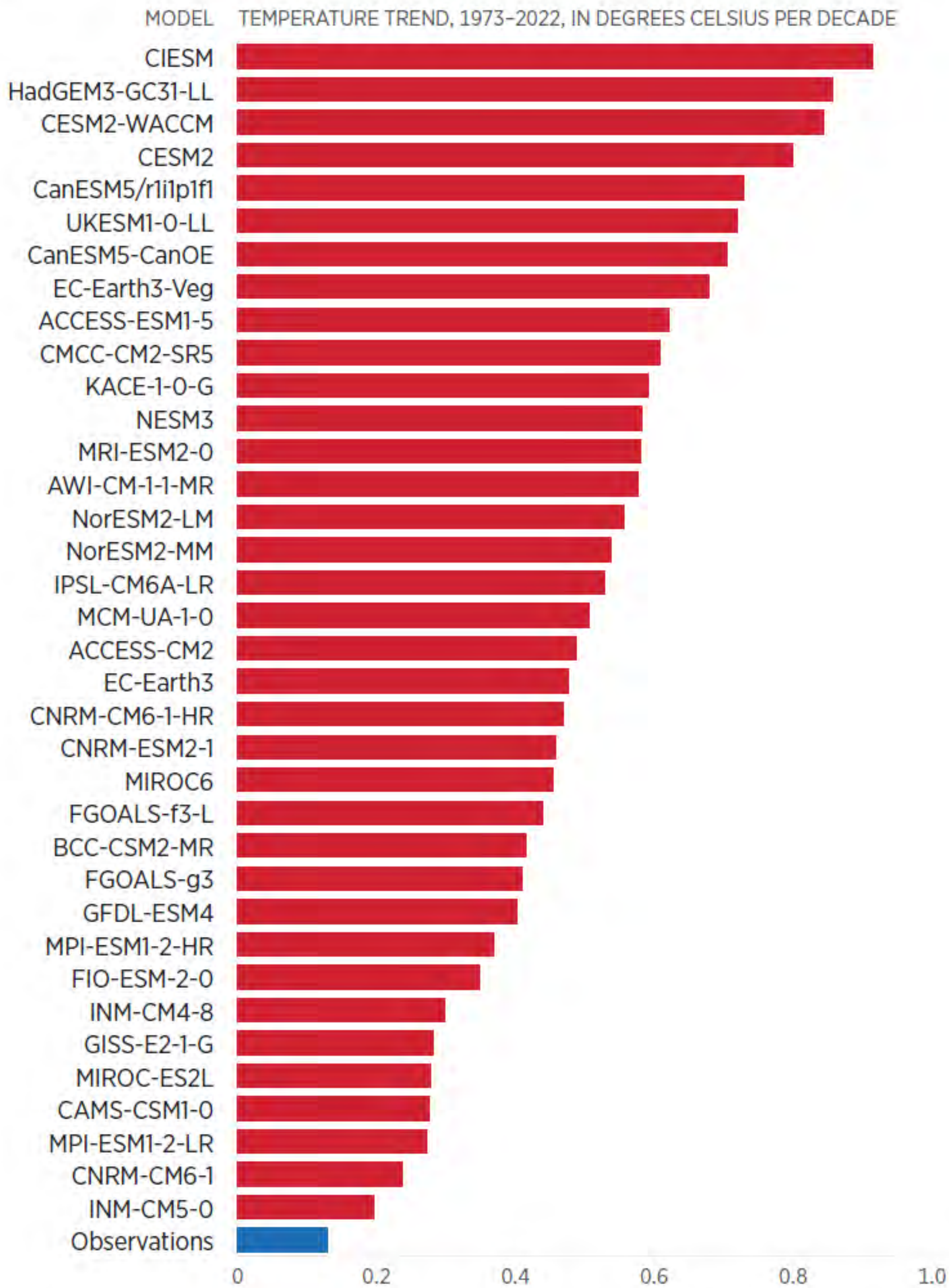
According to the *Climate Change in Colorado* report:

> *Hot days and heat waves have become more common, and the number cold nights and cold waves has decreased across Colorado in recent decades, but the changes have not been equal.*
>
> *Several notable and high impact winter storm events have occurred over eastern Colorado in the last decade, including extreme cold, high winds, strong cold fronts, and large accumulations of snow.*
>
> *Future warming will lead to further reductions in Colorado's spring snowpack.*

Similar to the annual average temperature (Figure 3), the annual average minimum temperature in Colorado (Figure 10) saw a dip from 1901 to 1924, and another period of cooling from 1934 to 1975. Once again, these periods of cooling temperatures occurred as the atmospheric CO_2 concentration increased, contradicting claims that increasing CO_2 is the primary driver of modern warming.

Climate Models Vastly Overstated Warming

The observed 12–state U.S. Corn Belt summer temperature trend for 1973–2022 is considerably less than that produced by all 36 climate models used to promote changes in U.S. energy policy.



SOURCES: Author's calculations based on data from five different observation-based datasets and 36 climate models taking part in the sixth IPCC Climate Model Intercomparison Project, and KNMI Climate Explorer, "Starting Point," https://climexp.knmi.nl/start.cgi (accessed January 10, 2024).

Figure 9: *Average rate of summer temperature increases in the U.S. Corn Belt during 1973–2022 recorded in five data sets vs. the average predictions from 36 climate models. Spencer (2024)*

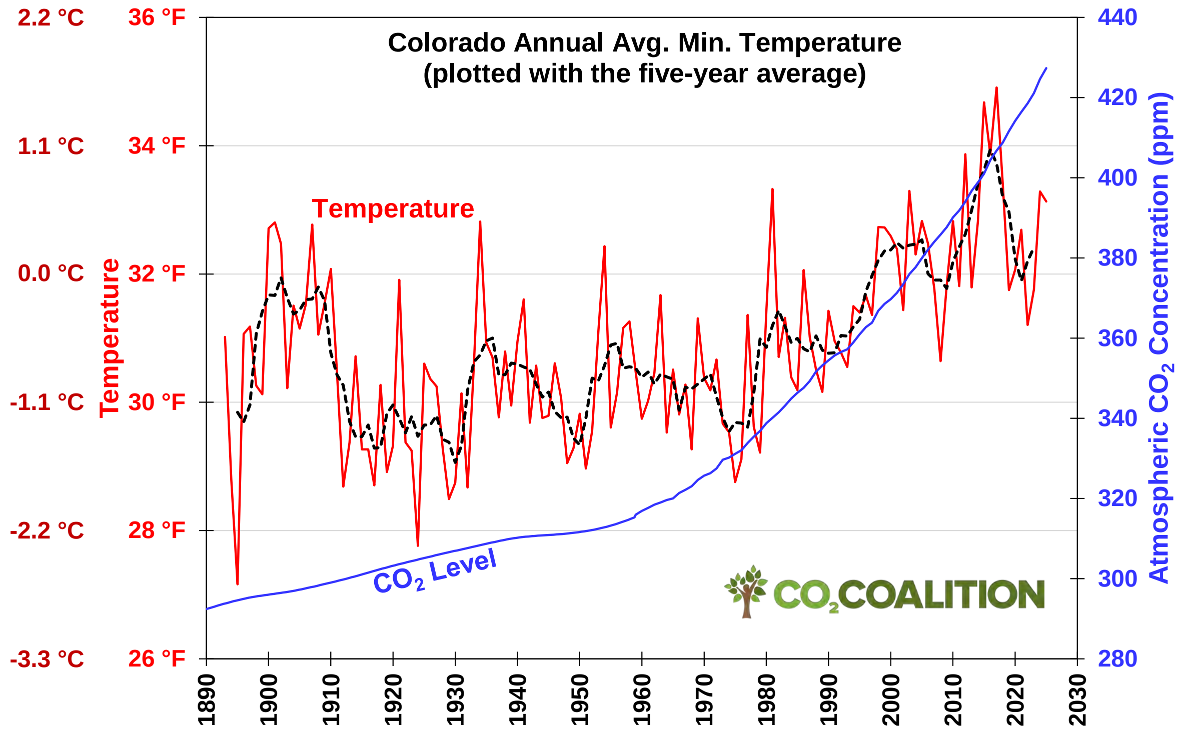


Figure 10: *Colorado annual average minimum temperature vs. atmospheric CO_2. Temperature: NOAA NCEI (2026g); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

However, compared to the annual average temperature (Figure 3), the increase in the annual average minimum temperature (Figure 10) since 1975 is more prominent, where the annual average minimum temperature in 2025 was about 4.4 °F (2.4 °C) warmer than that in 1975. As discussed in the previous section on the Colorado average temperature, rather than being detrimental, this increase in minimum temperature is a positive development, as this directly leads to a decrease in cold-related mortality and a beneficial extension of growing seasons.

Looking at temperatures at the other end of the spectrum, Figure 11 shows the annual average maximum temperature in Colorado. Similar to the annual average and annual average minimum temperatures, the annual average maximum temperature saw a dip in the early 20th century (1900 to 1912). However, the annual average maximum temperature was at its hottest in 1934, and this peak in temperature was followed by a decline lasting more than 50 years. These two periods of cooling occurred as the atmospheric CO_2 concentration increased, providing additional data that dispute the contention that CO_2 is the "control knob" for temperature.

It is also worth noting that despite its increase since 1993, recent values of the annual average maximum temperature in Colorado are comparable to those from past decades and from the late 1800s to the early 1900s. Therefore, hot temperatures in Colorado are not unusual and are not increasing at a dangerous rate.

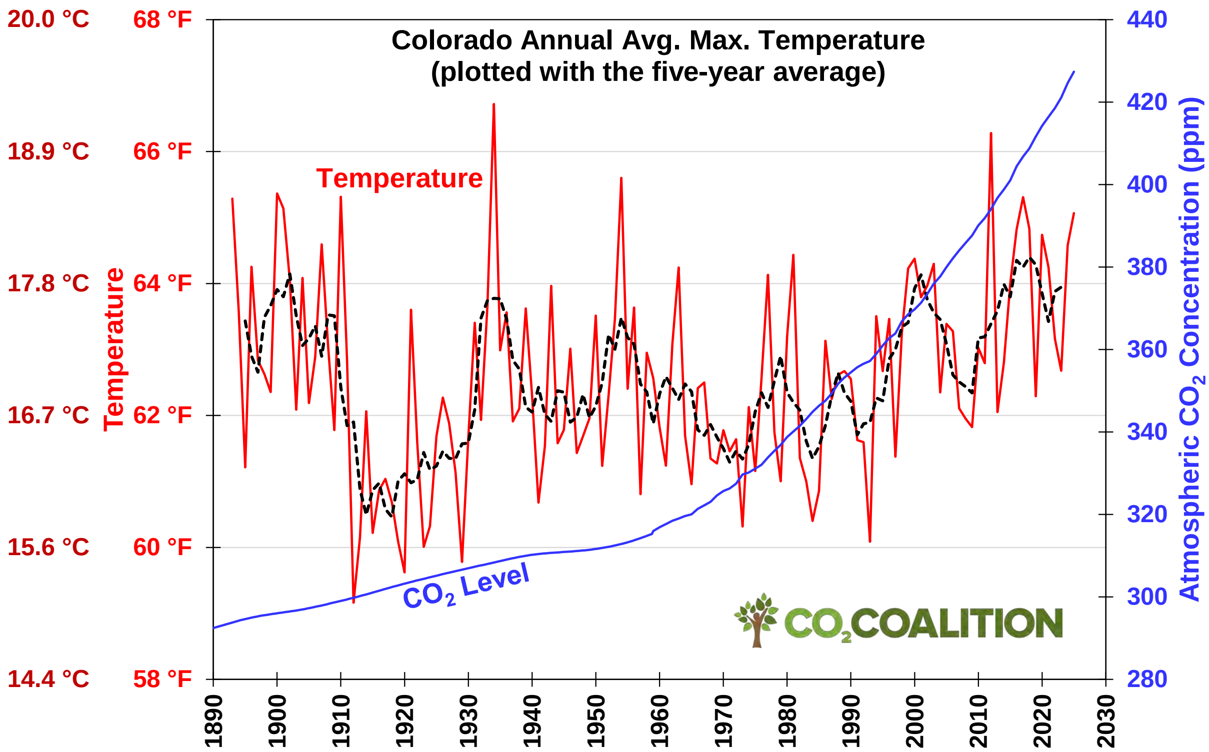


Figure 11: *Colorado annual average maximum temperature vs. atmospheric CO_2. Temperature: NOAA NCEI (2026g); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

Note that the annual average minimum temperature has warmed at a faster rate (0.061 °F/year since 1975) than the annual average maximum temperature (0.051 °F/year since 1993) during recent decades. This indicates that the increase in the annual average temperature in Colorado is driven primarily by cold temperatures becoming less cold, rather than warm temperatures becoming hotter.

In terms of hot days and heat waves vs. cold nights and cold waves, Bolinger et al. (2024) used 95 °F (35 °C) and 0 °F (-17.8 °C) as the thresholds, respectively. Therefore, we have used the same thresholds. To determine the annual number of hot days and cold nights in Colorado, we turn to the data from the Global Historical Climatology Network daily (GHCNd) stations (NOAA NCEI, 2026e), which integrate daily climate data from global land surface stations. The 24 GHCNd stations that were selected for this report are at the same sites as the USHCN stations in Colorado (Figure 2), with very similar values of latitude, longitude, and elevation.

Figure 12 shows the annual number of hot days in Colorado with temperatures of or above 95 °F (35 °C). Similar to the annual average maximum temperature, the annual number of hot days in Colorado peaked in the 1930s. Afterwards, the annual number of hot days has declined significantly. Therefore, any claim that heat waves are worsening or becoming more frequent in Colorado is false.

As for extreme cold in Colorado, Figure 13 shows the annual number of very cold nights in Colorado with temperatures at, or below 0 °F (-17.8 °C). The annual number of very cold nights in Colorado peaked in 1923 and has been declining since then. This trend is not surprising, given the increase in the annual average minimum temperature in Colorado (Figure 10).

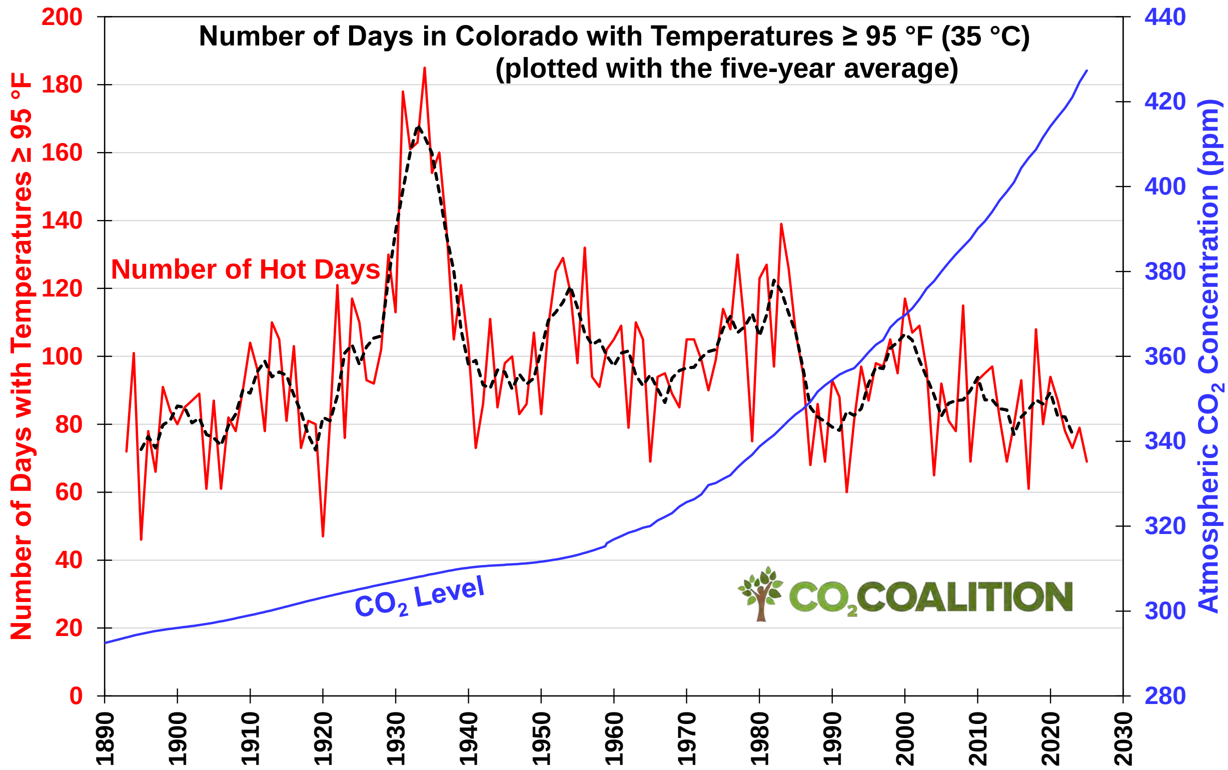


Figure 12: *Annual number of hot days in Colorado vs. atmospheric CO_2. Temperature: NOAA NCEI (2026e, 2026g); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

With the increase in the annual average minimum temperature (Figure 10) and annual number of cold nights (Figure 13) in Colorado, it should come as no surprise that the frequency of winter storms in Colorado has had an overall decreasing trend since in recent decades (Figure 14). Thus, the increase in the minimum temperature has reduced the threat of winter storms affecting Colorado.

Annual snowfall data (Figure 15) for Boulder, Colorado, contradict claims of a decline in spring snowpack. These data document that, while snowfall in Boulder is highly dynamic, it has, in fact, been steadily increasing since the early 20th century. This development is indeed good news for snow and ski enthusiasts.

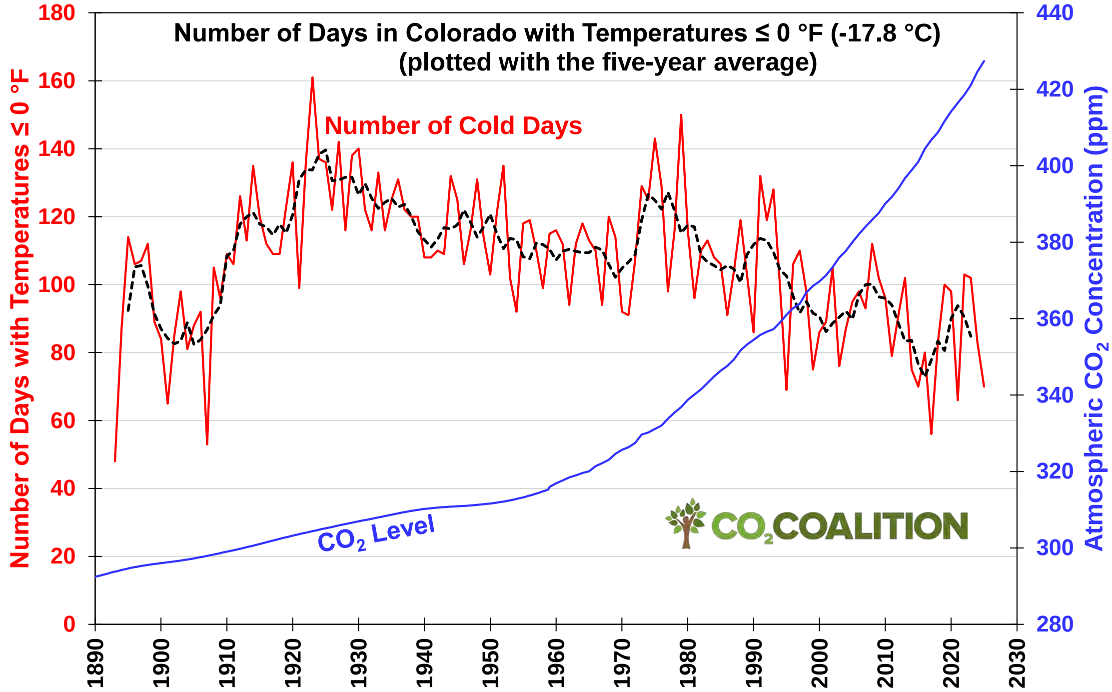


Figure 13: *Annual number of cold nights in Colorado vs. atmospheric CO_2. Temperature: NOAA NCEI (2026e, 2026g); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

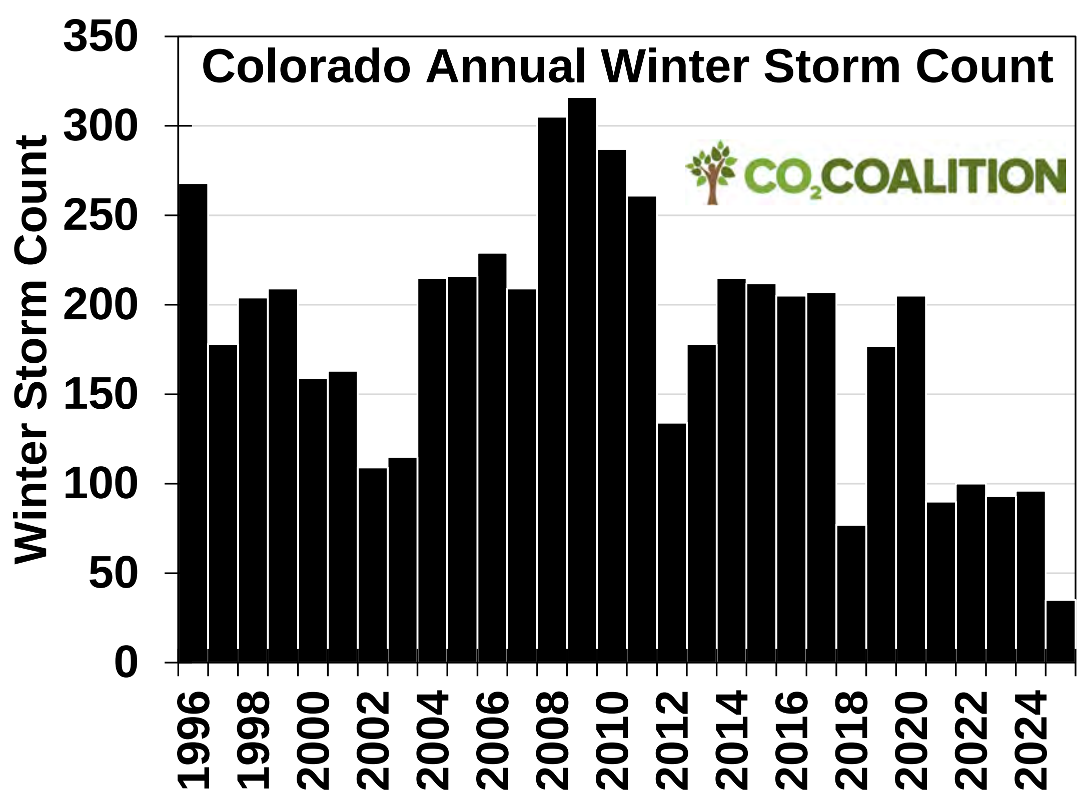


Figure 14: *Annual number of winter storms in Colorado. NOAA NCEI (2026f)*

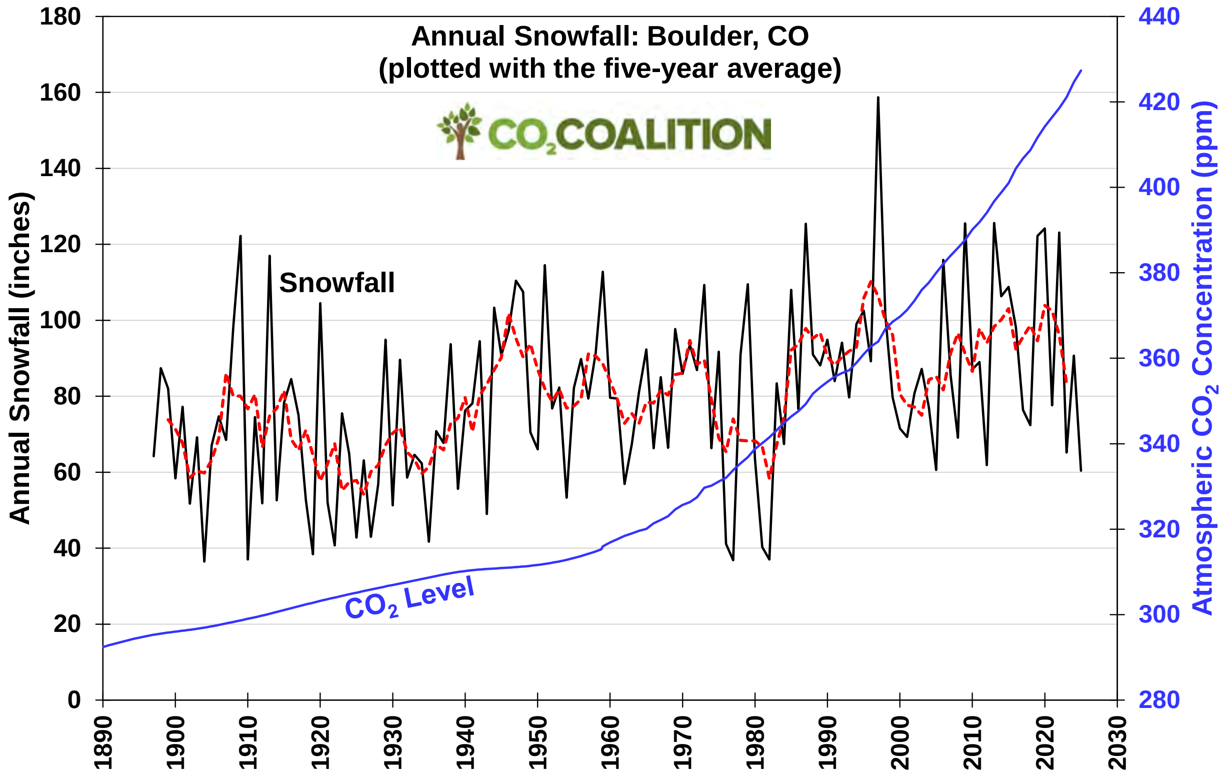


Figure 15: *Annual snowfall in Boulder, Colorado, vs. atmospheric CO_2. Snowfall: NOAA PSL (2026); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

EXTREME WEATHER EVENTS

Precipitation, Drought, and Floods

> *Colorado has observed persistent dry conditions in the 21st century. According to water year precipitation accumulations, October 1 – September 30, four of the five driest years have occurred since 2000.* (Bolinger et al., 2024)

According to the World Meteorological Organization (WMO, 2021), drought was the natural disaster that resulted in the highest number of fatalities from 1970 to 2019, claiming 650,000 lives. In addition to the human lives lost, the Food and Agriculture Organization of the United Nations (FAO, 2021) reported that from 2008 to 2018, agriculture bears 82% of the brunt from drought, costing $37 billion.

To determine if droughts are becoming worse in Colorado, we examined precipitation data (Figure 16). Annual precipitation in Colorado fluctuates greatly, but recent values are comparable to those from past decades and there is no long-term trend of either increasing or decreasing precipitation.

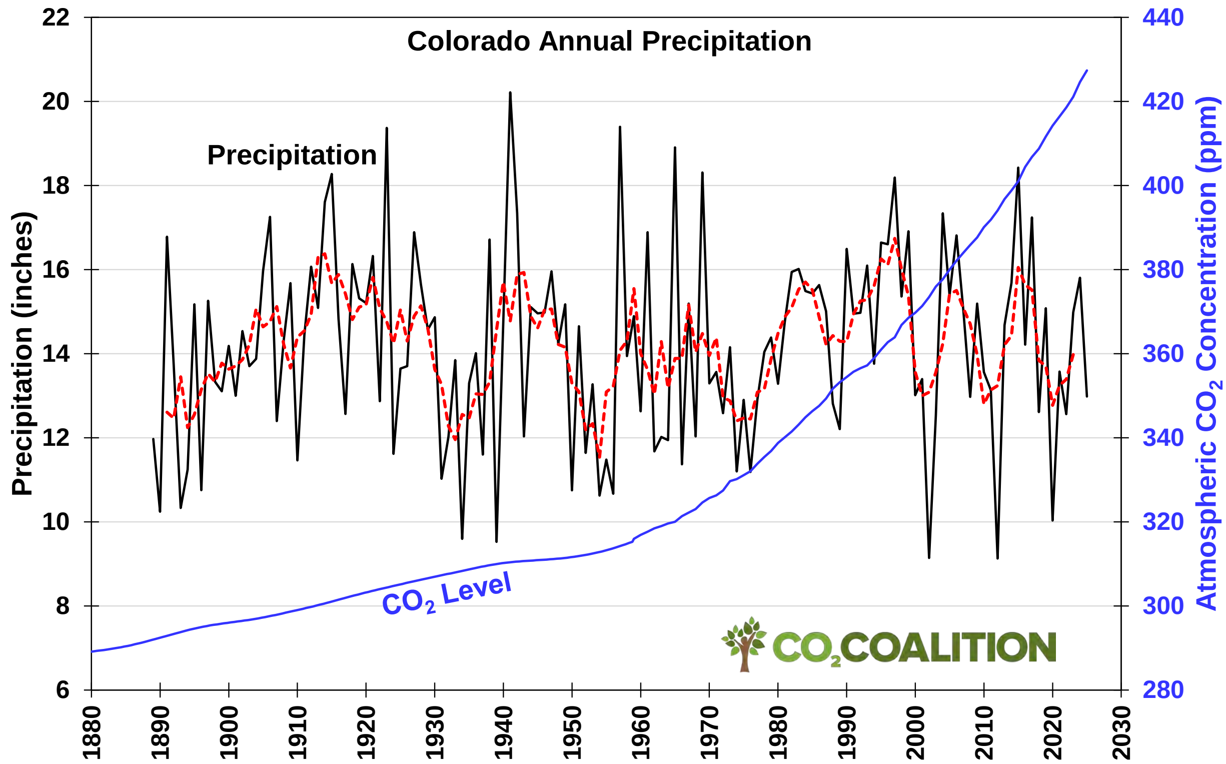


Figure 16: *Colorado annual precipitation vs. atmospheric CO_2.*
Precipitation: NOAA NCEI (2026g); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)

In addition to the annual precipitation, another metric used to measure drought is the Palmer Drought Severity Index (PDSI), which estimates relative soil moisture using simplified soil water balance (NOAA NIDIS, 2026). Positive and negative PDSI values indicate wet and dry conditions, respectively, with PDSI > 4 indicating "very wet conditions," and PDSI < -4 indicating "extreme drought."

Figure 17 shows the monthly PDSI values for Colorado. Since 1895, Colorado has been alternating between dry and wet periods. Over the last 20-plus years, Colorado has experienced more dry conditions than wet, but these recent years are very similar to conditions that were recorded in the period from the 1930s to late 1970s at low CO_2 levels.

If CO_2 cannot explain these droughts, then, what could be the cause of these droughts?

The answer is in the Pacific Ocean.

In the Pacific, under normal conditions, trade winds blowing westward in the Equatorial region push warm surface waters from South America towards Asia (NOAA National Ocean Service, 2024). Upwelling takes place as a result, where cold water rises from the depths to replace the warm water.

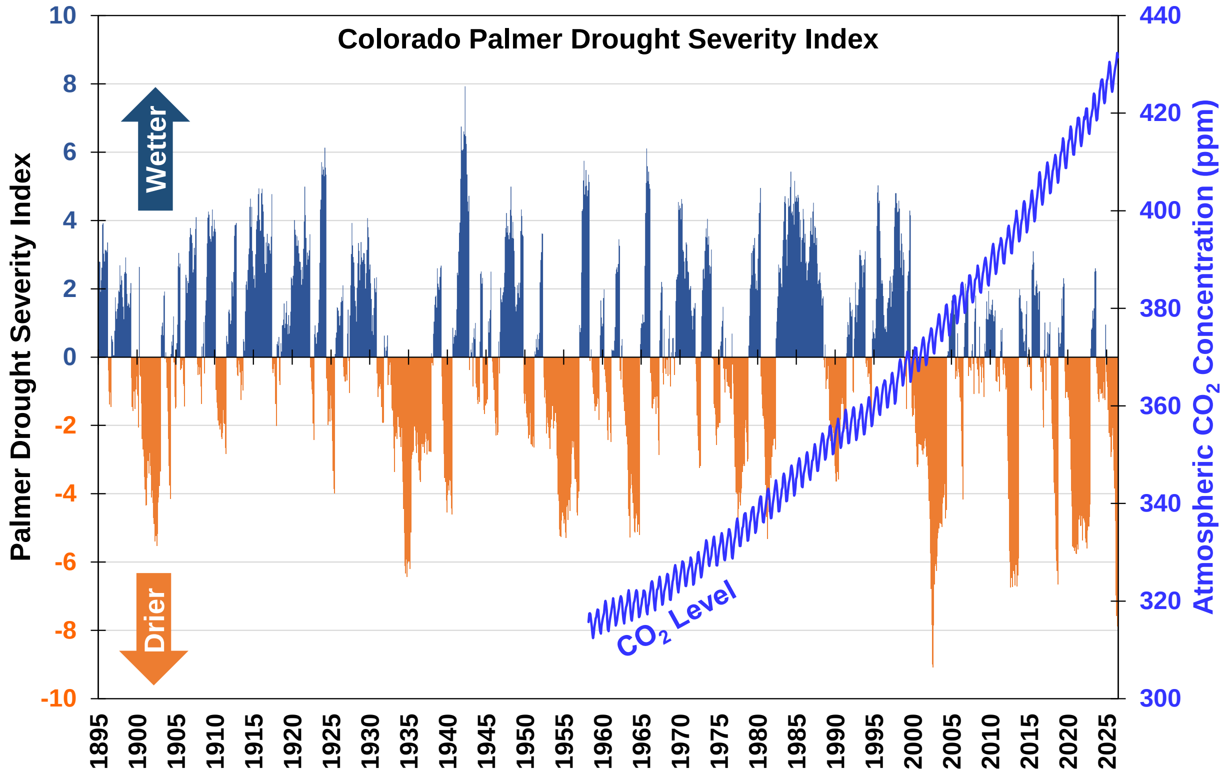


Figure 17: *Monthly Palmer Drought Severity Index (PDSI) for Colorado vs. atmospheric CO_2. PDSI: NOAA NCEI (2026a); CO_2 concentration: Lan and Keeling (2026)*

El Niño and La Niña are natural phenomena that break this cycle (Figure 18). These phenomena are referred to as the El Niño-Southern Oscillation (ENSO) cycle (NOAA Climate.gov, 2025; NOAA National Ocean Service, 2024). El Niño and La Niña occur every 2 to 7 years, without following any pattern, and these phenomena typically last 9 to 12 months, but can sometimes last for years. In the Northern Hemisphere, the effects of El Niño and La Niña are more prominent in the winter than in the summer (Figure 18).

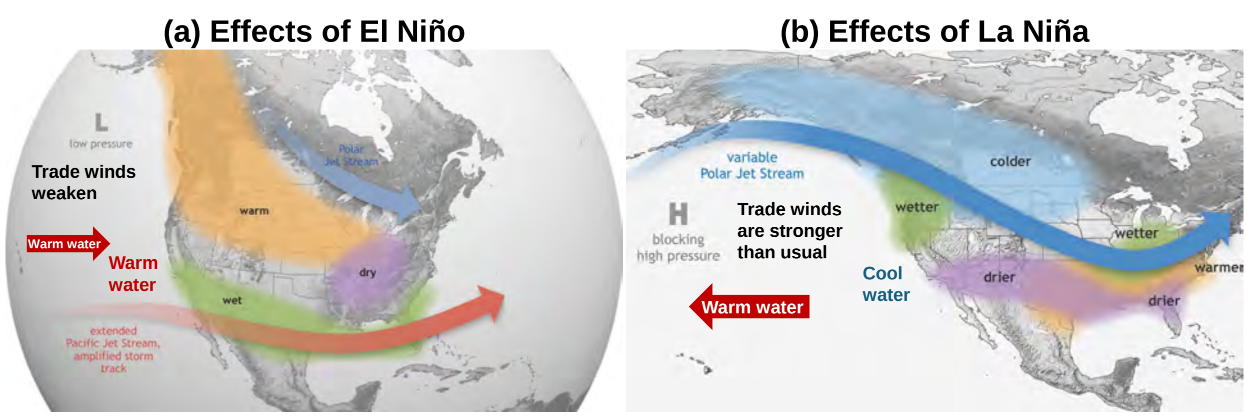


Figure 18: *Effects of: (a) El Niño and (b) La Niña on the climate in North America. NOAA National Ocean Service (2024)*

To determine if there are El Niño or La Niña conditions, the Southern Oscillation Index (SOI) is used (NOAA NCEI, 2026c). Negative SOI values occur when eastern tropical Pacific waters are warm (which corresponds to El Niño), and positive SOI values take place when eastern tropical Pacific waters are cold (which corresponds to La Niña) (NOAA NCEI, 2026c).

Figure 19 compares the PDSI values for Colorado against the SOI, with latter data available from 1951 onward. Notice that from 1951 onward, dry periods in Colorado tend to occur during La Niña, while wet periods tend to occur during El Niño, which is consistent with Figure 18. These observations suggest that, rather than the atmospheric CO_2 concentration controlling precipitation and drought, El Niño and La Niña can better explain the occurrences of dry and wet periods in Colorado. Bolinger et al. (2024) also noted this relation:

> *Colorado's precipitation variability is partially modulated by the El Niño-Southern Oscillation (ENSO).*

As natural phenomena, El Niño and La Niña are beyond our control, making Colorado droughts uncontrollable. Therefore, drought preparedness and mitigation should be a priority. Attempting to alter the climate by reducing CO_2 is futile and foolish.

Having discussed drought, let us now shift to the opposite end of the spectrum, namely, floods.

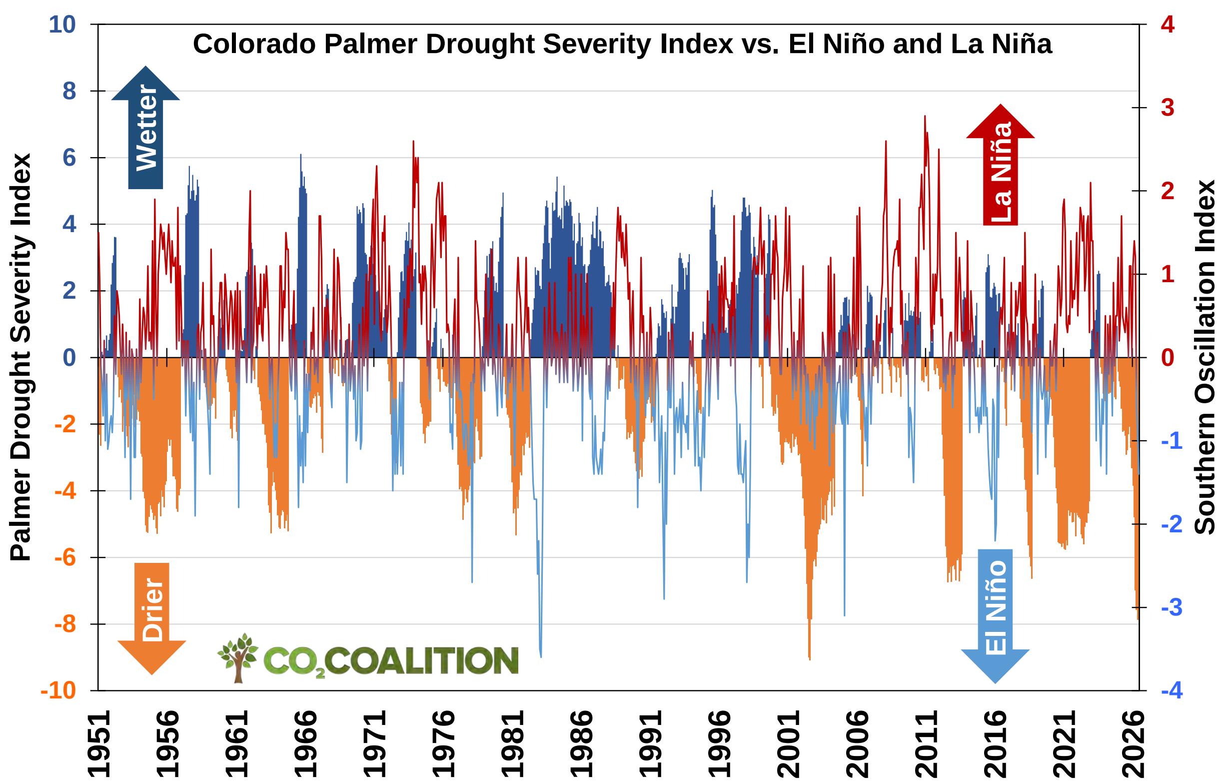


Figure 19: *Monthly Palmer Drought Severity Index (PDSI) for Colorado vs. Southern Oscillation Index (SOI). PDSI: NOAA NCEI (2026a); SOI: NOAA NCEI (2026c)*

Figures 20 and 21 show the annual reported number of floods and flash floods in Colorado, respectively. These data indicate that there is no overall trend of increased flooding, except for the high flood count in 2023 and the high flash flood count in 2013.

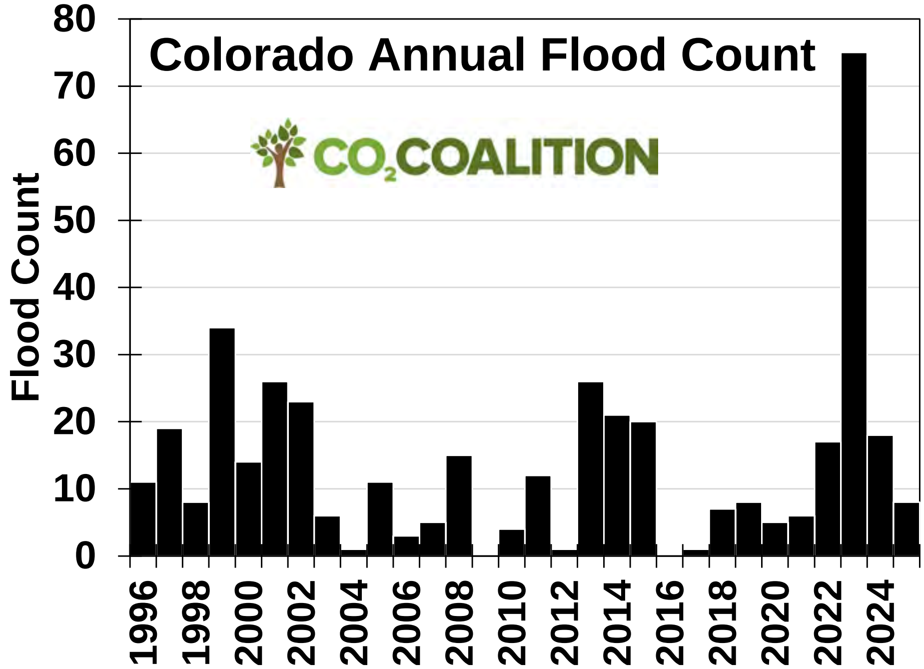


Figure 20: *Annual flood count in Colorado. NOAA NCEI (2026f)*

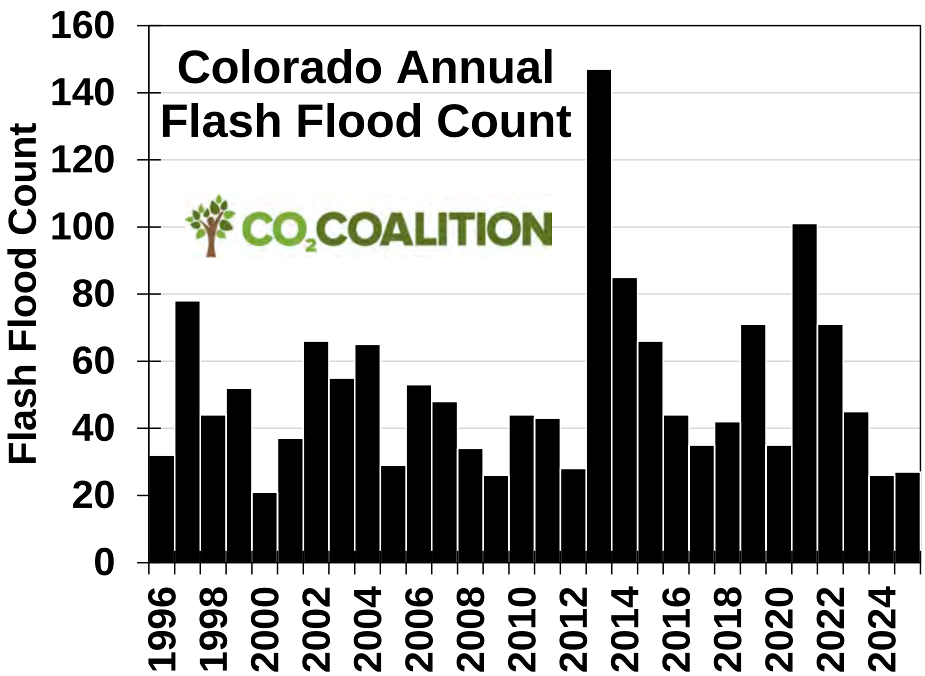


Figure 21: *Annual flash flood count in Colorado. NOAA NCEI (2026f)*

Are the exceptionally high flood counts in the 2013 and 2023 unusual or unprecedented?

Not at all.

For instance, Boulder experienced flooding in 1894, 1896, 1906, 1916, 1921, 1938, and 1969, with the 1894 and 1969 floods being the worst (Scott and Masters, 2013). These records indicate that floods have occurred time and time again in Colorado, which indicates that the flooding events that occurred in recent years are not unprecedented. Therefore, flood mitigation and flood preparedness, rather than attempting to alter the climate, should be prioritized to reduce the damage caused by floods.

Wildfires

> *Since 2000, Colorado has experienced a large increase in the number of large wildfires and in the annual area burned by all wildfires; on average, fires have burned at higher elevations and with higher intensity than in the late 20th century. While several factors have contributed to these trends, rising temperatures are a major driver.* (Bolinger et al., 2024)
>
> *Wildfire activity (both acres burned and number of fires) is expected to increase with climate change.* (Bolinger et al., 2024)

Are wildfires really getting worse?

The data prove otherwise.

For instance, Figure 22 shows data for the frequency and area burned by wildfires in the contiguous United States. Contrary to the above claim, the area burned and number of wildfires in the United States have dropped significantly over the past century. In fact, the area burned by wildfires has dropped by 90% since its peak in 1930, and the number of wildfires has dropped by nearly 70% since its peak in 1981. Therefore, wildfires in the United States are not becoming more frequent or severe.

Notice that the significant drop in the wildfire frequency and area burned coincides with the rising atmospheric CO_2 concentration and modest increase in temperature. This means that the rising atmospheric CO_2 concentration cannot be blamed for increasing wildfires, as wildfires are not increasing. If anything, the increasing atmospheric CO_2 concentration can be credited for its contribution to this decrease in wildfires.

In the leaves of plants are pores, or stomata, that open to “inhale” air that is rich in CO_2 and “exhale” air that is rich in oxygen. As plants emit oxygen, water vapor is also expelled. This phenomenon is the second largest contributor to water loss in plants. But the good news is that increasing CO_2 concentrations allow plants to keep their stomata open for a shorter duration, thus reducing the amount of water vapor lost through transpiration. As a result, plants need less

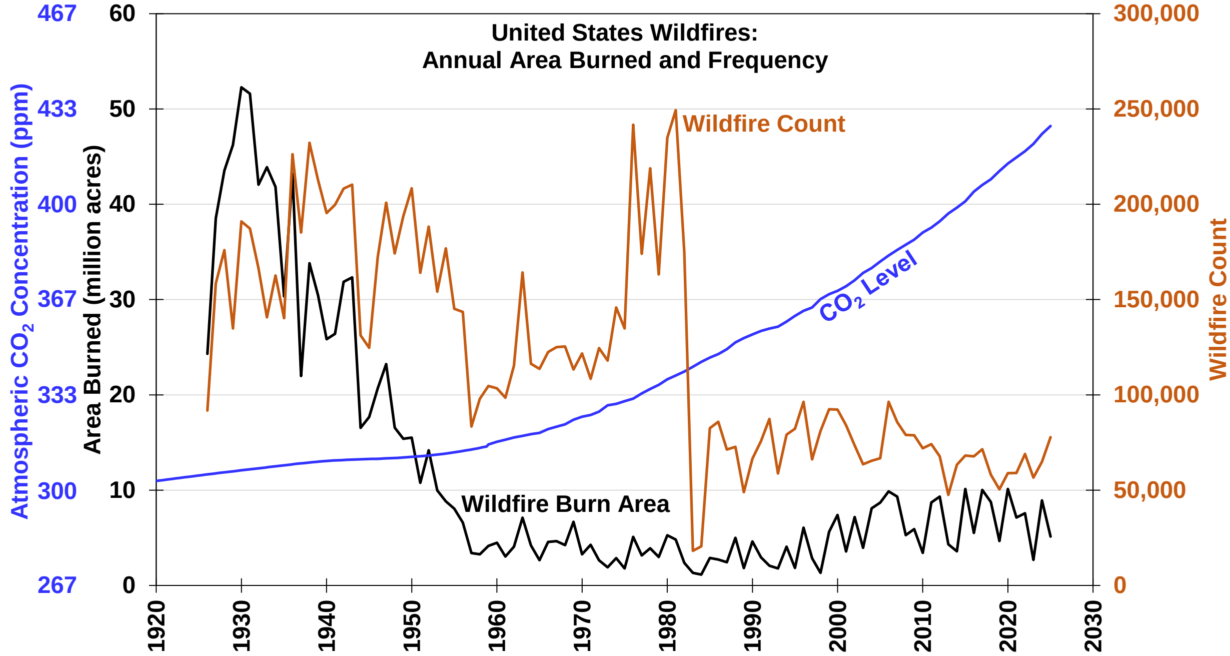


Figure 22: *Annual area burned and frequency of wildfires in the United States. Wildfires: NIFC (2020, 2026); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

water, and more water remains in the soil, which increases the plants' resistance to drought, while also reducing the dry conditions that contribute to wildfires. This phenomenon is good news for farmers living in areas affected by drought, as increased water-use efficiency of plants means that less water is needed to sustain them (Happer et al., 2023).

It is worth noting that the slight increase in the area burned by wildfires since the 1980s (Figure 22) is not caused by climate change, which is contrary to what Bolinger et al. (2024) claimed. Rather, it is because of changes to forest management practices on federal lands that include bans on logging and decreases in prescribed burns and other measures to prevent fires from starting—all actions taken at the urgings of environmental groups. A reduction of wildfires would require improvements in fire management policies, rather than attempting to control the climate.

Tornadoes

In the United States, tornadoes are one of the deadliest forms of extreme weather. Of all the countries in the world, the United States tops the list of tornado counts, averaging more than 1,000 annually (NOAA NCEI, 2026h) (Figure 23). Meanwhile, Canada ranks second with about 100 tornadoes a year (NOAA NCEI, 2026h).

As Figure 23 suggests, the unique geography of the United States makes it ripe for the formation of tornadoes. Cold Canadian air masses moving south and east across the Rocky Mountains

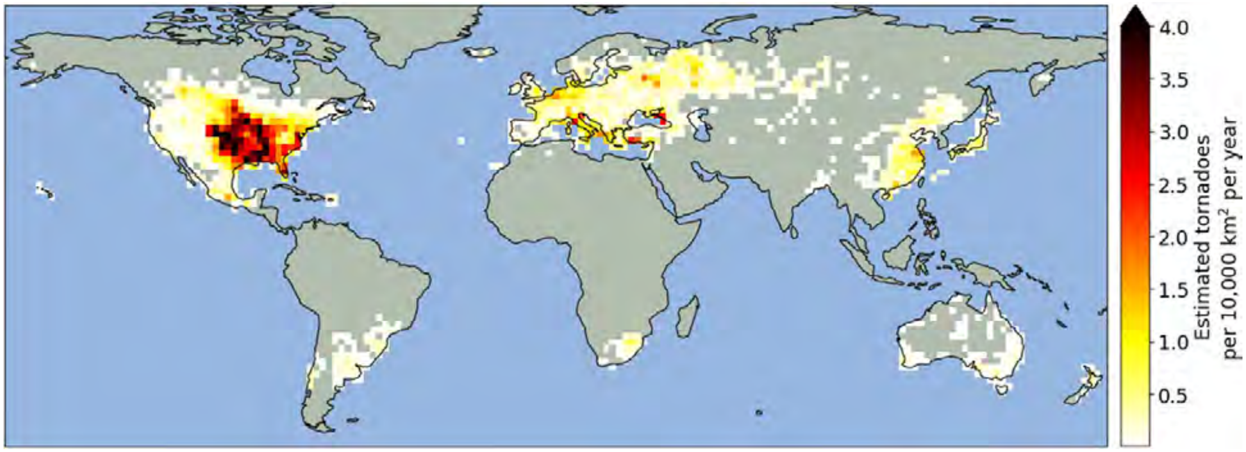


Figure 23: *Estimated annual worldwide tornado distribution, per 10,000 km^2, with a two-degree bin size. Maas (2024)*

(which runs through Colorado) and warm air from the Gulf of America provide the elements for forming tornadoes: (1) Warm, moist air near the ground, (2) cool and dry air above, and (3) horizontal winds that move faster at higher altitudes.

Reporting tornadoes can be challenging, as observations are needed:

> *One of the main difficulties with tornado records is that a tornado, or evidence of a tornado must have been observed. … If a tornado occurs in a place with few or no people, it is not likely to be documented.* (NOAA NCEI, 2026h)

Despite this challenge, NOAA noted that "strong to violent tornadoes (EF-3 to EF-5 category on the Enhanced Fujita scale) … would have likely been reported even during the decades before Doppler radar use became widespread and practices resulted in increasing tornado reports" (NOAA NCEI, 2026h).

Table 1 lists the wind speeds associated with each tornado classification on the Fujita Scale (F-Scale, used prior to February 1, 2007) and the Enhanced Fujita Scale (EF-Scale, used from February 1, 2007, onward to "align wind speeds more closely with associated storm damage") (NOAA NWS, 2016, 2026).

There have been improvements in the reporting of these tornadoes, thanks to Doppler radar and an increase in population that makes the spotting of a tornado more likely:

> *With increased National Doppler radar coverage, increasing population, and greater attention to tornado reporting, there has been an increase in the number of tornado reports over the past several decades.* (NOAA NCEI, 2026h)

Notice that NOAA acknowledged that better reporting of tornadoes resulted in more tornadoes being reported over the past decades. Colorado is no exception.

Table 1: *Tornado classifications based on wind speeds (in miles per hour, mph) in the Fujita Scale and Enhanced Fujita Scale.*

Fujita Scale (F-Scale) (used prior to February 1, 2007)		Enhanced Fujita Scale (EF-Scale) (used from February 1, 2007, onward)	
F-Scale Number	**Wind Speed (mph)**	**EF Rating**	**3 Second Gust (mph)**
F0	40–72	EF0	65–85
F1	73–112	EF1	86–110
F2	113–157	EF2	111–135
F3	158–206	EF3	136–165
F4	207–260	EF4	166–200
F5	261–318	EF5	Over 200

Sources: NOAA NWS (2016, 2026)

Figure 24 shows the annual reported number of tornadoes in Colorado (F1/EF1 to F5/EF5). Based on these data, from 1950 to the mid-1990s, there was an increase in the annual reported number of tornadoes rated F1/EF1 and stronger. But as NOAA noted, this increase reflects better reporting rather than an actual increase in the frequency of these tornadoes (NOAA NCEI, 2026h).

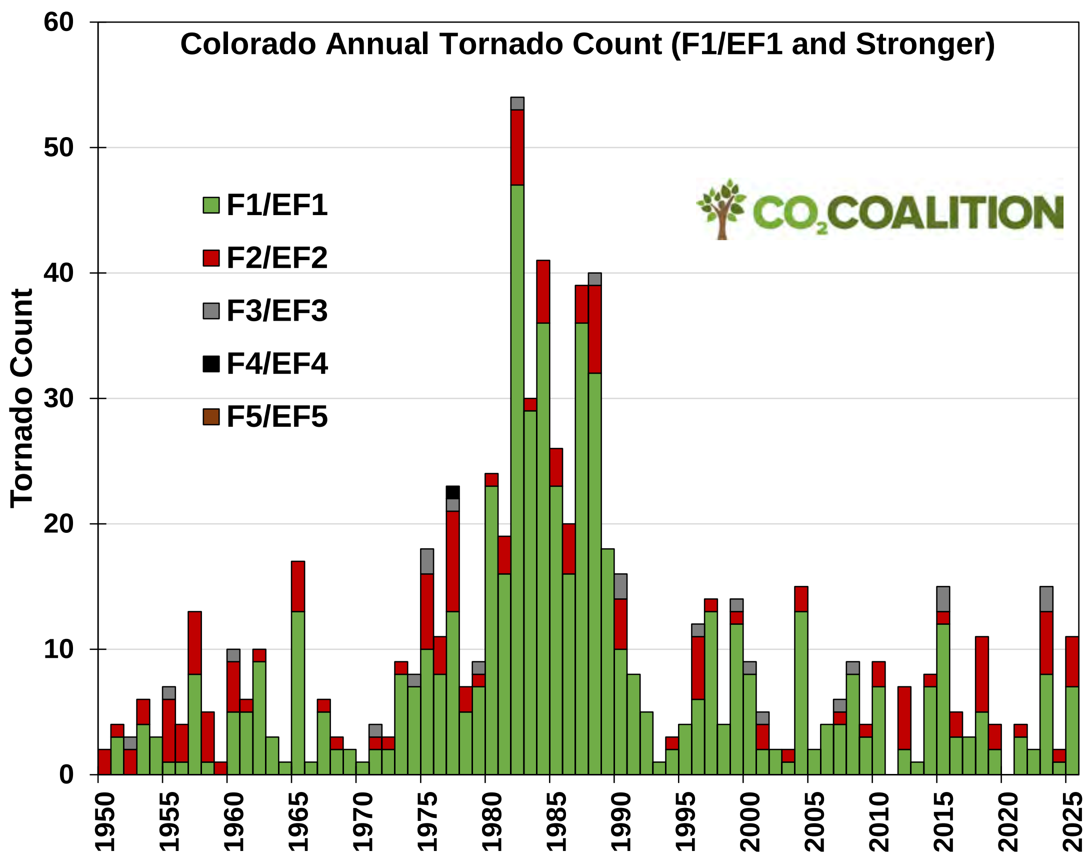


Figure 24: *Annual tornado count in Colorado. NOAA NCEI (2026f)*

Afterwards, from the mid-1990s onward, the data suggest a decrease in the frequency of these damaging tornadoes.

Furthermore, since 1950, “strong to violent tornadoes” with the F3/EF3 to F5/EF5 classifications (NOAA NCEI, 2026h) rarely form in Colorado. In fact, since 1950, tornadoes with the F4/EF4 classification have only been reported once in Colorado, in 1977, and tornadoes with the F5/EF5 classification have never been reported in the state.

Based on these observations, tornadoes are not becoming more frequent or violent in Colorado.

AIR QUALITY

> *It is likely that air quality in Colorado (particularly in the summer) will subsequently continue to degrade.* (Bolinger et al., 2024)

Is Colorado threatened by poor air quality?

The data suggest otherwise. Figure 25 shows the concentrations of pollutants in NOAA’s U.S. Southwest Climate Region, which consists of Arizona, Colorado, New Mexico, and Utah (NOAA NCEI, 2026b, 2026d), relative to the limits specified by the National Ambient Air Quality Standards (NAAQS) (U.S. EPA, 2025b, 2026). These pollutants are carbon monoxide (CO), lead (the data for the United States are shown, as data for the U.S. Southwest Climate Region are not available), nitrogen dioxide (NO_2), ozone (O_3), particulate matters with diameters of 2.5 microns (µm) or smaller (PM2.5), particulate matters with diameters of 10 µm or smaller (PM10), and sulfur dioxide (SO_2).

The data in Figure 25 indicate that the concentrations of all of the pollutants, except for ozone, are well below the limits specified by NAAQS. As for ozone, the data indicate that while fluctuating, its concentration is approximately at the limit specified by NAAQS, which means that the concentration of ozone is not dangerously high.

Rather than degrading, the air quality in Colorado has improved over the years.

PLANTS LOVE CO_2

THE GREENING OF EARTH

> *In a warmer future climate, overall drier soil conditions in the dust source region are very likely, which will tend to reduce vegetation cover …* (Bolinger et al., 2024)

Contrary to the above claim, Earth is enjoying an increase in vegetation, partly because of modest warming. Satellite data from NASA and NOAA has confirmed that much of Earth is greening.

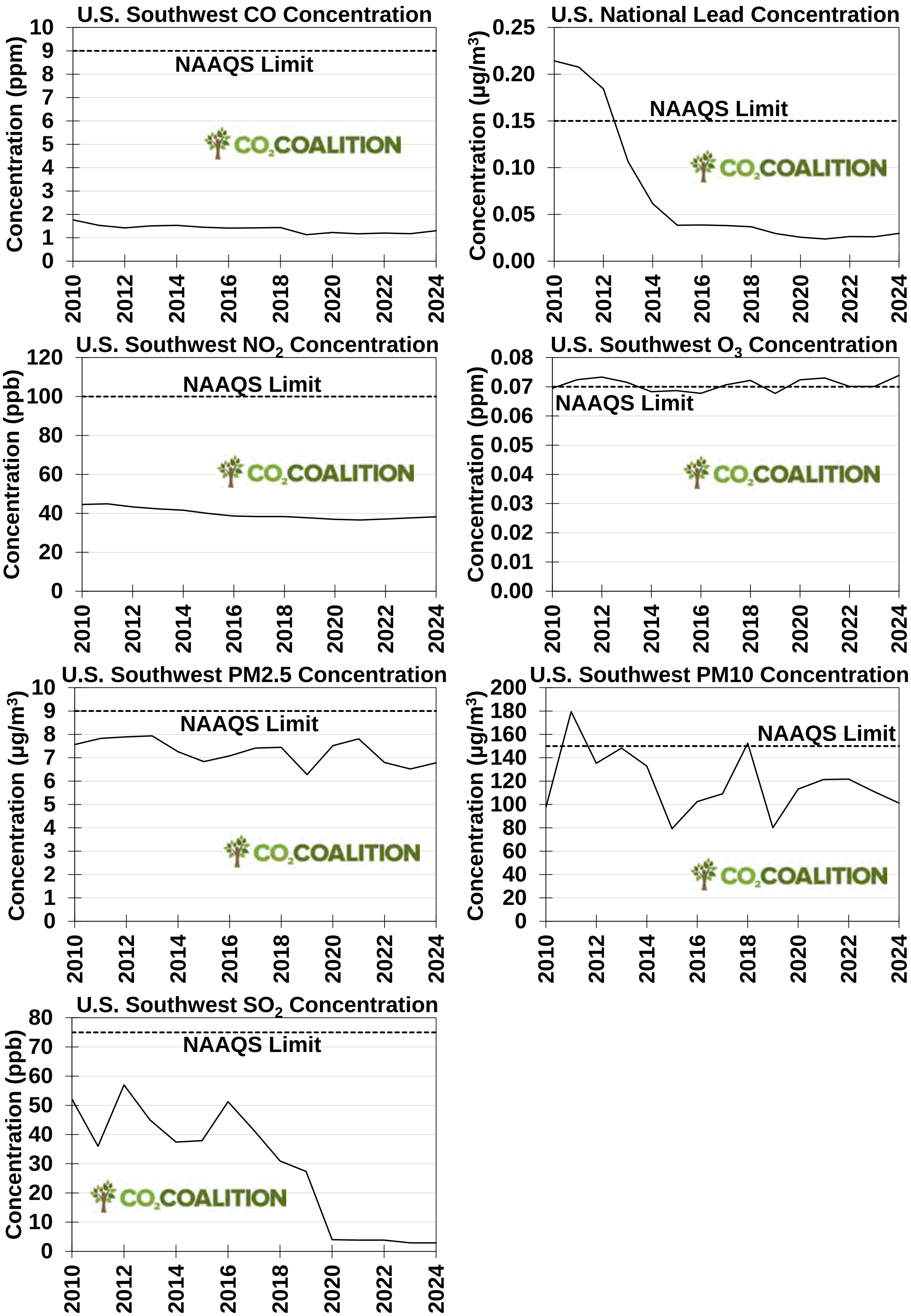


Figure 25: *Concentrations of pollutants in the U.S. Southwest Climate Region. U.S. EPA (2025b, 2026)*

For instance, a study funded by NASA and supported by the U.S. Department of Energy (Zhu et al., 2016) used satellite data from NASA's Moderate Resolution Imaging Spectrometer and NOAA's Advanced Very High Resolution Radiometer to measure the amount of leaf cover across Earth (Hille, 2016). The amount of cover is expressed using the leaf area index (Hille, 2016), which quantifies the leaf area in square meters (m^2) per m^2 of ground area (NASA Earth Observations, 2026). Because vegetation grows in layers, it is possible for the leaf area index to have values greater than one square meter of leaf area per square meter of ground area (NASA Earth Observations, 2026).

During 1982–2009, about 25% to 50% of the vegetated area on Earth experienced an increase in vegetation, while less than 4% experienced a decrease in vegetation (i.e., browning) (Zhu et al., 2016). CO_2 fertilization contributed about 70% to the greening of Earth, as confirmed by NASA (Figure 26) (Hille, 2016; Zhu et al., 2016).

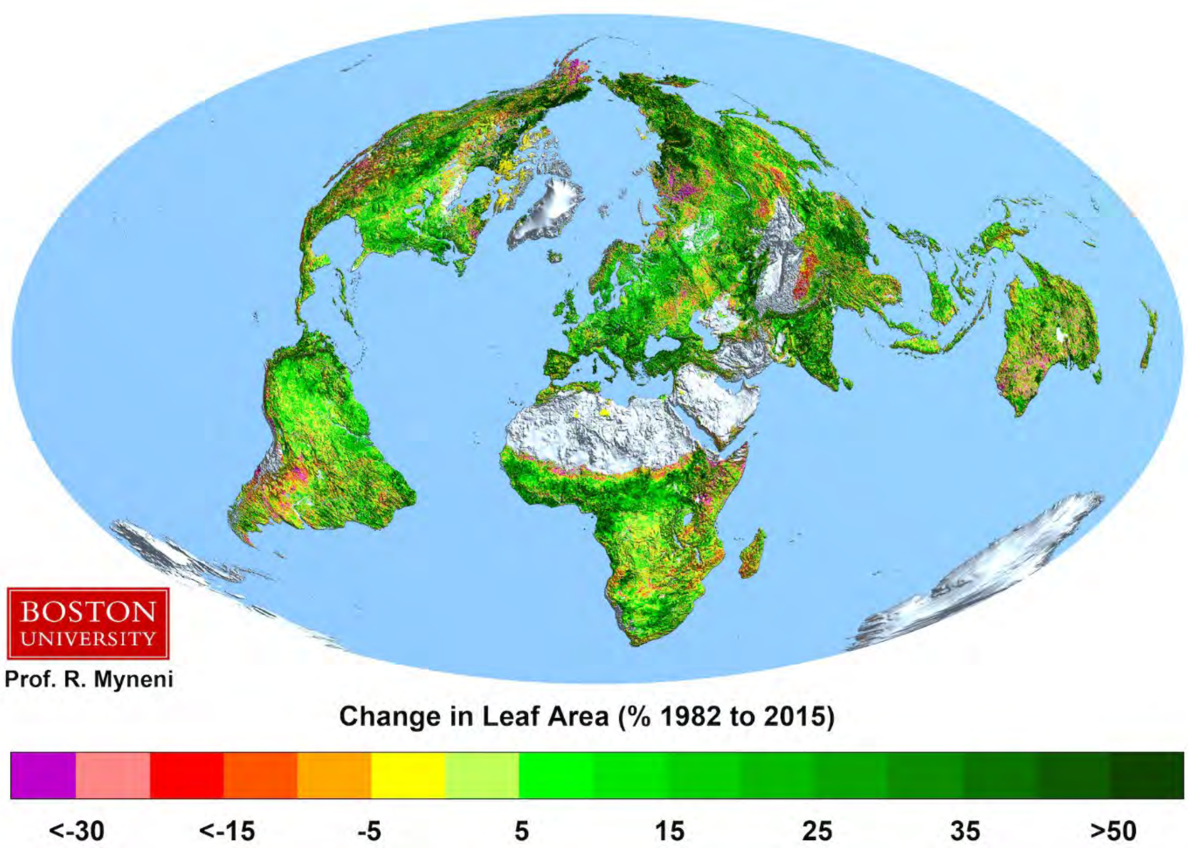


Figure 26: *The greening of Earth from 1982 to 2015. Myneni (2026) (used with permission)*

Claims that CO_2 is harmful to Earth's ecosystems are false. Both the increase in CO_2 concentration and the warming previously discussed, along with the deposition of reactive nitrogen from the consumption of fossil fuels, has contributed to this greening (Trepel et al., 2026). (More details regarding the benefits of CO_2 are provided in the next section.)

The greening trend continued into the 21st century. According to Chen et al. (2024) during 2001–2020, about 55% of Earth experienced greening and about 7% of Earth experienced browning.

In fact, based on an investigation using Normalized Difference Vegetation Index (NDVI) data during local growing seasons, Moderate Resolution Imaging Spectroradiometer (MODIS), and Visible Infrared Imaging Radiometer Suite (VIIRS), global greening peaked in 2025 (Anniwaer et al., 2026), extending the multi-decadal upward trend (Figure 27). A total of 68.2% of vegetated land surfaces experienced greening (Figure 27).

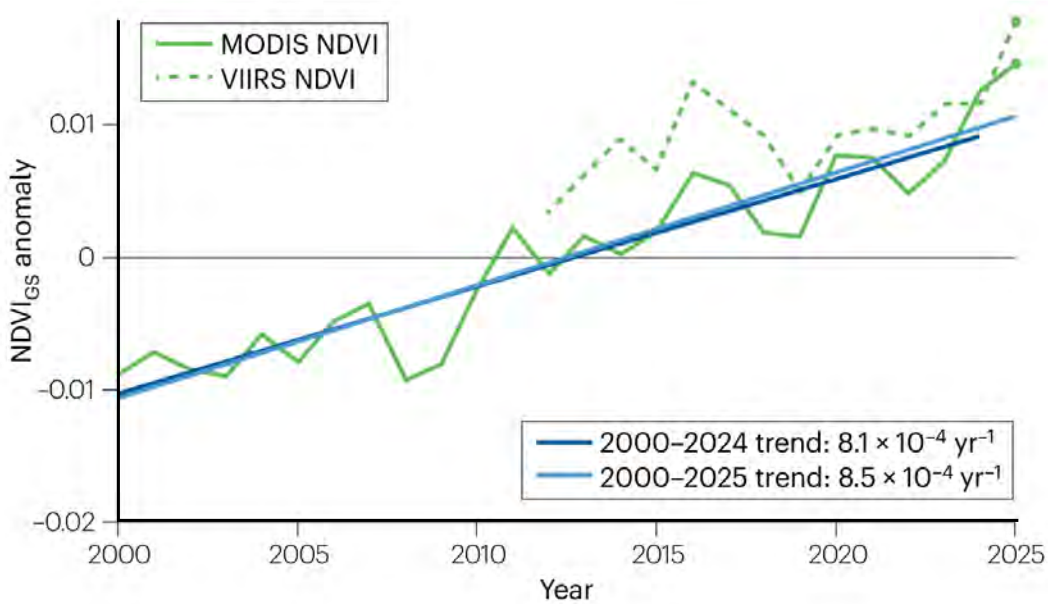
In fact, 72.1% of grasslands, 77.6% of croplands, 60.0% of forests, and 63.8% of other woody vegetation areas experienced greening (Anniwaer et al., 2026). The greening of Earth is partly due to CO_2 fertilization and the warming at high latitudes. Furthermore, the greening that occurred in southern Africa, southern Latin America, northern Australia, Europe, central North America, and northern China coincided with an increase in precipitation. Also contributing to this greening trend is land-use management practices, such as afforestation in China and increase in agriculture in India.

It is interesting to note that the browning in eastern Siberia coincided with the negative temperature anomalies during the early growing season (Anniwaer et al., 2026). Thus, adding to the discussions in the earlier section on average temperatures in Colorado, the observation regarding eastern Siberia suggests that a warmer climate is more conducive for plant growth than a colder climate.

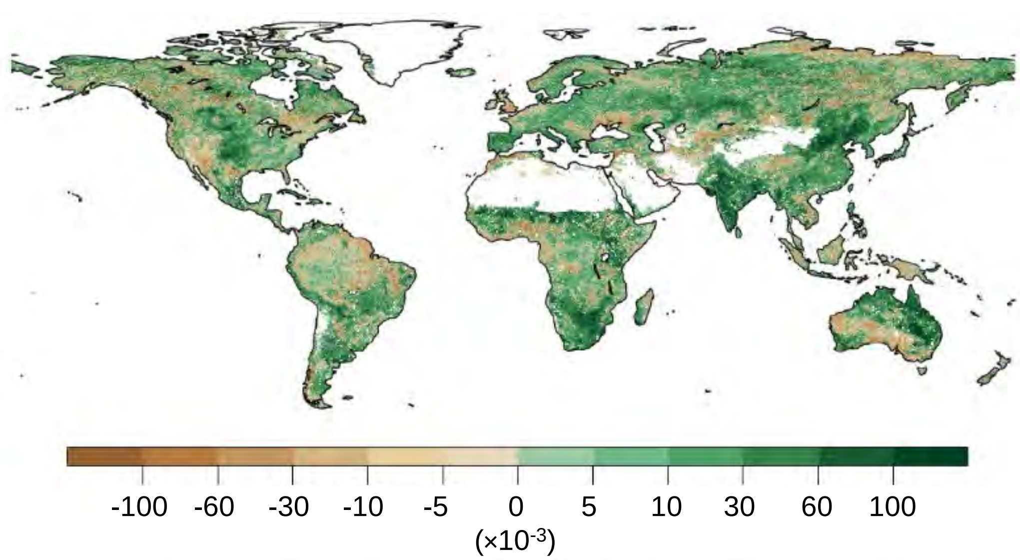
THE BENEFITS OF CARBON DIOXIDE (CO_2)

The contribution of CO_2 to the greening of Earth can be explained by how CO_2 benefits plants. As a reminder, CO_2 is plant food, as plants need CO_2, along with water, sunlight, and nutrients from the soil, to produce oxygen and food through photosynthesis. Without CO_2, plants cannot produce oxygen and food, making CO_2 necessary for life on Earth.

Increasing CO_2 helps plants grow bigger, produce more food, and use water more efficiently. Studies conducted by Idso and Kimball (1993, 1997, 2001) and Leavitt et al. (2003) have confirmed these benefits. In these studies, one group of sour-orange-tree seedlings were exposed to ambient air (with about 400 ppm CO_2 concentration) and another group was exposed to air enriched with CO_2 (about 700 ppm CO_2 concentration) in clear, open-top enclosures. Compared to the trees exposed to ambient air, the trees exposed to the CO_2-enriched air grew 2.75 times larger at the end of the second year, 2.0 times larger at the end of the fifth year, and 1.8 times larger at the end of nine years. Finally, water-use efficiency of the trees exposed to the CO_2-enriched air was 80% higher than the trees exposed to ambient air. The mechanism behind the latter benefit was discussed in the previous section on wildfires.



(a) Global Average Growing Season Normalized Difference Vegetation Index (NDVI) Anomalies (Relative to the 2000–2025 Average)



(b) Global Distribution of Growing Season Normalized Difference Vegetation Index (NDVI) in 2025 (Relative to the 2000–2025 Average)

Figure 27: *The greening of Earth from 2000 to 2025. Anniwaer et al. (2026)*

To further illustrate the benefits of CO_2 on plant growth and food production, Figure 28 shows the growth of 21-day-old rice seedlings that were exposed to different CO_2 concentrations. Notice that the rice plants grow bigger as the CO_2 concentration increases.

CO_2 is required for life on Earth, and higher levels contribute to making ecosystems thrive and increasing food security. Given these benefits, increased CO_2 concentrations are better for ecosystems and humanity.

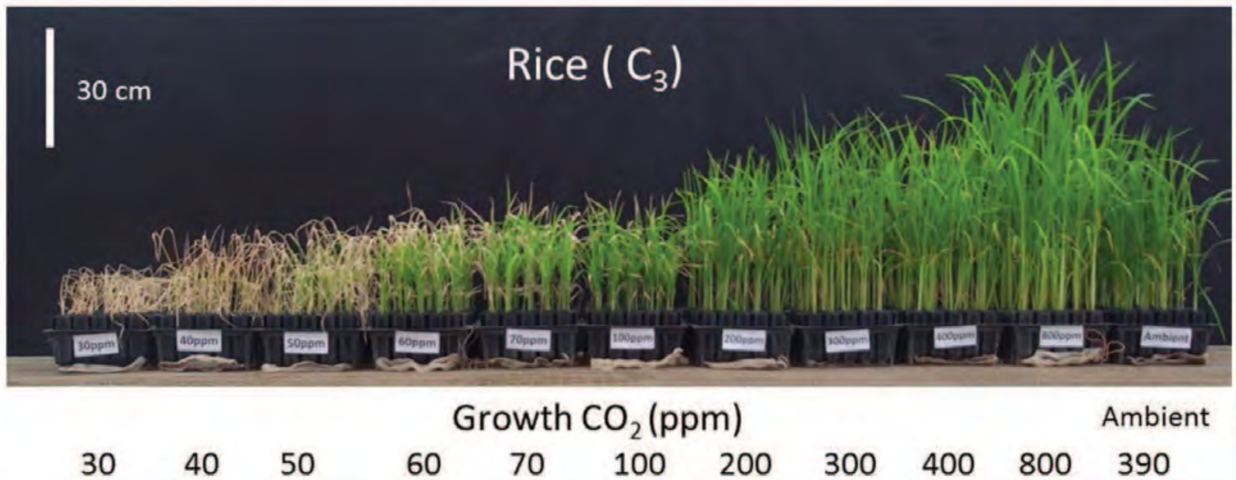


Figure 28: *Growth of 21-day-old rice seedlings at different CO_2 concentrations. von Caemmerer et al. (2012)*

AGRICULTURE

> *Challenges such as (loss of fruit crops) may become more acute in the future, as periods of extreme heat become much more frequent, but the risk of extreme cold remains.* (Bolinger et al., 2024)

According to global data, (Figure 29) global agricultural productivity is outpacing population growth, despite agricultural land use being mostly stable since 1960.

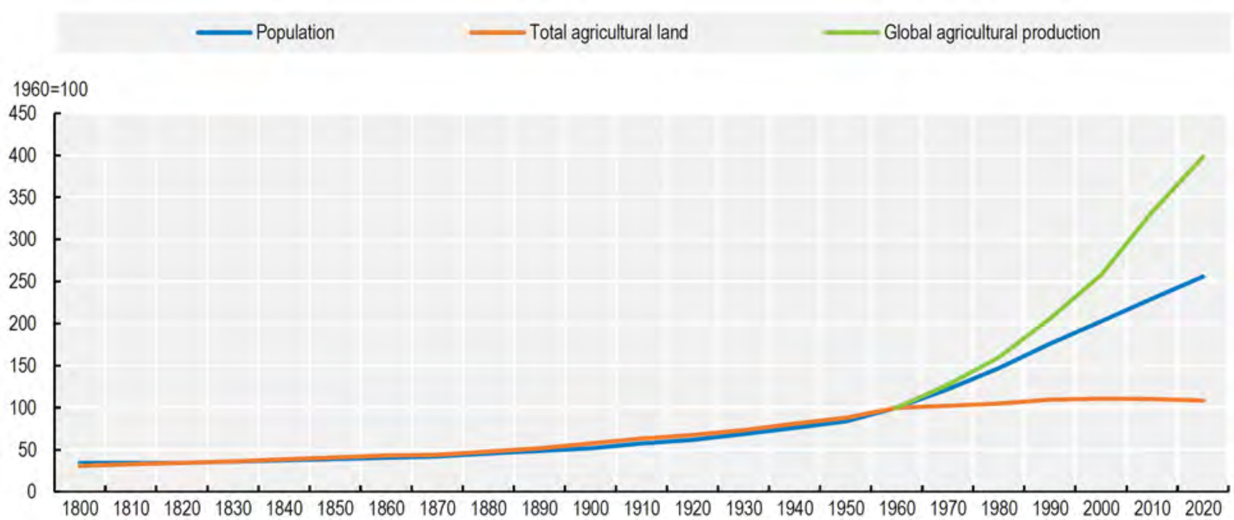


Figure 29: *Global population vs. agricultural production vs. agricultural land use. OECD (2021)*

This increase in global agricultural production and yield can be attributed to agricultural innovation, CO_2 fertilization, increasing drought resistance of plants due to increasing atmospheric CO_2 concentration, warmer weather (contributing to the lengthening of the growing season), and the use of fossil fuel-based fertilizers and pesticides.

Having discussed global agriculture, let us now turn our attention to Colorado. According to the USDA-NASS (2026b), the top four crops in Colorado in 2025 in terms of their value of production are corn grain, hay, wheat, and potatoes.

The data for the yield of these crops are shown in Figure 30. Based on these data, crop yield in Colorado has increased over the years. This increase coincides with higher concentrations of atmospheric CO_2. As discussed earlier, this simultaneous increase is no coincidence, as exposing plants to increasing concentrations of CO_2 has been shown to increase their growth and food production. Increasing CO_2 benefits agriculture.

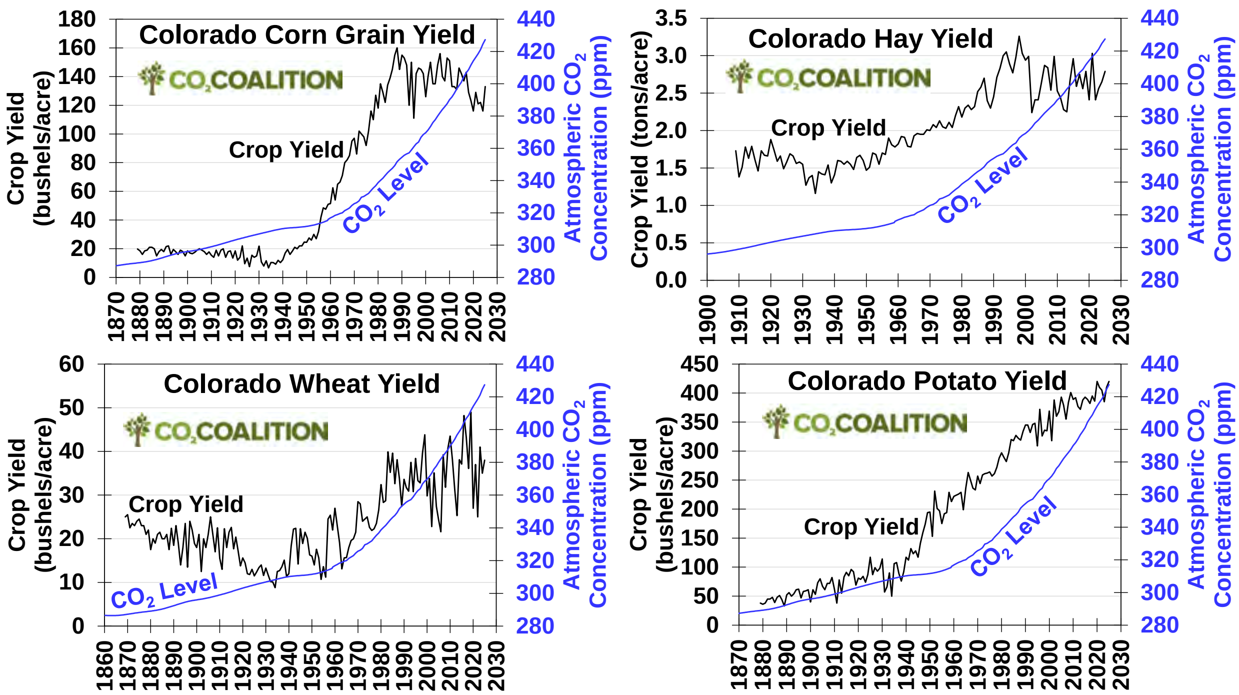


Figure 30: *Crop yield in Colorado vs. atmospheric CO_2.*
Crop yield: USDA-NASS (2026a); CO_2 concentration (before 1959): Keeling et al. (2026);
CO_2 concentration (1959 onward): Lan and Keeling (2026)

CARBON DIOXIDE THROUGH TIME

> *As of 2022, the annually averaged level of CO_2 in the atmosphere was at 420 parts per million (ppm), higher than at any time in at least 2 million years …* (Bolinger et al., 2024)

Is today's atmospheric CO_2 concentration at historically high levels?

Since the beginning of the Industrial Revolution in the mid-18th century, the level of atmospheric CO_2 has increased by more than 50% (Figure 31).

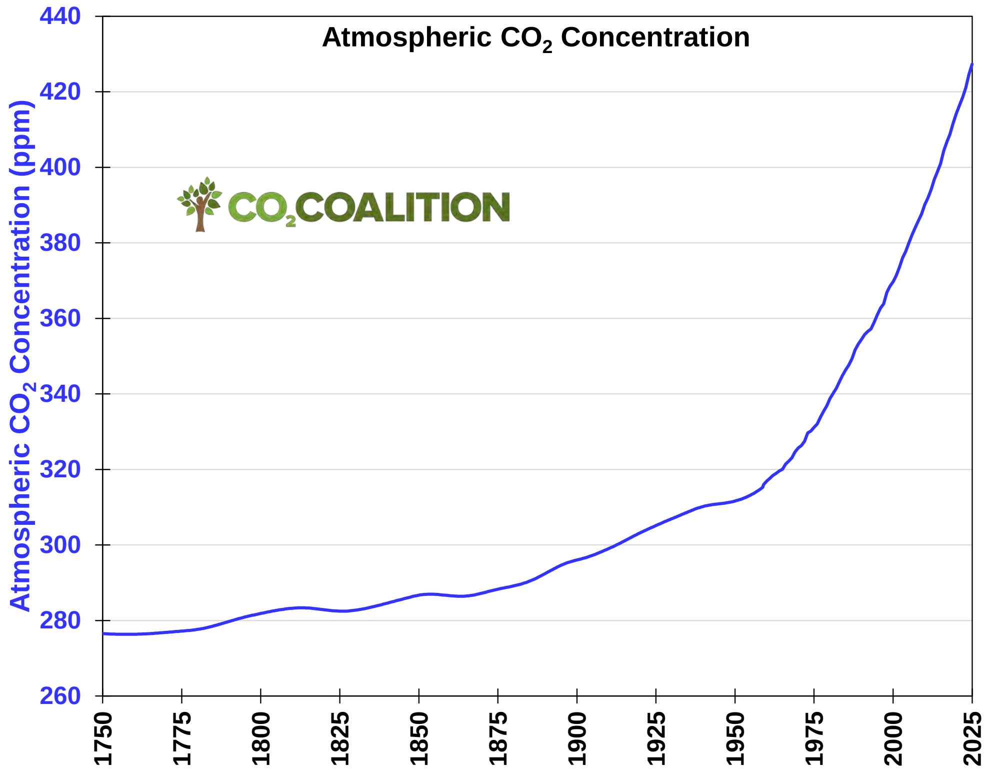


Figure 31: *Atmospheric CO_2 concentration since 1750. CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)*

Time scale is important. Put in a longer geological perspective, today's level of CO_2, while reflecting a recent increase, is seen to be significantly lower than during nearly all of Earth's history. Figure 32 shows that atmospheric CO_2 over the past 570 million years averaged nearly 2,600 ppm (Berner and Kothavala, 2001a, 2001b), roughly six times our current concentration (Lan and Keeling, 2026). Today's CO_2 concentration—nearly at an historical low—is preventing crops, trees, and other plants from reaching their full growth potential via photosynthesis. Claims that modern levels of atmospheric CO_2 are unprecedented are false.

As shown in Figure 32, atmospheric CO_2 peaked above 7,000 ppm during the past 570 million years. The overall decline in atmospheric CO_2 since the Devonian period was a result of: (1) the uptake of CO_2 by terrestrial plants, including trees that were buried deeply and eventually transformed to coal; (2) algal blooms dying and sinking to the bottom of oceans and lakes, forming carbon-rich muds that were buried deeply, heated, and converted into oil and natural gas; and (3) oceanic carbon reacting to form calcium carbonate ($CaCO_3$) rocks, primarily limestones.

The modern increase in atmospheric CO_2 is primarily the result of industrial CO_2 emissions from the burning of fossil fuels (Figure 33) (Engelbeen et al., 2024). Oceans and the biosphere act as CO_2 sinks, rather than CO_2 sources. The atmospheric CO_2 level is rising only about half as fast as one would expect from the rate of human CO_2 emissions, because natural carbon sinks are

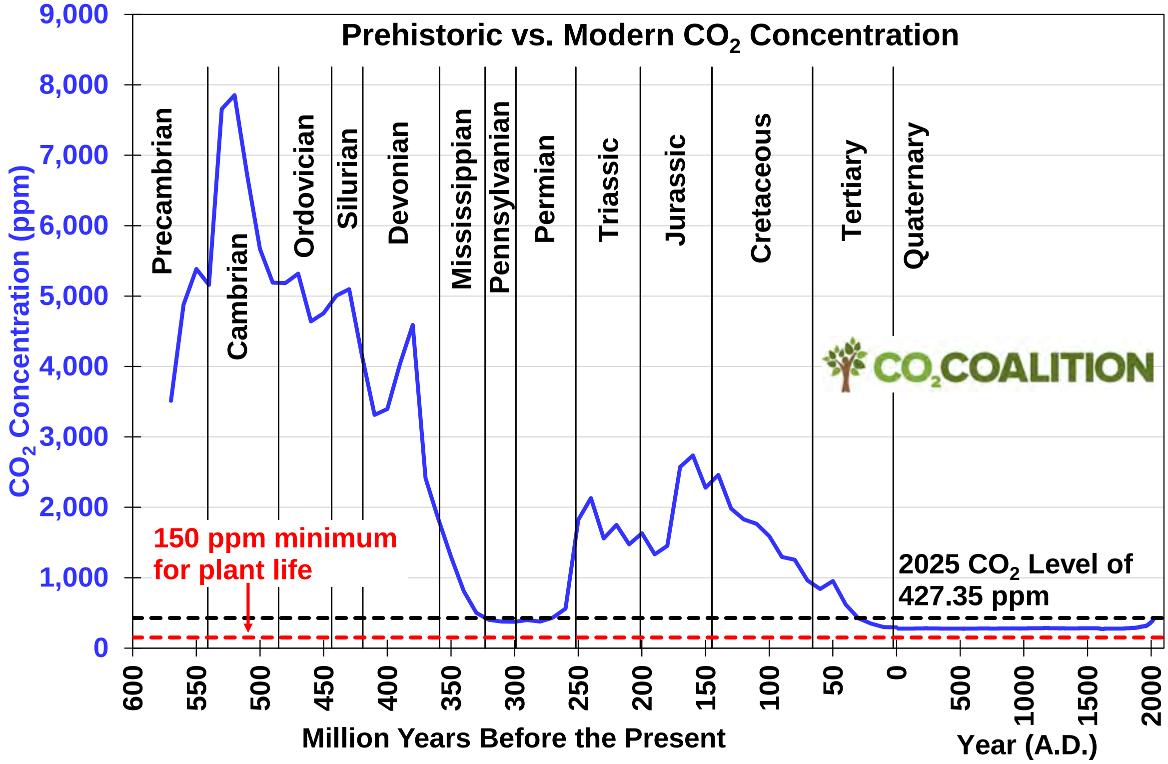


Figure 32: *Prehistoric CO_2 concentrations vs. recent CO_2 concentrations. Prehistoric CO_2 concentration: Berner and Kothavala (2001a, 2001b); Recent CO_2 concentration (before 1959): Keeling et al. (2026); Recent CO_2 concentration (1959 onward): Lan and Keeling (2026)*

removing CO_2 from the atmosphere about half as fast as humans are adding it. The two main natural carbon sinks are uptake by the oceans and huge increases in vegetative photosynthesis. This development is leading to increasing crop productivity, expanding forests, and shrinking deserts.

It is worth noting that at CO_2 concentrations below 150 ppm, most plants would die of CO_2 starvation, which would result in humans and animals dying from lack of food. Therefore, rather than being dangerous, the recent rise in atmospheric CO_2 is a positive development because the current concentration is suboptimal for plant life.

WARMING FROM COLORADO'S CARBON DIOXIDE EMISSIONS

> *It is estimated that the total warming influence of human drivers is responsible for all the globally averaged warming relative to 1850–1900 …* (Bolinger et al., 2024)

We have estimated the warming caused by Colorado's CO_2 emissions using a model developed by van Wijngaarden and Happer (2020, 2025b) and Happer (2026). The model is based on the radiative forcing, or the change in Earth's energy balance, resulting from the interaction of CO_2 with infrared radiation.

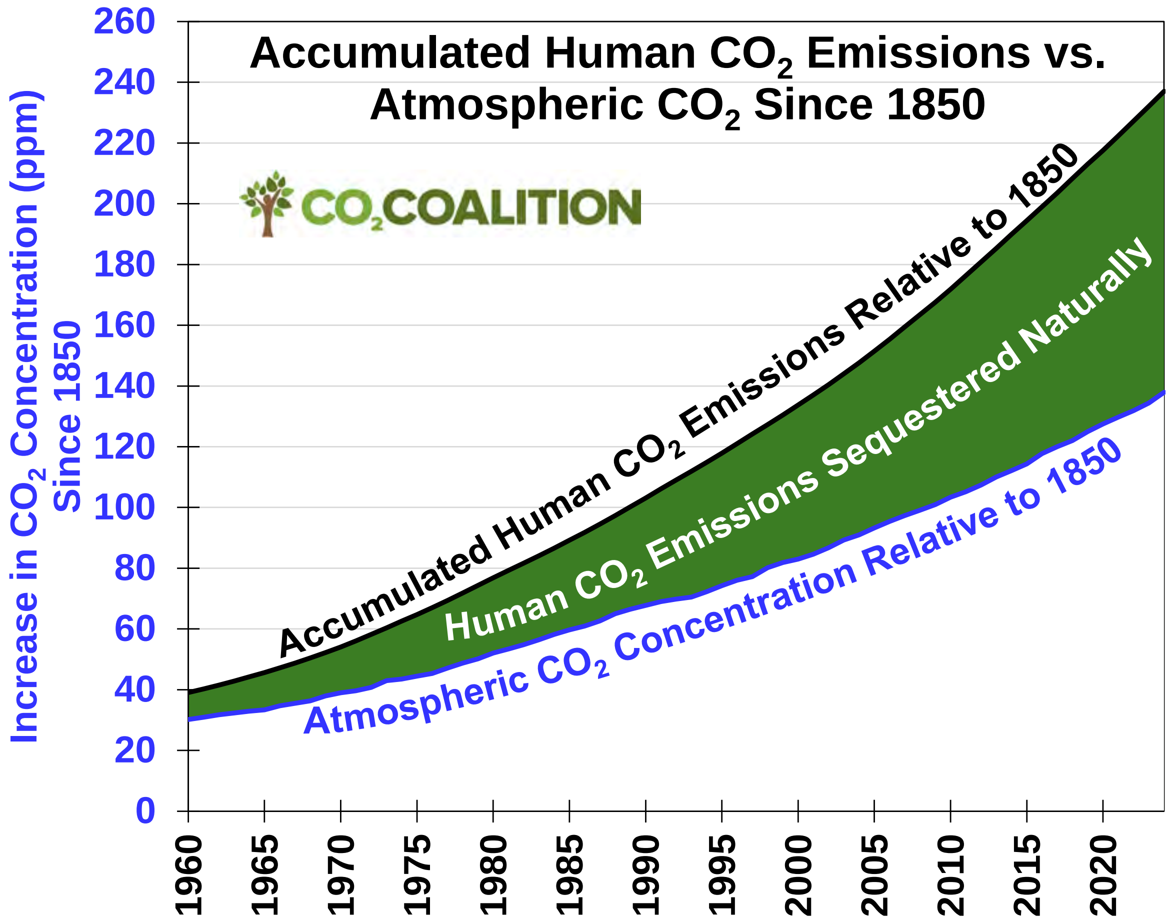


Figure 33: *CO_2 level is rising only half as fast as the human CO_2 emission rate.*
(Note: The atmospheric CO_2 concentration for 1850 was obtained through linear interpolation.)
CO_2 emission: Global Carbon Budget (2026); CO_2 concentration (before 1959): Keeling et al. (2026); CO_2 concentration (1959 onward): Lan and Keeling (2026)

Warming caused by increased atmospheric CO_2 is dependent on the amount of heat energy reflected from Earth's atmosphere back to the surface (van Wijngaarden and Happer, 2025a). The radiative forcing is dependent on the atmospheric CO_2 concentration and the frequency of the radiation exposed to the gas.

Based on this relationship, van Wijngaarden and Happer (2020, 2025b) computed the amount of heat that escapes from Earth's surface to outer space to be 307, 277, and 274 watts per square meter (W m^{-2}) at CO_2 concentration of 0, 400, and 800 ppm, respectively. As these numbers indicate, higher CO_2 concentrations in the atmosphere cause less energy to escape to outer space and more to be reflected to Earth's surface, resulting in CO_2's warming effect.

However, notice that adding the first 400 ppm of CO_2 to the atmosphere reduces the amount of heat that escapes to outer space by 30 W m^{-2} (i.e., the difference between 307 and 277 W m^{-2} above), while the next 400 ppm of CO_2 added to the atmosphere reduces the amount of heat that escapes to outer space by only 3 W m^{-2} (i.e., the difference between 277 and 274 W m^{-2} above). CO_2's diminishing warming effect as its presence increases occurs because at elevated concentrations of atmospheric CO_2, there is more interference between the CO_2 molecules that reduces the radiative forcing of these CO_2 molecules (van Wijngaarden and Happer, 2021). This "saturated" condition means that every additional CO_2 molecule in the atmosphere is likely to result in less radiative forcing and less warming (Happer et al., 2023).

Based on the above relation and their model for the radiative forcing of CO_2, van Wijngaarden and Happer (2020, 2025b) found that at atmospheric CO_2 concentrations of about 1 to 10,000 ppm, a doubling of the atmospheric CO_2 concentration would result in a 3 W m^{-2} reduction in the amount of heat energy that escapes from Earth's surface to outer space and a negligible warming effect of only 0.54 °C (Happer, 2026).

The predicted warming caused by U.S. CO_2 emissions from 2025 to 2100 is only about 0.07 °C (0.13 °F) (Table 2). This temperature rise is too small for home thermostat systems to detect. In fact, the temperature typically increases by more than 10 times that amount between 11:00 A.M. and noon (Palecki et al., 2021).

Finally, the predicted warming caused by Colorado's CO_2 emissions from 2025 to 2100 is on the order of a thousandth degree Celsius, only 0.0012 °C (0.0021 °F) (Table 2). This temperature increase cannot be measured or felt, rendering attempts to influence CO_2 levels useless.

Table 2: *Predicted warming due to the emissions of CO_2.*

	Year		
	2025	**2050**	**2100**
CO_2 Concentration (ppm)	427.35	540.6	867.2
Warming (relative to 2025) from CO_2 emissions		0.18 °C (0.33 °F)	0.55 °C (0.99 °F)
Warming (relative to 2025) from U.S. CO_2 emissions		0.023 °C (0.042 °F)	0.070 °C (0.126 °F)
Warming (relative to 2025) from Colorado's CO_2 emissions		0.00039 °C (0.00070 °F)	0.00117 °C (0.00210 °F)

Measured CO_2 concentration in 2025: Lan and Keeling (2026)
Predicted CO_2 concentration for 2050 and 2100: Meinshausen et al. (2020)
Predicted warming: Happer (2026); van Wijngaarden and Happer (2020, 2025b)
Worldwide and U.S. CO_2 emissions: Global Carbon Budget (2026)
U.S. and Colorado's CO_2 emissions: U.S. EIA (2026)

Therefore, any efforts by the United States and Colorado to achieve net zero CO_2 emissions would have very little effect on the temperature.

As a further comparison of Colorado's CO_2 emissions, in 2024, Colorado's total energy-related CO_2 emissions amounted to about 79.6 million metric tons (U.S. EIA, 2026), while China's CO_2 emissions from the burning of fossil fuels and cement production amounted to about 12.3 billion metric tons (Andrew and Peters, 2025; Friedlingstein et al., 2026; Global Carbon Budget, 2026). This means that in 2024, Colorado's annual CO_2 emissions were equivalent to China's CO_2 emissions over 57 hours.

In other words, if Colorado were to succeed in achieving net zero CO_2 emissions, China's continued emissions would negate Colorado's effort in a little more than two days.

SUMMARY AND CONCLUSIONS

The key findings of this study are as follows:

Temperature: Temperatures in Colorado have fluctuated since the late 1800s, alternating between periods of warming and cooling. Since the mid-1970s, Colorado's average temperature increased modestly, with temperatures during the 2020s comparable to those from past decades and from the late 1800s to the early 1900s, which indicates that Colorado is not warming dangerously. This modest warming can be primarily attributed to increasing annual average minimum temperatures, rather than hotter annual average maximum temperatures. In other words, the average temperature in Colorado is increasing because cold temperatures are becoming less cold, and not because hot temperatures are becoming hotter.

Heat waves and cold waves: The annual number of hot days in Colorado with temperatures at or above 95 °F (35 °C) has been decreasing since its peak in the 1930s, which means that heat waves are not becoming more frequent in Colorado. Similarly, since its peak in the 1920s, the annual number of cold days in Colorado with temperatures at or below 0 °F (-17.8 °C) has been decreasing.

Temperature-related mortality: Significantly more people die from the cold than the heat, meaning that warming temperatures will spare many people from early deaths from the cold.

Precipitation and drought: The annual precipitation in Colorado shows no indication of a decreasing trend, as recent values are comparable to those from past decades. Since 1895, Colorado has been alternating between dry and wet periods, which can be partially explained by natural phenomena in the Pacific Ocean, namely, El Niño and La Niña. There is no long-term trend of increasing drought.

Natural disasters: Wildfires, tornadoes, and winter storms are not becoming more frequent or severe. Except for a couple of unusual years that appear to be outliers, overall flood data do not indicate that these events are becoming more frequent or severe.

Air Quality: Air quality in Colorado and the United States has significantly improved over recent decades, with the concentrations of most pollutants below the limits specified by the National Ambient Air Quality Standards (NAAQS).

Agriculture: Crop productivity is increasing in Colorado and globally due to agricultural innovation, increased carbon dioxide fertilization, longer growing seasons, increased drought resistance related to higher CO_2 concentrations, and the use of fossil fuel-based fertilizers and pesticides.

Carbon dioxide: Carbon dioxide (CO_2) is necessary for life on Earth, as plants cannot produce oxygen and food without it. Increasing CO_2 concentrations allows them to grow faster, produce more food, and better resist drought. In fact, increased CO_2 concentrations have made significant contribution to the greening of Earth.

Conclusions: Based on the scientific evidence presented in this report, there is no climate crisis in Colorado. CO_2 is required for life on Earth, and policies to reduce CO_2 emissions are ecologically and economically damaging.

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The current report is based principally on the work of the following:

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These and other contributors to this evaluation represent the fields of climatology, meteorology, physics, chemistry, geology, agronomy, engineering, and more.

About the CO_2 Coalition

The CO_2 Coalition was established in 2015 as a non-partisan educational foundation operating under Section 501(c)(3) of the IRS code for the purpose of educating thought leaders, policy makers, and the public about the important contributions made by carbon dioxide (CO_2) to our lives and economy. The CO_2 Coalition seeks to engage in an informed and dispassionate discussion of climate change, humans' role in the climate system, the limitations of climate models, and the consequences of mandated reductions in CO_2 emissions.

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APPENDIX

TEMPERATURE ADJUSTMENTS AND FABRICATION OF DATA

As summarized in the previous section on this subject, the temperature data provided by NOAA's USHCN stations are influenced by factors that affect the temperatures recorded by these stations, including:

- Urban heat island effect that raises temperature readings (Spencer et al., 2025; Watts, 2022, 2026).
- Adjustments to raw temperature readings (Menne et al., 2009; NOAA NCEI, 2026g).
- Fabricated data for stations that no longer exist or are no longer reporting temperatures (Heller, 2022).

Urban heat island effect: This phenomenon refers to buildings and heat sinks (e.g., asphalt, concrete, and brick structures) that are located near USHCN stations that raise temperature readings at these stations (Michaels et al., 2023). A study conducted by Watts (2022) during April and May 2022 found that among the 128 temperature stations across the contiguous United States that were surveyed, 96% of these stations "are sited unacceptably," as these stations were located near heat sources and sinks, such as buildings, asphalt, etc. Based on his observations, Mr. Watts noted:

> *Data from the stations that have not been corrupted by faulty placement show a rate of warming in the United States reduced by almost half compared to all stations.* (Benson and Watts, 2022)

This finding was further confirmed by the studies conducted by Watts (2026) at Reno-Tahoe International Airport during 2024–2025. This study compared the temperature readings from two stations: (1) The official temperature station, which is located near runways, pavement, and buildings, and (2) a reference station, located 1.1 miles away from the official temperature station and from heat-retaining surfaces. The reference station is located on grassy ground, and more than 100 feet away from pavements and buildings, per NOAA's siting guidance.

Because of the station siting and the urban heat island effect, compared to the reference station, the warming bias of the official temperature station ranged from 0.64–2.91 °F (Watts, 2026). These warming biases are more prominent during the night than during the day, and are systematic, rather than random, and persist throughout the year. Furthermore, the official temperature station recorded warmer temperatures than the reference station on more than 90% of nights during both years. These nighttime warming biases, in turn, cause warming biases in the daily and monthly average temperatures.

The findings of Watts (2026) should come as no surprise, as airports have strong urban heat island effects (Tzavali et al., 2015). For instance, on July 9, 2000, in Heraclion, Greece, the airport “was 5.4–7°C [9.72–12.6 °F] warmer than urbanized areas and 7.3°C [13.14 °F] warmer than surrounding rural areas,” and on August 6, 2009, “air temperatures in densely built areas of Rotterdam [The Netherlands] were 1–2°C [1.8–3.6 °F] higher in the airport” (Tzavali et al., 2015).

The significant effect of urban heat islands on temperature readings was further verified by Spencer et al. (2025). Spencer et al. (2025) investigated the raw temperatures measured by the Global Historical Climatology Network from 1895 to 2023 for the contiguous United States. Spencer et al. (2025) found that the contribution of the urban heat island effect to the observed increase in the raw average temperature ranged from 8%, in the case of rural stations, to 65%, in the case of suburban and urban stations.

Adjustments to data: Over the years, the raw temperature measurements recorded by the USHCN stations (referred as the raw temperatures in our report), including those shown in Figure 2 for Colorado, have been adjusted to correct for “systematic” and “nonclimatic” biases (Menne et al., 2009). Examples of such biases are changes in the time when the temperatures were recorded (referred to as the time of observation bias, or TOB), changing station locations, changes in measuring instruments, and changes to the surroundings around the measuring instruments (Menne et al., 2009).

For instance, since around the mid-1900s, hundreds of USHCN stations have been shifting towards recording temperatures in the morning rather than in the afternoon. For these stations, temperature records taken during afternoons before the mid-1900s have slight warming biases, whereas temperature measurements taken during mornings after the mid-1900s saw reductions in temperatures due to the earlier time these measurements were taken. To correct for these biases, earlier temperature measurements were cooled, while later temperature measurements were warmed. These temperatures that were corrected for the time-of-observation bias (TOB) are referred as the TOB-corrected temperatures in our report.

The extent of the corrections on the annual average USHCN raw temperature records in Colorado to account for the TOB bias is summarized in Figure A-1.

Figure A-1 shows that adjustments to the raw temperatures prior to the mid-1970s consistently cooled the raw temperatures, while more recent adjustments warmed the raw temperatures. The result of these systematic “corrections” already exaggerated the recent warming trend when comparing the TOB-corrected temperatures against the raw temperatures.

However, given the different amount of corrections that need to be made to the USHCN raw temperature records over the years in Colorado to account for the time-of-observation bias, in our report, we reported the TOB-corrected temperatures, instead of the raw temperatures, to allow for a fairer comparison of the temperature data over different years regardless of whether the USHCN stations recorded the temperatures in the morning or in the afternoon.

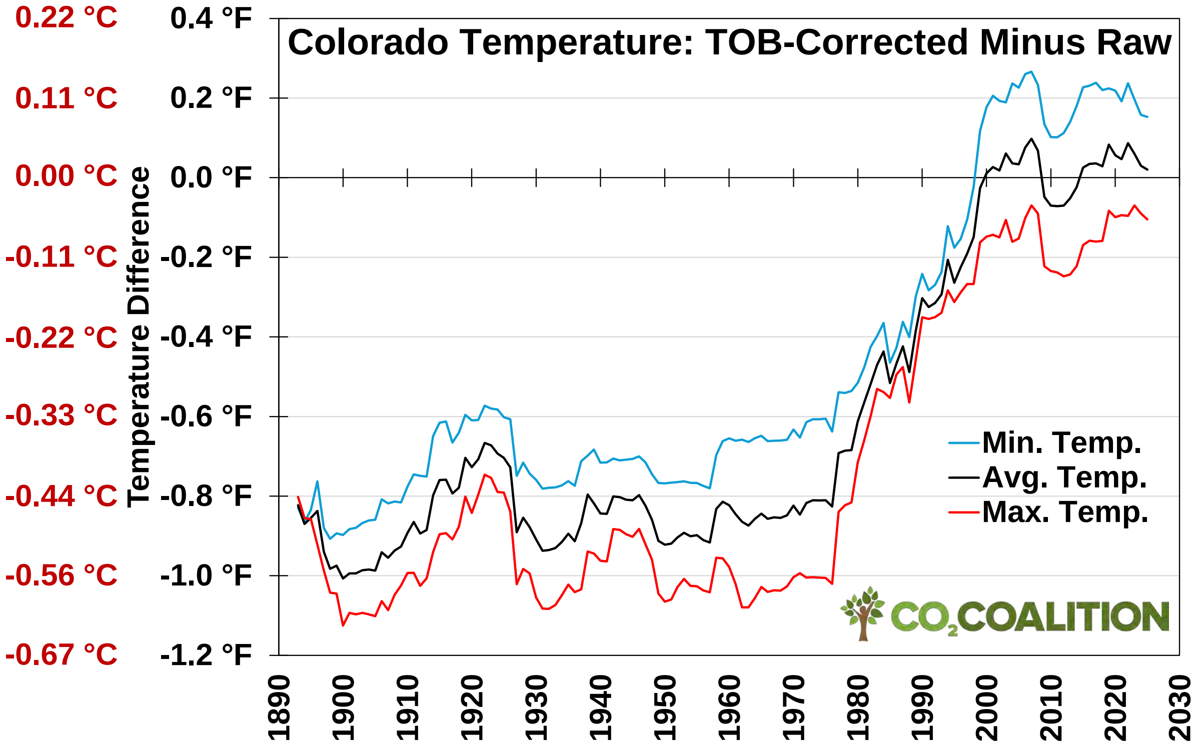

Figure A-1: *The corrections on the USHCN stations' raw temperature records in Colorado to account for the time-of-observation bias (TOB). NOAA NCEI (2026g)*

Fabrication of data: Figure A-2 shows that despite the inconsistencies in the number of USHCN stations in Colorado that report the monthly raw average temperatures since 1920 (which was the year when monthly raw average temperature readings started to become available for all 24 USHCN stations in Colorado), temperatures (referred as the final temperatures in our report) were somehow still being reported by all 24 USHCN stations in Colorado.

Where do these final temperatures come from? These final temperatures were generated by a computer model, instead of thermometers, to fill the gaps, such that temperatures were reported by all 24 USHCN stations in Colorado, regardless of whether or not these stations actually reported the temperature (Heller, 2022). For this reason, we opted not to use the data for the final temperatures in this report.

The consequence of including these model-generated temperatures is shown in Figure A-3, which shows the extent of the adjustments on the annual average USHCN raw temperature records in Colorado to generate the final temperatures.

Notice that the magnitude of the adjustments (Figure A-3) on the annual average USHCN raw temperature records to generate the final temperatures are larger compared to the magnitude of the corrections (Figure A-1) on the annual average USHCN raw temperature records in Colorado to account for the TOB.

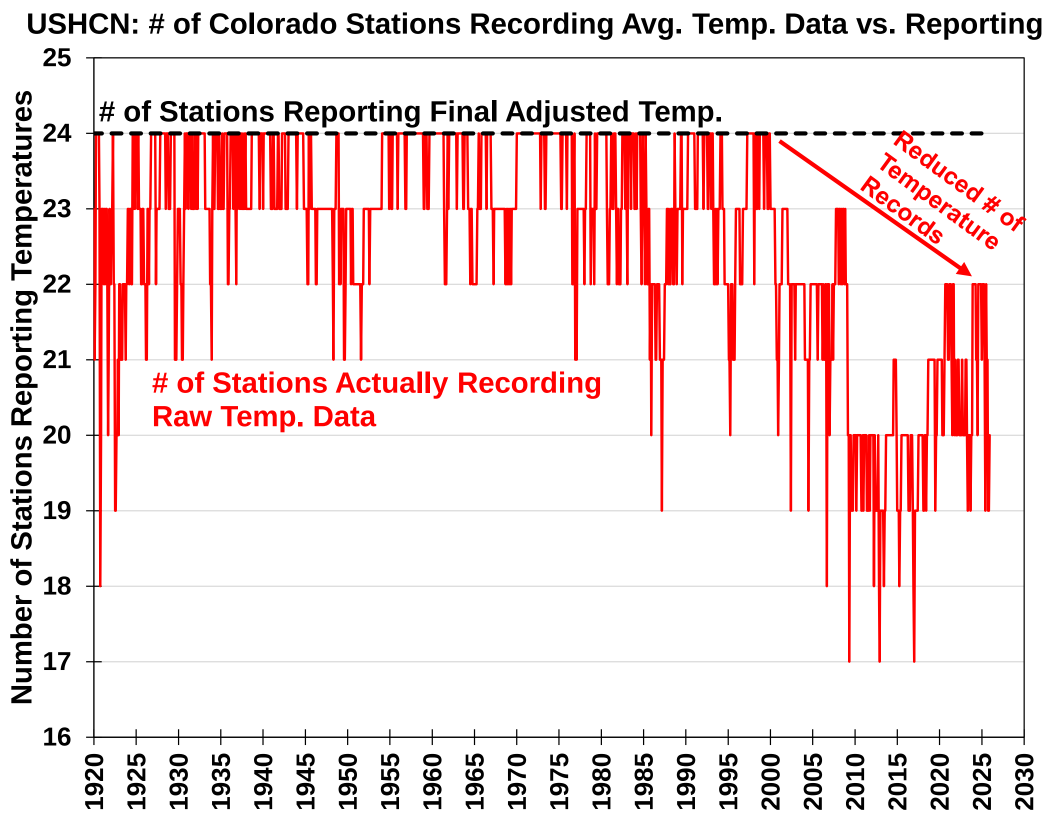

Figure A-2: *The number of USHCN stations reporting monthly average temperatures in Colorado: raw temperatures vs. final temperatures. NOAA NCEI (2026g)*

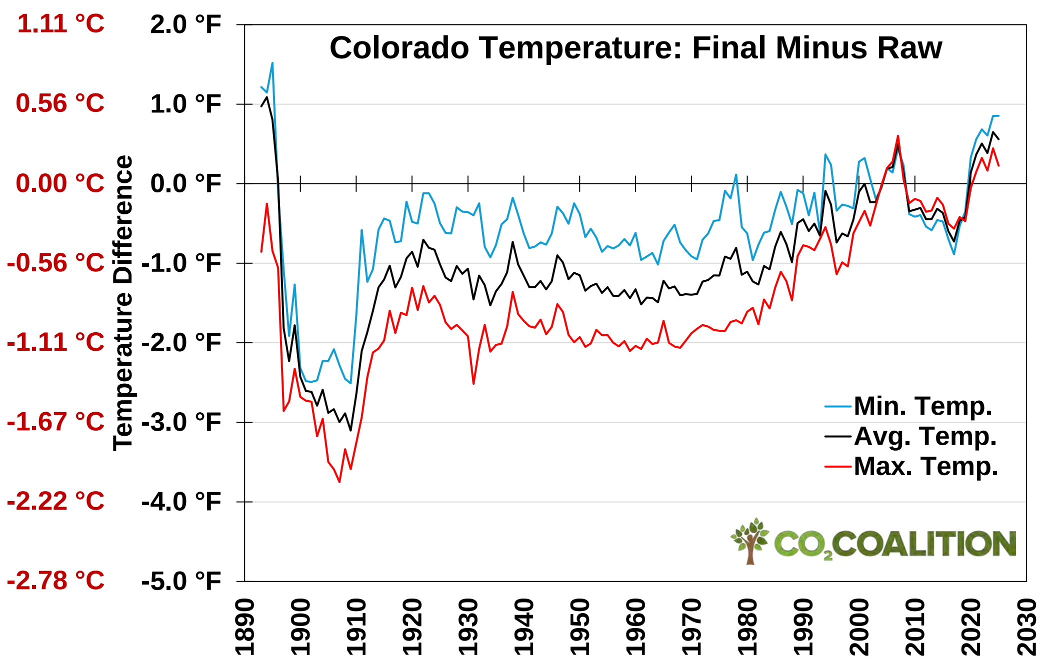

Figure A-3: *The adjustments on the USHCN stations' raw temperature records in Colorado to generate the final temperatures. Source: NOAA NCEI (2026g)*

Furthermore, the final temperatures were generated through significant cooling of earlier annual average USHCN raw temperature records from the late 1800s to the early 1900s and warming of recent annual average USHCN raw temperature records. Such adjustments result in further exaggerations in the warming of the annual average maximum and annual average final temperature records, when compared to both the raw and TOB-corrected temperature records.