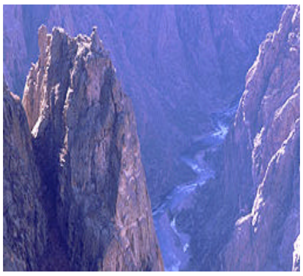
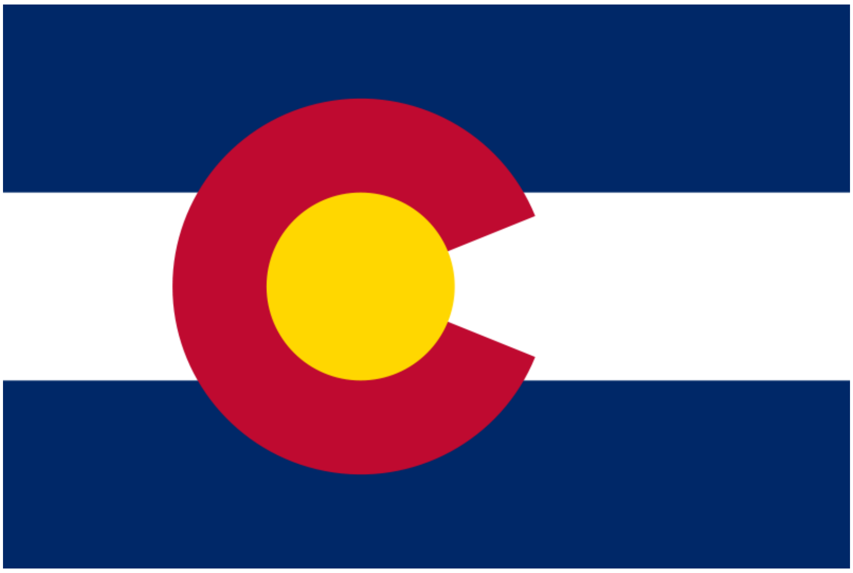
Observed Climate Change and the Negligible Global Effect of Greenhouse-gas Emission Limits in the State of Colorado



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Observed climate change in Colorado

Annual temperature: The historical time series of statewide annual temperatures in Colorado begins in 1895. Over the entire record, there has been an upward trend, which has resulted in temperatures in the early 21st century being about 2ºF warmer than temperatures 100 years ago. Despite this long-term rise however, the record continues to be largely dominated by annual and decadal-scale variability. The run of recent warm years comes on the heels of a period of falling temperatures that extended from the early 1940s through the early 1980s. Previous to then, temperatures warmed rapidly from the 1910s through the 1930s, long before high levels of industrial CO_2 emissions. The highest annual average statewide temperature was observed in 1934.

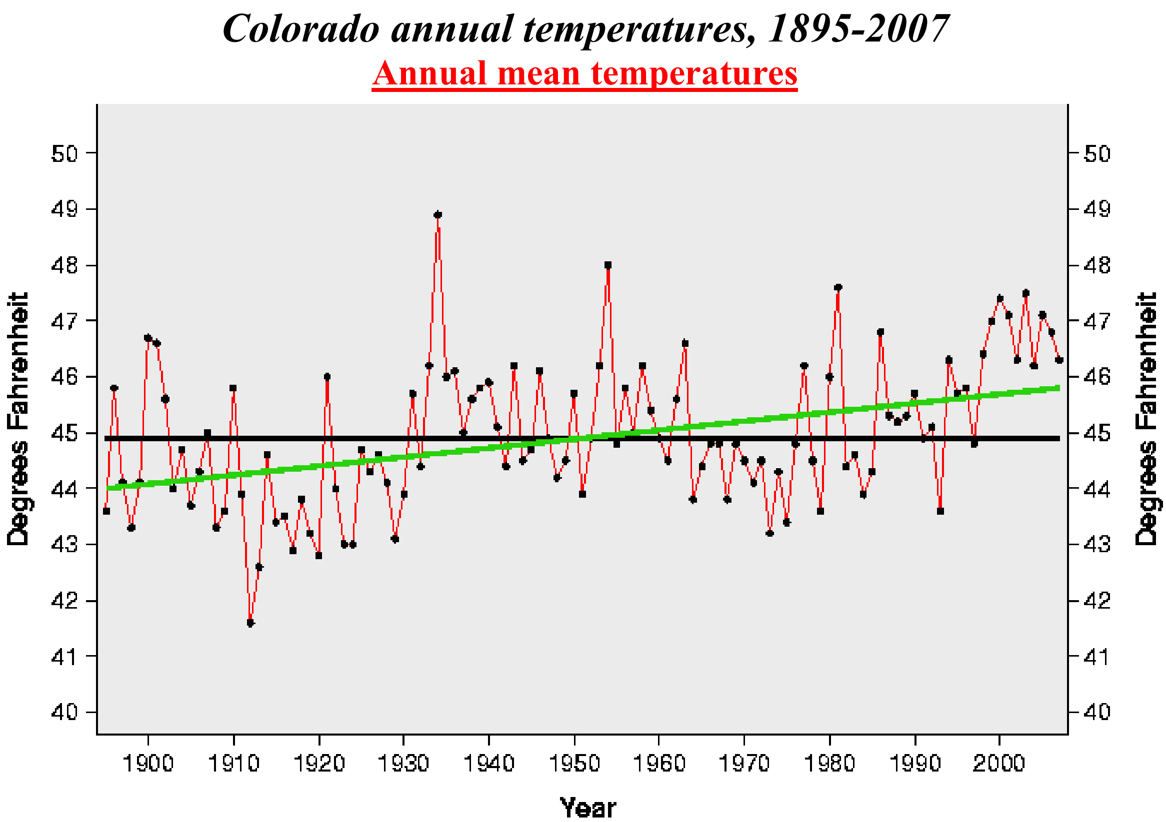


Figure 1. *Annual statewide average temperature history for Colorado, 1895-2007 (available from the National Climatic Data Center, http://www.ncdc.noaa.gov/oa/climate/research/cag3/co.html).*

Seasonal temperatures: When Colorado annual temperatures are broken down into individual seasons, it can be seen that the observed warming has been, with the exception of fall, pretty evenly spread out across the year. Still, throughout all seasons, there is a large degree of interannual and interdecadal variability.

Colorado seasonal temperatures, 1895-2007

Seasonal mean temperatures

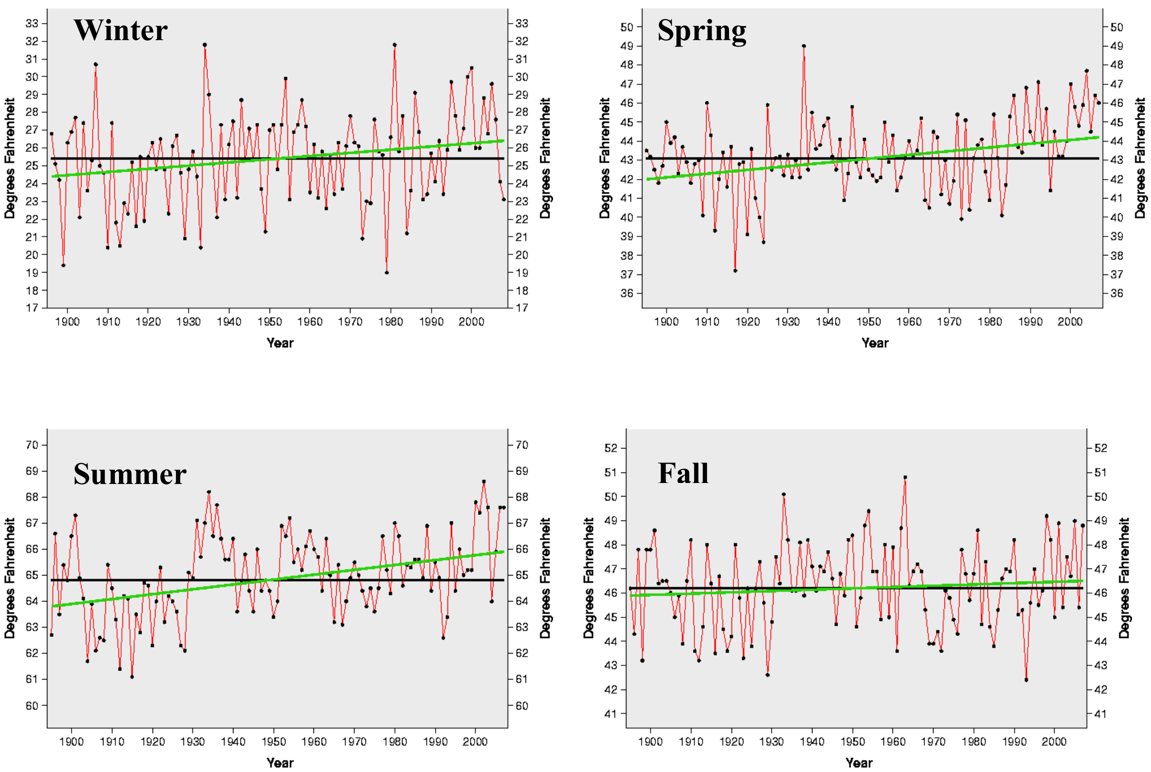
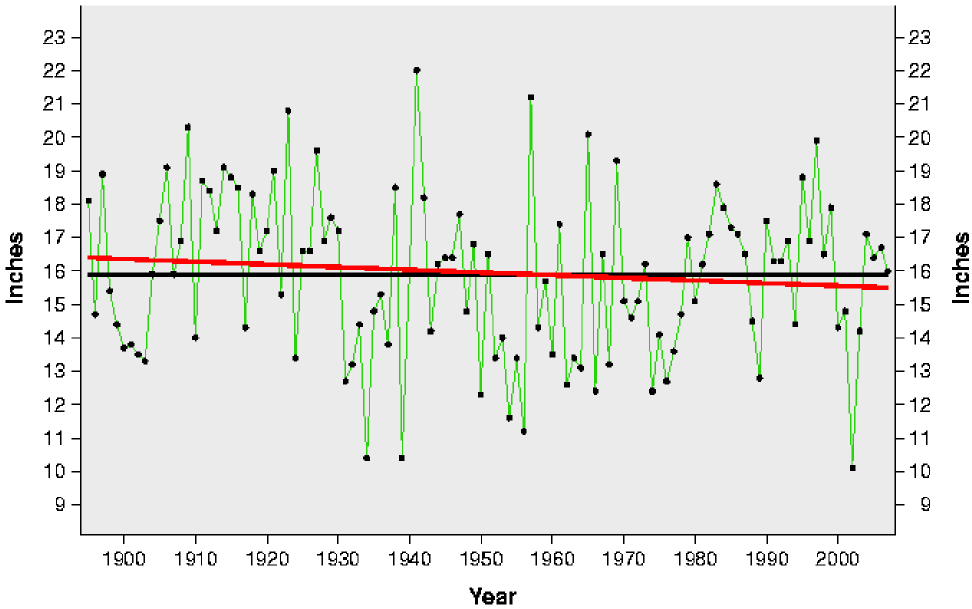


Figure 2. *Seasonal statewide average temperature history of Colorado (source: National Climatic Data Center, http://www.ncdc.noaa.gov/oa/climate/research/cag3/co.html).*

Precipitation: The precipitation history of Colorado indicates that the first part of the 20th century was wetter than the latter part, and thus exhibits an apparent overall slight downward trend. However, since 1950, the trend in precipitation is upwards indicating that a *recovery* is ongoing from the mid-20th century lows.

Colorado annual precipitation, 1895-2007



Colorado annual precipitation, 1950-2007

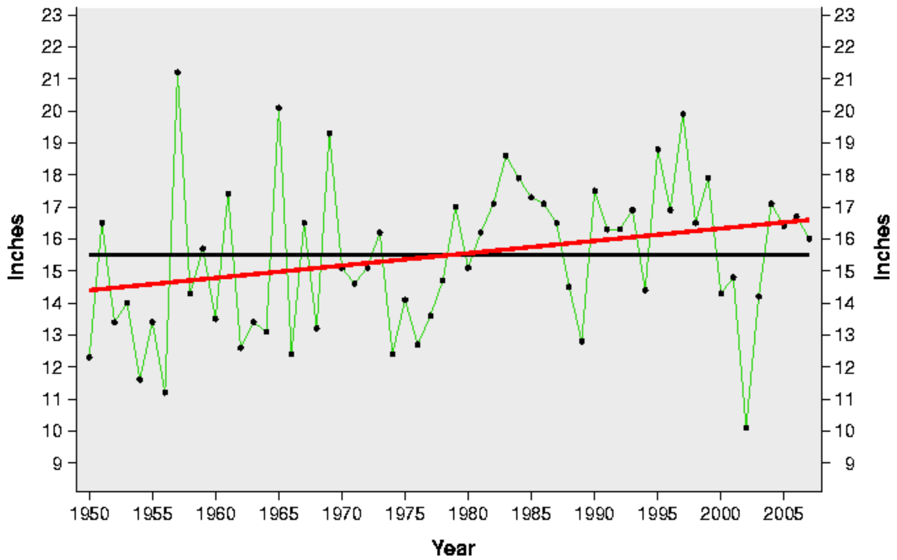


Figure 3. *Statewide average precipitation history of Colorado. The first few decades of the 20th century were a wetter period in Colorado than the most recent decades. However, there has been a rising trend from 1950 through 2007 (source: National Climatic Data Center, http://www.ncdc.noaa.gov/oa/climate/research/cag3/co.html).*

Drought: Since 1895, there has been a slight overall trend towards drier conditions across Colorado, likely a result of rising spring and summer temperatures coupled with a period of extreme wetness which dominated the early portions of the 20th century. However, since the end of the anomalous wet period, about 70 years ago, there has been *no trend* in moisture conditions when averaged across Colorado.

Colorado drought severity, 1895-2007
Palmer drought severity index

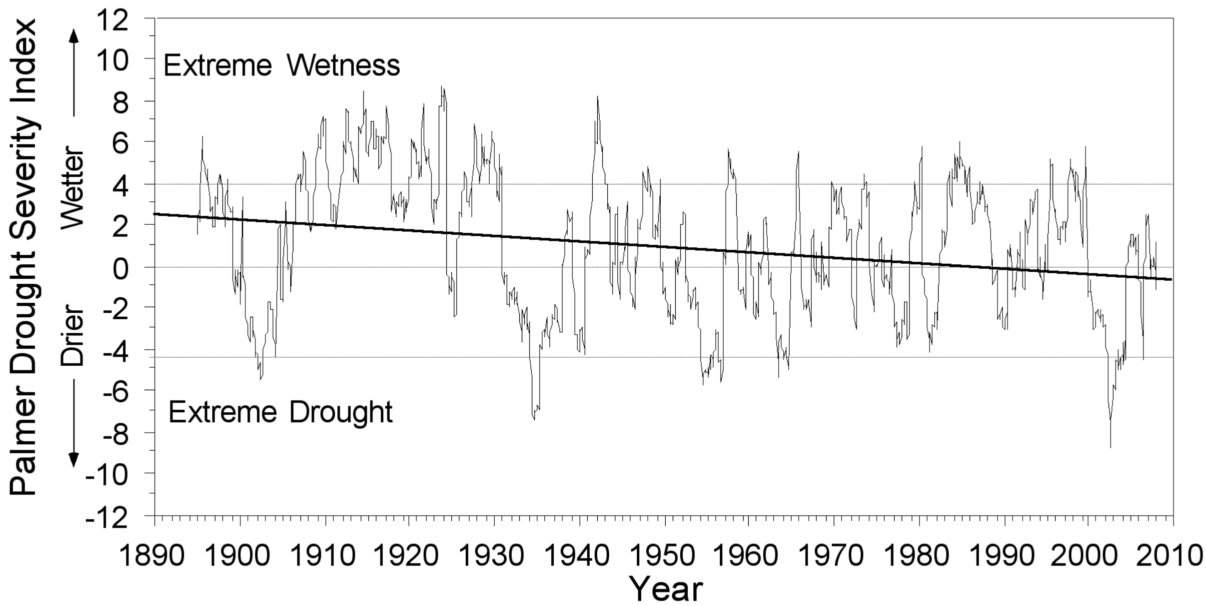


Figure 4. *Monthly statewide average values of the Palmer Drought Severity Index (PDSI) for the state of Colorado, 1895-2007 (data from the National Climate Data Center, www.ncdc.noaa.gov)*

According to records compiled by the National Climatic Data Center since 1895, statewide monthly average Palmer Drought Severity Index values—a standard measure of moisture conditions that takes into account both inputs from precipitation and losses from evaporation—show statistically significant downward trend (towards drying), although short-term variations are still quite evident. The string of dry years since the year 2000 acts together with the wet period in the earth 1900s to induce a negative trend in the drought record for Colorado. However, for the period from 1940-2007, there is no overall trend in moisture conditions across the state. Thus, is appears that the apparent 113-yr long downward trend is driven by early 20th century wet conditions, rather than by conditions in recent decades.

Paleodrought: The droughts experienced during the past century in Colorado pale in comparison to the large droughts that have occurred there in the past. The character of past climates can be judged from analysis of climate-sensitive proxies such as tree-rings. Using precipitation information about past precipitation contained in tree rings, Dr. Edward Cook and colleagues have been able to reconstruct a summertime PDSI record for Colorado that extends back in time about *2000 years*.

Interestingly, the trend over the past two millennia has been towards generally *wetter* conditions. In fact, one of the wettest periods during the past 2,000 years in Colorado, and across the American West at large, was the wet period that occurred during the early 20th century. But rather than anomalously wet periods, the most remarkable characteristic of the reconstructed drought history of Colorado is the prolonged dry periods and *"megadroughts"* that occurred many time in past centuries—droughts that dwarfed any conditions experienced in recent memory. In fact, *average* conditions from about 0 AD to 700 AD were nearly as dry as the *driest* 20-yr periods during the 20th century.

The paleo-climate record give us clear indication that droughts are a *natural* part of Colorado's climate system and thus should not be used as an example of events that are caused by any type of anthropogenic climate change. Instead, they have been far worse in the past, long before any possible human influences.

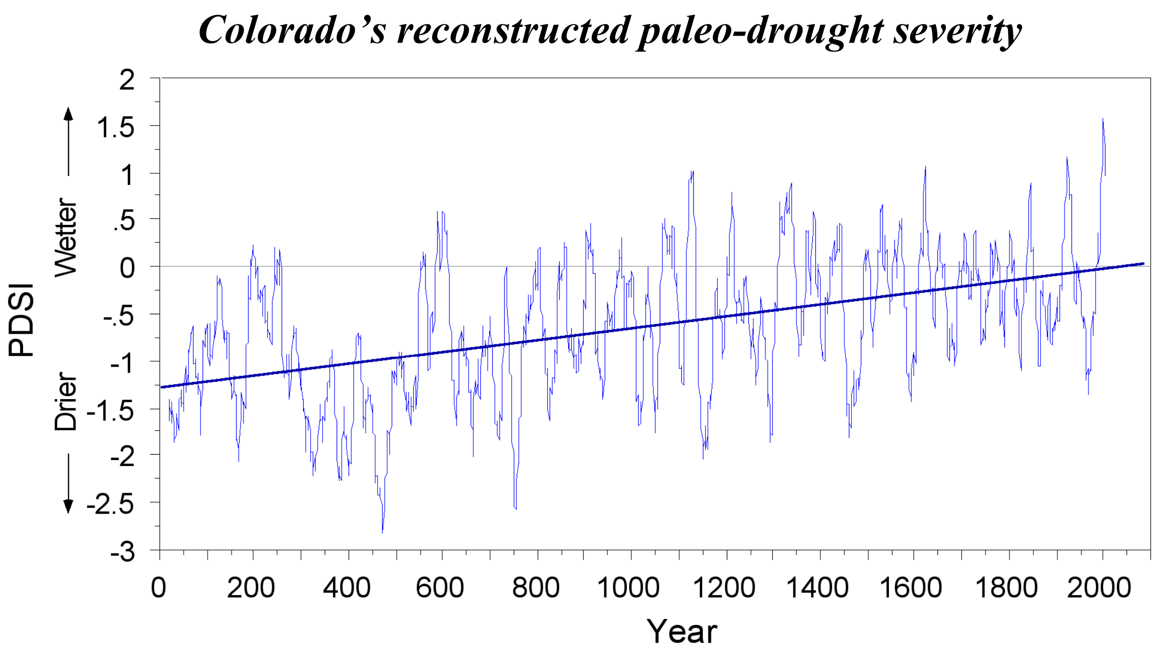


Figure 5. *The reconstructed summer (June, July, August) Palmer Drought Severity Index (PDSI) for Colorado from 0 A.D. to 2003 A.D. depicted as a 20-yr running mean. (National Climate Data Center, http://www.ncdc.noaa.gov/paleo/pdsi.html)*

Wildfires: There is a clear link between dry conditions and the outbreak of wildfires across the western United States, including the state of Colorado. Figure 6 shows the co-occurrence of regional wildfire and dry conditions in the U.S. Northern Rockies for the past several hundred years. Notice that most regional wildfire (red triangles) occur when conditions are dry (PDSI is below zero, or summer precipitation is less than normal). Most widespread wildfire outbreaks occur during times of low moisture levels.

Co-occurrence of droughts and wildfires in the Rocky Mountains

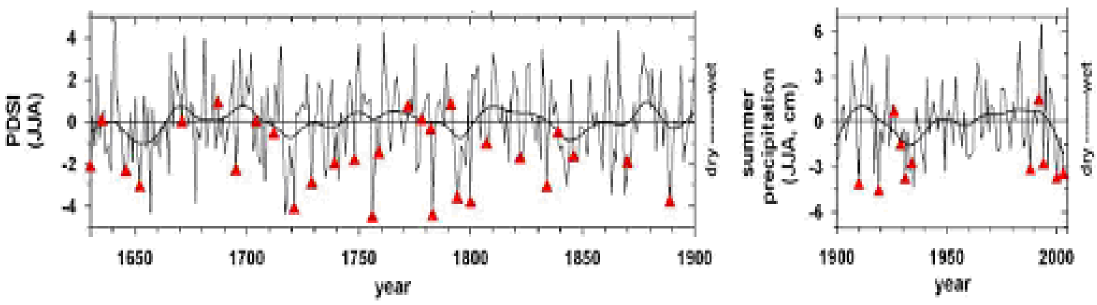


Figure 6. *Reconstructed summer Palmer Drought Severity Index during historical years (left) and regional summer precipitation during modern years (right) overlaid with the occurrence of regional wildfires (red triangles) in the Northern Rocky Mountains. (source Heyerdahl et al.)*

And, as we have seen from our review of the paleodrought history of Colorado (Figure 5), periods of low moisture levels are not uncommon and have been occurring for more than 2000 years.

A recent study created a paleo-reconstruction of wildfires across the western U.S. during the past 550 years using data collected on fire scars on trees (Kitzberger et al., 2007). In addition to finding the expected close occurrence between wildfires and droughts, the authors also found linkages between cycles of wildfire frequency and natural cycles of regional climate variability, both over the Pacific as well as the Atlantic Oceans. These natural cycles can go along way to explaining much of the variability in wildfire outbreaks.

Throughout history, wildfire and drought have been linked together in Colorado and the western United States. And wildfires and drought are both influenced by natural oscillations in patterns of sea surface temperature and atmospheric circulation systems in the Atlantic and Pacific oceans. There have been times in the past that have been extensively drier and have been associated with a greater frequency of wildfires than anything that we have experienced in the past 100 years, prior to any widespread human impact on the composition of the atmosphere. This demonstrates that without any human alterations, the climate can change and vary in such a manner as to make both drought and wildfire a much more common occurrence in the Colorado than it is today.

Heatwaves: The population of Colorado has become less sensitive to the impacts of excessive heat events over the course of the past 30-40 years. This is true in most major cities across the United States—a result of the increased availability and use of air-conditioning and the implementation of social programs aimed at caring for high-risk individuals—despite rising urban temperatures.

Heat-related mortality trends across the U.S.

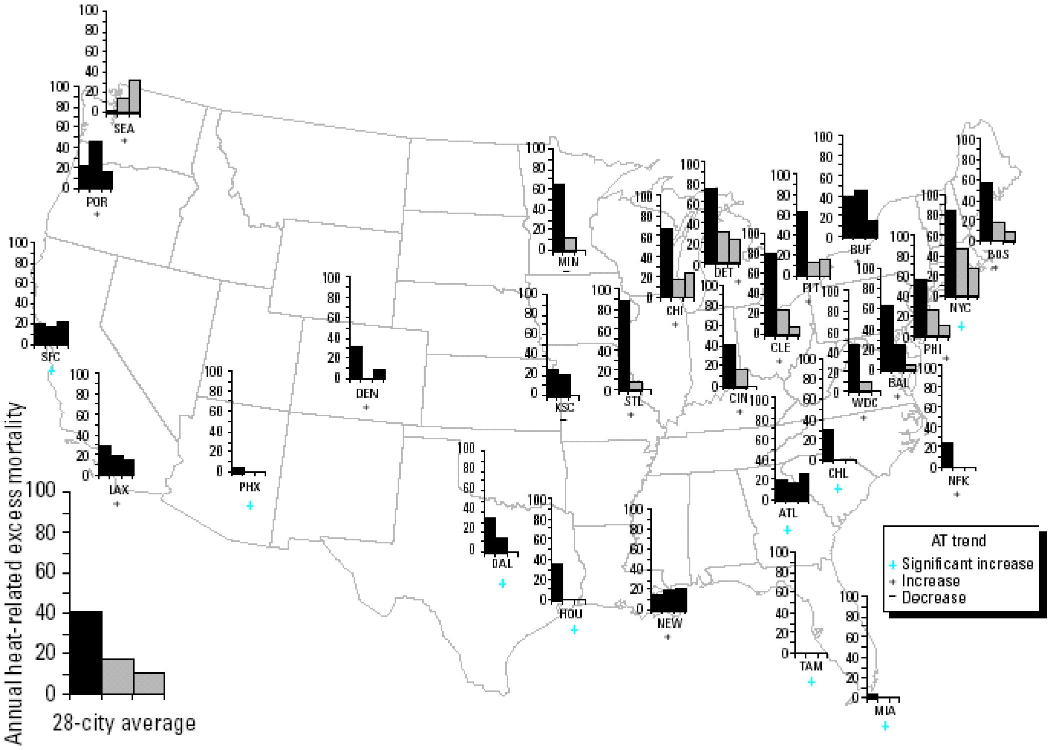


Figure 7. *Annual heat-related mortality rates (excess deaths per standard million population). Each histogram bar indicates a different decade (from left to right, 1970s, 1980s, 1990s). (Source: Davis et al., 2003b).*

A number of studies have shown that during the last several decades, the population in major U.S. cities has grown better adapted, and thus less sensitive, to the effects of excessive heat events (Davis et al., 2003ab). Each of the bars of the illustration above represents the annual number of heat-related deaths in 28 major cities across the United States. There should be three bars for each city, representing, from left to right, the decades of the 1970s, 1980s and 1990. For nearly all cities, including Denver, the number of heat-related deaths is declining (the bars are get smaller). This indicates that there has been a decrease in heat-related deaths over time—meaning that the population has become better adapted to heat waves. This adaptation is most likely a result of improvements in medical technology, access to air-conditioned homes, cars, and offices, increased public awareness of potentially dangerous weather situations, and proactive responses of municipalities during extreme weather events. Conversely, this also means that activist destruction of existing electricity generation capacity and prohibition of future capacity will link directly to preventable increased deaths.

The pattern of the distribution of heat-related mortality shows that in locations where extremely high temperatures are more commonplace, such as along the southern tier states, the prevalence of heat-related mortality is much lower than in the regions of the country where extremely high temperatures are somewhat rarer (e.g. the northeastern U.S.). This provides another demonstration that populations adapt to their prevailing climate conditions. If temperatures warm in the future and excessive heat events become more common, there is every reason to expect that adaptations will take place to lessen their impact on the general population.

Vector-borne diseases: Malaria, dengue fever, and West Nile Virus, which have been erroneously predicted to spread owing to "global warming," are not tropical diseases. Climate change will accordingly have a negligible effect on their transmission rates. These diseases are readily controlled by well-known public health policies.

Malaria epidemics occurred as far north as Archangel, Russia, in the 1920s, and in the Netherlands. Malaria was common in most of the United States until the 1950s (Reiter, 1996). In the late 1800s, when the United States was colder than today, malaria was endemic east of the Rocky Mountains—a region stretching from the Gulf Coast all the way up into northern Minnesota, including the eastern half of Colorado.

Malaria occurrence in the United States, 1880s

Figure 8. *In the late 19th century malaria was endemic in the shaded regions across the United States, including the eastern half of Colorado. (Source: Reiter, 2001)*

In 1878, 100,000 Americans were infected with malaria, and some 25,000 died. Malaria was eradicated from the United States in the 1950s not because of climate change (it was warmer in the 1950s than in the 1880s), but because of technological advances. Air-conditioning, the use of screen doors and windows, mosquito abatement spraying programs, the elimination of urban overpopulation brought about by the development of suburbs and automobile commuting were largely responsible for the decline in malaria (Reiter, 1996).

The effect of technology is also clear from statistics on dengue fever outbreaks, another mosquito-borne disease. In 1995, a dengue pandemic hit the Caribbean and Mexico. More than 2,000 cases were reported in the Mexican border town of Reynosa. But in the town of Hidalgo, Texas, located just across the river, there were only seven reported cases (Reiter, 1996). This is not just an isolated example. Data collected over the past decade have shown a similarly large disparity between incidence of disease in northern Mexico and in the southwestern United States, though there is very little to no climate difference.

Another "tropical" disease that is often wrongly linked to climate change is the West Nile Virus. The claim is often made that a warming climate is allowing the mosquitoes that carry West Nile Virus to spread into Colorado. This reasoning is incorrect. West Nile Virus, a mosquito-borne infection, was introduced to the United States through the port of New York in summer 1999. Since its introduction, it has spread rapidly, reaching the West Coast by 2002. Incidence has now been documented in every state as well as most provinces of Canada. This is not a sign that the U.S. and Canada are progressively warming. Rather, it is a sign that the existing environment is primed for the virus. In the infected territories, mean temperature has a range more than 40ºF. The virus can thrive from the tropics to the tundra of the Arctic – anywhere with a resident mosquito population. The already-resident mosquito populations of Colorado are appropriate hosts for the West Nile virus—as they are in every other state.

Impacts of climate-mitigation measures in Colorado

Globally, in 2003, humankind emitted 25,780 million metric tons of carbon dioxide (mmtCO_2: EIA, 2007a), of which emissions from Colorado accounted for 89.7 mmtCO_2, or only 0.35% (EIA, 2007b). The proportion of manmade CO_2 emissions from Colorado will decrease over the 21st century as the rapid demand for power in developing countries such as China and India outpaces the growth of Colorado's CO_2 emissions (EIA, 2007b).

During the past 5 years, global emissions of CO_2 from human activity have increased at an average rate of 3.5%/yr (EIA, 2007a), meaning that the annual *increase* of anthropogenic global CO_2 emissions is about 10 times greater than Colorado's *total* emissions. Even a complete cessation of *all* CO_2 emissions in Colorado will be undetectable globally. *A fortiori,* regulations prescribing a *reduction*, rather than a complete cessation, of Colorado's CO_2 emissions will have no effect on global climate.

Wigley (1998) examined the climate impact of adherence to the emissions controls agreed under the Kyoto Protocol by participating nations, and found that, if all developed countries meet their commitments in 2010 and maintain them through 2100, with a mid-range sensitivity of surface temperature to changes in CO_2, the amount of warming "saved" by the Kyoto Protocol would be 0.07°C by 2050 and 0.15°C by 2100. The global sea level rise "saved" would be 2.6 cm, or one inch. A complete cessation of CO_2 emissions in Colorado is only a tiny fraction of the worldwide reductions assumed in Dr. Wigley's global analysis, so its impact on future trends in global temperature and sea level will be only a minuscule fraction of the negligible effects calculated by Dr. Wigley.

We now apply Dr. Wigley's results to CO_2 emissions in Colorado, assuming that the ratio of U.S. CO_2 emissions to those of the developed countries which have agreed to limits under the Kyoto Protocol remains constant at 39% (25% of global emissions) throughout the 21st century. We also assume that developing countries such as China and India continue to emit at an increasing rate. Consequently, the annual proportion of global CO_2 emissions from human activity that is contributed by human activity in the United States will decline. Finally, we assume that the *proportion* of total U.S. CO_2 emissions in Colorado – now 1.5% – remains constant throughout the 21st century. With these assumptions, we generate the following table derived from Wigley's (1998) mid-range emissions scenario (which itself is based upon the IPCC's scenario "IS92a"):

Table 1

Projected annual CO_2 emissions ($mmtCO_2$)

Year	Global emissions: *Wigley, 1998*	Developed countries: *Wigley, 1998*	U.S. (39% of developed countries)	Colorado (1.5% of U.S.)
2000	26,609	14,934	5,795	89
2025	41,276	18,308	7,103	107
2050	50,809	18,308	7,103	107
2100	75,376	21,534	8,355	125

Note: *Developed countries' emissions, according to Wigley's assumptions, do not change between 2025 and 2050: neither does total U.S or Colorado emissions.*

In Table 2, we compare the total CO_2 emissions saving that would result if Colorado's CO_2 emissions were completely halted by 2025 with the emissions savings assumed by Wigley (1998) if all nations met their Kyoto commitments by 2010, and then held their emissions constant throughout the rest of the century. This scenario is "Kyoto Const."

Table 2

Projected annual CO_2 emissions savings ($mmtCO_2$)

Year	Colorado	Kyoto Const.
2000	0	0
2025	107	4,697
2050	107	4,697
2100	125	7,924

Table 3 shows the proportion of the total emissions reductions in Wigley's (1998) case that would be contributed by a complete halt of all Colorado's CO_2 emissions (calculated as column 2 in Table 2 divided by column 3 in Table 2).

Table 3

Colorado' percentage of emissions savings

Year	Colorado
2000	0.0%
2025	2.3%
2050	2.3%
2100	1.6%

Using the percentages in Table 3, and assuming that temperature change scales in proportion to CO_2 emissions, we calculate the global temperature savings that will result from the complete cessation of anthropogenic CO_2 emissions in Colorado:

Table 4

Projected global temperature savings (ºC)

Year	Kyoto Const	Colorado
2000	0	0
2025	0.03	0.0007
2050	0.07	0.002
2100	0.15	0.003

Accordingly, a cessation of all of Colorado's CO_2 emissions would result in a climatically-irrelevant global temperature reduction by the year 2100 of about three *thousandths* of a degree Celsius. Results for sea-level rise are also negligible:

Table 5

Projected global sea-level rise savings (cm)

Year	Kyoto Const	Colorado
2000	0	0
2025	0.2	0.005
2050	0.9	0.02
2100	2.6	0.04

A complete cessation of all anthropogenic emissions from Colorado will result in a global sea-level rise savings by the year 2100 of an estimated 0.04 cm, or two *hundredths* of an inch. Again, this value is climatically irrelevant.

Even if the entire Western world were to close down its economies completely and revert to the Stone Age, without even the ability to light fires, the *growth* in emissions from China and India would replace our *entire* emissions in little more than a decade. *The CO2 emissions "savings" from shutting down the entire state of Colorado would be replaced in the atmosphere in less than two months from just the increase of world emissions, to say nothing of natural flux. In this context, any cuts in emissions from Colorado would be extravagantly pointless.*

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Costs of Federal Legislation

And what would be the potential costs to Colorado of federal legislative actions designed to cap greenhouse gas emissions? An analysis was recently completed by the Science Applications International Corporation (SAIC), under contract from the American Council for Capital Formation and the National Association of Manufacturers (ACCF and NAM), using the National Energy Modeling System (NEMS); the same model employed by the US Energy Information Agency to examine the economic impacts.

For a complete description of their findings please visit:
http://instituteforenergyresearch.org/economic-impact/index.php

To summarize, SAIC found that by the year 2020, average annual household income in Colorado would decline by $977 to $3167 and by the year 2030 the decline would increase to between $4019 and $7328. The state would stand to lose between 21,000 and 31,000 jobs by 2020 and between 57,000 and 76,000 jobs by 2030. At the same time gas prices could increase by over $5 a gallon by the year 2030 and the states' Gross Domestic Product could decline by then by as much as $11.6 billion/yr.

All this economic hardship and human suffering would come with absolutely no detectable impact on the course of future climate. This is the epitome of a scenario that is all pain and no gain, and a capital case of heroic lunacy.

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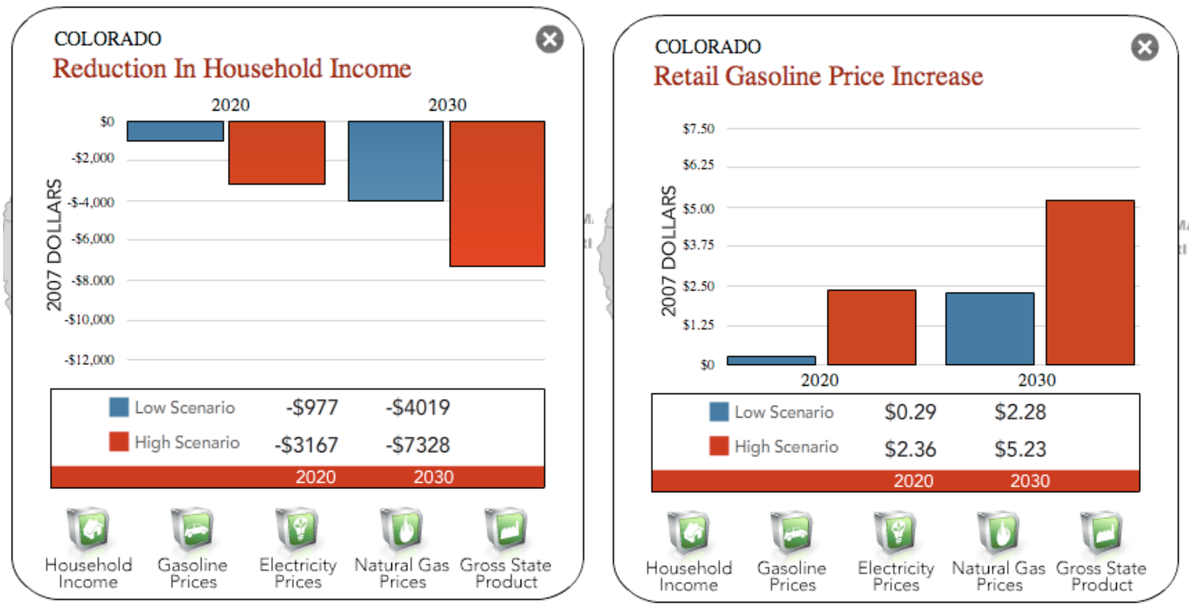

Figure 9. *The economic impacts in Colorado of federal legislation to limit greenhouse gas emissions green. (Source: Science Applications International Corporation, 2008, http://instituteforenergyresearch.org/economic-impact/index.php)*

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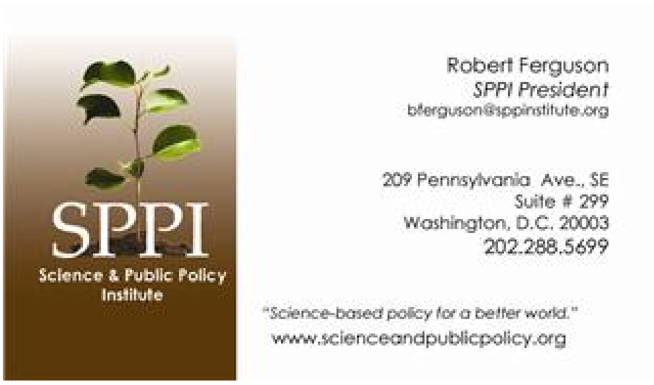

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