

## Colorado Climate Encyclopedia Entry

The combination of high elevation, mid-latitude, and interior continent geography results in a cool, dry but invigorating climate. The average annual temperature for the state is 43.5 degrees, which is 13.7 degrees below the global mean. The average statewide precipitation is 17", which is much lower than the global mean of 38". There are large seasonal swings in temperature and large day to night changes. The climate of local areas is profoundly affected by differences in elevation, and to a lesser degree, by the orientation of mountain ranges and valleys with respect to general air movements. Wide variations occur within short distances. For instance, the difference (35 degrees F) in annual mean temperature between Pikes Peak and Las Animas, 90 miles to the southeast, is about the same as that between southern Florida and Iceland.

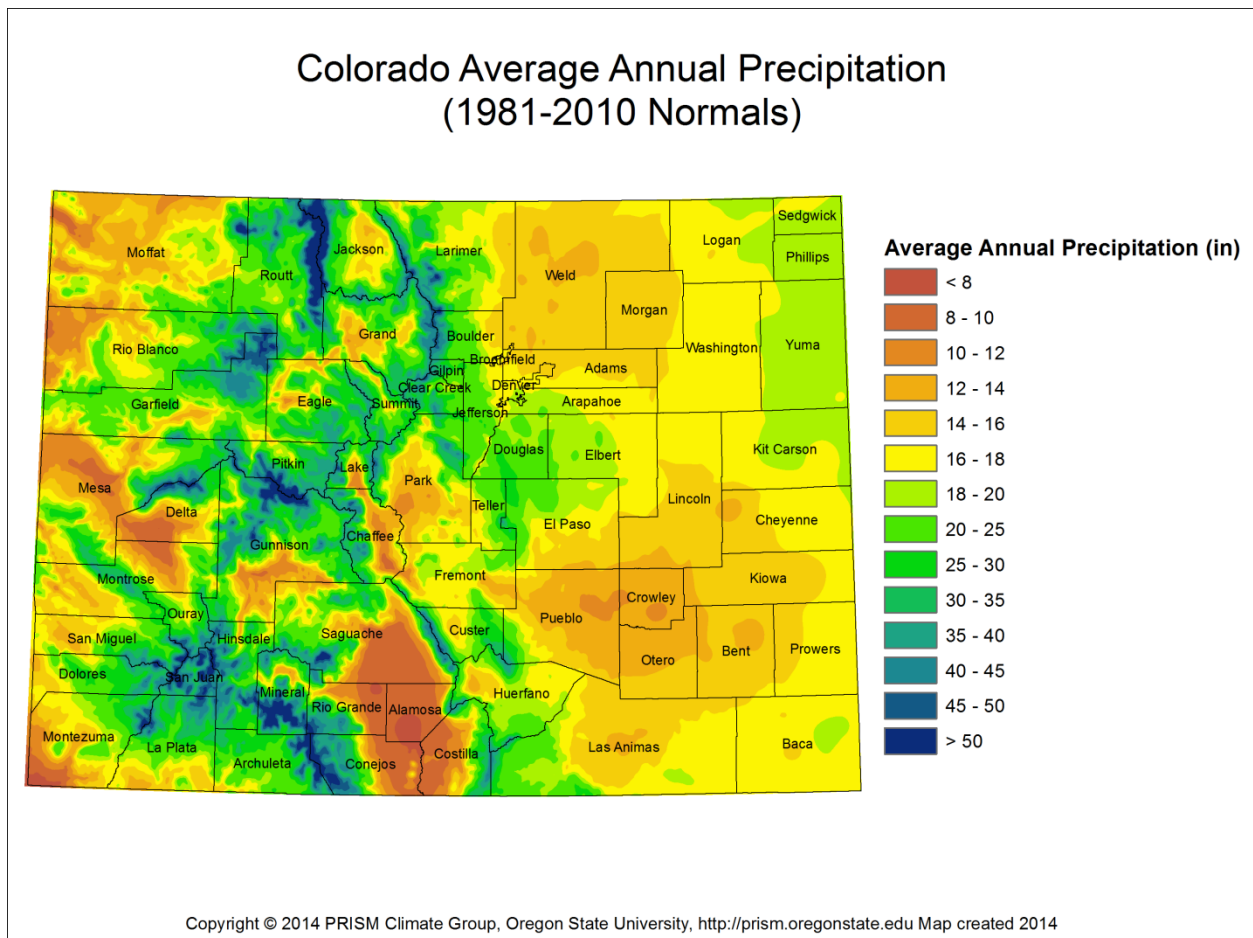
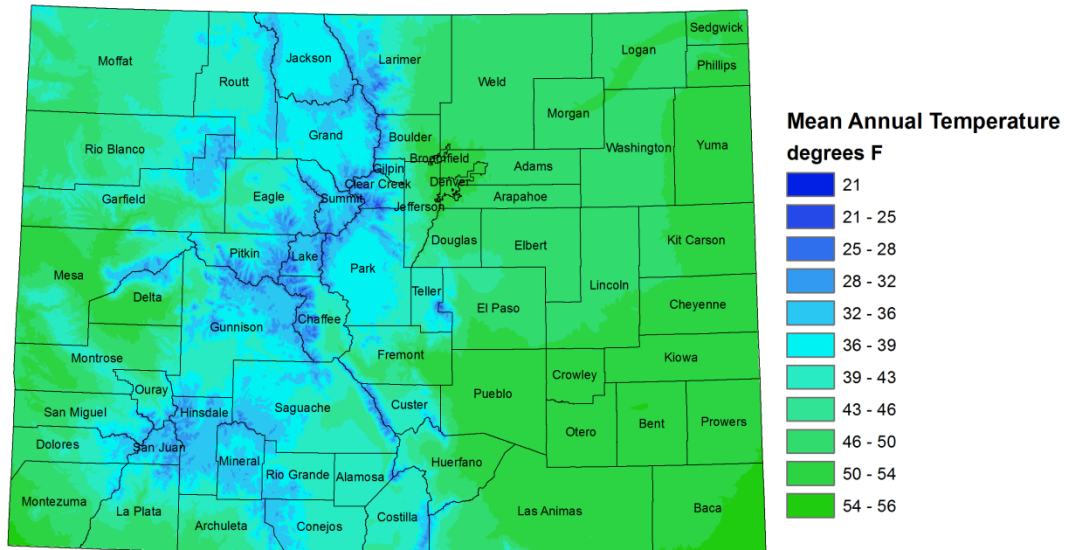


Figure 1: The map above depicts the average annual precipitation across the state of Colorado. Averages were computed by the PRISM Climate Group at 4-km resolution.

## Colorado Mean Annual Temperature (1981-2010 Normals)



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Figure 2: The map above depicts the average annual temperature across the state of Colorado. Averages were computed by the PRISM Climate Group at 4-km resolution.



*Photo 1: The photo above shows the instrumentation at the historic Fort Collins Weather Station.*

Different regions of Colorado have unique characteristics not shared across the entire state. Here these characteristics are broken down for Eastern Colorado, the Colorado Mountains, and Western Colorado.

Eastern Colorado: The climate of the plains is comparatively uniform from place to place, with characteristic features of low relative humidity, abundant sunshine, infrequent rains and snow, moderate to high wind movement, and a large daily and seasonal range in temperature. Summer daily maximum temperatures are often 95 F or above. Winter extremes are generally between zero and -15 F. The difference between the hottest and coldest officially recorded temperatures on the eastern plains is greater than 150 F.

### Maximum, Minimum, and Average Temperatures for Eastern Colorado 1981–2010

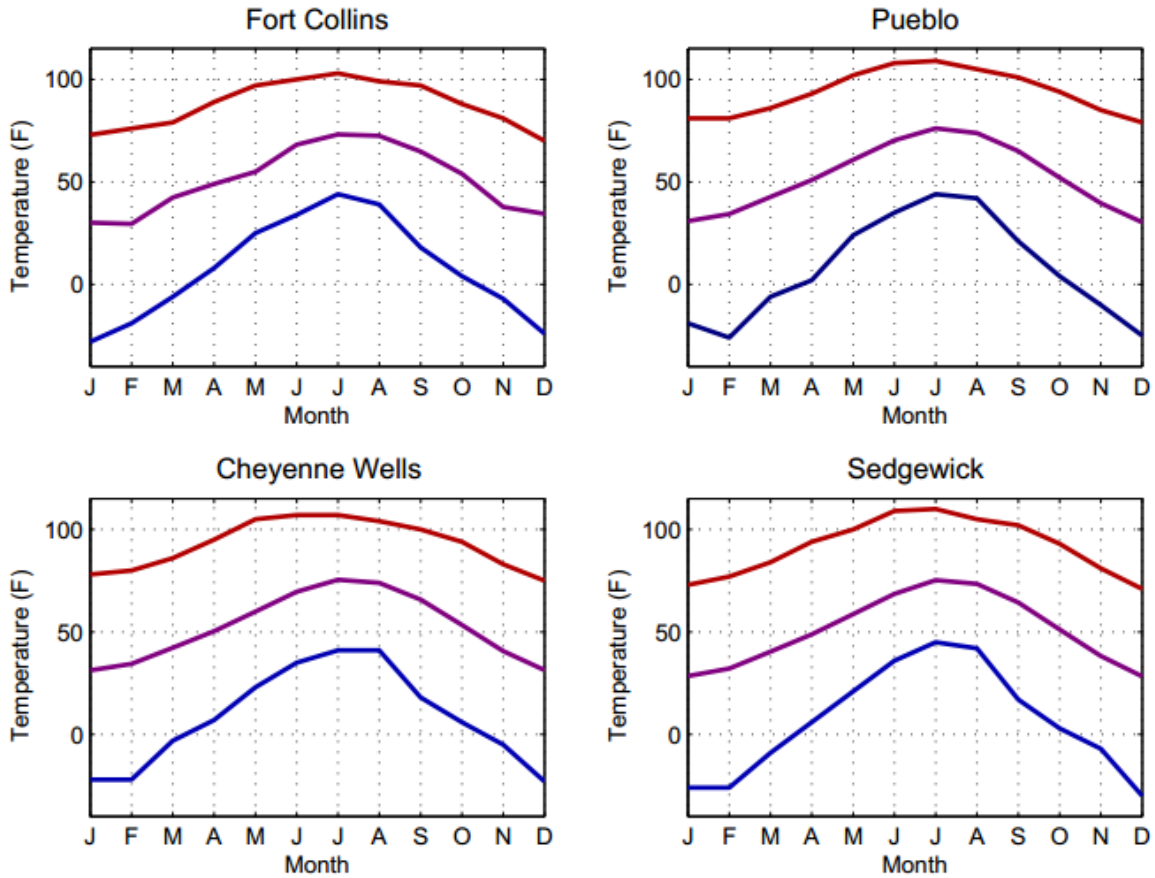


Figure 3: The four-panel plot above depicts recorded temperature data for four weather stations across eastern Colorado. Maximum temperatures recorded for each month are reported in red. Minimum temperatures are reported in blue. Average temperatures are reported in purple.

Average precipitation in eastern Colorado is between 10 and 20 inches. The wettest areas are on the northeastern plains near the Colorado-Kansas or Colorado-Nebraska border. The low elevation areas both north and south of the Palmer Divide, and directly east of the Rockies are the driest. Most of this precipitation falls either in the form of widespread soaking rains in April through early June, or as intense bursts of precipitation from thunderstorms in June through August. Year-to-year precipitation is highly variable and highly dependent on the number of large rain events in late spring and summer. It may be much higher or lower than average in any given year regardless of the phase of El Niño. Summertime thunderstorms may be severe with the most common associated threat being hail.

## Monthly Precipitation Totals for Eastern Colorado 1981–2010

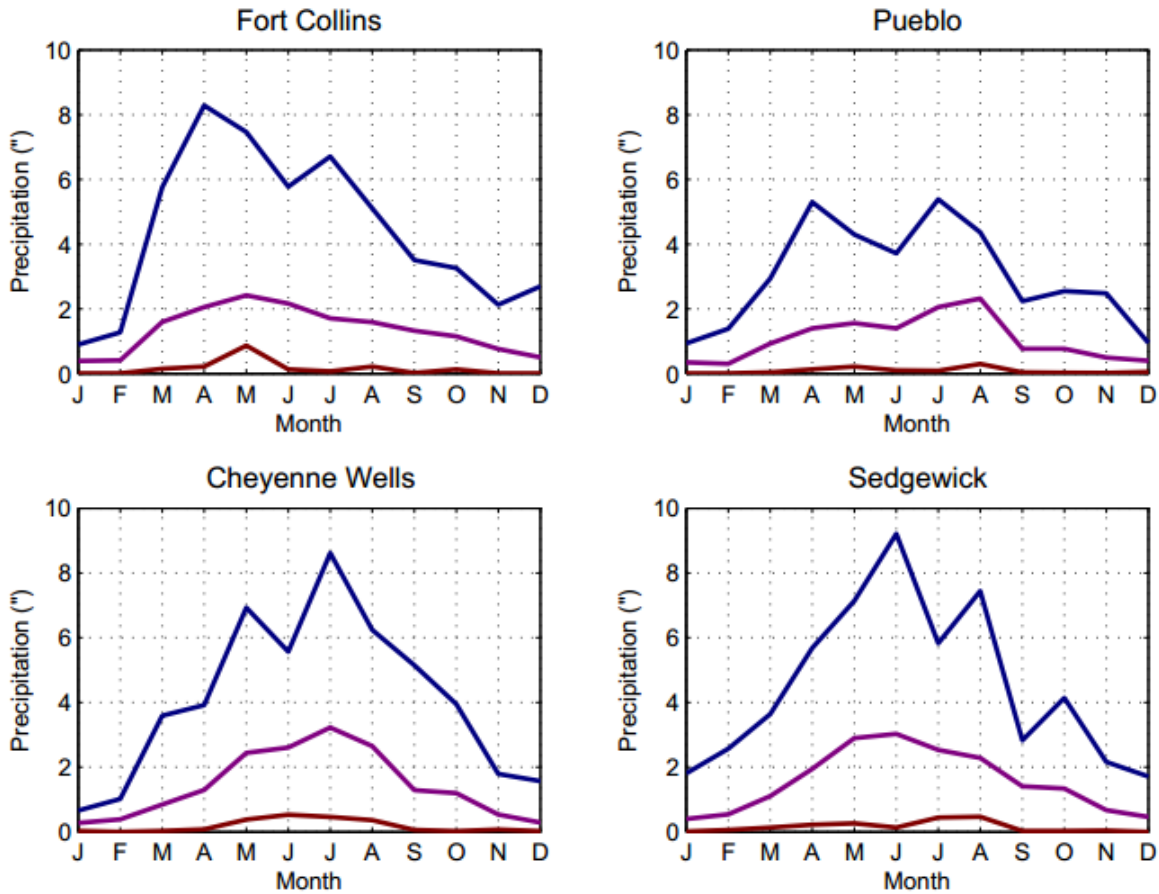


Figure 4: The four-panel plot above depicts monthly precipitation accumulations for four weather stations across eastern Colorado. Maximum accumulations recorded for each month are reported in blue. Minimum accumulations are reported in red. Monthly average accumulations are reported in purple.

Tornadoes will occur in almost every year somewhere in eastern Colorado between mid-May and early August. They are most often small, registering as an EF0 or EF1. The most frequent zone for tornadogenesis in all of the United States is a narrow, north-south-oriented strip of land situated northeast of the Denver metropolitan area.



*Photo 2: The photo above depicts the touchdown of a tornado near Wray, Colorado in June of 2016. This photo is courtesy of the KUSA Denver station.*

At the western edge of the plains and near the foothills of the mountains, there are a number of significant changes in climate. Average wind movement is less, but areas very near the mountains are subject to periodic, severe turbulent winds from the effects of high westerly winds over the mountain barrier. These winds are sometimes referred to as "chinook winds" when they warm, and "bora winds" when they are associated with a strong cold frontal passage downslope off of the mountains.

Colorado Mountains: Colorado is best known for its mountains. They occupy less of the area of the state than many realize, but they profoundly impact the climate of the entire region. The main feature of the mountainous area of central and western Colorado is the dramatic differences in climate over short distances. With elevations ranging from below 7,000 feet in the lower mountain valleys to more than 14,000 feet on the highest peaks, all aspects of the climate are affected: temperature, humidity, precipitation and, of course, wind. In general, temperatures decrease with elevation. This change in temperature with elevation is most profound on summer afternoons when temperatures consistently decrease by 4-5 F/1000 ft. Air heated at elevation quickly becomes unstable, causing it to rise and be whisked away from the land surface. This puts a low upper threshold on high temperatures at elevation. On clear and calm nights, especially with snow cover, the land surface very effectively radiates away the day's heat, and the coldest, densest air settles into the mountain river valleys. As such, the most extreme cold in the state of Colorado actually occurs in the mountain valleys, and not on the mountain

peaks. Under extreme conditions, temperatures have dipped as low as  $-60^{\circ}\text{F}$  at Taylor Reservoir and  $-61^{\circ}\text{F}$  along the Yampa valley in northwestern Colorado.

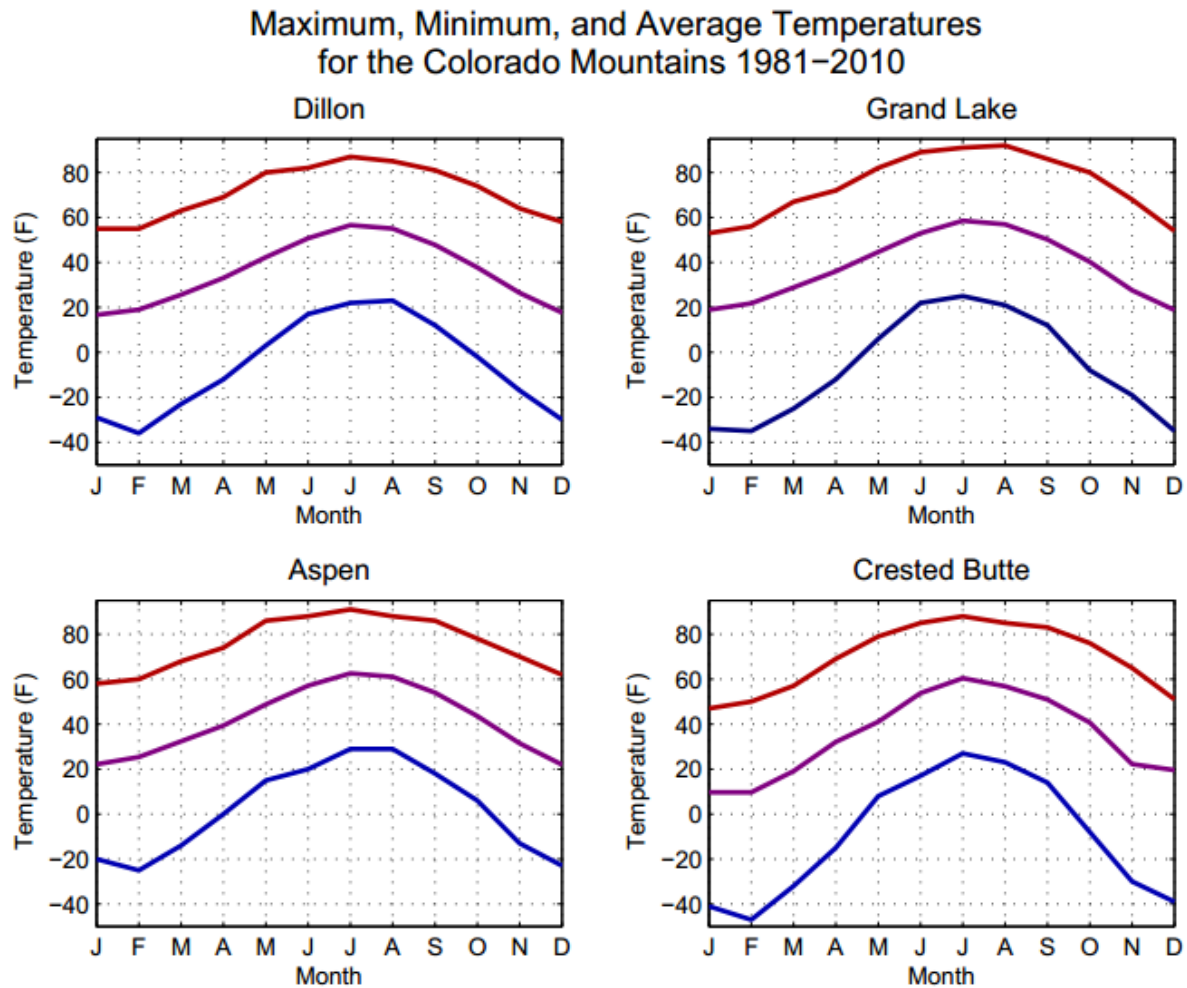


Figure 5: The four-panel plot above depicts recorded temperature data for four weather stations in the Colorado Mountains. Maximum temperatures recorded for each month are reported in red. Minimum temperatures are reported in blue. Average temperatures are reported in purple.

Wind patterns in the mountains are almost always controlled by topography. Mountain-valley circulations are common with winds often blowing up the valley from lower to higher elevation during the day reversing and blowing down the valleys at night. The mountains form a substantial block to regional air motion causing winds in most valleys west of the Continental Divide to be very light, especially in fall and winter, while winds along and east of the crest of the Continental Divide are much stronger and typically blow from a westerly direction much of the cool half of the year.

Precipitation patterns are largely controlled by mountain ranges and elevation, and to a lesser extent the direction of prevailing airflow. When weather systems move in from the west and northwest during the winter and spring months it is the mountain peaks that first intercept the air that receive the most precipitation. These areas are the wettest areas in the state of Colorado. Buffalo Pass at the north

end of the state and Wolf Creek Pass at the south end of the state both receive over 50" of precipitation and 350" of snowfall annually. Some of the high mountain valleys, which lie in the rain shadow of mountains, are the driest areas in the state, and receive an average of less than 10" of precipitation/year. Precipitation increases with elevation both winter and summer but the elevation effect is greatest in mid-winter when winds at mountain top level are typically strongest. High peaks and mountain ranges generally receive the majority of their precipitation during with winter months. Mountain precipitation primarily falls as snow from November through Mid-May. This creates seasonal snowpack about 9000 ft, lower in some areas.

### Monthly Precipitation Totals for the Colorado Mountains 1981-2010

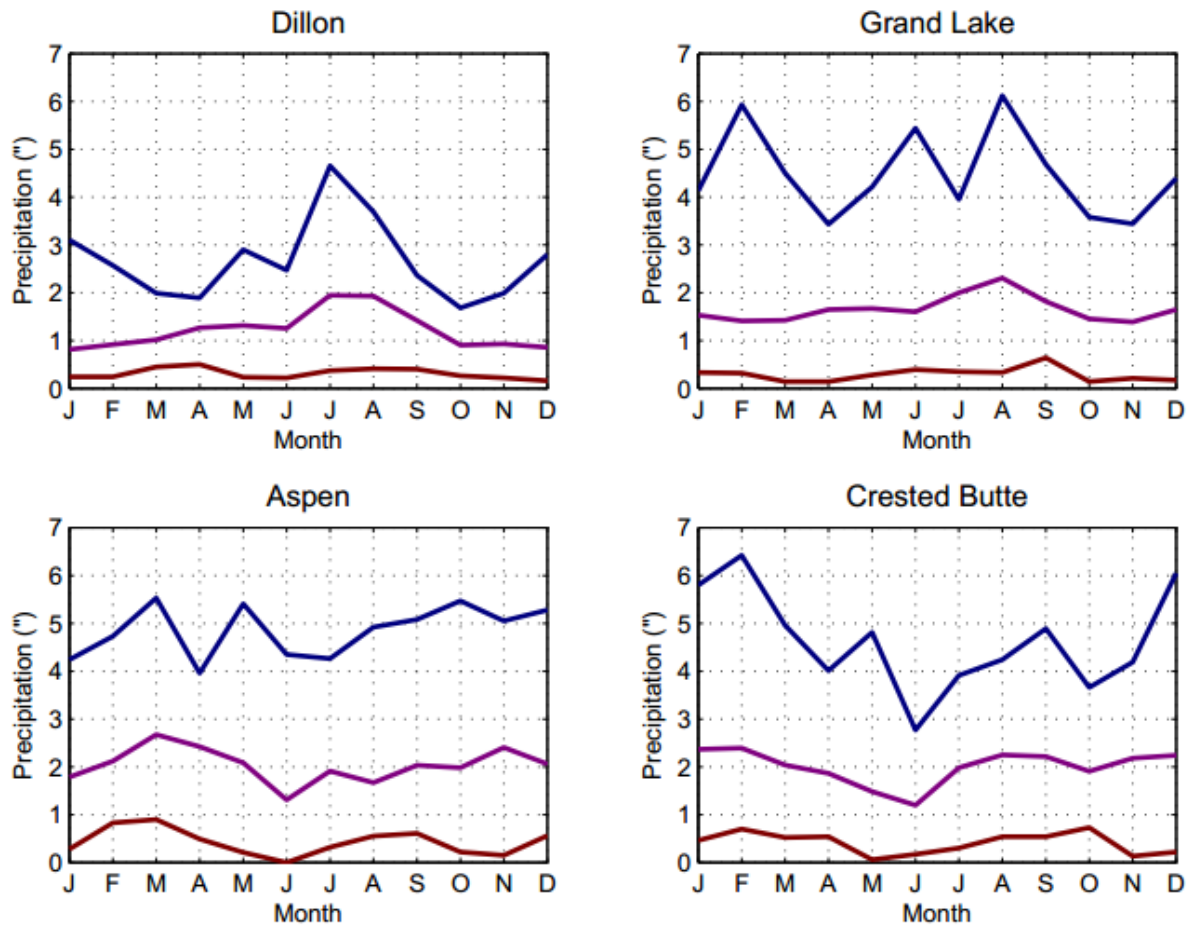


Figure 6: The four-panel plot above depicts monthly precipitation accumulations for four weather stations in the Colorado Mountains. Maximum accumulations recorded for each month are reported in blue. Minimum accumulations are reported in red. Monthly average accumulations are reported in purple.





*Photo 3: The photo above shows snowpack on top of Mount Princeton, one of Colorado's 14,000ft mountains. The temperature this morning was -18 degrees. Photo credit goes to Colorado Guy.*

Western Colorado: Farther west in Colorado the topography becomes slightly less extreme with lower elevations and combinations of canyons and plateaus. Elevation and topography remain dominant controls of local climates, but precipitation gets progressively less and temperature progressively warmer approaching the Utah border. Western Colorado winter weather is colder but calmer and less variable than east of the mountains. Temperatures can drop below zero F in all areas of western Colorado, but the valleys of west central and southwest Colorado receive abundant sunshine and the

winter climate is not harsh.

### Maximum, Minimum, and Average Temperatures for Western Colorado 1981–2010

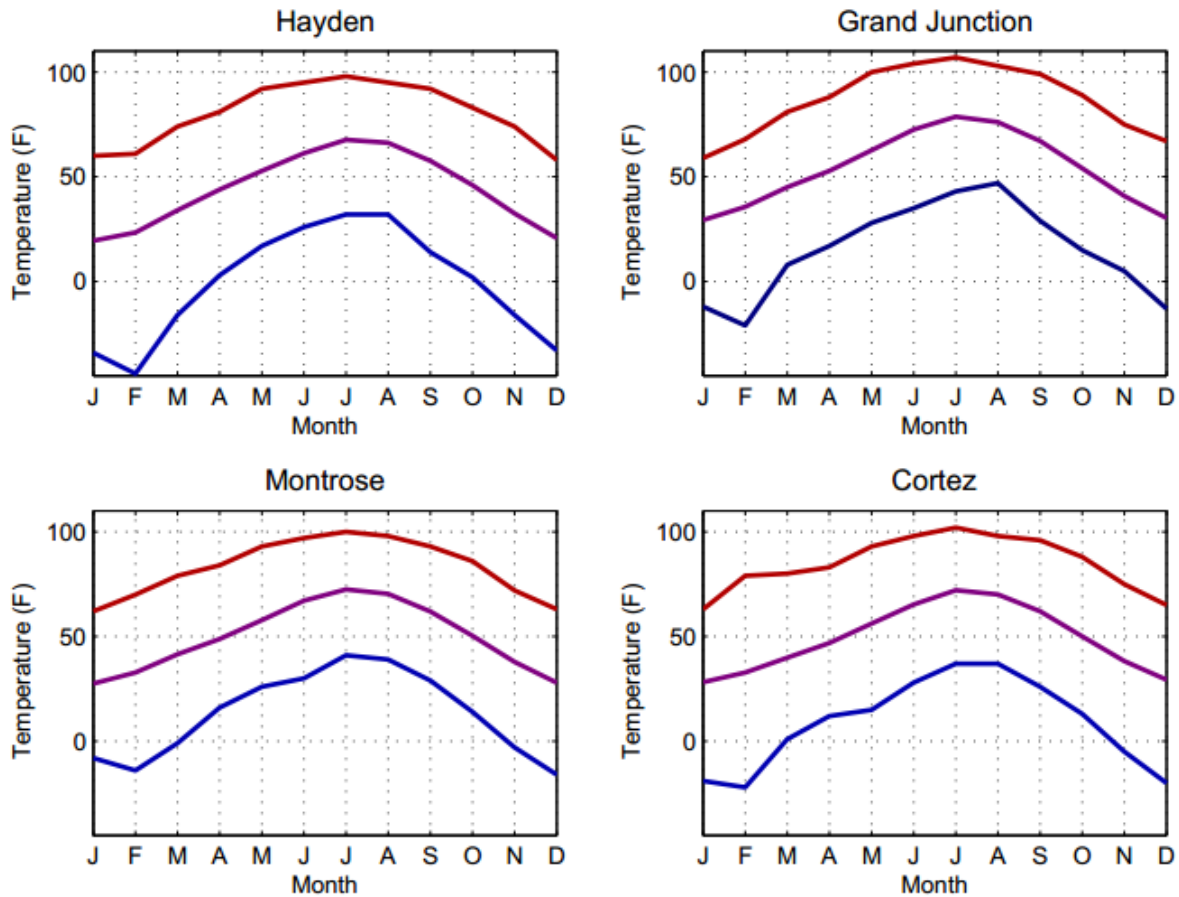


Figure 7: The four-panel plot above depicts recorded temperature data for four weather stations in western Colorado. Maximum temperatures recorded for each month are reported in red. Minimum temperatures are reported in blue. Average temperatures are reported in purple.

Precipitation west of the Continental Divide is more evenly distributed throughout the year than in the eastern plains. For most of western Colorado, the greatest monthly precipitation occurs in the winter months, while June is the driest month. Near the Utah border, late summer and early autumn can be the wettest time of year. During this time moisture from the Gulf of Mexico and Tropical Eastern Pacific is funneled northward into the state, and often falls as precipitation during afternoon thunderstorms.

### Monthly Precipitation Totals for Western Colorado 1981–2010

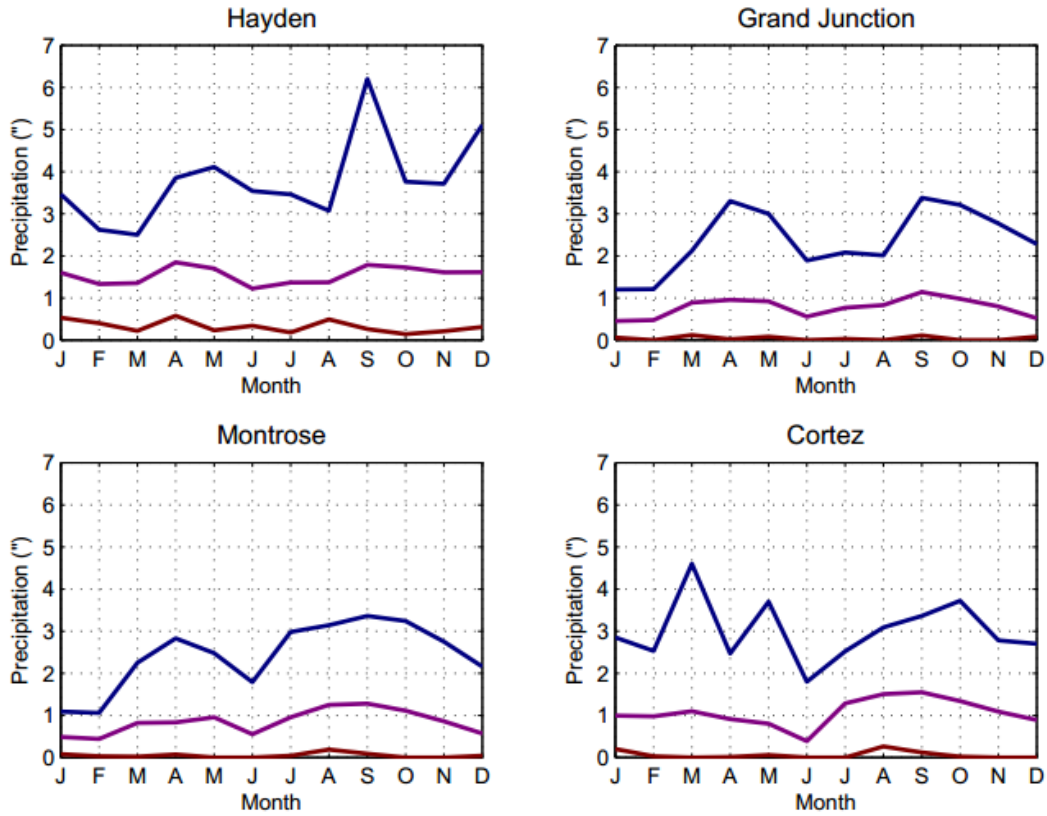


Figure 8: The four-panel plot above depicts monthly precipitation accumulations for four weather stations across western Colorado. Maximum accumulations recorded for each month are reported in blue. Minimum accumulations are reported in red. Monthly average accumulations are reported in purple.



*Photo 4: The Grand Mesa of western Colorado is shown here on a sunny afternoon. Photo credit: Grand Mesa Repeater Association.*

Severe Weather: A variety of types of threatening weather events are possible in Colorado. These include extreme cold, extreme heat, blizzard, high wind events, seasonal flooding, flash flooding, drought, forest fires, lightning, hail, and tornadoes. Despite being a semi-arid climate the most historically damaging events both from an economic standpoint are flash floods and droughts. The deadliest severe weather events in the state have historically been flash floods. The most flash-flood prone regions of Colorado are found along the base of the lower foothills east of the mountains. Several extreme floods, such as the Fort Collins Flood of 1997, the Front Range Flood of 2013 and the infamous Big Thompson Canyon flood of July 31, 1976, have occurred in this vulnerable area. The Big Thompson Flood is the deadliest single weather event in Colorado history, and took the lives of 144 people.



*Photo 5: The image above shows a helicopter view of road devastation in the Big Thompson Canyon during the Front Range Flood of 2013. Photo credit: Colorado National Guard.*

A Changing Climate: Measured temperature trends averaged across the state of Colorado are statistically significant for the last 30, 50, and 100 years. The greatest warming has occurred in the southwest corner of the state, the San Luis Valley in south-central Colorado, and along the northern Front Range. The southeastern corner of the state has actually undergone a slight cooling over the last century. Temperatures have risen by 3.4 F in the spring, 2.4 F in the summer, 2.3 F in the winter, and 1.5 F in the fall. Due to lack of reliable historic temperature data at high elevations it is not known whether or not warming is preferentially occurring at high elevations.

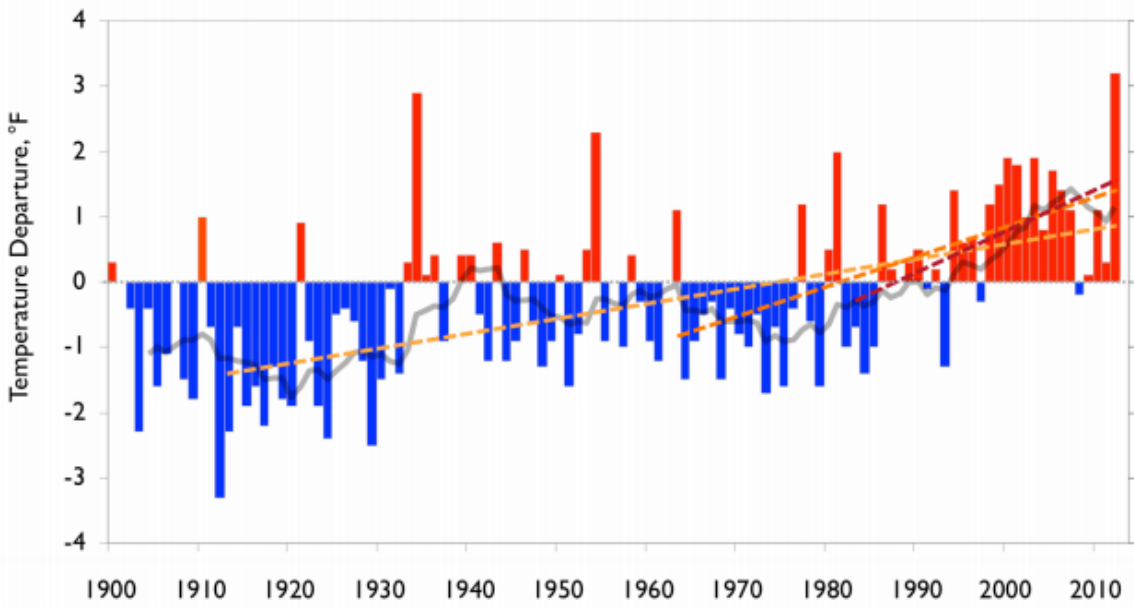


Figure 9: Depicted here are the yearly temperature departures from normal measured, and averaged across the state of Colorado (F). Departures are relative to a 1971-2000 reference period. Each bar represents one year. Blue (red) indicates a year of below (above) average temperature. The gray line shows decadal average temperature. The dashed lines show temperature trends for the last 30, 50, and 100 years.

There are no detectable widespread trends in precipitation across the state of Colorado. Average snowpack in Colorado is lower than 30 years ago, but there is not a statistically significant decreasing trend in snowpack. Climate modeling studies suggest Colorado seasonal snowpack is vulnerable to projected increases in temperatures, but less so than the Cascades and Sierras of the western United States.

**References:**

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**Additional Information:**

Colorado Climate Center – <http://climate.colostate.edu>

National Climate Data Center - <https://www.ncdc.noaa.gov/>

National Weather Service - <http://www.weather.gov/>