Climate of Colorado

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TOPOGRAPHIC FEATURES

To understand the regional and local climates of Colorado, you must begin with a basic knowledge of Colorado's topography. Colorado lies astride the highest mountains of the Continental Divide. Nearly rectangular, its north and south boundaries are the 41° and 37° N. parallels, and the east and went boundaries are the 102° and 109° W. meridians. It is eighth in size among the 50 states, with an area of over 104,000 square miles. Although known for its mountains, nearly 40 percent of its area is taken up by the eastern high plains.

Of particular importance to the climate are Colorado's interior continental location in the middle latitudes, the high elevation of the entire region, and the mountains and ranges extending north and south approximately through the middle of the State. With an average altitude of about 6,800 feet above sea level, Colorado is the highest contiguous State in the Union. Roughly three-quarters of the Nation's land above 10,000 feet altitude lies within its borders. The State has 59 mountains 14,000 feet or higher, and about 830 mountains between 11,000 and 14,000 feet in elevation.

Emerging gradually from the plains of Kansas and Nebraska, the high plains of Colorado slope gently upward for a distance of some 200 miles from the eastern border to the base of the foothills of the Rocky Mountains. The eastern portion of the State is generally level to rolling prairie broken by occasional hills and bluffs. Although subtle when compared to the high mountains of the Rockies, there are also important topographic features across eastern Colorado. Two major river valleys dissect eastern Colorado – the South Platte River in northeastern Colorado and the Arkansas River to the southeast. Higher ground extends eastward from the Rockies between the river valleys. High ground also extends eastward along the New Mexico border to the south and along the Wyoming and Nebraska borders to the north. These features have an impact on temperatures, wind patterns and storm tracks in all season of the year.

Elevations along the eastern border of Colorado range from about 3,350 feet at the lowest point in the State where the Arkansas River crosses into Kansas to near 4,000 feet. Elevations increase towards the west to between 5,000 and 6,500 feet where the plains meet the Front Range of the Rocky Mountain chain. Here elevations rise abruptly to 7,000 to 9,000 feet. Backing the foothills are the mountain ranges above 9,000 feet with the higher peaks over 14,000 feet. The most dramatic feature is Pike's Peak near Colorado Springs where elevations rise abruptly from less then 5,000 feet near Pueblo in the Arkansas Valley to over 14,000 feet at the top of the mountain. During the summer months, this topographic feature becomes a "thunderstorm machine" as thunderstorms develop almost any day that humidity is sufficiently high.

West of these "front ranges" are additional ranges, generally extending north and south, but with many spurs and extensions in other directions. These

ranges enclose numerous high mountain parks and valleys. Farther westward the mountains give way to rugged plateau country in the form of high mesas (some more than 10,000 feet in elevation) which extends to the western border of the State. This land is often cut by rugged canyons, the work of the many steams fed by accumulations of winter snow.

Colorado is a headwater state. All rivers in Colorado rise within its borders and flow outward, with the exception of the Green River, which flows diagonally across the extreme northwestern corner of the State. Four of the Nation's major rivers have their source in Colorado: the Colorado, the Rio Grande, the Arkansas, and the Platte.

GENERAL CLIMATE

The combination of high elevation, mid latitude interior continent geography results in a cool, dry but invigorating climate. There are large seasonal swings in temperature and large day to night changes. During summer there are hot days in the plains, but these are often relieved by afternoon thundershowers. Mountain regions are nearly always cool. Humidity is generally quite low; this favors rapid evaporation and a relatively comfortable feeling even on hot days. The thin atmosphere allows greater penetration of solar radiation and results in pleasant daytime conditions even during the winter. Outdoor work and recreation can often be carried out in relative comfort year round, but sunburn and skin cancer is a problem due to the intense high-elevation sunlight. At night, temperatures drop quickly, and freezing temperatures are possible in some mountain locations every month of the year.

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. The difference (35°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. The annual snowfall at Wolf Creek Pass (elevation 10,850 feet) in the southern mountains is averages nearly 400 inches and sometimes exceeds 600 inches while at Manassa in the San Luis Valley just east of Wolf Creek Pass annual snowfall is barely 40 inches. Statewide average annual precipitation is 17 inches but ranges from only 7 inches in the middle of the San Luis Valley in south central Colorado to over 60 inches in a few mountain locations. While temperature decreases, and precipitation generally increases with altitude, these patterns are modified by the orientation of mountain slopes with respect to the prevailing winds and by the effect of topographical features in creating local air movements.

As a result of the State's distance from major sources of moisture (the Pacific Ocean and the Gulf of Mexico), precipitation is generally light in the lower elevations. Prevailing air currents reach Colorado from westerly directions. Eastward-moving storms originating in the Pacific Ocean lose much of their moisture falling as rain or snow on the mountaintops and westward-facing slopes. Eastern slope areas receive relatively small amounts of precipitation from these storms, particularly in mid winter

Storms moving from the north usually carry little moisture. The frequency of such storms increases during the fall and winter months, and decreases rapidly in the spring. The accompanying outbreaks of polar air are responsible

for the sudden drops in temperature often experienced in the plains sections of the State. Occasionally these outbreaks are attended by strong northerly winds which come in contact with moist air from the south; the interaction of these air masses can cause a heavy fall of snow and the most severe of all weather conditions of the high plains, the blizzard. This cold air is frequently too shallow to cross the mountains to the western portion of the State so while the plains are in the grip of a very severe storm, the weather in the mountains and western valleys may be mild.

Occasionally, when the plains are covered with a shallow layer of cold air, strong westerly winds aloft work their way to the surface. Warmed by rapid descent from higher levels, these winds bring large and sudden temperature rises. This phenomenon is the "chinook" of the high plains and temperature rises of 25 to 35°F within a short time are not uncommon. Chinook winds greatly moderate average winter temperatures in areas near enough to the mountains to experience them frequently. Due to these wind patterns, some locations in the eastern foothills are warmer than adjacent areas on the eastern plains on many days during the winter.

Warm, moist air from the south moves into Colorado infrequently, but most often in the spring, summer and early autumn. As this air is carried northward and westward to higher elevations, the heaviest and most general rainfalls (and sometimes wet snows) occur over the eastern portions of the State from April through early September. For southern and western Colorado, the intrusions of moist air are most common from mid July into September associated with wind patterns sometimes called the Southwest Monsoon. Frequent showers and thunderstorms continue well into the summer. At times

during the summer, winds shift to the southwest and bring hot, dry air from the desert Southwest over the State. Such hot spells are usually of short duration.

CLIMATE OF THE EASTERN PLAINS

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, and 100°F temperatures have been observed at all plain stations. Such temperatures are not infrequent at altitudes below 5,000 feet; above that elevation they are comparatively rare. The highest temperatures in Colorado occur in the Arkansas Valley and lower elevations of South Platte and Republican Rivers. The hottest temperature ever recorded in Colorado was 114°F at Las Animas in July 1, 1933 and at Sedgwick on July 11, 1954. Because of the very low relative humidity accompanying these high temperatures, hot days cause less discomfort than in more humid areas. The usual winter extremes in the plains are from zero to -10°F to -15°F but have reached extraordinarily low readings of -30 to -40°F during some of the most extreme cold waves.

An important feature of the precipitation in the plains is the seasonal cycle. A very large proportion (70 to 80 percent of the annual total) falls during the growing season from April through September. Cool season precipitation can be important for soil moisture recharge, but midwinter precipitation is light and infrequent. More often, winter brings dry air and strong winds contributing to the aridity of the area. From early March through early June, periodic

widespread storms bring soaking beneficial moisture that helps crops and grasslands. Summer precipitation over the plains comes largely from thunderstorm activity and is sometimes extremely heavy. Localized rains in excess of 4" sometimes fall in just a few hours contributing to local flooding. In late May 1935 nearly two feet of rain fell along the Republican River in eastern Colorado causing one of the worst floods in state history. June flash floods in 1965 were also devastating. The weather station at Holly in southeast Colorado measured 18.81" of rainfall in that extraordinarily wet month. It is more common, however, to be too dry. Annual average precipitation ranges from less than 12 inches in the Arkansas Valley between Pueblo and Las Animas to almost 18 inches in extreme northeastern and southeastern corners of the state. Many years are drier than average, and some years receive only half or less the long-term average. The region seems almost always in or on the verge of drought. Multi-year drought is common to the area such as the decade-long drought of the 1930s, the severe drought of the mid 1950s and 1970s and the recent intense widespread drought of the early 2000s.

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. Temperature changes from day to day are not quite as great; summer temperatures are lower, and winter temperatures are higher. Not surprisingly, this milder corridor close to the mountains is where the

majority of Colorado's population now lives. Precipitation, which decreases gradually from the eastern border to a minimum near the mountains, increases rapidly with the increasing elevation of the foothills and proximity to higher ranges. The decrease in temperature from the eastern boundary westward to the foothills is less than might be expected with increasing altitude. This results from mountain and valley winds and greater frequency of the chinook. Below the Royal Gorge of the Arkansas River, the mountain and valley winds are persistent enough to modify the climate over a considerable area. Descending air currents frequently prevent the stratification of air necessary for the occurrence of excessive cold. As a consequence, the winter climate is milder near Canon City and Penrose than anywhere else in the State.

CLIMATE OF MOUNTAINS OF COLORADO

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. Summer afternoon temperatures consistently decrease about 4-5 degrees F per thousand feet. Typical July afternoon temperatures are in the 70s and 80s in the lower valleys but are only in the 50s and 60s in the higher mountains. But elevational

temperature changes are often masked by temperature inversions especially at night and during the winter. Cold air is more dense than warmer air and collects in some of the mountain valleys. On clear nights, especially during winter when the ground is snow covered, strong temperature inversions form. Under these circumstances, the coldest temperatures are found near the center of these high valleys, while temperatures in the high mountains are considerably warmer. The San Luis Valley around Alamosa, the Gunnison Valley around Gunnison, the Eagle Valley, the Fraser valley and the Yampa Valley near Steamboat Springs all can be very cold on clear winter nights. Subzero Fahrenheit temperatures are commonplace in these areas and the most winters see at least a few nights with temperatures dropping below -30°F. Even in summer, temperatures can dip below freezing. Under extreme conditions, temperatures have dipped as low as -60°F at Taylor Reservoir and -61°F along the Yampa valley in northwestern Colorado. Such cold temperatures are rare but demonstrate the extremes that mountain weather patterns can produce. Fortunately, these cold temperatures are nearly always accompanied by light or calm winds.

It is quite a different story on the mountain peaks. Strong winds are common at elevations above tree-line (approximately 11,500 feet) throughout the winter months and can exceed 50 to 100 mph in exposed locations. Outdoor adventurers must be prepared for the most extreme of conditions year round, but particularly in winter and spring.

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. 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. Snow accumulates without melting in shaded or level areas at elevations above about 8,000 feet. When it melts in the spring, this snow is the primary source of water for much of the population of the state and provides water for extensive irrigation. Considerable effort is made every year to measure the accumulating snowpack so that water providers and resource managers can plan ahead for the coming summer. Most of the mountain snow melts during May and June when rivers reach their peak for the year.

In summer, mountain peaks and ranges are effective thunderstorm generators whenever the regional air masses are sufficiently moist. Some years, local thunderstorms form nearly every afternoon in and near the mountains. The last half of July and much of August is particularly prone to mountain thunderstorms while June is often a much drier month in the high country. Snow and soft hail are possible from mountain storms even in July and August. Hikers and participants in other outdoor activities in the mountains during the summer months must be careful to avoid exposed ridges during stormy periods, as

lightning poses a very serious threat throughout the summer. Lightning also triggers forest fires in drier years.

CLIMATE OF 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. An area of western Colorado near Grand Junction is particularly mild and has developed an extensive fruit growing area. Anything from apricots and peaches to wine grapes and sweet corn is grown in the area from Delta and Paonia to Grand Junction and Palisade. Most of the population of western Colorado lives in this region. Summer afternoon temperatures can exceed 100 deg F several times each summer at elevations below 5500 feet, but it only takes a short drive to higher elevations to find cooler air. Temperatures only rarely drop below -10 F. Rare extreme cold, however, has had devastating effects on local orchards. Back in January 1963. Temperatures dropped below -20 in the fruit growing area and many trees were killed.

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. While precipitation only averages from 8 to 14 inches in these western valleys, localized flood-producing storms are still possible. Occasionally, moisture from decayed Pacific hurricanes have fueled widespread heavy rains. Extensive flooding occurred in October 1970 following one of these storm systems.

SEVERE STORMS

Thunderstorms are quite prevalent in the eastern plains and along the eastern slopes of the mountains during the spring and summer. These often become quite severe, and the frequency of hail damage to crops in northeastern Colorado is quite high. With an average frequency of 6 or may hail days per year, some counties of eastern Colorado are among the most hail prone areas in the entire country.

Tornadoes, once thought to be only a small threat to the residents of eastern Colorado, have been found to be quite common with the improvement in severe storm detection in recent decades. Tornadoes are relatively rare in the mountains and western valleys but do occur. In most years, at least 40 tornadoes are confirmed. Most of these tornadoes are small and short lived, usually classified in intensity as F0 or F1. However, occasional strong tornadoes have been reported. The number of tornado fatalities remains very low for

Colorado, but much of this is due to the low population density of some of the most tornado prone areas of eastern Colorado.

Lightning has emerged as one of the greatest weather hazards in Colorado. Each year there are typically several fatalities and injuries. Unlike tornadoes that are most common in selected areas of the state, lightning can and does occur everywhere. Lightning strike statistics indicate that the most lightning prone areas of Colorado are the high ground above tree line between Denver and Colorado Springs and the Raton Plateau south and southeast of Trinidad near the New Mexico border.

Fall, winter and spring blizzards on the eastern high plains are another weather hazard deserving attention. While Colorado blizzards are less frequent and drop less snow than in areas further east and north, they can still be devastating. As recently as 1997 several fatalities were directly attributable to an October blizzard which caught many travelers unprepared.

Heavy snows in the high mountains are much more common. Each year several lives are lost due to avalanches. Avalanches pose a serious problem to residents, road maintenance crews and back country travelers. Considerable effort is made each year to predict and manage avalanches.

A spring flood potential results from the melting of the snow pack at the higher elevations. In a year of near-normal snow accumulations in the mountains and normal spring temperatures, river stages become high, but there is no general flooding. In years when snow cover is heavy, or when there is widespread lower elevation snow accumulation and a sudden warming in the spring, there may be extensive flooding.

The greatest threat of flooding in Colorado is not snowmelt, however. It is flash flooding from localized intense thunderstorms. 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 infamous Big Thompson Canyon flood of July 31, 1976 have occurred in this vulnerable area. Flash floods occur on the western slopes as well, but with somewhat lower frequency and intensity due to a reduced supply of low level moisture to fuel such storms.