Climate of Wyoming

Introduction

This publication consists of a narrative that describes some of the principal climatic features and a number of climatological summaries for stations in various geographic regions of the State. The detailed information presented should be sufficient for general use; however, some users may require additional information.

The National Climatic Data Center (NCDC) located in Asheville, North Carolina is authorized to perform special services for other government agencies and for private clients at the expense of the requester. The amount charged in all cases is intended to solely defray the expenses incurred by the government in satisfying such specific requests to the best of its ability. It is essential that requesters furnish the NCDC with a precise statement describing the problem so that a mutual understanding of the specifications is reached.

Unpublished climatological summaries have been prepared for a wide variety of users to fit specific applications. These include wind and temperature studies at airports, heating and cooling degree day information for energy studies, and many others. Tabulations produced as by-products of major products often contain information useful for unrelated special problems.

The Means and Extremes of meteorological variables in the Climatography of the U.S. No.20 series are recorded by observers in the cooperative network. The Normals, Means and Extremes in the Local Climatological Data, annuals are computed from observations taken primarily at airports.

The editor of this publication expresses his thanks to those State Climatologists, who, over the years, have made significant and lasting contributions toward the development of this very useful series.

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Topographic Features- Wyoming's outstanding features are its majestic mountains and high plains. Its mean elevation is about 6,700 feet above sea level (ranks 2nd in the US) and even when the mountains are excluded, the average elevation over the southern part of the State is well over 6,000 feet, while much of the northern portion is some 2,500 feet lower. The lowest point, 3,125 feet, is near the northeast corner where the Belle Fourche River crosses into South Dakota. The highest point is Gannett Peak at 13,804 feet, which is part of the Wind River Range in the west-central portion. Since the mountain ranges lie in a general north-south direction, they are perpendicular to the prevailing westerlies, therefore, the mountain ranges provide effective barriers which force the air currents moving in from the Pacific Ocean to rise and drop much of their moisture along the western slopes. The State is considered semi-arid east of the mountains. There are several mountain ranges, but the mountains themselves cover less area than the high plains. The topography and variations in elevation make it difficult to divide the State into homogeneous, climatological areas.

The Continental Divide splits the State from near the northwest corner to the center of the southern border. This leaves most of the drainage areas to the east. The run-off drains into three great river systems, the: Columbia, Colorado, and Missouri. The Snake, with its tributaries in the northwest, flows into the Columbia. The Green River drains most of the Southwest portion and joins the Colorado. The Yellowstone, Wind River, Big Horn, Tongue and Powder drainage areas cover most of the north portion and flow northward into the Missouri. The Belle Fourche, Cheyenne and Niobrara cover the east-central portion and flow eastward. Meanwhile, the Platte River drains the southeast and flows eastward into Nebraska. There is a relatively small area along the southwest border that is drained by the Bear River which flows into the Great Salt Lake. In the south-central portion west of Rawlins, there is an area called the Great Divide Basin. Part of this area is often referred to as the Red Desert. There is no drainage from this Basin and precipitation, which averages only seven to 10 inches annually, follows creek beds to ponds or small lakes where it either evaporates or percolates into the ground.

Snow accumulates to considerable depths in the high mountains and many of the streams fed by the melting snow furnish ample quantities of water for irrigation for thousands of acres of land. The snowmelt also furnishes the water to generate electric power and for domestic use.

Rapid run-off from heavy rain during thunderstorms causes flash flooding on the headwater streams, and when the time of these storms coincides with the melting of the snow pack, the flooding is intensified. When overflow occurs in the vicinity of communities situated near the streams, considerable damage results.

Temperature- Due to its elevation, Wyoming has a relatively cool climate. Nationally, it ranks 41st for the US with an annual average of 45.6 degrees Fahrenheit (° F). Above the 6,000 feet level, temperatures rarely exceeds 100° F. The warmest parts of the State are the lower portions

of portions of the Big Horn Basin, the lower elevations of the central and northeast portions and along the eastern border. The highest recorded temperature is 115° F on August 8, 1983, at Basin in the Big Horn Basin. The average maximum temperature at Basin in July is 92° F. For most of the State, mean maximum temperatures in July range between 85 and 95. With increasing elevation, average values drop rapidly (3.0 to 5.5° F per 1,000 feet). A few places in the mountains at about the 9,000 foot level have average maximums in July close to 70. Summer nights are almost invariably cool, even though daytime readings may be quite high at times. For most places away from the mountains, the mean minimum temperature in July ranges from 50 to 60° F. Of course, the mountains and high valleys are much cooler with average lows in the middle of the summer in the 30s and 40s with occasional drops below freezing.

In the wintertime, it is characteristic to have rapid and frequent changes between mild and cold spells. Usually there are less than 10 cold waves during a winter and frequently less than half that number for most of the State. The majority of cold waves move southward on the east side of the Divide. Sometimes only the northeast part of the State is affected by the cold air as it slides eastward over the plains. Many of the cold waves are not accompanied by enough snow to cause severe conditions. In January, the coldest month generally, minimum temperatures range mostly from five to 10° F. In the western valleys mean values go down to about -5. The record low for the State is -66° F observed February 9, 1933, at Yellowstone Park. During warm spells in the winter, nighttime temperatures frequently remain above freezing. Chinooks, warm downslope winds, are common along the eastern slopes.

Numerous valleys provide ideal pockets for the collection of cold air drainage at night. Protecting mountain ranges prevent the wind from stirring the air, and the colder, heavier air settles into the valleys often sending readings well below zero. It is common to have temperatures in the valleys considerably lower than on the nearby mountain side. Big Piney in the Green River Valley is such a location. Mean January temperatures in the Big Horn Basin show the variation between readings in the lower part of the valley and those higher up. At Worland and Basin in the lower portion of the Big Horn Basin, not far from the 4,000 foot level, the mean minimum temperature for January is 2° F, while Cody, close to 5,000 feet on the west side of the valley has a mean January minimum of 15. January has occasional mild periods when maximum readings will reach the 50s; however, winters are usually long and cold.

For most of the State, sunshine ranges from 60 percent of the possible amount during the winter to about 75 percent during the summer (ranks 9th in the US with an annual average of 64 percent). Mountain areas receive less, and in the wintertime the estimated amount over the northwestern mountains is about 45 percent. In the summertime when sunshine is greatest, not only in time but also intensity, it is characteristic for the mornings to be mostly clear. Cumulus clouds develop nearly every day and frequently blot out the sun for a portion of the afternoons. The altitude has less atmosphere for the sun's rays to penetrate and because of the very small amount of fog, haze and smoke, the intensity of sunshine in unusually high.

Precipitation- Like other states in the west, precipitation varies a great deal from one location to another. The period of maximum precipitation occurs in the spring and early summer for most of the State. Precipitation is greater over the mountain ranges and usually at the higher elevations, although elevation alone is not the predominant influence. For example, over most of

the southwest portion, where the elevation ranges from 6,500 feet to 8,500 feet, annual precipitation varies from seven to 10 inches. At lower elevations over the northeast portion and along the eastern border, where elevations are mostly in the range from 4,000 to 5,500 feet, annual averages are from 12 to 16 inches. The relatively dry southwest portion is a high plateau nearly surrounded by mountain ranges.

The Big Horn Basin provides a striking example of the effect of mountain ranges in blocking the flow of moisture laden air from the east as well as from the west. The lower portion of the Basin has an annual precipitation of five to eight inches, and it is the driest part of the State. The station logging the lowest average annual precipitation is Deaver (4,105 feet) with 5.52 inches. In the southern part of the Basin, Worland at 4,172 feet has an annual mean of eight inches as compared with Thermopolis at 4,313 feet and 12 inches. Only a few locations statewide receive as much as 40 inches a year, based on gage records. The least annual lower elevation total recorded for any place in Wyoming is 1.28 inches at Lysite (5260 feet) in 1960 and the greatest annual lower elevation total is 55.46 inches at Grassy Lake Dam (7240 feet) in 1945. The long-term, statewide average precipitation is 13.12 inches.

During the summer, showers are quite frequent but often amount to only a few hundredths of an inch. Occasionally there will be some very heavy rain associated with thunderstorms covering a few square miles. There are usually several local storms each year with from one to two inches of rain in a 24-hour period. On rare occasions, 24-hour amounts range from three to five inches. The greatest 24-hour total recorded for any place in Wyoming is 6.06 inches at Cheyenne on August 1, 1985. Precipitation occurs on average only one in five days across the State during the year.

Hailstorms are the most destructive type of local storm for the State, with damage to crops and property from hail amounting to many thousands of dollars. Occasionally a hailstorm will pass over a city and cause severe damage. Most of the hailstorms pass over the open rangeland and damage is slight, although in small areas of crop-producing land, some farmers occasionally lose an entire crop due to hail. Severe hail (>0.75 inch) occurs less than two times a year for most of the State, but increases to six events annually over the extreme southeast corner.

Wyoming ranks 36th in number of lightning fatalities, 33rd in injuries, and 40th in property damage from 1959 - 1994. The eastern plains have more than three times (75 per 10 square miles) of cloud to ground lightning strike as does the western half of the State. Platte, Weston, Crook, and parts of Campbell, Niobrara and Laramie counties receive the most lightning in the State. These values probably vary by 50 percent a year depending on whether in a drought or enhanced monsoon flow. However, the locations of maximum and minimum strikes do not change much from year to year.

Tornadoes, the most intense wind events on earth, have been recorded with winds in excess of 315 mph. Fortunately, Wyoming lies west of “tornado alley” and the frequency and intensity of tornadoes are greatly diminished in comparison. Wyoming ranks 25th in number of tornadoes, 33rd in fatalities, 37th in injuries, and 36th in property damage ($34.13 million) in the US from 1950 - 1994. June has nearly twice the quantity of tornadoes as May and July while November through March has no reported tornadoes. Tornado statistics, especially prior to the 1970s must

be viewed as incomplete since many twisters must have occurred without being witnessed. Wyoming's open range land experience little if any damage from these storms so many go unreported. In the 1990s, the Internet and Doppler radar have increased the public's awareness of tornadoes with the potential of more being observed and reported. However, the trend in annual tornadoes has decreased since 1976 by one third and this appears to have coincided with a major hemispheric weather pattern shift. Annual tornado statistics shows a wide degree of variation across the State. For example, 42 tornadoes were counted in 1979 while no tornadoes occurred in 1951 and 1970. By county, of the 531 confirmed tornadoes recorded (1950 - 2001), Laramie County had the most with 88 while Teton County recorded only one. Granted Laramie County has the largest population, thus the opportunity to see more tornadoes, the fact that extreme southeast Wyoming is closest to tornado alley explains this higher number.

Wyoming is quite windy, and during the winter there are frequent periods when the wind reaches 30 to 40 mph with gusts to 50 or 60 mph (ranks 1st in the US with an annual average of speed of 12.9 mph). Prevailing directions in the different localities vary from west-southwest through west to northwest. In many localities winds are so strong and constant from those directions that trees show a definite lean towards the east or southeast. Many wind farms have been established over southern Wyoming in places such as Arlington, Medicine Bow, Rock River and just south of Cheyenne in order to take advantage of this important renewable energy source.

Snow falls frequently from November through May at lower elevations and is usually light to moderate. About five times a year, on average, stations at the lower elevations will have snowfall exceeding five inches. Falls of 10 to 15 inches or more for a single storm occur, but are infrequent outside of the mountains. Wind will frequently accompany or follow a snowstorm and pile the snow into drifts several feet deep. The snow sometimes drifts so much that it is difficult to obtain an accurate measurement of snowfall. An unusually heavy snow occurred at Sheridan on April 3 - 4, 1955. During this period the snowfall amounted to 39.0 inches, had a water equivalent of 4.30 inches and blizzard conditions lasted more than 43 hours. High winds and low temperatures with snow cause blizzard or near-blizzard conditions. These conditions sometimes last a day or two, but it is uncommon for a severe blizzard to last over three days.

Total annual snowfall varies considerably. At the lower elevations in the east, the range is from 60 to 70 inches. Over the drier southwest portion, amounts vary from 45 to 55 inches. Snow is very light in the Big Horn Basin with annual averages from 15 to 20 inches over the lower portion and 30 to 40 inches on the sides of the Basin where elevations range from 5,000 to 6,000 feet. The mountains receive a great deal more and in the higher ranges annual amounts are well over 200 inches. At Beckler River Ranger Station in the southwest corner of Yellowstone Park, the snowfall average is 262 inches for a 20-year period.

The weather pattern most favorable for precipitation is one with a low-pressure center a little to the south of the State. This will normally provide a condition where relatively cool air at the surface is overrun by warmer moist air. Studies of wind flow patterns indicate that Wyoming is covered most of the time by air from the Pacific. A smaller percentage of time, the State is covered by cold air masses that move down from Canada.

The statewide drought that began in the spring of 2000 over Wyoming is considered by many to be the most severe in their collective memory. However, some old timers have indicated that they remember streams drying up in the 1930s and 1950s. According to instrument records since 1895, there have been only six statewide droughts and all lasted three years or less. This doesn't mean that a specific river basin has not seen droughts last much longer. In fact, Wyoming averages severe or extreme drought conditions generally 10 to greater than 20 percent of the time. Numerous studies that have examined tree rings, lake sediments and archaeological data, etc. during the previous 2,000 years reveal that prior to 1200 A.D., droughts over the west were not only more frequent but have lasted as long as 50 to 100 years. During the past 800 years, fortunately, major droughts have been relatively mild in comparison.

The average relative humidity is quite low and provides delightful summer weather. During the warmer part of the summer days, the humidity drops to about 25 to 30 percent, and on a few occasions it will be as low as five to 10 percent. Late at night when the temperature is lowest, the humidity will generally rise to 65 or 75 percent. This results in an average diurnal variation of about 40 to 45 percent during the summer, but in the winter the variation is much less. Low relative humidity, high percentage of sunshine and rather high average winds all contribute to a high rate of evaporation. Because of frequent spells of freezing weather before May 1 and after September 30, it is difficult to obtain consistent records of evaporation for more than the five month period from May through September. For this period, the average amount of evaporation is approximately 41 inches, as determined from evaporation pans at a few selected locations. The overall range is from 30 to about 50 inches.

Climate and the Economy- Early fall and late spring freezes are characteristic. This results in long winters and short growing seasons. However, there are rapid changes through the fall, winter and spring seasons, with frequent variations from cold to mild periods. The average growing season (freeze-free period) for the principal agricultural areas is approximately 125 days. For hardier plants, which can stand a temperature of 28° F or slightly lower, the growing season in the agricultural areas east of the Divide is approximately 145 days. In the mountains and high valleys freezing temperatures may occur any time during the summer. For tender plants there is practically no growing season in such areas as the upper Green River Valley, the Star Valley and Jackson Hole. At Farson near Sandy Creek, a tributary of the Green River, the average is 42 days between the last temperature of 32° F in early summer and the first freeze in late summer. For the places like the Star Valley and Jackson Hole, the growing season is even shorter.

Most of the State has been subjected to erosion for tens of thousands of years and less than 10 percent is covered with a mantle of recent (geologically speaking) water-transported soil. The lack of such soil and adequate moisture limits the natural vegetation to hardy plants, such as sagebrush, greasewood and short grass. Low relative humidity and the high rate of evaporation add to the problem. A number of abandoned homesteads of one-time enthusiastic settlers bear silent testimony to the lack of moisture. Even so, dryland farming is carried on successfully in some areas. Approximately 42 percent of the State's total area is privately-owned land, the majority of which is used for grazing, although some is timberland. The fact that most of the State is still federally-owned attests to the semi-arid climate which has made the land less attractive to homesteaders. Nearly four percent of the State is cultivated cropland, including both

irrigated and non-irrigated. Another 13 percent is covered with forests, while parks and recreational areas take up about four percent.

The majority of the State is used for grazing and has a general appearance of dryness most of the time. The more abundant spring moisture brings a greener landscape often with myriad, varicolored wild flowers. As the season merges into summer, grasses and flowers turn brown, but continue to serve as food for livestock. Native grasses are nutritious, although scant. There are some very fine grazing areas with luxuriant grasses, especially in or near the mountains. Grass is generally so scarce that large ranches are required for profitable operation. The average for most cattle grazing is about 35 to 40 acres per cow. The mountain areas provide timber and a storage place for the winter snows which in the spring and summer feed lakes and reservoirs used in the irrigation districts. Most of the irrigated land is located in the valleys of the following river systems and their tributaries: North Platte, Wind River, Big Horn, Tongue and Green. Principal crops in the irrigation districts are sugar beets, beans, potatoes and hay. On the non-irrigated land, the principal crops are hay and small grains, such as wheat, barley and oats.

Tourism is increasingly important to Wyoming's economy and millions of persons, including many sportsmen, visit the State annually to enjoy Yellowstone and Grand Teton National Parks.