# COLORADO CLIMATE SUMMARY

# WATER-YEAR SERIES

## (October 1988–September 1989)

Nolan J. Doesken

Thomas B. McKee

Climatology Report No. 90-2

# Colorado Climate Summary
# Water-Year Series

(October 1988-September 1989)

by

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Department of Atmospheric Science
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Fort Collins, CO 80523

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## ACKNOWLEDGMENTS

As always we would like to take this opportunity to thank the many cooperative weather observers in Colorado and their National Weather Service supervisors, Jerry Sherlin and Michael Elias, for making it possible to monitor the climate in all parts of Colorado at a very low cost. Again, our sincere thanks are in order.

The authors also wish to express their appreciation to Odilia Bliss for doing a fine job of preparing and processing each month's climate data and assembling this finished product. The work of John Kleist in automating much of the data analysis has been very helpful.

These summaries have been made possible by funding for the Colorado Climate Center from the CSU Agricultural Experiment Station through the College of Engineering.

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# I. INTRODUCTION

The 1989 Water Year marked the 15th year of existence of the Colorado Climate Center (CCC) and the 12th year of closely monitoring the climate of this diverse and interesting state. The first monthly climate summary prepared by the CCC was written in early 1977 in the midst of an unprecedented severe winter drought. Since that time Colorado has experienced a myriad of extremes -- record winter cold, incredible snowstorms, disastrous hail storms and tornadoes, brief dry periods, some of the snowiest years in the past 60 years and one of the wettest consecutive periods in the state as a whole. Our monthly descriptions of Colorado climate have expanded to document and describe as much of this information as possible.

The monthly climate descriptions are intended to accomplish several purposes. They are a written historical record of what our climate has been which can hopefully always be used as a reference in the future. By tracking monthly departures of temperature and precipitation from long-term averages, these summaries also become tools for operations, planning and policy-making related to agriculture, water resources, recreation, land use and energy. Finally these summaries are used to educate the people of Colorado about our unique climate and its impact on our lives and livelihoods.

In Colorado, the Water Year (October 1 through September 30) is the most appropriate period for monitoring climate. This 12-month period is directly correlated with the state's water storage--water usage cycle. In October snow usually begins to accumulate in the high mountains. As winter progresses, the snowpack normally continues to build. This snow is the frozen reservoir which supports the huge ski and winter recreation industry. As it melts in the subsequent spring and summer, it supplies much of the water for human consumption, for extensive irrigation, for industry, and to satisfy long-standing streamflow compacts with neighboring states. Irrigated agriculture still accounts for the vast majority of water used in Colorado. Therefore, demand for water peaks during the summer and tapers off as temperatures drop, crops are harvested, and autumn arrives. September marks an appropriate end to the water year.

Because of the crucial importance of water to Colorado, this publication emphasizes precipitation and water-year accumulated precipitation. Comparisons with long-term averages are made to help determine which parts of the state are wetter or drier than average. This makes it possible to document the availability of water resources and to assess potential drought situations.

Each month's summary begins with a brief one-paragraph description of observed general temperature and precipitation patterns. This is followed by a section called: "Colorado's (Monthly) Climate." This section is not a forecast in the normal sense but is a generalized statewide climatological description (based on past records) of what weather conditions can most typically be expected. This section is really designed as an educational tool for newcomers to Colorado and to those just learning about climate to help familiarize themselves with the nature of our climate--how it varies both in time and in space. It is also a potential planning tool for those individuals, businesses, researchers, and government agencies who are trying to take climate into account in planning and scheduling activities.

Following the "Look Ahead" section is a special feature story on some aspect of Colorado's climate. Research results, new climate publications, and items of general public interest may appear in this section. Here is a list of this year's special features and the pages on which they are found.

The daily weather description follows and includes a table of extremes of temperature, precipitation and snow. This narrative section gives the dates of major storms, heat waves and cold blasts and gives selected examples from across Colorado.

One page is dedicated each month to the precipitation pattern. A brief narrative description is followed by a list of the wettest and driest National Weather Service reporting stations. A detailed map showing precipitation amounts is contoured to show which areas were above and below average.

The next page of the summary includes a similar assessment of the water year accumulated precipitation. A brief narrative comparison is made between the current and the past year's precipitation. This is accompanied by a tabular comparison of the wettest and driest locations in the state and a contoured map analysis of the current year's accumulated precipitation compared to average.

Temperature data for the month and comparisons to average are described in a short paragraph. The monthly temperatures for approximately 55 selected locations are plotted on a map and are analyzed using contour lines of departures from the 1961-80 averages. Along with the air temperature data, a detailed analysis of Fort Collins daily soil temperatures at several depths is presented. Soil temperature is an important climatic element in agriculture, construction, and energy conservation. Unfortunately, detailed soil temperature data are not available throughout Colorado.

Heating degree day data for 36 Colorado cities is published each month in a data table similar to previous years. A description of heating degree days and their use is given in Section II of this report.

The next two page are tabular climate information for the month for selected Colorado stations. Stations are divided into 4 regions: the Eastern Plains, the Foothills/Adjacent Plains (includes the Front Range urban corridor), the Mountains and High Interior Valleys, and the Western Valleys (includes stations in western Colorado below 7,000 feet). Data presented for each station include the average high, low and mean temperature for the month and the departure from the 1961-1980 average, the highest and lowest temperature recorded during the month, the monthly total of heating, cooling and growing degree days (see Section II for definitions), the monthly total precipitation, the departure from the 1961-1980 average, the percent of the 1961-1980 average, and the total number of days with measurable precipitation.

Following the data tables is a comparative table of number of clear, partly cloudy and cloudy days and the percent of possible sunshine for several National Weather Service stations. This is followed by a graph of daily total solar radiation data measured at Fort Collins.

Specific daily temperature and precipitation data are not listed here. Daily data can be obtained in digital and/or hard copy form from the Colorado Climate Center and the National Climatic Data Center (Asheville, NC). Much of the daily data are published in the government document, Climatological Data.

Most temperature and precipitation data used in the monthly summaries were obtained from the National Weather Service cooperative observer network. Data from the major National Weather Service stations, such as Denver and Grand Junction, are also used extensively. A few volunteers who are not affiliated with the National Weather

Service's networks are also included based on the Colorado Climate Center's judgement that the data are of good quality.

The averages which are used in this report for both temperature and precipitation were calculated using 1961-1980 data. Heating degree day normals were based on 1951-1980 data.

The written descriptions give a good general accounting of each month's weather, but the majority of information is contained on the maps and tables which accompany each report. The accuracy of all of these maps and tables is quite good. However, these reports were initially prepared soon after the end of each month, and preliminary information had to be used. Therefore, some of the precipitation, temperature, and heating, cooling and growing degree day values may differ slightly from what is later published by the National Climatic Data Center.

Beginning in January 1988 an additionally energy-related climate feature was added to the monthly climate report. A special program at University of Colorado at Boulder and Colorado State University called the Joint Center for Energy Management (JCEM) is funded to undertake various efforts to help conserve energy in Colorado. One project at the University of Colorado estabished a small network of automated weather stations across Colorado. One page of each monthly report is dedicated to briefly summarizing statewide weather conditions, including temperatures, humidity, solar energy, windspeed and direction. This summarized data (tables and compressed graphs) are provided to the Colorado Climate Center each month by Joint Center for Energy Management graduate students at the University of Colorado. An additional page features a special educational example where some aspect of climate is explored in terms of its effect on energy or energy use. These articles listed below are also authored by University of Colorado JCEM graduate students.

1) Daylighting -- Turning windows into energy savers. (October 88, pp. 20)
2) Modeling of Weather Data. (November 88, pp. 31)
3) Dressing Your House for Winter. (December 88, pp. 42)
4) Passive Solar Heating. (January 89, pp. 53)
5) Photovoltaics. (February 89, pp. 64)
6) Solar Greenhouses. (March 89, pp. 75)
7) Night Precooling. (April 89, pp. 86)
8) Relative Humidity and the Dew Point -- Mountain dew. (May 89, pp. 97)
9) Air Conditioning. (June 89, pp. 108)
10) Solar Cooling. (July 89, pp. 119)
11) Solar Ponds. (August 89, pp. 130)
12) Keep the Home Fires Burning. (September 89, pp. 141)

## II. EXPLANATION OF DEGREE DAYS

Many climatic factors affect fuel consumption for heating and cooling. Wind, solar radiation and humidity all play a part, but temperature is by far the most important element. Very simply, the colder it gets; the more energy is needed to stay warm.

A simple index, given the name, heating degree days, was devised several years ago to relate air temperatures to energy consumption (for heating). The number of heating degrees for a given day is calculated by subtracting the mean daily temperature (the average of the daily high and low temperature) from $65^{\circ}$F. Sixty-five degrees is used as the base temperature because at that temperature a typical building will not require any heating to maintain comfortable indoor temperatures. That difference ($65^{\circ}$F minus the mean daily temperature) is the number of heating degrees for that day. The daily values are accumulated throughout the heating season to give heating degree day totals. Different base temperatures can be used to calculate heating degree days, but $65^{\circ}$ is the long-standing traditional base.

The heating degree day total for a month or for an entire heating season is approximately proportional to the quantity of fuel consumed for heating. Therefore, the colder it gets and the longer it stays cold, the more heating degree days are accumulated and the more energy is required to heat buildings to a comfortable temperature.

So why is this important? Very simply, if you know how much energy you have used for heating your home or business during a certain period of time, and if you also know the heating degree day total for the same period, you can then establish an energy consumption ratio. With that information you can then make reasonable estimates of your future energy consumption and costs. Also, you can easily check the success and calculate the savings resulting from energy conservation measures such as new insulation, storm windows or lowering the thermostat.

Cooling degree days are calculated in a similar fashion. Cooling degrees occur each day the daily mean temperature is above 65°F. They are accumulated each day throughout the cooling season and are roughly proportional to the amount of energy required to cool a building to a comfortable inside temperature. Cooling degree days are less useful than heating degree days, especially here in Colorado where air conditioning requirements are minimal in many parts of the state. However, they still offer a means of making general comparisons from site to site, year to year or month to month.

Growing degree days are a measure of temperature which has been found to correlate with the rate of development and maturation of crops. Several methods exist for computing growing degree days. In this report the "corn" growing degree day definition was used. The optimum growth occurs at 86°F and essentially no growth occurs at temperatures below 50°F. Therefore, when computing the daily mean temperature any minimum temperature below 50° is counted at 50° and any maximum above 86° is counted as 86°. Growing degree day totals are this adjusted mean temperature (°F) minus 50°F summed for each day.

## III. 1989 WATER-YEAR IN REVIEW

In previous years up through the 1984 water year summary, several pages were written recapping the highlights of the year's climate and the impact it had on Colorado. This section now appears in abbreviated form as the special feature story that accompanies the September 1989 summary found on pages 132-134.

# COLORADO CLIMATE

## OCTOBER 1988



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Volume 12 Number 1


<u>October in Review:</u>

October was extremely dry statewide -- the driest October since 1964. Sunshine was plentiful, winds were light and temperatures were substantially above average. Except for some gnawing concerns over diminishing soil moisture and snow-free mountains, it was a truly delightful autumn month.

<u>Colorado's December Climate:</u>

Most of Colorado enjoyed a crisp, white Christmas last year, and December as a whole was cold and snowy. This was actually a very unusual circumstance. Historically, the likelihood for a white Christmas is only 20 to 40% east of the mountains, increasing to 30 to 60% on the Western Slope and rising to near 100% in the high mountains.

Daylength reaches a minimum on Dec. 21 as the official winter season begins. With long nights, short days and a midday sun that only climbs to an angle of about 28° above the horizon, temperatures continue to fall and each new cold front seems to bring ever colder air. In the mountains, daytime temperatures typically rise into the 20s while the surrounding valleys may reach the 30s. Nighttime readings of 0°F or below become common in the higher valleys. Western Slope cities like Grand Junction are noticeably warmer, especially at night, but are still frequently colder than cities at comparable elevations east of the mountains. Downslope winds are responsible for the warming that help moderate the Front Range cities. Highs in the 40s and 50s with lows in the teens are common. But there is a price to pay for these warmer temperatures. Some chinook winds may be very strong gusting to 100 mph or higher in preferred locations near the base of the eastern foothills. There are also arctic cold blasts to look out for which periodically come sliding down from Canada across the High Plains. Day-to-day temperature changes are therefore much more dramatic on the Eastern Plains than they are in the mountains and western valleys.

In a typical December, one storm after another marches across the Rockies forcing Pacific moisture up against the mountain barriers. This results in greater cloudiness over and west of the mountains with more sunshine east of the Divide. The northern and central mountains can expect 10 to 15 days with snow during the month. Only 6-12 snow days are expected in the southern mountains, but there the potential is greater for very heavy snows. East of the mountains only 3 to 6 snow days usually occur. Total precipitation ranges from 2 to 5" in the mountains (30-80" snow). The Western Slope and eastern foothills average 0.50 - 0.80" (8-20" snow), and on the plains precipitation is normally less than 0.50".

<u>Climate Change and Climate Data -- A Few Things to Think About:</u>

In case you hadn't noticed, the topic of "Climate Change" pushed its way with incredible force into the news in 1988. For decades and even centuries, climate change has been a topic of academic discourse. But with the help of widespread drought conditions this past spring and summer from the Northern Rockies across the Midwest and lots of record-breaking temperatures, the words "Global Warming" and "Climate Change" became headline news and everyone in the country became an expert. Things have quieted considerably this fall, but the attendance (close to 800) at the October 25 "Global Warming Seminar" organized by Colorado Senator Tim Wirth showed that Coloradans are not taking lightly some of the projections of warmer temperatures and reduced water resources during the next few decades.

There has been plenty written on the increases of greenhouse gases in the earth's atmosphere. It is true -- concentrations of carbon dioxide, methane and a number of trace gases have been increasing in the atmosphere apparently as a direct result of man's industrialization of the globe. These gases allow the sun's energy to pass through the

(continued on Page -2-)

atmosphere on the way in but trap it in the form of heat as the energy radiates back toward space. Intuitively, it seems obvious to the casual scientist in all of us that the earth will most certainly become a warmer place -- probably in direct proportion to the concentration of these assorted greenhouse gases in the atmosphere. Well, it is not that simple. In fact, it is painfully complex. Assuming that the atmosphere does begin to warm, a whole lot of other things can begin to happen -- some may offset the effects of greenhouse warming, others may accentuate it. Cloud patterns could change, ocean temperatures and ocean currents could change, jet stream strength and position could be modified, biological activity may make some adjustments and the list goes on and on.

The source of most of the recent projections of what changes in climate are most likely to occur as a result of increases in greenhouse gases are based on large computer simulation models. These models are excellent scientific tools for objectively testing how specified changes in the earth-atmosphere system may affect the earth's climate. These models are among the most complex computer programs in the world. But what most laymen don't realize is that they are still extremely crude. Only recently have such features as clouds and oceans been added to these global climate models and only in very simplified form. By no means is it appropriate to assume that these models fully represent the complexities of our marvelous earth-atmosphere system. Keeping these limitations in mind, the consensus opinion from the several organizations using global climate models to study the global warming issue is that warming will occur over much of the globe and will be most evident in higher latitudes. Warming is probably already occurring and should be evident above the "noise" of natural climate variability within the next one or two decades. Most scientists agree, though, that the 1988 drought and heatwave were still within the envelope of natural year to year climate variability.

With this brief background (if you are truly interested in this topic please pursue independent reading) I want to introduce the subject of climate data. It is not terribly glamorous but I think it is extremely important. Many present qualified and not-so-qualified scientists are analyzing long-term climate records trying to detect global warming. Here in Colorado we are doing the same thing -- and have been for about 12 years. The Colorado Climate Center has generated literally hundreds of graphs of long-term temperature and precipitation data for any weather station we can find with 50 or more years of data. I'll show you a few graphs before the end of this story.

I think it is generally perceived that historic climate data are readily available, of high quality, and fully able to identify and resolve any fluctuations and changes that our climate may be undergoing. Unfortunately, that is a myth. Climate data in our country have a number of problems, and the problems are not going away. To begin with, there are very few locations where continuous weather records have been collected for more than a century. In studies of climate change it is extremely beneficial to have as long a record as possible. Ten or twenty years of data just doesn't do the job. We are fortunate here in Colorado. We now have 8 cities where weather records have been gathered for at least a century. We will add about 8 more cities to that list by the year 2000. We maintain one of those stations here in Fort Collins. But just because a station has been collecting data for a long time does not mean that the station has been collecting data suitable for studying long-term widespread climate changes. Our Fort Collins station, for example, shows a very systematic warming over the years indicative of a gradual climate change. But look at the data for a rural station like Rocky Ford (just celebrated their centennial this year). While it appears that some warming was occurring at both locations up to about 1940, temperatures since than have been steady or falling slightly at Rocky Ford while Fort Collins temperatures have continued to rise. What you are seeing there is evidence of the urban heat island effect. It is widely recognized that as cities grow and develop they get a little warmer than surrounding rural areas. Fort Collins has seen marked urbanization over the past 3 decades that has resulted in a continued warming trend that has not been experienced in rural areas. It turns out that many of our long-term stations in the U.S. and around the world are located within major metropolitan areas, thus compromising the value of their data.

Another problem that is especially hard on data quality here in Colorado is the problem of station moves. Whenever a weather station has to be relocated, there is always a risk that the new location, regardless of how minor the move, may have subtle or not so subtle climate differences. A great example here in Colorado was the relocation of the Dillon weather station when the large reservoir there was constructed. Its new location was within a mile of the old town of Dillon and about 200 feet higher in elevation, but climate differences were great. The reservoir was blamed for changing the climate of the area. In truth, the majority of the change was a result of the new location of the weather station. In parts of the country, a 1-mile station move may have no effect, but in the mountains and other areas of complex terrain, a 1-mile move can make a dramatic difference. There has been no organized program in our country to assure that a large number of weather stations are preserved free from station moves. Station relocations, even of primary weather stations like Denver, occur surprisingly frequently. Of the 200+ official National Weather Service stations in Colorado, 5% to 10% of the stations are likely relocated in any given year. This statistic probably applies to the rest of the country. At this rate, most weather stations in the country are relocated within any ten to twenty year period. (continued on Page -3-)

Climate Change and Climate Data -- A Few Things to Think About: continued

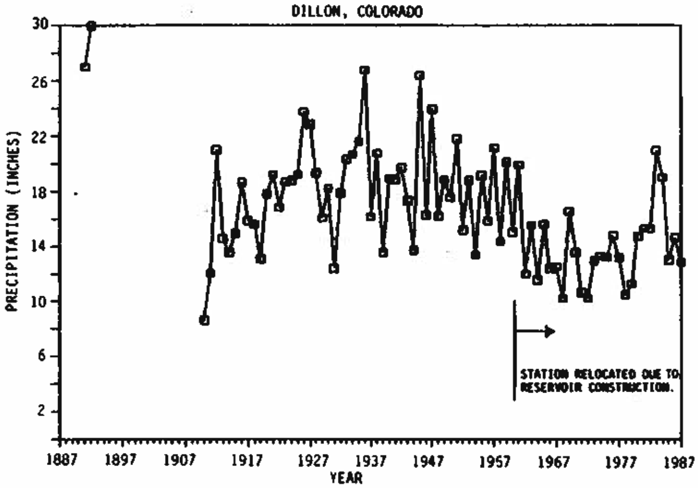
Still another problem is instrumentation. For many decades the same traditional maximum and minimum thermometers have been used at most National Weather Service stations to record daily temperatures. A change over has been taking place in recent years as electronic thermometers and plastic weather shelters are replacing the standard mercury and alcohol-in-glass thermometers and large wooden thermometer enclosures (called Cotton Region shelters). Another major change is just around the corner. Within the next two years, weather stations at most major airports, which are currently staffed with trained weather observers, will be replaced by fully automated weather stations that electronically measure not only temperature, humidity and wind (it has been possible to do this automatically for many years already) but will also detect thunderstorms, distinguish between rain, drizzle, snow and other types of precipitation, assess visibility, cloud characteristics, snowdepth and much more. These stations will take continuous around-the-clock measurements. This will be a great improvement for aviation and will be a help to weather forecasters. But more than likely it will again result in apparent climate changes. Different instruments, despite plenty of testing, have different performance characteristics. For most applications, a difference of a couple of degrees would mean very little. But in the study of climate change, a difference of a degree or two can make all the difference in the world.

One other problem may be the hardest one yet to reckon with -- data quality control. Over the years, the National Climatic Data Center has always scrutinized all climate data for the country before archiving the data and publishing information. Severe budget cuts in recent years have had a big effect on this process. Now, data are subjected to quick computerized scanning to point out data that appear out of line. Human involvement is kept to a minimum. These methods definitely save time, but it is not clear how much it helps data quality. The problem is especially bad here in the West where dramatic local climate differences can be real. The result has been that the computer often suggests that perfectly accurate observations are in error because they don't match surrounding stations. Just last month, I found that 3 temperatures had been "corrected" here at our Fort Collins weather station in order to match up with surrounding stations. In all cases, our original observations were correct and the changes were wrong. Hopefully, our complaints were received in time to correct the national archive.

In summary, I just want you to be aware that working with climate data isn't as straight forward as one might think. A large number of "apparent" climate changes are nothing more than relocated weather stations, changes in the time of day when the observations are taken, urbanization or vegetation changes in the vicinity of the weather station, or changes in the types of instrumentation being used. These problems are so pervasive that it is nearly impossible to find totally "clean" data sets for research purposes. We should be able to do better than this. Scientists have to spend much of their time massaging the data to try to compensate for the problems. This is really frustrating. As a climatologist, if there is one thing I would like to leave behind for future generations it would be good consistent data. The global warming issue will probably come and go. But other issues of equal or greater importance will follow. To solve tough problems we need good data.

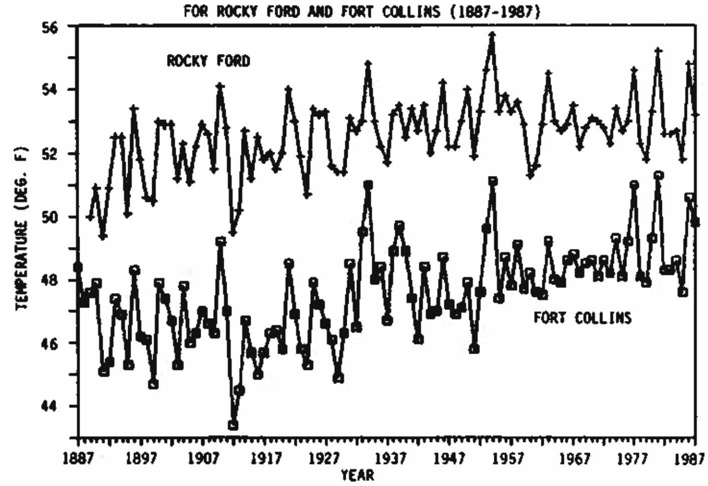
ANNUAL PRECIPITATION

DILLON, COLORADO




AVERAGE ANNUAL TEMPERATURES

FOR ROCKY FORD AND FORT COLLINS (1887-1987)




Special Note to Cooperative Weather Observers: I hope you realize how much your efforts here in Colorado are appreciated. Most of the problems discussed above are beyond your control. We are continuing to work with the National Weather Service and the National Climatic Data Center to keep the cooperative weather observing program a central part of our nation's climate program. The development of new automated weather observing systems in no way replaces what you are doing. If anything, it makes your data even more important. Keep up the good work. In the future, we will be recognizing some of you for your long and faithful service.

# OCTOBER 1988 DAILY WEATHER

| Date | Event |
|---|---|
| 1-2 | Mild west, but cool and breezy east as a stationary low pressure area still sat over Kansas. Then sunny and warmer on the 2nd. Denver reached 81°F. |
| 3-4 | Continued dry and warm west, but a mass of cold Canadian air moved down the High Plains during the day on the 3rd. A few thunder sprinkles developed over the foothills. Then low clouds, fog and drizzle set in east of the mountains. On the 4th, temperatures mostly hovered in the 40s and 50s east of the mountains. |
| 5-7 | The first freeze of the season for parts of eastern Colorado on the 5th. Cold air aloft and a little weak "upslope" flow east of the mountains created a period of cool, showery weather over the state. Thunderstorms, surprisingly numerous for October, rumbled over the mountains and foothills on the 5th. More showers developed on the 6th and 7th, most numerous in southern Colorado. Rainfall was quite light, but a few areas received modest totals. Paradox, for example, got 0.65" on the 5th, Norwood measured 0.88" on the 6th and Rico received 0.45" on the 7th. |
| 8-10 | Warmer on the 8th and generally dry. Then a cold front and upper air disturbance dropped down from the north triggering some mountain snows on the 9th. Mount Evans got about 5" of snow and a number of locations reported thunder. Seasonal temperature on the 10th. Dry statewide except for some showers over the San Juans. Silverton reported 0.23" from an afternoon thundershower. |
| 11-13 | Beautiful autumn weather 11-12th. Temperatures mostly in the 60s and 70s during the day. An upper air disturbance on the 13th sent some clouds over the state. A few showers in west central Colorado was all it could muster up. Glenwood Springs got 0.17" on the 13th. |
| 14-26 | Dry northwesterly winds aloft. Consistently warm daytime temperatures in western Colorado with abundant sunshine. Daytime temperatures mostly in the 60s, 70s or low 80s with lows in the 20s, 30s or 40s (depending on elevation and location). Some 50-degree diurnal temperature fluctuations occurred in some western valleys. Cochetopa Creek, near Gunnison, went from 68° on the 22nd down to 11° the morning of the 23rd and back up to 67° that afternoon. Areas east of the mountains were also dry, but weather was a bit more changeable. Cold fronts brought colder temperatures to the plains on the 15th, 17th, 19th, 22nd and 25th. But temperatures always rebounded quickly. Several areas received light precipitation (low elevation rain and mountain snows) on the 19th. Warmest temperatures were reported on the 16th, 22nd and 26th when afternoon readings soared into the 70s and 80s. Las Animas' 90° reading on the 16th was the warmest in the state. |
| 27-29 | A strong storm crossed Montana and brought much cooler air behind it into eastern Colorado. Daytime temperatures dropped into the 40s and 50s and nighttime readings were the coldest of the autumn. Sedgwick woke to 18° on the 28th. A few upslope showers developed near Denver on the 29th as a cold high pressure area moved into the Midwest. A little rain also fell in the southwest. Cortez measured 0.35" on the 29th. |
| 30-31 | Unseasonably warm again. A lovely Halloween for the second consecutive year. |

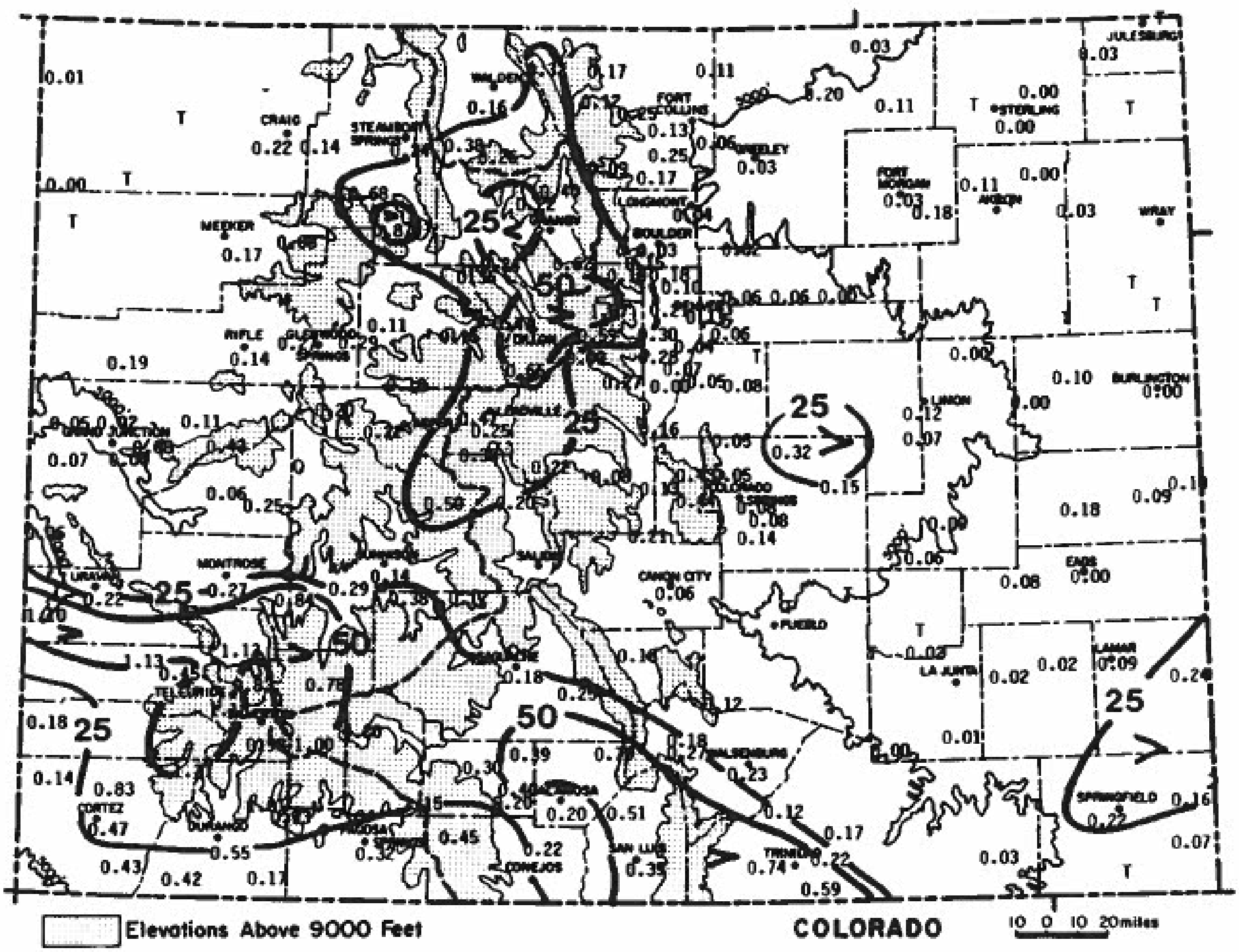
## October 1988 Extremes

| | | | |
|---|---|---|---|
| Highest Temperature | 90°F | October 16 | Las Animas |
| Lowest Temperature | 10°F | October 31 | Hohnholz Ranch |
| Greatest Total Precipitation | 1.31" | | Rico |
| Least Total Precipitation | 0.00" | | Burlington and 10 other cities |
| Greatest Total Snowfall | 14" | | Mount Evans Research Research Center |

## OCTOBER 1988 PRECIPITATION

In the last 100 years there have only been about 18 individual months (most were autumn months) that were as dry as this October. Every single station was below its average for the month. That was the first time that has happened in at least 12 years. About 1/3 of all reporting stations in the state received less than 0.10" for the month. The wettest areas of the state only received a little more than half of their average moisture. These areas included Yampa (73%), portions of Summit and Clear Creek counties, an area from Trinidad over to the San Luis Valley and the western portion of the San Juan Mountains. Paradox managed to get 1.10" in October, 95% of average. As is often the case in October, the largest precipitation totals were mostly found in the southwest. For the rest of the state, conditions were dry, and soil moisture reserves continued to be depleted.

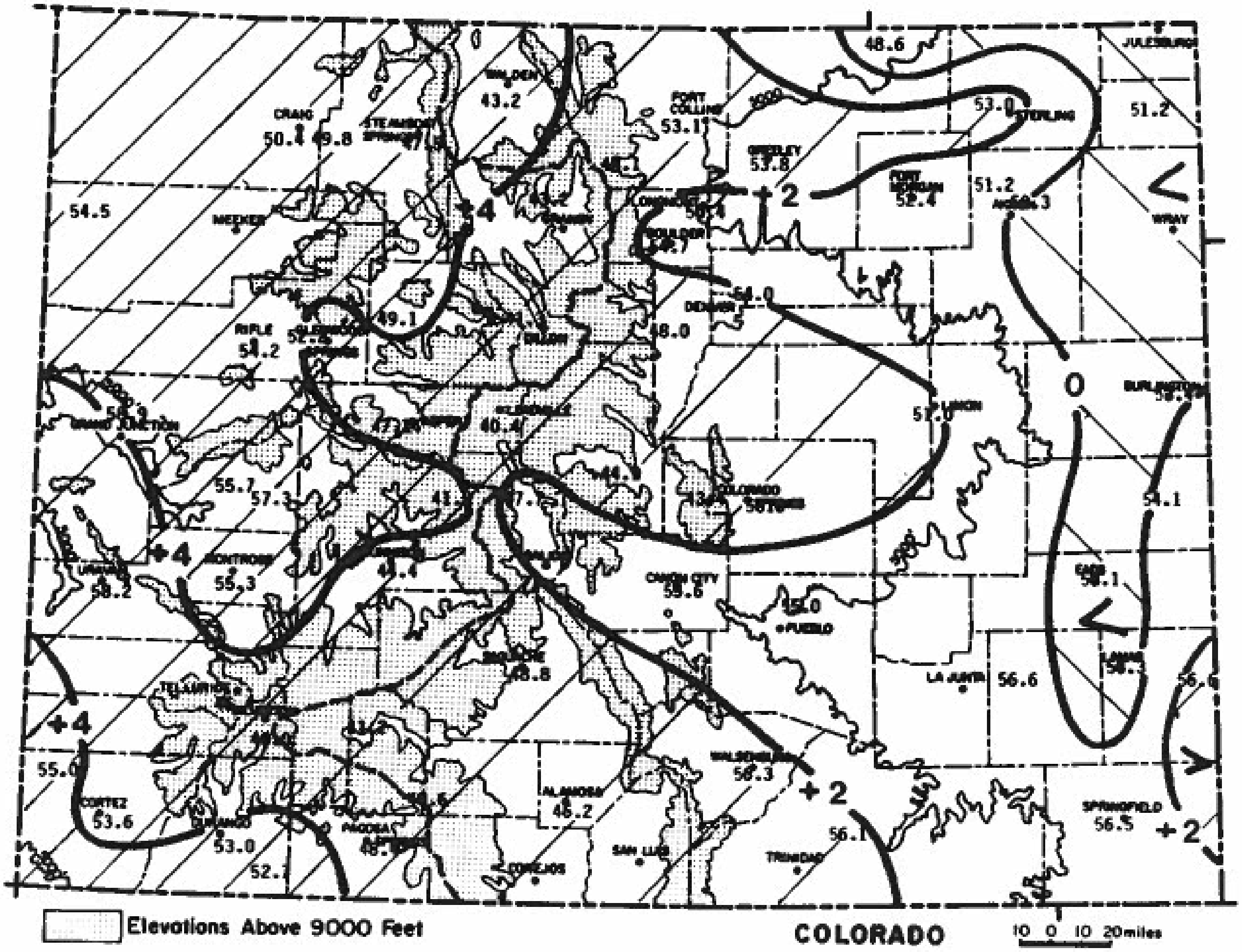
| Greatest | | Least | |
|---|---|---|---|
| Rico | 1.31" | Burlington | 0.00" |
| Telluride | 1.18" | Byers 5ENE | 0.00" |
| Wolf Creek Pass 1E | 1.15" | Cheraw | 0.00" |
| Norwood · | 1.13" | Dinosaur Natl. Mon. | 0.00" |
| Ridgway | 1.13" | Eads | 0.00" |
| | | (many others with 0.00" or Trace) | |




Precipitation amounts (inches) for October 1988 and contours of precipitation as a percent of the 1961-1980 average.

## OCTOBER 1988 TEMPERATURES AND DEGREE DAYS

A number of intrusions of cold air into eastern Colorado during the month offset the many very mild days. As a result, October mean temperatures were close to average across the Eastern Plains. However, from the foothills westward to Utah, temperatures were persistently mild and ended up 3 to 6 degrees F above average. At Montrose, temperatures for the month averaged 55.3 deg., 5 degrees above average. This was their 3rd warmest October since records began there in 1885. Only October 1950 and 1963 were warmer. High temperatures on the Western Slope climbed into the 60s, 70s or 80s every day during the month. The first killing frost of the autumn was also very late in coming at many locations both east and west of the mountains. At Fort Collins the first freezing temperature did not occur until October 23rd -- the latest on record in 100 years.

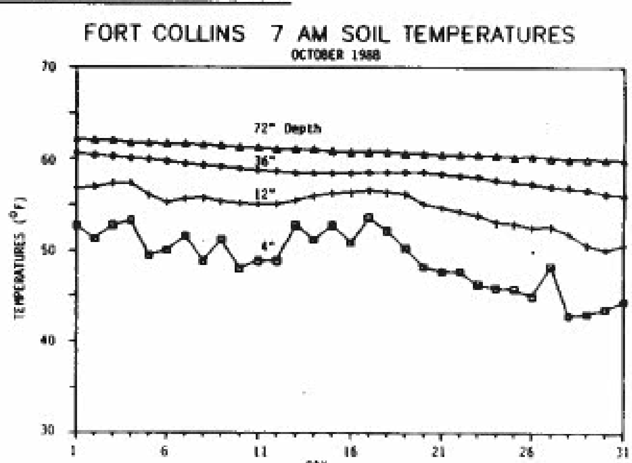



October 1988 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## OCTOBER 1988 SOIL TEMPERATURES

Soil temperatures remained above average at all depths throughout October. A steady downward trend is always expected.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.



# Table 1. Heating Degree Day Data through October 1988 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 87-88 | 66 | 96 | 364 | 601 | 1130 | 1556 | 1867 | 1381 | 1031 | 658 | 454 | 102 | 9306 |
| | 88-89 | 28 | 50 | 337 | 575 | | | | | | | | | 990 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 87-88 | 112 | 152 | 355 | 563 | 1024 | 1382 | 1450 | 1146 | 1136 | 734 | 517 | 123 | 8694 |
| | 88-89 | 34 | 79 | 394 | 550 | | | | | | | | | 1057 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 87-88 | 7 | 33 | 122 | 370 | 713 | 1053 | 1107 | 842 | 739 | 400 | 203 | 14 | 5603 |
| | 88-89 | 1 | 4 | 125 | 311 | | | | | | | | | 441 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 87-88 | 49 | 117 | 313 | 549 | 955 | 1277 | 1357 | 1010 | 1030 | 639 | 472 | 102 | 7870 |
| | 88-89 | 37 | 41 | 350 | 530 | | | | | | | | | 958 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 87-88 | 5 | 20 | 72 | 375 | 724 | 1037 | 1221 | 935 | 779 | 449 | 178 | 14 | 5809 |
| | 88-89 | 4 | 5 | 101 | 352 | | | | | | | | | 462 |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 87-88 | 11 | 36 | 87 | 374 | 668 | 1007 | 1144 | 858 | 767 | 407 | 191 | 16 | 5566 |
| | 88-89 | 0 | 9 | 112 | 287 | | | | | | | | | 408 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 87-88 | 17 | 74 | 150 | 445 | 767 | 1108 | 1256 | 958 | 886 | 499 | 273 | 25 | 6458 |
| | 88-89 | 7 | 10 | 154 | 366 | | | | | | | | | 537 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 87-88 | 6 | 35 | 154 | 396 | 860 | 1179 | 1351 | 1008 | 899 | 609 | 362 | 56 | 6915 |
| | 88-89 | 0 | 1 | 188 | 349 | | | | | | | | | 538 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 87-88 | 55 | 96 | 227 | 534 | 950 | 1376 | 1561 | 1264 | 1076 | 593 | 399 | 52 | 8183 |
| | 88-89 | 1 | 14 | 285 | 442 | | | | | | | | | 742 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 87-88 | 0 | 11 | 108 | 354 | 737 | 1102 | 1300 | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | | | | | | | | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 87-88 | 11 | 21 | 110 | 410 | 745 | 1125 | 1227 | 889 | 811 | 437 | 215 | 14 | 6015 |
| | 88-89 | 7 | 0 | 129 | 333 | | | | | | | | | 469 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 87-88 | 296 | 346 | 556 | 763 | 1145 | 1491 | 1629 | 1376 | 1379 | 933 | 717 | 322 | 10953 |
| | 88-89 | E230 | 283 | 565 | 728 | | | | | | | | | 1806 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 87-88 | 14 | 44 | 188 | 435 | 851 | 1206 | 1391 | 972 | 859 | 514 | 346 | 42 | 6862 |
| | 88-89 | 1 | 5 | 191 | 365 | | | | | | | | | 562 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 87-88 | 54 | 75 | 254 | 509 | 950 | 1331 | 1544 | 1173 | 1002 | 607 | 404 | 52 | 7955 |
| | 88-89 | 3 | 11 | 301 | 486 | | | | | | | | | 801 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 87-88 | 69 | 118 | 333 | 602 | 922 | 1255 | 1310 | 1029 | 992 | 645 | 462 | 111 | 7848 |
| | 88-89 | 60 | 50 | 355 | 517 | | | | | | | | | 1036 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 87-88 | 12 | 37 | 146 | 453 | 784 | 1140 | 1252 | 936 | 821 | 479 | 217 | 8 | 6285 |
| | 88-89 | 3 | 2 | 163 | 362 | | | | | | | | | 530 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 87-88 | 12 | 29 | 110 | 430 | 773 | 1154 | 1484 | 1055 | 826 | 495 | 206 | 17 | 6591 |
| | 88-89 | 6 | 3 | 124 | 383 | | | | | | | | | 516 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 87-88 | 0 | 6 | 34 | 248 | 754 | 1147 | 1469 | 1031 | 741 | 350 | 172 | 8 | 5960 |
| | 88-89 | 0 | 0 | 106 | 183 | | | | | | | | | 289 |

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING DATA

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 87-88 | 207 | 257 | 480 | 677 | 1098 | 1516 | 1642 | 1413 | 1372 | 907 | 602 | 238 | 10409 |
| | 88-89 | 191 | 208 | 461 | 667 | | | | | | | | | 1527 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 87-88 | 10 | 26 | 119 | 424 | 762 | 1157 | 1363 | 955 | 807 | 437 | 204 | 6 | 6270 |
| | 88-89 | 5 | 1 | 116 | 340 | | | | | | | | | 462 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | E 75 | E 125 | 394 | 631 | | | | | | | | | 1225 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 87-88 | 0 | 3 | 35 | 273 | 653 | 1032 | 1278 | 837 | 638 | 327 | 103 | 1 | 5180 |
| | 88-89 | 0 | 0 | 32 | 252 | | | | | | | | | 284 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 87-88 | 346 | 393 | 578 | 763 | 1180 | 1534 | 1577 | 1326 | 1355 | 957 | 741 | 360 | 11110 |
| | 88-89 | 318 | 306 | 601 | 730 | | | | | | | | | 1955 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 87-88 | 21 | 66 | 158 | 502 | 840 | 1209 | 1354 | 1022 | 943 | 569 | 321 | 35 | 7040 |
| | 88-89 | 9 | 7 | 167 | 428 | | | | | | | | | 611 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 87-88 | 12 | 33 | 159 | 464 | 805 | 1169 | 1383 | 1035 | 847 | 509 | 222 | 20 | 6658 |
| | 88-89 | 10 | 8 | 203 | 445 | | | | | | | | | 666 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | | | | | | | | | M |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 87-88 | 5 | 30 | 129 | 349 | 849 | 1160 | 1332 | 1003 | 817 | 468 | 230 | 26 | 6398 |
| | 88-89 | 0 | 1 | 169 | 292 | | | | | | | | | 462 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 87-88 | 104 | 105 | 347 | 523 | 947 | 1292 | 1548 | 1187 | 996 | 663 | 485 | 143 | 8340 |
| | 88-89 | 30 | 61 | 325 | 506 | | | | | | | | | 922 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 87-88 | 4 | 17 | 43 | 355 | 754 | 1111 | 1399 | 903 | 777 | 399 | 167 | 8 | 5937 |
| | 88-89 | 1 | 0 | 84 | 308 | | | | | | | | | 393 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 87-88 | 9 | 24 | 125 | 391 | 819 | 1209 | 1430 | 1039 | 865 | 454 | 268 | 14 | 6647 |
| | 88-89 | 0 | 0 | 198 | 327 | | | | | | | | | 525 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 87-88 | 77 | 127 | 330 | 590 | 1033 | 1448 | 1619 | 1336 | 1167 | 674 | 433 | 95 | 8929 |
| | 88-89 | 27 | 45 | 336 | 537 | | | | | | | | | 945 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 87-88 | 12 | 31 | 108 | 413 | 742 | E1140 | 1475 | 1029 | 831 | 476 | 197 | 12 | 6466 |
| | 88-89 | 1 | 1 | 116 | 363 | | | | | | | | | 481 |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 87-88 | 161 | 222 | 426 | 603 | 992 | 1269 | 1354 | 1109 | 1092 | 720 | 547 | 208 | 8703 |
| | 88-89 | 131 | 147 | 397 | 570 | | | | | | | | | 1245 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 87-88 | 4 | 25 | 80 | 330 | 730 | 1054 | 1209 | 850 | 803 | 438 | 234 | 13 | 5770 |
| | 88-89 | 8 | 5 | 100 | 266 | | | | | | | | | 379 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 87-88 | 215 | 281 | 495 | 740 | 1242 | 1499 | 1572 | 1343 | 1340 | 835 | 638 | 184 | 10384 |
| | 88-89 | 144 | 189 | 507 | 668 | | | | | | | | | 1508 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 87-88 | 3 | 30 | 101 | 332 | 707 | 977 | 1109 | 826 | 773 | 401 | 238 | 25 | 5522 |
| | 88-89 | 2 | 3 | 119 | 266 | | | | | | | | | 390 |

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING DATA

# OCTOBER 1988 CLIMATIC DATA

## Eastern Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| NEW RAYMER 21N | 64.5 | 32.7 | 48.6 | -0.6 | 80 | 19 | 500 | 0 | 238 | 0.03 | -0.49 | 5.8 | 1 |
| STERLING | 70.5 | 35.5 | 53.0 | 3.1 | 85 | 21 | 363 | 0 | 328 | 0.00 | -0.84 | 0.0 | 0 |
| FORT MORGAN | 68.7 | 36.0 | 52.4 | 1.4 | 83 | 26 | 383 | 0 | 303 | 0.03 | -0.54 | 5.3 | 1 |
| AKRON FAA AP | 66.0 | 36.3 | 51.2 | 0.3 | 80 | 22 | 418 | 0 | 263 | 0.11 | -0.54 | 16.9 | 3 |
| AKRON 4E | 66.7 | 33.9 | 50.3 | -0.1 | 82 | 18 | 447 | 0 | 275 | 0.00 | -0.54 | 0.0 | 0 |
| HOLYOKE | 66.3 | 36.1 | 51.2 | -1.1 | 82 | 20 | 420 | 0 | 273 | 0.00 | -0.73 | 0.0 | 0 |
| BURLINGTON | 67.4 | 39.5 | 53.4 | -0.6 | 83 | 23 | 352 | 0 | 286 | 0.00 | -0.76 | 0.0 | 0 |
| LIMON WSMO | 67.1 | 34.9 | 51.0 | 2.4 | 78 | 23 | 428 | 0 | 275 | 0.12 | -0.48 | 20.0 | 2 |
| CHEYENNE WELLS | 69.4 | 38.7 | 54.1 | 0.8 | 84 | 24 | 336 | 3 | 318 | 0.09 | -0.74 | 10.8 | 1 |
| EADS | 68.4 | 37.8 | 53.1 | -1.2 | 82 | 28 | 364 | 0 | 298 | 0.00 | -0.77 | 0.0 | 0 |
| LAMAR | 73.2 | 33.5 | 53.3 | -1.7 | 88 | 24 | 353 | 0 | 369 | 0.09 | -0.64 | 12.3 | 3 |
| LAS ANIMAS | 75.8 | 37.4 | 56.6 | 0.8 | 90 | 27 | 252 | 1 | 396 | 0.02 | -0.61 | 3.2 | 1 |
| HOLLY | 73.7 | 39.5 | 56.6 | 2.6 | 87 | 28 | 257 | 3 | 377 | 0.24 | -0.56 | 30.0 | 2 |
| SPRINGFIELD 7WSW | 72.9 | 40.2 | 56.5 | 1.3 | 86 | 29 | 258 | 4 | 362 | 0.22 | -0.48 | 31.4 | 4 |

## Foothills/Adjacent Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| FORT COLLINS | 68.0 | 38.3 | 53.1 | 3.1 | 78 | 23 | 362 | 0 | 288 | 0.13 | -0.88 | 12.9 | 3 |
| GREELEY UNC | 69.3 | 38.3 | 53.8 | 3.1 | 82 | 23 | 340 | 0 | 308 | 0.03 | -0.96 | 3.0 | 2 |
| ESTES PARK | 63.5 | 32.6 | 48.1 | 2.8 | 70 | 15 | 516 | 0 | 220 | 0.09 | -0.69 | 11.5 | 2 |
| LONGMONT 2ESE | 69.4 | 31.4 | 50.4 | 0.0 | 81 | 16 | 445 | 1 | 311 | 0.04 | -0.84 | 4.5 | 1 |
| BOULDER | 69.8 | 39.7 | 54.7 | 1.2 | 80 | 25 | 311 | 0 | 315 | 0.03 | -1.15 | 2.5 | 1 |
| DENVER WSFO AP | 69.9 | 38.1 | 54.0 | 2.3 | 81 | 25 | 333 | 0 | 316 | 0.06 | -0.82 | 6.8 | 2 |
| EVERGREEN | 65.9 | 30.2 | 48.0 | 3.2 | 73 | 19 | 517 | 0 | 255 | 0.30 | -0.88 | 25.4 | 5 |
| LAKE GEORGE 8SW | 61.6 | 28.2 | 44.9 | 2.6 | 67 | 20 | 615 | 0 | 188 | 0.08 | -0.65 | 11.0 | 2 |
| RUXTON PARK | 60.7 | 26.1 | 43.4 | 4.2 | 69 | 15 | 661 | 0 | 171 | 0.44 | -0.92 | 32.4 | 5 |
| COLORADO SPRINGS | 67.6 | 38.3 | 53.0 | 2.4 | 80 | 24 | 366 | 0 | 280 | 0.08 | -0.67 | 10.7 | 3 |
| CANON CITY 2SE | 71.6 | 39.6 | 55.6 | 1.4 | 83 | 24 | 287 | 3 | 343 | 0.06 | -0.81 | 6.9 | 1 |
| PUEBLO WSO AP | 73.4 | 36.5 | 55.0 | 1.0 | 88 | 24 | 308 | 4 | 369 | 0.00 | -0.58 | 0.0 | 0 |
| WALSENBURG | 72.6 | 40.0 | 56.3 | 3.2 | 84 | 28 | 266 | 3 | 363 | 0.23 | -0.85 | 21.3 | 1 |
| TRINIDAD FAA AP | 73.7 | 38.5 | 56.1 | 2.5 | 84 | 27 | 266 | 0 | 375 | 0.17 | -0.72 | 19.1 | 3 |

## Mountains/Interior Valleys

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| WALDEN | 61.3 | 25.2 | 43.2 | 4.5 | 69 | 13 | 668 | 0 | 186 | 0.16 | -0.66 | 19.5 | 2 |
| LEADVILLE 2SW | 55.5 | 25.2 | 40.4 | 3.4 | 63 | 18 | 730 | 0 | 96 | 0.25 | -0.85 | 22.7 | 6 |
| BUENA VISTA | 66.9 | 28.5 | 47.7 | 1.6 | 73 | 19 | 530 | 0 | 273 | 0.20 | -0.58 | 25.6 | 1 |
| SAGUACHE | 66.0 | 31.6 | 48.8 | 4.0 | 73 | 25 | 494 | 0 | 257 | 0.18 | -0.56 | 24.3 | 1 |
| HERMIT 7ESE | 61.4 | 21.0 | 41.2 | 2.7 | 70 | 15 | 730 | 0 | 181 | 0.13 | -1.44 | 8.3 | 1 |
| ALAMOSA WSO AP | 67.6 | 24.7 | 46.2 | 2.5 | 74 | 18 | 575 | 0 | 279 | 0.20 | -0.52 | 27.8 | 3 |
| STEAMBOAT SPRINGS | 67.6 | 27.3 | 47.5 | 5.6 | 76 | 20 | 537 | 0 | 282 | 0.24 | -1.40 | 14.6 | 3 |
| GRAND LAKE 6SSW | 58.7 | 27.7 | 43.2 | 3.4 | 64 | 21 | 667 | 0 | 142 | 0.22 | -0.67 | 24.7 | 4 |
| DILLON 1E | 58.1 | 24.4 | 41.3 | 2.2 | 64 | 19 | 728 | 0 | 132 | 0.47 | -0.28 | 62.7 | 4 |
| ASPEN 1SW | 62.0 | 32.2 | 47.1 | 3.6 | 70 | 22 | 550 | 0 | 193 | 0.22 | -1.49 | 12.9 | 4 |
| TAYLOR PARK | 57.1 | 26.4 | 41.8 | 8.8 | 65 | 20 | 714 | 0 | 121 | 0.50 | -0.74 | 40.3 | 3 |
| TELLURIDE | 63.8 | 29.0 | 46.4 | 3.3 | 73 | 16 | 570 | 0 | 222 | 1.18 | -1.04 | 53.2 | 10 |
| PAGOSA SPRINGS | 70.8 | 26.0 | 48.4 | 3.1 | 78 | 20 | 506 | 0 | 329 | 0.32 | -1.67 | 16.1 | 7 |
| SILVERTON | 61.4 | 18.7 | 40.0 | 3.0 | 73 | 11 | 764 | 0 | 185 | 0.98 | -1.29 | 43.2 | 5 |
| WOLF CREEK PASS 1 | 55.1 | 26.2 | 40.6 | 4.1 | 63 | 20 | 749 | 0 | 96 | 1.15 | -2.98 | 27.8 | 6 |

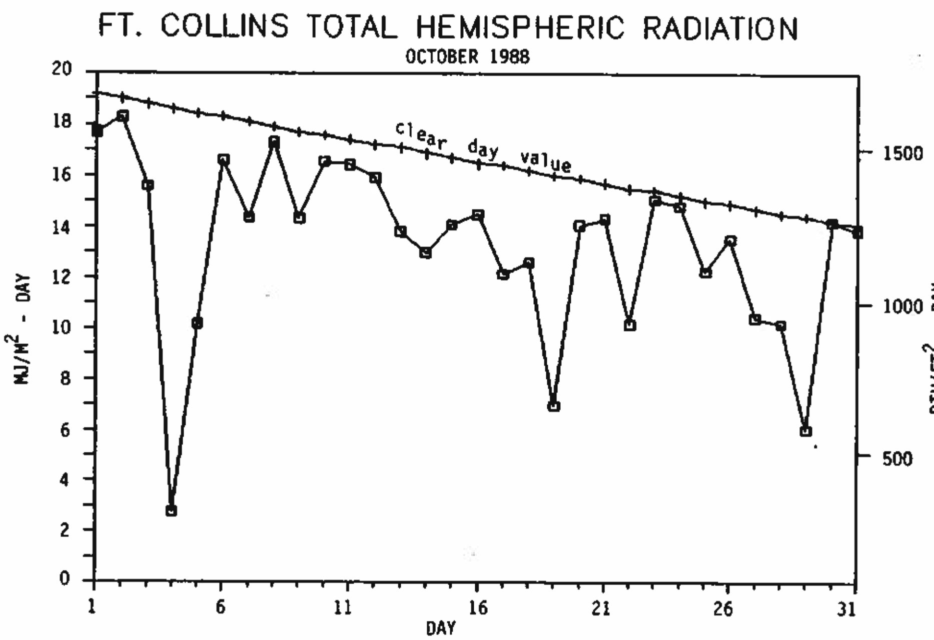
## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 68.7 | 32.1 | 50.4 | 5.2 | 78 | 26 | 442 | 0 | 298 | 0.22 | -1.08 | 16.9 | 4 |
| HAYDEN | 68.0 | 31.6 | 49.8 | 4.8 | 77 | 25 | 463 | 0 | 288 | 0.14 | -1.20 | 10.4 | 3 |
| RANGELY 1E | 72.8 | 36.1 | 54.5 | 6.0 | 79 | 28 | 320 | 0 | 362 | 0.00 | -0.95 | 0.0 | 0 |
| EAGLE FAA AP | 68.9 | 29.2 | 49.1 | 4.3 | 79 | 23 | 486 | 0 | 303 | 0.11 | -0.77 | 12.5 | 1 |
| GLENWOOD SPRINGS | 71.2 | 33.2 | 52.2 | 3.7 | 79 | 28 | 388 | 0 | 337 | 0.27 | -1.19 | 18.5 | 3 |
| RIFLE | 74.9 | 33.4 | 54.2 | 5.5 | 85 | 28 | 327 | 0 | 394 | 0.14 | -1.01 | 12.2 | 2 |
| GRAND JUNCTION WS | 73.6 | 44.1 | 58.9 | 4.0 | 83 | 38 | 183 | 4 | 380 | 0.02 | -0.89 | 2.2 | 1 |
| CEDAREDGE | 73.0 | 38.5 | 55.7 | 5.0 | 80 | 31 | 279 | 0 | 363 | 0.06 | -1.17 | 4.9 | 1 |
| PAONIA 1SW | 72.9 | 41.6 | 57.3 | 5.9 | 82 | 37 | 234 | 0 | 363 | 0.25 | -1.17 | 17.6 | 3 |
| GUNNISON | 65.3 | 23.5 | 44.4 | 3.1 | 74 | 18 | 631 | 0 | 244 | 0.14 | -0.72 | 16.3 | 2 |
| MONTROSE NO. 2 | 71.1 | 39.6 | 55.3 | 4.8 | 81 | 35 | 292 | 0 | 334 | 0.27 | -0.86 | 23.9 | 4 |
| URAVAN | 78.1 | 38.4 | 58.2 | 3.6 | 87 | 32 | 202 | 0 | 440 | 0.22 | -1.18 | 15.7 | 3 |
| YELLOW JACKET 2W | 69.5 | 40.5 | 55.0 | 4.9 | 78 | 35 | 301 | 0 | 308 | 0.14 | -1.81 | 7.2 | 3 |
| CORTEZ | 71.9 | 35.3 | 53.6 | 3.6 | 80 | 29 | 349 | 0 | 345 | 0.47 | -1.13 | 29.4 | 4 |
| DURANGO | 72.2 | 33.8 | 53.0 | 4.0 | 83 | 29 | 365 | 0 | 351 | 0.55 | -1.47 | 27.2 | 3 |
| IGNACIO 1N | 74.3 | 31.2 | 52.7 | 5.0 | 87 | 24 | 374 | 0 | 382 | 0.17 | -1.38 | 11.0 | 3 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## OCTOBER 1988 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days: clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 13 | 10 | 8 | -- | -- |
| Denver | 13 | 11 | 7 | 71% | 73% |
| Fort Collins | 12 | 15 | 4 | -- | -- |
| Grand Junction | 17 | 5 | 9 | 82% | 74% |
| Pueblo | 17 | 7 | 7 | 81% | 79% |



# DAYLIGHTING - TURNING WINDOWS INTO ENERGY SAVERS

## What is Daylighting?

Daylighting is a very old concept that, before the advent of electric lighting, was the source of light for interior spaces. With electric lighting available, however, daylighting was pushed aside as a design parameter. In recent times, though, energy concerns are of prime importance and daylighting is once again being employed, but now with the engineering vigor of any environmental system. Recent development of engineering tools have made it possible to implement daylighting properly and efficiently.

Daylight can be broken up into three components: direct (from the sun itself), diffuse (from the rest of the sky), and reflected (from the ground). The direct component is generally not considered in designs due to its radical change during the course of a day. The diffuse component, on the other hand, holds a very constant value from about one hour after sunrise until about one hour before sunset. Hence, this is the workable light source the engineer tries to bring into the space. On partly cloudy days, the diffuse component actually increases but is slightly more erratic. Approximately the same quantity of diffuse light is available on cloudy days as on clear days, but the intensity can vary from one hour to the next. Even in England, a notoriously cloudy environment, daylighting is mandated via building codes.

## How to Make Daylighting Work

Daylighting performs best when implemented as background lighting, supplemented with electric task lighting. Scale models are frequently used to test a daylighting system's performance. This is a very useful tool not available to electric lighting designs due to the photometric characteristics of electrically generated light.

There are several techniques available for detailed daylighting analysis. These techniques are divided into two basic categories. The first type derives relative illuminance values (illuminance being the amount of light falling onto a surface), relative, meaning values of percent of available daylight. The general equation that describes a Daylight Factor, but not explicitly used for calculations, is given by the ratio of the interior to the exterior illuminance. The Daylight Factor method has been used to develop special protractors which, when laid out on building plans or sections, yield calculated Daylight Factor information. This enables calculations to be made in a matter of minutes. The second type derives absolute illuminance values, meaning actual footcandle levels (a footcandle is one lumen per square foot). This is the recommended type in the U.S. Flux Transfer, an absolute illuminance method, is designed to be run on a micro)computer due to the large number of calculations involved. This method is much more versatile and accurate than other methods. As a result of the implementation of Flux Transfer, there are some very good daylighting analysis computer programs on the market.

## Control of Daylighting Systems

Control strategies are of the utmost importance to the success of a daylighting design. The two basic control strategies are dimming systems and step controls. Since dimming systems are infamously expensive and good dimming ballasts and lamps are hard to find, step controls are generally used in conjunction with three lamp luminaires. Three tiered stepping does not provide the same level of lumen control as dimming systems, but has proven to be successful. In Denver, for example, the perimeter lights of an office building can be completely off about 65% of the day without any loss in task illumination. If a window's daylighting contribution to a space is assessed, and a suitable electric lighting system is designed, then windows can save a significant amount of energy devoted to lighting. Additionally, the decreased number of lamps burning in a space significantly decreases the cooling load of that space. Furthermore, a perimeter daylighting system can be implemented with the same or less area of glazing than would be built into a standard building. Hence, windows, which have classically been net losers with respect to energy, have the capability of being net gainers as long as their potential is realized.

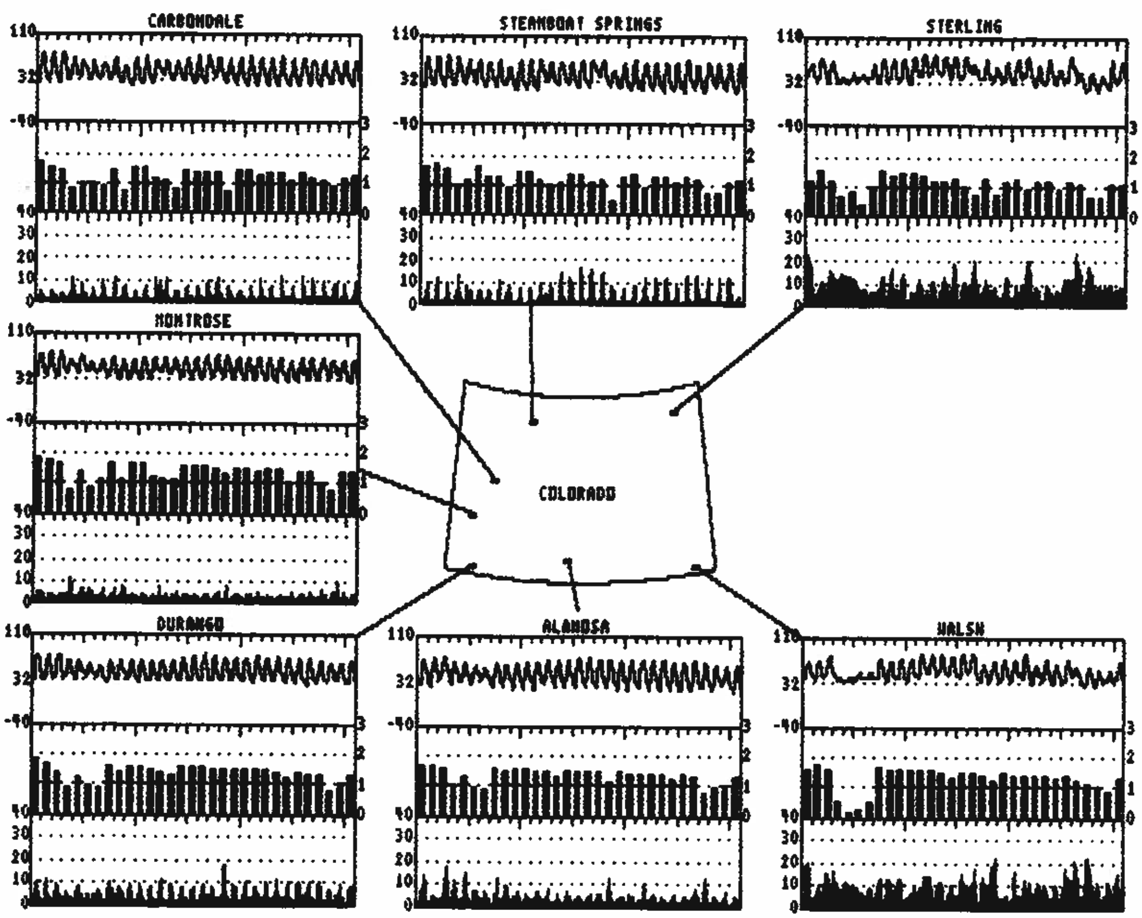
This report was prepared by Mark Jongewaard of the Joint Center for Energy Management.

# WTHRNET WEATHER DATA OCTOBER 1988

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh |
|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | 45.5 | 48.5 | 46.3 | 51.3 | 42.3 | 49.8 | 53.0 |
| **monthly temperature extremes and time of occurance ( °F day/hour )** | | | | | | | |
| maximum: | 73.0 3/15 | 76.1 17/16 | 76.3 3/15 | 78.3 3/15 | 74.8 3/14 | 82.0 12/15 | 84.2 17/13 |
| minimum: | 18.1 31/ 7 | 27.0 27/ 7 | 22.5 26/ 7 | 29.5 26/ 6 | 15.3 31/ 7 | 19.8 29/ 6 | 27.7 29/ 7 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | |
| 5 AM | 84 / 23 | 74 / 27 | 92 / 28 | 77 / 30 | 94 / 23 | 71 / 29 | 78 / 35 |
| 11 AM | 38 / 31 | 35 / 32 | 43 / 33 | 42 / 37 | 41 / 32 | 44 / 35 | 44 / 37 |
| 2 PM | 25 / 25 | 27 / 29 | 29 / 30 | 30 / 34 | 26 / 27 | 34 / 32 | 36 / 35 |
| 5 PM | 26 / 23 | 30 / 27 | 28 / 27 | 29 / 31 | 28 / 25 | 35 / 29 | 39 / 34 |
| 11 PM | 56 / 25 | 59 / 27 | 66 / 29 | 54 / 30 | 70 / 26 | 59 / 29 | 67 / 35 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | |
| day | 166 | 209 | 250 | 271 | 231 | 188 | 165 |
| night | 175 | 79 | 169 | 148 | 111 | 227 | 227 |
| **monthly average wind speed ( miles per hour )** | 2.95 | 3.32 | 2.68 | 2.40 | 2.85 | 7.49 | 7.33 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | |
| 0 to 3 | 451 | 452 | 554 | 528 | 538 | 95 | 78 |
| 3 to 12 | 280 | 288 | 188 | 216 | 182 | 553 | 574 |
| 12 to 24 | 13 | 4 | 2 | 0 | 24 | 95 | 92 |
| > 24 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **monthly average daily total insolation ( $Btu/ft^2 \cdot day$ )** | 1337 | 1362 | 1229 | 1343 | 1199 | 1085 | 1269 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | |
| 60-80% | 229 | 195 | 199 | 226 | 198 | 173 | 231 |
| 40-60% | 62 | 46 | 60 | 53 | 57 | 67 | 49 |
| 20-40% | 30 | 60 | 44 | 25 | 43 | 53 | 22 |
| 0-20% | 11 | 16 | 15 | 10 | 17 | 29 | 38 |

## The State-Wide Picture

Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40° to 110°F, the middle one gives the daily total solar radiation on a horizontal plane, up to 4000 Btu per square foot per day, and the bottom graph illustrates the hourly average wind speed from 0 to 40 miles per hour. Continuing problems with the Stratton station have prevented us from retrieving data from this site.



# COLORADO CLIMATE

## NOVEMBER 1988

Colorado Climate Center
Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado 80523

*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 2

<u>November in Review:</u>

A series of Pacific storm systems dumped much-appreciated snows over most of the Colorado mountains in November. Precipitation totals ended up well above average in the western half of the state. Conditions remained very dry east of the mountains. Temperatures were above average across the eastern plains but were near or a little below average in the mountains.

<u>Colorado's January Climate:</u>

We have been overdue for a cold and snowy January, and last year got back at us. Strong, cold winds made it seem even worse than usual. This year may be better, but when it comes to January it is best to prepare for the worst. Based on long-term averages, January is the coldest month of the year and the month with the greatest frequency of sub-zero temperatures. It is also a month of frequent and heavy mountain snows.

To give you an idea of what to expect on an "average" January day, daytime temperatures rise into the 30s and 40s from the Eastern Plains into the foothills with lows mostly in the lower teens on the plains and a little warmer in the lower foothills. On the Western Slope, daily highs average in the 30s with lows mostly in the teens. As expected, in the mountains conditions are colder but with more local variations. Highs in the 20s are common but lows vary greatly with topography. Lows near zero are typical in the higher mountains and some of the valleys. But certain high valleys west of the Continental Divide are preferred cold spots and temperatures are often well below zero. Fraser dropped to -53° back on 10 January 1962. Fortunately, these cold valley temperatures are usually accompanied by little or no wind.

Precipitation, which nearly always falls as snow, is greatly affected by the mountains. January is often the snowiest month of the year in the mountains and on the Western Slope, while east of the mountains it is a very dry month. January moisture averages between 0.50" and 1.00" (8-20" snow) on the Western Slope. Most mountain areas receive 2" to 4" of moisture (30 to 60" snow) with locally higher amounts. The eastern foothills can expect 0.30" to 1.00" (6-25" snow), while on the plains and in the San Luis Valley only about 0.20" to 0.50" of moisture (5-12" snow) falls most years. Mountain precipitation in January is very important to the state. It contributes approximately 23% on the average to the total winter snowpack. That snowpack is our primary source of surface water supplies.

Describing averages just doesn't do justice to January weather, especially east of the mountains. Day to day temperature variations can be great, and most precipitation falls from a few events. Occasional downslope windstorms occur along the Front Range and winds surpass 60-80 mph in preferred areas. Surprisingly warm temperatures can occur east of the mountains, but warm weather is often terminated by brutal Arctic outbreaks. It is not unusual on the plains to see 60-degree weather one day followed by zero the next. Be prepared for a few periods of adverse winter weather, avoid travel during stormy episodes, and January in Colorado can be surprisingly pleasant.

<u>Precipitation and Elevation -- How are they related?</u>

It is generally assumed that precipitation increases with elevation here in the Central Rockies. Anyone who has studied the detailed average annual precipitation map produced by our office a few years ago probably realizes that the wettest areas of the state are all in high mountain locations. There is no doubt that our complex topography affects precipitation patterns. Mountain barriers do increase precipitation during many meteorological situations. By forcing air masses to rise over these rocky barriers air

(continued on page 9)

# N O V E M B E R 1 9 8 8 D A I L Y W E A T H E R

| Date | Event |
|---|---|
| 1-2 | A continuation of October's mild and dry weather. Most of the state enjoyed the warmest temperatures of the month with 70s and even low 80s nearly everywhere east of the mountains. 60° readings reached elevations above 8,000 feet. |
| 3-4 | A Pacific cold front raced across the state on the 3rd. Still quite warm on the 3rd ahead of the front. Grand Junction reached 72° and Las Animas hit 84°, the warmest in the state for the month. Then windy and colder. Mountain snows developed across northern Colorado with rains at lower elevations. Some substantial precipitation totals in the northern mountains. Steamboat Springs reported 0.56" of cold rain. Winter Park measured 11" of wet snow (1.46" water content). A few light showers spilled over into the eastern foothills and continued on the 4th. Otherwise, it remained dry east of the mountains with some reports of blowing topsoil. |
| 5-7 | Clearing but cool on the 5th. Then increasing clouds and much warmer again on the 6th with high temperatures returning to the 60s and 70s again over most of the state. Salida enjoyed a high temperature of 66° and Pueblo reached 77°. Another Pacific cold front then zipped across Colorado on the 7th. Some mountain snows developed in the northern mountains, but precipitation totals were very light. |
| 8-19 | A much-appreciated series of 4 storms brought substantial moisture to the Colorado mountains. The first storm moved in on the afternoon of the 8th with low elevation rains west of the mountains and heavy wet snows in the mountains, heaviest in the central mountains. Aspen, reported 1.90" of moisture from the storm. This may have been the greatest 1-day storm ever to hit Aspen in November. A little precipitation spread east of the mountains as the storm moved rapidly eastward on the 9th. Some convective showers in northeast Colorado produced local snow pellets and even some thunder. Greeley reported 0.19" of moisture and Littleton got 0.40". Dry but chilly on the 10th, then increasing clouds again as the next storm approached. Rain and even some thunder spread across western Colorado on the 11th with totals ranging from just a trace at Gunnison and 0.05" at Browns Park (in extreme NW Colorado) to more than 0.80" at Cortez, Mesa Verde and Yellow Jacket. Just a few sprinkles east of the mountains later on the 11th and breezy. A pleasant interlude 12-13th before the strongest of the series of storms crossed the state 14-15th. Most areas of the state received some moisture, and many areas east of the mountains reported their first snowfall of the winter on the 15th. Wolf Creek Pass received about 20" of snow. Blanca, in the dry San Luis Valley, received a surprising 10" of snow with 0.77" water content. The storm looked like a potential major blizzard for the eastern plains but moved too quickly to drop much moisture. Limon did receive 2.3" of snow with winds gusing over 40 mph. Cold but dry on the 16th. Then the 4th storm began moving in on the 17th. This last storm failed to get well organized and was less moisture-laden. A few inches of mountain snow was common. However, a period of heavy snow developed in south central Colorado late on the 18th. Close to a foot of snow fell near Trinidad before the storm cleared out on the 19th. As skies cleared some very cold temperatures were noted. Crested Butte reported a low of -19°. |
| 20-23 | Sunny but cold 20-21st. Alamosa dipped to -9° on the morning of the 20th. Then much warmer statewide 22-23rd as a new storm began developing to our west. Boulder hit 70° on the 23rd. |
| 24-27 | Very windy and colder east of the mountains on Thanksgiving (24th). Snows fell in the mountains and continued onto the 25th producing great holiday weekend skiing. 30" of snow fell at Wolf Creek Pass and about 10" fell at Leadville 24-25th. Lemon Dam, near Durango, received 17" of snow with 1.46" of water content. Continued unsettled 26-27th and very cold. Antero Reservoir had -20° early on the 27th, the coldest in the state for the month. A few snow showers moved south along the Front Range on the 27th as more cold air moved down across the plains. |
| 28-30 | Breifly warmer on the 28th but another cold front accompanied by some very strong winds later on the 28th (gusts over 60 mph at Fort Collins) dropped temperatures back below average for the last 2 days of November. A dusting of mountain snows accompanied this strong Pacific cold front. |

## November 1988 Extremes

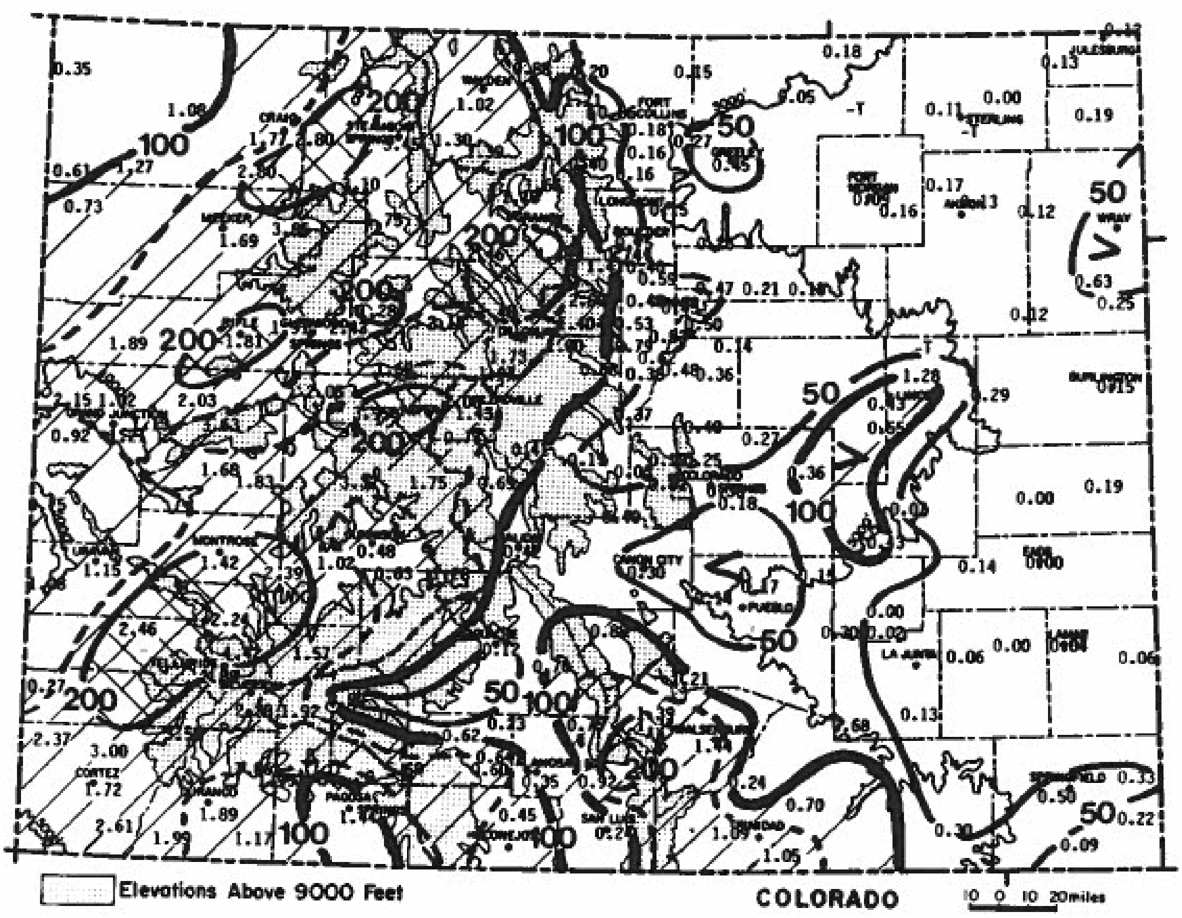
| | | | |
|---|---|---|---|
| Highest Temperature | 84°F | November 3 | Las Animas |
| Lowest Temperature | -20°F | NOvember 27 | Antero Reservoir |
| Greatest Total Precipitation | 5.68" | | Wolf Creek Pass 1E |
| Least Total Precipitation | 0.00" | | John Martin Dam and 5 other stations |
| Greatest Total Snowfall* | 84" | | Wolf Creek Pass 1E |

*For existing weather stations with complete daily records. Higher values are likely for unmonitored locations.

# NOVEMBER 1988 PRECIPITATION

The barrage of mid-November storms resulted in above average precipitation for November over almost all areas of Colorado in and west of the mountains. More than double the average November precipitation fell on the northwestern slopes of the San Juan mountains and in a number of more localized areas including Rifle, Eagle, Hayden, Dillon, Aspen and Winter Park. Aspen's 3.95" total ranked as the second wettest November in the past 30 years. The only drier than average areas in the western half of the state were the immediate Gunnison area, extreme northwest Colorado, and a portion of the San Luis Valley. East of the mountains, precipitation dropped off very quickly, and most areas experienced the second consecutive month of extremely dry weather. The majority of eastern Colorado received less than 0.25" of moisture (generally less than 50% of average). The only truly wet area east of the mountains was the southern Front Range including Walsenburg and Trinidad where the storm of November 18-19th dropped heavy snows.

| Greatest | | Least | |
|---|---|---|---|
| Wolf Creek Pass 1E | 5.68" | Cheraw 1N | 0.00" |
| Winter Park | 4.48" | Eads | 0.00" |
| Ouray | 4.42" | Fleming 1S | 0.00" |
| Aspen 1SW | 3.95" | Ordway 2ENE | 0.00" |
| Marvine Ranch | 3.85" | Kit Carson 6SE | 0.00" |
| | | John Martin Dam | 0.00" |

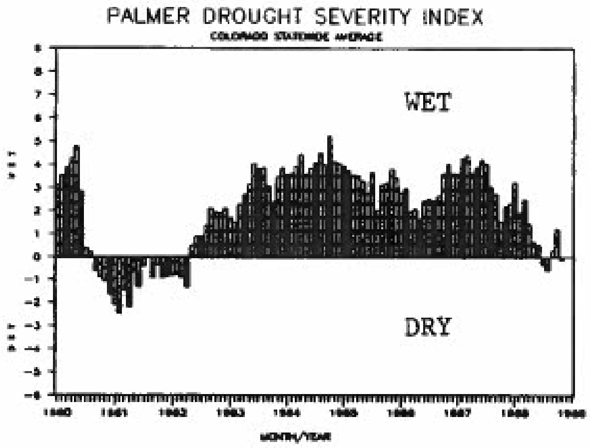


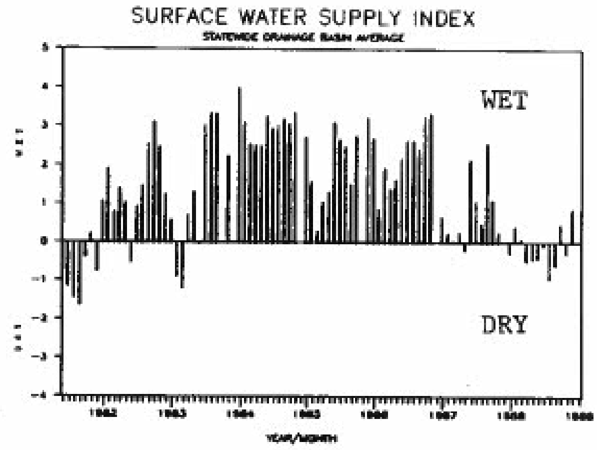

Precipitation amounts (inches) for November 1988 and contours of precipitation as a percent of the 1961-1980 average. Dotted line is 150% of average.

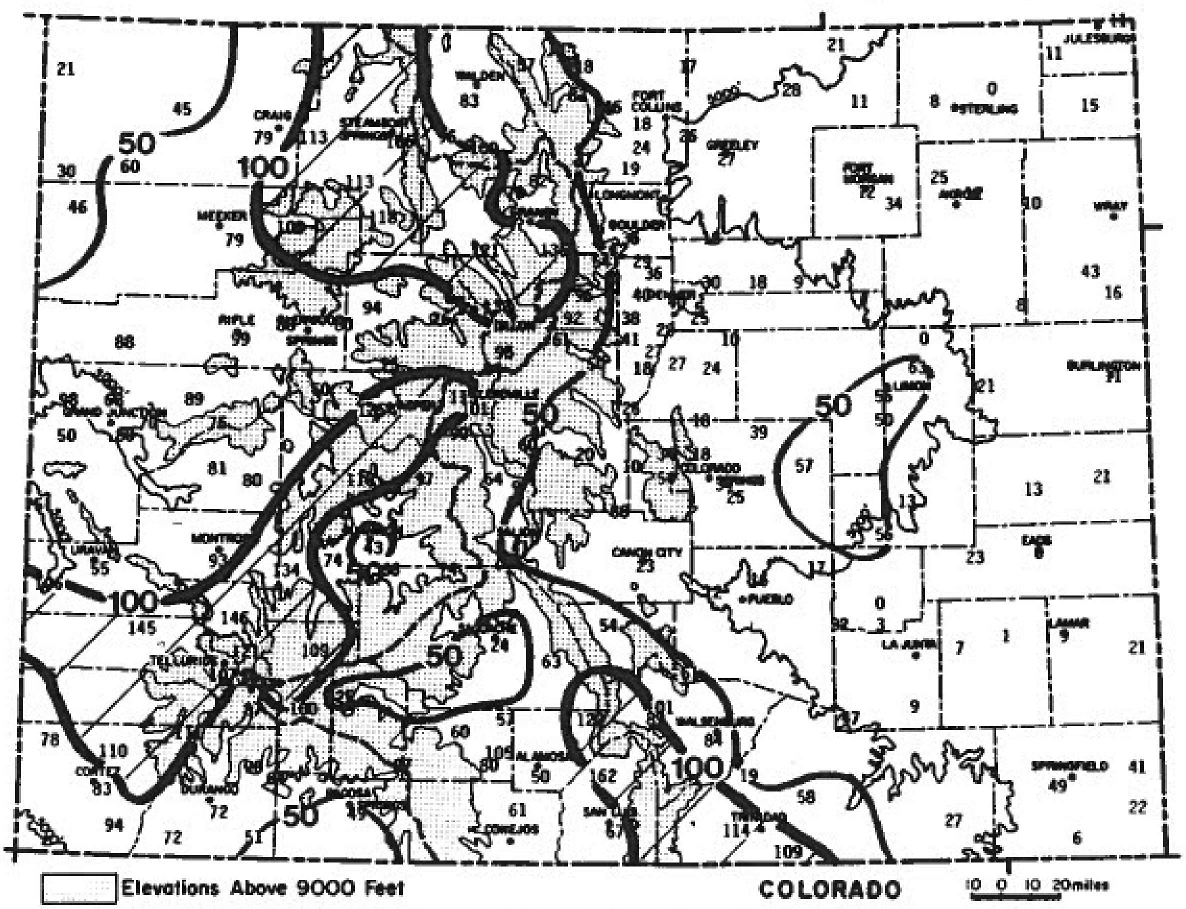
# 1989 WATER YEAR PRECIPITATION

The combination of a very dry October and a wet November left western Colorado fairly close to average for the first 2 months of the 1988 water year. East of the mountains is a different story. Almost all of eastern Colorado has had less than 25% of the October-November average moisture. A handful of locations have received no measurable precipitation. For the plains, this is one of the driest starts to a water year in a long time.

At this time it is too early to know what our water supplies will be for the coming growing season. But as the two drought indexes currently used to monitor Colorado's water availability show, we appear to be at the end of what has truly been an unusually wet period during the past several years. We have now returned to more normal conditions. This does not foretell drought, but closer monitoring will now be appropriate.



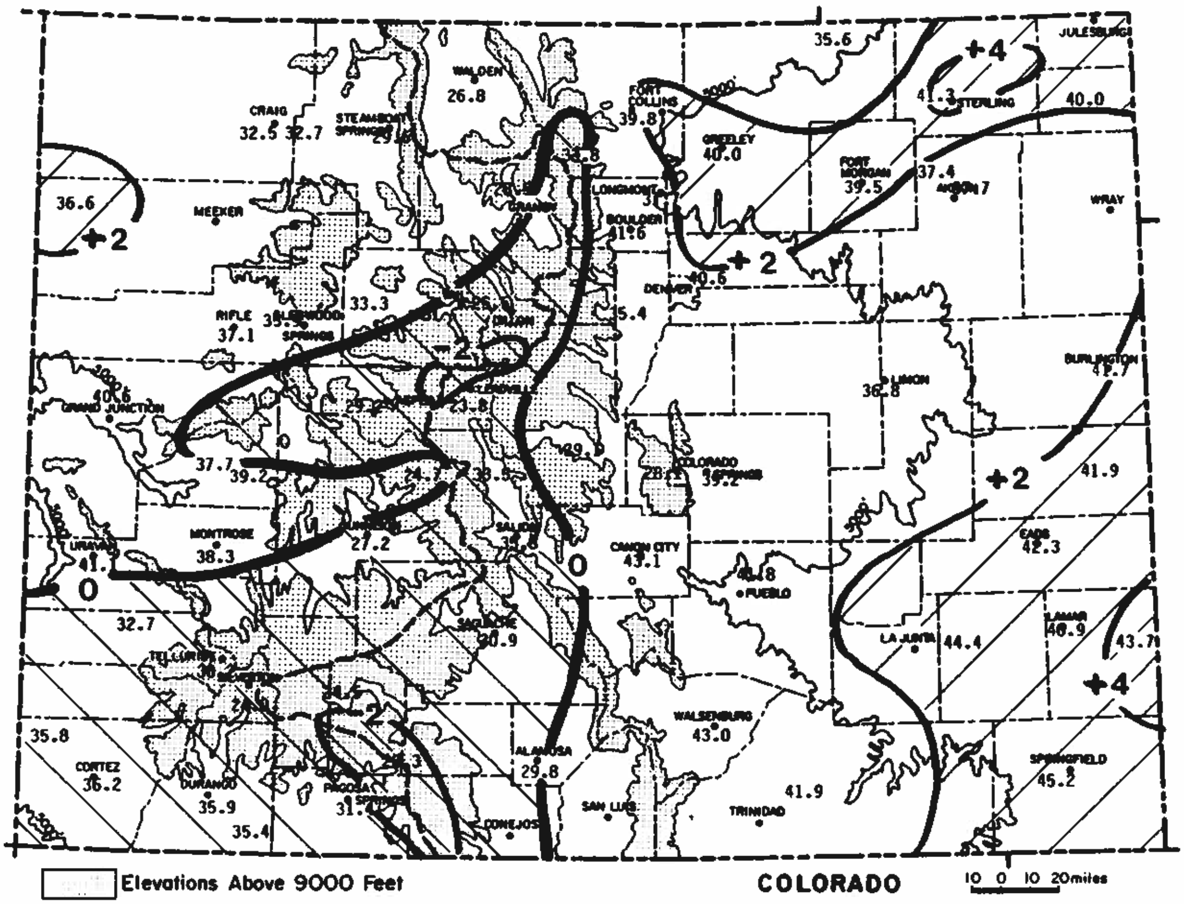




Precipitation for October 1988 through November 1988 as a percent of the 1961-1980 average.

## NOVEMBER 1988 TEMPERATURES

## AND DEGREE DAYS

November temperatures for the month as a whole ended up a little below average in central and southwestern Colorado. Higher mountain locations were the coldest, both in an absolute sense and relative to average. Both Climax and Wolf Creek Pass were more than 3 degrees colder than average. Northwestern Colorado and all of the eastern half of the state continued to be warmer than average. The warmest anomalies were found in the lower valleys of the Platte and Arkansas rivers. Sterling and Holly were each more than 4 degrees warmer than average. The variety of warm and cold temperatures observed during the month were well within the normal range of variability for the month of November.




November 1988 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## NOVEMBER 1988 SOIL TEMPERATURES

The dry weather, decreasing solar energy, and colder air temperatures later in the month resulted in rapidly falling soil temperatures in the upper levels. However, except for near the surface, soil temperatures remained warmer than usual for this time of year.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.

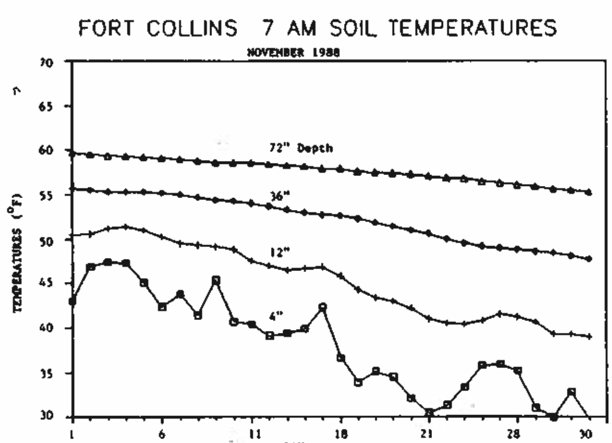


Table 1. Heating Degree Day Data through November 1988 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 87-88 | 66 | 96 | 364 | 601 | 1130 | 1556 | 1867 | 1381 | 1031 | 658 | 454 | 102 | 9306 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | | | | | | | | 2038 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 87-88 | 112 | 152 | 355 | 563 | 1024 | 1382 | 1450 | 1146 | 1136 | 734 | 517 | 123 | 8694 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | | | | | | | | 2127 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 87-88 | 7 | 33 | 122 | 370 | 713 | 1053 | 1107 | 842 | 739 | 400 | 203 | 14 | 5603 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | | | | | | | | 1133 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 87-88 | 49 | 117 | 313 | 549 | 955 | 1277 | 1357 | 1010 | 1030 | 639 | 472 | 102 | 7870 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | | | | | | | | 1895 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 87-88 | 5 | 20 | 72 | 375 | 724 | 1037 | 1221 | 935 | 779 | 449 | 178 | 14 | 5809 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | | | | | | | | 1154 |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 87-88 | 11 | 36 | 87 | 374 | 668 | 1007 | 1144 | 858 | 767 | 407 | 191 | 16 | 5566 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | | | | | | | | 1058 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 87-88 | 17 | 74 | 150 | 445 | 767 | 1108 | 1256 | 958 | 886 | 499 | 273 | 25 | 6458 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | | | | | | | | 1304 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 87-88 | 6 | 35 | 154 | 396 | 860 | 1179 | 1351 | 1008 | 899 | 609 | 362 | 56 | 6915 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | | | | | | | | 1393 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 87-88 | 55 | 96 | 227 | 534 | 950 | 1376 | 1561 | 1264 | 1076 | 593 | 399 | 52 | 8183 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | | | | | | | | 1709 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 87-88 | 0 | 11 | 108 | 354 | 737 | 1102 | 1300 | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | | | | | | | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 87-88 | 11 | 21 | 110 | 410 | 745 | 1125 | 1227 | 889 | 811 | 437 | 215 | 14 | 6015 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | | | | | | | | 1192 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 87-88 | 296 | 346 | 556 | 763 | 1145 | 1491 | 1629 | 1376 | 1379 | 933 | 717 | 322 | 10953 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | | | | | | | | 2984 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 87-88 | 14 | 44 | 188 | 435 | 851 | 1206 | 1391 | 972 | 859 | 514 | 346 | 42 | 6862 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | | | | | | | | 1431 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 87-88 | 54 | 75 | 254 | 509 | 950 | 1331 | 1544 | 1173 | 1002 | 607 | 404 | 52 | 7955 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | | | | | | | | 1743 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 87-88 | 69 | 118 | 333 | 602 | 922 | 1255 | 1310 | 1029 | 992 | 645 | 462 | 111 | 7848 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | | | | | | | | 1864 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 87-88 | 12 | 37 | 146 | 453 | 784 | 1140 | 1252 | 936 | 821 | 479 | 217 | 8 | 6285 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | | | | | | | | 1281 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 87-88 | 12 | 29 | 110 | 430 | 773 | 1154 | 1484 | 1055 | 826 | 495 | 206 | 17 | 6591 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | | | | | | | | 1273 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 87-88 | 0 | 6 | 34 | 248 | 754 | 1147 | 1469 | 1031 | 741 | 350 | 172 | 8 | 5960 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | | | | | | | | 1015 |

* = AVES ADJUSTED FOR STATION MOVES M = MISSING E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 87-88 | 207 | 257 | 480 | 677 | 1098 | 1516 | 1642 | 1413 | 1372 | 907 | 602 | 238 | 10409 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | | | | | | | | 2614 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 87-88 | 10 | 26 | 119 | 424 | 762 | 1157 | 1363 | 955 | 807 | 437 | 204 | 6 | 6270 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | | | | | | | | 1204 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | | | | | | | | 2351 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 87-88 | 0 | 3 | 35 | 273 | 653 | 1032 | 1278 | 837 | 638 | 327 | 103 | 1 | 5180 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | | | | | | | | 893 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 87-88 | 346 | 393 | 578 | 763 | 1180 | 1534 | 1577 | 1326 | 1355 | 957 | 741 | 360 | 11110 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | | | | | | | | 3181 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 87-88 | 21 | 66 | 158 | 502 | 840 | 1209 | 1354 | 1022 | 943 | 569 | 321 | 35 | 7040 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | | | | | | | | 1450 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 87-88 | 12 | 33 | 159 | 464 | 805 | 1169 | 1383 | 1035 | 847 | 509 | 222 | 20 | 6658 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | | | | | | | | 1478 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | | | | | | | | M |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 87-88 | 5 | 30 | 129 | 349 | 849 | 1160 | 1332 | 1003 | 817 | 468 | 230 | 26 | 6398 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | | | | | | | | 1256 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 87-88 | 104 | 105 | 347 | 523 | 947 | 1292 | 1548 | 1187 | 996 | 663 | 485 | 143 | 8340 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | | | | | | | | 1921 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 87-88 | 4 | 17 | 43 | 355 | 754 | 1111 | 1399 | 903 | 777 | 399 | 167 | 8 | 5937 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | | | | | | | | 1082 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 87-88 | 9 | 24 | 125 | 391 | 819 | 1209 | 1430 | 1039 | 865 | 454 | 268 | 14 | 6647 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | | | | | | | | 1351 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 87-88 | 77 | 127 | 330 | 590 | 1033 | 1448 | 1619 | 1336 | 1167 | 674 | 433 | 95 | 8929 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | | | | | | | | 1998 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 87-88 | 12 | 31 | 108 | 413 | 742 | E1140 | 1475 | 1029 | 831 | 476 | 197 | 12 | 6466 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | | | | | | | | 1184 |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 87-88 | 161 | 222 | 426 | 603 | 992 | 1269 | 1354 | 1109 | 1092 | 720 | 547 | 208 | 8703 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | | | | | | | | 2281 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 87-88 | 4 | 25 | 80 | 330 | 730 | 1054 | 1209 | 850 | 803 | 438 | 234 | 13 | 5770 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | | | | | | | | 1065 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 87-88 | 215 | 281 | 495 | 740 | 1242 | 1499 | 1572 | 1343 | 1340 | 835 | 638 | 184 | 10384 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | | | | | | | | 2647 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 87-88 | 3 | 30 | 101 | 332 | 707 | 977 | 1109 | 826 | 773 | 401 | 238 | 25 | 5522 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | | | | | | | | 1044 |

* = AVES ADJUSTED FOR STATION MOVES M = MISSING E = ESTIMATED

# NOVEMBER 1988 CLIMATIC DATA

## Eastern Plains

| Name | Max | Min | Temperature Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEW RAYMER 21N | 49.0 | 22.2 | 35.6 | -0.3 | 73 | 10 | 875 | 0 | 70 | 0.18 | -0.10 | 64.3 | 4 |
| STERLING | 56.5 | 26.1 | 41.3 | 5.2 | 78 | 14 | 703 | 0 | 137 | 0.11 | -0.33 | 25.0 | 3 |
| FORT MORGAN | 54.6 | 24.3 | 39.5 | 2.8 | 76 | 13 | 757 | 0 | 115 | 0.09 | -0.27 | 25.0 | 2 |
| AKRON FAA AP | 51.9 | 22.8 | 37.4 | 0.7 | 76 | 10 | 823 | 0 | 92 | 0.17 | -0.29 | 37.0 | 4 |
| AKRON 4E | 52.9 | 22.4 | 37.7 | 0.9 | 77 | 7 | 814 | 0 | 110 | 0.13 | -0.40 | 24.5 | 3 |
| HOLYOKE | 54.4 | 25.6 | 40.0 | 2.0 | 77 | 14 | 742 | 0 | 121 | 0.19 | -0.33 | 36.5 | 2 |
| BURLINGTON | 54.7 | 28.8 | 41.7 | 2.0 | 77 | 14 | 692 | 0 | 114 | 0.15 | -0.40 | 27.3 | 3 |
| LIMON WSMO | 51.7 | 21.9 | 36.8 | 0.8 | 73 | 7 | 839 | 0 | 95 | 0.43 | 0.05 | 113.2 | 4 |
| CHEYENNE WELLS | 55.9 | 27.9 | 41.9 | 2.8 | 78 | 10 | 686 | 0 | 126 | 0.19 | -0.30 | 38.8 | 3 |
| EADS | 57.0 | 27.6 | 42.3 | 2.6 | 78 | 11 | 674 | 0 | 152 | 0.00 | -0.71 | 0.0 | 0 |
| LAMAR | 60.3 | 21.5 | 40.9 | 0.6 | 82 | 7 | 715 | 0 | 181 | 0.04 | -0.56 | 6.7 | 1 |
| LAS ANIMAS | 62.6 | 26.2 | 44.4 | 3.4 | 84 | 8 | 609 | 0 | 207 | 0.06 | -0.44 | 12.0 | 2 |
| HOLLY | 60.4 | 27.0 | 43.7 | 4.4 | 79 | 9 | 631 | 0 | 178 | 0.06 | -0.51 | 10.5 | 2 |
| SPRINGFIELD 7WSW | 60.9 | 29.5 | 45.2 | 3.5 | 79 | 14 | 585 | 0 | 193 | 0.50 | -0.25 | 66.7 | 2 |

## Foothills/Adjacent Plains

| Name | Max | Min | Temperature Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FORT COLLINS | 52.8 | 26.7 | 39.8 | 2.5 | 72 | 12 | 751 | 0 | 89 | 0.18 | -0.45 | 28.6 | 6 |
| GREELEY UNC | 52.7 | 27.3 | 40.0 | 3.1 | 75 | 16 | 742 | 0 | 90 | 0.45 | -0.31 | 59.2 | 4 |
| ESTES PARK | 45.9 | 21.7 | 33.8 | -0.8 | 63 | 5 | 929 | 0 | 33 | 0.40 | -0.12 | 76.9 | 1 |
| LONGMONT 2ESE | 56.0 | 19.4 | 37.7 | 0.5 | 78 | 8 | 812 | 0 | 132 | 0.15 | -0.46 | 24.6 | 2 |
| BOULDER | 54.2 | 29.0 | 41.6 | 0.8 | 75 | 13 | 692 | 0 | 115 | 0.75 | -0.21 | 78.1 | 3 |
| DENVER WSFO AP | 54.0 | 27.2 | 40.6 | 1.8 | 78 | 13 | 723 | 0 | 115 | 0.47 | -0.36 | 56.6 | 3 |
| EVERGREEN | 50.4 | 20.3 | 35.4 | 1.2 | 69 | 7 | 882 | 0 | 78 | 0.53 | -0.47 | 53.0 | 4 |
| LAKE GEORGE 8SW | 42.9 | 15.4 | 29.1 | 0.8 | 60 | -1 | 1070 | 0 | 33 | 0.15 | -0.23 | 39.5 | 3 |
| RUXTON PARK | 40.9 | 15.2 | 28.1 | 0.2 | 65 | -5 | 1100 | 0 | 21 | 0.82 | -0.12 | 87.2 | 4 |
| COLORADO SPRINGS | 52.9 | 25.4 | 39.2 | 1.5 | 71 | 10 | 767 | 0 | 104 | 0.36 | -0.17 | 67.9 | 4 |
| CANON CITY 2SE | 57.8 | 28.4 | 43.1 | 0.8 | 75 | 13 | 650 | 0 | 154 | 0.30 | -0.36 | 45.5 | 4 |
| PUEBLO WSO AP | 59.7 | 23.9 | 41.8 | 1.3 | 80 | 9 | 689 | 0 | 171 | 0.17 | -0.30 | 36.2 | 2 |
| WALSENBURG | 55.6 | 30.4 | 43.0 | 1.9 | 72 | 9 | 654 | 0 | 126 | 1.44 | 0.55 | 161.8 | 6 |
| TRINIDAD FAA AP | 57.7 | 26.1 | 41.9 | 0.9 | 78 | 9 | 686 | 0 | 159 | 0.70 | 0.11 | 118.6 | 4 |

## Mountains/Interior Valleys

| Name | Max | Min | Temperature Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WALDEN | 37.8 | 15.8 | 26.8 | 0.5 | 58 | -2 | 1139 | 0 | 7 | 1.02 | 0.43 | 172.9 | 9 |
| LEADVILLE 2SW | 35.7 | 11.9 | 23.8 | -1.2 | 52 | -8 | 1226 | 0 | 2 | 1.43 | 0.53 | 158.9 | 14 |
| SALIDA | 49.1 | 22.5 | 35.8 | -0.7 | 68 | -1 | 867 | 0 | 66 | 0.42 | -0.20 | 67.7 | 4 |
| BUENA VISTA | 47.2 | 19.8 | 33.5 | -0.3 | 64 | 1 | 937 | 0 | 60 | 0.69 | 0.10 | 116.9 | 5 |
| SAGUACHE | 46.3 | 15.5 | 30.9 | -0.4 | 62 | 2 | 1017 | 0 | 51 | 0.12 | -0.37 | 24.5 | 3 |
| HERMIT 7ESE | 41.2 | 7.8 | 24.5 | -0.1 | 58 | -17 | 1208 | 0 | 20 | 0.50 | -0.68 | 42.4 | 3 |
| ALAMOSA WSO AP | 46.6 | 13.0 | 29.8 | -0.0 | 66 | -9 | 1048 | 0 | 62 | 0.35 | -0.01 | 97.2 | 6 |
| STEAMBOAT SPRINGS | 39.9 | 19.3 | 29.6 | 0.7 | 65 | 5 | 1053 | 0 | 22 | 3.45 | 1.64 | 190.6 | 13 |
| GRAND LAKE 6SSW | 38.6 | 18.4 | 28.5 | 0.7 | 58 | 1 | 1087 | 0 | 12 | 1.18 | 0.31 | 135.6 | 16 |
| DILLON 1E | 37.6 | 13.4 | 25.5 | -1.2 | 58 | -3 | 1178 | 0 | 12 | 1.48 | 0.77 | 208.5 | 12 |
| CLIMAX | 29.2 | 7.4 | 18.3 | -3.5 | 45 | -8 | 1394 | 0 | 0 | 1.97 | 0.24 | 113.9 | 16 |
| ASPEN 1SW | 40.0 | 18.4 | 29.2 | -0.8 | 60 | 0 | 1070 | 0 | 19 | 3.95 | 2.35 | 246.9 | 13 |
| TAYLOR PARK | 38.3 | 11.1 | 24.7 | 5.5 | 53 | -4 | 1204 | 0 | 5 | 1.75 | 0.68 | 163.6 | 9 |
| TELLURIDE | 42.9 | 17.5 | 30.2 | -1.0 | 61 | 0 | 1036 | 0 | 22 | 2.88 | 1.33 | 185.8 | 11 |
| PAGOSA SPRINGS | 49.1 | 13.8 | 31.4 | -1.5 | 69 | -11 | 999 | 0 | 78 | 1.44 | -0.16 | 90.0 | 7 |
| SILVERTON | 41.6 | 6.5 | 24.0 | 0.3 | 63 | -12 | 1220 | 0 | 24 | 2.28 | 0.83 | 157.2 | 11 |
| WOLF CREEK PASS 1 | 35.4 | 9.2 | 22.3 | -3.8 | 51 | -10 | 1273 | 0 | 2 | 5.68 | 1.98 | 153.5 | 12 |

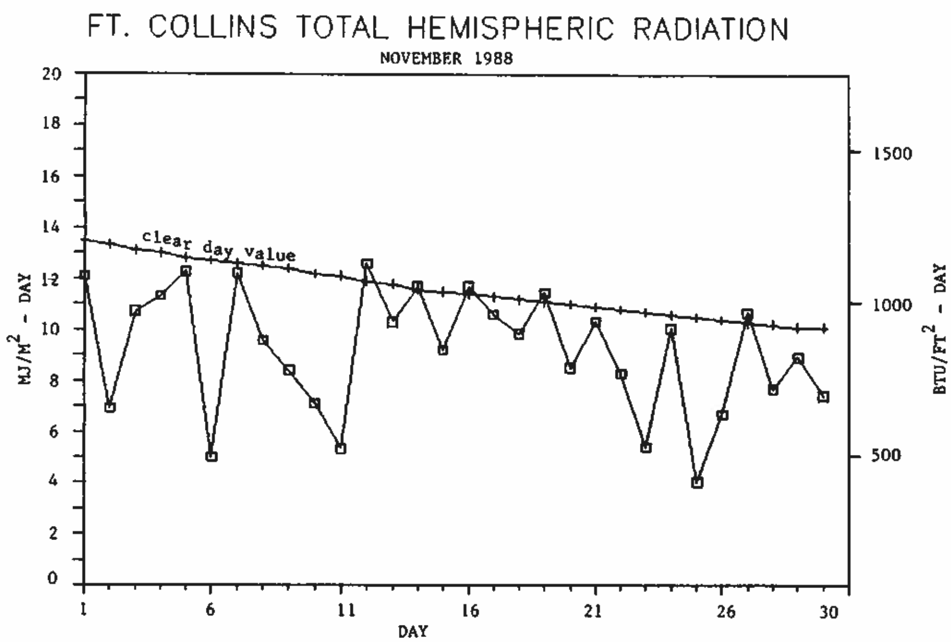
## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 42.5 | 22.6 | 32.5 | 1.1 | 67 | 11 | 967 | 0 | 41 | 1.77 | 0.57 | 147.5 | 10 |
| HAYDEN | 42.5 | 23.0 | 32.7 | 0.9 | 65 | 10 | 961 | 0 | 27 | 2.80 | 1.56 | 225.8 | 15 |
| RANGELY 1E | 48.9 | 24.3 | 36.6 | 2.9 | 67 | 12 | 843 | 0 | 66 | 0.73 | 0.10 | 115.9 | 5 |
| EAGLE FAA AP | 45.5 | 21.2 | 33.3 | 1.7 | 65 | 2 | 942 | 0 | 47 | 1.28 | 0.69 | 216.9 | 9 |
| GLENWOOD SPRINGS | 47.4 | 24.3 | 35.9 | 0.5 | 69 | 8 | 866 | 0 | 63 | 1.91 | 0.91 | 191.0 | 11 |
| RIFLE | 49.7 | 24.6 | 37.1 | 0.5 | 67 | 10 | 826 | 0 | 70 | 1.81 | 1.00 | 223.5 | 9 |
| GRAND JUNCTION WS | 51.2 | 30.0 | 40.6 | 0.4 | 72 | 17 | 726 | 0 | 83 | 1.02 | 0.41 | 167.2 | 7 |
| CEDAREDGE | 49.9 | 25.5 | 37.7 | -0.2 | 67 | 9 | 811 | 0 | 68 | 1.68 | 0.78 | 186.7 | 6 |
| PAONIA 1SW | 51.2 | 27.3 | 39.2 | 0.6 | 70 | 12 | 764 | 0 | 88 | 1.83 | 0.66 | 156.4 | 8 |
| GUNNISON | 42.8 | 11.7 | 27.2 | -0.9 | 63 | -5 | 1126 | 0 | 40 | 0.48 | -0.08 | 85.7 | 2 |
| MONTROSE NO. 2 | 50.4 | 26.2 | 38.3 | 0.8 | 69 | 12 | 794 | 0 | 86 | 1.42 | 0.74 | 208.8 | 7 |
| URAVAN | 55.7 | 26.5 | 41.1 | 0.1 | 74 | 15 | 710 | 0 | 125 | 1.15 | 0.09 | 108.5 | 8 |
| NORWOOD | 45.9 | 19.4 | 32.7 | -1.1 | 67 | -8 | 960 | 0 | 43 | 2.46 | 1.48 | 251.0 | 5 |
| YELLOW JACKET 2W | 47.2 | 24.4 | 35.8 | -1.5 | 65 | 5 | 870 | 0 | 59 | 2.37 | 1.13 | 191.1 | 6 |
| CORTEZ | 50.1 | 22.3 | 36.2 | -2.1 | 68 | 5 | 855 | 0 | 83 | 1.72 | 0.69 | 167.0 | 6 |
| DURANGO | 50.3 | 21.5 | 35.9 | -1.5 | 69 | 7 | 869 | 0 | 79 | 1.89 | 0.56 | 142.1 | 8 |
| IGNACIO 1N | 51.7 | 19.1 | 35.4 | -0.3 | 71 | 2 | 880 | 0 | 90 | 1.17 | 0.14 | 113.6 | 8 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## NOVEMBER 1988 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 10 | 12 | 8 | -- | -- |
| Denver | 7 | 14 | 9 | 62% | 65% |
| Fort Collins | 6 | 16 | 8 | -- | -- |
| Grand Junction | 7 | 9 | 14 | 62% | 63% |
| Pueblo | 11 | 11 | 8 | 72% | 74% |



Precipitation and Elevation -- How are they related? (continued)

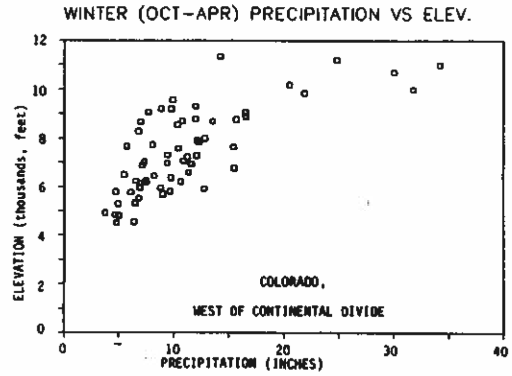
expands, cool and if sufficient moisture is present, condensation and precipitation may result. But mountains also block moisture flow and cause descending air on the downwind side of the barrier. This leads to dramatic rain shadow effects which are evident near almost any mountain range in the world.

As the thermal stability, atmospheric temperatures, moisture content, jet stream strength and location vary through the year, the exact role that our mountains play in precipitation processes also varies. The result is differences in precipitation-elevation relationships as you go through the year. Precipitation increases most dramatically with elevation when wind velocities aloft are greatest and the atmosphere is thermally stable. This occurs most often during the winter months. In the summer, winds aloft weaken greatly reducing the component of upward motion in the atmosphere caused by the mountains. Instead, convective precipitation processes become dominant as large amounts of solar energy are absorbed at ground level causing the atmosphere to become thermally unstable. Available moisture actually decreases with elevation, but this is largely compensated by a higher frequency of thunderstorm initiations with elevation.

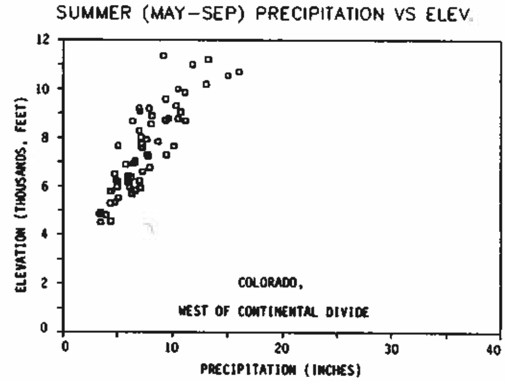
Using many of the data points previously used to produce the Colorado Average Annual Precipitation map, precipitation vs. elevation graphs were produced for the winter season (October-April), the summer season (May-September) and also for average annual precipitation. Seasonal differences are quite apparent. Perhaps even more apparent are the large differences in precipitation-elevation relationships between areas east and west of the Continental Divide. West of the Divide there is a noisy but systematic increase in winter precipitation with elevation of roughly 2.5 inches per 1000 feet. The summer increase is only about 1.5 inches per 1000 feet but is quite consistent. East of the Divide, winter precipitation appears to be nearly constant with elevation from the lowest elevations of the extreme Eastern Plains on up to about 8,500 feet MSL. Above that, precipitation then increases rapidly to the crest of the Continental Divide. In the summer there is no systematic increase of precipitation with elevation east of the Divide.

Average seasonal preciptation combines many types of storm systems and precipitation events. Individual storms may show quite different behavior from the patterns indicated by seasonal averages. Even so, these seasonal relationships offer a great deal of insight into precipitation processes here in Colorado. It is true, precipitation does increase with elevation -- but there is a lot more to it than that. From simple linear regression and available precipitation records, one would project an estimate of about 27" of precipitation per year at an elevation of 10,000 feet. That would be a very good estimate for many locations. But observations show that annual average precipitation ranges form less than 15" to more than 50" at 10,000 feet in different areas of Colorado. The next time you travel across the Colorado mountains keep this in mind. Even without a copy of the precipitation map at your side, there's a good chance that you can detect some of those patterns just by looking at vegetation, snow accumulation and other natural indicators.

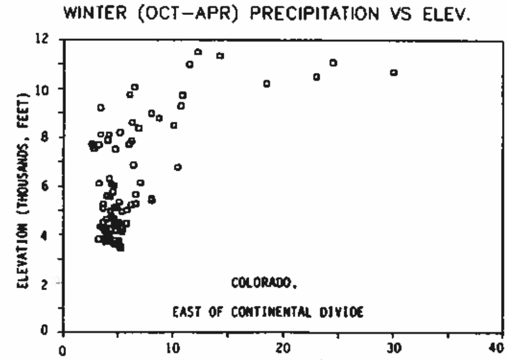
WINTER (OCT-APR) PRECIPITATION VS ELEV.



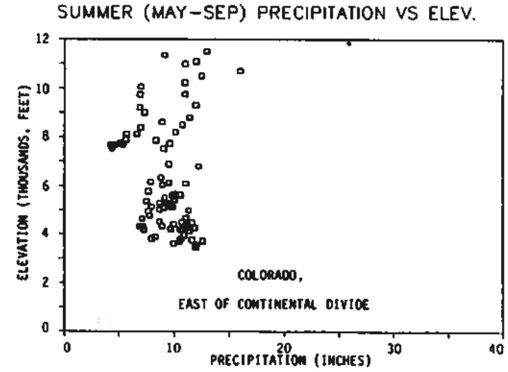

SUMMER (MAY-SEP) PRECIPITATION VS ELEV.




WINTER (OCT-APR) PRECIPITATION VS ELEV.

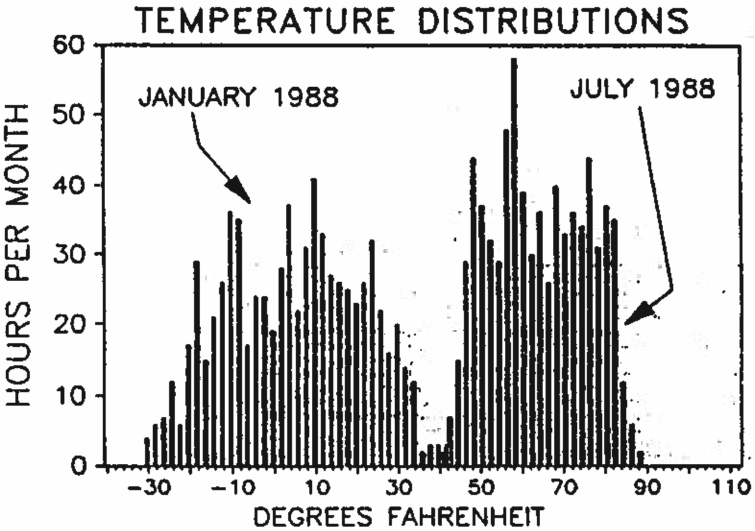



SUMMER (MAY-SEP) PRECIPITATION VS ELEV.



## Modeling of Weather Data

It is often desirable to simulate a building's energy performance before the structure is actually built. This kind of modeling can help the architects and engineers decide which is the most efficient heating and cooling systems for that building. A variety of models are available for this purpose.



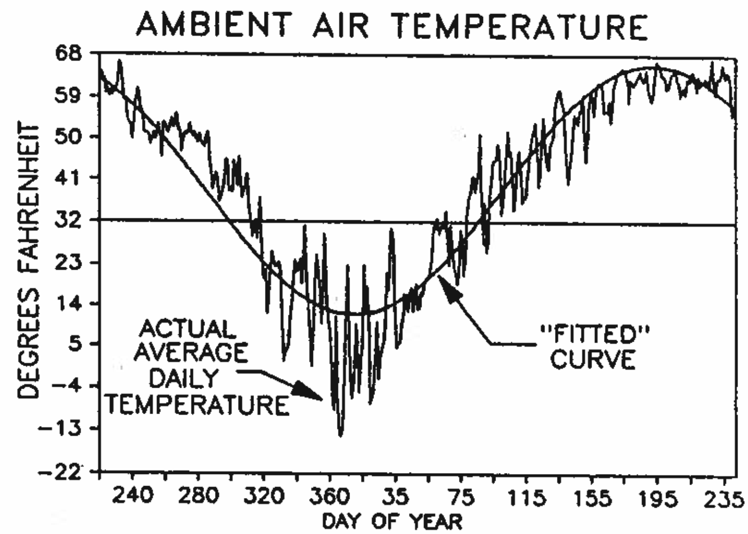

### Bin Distributions

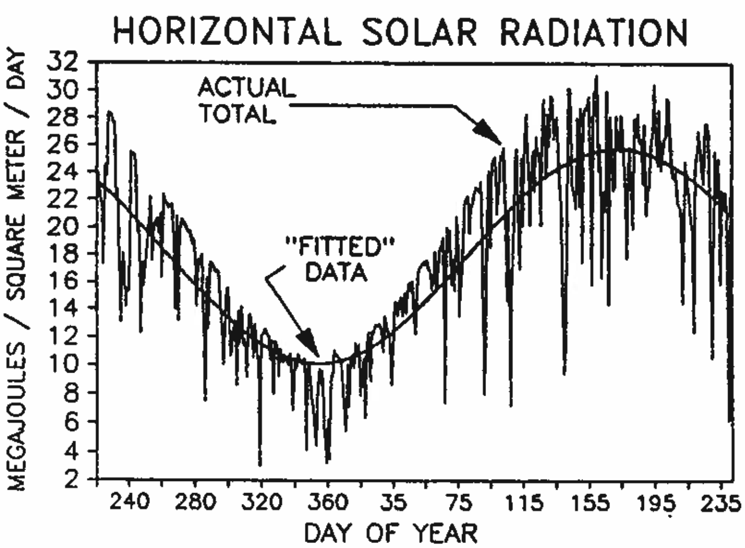
A very effective way to simulate temperature data is through the so-called "bin method": hourly data is distributed into a predetermined range of bins, usually five degrees Fahrenheit wide, and totaled up for a given time period. This typically results in eight to ten bins per month. The rate of heat loss or gain experienced by the building can be computed from both the thermostat set point and the bin temperature. This rate of energy transfer is multiplied by the number of hours in that bin to provide the total energy requirements for conditioning the building climate.

The figure on the left demonstrates the difference between January and July temperatures in Alamosa. The bins in this example are two degrees wide. The January distribution suggests a wide range of temperatures, whereas in July certain bins occur much more often than others, due to the nighttime clear sky temperature.

### Curve Fitting

Another way to simulate data is through the use of curve fitting. This refers to a practice where a linear regression is performed on a set of data to yield a curve or line which best "fits" the original data. This is most often done on a yearly scale with daily averages or daily totals. Due to the nature of solar radiation and temperature, a periodic function gives the best match. Another benefit of using sinusoidal fitting is that the relationships between yearly data also come out of the analysis. The graphs to the right and below show the temperature and solar data for Alamosa during the past year. The solar and air temperature data fits reach their lowest points 20 days apart, a relatively short lag time as compared to coastal cities.




### Why Model Data?

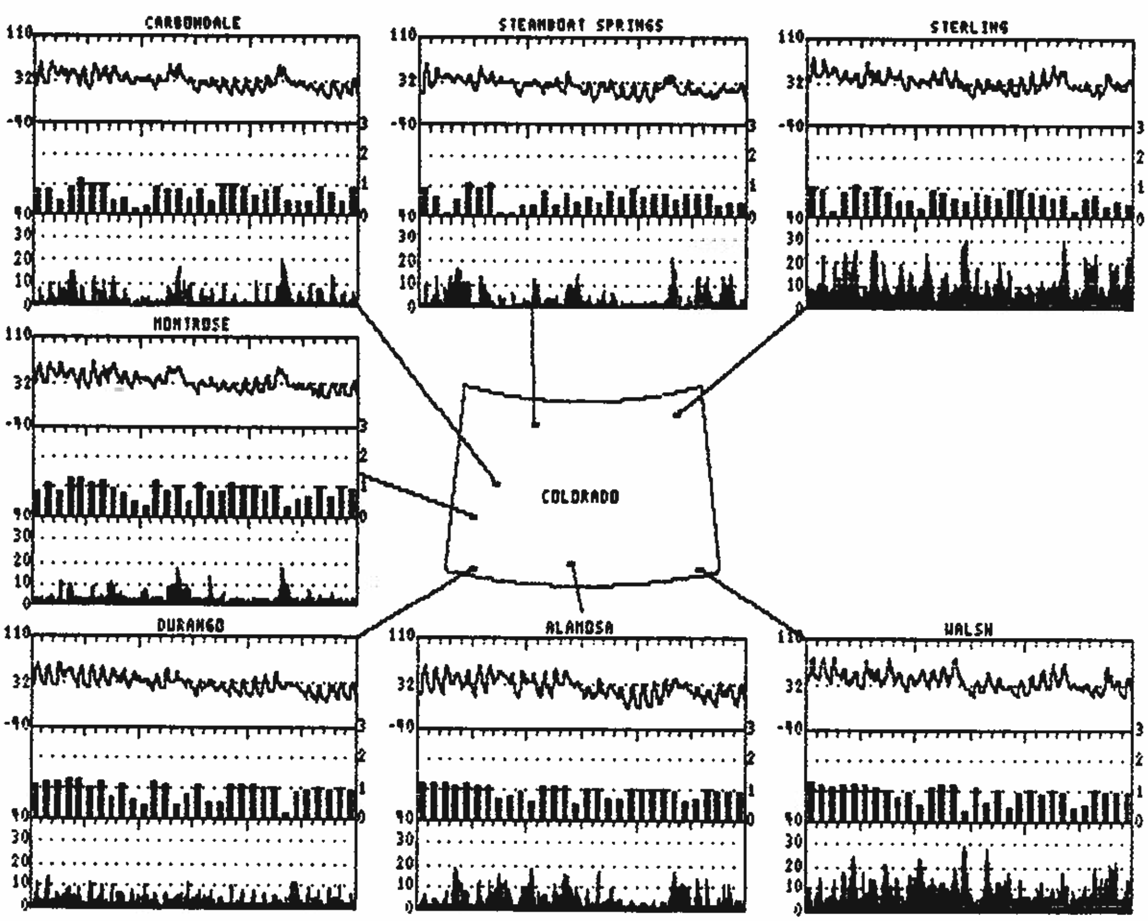
As you undoubtably have noticed from the graphs shown here, the "fitted" data does not always match the actual data very well. This problem can be reduced by defining a standard deviation of the fitted data, but not eliminated completely. Nonetheless, modeling data is preferred over using hourly data for simulations because of the time involved in many of the computer models. As fast as computers are, an accurate building energy simulation using a year's worth of hourly data (8760 hours) can take several hours to run, while a bin method or curve fit model may take only a fraction of that time. This saves money in both computer and personnel time, and also allows for quick evaluations of different kinds of building systems.

WTHRNET WEATHER DATA NOVEMBER 1988

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh |
|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | 29.4 | 32.0 | 32.5 | 35.9 | 26.5 | 37.1 | 42.4 |
| **monthly temperature extremes and time of occurence ( °F day/hour )** | | | | | | | |
| maximum: | 64.9 6/15 | 65.1 3/15 | 63.3 2/15 | 67.8 6/15 | 61.7 1/14 | 75.0 1/14 | 77.9 3/14 |
| minimum: | -7.6 20/ 3 | 3.6 27/ 8 | 4.6 28/ 6 | 10.2 28/ 6 | 0.0 21/ 2 | 10.8 16/ 5 | 15.8 16/ 7 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | |
| 5 AM | 79 / 13 | 82 / 19 | 84 / 20 | 78 / 22 | 88 / 18 | 68 / 19 | 64 / 22 |
| 11 AM | 49 / 19 | 50 / 22 | 58 / 22 | 52 / 24 | 70 / 22 | 48 / 24 | 40 / 24 |
| 2 PM | 34 / 16 | 43 / 21 | 48 / 22 | 42 / 23 | 59 / 21 | 37 / 22 | 33 / 22 |
| 5 PM | 39 / 14 | 46 / 19 | 50 / 20 | 46 / 21 | 66 / 20 | 42 / 19 | 35 / 20 |
| 11 PM | 65 / 13 | 72 / 20 | 76 / 22 | 71 / 23 | 85 / 18 | 62 / 19 | 56 / 21 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | |
| day | 206 | 187 | 261 | 214 | 192 | 253 | 216 |
| night | 199 | 88 | 183 | 172 | 157 | 255 | 269 |
| **monthly average wind speed ( miles per hour )** | 4.69 | 3.17 | 3.36 | 3.28 | 3.82 | 10.23 | 8.82 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | |
| 0 to 3 | 333 | 432 | 467 | 471 | 438 | 27 | 40 |
| 3 to 12 | 334 | 286 | 231 | 234 | 221 | 483 | 509 |
| 12 to 24 | 53 | 2 | 22 | 15 | 41 | 188 | 164 |
| > 24 | 0 | 0 | 0 | 0 | 0 | 22 | 7 |
| **monthly average daily total insolation ( Btu/ft²·day )** | 953 | 933 | 734 | 884 | 625 | 619 | 942 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | |
| 60-80% | 194 | 153 | 95 | 129 | 77 | 122 | 181 |
| 40-60% | 50 | 54 | 64 | 76 | 75 | 50 | 45 |
| 20-40% | 34 | 52 | 88 | 46 | 83 | 53 | 36 |
| 0-20% | 21 | 34 | 43 | 26 | 57 | 38 | 14 |

## The State-Wide Picture

The figure below shows the monthly weather for the eight WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40 degrees to 110 degrees Fahrenheit, the middle one gives the daily total solar radiation on a horizontal plane, up to 4000 Btu per square foot per day, and the bottom graph illustrates the hourly average wind speed from 0 to 40 miles per hour. Continuing problems with the Stratton station have prevented us from retrieving data from this site.



# COLORADO CLIMATE

## DECEMBER 1988

Colorado Climate Center
Department of Atmospheric Science
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Volume 12 Number 3

December in Review:

Above average precipitation fell along the Front Range and in a few mountain areas. The rest of the state was near or below average. Most mountain snowfall occurred just before the Christmas holiday creating fine but cold skiing conditions. Clear skies were common during the month, and areas with snowcover experienced colder than average temperatures. Some western valleys and the eastern quarter of the state were warmer than average.

Colorado's February Climate:

Last year Colorado experienced a dry February with fairly average temperatures. Very cold weather early in the month gave way to almost springlike conditions near the end of the month. This is often what February is like here east of the mountains, but in the high country it's hard to see much difference from January.

The most obvious change that begins to occur in February is the increased daylength. It increases by more than 2 minutes per day. Solar energy reaching level ground increases by more than 35% through the month. This results in warming temperatures. In the mountains the warmup is barely noticeable -- only 1 to 4 degrees F on average. But in some low elevation valleys the change is surprisingly dramatic. Both Grand Junction and Lamar, for example, see average temperatures climb by about 10 degrees during February. It is even possible to see a day or two with temperatures in the 80s down in southeast Colorado. This is nice to look forward to, but don't get too comfortable yet. Many of the coldest temperatures ever reported in Colorado have occurred in early February -- such as -31°F at Pueblo, -41°F at Fort Collins, -60°F at Taylor Park and -61°F at Maybell (the all-time record for the state). Refer to special feature below. There is a good chance of subzero weather during the first 2 weeks of February in many parts of the state. After that, the chances for severe cold are usually over. In the mountains, however, subzero temperatures are fair game throughout the month.

Over the past several decades February has reliably been extremely dry east of the mountains. Frequent clear skies and abundant sunshine hide the fact that the stormy and considerably wetter weather of spring is just around the corner. At Sterling, for example, 47 of the past 54 years have received less than 0.50" of moisture in February. Most of the Eastern Plains average about 0.25" (3-8" snow) for the month. It's quite a different story in the mountains as storms continue to hit with fair regularity. February precipitation averages between 2.00" and 4.00" (30-60" snow) in most of the high country and contributes a significant share to the total winter snowpack. By the end of the month we will begin to have a good idea of what our water supply picture will be for the coming growing season.

When is it OK to say "Brrrrrrrr"?

The date of February 1 is memorable here in Colorado. Many of the all-time record low temperatures for individual cities have occurred on that date. Just 4 years ago (Feb. 1, 1985) Maybell, in northwest Colorado, claimed notoriety when it moved ahead (????) of Taylor Park Reservoir as the holder of the coldest temperature ever officially reported in Colorado (-61°F). That same morning, Taylor Park Reservoir could only muster a measly -60° which tied their previous record set on the same day in 1951. Even down in the Colorado "lowlands" Feb. 1 brings back memories of painful cold. It seems hard to believe, but the mercury really did shrink to -41°F back in 1951 at both Fort Collins and Fort Morgan. Even in the Arkansas Valley readings that morning fell to -30° or colder.

(continued on page -9-)

## DECEMBER 1988 DAILY WEATHER

| Date | Event |
|---|---|
| 1-5 | A large high pressure ridge held its ground over most of the western U.S. Cloudless conditions prevailed over nearly the entire state, but some local air pollution problems developed. Daytime temperatures were unusually warm, especially east of the mountains, but nighttime temperatures plummetted to near or below average due to the clear and very dry atmosphere. Estes Park soared to a high of 59° on the 2nd after a low of 5° that morning. Denver reached a high of 68° on the 2nd. Even Wolf Creek Pass experienced highs in the 50s each day. Lows in some mountain valleys were well below zero each night. |
| 6-8 | Sunny and mild conditions continued on the 6th, but clouds began spreading into the state from the northwest and some snow began before midnight. Colder temperatures and snow spread over much of the state on the 7th. Snow was mostly light with just a few inches in the mountains. However, locally very heavy snow dropped on portions of the Front Range. Fort Collins reported 11", Boulder nearly 13", with more than 16" in several foothills locations. Clearing and cold in the 8th with patchy fog. |
| 9-13 | Partly cloudy and quite cool 9-11th. Northwesterly winds aloft. A skiff of snow in the northern mountains and eastern foothills on the 11th as an upper air disturbance passed north and east of Colorado. Breezy and much warmer 12-13th as downslope winds developed east of the mountains. Very strong winds near Boulder on the 12th. Some record high temperatures on the 13th. Pueblo climbed to 73° that day. Littleton's 76° was the warmest in the state for the month. |
| 14-15 | An abrupt change in the weather east of the mountains and gradually cooler west. Snow developed in northern Colorado during the day on the 14th and spread gradually southward. Moisture was again light in most mountain and Western Slope locations (although Eagle was surprised by a quick 6" snowfall). Modest snowfall totals all along the eastern foothills and adjacent plains from border to border. Denver and Pueblo each picked up about 6" but a few locations like Boulder and Ruxton Park (west of Colorado Springs) received a foot or more of new snow. Very cold on the 15th east of the mountains. Daytime highs reached only into the teens and twenties. |
| 16-18 | Clear east of the mountains. Partly cloudy west as the storm that had been affecting Colorado retreated back toward the SW over California. A cold morning on the 16th. Some of the first subzero temperatures of the year east of the mountains. Byers dipped to -5°. Then warming up again, especially east of the mountains. Lamar reached 65° on the 18th. |
| 19-26 | A much-welcomed change to snowy mountain weather. First, the storm system that had retreated to California moved back across Colorado 19-20th. Then three more Pacific storm systems attacked in rapid succession culminating with a large low pressure trough which dumped heavy snows on Christmas Day over the Central and Southern mountains. The timing was excellent for holiday ski vacations. Total snowfall for this period was 1-3 feet over most mountain areas. But a few places in southwest Colorado were harder hit. Rico measured 41" of new snow, Telluride added 46" in town and Wolf Creek Pass was buried by nearly 6 feet of new snow. Eastern Colorado escaped most of this stormy weather, but some rains and light snows fell out on the plains on the 19th. Burlington reported 0.60". A strong downslope windstorm buffetted the Front Range on the 22nd. Then early on the 26th, much of the Front Range from Colorado Springs northward received a couple inches of fresh snow. Boulder again lead the pack with 7". |
| 27-31 | A few mountain snowshowers as bone-chilling cold settled in over the state 27-28th and remained in the western valleys for the rest of the month. Subzero nighttime temperature readings were widespread across the state 27th-28th. At Echo Lake, near Mt. Evans, the daytime high on the 27th was only -2°. Taylor Park Reservoir had a -42°F reading on the morning of the 28th, the coldest in the state. A gradual warming trend then began which saw temperatures east of the mountains climb back into the 40s and 50s by the end of the month. But in the mountain valleys and on the Western Slope temperatures remained very cold. Gunnison had a high of -5° on the 29th and lows continued to fall far below zero each night. |

### December 1988 Extremes

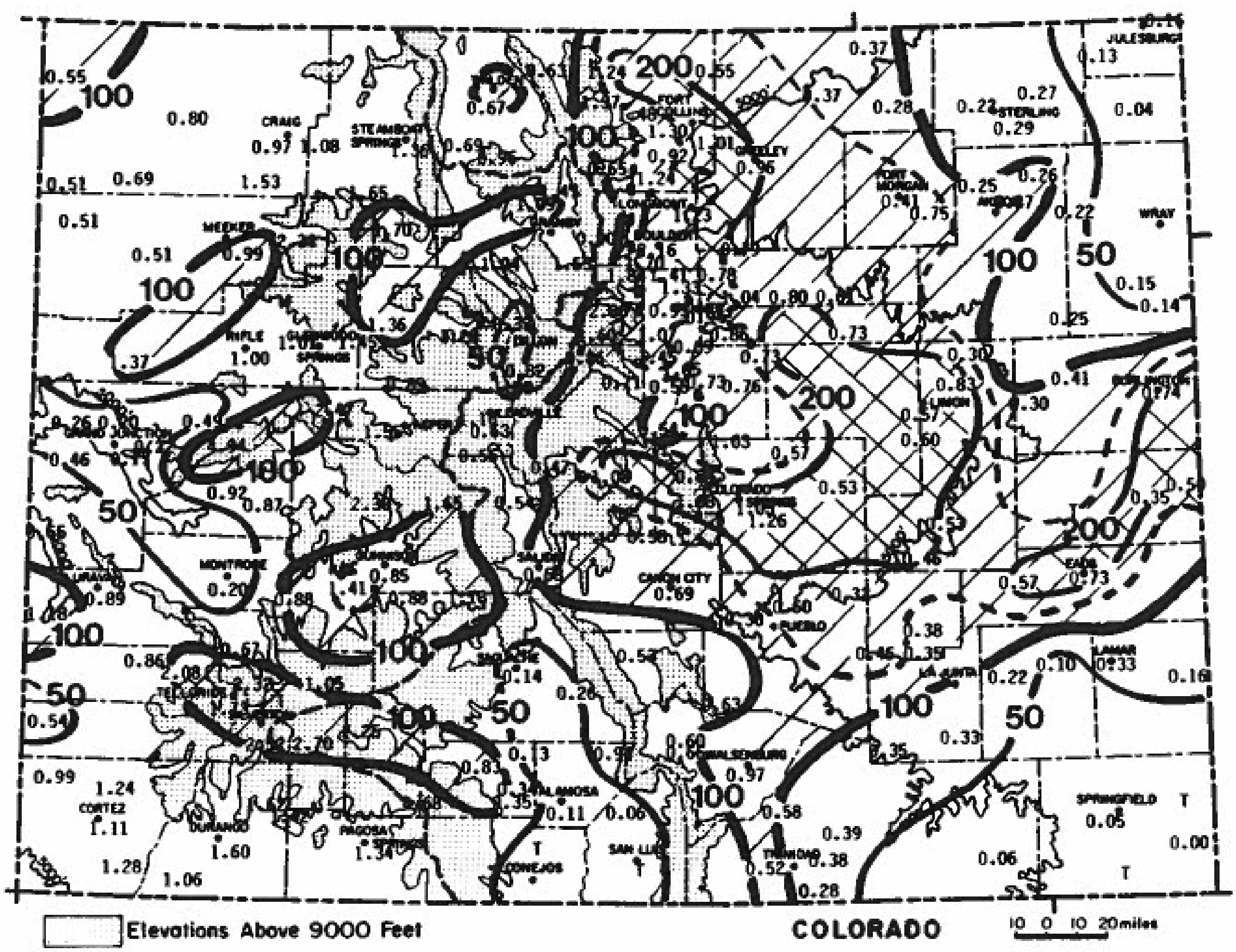
| | | | |
|---|---|---|---|
| Highest Temperature | 76°F | December 13 | Littleton |
| Lowest Temperature | -42°F | December 28 | Taylor Park Reservoir |
| Greatest Total Precipitation | 4.94" | | Bonham Reservoir |
| Least Total Precipitation | 0.00" | | Stonington |
| | Trace | | Several stations |
| Greatest Total Snowfall* | 81" | | Wolf Creek Pass 1E |
| Greatest Snowdepth ** | 82" | | Tower (Buffalo Pass) |

*For existing weather stations with complete daily records.
Higher values are likely for unmonitored locations.
**From Soil Conservation Service snowpack measurements.

## DECEMBER 1988 PRECIPITATION

A pair of early December snowstorms, which targeted the Colorado Front Range, resulted in monthly precipitation totals well above long-term averages in some areas. Wettest areas, compared to average, included Boulder (2.16", 342% of average) and Fountain (1.26", 406% if average). A band of good moisture also fell from Haswell to Burlington, but both eastern corners of the state were very dry, with little or no moisture in some areas. In the mountains and western valleys most of the month's moisture came December 19-26th. A few areas received above average snowfall including parts of the San Juans, the upper Gunnison Valley, the Grand Mesa and areas near Eagle, Yampa and Granby. Surrounding mountain areas generally measured just 70-90% of the average. The Grand Valley near Grand Junction and much of the San Luis Valley were skipped by most moisture and ended up with less than 50% of the average snowfall.

| Greatest | | Least | |
|---|---|---|---|
| Bonham Reservoir | 4.94" | Stonington | 0.00" |
| Wolf Creek Pass 1E | 4.68" | Walsh 1W | Trace |
| Mt. Evans Research | 2.80" | Campo 7S | Trace |
| Rio Grande Resvr. | 2.70" | San Luis 2SE | Trace |
| Silverton | 2.52" | Manassa | Trace |

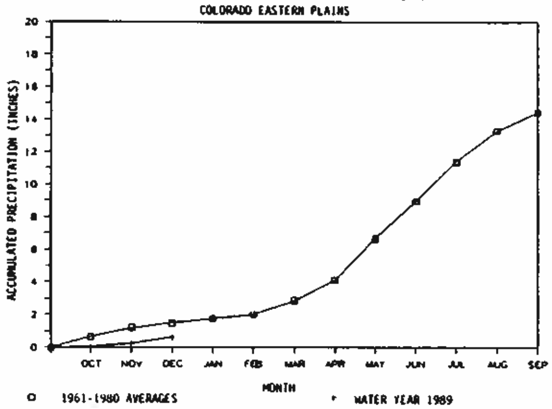



Precipitation amounts (inches) for December 1988 and contours of precipitation as a percent of the 1961-1980 average.
Dashed line is 150% of average.

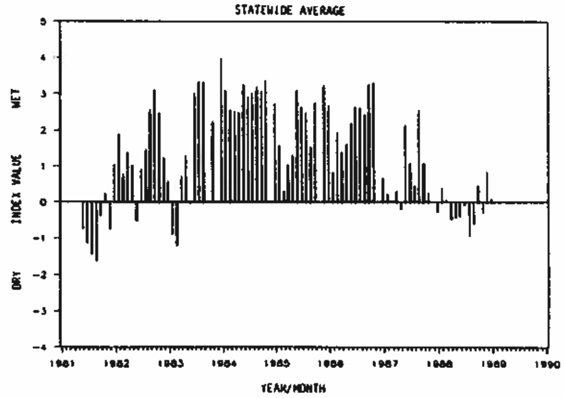
December moisture did little to improve the situation on the Eastern Plains. Most eastern counties of the state have received only 10% to 40% of their average October-December precipitation. Some areas of extreme western Colorado are also doing poorly. Fortunately, mountain precipitation has been decent. Statewide, mountain precipitation is about 90% of average but ranges from only 56% of average at Pagosa Springs to more than 120% of average at Rio Grande Reservoir, Ouray, Cimarron, Yampa and Cabin Creek.

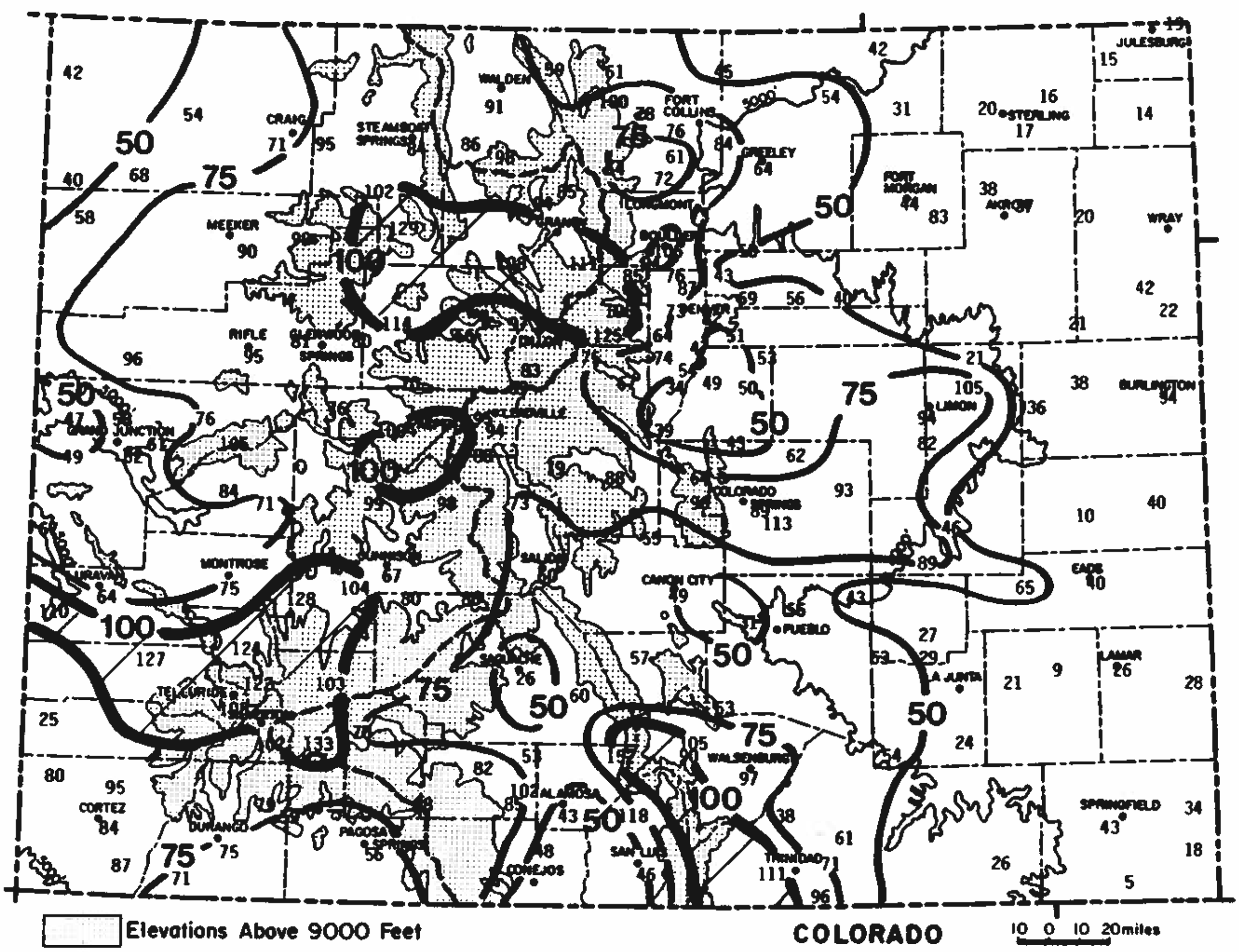
Statewide, this is the driest first 3 months for a water year since October-December of 1980. Conditions on the plains are especially dry and will begin to become a problem should strong spring wind storms develop before our normal spring snows arrive. The situation is not critical since even normal winter moisture is in short supply. But it deserves a close watch at this time.

ACCUMULATED PRECIPITATION
COLORADO EASTERN PLAINS




SURFACE WATER SUPPLY INDEX
STATEWIDE AVERAGE

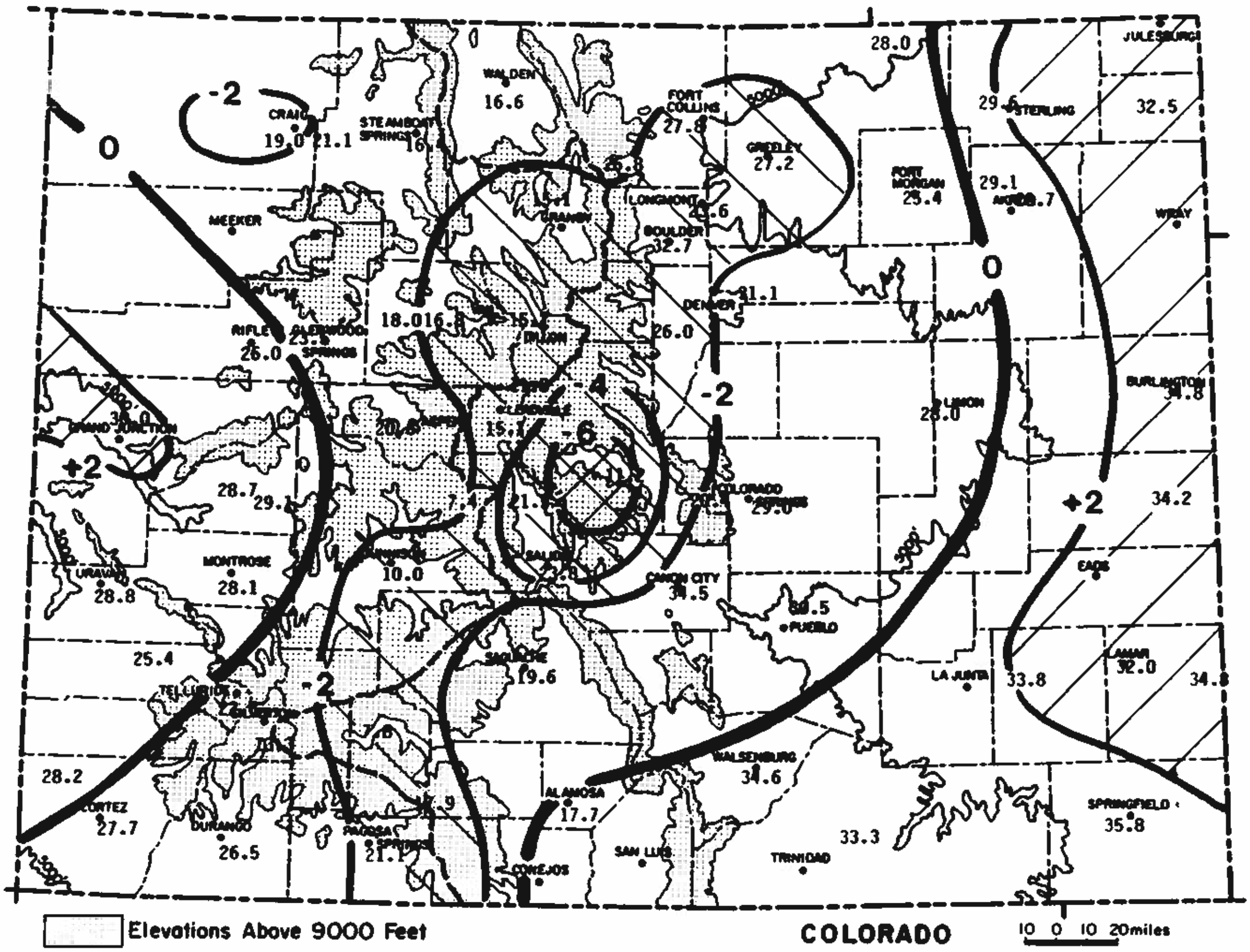



Precipitation for October 1988 through December 1988
as a percent of the 1961-1980 average.

## DECEMBER 1988 TEMPERATURES AND DEGREE DAYS

True winter cold temperatures grasped the state in late December producing many subzero readings. But overall, monthly temperatures were fairly close to long-term averages. With the help of more clear skies than usual, diurnal temperature ranges were quite large. Where snowcover prevailed for most of the month, temperatures ended up below average. This included most of the mountains and areas near the Front Range. The greatest anomally was in South Park and the upper Arkansas Valley were temperatures were locally as much as 7 degrees colder than average. At the same time, both eastern and extreme western Colorado were warmer than average. Cheyenne Wells and Holly each ended up about 4 degrees warmer than average.

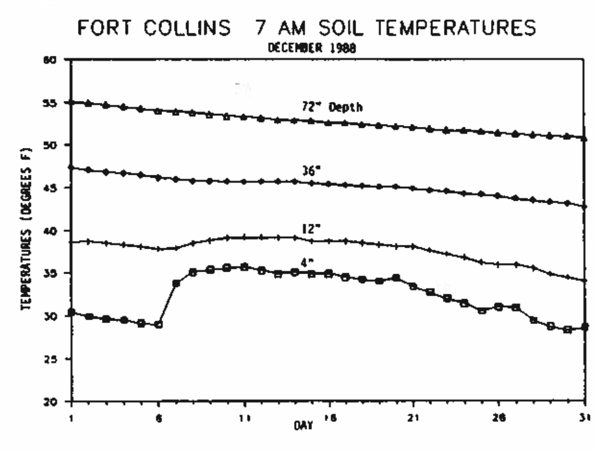



December 1988 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## DECEMBER 1988 SOIL TEMPERATURES

The remarkable insulating effect of fresh snow is clearly seen in this diagram. A foot of snow on the 7th quickly warmed the soil as far down as 1 foot. Even 3 feet deep it slowed the rate of heat loss. Only after most of the snow melted or compacted did significant soil cooling again begin to occur.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.



# Table 1. Heating Degree Day Data through December 1988 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 87-88 | 66 | 96 | 364 | 601 | 1130 | 1556 | 1867 | 1381 | 1031 | 658 | 454 | 102 | 9306 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | | | | | | | 3495 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 87-88 | 112 | 152 | 355 | 563 | 1024 | 1382 | 1450 | 1146 | 1136 | 734 | 517 | 123 | 8694 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | | | | | | | 3502 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 87-88 | 7 | 33 | 122 | 370 | 713 | 1053 | 1107 | 842 | 739 | 400 | 203 | 14 | 5603 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | | | | | | | 2126 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 87-88 | 49 | 117 | 313 | 549 | 955 | 1277 | 1357 | 1010 | 1030 | 639 | 472 | 102 | 7870 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | | | | | | | 3237 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 87-88 | 5 | 20 | 72 | 375 | 724 | 1037 | 1221 | 935 | 779 | 449 | 178 | 14 | 5809 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | | | | | | | 2079 |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 87-88 | 11 | 36 | 87 | 374 | 668 | 1007 | 1144 | 858 | 767 | 407 | 191 | 16 | 5566 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | | | | | | | 1995 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 87-88 | 17 | 74 | 150 | 445 | 767 | 1108 | 1256 | 958 | 886 | 499 | 273 | 25 | 6458 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | | | | | | | 2403 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 87-88 | 6 | 35 | 154 | 396 | 860 | 1179 | 1351 | 1008 | 899 | 609 | 362 | 56 | 6915 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | | | | | | | 2541 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 87-88 | 55 | 96 | 227 | 534 | 950 | 1376 | 1561 | 1264 | 1076 | 593 | 399 | 52 | 8183 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | | | | | | | 3126 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 87-88 | 0 | 11 | 108 | 354 | 737 | 1102 | 1300 | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | | | | | | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 87-88 | 11 | 21 | 110 | 410 | 745 | 1125 | 1227 | 889 | 811 | 437 | 215 | 14 | 6015 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | | | | | | | 2235 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 87-88 | 296 | 346 | 556 | 763 | 1145 | 1491 | 1629 | 1376 | 1379 | 933 | 717 | 322 | 10953 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | 1536 | | | | | | | 4520 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 87-88 | 14 | 44 | 188 | 435 | 851 | 1206 | 1391 | 972 | 859 | 514 | 346 | 42 | 6862 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | | | | | | | 2613 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 87-88 | 54 | 75 | 254 | 509 | 950 | 1331 | 1544 | 1173 | 1002 | 607 | 404 | 52 | 7955 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | | | | | | | 3191 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 87-88 | 69 | 118 | 333 | 602 | 922 | 1255 | 1310 | 1029 | 992 | 645 | 462 | 111 | 7848 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | | | | | | | 3067 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 87-88 | 12 | 37 | 146 | 453 | 784 | 1140 | 1252 | 936 | 821 | 479 | 217 | 8 | 6285 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | | | | | | | 2428 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 87-88 | 12 | 29 | 110 | 430 | 773 | 1154 | 1484 | 1055 | 826 | 495 | 206 | 17 | 6591 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | | | | | | | 2495 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 87-88 | 0 | 6 | 34 | 248 | 754 | 1147 | 1469 | 1031 | 741 | 350 | 172 | 8 | 5960 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | | | | | | | 2093 |

* = AVES ADJUSTED FOR STATION MOVES M = MISSING E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 87-88 | 207 | 257 | 480 | 677 | 1098 | 1516 | 1642 | 1413 | 1372 | 907 | 602 | 238 | 10409 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | | | | | | | 4154 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 87-88 | 10 | 26 | 119 | 424 | 762 | 1157 | 1363 | 955 | 807 | 437 | 204 | 6 | 6270 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | | | | | | | 2370 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | 1698 | | | | | | | 4049 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 87-88 | 0 | 3 | 35 | 273 | 653 | 1032 | 1278 | 837 | 638 | 327 | 103 | 1 | 5180 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | | | | | | | 1851 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 87-88 | 346 | 393 | 578 | 763 | 1180 | 1534 | 1577 | 1326 | 1355 | 957 | 741 | 360 | 11110 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | | | | | | | 4720 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 87-88 | 21 | 66 | 158 | 502 | 840 | 1209 | 1354 | 1022 | 943 | 569 | 321 | 35 | 7040 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | | | | | | | 2588 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 87-88 | 12 | 33 | 159 | 464 | 805 | 1169 | 1383 | 1035 | 847 | 509 | 222 | 20 | 6658 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | | | | | | | 2754 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | | | | | | | M |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 87-88 | 5 | 30 | 129 | 349 | 849 | 1160 | 1332 | 1003 | 817 | 468 | 230 | 26 | 6398 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | | | | | | | 2394 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 87-88 | 104 | 105 | 347 | 523 | 947 | 1292 | 1548 | 1187 | 996 | 663 | 485 | 143 | 8340 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | | | | | | | 3275 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 87-88 | 4 | 17 | 43 | 355 | 754 | 1111 | 1399 | 903 | 777 | 399 | 167 | 8 | 5937 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | | | | | | | 2144 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 87-88 | 9 | 24 | 125 | 391 | 819 | 1209 | 1430 | 1039 | 865 | 454 | 268 | 14 | 6647 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | | | | | | | 2554 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 87-88 | 77 | 127 | 330 | 590 | 1033 | 1448 | 1619 | 1336 | 1167 | 674 | 433 | 95 | 8929 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | | | | | | | 3499 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 87-88 | 12 | 31 | 108 | 413 | 742 | E1140 | 1475 | 1029 | 831 | 476 | 197 | 12 | 6466 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | | | | | | | 2273 |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 87-88 | 161 | 222 | 426 | 603 | 992 | 1269 | 1354 | 1109 | 1092 | 720 | 547 | 208 | 8703 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | | | | | | | 3586 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 87-88 | 4 | 25 | 80 | 330 | 730 | 1054 | 1209 | 850 | 803 | 438 | 234 | 13 | 5770 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | | | | | | | 2040 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 87-88 | 215 | 281 | 495 | 740 | 1242 | 1499 | 1572 | 1343 | 1340 | 835 | 638 | 184 | 10384 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | | | | | | | 4142 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 87-88 | 3 | 30 | 101 | 332 | 707 | 977 | 1109 | 826 | 773 | 401 | 238 | 25 | 5522 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | | | | | | | 1980 |

* = AVES ADJUSTED FOR STATION MOVES M = MISSING E = ESTIMATED

## DECEMBER 1988 CLIMATIC DATA

### Eastern Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEW RAYMER 21N | 41.8 | 14.2 | 28.0 | -0.8 | 65 | -7 | 1142 | 0 | 39 | 0.37 | 0.11 | 142.3 | 4 |
| STERLING | 45.2 | 14.1 | 29.6 | 2.6 | 65 | -6 | 1089 | 0 | 51 | 0.22 | -0.09 | 71.0 | 4 |
| FORT MORGAN | 41.9 | 8.9 | 25.4 | -1.9 | 64 | -11 | 1222 | 0 | 38 | 0.41 | 0.16 | 164.0 | 6 |
| AKRON FAA AP | 42.9 | 15.3 | 29.1 | 0.5 | 63 | -6 | 1106 | 0 | 36 | 0.25 | 0.00 | 100.0 | 5 |
| AKRON 4E | 42.8 | 14.5 | 28.7 | 1.1 | 65 | -5 | 1119 | 0 | 39 | 0.37 | 0.09 | 132.1 | 3 |
| HOLYOKE | 47.5 | 17.5 | 32.5 | 2.8 | 69 | -1 | 1002 | 0 | 66 | 0.04 | -0.33 | 10.8 | 2 |
| BURLINGTON | 47.8 | 21.8 | 34.8 | 2.9 | 72 | 4 | 925 | 0 | 59 | 0.74 | 0.42 | 231.2 | 3 |
| LIMON WSMO | 41.6 | 14.4 | 28.0 | -0.7 | 65 | -1 | 1138 | 0 | 32 | 0.57 | 0.37 | 285.0 | 4 |
| CHEYENNE WELLS | 48.5 | 19.9 | 34.2 | 3.5 | 65 | 4 | 947 | 0 | 55 | 0.35 | 0.13 | 159.1 | 4 |
| EADS | 47.9 | 17.9 | 32.9 | 1.7 | 66 | 6 | 988 | 0 | 53 | 0.73 | 0.39 | 214.7 | 2 |
| LAMAR | 52.3 | 11.7 | 32.0 | 0.4 | 73 | -1 | 1012 | 0 | 95 | 0.33 | -0.05 | 86.8 | 3 |
| LAS ANIMAS | 51.6 | 16.1 | 33.8 | 2.1 | 73 | 1 | 958 | 0 | 78 | 0.22 | -0.02 | 91.7 | 5 |
| HOLLY | 52.0 | 17.6 | 34.8 | 4.0 | 74 | 1 | 932 | 0 | 82 | 0.16 | -0.09 | 64.0 | 4 |
| SPRINGFIELD 7WSW | 51.7 | 19.9 | 35.8 | 1.6 | 74 | 2 | 897 | 0 | 80 | 0.05 | -0.26 | 16.1 | 3 |

### Foothills/Adjacent Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FORT COLLINS | 42.3 | 13.3 | 27.8 | -2.1 | 64 | -5 | 1147 | 0 | 33 | 1.30 | 0.84 | 282.6 | 5 |
| GREELEY UNC | 41.3 | 13.0 | 27.2 | -2.5 | 63 | -7 | 1166 | 0 | 34 | 0.96 | 0.49 | 204.3 | 6 |
| ESTES PARK | 40.0 | 13.7 | 26.8 | -1.8 | 66 | -8 | 1174 | 0 | 26 | 0.65 | 0.19 | 141.3 | 2 |
| LONGMONT 2ESE | 41.6 | 5.5 | 23.6 | -5.9 | 63 | -16 | 1276 | 0 | 26 | 1.23 | 0.80 | 286.0 | 4 |
| BOULDER | 45.4 | 20.1 | 32.7 | -2.4 | 65 | 0 | 993 | 0 | 53 | 2.16 | 1.53 | 342.9 | 5 |
| DENVER WSFO AP | 45.5 | 16.6 | 31.1 | -0.9 | 70 | -3 | 1043 | 0 | 49 | 1.04 | 0.50 | 192.6 | 6 |
| EVERGREEN | 43.8 | 8.1 | 26.0 | -2.2 | 66 | -8 | 1203 | 0 | 38 | 1.07 | 0.32 | 142.7 | 4 |
| LAKE GEORGE 8SW | 27.8 | -5.5 | 11.2 | -7.2 | 50 | -21 | 1660 | 0 | 0 | 1.08 | 0.71 | 291.9 | 6 |
| RUXTON PARK | 37.1 | 3.6 | 20.4 | -2.0 | 53 | -15 | 1376 | 0 | 5 | 1.68 | 0.92 | 221.1 | 4 |
| COLORADO SPRINGS | 41.8 | 16.6 | 29.2 | -1.5 | 69 | 4 | 1099 | 0 | 35 | 1.05 | 0.66 | 269.2 | 5 |
| CANON CITY 2SE | 48.0 | 21.0 | 34.5 | -1.5 | 69 | 0 | 937 | 0 | 64 | 0.69 | 0.11 | 119.0 | 2 |
| PUEBLO WSO AP | 47.5 | 13.4 | 30.5 | -1.5 | 73 | -7 | 1062 | 0 | 51 | 0.60 | 0.25 | 171.4 | 4 |
| WALSENBURG | 48.2 | 21.1 | 34.6 | 0.1 | 68 | 4 | 936 | 0 | 59 | 0.97 | 0.22 | 129.3 | 3 |
| TRINIDAD FAA AP | 49.8 | 16.8 | 33.3 | 0.1 | 69 | 2 | 975 | 0 | 71 | 0.39 | -0.18 | 68.4 | 3 |

### Mountains/Interior Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WALDEN | 31.3 | 1.9 | 16.6 | -1.6 | 45 | -18 | 1495 | 0 | 0 | 0.67 | 0.05 | 108.1 | 6 |
| LEADVILLE 2SW | 31.3 | -1.1 | 15.1 | -2.9 | 52 | -20 | 1539 | 0 | 1 | 0.63 | -0.47 | 57.3 | 11 |
| SALIDA | 39.0 | 8.6 | 23.8 | -5.0 | 58 | -7 | 1271 | 0 | 14 | 0.68 | 0.07 | 111.5 | 2 |
| BUENA VISTA | 36.5 | 6.5 | 21.5 | -4.7 | 55 | -11 | 1342 | 0 | 5 | 0.54 | -0.04 | 93.1 | 8 |
| SAGUACHE | 35.3 | 4.0 | 19.6 | -1.1 | 50 | -10 | 1401 | 0 | 0 | 0.14 | -0.29 | 32.6 | 3 |
| HERMIT 7ESE | 24.6 | -9.1 | 7.8 | -5.1 | 32 | -32 | 1768 | 0 | 0 | 2.25 | 0.82 | 157.3 | 4 |
| ALAMOSA WSO AP | 36.7 | -1.3 | 17.7 | 0.2 | 51 | -16 | 1457 | 0 | 1 | 0.11 | -0.34 | 24.4 | 4 |
| STEAMBOAT SPRINGS | 29.5 | 3.3 | 16.4 | -0.8 | 38 | -20 | 1501 | 0 | 0 | 1.36 | -1.18 | 53.5 | 12 |
| GRAND LAKE 6SSW | 26.3 | 3.9 | 15.1 | -2.5 | 42 | -27 | 1540 | 0 | 0 | 1.09 | 0.22 | 125.3 | 9 |
| DILLON 1E | 29.4 | 1.1 | 15.2 | -3.5 | 45 | -15 | 1536 | 0 | 0 | 0.33 | -0.54 | 37.9 | 8 |
| AVON | 30.8 | 2.9 | 16.8 | -5.2 | 42 | -15 | 1487 | 0 | 0 | 0.93 | -0.47 | 66.4 | 7 |
| CLIMAX | 24.9 | -1.2 | 11.8 | -3.6 | 43 | -25 | 1641 | 0 | 0 | 1.02 | -1.09 | 48.3 | 11 |
| ASPEN 1SW | 33.2 | 8.0 | 20.6 | -1.4 | 46 | -12 | 1375 | 0 | 0 | 1.55 | -0.86 | 64.3 | 10 |
| TAYLOR PARK | 24.1 | -9.2 | 7.4 | 0.9 | 42 | -42 | 1776 | 0 | 0 | 1.65 | 0.00 | 100.0 | 7 |
| TELLURIDE | 37.5 | 7.7 | 22.6 | -0.6 | 51 | -13 | 1305 | 0 | 1 | 1.73 | 0.02 | 101.2 | 8 |
| PAGOSA SPRINGS | 40.9 | 1.3 | 21.1 | -2.4 | 57 | -25 | 1354 | 0 | 11 | 1.34 | -0.55 | 70.9 | 6 |
| SILVERTON | 34.4 | -7.7 | 13.3 | -0.7 | 49 | -30 | 1595 | 0 | 0 | 2.52 | 0.58 | 129.9 | 9 |
| WOLF CREEK PASS 1 | 32.5 | 3.2 | 17.9 | -3.9 | 53 | -18 | 1453 | 0 | 7 | 4.68 | -0.55 | 89.5 | 11 |

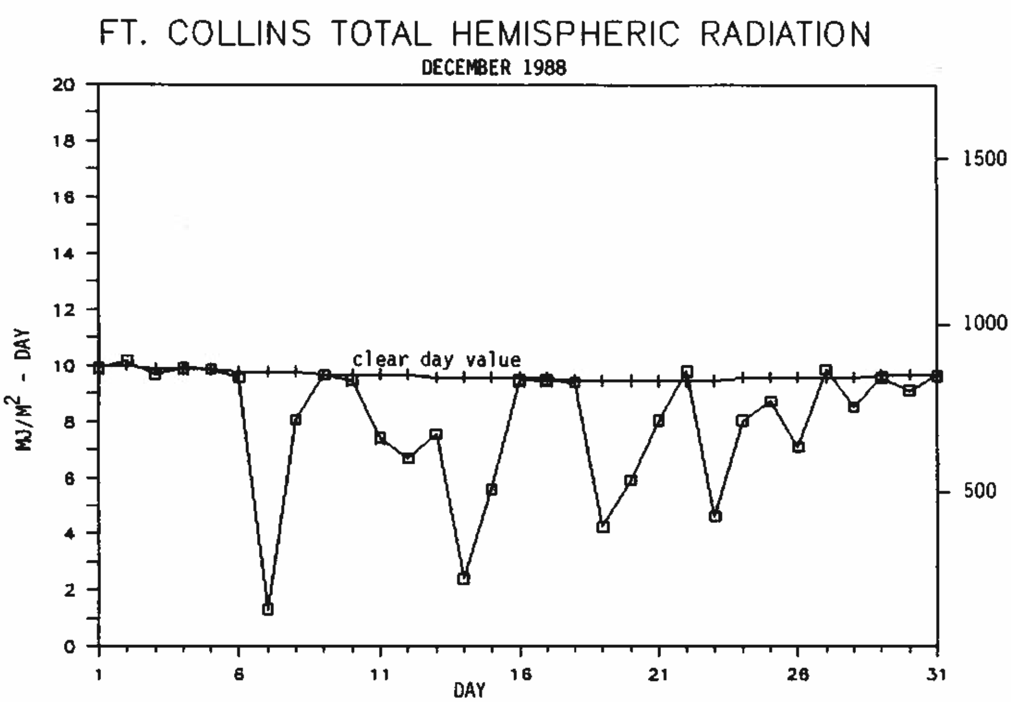
## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 31.4 | 6.5 | 19.0 | -2.3 | 46 | -14 | 1417 | 0 | 0 | 0.97 | -0.68 | 58.8 | 13 |
| HAYDEN | 33.5 | 8.8 | 21.1 | 1.1 | 46 | -14 | 1355 | 0 | 0 | 1.08 | -0.57 | 65.5 | 11 |
| RANGELY 1E | 33.6 | 7.4 | 20.5 | 1.3 | 47 | -15 | 1373 | 0 | 0 | 0.51 | -0.04 | 92.7 | 6 |
| EAGLE FAA AP | 31.5 | 4.5 | 18.0 | -1.9 | 45 | -17 | 1448 | 0 | 0 | 1.36 | 0.42 | 144.7 | 10 |
| GLENWOOD SPRINGS | 36.4 | 10.6 | 23.5 | -1.5 | 50 | -8 | 1279 | 0 | 0 | 1.01 | -0.44 | 69.7 | 8 |
| RIFLE | 40.1 | 11.9 | 26.0 | 1.4 | 51 | -10 | 1203 | 0 | 4 | 1.00 | -0.13 | 88.5 | 9 |
| GRAND JUNCTION WS | 41.0 | 18.9 | 30.0 | 2.2 | 52 | 6 | 1078 | 0 | 2 | 0.20 | -0.40 | 33.3 | 8 |
| CEDAREDGE | 42.0 | 15.5 | 28.7 | 0.4 | 54 | -4 | 1117 | 0 | 5 | 0.92 | -0.08 | 92.0 | 9 |
| PAONIA 1SW | 41.0 | 17.1 | 29.1 | 0.5 | 56 | -1 | 1106 | 0 | 7 | 0.87 | -0.64 | 57.6 | 7 |
| GUNNISON | 26.8 | -6.7 | 10.0 | -3.7 | 38 | -34 | 1698 | 0 | 0 | 0.90 | 0.13 | 116.9 | 1 |
| MONTROSE NO. 2 | 39.6 | 16.5 | 28.1 | 0.7 | 50 | 2 | 1138 | 0 | 0 | 0.20 | -0.50 | 28.6 | 4 |
| URAVAN | 43.6 | 14.1 | 28.8 | -1.5 | 53 | -4 | 1113 | 0 | 9 | 0.89 | -0.14 | 86.4 | 8 |
| NORWOOD | 38.5 | 12.4 | 25.4 | 1.4 | 51 | -8 | 1218 | 0 | 2 | 0.86 | -0.18 | 82.7 | 5 |
| YELLOW JACKET 2W | 40.3 | 16.0 | 28.2 | 0.9 | 58 | -7 | 1135 | 0 | 13 | 0.99 | -0.16 | 86.1 | 8 |
| CORTEZ | 41.9 | 13.5 | 27.7 | -0.3 | 59 | 0 | 1148 | 0 | 16 | 1.11 | -0.16 | 87.4 | 6 |
| DURANGO | 41.1 | 11.9 | 26.5 | -1.0 | 56 | -14 | 1182 | 0 | 17 | 1.60 | -0.39 | 80.4 | 8 |
| IGNACIO 1N | 43.6 | 9.0 | 26.3 | 0.9 | 59 | -9 | 1194 | 0 | 26 | 0.95 | -0.29 | 76.6 | 1 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## DECEMBER 1988 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 17 | 10 | 4 | -- | -- |
| Denver | 16 | 10 | 5 | 77% | 67% |
| Fort Collins | 15 | 10 | 6 | -- | -- |
| Grand Junction | 12 | 9 | 10 | 67% | 60% |
| Pueblo | 19 | 7 | 5 | 78% | 72% |



When is it OK to say "Brrrrrrr"? continued

When it's that cold -- when your nose hairs freeze the very first breath you take after stepping outside, when the condensation from your breath immediately turns to sparkling ice crystals glittering in the rising sun, when (if you're lucky enough to get your car started) absolutely ever moving part creaks and groans as you back down your driveway -- then most everyone agrees, it's "Brrrrrrrrr...cold." Fortunately, such severe cold is rare in many parts of the state. But in certain mountain valleys severe cold is a part of life. Any time from late December into February, whenever the skies clear off after a recent fresh snow you can almost be sure that some -30°F temperatures will be reported. It's not the mountain peaks that get the coldest. Instead it is the broad, snowcovered valleys below where the heavier and denser cold air settles. Gunnison, Taylor Park, Creede, Rio Grande Reservoir, Silverton, Fraser, Eagle, Kremmling, Craig, Maybell -- these are a few of the places in Colorado where it is almost impossible for the temperature to stay above zero on any clear, calm and snowcovered night during winter (see special feature in Dec. 1986 issue of COLORADO CLIMATE).

Deciding how to define "Brrrrrr" cold based on daytime maximum temperatures is a little trickier. If the sun shines and winds stay calm, no matter how cold it really is, it just doesn't feel too awful. Watching young men near some of Colorado ski resorts shovelling snow while wearing only boots and gym shorts may tell you something about how cold it feels on a sunny, still winter day in the Colorado mountains. The days that really keep us inside are days when the temperature stays below freezing all day, the sun does not shine and/or strong winds relentlessly bite through our clothing. A detailed comparison of how often these conditions occur would be very informative, but unfortunately very few Colorado weather stations collect such detailed information. For now, let's be content to use the data we do have at our fingertips to compare the number of days when the high temperature for the day remains at or below freezing. The purpose here is not to promote or settle arguments about which town is really the "Icebox of the Nation". I'll leave that up to some of you mayors. Let's just get a feel for how various parts of Colorado compare and how different we are from other parts of the country.

A Comparison of Some Aspects of Cold Temperatures

| Location | Average Number of Days per Year * Daily Max T ≤32°F | Daily Min T ≤0°F | All-time Coldest ** | |
|---|---|---|---|---|
| Alamosa | 34 | 48 | -50 | 1/28/1948 |
| Berthoud Pass | 129 | 53 | -34 | 2/ 1/1985 |
| Boulder | 15 | 5 | -28 | 2/ 8/1936 |
| Burlington | 19 | 7 | -25 | 1/ 4/1959 |
| Canon City | 9 | 4 | -23 | 1/12/1963 |
| Colorado Springs | 26 | 7 | -27 | 2/ 1/1951 |
| Denver | 22 | 8 | -30 | 2/ 8/1936 |
| Dillon | 58 | 55 | -45 | 2/ 1/1951 |
| Durango | 9 | 11 | -30 | 1/13/1963 |
| Eagle | 35 | 39 | -51 | 1/12/1963 |
| Estes Park | 28 | 14 | -39 | 2/ 1/1951 |
| Fort Collins | 23 | 11 | -41 | 2/ 1/1951 |
| Fraser | 88 | 88 | -53 | 1/10/1962 |
| Glenwood Springs | 23 | 10 | -28 | 2/ 8/1933 |
| Grand Junction | 23 | 5 | -23 | 1/13/1963 |
| Greeley | 27 | 12 | -39 | 2/ 1/1951 |
| Gunnison | 65 | 68 | -47 | 12/25/1924 |
| Lamar | 18 | 8 | -29 | 1/30/1949 |
| Leadville | 76 | 39 | -38 | 2/ 1/1985 |
| Maybell | 41 | 40 | -61 | 2/ 1/1985 |
| Mesa Verde Natl. Park | 16 | 1 | -20 | 1/13/1963 |
| Montrose | 19 | 7 | -27 | 2/13/1905 |
| Ouray | 26 | 6 | -22 | 1/13/1963 |
| Pueblo | 18 | 9 | -31 | 2/ 1/1951 |
| Salida | 16 | 12 | -35 | 1/ 2/1919 |
| Silverton | 39 | 65 | -39 | 2/ 1/1985 |
| Steamboat Springs | 60 | 48 | -50 | 1/12/1963 |
| Sterling | 30 | 14 | -30 | 2/ 5/1982 |
| Taylor Park | 78 | 91 | -60 | 2/ 1/1951,85 |
| Trinidad | 12 | 5 | -32 | 1/12/1963 |
| Wolf Creek Pass | 86 | 36 | -40 | 2/ 5/1982 |
| Barrow, Alaska | 256 | 170 | -56 | 2/ /1924 |
| Boston, Mass. | 28 | 1 | -12 | 1/ /1957 |
| Chicago, Illinois | 51 | 14 | -27 | 1/ /1985 |
| Intl. Falls, Minn. | 114 | 69 | -46 | 1/ /1968 |
| Omaha, Nebraska | 45 | 16 | -24 | 12/ /1983 |
| Spokane, Washington | 39 | 6 | -25 | 12/ /1968 |

* 1951-80 averages where available ** Available records through 1987

Joint Center for Energy Management - December 1988

Dressing Your House for Winter

When it's cold and there is a fierce wind blowing most of us would not think of stepping outside without a jacket to contain our body heat and a scarf to keep the wind from sneaking down our backs. Likewise, our houses should be "buttoned up" to prevent excessive heat loss and cold drafts.

Gore-Tex on the Walls?

Most of us don't put large jackets over our houses, but rather we wrap the walls and ceiling with insulation to keep the heat in. Unfortunately, many houses in Colorado are not insulated enough to provide cost-effective protection. You may have heard of "R-values" for insulation. This is the "resistance" to energy flow (in the form of heat) through the insulation, where the thermal resistance is the reciprocal of the thermal conductivity. For example, six inches of the standard fiber glass batt such as you might find in your attic will transmit 0.05 BTU/hour per square foot for every degree Fahrenheit difference across the insulation. The conductance of this thickness of insulation is therefore 0.05 BTU/hr-°F-ft² and the resistance is 1/0.05, or an R-value of 20. To put things in perspective, putting one BTU (British Thermal Unit) into one pound of water will raise the water temperature one degree Fahrenheit.

Let's look at a typical residence, which might have a natural gas furnace and 3500 square feet of R-8 insulation on the walls and ceiling. We can assume that during a normal winter month the average outside temperature is around 20°F and the thermostat is set at a constant 65°F. The monthly average heat loss from our typical house can then be estimated:

| (65°F - 20°F) | x | 3500 square feet | x | 1/8 | = | 19,700 BTU/hr. |
|---|---|---|---|---|---|---|
| temperature difference across insulation | | total insulation area | | conductivity of insulation (1/R) | | |

The average residential cost of natural gas is about 40¢ per hundred cubic feet (CCF) and one CCF will yield about 70,000 BTU of heat (taking into account combustion and furnace efficiencies), so the total energy price is about 0.57¢ per thousand BTUs. In our example this is about 11.2 cents every hour, or a total of $83 dollars a month. This is just an example, of course, and does not reflect all residential homes. Most houses have more insulation in the ceilings than the walls, and we have ignored the losses through windows and doors. Chances are, however, if you do live in a typical residence your monthly gas bill for December will be somewhere in this neighborhood (no pun intended).

This example also shows how extra insulation can be used to save money. If the house had twice the insulation (R-16) we could save over $40 dollars a month. If it cost $200 to reinsulate then we would recover all that money over a five month heating season, and by the next winter we could sit back and enjoy our savings - and be more comfortable, too.

Putting scarves on our houses is also rarely done, most likely because such a garment would take an awfully long time to knit. But the leakage of cold air into our houses is another cause of high energy consumption. Common problem spots where outside air infiltration occur are leaky flue dampers, windows and doors which don't seal shut properly, open basement windows, the external openings for electrical, telephone and gas conduits, and actual cracks in the walls. The rate of infiltration increases dramatically with higher wind speeds: high pressure is created on the leeward side of the house forcing cold air in, while a negative pressure on the sheltered side pulls warm air out. Now a little fresh air never hurt anyone, especially in this day and age of high radon levels and formaldehyde outgassing from building materials, but too much fresh air and you'll be spending a good deal of money sending heat out between the cracks. A few bucks invested on caulking can return a surprisingly large dividend by reducing infiltration, and will also make your house more comfortable by getting rid of those invisible drafts. Keep in mind, though, that the aluminum siding around most storm windows is 200 times as conductive as the glass it supports. A two by three foot window (six square feet) with a half inch aluminum molding around it (0.4 square feet) will experience almost all of it's conductive heat loss through the edges! Always insulate the support of a window as well as the window itself.

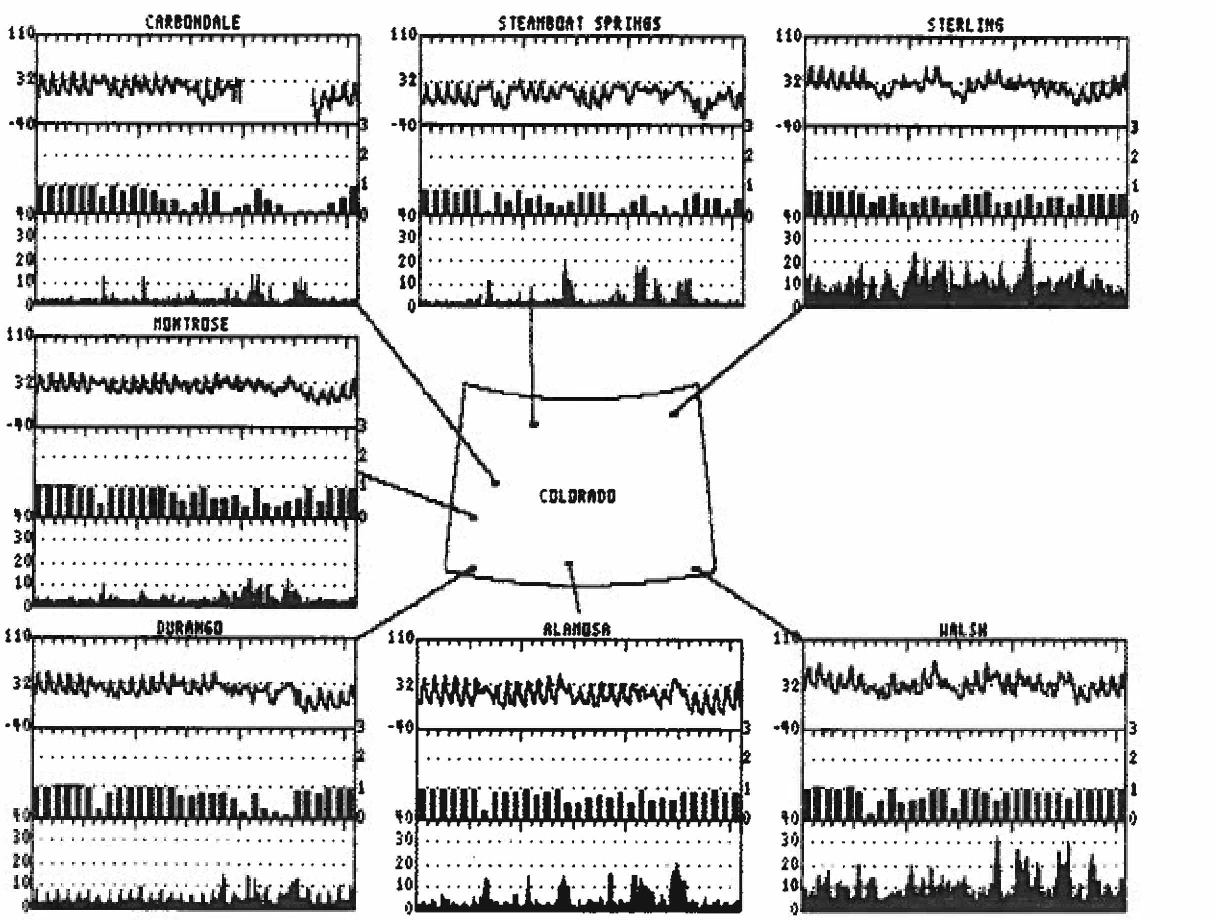
A residence is like the people it houses; it generates heat internally and it needs to get fresh air. Dressing your house for the winter months will keep you warm and healthy and save you money at the same time.

# WTHRNET WEATHER DATA    DECEMBER 1988

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh |
|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | 16.4 | 21.8 | 18.6 | 25.3 | 10.9 | 28.1 | 34.0 |
| **monthly temperature extremes and time of occurence ( °F day/hour )** | | | | | | | |
| maximum: | 50.4 14/15 | 52.7 13/13 | 47.1 4/14 | 48.6 13/13 | 35.8 10/14 | 70.2 31/ 0 | 73.6 13/15 |
| minimum: | -14.8 29/ 8 | -15.7 27/ 7 | -34.1 28/ 3 | -1.1 29/ 5 | -23.8 28/ 7 | -0.9 27/ 5 | 1.2 27/ 7 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | |
| 5 AM | 83 / 0 | 84 / 10 | 70 / 5 | 84 / 14 | 88 / 1 | 71 / 12 | 62 / 12 |
| 11 AM | 57 / 11 | 57 / 16 | 54 / 11 | 61 / 19 | 79 / 10 | 53 / 18 | 36 / 16 |
| 2 PM | 38 / 10 | 51 / 17 | 35 / 11 | 48 / 18 | 60 / 12 | 42 / 17 | 29 / 14 |
| 5 PM | 40 / 7 | 55 / 15 | 45 / 11 | 51 / 16 | 68 / 9 | 48 / 14 | 30 / 10 |
| 11 PM | 73 / 4 | 81 / 13 | 67 / 9 | 79 / 16 | 88 / 5 | 65 / 13 | 52 / 11 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | |
| day | 228 | 173 | 199 | 245 | 164 | 227 | 174 |
| night | 195 | 74 | 178 | 169 | 133 | 251 | 242 |
| **monthly average wind speed ( miles per hour )** | 3.40 | 2.97 | 2.08 | 2.67 | 2.41 | 8.99 | 8.68 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | |
| 0 to 3 | 507 | 502 | 650 | 541 | 614 | 42 | 44 |
| 3 to 12 | 196 | 230 | 91 | 201 | 97 | 550 | 543 |
| 12 to 24 | 41 | 12 | 3 | 2 | 27 | 141 | 139 |
| > 24 | 0 | 0 | 0 | 0 | 0 | 11 | 18 |
| **monthly average daily total insolation ( Btu/ft²·day )** | 796 | 756 | 571 | 768 | 539 | 723 | 816 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | |
| 60-80% | 181 | 152 | 114 | 158 | 92 | 131 | 188 |
| 40-60% | 70 | 62 | 30 | 46 | 52 | 68 | 49 |
| 20-40% | 41 | 31 | 52 | 60 | 72 | 43 | 24 |
| 0-20% | 17 | 52 | 87 | 17 | 55 | 24 | 17 |

## The State-Wide Picture

The figure below shows the monthly weather for WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40 degrees to 110 degrees Fahrenheit, the middle one gives the daily total solar radiation on a horizontal plane, up to 4000 Btu per square foot per day, and the bottom graph illustrates the hourly average wind speed from 0 to 40 miles per hour. A problem with the Carbondale station prevented us from retrieving temperature data between the 20th to the 26th.



# COLORADO CLIMATE

## JANUARY 1989



Colorado Climate Center
Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado 80523



*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 4


### January in Review:

Colorado enjoyed a relatively placid January. Major storms were few, and sunshine was more plentiful than usual over the whole state. Precipitation was near or below average over the majority of the state, but there were a number of wet areas primarily east of the Continental Divide. Temperatures were much warmer than usual east of the mountains, while in and west of the mountains conditions were colder than average.

### Colorado's March Climate:

We've got some good news and some bad news. First the good news: the frigid temperatures we've been experiencing will soon be history and March temperatures will be on the rise. The bad news: expect some strong storms, increasing winds, rapid temperature changes and some heavy precipitation. We usually have some very nice days in March, and gardeners can make some progress and even plant a few things at lower elevations. But major storms develop quickly and moisture sources are more plentiful as springtime temperatures climb.

For what it's worth, average March temperatures at elevations below about 6000 feet are in the 50s during the day with 20s at night. Temperatures generally decrease with elevation most days, and up in the mountains highs only average in the 30s with single digit lows. But don't count on too many "average" days. It's not unusual to be 20 degrees above average one day and 20 degrees below a day or two later. Some warming is usually obvious during the month with the greatest warming occurring at low elevations. Spring comes much more slowly in the high country. In some mountain areas, March temperatures are only a few degrees (5-7 degrees F) above typical January values.

Newcomers are often surprised to discover that one characteristic of Colorado, especially the Front Range area, is that as temperatures rise, snowfall increases. For most areas from the crest of our Rockies almost to the Kansas border, March is the snowiest month of the year. It is also the month with the greatest threat of severe blizzards on the High Plains. Storms can begin abruptly, so travellers on the open plains must be cautious. Average precipitation across the state ranges from only 0.25-0.50" in the San Luis Valley and 0.50-1.00" (6-15" snow) on the Western Slope to 0.60-2.00" (7-30" snow) from the Eastern Plains into the foothills and 2-5" (30-80" snow) in the high mountains. Mountain snows were not great last March, but there have been some remarkable years. In 1961 Wolf Creek Pass totalled 187" of new snow. Instead of steady, light precipitation typical of mid-winter, March precipitation becomes more showery. Some of the most intense snowfall rates in Colorado occur during the spring months. Three inches or even more can fall in a single hour.

### The Wild Winds of Spring:

Growing up in the Midwest, I remember liking many things about spring -- the moist, rich soil, abundant vegetation, threats of severe thunderstorms. One of the things I never really cared for, though, was the winds. It would either be warm and windy, cold and windy, or just windy. The wind just never seemed to stop. When I was in a kite-flying mood, the winds were much to my liking. At other times, delivering newspapers for example, the wind was not my friend. For many parts of the country, March and April are the windiest months of the year. That was definitely the case back in Illinois, and it's true for parts but not all of Colorado.

There are some very good reasons why winds blow so strong and frequently during the spring. For one thing, upper level winds in the atmosphere are still very strong. What we often call the jet stream is alive and well during the spring, often meandering overhead before beginning to weaken and retreat northward later in the spring. These

(continued on Page -9-)

## J A N U A R Y   1 9 8 9   D A I L Y   W E A T H E R

| Date | Event |
|---|---|
| 1-3 | Generally dry except for a dusting of mountain snow on the 1st. Cold air briefly pushed into NE Colorado on the 1st but was quickly replaced by mild air as a fast moving upper air disturbance helped produce chinook winds on the 2nd. Seasonal west and very warm east on the 3rd with highs in the 50s across the plains. Some increasing clouds from the south on the 3rd. |
| 4-7 | An upper-level low pressure system that had been spinning south of California began moving NE on the 4th. Heavy snows began in southern Colorado. With very little cold air with the system, rains, unusual for January, spread over parts of the Eastern Plains overnight. Denver received 0.25" of rain. Close to 0.50" fell near Holyoke and Wray -- more moisture than usually falls in the entire month. Temperatures remained quite warm on the 6th as a second storm with plentiful Pacific moisture moved in from the west. The storm quickly moved northeast out of the area and cold, blustery conditions engulfed moist of the state. Temperatures in the higher mountains stayed below 0° throughout the day on the 7th. Most of the mountains received some snow but most was light to moderate. The Grand Mesa, however, received more than a foot of new snow. |
| 8-11 | Strong northwesterly winds aloft created orographic snows in the northern and central mountains 8-10th. Continued cold and windy but with moderating temperatures. Strong downslope winds produced some wind damage at the base of the foothills on the 9th. Wile cool temperatures persisted in the mountains and western valleys on the 10th, areas east of the mountains experienced springlike temperatures. Highs in the 50s and 60s were common. Then sharply colder on the 11th as a strong storm system crossed the state. Snow fell over most of the state from the Front Range westward. Snowfall totals of a few inches were common. Eagle received 6" of new snow. Some of the heaviest snows fell along the southern Front Range. Canon City picked up nearly 8 inches. |
| 12-14 | Clearing and very cold statewide but especially over the mountains. Subzero temperatures were observed over most of the state. Pueblo dipped to -11° on the 13th and Grand Junction reached -6° on the 14th. Other places would have found those readings downright tropical. Fraser reached -34° on the 13th, Crested Butte -39°, Antero Reservoir -46° and good old Taylor Park was a brittle -56°F. Temperatures warmed a bit on the 14th as another cold front brought clouds and a dusting of mountain snows. |
| 15-22 | The jet stream retreated northward and sunshine dominated the state. Mountain valleys remained quite frigid during this week, but winds were calm and conditions invigorating. East of the mountains very mild temperatures persisted with high temperatures often in the 50s and 60s. Some strong winds were reported 16-17th. |
| 23-29 | An unsettled period. A complex storm system tried to get organized over Colorado on the 23-25th. Some heavy snows fell near Grand Junction (7") and over the San Juan Mountains. Much colder temperatures with periods of light snow and freezing drizzle east of the mountains. 1-2" snowfalls were common the Plains and along the Front Range. The storm then dropped south into Old Mexico on the 26th. As skies cleared, mountain temperatures dropped again. Granby was -22° on the morning of the 26th. Then clouds and moisture began streaming northward again on the 27th and parts of southern Colorado received more heavy snow. Rio Grande Reservoir picked up a fresh foot of new snow. Some rains again fell in southeast Colorado. Holly got 0.45" from the showers. Overnight on the 27th the storm snuck northward. Front Range residents woke to a raging snowstorm on the 28th. Before it was over, Greeley had 10", Denver 9", Boulder 9" and Evergreen 16" of unexpected snow. |
| 29-31 | Sunny to partly cloudy. Seasonal temperatures west but quickly warming west. Even as all eyes began to turn northward in anticipation of a remarkable cold surge perched over Alaska and Canada, temperatures soared east of the mountains on the 31st to record or near record levels. Pueblo hit 75°, Denver 70°, Evergreen 64°, 76° at Burlington, 78° at Cheyenne Wells, Las Animas and Springfield and a whopping 80° south of Campo in extreme SE Colorado. That came within one degree of the all time highest January temperature observed anywhere in Colorado. |

### January 1989 Extremes

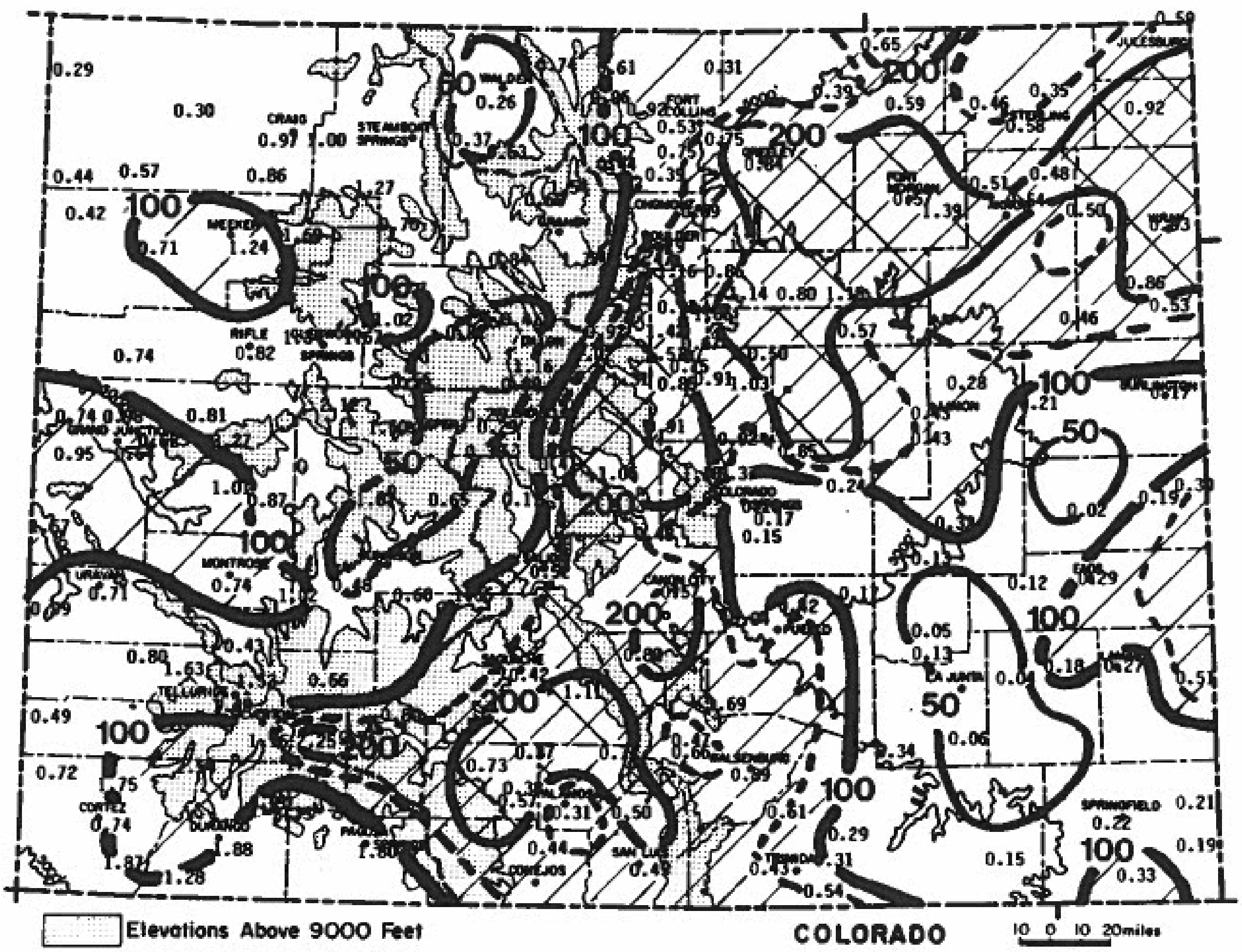
| | | | |
|---|---|---|---|
| Highest Temperature | 80°F | January 31 | Campo 7S |
| Lowest Temperature | -56°F | January 13 | Taylor Park Reservoir |
| Greatest Total Precipitation | 5.25" | | Wolf Creek Pass 1E |
| Least Total Precipitation | 0.02" | | Kit Carson 6S |
| Greatest Total Snowfall* | 79" | | Wolf Creek Pass 1E |
| Greatest Snowdepth ** | 84" | | Upper San Juan (near Wolf Creek Pass) |

*For existing weather stations with complete daily records. Higher values are likely for unmonitored locations.
**From Soil Conservation Service snowpack measurements.

## JANUARY 1989 PRECIPITATION

Moisture-bearing storms were uncommonly infrequent over Colorado in January. As a result, the majority of the state and most mountain areas were drier than average for the month as a whole. However, with the help of an unusual episode of rain on the Eastern Plains early in the month and a double hit from a late January storm, several areas which are normally very dry in January -- the San Luis Valley, South Park and much of the South Platte drainage ended up considerably wetter than average. Nearly 40 locations received more than double their average precipitation. While this sounds impressive, the majority of those locations average less than .50" of moisture in January. Actual precipitation totals were still quite low. Of the 200 plus official reporting stations including all mountain stations, only 24 received 1.50" or more for the month. A number of locations received less than half of their average January precipitation. Crested Butte, for example, received only 1.01" of moisture, 34% of average. The snowiest mountain area was the San Juan mountains; Wolf Creek Pass picked up more than 5" of moisture.

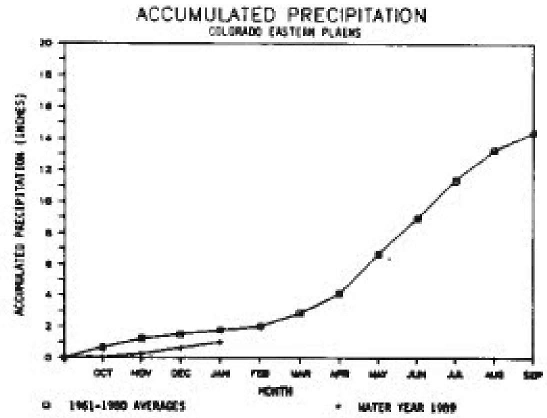
| Greatest | | Least | |
|---|---|---|---|
| Wolf Creek Pass 1E | 5.25" | Kit Carson 6S | 0.02" |
| Bonham Reservoir | 3.27" | Pueblo Reservoir | 0.04" |
| Rico | 2.54" | Las Animas | 0.04" |
| Vallecito Dam | 2.35" | Ordway 2 ENE | 0.05" |
| Rio Grande Reservoir | 2.25" | La Junta 20 S | 0.06" |

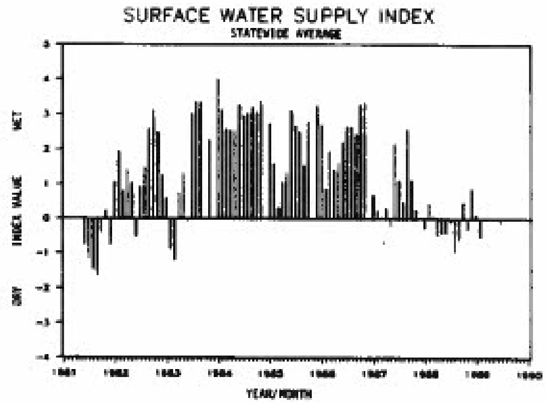


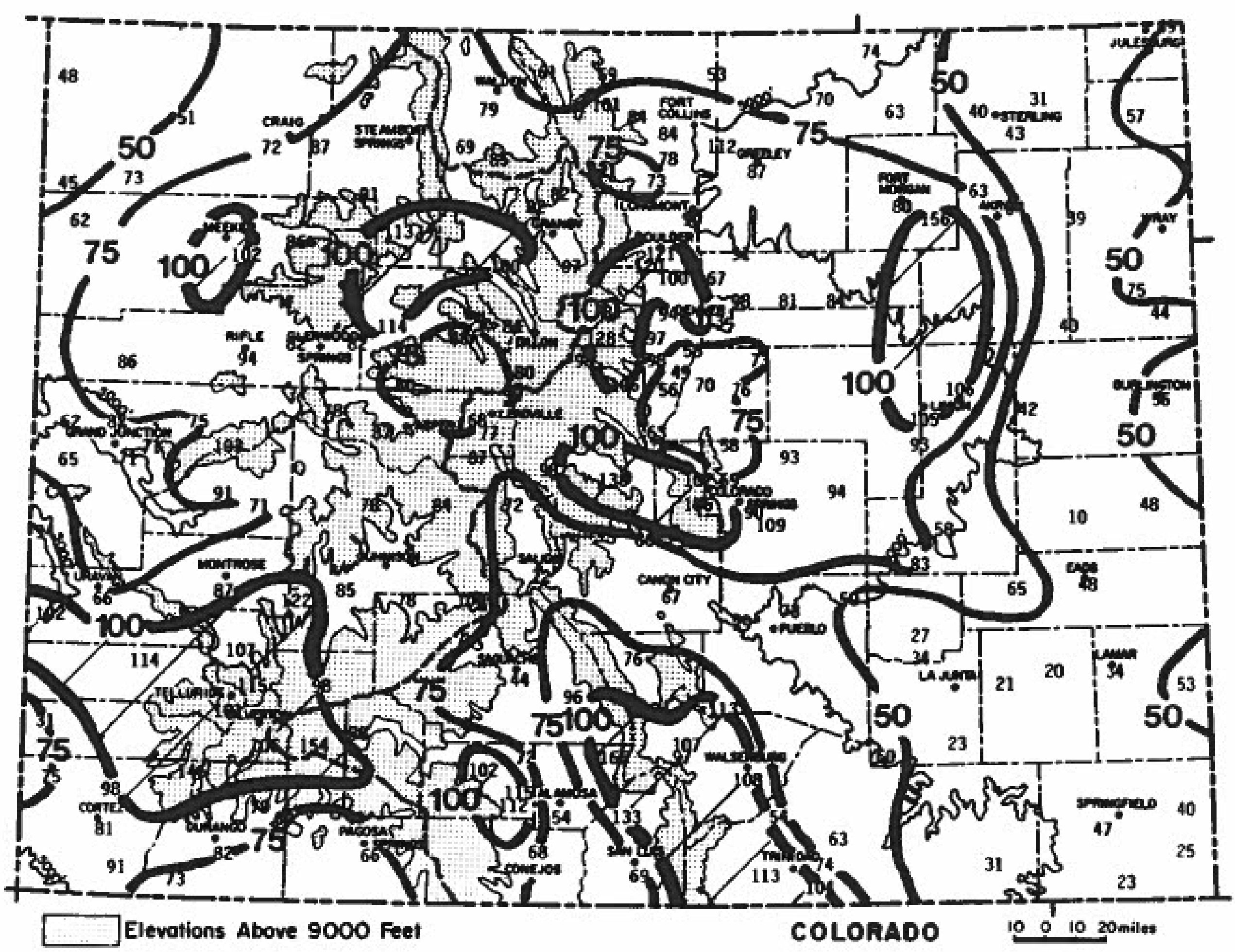

Precipitation amounts (inches) for January 1989 and contours of precipitation as a percent of the 1961-1980 average. Dashed line is 150% of average.

# 1989 WATER YEAR PRECIPITATION

For the first four months of the 1989 water year, precipitation has been at its lowest level in Colorado since 1981. Most areas in or near the mountains are ranging from 25% below average to about 15% above average. While on the low side, this is well within the normal range. The driest areas are in extreme western Colorado and over wide areas of eastern Colorado. Several locations in southeast Colorado have received 25% or less of their average. While the plains are well below average, typical winter precipitation is very light. As the graph below suggests, deficits could easily be made up in the spring months. If dry weather persists into March, some problems could begin to emerge, including blowing soils.



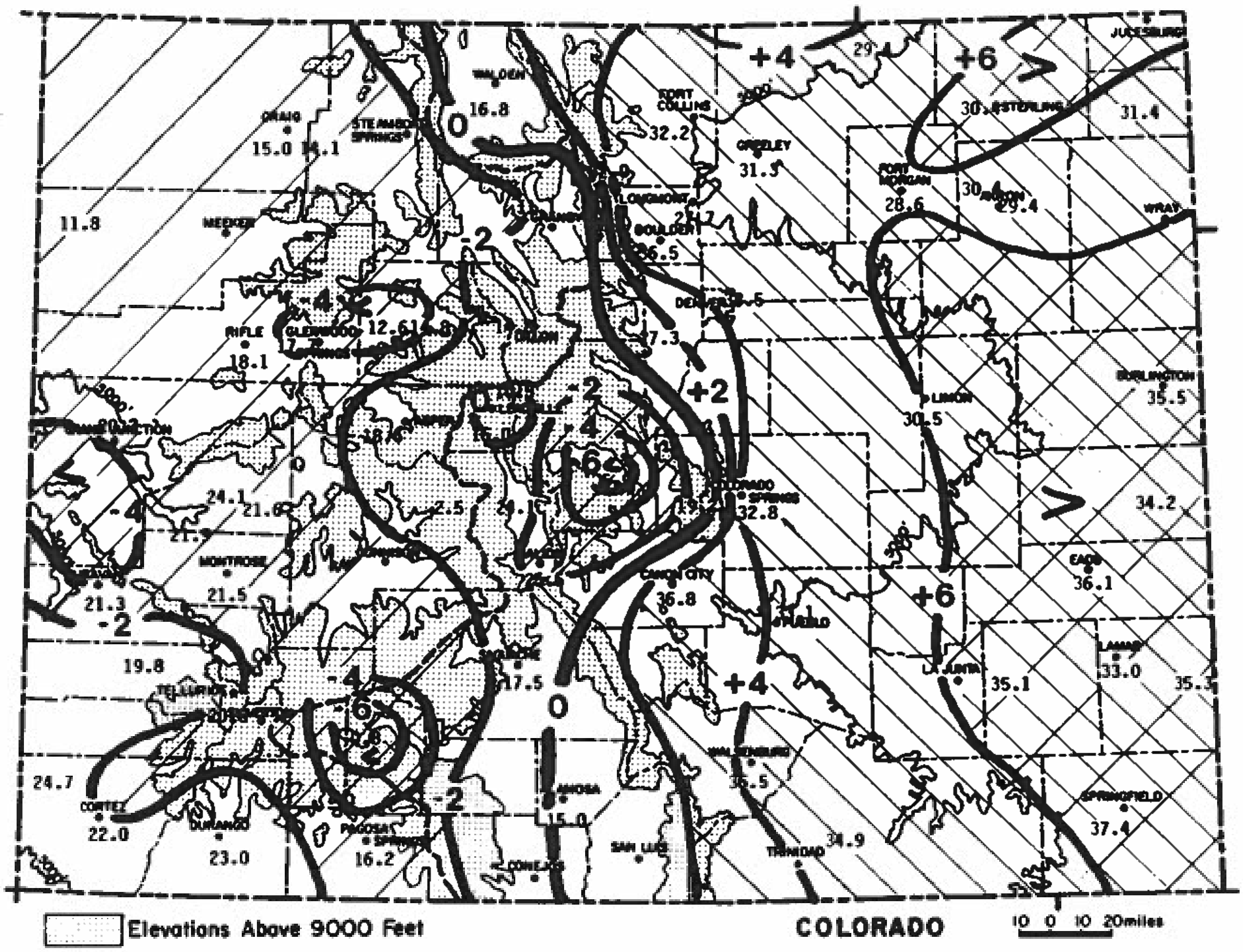




Precipitation for October 1988 through January 1989
as a percent of the 1961-1980 average.

## JANUARY 1989 TEMPERATURES AND DEGREE DAYS

The mountains created a distinct barrier between warm and cold air for the month of January. From the mountains westward, most locations were 2 to 4 degrees Fahrenheit cooler than average. Frequent clear skies were partly to blame for this pattern which allowed dramatic radiational cooling to occur when the sun set. Meanwhile, eastern Colorado enjoyed an unusually mild month. Most areas were 4 to 8 degrees above average for the month. Comparably warm January's only occur about one out of every 8 to 12 years. While extremely cold temperatures did occur in some mountain valleys, eastern Colorado escaped the cold. Many locations experienced no subzero temperatures for the entire month, which is quite rare for January.




January 1989 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## JANUARY 1989 SOIL TEMPERATURES

With a lack of January snowcover, soil temperatures cooled and frost penetrated deeper into the ground. Warmer air temperatures after the middle of the month allowed near-surface soil temperatures to recover again to near the freezing point.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.

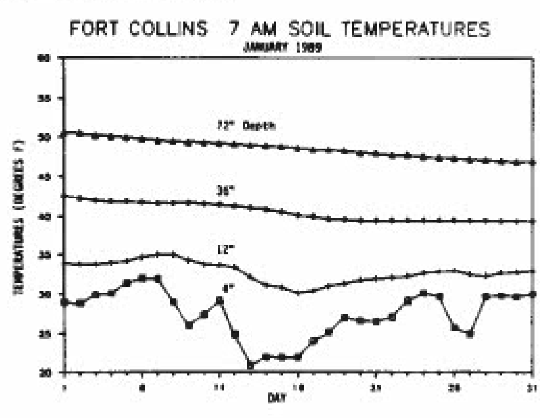


Table 1. Heating Degree Day Data through January 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 87-88 | 66 | 96 | 364 | 601 | 1130 | 1556 | 1867 | 1381 | 1031 | 658 | 454 | 102 | 9306 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | | | | | | 5039 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 87-88 | 112 | 152 | 355 | 563 | 1024 | 1382 | 1450 | 1146 | 1136 | 734 | 517 | 123 | 8694 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | | | | | | 4937 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 87-88 | 7 | 33 | 122 | 370 | 713 | 1053 | 1107 | 842 | 739 | 400 | 203 | 14 | 5603 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | | | | | | 3006 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 87-88 | 49 | 117 | 313 | 549 | 955 | 1277 | 1357 | 1010 | 1030 | 639 | 472 | 102 | 7870 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | | | | | | 4497 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 87-88 | 5 | 20 | 72 | 375 | 724 | 1037 | 1221 | 935 | 779 | 449 | 178 | 14 | 5809 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | | | | | | 2987 |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 87-88 | 11 | 36 | 87 | 374 | 668 | 1007 | 1144 | 858 | 767 | 407 | 191 | 16 | 5566 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | | | | | | 2861 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 87-88 | 17 | 74 | 150 | 445 | 767 | 1108 | 1256 | 958 | 886 | 499 | 273 | 25 | 6458 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | | | | | | 3391 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 87-88 | 6 | 35 | 154 | 396 | 860 | 1179 | 1351 | 1008 | 899 | 609 | 362 | 56 | 6915 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | | | | | | 3867 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 87-88 | 55 | 96 | 227 | 534 | 950 | 1376 | 1561 | 1264 | 1076 | 593 | 399 | 52 | 8183 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | | | | | | 4666 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 87-88 | 0 | 11 | 108 | 354 | 737 | 1102 | 1300 | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | 1327 | | | | | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 87-88 | 11 | 21 | 110 | 410 | 745 | 1125 | 1227 | 889 | 811 | 437 | 215 | 14 | 6015 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | | | | | | 3204 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 87-88 | 296 | 346 | 556 | 763 | 1145 | 1491 | 1629 | 1376 | 1379 | 933 | 717 | 322 | 10953 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | | | | | | 6066 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 87-88 | 14 | 44 | 188 | 435 | 851 | 1206 | 1391 | 972 | 859 | 514 | 346 | 42 | 6862 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | | | | | | 3909 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 87-88 | 54 | 75 | 254 | 509 | 950 | 1331 | 1544 | 1173 | 1002 | 607 | 404 | 52 | 7955 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | | | | | | 4808 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 87-88 | 69 | 118 | 333 | 602 | 922 | 1255 | 1310 | 1029 | 992 | 645 | 462 | 111 | 7848 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | | | | | | 4226 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 87-88 | 12 | 37 | 146 | 453 | 784 | 1140 | 1252 | 936 | 821 | 479 | 217 | 8 | 6285 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | | | | | | 3439 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 87-88 | 12 | 29 | 110 | 430 | 773 | 1154 | 1484 | 1055 | 826 | 495 | 206 | 17 | 6591 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | | | | | | 3616 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 87-88 | 0 | 6 | 34 | 248 | 754 | 1147 | 1469 | 1031 | 741 | 350 | 172 | 8 | 5960 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | | | | | | 3472 |

* = AVES ADJUSTED FOR STATION MOVES     M = MISSING     E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 87-88 | 207 | 257 | 480 | 677 | 1098 | 1516 | 1642 | 1413 | 1372 | 907 | 602 | 238 | 10409 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | | | | | | 5817 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 87-88 | 10 | 26 | 119 | 424 | 762 | 1157 | 1363 | 955 | 807 | 437 | 204 | 6 | 6270 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | | | | | | 3410 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | 1698 | 2096 | | | | | | 6145 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 87-88 | 0 | 3 | 35 | 273 | 653 | 1032 | 1278 | 837 | 638 | 327 | 103 | 1 | 5180 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | | | | | | 2770 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 87-88 | 346 | 393 | 578 | 763 | 1180 | 1534 | 1577 | 1326 | 1355 | 957 | 741 | 360 | 11110 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | | | | | | 6232 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 87-88 | 21 | 66 | 158 | 502 | 840 | 1209 | 1354 | 1022 | 943 | 569 | 321 | 35 | 7040 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | | | | | | 3648 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 87-88 | 12 | 33 | 159 | 464 | 805 | 1169 | 1383 | 1035 | 847 | 509 | 222 | 20 | 6658 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | | | | | | 3905 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | M | | | | | | M |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 87-88 | 5 | 30 | 129 | 349 | 849 | 1160 | 1332 | 1003 | 817 | 468 | 230 | 26 | 6398 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | | | | | | 3734 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 87-88 | 104 | 105 | 347 | 523 | 947 | 1292 | 1548 | 1187 | 996 | 663 | 485 | 143 | 8340 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | | | | | | 4784 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 87-88 | 4 | 17 | 43 | 355 | 754 | 1111 | 1399 | 903 | 777 | 399 | 167 | 8 | 5937 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | | | | | | 3124 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 87-88 | 9 | 24 | 125 | 391 | 819 | 1209 | 1430 | 1039 | 865 | 454 | 268 | 14 | 6647 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | | | | | | 3999 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 87-88 | 77 | 127 | 330 | 590 | 1033 | 1448 | 1619 | 1336 | 1167 | 674 | 433 | 95 | 8929 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | | | | | | 5139 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 87-88 | 12 | 31 | 108 | 413 | 742 | E1140 | 1475 | 1029 | 831 | 476 | 197 | 12 | 6466 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | | | | | | 3339 |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 87-88 | 161 | 222 | 426 | 603 | 992 | 1269 | 1354 | 1109 | 1092 | 720 | 547 | 208 | 8703 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | | | | | | 4949 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 87-88 | 4 | 25 | 80 | 330 | 730 | 1054 | 1209 | 850 | 803 | 438 | 234 | 13 | 5770 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | | | | | | 2965 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 87-88 | 215 | 281 | 495 | 740 | 1242 | 1499 | 1572 | 1343 | 1340 | 835 | 638 | 184 | 10384 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | | | | | | 5629 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 87-88 | 3 | 30 | 101 | 332 | 707 | 977 | 1109 | 826 | 773 | 401 | 238 | 25 | 5522 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | | | | | | 2856 |

* = AVES ADJUSTED FOR STATION MOVES     M = MISSING     E = ESTIMATED

# JANUARY 1989 CLIMATIC DATA

## Eastern Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| NEW RAYMER 21N | 45.1 | 13.6 | 29.4 | 4.2 | 64 | -4 | 1097 | 0 | 42 | 0.65 | 0.34 | 209.7 | 5 |
| STERLING | 47.2 | 13.6 | 30.4 | 7.5 | 65 | -1 | 1066 | 0 | 45 | 0.46 | 0.12 | 135.3 | 4 |
| FORT MORGAN | 44.2 | 13.1 | 28.6 | 5.9 | 64 | 1 | 1121 | 0 | 36 | 0.57 | 0.39 | 316.7 | 4 |
| AKRON FAA AP | 45.5 | 15.3 | 30.4 | 5.5 | 59 | 1 | 1065 | 0 | 41 | 0.51 | 0.23 | 182.1 | 4 |
| AKRON 4E | 45.4 | 13.5 | 29.4 | 4.6 | 61 | -3 | 1096 | 0 | 52 | 0.54 | 0.28 | 207.7 | 5 |
| HOLYOKE | 47.5 | 15.4 | 31.4 | 5.1 | 66 | 0 | 1035 | 0 | 55 | 0.92 | 0.54 | 242.1 | 5 |
| BURLINGTON | 50.1 | 20.9 | 35.5 | 6.8 | 76 | 6 | 908 | 0 | 70 | 0.17 | -0.07 | 70.8 | 2 |
| LIMON WSMO | 45.4 | 15.7 | 30.5 | 6.0 | 68 | 0 | 1060 | 0 | 40 | 0.43 | 0.14 | 148.3 | 6 |
| CHEYENNE WELLS | 50.7 | 17.8 | 34.2 | 6.1 | 78 | 0 | 948 | 0 | 71 | 0.19 | 0.03 | 118.7 | 3 |
| EADS | 50.1 | 20.1 | 36.1 | 8.4 | 64 | 9 | 774 | 0 | 62 | 0.29 | 0.02 | 107.4 | 2 |
| LAMAR | 54.4 | 11.7 | 33.0 | 4.8 | 77 | -1 | 982 | 0 | 120 | 0.27 | -0.11 | 71.1 | 4 |
| LAS ANIMAS | 56.2 | 14.1 | 35.1 | 6.8 | 78 | -6 | 919 | 0 | 134 | 0.04 | -0.17 | 19.0 | 3 |
| HOLLY | 53.9 | 16.6 | 35.3 | 8.4 | 77 | 0 | 917 | 0 | 110 | 0.51 | 0.31 | 255.0 | 3 |
| SPRINGFIELD 7WSW | 53.5 | 21.2 | 37.4 | 6.6 | 78 | 4 | 848 | 0 | 104 | 0.22 | -0.12 | 64.7 | 3 |

## Foothills/Adjacent Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| FORT COLLINS | 46.4 | 18.0 | 32.2 | 5.8 | 59 | 1 | 1011 | 0 | 34 | 0.53 | 0.09 | 120.5 | 4 |
| GREELEY UNC | 45.9 | 16.6 | 31.3 | 5.2 | 61 | -2 | 1042 | 0 | 40 | 0.84 | 0.46 | 221.1 | 5 |
| ESTES PARK | 43.1 | 20.9 | 32.0 | 5.2 | 58 | -11 | 1016 | 0 | 19 | 0.44 | 0.00 | 100.0 | 2 |
| LONGMONT 2ESE | 44.5 | 10.8 | 27.7 | 2.0 | 64 | -4 | 1151 | 0 | 29 | 0.69 | 0.28 | 168.3 | 5 |
| BOULDER | 49.5 | 23.4 | 36.5 | 5.0 | 69 | 5 | 880 | 0 | 70 | 1.19 | 0.56 | 188.9 | 5 |
| DENVER WSFO AP | 47.8 | 19.2 | 33.5 | 5.0 | 64 | 0 | 969 | 0 | 61 | 1.14 | 0.63 | 223.5 | 5 |
| EVERGREEN | 46.1 | 8.6 | 27.3 | 1.2 | 64 | -11 | 1159 | 0 | 43 | 1.42 | 0.94 | 295.8 | 5 |
| LAKE GEORGE 8SW | 24.5 | -12.8 | 5.9 | -9.6 | 42 | -43 | 1826 | 0 | 0 | 1.05 | 0.82 | 456.5 | 5 |
| RUXTON PARK | 34.3 | 4.1 | 19.2 | -1.3 | 51 | -21 | 1412 | 0 | 1 | 0.89 | 0.35 | 164.8 | 6 |
| COLORADO SPRINGS | 45.7 | 19.8 | 32.8 | 4.9 | 70 | 2 | 988 | 0 | 42 | 0.23 | -0.01 | 95.8 | 6 |
| CANON CITY 2SE | 49.7 | 23.9 | 36.8 | 3.3 | 68 | 0 | 866 | 0 | 71 | 0.57 | 0.29 | 203.6 | 4 |
| PUEBLO WSO AP | 50.6 | 15.6 | 33.1 | 4.1 | 75 | -11 | 980 | 0 | 93 | 0.42 | 0.20 | 190.9 | 5 |
| WALSENBURG | 49.4 | 23.7 | 36.5 | 4.6 | 64 | -1 | 876 | 0 | 60 | 0.89 | 0.35 | 164.8 | 5 |
| TRINIDAD FAA AP | 52.0 | 17.9 | 34.9 | 4.4 | 71 | -2 | 925 | 0 | 95 | 0.29 | -0.12 | 70.7 | 5 |

## Mountains/Interior Valleys

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| WALDEN | 29.3 | 4.3 | 16.8 | 1.7 | 45 | -24 | 1487 | 0 | 0 | 0.26 | -0.37 | 41.3 | 8 |
| LEADVILLE 2SW | 31.8 | 0.1 | 16.0 | 1.5 | 47 | -27 | 1512 | 0 | 0 | 0.29 | -0.91 | 24.2 | 7 |
| SALIDA | 40.4 | 10.7 | 25.5 | -2.4 | 55 | -24 | 1217 | 0 | 7 | 0.52 | 0.17 | 148.6 | 3 |
| BUENA VISTA | 39.3 | 9.0 | 24.1 | -1.6 | 56 | -13 | 1260 | 0 | 3 | 0.17 | -0.10 | 63.0 | 3 |
| SAGUACHE | 33.2 | 1.9 | 17.5 | -0.4 | 43 | -14 | 1463 | 0 | 0 | 0.42 | 0.15 | 155.6 | 4 |
| HERMIT 7ESE | 15.1 | -13.4 | 0.8 | -9.5 | 30 | -42 | 1983 | 0 | 0 | 1.45 | 0.63 | 176.8 | 4 |
| ALAMOSA WSO AP | 35.3 | -5.4 | 15.0 | 0.2 | 46 | -20 | 1544 | 0 | 0 | 0.31 | 0.06 | 124.0 | 7 |
| STEAMBOAT SPRINGS | 25.5 | -1.8 | 11.9 | -2.6 | 39 | -28 | 1640 | 0 | 0 | 1.59 | -1.14 | 58.2 | 13 |
| GRAND LAKE 6SSW | 25.9 | -3.7 | 11.1 | -1.9 | 42 | -32 | 1663 | 0 | 0 | 0.60 | -0.51 | 54.1 | 12 |
| DILLON 1E | 31.2 | -1.5 | 14.8 | -0.7 | 47 | -21 | 1546 | 0 | 0 | 0.41 | -0.45 | 47.7 | 9 |
| AVON | 30.4 | -0.7 | 14.8 | -4.7 | 46 | -26 | 1549 | 0 | 0 | 1.14 | -0.26 | 81.4 | 10 |
| CLIMAX | 26.2 | -5.1 | 10.5 | -2.2 | 43 | -27 | 1680 | 0 | 0 | 0.89 | -1.34 | 39.9 | 12 |
| ASPEN 1SW | 33.8 | 3.5 | 18.6 | -1.4 | 48 | -16 | 1435 | 0 | 0 | 1.50 | -1.00 | 60.0 | 9 |
| TAYLOR PARK | 21.8 | -16.7 | 2.5 | 0.4 | 40 | -56 | 1930 | 0 | 0 | 0.65 | -0.79 | 45.1 | 6 |
| TELLURIDE | 37.7 | 3.9 | 20.8 | -0.3 | 51 | -13 | 1363 | 0 | 1 | 1.49 | -0.21 | 87.6 | 8 |
| PAGOSA SPRINGS | 38.5 | -6.1 | 16.2 | -4.0 | 49 | -29 | 1509 | 0 | 0 | 1.80 | -0.08 | 95.7 | 5 |
| SILVERTON | 34.3 | -15.6 | 9.3 | -2.1 | 52 | -34 | 1719 | 0 | 1 | 1.96 | 0.35 | 121.7 | 9 |
| WOLF CREEK PASS 1 | 32.9 | 3.5 | 18.2 | 1.3 | 48 | -23 | 1441 | 0 | 0 | 5.25 | 1.52 | 140.8 | 8 |

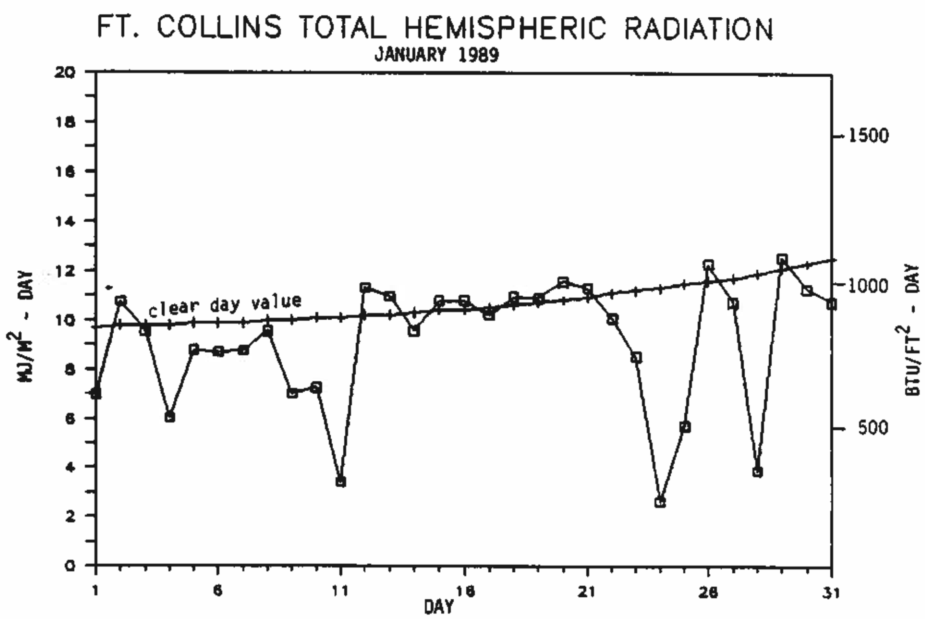
## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 27.3 | 2.8 | 15.0 | -2.0 | 43 | -13 | 1540 | 0 | 0 | 0.97 | -0.33 | 74.6 | 8 |
| HAYDEN | 26.2 | 2.1 | 14.1 | -2.2 | 42 | -13 | 1569 | 0 | 0 | 1.00 | -0.49 | 67.1 | 10 |
| RANGELY 1E | 27.2 | -3.6 | 11.8 | -3.8 | 38 | -17 | 1642 | 0 | 0 | 0.42 | -0.11 | 79.2 | 4 |
| EAGLE FAA AP | 27.8 | -2.6 | 12.6 | -5.5 | 46 | -28 | 1617 | 0 | 0 | 1.02 | 0.14 | 115.9 | 8 |
| GLENWOOD SPRINGS | 32.1 | 3.3 | 17.7 | -4.9 | 47 | -12 | 1454 | 0 | 0 | 1.34 | -0.24 | 84.8 | 9 |
| RIFLE | 35.4 | 0.8 | 18.1 | -2.9 | 48 | -15 | 1445 | 0 | 0 | 0.82 | -0.08 | 91.1 | 7 |
| GRAND JUNCTION WS | 32.8 | 7.6 | 20.2 | -3.5 | 43 | -6 | 1379 | 0 | 0 | 0.98 | 0.40 | 169.0 | 5 |
| CEDAREDGE | 39.0 | 9.2 | 24.1 | -1.3 | 53 | -8 | 1260 | 0 | 2 | 1.01 | 0.15 | 117.4 | 7 |
| PAONIA 1SW | 36.0 | 7.1 | 21.6 | -2.7 | 56 | -15 | 1341 | 0 | 3 | 0.87 | -0.35 | 71.3 | 8 |
| DELTA | 36.7 | 7.1 | 21.9 | -3.1 | 58 | 0 | 1327 | 0 | 4 | 0.00 | -0.35 | 0.0 | 0 |
| GUNNISON | 13.4 | -19.0 | -2.8 | -11.1 | 32 | -35 | 2096 | 0 | 0 | 1.24 | 0.39 | 145.9 | 7 |
| MONTROSE NO. 2 | 35.3 | 7.8 | 21.5 | -2.4 | 49 | -8 | 1340 | 0 | 0 | 0.74 | 0.24 | 148.0 | 8 |
| URAVAN | 37.3 | 5.3 | 21.3 | -6.2 | 53 | -10 | 1347 | 0 | 2 | 0.71 | -0.29 | 71.0 | 5 |
| NORWOOD | 34.4 | 5.2 | 19.8 | -1.6 | 47 | -11 | 1391 | 0 | 0 | 0.80 | -0.28 | 74.1 | 4 |
| YELLOW JACKET 2W | 37.6 | 11.9 | 24.7 | 0.8 | 49 | -6 | 1242 | 0 | 0 | 0.72 | -0.54 | 57.1 | 6 |
| CORTEZ | 38.8 | 5.1 | 22.0 | -2.5 | 49 | -11 | 1326 | 0 | 0 | 0.74 | -0.29 | 71.8 | 4 |
| DURANGO | 38.2 | 7.7 | 23.0 | -1.5 | 48 | -11 | 1296 | 0 | 0 | 1.88 | 0.08 | 104.4 | 8 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## JANUARY 1989 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 21 | 2 | 8 | -- | -- |
| Denver | 18 | 7 | 6 | 79% | 72% |
| Fort Collins | 14 | 10 | 7 | -- | -- |
| Grand Junction | 17 | 5 | 9 | 80% | 58% |
| Pueblo | 20 | 3 | 8 | 77% | 75% |



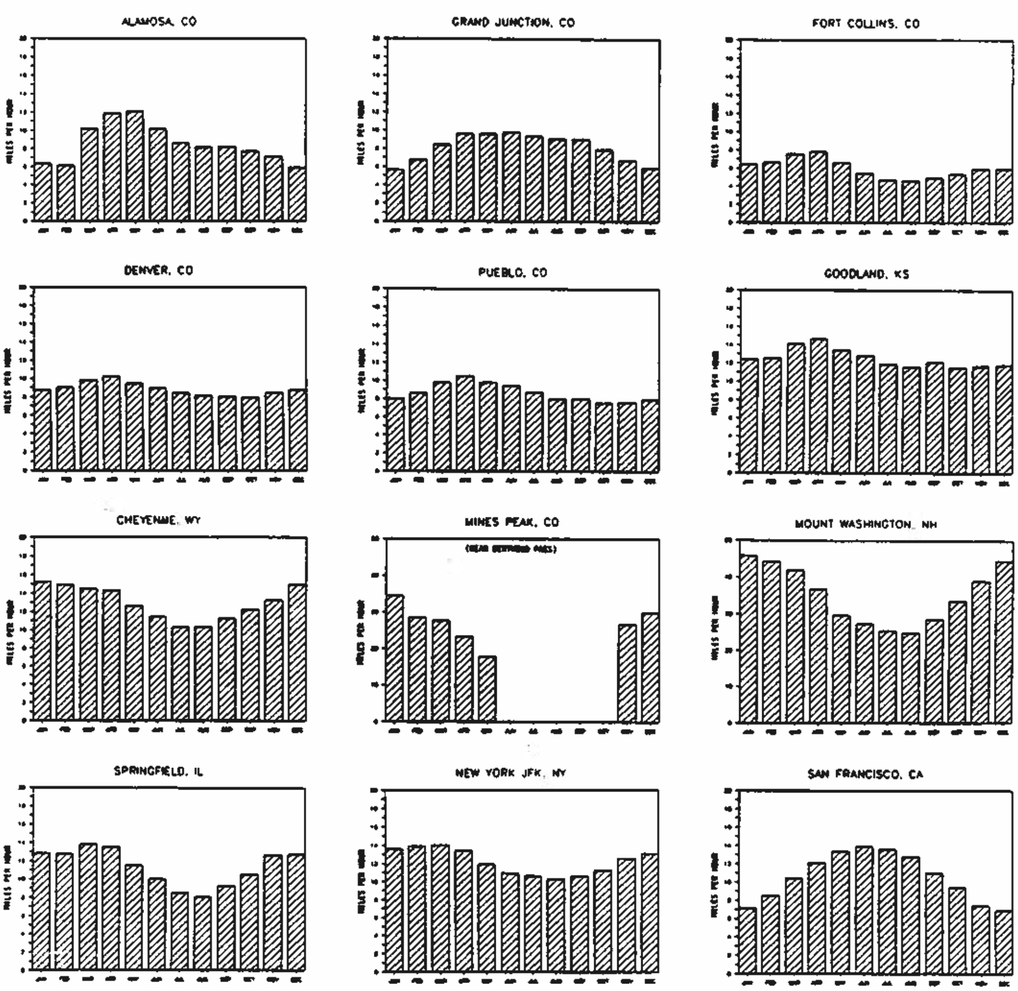
The Wild Winds of Spring: (continued from page -1-)

strong winds aloft help bring frequent storm systems and airmass changes to mid-latitude continental areas. To go along with this, there are often huge temperature differences at ground level from our southern states up to the Dakotas and southern Canada. These temperature gradients help generate deep low pressure areas that drive widespread strong winds. Another factor is sunlight. As the sun moves steadily higher in the sky and daylength increases, the ground begins to warm rapidly. Warm air near the surface with colder air aloft creates thermal instability in the atmosphere. Denver residents and people in many of the Great Basin cities welcome this change because the instability helps mix air pollution into the atmosphere instead of trapping it over each city. But this mixing also helps the stronger winds aloft to work their way down to ground level -- hence, more windy weather.

To give you an idea of how Colorado wind patterns behave, monthly average wind speeds are given for a number of cities in graphical form. Graphs for a few other locations in the U.S. are also shown for comparison. Colorado seasonal wind patterns are not unlike most of the rest of the country. Spring does tend to be the windiest time of year. Most Colorado locations experience their highest average wind speeds in the month of April, one month later than most of the rest of the country. But the difference between March and April really are not very great. We do see some interesting differences between a few Colorado locations. Some areas see moderate winds throughout the year. Other locations, like Grand Junction and Alamosa see a significant decrease in winds during the middle of winter. Up in the high mountains the strongest winds blow in mid-winter. These seasonal patterns reveal some important climate characteristics of the state. For example, valley locations tend to be very calm during the winter as cold, dense air becomes trapped.

There are a lot more variations in wind speeds than you might think. Diurnal (day to night) fluctuations are generally predictable -- stronger winds during the daytime, weaker at night. But even this varies markably with seasons and from place to place around Colorado. We'll look at this in greater detail in a future summary. For now, look at some of the JCEM WTHRNET data. The graphs may test your eyesight, but you can begin to learn how our Colorado winds behave.

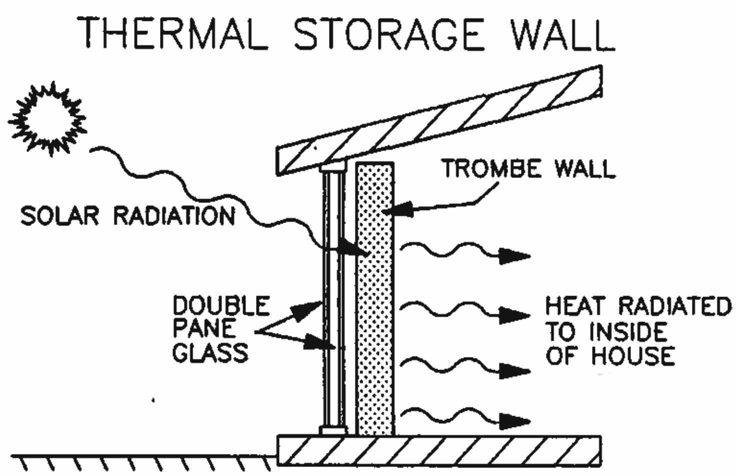
COMPARISON OF MONTHLY AVERAGE WIND SPEEDS FOR SELECTED LOCATIONS



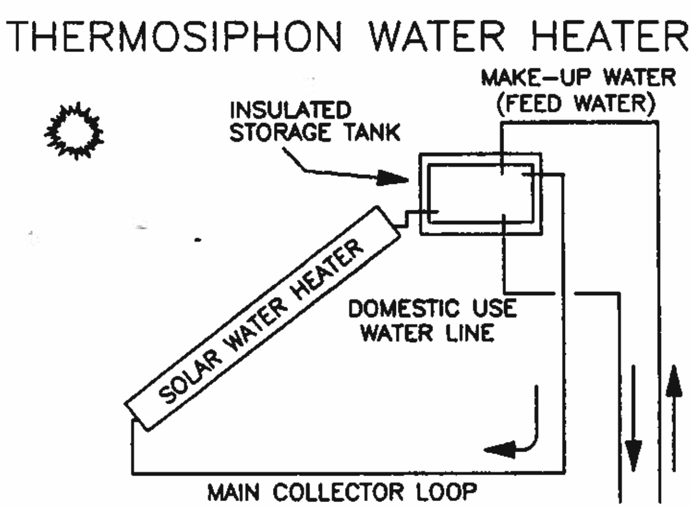
## PASSIVE SOLAR HEATING

Though the "Big Chill" of the winter seems to be over, the lasting effects will be seen later this month when we get our electric and gas bills. We can expect to pay perhaps twice as much as we did in January because of the few extremely cold days at the start of February. It is at times like these that a number of us seriously consider the benefits of using solar heating to supplement that of electric baseboards or gas furnaces. Solar heating can be broken down into two categories: passive and active. Active heating involves the use of pumps or fans to push water or air around to transfer energy from a hot place, i.e. the collector, to a cold place such as the rooms of a house. Passive heating, on the other hand, implies that the heat transfer takes place without any external energy other than the sun.

Thermal storage walls are like big heat "batteries" which are charged by the sun during the day and then release the energy at night. The drawing on the right shows a typical configuration of such a Trombe wall (so named for the person who initially investigated this idea). Most often made of concrete or brick, the thickness of the wall is designed such that a heat "pulse" will travel from the outward facing side to the inside in about six to eight hours. Solar energy collected at 2 PM would thus be delivered to the space between the hours of 8 and 10 at night when it is needed the most. The heat transfer can also be facilitated by putting ducts in the bottom and top of the wall. Air between the glass and wall will rise naturally (due to the buoyancy of the heated air), drawing cold room air in through the lower duct and supplying warm air to the space through the upper duct.




Water can also be heated passively, in this case through use of the "thermosiphon". A schematic is shown here on the left. In this type of system an insulated storage tank is filled with cold water at night. During the day water in the collector is heated by the sun and will circulate through the collector and storage tank since hot water is lighter than cold water. The trick is to place the tank <u>above</u> the top of the collector. Hot water can then be retrieved from the tank; since the tank is most often placed in an attic or on the roof, no pump is required to provide sufficient water pressure to the house. The only energy needed is a pump to supply feed water to the tank originally. Of course, in cold environments such as Colorado it is necessary to circulate an antifreeze mixture through the collector and to use a heat exchanger in the storage tank to actually heat the water.

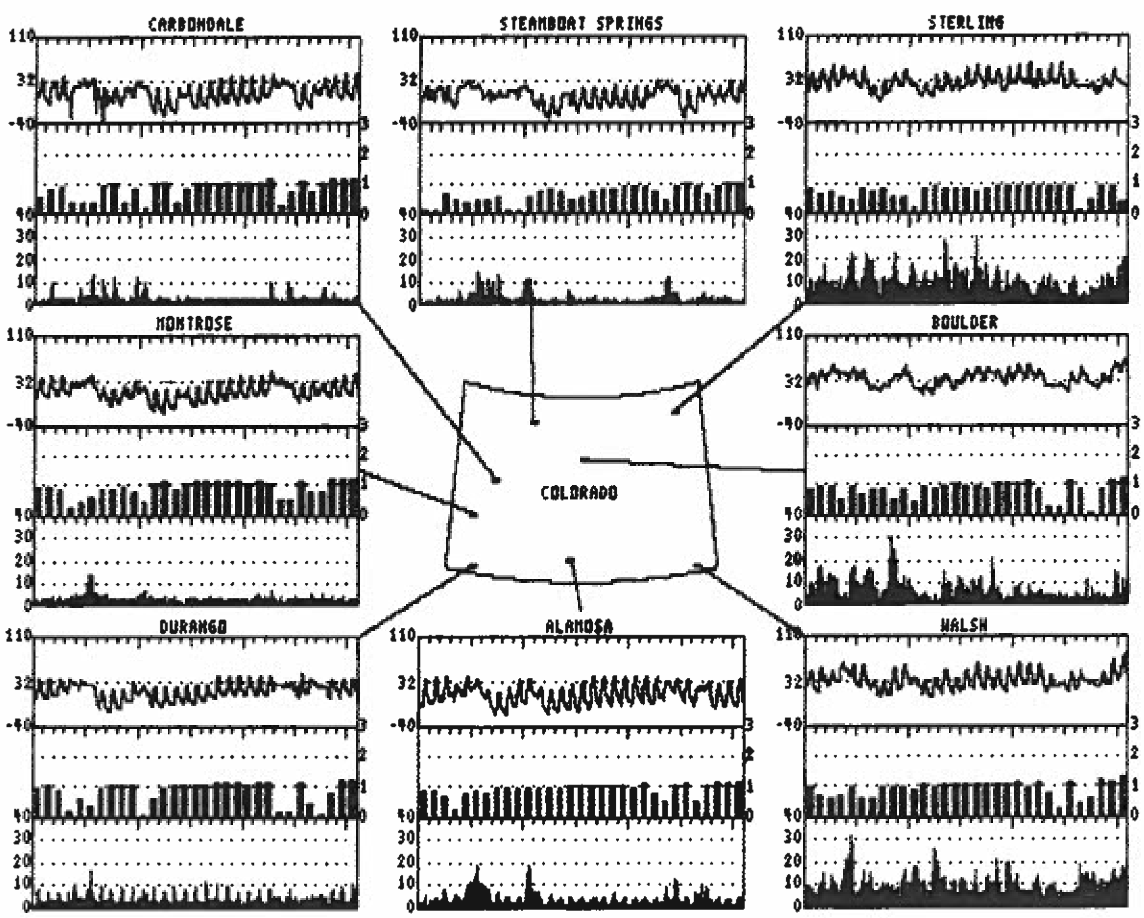


WTHRNET WEATHER DATA JANUARY 1989

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh |
|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | | | | | | | |
| | 13.6 | 19.4 | 12.7 | 17.3 | 6.5 | 29.8 | 35.0 |
| **monthly temperature extremes and time of occurence ( °F day/hour )** | | | | | | | |
| maximum: | 44.6 19/15 | 48.0 26/14 | 47.8 30/15 | 51.1 23/15 | 34.9 5/12 | 63.7 22/16 | 78.3 31/15 |
| minimum: | -19.8 13/ 6 | -16.1 8/ 8 | -38.7 7/ 8 | -17.5 13/ 8 | -27.6 26/ 5 | -3.5 8/ 7 | 7.7 12/ 0 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | |
| 5 AM | 83 / -4 | 87 / 7 | 87 / -0 | 84 / 5 | 86 / -3 | 63 / 9 | 55 / 9 |
| 11 AM | 56 / 8 | 58 / 15 | 66 / 8 | 61 / 13 | 80 / 6 | 47 / 16 | 36 / 15 |
| 2 PM | 39 / 9 | 56 / 17 | 46 / 11 | 52 / 15 | 60 / 8 | 35 / 15 | 30 / 15 |
| 5 PM | 41 / 8 | 57 / 16 | 47 / 9 | 55 / 14 | 64 / 5 | 37 / 11 | 30 / 12 |
| 11 PM | 77 / 1 | 86 / 12 | 84 / 5 | 81 / 7 | 88 / 1 | 54 / 9 | 46 / 9 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | |
| day | 228 | 191 | 194 | 198 | 167 | 235 | 196 |
| night | 201 | 93 | 174 | 167 | 142 | 230 | 264 |
| **monthly average wind speed ( miles per hour )** | | | | | | | |
| | 2.99 | 2.72 | 2.38 | 2.34 | 2.11 | 8.48 | 8.21 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | |
| 0 to 3 | 492 | 528 | 619 | 610 | 625 | 51 | 37 |
| 3 to 12 | 236 | 214 | 121 | 132 | 115 | 542 | 588 |
| 12 to 24 | 16 | 2 | 2 | 2 | 4 | 145 | 112 |
| > 24 | 0 | 0 | 0 | 0 | 0 | 6 | 7 |
| **monthly average daily total insolation ( Btu/ft²·day )** | | | | | | | |
| | 912 | 806 | 830 | 888 | 648 | 747 | 915 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | |
| 60-80% | 193 | 161 | 144 | 167 | 99 | 156 | 186 |
| 40-60% | 67 | 42 | 57 | 42 | 78 | 43 | 74 |
| 20-40% | 32 | 25 | 50 | 40 | 62 | 39 | 25 |
| 0-20% | 15 | 62 | 23 | 24 | 43 | 43 | 22 |

## The State-Wide Picture

The figure below shows monthly weather at WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40°F to 110°F, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 Btu/ft²/day, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour.



# COLORADO CLIMATE

## FEBRUARY 1989



**Colorado Climate Center**
**Department of Atmospheric Science**
**Colorado State University**
**Fort Collins, Colorado 80523**



*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 5


February in Review:

A wild blast of cold and snow during the first week of February will find a place in the Colorado climate history books. The month as a whole ended up much colder than average over northwest Colorado and all areas east of the mountains. Most areas were also wetter than average except extreme southwest Colorado and a number of counties on the Eastern Plains.

Colorado's April Climate:

One way to visualize April is to take March and just warm it up a few degrees. As in March, dramatic day to day temperature changes still occur. There is plenty of wind. Don't be surprised to have some overcast dreary days and one or two heavy snowstorms. There are also some differences. Temperatures are noticeably warmer in April. Mountain snows begin to melt a little. Best of all, we begin to get some honest rains and often our first widespread thunderstorm activity of the year.

Winter remains well established in the Colorado high country in April. For the central mountains it is often the wettest month of the year. While low elevation snowpack melts quickly in April, at elevations above 10,000 feet snowdepths usually reach their maximum for the year. Daytime temperatures usually rise above the freezing point, but drop back into the teens at night. Subzero temperatures are still possible, but they become rare after the first week of April.

At lower elevations warmer temperatures are most noticeable. Although the daytime temperatures below 7500 feet average in the 50s and 60s, it is not at all uncommon to have temperatures in the 70s. In southeast Colorado, even the 80s are fairly normal. At the same time, expect a number of days where temperatures stay in the 30s and 40s. Nighttime temperatures remain chilly, averaging in the 30s for the month over most of the state below 6000 feet. The last freezing temperatures of the spring usually come in April only in a few preferred locations in western Colorado near Grand Junction. Elsewhere, you'll have to wait until May or even later to plant your beans and tomatoes.

Precipitation is normally on the increase in April east of the mountains. April precipitation totals average between 1" and 2" over most of eastern Colorado. Totals increase to more than 2" in portions of the eastern foothills and reach a maximum of more than 4" in some mountain areas. West of the mountains, April precipitation generally averages between 0.75" and 1.5". As the month progresses, more and more of the moisture falls as rain. Snowfall averages range from just 1-3" over the western valleys and southeast Colorado increasing to 6-12" along the Front Range and 2-3 feet in the eastern foothills and mountains. The all-time heaviest snowstorms to hit Colorado have occurred during April.

The "ALASKA BLASTER" -- A Week of Weather Worth Remembering:

Perhaps the most widely publicized cold wave of all time slipped into eastern Colorado during the evening of 31 January 1989. Most of the state has experienced colder temperatures, and heavier snows. But the February 1989 combination of extreme cold (especially daytime temperatures) and heavy snow made this episode unique among all other cold waves during the past century.

The "Alaska Blaster" gained its name and notoriety from its half-month occupation of Alaska and northwestern Canada. Human activities came to a screeching (literally) halt during parts of the last half of January in that land of hardy souls when temperatures lingered in the minus 40s, 50s and 60s for several consecutive days. While Alaska was freezing, local Chamber's of Commerce in parts of Colorado could have been rewriting their

(continued on page -9-)

# FEBRUARY 1989 DAILY WEATHER

| Date | Event |
|---|---|
| 1-4 | An extremely cold air mass moved into eastern and northern Colorado (see Special Feature Story) while strong westerly winds aloft brought mild temperatures and plenty of moisture into the mountains. Temperatures fell far below zero and remained there for several days over the Eastern Plains, lower eastern foothills and northern valleys. High temperatures on the 3rd and 4th stayed below -10° at several locations matching or breaking all-time records. Meanwhile, temperatures in the mountains and southwest valleys rose into the 30s, 40s with even some 50s. Remarkably heavy snows fell in the cold air, Fort Collins and Colorado Springs each received close to a foot of snow with temperatures continuously below -10°F. Craig received better than 2 feet of snow. Grand Junction received a record-breaking 11" of snow on the 3rd-4th as the cold air pushed into the valley. Three to five feet of snow fell within 48 hours over parts of the San Juan Mountains. |
| 5-7 | The cold air mass pushed south and finally engulfed the entire state. Snows continued on the 5th and 6th primarily over and near the southern mountains. Walsenburg recorded 16" of new snow before it finally ended on the 6th. As skies cleared, the coldest nighttime temperatures in several years occurred and some daily records were set. Boulder and Denver each dropped to -24° on the 5th. On the 6th, the coldest temperatures were observed over the northern mountains and western valleys. Rifle woke to -32° early on the 6th. The Orchard Mesa Research Center near Grand Junction dipped to -21° -- their coldest temperature on record. Steamboat Springs had -42° and Walden -47°. On the 7th, the coldest temperatures were observed further south. Crested Butte fell to -42°, Pueblo was -24° and Antero Reservoir was -51°, the coldest in the state for the month. |
| 8-15 | Temperatures moderated 8-11th but remained below average. Snows, mostly light, moved into western Colorado on the 9th, continued sporadically on the 10th and spread into the northern mountains and Front Range on the 11th. Quite mild 10-12th. Then colder 13-15th as a low pressure trough aloft slowly crossed Colorado. Occasional mountain snow showers continued. Low clouds and local fog lingered east of the mountains, finally clearing on the 15th. |
| 16-20 | Moderating days but cold nights, 16-18th in the mountains and western valleys. Taylor Park was -25° early on the 16th. Another Arctic surge pushed briefly into northeast Colorado on the 17th holding daytime temperatures in the teens. Cool, hazy conditions continued east of the mountains 18-20th. Very mild in the mountains 18th but with increasing clouds. Snow developed overnight with some Western Slope rains and then spread southeastward 19-20th. Locally heavy snows were reported in the mountains and southeast foothills. Aspen received a foot of new snow. Eleven inches fell at the Great Sand Dunes National Monument, and about 8" of wet snow was reported at Trinidad. |
| 21-25 | Quite breezy with seasonal temperatures 21-22nd. Then warm statewide 23-25th for the only time this month as a high pressure ridge covered the Rocky Mountain region. Temperatures in the 50s and 60s were quite welcome (40s in the higher mountains). Denver hit the 70° mark on the 25th. The 83° reading at Las Animas was the warmest in the state for the month. |
| 26-28 | A much weaker cousin to the "Alaska Blaster" of early February moved down across the High Plains bringing much colder temperatures. A good surge of Pacific moisture came into the northern mountains on the 26th. Heavy snows were very localized, but Winter Park received 11" of snow and Mount Evans reported 13". While the month ended with pleasant weather in western Colorado, low clouds, fog, freezing drizzle and light snow covered much of the eastern half of the state. Up to 4" of snow fell over the northeast plains 27th-28th. |

## February 1989 Extremes

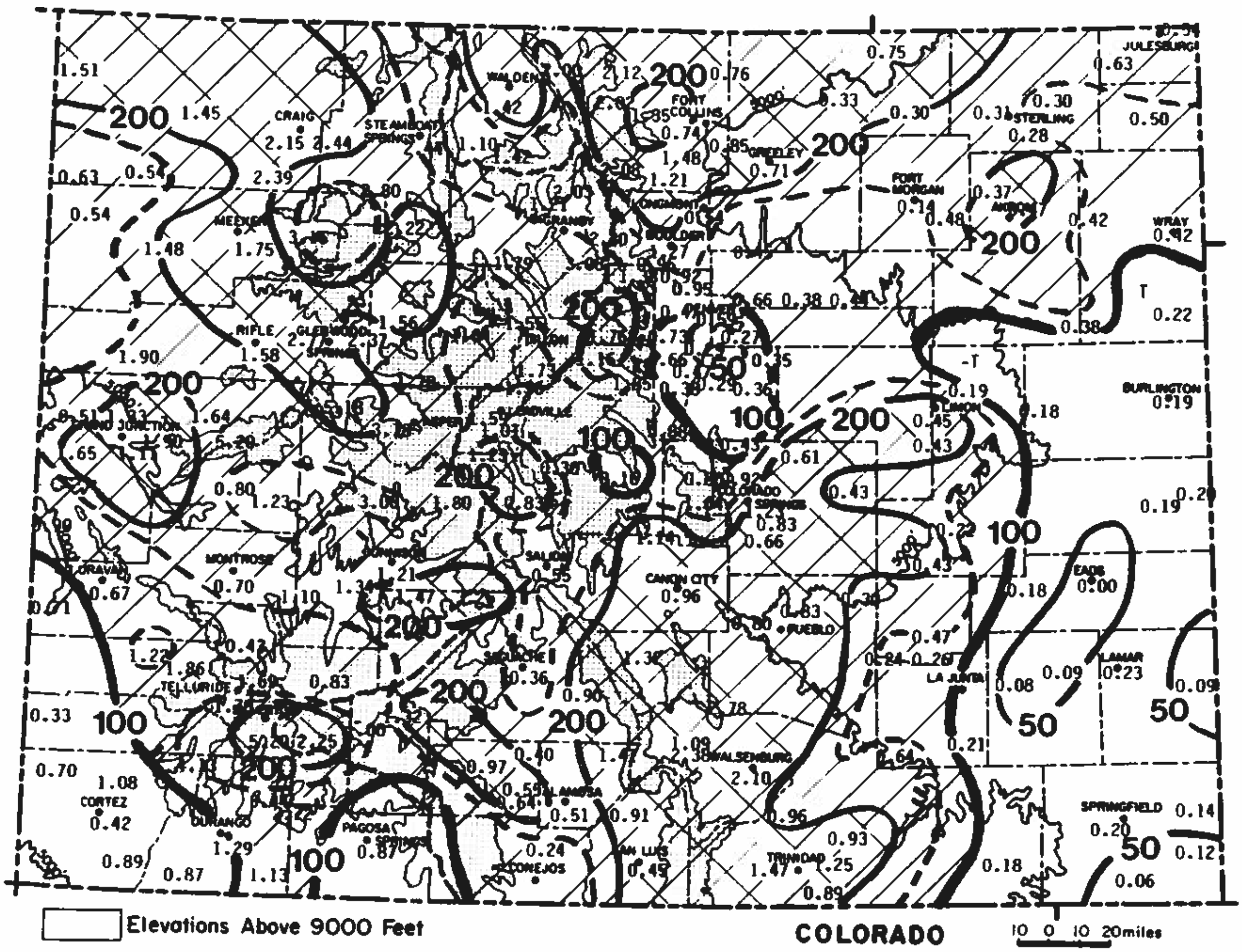
| | | | |
|---|---|---|---|
| Highest Temperature | 83°F | February 25 | Las Animas |
| Lowest Temperature | -51°F | February 7 | Antero Reservoir |
| Greatest Total Precipitation | 5.20" | | Silverton and Bonham Reservoir |
| Least Total Precipitation | Trace | | Eads, Idalia 5NNE and Shaw 2E |
| Greatest Total Snowfall* | 88" | | Wolf Creek Pass 1E |
| Greatest Snowdepth ** | 114" | | Tower, Upper San Juan |

*For existing weather stations with complete daily records. Higher values are likely for unmonitored locations.
**From Soil Conservation Service snowpack measurements.

# FEBRUARY 1989 PRECIPITATION

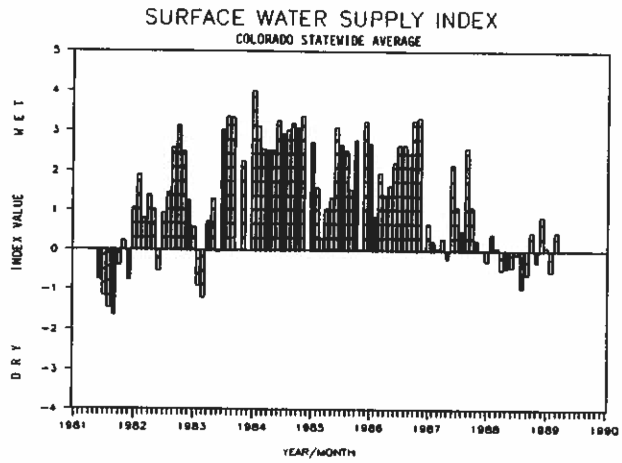
With the help of widespread heavy snows February 2-5th, most of Colorado ended up wetter than average for the month. Later storms on the 10-12th, 19-20th and 26-28th made lesser contributions. Several areas received more than double the average February precipitation. These wettest areas included portions of northwest Colorado, North Park, the Grand Junction area, parts of the upper Gunnison and Arkansas valleys, several areas in the San Juan Mountains and extensive areas along the Front Range from Wyoming to New Mexico. Close to 4 times the average precipitation was observed at Colorado Springs, Pueblo, Estes Park and at the Great Sand Dunes. Local dry spots were found from south Denver southward to Monument, in the lower elevations of southwest Colorado, and over much of the east-central and southeast plains. Many plains areas have now been well below average every month since September 1988.

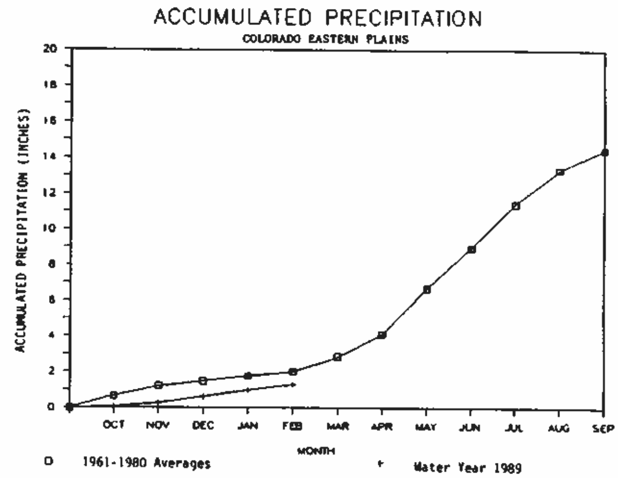
| Greatest | | Least | |
|---|---|---|---|
| Bonham Reservoir | 5.20" | Idalia 5NNE | Trace |
| Silverton | 5.20" | Shaw 2E | Trace |
| Redstone 4W | 5.18" | Campo 7S | 0.06" |
| Rico | 4.13" | Las Animas | 0.08" |
| Aspen 1SW | 3.78" | John Martin Dam, Holly | 0.09" |

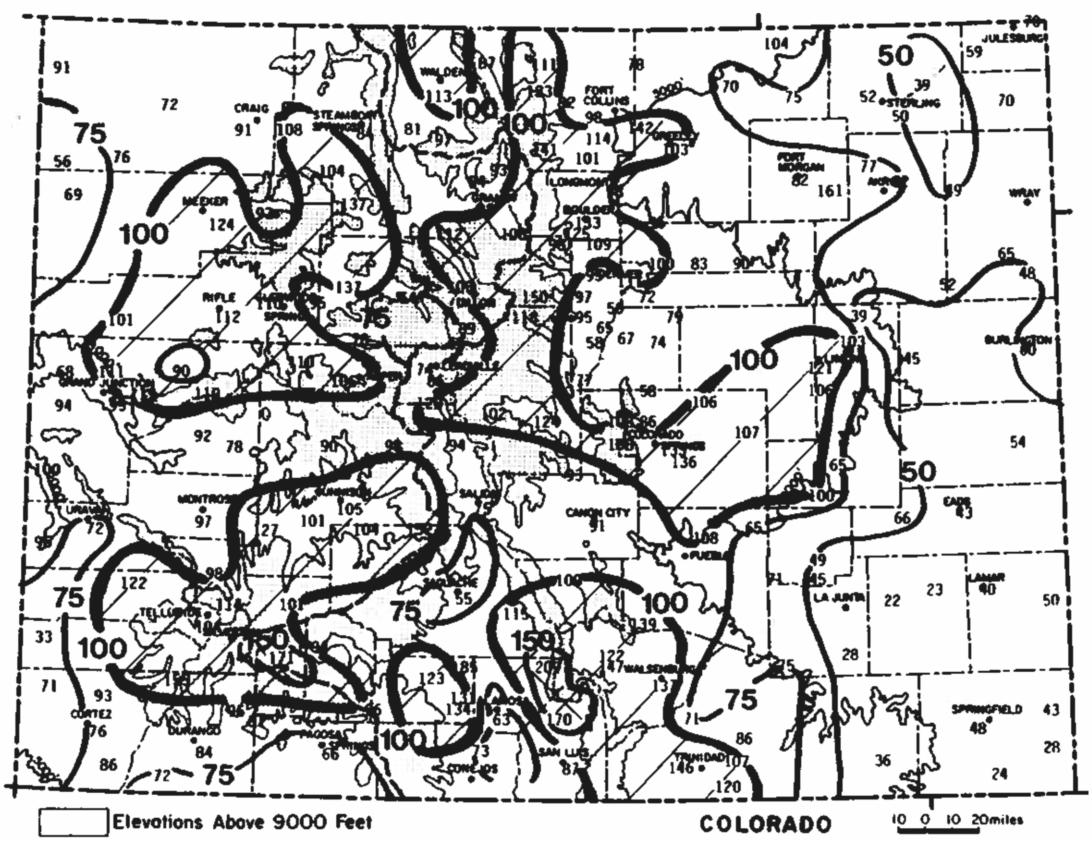



Precipitation amounts (inches) for February 1989 and contours of precipitation as a percent of the 1961-1980 average.
Dashed line is 150% of average.

The heavy snows of early February made a much-appreciated contribution to mountain snowpack and water-year precipitation totals. Most mountain areas are near or a little above average through the first 5 months of the 1989 water year. The wettest areas are found in the southwestern mountains. Rio Grande Reservoir has received 10.12" of moisture since October 1, 171% of average. Some dry areas remain in the northern and central mountains, in parts of the San Luis Valley and along the Utah border. With another dry month over portions of the plains, potential drought problems are emerging over eastern Colorado. Most of the eastern quarter of the state has received less than 60% of the average October-February precipitation. Less than 25% of average winter precipitation has fallen at John Martin Dam, Las Animas and Campo in southeast Colorado. Good spring moisture could quickly reverse this situation, but for now, this area bears close watching. Should the spring winds arrive before the spring rains/snows, there could be trouble.



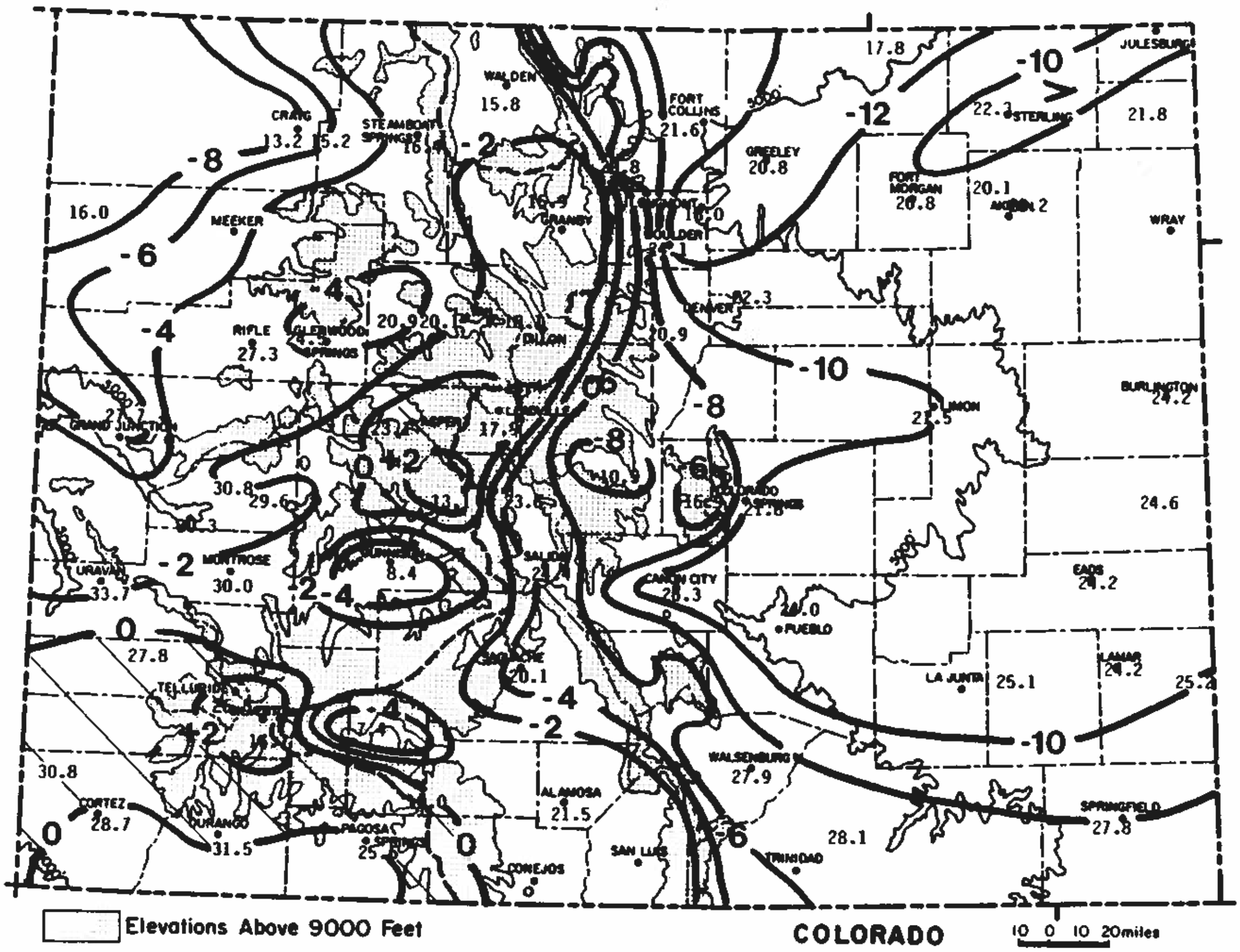




Precipitation for October 1988 through February 1989
as a percent of the 1961-1980 average.

## FEBRUARY 1989 TEMPERATURES AND DEGREE DAYS

It wasn't the coldest February on record, but it sure gave it a good shot. Those first few days of the month saw daily mean temperatures as much as 45 degrees below historic averages. Warmer temperatures later in the month failed to compensate for the early cold wave. Nearly all of eastern Colorado ended up at least 8 degrees Fahrenheit colder than average. Greeley and Longmont were each more than 13 degrees below their long-term averages. Many areas of northwestern Colorado were also considerably below average. The area of Colorado that escaped the cold was the southwest. Telluride and Silverton each were more than 2 degrees above average. A finger of milder temperatures (relative to average) extended northward along the Continental Divide all the way up to Granby which was just 0.2 degrees below average.




February 1989 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## FEBRUARY 1989 SOIL TEMPERATURES

The cold wave of early February came at the perfect time of the season to send frost deep into the ground. Fortunately, new snow helped insulate the ground in many parts of the state. Frost penetration of 2 feet was common along the Front Range in undisturbed areas, deeper than has been observed for a number of years. Deeper penetration was reported in northeast Colo.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.

FORT COLLINS 7 AM SOIL TEMPERATURES

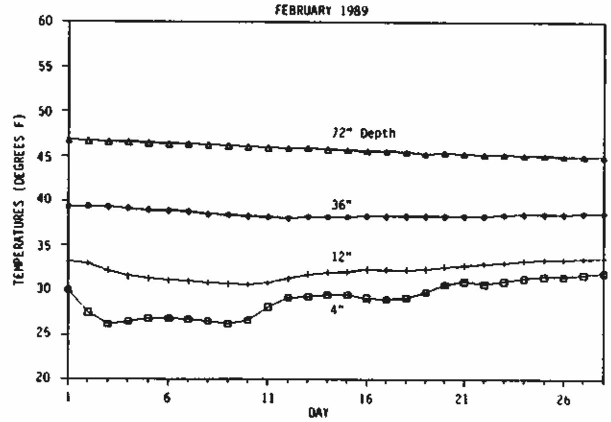


Table 1. Heating Degree Day Data through February 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 87-88 | 66 | 96 | 364 | 601 | 1130 | 1556 | 1867 | 1381 | 1031 | 658 | 454 | 102 | 9306 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | 1210 | | | | | 6249 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 87-88 | 112 | 152 | 355 | 563 | 1024 | 1382 | 1450 | 1146 | 1136 | 734 | 517 | 123 | 8694 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | 1171 | | | | | 6108 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 87-88 | 7 | 33 | 122 | 370 | 713 | 1053 | 1107 | 842 | 739 | 400 | 203 | 14 | 5603 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | 1139 | | | | | 4145 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 87-88 | 49 | 117 | 313 | 549 | 955 | 1277 | 1357 | 1010 | 1030 | 639 | 472 | 102 | 7870 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | 1153 | | | | | 5650 |
| BURLINGTON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 87-88 | 5 | 20 | 72 | 375 | 724 | 1037 | 1221 | 935 | 779 | 449 | 178 | 14 | 5809 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | 1135 | | | | | 4122 |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 87-88 | 11 | 36 | 87 | 374 | 668 | 1007 | 1144 | 858 | 767 | 407 | 191 | 16 | 5566 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | 1078 | | | | | 3939 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 87-88 | 17 | 74 | 150 | 445 | 767 | 1108 | 1256 | 958 | 886 | 499 | 273 | 25 | 6458 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | 1205 | | | | | 4596 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 87-88 | 6 | 35 | 154 | 396 | 860 | 1179 | 1351 | 1008 | 899 | 609 | 362 | 56 | 6915 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | 1008 | | | | | 4875 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 87-88 | 55 | 96 | 227 | 534 | 950 | 1376 | 1561 | 1264 | 1076 | 593 | 399 | 52 | 8183 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | 1443 | | | | | 6109 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 87-88 | 0 | 11 | 108 | 354 | 737 | 1102 | 1300 | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | 1327 | 964 | | | | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 87-88 | 11 | 21 | 110 | 410 | 745 | 1125 | 1227 | 889 | 811 | 437 | 215 | 14 | 6015 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | 1190 | | | | | 4394 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 87-88 | 296 | 346 | 556 | 763 | 1145 | 1491 | 1629 | 1376 | 1379 | 933 | 717 | 322 | 10953 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | 1307 | | | | | 7373 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 87-88 | 14 | 44 | 188 | 435 | 851 | 1206 | 1391 | 972 | 859 | 514 | 346 | 42 | 6862 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | 933 | | | | | 4842 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 87-88 | 54 | 75 | 254 | 509 | 950 | 1331 | 1544 | 1173 | 1002 | 607 | 404 | 52 | 7955 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | 1227 | | | | | 6035 |
| EVERGREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 87-88 | 69 | 118 | 333 | 602 | 922 | 1255 | 1310 | 1029 | 992 | 645 | 462 | 111 | 7848 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | 1227 | | | | | 5453 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 87-88 | 12 | 37 | 146 | 453 | 784 | 1140 | 1252 | 936 | 821 | 479 | 217 | 8 | 6285 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | 1207 | | | | | 4646 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 87-88 | 12 | 29 | 110 | 430 | 773 | 1154 | 1484 | 1055 | 826 | 495 | 206 | 17 | 6591 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | 1230 | | | | | 4846 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 87-88 | 0 | 6 | 34 | 248 | 754 | 1147 | 1469 | 1031 | 741 | 350 | 172 | 8 | 5960 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | 1037 | | | | | 4509 |
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 87-88 | 207 | 257 | 480 | 677 | 1098 | 1516 | 1642 | 1413 | 1372 | 907 | 602 | 238 | 10409 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | 1368 | | | | | 7185 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 87-88 | 10 | 26 | 119 | 424 | 762 | 1157 | 1363 | 955 | 807 | 437 | 204 | 6 | 6270 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | 1230 | | | | | 4640 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | 1698 | 2096 | 1578 | | | | | 7723 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 87-88 | 0 | 3 | 35 | 273 | 653 | 1032 | 1278 | 837 | 638 | 327 | 103 | 1 | 5180 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | 1109 | | | | | 3879 |
| LEADVILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 87-88 | 346 | 393 | 578 | 763 | 1180 | 1534 | 1577 | 1326 | 1355 | 957 | 741 | 360 | 11110 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | 1310 | | | | | 7542 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 87-88 | 21 | 66 | 158 | 502 | 840 | 1209 | 1354 | 1022 | 943 | 569 | 321 | 35 | 7040 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | 1211 | | | | | 4859 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 87-88 | 12 | 33 | 159 | 464 | 805 | 1169 | 1383 | 1035 | 847 | 509 | 222 | 20 | 6658 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | 1307 | | | | | 5212 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | M | M | | | | | M |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 87-88 | 5 | 30 | 129 | 349 | 849 | 1160 | 1332 | 1003 | 817 | 468 | 230 | 26 | 6398 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | 972 | | | | | 4706 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 87-88 | 104 | 105 | 347 | 523 | 947 | 1292 | 1548 | 1187 | 996 | 663 | 485 | 143 | 8340 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | 1095 | | | | | 5879 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 87-88 | 4 | 17 | 43 | 355 | 754 | 1111 | 1399 | 903 | 777 | 399 | 167 | 8 | 5937 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | 1141 | | | | | 4265 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 87-88 | 9 | 24 | 125 | 391 | 819 | 1209 | 1430 | 1039 | 865 | 454 | 268 | 14 | 6647 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | 1049 | | | | | 5048 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 87-88 | 77 | 127 | 330 | 590 | 1033 | 1448 | 1619 | 1336 | 1167 | 674 | 433 | 95 | 8929 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | 1355 | | | | | 6494 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 87-88 | 12 | 31 | 108 | 413 | 742 | E1140 | 1475 | 1029 | 831 | 476 | 197 | 12 | 6466 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | 1189 | | | | | 4528 |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 87-88 | 161 | 222 | 426 | 603 | 992 | 1269 | 1354 | 1109 | 1092 | 720 | 547 | 208 | 8703 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | 1071 | | | | | 6020 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 87-88 | 4 | 25 | 80 | 330 | 730 | 1054 | 1209 | 850 | 803 | 438 | 234 | 13 | 5770 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | 1026 | | | | | 3991 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 87-88 | 215 | 281 | 495 | 740 | 1242 | 1499 | 1572 | 1343 | 1340 | 835 | 638 | 184 | 10384 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | 1369 | | | | | 6998 |
| WALSENBURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 87-88 | 3 | 30 | 101 | 332 | 707 | 977 | 1109 | 826 | 773 | 401 | 238 | 25 | 5522 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | 1031 | | | | | 3887 |

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING    E = ESTIMATED

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING    E = ESTIMATED

# FEBRUARY 1989 CLIMATIC DATA

## Eastern Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| NEW RAYMER 21N | 28.7 | 6.9 | 17.8 | -12.8 | 65 | -26 | 1314 | 0 | 19 | 0.75 | 0.62 | 576.9 | 9 |
| STERLING | 35.1 | 9.5 | 22.3 | -8.6 | 66 | -18 | 1189 | 0 | 29 | 0.31 | 0.14 | 182.4 | 5 |
| FORT MORGAN | 32.9 | 8.8 | 20.8 | -10.1 | 69 | -18 | 1230 | 0 | 27 | 0.14 | 0.00 | 100.0 | 2 |
| AKRON FAA AP | 31.1 | 9.2 | 20.1 | -10.8 | 67 | -19 | 1246 | 0 | 22 | 0.37 | 0.19 | 205.6 | 4 |
| AKRON 4E | 32.7 | 7.7 | 20.2 | -9.0 | 70 | -22 | 1247 | 0 | 30 | 0.47 | 0.26 | 223.8 | 4 |
| HOLYOKE | 33.6 | 10.0 | 21.8 | -10.8 | 69 | -18 | 1204 | 0 | 39 | 0.50 | 0.16 | 147.1 | 5 |
| BURLINGTON | 37.0 | 11.3 | 24.2 | -10.4 | 74 | -18 | 1135 | 0 | 48 | 0.19 | -0.01 | 95.0 | 2 |
| LIMON WSMO | 33.8 | 9.2 | 21.5 | -9.6 | 70 | -19 | 1211 | 0 | 27 | 0.45 | 0.27 | 250.0 | 6 |
| CHEYENNE WELLS | 38.0 | 11.2 | 24.6 | -9.0 | 76 | -15 | 1125 | 0 | 38 | 0.19 | 0.03 | 118.7 | 2 |
| EADS | 36.4 | 12.0 | 24.2 | -10.5 | 77 | -13 | 1136 | 0 | 49 | 0.00 | -0.23 | 0.0 | 0 |
| LAMAR | 37.4 | 10.9 | 24.2 | -11.3 | 77 | -16 | 1134 | 0 | 36 | 0.23 | -0.06 | 79.3 | 4 |
| LAS ANIMAS | 38.4 | 11.9 | 25.1 | -11.2 | 83 | -17 | 1109 | 0 | 48 | 0.08 | -0.18 | 30.8 | 4 |
| HOLLY | 36.7 | 13.7 | 25.2 | -8.5 | 77 | -11 | 1107 | 0 | 32 | 0.09 | -0.17 | 34.6 | 3 |
| SPRINGFIELD 7WSW | 41.2 | 14.5 | 27.8 | -8.0 | 78 | -12 | 1032 | 0 | 58 | 0.20 | -0.13 | 60.6 | 4 |

## Foothills/Adjacent Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| FORT COLLINS | 32.8 | 10.3 | 21.6 | -10.9 | 66 | -19 | 1207 | 0 | 16 | 0.74 | 0.37 | 200.0 | 10 |
| GREELEY UNC | 31.6 | 10.0 | 20.8 | -13.0 | 68 | -20 | 1230 | 0 | 20 | 0.71 | 0.43 | 253.6 | 8 |
| ESTES PARK | 37.2 | 4.5 | 20.8 | -8.6 | 55 | -35 | 1229 | 0 | 9 | 2.08 | 1.70 | 547.4 | 3 |
| LONGMONT 2ESE | 32.5 | 3.6 | 18.0 | -13.9 | 65 | -28 | 1307 | 0 | 19 | 0.54 | 0.17 | 145.9 | 4 |
| BOULDER | 35.4 | 12.8 | 24.1 | -12.1 | 68 | -24 | 1139 | 0 | 29 | 1.27 | 0.63 | 198.4 | 10 |
| DENVER WSFO AP | 32.7 | 12.0 | 22.3 | -11.4 | 70 | -24 | 1190 | 0 | 24 | 0.66 | 0.08 | 113.8 | 11 |
| EVERGREEN | 36.6 | 5.3 | 20.9 | -8.1 | 65 | -27 | 1227 | 0 | 24 | 0.73 | -0.03 | 96.1 | 7 |
| LAKE GEORGE 8SW | 27.9 | -6.8 | 10.5 | -9.2 | 50 | -42 | 1519 | 0 | 0 | 0.16 | -0.15 | 51.6 | 4 |
| RUXTON PARK | 30.5 | 3.4 | 16.9 | -5.1 | 52 | -31 | 1340 | 0 | 2 | 1.04 | 0.15 | 116.9 | 8 |
| COLORADO SPRINGS | 31.7 | 11.8 | 21.8 | -10.7 | 69 | -17 | 1205 | 0 | 21 | 1.23 | 0.93 | 410.0 | 13 |
| CANON CITY 2SE | 38.5 | 14.0 | 26.3 | -10.9 | 75 | -16 | 1078 | 0 | 49 | 0.96 | 0.54 | 228.6 | 6 |
| PUEBLO WSO AP | 36.6 | 11.4 | 24.0 | -11.4 | 76 | -24 | 1141 | 0 | 40 | 0.83 | 0.58 | 332.0 | 6 |
| WALSENBURG | 41.3 | 14.4 | 27.9 | -7.6 | 69 | -17 | 1031 | 0 | 43 | 2.10 | 1.28 | 256.1 | 7 |
| TRINIDAD FAA AP | 43.8 | 12.5 | 28.1 | -6.9 | 71 | -17 | 1026 | 0 | 59 | 0.93 | 0.52 | 226.8 | 6 |

## Mountains/Interior Valleys

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| WALDEN | 28.7 | 3.0 | 15.8 | -2.6 | 48 | -47 | 1369 | 0 | 0 | 1.42 | 0.96 | 308.7 | 8 |
| LEADVILLE 2SW | 32.3 | 3.6 | 17.9 | 1.4 | 48 | -31 | 1310 | 0 | 0 | 1.01 | 0.01 | 101.0 | 12 |
| SALIDA | 37.7 | 11.1 | 24.4 | -5.8 | 64 | -33 | 1130 | 0 | 21 | 0.55 | -0.09 | 85.9 | 6 |
| BUENA VISTA | 37.6 | 9.5 | 23.6 | -5.1 | 58 | -23 | 1153 | 0 | 12 | 0.83 | 0.48 | 237.1 | 5 |
| SAGUACHE | 33.8 | 6.5 | 20.1 | -4.8 | 54 | -20 | 1250 | 0 | 2 | 0.36 | 0.10 | 138.5 | 3 |
| HERMIT 7ESE | 23.3 | -8.6 | 7.4 | -7.1 | 32 | -38 | 1606 | 0 | 0 | 1.00 | 0.28 | 138.9 | 2 |
| ALAMOSA WSO AP | 38.8 | 4.2 | 21.5 | -0.9 | 61 | -30 | 1210 | 0 | 16 | 0.28 | -0.02 | 93.3 | 4 |
| STEAMBOAT SPRINGS | 29.2 | 3.5 | 16.4 | -3.1 | 54 | -42 | 1355 | 0 | 2 | 2.44 | 0.40 | 119.6 | 11 |
| GRAND LAKE 6SSW | 28.9 | 2.9 | 15.9 | -0.2 | 52 | -41 | 1368 | 0 | 1 | 1.21 | 0.40 | 149.4 | 11 |
| DILLON 1E | 33.4 | 2.8 | 18.1 | -0.4 | 52 | -31 | 1307 | 0 | 1 | 1.55 | 0.66 | 174.2 | 10 |
| AVON | 34.0 | 6.3 | 20.1 | -2.4 | 52 | -30 | 1250 | 0 | 1 | 1.85 | 0.65 | 154.2 | 10 |
| CLIMAX | 29.2 | -0.5 | 14.4 | -0.5 | 53 | -28 | 1410 | 0 | 2 | 1.56 | -0.28 | 84.8 | 10 |
| ASPEN 1SW | 37.4 | 8.9 | 23.1 | 0.4 | 60 | -25 | 1171 | 0 | 8 | 3.78 | 1.68 | 180.0 | 12 |
| TAYLOR PARK | 30.4 | -4.3 | 13.1 | 7.1 | 48 | -47 | 1446 | 0 | 0 | 1.80 | 0.74 | 169.8 | 5 |
| TELLURIDE | 39.4 | 13.6 | 26.5 | 2.5 | 57 | -17 | 1071 | 0 | 6 | 1.78 | 0.31 | 121.1 | 7 |
| PAGOSA SPRINGS | 42.9 | 8.4 | 25.6 | -0.1 | 62 | -26 | 1095 | 0 | 19 | 0.87 | -0.47 | 64.9 | 6 |
| SILVERTON | 36.1 | -2.7 | 16.7 | 2.8 | 55 | -38 | 1344 | 0 | 6 | 5.20 | 3.61 | 327.0 | 14 |
| WOLF CREEK PASS 1 | 32.7 | 5.4 | 19.0 | 0.9 | 48 | -17 | 1281 | 0 | 0 | 3.21 | -0.70 | 82.1 | 10 |

## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 23.6 | 2.7 | 13.2 | -8.7 | 49 | -41 | 1443 | 0 | 0 | 2.15 | 0.95 | 179.2 | 14 |
| HAYDEN | 25.7 | 4.6 | 15.2 | -6.5 | 46 | -44 | 1390 | 0 | 0 | 2.44 | 1.29 | 212.2 | 14 |
| RANGELY 1E | 28.1 | 3.9 | 16.0 | -8.3 | 47 | -30 | 1364 | 0 | 0 | 0.54 | 0.05 | 110.2 | 5 |
| EAGLE FAA AP | 34.1 | 7.8 | 20.9 | -4.0 | 52 | -35 | 1227 | 0 | 1 | 1.56 | 0.96 | 260.0 | 11 |
| GLENWOOD SPRINGS | 37.3 | 11.8 | 24.5 | -5.3 | 60 | -24 | 1127 | 0 | 10 | 2.77 | 1.64 | 245.1 | 11 |
| RIFLE | 41.0 | 13.7 | 27.3 | -2.4 | 58 | -32 | 1049 | 0 | 16 | 1.58 | 0.83 | 210.7 | 9 |
| GRAND JUNCTION WS | 37.6 | 17.7 | 27.7 | -6.3 | 56 | -18 | 1037 | 0 | 11 | 1.33 | 0.86 | 283.0 | 6 |
| CEDAREDGE | 44.3 | 17.2 | 30.8 | -1.4 | 64 | -20 | 952 | 0 | 31 | 0.80 | -0.02 | 97.6 | 10 |
| PAONIA 1SW | 42.1 | 17.0 | 29.6 | -2.3 | 65 | -17 | 984 | 0 | 27 | 1.23 | 0.15 | 113.9 | 10 |
| DELTA | 43.5 | 17.1 | 30.3 | -3.3 | 70 | -8 | 964 | 0 | 42 | 0.00 | -0.41 | 0.0 | 0 |
| GUNNISON | 23.7 | -6.9 | 8.4 | -5.4 | 43 | -38 | 1578 | 0 | 0 | 1.21 | 0.55 | 183.3 | 7 |
| MONTROSE NO. 2 | 41.9 | 18.1 | 30.0 | -1.5 | 68 | -14 | 972 | 0 | 27 | 0.70 | 0.29 | 170.7 | 5 |
| URAVAN | 47.5 | 19.9 | 33.7 | -2.1 | 70 | -10 | 871 | 0 | 53 | 0.67 | 0.11 | 119.6 | 9 |
| NORWOOD | 40.2 | 15.5 | 27.8 | 0.2 | 68 | -27 | 1032 | 0 | 17 | 1.22 | 0.52 | 174.3 | 4 |
| YELLOW JACKET 2W | 42.9 | 18.7 | 30.8 | 1.5 | 60 | -20 | 950 | 0 | 21 | 0.70 | -0.41 | 63.1 | 7 |
| CORTEZ | 42.8 | 14.6 | 28.7 | -1.8 | 64 | -22 | 1008 | 0 | 28 | 0.42 | -0.51 | 45.2 | 3 |
| DURANGO | 44.6 | 18.5 | 31.5 | 0.6 | 65 | -10 | 933 | 0 | 32 | 1.29 | -0.09 | 93.5 | 8 |

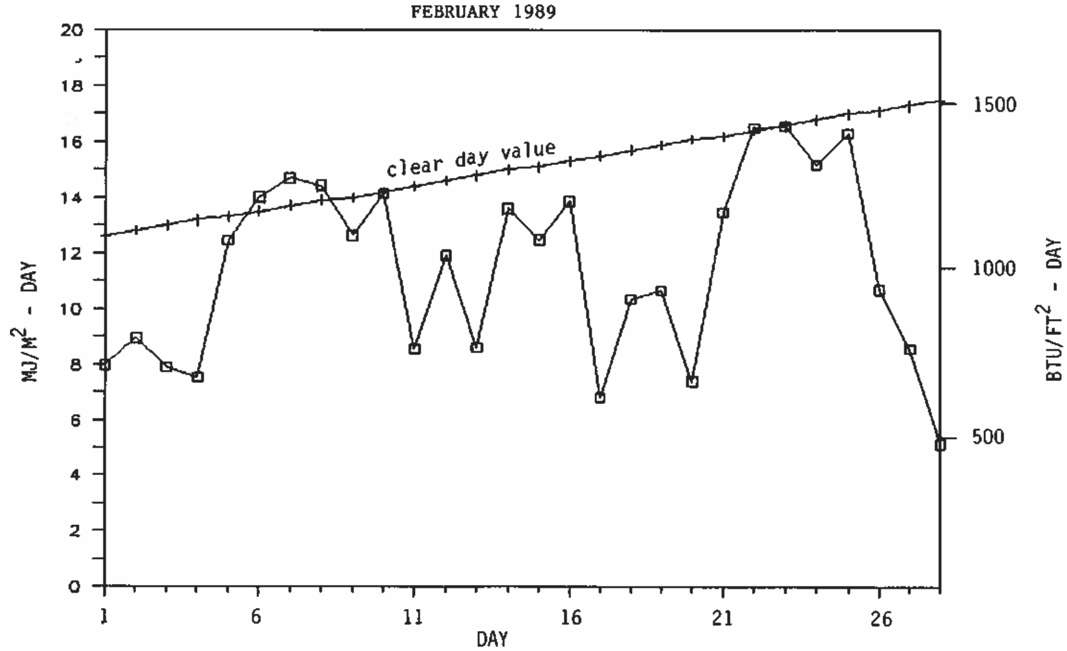
* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## FEBRUARY 1989 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 8 | 7 | 13 | -- | -- |
| Denver | 8 | 5 | 15 | 55% | 71% |
| Fort Collins | 5 | 11 | 12 | -- | -- |
| Grand Junction | 7 | 9 | 12 | 71% | 64% |
| Pueblo | 7 | 8 | 13 | 63% | 74% |

FT. COLLINS TOTAL HEMISPHERIC RADIATION

FEBRUARY 1989



The "ALASKA BLASTER" -- A Week of Weather Worth Remembering: continued

business brochures bragging about the balmy banana belt climate that makes life in Colorado so wonderful (or so I've heard). Afterall, January temperatures were much above average east of the mountains. For example, Denver temperatures climbed above 50°F on more than half of the days during the month. Colorado Springs hit 70°F on the January 31. It had been a very pleasant winter -- until February arrived.

It only took a few hours for the warmth of January to surrender to the invasion of the "Alaska Blaster." Much of eastern Colorado found daytime temperatures on February 1 to be 50 to 60 degrees colder than the previous day. And that was only the beginning. Before the arctic airmass finally began to retreat, the entire state was engulfed by sub-zero cold, and many areas were also buried by deep snow. The artic encroachment created some cruel contrasts. On February 1 temperatures in Denver were only in the teens -- but just a few hundred feet above the Red Rocks amphitheater it was in the 40s. The contrast became even greater on the 2nd and 3rd as howling westerly winds aloft pushed warm, moist Pacific air into the mountains and up and over the frigid air near the ground. The high temperature during the day on the 3rd in Fort Collins was a disgusting -11°F. Meanwhile, Gunnison was in the 30s and up at Climax (11,350 ft above sea level) it reached a torrid 46°F.

While the cold air blasted across the Eastern Plains, it only leaked into the western valleys. As it did, remarkably heavy snows developed. The cold filled the Yampa Valley late on the 2nd, then spilled into the White River Valley early on the 3rd. Areas near Craig picked up a quick 2 feet of snow in the process. Then late on the 3rd, the storm spread into the central and southern mountains dropping up to 3 feet of snow in some areas. Another burst of heavy snow and blizzard winds swept across parts of the state late on the 4th. Residents of Walden, very familiar with adverse winter weather, experienced extreme cold combined with heavy snow and winds gusting to nearly 40 mph. A common remark was, "worst blizzard we've ever seen." This final surge pulled the cold air over the entire state by the morning of the 5th but marked the end of the really heavy snows. The coldest temperatures then shifted from the eastern plains up into the mountains and western valleys. People in the northern mountains woke to temperatures below -30° on the 6th. The Spicer weather station southwest of Walden recorded -50°F. The coldest temperatures shifted farther south on the 7th. Alamosa reported -30°, Silverton had -38°, and Antero Reservoir had a nippy -51°. Even the Western Slope suffered from this cold wave. Grand Junction had 4 consecutive nights with temperatures below -10° including -18° on the 6th. It appears to rank as the third coldest episode this century in western Colorado behind similar cold periods in February 1933 and January 1963.

There were many and varied impacts from this cold blast. Auto mechanics did a booming business keeping cars operative. Human frostbite cases increased. Livestock and wildlife suffered (although no firm statistics are available yet to assess loss of life). Travel came to a complete halt over parts of the state on the 4th, and the men's World Cup downhill ski event at Vail was postponed. All-time record natural gas consumption and very high electricity usage were noted in many areas. Power outages occurred as some transmission lines failed. Plumbing problems caused literally millions of dollars of damage. Western Slope fruit orchards sustained severe damage that may be longer lasting than just this coming growing season.

As always during severe weather, there was a spectacular bright side to this frigid story. There were countless examples of human generosity and goodwill as people pulled together to survive the elements. It almost makes you wish the arctic siege wouldn't have ended so quickly.

FEBRUARY 2-7, 1989 "ALASKA BLASTER" STORM HIGHLIGHTS FOR SELECTED COLORADO LOCATIONS.

| | Coldest Temp. | | | | Coldest Temp. | | |
|---|---|---|---|---|---|---|---|
| Location | Daily Maximum | Daily Minimum | Snowfall (inches) | Location | Daily Maximum | Daily Minimum | Snowfall (inches) |
| Alamosa | 10°F | -30°F | 3" | Gunnison | -10°F | -38°F | 12" |
| Antero Resvr | -6 | -51 | 10" | Hayden | -12 | -44 | 25" |
| Aspen | 8 | -25 | 24" | Lamar | 4 | -16 | 5" |
| Boulder | -12 | -24 | 11" | Leadville | 5 | -31 | 17" |
| Burlington | -8 | -18 | 1" | Pueblo | -1 | -24 | 11" |
| Colo. Springs | -9 | -17 | 15" | Red Feather | -14 | -34 | 33" |
| Cortez | 11 | -22 | 5" | Rifle | 8 | -32 | 22" |
| Craig 4SW | -14 | -41 | 21" | Rocky Ford | -1 | -20 | 4" |
| Crested Butte | 5 | -42 | 31" | Salida | -9 | -33 | 12" |
| Denver | -9 | -24 | 4" | Silverton | 13 | -38 | 48" |
| Dillon | 3 | -31 | 17" | Steamboat | -7 | -42 | 11" |
| Durango | 19 | -10 | 14" | Sterling | -8 | -18 | 8" |
| Estes Park | -15 | -35 | 30" | Trinidad | -6 | -15 | 10" |
| Fort Collins | -10 | -19 | 13" | Vail | -1 | -30 | 17" |
| Glenwood Spr. | -11 | -24 | 23" | Walden | -9 | -47 | 17" |
| Grand Junct | 6 | -18 | 11" | Westcliffe | -6 | -33 | 25" |
| Greeley | -10 | -20 | 5" | Wolf Creek Pass | 20 | -17 | 60" |

# Photovoltaics

When people think of solar energy and how it is used, a common image may be the flat plate collectors seen on rooftops or large south-facing windows for passive solar gain. However, there is another way in which the sun's energy is used which may be less well known. Solar cells, also called photovoltaics (PV's), are used to create electricity directly from the sun's radiation. It is not a new idea; solar cells have been researched for the past 30 years. While they are still more expensive to use than buying your electricity from the electric company, in places where the public utility does not run power lines, photovoltaics can prove to be more economical.

A short review on electricity is probably helpful before talking more about PV's. An often made comparison is that between electricity and water in a pipe. With water, current refers to the flow rates in gallons per minute, cubic feet per second or something similar. With electricity, current refers to a number of electrons passing through a conductor per time period. As water flows through a pipe, it can have varied pressure. If you had two garden hoses with the same flow rate but different pressure, the one with the higher pressure would squirt farther. This pressure is similar to the voltage in an electrical system. If you had two electrical wires with equal current, the one with higher voltage would be able to run more powerful machines.

A PV cell is made up of silicon that is divided into two layers where each layer is impregnated with different elements. The two layers differ by the charge within. (See figure 1.) Sunlight is made up of tiny bits of energy called photons. When a photon hits the cell, it provides energy to move the charges within the silicon. This sets up a direct current. To be useful, the electricity obtained from the solar cells must be of a current and voltage that your machines can use. One solar cell by itself usually does not provide this power. Many solar cells must be arranged into a parallel and series arrangement which then provides the useful current and voltage. This electricity can be stored in batteries for later use, used right away or sold to the public utility if the system is hooked up to a grid.

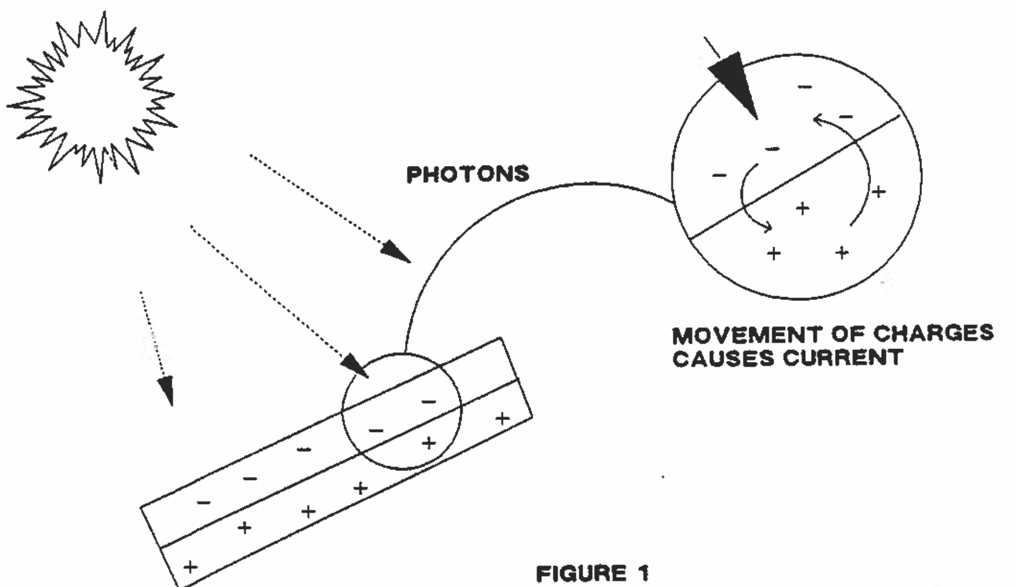



**FIGURE 1**
**SINGLE SOLAR CELL**

The solar cell system is made up of various components.(See figure 2.) Batteries have been mentioned as a storage device. The current obtained from the PV array is a direct current(DC). Since most of the devices in the home run on an alternating current (AC), the electricity needs to be changed by an invertor from DC to AC current. The output of the current is proportional to the intensity of the sun's radiation while the voltage is relatively independent of the intensity. However, the voltage is sensitive to the changing temperature of the solar cell itself and tends to decrease as the temperature rises. This is different from a thermal solar system in that this system can actually provide higher efficiency at a lower ambient temperature!

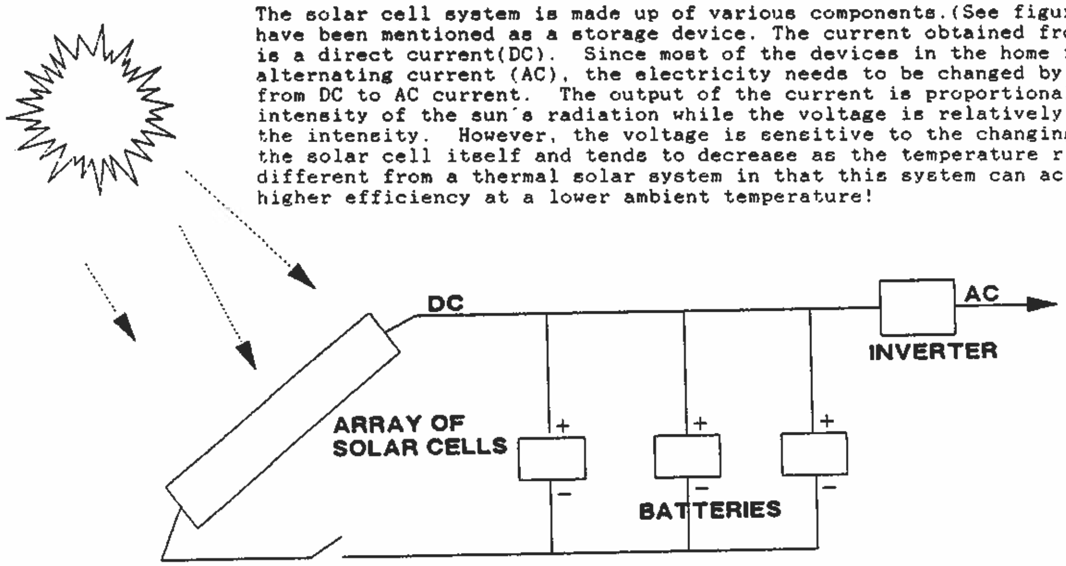
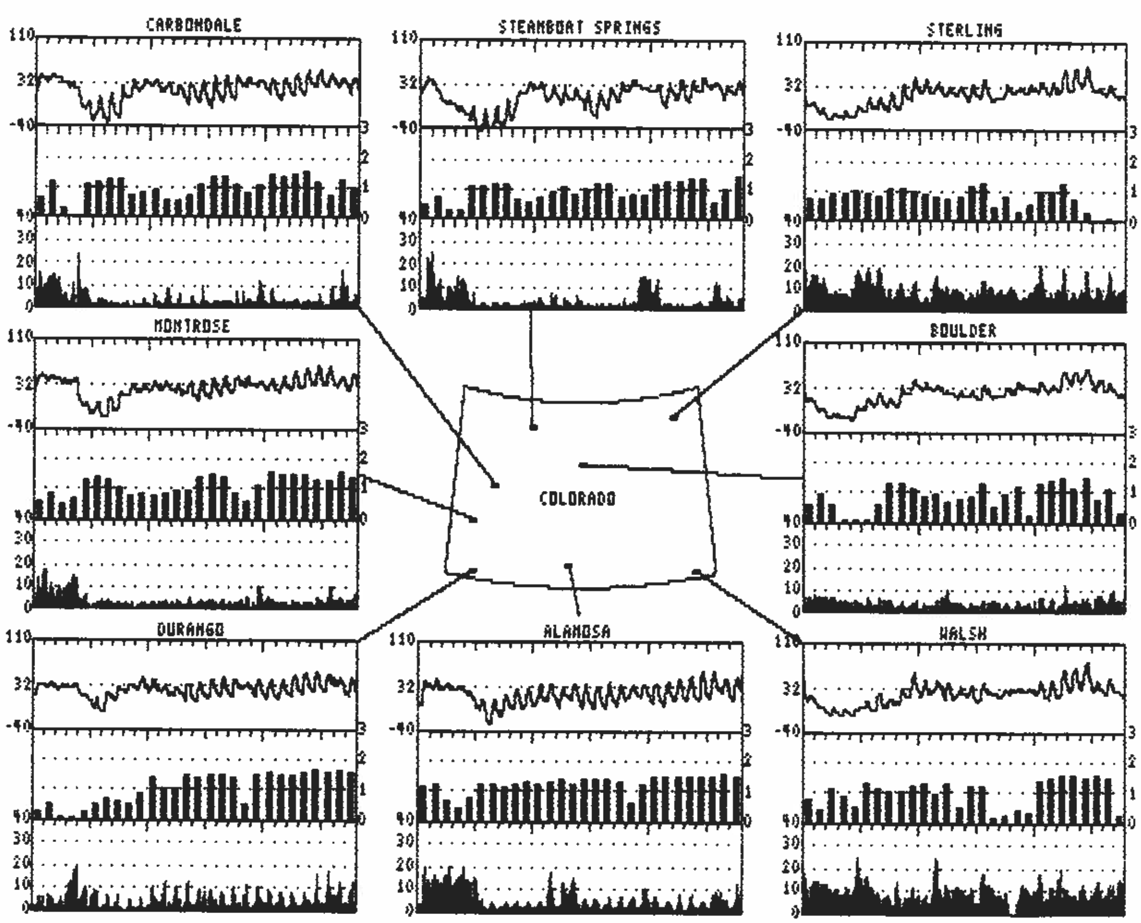



**FIGURE 2**
**PHOTOVOLTAIC SYSTEM**

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh | Boulder |
|---|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | 21.5 | 27.4 | 23.0 | 28.2 | 12.7 | 19.1 | 24.7 | 22.7 |
| **monthly temperature extremes and time of occurence ( °F day/hour )** | | | | | | | | |
| maximum: | 59.5 25/16 | 57.6 25/14 | 54.7 24/16 | 65.7 25/14 | 47.8 25/15 | 66.9 25/14 | 77.5 25/16 | 65.1 25/14 |
| minimum: | -29.2 7/ 7 | -12.3 6/23 | -31.4 7/ 7 | -20.7 7/ 6 | -44.3 6/ 7 | -20.4 3/ 5 | -11.4 3/ 8 | -20.2 5/ 7 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | | |
| 5 AM | 88 / 7 | 83 / 14 | 86 / 10 | 83 / 16 | 84 / 2 | 80 / 7 | 82 / 13 | 73 / 10 |
| 11 AM | 56 / 14 | 56 / 19 | 57 / 15 | 60 / 20 | 68 / 8 | 65 / 12 | 62 / 16 | 55 / 9 |
| 2 PM | 43 / 15 | 53 / 20 | 46 / 15 | 49 / 19 | 54 / 10 | 55 / 13 | 53 / 16 | 52 / 10 |
| 5 PM | 45 / 13 | 52 / 19 | 50 / 15 | 51 / 19 | 60 / 9 | 55 / 11 | 54 / 15 | 53 / 10 |
| 11 PM | 78 / 11 | 77 / 18 | 80 / 14 | 80 / 18 | 83 / 6 | 74 / 9 | 69 / 12 | 63 / 9 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | | |
| day | 209 | 203 | 218 | 231 | 193 | 203 | 147 | 88 |
| night | 195 | 85 | 190 | 166 | 162 | 190 | 186 | 158 |
| **monthly average wind speed ( miles per hour )** | 4.63 | 3.35 | 3.24 | 2.97 | 3.29 | 8.54 | 8.26 | 3.39 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | | |
| 0 to 3 | 336 | 408 | 456 | 454 | 471 | 6 | 29 | 305 |
| 3 to 12 | 261 | 248 | 185 | 202 | 169 | 560 | 521 | 367 |
| 12 to 24 | 75 | 16 | 22 | 16 | 31 | 106 | 104 | 0 |
| > 24 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| **monthly average daily total insolation ( Btu/ft²·day )** | 1234 | 1049 | 1008 | 1095 | 946 | 793 | 987 | 844 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | | |
| 60-80% | 183 | 97 | 100 | 121 | 103 | 86 | 123 | 83 |
| 40-60% | 59 | 43 | 71 | 74 | 74 | 80 | 52 | 68 |
| 20-40% | 37 | 49 | 63 | 69 | 72 | 49 | 43 | 48 |
| 0-20% | 8 | 76 | 40 | 19 | 37 | 33 | 64 | 77 |

## The State-Wide Picture

The figure below shows monthly weather at WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40°F to 110°F, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 Btu/ft²/day, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour.



# COLORADO CLIMATE

## MARCH 1989

Colorado Climate Center
Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado 80523

*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 6

March in Review:

The deep freeze of February was quickly forgotten (except where damage to vegetation was severe) as unseasonably mild temperatures covered most of Colorado in March. There were a few strong storms with rapid temperature changes and strong winds typical of March. But for the most part the weather was relatively placid. Precipitation was well below average statewide with the exception of a few areas in the mountains.

Colorado's May Climate:

Energetic springtime weather continues in May and often impacts human activities. For example, the severe weather season is upon us. Although most of Colorado's worst tornadoes and hailstorms come a little later, May still accounts for about 20% of the year's significant hailstorms and 25% of the year's tornadoes. The flood season is also here. Warming temperatures bring high water to many Colorado rivers and streams. Currently, the likelihood of snowmelt flooding this year seems quite low, but unusually heavy May rains can change that forecast in a big hurry. There is also the threat of drought to contend with. May precipitation is extremely important to dryland agriculture in this state. Last year, a single storm system dropped up to 4" of soaking rains to parts of eastern Colorado and rescued the wheat crop. May moisture is more reliable than other months across the plains -- but when the moisture fails, look out. Of the 10 driest growing seasons on record at selected eastern plains locations, more than 50% were characterized by having less than half of the average May rainfall.

Most May precipitation falls as rain at elevations below 6500 feet. But mountain snows are still common and sometimes sneak down to lower elevations. May precipitation typically ranges from 0.50-1.00" on the Western Slope to 2-4" in the northern mountains and across the northeast quarter of the state. From Denver northward to Wyoming and east to Nebraska, May is frequently the wettest and cloudiest month of the year. At the same time, precipitation is normally on the decline over the opposite corner of the state. The San Juan mountains average only 1-2" of precipitation for the month.

May temperatures are pretty reasonable. You still find temperatures in the higher mountains lingering in the chilly 40s during the day and 20s at night. Elsewhere, conditions are much more tolerable. 70s in the day and 40s at night are most common over lower elevation zones. During heatwaves, 80s are likely with even some 90s. These are balanced by a handful of cloudy, damp days where the temperatures stay in the 40s and 50s. Despite warm daytime temperatures, frosts in May are still possible in most parts of the state. (Up to date frost and growing season probabilities are contained in a new Colorado Climate Center report. See the order blank attached to the February 1989 Colorado Climate report.)

What in the World are Growing Degree Days?

Each month since November 1984 we have been publishing tables of monthly climatic data for many locations in Colorado in this publication. One set of columns is labelled "Degree Days." More than likely you either know exactly what these numbers are or else you could care less. Utilities, heating and cooling engineers, architects, and energy conservation specialists are all very familiar with heating and cooling degree days. These are simple accumulations of outdoor temperature that equate quite nicely to the amount of energy required to heat or cool buildings to specified indoor temperatures. The larger the number of degree days, the more energy is required for heating or cooling. The 3rd column, labelled "GROW" is perhaps a bit more obscure, but it is very important to Colorado agriculture.

(continued on page -9-)

# MARCH 1989 DAILY WEATHER

| Date | Event |
|---|---|
| 1-5 | A weaker cousin to the "Alaska Blaster" of early February visited Colorado. On the 1st and 2nd a shallow layer of very cold air, with some light snow and freezing drizzle, lay across portions of eastern Colorado. Meanwhile, other areas, especially the southern Front Range, were quite warm. Colorado Springs reached 60° on the 2nd and Castle Rock hit 59° while Denver only made it to 36°. A very deep low pressure area then formed 2nd-3rd over the Great Basin and dropped south of Colorado by the 4th. Widespread snow with low elevation rain fell over the mountains and Western Slope on the 3rd while extremely cold temperatures and a little light snow gripped eastern Colorado. Aspen received 18" of new snow. comparable amounts fell over much of the San Juan Mountains. High temperatures were only in the single digits on the northeast plains on the 3rd. Akron and Holyoke only rose to +3°F. Skies began to clear on the 4th but some snows continued in the south. Very cold nighttime temperatures were observed statewide early on the 5th. Springfield had a -3° reading and Julesburg dropped to -13°. The -32° reading at Taylor Park Reservoir was by far the coldest in the state for the month. |
| 6-13 | A rapid transition to very warm weather occurred as a massive ridge of high pressure developed and remained stationary over the southern Rockies. Except for a band of rainshowers that crossed the mountains on the 7th, the remainder of the period was completely dry statewide. Middle and high level clouds were present throughout the week, especially in northern Colorado. Daytime temperatures soared into the 70s 8-13th at many low elevation stations east and west of the mountains. Delta hit 82°. Many new daily record temperatures were set on the 10th. 80s were common in southeast Colorado. Campo's 94° reading on the 11th was the warmest in the state. 60s were found as high as 9,000 feet, and some early snowmelt began. On the 11-13th there were also excellent displays of aurora borealis visible from most areas of the state. |
| 14-17 | A deep low pressure area passed northeast of Colorado on the 14th and caused locally damaging winds and blowing dust over eastern Colorado. Chilly temperatures accompanied the winds and a little snow fell in the mountains. Continued breezy but warmer 15-16th. On the 17h a disturbance in the jet stream raced directly across the state and created another round of very strong winds with blowing dust over the plains. |
| 18-21 | Clouds increased from the west on the 18th as a new storm began developing northwest of Colorado. Mountain snows with some low elevation rain developed on the 19th and spilled over the mountains late in the day. Rains changed to snow overnight east of the mountains. Strong winds and very cold temperatures created problems, and some NE Colorado schools were closed on the 20th. Overall, precipitation from the storm was fairly light. Some of the larger totals included 0.51" at Rangely, 0.54" at Ouray (6" snow) and 0.48" at Boulder (6.5" snow). Chilly morning temperatures were observed on the 21st as skies cleared. Lamar fell to 5° that morning. |
| 22-25 | Partly cloudy and dry with pleasantly mild springtime temperatures. A few gusty sprinkles on the 23rd as a very weak disturbance crossed the state. |
| 26-28 | A weak storm passed south of Colorado. Some thunderstorms and mountain snows 26-27th over southern counties. Cortez picked up 0.32" of rain. |
| 29-31 | A cold front swept across the state on the 29th leaving cool, moist unstable air over the state. Convective snow showers erupted over and near the mountains 29-30th and an area of cold but much appreciated rain moved across SE Colorado on the 29th. Lamar received 0.44" of rain while close to a foot of snow fell over portions of the northern and central mountains. Breckenridge reported 10.5" of wet snow (1.02" of water equivalent). Partly cloudy with seasonal temperatures on the 31st. |

## March 1989 Extremes

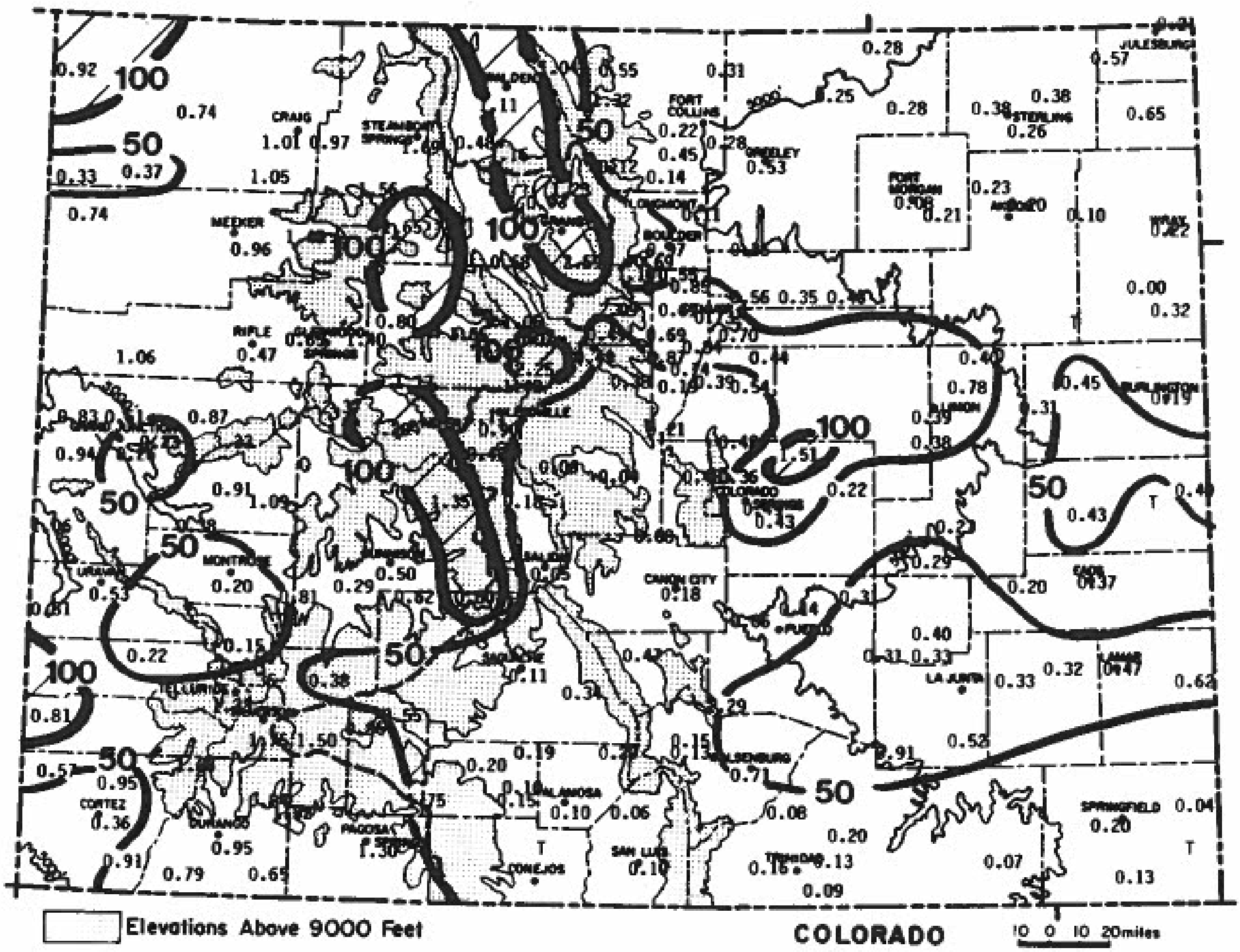
| | | | |
|---|---|---|---|
| Highest Temperature | 94°F | March 11 | Campo 7S |
| Lowest Temperature | -32°F | March 5 | Taylor Park Reservoir |
| Greatest Total Precipitation | 3.33" | | Bonham Reservoir |
| Least Total Precipitation | 0.00" | | Idalia 5NNE |
| Greatest Total Snowfall* | 35" | | Aspen 1SW |
| Greatest Snowdepth ** | 114" | | Tower (Buffalo Pass) |

*For existing weather stations with complete daily records.
Higher values are likely for unmonitored locations.
**From Soil Conservation Service snowpack measurements.

## MARCH 1989 PRECIPITATION

Major snowstorms were few in number in March. As a result, most of the state ended up drier than average. Many areas, especially east of the mountains, received less than half of their average March moisture. There were 35 weather stations east of the Continental Divide that reported less than 25% of average, and 5 stations indicated no measurable precipitation for the entire month. Moisture conditions were a little better in western Colorado. A few mountain locations were slightly wetter than average, including a strip from Walden to Winter Park, the Breckenridge area, and another narrow strip from Yampa southward to Aspen and on to Sargents (near Monarch Pass). While March has a reputation for wet weather, Colorado has not had a really wet March statewide since 1983 and 1984.

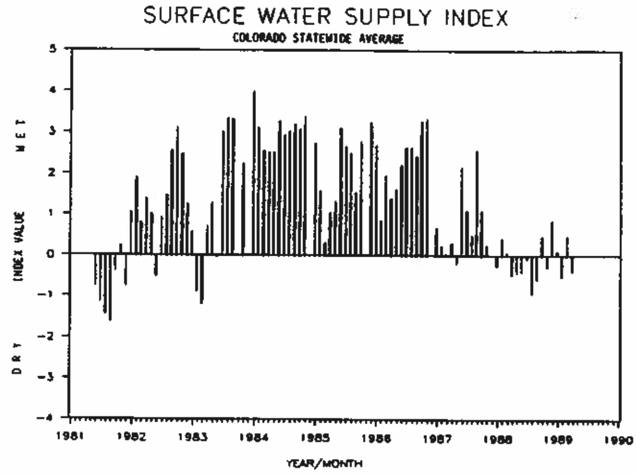
| Greatest | | Least | |
|---|---|---|---|
| Bonham Reservoir | 3.33" | Stonington | Trace |
| Aspen 1SW | 3.20" | Cheyenne Wells | Trace |
| Winter Park | 2.59" | Joes | Trace |
| Redstone 4W | 2.37" | Manassa | Trace |
| Breckenridge | 2.25" | Idalia 5NNE | 0.00" |

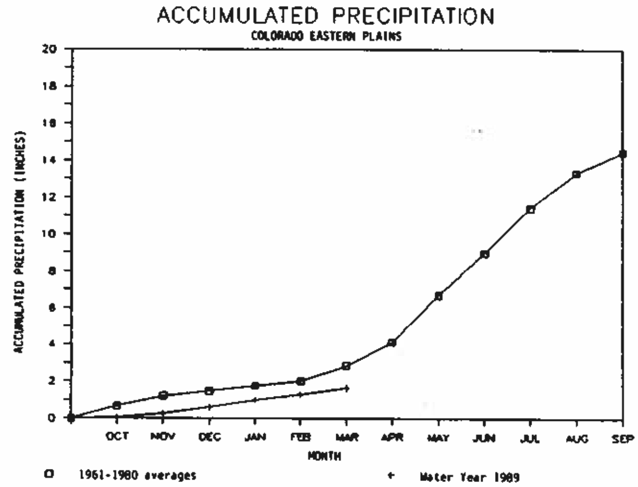


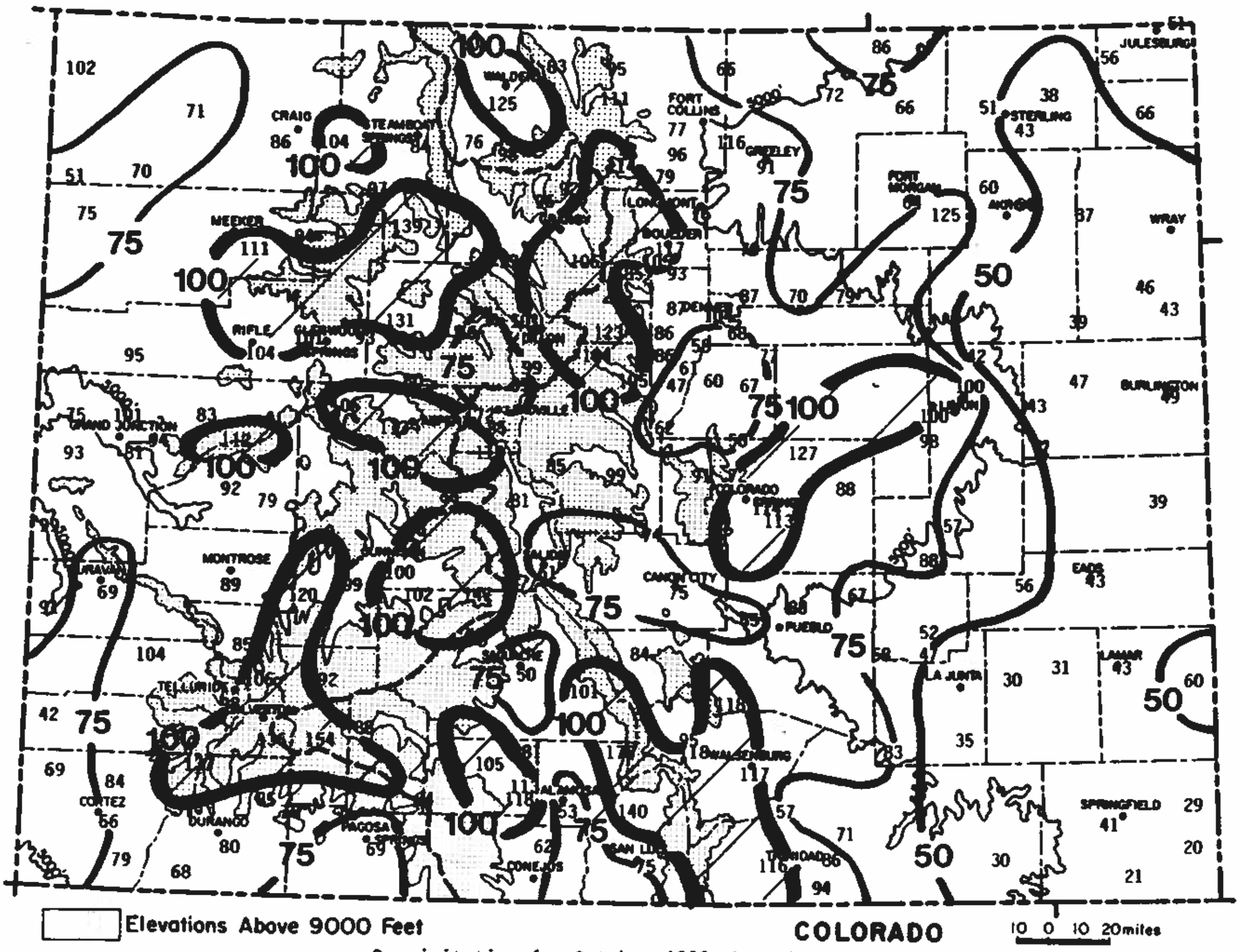

Precipitation amounts (inches) for March 1989 and contours of precipitation as a percent of the 1961-1980 average. Dashed line is 150% of average.

# 1989 WATER YEAR PRECIPITATION

Precipitation for the first 6 months of the 1989 water year is not doing too well across Colorado. Areas with near or above average moisture for this period shrunk and now include only spotty areas in and near the mountains. The San Juan Mountains and Sangre de Cristo Range continued to be in the best shape. Rio Grande Reservoir has received 154% of the average October-March precipitation. Dry areas are increasing both east and west of the mountains. Nearly all areas in eastern Colorado east of a line running north-south through Limon have had less than half of their average moisture. The dry winter is not a sure harbinger of a dry spring and summer. Historically there is no predictive relationship between winter precipitation and subsequent spring and summer moisture. Nevertheless, farmers will be waiting nervously to see if adequate spring moisture arrives in time to help range conditions, winter wheat and other crops.



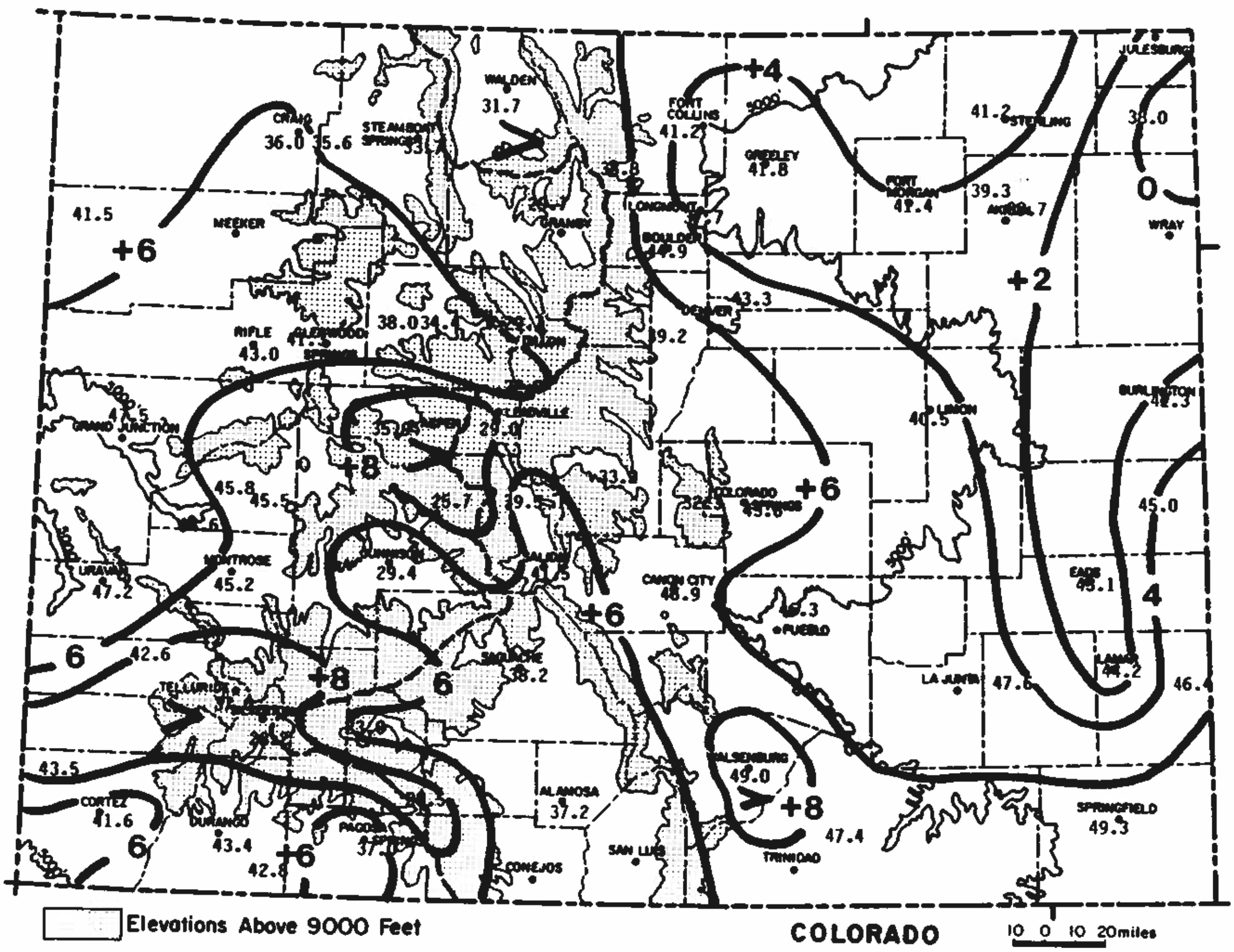




Precipitation for October 1988 through March 1989
as a percent of the 1961-1980 average.

## MARCH 1989 TEMPERATURES AND DEGREE DAYS

March made a dramatic rebound from the frigid conditions experienced in February. The entire state, except for extreme northeastern Colorado, was warmer than average. Most locations were between 4 degrees and 8 degrees above the historic March average. Except for the first few days of the month, warmer than average conditions were very persistent statewide. At Montrose, this was the 4th warmest March since their records began in 1904. At Durango, this was the 5th warmest March since 1894. While it was an unusually warm month, as recently as 1986 March temperatures were even more balmy.




March 1989 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## MARCH 1989 SOIL TEMPERATURES

Soil temperatures remained cold in early March and then warmed quickly. By the end of the month, soil temperatures were nearly uniform with depth.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.

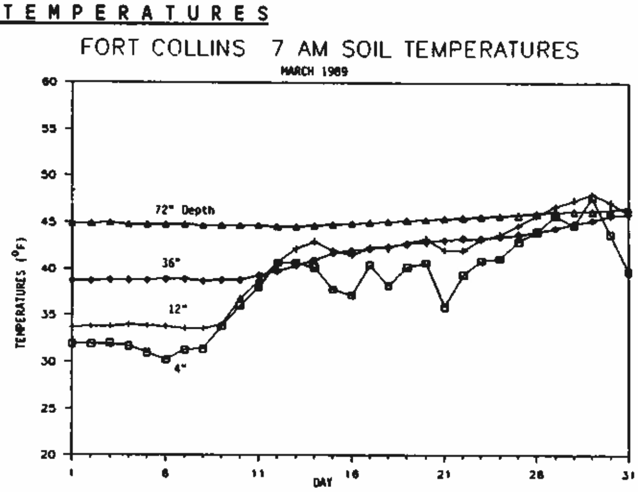


Table 1. Heating Degree Day Data through March 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 87-88 | 66 | 96 | 364 | 601 | 1130 | 1556 | 1867 | 1381 | 1031 | 658 | 454 | 102 | 9306 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | 1210 | 854 | | | | 7103 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 87-88 | 112 | 152 | 355 | 563 | 1024 | 1382 | 1450 | 1146 | 1136 | 734 | 517 | 123 | 8694 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | 1171 | 899 | | | | 7007 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 87-88 | 7 | 33 | 122 | 370 | 713 | 1053 | 1107 | 842 | 739 | 400 | 203 | 14 | 5603 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | 1139 | 615 | | | | 4760 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 87-88 | 49 | 117 | 313 | 549 | 955 | 1277 | 1357 | 1010 | 1030 | 639 | 472 | 102 | 7870 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | 1153 | 784 | | | | 6434 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 87-88 | 5 | 20 | 72 | 375 | 724 | 1037 | 1221 | 935 | 779 | 449 | 178 | 14 | 5809 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | 1135 | 697 | | | | 4819 |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 87-88 | 11 | 36 | 87 | 374 | 668 | 1007 | 1144 | 858 | 767 | 407 | 191 | 16 | 5566 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | 1078 | 554 | | | | 4493 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 87-88 | 17 | 74 | 150 | 445 | 767 | 1108 | 1256 | 958 | 886 | 499 | 273 | 25 | 6458 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | 1205 | 655 | | | | 5251 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 87-88 | 6 | 35 | 154 | 396 | 860 | 1179 | 1351 | 1008 | 899 | 609 | 362 | 56 | 6915 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | 1008 | 718 | | | | 5593 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 87-88 | 55 | 96 | 227 | 534 | 950 | 1376 | 1561 | 1264 | 1076 | 593 | 399 | 52 | 8183 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | 1443 | 894 | | | | 7003 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 87-88 | 0 | 11 | 108 | 354 | 737 | 1102 | 1300 | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | 1327 | 964 | 613 | | | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 87-88 | 11 | 21 | 110 | 410 | 745 | 1125 | 1227 | 889 | 811 | 437 | 215 | 14 | 6015 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | 1190 | 665 | | | | 5059 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 87-88 | 296 | 346 | 556 | 763 | 1145 | 1491 | 1629 | 1376 | 1379 | 933 | 717 | 322 | 10953 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | 1307 | 1088 | | | | 8461 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 87-88 | 14 | 44 | 188 | 435 | 851 | 1206 | 1391 | 972 | 859 | 514 | 346 | 42 | 6862 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | 933 | 666 | | | | 5508 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 87-88 | 54 | 75 | 254 | 509 | 950 | 1331 | 1544 | 1173 | 1002 | 607 | 404 | 52 | 7955 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | 1227 | 829 | | | | 6864 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 87-88 | 69 | 118 | 333 | 602 | 922 | 1255 | 1310 | 1029 | 992 | 645 | 462 | 111 | 7848 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | 1227 | 794 | | | | 6247 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 87-88 | 12 | 37 | 146 | 453 | 784 | 1140 | 1252 | 936 | 821 | 479 | 217 | 8 | 6285 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | 1207 | 732 | | | | 5378 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 87-88 | 12 | 29 | 110 | 430 | 773 | 1154 | 1484 | 1055 | 826 | 495 | 206 | 17 | 6591 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | 1230 | 726 | | | | 5572 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 87-88 | 0 | 6 | 34 | 248 | 754 | 1147 | 1469 | 1031 | 741 | 350 | 172 | 8 | 5960 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | 1037 | 534 | | | | 5043 |

* = AVES ADJUSTED FOR STATION MOVES M = MISSING E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 87-88 | 207 | 257 | 480 | 677 | 1098 | 1516 | 1642 | 1413 | 1372 | 907 | 602 | 238 | 10409 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | 1368 | 1086 | | | | 8271 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 87-88 | 10 | 26 | 119 | 424 | 762 | 1157 | 1363 | 955 | 807 | 437 | 204 | 6 | 6270 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | 1230 | 711 | | | | 5351 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | 1698 | 2096 | 1578 | 1096 | | | | 8819 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 87-88 | 0 | 3 | 35 | 273 | 653 | 1032 | 1278 | 837 | 638 | 327 | 103 | 1 | 5180 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | 1109 | 535 | | | | 4414 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 87-88 | 346 | 393 | 578 | 763 | 1180 | 1534 | 1577 | 1326 | 1355 | 957 | 741 | 360 | 11110 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | 1310 | 1112 | | | | 8654 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 87-88 | 21 | 66 | 158 | 502 | 840 | 1209 | 1354 | 1022 | 943 | 569 | 321 | 35 | 7040 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | 1211 | 751 | | | | 5610 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 87-88 | 12 | 33 | 159 | 464 | 805 | 1169 | 1383 | 1035 | 847 | 509 | 222 | 20 | 6658 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | 1307 | 841 | | | | 6053 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | M | M | M | | | | M |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 87-88 | 5 | 30 | 129 | 349 | 849 | 1160 | 1332 | 1003 | 817 | 468 | 230 | 26 | 6398 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | 972 | 605 | | | | 5311 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 87-88 | 104 | 105 | 347 | 523 | 947 | 1292 | 1548 | 1187 | 996 | 663 | 485 | 143 | 8340 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | 1095 | 860 | | | | 6739 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 87-88 | 4 | 17 | 43 | 355 | 754 | 1111 | 1399 | 903 | 777 | 399 | 167 | 8 | 5937 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | 1141 | 573 | | | | 4838 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 87-88 | 9 | 24 | 125 | 391 | 819 | 1209 | 1430 | 1039 | 865 | 454 | 268 | 14 | 6647 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | 1049 | 674 | | | | 5722 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 87-88 | 77 | 127 | 330 | 590 | 1033 | 1448 | 1619 | 1336 | 1167 | 674 | 433 | 95 | 8929 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | 1355 | 964 | | | | 7458 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 87-88 | 12 | 31 | 108 | 413 | 742 | E1140 | 1475 | 1029 | 831 | 476 | 197 | 12 | 6466 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | 1189 | 730 | | | | 5258 |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 87-88 | 161 | 222 | 426 | 603 | 992 | 1269 | 1354 | 1109 | 1092 | 720 | 547 | 208 | 8703 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | 1071 | 858 | | | | 6878 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 87-88 | 4 | 25 | 80 | 330 | 730 | 1054 | 1209 | 850 | 803 | 438 | 234 | 13 | 5770 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | 1026 | 538 | | | | 4529 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 87-88 | 215 | 281 | 495 | 740 | 1242 | 1499 | 1572 | 1343 | 1340 | 835 | 638 | 184 | 10384 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | 1369 | 1023 | | | | 8021 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 87-88 | 3 | 30 | 101 | 332 | 707 | 977 | 1109 | 826 | 773 | 401 | 238 | 25 | 5522 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | 1031 | 492 | | | | 4379 |

* = AVES ADJUSTED FOR STATION MOVES M = MISSING E = ESTIMATED

# MARCH 1989 CLIMATIC DATA

## Eastern Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STERLING | 57.9 | 24.5 | 41.2 | 4.4 | 85 | -11 | 730 | 0 | 225 | 0.38 | -0.42 | 47.5 | 4 |
| FORT MORGAN | 57.0 | 25.8 | 41.4 | 4.0 | 80 | -2 | 726 | 0 | 206 | 0.08 | -0.48 | 14.3 | 1 |
| AKRON FAA AP | 56.2 | 22.4 | 39.3 | 3.0 | 81 | -10 | 790 | 0 | 190 | 0.23 | -0.64 | 26.4 | 6 |
| AKRON 4E | 54.8 | 22.5 | 38.7 | 3.3 | 82 | -13 | 806 | 0 | 189 | 0.20 | -0.62 | 24.4 | 3 |
| HOLYOKE | 52.5 | 23.4 | 38.0 | -0.6 | 85 | -7 | 829 | 0 | 167 | 0.65 | -0.48 | 57.5 | 6 |
| BURLINGTON | 58.6 | 25.9 | 42.3 | 2.3 | 83 | -7 | 697 | 0 | 204 | 0.19 | -0.63 | 23.2 | 3 |
| LIMON WSMO | 58.6 | 22.4 | 40.5 | 4.3 | 82 | -5 | 751 | 0 | 200 | 0.39 | -0.35 | 52.7 | 4 |
| CHEYENNE WELLS | 62.7 | 27.3 | 45.0 | 5.6 | 86 | -2 | 611 | 0 | 258 | 0.00 | -0.69 | 0.0 | 0 |
| EADS | 59.7 | 26.5 | 43.1 | 1.6 | 87 | 2 | 677 | 3 | 233 | 0.37 | -0.47 | 44.0 | 1 |
| LAMAR | 65.5 | 23.0 | 44.2 | 1.5 | 92 | -2 | 635 | 0 | 291 | 0.47 | -0.46 | 50.5 | 2 |
| LAS ANIMAS | 68.1 | 27.1 | 47.6 | 4.1 | 91 | -1 | 535 | 2 | 312 | 0.33 | -0.29 | 53.2 | 2 |
| HOLLY | 66.5 | 26.3 | 46.4 | 5.7 | 92 | 1 | 572 | 0 | 292 | 0.62 | -0.08 | 88.6 | 4 |
| SPRINGFIELD 7WSW | 69.5 | 29.0 | 49.3 | 7.7 | 90 | -3 | 490 | 9 | 333 | 0.20 | -0.71 | 22.0 | 3 |

## Foothills/Adjacent Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FORT COLLINS | 55.6 | 26.7 | 41.2 | 3.7 | 72 | -1 | 732 | 0 | 158 | 0.22 | -0.88 | 20.0 | 4 |
| GREELEY UNC | 56.7 | 26.8 | 41.8 | 1.8 | 76 | -1 | 711 | 0 | 179 | 0.53 | -0.42 | 55.8 | 5 |
| ESTES PARK | 51.8 | 25.9 | 38.8 | 6.3 | 68 | -9 | 806 | 0 | 87 | 0.12 | -0.61 | 16.4 | 2 |
| LONGMONT 2ESE | 55.5 | 19.8 | 37.7 | 0.3 | 75 | -10 | 841 | 0 | 174 | 0.11 | -0.80 | 12.1 | 1 |
| BOULDER | 60.1 | 29.7 | 44.9 | 4.6 | 79 | -1 | 615 | 0 | 213 | 0.97 | -0.39 | 71.3 | 4 |
| DENVER WSFO AP | 58.5 | 28.0 | 43.3 | 4.9 | 79 | -5 | 665 | 0 | 199 | 0.56 | -0.58 | 49.1 | 5 |
| EVERGREEN | 57.4 | 21.0 | 39.2 | 7.0 | 73 | -8 | 794 | 0 | 148 | 0.69 | -0.61 | 53.1 | 3 |
| LAKE GEORGE 8SW | 48.4 | 18.1 | 33.2 | 6.7 | 65 | -9 | 980 | 0 | 54 | 0.04 | -0.51 | 7.3 | 1 |
| RUXTON PARK | 46.2 | 18.4 | 32.3 | 6.7 | 66 | -10 | 1006 | 0 | 42 | 0.45 | -1.10 | 29.0 | 2 |
| COLORADO SPRINGS | 59.5 | 27.8 | 43.6 | 7.0 | 78 | 0 | 655 | 0 | 181 | 0.49 | -0.31 | 61.2 | 2 |
| CANON CITY 2SE | 63.3 | 30.5 | 46.9 | 6.2 | 82 | 5 | 554 | 0 | 243 | 0.18 | -0.65 | 21.7 | 3 |
| PUEBLO WSO AP | 66.9 | 25.7 | 46.3 | 5.3 | 86 | 3 | 573 | 0 | 289 | 0.14 | -0.59 | 19.2 | 1 |
| WALSENBURG | 65.8 | 32.1 | 49.0 | 9.1 | 80 | 3 | 492 | 1 | 271 | 0.71 | -0.61 | 53.8 | 3 |
| TRINIDAD FAA AP | 67.5 | 27.3 | 47.4 | 7.1 | 84 | 2 | 538 | 0 | 294 | 0.20 | -0.69 | 22.5 | 3 |

## Mountains/Interior Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WALDEN | 45.0 | 18.5 | 31.7 | 7.6 | 61 | -21 | 1023 | 0 | 34 | 1.11 | 0.54 | 194.7 | 9 |
| LEADVILLE 2SW | 43.1 | 14.8 | 29.0 | 8.0 | 61 | -19 | 1112 | 0 | 17 | 0.90 | -0.40 | 69.2 | 10 |
| SALIDA | 57.2 | 25.8 | 41.5 | 5.3 | 73 | 3 | 721 | 0 | 146 | 0.05 | -0.73 | 6.4 | 1 |
| BUENA VISTA | 55.4 | 23.6 | 39.5 | 5.9 | 70 | 3 | 784 | 0 | 122 | 0.18 | -0.45 | 28.6 | 3 |
| SAGUACHE | 54.3 | 22.2 | 38.2 | 5.3 | 66 | 12 | 821 | 0 | 109 | 0.11 | -0.31 | 26.2 | 4 |
| HERMIT 7ESE | 38.7 | 7.3 | 23.0 | 3.7 | 50 | -12 | 1295 | 0 | 0 | 0.95 | -0.51 | 65.1 | 1 |
| ALAMOSA WSO AP | 58.2 | 16.2 | 37.2 | 5.6 | 73 | 3 | 854 | 0 | 156 | 0.10 | -0.33 | 23.3 | 2 |
| STEAMBOAT SPRINGS | 47.5 | 19.8 | 33.7 | 6.9 | 61 | -15 | 964 | 0 | 45 | 1.69 | -0.23 | 88.0 | 8 |
| GRAND LAKE 6SSW | 43.2 | 16.2 | 29.7 | 7.3 | 55 | -25 | 1086 | 0 | 9 | 0.93 | 0.08 | 109.4 | 10 |
| DILLON 1E | 43.7 | 15.8 | 29.7 | 6.4 | 61 | -18 | 1088 | 0 | 26 | 1.05 | -0.06 | 94.6 | 9 |
| AVON | 49.1 | 19.6 | 34.4 | 5.9 | 65 | -9 | 943 | 0 | 64 | 1.16 | -0.19 | 85.9 | 6 |
| CLIMAX | 37.3 | 8.4 | 22.8 | 4.4 | 55 | -18 | 1298 | 0 | 4 | 1.43 | -0.70 | 67.1 | 8 |
| ASPEN 1SW | 49.3 | 22.5 | 35.9 | 8.4 | 68 | -4 | 899 | 0 | 60 | 3.20 | 1.00 | 145.5 | 7 |
| TAYLOR PARK | 41.8 | 9.5 | 25.7 | 13.5 | 55 | -32 | 1213 | 0 | 7 | 1.35 | 0.09 | 107.1 | 5 |
| TELLURIDE | 51.1 | 22.9 | 37.0 | 8.6 | 63 | -2 | 858 | 0 | 61 | 1.33 | -0.62 | 68.2 | 7 |
| PAGOSA SPRINGS | 57.1 | 16.9 | 37.0 | 4.7 | 72 | 4 | 860 | 0 | 138 | 1.30 | -0.14 | 90.3 | 3 |
| SILVERTON | 47.5 | 8.8 | 28.2 | 8.2 | 61 | -20 | 1133 | 0 | 31 | 1.75 | -0.16 | 91.6 | 6 |
| WOLF CREEK PASS 1 | 42.6 | 16.5 | 29.5 | 8.3 | 57 | -6 | 1093 | 0 | 14 | 1.75 | -3.11 | 36.0 | 5 |

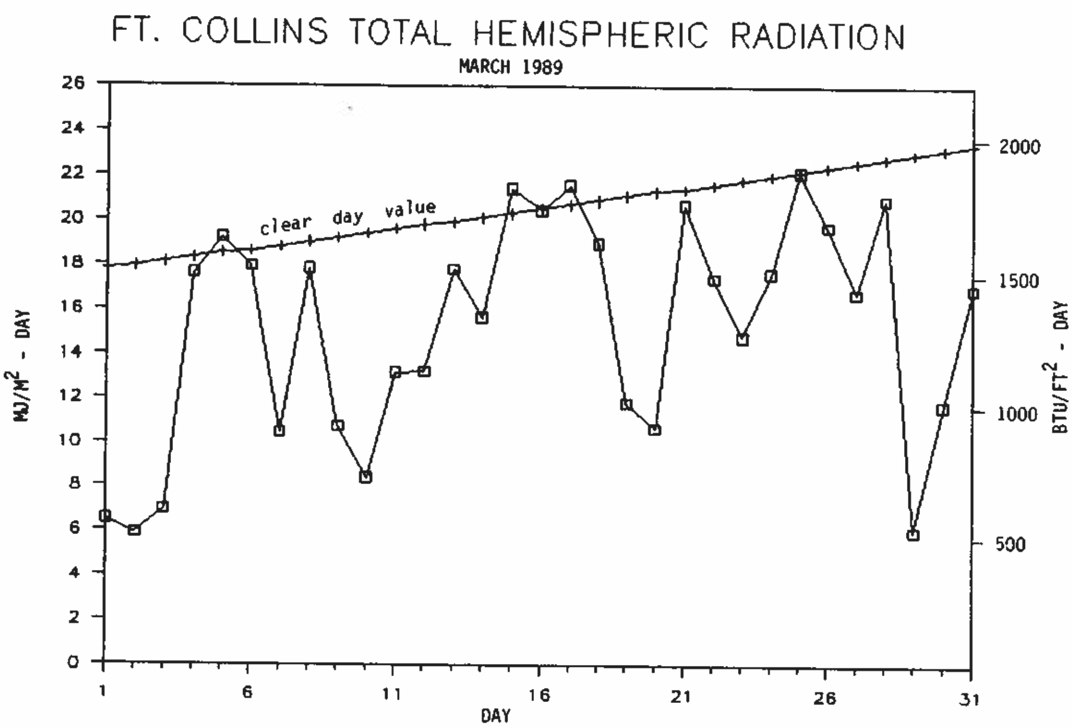
## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 48.6 | 23.3 | 36.0 | 5.6 | 62 | -9 | 894 | 0 | 59 | 1.01 | -0.54 | 65.2 | 5 |
| HAYDEN | 47.4 | 23.8 | 35.6 | 7.2 | 61 | -7 | 905 | 0 | 42 | 0.97 | -0.21 | 82.2 | 7 |
| RANGELY 1E | 56.5 | 26.6 | 41.5 | 6.5 | 67 | 5 | 719 | 0 | 142 | 0.74 | -0.03 | 96.1 | 4 |
| EAGLE FAA AP | 52.2 | 23.8 | 38.0 | 5.1 | 70 | 0 | 829 | 0 | 85 | 0.80 | 0.03 | 103.9 | 7 |
| GLENWOOD SPRINGS | 55.1 | 27.5 | 41.3 | 5.2 | 73 | 8 | 728 | 0 | 120 | 0.65 | -0.59 | 52.4 | 5 |
| RIFLE | 59.0 | 27.0 | 43.0 | 5.3 | 76 | 9 | 674 | 0 | 165 | 0.47 | -0.38 | 55.3 | 4 |
| GRAND JUNCTION WS | 60.3 | 34.7 | 47.5 | 5.3 | 76 | 17 | 534 | 0 | 182 | 0.51 | -0.31 | 62.2 | 5 |
| CEDAREDGE | 60.7 | 30.9 | 45.8 | 7.0 | 75 | 7 | 588 | 0 | 181 | 0.91 | -0.09 | 91.0 | 5 |
| PAONIA 1SW | 59.5 | 31.5 | 45.5 | 6.6 | 77 | 9 | 596 | 0 | 178 | 1.09 | -0.19 | 85.2 | 5 |
| DELTA | 63.3 | 26.7 | 45.0 | 4.0 | 82 | 11 | 613 | 0 | 226 | 0.38 | -0.10 | 79.2 | 1 |
| GUNNISON | 44.2 | 14.5 | 29.4 | 3.9 | 59 | -18 | 1096 | 0 | 27 | 0.50 | -0.19 | 72.5 | 3 |
| MONTROSE NO. 2 | 59.5 | 30.8 | 45.2 | 6.6 | 79 | 12 | 605 | 0 | 172 | 0.20 | -0.33 | 37.7 | 3 |
| URAVAN | 63.5 | 31.0 | 47.2 | 4.0 | 79 | 17 | 544 | 0 | 224 | 0.53 | -0.44 | 54.6 | 3 |
| NORWOOD | 57.3 | 28.0 | 42.6 | 8.8 | 89 | 6 | 688 | 0 | 139 | 0.22 | -0.89 | 19.8 | 2 |
| YELLOW JACKET 2W | 57.3 | 29.8 | 43.5 | 8.5 | 73 | 11 | 657 | 0 | 146 | 0.57 | -0.49 | 53.8 | 3 |
| CORTEZ | 58.9 | 24.4 | 41.6 | 4.3 | 76 | 15 | 718 | 0 | 163 | 0.36 | -0.98 | 26.9 | 4 |
| DURANGO | 59.5 | 27.2 | 43.4 | 6.1 | 75 | 15 | 666 | 0 | 170 | 0.95 | -0.68 | 58.3 | 3 |
| IGNACIO 1N | 61.4 | 24.3 | 42.8 | 7.6 | 78 | 15 | 681 | 0 | 198 | 0.65 | -0.55 | 54.2 | 4 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## MARCH 1989 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 8 | 9 | 14 | -- | -- |
| Denver | 6 | 10 | 15 | 72% | 71% |
| Fort Collins | 4 | 15 | 12 | -- | -- |
| Grand Junction | 5 | 7 | 19 | 70% | 64% |
| Pueblo | 8 | 15 | 8 | 77% | 75% |



Growing degree days (GDD's) are very similar to heating and cooling degree days in form and computation. They are based on the mean daily temperature (the average of each day's high and low temperature). The rate of growth and development of many forms of vegetation is related to the temperature (all other factors being equal). The warmer the temperatures, the faster the vegetation grows and matures. But there is a problem. Some plants prefer cool temperatures. Others won't grow until it is consistently warm. Thus, there is no single definition for GDD's that applies well to all plants -- rather, there is a whole family of definitions each geared to a particular plant or family of plants.

GDD's are easy to compute, once you establish the temperature limits for plant growth. For example, some cool weather grasses will grow whenever the mean temperature is above about 40°F. Simply subtract the threshold temperature (in this case, 40°) from the mean temperature for each day [(Tmax + Tmin)/2]. That gives the number of growing degrees for that particular day. Add each daily total together for every day in the month or in an entire growing season, and that gives the total number of "growing degree days" for that period. For plants that prefer warmer temperatures, you simply use a warmer threshold to subtract from the mean daily temperature.

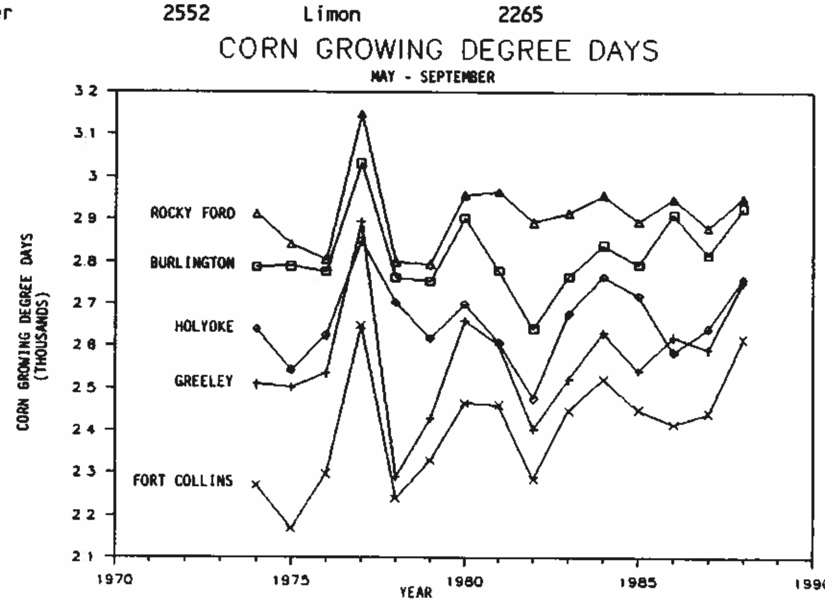
This concept works pretty well, but not perfectly. As temperatures continue to rise, you usually reach a point of diminishing returns. For most plants, when temperatures get really hot, their growth slows. At a bit higher temperature, growth ceases. And at a bit higher level still, the plant dies. Therefore, upper temperature limits are also appropriate in computing GDD's.

The growing degree days which we show in our data tables each month are "corn GDD's." This definition, developed for corn, has both a lower and upper limit. Corn grows very little at temperatures below 50°, so 50 is subtracted from each mean daily temperature. Maximum growth has been found to occur at a temperature of 86°. Therefore, when the maximum daily temperature exceeds 86° it is set equal to 86°. The maximum number of corn growing degrees that could occur for one day is therefore 36, but that could only occur if the low temperature was also 86 (which never happens in Colorado).

In much of the Midwestern corn belt there are adequate GDD's every year for corn to grow and mature. But here in Colorado where the growing season is shorter and nighttime temperatures cool quickly, GDD's are very important to the success of the crop. Last year Colorado had an excellent corn crop. When you look at the number of corn GDD's last year you can see why. While the nation was battling drought and hot temperatures, it was actually a blessing for Colorado farmers who had adequate irrigation water to raise corn. Average growing degree days for corn are shown in the table below for several Colorado locations. In general, it is difficult or impossible to raise corn where the GDD total for the May-September growing season is less than 2200.

Average May-September Growing Degree Days

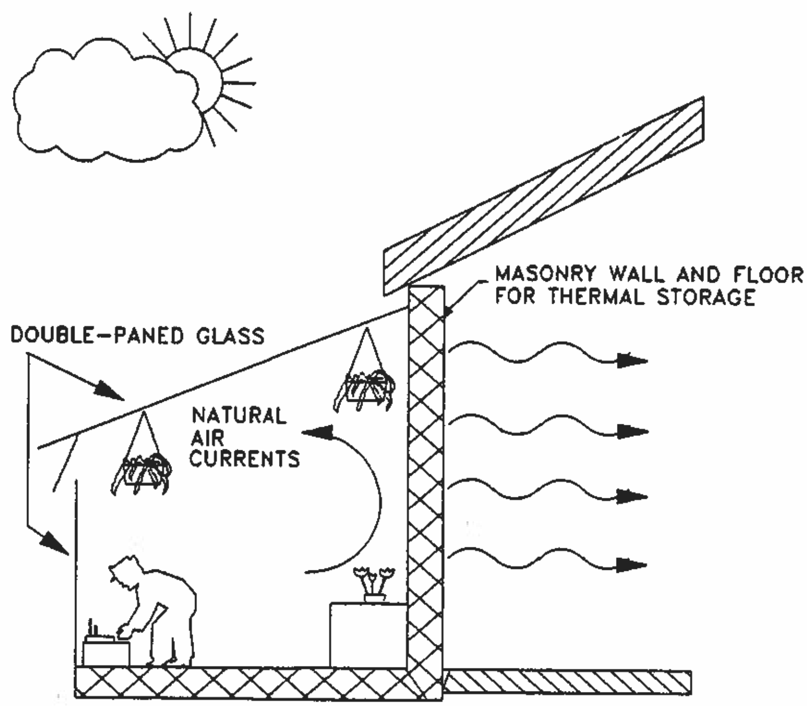
| Location | GDD's | Location | GDD's | Location | GDD's |
|---|---|---|---|---|---|
| Alamosa | 2009 | Durango | 2194 | Montrose | 2488 |
| Akron | 2517 | Fort Collins | 2291 | Pueblo | 2868 |
| Boulder | 2651 | Grand Junction | 3037 | Rifle | 2442 |
| Burlinigton | 2726 | Greeley | 2525 | Rocky Ford | 2906 |
| Canon City | 2829 | Holyoke | 2675 | Silverton | 1282 |
| Colo. Springs | 2334 | Gunnison | 1902 | Steamboat | 1886 |
| Cortez | 2481 | Lamar | 3063 | Sterling | 2553 |
| Craig | 2093 | Leadville | 1123 | Trinidad | 2617 |
| Denver | 2552 | Limon | 2265 | | |



# SOLAR GREENHOUSES

With the onset of spring,many people are beginning to till the soil in preparation for this years vegetable/flower garden. Thoughts are turning outside as we spend more time there after the long winter.
Spring and summer can also be the time to add a new greenhouse to your house. Solar greenhouses can provide a year-round growing environment. heating of the main house in the winter and pure enjoyment in the feeling of being surrounded by greenery.

Greenhouses attached to the home are a mixture of direct and indirect passive solar systems. The solar radiation strikes an interior wall which warms up and passes the heat to the inside of the home, as well as heating the air in the greenhouse. (See figure 1.)



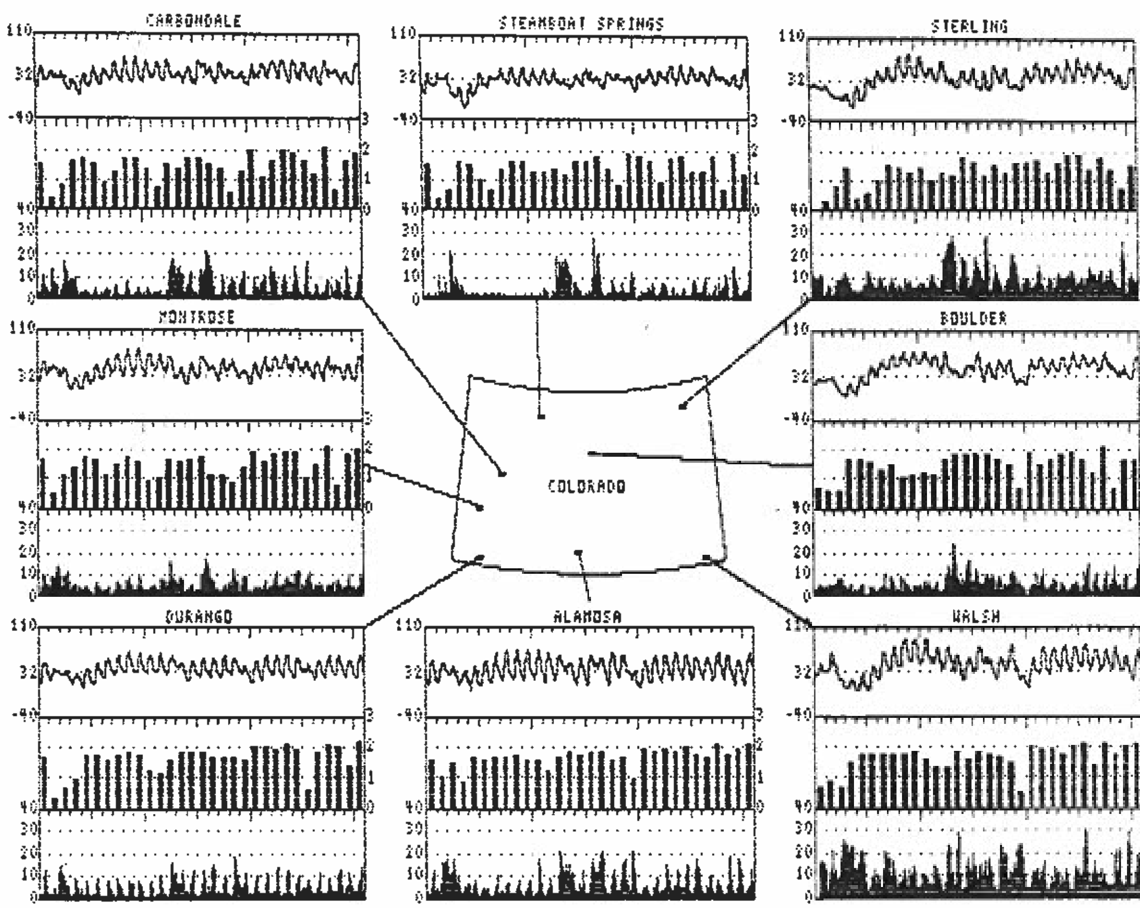

An attached greenhouse which faces south will intercept most of the sun's rays during the winter. The east and west sides may need some sort of shading during the summer to keep out excess radiation when the days are longer. Windows are strategically placed within the greenhouse to let out excess heat. Night insulation such as shades can be used to decrease heat loss during the winter. Unlike a basic thermal wall, an attached greenhouse usually supplies heat during the day and early evening hours but does not continue to supply heat into the night. With a little more construction, the greenhouse can be built with thermal walls to store heat and can then help with heating throughout the night (as shown in figure 1.)

The thermal wall, a sort of heat battery that stores energy and passes it on later, can be made of either masonry or water. In colder climates such as Colorado, these may be used together to keep the greenhouse from freezing at night. Heat can also be taken from the greenhouse and stored in rock piles for later use; doing this makes it a more efficient system. A greenhouse may pass on 15-30% of the solar radiation absorbed by the thermal wall into the adjacent space. If you lived in Walsh and had a greenhouse attached to your home of a couple hundred feet, it may decrease your monthly gas useage by one quarter to one third.

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh | Boulder |
|---|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | 37.9 | 38.7 | 38.7 | 44.0 | 31.1 | 37.6 | 45.9 | 44.3 |
| **monthly temperature extremes and time of occurence ( °F day/hour )** | | | | | | | | |
| maximum: | 71.4 10/15 | 67.3 9/16 | 68.9 9/15 | 76.5 10/16 | 57.2 25/15 | 120.1 31/ 0 | 86.4 10/15 | 74.5 10/17 |
| minimum: | 3.2 5/ 7 | 7.5 5/ 5 | 1.9 5/ 7 | 12.2 4/ 3 | -18.6 5/ 3 | -13.9 5/ 5 | 1.2 5/ 6 | -0.0 4/ 4 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | | |
| 5 AM | 74 / 12 | 72 / 18 | 82 / 22 | 63 / 19 | 90 / 20 | 79 / 20 | 57 / 16 | 52 / 15 |
| 11 AM | 28 / 15 | 39 / 21 | 43 / 22 | 34 / 21 | 57 / 22 | 49 / 24 | 34 / 20 | 37 / 18 |
| 2 PM | 21 / 14 | 33 / 20 | 33 / 20 | 27 / 19 | 46 / 21 | 39 / 23 | 25 / 20 | 29 / 16 |
| 5 PM | 21 / 13 | 32 / 19 | 32 / 19 | 28 / 19 | 55 / 23 | 40 / 21 | 24 / 18 | 31 / 17 |
| 11 PM | 45 / 12 | 59 / 20 | 65 / 22 | 46 / 19 | 82 / 23 | 66 / 21 | 41 / 14 | 41 / 16 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | | |
| day | 222 | 179 | 255 | 228 | 170 | 204 | 152 | 125 |
| night | 179 | 81 | 194 | 167 | 132 | 209 | 239 | 202 |
| **monthly average wind speed ( miles per hour )** | 5.54 | 4.06 | 4.62 | 4.38 | 3.58 | 8.35 | 10.20 | 4.46 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | | |
| 0 to 3 | 286 | 405 | 400 | 299 | 471 | 41 | 57 | 284 |
| 3 to 12 | 361 | 309 | 289 | 429 | 221 | 584 | 439 | 434 |
| 12 to 24 | 97 | 30 | 55 | 16 | 40 | 103 | 227 | 25 |
| > 24 | 0 | 0 | 0 | 0 | 1 | 16 | 13 | 1 |
| **monthly average daily total insolation ( Btu/ft²·day )** | 1656 | 1610 | 1422 | 1454 | 1354 | 1306 | 1601 | 1420 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | | |
| 60-80% | 240 | 124 | 120 | 155 | 129 | 146 | 227 | 155 |
| 40-60% | 75 | 71 | 73 | 85 | 74 | 111 | 63 | 63 |
| 20-40% | 33 | 55 | 72 | 64 | 89 | 54 | 49 | 80 |
| 0-20% | 8 | 34 | 38 | 25 | 41 | 18 | 20 | 23 |

## The State-Wide Picture

The figure below shows monthly weather at WITHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40°F to 110°F, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 Btu/ft²/day, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour.



# COLORADO CLIMATE

APRIL 1989



Colorado Climate Center
Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado 80523



*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 7


## April in Review:

A mountain snow blitz in early April and a week of record-breaking heat later in the month were the most memorable features of the month. Except for some local wet spots in central Colorado, most of the state was much drier than average. With warmer than average temperatures statewide, mountain snowmelt began early and soil moisture at lower elevations deteriorated. For the first time since 1981, there was realistic concern about widespread developing drought.

## Colorado's June Climate:

In a typical June, a few lingering episodes of cool, damp weather occur early in the month over northern and eastern Colorado. By mid-month these stormy periods become rare and during the last 2 weeks of June, summer at its hot and dry best encompasses the entire state. During this final stage of the winter-summer transition, severe thunderstorms with hail and tornadoes reach their maximum frequency from the Front Range across the Eastern Plains. Last year, summer heat got off to an early start in June, and severe weather pounded parts of Colorado. The group of tornadoes that struck Denver on the 15 June 1988 were perhaps the most photographed tornadoes of all time.

June is also a month when melting snow swells the many river systems flowing down from the mountains, and river rafters and kayakers swarm in to experience the white-water thrill. With below average mountain snowpack and early melting due to warm April weather, it appears the white water may be a little sluggish and short-lived this year. Flooding from snowmelt is very unlikely. But don't write off flood potential altogether. While infrequent, the heaviest widespread flood-producing rain storms that Colorado has ever experienced have occurred from the last few days of May into the middle of June. There are still plenty of Coloradoans around who can tell some hair-raising stories about what happens when it rains 10 or 12 inches in a few hours (such as June 1965).

Last year brought unusually heavy rains to southern Colorado and the San Juan mountains, but that is not the norm. It is typically the driest month of the year over southwest Colorado with moisture increasing toward the north and east. In a typical June, northeastern Colorado receives close to 3" of rain. Totals fall off to about 1.50-2.00" along the Front Range, 1-2" in the mountains and less than 1" across the Western Slope. For the Colorado mountains, June is the sunniest month of the year.

Daytime temperatures at lower elevations rise into the 70s early in June, but are usually in the 80s and 90s late in the month. Lows drop into the 40s and 50s. But above 10,000 feet, daytime highs normally reach only into the 50s, and temperatures drop below freezing at night. Day to day changes become much less dramatic than during the winter and spring months.

## A 20% Chance of Afternoon and Evening Thunderstorms:

The often heard summer weather forecast, "Partly cloudy with a 20% chance of afternoon and evening thunderstorms," while usually appropriate, does not do justice to the marvels of Rocky Mountain thunderstorms. Somehow it seems the combination of rugged mountains and billowing thunderheads deserves something a bit more eloquent and poetic. I am not going to make any firm suggestions here. Rather, I am going to try to deliver a few facts about our summer thunderstorms and let you write the poetry.

For the year as a whole, Florida is definitely the thunderstorm capital of the U.S., with some areas of the peninsula experiencing more than 120 thunderstorms per year. But during the summer months, portions of Colorado make a strong challenge for the most thunderstorm-prone area of the entire country. Thunderstorms don't occur daily, but over the course of the summer (June-August) some areas in Colorado are hit by several dozen separate thunderstorms.

(continued on page -9-)

# APRIL 1989 DAILY WEATHER

| Date | Event |
|---|---|
| 1-4 | Mild temperatures along with strong winds and copious Pacific moisture accompanied three upper air disturbances that raced across Colorado from west to east in rapid succession. Very heavy snows fell on some mountain areas. 32 inches of wet snow piled up in Breckenridge, and Mount Evans Research Center measured 26" during this period. Really heavy snows were quite localized, however, and Western Slope areas mostly just got a spattering of rain showers. Despite sinking westerly winds, some measurable foothills snowshowers and Eastern Plains sprinkles spilled over east of the mountains. Colder on the 4th. |
| 5-7 | Lingering mountain snowshower 5-6th. Windy with warming temperatures. Many areas in the mountains and along the Front Range experienced wind gusts of 50 mph or greater on the 7th. Low elevation temperatures climbed into the 70s and 80s on the 6-7th. Pueblo's 89°F reading on the 7th set a new record for the date. Meanwhile, California experienced their worst April heatwave of recorded history. |
| 8-10 | Sharply colder east of the mountains on the 8th with a more gradual cooling trend across the mountains and western valleys. Some light upslope rain and snow showers across eastern Colorado developed into a significant spring snowstorm from the Front Range out to northeastern Colorado on the 9th. Boulder received 1 foot of snow. 6-8" of snow from Castle Rock to Monument put a "whammo" on travel on I-25. Precipitation was much less over SE Colorado, but the northeastern plains received some very beneficial moisture. 4-8" of snow was common with a water equivalent of more than 0.50" in some locations. Bonny Lake reported 0.69" of precipitation. As the snow moved southward and skies cleared early on the 10th, some of the coldest temperatures of the month were observed. Colorado Springs awoke to 8°F on the 10th and Akron 4E had a nippy 0°F. The -14°F reading at Mount Evans Research Center was the coldest in the state for this month. |
| 11-18 | Quite cool 11-12 as an upper-level disturbance drifted southeastward across Colorado. Light to moderate mountain snows developed on the 11th and some light rain and snow showers moved out across SE Colorado on the 12th. Buena Vista received 0.43" of moisture and Wolf Creek Pass added 0.40". A nice gradual warming trend then began on the 13th and continued through the period with very mild days but cool nights. A weak upper air disturbance triggered a few showers on the 16th across the northern mountains and sent some cooler air across the eastern plains on the 17th and 18th. |
| 19-23 | A ridge of high pressure built up over the southern Rockies and produced a full-fledged heatwave over all of Colorado. Temperatures climbed into the 60s all the way up to 10,000 feet getting the spring snow melt off to an early start. At lower elevations, temperatures soared into the 80s and 90s breaking many daily and monthly records. Las Animas hit 100°F on the 21st, the first time the century mark had ever been reached in April anywhere in Colorado. |
| 24-26 | A low pressure system aloft drifted slowly closer to Colorado producing southerly winds aloft and increasing humidity. At the same time, cooler air pushed into eastern Colorado from the north. The resulting airmass combat resulted in the first major thunderstorm development of the season. Some hail and high winds were observed late on the 24th near Greeley and Fort Collins. More storms popped up on the 25th and 26th, again primarily over northeast areas. |
| 27-30 | The upper level storm system passed north of Colorado, bringing scattered periods of rain and snow and much cooler temperatures. Quite windy on the 27th. Most mountain precipitation was fairly light and extreme SW Colorado missed the moisture completely. Aspen received 13" of new snow during the period and Mount Evans added 18". Easterly upslope winds developed east of the mountains 28-30th with occasional showers, low clouds and fog. Moderate cold rains and snows developed in some areas on the 30th. Wheatridge reported 5" of wet snow and parts of SE Colorado had more than 0.50" of much-needed rainfall. |

## April 1989 Extremes

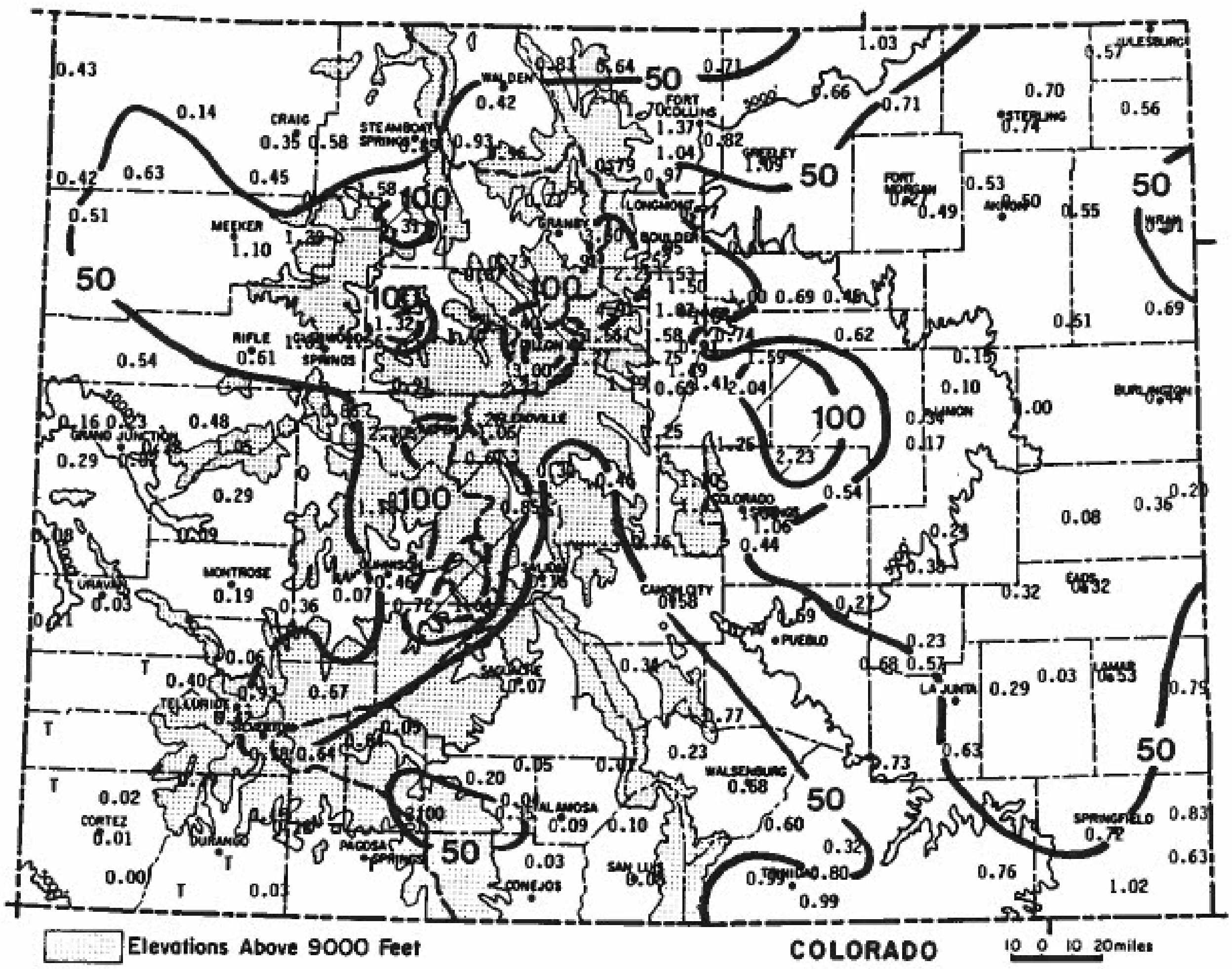
| | | | |
|---|---|---|---|
| Highest Temperature | 100°F | April 21 | Las Animas |
| Lowest Temperature | -14°F | April 10 | Mt. Evans Research Center |
| Greatest Total Precipitation | 4.91" | | Mt. Evans Research Center |
| Least Total Precipitation | 0.00" | | Mesa Verde National Park, Flagler 2NW |
| Greatest Total Snowfall* | 66" | | Mt. Evans Research Center |
| Greatest Snowdepth ** | 99" | | Tower (Buffalo Pass) |

*For existing weather stations with complete daily records. Higher values are likely for unmonitored locations.
**From Soil Conservation Service snowpack measurements.

# APRIL 1989 PRECIPITATION

Three storm systems accounted for nearly all of the April precipitation. The much-publicized mountain snow blitz during the first few days of the month was more localized than most people realized. Most of the mountains received some wet snow, but the really heavy snows were limited to just a few areas in the central mountains. These areas, including Yampa, Breckenridge, Aspen and locations near Monarch Pass, ended up wetter than average for the month as did a small area near Castle Rock. Elsewhere, the remainder of the state was drier than average. No measurable precipitation at all fell over southwestern Colorado, and many locations both east and west of the Continental Divide received less than half of average.

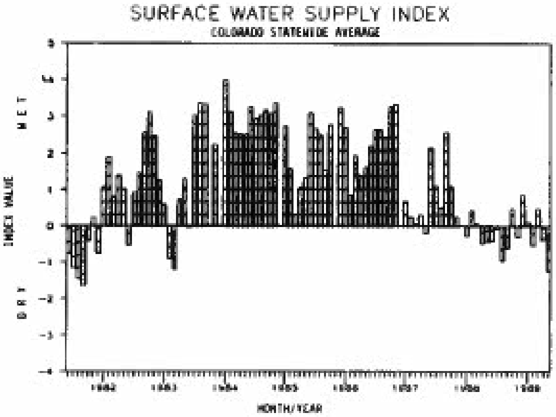
| Greatest | | Least | |
|---|---|---|---|
| Mount Evans Research Center | 4.91" | Mesa Verde Natl. Park | 0.00" |
| | | Flagler 2 NW | 0.00" |
| Silver Lake | 3.60" | Durango | Trace |
| Breckenridge | 3.00" | Pagosa Springs | Trace |
| Winter Park | 2.91" | Northdale | Trace |
| Aspen 1SW | 2.30" | Crestone 1 SE | Trace |

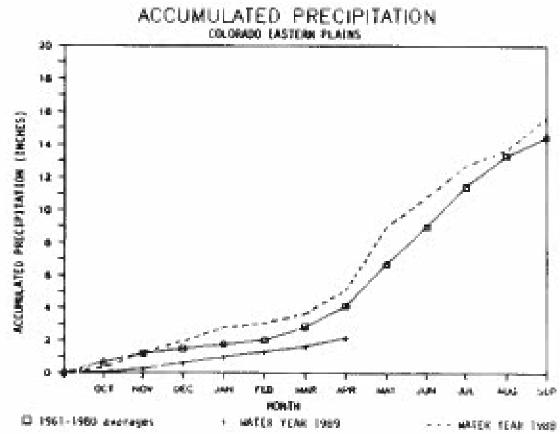


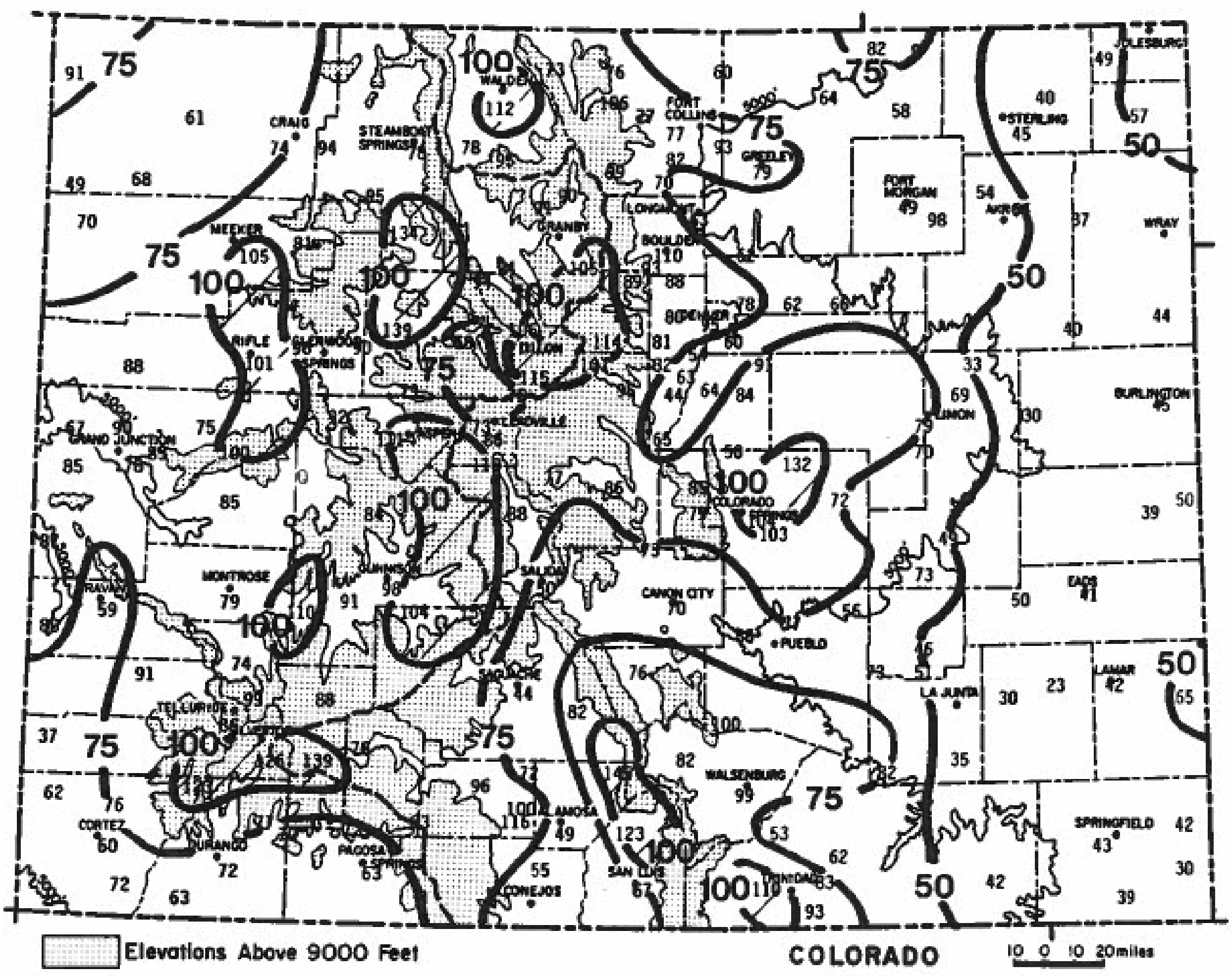

Precipitation amounts (inches) for April 1989 and contours of precipitation as a percent of the 1961-1980 average. Dashed line is 150% of average.

## 1989 WATER YEAR PRECIPITATION

Water supply conditions continue to decline over Colorado. Local pockets with above average precipitation still remain which include Rifle, Eagle, Yampa, Winter Park, Dillon, Breckenridge, Aspen, and Colorado Springs. Most of these locations are only slightly above average. The only truly wet areas cover a small portion of the San Juans from Rico to Rio Grande Reservoir and a small band near the Sangre de Cristo's from Blanca to the Great Sand Dunes. Most mountain areas have received between 70% and 90% of average. Conditions are much worse over extreme northwest, southwest and much of eastern Colorado. From Sterling to Springfield almost every weather station has received less than half the average October-April moisture. At Akron, this has been the 7th driest first 7 months of a water year this century. John Martin Dam has received only 0.74" of total precipitation since October 1.



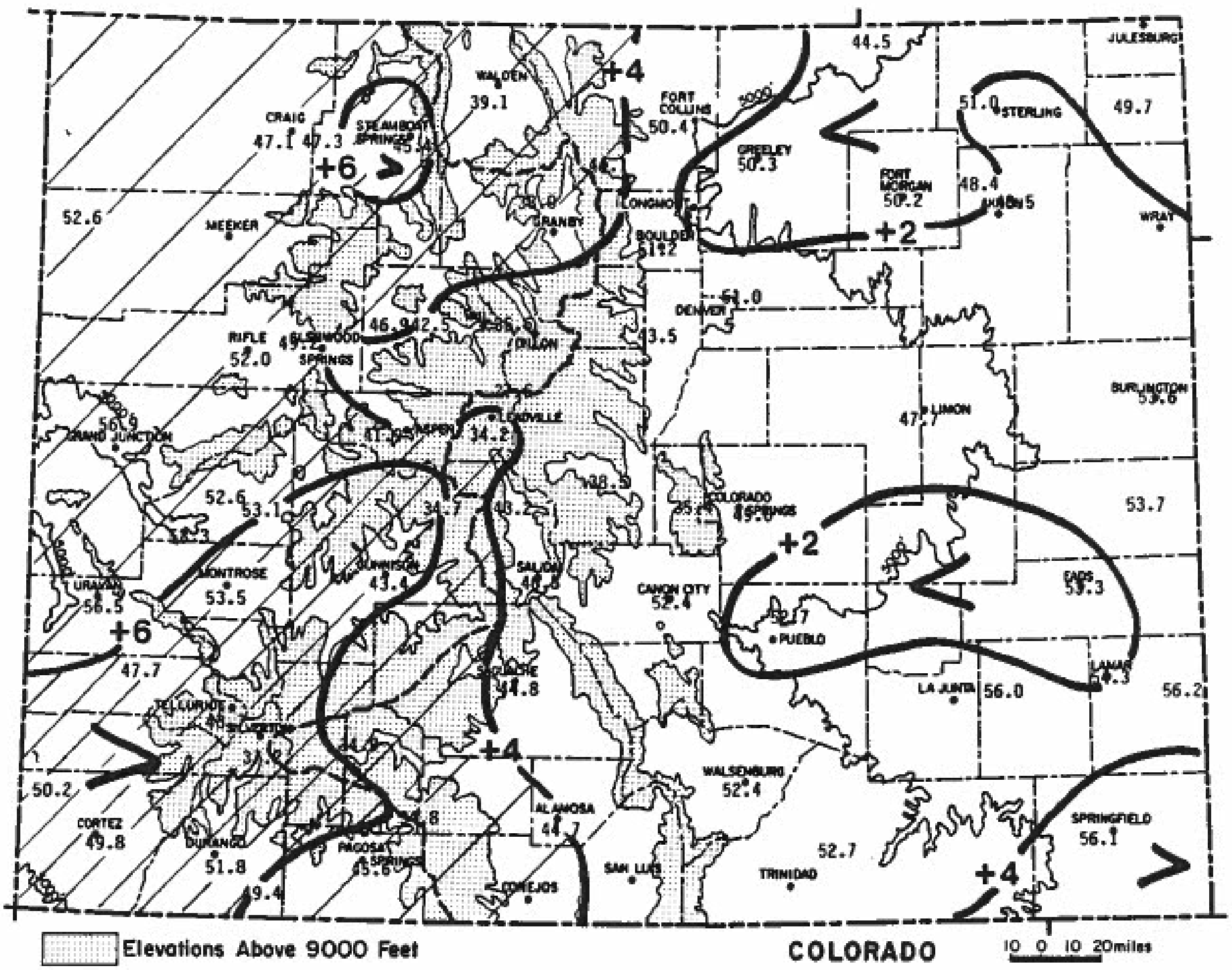




Precipitation for October 1988 through April 1989
as a percent of the 1961-1980 average.

## APRIL 1989 TEMPERATURES AND DEGREE DAYS

Unseasonably warm temperatures from April 15 to the 26th helped make this a warmer than average month statewide. East of the mountains, temperatures for the month ended up only about 1 to 3 degrees F above average, but the western half of the state was generally 5 to 7 degrees above average. At Grand Junction this was the 6th warmest April since records began there in 1892.

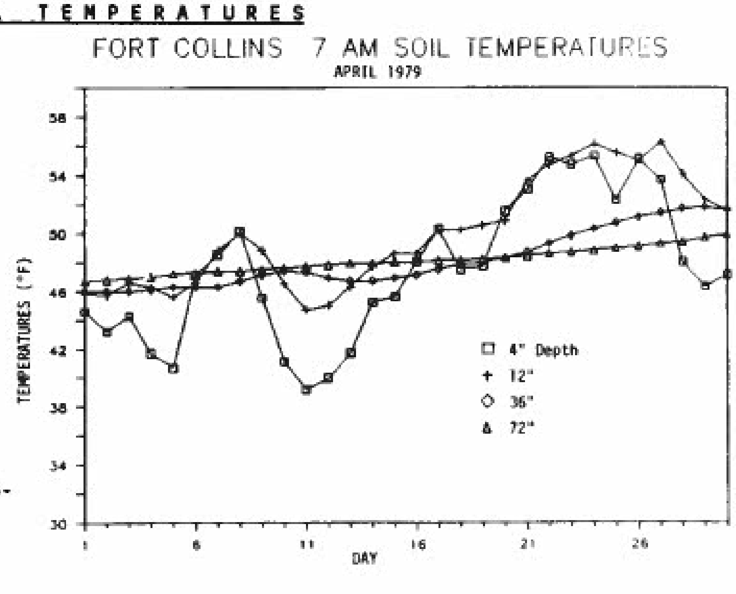



April 1989 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## APRIL 1989 SOIL TEMPERATURES

Soil temperatures in the upper 2-3 feet climbed rapidly in mid April in response to the early heatwave. From the 20th to the 27th temperatures climbed well into the 50s even below a depth of 1 foot.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.



# Table 1. Heating Degree Day Data through April 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 87-88 | 66 | 96 | 364 | 601 | 1130 | 1556 | 1867 | 1381 | 1031 | 658 | 454 | 102 | 9306 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | 1210 | 854 | 600 | | | 7703 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 87-88 | 112 | 152 | 355 | 563 | 1024 | 1382 | 1450 | 1146 | 1136 | 734 | 517 | 123 | 8694 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | 1171 | 899 | 692 | | | 7699 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 87-88 | 7 | 33 | 122 | 370 | 713 | 1053 | 1107 | 842 | 739 | 400 | 203 | 14 | 5603 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | 1139 | 615 | 427 | | | 5187 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 87-88 | 49 | 117 | 313 | 549 | 955 | 1277 | 1357 | 1010 | 1030 | 639 | 472 | 102 | 7870 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | 1153 | 784 | 645 | | | 7079 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 87-88 | 5 | 20 | 72 | 375 | 724 | 1037 | 1221 | 935 | 779 | 449 | 178 | 14 | 5809 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | 1135 | 697 | 375 | | | 5194 |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 87-88 | 11 | 36 | 87 | 374 | 668 | 1007 | 1144 | 858 | 767 | 407 | 191 | 16 | 5566 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | 1078 | 554 | 382 | | | 4875 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 87-88 | 17 | 74 | 150 | 445 | 767 | 1108 | 1256 | 958 | 886 | 499 | 273 | 25 | 6458 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | 1205 | 655 | 475 | | | 5726 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 87-88 | 6 | 35 | 154 | 396 | 860 | 1179 | 1351 | 1008 | 899 | 609 | 362 | 56 | 6915 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | 1008 | 718 | 450 | | | 6043 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 87-88 | 55 | 96 | 227 | 534 | 950 | 1376 | 1561 | 1264 | 1076 | 593 | 399 | 52 | 8183 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | 1443 | 894 | 531 | | | 7534 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 87-88 | 0 | 11 | 108 | 354 | 737 | 1102 | 1300 | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | 1327 | 964 | 613 | 345 | | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 87-88 | 11 | 21 | 110 | 410 | 745 | 1125 | 1227 | 889 | 811 | 437 | 215 | 14 | 6015 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | 1190 | 665 | 432 | | | 5491 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 87-88 | 296 | 346 | 556 | 763 | 1145 | 1491 | 1629 | 1376 | 1379 | 933 | 717 | 322 | 10953 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | 1307 | 1088 | 875 | | | 9336 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 87-88 | 14 | 44 | 188 | 435 | 851 | 1206 | 1391 | 972 | 859 | 514 | 346 | 42 | 6862 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | 933 | 666 | 388 | | | 5896 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 87-88 | 54 | 75 | 254 | 509 | 950 | 1331 | 1544 | 1173 | 1002 | 607 | 404 | 52 | 7955 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | 1227 | 829 | 536 | | | 7400 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 87-88 | 69 | 118 | 333 | 602 | 922 | 1255 | 1310 | 1029 | 992 | 645 | 462 | 111 | 7848 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | 1227 | 794 | 636 | | | 6883 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 87-88 | 12 | 37 | 146 | 453 | 784 | 1140 | 1252 | 936 | 821 | 479 | 217 | 8 | 6285 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | 1207 | 732 | 433 | | | 5811 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 87-88 | 12 | 29 | 110 | 430 | 773 | 1154 | 1484 | 1055 | 826 | 495 | 206 | 17 | 6591 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | 1230 | 726 | 446 | | | 6018 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 87-88 | 0 | 6 | 34 | 248 | 754 | 1147 | 1469 | 1031 | 741 | 350 | 172 | 8 | 5960 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | 1037 | 534 | 260 | | | 5303 |

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING    E = ESTIMAT'

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 87-88 | 207 | 257 | 480 | 677 | 1098 | 1516 | 1642 | 1413 | 1372 | 907 | 602 | 238 | 10409 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | 1368 | 1086 | 805 | | | 9076 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 87-88 | 10 | 26 | 119 | 424 | 762 | 1157 | 1363 | 955 | 807 | 437 | 204 | 6 | 6270 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | 1230 | 711 | 444 | | | 5795 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | 1698 | 2096 | 1578 | 1096 | 640 | | | 9459 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 87-88 | 0 | 3 | 35 | 273 | 653 | 1032 | 1278 | 837 | 638 | 327 | 103 | 1 | 5180 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | 1109 | 535 | 303 | | | 4717 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 87-88 | 346 | 393 | 578 | 763 | 1180 | 1534 | 1577 | 1326 | 1355 | 957 | 741 | 360 | 11110 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | 1310 | 1112 | 914 | | | 9568 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 87-88 | 21 | 66 | 158 | 502 | 840 | 1209 | 1354 | 1022 | 943 | 569 | 321 | 35 | 7040 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | 1211 | 751 | 516 | | | 6126 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 87-88 | 12 | 33 | 159 | 464 | 805 | 1169 | 1383 | 1035 | 847 | 509 | 222 | 20 | 6658 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | 1307 | 841 | 542 | | | 6595 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | M | M | M | M | | | M |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 87-88 | 5 | 30 | 129 | 349 | 849 | 1160 | 1332 | 1003 | 817 | 468 | 230 | 26 | 6398 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | 972 | 605 | 348 | | | 5659 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 87-88 | 104 | 105 | 347 | 523 | 947 | 1292 | 1548 | 1187 | 996 | 663 | 485 | 143 | 8340 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | 1095 | 860 | 574 | | | 7313 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 87-88 | 4 | 17 | 43 | 355 | 754 | 1111 | 1399 | 903 | 777 | 399 | 167 | 8 | 5937 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | 1141 | 573 | 378 | | | 5216 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 87-88 | 9 | 24 | 125 | 391 | 819 | 1209 | 1430 | 1039 | 865 | 454 | 268 | 14 | 6647 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | 1049 | 674 | 381 | | | 6103 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 87-88 | 77 | 127 | 330 | 590 | 1033 | 1448 | 1619 | 1336 | 1167 | 674 | 433 | 95 | 8929 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | 1355 | 964 | 581 | | | 8039 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 87-88 | 12 | 31 | 108 | 413 | 742 | E1140 | 1475 | 1029 | 831 | 476 | 197 | 12 | 6466 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | 1189 | 730 | 416 | | | 5674 |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 87-88 | 161 | 222 | 426 | 603 | 992 | 1269 | 1354 | 1109 | 1092 | 720 | 547 | 208 | 8703 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | 1071 | 858 | 633 | | | 7511 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 87-88 | 4 | 25 | 80 | 330 | 730 | 1054 | 1209 | 850 | 803 | 438 | 234 | 13 | 5770 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | 1026 | 538 | 378 | | | 4907 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 87-88 | 215 | 281 | 495 | 740 | 1242 | 1499 | 1572 | 1343 | 1340 | 835 | 638 | 184 | 10384 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | 1369 | 1023 | 772 | | | 8793 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 87-88 | 3 | 30 | 101 | 332 | 707 | 977 | 1109 | 826 | 773 | 401 | 238 | 25 | 5522 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | 1031 | 492 | 376 | | | 4755 |

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING    E = ESTIMATED

# APRIL 1989 CLIMATIC DATA

## Eastern Plains

| Name | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| NEW RAYMER 21N | 59.9 | 29.2 | 44.5 | -0.9 | 87 | 3 | 613 | 5 | 194 | 1.03 | -0.16 | 86.6 | 5 |
| STERLING | 67.9 | 34.2 | 51.0 | 3.3 | 90 | 6 | 416 | 5 | 289 | 0.69 | -0.59 | 53.9 | 2 |
| FORT MORGAN | 65.8 | 34.5 | 50.2 | 1.8 | 90 | 11 | 446 | 10 | 257 | 0.27 | -0.90 | 23.1 | 1 |
| AKRON FAA AP | 63.2 | 33.5 | 48.4 | 1.7 | 89 | 4 | 509 | 18 | 239 | 0.53 | -0.79 | 40.2 | 3 |
| AKRON 4E | 64.0 | 33.0 | 48.5 | 2.3 | 90 | 0 | 497 | 8 | 239 | 0.50 | -0.77 | 39.4 | 3 |
| HOLYOKE | 64.8 | 34.6 | 49.7 | 0.3 | 92 | 11 | 469 | 15 | 246 | 0.56 | -0.96 | 36.8 | 2 |
| BURLINGTON | 69.8 | 37.4 | 53.6 | 3.3 | 93 | 12 | 375 | 39 | 310 | 0.44 | -0.76 | 36.7 | 3 |
| LIMON WSMO | 63.5 | 32.0 | 47.7 | 2.7 | 88 | 8 | 516 | 4 | 230 | 0.34 | -0.71 | 32.4 | 5 |
| CHEYENNE WELLS | 70.5 | 36.8 | 53.7 | 3.8 | 95 | 10 | 372 | 42 | 313 | 0.36 | -0.52 | 40.9 | 3 |
| EADS | 70.4 | 36.3 | 53.3 | 1.4 | 93 | 13 | 370 | 27 | 306 | 0.32 | -0.66 | 32.7 | 2 |
| LAMAR | 74.4 | 34.3 | 54.3 | 0.3 | 98 | 17 | 339 | 28 | 346 | 0.53 | -0.73 | 42.1 | 4 |
| LAS ANIMAS | 74.6 | 37.5 | 56.0 | 2.2 | 100 | 22 | 303 | 41 | 346 | 0.29 | -0.71 | 29.0 | 4 |
| HOLLY | 74.9 | 37.5 | 56.2 | 3.7 | 98 | 19 | 294 | 39 | 355 | 0.79 | -0.18 | 81.4 | 4 |
| SPRINGFIELD 7WSW | 74.6 | 37.7 | 56.1 | 4.5 | 97 | 15 | 307 | 50 | 357 | 0.72 | -0.74 | 49.3 | 6 |

## Foothills/Adjacent Plains

| Name | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| FORT COLLINS | 64.4 | 36.5 | 50.4 | 3.5 | 88 | 11 | 433 | 4 | 241 | 1.37 | -0.42 | 76.5 | 7 |
| GREELEY UNC | 64.9 | 35.7 | 50.3 | 1.5 | 90 | 11 | 444 | 10 | 245 | 1.09 | -0.85 | 56.2 | 8 |
| ESTES PARK | 57.1 | 31.2 | 44.1 | 4.4 | 75 | 11 | 616 | 0 | 152 | 0.79 | -0.51 | 60.8 | 4 |
| LONGMONT 2ESE | 65.1 | 28.4 | 46.7 | -0.5 | 88 | 6 | 542 | 2 | 249 | 0.77 | -1.15 | 40.1 | 5 |
| BOULDER | 65.0 | 37.4 | 51.2 | 2.4 | 88 | 9 | 427 | 21 | 262 | 1.95 | -0.21 | 90.3 | 11 |
| DENVER WSFO AP | 64.6 | 37.5 | 51.0 | 3.3 | 89 | 11 | 432 | 19 | 250 | 1.00 | -0.82 | 54.9 | 7 |
| EVERGREEN | 59.3 | 27.7 | 43.5 | 3.1 | 81 | -3 | 636 | 0 | 184 | 1.58 | -0.69 | 69.6 | 10 |
| LAKE GEORGE 8SW | 53.4 | 23.7 | 38.5 | 2.1 | 70 | 0 | 787 | 0 | 109 | 0.43 | -0.49 | 46.7 | 6 |
| RUXTON PARK | 49.3 | 21.6 | 35.4 | 1.7 | 70 | -11 | 880 | 0 | 90 | 1.43 | -1.06 | 57.4 | 5 |
| COLORADO SPRINGS | 62.9 | 35.1 | 49.0 | 2.7 | 83 | 8 | 475 | 3 | 230 | 1.06 | -0.22 | 82.8 | 6 |
| CANON CITY 2SE | 67.9 | 36.8 | 52.4 | 2.6 | 88 | 7 | 382 | 13 | 291 | 0.58 | -0.54 | 51.8 | 5 |
| PUEBLO WSO AP | 70.7 | 34.8 | 52.7 | 1.1 | 93 | 13 | 378 | 16 | 316 | 0.59 | -0.35 | 62.8 | 6 |
| WALSENBURG | 69.3 | 35.5 | 52.4 | 4.0 | 87 | 14 | 376 | 7 | 302 | 0.68 | -0.95 | 41.7 | 5 |
| TRINIDAD FAA AP | 70.0 | 35.3 | 52.7 | 3.0 | 91 | 14 | 378 | 17 | 314 | 0.32 | -0.69 | 31.7 | 5 |

## Mountains/Interior Valleys

| Name | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| WALDEN | 54.4 | 23.7 | 39.1 | 4.7 | 73 | -1 | 772 | 0 | 118 | 0.42 | -0.37 | 53.2 | 7 |
| LEADVILLE 2SW | 47.2 | 21.2 | 34.2 | 5.2 | 64 | -3 | 914 | 0 | 48 | 1.06 | -0.34 | 75.7 | 11 |
| SALIDA | 63.3 | 29.7 | 46.5 | 2.2 | 81 | 10 | 548 | 0 | 219 | 0.16 | -1.09 | 12.8 | 3 |
| BUENA VISTA | 59.3 | 27.1 | 43.2 | 2.1 | 76 | 5 | 645 | 0 | 166 | 0.85 | 0.15 | 121.4 | 6 |
| SAGUACHE | 62.3 | 27.4 | 44.8 | 3.6 | 75 | 13 | 598 | 0 | 194 | 0.07 | -0.44 | 13.7 | 1 |
| HERMIT 7ESE | 49.7 | 20.1 | 34.9 | 4.3 | 58 | 12 | 894 | 0 | 35 | 0.04 | -1.12 | 3.4 | 1 |
| ALAMOSA WSO AP | 65.9 | 23.5 | 44.7 | 4.0 | 80 | 13 | 600 | 0 | 247 | 0.09 | -0.33 | 21.4 | 1 |
| STEAMBOAT SPRINGS | 61.3 | 29.6 | 45.4 | 7.4 | 77 | 12 | 581 | 0 | 189 | 0.89 | -1.26 | 41.4 | 9 |
| GRAND LAKE 6SSW | 51.7 | 24.3 | 38.0 | 4.7 | 69 | 4 | 805 | 0 | 87 | 0.71 | -0.39 | 64.5 | 12 |
| DILLON 1E | 49.9 | 21.2 | 35.6 | 2.8 | 67 | 3 | 875 | 0 | 77 | 1.40 | 0.28 | 125.0 | 10 |
| AVON | 58.3 | 26.7 | 42.5 | 3.5 | 75 | 12 | 669 | 0 | 161 | 1.36 | 0.16 | 113.3 | 6 |
| CLIMAX | 42.1 | 13.1 | 27.6 | 1.9 | 59 | -12 | 1114 | 0 | 24 | 2.23 | -0.17 | 92.9 | 12 |
| ASPEN 1SW | 55.1 | 28.6 | 41.9 | 3.9 | 72 | 16 | 692 | 0 | 129 | 2.34 | 0.04 | 101.7 | 9 |
| TAYLOR PARK | 48.8 | 20.6 | 34.7 | 11.4 | 63 | -6 | 903 | 0 | 60 | 1.20 | 0.11 | 110.1 | 6 |
| TELLURIDE | 58.9 | 28.6 | 43.7 | 7.1 | 73 | 16 | 633 | 0 | 157 | 0.42 | -1.48 | 22.1 | 6 |
| PAGOSA SPRINGS | 66.9 | 24.2 | 45.6 | 5.0 | 79 | 16 | 574 | 0 | 260 | 0.00 | -1.03 | 0.0 | 0 |
| SILVERTON | 55.2 | 19.3 | 37.2 | 7.4 | 71 | 2 | 828 | 0 | 114 | 0.78 | -0.66 | 54.2 | 7 |
| WOLF CREEK PASS 1 | 50.0 | 19.6 | 34.8 | 5.8 | 60 | 11 | 900 | 0 | 45 | 2.00 | -0.95 | 67.8 | 2 |

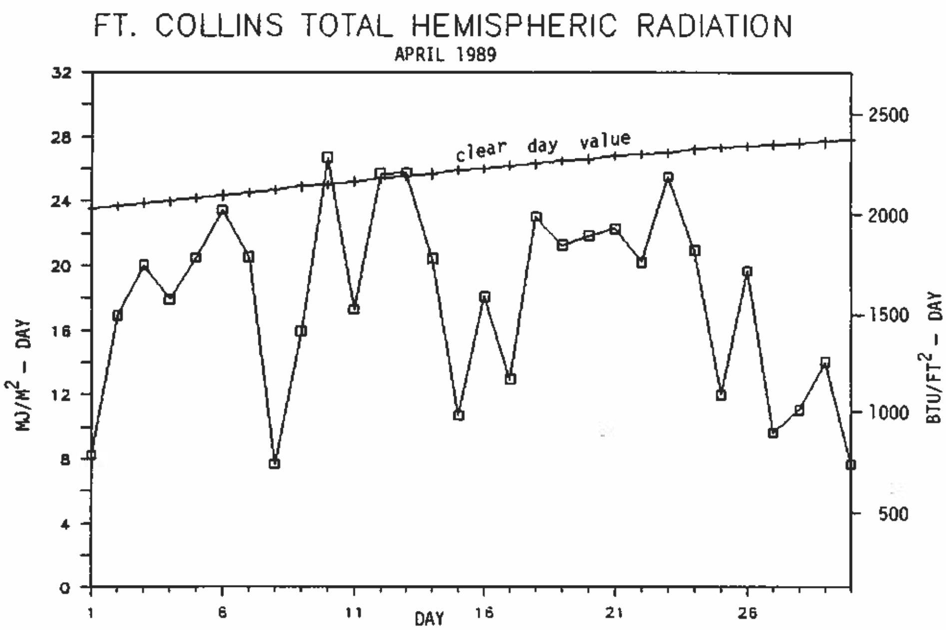
## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 62.0 | 32.1 | 47.1 | 5.1 | 80 | 13 | 531 | 0 | 197 | 0.35 | -1.45 | 19.4 | 6 |
| HAYDEN | 63.0 | 31.7 | 47.3 | 5.9 | 78 | 12 | 521 | 0 | 206 | 0.58 | -0.91 | 38.9 | 5 |
| RANGELY 1E | 68.6 | 36.7 | 52.6 | 5.9 | 83 | 21 | 366 | 4 | 292 | 0.61 | -0.33 | 64.9 | 4 |
| EAGLE FAA AP | 63.0 | 30.8 | 46.9 | 5.2 | 80 | 17 | 536 | 0 | 208 | 1.32 | 0.65 | 197.0 | 5 |
| GLENWOOD SPRINGS | 65.7 | 32.8 | 49.2 | 4.0 | 82 | 23 | 465 | 0 | 244 | 1.09 | -0.39 | 73.6 | 4 |
| RIFLE | 69.3 | 34.8 | 52.0 | 5.8 | 85 | 26 | 381 | 0 | 297 | 0.61 | -0.15 | 80.3 | 5 |
| GRAND JUNCTION WS | 71.1 | 42.8 | 56.9 | 5.6 | 85 | 27 | 260 | 26 | 339 | 0.23 | -0.51 | 31.1 | 5 |
| CEDAREDGE | 68.4 | 36.7 | 52.6 | 5.7 | 85 | 21 | 366 | 2 | 284 | 0.29 | -0.52 | 35.8 | 3 |
| PAONIA 1SW | 69.5 | 36.7 | 53.1 | 5.9 | 85 | 24 | 353 | 4 | 301 | 0.22 | -1.12 | 16.4 | 4 |
| DELTA | 73.5 | 33.0 | 53.3 | 3.4 | 95 | 22 | 345 | 3 | 353 | 0.09 | -0.37 | 19.6 | 2 |
| GUNNISON | 62.0 | 24.7 | 43.4 | 6.0 | 77 | 15 | 640 | 0 | 191 | 0.46 | -0.10 | 82.1 | 2 |
| MONTROSE NO. 2 | 68.7 | 38.2 | 53.5 | 6.3 | 84 | 25 | 348 | 7 | 291 | 0.19 | -0.55 | 25.7 | 3 |
| URAVAN | 73.8 | 39.2 | 56.5 | 5.0 | 87 | 31 | 252 | 6 | 363 | 0.03 | -1.02 | 2.9 | 2 |
| NORWOOD | 64.1 | 31.4 | 47.7 | 6.2 | 77 | 20 | 510 | 0 | 219 | 0.00 | -0.96 | 0.0 | 0 |
| YELLOW JACKET 2W | 67.5 | 32.8 | 50.2 | 6.9 | 79 | 21 | 437 | 1 | 272 | 0.00 | -0.85 | 0.0 | 0 |
| CORTEZ | 68.4 | 31.3 | 49.8 | 4.9 | 82 | 24 | 450 | 0 | 283 | 0.01 | -0.73 | 1.4 | 1 |
| DURANGO | 69.8 | 33.8 | 51.8 | 7.0 | 81 | 24 | 388 | 0 | 303 | 0.00 | -1.05 | 0.0 | 0 |
| IGNACIO 1N | 69.9 | 28.9 | 49.4 | 5.9 | 82 | 19 | 459 | 0 | 306 | 0.03 | -0.76 | 3.8 | 1 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## APRIL 1989 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days: clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 6 | 8 | 16 | -- | -- |
| Denver | 4 | 11 | 15 | 60% | 67% |
| Fort Collins | 3 | 14 | 13 | -- | -- |
| Grand Junction | 5 | 11 | 14 | 76% | 67% |
| Pueblo | 6 | 11 | 13 | 66% | 74% |



A 20% Chance of Afternoon and Evening Thunderstorms: continued

The stormiest areas, in terms of numbers of thunderstorms -- not severity, encompass the San Juan Mountains of southwest Colorado, the Sangre de Cristo Range east of Alamosa, and certain areas of the Front Range from Rocky Mountain National Park south to New Mexico. These areas typically receive about 50 thunderstorms each summer. The single greatest thunderstorm hot spot appears to be Pike's Peak where the count usually exceeds 60 storms. One volunteer weather observer, who lives in the mountains southwest of Boulder, counts each and every individual thunderstorm that passes his home close enough that thunder can be heard. Last summer, which was not an especially stormy one, he counted 124 separate storms. The fewest summer thunderstorms occur over northwest Colorado from Craig to Rangely. Individual locations there average less than 20 thunderstorms per summer.

There are three essential ingredients for producing thunderstorms: thermal energy (heat), thermal instability (an atmosphere where temperatures cool with increased elevation such that a parcel of rising warm air will continue to be warmer, and thus lighter, than the surrounding air), and moisture. Over the Rockies during the summertime there is almost always adequate thermal energy during the daytime. Thermal stability varies with changing weather patterns, but near the high mountain peaks local instability is created almost daily. The high mountain slopes, peaks and plateaus are effective solar energy absorbers creating a high-elevation heat source and a steep thermal lapse rate (large change of temperature with height) compared to the free atmosphere away from the mountains. The most variable ingredient, and hence the ingredient that most controls the distribution and frequency of storms is moisture.

The primary sources of summer moisture to Colorado is low level moisture from the Gulf of Mexico which is often present over Oklahoma, Kansas and Nebraska. It is an occasional visitor to our eastern plains and less frequently makes it into the mountains. Pikes Peak is the easternmost tall mountain in closest proximity to the Gulf moisture source. As such, its high frequency of summer storms is not surprising. (An interesting experiment would be to transport Pikes Peak to Louisiana for a summer. Then we'd really have something to write about.) The second major moisture source is subtropical low and mid level moisture that moves northward from Mexico primarily during July and August. The wind pattern that moves this moisture northward for a few weeks each summer has become known as the Southwest Monsoon. When this moisture source is in place, thunderstorms truly become a daily phenomenon. For Colorado, late July and early August is the period when monsoon moisture is most reliably present. Mountain camping is still pleasant during those weeks but a little more exciting. Hikers and mountain climbers frequently come back to camp with hair-raising stories of intimate experiences with atmospheric electricity. It is very difficult for either Gulf moisture from the east or monsoon moisture from the south to make its way into northwestern Colorado -- hence the lower frequency of storms in that area.

Storms don't spontaneously pop up at the same time each day over the entire state. The first storms of the day reliably form near the highest mountain ranges. In northern Colorado, the first thunder of the day typically occurs about noon or a little later. But in the southern mountains count on thunder a little earlier. The storms then migrate gradually out over adjacent valleys, plains and plateaus. Over the San Luis Valley the storms don't appear until after 2 or 3 p.m. and it's even a little later at Grand Junction. Out over the High Plains the storms often don't get rolling until late afternoon or evening when convection over the mountains has ceased. These late-forming plains storms are different than the mountain boomers. As they begin to tap the more abundant low-level moisture sources east of Colorado, the storms form lines or clusters and begin a steady march eastward toward the Midwest. These storms can become the longest lasting thunderstorm systems anywhere on our continent as they sometimes travel all the way to the Mississippi River before dissipating.

Experienced weather watchers in Colorado can often tell a lot about the weather by how early in the day the cumulus clouds begin to appear over the mountains. If the skies are still clear over the peaks at noon, expect a hot, dry day. But if clouds are already exploding at 9 a.m., it may be a day of numerous heavy storms.

There is something very special about our Rocky Mountain thunderstorms. Their ever changing beauty against a background of distant mountain ranges has always captured the imagination of Western artists. Their suddenness, their chill, their frequent hail, and their rainbows makes them unforgettable and almost enjoyable. Unlike storms back east, they leave the air fresh and cool rather than even more sultry and humid. Their moisture is almost always welcome here. They bring our deserts alive. But don't let these wonders of nature lull you into a blissful stupor. All thunderstorms are frightening and powerful. Each year lightning claims several lives and injures many others here in Colorado. Cattle and sheep have worse mortality statistics. Periodically, ensuing flash floods claim even more lives. Hail damages millions of dollars worth of our property. So please enjoy our summer thunderstorms, but enjoy them with appropriate caution and respect.

# NIGHT PRECOOLING

Summer is right around the bend and with it the potential of some hot days. The cooler evenings in Colorado give some relief from the heat, and many people try to take advantage of this by opening up the windows at night and closing up during the day. This pre-cooling of the house at night has been touted by many as an inexpensive way to lower cooling bills. But is it?

There are many variables that go into this determination. A calculation of the savings considers all sides of the issue. For example,a typical house anywhere in the U.S. is not typical. They cannot be lumped together as the norm for the country. But the majority of houses are wood frame with plaster paneling and the storage capacity of this type of house can be determined. The landscaping around this "typical" house also varies. If a house has more trees to shade it from the midday sun, it can stay cooler than one that is standing out in the middle of a new lot with 6 foot trees. The occupants themselves and their lifestyles also change the parameters; if the doors are always being opened and closed by all the little kids running about (as they tend to do in the summer), the hot air has more chance of filtering into the house than a house that is closed up for the day. This type of variable may make only a small difference in the overall determinations of savings, but it is there. The infiltration rate also depends on the tightness of the windows and doors as they sit closed. So it is not just during the winter that caulking is needed. The insulation in the roof and walls effects how much warm air can work its way into your home.

From a study done in 1987 at the University of Colorado, specific parameters were set for this "typical" house and calculations were done on possible savings. In the case where pre-cooling is most effective, a savings of $20-$30 per year appeared feasible.

In what type of house is pre-cooling most effective? Houses which "hold on" to temperature longer are better(i.e. more massive houses such as masonry). This allows the cooler air that is absorbed at night to be kept longer in the house. An example of this is the difference between adobe and wood. Adobe tends to "hold onto" temperature, causing a slower passage of heat or coolness through it than the passage through wood. Houses which have trees that shade the house from the sun means that less energy actually reaches the house to cause warming. Houses with good insulation, both in the attic and around windows and doors, are more effective for pre-cooling. Pre-cooling as also very effective in larger buildings and offices.

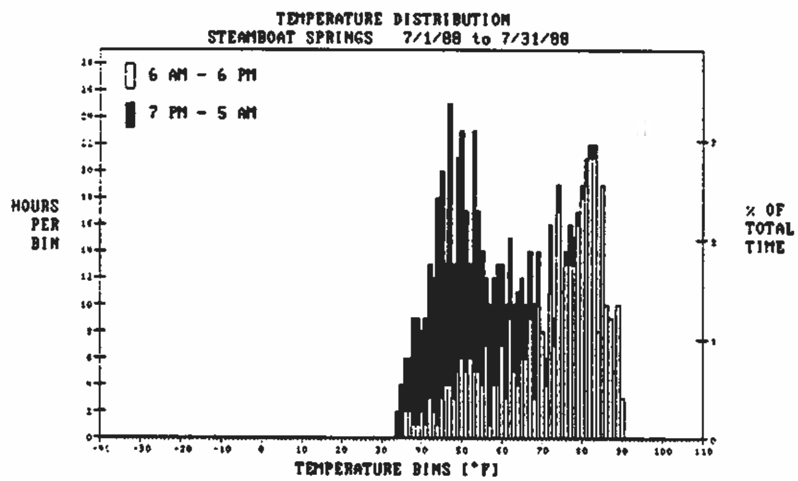



FIGURE 1.

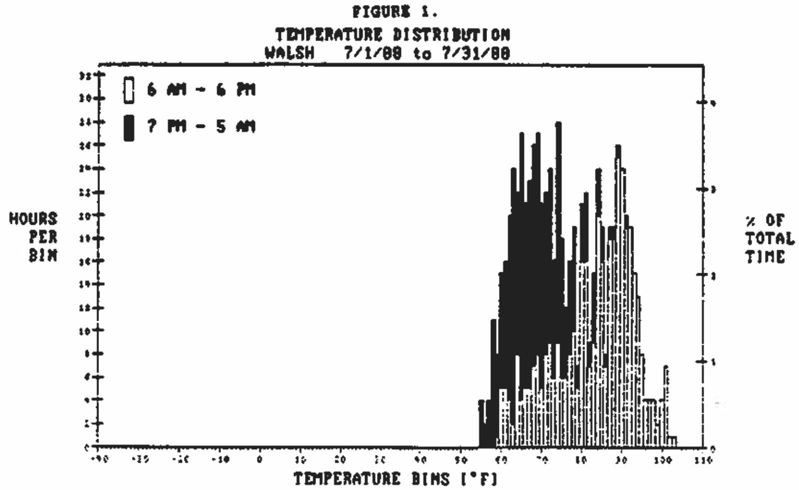



FIGURE 2.

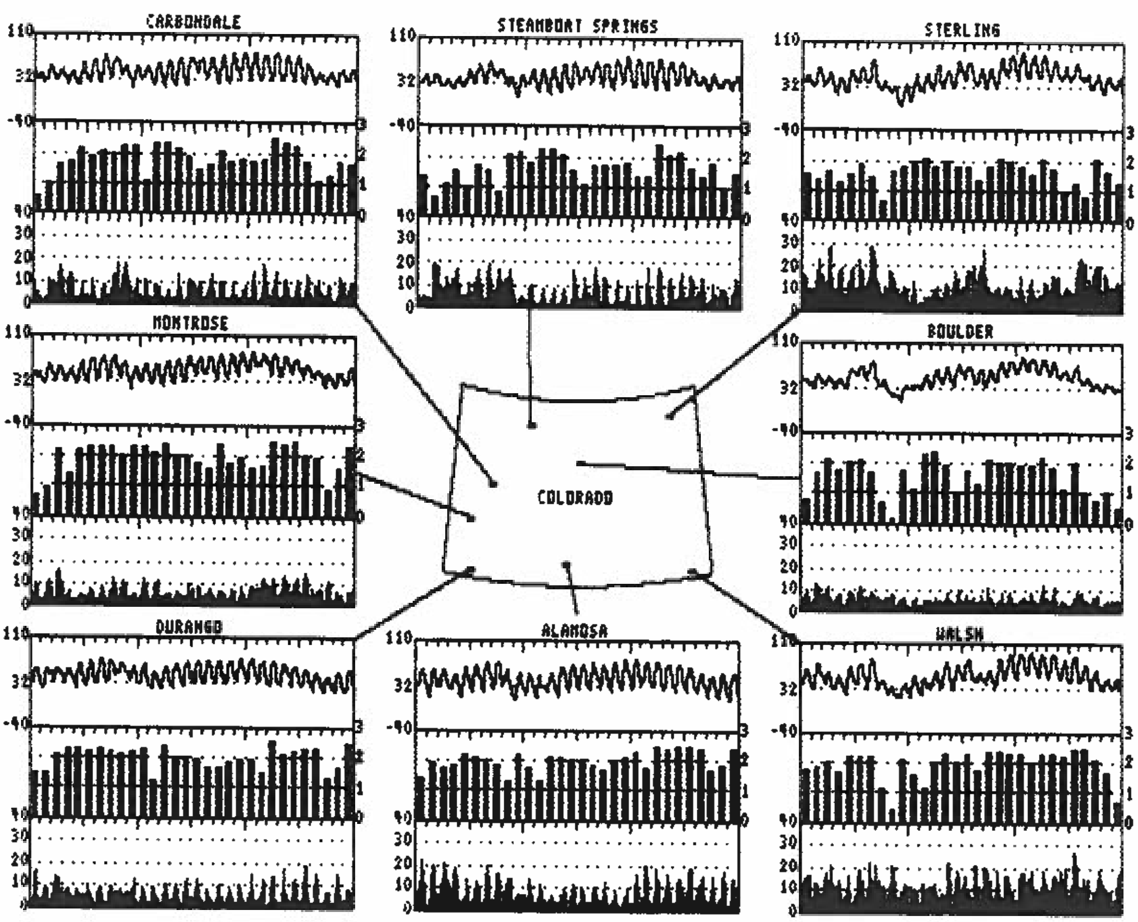
Figures 1 and 2 show temperature distributions for Montrose and Steamboat Springs during July of last year. The darker part of the bar graphs indicate nighttime temperatures. This shows that the night temperatures are anywhere from 20 to 30 degrees lower than daytime temperatures. This decrease in temperature is the phenomenon needed for pre-cooling.

WTHRNET WEATHER DATA APRIL 1989

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh | Boulder |
|---|---|---|---|---|---|---|---|---|
| monthly average temperature ( °F ) | 45.8 | 47.7 | 46.8 | 51.7 | 43.1 | 48.3 | 54.9 | 50.9 |
| monthly temperature extremes and time of occurence ( °F day/hour ) | | | | | | | | |
| maximum: | 78.4 20/14 | 73.0 21/15 | 78.1 20/13 | 81.3 20/13 | 75.7 20/13 | 91.0 21/16 | 94.1 22/14 | 86.7 21/15 |
| minimum: | 13.1 30/ 5 | 21.4 27/ 6 | 20.3 13/ 6 | 20.5 10/ 6 | 10.9 10/ 6 | 3.2 10/ 4 | 19.2 10/ 6 | 13.1 10/ 6 |
| monthly average relative humidity / dewpoint ( percent / °F ) | | | | | | | | |
| 5 AM | 59 / 13 | 55 / 17 | 77 / 24 | 49 / 17 | 82 / 24 | 70 / 26 | 54 / 23 | 52 / 21 |
| 11 AM | 20 / 15 | 24 / 20 | 33 / 23 | 26 / 21 | 37 / 22 | 41 / 28 | 30 / 26 | 38 / 23 |
| 2 PM | 18 / 16 | 20 / 18 | 25 / 21 | 24 / 21 | 29 / 20 | 32 / 26 | 25 / 25 | 35 / 23 |
| 5 PM | 19 / 14 | 19 / 17 | 23 / 19 | 21 / 19 | 27 / 18 | 29 / 24 | 29 / 25 | 35 / 24 |
| 11 PM | 34 / 11 | 38 / 16 | 47 / 21 | 33 / 16 | 52 / 21 | 55 / 25 | 45 / 24 | 44 / 22 |
| monthly average wind direction ( degrees clockwise from north ) | | | | | | | | |
| day | 239 | 204 | 258 | 254 | 244 | 210 | 175 | 144 |
| night | 174 | 77 | 187 | 159 | 145 | 222 | 223 | 204 |
| monthly average wind speed ( miles per hour ) | 6.14 | 4.53 | 4.74 | 4.69 | 5.42 | 9.99 | 9.30 | 4.31 |
| wind speed distribution ( hours per month for hourly average mph range ) | | | | | | | | |
| 0 to 3 | 252 | 328 | 351 | 238 | 305 | 34 | 18 | 206 |
| 3 to 12 | 364 | 359 | 330 | 466 | 328 | 478 | 525 | 513 |
| 12 to 24 | 104 | 33 | 39 | 16 | 87 | 195 | 174 | 1 |
| > 24 | 0 | 0 | 0 | 0 | 0 | 13 | 3 | 0 |
| monthly average daily total insolation ( Btu/ft²·day ) | 1970 | 1980 | 1800 | 1905 | 1617 | 1619 | 1923 | 1541 |
| "clearness" distribution ( hours per month in specified clearness index range ) | | | | | | | | |
| 60-80% | 237 | 134 | 123 | 185 | 143 | 156 | 227 | 120 |
| 40-60% | 78 | 92 | 96 | 70 | 80 | 112 | 66 | 77 |
| 20-40% | 47 | 55 | 81 | 63 | 116 | 59 | 45 | 81 |
| 0-20% | 11 | 28 | 27 | 20 | 31 | 46 | 34 | 69 |

## The State-Wide Picture

The figure below shows monthly weather at WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40°F to 110°F, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 Btu/ft²/day, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour.



COLORADO CLIMATE

MAY 1989

Colorado Climate Center
Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado 80523

*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 8

## May in Review:

An episode of damp, stormy weather in mid-May brought much-needed moisture to portions of Colorado's drought-stricken Eastern Plains. But in northeastern Colorado and across most of the mountains and Western Slope, precipitation was far below average for the 3rd month in a row. Temperatures were also warmer than average for the 3rd consecutive month.

## Colorado's July Climate:

July is the easiest month of the year to describe. Weather conditions are so consistent from year to year that I don't know how to improve on my description from the May 1988 issue of COLORADO CLIMATE. Here goes.

"Welcome to summer! Our summer makes quite an impression on the many visitors who flock to our state each year. Hot on the plains, cool in the mountains, sunny mornings, thundery afternoons, gorgeous sunsets, and calm and pleasant evenings are parts of our climate that tourists go home remembering."

"July produces the most predictable weather of the year. The often heard forecast 'partly cloudy with a 20% chance of afternoon and evening thundershowers' is usually pretty close. With weak winds aloft, the weather changes little from day to day. Elevation becomes the dominant climate control and convection (hot air rising) is the main cause of cloud formation and precipitation."

"July temperatures are reliably the hottest of the year. Deviations of more than a few degrees from long-term averages are uncommon. Daytime temperatures routinely decrease with elevation at a rate of about 4°F per thousand feet. Below 5,000' highs are usually in the 90s with lows near 60°F. Between 5,000' and 7,500' expect highs in the 80s and lows in the 50s. From 7,500' to 10,000' highs in the 70s are common with lows in the 40s. Above 10,000' highs in the 60s are expected. Even though it's July, nights in the mountains can still be cold. Lows in the 30s are normal and a few 20s are not surprising. Dry air helps make these cool temperatures possible. It also makes hot afternoons bearable. Afternoon relative humidities are typically 20% to 35%."

"Thunderstorms develop somewhere in the state nearly every day in July, but rainfall tends to be spotty and relatively light except in preferred thunderstorm regions such as Pikes Peak and parts of the San Juan and Sangre de Cristo mountain ranges. It is rare to awake to rain on the roof, but afternoon showers are common. Experienced hikers and climbers know to start their treks early to avoid the trauma that afternoon storms can bring. Lightning is a threat to safe outdoor activities across all parts of Colorado. An average of 3 people are killed each year by lightning with more deaths in July than any other month."

"Subtle but significant changes in cloud development can often be noted as July progresses. The 'Southwest Monsoon' (warm, moist wind bringing subtropical moisture northward across Mexico into Colorado) normally strengthens after the middle of July. As moisture increases, storms develop earlier in the day, cover larger areas and last longer into the night. Chances of local flash floods, such as the Big Thompson disaster, are markedly higher in late July than earlier in the month."

## Is Colorado Getting Hotter?

I have had the pleasure, during the past few months, to work with a high school student here in the Poudre R-1 school district. He (Erik Sparling, Poudre High School, junior) was able to work with the Colorado Climate Center as a part of a special Executive Intern Program sponsored jointly by the local school district and the Fort Collins Area Chamber of Commerce. While working with us, Erik chose to investigate the greenhouse effect/global warming issue by studying long-term trends in Colorado's hottest summer temperatures. In the figures and paragraphs that follow, I will try to describe briefly the results of his research.

(continued on page -9-)

## MAY 1989 DAILY WEATHER

| Date | Event |
|---|---|
| 1-4 | May 1st was the coldest morning of the month over most of the state. Temperatures dipped into the low 20s in northeast Colorado, upper 20s over most of the state and teens in the mountains. The 2°F reading at Bonham Reservoir was the coldest in the state for May. A little warmer on the 2nd with some scattered light showers (mountain snows). Stiff winds blew from the northwest 3-4th as a low pressure trough crossed Colorado. Significant precipitation fell across the northern and central mountains and some light showers extended eastward across the plains. Steamboat Springs picked up 0.82 of cold rain while Climax and Mt. Evans both received about 7" of new snow. |
| 5-8 | A large ridge of high pressure developed over the western states producing dry weather with much warmer temperatures statewide. By the afternoon of the 7th, temperatures climbed well into the 80s over most of the state below 7,000 ft elevation. Alamosa hit 81° and Pueblo had a toasty 93°. Turning cooler on the 8th over NE Colorado as a cold front triggered a few evening thunderstorms. Lamar picked up 0.64" of rain late on the 8th, and some areas on the plains reported hail. |
| 9-16 | Much colder east of the mountains on the 9th with damp, easterly "upslope" winds and dense cloudiness along the Front Range. A little light rain and drizzle fell. Meanwhile western Colorado remained very warm with Grand Junction hitting 89° for a high. Clouds increased during the day west of the mountains and some late-day showers and thunderstorms developed. A humid, stormy period then began over most of the state on the 10th and continued through the 16th as a large upper level low pressure area meandered over the Southwest. Storms developed each day and were most numerous over eastern Colorado 12th-16th. Storms produced plenty of hail (mostly small) and there were at least 2 reports of small tornadoes. Widespread moderate to heavy rains brought relief to developing drought conditions along the Front Range and over much of the southeastern plains. Denver got more than 2" of rain and Las Animas picked up 3.12" during the week (3 times more than in the previous 7 months combined). Unseasonably cool temperatures spread across the state during this period and rains turned to snow in the mountains. 22" of new snow was measured near Mt. Evans. |
| 17-21 | The storm system finally moved eastward pushing the clouds and precipitation eastward into the Midwest. A few more thunderstorms in southeast Colorado 17-18th, but drier and warmer across the state. A Pacific cold front crossed the state early on the 19th with brisk, dry winds. Some moisture slipped back into eastern Colorado late on the 20th and triggered some late night thunderstorms. Julesburg got 0.86" of rain from the storm. The moisture helped spawn an explosive storm on the 21st in east central Colorado that included a tornado and hail. The storm moved quickly into Kansas. |
| 22-23 | Another brief but extreme early-season heatwave developed hastening mountain snowmelt and breaking many high temperature records. Fort Collins hit 91° on the 23rd, their hottest May temperature in the past century. Denver hit 93°. The 104° reading at Las Animas was the hottest in the state. |
| 24-26 | Dry, windy and turning cooler on the 24th with some blowing dust on the plains. Quite chilly 25-26th, especially east of the mountains. Some evening thunderstorms developed in central Colorado on the 25th. (Limon received 0.50" of rain.) Some Coloradoans awoke to a surprise late snowstorm on the 26th. Nearly 4" accumulated near Castle Rock. Colorado Springs only managed to reach a high of 52°. |
| 27-29 | Again another brief, potent heatwave with more record breaking temperatures on the 28th and 29th. Craig and Estes Park both reached 81° on the 28th and Buena Vista hit 80° on the 29th. Denver had a 92° on the 28th and followed with a 93° on the 29th (Memorial Day). Late on the 29th brisk east winds developed across NE Colorado bringing cooler temperatures. A few big thunderstorms developed late. |
| 30-31 | Another upper level low pressure area approached from the west. Cooler statewide but continued dry on the western slope. Cool upslope winds east of the mountains helped kick off rounds of heavy storms each evening along the Front Range. The Fort Collins area was doused with 1 inch plus rains on the 30th. On the 31st it was Denver's turn. |

### May 1989 Extremes

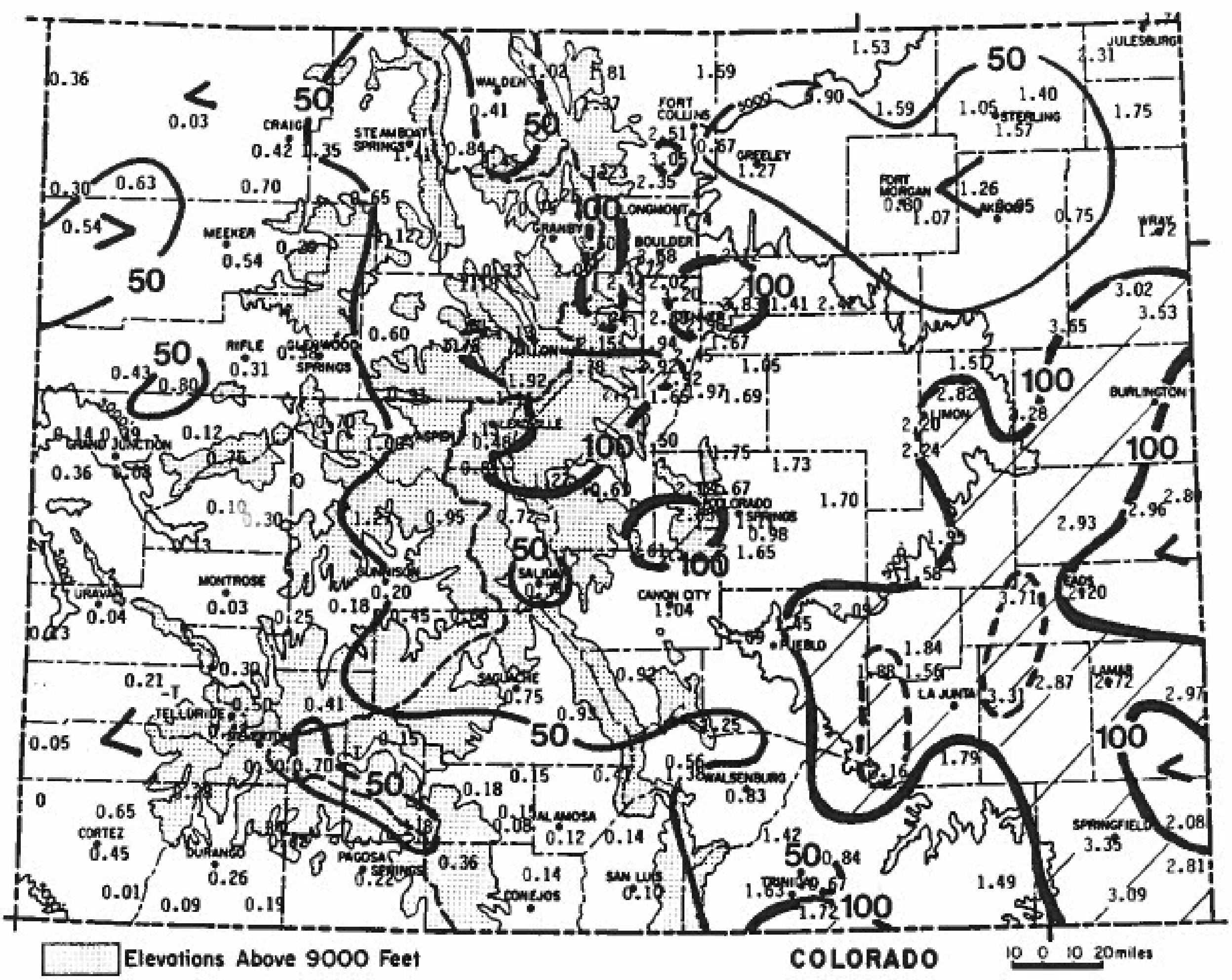
| | | | |
|---|---|---|---|
| Highest Temperature | 104°F | May 23 | Las Animas |
| Lowest Temperature | 2°F | May 1 | Bonham Reservoir |
| Greatest Total Precipitation | 3.83" | | Denver AP |
| Least Total Precipitation | 0.00" | | Yellow Jacket 2W |
| Greatest Total Snowfall* | 36" | | Mt. Evans Research Center |

*For existing weather stations with complete daily records.
Higher values are likely for unmonitored locations.

# MAY 1989 PRECIPITATION

May came through as usual with abundant and much-needed precipitation from the Front Range eastward across the plains. Denver was the wettest reporting station in the entire state, and since much of the state's news originates in Denver, most of us thought the entire state was sharing the wealth. While the rains did seem heavy in comparison to the previous dry months, precipitation was generally only near average in the wettest areas. Much of the rest of the state was again very dry. In northeastern counties from Weld county to the Nebraska border, most stations had only half or less of their average May precipitation. The situation was even worse in western Colorado. Most areas from Craig and Meeker south to Durango and Alamosa received only about one-fourth of their average moisture.

| Greatest | | Least | |
|---|---|---|---|
| Denver WSFO AP | 3.83" | Yellow Jacket 2W | 0.00" |
| Haswell | 3.71" | Placerville | Trace |
| Joes | 3.65" | Gateway 1SW | Trace |
| Silver Lake | 3.60" | Hermit 7ESE | Trace |
| Bonny Lake | 3.53" | Mesa Verde Natl Park | 0.01" |

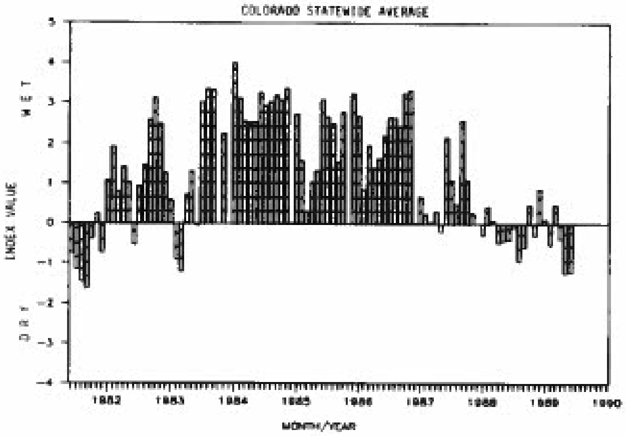



Precipitation amounts (inches) for May 1989 and contours of precipitation as a percent of the 1961-1980 average. Dashed line is 150% of average.

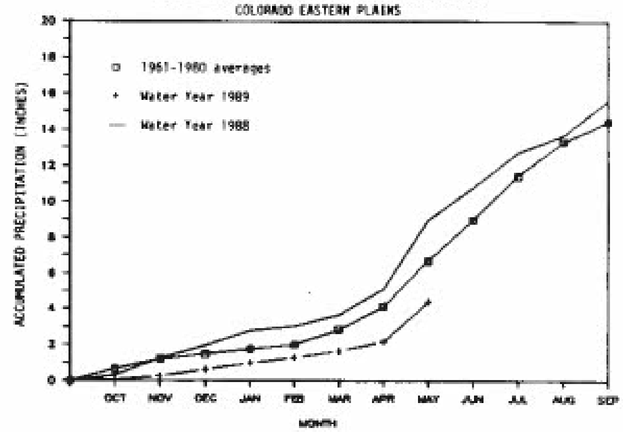
# 1989 WATER YEAR PRECIPITATION

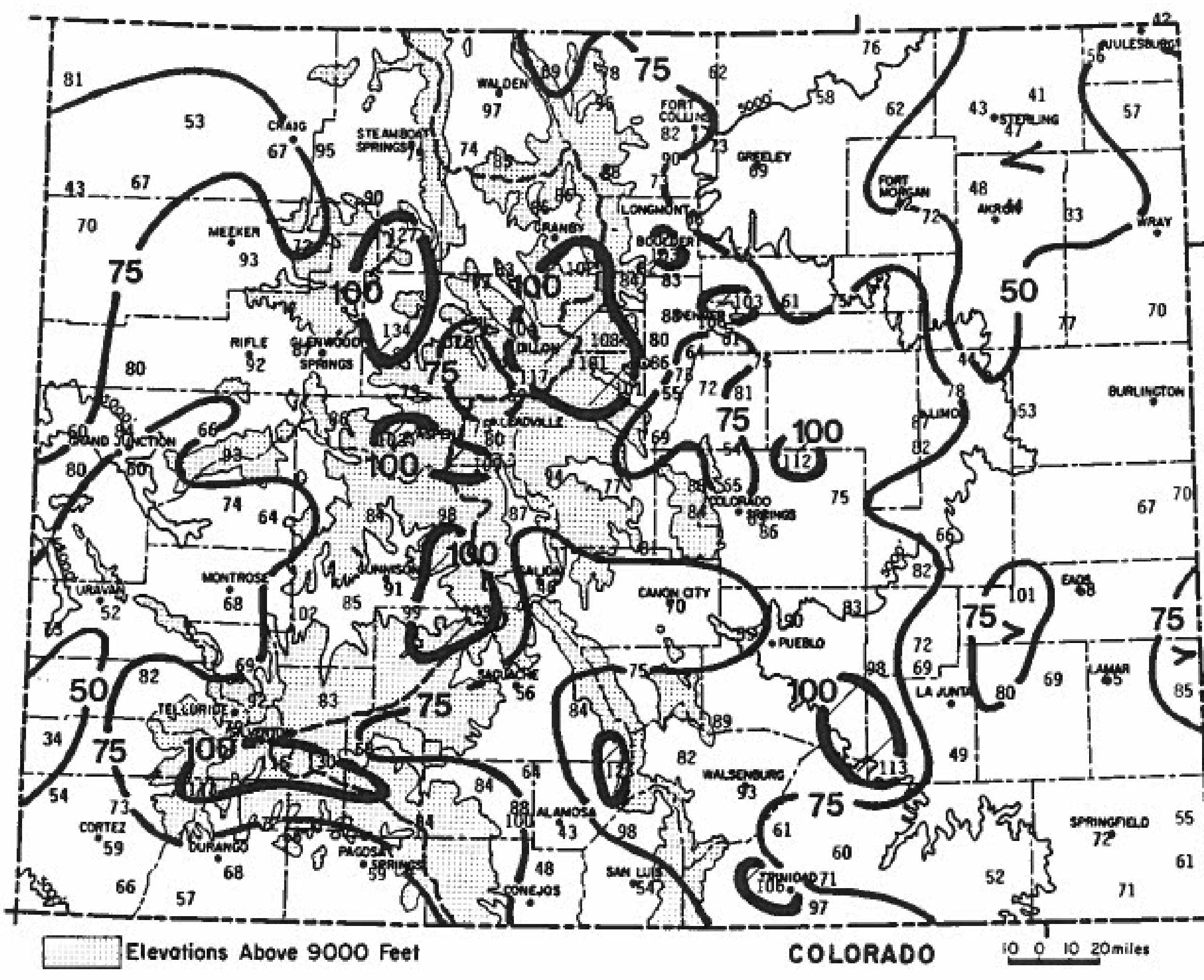
Even though the May rains did not soak the entire state, they did bring significant relief to portions of eastern Colorado. Water year precipitation totals across the plains are now mostly above 60% of average -- a significant improvement. However, it was still very dry at the end of May in northeast Colorado (driest Oct-May on record at Akron), and in the western half of the state the moisture situation continues to decline. This has been the driest spring (March-May) on record (more than 100 years) at Montrose and over other parts of southwest Colorado. In the mountains, water year precipitation is closer to average, but with this year's warm spring much of the snowpack has already melted and summer streamflows are likely to be very low.

SURFACE WATER SUPPLY INDEX
COLORADO STATEWIDE AVERAGE




ACCUMULATED PRECIPITATION
COLORADO EASTERN PLAINS

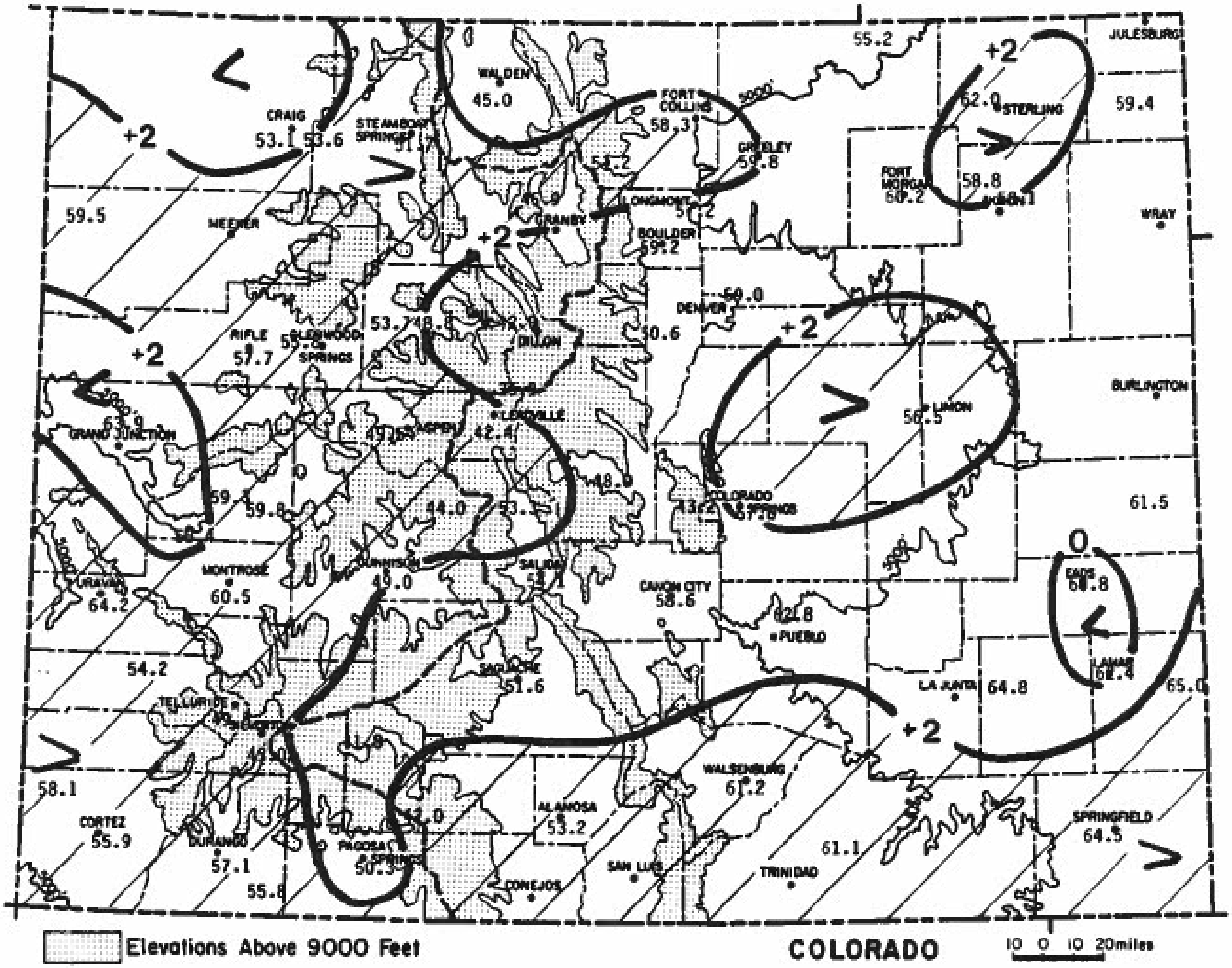



Precipitation for October 1988 through May 1989
as a percent of the 1961-1980 average.

## MAY 1989 TEMPERATURES AND DEGREE DAYS

This was the third consecutive warmer than average month across Colorado making this one of the warmer springs on record. Although Colorado experienced three separate episodes of record-breaking hot temperatures this month, most reporting stations were only about 2 degrees F above the long-term average. Several episodes of cool, damp weather east of the mountains helped to hold monthly averages down. On the Western Slope, daytime temperatures were as much as 5°F above average, but with dry air, nighttime temperatures were closer to normal.




May 1989 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## MAY 1989 SOIL TEMPERATURES

Soil temperatures were on the rise in May. These temperatures were generally close to or a little above the long-term average for this time of year.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.

FORT COLLINS 7 AM SOIL TEMPERATURES

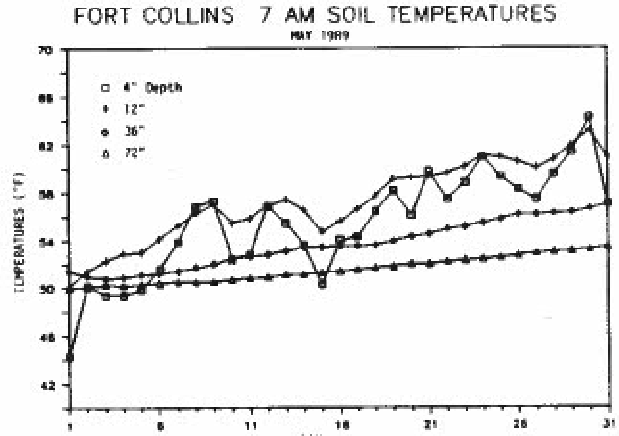


Table 1. Heating Degree Day Data through May 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 87-88 | 66 | 96 | 364 | 601 | 1130 | 1556 | 1867 | 1381 | 1031 | 658 | 454 | 102 | 9306 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | 1210 | 854 | 600 | 358 | | 8061 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 87-88 | 112 | 152 | 355 | 563 | 1024 | 1382 | 1450 | 1146 | 1136 | 734 | 517 | 123 | 8694 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | 1171 | 899 | 692 | 476 | | 8175 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 87-88 | 7 | 33 | 122 | 370 | 713 | 1053 | 1107 | 842 | 739 | 400 | 203 | 14 | 5603 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | 1139 | 615 | 427 | 209 | | 5396 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 87-88 | 49 | 117 | 313 | 549 | 955 | 1277 | 1357 | 1010 | 1030 | 639 | 472 | 102 | 7870 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | 1153 | 784 | 645 | 360 | | 7439 |
| BURLINGTON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 87-88 | 5 | 20 | 72 | 375 | 724 | 1037 | 1221 | 935 | 779 | 449 | 178 | 14 | 5809 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | 1135 | 697 | 375 | M | | 5194 |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 87-88 | 11 | 36 | 87 | 374 | 668 | 1007 | 1144 | 858 | 767 | 407 | 191 | 16 | 5566 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | 1078 | 554 | 382 | 226 | | 5101 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 87-88 | 17 | 74 | 150 | 445 | 767 | 1108 | 1256 | 958 | 886 | 499 | 273 | 25 | 6458 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | 1205 | 655 | 475 | 247 | | 5973 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 87-88 | 6 | 35 | 154 | 396 | 860 | 1179 | 1351 | 1008 | 899 | 609 | 362 | 56 | 6915 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | 1008 | 718 | 450 | 282 | | 6325 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 87-88 | 55 | 96 | 227 | 534 | 950 | 1376 | 1561 | 1264 | 1076 | 593 | 399 | 52 | 8183 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | 1443 | 894 | 531 | 365 | | 7899 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 87-88 | 0 | 11 | 108 | 354 | 737 | 1102 | 1300 | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | 1327 | 964 | 613 | 345 | 211 | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 87-88 | 11 | 21 | 110 | 410 | 745 | 1125 | 1227 | 889 | 811 | 437 | 215 | 14 | 6015 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | 1190 | 665 | 432 | 213 | | 5704 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 87-88 | 296 | 346 | 556 | 763 | 1145 | 1491 | 1629 | 1376 | 1379 | 933 | 717 | 322 | 10953 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | 1307 | 1088 | 875 | 679 | | 10015 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 87-88 | 14 | 44 | 188 | 435 | 851 | 1206 | 1391 | 972 | 859 | 514 | 346 | 42 | 6862 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | 933 | 666 | 388 | 237 | | 6133 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 87-88 | 54 | 75 | 254 | 509 | 950 | 1331 | 1544 | 1173 | 1002 | 607 | 404 | 52 | 7955 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | 1227 | 829 | 536 | 344 | | 7744 |
| EVERGREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 87-88 | 69 | 118 | 333 | 602 | 922 | 1255 | 1310 | 1029 | 992 | 645 | 462 | 111 | 7848 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | 1227 | 794 | 636 | 439 | | 7322 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 87-88 | 12 | 37 | 146 | 453 | 784 | 1140 | 1252 | 936 | 821 | 479 | 217 | 8 | 6285 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | 1207 | 732 | 433 | 216 | | 6027 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 87-88 | 12 | 29 | 110 | 430 | 773 | 1154 | 1484 | 1055 | 826 | 495 | 206 | 17 | 6591 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | 1230 | 726 | 446 | 183 | | 6201 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 87-88 | 0 | 6 | 34 | 248 | 754 | 1147 | 1469 | 1031 | 741 | 350 | 172 | 8 | 5960 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | 1037 | 534 | 260 | 113 | | 5416 |

* = AVES ADJUSTED FOR STATION MOVES  M = MISSING  E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 87-88 | 207 | 257 | 480 | 677 | 1098 | 1516 | 1642 | 1413 | 1372 | 907 | 602 | 238 | 10409 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | 1368 | 1086 | 805 | 584 | | 9660 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 87-88 | 10 | 26 | 119 | 424 | 762 | 1157 | 1363 | 955 | 807 | 437 | 204 | 6 | 6270 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | 1230 | 711 | 444 | 184 | | 5979 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | 1698 | 2096 | 1578 | 1096 | 640 | 487 | | 9946 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 87-88 | 0 | 3 | 35 | 273 | 653 | 1032 | 1278 | 837 | 638 | 327 | 103 | 1 | 5180 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | 1109 | 535 | 303 | 114 | | 4831 |
| LEADVILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 87-88 | 346 | 393 | 578 | 763 | 1180 | 1534 | 1577 | 1326 | 1355 | 957 | 741 | 360 | 11110 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | 1310 | 1112 | 914 | 695 | | 10263 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 87-88 | 21 | 66 | 158 | 502 | 840 | 1209 | 1354 | 1022 | 943 | 569 | 321 | 35 | 7040 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | 1211 | 751 | 516 | 275 | | 6401 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 87-88 | 12 | 33 | 159 | 464 | 805 | 1169 | 1383 | 1035 | 847 | 509 | 222 | 20 | 6658 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | 1307 | 841 | 542 | 256 | | 6851 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | M | M | M | M | M | | M |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 87-88 | 5 | 30 | 129 | 349 | 849 | 1160 | 1332 | 1003 | 817 | 468 | 230 | 26 | 6398 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | 972 | 605 | 348 | 180 | | 5839 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 87-88 | 104 | 105 | 347 | 523 | 947 | 1292 | 1548 | 1187 | 996 | 663 | 485 | 143 | 8340 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | 1095 | 860 | 574 | 447 | | 7760 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 87-88 | 4 | 17 | 43 | 355 | 754 | 1111 | 1399 | 903 | 777 | 399 | 167 | 8 | 5937 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | 1141 | 573 | 378 | 134 | | 5350 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 87-88 | 9 | 24 | 125 | 391 | 819 | 1209 | 1430 | 1039 | 865 | 454 | 268 | 14 | 6647 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | 1049 | 674 | 381 | 224 | | 6327 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 87-88 | 77 | 127 | 330 | 590 | 1033 | 1448 | 1619 | 1336 | 1167 | 674 | 433 | 95 | 8929 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | 1355 | 964 | 581 | 401 | | 8440 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 87-88 | 12 | 31 | 108 | 413 | 742 | E1140 | 1475 | 1029 | 831 | 476 | 197 | 12 | 6466 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | 1189 | 730 | 416 | 152 | | 5826 |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 87-88 | 161 | 222 | 426 | 603 | 992 | 1269 | 1354 | 1109 | 1092 | 720 | 547 | 208 | 8703 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | 1071 | 858 | 633 | 463 | | 7974 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 87-88 | 4 | 25 | 80 | 330 | 730 | 1054 | 1209 | 850 | 803 | 438 | 234 | 13 | 5770 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | 1026 | 538 | 378 | 159 | | 5066 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 87-88 | 215 | 281 | 495 | 740 | 1242 | 1499 | 1572 | 1343 | 1340 | 835 | 638 | 184 | 10384 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | 1369 | 1023 | 772 | 612 | | 9405 |
| WALSENBURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 87-88 | 3 | 30 | 101 | 332 | 707 | 977 | 1109 | 826 | 773 | 401 | 238 | 25 | 5522 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | 1031 | 492 | 376 | 164 | | 4919 |

* = AVES ADJUSTED FOR STATION MOVES  M = MISSING  E = ESTIMATED

# MAY 1989 CLIMATIC DATA

## Eastern Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEW RAYMER 21N | 70.0 | 40.5 | 55.2 | 0.2 | 91 | 21 | 312 | 17 | 318 | 1.53 | -0.84 | 64.6 | 8 |
| STERLING | 77.5 | 46.5 | 62.0 | 4.0 | 98 | 23 | 152 | 65 | 419 | 1.05 | -2.14 | 32.9 | 7 |
| FORT MORGAN | 74.7 | 45.7 | 60.2 | 1.9 | 96 | 25 | 183 | 42 | 388 | 0.80 | -1.66 | 32.5 | 4 |
| AKRON FAA AP | 73.2 | 44.4 | 58.8 | 2.3 | 96 | 22 | 219 | 33 | 365 | 1.26 | -1.84 | 40.6 | 8 |
| AKRON 4E | 73.2 | 43.1 | 58.1 | 1.7 | 97 | 19 | 246 | 39 | 362 | 0.95 | -2.25 | 29.7 | 5 |
| HOLYOKE | 72.2 | 46.6 | 59.4 | 0.3 | 95 | 22 | 207 | 39 | 358 | 1.75 | -1.29 | 57.6 | 8 |
| LIMON WSMO | 70.8 | 42.2 | 56.5 | 3.4 | 90 | 26 | 275 | 20 | 333 | 2.20 | 0.02 | 100.9 | 9 |
| CHEYENNE WELLS | 75.5 | 47.5 | 61.5 | 1.8 | 97 | 32 | 163 | 63 | 411 | 2.96 | -0.04 | 98.7 | 9 |
| EADS | 73.6 | 48.0 | 60.8 | -0.4 | 95 | 30 | 177 | 57 | 389 | 2.20 | -0.39 | 84.9 | 9 |
| LAMAR | 78.7 | 46.0 | 62.4 | -0.7 | 100 | 29 | 154 | 79 | 440 | 2.72 | 0.11 | 104.2 | 10 |
| LAS ANIMAS | 80.3 | 49.3 | 64.8 | 1.5 | 104 | 26 | 114 | 115 | 486 | 3.31 | 1.36 | 169.7 | 10 |
| HOLLY | 80.8 | 49.1 | 65.0 | 2.8 | 100 | 30 | 77 | 83 | 478 | 2.97 | 0.33 | 112.5 | 14 |
| SPRINGFIELD 7WSW | 79.9 | 49.2 | 64.5 | 4.2 | 98 | 29 | 112 | 104 | 475 | 3.35 | 0.66 | 124.5 | 8 |

## Foothills/Adjacent Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FORT COLLINS | 72.5 | 44.1 | 58.3 | 2.0 | 91 | 29 | 216 | 17 | 358 | 2.51 | -0.12 | 95.4 | 10 |
| GREELEY UNC | 74.5 | 45.1 | 59.8 | 2.0 | 95 | 27 | 184 | 30 | 386 | 1.27 | -1.38 | 47.9 | 7 |
| ESTES PARK | 65.9 | 36.4 | 51.2 | 3.2 | 81 | 19 | 422 | 1 | 254 | 1.23 | -0.74 | 62.4 | 6 |
| LONGMONT 2ESE | 72.9 | 41.5 | 57.2 | 0.1 | 93 | 18 | 256 | 21 | 353 | 1.74 | -0.62 | 73.7 | 9 |
| BOULDER | 74.0 | 44.4 | 59.2 | 0.8 | 91 | 24 | 209 | 33 | 389 | 2.68 | -0.36 | 88.2 | 11 |
| DENVER WSFO AP | 72.9 | 45.1 | 59.0 | 1.9 | 93 | 27 | 213 | 34 | 364 | 3.83 | 1.64 | 174.9 | 15 |
| EVERGREEN | 66.5 | 34.7 | 50.6 | 1.6 | 88 | 18 | 439 | 0 | 263 | 1.94 | -0.64 | 75.2 | 12 |
| LAKE GEORGE 8SW | 62.0 | 33.9 | 48.0 | 1.8 | 78 | 17 | 522 | 2 | 205 | 0.61 | -0.58 | 51.3 | 3 |
| RUXTON PARK | 56.6 | 29.9 | 43.2 | -0.1 | 75 | 13 | 666 | 0 | 145 | 2.65 | 0.12 | 104.7 | 10 |
| COLORADO SPRINGS | 71.1 | 44.1 | 57.6 | 2.1 | 91 | 31 | 247 | 25 | 335 | 1.11 | -0.86 | 56.3 | 10 |
| CANON CITY 2SE | 73.1 | 44.1 | 58.6 | 0.3 | 92 | 29 | 226 | 33 | 365 | 1.04 | -0.39 | 72.7 | 9 |
| PUEBLO WSO AP | 78.6 | 46.9 | 62.8 | 1.6 | 98 | 32 | 134 | 72 | 445 | 1.45 | 0.36 | 133.0 | 10 |
| WALSENBURG | 78.1 | 44.3 | 61.2 | 3.7 | 93 | 25 | 164 | 54 | 449 | 0.83 | -0.58 | 58.9 | 7 |
| TRINIDAD FAA AP | 77.6 | 44.5 | 61.1 | 2.1 | 93 | 29 | 159 | 46 | 437 | 0.84 | -0.70 | 54.5 | 5 |

## Mountains/Interior Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WALDEN | 63.2 | 26.7 | 45.0 | 0.9 | 77 | 12 | 612 | 0 | 216 | 0.41 | -0.71 | 36.6 | 9 |
| LEADVILLE 2SW | 57.2 | 27.5 | 42.4 | 2.9 | 70 | 17 | 695 | 0 | 135 | 0.48 | -0.72 | 40.0 | 5 |
| SALIDA | 70.9 | 37.3 | 54.1 | 1.8 | 85 | 21 | 338 | 9 | 334 | 0.34 | -0.78 | 30.4 | 5 |
| BUENA VISTA | 68.2 | 38.4 | 53.3 | 3.4 | 80 | 28 | 360 | 3 | 293 | 0.72 | -0.18 | 80.0 | 3 |
| SAGUACHE | 68.6 | 34.5 | 51.6 | 1.3 | 82 | 19 | 405 | 0 | 295 | 0.75 | 0.06 | 108.7 | 4 |
| HERMIT 7ESE | 56.3 | 27.3 | 41.8 | 0.3 | 66 | 15 | 712 | 0 | 105 | 0.00 | -1.01 | 0.0 | 0 |
| ALAMOSA WSO AP | 73.4 | 33.1 | 53.2 | 2.7 | 84 | 15 | 358 | 0 | 369 | 0.12 | -0.57 | 17.4 | 3 |
| STEAMBOAT SPRINGS | 70.4 | 33.1 | 51.7 | 4.2 | 81 | 20 | 401 | 0 | 326 | 1.41 | -0.60 | 70.1 | 6 |
| GRAND LAKE 6SSW | 61.3 | 30.4 | 45.9 | 2.2 | 74 | 17 | 584 | 0 | 183 | 0.75 | -0.59 | 56.0 | 11 |
| DILLON 1E | 57.7 | 28.1 | 42.9 | 0.6 | 72 | 16 | 679 | 0 | 146 | 1.13 | -0.07 | 94.2 | 8 |
| AVON | 65.0 | 32.5 | 48.8 | 0.3 | 80 | 22 | 495 | 0 | 243 | 0.80 | -0.40 | 66.7 | 9 |
| CLIMAX | 48.5 | 23.2 | 35.9 | 0.3 | 65 | 6 | 894 | 0 | 50 | 1.11 | -0.74 | 60.0 | 11 |
| ASPEN 1SW | 64.3 | 34.7 | 49.5 | 2.5 | 78 | 24 | 476 | 0 | 229 | 1.00 | -1.10 | 47.6 | 7 |
| TAYLOR PARK | 58.4 | 29.6 | 44.0 | 7.7 | 71 | 14 | 645 | 0 | 150 | 0.95 | -0.21 | 81.9 | 6 |
| TELLURIDE | 66.1 | 33.5 | 49.8 | 3.7 | 78 | 21 | 463 | 0 | 256 | 0.42 | -1.21 | 25.8 | 4 |
| PAGOSA SPRINGS | 71.7 | 28.8 | 50.3 | 1.2 | 82 | 17 | 447 | 0 | 343 | 0.22 | -0.84 | 20.8 | 3 |
| SILVERTON | 61.8 | 24.1 | 43.0 | 2.1 | 73 | 9 | 677 | 0 | 195 | 0.30 | -1.08 | 21.7 | 5 |
| WOLF CREEK PASS 1 | 55.3 | 28.7 | 42.0 | 2.9 | 65 | 21 | 707 | 0 | 107 | 1.87 | -0.06 | 96.9 | 5 |

## Western Valleys

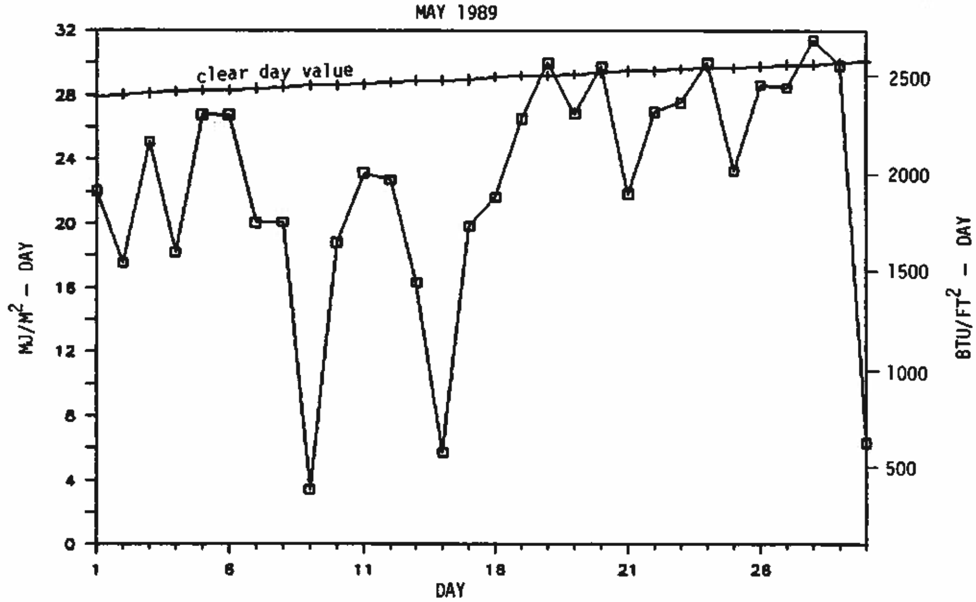
| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 69.1 | 37.1 | 53.1 | 1.6 | 82 | 23 | 365 | 3 | 309 | 0.42 | -1.23 | 25.5 | 7 |
| HAYDEN | 71.0 | 36.3 | 53.6 | 2.1 | 82 | 24 | 345 | 0 | 332 | 1.35 | 0.07 | 105.5 | 9 |
| RANGELY 1E | 76.3 | 42.7 | 59.5 | 3.1 | 87 | 31 | 183 | 17 | 420 | 0.54 | -0.37 | 59.3 | 3 |
| EAGLE FAA AP | 71.4 | 36.1 | 53.7 | 2.6 | 84 | 22 | 344 | 2 | 342 | 0.60 | -0.07 | 89.6 | 6 |
| GLENWOOD SPRINGS | 72.4 | 39.1 | 55.8 | 1.3 | 85 | 27 | 283 | 3 | 355 | 0.38 | -1.07 | 26.2 | 8 |
| RIFLE | 76.3 | 39.2 | 57.7 | 2.3 | 88 | 29 | 224 | 4 | 413 | 0.31 | -0.65 | 32.3 | 4 |
| GRAND JUNCTION WS | 77.9 | 49.8 | 63.9 | 1.9 | 90 | 39 | 113 | 85 | 470 | 0.39 | -0.43 | 47.6 | 4 |
| CEDAREDGE | 76.9 | 41.7 | 59.3 | 2.8 | 88 | 31 | 185 | 17 | 426 | 0.10 | -1.02 | 8.9 | 2 |
| PAONIA 1SW | 76.9 | 42.7 | 59.8 | 3.0 | 88 | 33 | 176 | 22 | 427 | 0.30 | -0.99 | 23.3 | 6 |
| DELTA | 79.7 | 37.0 | 58.4 | -1.1 | 92 | 27 | 211 | 15 | 446 | 0.13 | -0.43 | 23.2 | 4 |
| GUNNISON | 68.6 | 29.3 | 49.0 | 1.9 | 80 | 17 | 487 | 0 | 298 | 0.20 | -0.42 | 32.3 | 3 |
| MONTROSE NO. 2 | 75.6 | 45.4 | 60.5 | 3.7 | 87 | 33 | 180 | 50 | 430 | 0.03 | -0.73 | 3.9 | 1 |
| URAVAN | 81.7 | 46.6 | 64.2 | 2.9 | 94 | 34 | 108 | 88 | 499 | 0.04 | -0.97 | 4.0 | 3 |
| NORWOOD | 71.3 | 37.2 | 54.2 | 3.1 | 87 | 25 | 326 | 2 | 343 | 0.21 | -0.80 | 20.8 | 3 |
| YELLOW JACKET 2W | 74.5 | 41.8 | 58.1 | 4.4 | 85 | 31 | 215 | 7 | 393 | 0.00 | -1.19 | 0.0 | 0 |
| CORTEZ | 75.1 | 36.7 | 55.9 | 2.5 | 88 | 29 | 282 | 9 | 399 | 0.45 | -0.47 | 48.9 | 2 |
| DURANGO | 77.0 | 37.2 | 57.1 | 3.8 | 86 | 26 | 237 | 0 | 426 | 0.26 | -0.86 | 23.2 | 3 |
| IGNACIO 1N | 77.1 | 34.5 | 55.8 | 3.4 | 87 | 22 | 277 | 0 | 427 | 0.19 | -0.67 | 22.1 | 2 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## MAY 1989 SUNSHINE AND SOLAR RADIATION

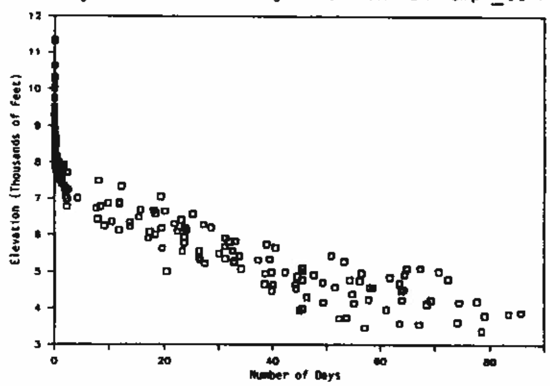
| Station | Number of Days: clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 9 | 8 | 14 | -- | -- |
| Denver | 9 | 8 | 14 | 69% | 65% |
| Fort Collins | 6 | 15 | 10 | -- | -- |
| Grand Junction | 11 | 11 | 9 | 83% | 71% |
| Pueblo | 8 | 10 | 13 | 73% | 73% |

FT. COLLINS TOTAL HEMISPHERIC RADIATION
MAY 1989



As a beginning point, the average frequency of daily high temperatures at or above 90°F were analyzed for 178 locations across Colorado. Not surprisingly, 90° plus temperatures were found to occur most frequently in southeast Colorado. Las Animas, with more than 80 days per year with temperatures at or above 90°F is the state's hot spot. Elevation has a huge effect on the frequency of hot temperatures. As the graph below shows, the frequency of high temperatures ≥ 90° drops very quickly with elevation. At an elevation of 7000 feet, Colorado locations average only 2 to 20 days ≥ 90°F. Above 8000 feet, 90° temperatures are extremely rare and above 9000 feet they do not occur.

Average Annual No. of Days with Maximum Temp ≥ 90°F.




The next analysis, which seemed simple enough, was actually a rigorous exercise of diligence and discipline. We simply wanted to find out for each month of the year what has been the highest temperature ever recorded anywhere in Colorado and where did it occur. We've had this sort of information for a few individual stations but never for the entire state. These have been tabulated routinely during the past 40 years or so, but prior to that time Erik had to visually scan through hundreds of daily high temperatures each month to find the highest one for the state. A tabulation was prepared back into the 1880s and here is what we found.

Highest Statewide Daily Maximum Temperature for each month, 1887-1989

| Month | Temp. | Year | Location | Month | Temp. | Year | Location |
|---|---|---|---|---|---|---|---|
| Jan | 84°F | 1916 | Las Animas | Jul | 118°F | 1888 | Bennett |
| Feb | 90 | 1904 | Blaine | Aug | 112 | 1938 | Sedgwick |
| Mar | 96 | 1907 | Holly | Sep | 107 | 1947 | Eads |
| Apr | 100 | 1989 | Las Animas | Oct | 100 | 1910 | Sheridan Lake |
| May | 106 | 1934 | Eads | Nov | 93 | 1915 | Sedgwick |
| Jun | 113 | 1953 | Eversoll Ranch | Dec | 88 | 1915 | Las Animas |

Perhaps this information is little more than interesting trivia. But now that we have this, we can put each new month's climate information into a more accurate historical perspective. I would never have known, for example, that the 100°F reading at Las Animas this past April was the warmest April temperature ever observed in this state. This exercise was not without its share of frustration (talk to Erik if you want to get the real story). For example, if you believe the data at face value, Breckenridge was the Colorado hot spot for several months back in the 1880s. Unless there was a volcano erupting, or the old town was even wilder than its reputation, Breckenridge physically could not possibly have had the warmest temperatures in the state. More than likely the thermometer was left out in the direct sun. The 118° reading at Bennett is also almost certainly an error. 114° at Las Animas in July 1933 and 114° at Sedgwick in July 1954 are likely the true Colorado record.

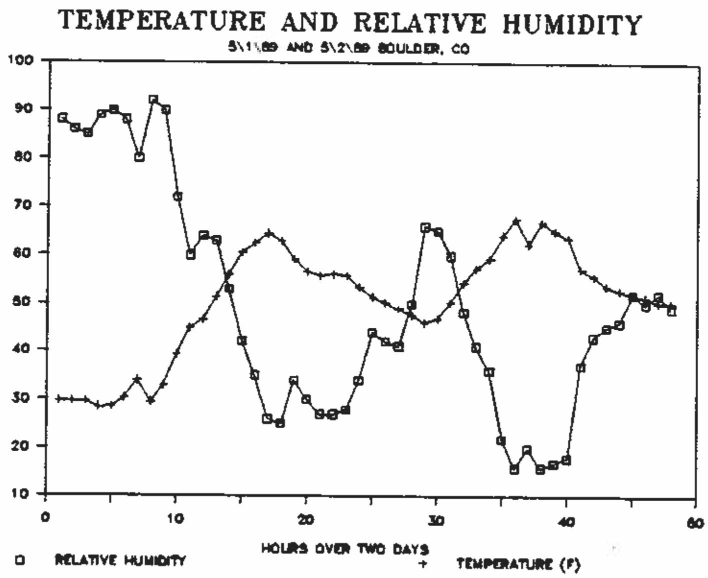
After these preliminary studies, the time finally came to look at trends. We identified a handful of stations across the state with excellent quality long-term daily temperature data. For those stations (Grand Junction, Montrose, Steamboat Springs, Fort Collins, Rocky Ford, and Las Animas), Erik tabulated the frequency of summer (June-August) daily maximum temperatures above several thresholds in addition to the commonly used 90 degree threshold. While it may seem that weather is pretty much the same from one summer to the next, there is actually large variations in how many times the temperature rises above specified levels. The most outstanding feature of the past century was the incredible heat of the 1930s. It appears that all of Colorado had a very large increase in the number of hot summer days during that decade compared to the previous decades. The 1910s and 20s were quite cool. Hot temperature extremes diminished sharply in the 1940s and then increased again at these key stations during the 1950s. Another cooling trend was then noted that continued into the early 1970s. Since then a warming seems to have begun again that is most pronounced east of the mountains.

Our conclusions: For most of Colorado we definitely are having a higher frequency of hot summer days than we did during the 1940s and prior to the 1930s. We are not as hot as we were in the 1930s, but most of the state has been on an upward climb in recent years. From this analysis it would be very difficult to prove that we are experiencing effects from the hypothesized global warming -- at least not yet. The natural year-to-year variations in the climate are still greater than any underlying trend, even in the stable climate regime of the summer season. We will continue to track these trends and keep you all posted. If there are any more of you climate enthusiasts like Erik out there, come by and see us. There are more than enough research projects to keep all of us hopping for a long, long time.

## Relative Humidity and the Dew Point
(Mountain Dew)

Picture yourself down in Florida. The sun is shining. It is hot. The thermometer says 90 degrees, but you could swear it is closer to 100. You feel sticky and uncomfortable. Oh, to be back in Colorado where 90 degrees is hot but not so drenching of body and spirit. Why is there such a difference? Humidity! The relative humidity in Florida is much higher than in Colorado.

Each month we show you weather information from around the state. One of the topics displayed is that of the monthly averaged relative humidity and dew point at various times of the day. Just what does this tell you? In scientific terms, relative humidity is the ratio of the partial pressure of the water vapor in air to the vapor pressure of water in saturated air at the same temperature. A bit more simply stated, relative humidity is the percentage of moisture held by the air at a specific temperature compared to the maximum amount that the air could absorb. As air cools off, its ability to absorb water decreases. The dewpoint is the temperature at which vapor will begin to condense, or when the relative humidity reaches 100%. Cooler air can hold less water and so, with no change in the absolute amount of moisture from the day to night, the relative humidity increases at night. (See graph.)




Relative humidity can be a subjective experience, as described in the Florida scenario, but it also has physiological ramifications. The passageways of the nose, throat and lungs are lined by cells which contain little hairs (cilia). The job of these cilia is to move particles of dust that are inhaled to keep the cells free of anything that may encourage the growth of bacteria. When the relative humidity goes below 40% , the motion of the cilia decreases and a milieu can be set up that increases bacteria or viral growth. Relative humidity can also effect your pocketbook. Furniture is generally a large purchase, and one which is not quickly replaced. Low humidity tends to dry out wood furniture, while high humidity tends to warp wood. Static electricity build-up ,besides being a nuisance for small shocks, can cause paper to stick to itself and cause problems when copying. The static electricity is caused by low relative humidity and the lack of water in the air for the charged particles on which to adhere. The dewpoint can be of interest, especially if you forget to water outdoor plants. If the dewpoint is reached at some time during the night, the plants will obtain some moisture from the air as the vapor condenses. This can keep them alive during periodic episodes of forgetfulness.

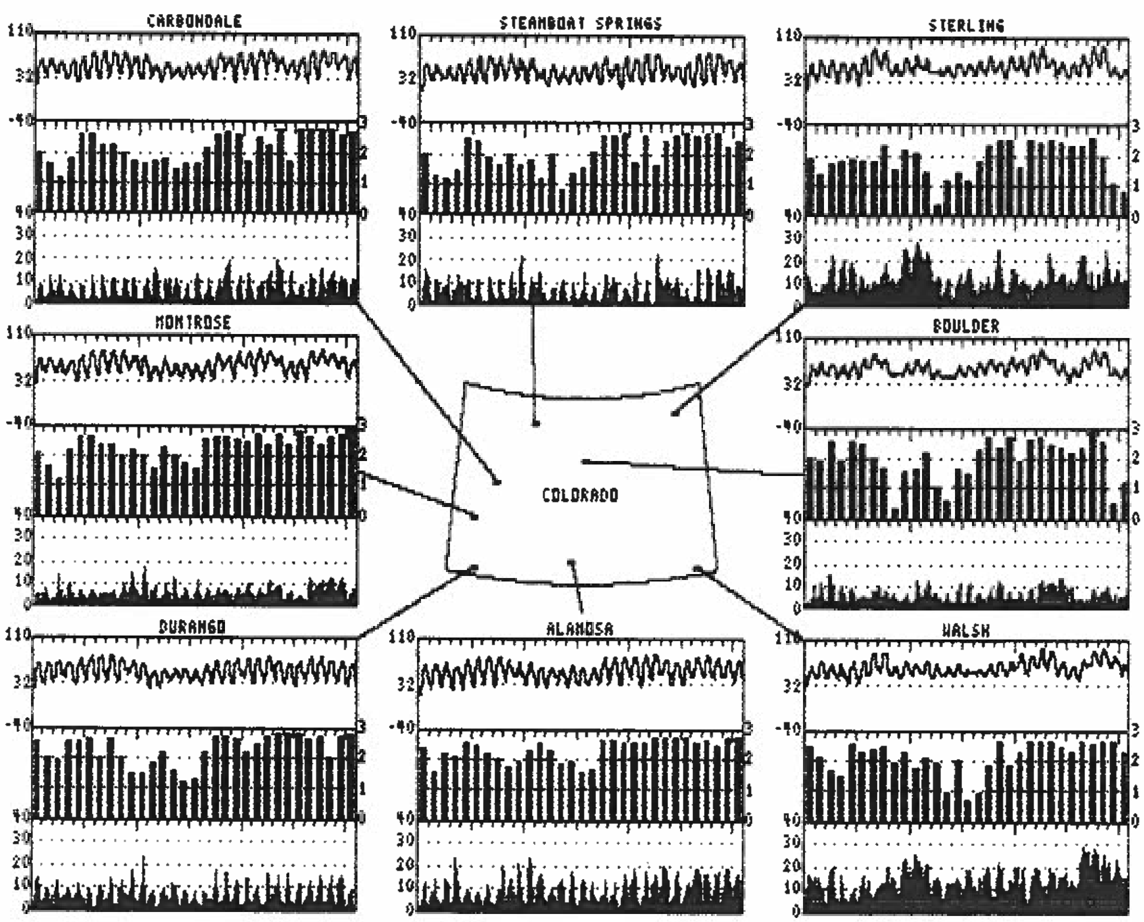
The difficulties that nature provides us by way of low or high humidity is now dealt with by mans ability to condition the buildings in which he lives and works. HVAC (heating, ventilating and air conditioning) systems can remove excess moisture by using chilled water coil condensation or add moisture through steam humidifiers or evaporative coolers. This comfort level ,however, requires energy and money to sustain.

This paper was written by Mary Sutter and Peter Curtiss of the Joint Center for Energy Management at the University of Colorado, Boulder.

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh | Boulder |
|---|---|---|---|---|---|---|---|---|
| monthly average temperature ( °F ) | 55.2 | 53.1 | 54.3 | 59.4 | 48.9 | 58.4 | 63.3 | 59.7 |
| monthly temperature extremes and time of occurence ( °F day/hour ) | | | | | | | | |
| maximum: | 82.8 23/13 | 77.4 23/15 | 81.9 23/14 | 84.9 28/16 | 79.5 28/15 | 95.4 28/17 | 97.2 23/15 | 91.0 28/15 |
| minimum: | 16.0 1/ 5 | 25.0 1/ 5 | 22.1 1/ 6 | 28.0 1/ 5 | 16.0 1/ 5 | 19.8 1/ 1 | 32.2 1/ 5 | 28.4 1/ 4 |
| monthly average relative humidity / dewpoint ( percent / °F ) | | | | | | | | |
| 5 AM | 62 / 22 | 57 / 22 | 77 / 29 | 45 / 21 | 91 / 29 | 73 / 36 | 77 / 44 | 54 / 29 |
| 11 AM | 18 / 20 | 26 / 24 | 28 / 27 | 22 / 25 | 37 / 28 | 41 / 37 | 42 / 41 | 37 / 31 |
| 2 PM | 15 / 20 | 20 / 22 | 22 / 24 | 18 / 23 | 28 / 25 | 33 / 34 | 36 / 39 | 31 / 30 |
| 5 PM | 17 / 20 | 18 / 20 | 21 / 23 | 17 / 22 | 27 / 24 | 33 / 33 | 34 / 38 | 29 / 28 |
| 11 PM | 32 / 18 | 36 / 19 | 44 / 25 | 28 / 19 | 63 / 29 | 61 / 37 | 60 / 42 | 42 / 30 |
| monthly average wind direction ( degrees clockwise from north ) | | | | | | | | |
| day | 216 | 225 | 257 | 246 | 237 | 158 | 150 | 130 |
| night | 188 | 71 | 179 | 158 | 133 | 186 | 194 | 216 |
| monthly average wind speed ( miles per hour ) | 7.11 | 5.02 | 5.07 | 4.44 | 4.63 | 10.40 | 11.62 | 4.46 |
| wind speed distribution ( hours per month for hourly average mph range ) | | | | | | | | |
| 0 to 3 | 174 | 317 | 343 | 262 | 367 | 28 | 18 | 264 |
| 3 to 12 | 423 | 373 | 344 | 469 | 322 | 483 | 393 | 471 |
| 12 to 24 | 147 | 54 | 53 | 13 | 55 | 216 | 309 | 9 |
| > 24 | 0 | 0 | 0 | 0 | 0 | 17 | 24 | 0 |
| monthly average daily total insolation ( Btu/ft²·day ) | 2317 | 2282 | 2166 | 2276 | 2023 | 1866 | 2113 | 1960 |
| "clearness" distribution ( hours per month in specified clearness index range ) | | | | | | | | |
| 60-80% | 262 | 165 | 180 | 217 | 210 | 185 | 224 | 166 |
| 40-60% | 102 | 82 | 98 | 100 | 86 | 87 | 94 | 78 |
| 20-40% | 47 | 66 | 64 | 55 | 89 | 84 | 59 | 78 |
| 0-20% | 11 | 32 | 21 | 14 | 38 | 63 | 44 | 62 |

## The State-Wide Picture

The figure below shows monthly weather at WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40°F to 110°F, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 Btu/ft²/day, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour.



# COLORADO CLIMATE

## JUNE 1989

Colorado Climate Center
Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado 80523

*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 9


### June in Review:

The dry weather of recent months in western Colorado continued in June. East of the mountains the heavens opened, and most areas received abundant rainfall without excessive damaging hail. Temperatures for the month were seasonal in the western half of the State while the eastern plains enjoyed a cooler than average month.

### Colorado's August Climate:

Last year the Southwest Monsoon brought above average precipitation to southern portions of Colorado but left much of northern Colorado high and dry. Historically, the seasonal flow of moist subtropical air into southern Colorado begins during July, is most steady and reliable around the first of August, and then retreats southward later in the month. Heaviest rains and the most frequent thunderstorms occur over the southern mountains and across portions of southeast and central Colorado. But some very heavy storms are also possible in northern and northeast Colorado early in the month. Early August storms are often slow moving and can bring locally heavy rains and possible flash floods. Fortunately, the likelihood of tornadoes decreases dramatically in comparison to June and July. Hail can still be a problem early in the month, but hail probabilities are also waning. Monthly precipitation totals average about 1" in extreme west and northwest Colorado. Totals of 1" to 2" are common from the Front Range northeastward to Nebraska and also over the San Luis Valley, portions of the Arkansas Valley and at low elevations in southwest Colorado. Most of the mountains and also the area from Colorado Springs east to Burlington receives about 2" to 3". of rainfall. The wettest areas are the San Juan, Sangre de Cristo and Wet Mountains as well as the Pikes Peak area where monthly totals often exceed 3". Despite these rains, soils and forests in Colorado usually continue to dry our through the month. Evaporation rates tend to outstrip precipitation, so don't expect sudden improvements in range and forest conditions.

Temperatures in August are not much different than in July. For the state as a whole, August temperatures average just 2 degrees less than July. Intense heatwaves are possible, but they tend to be more short-lived than July heatwaves. Occasionally, very hot days with low humidities occur late in the month creating very high wild fire potential. Average temperatures for the State for August are as follows. Hottest areas are over southeast Colorado and in low elevation areas on the Western Slope with highs in the low 90s with daily lows in the low 60s. Highs are in the 80s with lows in the 50s over most of the rest of the state with elevations below 7000 feet. From 7000 to 10,000 feet highs reach the 70s with lows in the 40s. Above that, highs only in the 50s and 60s occur with lows that sometimes flirt with the freezing point. On rare occasions, mountain temperatures have dropped to near the 20°F mark late in the month.

### Weather Observers Are True Historians:

There are more than 200 official weather observers in Colorado right now reading weather instruments each day and recording their observations on paper. In addition, their may be 1000 or more hobby weather watchers here in Colorado who are sufficiently fascinated by our Colorado weather to collect and record their own personal weather observations. These current observers simply compliment the many thousand amateur weather observers who have officially or otherwise recorded information about Colorado climate during the past 120+ years. Probably very few of these people ever thought of themselves as historians. But the written records that they leave behind have told and continue to tell us a lot about our State's history. The weather records obviously document the climate history of our State. In addition, other optional remarks that observers jot down along side their weather records can tell a whole lot about many other aspects of life in Colorado.

(continued on page -9-)

# JUNE 1989 DAILY WEATHER

| Date | Event |
|---|---|
| 1-4 | An upper-level low pressure trough loitered over the West while easterly upslope winds pumped moisture into eastern Colorado. Scattered mostly light showers and thundershowers skipped across the plains 1-2nd. An extra surge of moist easterly winds pushed across eastern Colorado 3-4th. Storms formed over eastern foothills on the 3rd and then spread southeastward. With low clouds and light rain, temperatures stayed in the 50s all day across much of northeast Colorado on the 4th. Precipitation exceeded 1" for the 3-4th at numerous locations. Close to 2" fell near Akron, 2.52" at Fort Morgan, 2.60" at Cheyenne Wells and 2.88" near Brush. |
| 5-13 | Cool but unsettled weather as a series of upper air disturbances slowly crossed the State. Some thunderstorms each day -- heaviest on the 6th, 8th, 9th and 10th. Heaviest rains fell out across the plains, but all except extreme western and southwestern Colorado received at least a few light showers. Some of the heaviest rainfall reports included 0.82" at Dillon on the 8th (included 4" of small hail), 2.59" near Campo 9-10th and 2.15" at Fountain 12-13th. The 0.35" total at Montrose on the 11th was that city's greatest precipitation in several months. |
| 14-16 | Mostly dry and warmer. A few thundershowers popped up on the 16th but produced little rain. Grand Junction saw temperatures in the upper 90s for the first time so far this year. |
| 17-19 | A Pacific cold front raced across Colorado late on the 16th and triggered very strong winds early on the 17th. Some minor wind damage was reported along the Front Range. Temperatures then soared 18-19th as a high pressure ridge aloft developed. Temperatures on the 19th reached new records for the date at several locations. Estes Park hit 88°, Denver 98° and the 109° maximum at Las Animas was the highest in the State for the month. |
| 20-26 | A little cooler on the 20th as a low pressure area approached from the northwest. Then windy overnight and much colder 21st as an unusually cold airmass for this time of year swept in. Not much moisture accompanied the front, but some hefty storms formed in extreme southeast Colorado. An area of rain developed in the foothills and mountains west of Denver and Colorado Springs and turned to snow late on the 21st above 7000 feet. At least 2" of snowfall was reported at several weather stations. Bailey awoke to 3" of snow and 1.10" of moisture on the 22nd -- one of their latest snows ever reported. The 9" of new snow at the Mt. Evans Research Center was the greatest amount reported. Even flakes of snow were observed near Trinidad and north of New Raymer early on the 22nd. Near record low temperatures were reported early on the 22nd over the mountains and Western Slope. Walden dipped to 20°F. The weather station at Delta dropped to 32° -- their latest spring freeze on record. Western Colorado remained dry 23-26th with moderating temperatures. East of the mountains conditions remained unsettled and quite cool. Several hail-producing storms erupted across the plains, especially 24-25th. More than 2" of rain was reported at Bonny Lake. |
| 27-30 | Warmer temperatures statewide as a large high pressure ridge formed over Colorado and the Southwest. But moist air remained in place over eastern Colorado helping to fuel more strong storms especially 28-29th. A huge storm complex formed over extreme eastern Colorado on the 28th and inundated Goodland, KS, with more than 4" of rain. Outflow from that storm sent strong southeast winds back towards the Front Range where they triggered an unusual round of nocturnal thunderstorms. Holyoke reported more than 2" of rain from a severe hailstorm on the 29th. Tornadoes were spotted near Eads that same day. Drier air intruded on the 30th to signal the beginning of a major heatwave. |

## June 1989 Extremes

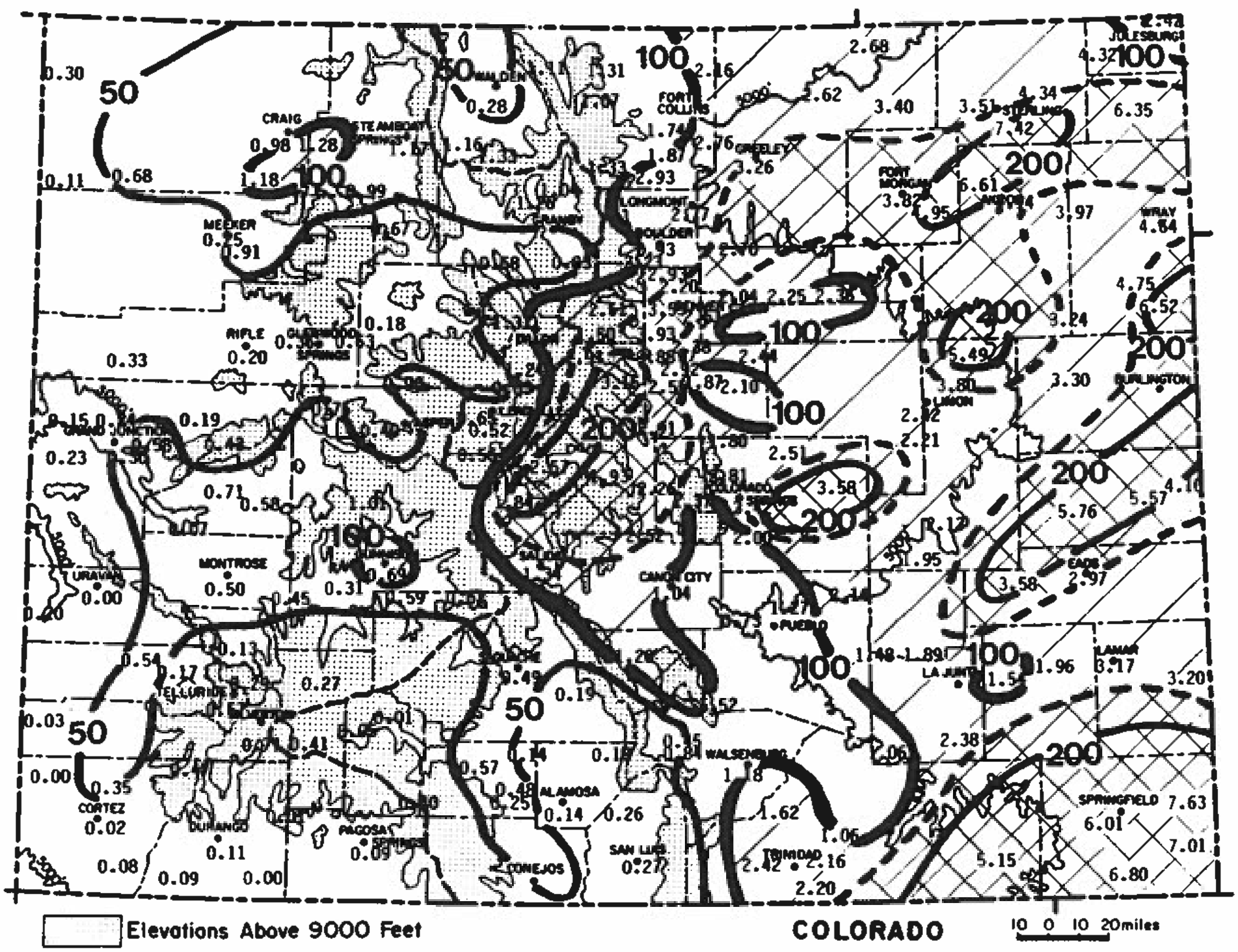
| | | | |
|---|---|---|---|
| Highest Temperature | 109°F | June 20 | Las Animas |
| Lowest Temperature | 14°F | June 10 | Florissant Fossil Beds National Monument |
| Greatest Total Precipitation | 7.63" | | Walsh 1W |
| Least Total Precipitation | 0.00" | | Yellow Jacket 2W, Uravan, Iganico 1N |
| Greatest Total Snowfall* | 13" | | Mt. Evans Research Center |

*For existing weather stations with complete daily records. Higher values are likely for unmonitored locations.

## JUNE 1989 PRECIPITATION

Moderate to heavy rains were widespread across eastern Colorado in early June. Storms later in the month were more scattered but still brought considerable moisture to some local areas. Little of this moisture was evidenced in the mountains and on the Western Slope, however. Precipitation totals ended up above average over most of the eastern half of the State. Several separate areas including South Park, portions of eastern El Paso County, a band from Brush to east of Sterling, a strip crossing much of Cheyenne County and a good chunk of extreme southeastern Colorado received more than double the June average. A number of plains stations reported in excess of 5" of rainfall for the month. Meanwhile, most monthly totals in western Colorado were well below one inch. The San Juan Mountains, the immediate Colorado River Valley and the entire western edge of the State received less than 50% of average. In some areas this was the 4th consecutive extremely dry month.

| Greatest | | Least | |
|---|---|---|---|
| Walsh 1W | 7.63" | Yellow Jacket 2W | 0.00" |
| Leroy 5WSW | 7.42" | Uravan | 0.00" |
| Stonington | 7.01" | Ignacio 1N | 0.00" |
| Campo 7S | 6.80" | Gateway 1SW | Trace |
| Akron 1N | 6.61" | Vallecito Dam | 0.01" |
| Bonny Lake | 6.52" | Creede | 0.01" |



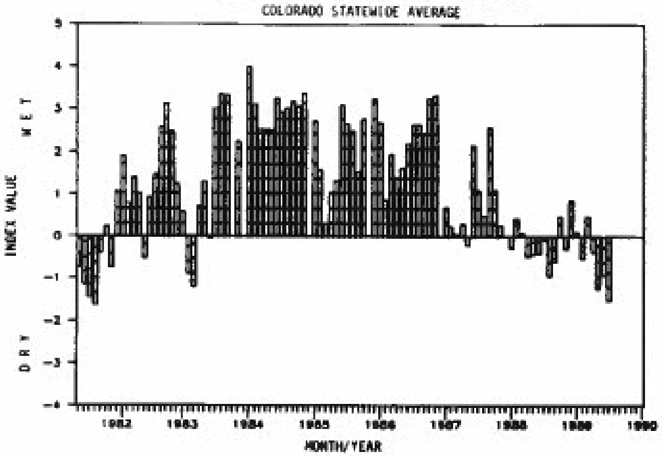

Precipitation amounts (inches) for June 1989 and contours of precipitation as a percent of the 1961-1980 average. Dashed line is 150% of average.

## 1989 WATER YEAR PRECIPITATION

A few dry pockets remain in eastern Colorado, but for most of that region the excellent rains of late May and June have brought totals back up to near average for the year. At the same time, however, conditions continue to deteriorate in western Colorado. The March-June period has been extremely dry, especially in southwest Colorado. Some areas have had less than one inch of moisture. Impacts are being seen in terms of reduced streamflows, lower hay production, declining range conditions and increased forest fire potentials. This is the driest western Colorado has been since the extremely severe drought of 1976-77. That year, most of the mountains and Western Slope received less than half of the moisture received so far this year.

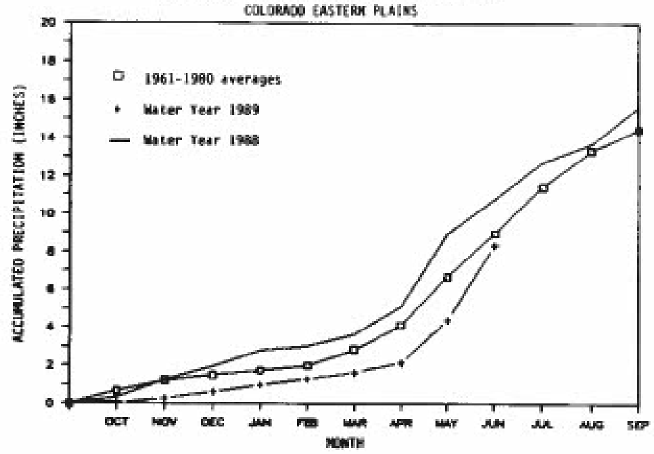
SURFACE WATER SUPPLY INDEX

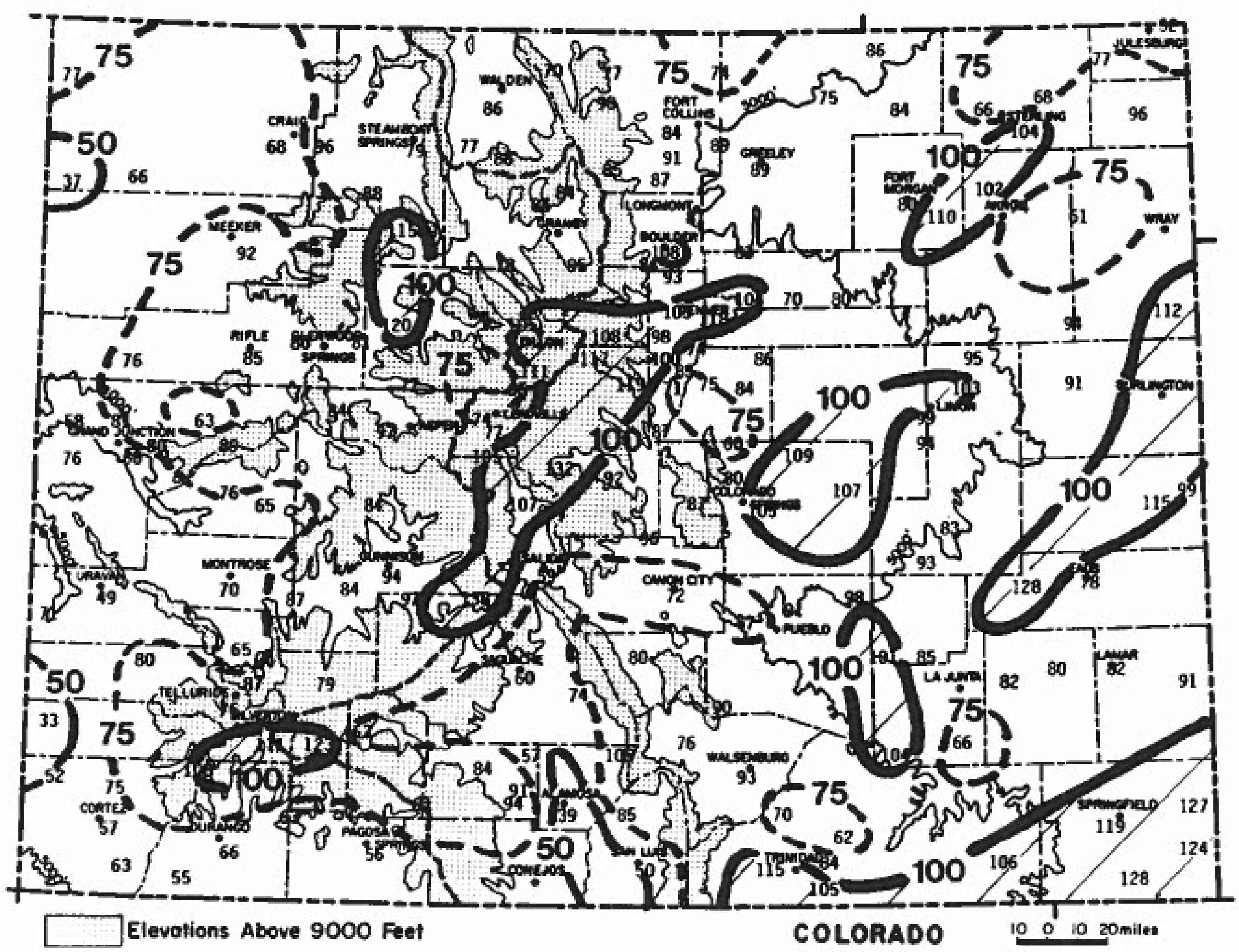
COLORADO STATEWIDE AVERAGE




ACCUMULATED PRECIPITATION

COLORADO EASTERN PLAINS

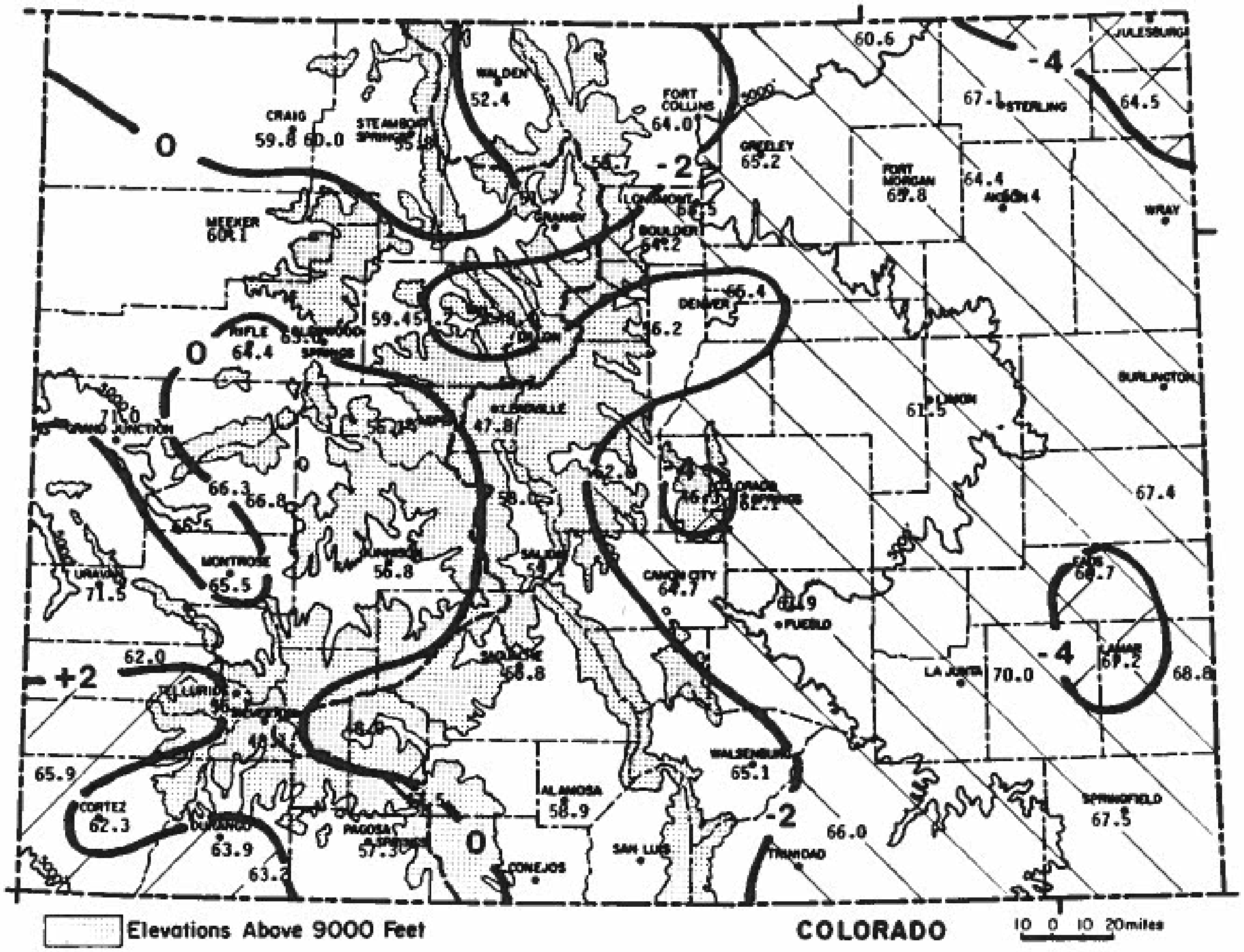



Precipitation for October 1988 through June 1989
as a percent of the 1961-1980 average.

## JUNE 1989 TEMPERATURES AND DEGREE DAYS

A brief heatwave on June 19th sent temperatures skyrocketing to record levels in some areas. But for the most part, June temperatures were pleasant. Across all of eastern Colorado, June ended up a few degrees cooler than average -- the coolest June since 1983. In western Colorado temperatures were very close to the seasonal average. Only in extreme southwestern areas were temperatures more than one degree above the long-term averages.




June 1989 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## JUNE 1989 SOIL TEMPERATURES

Soil temperatures continued to increase at all depths during the month of June, as expected.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.

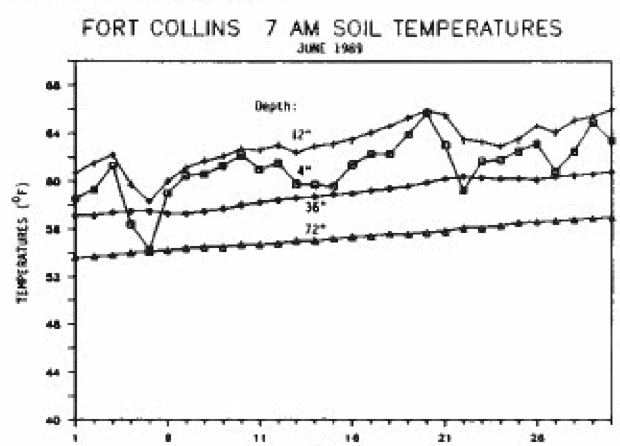


Table 1. Heating Degree Day Data through June 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 87-88 | 66 | 96 | 364 | 601 | 1130 | 1556 | 1867 | 1381 | 1031 | 658 | 454 | 102 | 9306 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | 1210 | 854 | 600 | 358 | 180 | 8241 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 87-88 | 112 | 152 | 355 | 563 | 1024 | 1382 | 1450 | 1146 | 1136 | 734 | 517 | 123 | 8694 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | 1171 | 899 | 692 | 476 | 269 | 8444 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 87-88 | 7 | 33 | 122 | 370 | 713 | 1053 | 1107 | 842 | 739 | 400 | 203 | 14 | 5603 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | 1139 | 615 | 427 | 209 | 89 | 5485 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 87-88 | 49 | 117 | 313 | 549 | 955 | 1277 | 1357 | 1010 | 1030 | 639 | 472 | 102 | 7870 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | 1153 | 784 | 645 | 360 | 207 | 7646 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 87-88 | 5 | 20 | 72 | 375 | 724 | 1037 | 1221 | 935 | 779 | 449 | 178 | 14 | 5809 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | 1135 | 697 | 375 | M | M | 5194 |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 87-88 | 11 | 36 | 87 | 374 | 668 | 1007 | 1144 | 858 | 767 | 407 | 191 | 16 | 5566 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | 1078 | 554 | 382 | 226 | 90 | 5191 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 87-88 | 17 | 74 | 150 | 445 | 767 | 1108 | 1256 | 958 | 886 | 499 | 273 | 25 | 6458 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | 1205 | 655 | 475 | 247 | 134 | 6107 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 87-88 | 6 | 35 | 154 | 396 | 860 | 1179 | 1351 | 1008 | 899 | 609 | 362 | 56 | 6915 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | 1008 | 718 | 450 | 282 | 112 | 6437 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 87-88 | 55 | 96 | 227 | 534 | 950 | 1376 | 1561 | 1264 | 1076 | 593 | 399 | 52 | 8183 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | 1443 | 894 | 531 | 365 | 169 | 8068 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 87-88 | 0 | 11 | 108 | 354 | 737 | 1102 | 1300 | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | 1327 | 964 | 613 | 345 | 211 | 53 | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 87-88 | 11 | 21 | 110 | 410 | 745 | 1125 | 1227 | 889 | 811 | 437 | 215 | 14 | 6015 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | 1190 | 665 | 432 | 213 | 76 | 5780 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 87-88 | 296 | 346 | 556 | 763 | 1145 | 1491 | 1629 | 1376 | 1379 | 933 | 717 | 322 | 10953 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | 1307 | 1088 | 875 | 679 | 490 | 10505 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 87-88 | 14 | 44 | 188 | 435 | 851 | 1206 | 1391 | 972 | 859 | 514 | 346 | 42 | 6862 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | 933 | 666 | 388 | 237 | 76 | 6209 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 87-88 | 54 | 75 | 254 | 509 | 950 | 1331 | 1544 | 1173 | 1002 | 607 | 404 | 52 | 7955 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | 1227 | 829 | 536 | 344 | 181 | 7925 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 87-88 | 69 | 118 | 333 | 602 | 922 | 1255 | 1310 | 1029 | 992 | 645 | 462 | 111 | 7848 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | 1227 | 794 | 636 | 439 | 261 | 7583 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 87-88 | 12 | 37 | 146 | 453 | 784 | 1140 | 1252 | 936 | 821 | 479 | 217 | 8 | 6285 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | 1207 | 732 | 433 | 216 | 92 | 6119 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 87-88 | 12 | 29 | 110 | 430 | 773 | 1154 | 1484 | 1055 | 826 | 495 | 206 | 17 | 6591 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | 1230 | 726 | 446 | 183 | 77 | 6278 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 87-88 | 0 | 6 | 34 | 248 | 754 | 1147 | 1469 | 1031 | 741 | 350 | 172 | 8 | 5960 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | 1037 | 534 | 260 | 113 | 8 | 5424 |

* = AVES ADJUSTED FOR STATION MOVES  M = MISSING  E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 87-88 | 207 | 257 | 480 | 677 | 1098 | 1516 | 1642 | 1413 | 1372 | 907 | 602 | 238 | 10409 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | 1368 | 1086 | 805 | 584 | 391 | 10051 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 87-88 | 10 | 26 | 119 | 424 | 762 | 1157 | 1363 | 955 | 807 | 437 | 204 | 6 | 6270 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | 1230 | 711 | 444 | 184 | 71 | 6050 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | 1698 | 2096 | 1578 | 1096 | 640 | 487 | 241 | 10187 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 87-88 | 0 | 3 | 35 | 273 | 653 | 1032 | 1278 | 837 | 638 | 327 | 103 | 1 | 5180 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | 1109 | 535 | 303 | 114 | 31 | 4862 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 87-88 | 346 | 393 | 578 | 763 | 1180 | 1534 | 1577 | 1326 | 1355 | 957 | 741 | 360 | 11110 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | 1310 | 1112 | 914 | 695 | 509 | 10772 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 87-88 | 21 | 66 | 158 | 502 | 840 | 1209 | 1354 | 1022 | 943 | 569 | 321 | 35 | 7040 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | 1211 | 751 | 516 | 275 | 143 | 6544 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 87-88 | 12 | 33 | 159 | 464 | 805 | 1169 | 1383 | 1035 | 847 | 509 | 222 | 20 | 6658 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | 1307 | 841 | 542 | 256 | 110 | 6961 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 87-88 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | 88-89 | M | M | M | M | M | M | M | M | M | M | M | 165 | M |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 87-88 | 5 | 30 | 129 | 349 | 849 | 1160 | 1332 | 1003 | 817 | 468 | 230 | 26 | 6398 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | 972 | 605 | 348 | 180 | 64 | 5903 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 87-88 | 104 | 105 | 347 | 523 | 947 | 1292 | 1548 | 1187 | 996 | 663 | 485 | 143 | 8340 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | 1095 | 860 | 574 | 447 | 230 | 7990 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 87-88 | 4 | 17 | 43 | 355 | 754 | 1111 | 1399 | 903 | 777 | 399 | 167 | 8 | 5937 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | 1141 | 573 | 378 | 134 | 35 | 5385 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 87-88 | 9 | 24 | 125 | 391 | 819 | 1209 | 1430 | 1039 | 865 | 454 | 268 | 14 | 6647 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | 1049 | 674 | 381 | 224 | 74 | 6401 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 87-88 | 77 | 127 | 330 | 590 | 1033 | 1448 | 1619 | 1336 | 1167 | 674 | 433 | 95 | 8929 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | 1355 | 964 | 581 | 401 | 273 | 8713 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 87-88 | 12 | 31 | 108 | 413 | 742 | E1140 | 1475 | 1029 | 831 | 476 | 197 | 12 | 6466 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | 1189 | 730 | 416 | 152 | 59 | 5885 |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 87-88 | 161 | 222 | 426 | 603 | 992 | 1269 | 1354 | 1109 | 1092 | 720 | 547 | 208 | 8703 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | 1071 | 858 | 633 | 463 | 263 | 8237 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 87-88 | 4 | 25 | 80 | 330 | 730 | 1054 | 1209 | 850 | 803 | 438 | 234 | 13 | 5770 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | 1026 | 538 | 378 | 159 | 79 | 5145 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 87-88 | 215 | 281 | 495 | 740 | 1242 | 1499 | 1572 | 1343 | 1340 | 835 | 638 | 184 | 10384 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | 1369 | 1023 | 772 | 612 | 371 | 9776 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 87-88 | 3 | 30 | 101 | 332 | 707 | 977 | 1109 | 826 | 773 | 401 | 238 | 25 | 5522 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | 1031 | 492 | 376 | 164 | 82 | 5001 |

* = AVES ADJUSTED FOR STATION MOVES  M = MISSING  E = ESTIMATED

# JUNE 1989 CLIMATIC DATA

## Eastern Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| NEW RAYMER 21N | 74.6 | 46.7 | 60.6 | -3.8 | 98 | 37 | 170 | 45 | 369 | 2.68 | 0.18 | 107.2 | 8 |
| STERLING | 80.9 | 53.3 | 67.1 | -1.1 | 105 | 41 | 59 | 128 | 498 | 3.51 | 0.78 | 128.6 | 11 |
| FORT MORGAN | 78.5 | 53.2 | 65.8 | -2.6 | 103 | 42 | 77 | 111 | 472 | 3.82 | 1.80 | 189.1 | 8 |
| AKRON FAA AP | 77.9 | 51.0 | 64.4 | -2.5 | 102 | 42 | 94 | 81 | 444 | 6.61 | 3.97 | 250.4 | 12 |
| AKRON 4E | 76.7 | 50.2 | 63.4 | -3.2 | 101 | 38 | 114 | 74 | 424 | 4.14 | 1.43 | 152.8 | 9 |
| HOLYOKE | 76.1 | 52.9 | 64.5 | -4.6 | 100 | 41 | 84 | 74 | 441 | 6.35 | 2.99 | 189.0 | 12 |
| LIMON WSMO | 75.5 | 47.6 | 61.5 | -2.5 | 92 | 38 | 143 | 46 | 390 | 2.42 | 0.62 | 134.4 | 11 |
| CHEYENNE WELLS | 80.9 | 53.9 | 67.4 | -2.1 | 97 | 40 | 60 | 138 | 519 | 5.57 | 3.42 | 259.1 | 9 |
| EADS | 79.7 | 53.7 | 66.7 | -4.3 | 100 | 43 | 67 | 125 | 492 | 2.97 | 0.93 | 145.6 | 7 |
| LAMAR | 82.3 | 52.1 | 67.2 | -6.0 | 105 | 38 | 64 | 141 | 505 | 3.17 | 0.85 | 136.6 | 13 |
| LAS ANIMAS | 84.7 | 55.3 | 70.0 | -3.4 | 109 | 40 | 31 | 188 | 559 | 1.54 | -0.20 | 88.5 | 9 |
| HOLLY | 82.2 | 55.5 | 68.8 | -3.7 | 99 | 40 | 46 | 167 | 542 | 3.20 | 0.13 | 104.2 | 14 |
| SPRINGFIELD 7WSW | 81.6 | 53.5 | 67.5 | -2.6 | 95 | 40 | 53 | 135 | 525 | 6.01 | 3.90 | 284.8 | 13 |

## Foothills/Adjacent Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| FORT COLLINS | 76.9 | 51.0 | 64.0 | -1.4 | 97 | 42 | 92 | 69 | 435 | 1.74 | -0.10 | 94.6 | 9 |
| GREELEY UNC | 78.9 | 51.6 | 65.2 | -2.7 | 100 | 41 | 71 | 87 | 457 | 3.26 | 1.45 | 180.1 | 7 |
| ESTES PARK | 70.4 | 41.1 | 55.7 | -0.9 | 88 | 32 | 276 | 6 | 314 | 1.33 | -0.43 | 75.6 | 6 |
| LONGMONT 2ESE | 77.2 | 49.9 | 63.5 | -2.5 | 101 | 40 | 110 | 73 | 414 | 2.77 | 0.77 | 138.5 | 7 |
| BOULDER | 78.6 | 49.9 | 64.2 | -2.9 | 94 | 41 | 89 | 73 | 444 | 2.93 | 0.67 | 129.6 | 13 |
| DENVER WSFO AP | 78.4 | 52.4 | 65.4 | -1.0 | 98 | 43 | 76 | 96 | 464 | 2.04 | 0.17 | 109.1 | 9 |
| EVERGREEN | 71.4 | 40.9 | 56.2 | -1.5 | 89 | 34 | 261 | 3 | 328 | 3.93 | 1.82 | 186.3 | 19 |
| LAKE GEORGE 8SW | 67.8 | 37.4 | 52.6 | -2.5 | 82 | 26 | 366 | 0 | 274 | 1.93 | 0.65 | 150.8 | 10 |
| RUXTON PARK | 59.6 | 33.1 | 46.3 | -5.1 | 78 | 28 | 553 | 0 | 155 | 2.37 | 0.01 | 100.4 | 16 |
| COLORADO SPRINGS | 75.0 | 49.1 | 62.1 | -3.1 | 94 | 42 | 134 | 54 | 392 | 3.42 | 1.10 | 147.4 | 11 |
| CANON CITY 2SE | 78.7 | 50.8 | 64.7 | -3.0 | 97 | 41 | 90 | 88 | 454 | 1.04 | -0.26 | 80.0 | 9 |
| PUEBLO WSO AP | 83.7 | 52.1 | 67.9 | -3.0 | 101 | 42 | 35 | 128 | 504 | 1.27 | -0.05 | 96.2 | 12 |
| WALSENBURG | 81.0 | 49.3 | 65.1 | -1.5 | 96 | 38 | 82 | 91 | 470 | 1.18 | -0.04 | 96.7 | 10 |
| TRINIDAD FAA AP | 81.0 | 51.0 | 66.0 | -2.5 | 95 | 40 | 79 | 117 | 497 | 1.06 | -0.47 | 69.3 | 10 |

## Mountains/Interior Valleys

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| WALDEN | 71.4 | 33.4 | 52.4 | -0.8 | 86 | 20 | 371 | 0 | 329 | 0.28 | -0.74 | 27.5 | 7 |
| LEADVILLE 2SW | 64.3 | 31.3 | 47.8 | -0.7 | 77 | 26 | 509 | 0 | 223 | 0.52 | -0.48 | 52.0 | 6 |
| SALIDA | 74.7 | 43.5 | 59.1 | -1.4 | 90 | 36 | 186 | 15 | 384 | 1.34 | 0.43 | 147.3 | 10 |
| BUENA VISTA | 74.0 | 42.0 | 58.0 | -0.7 | 86 | 33 | 207 | 4 | 368 | 1.84 | 1.03 | 227.2 | 11 |
| SAGUACHE | 72.6 | 41.1 | 56.8 | -1.5 | 83 | 34 | 237 | 0 | 344 | 0.49 | -0.08 | 86.0 | 8 |
| HERMIT 7ESE | 66.8 | 29.3 | 48.0 | -1.4 | 82 | 19 | 500 | 0 | 257 | 0.05 | -0.67 | 6.9 | 2 |
| ALAMOSA WSO AP | 78.1 | 39.6 | 58.9 | -0.3 | 90 | 30 | 180 | 6 | 423 | 0.14 | -0.58 | 19.4 | 4 |
| STEAMBOAT SPRINGS | 75.1 | 36.5 | 55.8 | 1.0 | 90 | 25 | 273 | 5 | 380 | 1.17 | -0.28 | 80.7 | 6 |
| GRAND LAKE 6SSW | 67.9 | 35.5 | 51.7 | -0.2 | 81 | 26 | 391 | 0 | 276 | 1.26 | -0.04 | 96.9 | 8 |
| DILLON 1E | 64.6 | 32.1 | 48.4 | -2.2 | 80 | 17 | 490 | 0 | 228 | 1.37 | 0.21 | 118.1 | 9 |
| AVON | 72.8 | 35.6 | 54.2 | -2.8 | 88 | 20 | 321 | 6 | 352 | 0.56 | -0.44 | 56.0 | 8 |
| CLIMAX | 56.3 | 31.0 | 43.7 | -1.4 | 73 | 21 | 629 | 0 | 116 | 0.63 | -0.85 | 42.6 | 7 |
| ASPEN 1SW | 72.1 | 40.1 | 56.1 | 1.1 | 86 | 30 | 269 | 7 | 336 | 0.40 | -1.01 | 28.4 | 5 |
| TELLURIDE | 74.9 | 37.3 | 56.1 | 2.0 | 88 | 24 | 263 | 0 | 379 | 0.57 | -0.65 | 46.7 | 5 |
| PAGOSA SPRINGS | 78.9 | 35.6 | 57.3 | 0.2 | 92 | 28 | 230 | 5 | 432 | 0.09 | -0.68 | 11.7 | 4 |
| SILVERTON | 69.2 | 27.0 | 48.1 | 0.1 | 80 | 20 | 501 | 0 | 295 | 0.71 | -0.54 | 56.8 | 4 |
| WOLF CREEK PASS 1 | 62.7 | 32.3 | 47.5 | 0.1 | 73 | 26 | 516 | 0 | 200 | 0.40 | -1.24 | 24.4 | 5 |

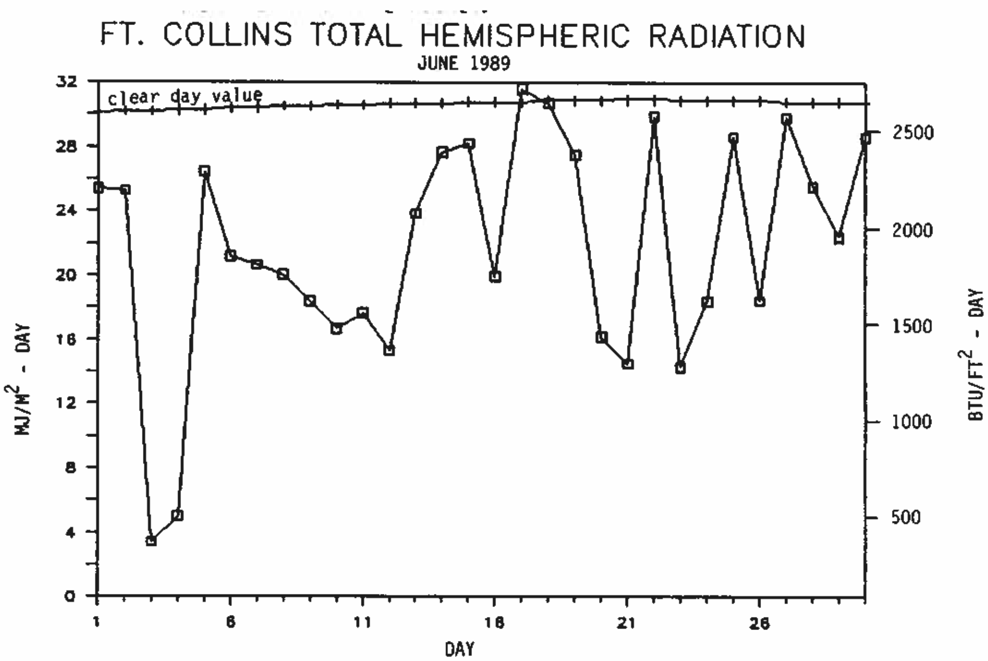
## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 77.0 | 42.7 | 59.8 | 0.5 | 94 | 31 | 169 | 21 | 407 | 0.98 | -0.37 | 72.6 | 8 |
| HAYDEN | 77.8 | 42.2 | 60.0 | 0.1 | 92 | 29 | 165 | 25 | 418 | 1.28 | 0.06 | 104.9 | 5 |
| MEEKER NO. 2 | 79.0 | 41.3 | 60.1 | -0.9 | 93 | 27 | 165 | 27 | 433 | 0.25 | -0.60 | 29.4 | 2 |
| RANGELY 1E | 84.0 | 51.2 | 67.6 | 1.5 | 98 | 38 | 27 | 116 | 519 | 0.13 | -0.60 | 17.8 | 2 |
| EAGLE FAA AP | 78.4 | 40.4 | 59.4 | -0.1 | 95 | 24 | 181 | 17 | 421 | 0.18 | -0.67 | 21.2 | 4 |
| GLENWOOD SPRINGS | 80.9 | 45.1 | 63.0 | -0.1 | 96 | 34 | 98 | 46 | 454 | 0.36 | -0.95 | 27.5 | 7 |
| RIFLE | 83.8 | 45.0 | 64.4 | 0.8 | 97 | 32 | 74 | 62 | 490 | 0.20 | -0.63 | 24.1 | 4 |
| GRAND JUNCTION WS | 86.0 | 55.9 | 71.0 | -1.0 | 100 | 44 | 8 | 195 | 597 | 0.24 | -0.26 | 48.0 | 6 |
| CEDAREDGE | 84.4 | 48.2 | 66.3 | 0.8 | 97 | 34 | 49 | 94 | 526 | 0.71 | -0.02 | 97.3 | 4 |
| PAONIA 1SW | 83.9 | 49.7 | 66.8 | 1.3 | 97 | 36 | 42 | 103 | 519 | 0.58 | -0.22 | 72.5 | 4 |
| DELTA | 86.1 | 45.0 | 65.5 | -2.3 | 100 | 32 | 53 | 76 | 515 | 0.07 | -0.48 | 12.7 | 2 |
| GUNNISON | 75.5 | 38.1 | 56.8 | 1.7 | 88 | 31 | 241 | 2 | 390 | 0.69 | 0.15 | 127.8 | 6 |
| MONTROSE NO. 2 | 80.7 | 50.3 | 65.5 | -0.4 | 95 | 37 | 64 | 85 | 491 | 0.50 | -0.11 | 82.0 | 4 |
| URAVAN | 89.6 | 53.3 | 71.5 | 1.3 | 104 | 42 | 7 | 210 | 592 | 0.00 | -0.42 | 0.0 | 0 |
| NORWOOD | 79.5 | 44.5 | 62.0 | 1.9 | 90 | 28 | 113 | 32 | 456 | 0.54 | -0.32 | 62.8 | 1 |
| YELLOW JACKET 2W | 83.4 | 48.4 | 65.9 | 2.6 | 95 | 39 | 46 | 79 | 510 | 0.00 | -0.49 | 0.0 | 0 |
| CORTEZ | 81.9 | 42.6 | 62.3 | -0.3 | 94 | 32 | 112 | 39 | 478 | 0.02 | -0.39 | 4.9 | 1 |
| DURANGO | 84.3 | 43.5 | 63.9 | 2.5 | 97 | 35 | 76 | 51 | 491 | 0.11 | -0.46 | 19.3 | 3 |
| IGNACIO 1N | 85.9 | 40.5 | 63.2 | 2.0 | 97 | 31 | 87 | 40 | 515 | 0.00 | -0.53 | 0.0 | 0 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## JUNE 1989 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days: clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 6 | 13 | 11 | -- | -- |
| Denver | 7 | 11 | 12 | 61% | 71% |
| Fort Collins | 4 | 17 | 9 | -- | -- |
| Grand Junction | 9 | 12 | 9 | 85% | 79% |
| Pueblo | 11 | 6 | 13 | 78% | 79% |



Weather Observers Are True Historians: continued

Here at the Colorado Climate Center we are proud to maintain a library containing many of the original records or copies of day by day weather reports for hundreds of locations around Colorado. Most of our files go back to 1893, but for a few locations we have log books that begin as early as 1871. Some fascinating entries have been found on these weather report sheets, and I would like to share some with you.

Just this past month, Neil Lindstrom, the weather observer at the Leroy 5 WSW station near Sterling noted "3-inch deep nickel-size hail until noon". This brief remark along with his report of 3.87" of precipitation in his raingage on the morning of June 9th made it very clear that they had just had themselves one nasty storm the previous evening. Mr. Lindstrom also observed "rainbow at 7 AM in the west" on June 17th. I don't know about you, but morning rainbows always catch my attention (so far, I've seen 2 in my life). His remark was certainly appreciated. Mrs. Armilda Burnhenn, the weather observer for the past 30 years down at Stonington in southeast Colorado also made a helpful remark in June. Beside her precipitation record she wrote "all rains came real nice except June 10 when it rained a little hard for about half an hour." With a monthly total of more than 7" of rain at her station, the 2nd wettest June on record, I might have thought they were flooded and had half their topsoil washed away were it not for her brief comment.

Here are a few other remarks we have found on the cooperative weather reports from past years. These are just a small sample of the taste of Colorado history we get from the old weather reports.

December 2, 1893: "2nd rabbit hunt -- 1799 jacks killed to 50 guns. Rabbits donated to poor of Denver and Pueblo. A BAD DAY FOR RABBITS!" George T. Herbert, Lamar.

March 10, 1894: "High wind full of electricity burned two farmers out by wire fence ..." Alfred Wallet, Burlington.

August 1900: " ... Forest fires have been raging for almost two and one-half months." J. K. P. McCallum, Walden.

July 1901: "Chinch bugs, grasshoppers and drouth have cut crops short, large black beetle or bug have stripped potato vines. Prosperous farmers !(?)" E. E. T. Hazen, Holyoke.

January 4, 1906: Observation was missed but observer gave an excuse, "Went to Pueblo to see Ben Hur." F. M. Tague, Las Animas.

August 15, 1918: "A distinct rainbow visible by moonlight at 9:45 PM" G. F. Smyder, Fort Lewis.

January 23, 1937: "Duststorm -- 10 AM to 2:30 PM direction NE. Visibility 2 to 4 city blocks." Joseph Schwickrath, Stratton.

January 1949: "Blizzard from 2nd - 5th. Many cattle lost. Virtually every one had to dig out. All snow blown from wheat fields." Layton D. Munson, Sedgwick (still active weather observer for area).

In conclusion, I want to appeal to all of you who are weather observers today to remember that you are historians. The "Record of Climatological Observations" that you fill out each month will be saved. Centuries from now, if our literate world still exists, your weather reports will continue to be read and studied with great interest. Scientists will not only study your temperature and precipitation data as they evaluate how the world's climate has changed, but they will also muse over your remarks as they wonder and marvel about how you lived and how you interpreted the world around you. Today you have an opportunity to leave something behind. The comments that you make today about the rainbow in the west, the wheat aphids in your fields, the drought that starves your cattle, the hailstorm that breaks your windshield, etc., etc., may seem to trivial. But in the years that follow, those remarks may become the most interesting words that you will ever write. There is no better way to help bring to life all those temperature and precipitation numbers that you so diligently record.

Thanks to all of you who are weather observers here in Colorado. Keep up the good work. Thanks also to Cynthia Almeda, a junior at South High School in Pueblo, who spent many hours here at the Colorado Climate Center examining the old climate records as a part of the 1989 Summer Science Motivation Program at CSU. She helped uncover these and many, many other interesting remarks.

## AIR CONDITIONING

Practically all commercial office buildings use some form of air conditioning. While we usually associate "air conditioning" with cold air, in the strictest sense you are conditioning the air in a number of ways. Conditioned air means that the temperature, humidity, cleanliness and motion of the air are all taken into account and changed from the outside conditions to the comfort range of humans. This range and been empirically derived for a variety of working conditions to increase the quantity and quality of human work. Figure 1 compares relative humidity and temperature and shows a comfort range for sedentary or slightly active, normally clothed persons.

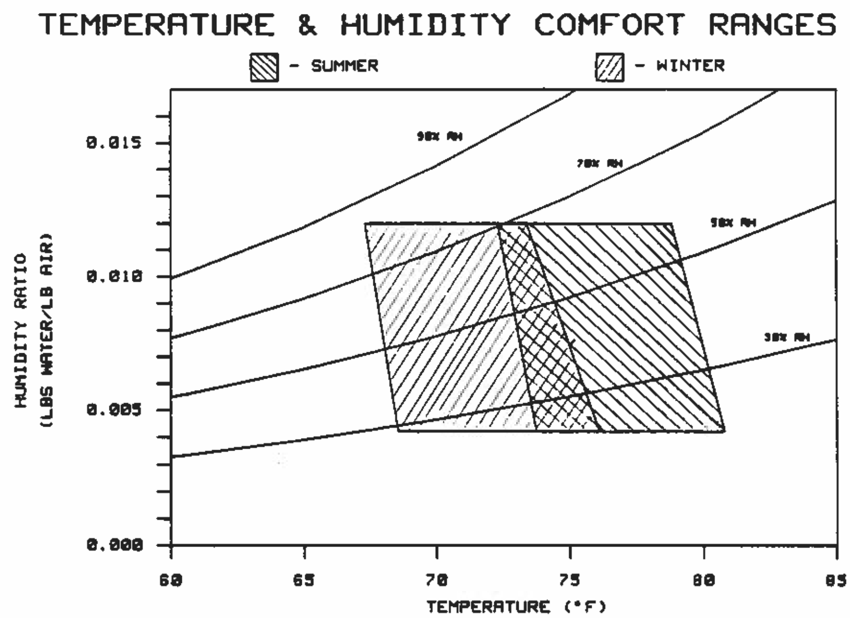



FIGURE 1

In 1833, Dr. John Gorrie hung buckets of ice in hospital rooms and blew air over them in an attempt to cool the rooms of malaria and yellow fever patients. Although the air cooled, this method did not change the humidity. There were numerous variations on this theme until 1902 when Willis Carrier invented a fan-coil system for use in a printing company. This was the beginning of actual conditioned air. In his system, Carrier passed air over coils which contained chilled water. He balanced the temperature of the coil surface and the air flow to meet a specific dew point temperature. This caused condensation of the moisture in the air up to the dew point and allowed Carrier to choose any humidity he desired. Today we employ much of the same idea, though on a much larger scale. Heat pumps or chillers are used to remove energy (heat) from the interior of buildings and 'dump' it outside (and making the outdoors even hotter in the process).

Modern construction reflects the dependence we have on air conditioning. High rise buildings with windows that do not open, shopping malls with no windows and grocery stores with open freezers are a few examples of this reliance. Man's ability to use his brain for higher pursuits comes only after the physiological needs are attended to and are not an impingement on the consciousness. The productivity of the worker increases as energy is diverted from keeping the body cool to the task at hand. Products we now enjoy would not be possible without conditioned air. The microchip which runs so much of business through computers cannot be manufactured in an unclean environment. Hospital surgery rooms require a relatively sterile, cool atmosphere. Computers themselves need clean air to run effectively.

With the advantages of conditioned air comes the task of using it responsibly. The energy used is becoming more expensive and environmentally taxing. Public service is in the business of providing energy and, as a business, finds it difficult to tell customers they are out of the commodity they sell. This most likely leads to a demand tax for the building of more plants to cover possibly only a few days energy during the peak times. The refrigerant in air conditioners causes ozone depletion if it leaks.
This shows the necessity of proper maintenance. As always, the search for alternative methods of providing energy and keeping cool needs to be thorough so we can continue to enjoy conditioned air.

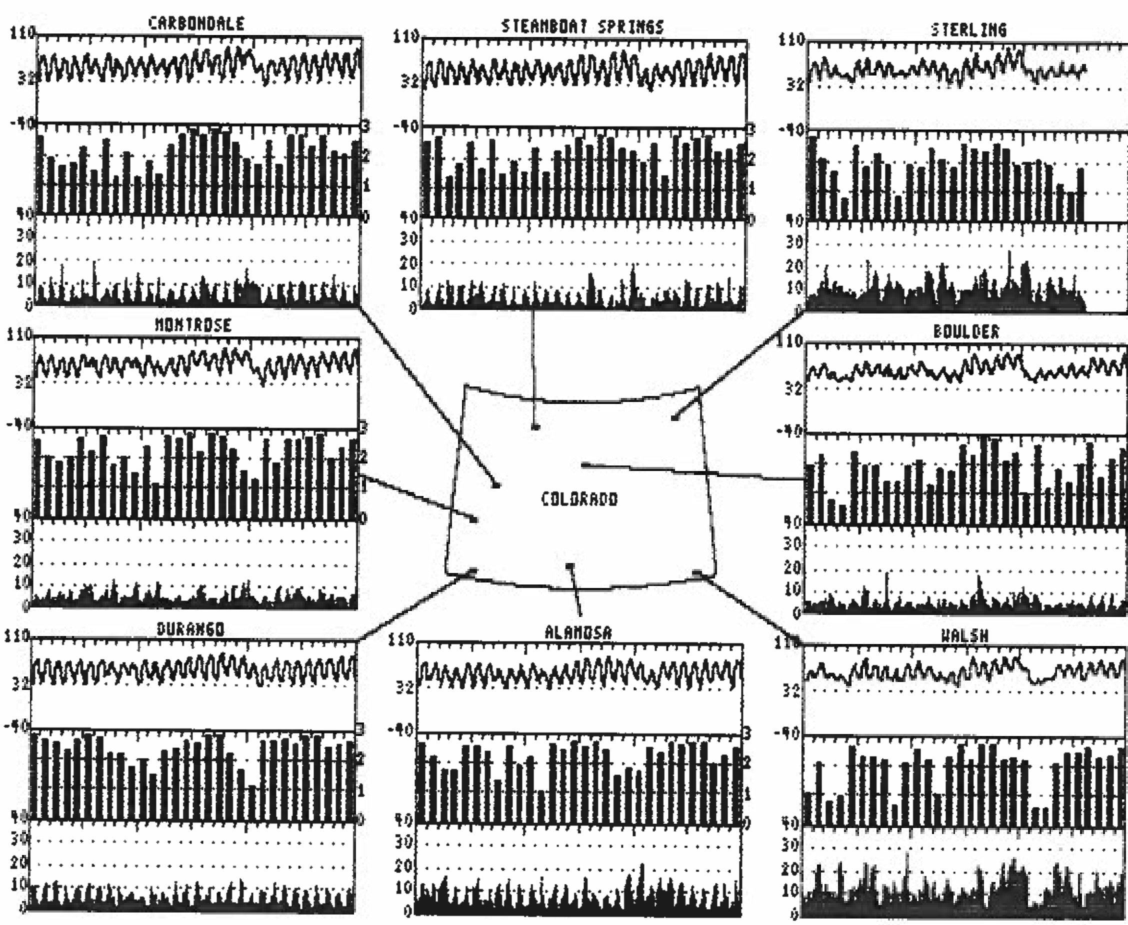
This paper was written by Mary Sutter and Peter Curtiss of the Joint Center for Energy Management, Campus Box 428, Boulder, CO 80309-0428

WTHRNET WEATHER DATA JUNE 1989

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh | Boulder |
|---|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | 59.2 | 59.3 | 59.6 | 65.0 | 55.4 | 62.6 | 65.6 | 64.9 |
| **monthly temperature extremes and time of occurence ( °F day/hour )** | | | | | | | | |
| maximum: | 86.4 18/15 | 87.3 18/17 | 91.6 19/14 | 92.7 18/16 | 89.4 19/14 | 100.9 19/15 | 92.1 20/14 | 94.3 19/15 |
| minimum: | 33.6 11/ 5 | 31.8 22/ 5 | 28.0 22/ 5 | 31.1 22/ 5 | 22.5 22/ 5 | 38.8 15/ 3 | 42.3 5/ 3 | 45.5 5/ 4 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | | |
| 5 AM | 76 / 33 | 51 / 24 | 82 / 34 | 50 / 29 | 91 / 33 | 80 / 45 | 87 / 52 | 57 / 36 |
| 11 AM | 24 / 29 | 22 / 28 | 25 / 30 | 21 / 29 | 28 / 32 | 49 / 46 | 59 / 55 | 35 / 37 |
| 2 PM | 17 / 23 | 17 / 25 | 20 / 27 | 17 / 26 | 22 / 27 | 38 / 43 | 49 / 52 | 33 / 35 |
| 5 PM | 19 / 24 | 16 / 23 | 19 / 26 | 17 / 25 | 24 / 27 | 40 / 43 | 48 / 49 | 29 / 33 |
| 11 PM | 41 / 27 | 36 / 23 | 45 / 30 | 29 / 24 | 66 / 36 | 68 / 46 | 75 / 53 | 48 / 38 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | | |
| day | 184 | 214 | 242 | 254 | 233 | 174 | 153 | 140 |
| night | 182 | 77 | 188 | 157 | 136 | 201 | 204 | 221 |
| **monthly average wind speed ( miles per hour )** | 5.84 | 4.20 | 4.24 | 3.75 | 3.83 | 9.02 | 10.23 | 3.75 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | | |
| 0 to 3 | 217 | 335 | 376 | 321 | 394 | 23 | 33 | 304 |
| 3 to 12 | 424 | 379 | 329 | 398 | 307 | 473 | 454 | 410 |
| 12 to 24 | 79 | 6 | 15 | 1 | 19 | 123 | 229 | 6 |
| > 24 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 |
| **monthly average daily total insolation ( Btu/ft²·day )** | 2259 | 2392 | 2184 | 2242 | 2243 | 1952 | 1989 | 1905 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | | |
| 60-80% | 242 | 190 | 200 | 223 | 237 | 182 | 203 | 152 |
| 40-60% | 85 | 61 | 93 | 108 | 94 | 86 | 76 | 107 |
| 20-40% | 53 | 70 | 82 | 65 | 57 | 62 | 53 | 69 |
| 0-20% | 33 | 20 | 13 | 20 | 25 | 64 | 85 | 66 |

## The State-Wide Picture

The figure below shows monthly weather at WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40°F to 110°F, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 Btu/ft²/day, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour. Only the first 26 days of Sterling data are available.



COLORADO CLIMATE

JULY 1989

Colorado Climate Center
Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado 80523

*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 10

## July in Review:

Hot and dry weather with extreme wildfire potential was the rule over Colorado in early July. Cooler temperatures and higher humidity covered the State later in the month bringing scattered but numerous showers and thunderstorms. The month ended up warmer than average over most of Colorado with generally above average moisture over the western half of the State but drier than average over much of the plains.

## Colorado's September Climate:

Summer always seems to slip away so quickly. By the time September roles around, the words "frost" and "snow" return to our climate summaries. But don't let them scare you. Fall is still a wonderful time to work or play in Colorado.

Officially or unofficially, September marks the end of summer. Daylength shortens rapidly, and as it does a number of changes in our weather occur. The afternoon thunderheads that we become so accustomed to over the summer begin to disappear. Humidity decreases and as it does the skies seem to become bluer and temperatures don't even wait until sunset to begin their evening descent. Large day to night temperature differences become common. Temperatures remain comfortably mild, however. Early in the month low elevations typically have daily highs in the 70s and 80s. Some 90-degree weather is not unusual. In the higher mountains 60s are common. At night, lows drop into the 40s and 50s at lower elevations with 30s and 40s in the mountains. But by the end of the month, temperatures have usually dropped at least 10 degrees. Some highs in the 60s are typical below 6000 feet with 50s in the high country. Lows in the 30s and 40s are to be expected with much chillier nights in the mountains. Strong cold fronts are not frequent in September, but every now and then we've had a "good" one. In 1985, a late September cold front brought frost to most of the state, snow to many areas and temperatures that hovered near the freezing point on the 29th.

September precipitation can be very unpredictable. Most years are quite dry and most Septembers are dominated by sunny weather. For most of Colorado's weather stations, September precipitation is less than 1" in more than 50% of the years. But sporadically, very cloudy and wet weather occurs. Large precipitation totals are especially possible in western Colorado where remnants of Pacific hurricanes occasionally link with mid-latitude frontal systems to produce copious rains. For the record, average precipitation for the month is generally between 1.00" and 1.50" and is surprizingly uniformly distributed over the state. The San Juan Mountains are the exception where precipitation averages 2" to 4". At least one dusting of mountain snow can usually be expected. Along the Front Range urban corridor, a September snow can be expected about one year in eight.

## Updated Statistics on Autumn Frost Probabilities:

Looking back at past issues of COLORADO CLIMATE, I see that we have often used the July summary to warn you of the rapid approach of autumn frosts. With the help of a great deal of new frost statistics computed for our recent publication, "Colorado Temperatures With Degree Day and Growing Season Data," I think it is appropriate to do it again. By the way, if you ordered a copy of this report you should be receiving it soon. Sorry for the long delay, but it should be worth the wait. It is one of the most detailed and comprehensive summaries of temperature for a state that I've ever seen. It's not too late to put in an order. Refer back to your February 1989 COLORADO CLIMATE for information on how to order.

(continued on page -9-)

## J U L Y   1 9 8 9   D A I L Y   W E A T H E R

| Date | Event |
|---|---|
| 1-9 | A major summer heatwave baked Colorado. Predominantly sunny and dry throughout the period, with large day-night temperature variations (more than 60° in some mountain valleys) as a large upper level dome of high pressure covered the Southwest. A few widely scattered thundershowers developed -- one near Pueblo on the 3rd and a few in the mountains 6-8th. Otherwise there was no precipitation. The most intense heat occurred 4-9th. Temperatures soared into the 80s and 90s high into the mountains. 100+ readings were common at lower elevations. Locations such as Denver and Glenwood Springs set new records with 5 consecutive days with maximum temperatures of 100°F or higher. Some examples of the highest observed temperatures during the heatwaves were: 71° at Mount Evans Research Center, 88° at Crested Butte, 95° at Buena Vista and Vail, 96° at Alamosa, 99° at Craig and Pagosa Springs, 102° at Durango, 103° at Denver, 104° at Grand Junction, 105° at Longmont, Northglenn and Pueblo and 107° at Fort Morgan. Palisade hit 108° on the 6th but was equaled by Sedgwick 5S on the 8th as the hottest temperature in Colorado for the month. Several forest fires were burning during this period, but on the 9th a combination of lower humidity (<10% in some areas) and strong winds in advance of a cool front sent fires raging. A fire near Boulder burned many homes that day. |
| 10-15 | Some cooler air slipped into northern Colorado on the 10th and moisture began moving northward into the Colorado mountains. Welcome rains fell at Walden (0.75") and Eagle (0.45") on the 10th and became more widespread 11-12th. An inch or more of rain fell in some mountain areas such as Leadville and Buena Vista. Showers decreased in the mountains but increased over the plains 13-14th. Some large thunderstorms erupted on the 13th especially near the Palmer Ridge. Colorado Springs reported 1.10" of rain and hail was reported in several areas. Scattered storms again developed over the plains 14-15th with seasonal summer temperatures. |
| 16-21 | The high pressure ridge became re-established over the Southwest but then was squeezed westward by an upper level low over the Midwest. This pattern produced seasonably warm weather with little or no precipitation. Low level moisture began advancing into southern Colorado late in the period. Alamosa received 0.34" of rain on the 20th and 0.40" on the 21st -- their heaviest 2-day rain in several years. |
| 22-26 | The upper level low over the Midwest drifted westward toward Colorado. Hazy and more humid air settled into eastern Colorado as winds aloft became very light from the north. As the high pressure ridge weakened over the Southwest, the atmosphere became convectively unstable. Thundershowers erupted daily over and near the mountains. Some substantial rainfall amounts were reported. Craig received 0.75", Yellow Jacket rejoiced with 0.95" of moisture and Steamboat Springs splashed through 1.29" of rainfall late on the 23rd. Center was flooded by 2.18" of rain on the 24th, their heaviest 24-hour rainfall on record. Durango received 1.36" of rain on the 26th. |
| 27-31 | An abundant supply of residual and subtropical moisture accompanied by weak winds aloft fueled a very typical late July weather pattern of active convection, slow moving storms and lingering clouds. A small upper air disturbance drifted northeast into Colorado on the 29th. Very heavy rains developed on the 29th and continued as steady rains over northeast Colorado early on the 30th. Temperatures on the 30th stayed in the 60s and 70s from the Front Range east to Nebraska. Some rainfall amounts included 2.00" at Cedaredge, 3.15" at Buckley Field in Aurora, 3.40" at Greeley and 4.13" at Briggsdale. Clearing, warmer and drier over much of the state 31st, but some more storms in southwest and southeast areas. Stonington got 1.40". |

### July 1989 Extremes

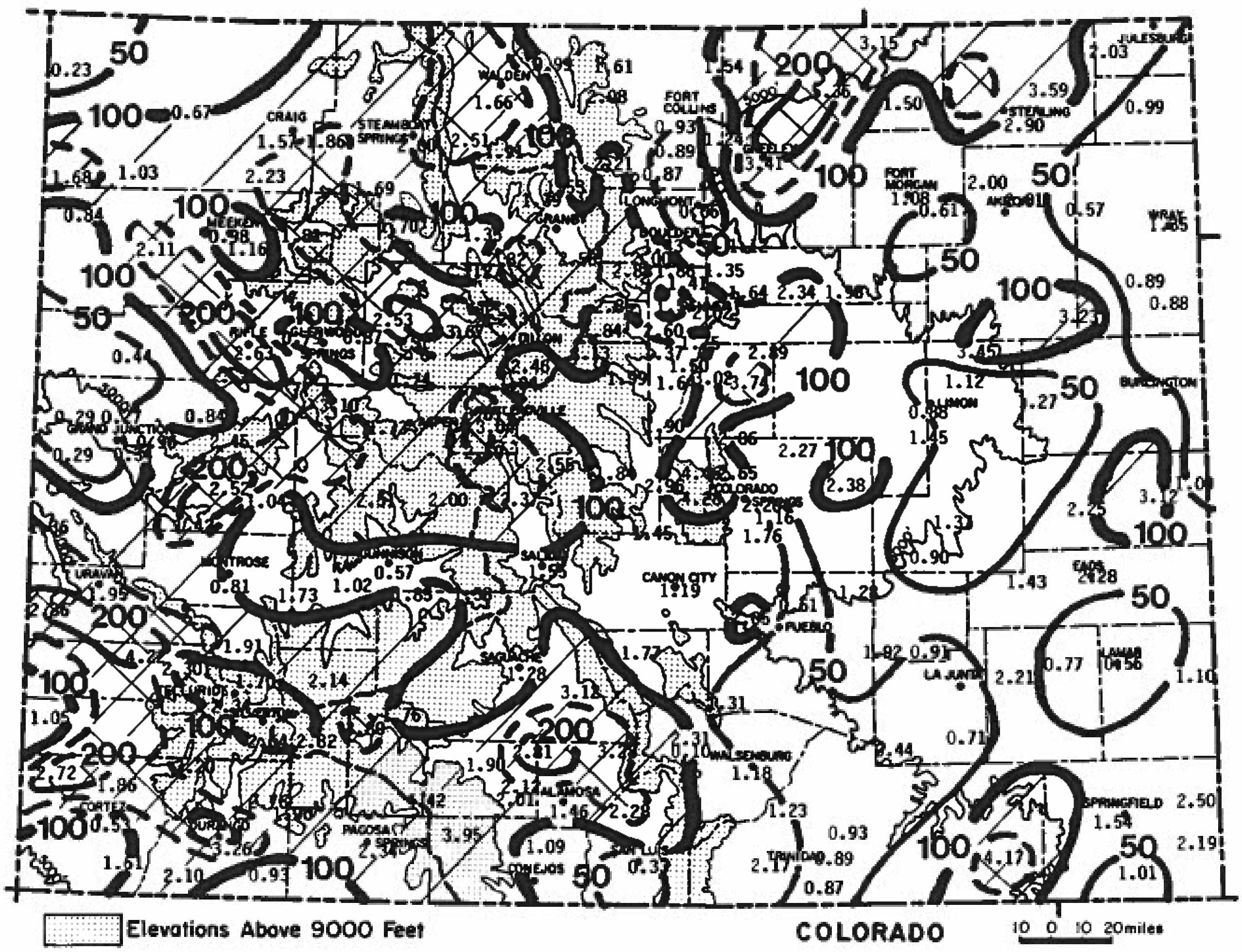
| | | | |
|---|---|---|---|
| Highest Temperature | 108°F | July 6 | Palisade |
| | | July 8 | Sedgwick 5S |
| Lowest Temperature | 21°F | July 2 | Silverton |
| Greatest Total Precipitation | 5.36" | | Briggsdale |
| Least Total Precipitation | 0.06" | | Longmont 2ESE |

*For existing weather stations with complete daily records.
Higher values are likely for unmonitored locations.

## JULY 1989 PRECIPITATION

The first 10 days of July were dry over most of the State. The 11-15th brought scattered storms to most of Colorado. The 16-21st were again dry. The seasonal monsoonal moisture then appeared on schedule in western Colorado producing daily showers for the remainder of the month. Widespread rains finally spilled into eastern Colorado during the final 4 days of the month. The resulting monthly rainfall totals produced a speckled pattern of wet and dry pockets over the state. The western half of the state was primarily wetter than average. A handful of weather stations measured more than double the July average. These included Durango, Paradox, Center, Delta, Cedaredge, Rifle and Eagle. At the same time, other nearby areas were dry. Cortez, San Luis, Gunnison and Grand Junction all received only half or less of their average. East of the mountains many areas were dry. About 30% of the weather stations east of the mountains recorded 50% or less of their average. But there were a few wet spots. Greeley and Briggsdale each received more than double their July average.

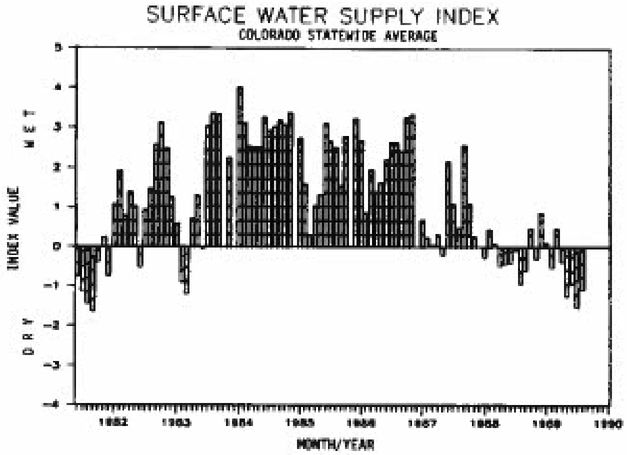
| Greatest | | Least | |
|---|---|---|---|
| Briggsdale | 5.36" | Longmont 2ESE | 0.06" |
| Manitou Springs | 4.46" | Browns Park Refuge | 0.23" |
| Wolf Creek Pass | 4.42" | Grand Junction WSO | 0.27" |
| Ruxton Park | 4.28" | Colorado Natl. Mon. | 0.29" |
| Norwood | 4.22" | Fruita | 0.29" |

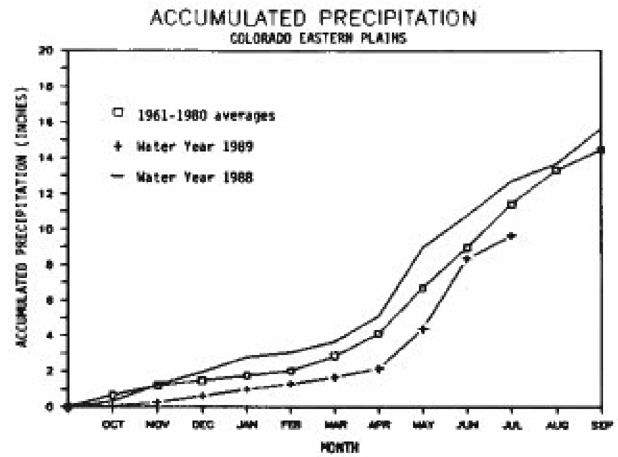


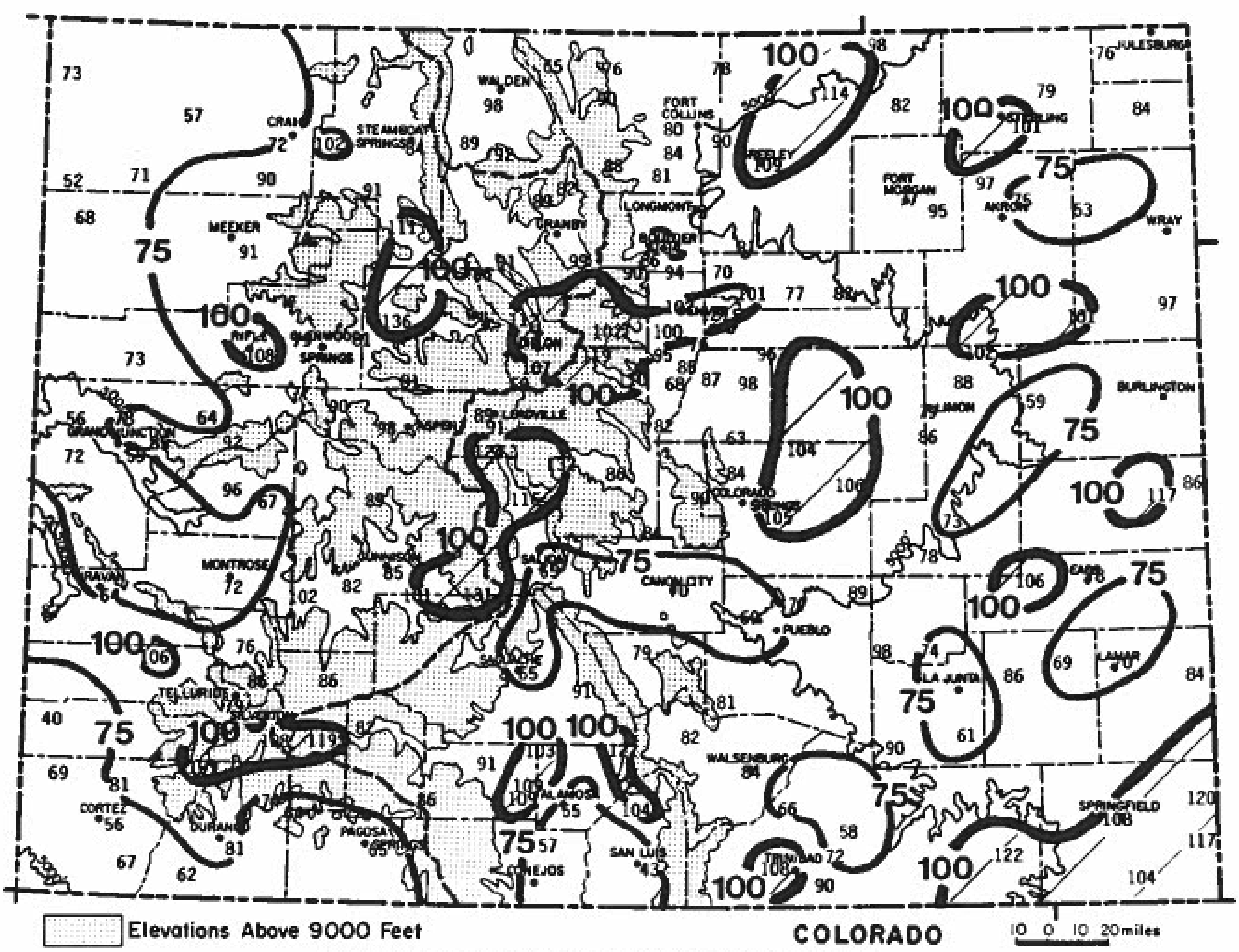

Precipitation amounts (inches) for July 1989 and contours of precipitation as a percent of the 1961-1980 average. Dashed line is 150% of average.

## 1989 WATER YEAR PRECIPITATION

Statewide, total precipitation for the first 10 months of the 1989 Water Year has been 10% to 20% below average. 45 out of the 189 weather stations with complete data for the year have actually had 100% or more of their average moisture. 44 stations have received only 75% or less of their average. The driest areas generally lie in extreme west and southwest Colorado. The wetter areas are scattered almost randomly around the state. This has been a dry year for Colorado and adverse impacts, especially in terms of agricultural production and wildfires, have been significant. But precipitation totals are much higher than in some of the well-known drought years of the past such as 1977 and 1934. From a statewide perspective, this year's precipitation could be estimated as a once in 10 to 20 year event. The serious impacts were largely a result of the timing of the precipitation more so than the magnitude of moisture deficits.



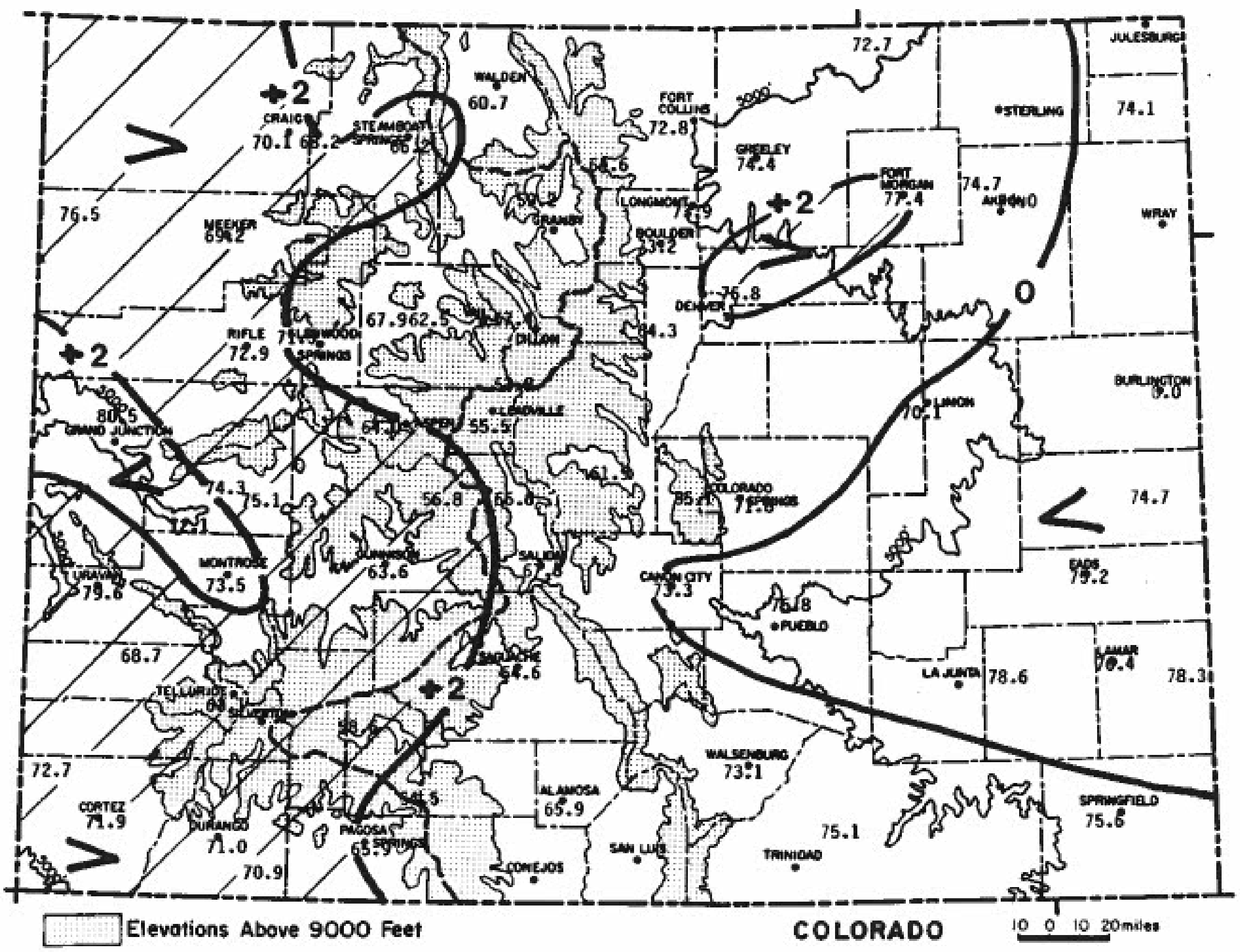




Precipitation for October 1988 through July 1989
as a percent of the 1961-1980 average.

## JULY 1989 TEMPERATURES

## AND DEGREE DAYS

Despite the heavily publicized record-breaking heatwave of early July, temperatures for the month as a whole were only a little above average. Over most of Colorado, daily high temperatures were unusually warm, but nighttime lows were seasonal. The warmest areas were in western Colorado where most stations ended up 1 to 3 degrees above average. East of the mountains, cool temperatures in the last half of July were responsible for keeping monthly means very close to average. The Arkansas Valley and the easternmost counties were actually slightly cooler than average.




July 1989 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

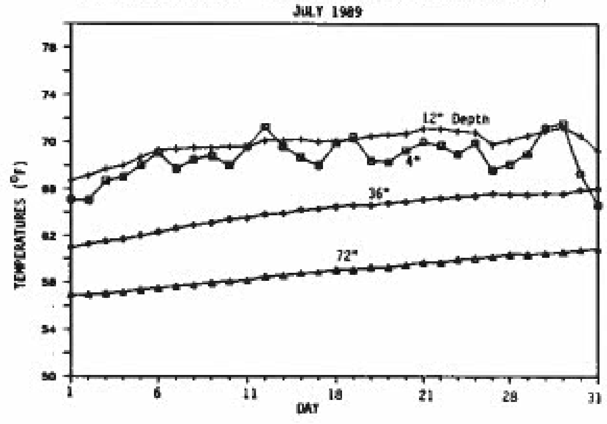
## JULY 1989 SOIL TEMPERATURES

Deep soil temperatures continued to steadily increase during July. Nearer the surface, temperatures peaked and leveled off during the month and then cooled in response to the cloudy, rainy weather near the end of July.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.

FORT COLLINS 7 AM SOIL TEMPERATURES

JULY 1989



# Table 1. Heating Degree Day Data through July 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | 1210 | 854 | 600 | 358 | 180 | 8241 |
| | 89-90 | 17 | | | | | | | | | | | | 17 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | 1171 | 899 | 692 | 476 | 269 | 8444 |
| | 89-90 | 68 | | | | | | | | | | | | 68 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | 1139 | 615 | 427 | 209 | 89 | 5485 |
| | 89-90 | 1 | | | | | | | | | | | | 1 |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | 1153 | 784 | 645 | 360 | 207 | 7646 |
| | 89-90 | 39 | | | | | | | | | | | | 39 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | 1135 | 697 | 375 | M | M | 5194 |
| | 89-90 | M | | | | | | | | | | | | M |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | 1078 | 554 | 382 | 226 | 90 | 5191 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | 1205 | 655 | 475 | 247 | 134 | 6107 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | 1008 | 718 | 450 | 282 | 112 | 6437 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | 1443 | 894 | 531 | 365 | 169 | 8068 |
| | 89-90 | 4 | | | | | | | | | | | | 4 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 88-89 | M | M | M | M | M | M | 1327 | 964 | 613 | 345 | 211 | 53 | M |
| | 89-90 | 11 | | | | | | | | | | | | 11 |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | 1190 | 665 | 432 | 213 | 76 | 5780 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | 1307 | 1088 | 875 | 679 | 490 | 10505 |
| | 89-90 | 226 | | | | | | | | | | | | 226 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | 933 | 666 | 388 | 237 | 76 | 6209 |
| | 89-90 | 2 | | | | | | | | | | | | 2 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | 1227 | 829 | 536 | 344 | 181 | 7925 |
| | 89-90 | 1 | | | | | | | | | | | | 1 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | 1227 | 794 | 636 | 439 | 261 | 7583 |
| | 89-90 | 49 | | | | | | | | | | | | 49 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | 1207 | 732 | 433 | 216 | 92 | 6119 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | 1230 | 726 | 446 | 183 | 77 | 6278 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | 1037 | 534 | 260 | 113 | 8 | 5424 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING    E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | 1368 | 1086 | 805 | 584 | 391 | 10051 |
| | 89-90 | 168 | | | | | | | | | | | | 168 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | 1230 | 711 | 444 | 184 | 71 | 6050 |
| | 89-90 | 1 | | | | | | | | | | | | 1 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | 1698 | 2096 | 1578 | 1096 | 640 | 487 | 241 | 10187 |
| | 89-90 | 61 | | | | | | | | | | | | 61 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | 1109 | 535 | 303 | 114 | 31 | 4862 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | 1310 | 1112 | 914 | 695 | 509 | 10772 |
| | 89-90 | 285 | | | | | | | | | | | | 285 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | 1211 | 751 | 516 | 275 | 143 | 6544 |
| | 89-90 | 1 | | | | | | | | | | | | 1 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | 1307 | 841 | 542 | 256 | 110 | 6961 |
| | 89-90 | 2 | | | | | | | | | | | | 2 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 88-89 | M | M | M | M | M | M | M | M | M | M | M | 165 | M |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | 972 | 605 | 348 | 180 | 64 | 5903 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | 1095 | 860 | 574 | 447 | 230 | 7990 |
| | 89-90 | 24 | | | | | | | | | | | | 24 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | 1141 | 573 | 378 | 134 | 35 | 5385 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | 1049 | 674 | 381 | 224 | 74 | 6401 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | 1355 | 964 | 581 | 401 | 273 | 8713 |
| | 89-90 | 18 | | | | | | | | | | | | 18 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | 1189 | 730 | 416 | 152 | 59 | 5885 |
| | 89-90 | M | | | | | | | | | | | | M |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | 1071 | 858 | 633 | 463 | 263 | 8237 |
| | 89-90 | 72 | | | | | | | | | | | | 72 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | 1026 | 538 | 378 | 159 | 79 | 5145 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | 1369 | 1023 | 772 | 612 | 371 | 9776 |
| | 89-90 | 132 | | | | | | | | | | | | 132 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | 1031 | 492 | 376 | 164 | 82 | 5001 |
| | 89-90 | 0 | | | | | | | | | | | | 0 |

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING    E = ESTIMATED

# JULY 1989 CLIMATIC DATA

## Eastern Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEW RAYMER 21N | 89.0 | 56.3 | 72.7 | 1.6 | 101 | 49 | 8 | 256 | 638 | 3.15 | 0.99 | 145.8 | 5 |
| FORT MORGAN | 92.8 | 61.9 | 77.4 | 2.2 | 107 | 56 | 0 | 393 | 741 | 1.08 | -0.62 | 63.5 | 6 |
| AKRON FAA AP | 88.9 | 60.5 | 74.7 | 1.1 | 104 | 49 | 3 | 312 | 696 | 2.00 | -0.63 | 76.0 | 4 |
| AKRON 4E | 89.8 | 58.3 | 74.0 | 0.6 | 107 | 49 | 0 | 291 | 667 | 2.01 | -0.56 | 78.2 | 5 |
| HOLYOKE | 86.8 | 61.5 | 74.1 | -0.9 | 104 | 55 | 0 | 291 | 705 | 0.99 | -1.79 | 35.6 | 2 |
| LIMON WSMO | 86.6 | 53.6 | 70.1 | -0.6 | 99 | 49 | 1 | 169 | 583 | 0.88 | -2.02 | 30.3 | 8 |
| CHEYENNE WELLS | 89.5 | 60.0 | 74.7 | -0.7 | 101 | 52 | 0 | 311 | 706 | 3.12 | 0.65 | 126.3 | 5 |
| EADS | 89.4 | 61.0 | 75.2 | -1.8 | 100 | 55 | 0 | 326 | 721 | 2.28 | -0.55 | 80.6 | 2 |
| LAMAR | 93.9 | 58.8 | 76.4 | -2.5 | 103 | 52 | 0 | 363 | 702 | 0.56 | -1.84 | 23.3 | 6 |
| LAS ANIMAS | 94.5 | 62.7 | 78.6 | -0.7 | 107 | 56 | 0 | 428 | 759 | 2.21 | -0.04 | 98.2 | 5 |
| HOLLY | 94.3 | 62.3 | 78.3 | -0.4 | 105 | 53 | 0 | 421 | 752 | 1.10 | -0.97 | 53.1 | 7 |
| SPRINGFIELD 7WSW | 92.1 | 59.1 | 75.6 | 0.3 | 100 | 53 | 0 | 338 | 707 | 1.54 | -0.90 | 63.1 | 6 |

## Foothills/Adjacent Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FORT COLLINS | 87.5 | 58.1 | 72.8 | 1.3 | 98 | 53 | 0 | 249 | 663 | 0.93 | -0.84 | 52.5 | 4 |
| GREELEY UNC | 91.1 | 57.6 | 74.4 | 0.9 | 103 | 53 | 1 | 297 | 672 | 3.41 | 2.20 | 281.8 | 3 |
| ESTES PARK | 81.6 | 47.5 | 64.6 | 2.3 | 96 | 39 | 67 | 62 | 493 | 2.21 | 0.04 | 101.8 | 8 |
| LONGMONT 2ESE | 92.4 | 55.3 | 73.9 | 1.5 | 105 | 50 | 2 | 286 | 639 | 0.06 | -1.00 | 5.7 | 1 |
| BOULDER | 89.5 | 56.9 | 73.2 | -0.3 | 100 | 52 | 1 | 264 | 652 | 1.43 | -0.46 | 75.7 | 7 |
| DENVER WSFO AP | 91.5 | 60.2 | 75.8 | 2.5 | 103 | 55 | 0 | 345 | 708 | 1.64 | -0.26 | 86.3 | 4 |
| EVERGREEN | 81.8 | 46.8 | 64.3 | 0.5 | 93 | 41 | 49 | 37 | 481 | 2.60 | 0.35 | 115.6 | 8 |
| LAKE GEORGE 8SW | 77.3 | 46.5 | 61.9 | 0.6 | 88 | 39 | 95 | 7 | 426 | 1.84 | -0.69 | 72.7 | 8 |
| RUXTON PARK | 70.5 | 39.8 | 55.1 | -1.2 | 83 | 35 | 300 | 1 | 325 | 4.28 | 0.04 | 100.9 | 10 |
| COLORADO SPRINGS | 85.9 | 57.6 | 71.8 | 0.6 | 97 | 53 | 0 | 220 | 635 | 2.26 | -0.64 | 77.9 | 7 |
| CANON CITY 2SE | 88.3 | 58.2 | 73.3 | -0.3 | 99 | 52 | 0 | 263 | 668 | 1.19 | -0.72 | 62.3 | 8 |
| PUEBLO WSO AP | 93.7 | 59.8 | 76.8 | -0.4 | 105 | 55 | 0 | 373 | 718 | 0.61 | -1.33 | 31.4 | 6 |
| WALSENBURG | 88.5 | 57.8 | 73.1 | 0.9 | 99 | 51 | 0 | 259 | 661 | 1.18 | -1.22 | 49.2 | 6 |
| TRINIDAD FAA AP | 90.6 | 59.7 | 75.1 | 1.1 | 99 | 51 | 0 | 320 | 703 | 0.93 | -1.24 | 42.9 | 6 |

## Mountains/Interior Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WALDEN | 82.1 | 39.3 | 60.7 | 1.8 | 94 | 29 | 132 | 6 | 483 | 1.66 | 0.73 | 178.5 | 9 |
| LEADVILLE 2SW | 73.1 | 38.0 | 55.5 | 1.0 | 83 | 28 | 285 | 0 | 364 | 3.04 | 0.74 | 132.2 | 13 |
| SALIDA | 85.2 | 49.9 | 67.5 | 1.8 | 96 | 43 | 10 | 97 | 541 | 1.55 | -0.14 | 91.7 | 9 |
| BUENA VISTA | 82.5 | 48.7 | 65.6 | 0.7 | 95 | 43 | 39 | 65 | 500 | 2.37 | 0.80 | 151.0 | 13 |
| SAGUACHE | 80.6 | 48.6 | 64.6 | 0.6 | 90 | 42 | 35 | 34 | 485 | 1.28 | -0.33 | 79.5 | 10 |
| HERMIT 7ESE | 78.6 | 38.7 | 58.6 | 2.8 | 89 | 29 | 190 | 0 | 441 | 3.80 | 1.48 | 163.8 | 8 |
| ALAMOSA WSO AP | 84.7 | 47.0 | 65.9 | 0.8 | 96 | 35 | 17 | 52 | 519 | 1.46 | 0.12 | 109.0 | 11 |
| STEAMBOAT SPRINGS | 86.1 | 46.3 | 66.2 | 4.6 | 95 | 36 | 18 | 63 | 539 | 2.00 | 0.72 | 156.2 | 7 |
| GRAND LAKE 6SSW | 77.0 | 41.4 | 59.2 | 1.1 | 85 | 34 | 168 | 0 | 426 | 1.39 | 0.04 | 103.0 | 11 |
| DILLON 1E | 75.4 | 39.5 | 57.4 | 0.5 | 84 | 30 | 226 | 0 | 398 | 2.31 | 0.76 | 149.0 | 11 |
| AVON | 83.2 | 41.7 | 62.5 | -1.5 | 94 | 25 | 100 | 30 | 496 | 1.43 | 0.13 | 110.0 | 7 |
| CLIMAX | 66.7 | 40.8 | 53.8 | 2.1 | 76 | 34 | 342 | 0 | 267 | 1.84 | -0.24 | 88.5 | 9 |
| ASPEN 1SW | 80.3 | 47.8 | 64.0 | 2.0 | 91 | 42 | 68 | 43 | 472 | 1.73 | 0.03 | 101.8 | 12 |
| TAYLOR PARK | 72.8 | 40.9 | 56.8 | 3.4 | 83 | 34 | 246 | 0 | 360 | 2.00 | 0.46 | 129.9 | 12 |
| TELLURIDE | 82.4 | 43.9 | 63.1 | 3.1 | 93 | 35 | 72 | 22 | 483 | 2.34 | -0.08 | 96.7 | 10 |
| PAGOSA SPRINGS | 86.7 | 45.1 | 65.9 | 1.8 | 99 | 34 | 24 | 58 | 521 | 2.34 | 0.60 | 134.5 | 10 |
| SILVERTON | 77.4 | 34.3 | 55.8 | 1.9 | 88 | 21 | 277 | 0 | 429 | 2.64 | -0.09 | 96.7 | 13 |
| WOLF CREEK PASS 1 | 69.7 | 39.2 | 54.5 | 1.4 | 80 | 35 | 320 | 0 | 315 | 4.42 | 1.19 | 136.8 | 12 |

Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 88.8 | 51.3 | 70.1 | 3.4 | 99 | 45 | 4 | 170 | 573 | 1.57 | 0.27 | 120.8 | 8 |
| HAYDEN | 86.6 | 49.8 | 68.2 | 1.4 | 97 | 41 | 4 | 112 | 555 | 1.86 | 0.78 | 172.2 | 6 |
| MEEKER NO. 2 | 87.9 | 50.4 | 69.2 | 2.0 | 97 | 41 | 0 | 137 | 570 | 0.98 | -0.13 | 88.3 | 4 |
| RANGELY 1E | 93.8 | 59.2 | 76.5 | 3.2 | 102 | 52 | 0 | 365 | 707 | 0.84 | -0.10 | 89.4 | 5 |
| EAGLE FAA AP | 87.4 | 48.5 | 67.9 | 1.4 | 99 | 38 | 1 | 100 | 549 | 2.53 | 1.50 | 245.6 | 13 |
| GLENWOOD SPRINGS | 90.7 | 52.3 | 71.5 | 1.6 | 102 | 44 | 0 | 207 | 595 | 0.79 | -0.48 | 62.2 | 10 |
| RIFLE | 92.8 | 53.1 | 72.9 | 2.6 | 103 | 41 | 0 | 252 | 623 | 2.63 | 1.94 | 381.2 | 5 |
| GRAND JUNCTION WS | 95.3 | 65.6 | 80.5 | 1.4 | 104 | 57 | 0 | 489 | 808 | 0.27 | -0.29 | 48.2 | 5 |
| CEDAREDGE | 93.3 | 55.4 | 74.3 | 2.4 | 103 | 45 | 0 | 297 | 645 | 2.52 | 1.68 | 300.0 | 6 |
| PAONIA 1SW | 93.2 | 57.0 | 75.1 | 2.7 | 105 | 50 | 0 | 322 | 671 | 1.04 | -0.09 | 92.0 | 8 |
| DELTA | 94.2 | 50.0 | 72.1 | -1.6 | 105 | 40 | 11 | 239 | 581 | 1.42 | 0.76 | 215.2 | 5 |
| GUNNISON | 83.5 | 43.6 | 63.6 | 2.4 | 92 | 33 | 61 | 23 | 504 | 0.57 | -0.74 | 43.5 | 5 |
| MONTROSE NO. 2 | 89.7 | 57.2 | 73.5 | 1.2 | 99 | 52 | 0 | 271 | 659 | 0.81 | -0.07 | 92.0 | 6 |
| URAVAN | 99.0 | 60.3 | 79.6 | 2.4 | 110 | 50 | 0 | 462 | 723 | 1.95 | 0.79 | 168.1 | 8 |
| NORWOOD | 85.4 | 52.1 | 68.7 | 2.4 | 96 | 49 | 4 | 128 | 553 | 4.22 | 2.46 | 239.8 | 8 |
| YELLOW JACKET 2W | 89.0 | 56.4 | 72.7 | 2.1 | 98 | 52 | 0 | 246 | 639 | 2.72 | 1.42 | 209.2 | 8 |
| CORTEZ | 90.2 | 53.6 | 71.9 | 3.1 | 98 | 37 | 0 | 224 | 626 | 0.53 | -0.50 | 51.5 | 6 |
| DURANGO | 90.3 | 51.7 | 71.0 | 2.2 | 102 | 44 | 2 | 195 | 574 | 3.26 | 1.75 | 215.9 | 14 |
| IGNACIO 1N | 91.6 | 50.2 | 70.9 | 2.7 | 99 | 37 | 1 | 192 | 587 | 0.93 | -0.42 | 68.9 | 10 |

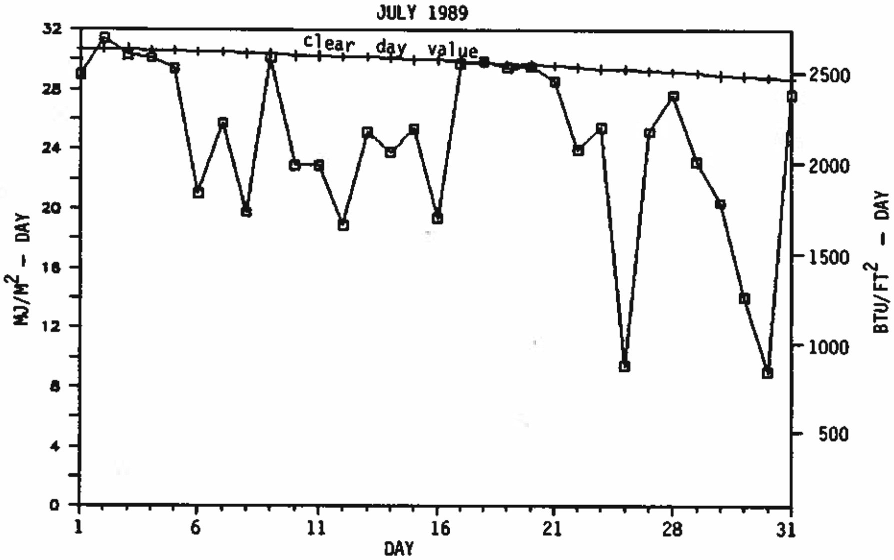
* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## JULY 1989 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 16 | 11 | 4 | -- | -- |
| Denver | 15 | 13 | 3 | 76% | 71% |
| Fort Collins | 12 | 15 | 4 | -- | -- |
| Grand Junction | 15 | 9 | 7 | 88% | 78% |
| Pueblo | 18 | 9 | 4 | 87% | 78% |

FT. COLLINS TOTAL HEMISPHERIC RADIATION

JULY 1989



Updated Statistics on Autumn Frost Probabilities continued

The following table presents the most up-to-date frost dates:

| Station | Period of Record | Probability that the first autumn freeze (32°F) will occur on or before this date | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Earliest | 10% | 20% | 50% | 80% | 90% | Last |
| Akron | 1937-87 | Sep 13 | Sep 19 | Sep 23 | Oct 2 | Oct 11 | Oct 15 | Oct 28 |
| Alamosa | 1948-87 | Aug 21 | Sep 1 | Sep 4 | Sep 10 | Sep 18 | Sep 22 | Sep 29 |
| Boulder | 1948-87 | Sep 12 | Sep 19 | Sep 25 | Oct 6 | Oct 18 | Oct 23 | Oct 31 |
| Buena Vista | 1948-87 | Sep 2 | Sep 8 | Sep 12 | Sep 19 | Sep 27 | Oct 1 | Oct 6 |
| Burlington | 1918-87 | Sep 6 | Sep 16 | Sep 21 | Oct 2 | Oct 13 | Oct 19 | Nov 2 |
| Canon City | 1948-87 | Sep 17 | Sep 21 | Sep 27 | Oct 8 | Oct 19 | Oct 25 | Nov 5 |
| Colorado Springs | 1948-87 | Sep 3 | Sep 20 | Sep 25 | Oct 5 | Oct 15 | Oct 20 | Oct 31 |
| Cortez | 1929-87 | Sep 9 | Sep 15 | Sep 20 | Sep 30 | Oct 10 | Oct 15 | Oct 23 |
| Craig | 1948-77 | Aug 1 | Aug 23 | Aug 30 | Sep 11 | Sep 23 | Sep 29 | Oct 4 |
| Denver (airport) | 1948-87 | Sep 8 | Sep 20 | Sep 26 | Oct 7 | Oct 18 | Oct 24 | Oct 30 |
| Dillon | 1909-87 | ----- | ------ | Jul 21 | Aug 2 | Aug 15 | Aug 22 | Sep 25 |
| Durango | 1900-87 | Aug 23 | Sep 6 | Sep 11 | Sep 20 | Sep 29 | Oct 4 | Oct 15 |
| Fort Collins | 1900-87 | Aug 25 | Sep 13 | Sep 18 | Sep 28 | Oct 7 | Oct 12 | Oct 23 |
| Fort Morgan | 1948-87 | Sep 9 | Sep 18 | Sep 23 | Oct 2 | Oct 12 | Oct 16 | Nov 1 |
| Grand Junction | 1900-87 | Sep 18 | Oct 6 | Oct 11 | Oct 21 | Oct 31 | Nov 5 | Nov 26 |
| Greeley | 1948-87 | Sep 13 | Sep 18 | Sep 22 | Oct 1 | Oct 9 | Oct 14 | Oct 23 |
| Gunnison | 1900-87 | Jul 19 | Aug 1 | Aug 8 | Aug 22 | Sep 4 | Sep 11 | Sep 23 |
| Lamar | 1918-87 | Sep 13 | Sep 23 | Sep 28 | Oct 7 | Oct 17 | Oct 21 | Nov 1 |
| Montrose | 1900-87 | Sep 9 | Sep 19 | Sep 25 | Oct 5 | Oct 15 | Oct 21 | Oct 30 |
| Pueblo | 1954-87 | Sep 19 | Sep 24 | Sep 29 | Oct 10 | Oct 21 | Oct 26 | Nov 1 |
| Rifle | 1910-87 | Aug 17 | Sep 7 | Sep 12 | Sep 22 | Oct 2 | Oct 7 | Oct 24 |
| Rocky Ford | 1918-87 | Sep 9 | Sep 21 | Sep 26 | Oct 4 | Oct 13 | Oct 18 | Nov 1 |
| Steamboat Springs | 1908-87 | Jul 19 | Jul 25 | Jul 31 | Aug 14 | Aug 27 | Sep 3 | Sep 17 |
| Sterling | 1948-87 | Sep 1 | Sep 13 | Sep 18 | Sep 27 | Oct 7 | Oct 12 | Oct 28 |
| Trinidad | 1948-87 | Sep 17 | Sep 22 | Sep 27 | Oct 6 | Oct 15 | Oct 20 | Oct 24 |

The areas of Colorado where freezes occur first are obviously up in the mountains. In fact, some areas -- mostly above 9,000' -- can experience freezing temperatures at any time during the summer. Freezes work their way down during September to lower elevations and by the middle of October the entire State has usually had a hard freeze. Based on median freeze dates, the last areas to have a freeze are typically the lower Arkansas Valley (2nd week of October), Mesa Verde (Oct 15) and finally the Grand Valley from Grand Junction to Palisade (Oct 21).

If you compare these numbers to the ones we published in the July 1986 edition of COLORADO CLIMATE you will find that things have not changed much. That is reassuring. That probably means if you have an old growing season publication for Colorado, you don't need to buy a new one. While there are dramatic year to year changes in frost dates (there may as much as a 2 month difference between the earliest and latest observed dates of the first autumn freeze), our experience has shown that it only takes about 15 consecutive years of data to pin down the median of the distribution. But it takes much longer to make accurate assessments of the 10% and 90% nonexceedance dates.

What this analysis doesn't solve is the age-old question of what really is a killing frost. A 32° temperature measured in an appropriate weather shelter may or may not mean that serious frost damage has occurred to plants. In the early years of weather observations, the determination of killing frost was made independently by each weather observer based both on the temperature and on the observed impact on nearby vulnerable vegetation. In recent decades, temperature alone has been used to make the determination. Usually, when the temperature of an official sheltered thermometer about 5 feet above ground level reaches 32°, the temperature is indeed much colder at ground and leaf canopy level. This is especially true when skies are clear, humidity is low and winds are calm. Therefore, a 32° shelter temperature usually means killing frost for your pumpkins, squash, beans and tomatoes. That is why you sometimes see a light glistening frost when you hear that the low temperature may have only reached 35° or 36°. But if it is windy, cloudy or foggy that may not be the case and a 32° temperature may only cause localized damage. Therefore, some prefer to use a 28°F shelter temperature as the killing frost threshold. Then there is no doubt. Nothing is ever simple, is it.

Freeze probability data for many locations in addition to those shown above are available from the Colorado Climate Center. Contact us.

# SOLAR COOLING

The latest heat wave experienced in Colorado drove people to the hardware store looking for fans and air conditioners. Hollywood did its best to lure us into the cool theaters with the rash of thriller/adventure movies out recently. Many would have sought out the theaters even without all the new excitement to pursue because of the advantage of decreased temperatures and relief from the sun beating down on them. To some, however, the sun beating down was a source of cooling. How, you ask, can a clear sky with a fierce sun be in any way cooling? Solar air conditioning! Using the energy from the sun as the heat source for absorption chillers helps reduce the need for fossil fueled energy to create a cool inner environment.

All air conditioners are based on some kind of refrigeration cycle. Most use an environmentally taxing and ozone depleting fluid to move heat from one place (your house) to another (the outdoors). Absorption chillers work in much of the same way except they use water or other equally benign fluids to transport the heat. It is a cycle that can be adapted to use the sun as an energy source. Standard cycles cannot be adapted but must rely on energy made by man.

Absorption chillers are probably best described by first going over a standard refrigeration cycle and then comparing that to the absorption chiller cycle. Figure 1 shows the four components to a basic refrigeration system. The evaporator is where heat pulled from an area enters the cycle. At this point, everything is at a low pressure as the heat is absorbed by a liquid refrigerant such as Freon or R-22 and then vaporized. This vapor moves to the compressor where it is pumped to a high pressure. Work input is needed to create this large pressure differential and you pay for it depending on the amount of electricity used. The condenser condenses the vapor back to a liquid and the process dumps out heat. This heat is what you feel when you stand next to your air conditioners outside the home. The refrigerant then goes through a valve which reduces the pressure back to the correct pressure to allow for evaporation and the cycle starts all over.

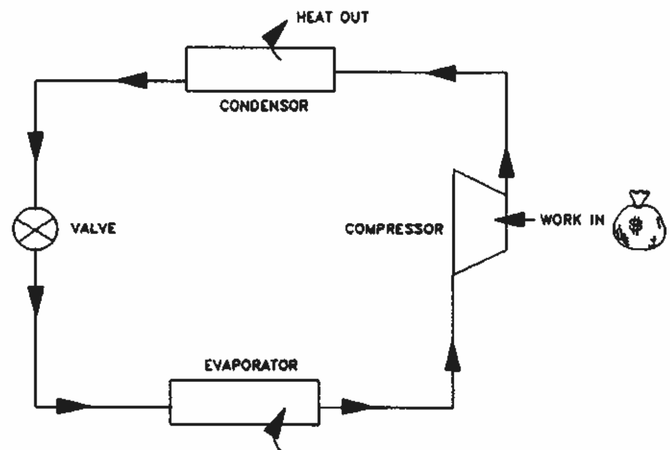



Figure 1.

Figure 2 has the 7 components used by the absorption chiller cycle. The compressor is gone along with the large utility bills needed to run it. In its place is an absorber, generator, valve and a small pump. The evaporator does the same job in both cycles. The chiller contains a refrigerant (water or ammonia) and an absorbing fluid (lithium bromide or water). Refrigerant vapor moves from the evaporator to the absorber where it dissolves in absorbent (much like carbon dioxide dissolves in soda pop). Heat is removed and a pump moves the absorbent/refrigerant mixture up to a generator. Heat is used at this point to separate the mixture and in the process to build up a small pressure differential needed for the condenser. Energy collected through solar collectors can provide this heat. A valve enables water to return to the absorber at the beginning pressure. Once the refrigerant vapor moves into the condenser, the cycle is again the same as the standard refrigeration cycle.

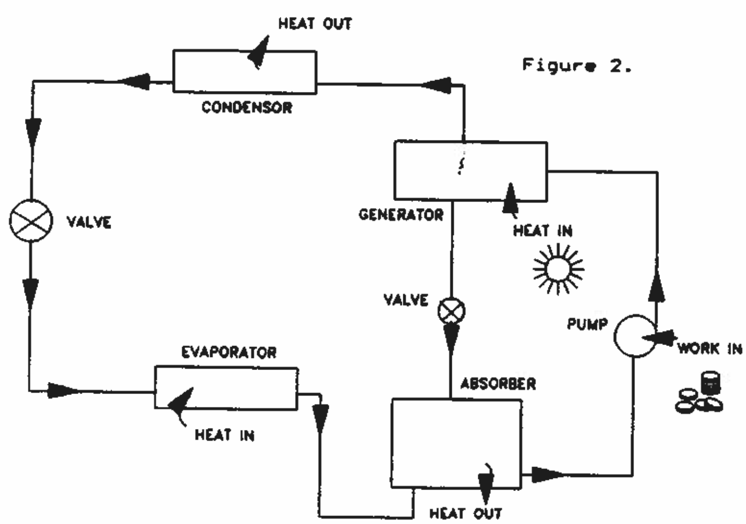



Figure 2.

Absorption chillers have been studied for at least 10 years. They work best in large systems since the absorber chamber needs to be large. The market for them is still low, but may be expanding as technological advances allows the price to reduce and the price to the environment from the use of standard air conditioners continues to rise.

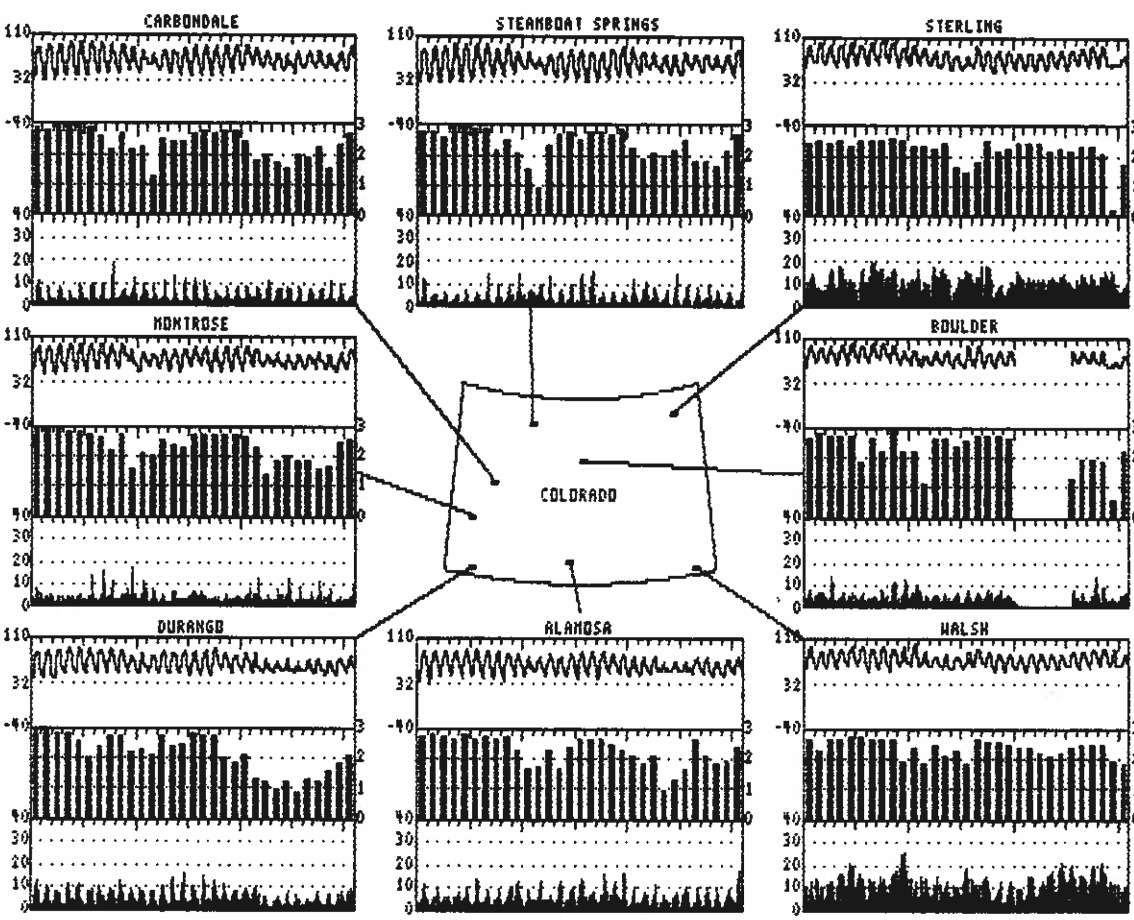
This article was written by Mary Sutter and Peter Curtiss of the Joint Center for Energy Management, Campus Box 428, Boulder, CO 80309-0428.

# WTHRNET WEATHER DATA JULY 1989

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Walsh | Boulder |
|---|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | 65.1 | 65.9 | 66.9 | 71.4 | 63.9 | 74.8 | 74.6 | 76.4 |
| **monthly temperature extremes and time of occurence ( °F day/hour )** | | | | | | | | |
| maximum: | 90.3 6/15 | 92.3 5/15 | 95.7 6/16 | 97.0 6/16 | 95.7 7/15 | 106.5 8/16 | 98.1 11/16 | 101.1 7/16 |
| minimum: | 35.1 2/ 5 | 41.2 3/ 5 | 34.3 2/ 5 | 45.9 2/ 5 | 30.6 2/ 5 | 49.3 20/ 5 | 55.8 22/ 5 | 58.5 16/ 5 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | | |
| 5 AM | 81 / 42 | 62 / 36 | 88 / 43 | 59 / 38 | 95 / 42 | 72 / 49 | 80 / 55 | 34 / 29 |
| 11 AM | 35 / 40 | 32 / 39 | 39 / 49 | 27 / 40 | 39 / 47 | 32 / 46 | 37 / 50 | 21 / 31 |
| 2 PM | 26 / 35 | 29 / 36 | 29 / 43 | 21 / 37 | 29 / 43 | 23 / 39 | 28 / 46 | 17 / 29 |
| 5 PM | 31 / 36 | 32 / 35 | 31 / 42 | 24 / 36 | 34 / 43 | 21 / 37 | 30 / 45 | 18 / 29 |
| 11 PM | 52 / 39 | 50 / 36 | 60 / 45 | 41 / 37 | 70 / 47 | 48 / 46 | 58 / 52 | 27 / 30 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | | |
| day | 179 | 192 | 231 | 242 | 216 | 145 | 148 | 102 |
| night | 153 | 80 | 174 | 154 | 116 | 183 | 191 | 201 |
| **monthly average wind speed ( miles per hour )** | 4.17 | 3.92 | 3.38 | 3.05 | 3.00 | 9.70 | 9.55 | 3.69 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | | |
| 0 to 3 | 291 | 365 | 452 | 411 | 477 | 21 | 44 | 266 |
| 3 to 12 | 432 | 367 | 288 | 328 | 247 | 536 | 489 | 344 |
| 12 to 24 | 20 | 12 | 4 | 5 | 16 | 187 | 208 | 3 |
| > 24 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| **monthly average daily total insolation ( $Btu/ft^2 \cdot day$ )** | 2242 | 2112 | 2374 | 2332 | 2364 | 2213 | 2349 | 2269 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | | |
| 60-80% | 243 | 163 | 178 | 264 | 186 | 256 | 277 | 172 |
| 40-60% | 77 | 60 | 69 | 63 | 54 | 84 | 91 | 53 |
| 20-40% | 56 | 73 | 33 | 49 | 47 | 50 | 43 | 45 |
| 0-20% | 39 | 65 | 38 | 32 | 39 | 50 | 21 | 32 |

## The State-Wide Picture

The figure below shows monthly weather at WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40°F to 110°F, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 $Btu/ft^2/day$, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour. Boulder data was not available from 7/20 to 7/25 due to station repairs.



# COLORADO CLIMATE

AUGUST 1989

Colorado Climate Center
Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado 80523

*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 11

## August in Review:

Scattered thunderstorms early in August became heaviest and most widespread 11th - 12th. Thereafter, the summer storms began their typical late summer decline. Precipitation totals ended up above average over most of the eastern plains and parts of the Western Slope. The majority of the mountains received below average rainfall totals. Temperatures were very pleasant statewide throughout the month. There were no prolonged hot spells, and temperatures ended up near or slightly below the long-term average.

## Colorado's October Climate:

The "first snow" contests, so popular here in Colorado in most Octobers, won't have as many participants this year thanks to the early September snow that struck parts of Colorado. But that won't stop our many snow lovers from seeking other indications of what kind of winter may lie ahead. Some years significant mountain snows already have accumulated by Halloween. At other times, little or no snow falls anywhere in Colorado. Typically, one major storm brings the first heavy snows of the season to the mountains sometime in mid-October -- right at the peak of hunting season. Later, on about Halloween, another storm often whitens the Front Range and northeastern Colorado. But no matter what the initial trend seems to be here in the autumn, it usually has little bearing on what the winter will actually be like.

October does have some traits that are worth mentioning. In many ways, it is a wonderful month. Sunshine is normally abundant. Winds tend to be light. Temperatures typically cool steadily during the month, but are pleasant and invigorating most of the time. Lower elevations enjoy many days with daytime temperatures in the 70s, especially early in the month. By the end of the month, 50s and 60s are more common. With clear skies and low humidity, temperatures drop quickly at sunset, and very large day-night differences occur. You can plan on lows in the 30s at low elevations early in the month dropping into the 20s later on. Conditions are noticeably cooler in the mountains where highs by the end of the month may struggle to reach 40° during the day and lows dip into the teens at night. Subzero temperatures are not unheard of following heavy autumn snowfalls.

The jet stream usually begins to strengthen in October, bringing more Pacific moisture and less Gulf of Mexico moisture into Colorado. As a result, precipitation east of the mountains begins to taper off. October precipitation averages only 0.50"-0.75" on the Eastern Plains and about 1" along the Front Range and across the Western Slope. It increases to 1.00"-2.50" in the northern and central mountains and reaches a maximum of 2"-4" over the southwestern mountains. Unfortunately, average precipitation rarely falls. Like September, October tends to be drier than average most years but occasionally it can get very wet. Last year was one of the dry ones.

## Diurnal Temperature Variations -- Colorado has its Ups and Downs:

The first year I lived in Colorado I took an autumn trip to Alamosa and Gunnison to install some weather instruments before winter set in. It was an eye-opening experience for me. I was expecting cool temperatures, but what I found was more than I, with my Midwestern wardrobe, had bargained for. Each morning as I left the motel about 7:30 AM I found it painfully cold. My cotton sweatshirt did nothing to keep me warm in the sub 20° weather. Fortunately, by 9:00 AM, with the help of powerful sunshine, it was already comfortable, and by 10:30 I had to rip off my sweatshirt. After lunch, it was T-shirt weather. By sunset I again needed my sweatshirt, and by dinner I was once again freezing cold.

(continued on page -9-)

# AUGUST 1989 DAILY WEATHER

| Date | Event |
|---|---|
| 1-2 | Moist, southwesterly winds aloft fueled widespread and locally heavy thunderstorm activity. The mountains and Western Slope were especially hard hit. Several weather stations including Gunnison, Pagosa Springs, Avon and Rio Grande Reservoir measured more than 1" of rain in 24 hours. Mesa Verde National Park reported 1.91" at their morning observation on the 1st with another 1.07" on the 2nd. |
| 3-7 | Drier air moved into western Colorado with pleasant summer temperatures as the winds aloft shifted from the southwest to the west and northwest during the period. Hot east of the mountains 3-4th, then gradually cooler on the 5th as a high pressure area over Canada moved southward across the Great Plains. Easterly upslope breezes helped set off a few thunderstorms along the Front Range on the 5th which became more numerous 6th-7th. |
| 8-13 | Large high pressure ridge sat over the Southwest. A few scattered thundershowers developed on the 8th. More moisture began spreading into western Colorado late on the 9th. Showers and thunderstorms became more numerous on the 10th and 11th as an upper air disturbance drifted over the state. By the 12th, low clouds, fog and rain covered much of the state and kept daytime temperatures in the 70s in many areas. Clearing and a little warmer on the 13th although parts of southeastern Colorado got more rain. All of Colorado got some rain 10-13th, and locally heavy amounts were reported. Eads received 1.50" on the 11th with another 1.53" on the 12th. Palisade reported 0.89" for the 24-hours ending early on the 12th. Hayden totalled 1.10" and Haswell 2.32" on the 12th. The Air Force Academy indicated 3.07" of rain on the 13th to top off this wet period. |
| 14-22 | A cool period for Colorado as a broad trough of low pressure aloft pushed into the western U.S. Thunderstorms developed daily especially over and near the mountains, but precipitation totals were mostly light. A few weak upper air disturbances tracked across the state enhancing the late evening storminess over the plains. The "shortwave" that passed over Colorado late on the 17th and 18th produced some decent rains over western Colorado. Ouray reported 0.81" on the 18th. |
| 23-29 | Drier air took over with pleasantly warm days but cool nights, especially in the mountains. Some chilly morning temperatures were noted in most mountain locations reminding us of autumn's approach. The 23° reading on the 26th at Silverton was the coolest in the state. Little or no precipitation fell on the mountains and western valleys. But localized evening storms (23rd near Fort Collins, 25th and 26th over northeastern Colorado and 29th over Denver) produced local downpours, hail and spectacular lightning. |
| 30-31 | Hot and dry weather made a comeback with many 90° plus daytime temperatures. Just a few very light showers over the San Juan Mountains. |

## August 1989 Extremes

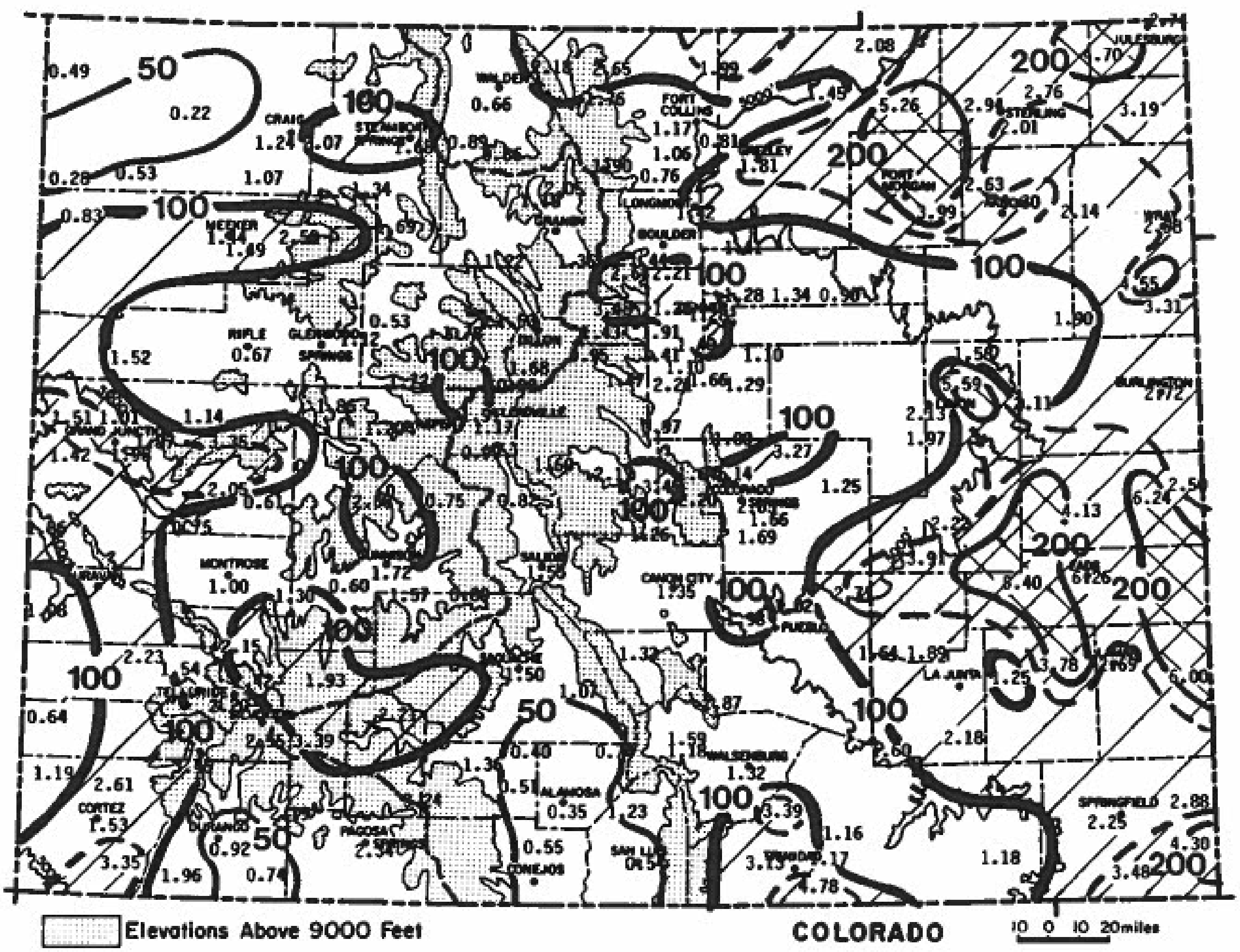
| | | | |
|---|---|---|---|
| Highest Temperature | 103°F | August 31 | Las Animas |
| Lowest Temperature | 23°F | August 26 | Silverton |
| Greatest Total Precipitation | 6.26" | | Eads |
| Least Total Precipitation | 0.22" | | Maybell |

*For existing weather stations with complete daily records. Higher values are likely for unmonitored locations.

## AUGUST 1989 PRECIPITATION

Frequent and locally heavy thundershower activity helped to give the impression that excessive rainfalls were occurring. But when the final statistics were compiled, only about half of Colorado was wetter than average for the month. The heaviest rainfalls were reported over eastern Colorado where a number of very heavy storms were reported. New Raymer, Sedgwick, Cheyenne Wells, Holly, John Martin Dam, and Haswell all reported at least 250% of their average August precipitation. A few areas were also wet over and west of the mountains. Mesa Verde picked up a welcomed 3.35" of rainfall -- almost as much as they had received in the previous 6 months combined. Dry areas encompassed much of the mountains, parts of the Front Range and portions of south central and northwest Colorado. Durango, Alamosa, Maybell and Buena Vista all received less than half of average.

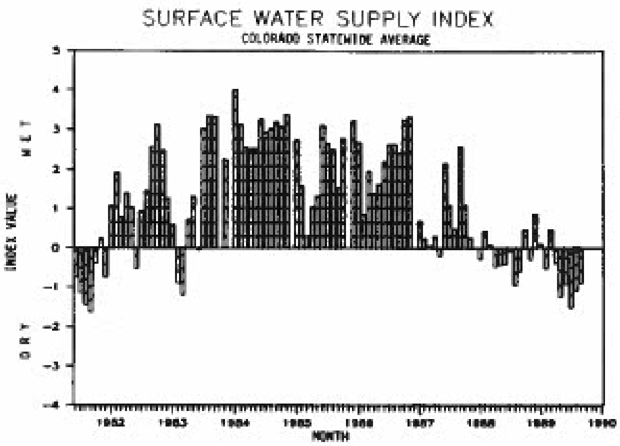
| Greatest | | Least | |
|---|---|---|---|
| Eads | 6.26" | Maybell | 0.22" |
| Cheyenne Wells | 6.24" | Dinosaur Natl Mon. | 0.28" |
| Holly | 6.00" | Alamosa WSO AP | 0.35" |
| Genoa | 5.59" | Center 4SSW | 0.40" |
| Haswell | 5.40" | Browns Park Refuge | 0.49" |

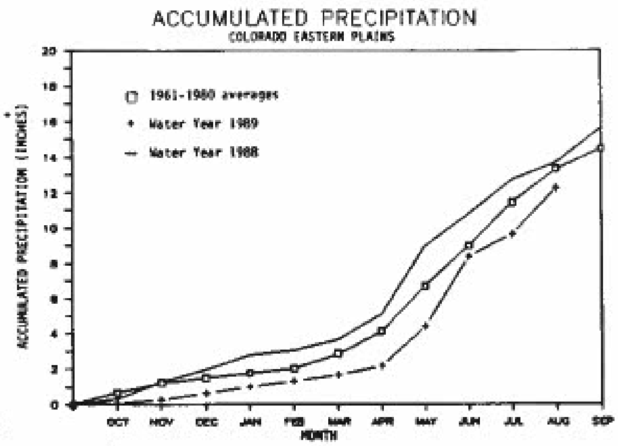


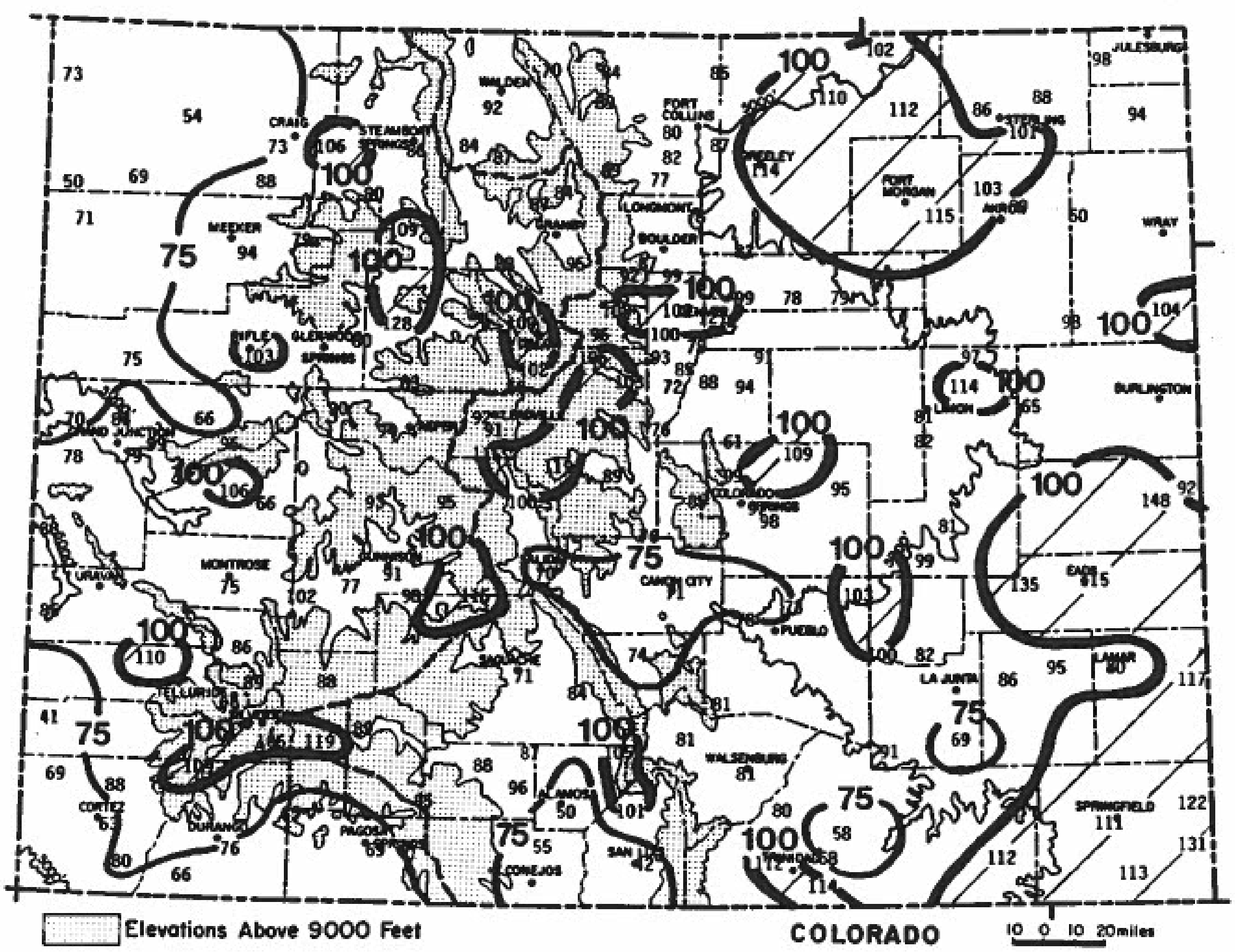

Precipitation amounts (inches) for August 1989 and contours of precipitation as a percent of the 1961-1980 average. Dashed line is 150% of average.

## 1989 WATER YEAR PRECIPITATION

Precipitation totals for the first 11 months of the 1989 water year show that Colorado has had a moderately dry year. While drought has been a widely used term this year, conditions could have been much worse. 11% of the weather stations in Colorado have reported a wet year ( >110% of average precipitation). 32% of the weather stations have had a normal year (between 90% and 110% of average). 26% of our weather stations received between 80% and 90% of average. The remaining 31% of the official reporting stations, most of them in western Colorado, have had a very dry year (less than 80% of average. For example, Alamosa had reported only 3.51" of moisture since October 1, 1988 -- just 50% of average.



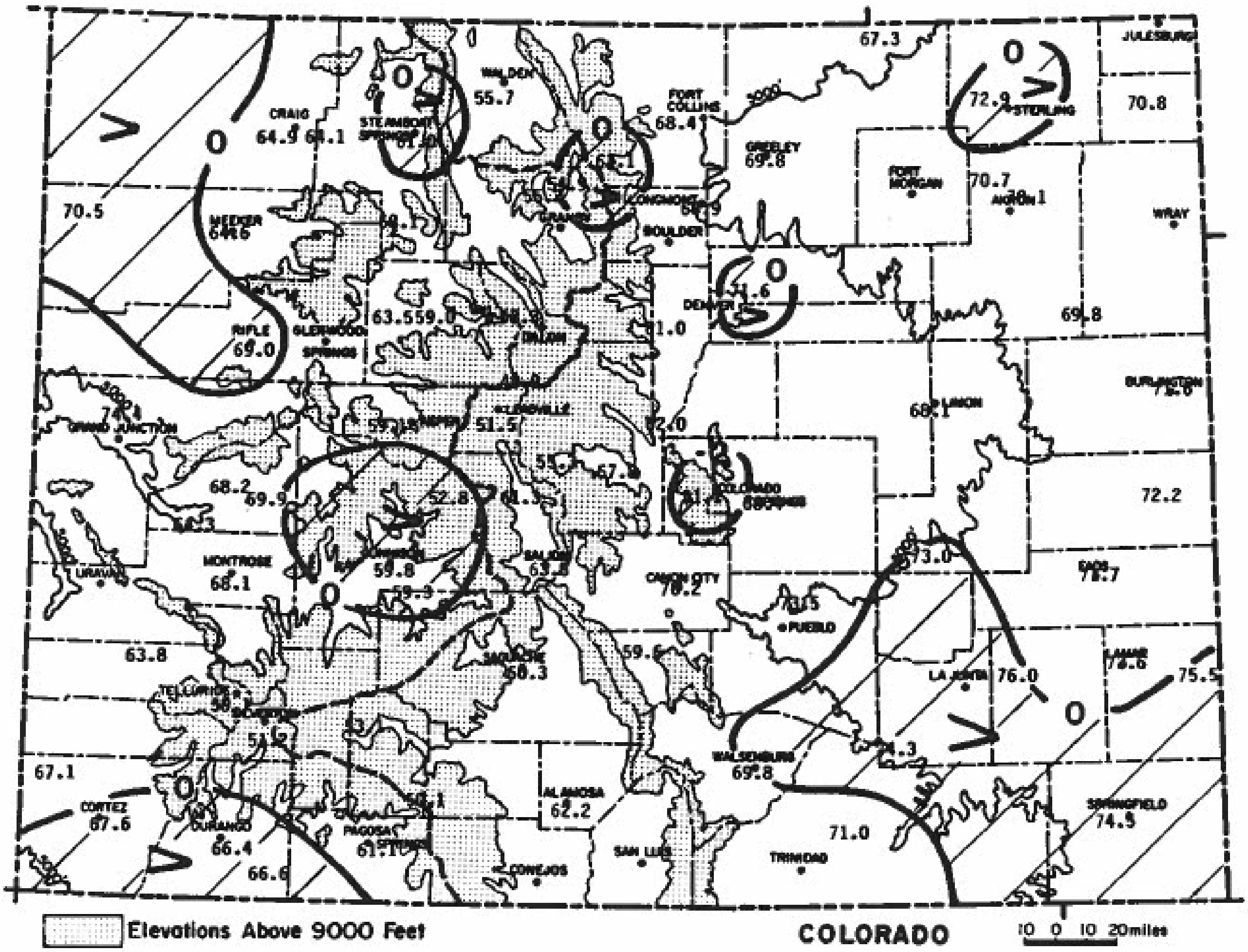




Precipitation for October 1988 through August 1989
as a percent of the 1961-1980 average.

## AUGUST 1989 TEMPERATURES AND DEGREE DAYS

After the record-breaking heatwave of early July, August temperatures across Colorado seemed downright cool. Higher humidities and warmer nighttime temperatures early in August kept it a bit stuffy. But for most of the month, days were comfortably warm and nights pleasantly cool. For the month as a whole, temperatures across the state were near or a little below average. The coolest areas compared to average were mostly east of the Continental Divide.

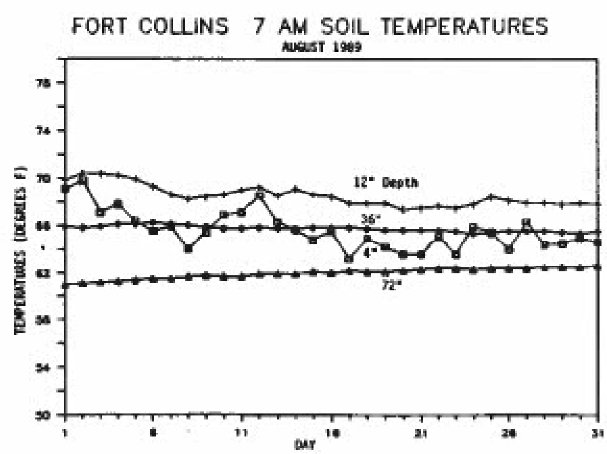



August 1989 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

## AUGUST 1989 SOIL TEMPERATURES

Near-surface soil temperatures began to cool a little in response to the cooler air temperatures. Deep soil temperatures, however, continued to increase slowly during August.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.



# Table 1. Heating Degree Day Data through August 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | 1210 | 854 | 600 | 358 | 180 | 8241 |
| | 89-90 | 17 | 82 | | | | | | | | | | | 99 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | 1171 | 899 | 692 | 476 | 269 | 8444 |
| | 89-90 | 68 | 176 | | | | | | | | | | | 244 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | 1139 | 615 | 427 | 209 | 89 | 5485 |
| | 89-90 | 1 | M | | | | | | | | | | | M |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | 1153 | 784 | 645 | 360 | 207 | 7646 |
| | 89-90 | 39 | 112 | | | | | | | | | | | 151 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | 1135 | 697 | 375 | M | M | M |
| | 89-90 | M | 4 | | | | | | | | | | | M |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | 1078 | 554 | 382 | 226 | 90 | 5191 |
| | 89-90 | 0 | 0 | | | | | | | | | | | 0 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | 1205 | 655 | 475 | 247 | 134 | 6107 |
| | 89-90 | 0 | 4 | | | | | | | | | | | 4 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | 1008 | 718 | 450 | 282 | 112 | 6437 |
| | 89-90 | 0 | 16 | | | | | | | | | | | 16 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | 1443 | 894 | 531 | 365 | 169 | 8068 |
| | 89-90 | 4 | 46 | | | | | | | | | | | 50 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 88-89 | M | M | M | M | M | M | 1327 | 964 | 613 | 345 | 211 | 53 | M |
| | 89-90 | 11 | 74 | | | | | | | | | | | 85 |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | 1190 | 665 | 432 | 213 | 76 | 5780 |
| | 89-90 | 0 | 0 | | | | | | | | | | | 0 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 88-89 E | 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | 1307 | 1088 | 875 | 679 | 490 | 10505 |
| | 89-90 | 226 | 357 | | | | | | | | | | | 583 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | 933 | 666 | 388 | 237 | 76 | 6209 |
| | 89-90 | 2 | 19 | | | | | | | | | | | 21 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | 1227 | 829 | 536 | 344 | 181 | 7925 |
| | 89-90 | 1 | 60 | | | | | | | | | | | 61 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | 1227 | 794 | 636 | 439 | 261 | 7583 |
| | 89-90 | 49 | 118 | | | | | | | | | | | 167 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | 1207 | 732 | 433 | 216 | 92 | 6119 |
| | 89-90 | 0 | 3 | | | | | | | | | | | 3 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | 1230 | 726 | 446 | 183 | 77 | 6278 |
| | 89-90 | 0 | 2 | | | | | | | | | | | 2 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | 1037 | 534 | 260 | 113 | 8 | 5424 |
| | 89-90 | 0 | 0 | | | | | | | | | | | 0 |

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING    E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | 1368 | 1086 | 805 | 584 | 391 | 10051 |
| | 89-90 | 168 | 306 | | | | | | | | | | | 474 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | 1230 | 711 | 444 | 184 | 71 | 6050 |
| | 89-90 | 1 | 2 | | | | | | | | | | | 3 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 88-89 E | 75 E | 125 | 394 | 631 | 1126 | 1698 | 2096 | 1578 | 1096 | 640 | 487 | 241 | 10187 |
| | 89-90 | 61 | 155 | | | | | | | | | | | 216 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | 1109 | 535 | 303 | 114 | 31 | 4862 |
| | 89-90 | 0 | 0 | | | | | | | | | | | 0 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | 1310 | 1112 | 914 | 695 | 509 | 10772 |
| | 89-90 | 285 | 412 | | | | | | | | | | | 697 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | 1211 | 751 | 516 | 275 | 143 | 6544 |
| | 89-90 | 1 | 6 | | | | | | | | | | | 7 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | 1307 | 841 | 542 | 256 | 110 | 6961 |
| | 89-90 | 2 | 8 | | | | | | | | | | | 10 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 88-89 | M | M | M | M | M | M | M | M | M | M | M | 165 | M |
| | 89-90 | 0 | 41 | | | | | | | | | | | 41 |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | 972 | 605 | 348 | 180 | 64 | 5903 |
| | 89-90 | 0 | 10 | | | | | | | | | | | 10 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | 1095 | 860 | 574 | 447 | 230 | 7990 |
| | 89-90 | 24 | 118 | | | | | | | | | | | 142 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | 1141 | 573 | 378 | 134 | 35 | 5385 |
| | 89-90 | 0 | 0 | | | | | | | | | | | 0 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | 1049 | 674 | 381 | 224 | 74 | 6401 |
| | 89-90 | 0 | 2 | | | | | | | | | | | 2 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | 1355 | 964 | 581 | 401 | 273 | 8713 |
| | 89-90 | 18 | 117 | | | | | | | | | | | 135 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | 1189 | 730 | 416 | 152 | 59 | 5885 |
| | 89-90 | M | 3 | | | | | | | | | | | M |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | 1071 | 858 | 633 | 463 | 263 | 8237 |
| | 89-90 | 72 | 175 | | | | | | | | | | | 247 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | 1026 | 538 | 378 | 159 | 79 | 5145 |
| | 89-90 | 0 | 1 | | | | | | | | | | | 1 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | 1369 | 1023 | 772 | 612 | 371 | 9776 |
| | 89-90 | 132 | 279 | | | | | | | | | | | 411 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | 1031 | 492 | 376 | 164 | 82 | 5001 |
| | 89-90 | 0 | 2 | | | | | | | | | | | 2 |

* = AVES ADJUSTED FOR STATION MOVES    M = MISSING    E = ESTIMATED

# AUGUST 1989 CLIMATIC DATA

## Eastern Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEW RAYMER 21N | 81.1 | 53.5 | 67.3 | -1.3 | 92 | 49 | 19 | 96 | 535 | 2.08 | 0.62 | 142.5 | 10 |
| STERLING | 87.4 | 58.5 | 72.9 | 1.4 | 99 | 49 | 3 | 253 | 669 | 2.94 | 1.11 | 160.7 | 9 |
| FORT MORGAN | 86.0 | 58.3 | 72.1 | 0.2 | 96 | 51 | 2 | 229 | 656 | 3.04 | 1.54 | 202.7 | 10 |
| AKRON FAA AP | 84.0 | 57.5 | 70.7 | -0.4 | 94 | 46 | 4 | 191 | 632 | 2.63 | 0.85 | 147.8 | 10 |
| AKRON 4E | 83.8 | 56.3 | 70.1 | -1.5 | 97 | 50 | 10 | 173 | 603 | 3.30 | 1.53 | 186.4 | 9 |
| HOLYOKE | 81.9 | 59.7 | 70.8 | -1.6 | 94 | 52 | 6 | 192 | 639 | 3.19 | 1.26 | 165.3 | 11 |
| JOES | 83.2 | 56.5 | 69.8 | -2.7 | 96 | 50 | 5 | 161 | 600 | 1.90 | -0.30 | 86.4 | 5 |
| BURLINGTON | 84.5 | 58.6 | 71.6 | -1.1 | 94 | 53 | 4 | 215 | 652 | 2.72 | 0.53 | 124.2 | 8 |
| LIMON WSMO | 82.5 | 53.6 | 68.1 | -0.4 | 92 | 48 | 6 | 107 | 557 | 2.13 | -0.32 | 86.9 | 11 |
| CHEYENNE WELLS | 85.5 | 58.8 | 72.2 | -0.5 | 96 | 54 | 0 | 232 | 670 | 6.24 | 4.32 | 325.0 | 9 |
| EADS | 84.0 | 59.4 | 71.7 | -2.3 | 94 | 53 | 5 | 219 | 661 | 6.26 | 4.53 | 361.8 | 8 |
| ORDWAY 21N | 89.1 | 56.9 | 73.0 | 0.2 | 99 | 50 | 1 | 258 | 658 | 3.99 | 1.89 | 190.0 | 8 |
| LAMAR | 89.6 | 57.5 | 73.6 | -2.3 | 100 | 47 | 2 | 275 | 669 | 2.69 | 0.75 | 138.7 | 9 |
| LAS ANIMAS | 91.4 | 60.6 | 76.0 | 0.0 | 103 | 50 | 0 | 350 | 718 | 1.25 | -0.18 | 87.4 | 9 |
| HOLLY | 89.2 | 61.9 | 75.5 | 0.3 | 101 | 55 | 0 | 335 | 738 | 6.00 | 4.13 | 320.9 | 7 |
| SPRINGFIELD 7WSW | 89.9 | 59.2 | 74.5 | 1.7 | 100 | 53 | 0 | 302 | 699 | 2.25 | 0.57 | 133.9 | 9 |
| TIMPAS 13SW | 90.1 | 58.5 | 74.3 | 0.5 | 99 | 52 | 0 | 295 | 689 | 1.60 | -0.03 | 98.2 | 5 |

## Foothills/Adjacent Plains

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FORT COLLINS | 81.7 | 55.0 | 68.4 | -0.3 | 89 | 50 | 3 | 115 | 571 | 1.16 | -0.21 | 84.7 | 6 |
| GREELEY UNC | 84.7 | 54.9 | 69.8 | -1.1 | 92 | 49 | 2 | 158 | 601 | 1.81 | 0.66 | 157.4 | 7 |
| ESTES PARK | 76.0 | 46.2 | 61.1 | 0.9 | 84 | 34 | 122 | 9 | 427 | 1.90 | -0.16 | 92.2 | 11 |
| LONGMONT 2ESE | 85.9 | 51.9 | 68.9 | -0.8 | 92 | 46 | 8 | 135 | 560 | 1.42 | 0.25 | 121.4 | 10 |
| DENVER WSFO AP | 86.0 | 57.3 | 71.6 | 0.6 | 93 | 50 | 0 | 214 | 649 | 1.28 | -0.25 | 83.7 | 11 |
| EVERGREEN | 77.7 | 44.3 | 61.0 | -0.5 | 85 | 37 | 118 | 3 | 442 | 1.91 | -0.09 | 95.5 | 13 |
| CHEESMAN | 81.6 | 42.3 | 62.0 | -1.3 | 87 | 34 | 95 | 8 | 496 | 0.97 | -1.41 | 40.8 | 9 |
| LAKE GEORGE 8SW | 71.6 | 44.0 | 57.8 | -1.0 | 75 | 37 | 214 | 0 | 345 | 2.17 | -0.02 | 99.1 | 11 |
| ANTERO RESERVOIR | 72.1 | 38.5 | 55.3 | -0.2 | 78 | 27 | 298 | 0 | 350 | 1.60 | -0.48 | 76.9 | 9 |
| RUXTON PARK | 66.6 | 35.6 | 51.1 | -3.2 | 74 | 31 | 422 | 0 | 266 | 2.20 | -1.38 | 61.5 | 16 |
| COLORADO SPRINGS | 81.6 | 55.2 | 68.4 | -0.2 | 90 | 50 | 4 | 117 | 571 | 2.63 | -0.18 | 93.6 | 13 |
| CANON CITY 2SE | 84.6 | 55.8 | 70.2 | -0.9 | 91 | 48 | 0 | 172 | 624 | 1.35 | -0.36 | 78.9 | 12 |
| PUEBLO WSO AP | 90.0 | 57.1 | 73.5 | -0.7 | 99 | 52 | 0 | 273 | 658 | 1.02 | -0.78 | 56.7 | 12 |
| WESTCLIFFE | 76.9 | 42.3 | 59.6 | -1.4 | 9999 | 34 | 124 | 0 | 331 | 1.33 | -1.24 | 51.8 | 10 |
| WALSENBURG | 84.0 | 55.6 | 69.8 | 0.4 | 91 | 48 | 2 | 158 | 611 | 1.32 | -0.71 | 65.0 | 10 |
| TRINIDAD FAA AP | 86.3 | 55.7 | 71.0 | -0.5 | 95 | 49 | 1 | 191 | 630 | 1.16 | -0.69 | 62.7 | 11 |

## Mountains/Interior Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WALDEN | 74.7 | 36.6 | 55.7 | -0.2 | 80 | 26 | 279 | 0 | 391 | 0.66 | -0.54 | 55.0 | 7 |
| LEADVILLE 2SW | 67.6 | 35.4 | 51.5 | -1.0 | 72 | 28 | 412 | 0 | 279 | 1.17 | -0.83 | 58.5 | 11 |
| SALIDA | 80.5 | 46.0 | 63.3 | -0.7 | 85 | 35 | 63 | 18 | 488 | 1.55 | 0.03 | 102.0 | 9 |
| BUENA VISTA | 77.5 | 45.1 | 61.3 | -0.8 | 83 | 37 | 112 | 4 | 437 | 0.82 | -1.16 | 41.4 | 6 |
| SAGUACHE | 75.4 | 45.2 | 60.3 | -1.0 | 79 | 36 | 139 | 0 | 406 | 1.50 | -0.04 | 97.4 | 11 |
| HERMIT 7ESE | 70.4 | 35.8 | 53.1 | -0.7 | 76 | 25 | 361 | 0 | 321 | 2.75 | 0.63 | 129.7 | 5 |
| ALAMOSA WSO AP | 80.0 | 44.5 | 62.2 | -0.1 | 85 | 35 | 82 | 6 | 477 | 0.35 | -0.89 | 28.2 | 7 |
| STEAMBOAT SPRINGS | 79.4 | 42.7 | 61.0 | 1.4 | 86 | 34 | 117 | 3 | 470 | 1.68 | 0.18 | 112.0 | 11 |
| YAMPA | 72.5 | 43.7 | 58.1 | -1.2 | 79 | 33 | 207 | 0 | 358 | 1.69 | -0.07 | 96.0 | 10 |
| GRAND LAKE 1NW | 73.2 | 36.5 | 54.9 | 0.9 | 80 | 30 | 306 | 0 | 367 | 2.05 | -0.04 | 98.1 | 15 |
| GRAND LAKE 6SSW | 71.7 | 38.6 | 55.2 | -1.0 | 77 | 31 | 299 | 0 | 345 | 1.18 | -0.41 | 74.2 | 15 |
| DILLON 1E | 69.9 | 36.7 | 53.3 | -1.4 | 75 | 25 | 357 | 0 | 319 | 1.53 | -0.11 | 93.3 | 10 |
| AVON | 77.4 | 40.5 | 59.0 | -2.0 | 84 | 33 | 178 | 0 | 436 | 2.27 | 1.07 | 189.2 | 9 |
| CLIMAX | 60.6 | 37.1 | 48.9 | -0.4 | 71 | 27 | 493 | 0 | 174 | 0.80 | -1.51 | 34.6 | 5 |
| ASPEN 1SW | 74.0 | 44.1 | 59.1 | -0.4 | 80 | 38 | 176 | 0 | 377 | 1.20 | -0.70 | 63.2 | 10 |
| TAYLOR PARK | 67.5 | 38.1 | 52.8 | 1.4 | 73 | 29 | 368 | 0 | 280 | 0.75 | -1.10 | 40.5 | 5 |
| TELLURIDE | 76.7 | 41.4 | 59.1 | 1.2 | 83 | 34 | 175 | 0 | 421 | 2.20 | -0.50 | 81.5 | 11 |
| PAGOSA SPRINGS | 79.9 | 42.4 | 61.1 | -0.8 | 85 | 33 | 118 | 9 | 473 | 2.34 | -0.15 | 94.0 | 12 |
| SILVERTON | 70.0 | 32.4 | 51.2 | -1.3 | 76 | 23 | 421 | 0 | 319 | 2.55 | -0.43 | 85.6 | 17 |
| WOLF CREEK PASS 1 | 63.9 | 36.2 | 50.1 | -1.1 | 68 | 32 | 456 | 0 | 226 | 3.24 | -0.68 | 82.7 | 12 |

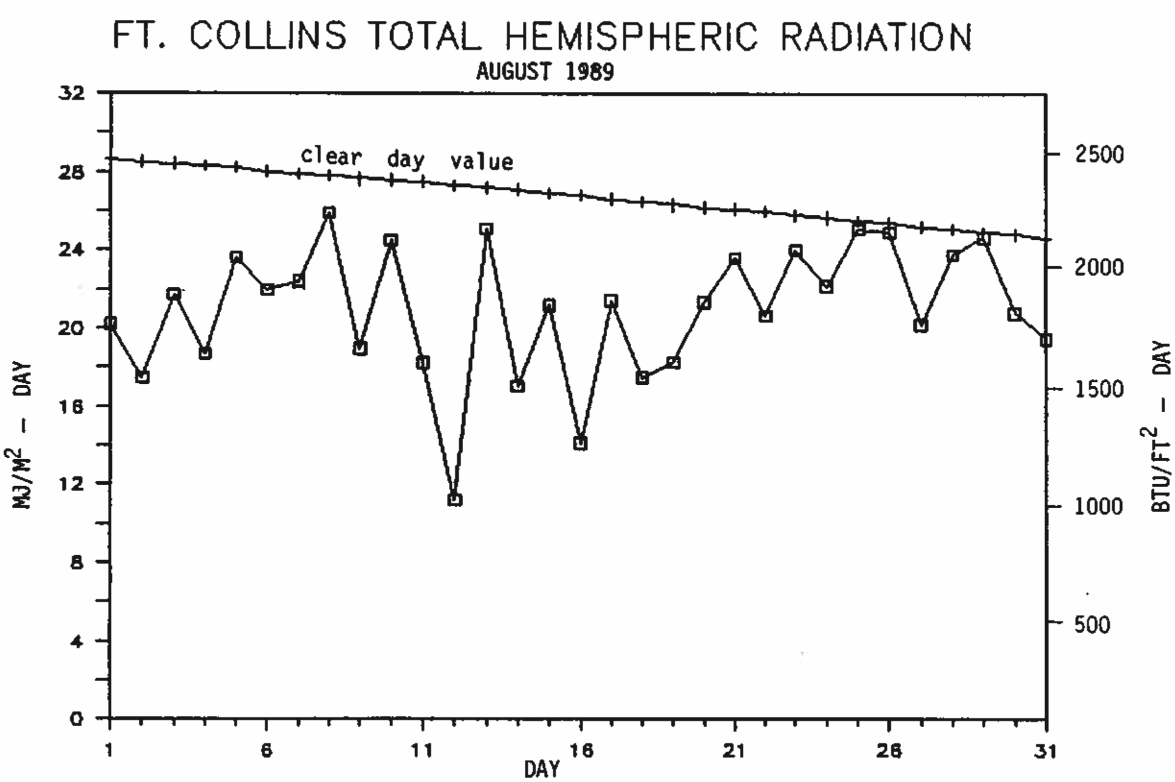
## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 81.2 | 48.6 | 64.9 | -0.0 | 88 | 40 | 46 | 49 | 511 | 1.24 | -0.36 | 77.5 | 8 |
| HAYDEN | 80.7 | 47.5 | 64.1 | -0.1 | 87 | 36 | 53 | 31 | 499 | 2.07 | 0.58 | 138.9 | 10 |
| MEEKER NO. 2 | 81.6 | 47.6 | 64.6 | -0.2 | 89 | 40 | 41 | 38 | 514 | 1.44 | 0.28 | 124.1 | 8 |
| RANGELY 1E | 86.3 | 54.8 | 70.5 | 0.5 | 94 | 45 | 4 | 183 | 619 | 0.83 | 0.02 | 102.5 | 8 |
| EAGLE FAA AP | 81.7 | 45.4 | 63.5 | -0.3 | 88 | 35 | 60 | 22 | 510 | 0.53 | -0.35 | 60.2 | 10 |
| RIFLE | 86.4 | 51.7 | 69.0 | 1.0 | 95 | 43 | 2 | 132 | 599 | 0.67 | -0.37 | 64.4 | 6 |
| GRAND JUNCTION WS | 87.8 | 61.0 | 74.4 | -1.6 | 95 | 53 | 0 | 300 | 717 | 1.01 | 0.25 | 132.9 | 9 |
| CEDAREDGE | 85.1 | 51.2 | 68.2 | -1.2 | 90 | 44 | 8 | 114 | 575 | 2.05 | 0.98 | 191.6 | 10 |
| PAONIA 1SW | 86.7 | 53.1 | 69.9 | 0.0 | 96 | 41 | 6 | 165 | 608 | 0.61 | -0.61 | 50.0 | 6 |
| DELTA | 83.1 | 45.5 | 64.3 | -6.7 | 98 | 35 | 74 | 59 | 508 | 0.75 | -0.11 | 87.2 | 11 |
| GUNNISON | 78.1 | 41.5 | 59.8 | 1.4 | 83 | 32 | 155 | 2 | 443 | 1.72 | 0.28 | 119.4 | 9 |
| COCHETOPA CREEK | 78.1 | 40.5 | 59.3 | 0.3 | 83 | 31 | 171 | 2 | 442 | 1.57 | -0.27 | 85.3 | 7 |
| MONTROSE NO. 2 | 83.4 | 52.8 | 68.1 | -1.5 | 89 | 44 | 10 | 114 | 572 | 1.00 | -0.04 | 96.2 | 8 |
| URAVAN | 91.3 | 56.9 | 74.1 | -0.5 | 100 | 49 | 0 | 289 | 668 | 1.85 | 0.66 | 155.5 | 8 |
| NORWOOD | 79.0 | 48.6 | 63.8 | -0.2 | 84 | 42 | 43 | 16 | 469 | 2.23 | 0.60 | 136.8 | 7 |
| YELLOW JACKET 2W | 82.3 | 52.0 | 67.1 | -0.7 | 93 | 46 | 9 | 82 | 544 | 1.19 | -0.51 | 70.0 | 5 |
| CORTEZ | 83.5 | 51.6 | 67.6 | 0.2 | 90 | 42 | 16 | 109 | 571 | 1.53 | 0.18 | 113.3 | 7 |
| DURANGO | 84.5 | 48.2 | 66.4 | 0.3 | 90 | 38 | 19 | 68 | 544 | 0.92 | -1.39 | 39.8 | 9 |
| IGNACIO 1N | 86.1 | 47.2 | 66.6 | 0.9 | 93 | 37 | 18 | 77 | 556 | 0.74 | -0.96 | 43.5 | 3 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## AUGUST 1989 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 11 | 16 | 4 | -- | -- |
| Denver | 10 | 17 | 4 | 70% | 73% |
| Fort Collins | 9 | 16 | 6 | -- | -- |
| Grand Junction | 13 | 14 | 4 | 78% | 76% |
| Pueblo | 11 | 16 | 4 | 82% | 78% |



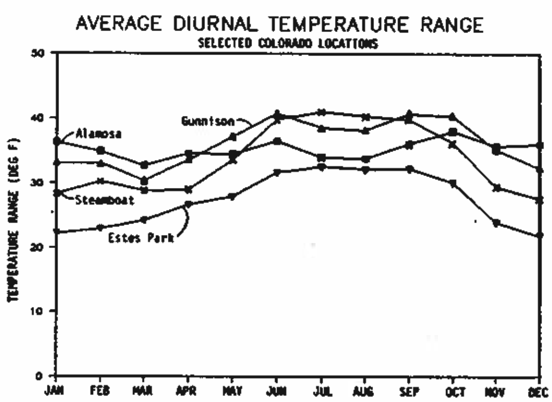
Diurnal Temperature Variations -- Colorado has its Ups and Downs:

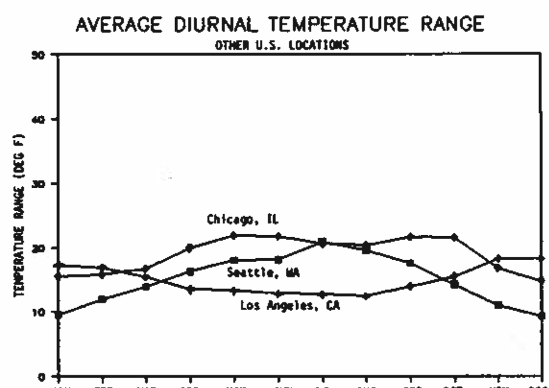
You folks who have spent your lives here in Colorado or in other high elevation areas of the semiarid West are used to this. You've experienced these temperature ups and downs all your lives. I saw my share of big changes back in the Midwest too, but there it was totally different. The changes occurred when strong cold fronts came through. One day it was in the 70s and the next it was down in the 30s. But here these big changes seem to occur every day, and the changes are greatest when the skies are clear and there are no cold fronts in sight.

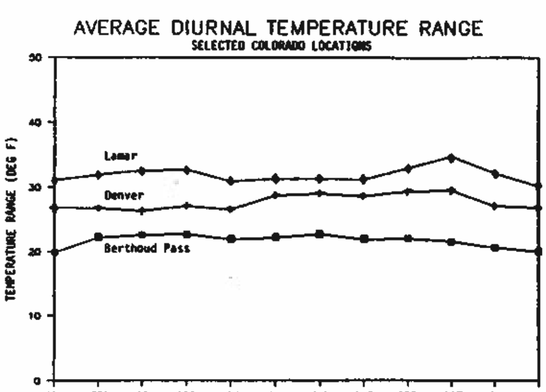
That trip was a good learning experience for a young climatologist in the West. In two or three days I learned more about radiational cooling, solar warming, temperature inversions, wind chill effects and cold air trapping valleys than I had ever learned in college and graduate school. Furthermore, I also learned why smart people in Colorado dress in layers. Vests, flannel shirts, windbreakers and sweatshirts may all be appropriate -- at the same time.

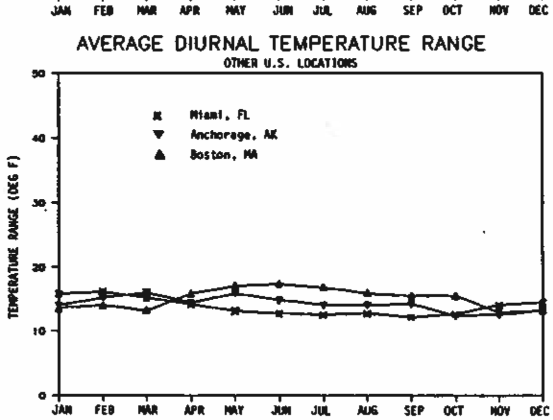
You can tell a great deal about the climate of an area from the "diurnal range" (the climatologists' term for the difference between the daily maximum and minimum temperature). In general, where it is cloudy a lot, the diurnal range is small. Where it is often clear, the diurnal range is large. But there is more to it than that. Even where it is clear, if the humidity is high, diurnal ranges will be lower than in drier areas. The largest diurnal ranges tend to occur in valleys. The lowest diurnal ranges occur near large bodies of water and on mountain tops. High elevation valleys are especially likely to have large ranges because they lose energy by radiation so effectively on clear nights. But any valley can be prone to collecting cold air at night. This happens because cold air, being heavier than warm air, flows like water into low spots where it happily stays until something comes (like Colorado sunshine) to warm it up again. So, you see, on my very first business trip in Colorado I happened to stumble into a couple of the valleys of Colorado that have the largest average diurnal temperature ranges.

Diurnal temperature ranges vary from day to day, month to month and place to place. Days with small ranges are typically cloudy, breezy, and probably damp. Successive days with large temperature ranges indicate clear weather with light winds and low humidities. If you've been looking at the WTHRNET graphs on page 11 of COLORADO CLIMATE each month since January 1988, you have had ample opportunity to see how diurnal temperature patterns vary. This month, the graphs for Carbondale and Steamboat Springs are excellent examples. The cloudy days with lower values of solar radiation early in the month were accompanied by small day-night temperature changes. However, during the last 10 days of the month, skies were clear and temperatures were varying by 50 degrees Fahrenheit or more. The following graphs compare average diurnal temperature ranges at a number of locations in and outside of Colorado. Some of the greatest day-night differences ever observed in Colorado (more than 70 degrees) have occurred in October. Get your layers ready.



The sun is ultimately the main source of energy used by modern man. The fossil fuels we use are basically plants that lived, photosynthesized and died under a slightly younger sun. But these fuels are finite and we need to learn how to use the sun directly if we are to sustain our current level of industrial, agricultural and technological growth. Federally backed research into solar energy began in earnest during the 1970's when the fossil fuel shortage peaked in public awareness. Lately, that awareness seems to have declined yet the decreasing amount of fossil fuel is no less real. Alternate sources of the energy we so thoughtlessly consume are needed.
Our alternatives are few. Nuclear energy creates wastes that we have not been able to deal with in a safe, effective manner. Coal resources are environmentally taxing as well as finite. Solar energy use needs to be maximized.

You may be aware of flat plate collectors seen on homes and businesses. Another form of solar collection is a solar pond. It is a simple and direct type of thermal conversion. It is just as its name implies, a pond of water. It collects the solar energy and stores it for further use. Ponds of water, by themselves, do not have the required ingredients needed to store solar heat effectively due to the natural convection currents set up by the density and temperature of the water within the pond. However, man can use other natural minerals such as salt to create the necessary environment to produce a storage device.

Figure 1 shows a typical salt-stabilized solar pond cross-section. The three layers indicated go from a salt-free top layer down through increasing salt concentrations and finally to a constant high salt concentration in the bottom layer. The increasing density of the water due to the increasing salt concentration keeps the natural currents (convection) from occurring. Sunlight travels through the upper two layers and strikes the darkened bottom of the pond. The lower zone heats up, but because it is heavier than the upper zones, does not rise to the surface. In addition, stagnant water is a very good insulator, and prevents heat in the lower layers from escaping. As a result, the lower layer can reach temperatures close to the boiling point! Other parts in the anatomy of a solar pond include the lining of the pond, the heat exchanger and the diffuser used to distribute salt into the water. The lining is an important part of the pond. It must be leak-free to insure the containment of the salt water. Without proper containment, heat is lost as well as the salt thereby creating an environmental hazard. The heat exchanger is placed in the pond. A fluid is pumped through it to extract heat which can then be used in various ways. The diffuser allows the salt to be distributed in a manner which creates the stratified layers.

The energy stored by the pond can be used, for example, to heat a greenhouse through the winter. Figure 2 shows the basic set-up for this. Experiments have also been done which use the heat to warm air for drying grain. Alternatively, the warmth could be stored in a rock bed and used for home space heating similar to its use in flat plate collectors. The solar pond can be used to warm other ponds through the winter to keep fish alive. The Israelis have perfected a method for using solar ponds in conjunction with low-temperature Rankine-cycle generators to produce electricity. One pond near the Dead Sea is capable of producing 1.5 megawatts continuously. Theoretically, enough electricity could be produced through the Great Salt Lake in Utah to equal 10 nuclear plants. The solar pond can be a powerful use of the sun.

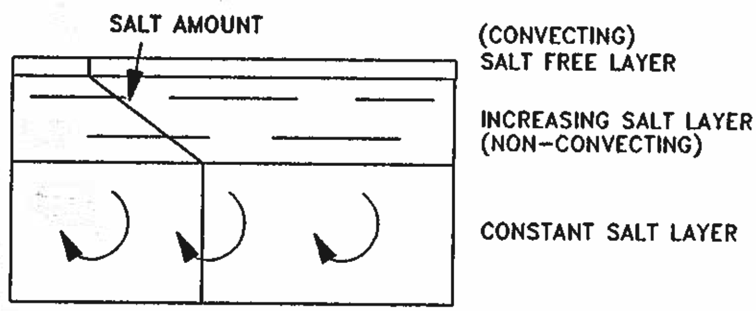


FIGURE 1

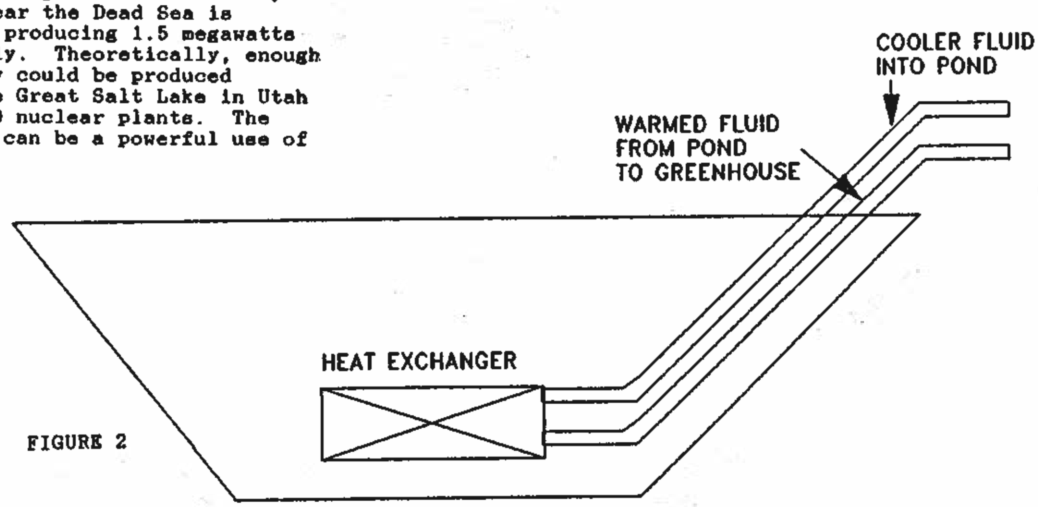


FIGURE 2

As in any energy source, there are positives and negatives. The positive aspects of solar ponds are their economical operating costs, the use of a renewable energy source and the low maintenance. When in operation, the pond makes no sound to add to today's noise pollution. The main drawback is the possible environmental impact if the pond were to leak. Plans would need to be available in case of a major pond spill to assure the containment of the salt before it made its way to the water table. The upkeep of the pond requires a place for the flushing of excess salt within the top layer to maintain the salt gradients. The ponds are best in agricultural areas that have large areas of land that can be set aside for this use.

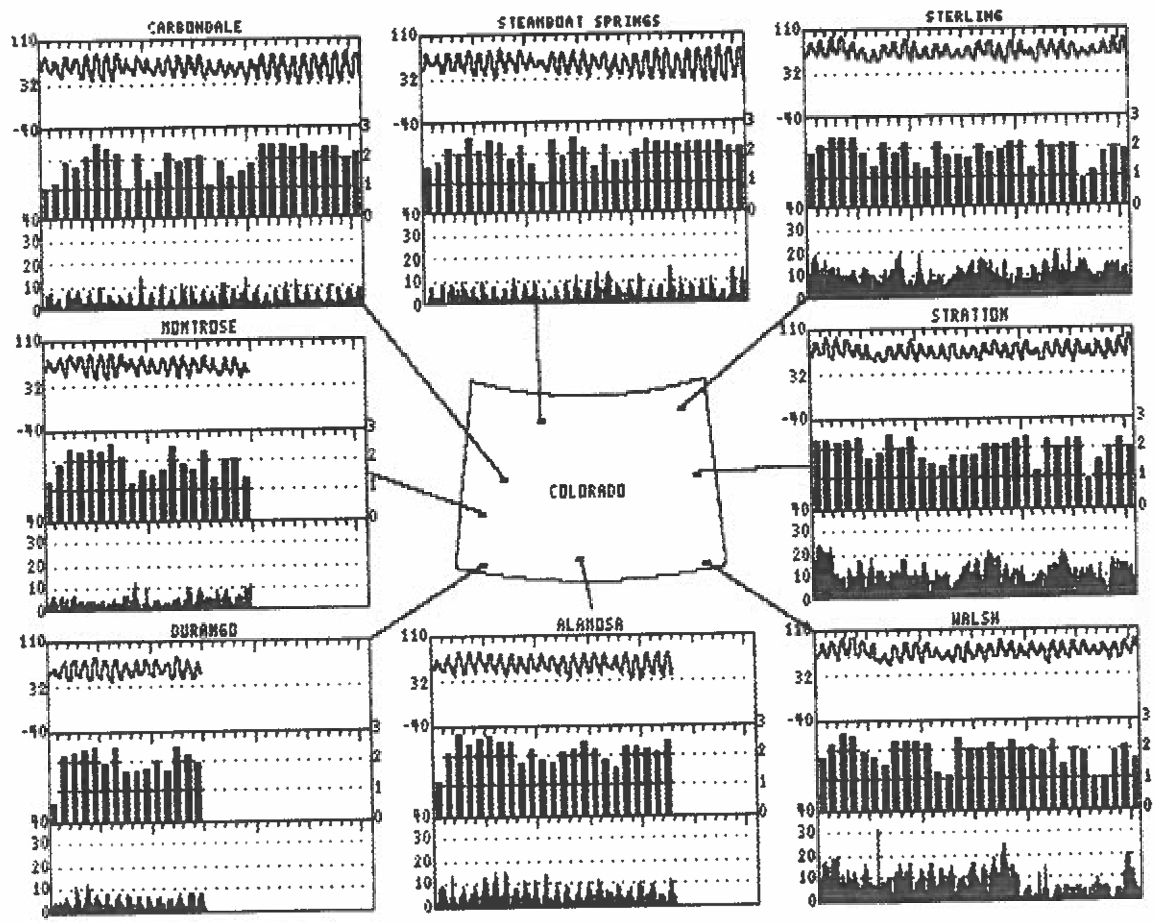
This paper was written by Mary Sutter and Peter Curtiss of the Joint Center for Energy Management, University of Colorado, Box 428, Boulder, CO 80309-0428.

WTHRNET WEATHER DATA AUGUST 1989

| | Alamosa | Durango | Carbondale | Montrose | Steamboat Springs | Sterling | Stratton | Walsh |
|---|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | 61.2 | 62.5 | 61.9 | 66.1 | 58.7 | 70.2 | 70.4 | 72.2 |
| **monthly temperature extremes and time of occurence ( °F day/hour )** | | | | | | | | |
| maximum: | 82.0 3/16 | 82.6 13/16 | 85.5 8/14 | 86.9 6/17 | 84.7 8/15 | 94.8 3/14 | 96.4 31/14 | 97.7 4/15 |
| minimum: | 36.3 23/ 6 | 44.6 7/ 6 | 34.0 26/ 6 | 47.1 15/ 6 | 27.0 28/ 6 | 51.6 23/ 4 | 51.4 26/ 5 | 52.9 8/ 5 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | | |
| 5 AM | 71 / 34 | 41 / 22 | 92 / 44 | 51 / 30 | 97 / 40 | 80 / 53 | 86 / 55 | 83 / 56 |
| 11 AM | 37 / 38 | 23 / 24 | 45 / 48 | 27 / 31 | 42 / 45 | 49 / 54 | 54 / 57 | 50 / 57 |
| 2 PM | 29 / 35 | 18 / 21 | 35 / 43 | 22 / 28 | 33 / 41 | 36 / 48 | 42 / 53 | 39 / 54 |
| 5 PM | 29 / 33 | 19 / 21 | 34 / 41 | 23 / 28 | 33 / 39 | 38 / 47 | 41 / 51 | 41 / 52 |
| 11 PM | 52 / 34 | 35 / 23 | 68 / 45 | 36 / 28 | 74 / 43 | 68 / 53 | 77 / 57 | 72 / 58 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | | |
| day | 152 | 91 | 228 | 149 | 228 | 163 | 128 | 142 |
| night | 124 | 40 | 180 | 101 | 131 | 186 | 191 | 187 |
| **monthly average wind speed ( miles per hour )** | 3.80 | 3.10 | 3.23 | 2.89 | 3.12 | 8.90 | 9.60 | 6.95 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | | |
| 0 to 3 | 257 | 208 | 465 | 288 | 481 | 27 | 19 | 182 |
| 3 to 12 | 285 | 150 | 276 | 188 | 249 | 562 | 530 | 413 |
| 12 to 24 | 12 | 1 | 3 | 1 | 14 | 155 | 192 | 139 |
| > 24 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 |
| **monthly average daily total insolation ( Btu/ft²·day )** | 2139 | 1970 | 1929 | 1889 | 2085 | 1858 | 1960 | 1926 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | | |
| 60-80% | 118 | 75 | 158 | 126 | 176 | 207 | 233 | 216 |
| 40-60% | 55 | 48 | 90 | 61 | 61 | 88 | 87 | 86 |
| 20-40% | 44 | 38 | 64 | 51 | 56 | 61 | 52 | 79 |
| 0-20% | 25 | 22 | 35 | 24 | 24 | 49 | 41 | 30 |

## The State-Wide Picture

The figure below shows monthly weather at WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40°F to 110°F, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 Btu/ft²/day, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour. Due to lightning strikes, some Alamosa, Durango and Montrose data are unavailable.



# COLORADO CLIMATE

## SEPTEMBER 1989



**Colorado Climate Center**
**Department of Atmospheric Science**
**Colorado State University**
**Fort Collins, Colorado 80523**



*This report has been prepared each month since January 1977 with the support of the Colorado Agricultural Experiment Station and the College of Engineering.*

Volume 12 Number 12


September in Review:

September was generally warm and dry west of the Continental Divide. East of the Divide experienced primarily wetter than average conditions with seasonal to a bit cooler than average temperatures. Some raging thunderstorms on the 7th and 8th and a rare early snowfall on September 12 highlighted the month.

Colorado's November Climate:

November weather often gets a bad rap. Even as ski areas begin to open and interest in winter recreation and holiday preparation grows, we are still reluctant to unpack our winter jackets and admit that summer is over. The return to "standard time" with pre-dinner darkness is a little hard to get used to. But, quite frankly, November weather isn't so bad. It is true that days are shorter, clouds are on the increase, mountain snows and Front Range winds become increasingly common, the furnace is running more often and there is frost to be scraped from the windshield many mornings. But it's good to see snow-capped mountains again as our frozen reservoir begins to fill again.

Temperatures aren't bad. Early in the month daytime highs average in the 50s at lower elevations and occasionally sneak up into the 60s and even the 70s. By the end of the month, 40s are more common, but some days still reach much higher (of course, they are averaged out by some much colder days which seem to often strike just after Thanksgiving). Nightly lows average in the 20s but dip ever more frequently into the teens later in the month. Meanwhile, the mountains and higher western valleys are well on their way toward winter. By month's end, subzero nighttime readings are fairly likely in some of the high country.

The jet stream strengthens and more frequently dips southward as the month progresses bringing more clouds and moisture into western Colorado from the Pacific. At the same time, areas east of the mountains see more wind (especially near the foothills) and less moisture as the mountains begin to exert their protection on the Front Range. Winds blowing from the west are warmed compressionally as the air is forced to descend the east slope of the Rockies. But don't feel too protected. The potential for large snowstorms does exist in November from the Front Range out across the plains. They don't occur every year -- perhaps only once in 5 to 10 years at any given location -- but potential storms almost always tease eastern Colorado at least once each November. More often than not the Thanksgiving weekend is the target -- so travellers beware. Most November precipitation falls as snow but may begin as rain both east and west of the mountains. Precipitation averages less than 0.75" (3-8" snow) in some western valleys, increases to 2-4" (30-60" snow) in some of the wetter mountain areas, and then decreases again east of the mountains to 0.60-1.00" (6-13" snow) along the Front Range and down to only about 0.50" (2-8" snow) across the eastern plains.

1989 Water Year Wrap-Up:

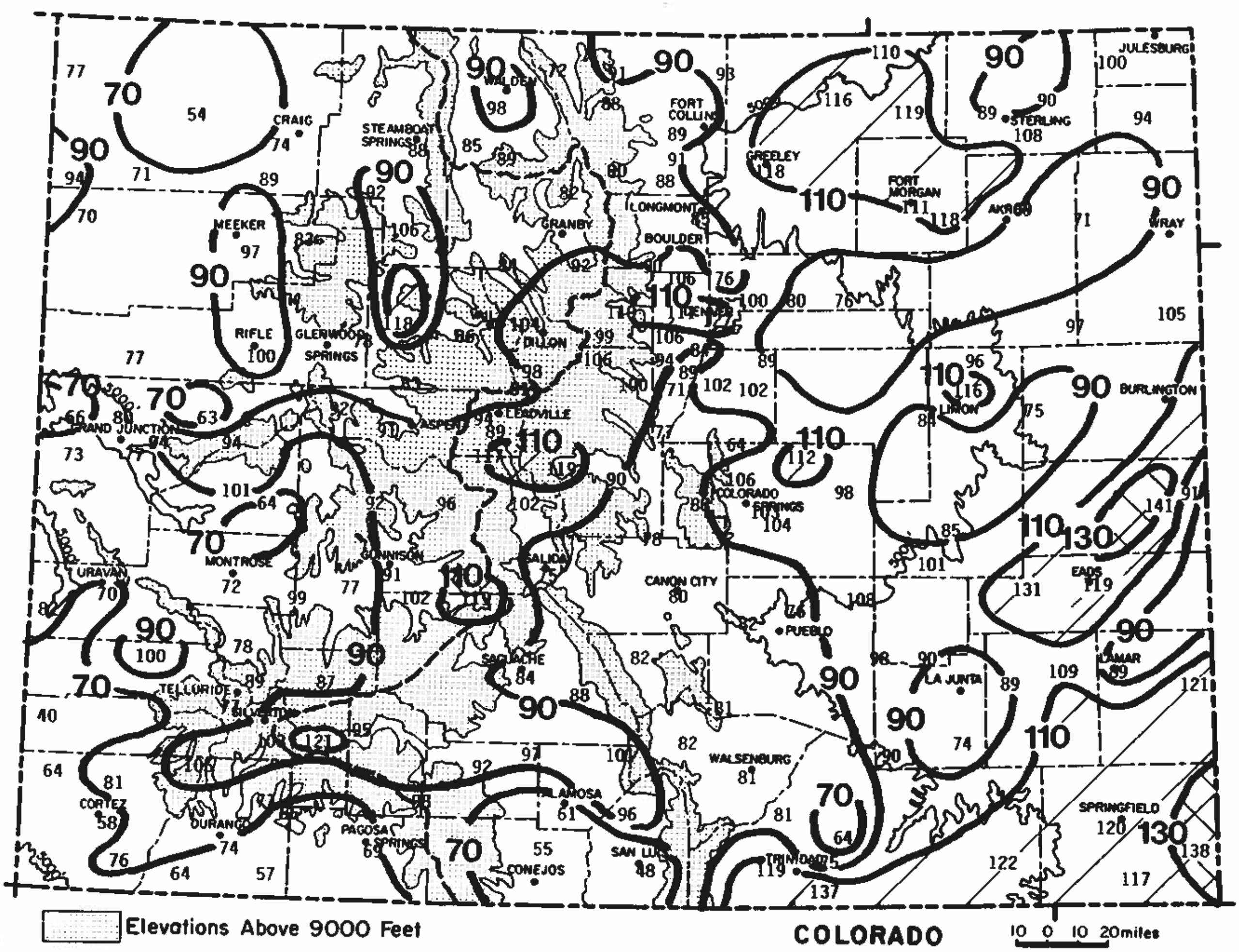
Drought made headlines throughout Colorado in 1989. A very dry fall and early spring across Colorado's eastern plains proved disastrous for dryland agriculture. Good rains fell on the plains in late May and June and again in August and September. These rains, while very beneficial, came too late to help much of the 1989 winter wheat crop. It ended up being the poorest crop since 1978. Range conditions also deteriorated badly, but summer moisture was sufficient to avert a major ranching disaster. By the end of the summer, moisture conditions in Eastern Colorado were generally average or above, and the immediate drought event had apparently ended.

(continued on page -2- and -3-)

## 1 9 8 9 W A T E R Y E A R W R A P - U P : continued

The mountains and Western Slope also got off to a bad start with an extremely dry October. However, mid-November brought a series of storms which whitened the mountains and got the snowpack and ski conditions off to a good start. December was stingy with its mountain snow, but storms arrived just in time for Christmas, and skiing conditions remained good. With the help of heavy February snows and very cold weather, mountain snowpack remained near or above average at the beginning of March and water supplies for the Colorado were looking good. That's when Mother Nature turned off the faucet. The months of March through June were extremely dry. In parts of southwest Colorado this was the driest spring on record in 100 years. With the help of unseasonably warm temperatures, snowpack melted prematurely, forests and rangeland dried up and surface water supplies dwindled. Instead of average water supplies, runoff ended up less than 70% of average for most Colorado watersheds. Several major forest fires were raging in early July and a crisis was arising for mountain and Western Slope ranchers as Federal land managers considered moving animals off some Federal lands to avoid overgrazing. Fortunately, summer monsoon moisture arrived in Colorado in July and August in sufficient quantity (average to a little above average) to avoid a major crisis. However, with a return of warm and dry weather on the Western Slope in September, concern lingered over potential serious long-term drought.

Two maps are shown here for the 1989 water year. The first map shows precipitation for the entire water year as a percent of the 1961-1980 average. Areas with less than 90% of average moisture are considered dry -- less than 70% of average is very dry. The driest areas are located primarily in the western 1/4 of the State and in the south half of the San Luis Valley. Areas south of Alamosa only received a total of about 4" of precipitation for the entire year, the lowest in the state. Isolated areas with above average precipitation were observed in the mountains such as Eagle and Rio Grande Reservoir. Otherwise, wetter than average conditions were limited to several areas on the eastern plains including eastern Weld County, Morgan County and much of southeastern Colorado.



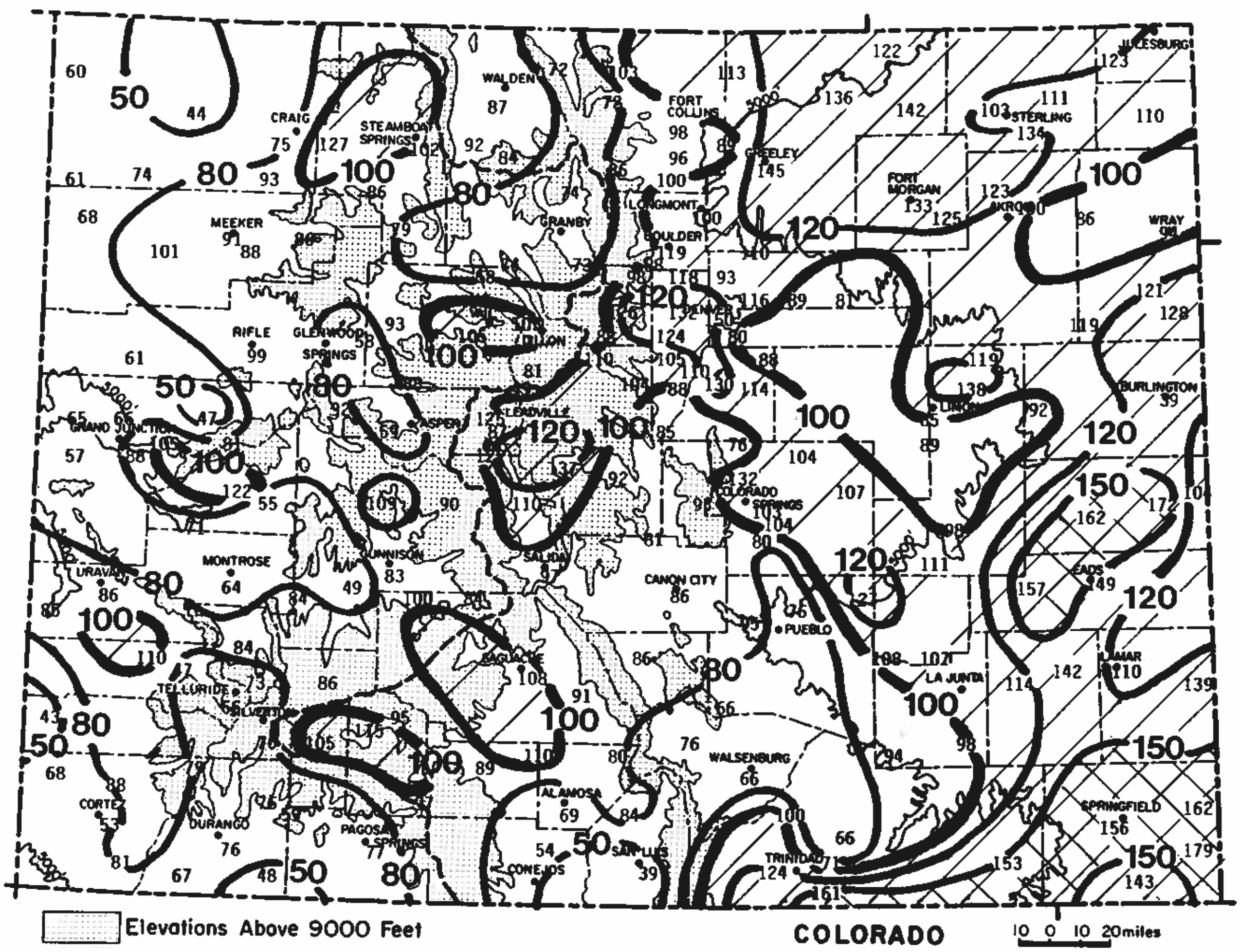

Precipitation for October 1988 through September 1989
as a percent of the 1961-1980 average.

1 9 8 9  W A T E R  Y E A R  W R A P - U P : continued

The second map shows growing season (May - September) precipitation as a percent of average. You can see that most of eastern Colorado enjoyed good summer precipitation while nearly all of western Colorado was drier than average.

In addition to the 1989 drought, there were several other noteworthy weather events during the year. The "Alaska Blaster" of February 1-7 brought a potent duo of extreme subzero cold and heavy snow to Colorado. A late-June snowstorm surprised residents of the eastern foothills. Summer lightning killed 4 Coloradans and injured at least 18. As usual, hailstorms pummelled various areas of eastern Colorado doing millions of dollars of damage to crops and property. A record-breaking heatwave of early July sent temperatures over the century mark in northern Colorado and caused record water usage. Near the end of the heatwave, a flash forest fire near Boulder destroyed many homes and buildings. Snow in early September seemed dramatically out of place after the kind of year we just experienced.

At this time, Coloradans look with anticipation toward the next winter and the new snowpack in the mountains. Interest this year will be especially keen since many reservoirs have been drawn down to their lowest level since before the 1980's wet spell. For the State as a whole, multi-year drought is much more threatening than a one-season or one-year drought. Let's hope for the best.




Precipitation for May-September 1989 (growing season) as a percent of the 1961-80 average.

## SEPTEMBER 1989 DAILY WEATHER

| Date | Event |
|---|---|
| 1-6 | Warm, summerlike weather continued across Colorado. Most low elevation areas enjoyed temperatures in the 80s and 90s. Las Animas reached 102° on the 3rd -- the hottest in the State. It was a little cooler on the 1st and 4th east of the mountains as two weak Pacific cold fronts moved across. A few showers fell on the plains on the 1st and 3rd. Subtropical moisture spread northward on the 4th, and widespread thunderstorm activity developed over southern Colorado. Storms continued late into the night east of the mountains. Wolf Creek Pass got more than an inch of rain. Southeast Colorado picked up from 1/4" to 3/4". A few thunderstorms again popped up on the 5th in extreme southern Colorado. Alamosa reported 0.58" of moisture. |
| 7-13 | Cooler air slipped into northern Colorado early on the 7th. Late in the day, thunderstorms erupted along the cold front. Local flash flooding occurred in the foothills near Boulder. A spectacular lightning display thrilled weather watchers along the Front Range late on the 7th. Morning thunderstorms also startled residents of Northern Colorado on the 8th. Then rain and much colder temperatures spread over most of the northern 2/3 of the State. Fort Morgan received 2.55" of rain by early on the 9th. The Western Slope also enjoyed modest precipitation. Meeker totalled 0.64". Weather improved on the 10th, but a new surge of much colder air drove southward late in the day triggering more thunderstorms east of the mountains. Lamar picked up nearly an inch of rain. Temperatures dropped to unseasonably cold levels east of the mountains on the 11th with moist easterly, upslope winds and temperatures only in the 30s and 40s. An upper level low pressure trough then deepened and approached from the west. Cold rains and snows began in the mountains on the 12th and drizzle changed to rain and snow east of the mountains -- one of the earliest snows on record for some areas. Fort Collins measured 3.7" of snow and Mount Evans Research Center ended up with nearly 20". Rains became quite heavy in southeast Colorado. Springfield and Walsh each received close to 1.50" of precipitation. Skies finally began to clear on the 13th, but temperatures stayed chilly. Several areas experienced their first freezing temperatures of the year. |
| 14-18 | Beautiful autumn weather with a rapid warming trend. Nighttime temperatures remained frosty 14-16th. Silverton's low of 16° on the 15th was the coldest in the state, but their high rebounded to 69° that day. Highs in the upper 80s were common at lower elevations and snow was quickly forgotten. Some clouds spread into Colorado from the southwest 16-17th and as much as 0.52" of rain fell over extreme NW Colorado late on the 17th. |
| 19-21 | A large storm system crossed Colorado. Moist southwesterly flow brought widespread rains to the mountains and western valleys 19-20th. Pagosa Springs reported 1.10" of rain but Wolf Creek Pass led the State with 2.40". Moisture was more spotty east of the mountains, but a few areas including Yuma, Las Animas and Canon City got more than 0.50". Temperatures remained cool. |
| 22-30 | The month ended up with a prolonged period of sunny, dry weather. The only prec[illegible] on the 27-28th when widely scattered light showers were pro[illegible] pulse of moisture from the southwest. Crisp autumn tem[illegible]d gave way to summerlike readings for the rest of the month. Day[illegible]s climbed into the 60s and 70s high into the mountains while 80s [illegible]r elevations. Nights were cool but pleasant. |



### September 1989 Extremes

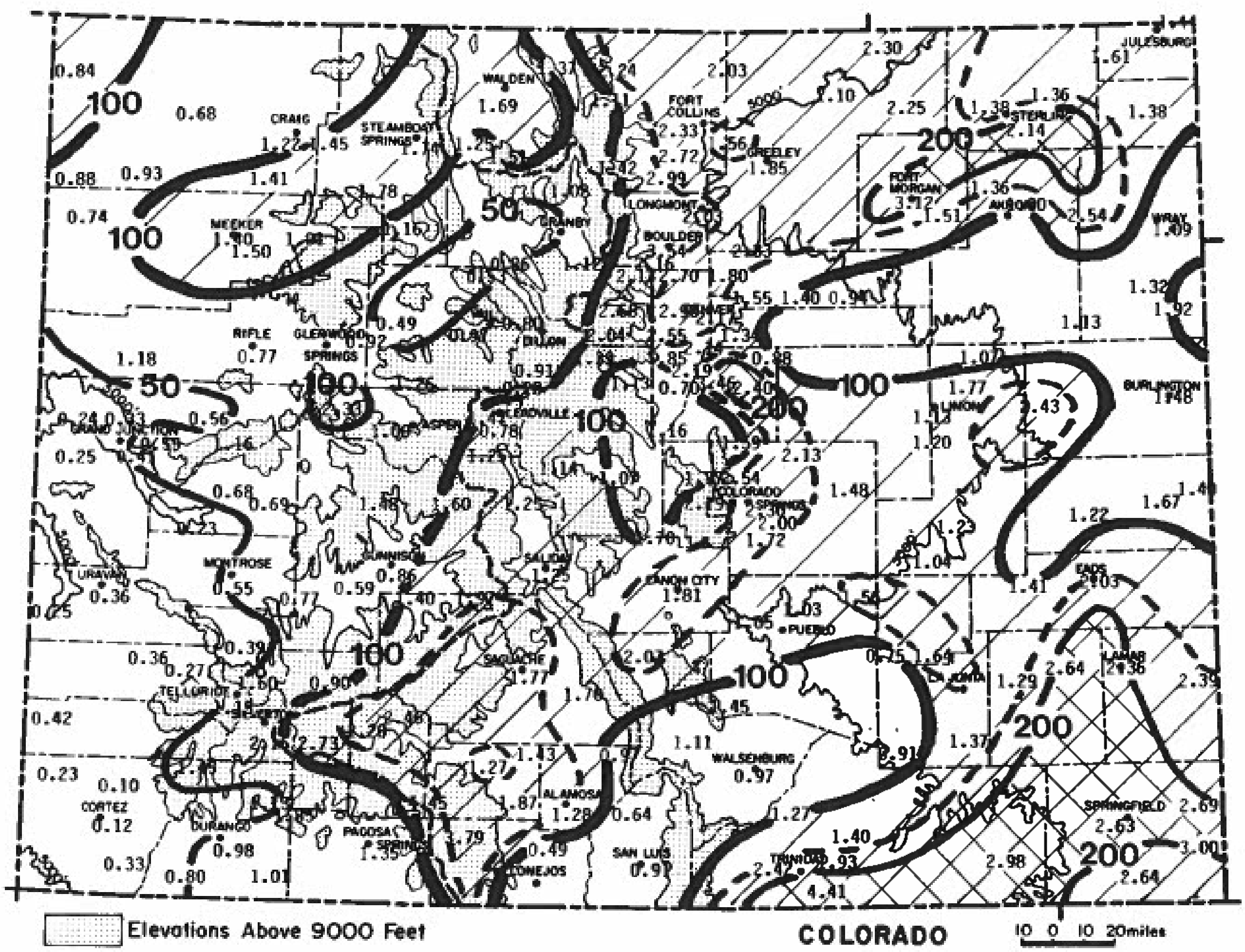
| | | | |
|---|---|---|---|
| High[illegible] | 102°F | September 3 | Las Animas |
| Lowe[illegible] | 16°F | September 15 | Silverton |
| Great[illegible]pitation | 4.45" | | Wolf Creek Pass 1E |
| Least[illegible]ation | 0.10" | | Dolores |
| Great[illegible]all* | 23" | | Mt Evans Research Cntr |
| Maxi[illegible] | 12" | | Mt Evans Research Cntr |

[illegible]ting weather stations with complete daily records.
[illegible]alues are likely for unmonitored locations.

## SEPTEMBER 1989 PRECIPITATION

September weather patterns brought favorable moisture to most of Colorado east of the Continental Divide. The wettest areas, compared to average, were along the Platte River from Brighton to Sterling, a small area near Castle Rock, portions of southeast Colorado from Trinidad to Springfield, and parts of the Rio Grande Basin above Del Norte. A handful of weather stations reported more than double their average September rainfall. Meanwhile, western Colorado reverted back to the dry patterns that plagued them during the spring. Southwestern areas from Grand Junction south to Cortez received only about 25% of average. Two storm systems, one complex system September 7-13th and a second storm 19-21st dropped most of the months moisture.

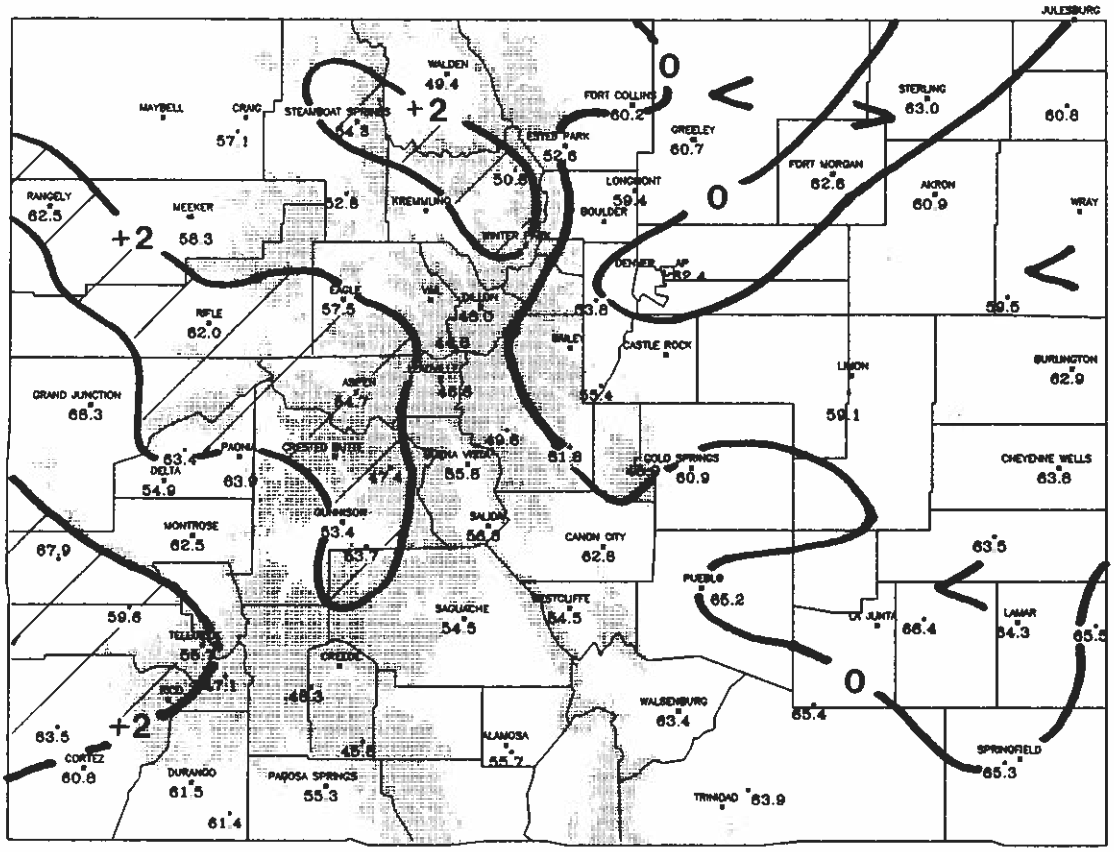
| Greatest | | Least | |
|---|---|---|---|
| Wolf Creek Pass 1E | 4.45" | Dolores | 0.10" |
| Wootton Ranch | 4.41" | Cortez | 0.12" |
| Platoro Dam | 3.79" | Climax | 0.20" |
| Boulder | 3.54" | Yellow Jacket 2W | 0.23" |
| Sedalia 4SSE | 3.46" | Delta | 0.23" |




Precipitation amounts (inches) for September 1989 and contours of precipitation as a percent of the 1961-1980 average. Dashed line is 150% of average.

## SEPTEMBER 1989 TEMPERATURES AND DEGREE DAYS

September temperatures ended up near to a little below average across eastern Colorado while the western half of the state was 1 to 3 degrees Fahrenheit warmer than average for the month. The majority of the month was actually warmer than average across the entire state. However, the cold air associated with the storm that brought snow on September 12th kept temperatures as much as 30 degrees below average 11-13th east of the mountains. During this period, a number of areas in northeast Colorado experienced freezing temperatures. This was at least 2 weeks earlier than usual. Little agricultural damage was reported, but many gardeners saw there pumpkins and tomatoes come to an early demise.




September 1989 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages. Shaded areas are elevations above 9000 feet.

## SEPTEMBER 1989 SOIL TEMPERATURES

Soil temperatures responded dramatically to the cold rains and melting snows that fell from the 8th through the 12th. Temperatures leveled off and returned to more typical levels later in the month.

These soil temperature measurements were taken at Colorado State University beneath sparse unirrigated sod with a flat, open exposure. These data are not representative of all Colorado locations.

FORT COLLINS 7 AM SOIL TEMPERATURES

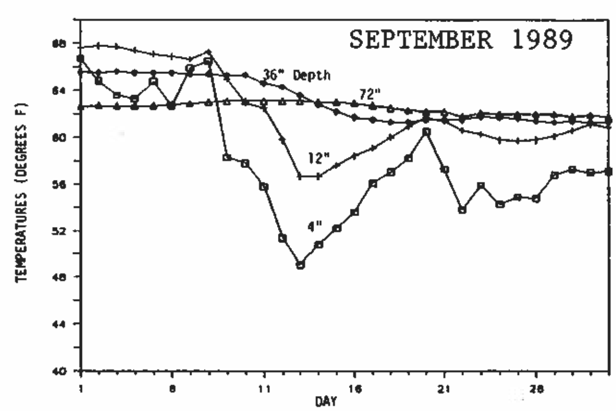


Table 1. Heating Degree Day Data through September 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | 1210 | 854 | 600 | 358 | 180 | 8241 |
| | 89-90 | 17 | 82 | 271 | | | | | | | | | | 370 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | 1171 | 899 | 692 | 476 | 269 | 8444 |
| | 89-90 | 68 | 176 | 303 | | | | | | | | | | 547 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | 1139 | 615 | 427 | 209 | 89 | 5485 |
| | 89-90 | 1 | M | M | | | | | | | | | | M |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | 1153 | 784 | 645 | 360 | 207 | 7646 |
| | 89-90 | 39 | 112 | 270 | | | | | | | | | | 421 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | 1135 | 697 | 375 | M | M | M |
| | 89-90 | M | 4 | M | | | | | | | | | | M |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | 1078 | 554 | 382 | 226 | 90 | 5191 |
| | 89-90 | 0 | 0 | 131 | | | | | | | | | | 131 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | 1205 | 655 | 475 | 247 | 134 | 6107 |
| | 89-90 | 0 | 4 | 172 | | | | | | | | | | 176 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | 1008 | 718 | 450 | 282 | 112 | 6437 |
| | 89-90 | 0 | 16 | 142 | | | | | | | | | | 158 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | 1443 | 894 | 531 | 365 | 169 | 8068 |
| | 89-90 | 4 | 46 | 235 | | | | | | | | | | 285 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 88-89 | M | M | M | M | M | M | 1327 | 964 | 613 | 345 | 211 | 53 | M |
| | 89-90 | M | M | M | | | | | | | | | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | 1190 | 665 | 432 | 213 | 76 | 5780 |
| | 89-90 | 0 | 0 | 153 | | | | | | | | | | 153 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 88-89 E | 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | 1307 | 1088 | 875 | 679 | 490 | 10505 |
| | 89-90 | 226 | 357 | 502 | | | | | | | | | | 1085 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | 933 | 666 | 388 | 237 | 76 | 6209 |
| | 89-90 | 2 | 19 | 106 | | | | | | | | | | 127 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | 1227 | 829 | 536 | 344 | 181 | 7925 |
| | 89-90 | 1 | 60 | 217 | | | | | | | | | | 278 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | 1227 | 794 | 636 | 439 | 261 | 7583 |
| | 89-90 | 49 | 118 | 325 | | | | | | | | | | 492 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | 1207 | 732 | 433 | 216 | 92 | 6119 |
| | 89-90 | 0 | 3 | 169 | | | | | | | | | | 172 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | 1230 | 726 | 446 | 183 | 77 | 6278 |
| | 89-90 | 0 | 2 | 156 | | | | | | | | | | 158 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | 1037 | 534 | 260 | 113 | 8 | 5424 |
| | 89-90 | 0 | 0 | 40 | | | | | | | | | | 40 |

* = AVES ADJUSTED FOR STATION MOVES  M = MISSING  E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | 1368 | 1086 | 805 | 584 | 391 | 10051 |
| | 89-90 | 168 | 306 | 427 | | | | | | | | | | 901 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | 1230 | 711 | 444 | 184 | 71 | 6050 |
| | 89-90 | 1 | 2 | 166 | | | | | | | | | | 169 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 88-89 E | 75 E | 125 | 394 | 631 | 1126 | 1698 | 2096 | 1578 | 1096 | 640 | 487 | 241 | 10187 |
| | 89-90 | 61 | 155 | 341 | | | | | | | | | | 557 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | 1109 | 535 | 303 | 114 | 31 | 4862 |
| | 89-90 | 0 | 0 | 99 | | | | | | | | | | 99 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | 1310 | 1112 | 914 | 695 | 509 | 10772 |
| | 89-90 | 285 | 412 | 545 | | | | | | | | | | 1242 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | 1211 | 751 | 516 | 275 | 143 | 6544 |
| | 89-90 | 1 | 6 | 204 | | | | | | | | | | 211 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | 1307 | 841 | 542 | 256 | 110 | 6961 |
| | 89-90 | 2 | 8 | 200 | | | | | | | | | | 210 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 88-89 | M | M | M | M | M | M | M | M | M | M | M | 165 | M |
| | 89-90 | 0 | 41 | 198 | | | | | | | | | | 239 |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | 972 | 605 | 348 | 180 | 64 | 5903 |
| | 89-90 | 0 | 10 | 110 | | | | | | | | | | 120 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | 1095 | 860 | 574 | 447 | 230 | 7990 |
| | 89-90 | 24 | 118 | 284 | | | | | | | | | | 426 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | 1141 | 573 | 378 | 134 | 35 | 5385 |
| | 89-90 | 0 | 0 | 94 | | | | | | | | | | 94 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | 1049 | 674 | 381 | 224 | 74 | 6401 |
| | 89-90 | 0 | 2 | 103 | | | | | | | | | | 105 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | 1355 | 964 | 581 | 401 | 273 | 8713 |
| | 89-90 | 18 | 117 | 315 | | | | | | | | | | 450 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | 1189 | 730 | 416 | 152 | 59 | 5885 |
| | 89-90 | M | 3 | 144 | | | | | | | | | | M |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | 1071 | 858 | 633 | 463 | 263 | 8237 |
| | 89-90 | 72 | 175 | 270 | | | | | | | | | | 517 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | 1026 | 538 | 378 | 159 | 79 | 5145 |
| | 89-90 | 0 | 1 | 111 | | | | | | | | | | 112 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | 1369 | 1023 | 772 | 612 | 371 | 9776 |
| | 89-90 | 132 | 279 | 461 | | | | | | | | | | 872 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | 1031 | 492 | 376 | 164 | 82 | 5001 |
| | 89-90 | 0 | 2 | 117 | | | | | | | | | | 119 |

* = AVES ADJUSTED FOR STATION MOVES  M = MISSING  E = ESTIMATED

Table 1. Heating Degree Day Data through September 1989 (base temperature, 65°F).

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOSA | AVE | 40 | 100 | 303 | 657 | 1074 | 1457 | 1519 | 1182 | 1035 | 732 | 453 | 165 | 8717 |
| | 88-89 | 28 | 50 | 337 | 575 | 1048 | 1457 | 1544 | 1210 | 854 | 600 | 358 | 180 | 8241 |
| | 89-90 | 17 | 82 | 271 | | | | | | | | | | 370 |
| ASPEN | AVE | 95 | 150 | 348 | 651 | 1029 | 1339 | 1376 | 1162 | 1116 | 798 | 524 | 262 | 8850 |
| | 88-89 | 34 | 79 | 394 | 550 | 1070 | 1375 | 1435 | 1171 | 899 | 692 | 476 | 269 | 8444 |
| | 89-90 | 68 | 176 | 303 | | | | | | | | | | 547 |
| BOULDER | AVE | 0 | 6 | 130 | 357 | 714 | 908 | 1004 | 804 | 775 | 483 | 220 | 59 | 5460 |
| | 88-89 | 1 | 4 | 125 | 311 | 692 | 993 | 880 | 1139 | 615 | 427 | 209 | 89 | 5485 |
| | 89-90 | 1 | M | M | | | | | | | | | | M |
| BUENA VISTA | AVE | 47 | 116 | 285 | 577 | 936 | 1184 | 1218 | 1025 | 983 | 720 | 459 | 184 | 7734 |
| | 88-89 | 37 | 41 | 350 | 530 | 937 | 1342 | 1260 | 1153 | 784 | 645 | 360 | 207 | 7646 |
| | 89-90 | 39 | 112 | 270 | | | | | | | | | | 421 |
| BURLING-TON | AVE | 6 | 5 | 108 | 364 | 762 | 1017 | 1110 | 871 | 803 | 459 | 200 | 38 | 5743 |
| | 88-89 | 4 | 5 | 101 | 352 | 692 | 925 | 908 | 1135 | 697 | 375 | M | M | M |
| | 89-90 | M | 4 | M | | | | | | | | | | M |
| CANON CITY | AVE* | 0 | 10 | 100 | 330 | 670 | 870 | 950 | 770 | 740 | 430 | 190 | 40 | 5100 |
| | 88-89 | 0 | 9 | 112 | 287 | 650 | 937 | 866 | 1078 | 554 | 382 | 226 | 90 | 5191 |
| | 89-90 | 0 | 0 | 131 | | | | | | | | | | 131 |
| COLORADO SPRINGS | AVE | 8 | 25 | 162 | 440 | 819 | 1042 | 1122 | 910 | 880 | 564 | 296 | 78 | 6346 |
| | 88-89 | 7 | 10 | 154 | 366 | 767 | 1099 | 988 | 1205 | 655 | 475 | 247 | 134 | 6107 |
| | 89-90 | 0 | 4 | 172 | | | | | | | | | | 176 |
| CORTEZ | AVE* | 5 | 20 | 160 | 470 | 830 | 1150 | 1220 | 950 | 850 | 580 | 330 | 100 | 6665 |
| | 88-89 | 0 | 1 | 188 | 349 | 855 | 1148 | 1326 | 1008 | 718 | 450 | 282 | 112 | 6437 |
| | 89-90 | 0 | 16 | 142 | | | | | | | | | | 158 |
| CRAIG | AVE | 32 | 58 | 275 | 608 | 996 | 1342 | 1479 | 1193 | 1094 | 687 | 419 | 193 | 8376 |
| | 88-89 | 1 | 14 | 285 | 442 | 967 | 1417 | 1540 | 1443 | 894 | 531 | 365 | 169 | 8068 |
| | 89-90 | 4 | 46 | 235 | | | | | | | | | | 285 |
| DELTA | AVE | 0 | 0 | 94 | 394 | 813 | 1135 | 1197 | 890 | 753 | 429 | 167 | 31 | 5903 |
| | 88-89 | M | M | M | M | M | M | 1327 | 964 | 613 | 345 | 211 | 53 | M |
| | 89-90 | M | M | M | | | | | | | | | | M |
| DENVER | AVE | 0 | 0 | 135 | 414 | 789 | 1004 | 1101 | 879 | 837 | 528 | 253 | 74 | 6014 |
| | 88-89 | 7 | 0 | 129 | 333 | 723 | 1043 | 969 | 1190 | 665 | 432 | 213 | 76 | 5780 |
| | 89-90 | 0 | 0 | 153 | | | | | | | | | | 153 |
| DILLON | AVE | 273 | 332 | 513 | 806 | 1167 | 1435 | 1516 | 1305 | 1296 | 972 | 704 | 435 | 10754 |
| | 88-89 | E 230 | 283 | 565 | 728 | 1178 | 1536 | 1546 | 1307 | 1088 | 875 | 679 | 490 | 10505 |
| | 89-90 | 226 | 357 | 502 | | | | | | | | | | 1085 |
| DURANGO | AVE | 9 | 34 | 193 | 493 | 837 | 1153 | 1218 | 958 | 862 | 600 | 366 | 125 | 6848 |
| | 88-89 | 1 | 5 | 191 | 365 | 869 | 1182 | 1296 | 933 | 666 | 388 | 237 | 76 | 6209 |
| | 89-90 | 2 | 19 | 106 | | | | | | | | | | 127 |
| EAGLE | AVE | 33 | 80 | 288 | 626 | 1026 | 1407 | 1448 | 1148 | 1014 | 705 | 431 | 171 | 8377 |
| | 88-89 | 3 | 11 | 301 | 486 | 942 | 1448 | 1617 | 1227 | 829 | 536 | 344 | 181 | 7925 |
| | 89-90 | 1 | 60 | 217 | | | | | | | | | | 278 |
| EVER-GREEN | AVE | 59 | 113 | 327 | 621 | 916 | 1135 | 1199 | 1011 | 1009 | 730 | 489 | 218 | 7827 |
| | 88-89 | 60 | 50 | 355 | 517 | 882 | 1203 | 1159 | 1227 | 794 | 636 | 439 | 261 | 7583 |
| | 89-90 | 49 | 118 | 325 | | | | | | | | | | 492 |
| FORT COLLINS | AVE | 5 | 11 | 171 | 468 | 846 | 1073 | 1181 | 930 | 877 | 558 | 281 | 82 | 6483 |
| | 88-89 | 3 | 2 | 163 | 362 | 751 | 1147 | 1011 | 1207 | 732 | 433 | 216 | 92 | 6119 |
| | 89-90 | 0 | 3 | 169 | | | | | | | | | | 172 |
| FORT MORGAN | AVE | 0 | 6 | 140 | 438 | 867 | 1156 | 1283 | 969 | 874 | 516 | 224 | 47 | 6520 |
| | 88-89 | 6 | 3 | 124 | 383 | 757 | 1222 | 1121 | 1230 | 726 | 446 | 183 | 77 | 6278 |
| | 89-90 | 0 | 2 | 156 | | | | | | | | | | 158 |
| GRAND JUNCTION | AVE | 0 | 0 | 65 | 325 | 762 | 1138 | 1225 | 882 | 716 | 403 | 148 | 19 | 5683 |
| | 88-89 | 0 | 0 | 106 | 183 | 726 | 1078 | 1379 | 1037 | 534 | 260 | 113 | 8 | 5424 |
| | 89-90 | 0 | 0 | 40 | | | | | | | | | | 40 |

* = AVES ADJUSTED FOR STATION MOVES M = MISSING E = ESTIMATED

Heating Degree Data — Colorado Climate Center (303) 491-8545

| STATION | | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GRAND LAKE | AVE | 214 | 264 | 468 | 775 | 1128 | 1473 | 1593 | 1369 | 1318 | 951 | 654 | 384 | 10591 |
| | 88-89 | 191 | 208 | 461 | 667 | 1087 | 1540 | 1663 | 1368 | 1086 | 805 | 584 | 391 | 10051 |
| | 89-90 | 168 | 306 | 427 | | | | | | | | | | 901 |
| GREELEY | AVE | 0 | 0 | 149 | 450 | 861 | 1128 | 1240 | 946 | 856 | 522 | 238 | 52 | 6442 |
| | 88-89 | 5 | 1 | 116 | 340 | 742 | 1166 | 1040 | 1230 | 711 | 444 | 184 | 71 | 6050 |
| | 89-90 | 1 | 2 | 166 | | | | | | | | | | 169 |
| GUNNISON | AVE | 111 | 188 | 393 | 719 | 1119 | 1590 | 1714 | 1422 | 1231 | 816 | 543 | 276 | 10122 |
| | 88-89 | E 75 | E 125 | 394 | 631 | 1126 | 1698 | 2096 | 1578 | 1096 | 640 | 487 | 241 | 10187 |
| | 89-90 | 61 | 155 | 341 | | | | | | | | | | 557 |
| LAS ANIMAS | AVE | 0 | 0 | 45 | 296 | 729 | 998 | 1101 | 820 | 698 | 348 | 102 | 9 | 5146 |
| | 88-89 | 0 | 0 | 32 | 252 | 609 | 958 | 919 | 1109 | 535 | 303 | 114 | 31 | 4862 |
| | 89-90 | 0 | 0 | 99 | | | | | | | | | | 99 |
| LEAD-VILLE | AVE | 272 | 337 | 522 | 817 | 1173 | 1435 | 1473 | 1318 | 1320 | 1038 | 726 | 439 | 10870 |
| | 88-89 | 318 | 306 | 601 | 730 | 1226 | 1539 | 1512 | 1310 | 1112 | 914 | 695 | 509 | 10772 |
| | 89-90 | 285 | 412 | 545 | | | | | | | | | | 1242 |
| LIMON | AVE | 8 | 6 | 144 | 448 | 834 | 1070 | 1156 | 960 | 936 | 570 | 299 | 100 | 6531 |
| | 88-89 | 9 | 7 | 167 | 428 | 839 | 1138 | 1060 | 1211 | 751 | 516 | 275 | 143 | 6544 |
| | 89-90 | 1 | 6 | 204 | | | | | | | | | | 211 |
| LONGMONT | AVE | 0 | 6 | 162 | 453 | 843 | 1082 | 1194 | 938 | 874 | 546 | 256 | 78 | 6432 |
| | 88-89 | 10 | 8 | 203 | 445 | 812 | 1276 | 1151 | 1307 | 841 | 542 | 256 | 110 | 6961 |
| | 89-90 | 2 | 8 | 200 | | | | | | | | | | 210 |
| MEEKER | AVE | 28 | 56 | 261 | 564 | 927 | 1240 | 1345 | 1086 | 998 | 651 | 394 | 164 | 7714 |
| | 88-89 | M | M | M | M | M | M | M | M | M | M | M | 165 | M |
| | 89-90 | 0 | 41 | 198 | | | | | | | | | | 239 |
| MONTROSE | AVE | 0 | 10 | 135 | 437 | 837 | 1159 | 1218 | 941 | 818 | 522 | 254 | 69 | 6400 |
| | 88-89 | 0 | 1 | 169 | 292 | 794 | 1138 | 1340 | 972 | 605 | 348 | 180 | 64 | 5903 |
| | 89-90 | 0 | 10 | 110 | | | | | | | | | | 120 |
| PAGOSA SPRINGS | AVE | 82 | 113 | 297 | 608 | 981 | 1305 | 1380 | 1123 | 1026 | 732 | 487 | 233 | 8367 |
| | 88-89 | 30 | 61 | 325 | 506 | 999 | 1354 | 1509 | 1095 | 860 | 574 | 447 | 230 | 7990 |
| | 89-90 | 24 | 118 | 284 | | | | | | | | | | 426 |
| PUEBLO | AVE | 0 | 0 | 89 | 346 | 744 | 998 | 1091 | 834 | 756 | 421 | 163 | 23 | 5465 |
| | 88-89 | 1 | 0 | 84 | 308 | 689 | 1062 | 980 | 1141 | 573 | 378 | 134 | 35 | 5385 |
| | 89-90 | 0 | 0 | 94 | | | | | | | | | | 94 |
| RIFLE | AVE | 6 | 24 | 177 | 499 | 876 | 1249 | 1321 | 1002 | 856 | 555 | 298 | 82 | 6945 |
| | 88-89 | 0 | 0 | 198 | 327 | 826 | 1203 | 1445 | 1049 | 674 | 381 | 224 | 74 | 6401 |
| | 89-90 | 0 | 2 | 103 | | | | | | | | | | 105 |
| STEAMBOAT SPRINGS | AVE* | 90 | 140 | 370 | 670 | 1060 | 1430 | 1500 | 1240 | 1150 | 780 | 510 | 270 | 9210 |
| | 88-89 | 27 | 45 | 336 | 537 | 1053 | 1501 | 1640 | 1355 | 964 | 581 | 401 | 273 | 8713 |
| | 89-90 | 18 | 117 | 315 | | | | | | | | | | 450 |
| STERLING | AVE | 0 | 6 | 157 | 462 | 876 | 1163 | 1274 | 966 | 896 | 528 | 235 | 51 | 6614 |
| | 88-89 | 1 | 1 | 116 | 363 | 703 | 1089 | 1066 | 1189 | 730 | 416 | 152 | 59 | 5885 |
| | 89-90 | M | 3 | 144 | | | | | | | | | | M |
| TELLURIDE | AVE | 163 | 223 | 396 | 676 | 1026 | 1293 | 1339 | 1151 | 1141 | 849 | 589 | 318 | 9164 |
| | 88-89 | 131 | 147 | 397 | 570 | 1036 | 1305 | 1363 | 1071 | 858 | 633 | 463 | 263 | 8237 |
| | 89-90 | 72 | 175 | 270 | | | | | | | | | | 517 |
| TRINIDAD | AVE | 0 | 0 | 86 | 359 | 738 | 973 | 1051 | 846 | 781 | 468 | 207 | 35 | 5544 |
| | 88-89 | 8 | 5 | 100 | 266 | 686 | 975 | 925 | 1026 | 538 | 378 | 159 | 79 | 5145 |
| | 89-90 | 0 | 1 | 111 | | | | | | | | | | 112 |
| WALDEN | AVE | 198 | 285 | 501 | 822 | 1170 | 1457 | 1535 | 1313 | 1277 | 915 | 642 | 351 | 10466 |
| | 88-89 | 144 | 189 | 507 | 668 | 1139 | 1495 | 1487 | 1369 | 1023 | 772 | 612 | 371 | 9776 |
| | 89-90 | 132 | 279 | 461 | | | | | | | | | | 872 |
| WALSEN-BURG | AVE | 0 | 8 | 102 | 370 | 720 | 924 | 989 | 820 | 781 | 501 | 240 | 49 | 5504 |
| | 88-89 | 2 | 3 | 119 | 266 | 654 | 936 | 876 | 1031 | 492 | 376 | 164 | 82 | 5001 |
| | 89-90 | 0 | 2 | 117 | | | | | | | | | | 119 |

* = AVES ADJUSTED FOR STATION MOVES M = MISSING E = ESTIMATED

# SEPTEMBER 1989 CLIMATIC DATA

## Eastern Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| NEW RAYMER 21N | 71.6 | 43.7 | 57.6 | -1.9 | 92 | 31 | 238 | 23 | 348 | 2.30 | 1.13 | 196.6 | 8 |
| STERLING | 79.1 | 46.9 | 63.0 | 1.9 | 95 | 33 | 144 | 92 | 458 | 1.38 | 0.28 | 125.5 | 5 |
| FORT MORGAN | 77.2 | 48.0 | 62.6 | 0.4 | 94 | 34 | 156 | 90 | 437 | 3.12 | 1.94 | 264.4 | 9 |
| AKRON 4E | 75.7 | 46.0 | 60.9 | -1.2 | 92 | 31 | 181 | 66 | 411 | 1.00 | -0.05 | 95.2 | 10 |
| HOLYOKE | 73.4 | 48.3 | 60.8 | -2.0 | 89 | 33 | 175 | 56 | 403 | 1.38 | 0.09 | 107.0 | 5 |
| JOES | 73.7 | 45.3 | 59.5 | -3.5 | 96 | 32 | 211 | 52 | 385 | 1.13 | -0.27 | 80.7 | 5 |
| BURLINGTON | 79.0 | 46.8 | 62.9 | -1.2 | 9999 | 33 | M | M | M | 1.48 | -0.02 | 98.7 | 2 |
| LIMON WSMO | 73.7 | 44.5 | 59.1 | -0.6 | 89 | 32 | 204 | 34 | 377 | 1.13 | 0.23 | 125.6 | 8 |
| CHEYENNE WELLS | 79.0 | 48.5 | 63.8 | -0.2 | 93 | 31 | 137 | 108 | 470 | 1.67 | -0.12 | 93.3 | 7 |
| EADS | 78.2 | 48.8 | 63.5 | -1.8 | 94 | 36 | 137 | 98 | 466 | 2.03 | 0.71 | 153.8 | 6 |
| ORDWAY 21N | 81.0 | 46.8 | 63.9 | 0.4 | 98 | 35 | 130 | 103 | 461 | 1.04 | 0.17 | 119.5 | 7 |
| LAMAR | 81.6 | 47.0 | 64.3 | -2.5 | 100 | 32 | 137 | 124 | 487 | 2.36 | 1.23 | 208.8 | 7 |
| LAS ANIMAS | 81.7 | 51.1 | 66.4 | -0.9 | 102 | 34 | 99 | 149 | 512 | 1.29 | 0.25 | 124.0 | 8 |
| HOLLY | 80.9 | 50.2 | 65.5 | 0.2 | 97 | 35 | 97 | 122 | 513 | 2.39 | 0.84 | 154.2 | 6 |
| SPRINGFIELD 7WSW | 80.7 | 49.9 | 65.3 | 0.0 | 97 | 35 | 111 | 129 | 498 | 2.63 | 1.46 | 224.8 | 8 |
| TIMPAS 13SW | 80.1 | 50.8 | 65.4 | 0.5 | 96 | 36 | 116 | 135 | 492 | 0.91 | -0.26 | 77.8 | 3 |

## Foothills/Adjacent Plains

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| FORT COLLINS | 74.2 | 46.2 | 60.2 | 0.2 | 87 | 33 | 169 | 31 | 395 | 2.33 | 1.09 | 187.9 | 7 |
| GREELEY UNC | 75.7 | 45.8 | 60.7 | -1.4 | 90 | 32 | 166 | 45 | 414 | 1.85 | 0.72 | 163.7 | 9 |
| ESTES PARK | 68.6 | 36.7 | 52.6 | -0.7 | 81 | 28 | 363 | 0 | 295 | 1.42 | 0.07 | 105.2 | 6 |
| LONGMONT 2ESE | 75.8 | 43.0 | 59.4 | -1.2 | 96 | 31 | 200 | 42 | 396 | 2.03 | 0.60 | 142.0 | 7 |
| DENVER WSFO AP | 76.5 | 48.4 | 62.4 | 0.5 | 92 | 33 | 153 | 83 | 438 | 1.55 | 0.17 | 112.3 | 7 |
| EVERGREEN | 70.2 | 37.5 | 53.8 | -0.0 | 83 | 30 | 325 | 0 | 322 | 2.55 | 1.10 | 175.9 | 9 |
| CHEESMAN | 75.6 | 35.3 | 55.4 | -1.0 | 88 | 24 | 279 | 0 | 394 | 1.16 | -0.11 | 91.3 | 7 |
| LAKE GEORGE 8SW | 67.0 | 36.7 | 51.8 | 0.0 | 76 | 29 | 386 | 0 | 266 | 1.07 | -0.01 | 99.1 | 6 |
| ANTERO RESERVOIR | 68.5 | 30.8 | 49.6 | 1.1 | 76 | 21 | 458 | 0 | 285 | 1.14 | 0.22 | 123.9 | 4 |
| RUXTON PARK | 61.9 | 29.8 | 45.9 | -1.9 | 75 | 22 | 568 | 0 | 207 | 2.19 | 0.31 | 116.5 | 8 |
| COLORADO SPRINGS | 74.0 | 47.9 | 60.9 | 0.5 | 91 | 34 | 172 | 57 | 396 | 2.30 | 0.94 | 169.1 | 9 |
| CANON CITY 2SE | 76.8 | 48.8 | 62.8 | 0.1 | 91 | 36 | 131 | 71 | 437 | 1.81 | 0.72 | 166.1 | 6 |
| PUEBLO WSO AP | 81.2 | 49.3 | 65.2 | -0.3 | 97 | 36 | 94 | 109 | 481 | 1.03 | 0.14 | 115.7 | 8 |
| WESTCLIFFE | 71.7 | 37.4 | 54.5 | 0.8 | 82 | 24 | 308 | 0 | 338 | 2.07 | 0.80 | 163.0 | 7 |
| WALSENBURG | 78.7 | 48.1 | 63.4 | 0.9 | 89 | 35 | 117 | 77 | 475 | 0.97 | -0.25 | 79.5 | 6 |
| TRINIDAD FAA AP | 78.7 | 49.1 | 63.9 | 0.3 | 90 | 36 | 111 | 86 | 470 | 1.40 | 0.33 | 130.8 | 7 |

## Mountains/Interior Valleys

| | Temperature | | | | | | Degree Days | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Max | Min | Mean | Dep | High | Low | Heat | Cool | Grow | Total | Dep | %Norm | # days |
| WALDEN | 69.1 | 29.7 | 49.4 | 1.3 | 79 | 19 | 461 | 0 | 295 | 1.69 | 0.57 | 150.9 | 8 |
| LEADVILLE 2SW | 64.1 | 29.1 | 46.6 | 0.1 | 73 | 21 | 545 | 0 | 221 | 0.78 | -0.62 | 55.7 | 5 |
| SALIDA | 74.7 | 38.8 | 56.8 | -0.1 | 85 | 28 | 239 | 2 | 381 | 1.25 | 0.33 | 135.9 | 5 |
| BUENA VISTA | 73.0 | 38.5 | 55.8 | 0.7 | 84 | 31 | 270 | 0 | 355 | 1.25 | 0.20 | 119.0 | 6 |
| SAGUACHE | 71.4 | 37.7 | 54.5 | 0.5 | 80 | 31 | 308 | 0 | 327 | 1.77 | 0.82 | 186.3 | 8 |
| HERMIT 7ESE | 68.1 | 28.6 | 48.3 | 0.9 | 77 | 20 | 494 | 0 | 278 | 2.20 | 0.77 | 153.8 | 3 |
| ALAMOSA WSO AP | 74.9 | 36.6 | 55.7 | 1.1 | 84 | 27 | 271 | 0 | 381 | 1.28 | 0.45 | 154.2 | 8 |
| STEAMBOAT SPRINGS | 72.9 | 35.7 | 54.3 | 2.7 | 83 | 28 | 315 | 0 | 351 | 1.74 | 0.14 | 108.7 | 6 |
| YAMPA | 68.6 | 36.9 | 52.8 | 1.0 | 77 | 26 | 360 | 0 | 287 | 1.16 | -0.32 | 78.4 | 4 |
| GRAND LAKE 1NW | 70.1 | 30.9 | 50.5 | 3.2 | 79 | 21 | 427 | 0 | 311 | 1.02 | -0.60 | 63.0 | 10 |
| DILLON 1E | 66.4 | 29.6 | 48.0 | 0.1 | 75 | 22 | 502 | 0 | 255 | 0.80 | -0.54 | 59.7 | 5 |
| AVON | 72.9 | 33.5 | 53.2 | -0.3 | 82 | 23 | 346 | 0 | 350 | 0.95 | -0.25 | 79.2 | 7 |
| CLIMAX | 57.6 | 31.6 | 44.6 | 1.7 | 68 | 21 | 604 | 0 | 133 | 0.20 | -1.36 | 12.8 | 5 |
| ASPEN 1SW | 70.5 | 38.9 | 54.7 | 2.2 | 80 | 30 | 303 | 0 | 311 | 1.00 | -0.80 | 55.6 | 7 |
| TAYLOR PARK | 64.3 | 30.6 | 47.4 | 3.5 | 72 | 24 | 517 | 0 | 223 | 1.60 | 0.06 | 103.9 | 4 |
| TELLURIDE | 74.7 | 36.8 | 55.7 | 4.3 | 83 | 22 | 270 | 0 | 378 | 1.15 | -0.99 | 53.7 | 6 |
| PAGOSA SPRINGS | 76.3 | 34.4 | 55.3 | 0.8 | 85 | 27 | 284 | 0 | 403 | 1.35 | -0.75 | 64.3 | 4 |
| SILVERTON | 68.6 | 25.6 | 47.1 | 1.6 | 77 | 16 | 530 | 0 | 288 | 2.16 | -0.38 | 85.0 | 11 |
| WOLF CREEK PASS 1 | 60.1 | 31.5 | 45.8 | 0.6 | 67 | 23 | 570 | 0 | 159 | 4.45 | 0.46 | 111.5 | 8 |

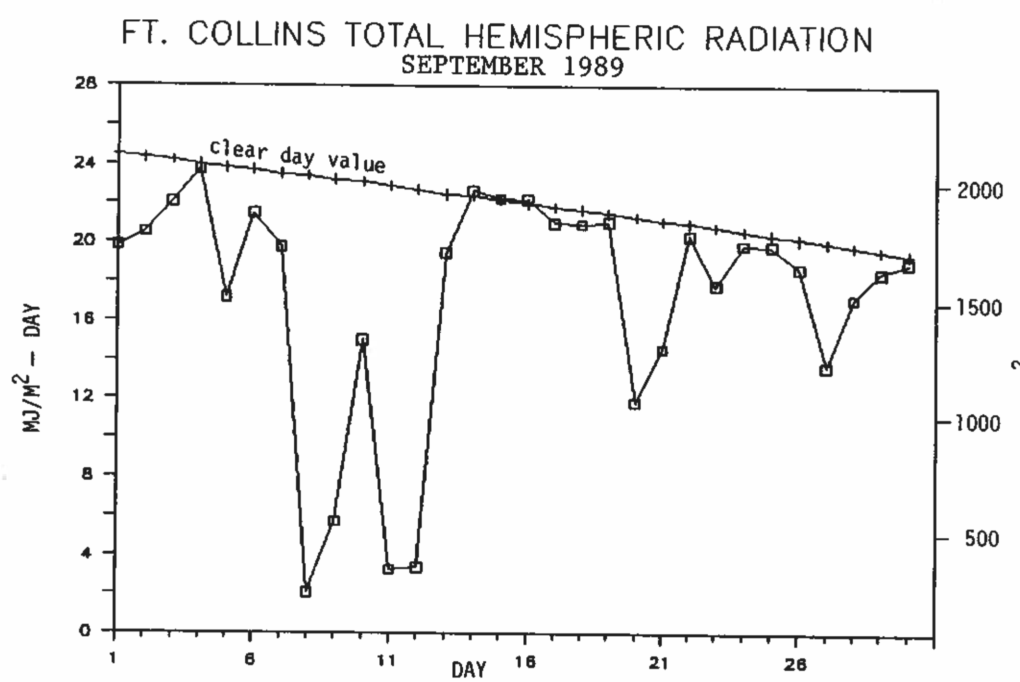
## Western Valleys

| Name | Temperature Max | Min | Mean | Dep | High | Low | Degree Days Heat | Cool | Grow | Precipitation Total | Dep | %Norm | # days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRAIG 4SW | 74.3 | 39.8 | 57.1 | 1.0 | 86 | 29 | 235 | 4 | 374 | 1.22 | -0.08 | 93.8 | 6 |
| MEEKER NO. 2 | 76.4 | 40.3 | 58.3 | 1.4 | 85 | 30 | 198 | 6 | 404 | 1.40 | 0.38 | 137.3 | 5 |
| RANGELY 1E | 80.3 | 44.6 | 62.5 | 2.2 | 90 | 34 | 104 | 34 | 461 | 0.74 | -0.35 | 67.9 | 7 |
| EAGLE FAA AP | 77.8 | 37.2 | 57.5 | 2.2 | 85 | 28 | 217 | 0 | 424 | 0.49 | -0.69 | 41.5 | 5 |
| RIFLE | 82.0 | 42.1 | 62.0 | 2.8 | 90 | 32 | 103 | 22 | 477 | 0.77 | -0.31 | 71.3 | 4 |
| GRAND JUNCTION WS | 82.8 | 53.7 | 68.3 | 1.6 | 93 | 43 | 40 | 145 | 551 | 0.33 | -0.39 | 45.8 | 4 |
| CEDAREDGE | 81.7 | 45.2 | 63.4 | 2.2 | 90 | 32 | 83 | 41 | 483 | 0.68 | -0.51 | 57.1 | 2 |
| PAONIA 1SW | 81.2 | 46.6 | 63.9 | 1.9 | 90 | 36 | 80 | 55 | 478 | 0.69 | -0.66 | 51.1 | 3 |
| DELTA | (?) 74.2 | 35.5 | 54.9 | -7.4 | 90 | 25 | 304 | 9 | 367 | 0.23 | -0.76 | 23.2 | 2 |
| GUNNISON | 74.3 | 32.6 | 53.4 | 2.1 | 82 | 26 | 341 | 0 | 372 | 0.86 | -0.05 | 94.5 | 3 |
| COCHETOPA CREEK | 74.2 | 33.1 | 53.7 | 2.7 | 82 | 23 | 332 | 0 | 370 | 1.40 | 0.40 | 140.0 | 4 |
| MONTROSE NO. 2 | 78.7 | 46.3 | 62.5 | 1.4 | 88 | 36 | 110 | 43 | 452 | 0.55 | -0.62 | 47.0 | 5 |
| URAVAN | 87.2 | 48.6 | 67.9 | 2.2 | 95 | 38 | 22 | 116 | 543 | 0.36 | -0.71 | 33.6 | 2 |
| NORWOOD | 75.8 | 43.4 | 59.6 | 3.1 | 83 | 31 | 156 | 2 | 404 | 0.36 | -1.24 | 22.5 | 3 |
| YELLOW JACKET 2W | 79.5 | 47.5 | 63.5 | 3.2 | 88 | 35 | 75 | 39 | 465 | 0.23 | -1.15 | 16.7 | 1 |
| CORTEZ | 79.6 | 42.0 | 60.8 | 0.6 | 87 | 33 | 142 | 23 | 456 | 0.12 | -1.08 | 10.0 | 3 |
| DURANGO | 81.6 | 41.4 | 61.5 | 3.0 | 89 | 34 | 106 | 7 | 478 | 0.98 | -0.75 | 56.6 | 6 |
| IGNACIO 1N | 82.9 | 39.8 | 61.4 | 3.6 | 90 | 30 | 118 | 16 | 490 | 1.01 | -0.52 | 66.0 | 4 |

* Data are received by the Colorado Climate Center for more locations than appear in these tables. Please contact the Colorado Climate Center if additional information is needed.

## SEPTEMBER 1989 SUNSHINE AND SOLAR RADIATION

| Station | Number of Days: clear | partly cloudy | cloudy | % of possible sunshine | average % of possible |
|---|---|---|---|---|---|
| Colorado Springs | 13 | 12 | 5 | -- | -- |
| Denver | 16 | 8 | 6 | 69% | 75% |
| Fort Collins | 13 | 13 | 4 | -- | -- |
| Grand Junction | 20 | 7 | 3 | 84% | 76% |
| Pueblo | 18 | 8 | 4 | 83% | 80% |



# KEEP THE HOME FIRES BURNING

Fire was most likely one of the main reasons that the species *homo sapiens* flourished. It certainly allowed man to spread to climates that otherwise were hostile. Jumping forward a bit, western European men had their fires outside during the summer for cooking and brought them inside to hearths that were nothing more than a stone slab in the middle of the floor. Smoke escaped through a hole in the roof or through crannies within the walls. It wasn't until the late thirteenth century that a crude chimney was built. Hearths were moved to the walls in the Norman castles because the second floors were made of wood which made the central hearth impractical. And by the late fourteenth century, there were wall fireplaces with chimneys in many room within a castle. But the common man made do with a hole in the roof of his cottage until the late 1500's. The closed stove began to appear in the 1700's. It provided prodigious amounts of heat to a room with just a small amount of wood as long as minimal fresh air was allowed into the room. Thermostatic controls for these stoves were invented in 1849 by the American Elisha Foote. We Americans produced more iron stoves than other countries during the 1800's. Now, with the advent of central heating, wood stoves are a rarity, not the common sight they once were.

Among the problems facing us today is the fact that the fossil fuel used to heat our homes is a dwindling fuel source. Some people are choosing to revert back to the days when the fuel was burned in the home to provide the heat directly. However, wood stoves have changed since the days of Ben Franklin. Technology has built stoves that burn wood pellets made of sawdust and agricultural residue. Not only is the fuel source different, these pellets can be added to the fire as needed by automatic controls. Definitely not the 'tending of the home fires' one may think of when referring to a wood stove. Even stoves using wood as fuel can provide heat for up to 8 hours without refueling. Today's wood stoves may have small electric blowers which circulate the warmed air. This allows for convective heat transfer as well as radiative heat transfer. Homes with a ceiling fan can create their own convection to work in tandem with a stove whose main form of heat transfer is radiation.

In the early days when the hearth was the only form of heating and cooking, wood preparation was an art. Wood was well seasoned and usually 'toasted' into a semi-charcoal state before being brought into the home. In parts of the Mediterranean, the wood was soaked in oils and aromatics. The laying of the fire had a precise method with its own vocabulary. Generations passed down how to choose the best woods for particular uses. Today, the U.S. Department of Energy can tell us approximate heating values on varying woods. Their values are for a cord of wood. A standard cord of wood is 128 cubic feet, an 8 foot by 4 foot stack which has a depth of 4 feet. Table 1 shows some of these values in millions of BTU's per cord. The cost of the heat in the wood is (2 x cost per cord/MMBTU per cord) assuming a 50% efficient stove. The actual wood heating cost includes the cost of the stove and chimney.

**TABLE 1**

**Approximate Heating Values per Cord of Wood**

| High (24-31 MMBtu) | Medium (20-24 MMBtu) | Low (16-20 MMBtu) |
|---|---|---|
| Oak | Western larch | Black Spruce |
| Dogwood | Pond pine | Red fir |
| Slash pine | Juniper | Black willow |
| Apple | Red maple | Ponderosa pine |
| Sugar maple | American elm | Quaking aspen |
| Longleaf pine | Douglas fir | Sugar pine |
| White ash | Norway pine | White pine |
| Black walnut | Chestnut | Western red cedar |

When deciding what size stove is best, the saying "bigger is better" does not apply. If the stove is too large for the home, the heat it puts out will overwhelm the residents and it will be damped way down. This causes the fire to be oxygen starved and created excess creosote which can build up and be a potential chimney fire. Most dealers of stoves give an approximate floor size for which their stove will comfortably provide heat. This is fine for the typical home, however, it your home has more than average insulation, or has more than average infiltration of air, this approximation may not hold.

Environmentally, wood heating is not a 'clean' burning form of energy. It releases carbon dioxide into the air which may or may not influence the greenhouse effect so prevalent in today's news. The metro area of Denver and Boulder regulate this by codes requiring specific equipment which helps to reduce this wood air pollution. This air pollution is a problem that man has been dealing with since he started using stoves for heating. There were formal complaints from France during Tudor times that the vines were being ruined by London smoke. And an anti-smog leaflet tried to influence the burning of coal in London in 1661. Wood, as a fuel source, needs to be tended by man to assure its continued existence. This is especially true in developing countries where 80% of the people use wood as a principle fuel source. It is expected that wood, as a form of solar energy, will be used for many years to come if the resource it treated properly and not overused.

This paper was written by Mary Sutter of the Joint Center for Energy Management at the University of Colorado, Box 428, Boulder, CO 80309-0428.

# WTHRNET WEATHER DATA SEPTEMBER 1989

| | Alamosa | Durango | Carbondale | Steamboat Springs | Sterling | Stratton | Walsh | Montrose |
|---|---|---|---|---|---|---|---|---|
| **monthly average temperature ( °F )** | | | | | | | | |
| | 54.6 | 56.2 | 56.9 | 52.1 | 60.2 | 61.1 | 62.7 | 0 |
| **monthly temperature extremes and time of occurence ( °F day/hour )** | | | | | | | | |
| maximum: | 79.3 17/15 | 79.9 24/16 | 84.9 2/15 | 82.9 6/15 | 90.5 30/14 | 91.9 18/14 | 94.5 3/16 | 0 |
| minimum: | 26.2 15/ 6 | 31.6 13/ 7 | 30.6 25/ 7 | 25.9 4/ 6 | 33.1 12/ 8 | 30.9 23/ 6 | 37.2 23/ 7 | 0 |
| **monthly average relative humidity / dewpoint ( percent / °F )** | | | | | | | | |
| 5 AM | 44 / 17 | 75 / 34 | 57 / 22 | 58 / 19 | 75 / 42 | 80 / 43 | 78 / 45 | 0 |
| 11 AM | 21 / 20 | 43 / 42 | 25 / 24 | 22 / 21 | 46 / 43 | 48 / 45 | 46 / 45 | 0 |
| 2 PM | 16 / 18 | 31 / 38 | 13 / 20 | 14 / 17 | 36 / 39 | 36 / 41 | 36 / 41 | 0 |
| 5 PM | 19 / 17 | 28 / 34 | 10 / 17 | 13 / 16 | 36 / 37 | 36 / 38 | 37 / 40 | 0 |
| 11 PM | 33 / 18 | 59 / 35 | 32 / 22 | 41 / 19 | 65 / 42 | 65 / 42 | 64 / 44 | 0 |
| **monthly average wind direction ( degrees clockwise from north )** | | | | | | | | |
| day | 91 | 222 | 161 | 153 | 145 | 113 | 142 | 0 |
| night | 79 | 85 | 111 | 74 | 170 | 186 | 189 | 0 |
| **monthly average wind speed ( miles per hour )** | | | | | | | | |
| | 4.31 | 3.79 | 3.41 | 3.50 | 9.11 | 10.02 | 6.42 | 0 |
| **wind speed distribution ( hours per month for hourly average mph range )** | | | | | | | | |
| 0 to 3 | 142 | 387 | 301 | 304 | 39 | 7 | 218 | 0 |
| 3 to 12 | 192 | 324 | 155 | 134 | 508 | 502 | 384 | 0 |
| 12 to 24 | 10 | 8 | 5 | 34 | 172 | 209 | 112 | 0 |
| > 24 | 0 | 0 | 0 | 0 | 1 | 2 | 6 | 0 |
| **monthly average daily total insolation ( Btu/ft²·day )** | | | | | | | | |
| | 1905 | 1822 | 1777 | 1714 | 1489 | 1551 | 1584 | 0 |
| **"clearness" distribution ( hours per month in specified clearness index range )** | | | | | | | | |
| 60-80% | 88 | 147 | 71 | 99 | 212 | 211 | 218 | 0 |
| 40-60% | 24 | 66 | 37 | 34 | 50 | 41 | 40 | 0 |
| 20-40% | 22 | 40 | 18 | 16 | 30 | 37 | 37 | 0 |
| 0-20% | 10 | 35 | 15 | 11 | 58 | 57 | 58 | 0 |

## The State-Wide Picture

The figure below shows monthly weather at WTHRNET sites around the state. Three graphs are given for each location: the top graph displays the hourly ambient air temperature, ranging from -40°F to 110°F, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 Btu/ft²/day, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour. Montrose data for this month is missing due to continuing problems.