COLORADO CLIMATE SUMMARY

WATER-YEAR SERIES

(October 1990 through September 1991)

Nolan J. Doesken
Thomas B. McKee

Climatology Report 92-2

DEPARTMENT OF ATMOSPHERIC SCIENCE
COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO

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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 1991 Water Year marked the 17th year of existence of the Colorado Climate Center (CCC) and the 14th 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. The Weather Blues, October 1990, page 20.
2. The Cost of Being Santa in the 90's, November 1990, page 31.
3. How Cold is Cold?, December 1990, page 42.
4. Let's Talk LUZ, January 1991, page 53.
5. Trash Turns Turbines, February 1991, page 64.
6. The Weather Handbook, March 1991, page 75.
7. The Art of a Snowball, April 1991, page 86.
8. Applications of Weather Data to Energy Related Topics, May 1991, Page 97.
9. Night Precooling, June 1991, page 108.
10. Modeling of Weather data, July 1991, page 119.
11. Saving Energy by Keeping Score, August 1991, page 130.
12. Hydro-Electric Power, September 1991, page 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°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°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° 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°F. Growing degree day totals are this adjusted mean temperature (°F) minus 50°F summed for each day.

III. 1991 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 1991 summary found on pages 132-136.

COLORADO CLIMATE

OCTOBER 1990

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 14 Number 1

October in Review:

Several cold fronts and 3 major storm systems crossed Colorado in October as the transition from summer to winter began in earnest. Temperatures, while varying between unseasonably mild and unseasonably cold during the month, ended up close to average across the State. Nearly all of Colorado also received one or more snows during the month. Precipitation ended up above average over the majority of Colorado. Abundant mountain snows were appreciated both by skiers, resorts and low-elevation water users.

Colorado's December Climate:

The kind of December that seems to make the largest number of Coloradans happy is a month when the mountains get frequent and plentiful snows (with most snow falling at night with the sun popping back out during the day) while the low elevations stay dry, snow-free and sunny. Keep the winds light so that the cold nighttime temperatures aren't a bother, and add 6" of fluffy snow on Christmas Eve across the whole state (that doesn't stick on highways or delay air traffic) and the month is nearly perfect. Believe it or not, we sometimes come close to that ideal -- but don't count on it. In reality, there will likely be some biting cold, some annoying and perhaps even damaging wind storms along the Front Range, air pollution when the winds are calm, some freezing drizzle and fog to disrupt travel and perhaps a major low-elevation snowstorm. In some years, such as 1989, mountains snows don't get off to an early start and Christmas skiing is less than perfect. Furthermore, don't be surprised if Christmas is brown instead of white across eastern Colorado and over some of the Western Slope.

In a typical December, temperatures will continue to drop throughout the month with each new cold front. An episode of subzero weather is quite common, especially late in the month. Last year temperatures dipped below -30°F on December 22 in northeast Colorado. Some mild episodes are still possible though, with low elevation daytime temperatures reaching into the 50s and even the 60s especially east of the mountains. These periods may be accompanied by annoying strong westerly winds or air pollution buildup. But nights are almost always cold across all of the State. On the average, December temperatures average in the 30s and 40s during the day with teens at night across low elevation areas. In the mountains 20s and 30s are more likely with nighttime lows near zero. Some of the warmest parts of Colorado in December are in the foothills at elevations of from 5500 to 7500 feet.

December precipitation is definitely greater in the mountains than at lower elevations. Average precipitation for the month ranges from less than 0.50" (5-10" snow) across the eastern plains to as much as 2.00 to 5.00" in high mountain areas (30-80" snow). The Western Slope, Front Range and eastern foothills can normally expect 0.50 to 1.00" of moisture (8-20" snow). Nearly all December moisture falls as snow. In a typical December, Colorado can expect 5 to 8 days with measurable precipitation over the Western Slope increasing to 6 to 12 days in the southern mountains. Precipitation falls most frequently in the northern and central mountains where 8 to 17 precipitation days are expected. Snow frequencies decrease dramatically east of the mountains averaging only 2 to 6 days.

What do we mean when we say "Mean Temperature"?

I greatly appreciate the abundant moisture much of Colorado has enjoyed since spring. As a result, I no longer feel obligated to dedicate the majority of our limited special feature space in our monthly climate summaries to drought, precipitation and water supplies. There are lots of other neat climate topics that are also worthy. This month I want to talk about "mean temperatures". You've probably stayed awake many nights thinking about them.

(continued on page 12)

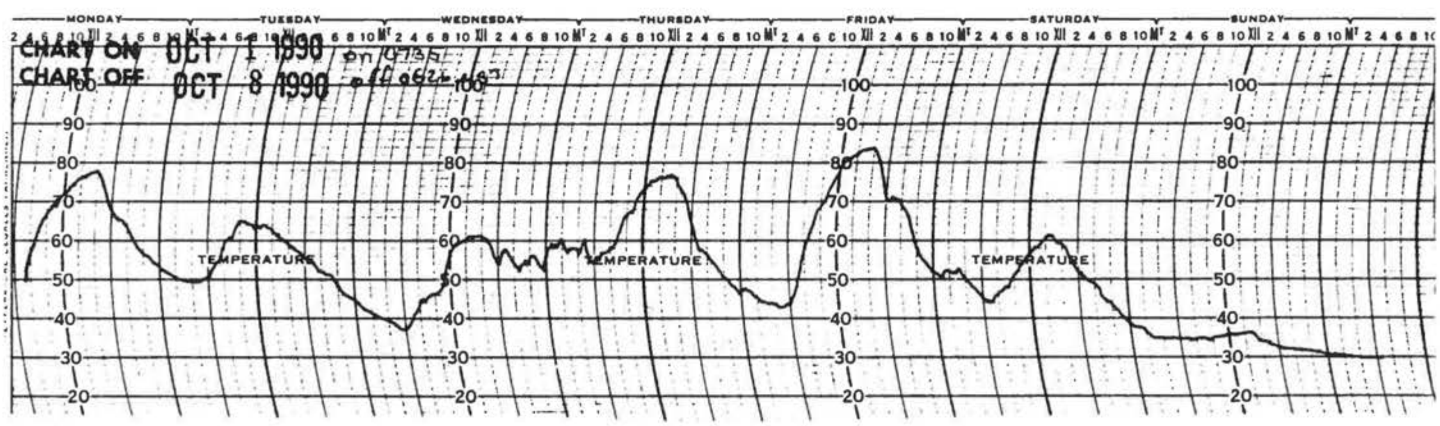
What do we mean when we say "Mean Temperature"? continued

We don't measure temperature just for the fun of it and to give ourselves something to talk about in the barber shop. Many aspects of life are directly affected by temperature -- human comfort, energy consumption, plant growth, insect development, evaporation from lakes and ponds, evapotranspiration from plants, livestock feed requirements, etc. The more we study or attempt to model these processes, the more we care about accurate temperature measurements. Because temperature is always changing, it is valuable for purposes of analysis and comparison to assign a single temperature value to a specified time period. Depending on our specific purpose, we may wish to describe the temperature over a one hour period, a portion of a day, an entire day, a week, a month, a season, a year or perhaps many years.

When we talk about "mean temperature" we are not describing temperatures as "nasty", "vile", "inferior", "foul" or any of these other dictionary definitions. By appropriate definition, the mean temperature over a period is simply the sum of the temperatures recorded at some specified time interval divided by the number of readings. Therefore, if you record the temperature every hour for a 1-day period, the mean temperature for that day is the sum of those 24 readings divided by 24. If you only record 2 temperatures for the day, the maximum and the minimum value, then the mean daily temperature is the sum of the maximum and the minimum reading divided by 2.

The most precise determination of mean temperature is to integrate (find the area beneath) the curving line that represents the continuous march of temperature through time and find the temperature where areas above and below are equal. This is normally impractical, however, since few weather stations retain continuous temperature measurements. Some weather stations do take readings each hour, some automated weather stations may average over shorter intervals of 5 minutes, 1 minute, or even just a few seconds. But for most areas of our country, the best available temperature data may simply be a daily reading of the highest and lowest temperature obtained at any time during the past 24 hours. As a result, the accepted way to compute mean daily temperatures is simply to average the highest and lowest temperatures for the day. This method has been employed for the past century in the U.S. It is typically used both at stations which have only maximum and minimum readings (such as Castle Rock, Grand Lake, Wray and Rangely) and also at locations where temperatures are reported every hour (like at Denver, Colorado Springs, Pueblo and Grand Junction).

How well does the simple method for determining the mean temperature actually represent the true mean? The question has been around a long time. Papers addressing that question were written more than a century ago. The Colorado Climate Center has investigated this in some detail for Colorado. The figure below shows the actual continuous temperature readings for the first week of October 1990 in Fort Collins. There was a variety of weather conditions that week ranging from record-breaking heat to overcast with snow. Some of the days had very smooth and systematic temperature patterns while other days had irregular variations.

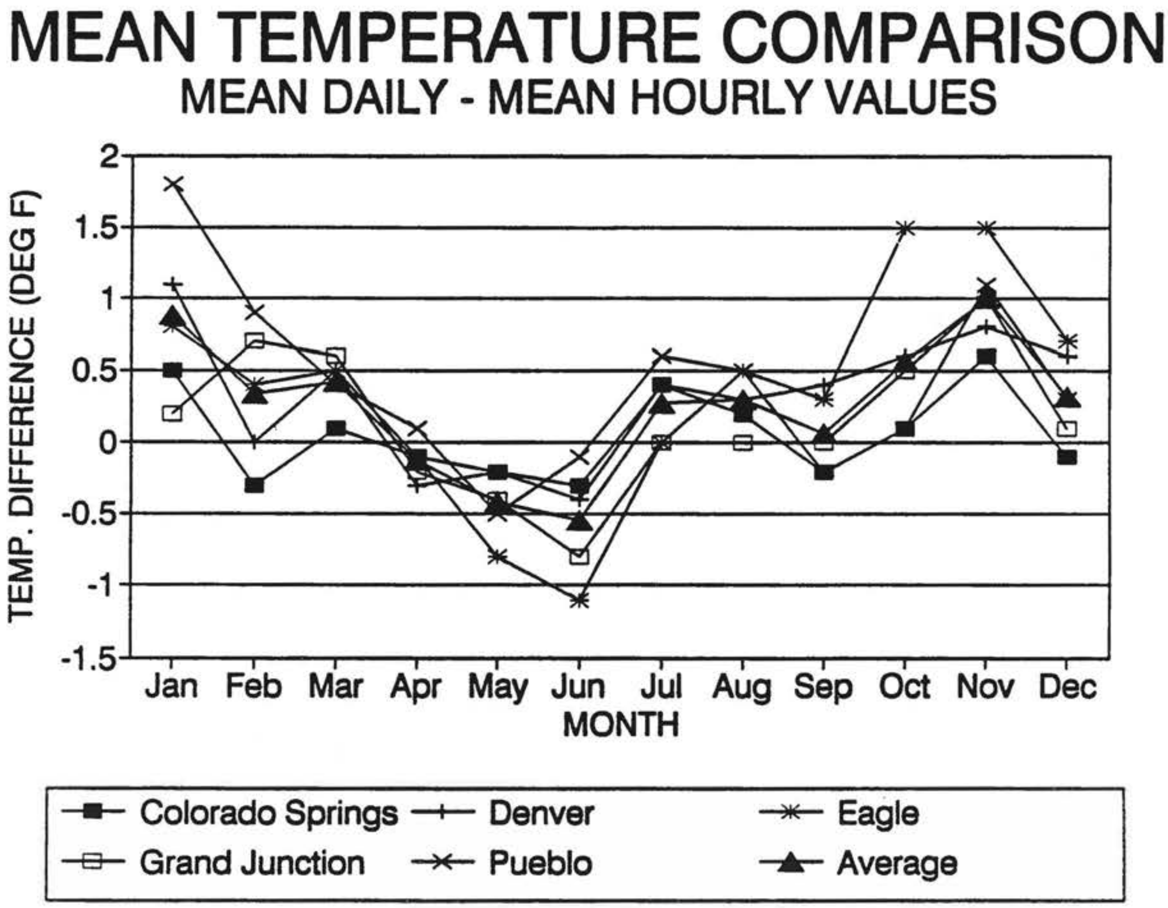


	Oct 1	Oct 2	Oct 3	Oct 4	Oct 5	Oct 6	Oct 7	Week
Mean (hourly)	60.2	55.0	50.1	61.8	62.8	50.4	34.1	53.5
Mean (Max-Min)	60.5	55.5	49.0	62.5	63.0	50.5	34.0	53.6

What do we mean when we say "Mean Temperature"? continued

As you can see, the mean temperature derived from just two points, the maximum and the minimum, compares extremely well with the mean derived from hourly values, even when the temperature pattern seemed very irregular. The biggest difference occurred on October 3 but was still only slightly more than a one-degree F difference. Over the whole week, there was only a 0.1 degree difference between the two methods. I could certainly find examples that show greater differences, but it doesn't occur very often and it usually averages out quickly. Indeed, the use of a simple mean appears to be justified.

Before terminating this discussion, I would like to show you some more comparisons. We compared mean monthly temperatures derived from hourly temperatures with means derived from just the daily maximum and minimum readings for several cities in Colorado where both data sets were available using many years of data. It turns out that there are some biases that should be recognized. The typical shape of the daily temperature curve changes somewhat as a function of the length of daylight and the time of year. During the winter the temperature stays cold longer and warms up only briefly. The opposite occurs, but to a lesser extent in the summer. As a result, mean temperatures derived from the daily maximum and minimum readings tend to overestimate the true mean during the fall and winter months and underestimate it during late spring and early summer. This is most true in areas like Eagle that have a predominance of clear and dry weather and a very large day-night temperature difference, but the same pattern holds true statewide.



Centennial:

As of October 1, 1990 we have completed the 100th year of civilian weather services in the United States. This also marks the centennial of the organized cooperative weather observing program in our country. I will be dedicating several monthly features to this topic during the 1991 water year. We will also be hosting a special program here at Colorado State University on June 8th of 1991. This will be our way of saying thanks for the marvelous contributions of so many people.

OCTOBER 1990 DAILY WEATHER

Date	Event
1-3	October got off to a beautiful start with very mild temperatures on the 1st. Clouds increased from the southwest during the day, however, as a storm from the Pacific Northwest merged with an upper level low over southern California. Already on the 2nd, dense clouds covered much of Colorado. Wind, rain, and scattered thunderstorms, with high mountain snows, hit much of the State. A west-east band across central Colorado was especially soaked. Uravan picked up 1.10", Paonia got 1.05" and Cedaredge added 1.48". East of the mountains, Joes reported 0.55", Colorado Springs got 0.62", and Eastonville measured 1.23". The storm quickly moved eastward on the 3rd leaving cool temperatures in its wake.
4-5	Unseasonably warm temperatures quickly returned accompanied by some gusty winds. Temperatures in the 70s and 80s were common, and 60s were felt high in the mountains. Denver's 86°F on the 5th tied the daily record. Holly and Las Animas shared honors for the warmest in the State with 95° on the 5th.
6-9	Warm temperatures continued in central and southern Colorado on the 6th, but much cooler air began pushing southward as a major new storm system took shape. Rains began late on the 6th in northern Colorado and then spread southward and changed to snow on the 7th as more cold air arrived. It was the first snowfall of the year for many areas and the first major snowstorm in the mountains. A foot or more of snow fell in some northern mountain locations, and several inches fell along the Front Range. More than one inch of water-equivalent precipitation was measured at Walden, Steamboat Springs, Craig, Hayden and Meeker. The first subfreezing temperatures of the fall were observed in many agricultural areas on the 7th and 8th. The storm advanced southward on the 8th and diminished. As skies cleared on the 9th, some very cold temperatures were observed. Westcliffe dipped to -3°F, the coldest in the State for the month and the first subzero reading of the season. Walden also dropped to -1° that morning.
10-18	Fairly strong westerly winds aloft for this early in the season brought a progression of fast-moving Pacific storm systems to the region. Cold fronts crossed Colorado on the 11th, 14th, and 17th. Some mountain snows accompanied the front on the 11th and again on the 17th but the rest of the State remained dry. Winds as strong as 70 mph accompanied the storm late on the 16th. After each frontal passage, warmer weather quickly returned.
19-21	Yet another system pushed across Colorado. This storm carried more moisture and also plunged further south. This gave much of Colorado the opportunity for precipitation. Rains developed over much of western Colorado on the 19th as temperatures cooled. East of the mountains, temperatures climbed into the 70s and 80s but cooled dramatically by the 20th. Many areas both east and west of the mountains received at least 0.50" of moisture by the afternoon of the 20th. Some areas received much more. Rifle received 1.29", Canon City got 1.40" and Glenwood Springs totalled 2.15" from the 2-day storm. In the mountains 3-14" of snow fell which helped get the new snowpack off to a good start. Lower elevations received from 0 to 5" of snow. Skies then cleared on the 21st but temperatures remained cool.
22-31	Temperatures remained cool 22-24th. A fairly weak cold front crossed Colorado on the 23rd which left some patches of fog over eastern Colorado early on the 24th. Then a period of fine, dry autumn weather set in that carried through to the end of the month. Daily high temperatures reached the 60s and 70s. Above about 9,000 feet elevation, 50s were the rule and some 80s were observed in eastern Colorado.

October 1990 Extremes

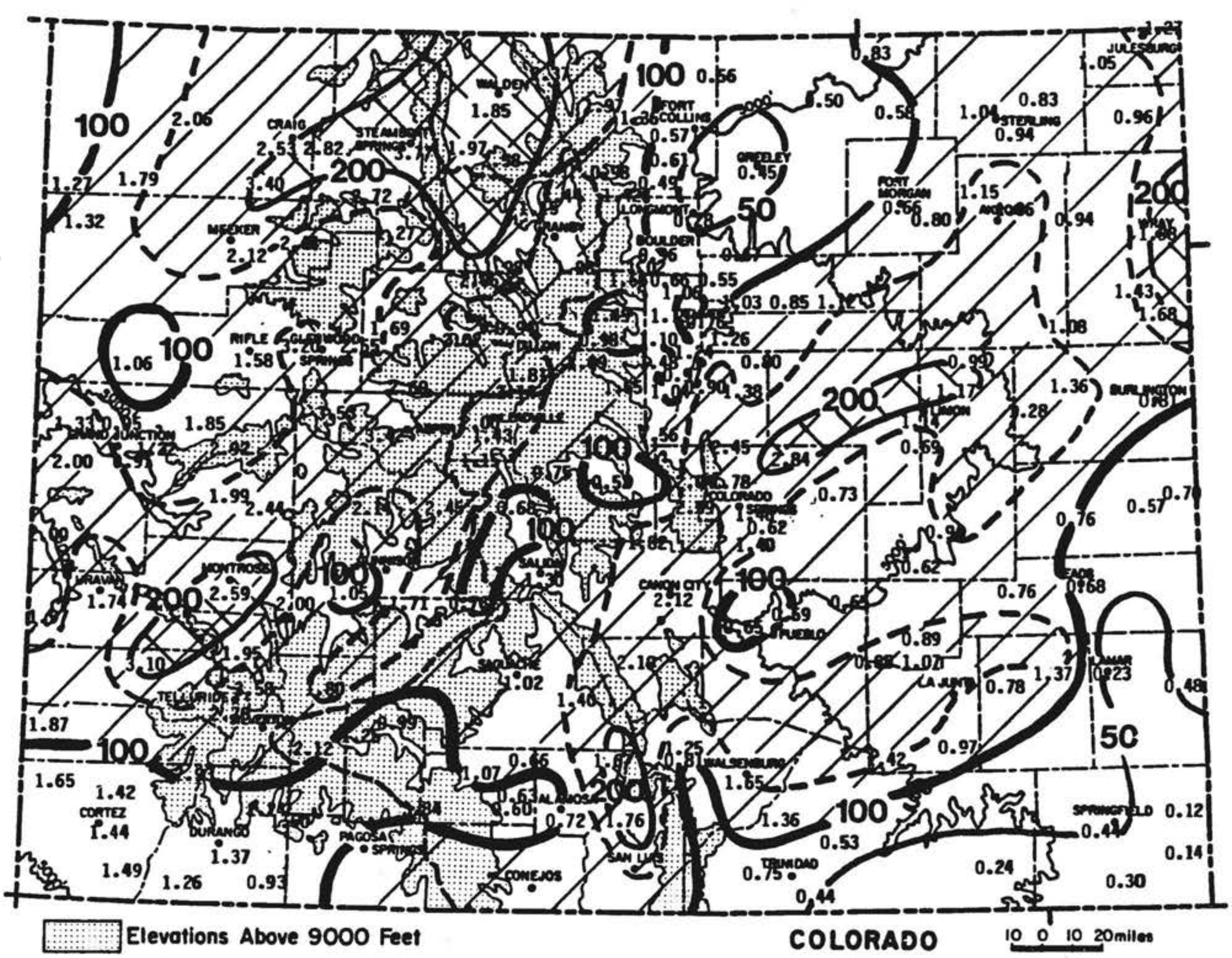
Highest Temperature	95°F	October 5	Las Animas, Holly
Lowest Temperature	-3°F	October 9	Westcliffe
Greatest Total Precipitation	3.84"		Wolf Creek Pass 1E
Least Total Precipitation	0.12"		Walsh 1W
Greatest Total Snowfall*	34.5"		Leadville
Maximum Snowdepth*	12"	October 8	Hohnholz Ranch

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

OCTOBER 1990 PRECIPITATION

Three storm systems were responsible for nearly all of the month's precipitation and left the majority of Colorado with wetter than average conditions. Seventy percent of the official weather stations in Colorado reported above average precipitation in October. One-third of the State received at least 50% more precipitation than average for the month and 10% of the stations received at least double their average. These wet areas were scattered across the region. Montrose, Steamboat Springs, Hayden, Walden, Great Sand Dunes, Genoa and Wray all received at least 200% of average. But there were also some dry areas. Below average precipitation was noted in extreme northwest Colorado, over portions of the San Juan Mountains and southwestern valleys, along the northern Front Range and across several southeastern counties. Ten reporting stations, mostly in extreme southeastern Colorado, received less than 50% of their average for the month. The Greeley-Loveland-Longmont area was also unusually dry. Walsh was the driest point in Colorado in October. Only 0.12" of moisture was recorded there.

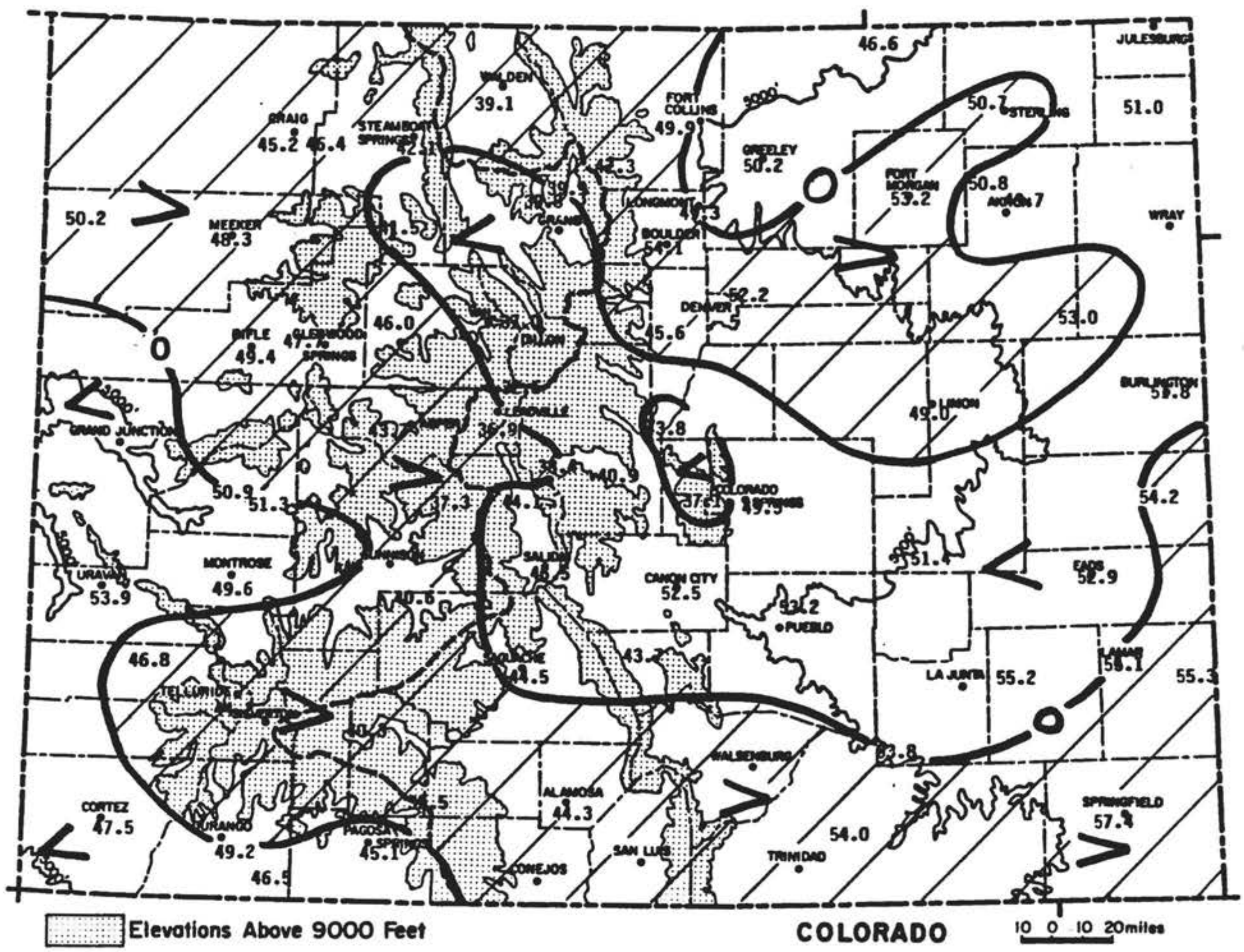
Greatest		Least	
Wolf Creek Pass 1E	3.84"	Walsh 1W	0.12"
Steamboat Springs	3.77"	Stonington	0.14"
Ouray	3.58"	Lamar	0.23"
Redstone 4W	3.53"	Kim 10SSE	0.24"
Aspen 1SW	3.42"	Longmont 2ESE	0.28"



Precipitation amounts (inches) for October 1990 and contours of precipitation as a percent of the 1961-1980 average.

OCTOBER 1990 TEMPERATURES AND DEGREE DAYS

October experienced alternating periods with above and below average temperatures which is to be expected during the autumn. For the month as a whole, these fluctuations averaged out and left most of the State near average. The majority of the mountain areas were a little warmer than average as was the area from Denver to Limon and Fort Morgan and also the southeasternmost counties. Slightly cooler than average conditions were found in the southwestern valleys of Colorado and in central and northeastern areas. Colorado Springs, Canon City, Buena Vista, Burlington and Holyoke all ended up more than one degree F cooler than average



October 1990 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

OCTOBER 1990 SOIL TEMPERATURES

October soil temperatures dropped steadily in the layers closest to the surface as is normal for this time of year. At the 10-foot depth, however, (not shown on graph) the temperature reached its highest point for the year of 61.5°F on 10/16. This is also typical since deep soil temperatures lag behind air temperature by several weeks or months. From now until late spring, the soils will be coldest near the surface and warm steadily with increasing 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.

FORT COLLINS 7 AM SOIL TEMPERATURES
OCTOBER 1990

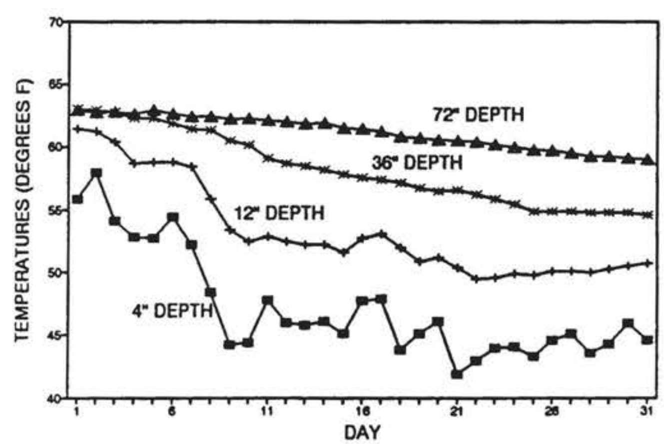


Table 1. Heating Degree Day Data through October 1990 (base temperature, 65°F).

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
	89-90	17	82	271	698	1001	1400	1554	1089	880	640	480	105	8217
	90-91	59	118	201	633									1011
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	89-90	68	176	303	671	974	1365	1365	1086	915	697	543	171	8334
	90-91	134	146	234	652									1166
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	89-90	1	0	E 139	M	E 567	E1064	E 776	E 925	E 760	502	321	21	M
	90-91	32	13	81	338									464
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	89-90	39	112	270	628	812	1202	1184	991	857	660	518	106	7379
	90-91	66	130	226	641									1063
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	89-90	0	4	E 130	415	684	1229	990	957	757	459	280	3	E5908
	90-91	10	4	76	407									497
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	89-90	0	0	131	379	584	1076	859	827	687	421	325	22	5311
	90-91	14	12	58	382									466
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	89-90	0	4	172	473	699	1163	966	928	805	526	345	24	6105
	90-91	28	21	83	473									605
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	89-90	0	16	142	494	850	1166	1222	959	776	490	377	59	6551
	90-91	1	6	151	539									697
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	89-90	4	46	235	586	892	1420	1319	1257	879	530	453	144	7765
	90-91	14	18	116	606									754
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	89-90	M	M	M	330	M	M	1161	865	626	355	237	22	M
	90-91	0	2	58	416									476
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	89-90	0	0	153	424	658	1160	879	882	781	469	265	7	5678
	90-91	12	3	64	388									467
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	89-90	226	357	502	861	1124	1495	1506	1271	1124	886	764	349	10465
	90-91	284	355	430	858									1927
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	89-90	2	19	106	520	789	1133	1278	965	724	479	359	44	6418
	90-91	4	28	118	481									631
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	89-90	1	60	217	593	896	1348	1286	986	806	545	269	68	7075
	90-91	15	23	134	583									755
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	89-90	49	118	325	657	818	1221	1115	1030	932	662	513	140	7580
	90-91	120	131	219	591									1061
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	89-90	0	3	169	458	711	1166	930	910	848	495	307	19	6016
	90-91	19	6	74	460									559
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	89-90	0	2	156	416	721	1285	1087	1010	776	450	274	10	6187
	90-91	18	7	63	421									509
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	89-90	0	0	40	316	729	1103	1124	820	557	271	139	20	5119
	90-91	0	0	28	360									388

* = 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
	89-90	168	306	427	768	1132	1449	1401	1205	1043	833	689	266	9687
	90-91	264	268	350	774									1656
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	89-90	1	2	166	454	729	1230	985	922	787	449	275	9	6009
	90-91	14	2	62	450									528
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	89-90	61	155	341	749	1069	1574	1647	1254	906	672	540	188	9156
	90-91	65	179	264	771									1279
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	89-90	0	0	99	323	684	1176	1030	887	638	309	188	2	5336
	90-91	4	0	21	308									333
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	89-90	285	412	545	880	1138	1507	1499	1265	1188	920	793	377	10809
	90-91	331	402	464	861									2058
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	89-90	1	6	204	508	762	1252	1078	991	815	555	364	33	6569
	90-91	36	11	96	491									634
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	89-90	2	8	200	484	749	1302	1048	994	917	552	319	25	6600
	90-91	24	11	101	481									617
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	89-90	0	41	198	543	869	1261	1169	1071	795	507	387	91	6932
	90-91	9	23	121	511									664
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	89-90	0	10	110	439	768	1156	1186	895	654	425	285	27	5955
	90-91	0	3	81	470									554
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	89-90	24	118	284	646	964	1298	1491	1160	873	630	524	164	8176
	90-91	44	108	177	608									937
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	89-90	0	0	94	373	676	1204	964	877	695	394	233	2	5512
	90-91	1	0	34	360									395
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	89-90	0	2	103	473	E 830	1130	1191	923	657	392	281	37	E6019
	90-91	0	4	69	474									547
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	89-90	18	117	315	M	974	1533	1580	1332	971	658	576	M	M
	90-91	129	E 110	255	700									E1194
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	89-90	0	3	144	428	719	1254	1074	1026	760	427	275	8	6118
	90-91	17	7	68	437									529
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	88-89	72	175	270	644	869	1264	1273	1023	922	664	509	145	7830
	89-90	117	179	267	635									1198
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	89-90	0	1	111	369	633	1153	980	874	681	420	266	8	5496
	90-91	4	6	46	334									390
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	89-90	132	279	461	802	1075	1490	1359	1287	1068	796	674	273	9696
	90-91	202	258	332	794									1586
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	89-90	0	2	117	345	581	1047	848	800	666	408	289	10	5113
	90-91	15	8	53	311									387

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

OCTOBER 1990 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	62.3	31.0	46.6	-2.6	84	20	562	0	230	0.83	0.31	159.6	6
STERLING	68.4	32.9	50.7	0.8	91	21	437	2	305	1.04	0.20	123.8	4
FORT MORGAN	66.8	39.6	53.2	2.2	80	30	360	3	271	0.95	0.38	166.7	3
AKRON FAA AP	65.1	36.4	50.8	-0.1	87	23	439	4	264	1.15	0.50	176.9	5
AKRON 4E	66.1	33.4	49.7	-0.7	89	21	467	2	275	1.06	0.52	196.3	5
HOLYOKE	66.0	36.0	51.0	-1.3	90	23	427	2	276	0.96	0.23	131.5	6
JOES	69.4	36.5	53.0	1.0	89	24	367	0	320	1.08	0.28	135.0	3
BURLINGTON	66.3	37.2	51.8	-2.2	86	24	407	4	278	0.81	0.05	106.6	5
LIMON WSMO	64.1	33.8	49.0	0.4	83	22	491	0	242	1.14	0.54	190.0	6
CHEYENNE WELLS	70.4	38.0	54.2	0.9	90	23	333	8	330	0.57	-0.26	68.7	4
EADS	68.8	37.1	52.9	-1.4	89	27	376	6	313	0.68	-0.09	88.3	3
ORDWAY 21N	70.0	32.7	51.4	-1.4	88	22	417	2	331	0.62	0.13	126.5	5
LAMAR	74.0	36.1	55.1	0.1	93	24	312	12	383	0.23	-0.50	31.5	3
LAS ANIMAS	73.8	36.7	55.2	-0.6	95	26	308	12	373	0.78	0.15	123.8	3
HOLLY	73.9	36.6	55.3	1.3	95	22	302	8	378	0.48	-0.32	60.0	3
SPRINGFIELD 7WSW	74.7	40.1	57.4	2.2	89	24	238	12	398	0.44	-0.26	62.9	3
TIMPAS 13SW	69.4	38.2	53.8	-0.2	89	24	348	8	324	1.42	0.71	200.0	4

Foothills/Adjacent Plains

	Temperature						Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
FORT COLLINS	65.2	34.6	49.9	-0.1	84	23	460	0	246	0.57	-0.44	56.4	4
GREELEY UNC	65.8	34.6	50.2	-0.5	86	24	450	0	265	0.45	-0.54	45.5	2
ESTES PARK	60.5	34.1	47.3	2.0	73	18	540	0	190	0.98	0.20	125.6	4
LONGMONT 2ESE	67.2	31.4	49.3	-1.1	87	16	481	0	288	0.28	-0.60	31.8	1
BOULDER	68.7	39.5	54.1	0.6	83	24	338	9	314	0.96	-0.22	81.4	5
DENVER WSFO AP	67.4	37.1	52.2	0.5	86	25	388	1	290	1.03	0.15	117.0	6
EVERGREEN	63.9	27.3	45.6	0.8	78	14	591	0	234	1.10	-0.08	93.2	6
CHEESMAN	64.2	23.5	43.8	-3.5	78	10	650	0	244	1.56	0.37	131.1	5
LAKE GEORGE 8SW	56.1	25.7	40.9	-1.4	69	10	742	0	137	0.52	-0.21	71.2	4
ANTERO RESERVOIR	55.2	21.7	38.4	0.2	65	3	816	0	118	0.75	0.04	105.6	5
RUXTON PARK	53.8	20.5	37.1	-2.1	68	0	857	0	106	2.59	1.23	190.4	5
COLORADO SPRINGS	63.5	35.5	49.5	-1.1	82	20	473	0	232	1.46	0.71	194.7	5
CANON CITY 2SE	67.8	37.2	52.5	-1.7	82	25	382	0	300	2.12	1.25	243.7	5
PUEBLO WSO AP	71.4	35.1	53.2	-0.8	89	26	360	3	340	0.59	0.01	101.7	4
WESTCLIFFE	61.1	26.3	43.7	-0.4	73	-3	655	0	200	2.19	1.00	184.0	6
WALSENBURG	70.9	39.1	55.0	1.9	83	17	311	7	341	1.65	0.57	152.8	5
TRINIDAD FAA AP	71.8	36.2	54.0	0.4	86	22	334	0	349	0.53	-0.36	59.6	1

Mountains/Interior Valleys

	Temperature						Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
WALDEN	53.9	24.3	39.1	0.4	70	-1	794	0	108	1.85	1.03	225.6	7
LEADVILLE 2SW	51.2	22.6	36.9	-0.1	64	3	861	0	64	1.43	0.33	130.0	8
SALIDA	62.8	30.2	46.5	-0.7	76	12	565	0	229	1.30	0.28	127.5	4
BUENA VISTA	60.6	27.5	44.1	-2.0	74	13	641	0	184	0.68	-0.10	87.2	5
SAGUACHE	60.7	28.3	44.5	-0.3	72	17	629	0	187	1.02	0.28	137.8	4
HERMIT 7ESE	59.5	21.1	40.3	1.8	69	13	758	0	167	1.25	-0.32	79.6	4
ALAMOSA WSO AP	63.3	25.4	44.3	0.6	76	15	633	0	222	0.72	-0.00	100.0	4
STEAMBOAT SPRINGS	58.4	25.9	42.1	0.2	74	12	700	0	164	3.77	2.13	229.9	8
YAMPA	55.6	27.4	41.5	-0.7	69	12	722	0	122	1.27	0.09	107.6	5
GRAND LAKE 1NW	56.6	23.2	39.9	1.3	69	10	770	0	132	1.44	0.22	118.0	10
GRAND LAKE 6SSW	55.6	23.9	39.8	-0.0	67	9	774	0	119	1.15	0.26	129.2	9
DILLON 1E	52.8	21.3	37.0	-2.1	66	8	858	0	95	0.94	0.19	125.3	6
CLIMAX	44.9	20.2	32.6	-1.4	58	-1	996	0	24	2.14	0.87	168.5	8
ASPEN 1SW	58.4	29.0	43.7	0.2	70	15	652	0	153	3.42	1.71	200.0	10
TAYLOR PARK	51.5	23.0	37.3	4.3	62	6	852	0	65	2.45	1.21	197.6	8
TELLURIDE	62.7	25.7	44.2	1.1	76	8	635	0	214	2.70	0.48	121.6	6
PAGOSA SPRINGS	64.7	25.6	45.1	-0.2	75	18	608	0	241	2.25	0.26	113.1	6
SILVERTON	56.9	17.6	37.2	0.2	68	2	853	0	132	2.75	0.48	121.1	6
WOLF CREEK PASS 1	48.7	22.3	35.5	-1.0	58	4	907	0	33	3.84	-0.29	93.0	9

Western Valleys

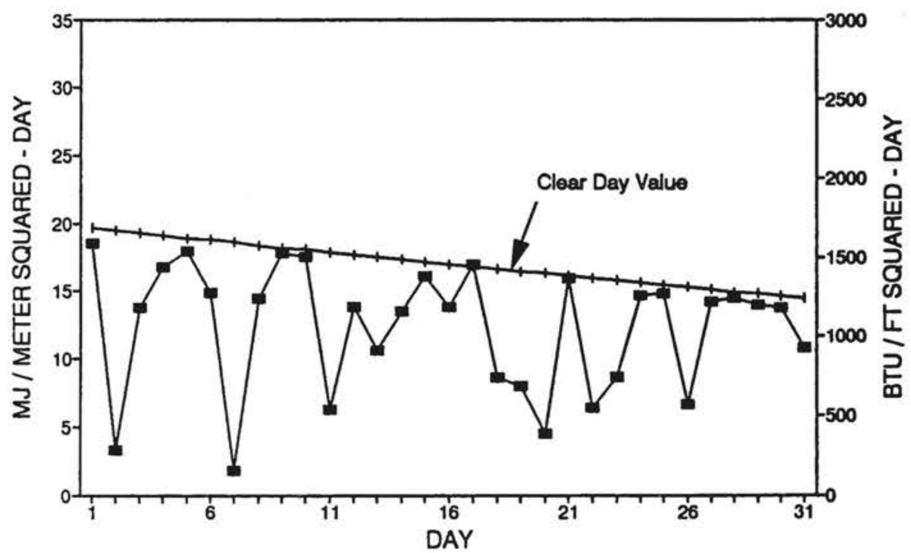
Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	60.4	30.1	45.2	0.0	77	22	606	0	196	2.53	1.23	194.6	7
HAYDEN	62.3	30.5	46.4	1.4	77	22	565	0	207	2.82	1.48	210.4	10
MEEKER NO. 2	65.6	30.9	48.3	2.1	77	19	511	0	253	2.41	1.03	174.6	8
RANGELY 1E	66.5	33.9	50.2	1.7	81	24	453	3	269	1.32	0.37	138.9	3
EAGLE FAA AP	64.1	27.9	46.0	1.2	79	18	583	0	237	1.69	0.81	192.0	6
GLENWOOD SPRINGS	64.5	30.9	47.7	-0.8	78	25	528	0	241	3.20	1.74	219.2	7
RIFLE	67.8	31.0	49.4	0.7	80	21	474	0	286	1.58	0.43	137.4	5
GRAND JUNCTION WS	66.8	39.6	53.2	-1.7	80	30	360	3	271	0.95	0.04	104.4	3
CEDAREDGE	67.7	34.1	50.9	0.2	79	23	432	0	282	1.99	0.76	161.8	6
PAONIA 1SW	65.7	36.9	51.3	-0.1	78	26	416	0	256	2.44	1.02	171.8	7
DELTA	69.1	33.5	51.3	-0.4	82	25	416	0	303	1.44	0.56	163.6	4
GUNNISON	58.7	21.2	39.9	-1.4	72	7	771	0	167	1.19	0.33	138.4	3
COCHETOPA CREEK	59.1	22.2	40.6	0.0	70	7	746	0	166	1.71	0.80	187.9	7
MONTROSE NO. 2	64.4	34.8	49.6	-0.9	77	24	470	0	237	2.59	1.46	229.2	6
URAVAN	71.3	36.5	53.9	-0.7	82	28	339	1	339	1.74	0.34	124.3	5
NORWOOD	61.2	32.4	46.8	0.5	73	19	559	0	192	3.10	1.62	209.5	6
YELLOW JACKET 2W	64.2	36.7	50.5	0.4	73	22	441	0	232	1.65	-0.30	84.6	5
CORTEZ	65.7	29.2	47.5	-2.5	75	20	539	0	255	1.44	-0.16	90.0	5
DURANGO	67.1	31.4	49.2	0.2	77	23	481	0	273	1.37	-0.65	67.8	6
IGNACIO 1N	62.9	30.1	46.5	-1.2	72	21	566	0	212	0.93	-0.62	60.0	5

* 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 1990 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	16	9	6	--	--
Denver	12	11	8	76%	73%
Fort Collins	11	11	9	--	--
Grand Junction	15	9	7	76%	74%
Limon	17	9	5	--	--
Pueblo	18	8	5	83%	79%

FT. COLLINS TOTAL HEMISPHERIC RADIATION
OCTOBER 1990



The Weather Blues

It was once believed that weather controlled a person's life. A change in the weather meant a change in your life. Later researchers came to the conclusion that weather had no effect at all on people. Today, it is believed that weather may have a tertiary effect on people and their attitudes. It will not regulate life, but weather may influence the decisions to be made. One of the new studies, by Robert Davis, relates weather conditions to employee absenteeism in six different cities. Even though the study was not absolute, it had some interesting results.

The weather during rush hour has a direct effect on employee attendance. If it is raining during or one hour before rush hour, work attendance is lower. Personal motivation is reduced with the added stress of traveling through rain. This is true if you do not live in a wet climate like Portland. In the wet climates there is no noticeable change due to rush hour rain.

Another weather effect has to do with the wind. On days of consecutively windy mornings, the attendance is above normal. This may be due to the passing of a cold front. Since the attendance is below normal during the rainy period, the windy days following it may be a rebound effect.

In all of Davis's results, climate plays a big part. People in different areas acclimatized to different weather conditions. For example, in Portland attendance is high on cloudy mornings, but low on clear mornings. In Albuquerque (where residents are used to low relative humidity) high relative humidity corresponds to low attendance. In Atlanta, a high humidity area, there is no noticeable change in absenteeism on days of high humidity.

Other studies have been done on other effects of weather. High relative humidity has been found to cause high stress. High humidity is associated with high temperatures which is related to depression, irritability, and increase in traffic accidents. On the front range of Colorado, it may be a good idea to watch out for foehns, warm dry winds occasionally found on the lee side of mountains. These winds are related to increased accidents, crimes, medical complaints and suicides. Any change from normal conditions usually yields positive behavior reaction, except if the change is toward really lousy conditions.

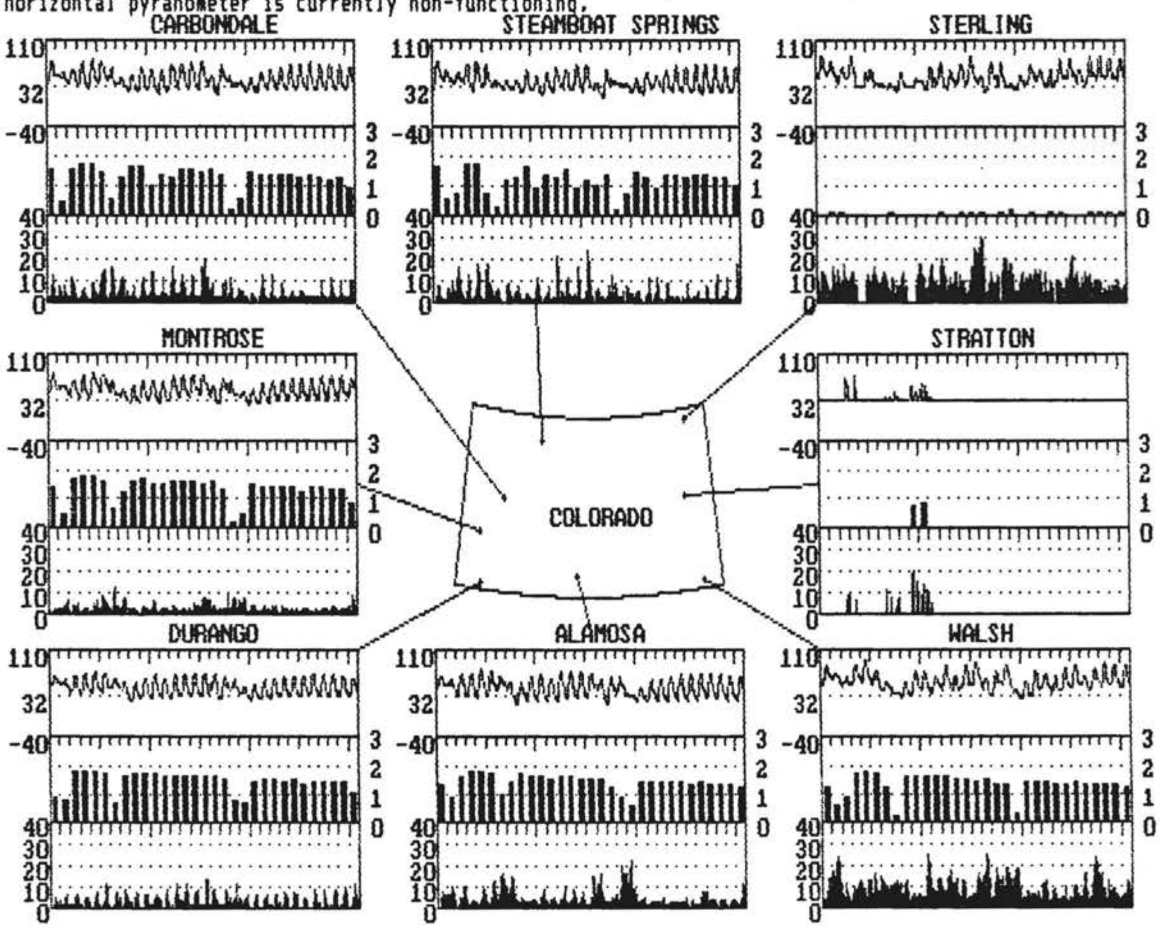
Even though weather does not have complete control of your life, it can sway decisions and moods. It may make working and traveling better suited for different times of the year. It also raises a very important question: Should Nancy Reagan have consulted a weatherman instead of an astrologer?

This article was written by Erika Komito of the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, CO. 80309-0428. Information in acquiring our weather data can be obtained by writing Mary Sutter at this address.

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (°F)								
	43.3	44.3	43.3	46.8	39.1	47.1	32.8	54.1
monthly temperature extremes and time of occurence (°F day/hour)								
maximum:	75.4 5/15	70.0 5/15	75.7 5/15	77.0 5/15	74.8 1/15	83.5 29/15	72.1 4/18	89.4 5/15
minimum:	15.1 9/ 6	21.4 9/ 6	18.1 18/ 6	21.7 21/ 6	13.8 18/ 6	21.7 18/ 4	32.0 1/ 1	24.6 21/ 6
monthly average relative humidity / dewpoint (percent / °F)								
5 AM	90 / 25	85 / 29	95 / 28	88 / 31	94 / 25	38 / 9	0 /-40	71 / 33
11 AM	37 / 27	48 / 35	46 / 30	44 / 34	55 / 31	23 / 13	2 /-36	37 / 32
2 PM	28 / 23	40 / 34	31 / 26	37 / 32	37 / 26	19 / 14	0 /-40	30 / 30
5 PM	29 / 21	41 / 31	34 / 25	37 / 30	39 / 25	22 / 13	0 /-40	32 / 29
11 PM	64 / 26	75 / 30	73 / 29	71 / 32	84 / 28	31 / 8	7 /-31	54 / 31
monthly average wind direction (degrees clockwise from north)								
day	171	212	250	249	214	182	5	160
night	185	90	180	138	114	199	8	237
monthly average wind speed (miles per hour)								
	4.18	2.79	3.39	2.42	2.90	8.75	0.53	8.61
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	359	483	487	525	496	106	704	37
3 to 12	348	255	231	214	179	502	31	542
12 to 24	37	5	22	1	33	126	9	159
> 24	0	0	0	0	0	10	0	6
monthly average daily total insolation (Btu/ft²·day)								
	1405	1415	1261	1342	1134	6490	62	1326
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	245	109	203	187	140	0	7	245
40-60%	35	57	40	28	43	1	3	47
20-40%	26	46	41	30	54	0	0	25
0-20%	18	23	29	27	47	0	0	24

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. Stratton station is currently non-functioning and all data should be disregarded. Sterling horizontal pyranometer is currently non-functioning.



COLORADO CLIMATE

NOVEMBER 1990

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.

<u>November in Review:</u> Volume 14 Number 2

A pair of strong storms in early November brought heavy precipitation to parts of Colorado and got the mountain snowpack off to a great early start. Then a long mid-month warm spell brought lovely weather to the entire State, set several record high temperatures and melted most of the snow. The month ended with another storm and a return to more seasonal temperatures. For the month as a whole, precipitation was above average nearly statewide and temperatures were warmer than usual, especially east of the mountains.

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

When our climate behaves "normally", which it does not always do, then we can expect January to deliver the coldest weather of the year. Since the winter of 1982-83, however, there has been a preference for December to be colder than January. Perhaps that will hold true again this year. But don't expect a big warm-up. Even in a warm January, temperatures fall well below freezing throughout the State nearly every night and mountain temperatures easily dip below zero. Some warm days are possible with temperatures climbing into the 50s and 60s, but these warm readings are only common east of the mountains. Colorado's western valleys should be ready for more cold. In years like this when there has been a powerful December cold wave with low elevations snow, our western valleys often fill with cold, stable air that is difficult to displace. In an average January, expect daytime temperatures to climb into the 30s and 40s on the majority of days with 20s in the mountains. At night we can expect lows typically in the teens and single digits but with warmer readings near the eastern foothills and colder, of course, in the mountains. The average daily minimum temperature at Colorado's proverbial cold spot, Taylor Park Reservoir, is -11.4°F for example.

January also has a reputation for excellent mountain snowfall with very dry conditions east of the mountains. Recent years have attempted to damage that reputation. Eight of the past 10 Januarys have been significantly drier than the 1961-1980 average in the mountains. Even during the very wet years of the mid-80's, January was usually dry. Meanwhile, east of the mountains, the last 10 years have provided above average moisture. In an average January, east of the mountains and in the San Luis Valley only totals about 0.25-0.50" (5-12" snow). Along the eastern foothills and over the Western Slope precipitation is somewhat greater, typically 0.30-1.00" (6-25" snow). Snows are heaviest in the mountains with an average of 1.00-4.00" of precipitation (20-60" snow). Orographic (mountain induced) precipitation processes are dominant in January more than in any other month of the year. As a result, precipitation increases more dramatically with elevation than at any time of year. It is quite common to receive 8" of high mountain snow from a storm while low elevations either side of the mountains get nothing.

One other thing to look for in January is downslope windstorms along the Front Range. While western valleys enjoy very light mid-winter winds, it's a different story in the eastern foothills. The most likely time of year for extreme winds (gust in excess of 80 mph) is late January.

<u>As It Gets Warmer, It Seems To Be Getting Colder</u>:

As I complete this climate report for the month of November 1990, a major December cold wave is freezing the western U.S. I'll have to wait a month to describe it to you, but I find this somewhat ironic. Only a few days ago we calculated for a local newspaper that for the first 11 months of 1990, this was stacking up to be one of the warmest years in Colorado during the past century. In fact, for our weather station here in Fort Collins, 6 of the 8 warmest years on record (based on mean temperatures for the January through November period -- for whatever that's worth) have occurred since 1977. Four out of the past 5 years have made the top 8. 1981 was the warmest on record followed by well-known years of heat and drought, 1954 and 1934 respectively. Next came 1986, 1977, 1990, 1987 and 1988. This seems to offer some tantalizing evidence that agrees with some of the global warming experts who are becoming increasingly confident that the warm-up is real and has arrived. But while looking at those numbers I was shivering from the 50-degree temperatures -- in my office. It was -15° outdoors at noon. This also brought back memories of the record cold of December 1989 in which temperatures fell into the -30s over much of northeastern Colorado just before Christmas. Then there was the "Alaska Blaster"

(continued on page 30)

NOVEMBER 1990 DAILY WEATHER

Date	Event
1-8	Mild weather on the 1st gave way to increasing clouds and showers as a major storm system moved toward Colorado. The low pressure area dropped into New Mexico on the 2nd. Very moist southwest to southerly winds aloft combined with cooler air from the north and easterly "upslope" winds east of the mountains to set off widespread high elevation snows and low elevation rains (which changed to snow in much of northern Colorado). By the time the storm diminished on the 3rd, much of the western and southern portions of the State had received at least 0.50" of moisture. A foot or more of snow had fallen at places like Aspen, Silverton and Westcliffe. Wolf Creek Pass totalled 2.32" of moisture from 20" of new snow. Southeastern Colorado received surprisingly heavy rains. Holly, for example, picked up 1.42" of rain. Skies cleared somewhat on the 4th and morning temperatures were quite chilly with a few subzero readings in the mountains. A warming trend then began but was quickly halted on the 5th as a 2nd major storm system dropped down from the northwest. This storm again brought moderate precipitation to much of the State, but only a little moisture spilled out across the eastern plains. Sargents (east of Gunnison) picked up 14" of new snow. Steamboat Springs added 11" and Boulder got 8". Cold temperatures then greeted many Coloradans early on the 7th as skies cleared. Longmont reported 9°F. Temperatures remained chilly on the 8th in many areas. Alamosa awoke to -4° that day.
9-19	Winter weather ended and gorgeous autumn weather returned to Colorado. A large high pressure ridge over the West 9-14th brought sunshine with very warm, calm days but cool nights. Daily high temperatures reached into the 50s high into the mountains with 60s, 70s and even some 80s at lower elevations. Several record highs were set across the State on the 14th. A Pacific cold front crossed Colorado on the 15th accompanied by clouds but no precipitation. It was cooler on the 16th especially east of the mountains. With westerly winds aloft 17-19th, mild temperatures prevailed. This mid-November warm spell succeeded in melting much of the early season snowfall all the way up to elevations of 11,000 feet.
20-21	A fast moving storm raced across Colorado late on the 20th accompanied by strong winds. The mountains and northwestern valleys received a little moisture and markedly cooler temperatures.
22-25	The weather was dry and mild for the Thanksgiving holiday but with periods of gusty winds especially east of the mountains. Winds fanned a wildfire near Boulder early on the 24th. Temperatures soared to record-breaking levels across much of the State on the 24th and 25th. Colorado Springs hit 77°F on the 24th and Wheat Ridge reached an amazing 84° on the 25th, the warmest in the State.
26-27	An intense winter storm took aim on Colorado. Forecasts looked bleak, but the storm moved too fast to produce as much snow as expected. Precipitation totals were still modest. 1.50" of water content was measured on the Grand Mesa, and Palisade reported 0.87" of moisture (mostly rain). 3-9" of snow were reported from Greeley to Julesburg.
28-30	Cold temperatures gripped Colorado in the wake of the storm. Hermit 7ESE and Platoro shared honors for the coldest temperature in Colorado with -20° on the 29th. As the month ended, cool temperatures continued in western Colorado but a rapid warm-up occurred east of the mountains.

November 1990 Extremes

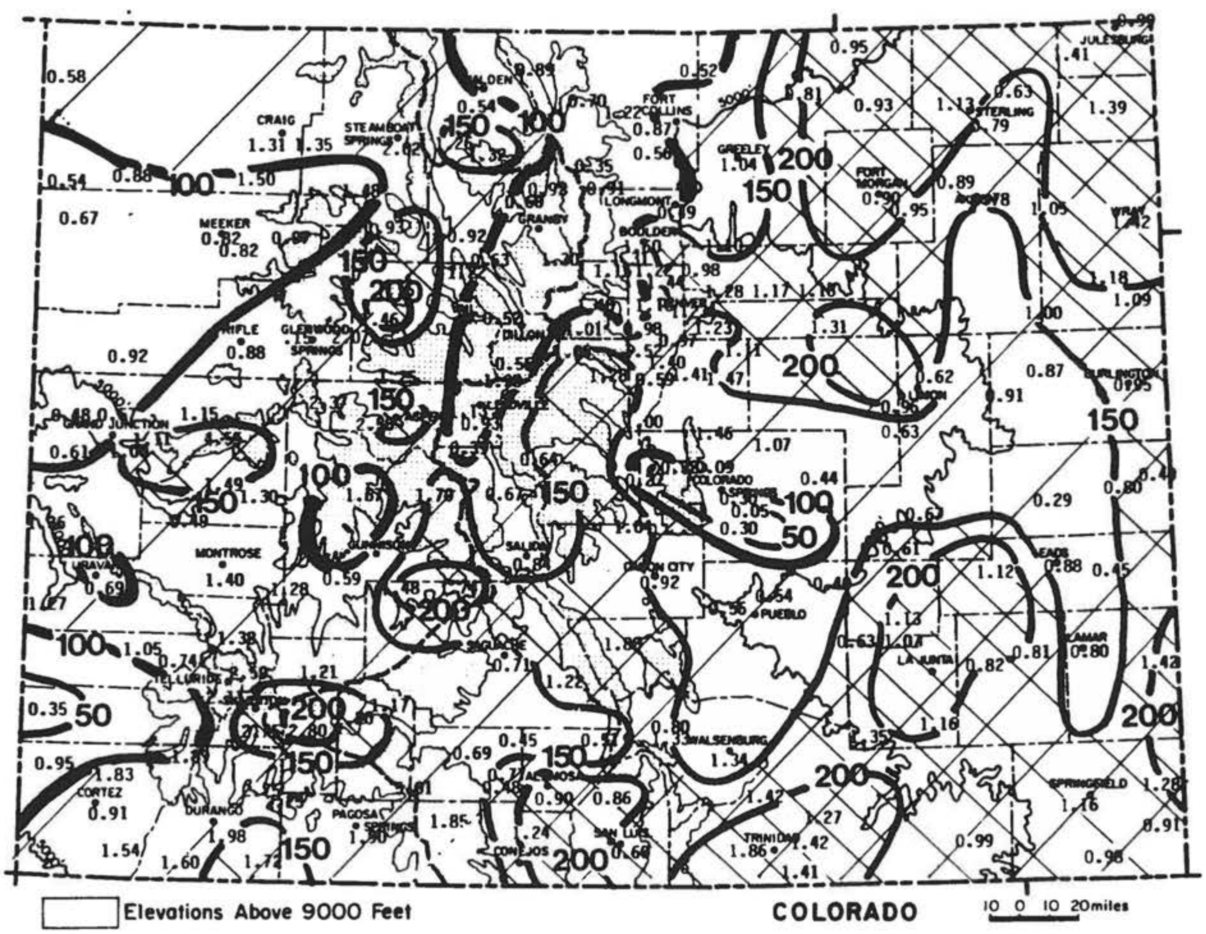
Highest Temperature	84°F	November 25	Wheat Ridge
Lowest Temperature	-20°F	November 29	Platoro Dam Hermit 7ESE
Greatest Total Precipitation	5.01"		Wolf Creek Pass 1E
Least Total Precipitation	0.05"		Fountain
Greatest Total Snowfall*	61.5"		Wolf Creek Pass 1E
Greatest Depth of Snow*	29"		Wolf Creek Pass 1E

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

NOVEMBER 1990 PRECIPITATION

Two storms early in the month and another storm near month's end provided nearly all of the November 1990 moisture. Despite a lengthy dry period in the middle of the month with very mild temperatures, precipitation ended up well above average over most of Colorado. Drier than average conditions were limited to parts of extreme western Colorado, the immediate Pikes Peak-Colorado Springs region and a band from Leadville and Dillon north-northeastward to Grand Lake, Estes Park and Fort Collins. Of the 214 official weather stations with complete November precipitation data, 36 received at least 200% of their average precipitation. 93 sites received from 121% to 199% of average. 56 locations were near normal (80% to 120% of average). 23 weather stations were dry (50%-79% of average), while only 6 sites reported very dry conditions (less than 50% of average).

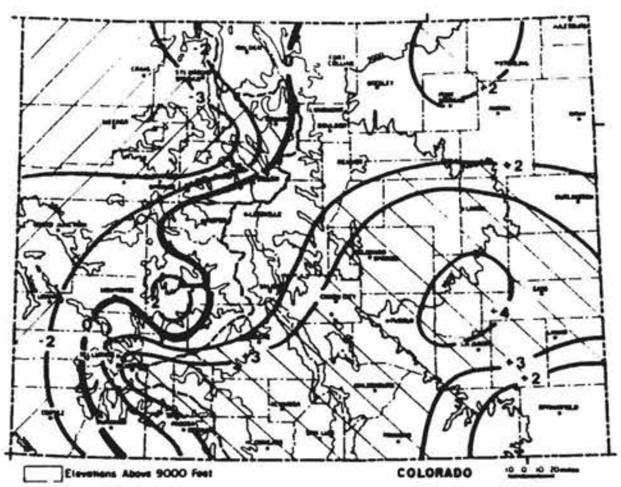
Greatest		Least	
Wolf Creek Pass 1E	5.01"	Fountain	0.05"
Bonham Reservoir	4.55"	Air Force Academy	0.09"
Rio Grande Reservoir	2.80"	Florissant Fossil Beds Natl. Mon.	0.27"
Lemon Dam	2.75"	Kit Carson 6S	0.29"
Silverton	2.75"	Colorado Springs WSO	0.30"
Ouray	2.59"		



Precipitation amounts (inches) for November 1990 and contours of precipitation as a percent of the 1961-1980 average.

1991 WATER YEAR PRECIPITATION

It is nice to be able to report that the 1991 water year is getting off to a good start. In the first 2 months of the water year, most of Colorado has received above average precipitation. The exceptions are a few scattered pockets in western Colorado, a small area in the northern mountains, the northern Front Range and a few spots in southeast Colorado. But even these areas are only a little drier than average. Warm weather has caused much of the early snow to melt even as high as 11,000 feet in the mountains. Still, the abundant autumn precipitation has contributed to soil moisture which will improve the runoff efficiency from the snowpack that accumulates during the rest of the winter. Palmer Drought Index values still indicate moderate drought over parts of western Colorado. However, the situation has been steadily improving in recent months and is much better than at this time last year.

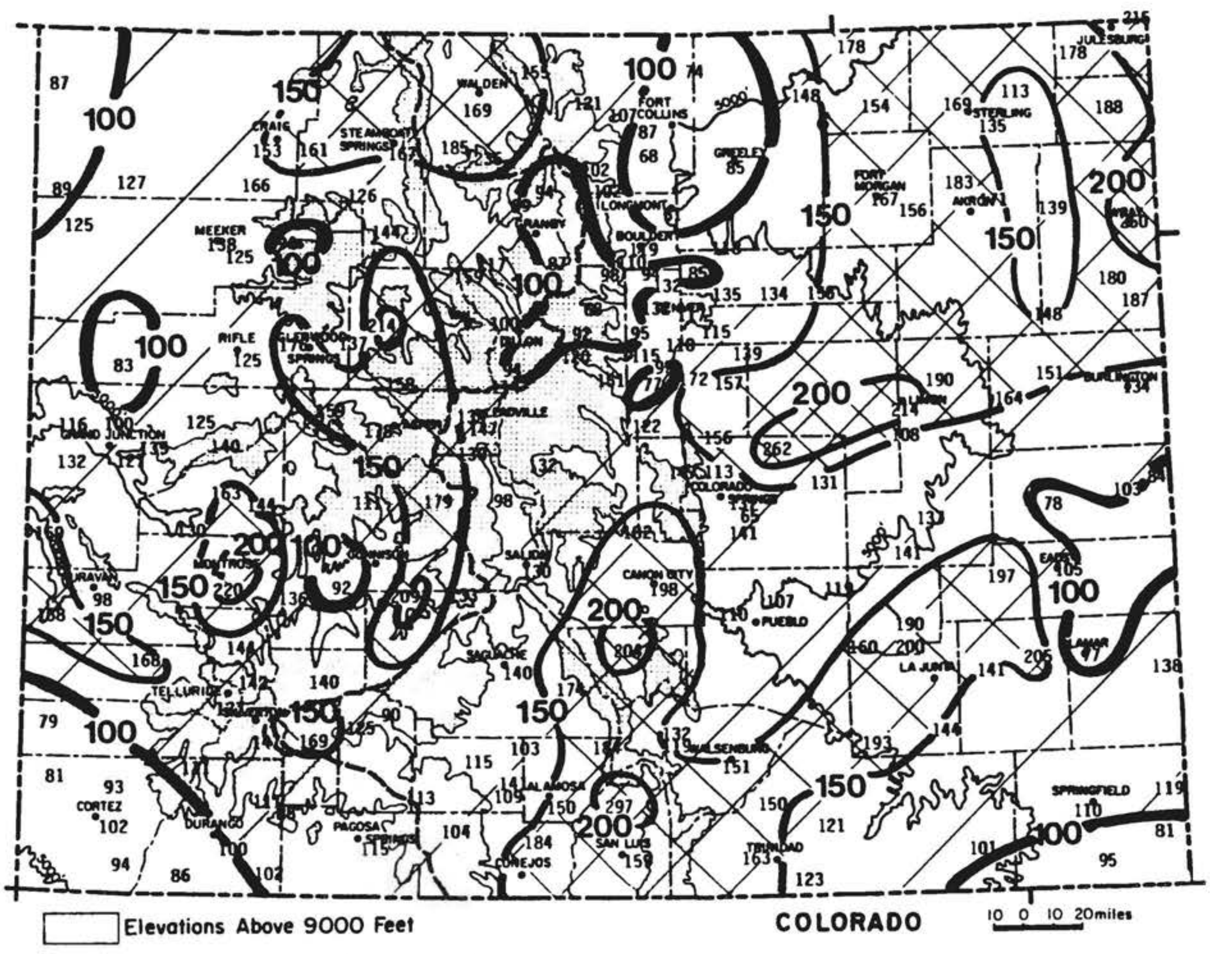


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

	extremely wet
+4	----------------
+3	ample moisture
+2	----------------
+1	
0	near normal
-1	
-2	----------------
	moderate drought
-3	----------------
	severe drought
-4	----------------
	extreme drought

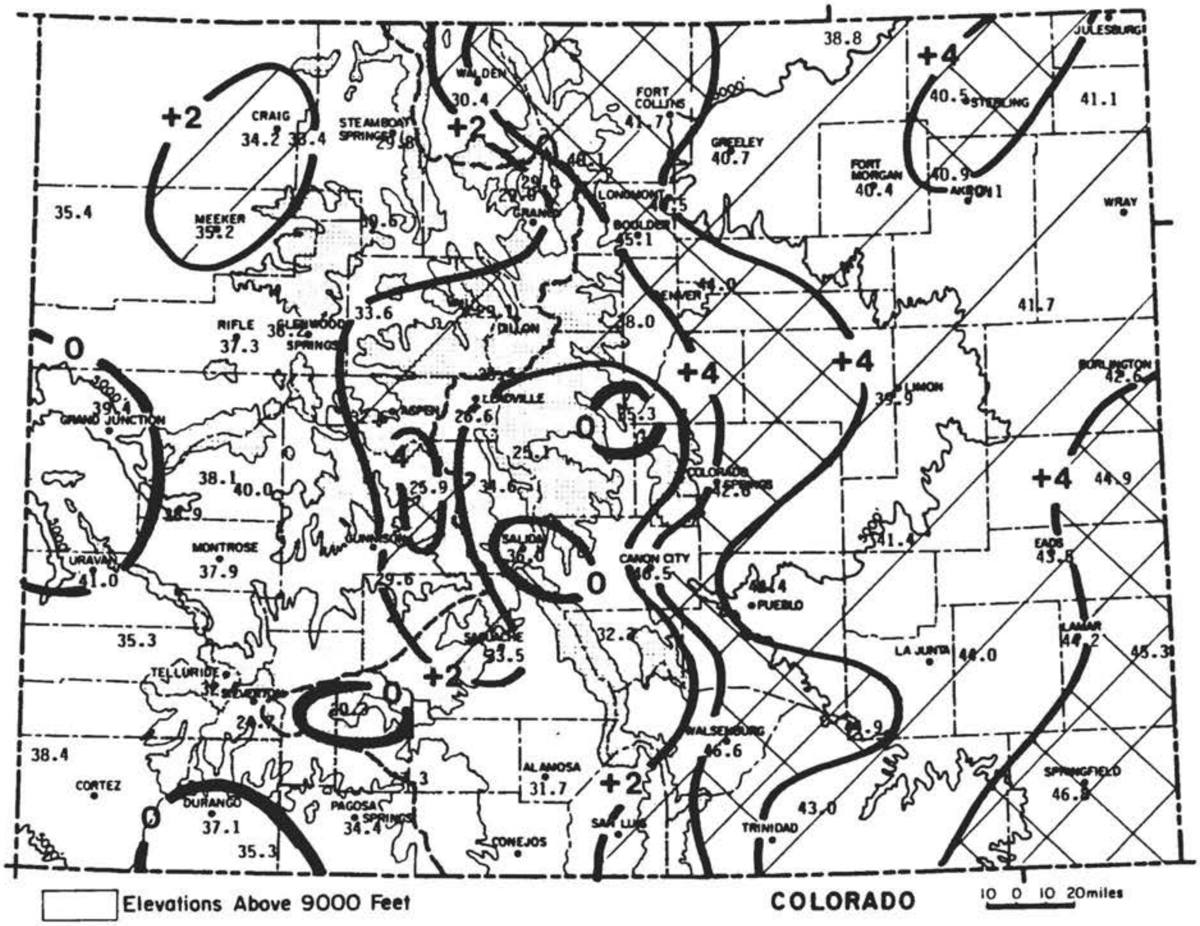


Precipitation for October 1990 through November 1990
as a percent of the 1961-1980 average.

NOVEMBER 1990 TEMPERATURES

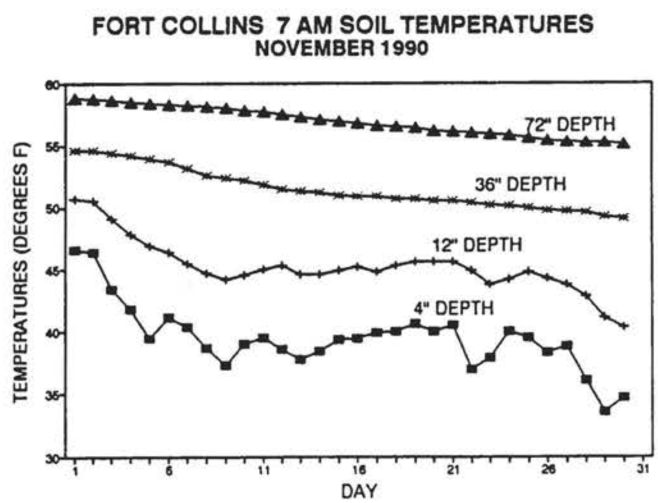
AND DEGREE DAYS

November temperatures were warmer than average at all but a handfull of locations. Temperatures were generally 3 to 5 degrees Fahrenheit above the 1961-1980 average in eastern Colorado. Monthly temperatures that warm in November can usually be expected only about 1 year in 8. The mountains and Western Slope were also above average but were mostly 1-3 degrees warmer than average. Salida, Grand Junction and Durango each reported monthly mean temperatures that were slightly cooler than normal. Several daily record high temperatures were set in various parts of the State. No new record lows were established.



November 1990 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

NOVEMBER 1990 SOIL TEMPERATURES



The mid-month warm spell allowed soil temperatures to level off until they again continued their normal autumn downward decline. Still, temperatures remained somewhat warmer than average at all depths at the end of November.

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 1990 (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
	89-90	17	82	271	698	1001	1400	1554	1089	880	640	480	105	8217
	90-91	59	118	201	633	990								2001
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	89-90	68	176	303	671	974	1365	1365	1086	915	697	543	171	8334
	90-91	134	146	234	652	964								2130
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	89-90	1	0 E	139	M E	567 E	1064 E	776 E	925 E	760	502	321	21	M
	90-91	32	13	81	338	589								1053
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	89-90	39	112	270	628	812	1202	1184	991	857	660	518	106	7379
	90-91	66	130	226	641	905								1968
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	89-90	0	4 E	130	415	684	1229	990	957	757	459	280	3	5908
	90-91	10	4	76	407	M								M
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	89-90	0	0	131	379	584	1076	859	827	687	421	325	22	5311
	90-91	14	12	58	382	548								1014
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	89-90	0	4	172	473	699	1163	966	928	805	526	345	24	6105
	90-91	28	21	83	473	663								1268
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	89-90	0	16	142	494	850	1166	1222	959	776	490	377	59	6551
	90-91	1	6	151	539	774								1471
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	89-90	4	46	235	586	892	1420	1319	1257	879	530	453	144	7765
	90-91	14	18	116	606	876								1630
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	89-90	M	M	M	330	M	M	1161	865	626	355	237	22	M
	90-91	0	2	58	416	751								1227
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	89-90	0	0	153	424	658	1160	879	882	781	469	265	7	5678
	90-91	12	3	64	388	623								1090
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	89-90	226	357	502	861	1124	1495	1506	1271	1124	886	764	349	10465
	90-91	284	355	430	858	1071								2998
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	89-90	2	19	106	520	789	1133	1278	965	724	479	359	44	6418
	90-91	4	28	118	481	832								1463
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	89-90	1	60	217	593	896	1348	1286	986	806	545	269	68	7075
	90-91	15	23	134	583	934								1689
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	89-90	49	118	325	657	818	1221	1115	1030	932	662	513	140	7580
	90-91	120	131	219	591	803								1864
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	89-90	0	3	169	458	711	1166	930	910	848	495	307	19	6016
	90-91	19	6	74	460	690								1249
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	89-90	0	2	156	416	721	1285	1087	1010	776	450	274	10	6187
	90-91	18	7	63	421	730								1239
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	89-90	0	0	40	316	729	1103	1124	820	557	271	139	20	5119
	90-91	0	0	28	360	759								1147

* = 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
	89-90	168	306	427	768	1132	1449	1401	1205	1043	833	689	266	9687
	90-91	264	268	350	774	1071								2727
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	89-90	1	2	166	454	729	1230	985	922	787	449	275	9	6009
	90-91	14	2	62	450	723								1251
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	89-90	61	155	341	749	1069	1574	1647	1254	906	672	540	188	9156
	90-91	65	179	264	771	1059								2338
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	89-90	0	0	99	323	684	1176	1030	887	638	309	188	2	5336
	90-91	4	0	21	308	624								957
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	89-90	285	412	545	880	1138	1507	1499	1265	1188	920	793	377	10809
	90-91	331	402	464	861	1141								3199
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	89-90	1	6	204	508	762	1252	1078	991	815	555	364	33	6569
	90-91	36	11	96	491	745								1379
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	89-90	2	8	200	484	749	1302	1048	994	917	552	319	25	6600
	90-91	24	11	101	481	727								1344
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	89-90	0	41	198	543	869	1261	1169	1071	795	507	387	91	6932
	90-91	9	23	121	511	885								1549
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	89-90	0	10	110	439	768	1156	1186	895	654	425	285	27	5955
	90-91	0	3	81	470	804								1358
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	89-90	24	118	284	646	964	1298	1491	1160	873	630	524	164	8176
	90-91	44	108	177	608	910								1847
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	89-90	0	0	94	373	676	1204	964	877	695	394	233	2	5512
	90-91	1	0	34	360	610								1005
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	89-90	0	2	103	473 E	830	1130	1191	923	657	392	281	37	6019
	90-91	0	4	69	474	824								1371
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	89-90	18	117	315	M	974	1533	1580	1332	971	658	576	M	M
	90-91	129 E	110	255	700	1013								2207
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	89-90	0	3	144	428	719	1254	1074	1026	760	427	275	8	6118
	90-91	17	7	68	437	725								1254
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	88-89	72	175	270	644	869	1264	1273	1023	922	664	509	145	7830
	89-90	117	179	267	635	972								2170
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	89-90	0	1	111	369	633	1153	980	874	681	420	266	8	5496
	90-91	4	6	46	334	654								1044
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	89-90	132	279	461	802	1075	1490	1359	1287	1068	796	674	273	9696
	90-91	202	258	332	794	1028								2614
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	89-90	0	2	117	345	581	1047	848	800	666	408	289	10	5113
	90-91	15	8	53	311	543								930

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

NOVEMBER 1990 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	53.5	24.0	38.8	2.9	75	3	779	0	134	0.95	0.67	339.3	6
STERLING	56.5	24.5	40.5	4.4	80	4	725	0	167	1.13	0.69	256.8	5
FORT MORGAN	56.8	24.0	40.4	3.7	79	7	730	0	167	0.90	0.54	250.0	3
AKRON FAA AP	53.8	27.9	40.9	4.2	77	10	717	0	135	0.89	0.43	193.5	5
AKRON 4E	54.9	25.4	40.1	3.4	78	7	739	0	155	0.78	0.25	147.2	5
HOLYOKE	57.2	25.1	41.1	3.1	79	7	710	0	171	1.39	0.87	267.3	4
JOES	57.1	26.3	41.7	2.7	80	8	691	0	177	1.00	0.40	166.7	4
BURLINGTON	55.0	30.3	42.6	2.9	78	16	419	0	98	0.95	0.40	172.7	1
LIMON WSMO	54.8	25.0	39.9	3.9	74	7	745	0	142	0.96	0.58	252.6	5
CHEYENNE WELLS	60.6	29.2	44.9	5.8	78	13	598	0	198	0.80	0.31	163.3	2
EADS	59.0	28.1	43.5	3.9	80	12	637	0	194	0.88	0.17	123.9	2
ORDWAY 21N	59.1	23.7	41.4	2.8	83	8	702	0	197	0.61	0.23	160.5	4
LAMAR	63.0	25.4	44.2	3.9	84	8	615	0	233	0.80	0.20	133.3	3
LAS ANIMAS	62.0	26.0	44.0	3.0	83	11	624	0	222	0.82	0.32	164.0	3
HOLLY	62.9	27.7	45.3	6.0	79	10	584	0	228	1.42	0.85	249.1	2
SPRINGFIELD 7WSW	62.9	30.8	46.8	5.1	80	14	537	0	223	1.16	0.41	154.7	3
TIMPAS 13SW	59.7	30.0	44.9	3.5	78	10	596	0	195	1.35	0.63	187.5	2

Foothills/Adjacent Plains

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
FORT COLLINS	56.0	27.5	41.7	4.5	74	11	690	0	140	0.87	0.24	138.1	5
GREELEY UNC	55.2	26.1	40.7	3.8	76	9	723	0	141	1.04	0.28	136.8	4
ESTES PARK	51.2	29.0	40.1	5.5	66	-1	741	0	80	0.35	-0.17	67.3	4
LONGMONT 2ESE	57.3	23.7	40.5	3.3	76	9	727	0	167	0.49	-0.12	80.3	3
BOULDER	57.8	32.5	45.1	4.4	77	9	589	0	163	1.60	0.64	166.7	4
DENVER WSFO AP	57.8	30.2	44.0	5.2	79	12	623	0	172	1.28	0.45	154.2	6
EVERGREEN	54.5	21.6	38.0	3.8	73	4	803	0	125	0.98	-0.02	98.0	4
CHEESMAN	54.4	16.3	35.3	-0.6	70	0	886	0	126	1.00	0.10	111.1	6
ANTERO RESERVOIR	41.2	8.9	25.1	1.1	56	-14	1189	0	11	0.64	0.30	188.2	4
COLORADO SPRINGS	56.9	28.4	42.6	5.0	77	13	663	0	157	0.30	-0.23	56.6	5
CANON CITY 2SE	60.3	32.6	46.5	4.2	78	13	548	0	197	0.92	0.26	139.4	3
PUEBLO WSO AP	63.0	25.8	44.4	3.9	82	9	610	0	230	0.54	0.07	114.9	5
WESTCLIFFE	47.2	17.4	32.3	-0.2	66	-2	973	0	47	1.80	1.04	236.8	3
WALSENBURG	60.0	33.2	46.6	5.5	76	8	543	0	180	1.34	0.45	150.6	6
TRINIDAD FAA AP	59.2	26.7	43.0	2.0	78	10	654	0	193	1.27	0.68	215.3	3

Mountains/Interior Valleys

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
WALDEN	43.4	17.5	30.4	4.1	60	-8	1028	0	24	0.54	-0.05	91.5	7
LEADVILLE 2SW	40.4	12.9	26.6	1.7	56	-11	1141	0	13	0.93	0.03	103.3	13
SALIDA	50.6	21.4	36.0	-0.5	67	6	864	0	77	0.84	0.22	135.5	3
BUENA VISTA	51.1	18.1	34.6	0.8	65	2	905	0	76	0.67	0.08	113.6	3
SAGUACHE	47.6	19.4	33.5	2.2	60	3	937	0	40	0.71	0.22	144.9	4
HERMIT 7ESE	35.2	5.5	20.3	-4.3	46	-20	1335	0	0	2.20	1.02	186.4	4
ALAMOSA WSO AP	47.3	16.1	31.7	1.9	59	-4	990	0	40	0.90	0.54	250.0	5
STEAMBOAT SPRINGS	45.3	14.3	29.8	0.9	64	-10	1013	0	45	2.02	0.21	111.6	6
YAMPA	41.4	19.8	30.6	1.2	55	-1	1026	0	14	1.93	0.89	185.6	7
GRAND LAKE 1NW	43.9	14.2	29.0	3.5	58	-7	1071	0	23	0.92	-0.35	72.4	8
GRAND LAKE 6SSW	42.7	15.4	29.0	1.3	57	-2	1071	0	15	0.60	-0.27	69.0	7
DILLON 1E	43.9	14.2	29.1	2.4	60	-7	1071	0	26	0.52	-0.19	73.2	6
CLIMAX	39.6	11.2	25.4	3.6	56	-8	1181	0	10	1.30	-0.43	75.1	8
ASPEN 1SW	46.8	18.5	32.6	2.7	63	-3	964	0	46	2.50	0.90	156.2	9
TAYLOR PARK	39.8	12.0	25.9	6.7	51	-9	1167	0	1	1.70	0.63	158.9	8
TELLURIDE	47.1	17.6	32.4	1.2	64	-2	972	0	45	2.11	0.56	136.1	10
PAGOSA SPRINGS	50.6	18.1	34.4	1.4	68	-1	910	0	74	1.90	0.30	118.7	8
SILVERTON	44.0	5.4	24.7	0.9	56	-18	1200	0	20	2.75	1.30	189.7	8
WOLF CREEK PASS 1	40.0	14.6	27.3	1.2	57	-4	1125	0	13	5.01	1.31	135.4	11

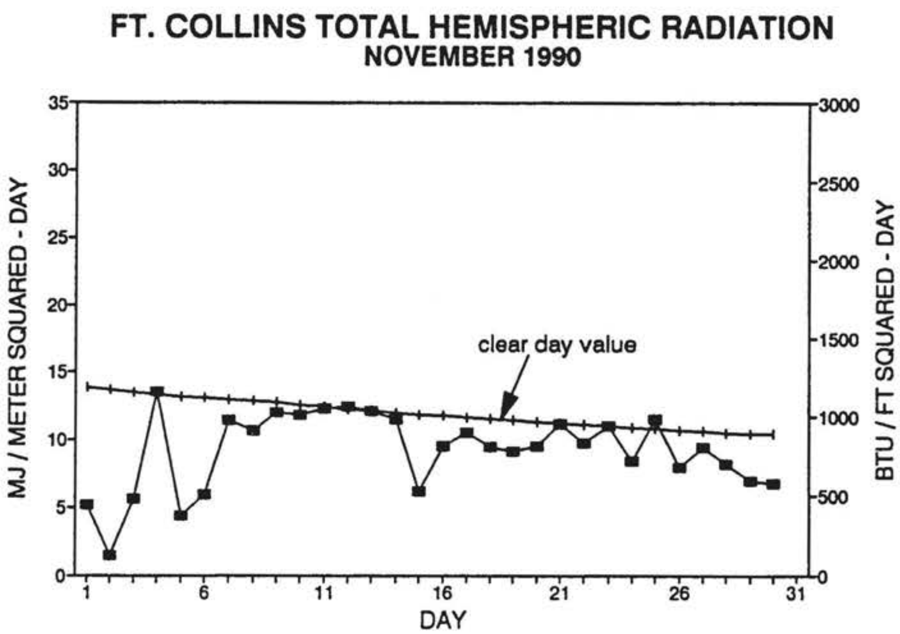
Western Valleys

Name	Max	Min	Temperature Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Total	Precipitation Dep	%Norm	# days
CRAIG 4SW	47.1	21.3	34.2	2.7	67	8	917	0	57	1.31	0.11	109.2	6
HAYDEN	46.8	20.0	33.4	1.5	67	0	940	0	58	1.35	0.11	108.9	5
MEEKER NO. 2	49.1	21.4	35.2	2.2	66	6	885	0	70	0.82	-0.14	85.4	5
RANGELY 1E	48.5	22.3	35.4	1.7	67	10	881	0	52	0.67	0.04	106.3	5
EAGLE FAA AP	48.1	19.2	33.6	2.1	64	-8	934	0	56	1.46	0.87	247.5	8
GLENWOOD SPRINGS	49.4	23.0	36.2	0.8	68	4	859	0	71	1.15	0.15	115.0	8
RIFLE	52.2	22.4	37.3	0.6	68	9	824	0	84	0.88	0.07	108.6	8
GRAND JUNCTION WS	51.2	27.7	39.4	-0.8	63	10	759	0	70	0.57	-0.04	93.4	4
CEDAREDGE	51.6	24.6	38.1	0.2	69	5	797	0	88	1.49	0.59	165.6	5
PAONIA 1SW	52.1	27.8	40.0	1.3	70	9	745	0	97	1.30	0.13	111.1	8
DELTA	53.0	24.9	38.9	0.4	68	12	776	0	94	0.49	-0.11	81.7	4
COCHETOPA CREEK	45.5	13.7	29.6	2.0	59	-6	1054	0	19	1.48	0.87	242.6	7
MONTROSE NO. 2	49.5	26.3	37.9	0.4	70	10	804	0	76	1.40	0.72	205.9	7
URAVAN	55.2	26.9	41.0	0.0	68	12	712	0	110	0.69	-0.37	65.1	6
NORWOOD	47.9	22.7	35.3	1.5	63	2	884	0	53	1.05	0.07	107.1	5
YELLOW JACKET 2W	50.9	26.0	38.4	1.1	66	2	789	0	76	0.95	-0.29	76.6	7
DURANGO	51.1	23.0	37.1	-0.3	68	6	832	0	76	1.98	0.65	148.9	8
IGNACIO 1N	48.9	21.7	35.3	-0.4	62	6	883	0	53	1.72	0.69	167.0	6

* 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 1990 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	11	11	8	--	--
Denver	11	11	8	71%	65%
Fort Collins	7	14	7	--	--
Grand Junction	12	6	12	56%	63%
Limon	9	10	11	--	--
Pueblo	12	9	9	74%	74%



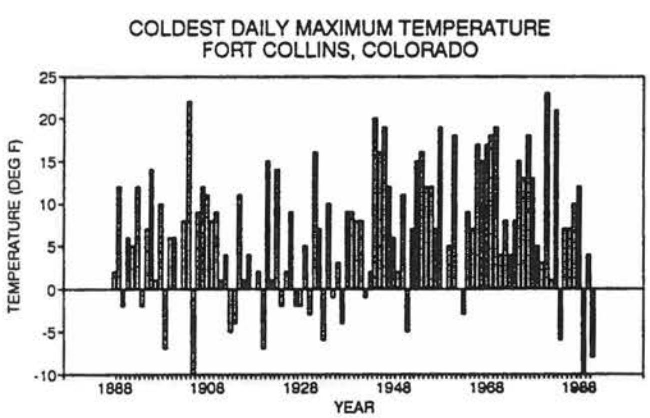
of February 1989, and many of us also still remember the new Colorado record of -61°F set at Maybell 1 February 1985. And how can we forget about the record 5-day stretch of continuous subzero temperatures that gripped parts of Colorado December 1983.

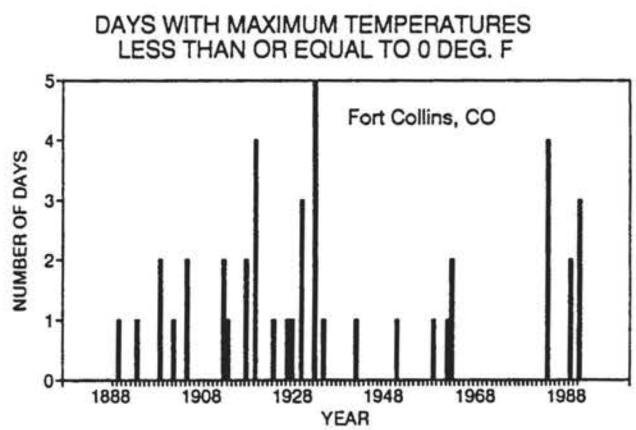
This confusion of hot and cold led me to do an analysis of episodes of extreme cold temperatures. I only analyzed one station with excellent historic records -- our Fort Collins weather station. Since severe cold waves tend to be large-scale phenomena, I think this will give a reasonable description of recent trends in Colorado. However, it may not be too representative of Western Slope conditions since shallow cold air can stay on one side or the other of the mountains without affecting the entire State. I'll need to address that at a future date.

For the purpose of this analysis, any day when the daily maximum temperature stays below 16°F is considered to be extremely cold. Any period of at least two consecutive days with the temperature never rising above 15 degrees F is considered an extreme cold episode. This definition misses a few occurrences when temperatures drop well below zero at night, but it catches almost every period in which cold temperatures had significant impacts. It also identifies correctly almost every incident when nighttime temperatures fell to -20°F or colder. Problems with dead batteries, flooded carburetors, frozen gas lines, frozen plumbing, frozen skin, excessive demand for electricity and natural gas are all worst when it stays cold both day and night for several days in a row.

During the past 104 years (the period with complete daily climatic data at Fort Collins) an average of 3 or 4 days each winter are extremely cold. Nearly 90% of all winters have at least 1 extremely cold day. 60% of all winters have at least 1 extreme cold episode. Fortunately, it is much less common to have multiple episodes of extreme cold in any one winter. There have only been 17 winters with 2 extreme episodes, 5 winters with 3 episodes (1894-95, 1904-05, 1931-32, 1972-73 and 1978-79), and only 3 winters with 4 extreme episodes (1898-99, 1919-20 and 1961-62). In the 1961-62 winter there were a record-breaking 16 days with high temperatures of 12 degrees or less. Cold episodes have begun as early as November 11 and have lasted as late as March 25. The primary season lies between December 7 and February 28. Out of a total of 96 episodes, 4 have occurred in November, 22 in December, 40 in January, 25 in February and 5 in March. There have been noticeable variations in the frequency of cold days during the past 104 years. Cold extremes were more common prior to 1940 than they have been since then. Cold extremes were most prevalent near the turn of the century, during the late 1910s, around 1930 and in the early 1960s. There was a noticeable lack of extreme cold in the mid 1940s and during the late 1960s.

While the number of days and episodes of extreme cold have not been increasing, the occurrences of subzero daytime temperatures have. From 1887 to 1935, 15 winters (about 1 out of every 3) experienced at least one day when maximum temperatures did not exceed 0°F. From 1936 to 1963 there were 5 years (approximately 1 out of 6) with one or more days with daytime temperatures of 0° or less. Then from 1964 to 1983 there were no subzero daily maximum temperatures. In fact, the coldest daily high temperature all winter in 1980-81 was only 23°F. In 1982-83, the coldest high was 21°F. Then along came the cold waves of December 1983 (118 consecutive subzero hours), February 1989 (consecutive high temperatures of -9 and -10, the coldest 2-day period on record) and now December 1990 (the 3rd longest subzero episode in history, following December 1983 and February 7-10, 1933). Also, in these recent years, the worst cold waves have been in December and February, not in January -- the normal coldest month of the year.





As usual, I don't know what all of this means and there is much more research that should be done. A few scientists speculate that episodic extreme winter cold will be more common in the future. We don't know that for a fact. However, if we are halfway smart, we should plan ahead and expect the worst. Even in the worst of times these cold waves are short-lived. A little insulation, a well-charged battery, some long johns, a little extra fuel and some common sense and we'll do just fine.

The Cost of Being Santa in the 90's

'Tis the season to be jolly.' Now, who's the jolliest of them all? Santa Claus! How is he still so jolly with the cost of everything skyrocketing? I asked the very same question to one of Santa's elves, Mary, when she was at the Dar Nits Cold general store in Alaska.

First of all, Santa is no fool. Traveling around the world each year keeps him pretty hip. To keep his house warm and to cook he uses a high efficiency wood-burning stove. In fact, Mary was in Alaska to pick up the wood shipment.

To power the tools and lighting in the work shop, Santa uses his new 1 Megawatt wind generator. It is more than enough to power the whole house even in the December rush. He has to keep his storage batteries underground so they do not freeze. Wind power is ideal for Santa since he is in the dark six months of the year, and he always has an abundance of wind.

The lightbulbs that Santa uses consume less power than normal lightbulbs. Similar to incadescent light bulbs, these flourescent bulbs radiate white light. They cost a lot more than regular light bulbs, but they can last from five to seven years and so pay for themselves in a short time. Rudolph has considered switching to the new light bulbs, too.

To keep all this energy in his house, Santa made sure his house was well insulated. He covers his windows in winter with special curtains that have a high R-value. R-values give an indication on the insulation. A high R-value means it is harder for the heat to move through the substance. In other words, the heat stays in, and the cold stays out. It also helps when the snow piles up high in front of them.

Hot water heating is as big a problem for Santa as it is for any home with teenagers living in it. Elves will not work without a hot shower in the morning. Santa uses biogas to power his hot water heater. He places reindeer droppings in a tank where they ferment. During fermentation, they release methane gas. The methane gas is collected and then used to power his hot water heater.

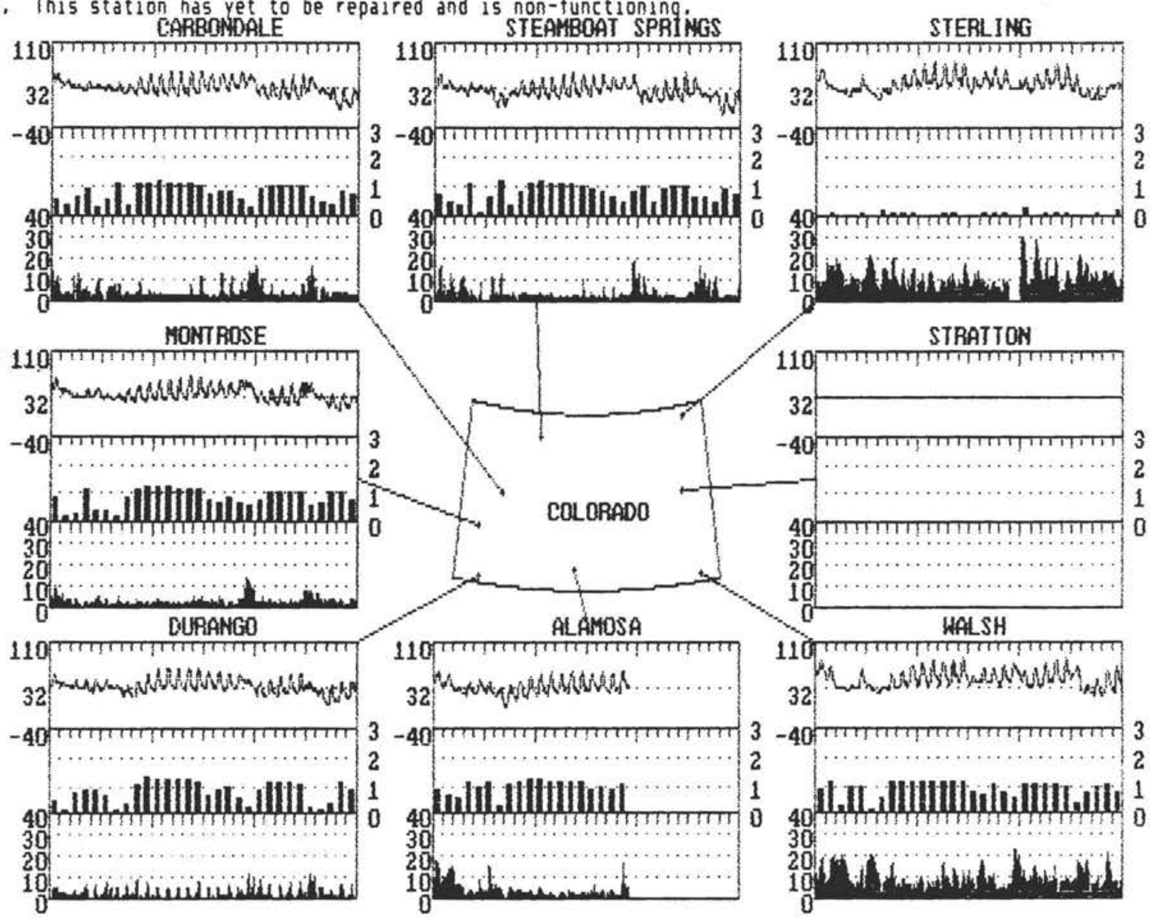
While most of us are going into cardiac arrest when we get our Public Service bill, Santa Claus has set himself up for economical energy use. Anyway, who wouldn't give Santa a deal on wood or hay?

This article was written by Erika Komito of the Joint Center for Energy Management with help from Mary, head elf. Information on acquiring our weather data can be obtained by writing Mary Sutter at the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, CO. 80309-0428.

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (°F)	31.6	33.0	31.5	34.7	26.3	38.1	32.0	44.4
monthly temperature extremes and time of occurence (°F day/hour)								
maximum:	58.5 15/16	62.1 12/15	61.5 14/15	65.5 14/15	58.5 14/15	78.8 12/16	32.0 1/ 1	79.9 25/12
minimum:	-0.8 8/ 4	1.9 28/ 6	-6.0 29/ 7	6.4 29/ 5	-13.2 29/ 7	10.8 7/ 5	32.0 1/ 1	15.4 28/ 0
monthly average relative humidity / dewpoint (percent / °F)								
5 AM	60 / 13	86 / 21	88 / 20	86 / 23	95 / 16	36 / 4	0 /-40	69 / 24
11 AM	41 / 16	53 / 25	57 / 22	57 / 27	68 / 23	26 / 9	0 /-40	38 / 26
2 PM	30 / 16	48 / 25	43 / 21	50 / 26	50 / 22	24 / 11	0 /-40	33 / 25
5 PM	31 / 15	58 / 26	52 / 21	53 / 25	63 / 22	26 / 7	0 /-40	40 / 24
11 PM	57 / 15	86 / 25	86 / 24	81 / 25	91 / 20	33 / 4	0 /-40	61 / 25
monthly average wind direction (degrees clockwise from north)								
day	117	195	235	220	171	210	0	175
night	116	99	180	148	122	223	0	243
monthly average wind speed (miles per hour)	2.29	2.19	3.01	2.50	2.31	8.73	0.00	6.68
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	533	526	490	517	560	61	720	33
3 to 12	163	192	209	196	126	502	0	525
12 to 24	24	0	9	3	15	148	0	162
> 24	0	0	0	0	0	9	0	0
monthly average daily total insolation (Btu/ft²·day)	620	806	760	835	758	6280	0	902
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	111	84	123	137	124	0	0	161
40-60%	40	57	50	51	53	0	0	48
20-40%	27	60	67	56	68	0	0	42
0-20%	10	63	58	44	40	1	0	31

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 station failure, no data are available for Alamosa from the 20th of the month to the end of the month. Horizontal insolation in Sterling continues to be unavailable. Disregard all data for Stratton. This station has yet to be repaired and is non-functioning.



COLORADO CLIMATE

DECEMBER 1990

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 14 Number 3

December in Review:

After a very gentle and sunny start, unsettled winter weather took over in mid December. Then a wicked cold blast hit Colorado on the 19th and left much of the State in the deep freeze for the remainder of the month. Temperatures for the month as a whole ended up several degrees below average, one of the 10 coldest Decembers in the past century. There were a number of precipitation opportunities during the month, but most of the snow was light. Precipitation totals ended up below average except near the New Mexico border.

Colorado's February Climate:

The last decade reveals no special trends in February climatic conditions. Some years have been warm (1987) and others cold (remember 1989). Some have been wet (1986) and others dry (1988). Last year brought some of each, depending on where you live in the State. Over the long term, February is usually a lot like January. Temperatures begin to warm up, but the change is hardly noticeable except in some of the low elevation valleys. Precipitation patterns are similar to January -- fairly frequent mountain snows while the eastern plains remain very dry. The wind doesn't blow much in the western valleys, but on the mountain tops it is almost always howling. Front Range winds are usually light, but every now and then windstorms shake the area. The sun usually shines a lot, but expect some cloudy days. We've even had some incredible fog (1978) but don't count on that. The most noticeable feature of February is the increasing daylength.

I still like winter, don't get me wrong, but as I get older as soon as Christmas is over I find myself looking forward to Valentine's day. It's not because I'm such a romantic. I just know that the worst of the cold weather will be over by then. The chances are if my car battery lasts until Valentines Day it will survive another 10 months -- and the same may apply for me. Severe winter cold waves (like those we described in the November summary) are still quite likely in early February but they phase out quickly after the 14th. That may be good news for you and me, but it is only some consolation for Colorado's wild animal populations. Even though temperatures begin to rise, snow in the mountains continues to get deeper for at least another month and new sources of food are hard to find. Much of the wildlife mortality in Colorado occurs later in the winter.

In an average February, precipitation totals only about 0.25" (3-8" snow) on the plains and in the San Luis Valley but increases to 0.50-1.00" (6-20" snow) in the eastern foothills. Western Slope precipitation, which still falls primarily as snow usually totals 0.50-1.50" (6-30" snow). The mountains can expect 1.50-3.50" (20-55"). Low elevation daytime temperatures typically rise into the 30s and 40s with a few days that are warmer. Lows average in the teens. Meanwhile in the mountains, highs are usually in the 20s and 30s with single digits at night -- warmer when it's cloudy and colder when it's clear.

The Climate of Iraq:

Recent events in the world have been distracting to say the least. I don't know what impact the outbreak of war has had on you, but I have found myself pondering my life's priorities and trying to decide what really matters and what doesn't. I have wondered about what the world will be like in 50 years and what life will be like for my children. I have also found myself combating my insecurities by trying to learn as much as I can about that part of the world -- the Middle East.

(continued on page 41)

DECEMBER 1990 DAILY WEATHER

Date	Event
1-3	Winds were brisk as the jet stream passed right over Colorado. A developing upper air trough raced overhead on the 2nd dropping 1-5" of snow in the northern and central mountains. Temperatures stayed below average statewide.
4-6	The Western Slope remained cool and dry while much warmer temperatures developed east of the Continental Divide on the 4th and 5th. Another cold front moved across on the 5th accompanied by a few mountain snowshowers. A brief period of snow fell along the Front Range early on the 6th--a trace to 2 inches.
7-11	Exceptional cloudless and calm weather covered Colorado as a large high pressure ridge aloft covered the Rockies. The mountains and Western Slope saw daytime temperatures reach the 40s and 50s. Dillon hit 49° on the 11th. It was much warmer east of the mountains especially on the 10-11th. Sixties and low 70s were common, but Lakewood claimed the State's warmest temperature with 75° on the 11th.
12-17	Weather conditions deteriorated quickly and remained unsettled. Low clouds, fog and light precipitation began in parts of Colorado on the 12th as a trough to the west teamed with damp upslope conditions east of the mountains. Most precipitation was light 12-13th but 3-8" of snow was common in the mountains and Grand Junction reported 0.57" of moisture (mostly rain) on the 13th. Mountain snows continued on the 14th as a strong low pressure center moved quickly eastward along the Wyoming border. Strong morning winds created blizzard conditions in many mountain areas including Aspen and Craig. Winds also swept down the Front Range onto the plains. Afternoon and evening winds gusted in excess of 60 mph in several areas blowing vehicles off highways and causing other localized damage. The 15th was cold but sunny. Clouds increased from the southwest on the 16th as the next storm approached. Significant snow fell across extreme southern Colorado from late on the 16th through the 17th. Lamar received 3" of snow, Alamosa got 7" and Wolf Creek Pass totalled nearly 20".
18-24	A dramatic weather change occurred as a massive polar air mass pushed southward and eventually engulfed all of the western U.S. Strong winds occurred on the 18th ahead of the front which reached northern Colorado during the evening. Temperatures plummeted on the 19th in eastern Colorado while the mountains and Western Slope remained quite mild. Snows increased and spread southward 19th-20th. The eastern plains were only lightly dusted and Front Range area received just a few inches. Snows became heavier in the mountains and in some western valleys. More than 1 foot fell over much of the San Juan Mountains. But the real story was the cold. Temperatures stayed below zero continuously for 2 to 5 days over northern and eastern Colorado making this one of the five worst cold waves this century. The coldest day was the 21st. Craig and Estes Park only reached -12°F for highs. Boulder, with a high of -8° and a low of -20°, recorded their coldest day in that city's recorded history. With clearing skies, many more records were set on the 22nd. Denver had a low of -25°F. Bailey dipped to -30°F. The cold gradually moderated except in southwest Colorado where the 23rd and 24th were their coldest days of the month. Mesa Verde's -15° on the 24th was their coldest temperature ever reported in December. Taylor Park's -49° reading that morning was the coldest in Colorado.
25-27	Christmas was partly cloudy and still plenty cold. A little snow fell across the northern and central mountains. The 26th and 27th were dry and mostly cold, but some Front Range areas had a mild chinook wind on the 27th. Evergreen rose to 51°, for example.
28-31	A second surge of Arctic air slipped down on Colorado on the 28th. Northeast Colorado took the brunt of the cold. Highs on the 29th were again near zero there. The mountains got more snow for holiday skiers. Most snow was light, but some heavier snows moved across Southern Colorado. As the month ended, cold air remained entrenched over western Colorado, but a welcome warming trend began east of the mountains.

December 1990 Extremes

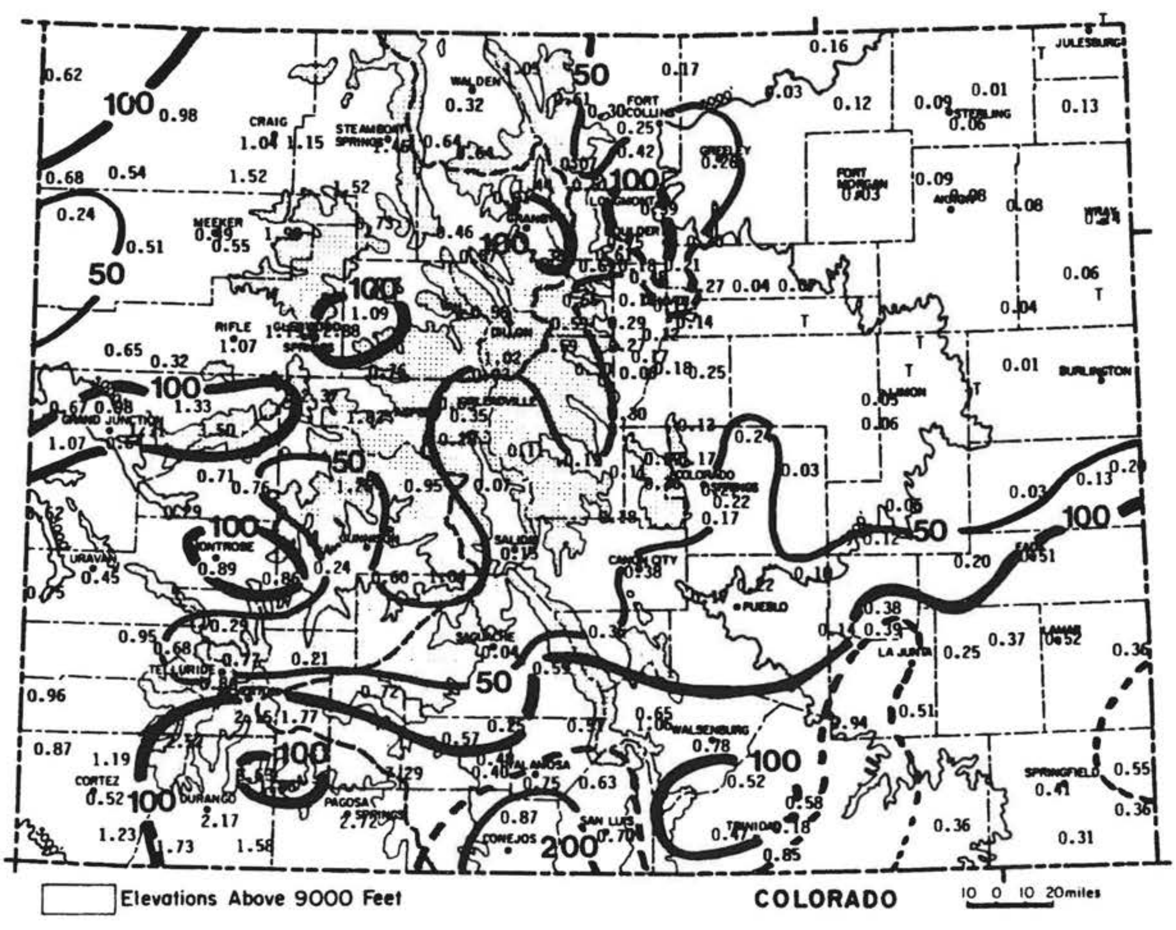
Highest Temperature	75°F	December 11	Lakewood
Lowest Temperature	-49°F	December 24	Taylor Park Reservoir
Greatest Total Precipitation	7.29"		Wolf Creek Pass 1E
Least Total Precipitation	Trace		Burlington and several other locations
Greatest Total Snowfall*	79.0"		Platoro Dam
Greatest Depth of Snow*	56"	December 24	Platoro Dam

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

DECEMBER 1990 PRECIPITATION

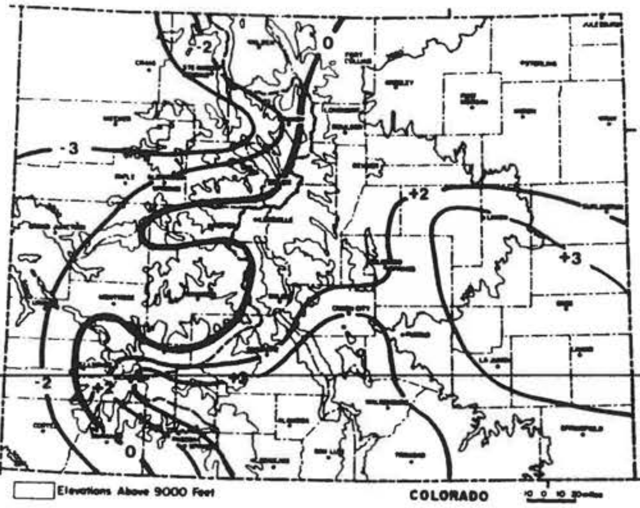
December precipitation got off to a slow start and was beginning to make the winter recreation industry in Colorado a little nervous again. A pair of modest snowstorms hit between the 12th and the 17th and definitely made things look a lot more like Christmas. Then the arctic blast hit the State on the 19th accompanied by generally light but widespread snow. Another dose of cold and snow moved in on the 28th and 29th. Total precipitation for the month ended up well below average except for a few spots along a line from Grand Junction to Longmont and in a strip along the southern border of the State. Still there was plenty of snow for skiing, and much of the lower elevations were snowcovered for the holiday season even though the snow was not deep (especially over the eastern plains). Out of 214 official weather stations with complete precipitation data for December, 75 stations received less than 50% of their monthly average. Most of these were in central and northeastern Colorado. Another 62 stations received from 50% to 79% of average. 43 stations received near average precipitation (80% to 120% of average). 28 stations were wetter than average (121% to 199% of average). Six stations ended up with more than 200% of their average December precipitation.

Greatest		Least	
Wolf Creek Pass 1E	7.29"	Burlington, Shaw,	
Bonham Reservoir	3.50"	Genoa, Bonny Lake,	
Shoshone Hydro Power	2.88"	Julesburg, Deer Trail,	
Pagosa Springs	2.72"	Flagler 2NW, and	
Lemon Dam	2.63"	Sedgwick 5S	Trace
Rico	2.52"	Stratton, Fleming 1S	0.01"



Precipitation amounts (inches) for December 1990 and contours of precipitation as a percent of the 1961-1980 average.

Despite a predominantly dry December, precipitation totals for the first 3 months of the 1991 water year are looking good. Nearly 3/4 of Colorado has received more precipitation than average. A few areas on the eastern plains, in the San Luis Valley and in the San Juan, Sangre de Cristo and Wet Mountains have received more than 150% of their 3-month average. Drier than average areas are limited to extreme southwest Colorado, isolated portions of the eastern plains and northwest Colorado, and a few areas in the central mountains and along the northern Front Range. Most of these areas are only a little below average. The Palmer Index still suggests that some areas of western Colorado remain in moderate drought, but we have improved greatly since this same time last year. At this same time last year the majority of Colorado had received less than 50% of the average precipitation, and the Palmer Index indicated dry to very dry conditions nearly statewide.

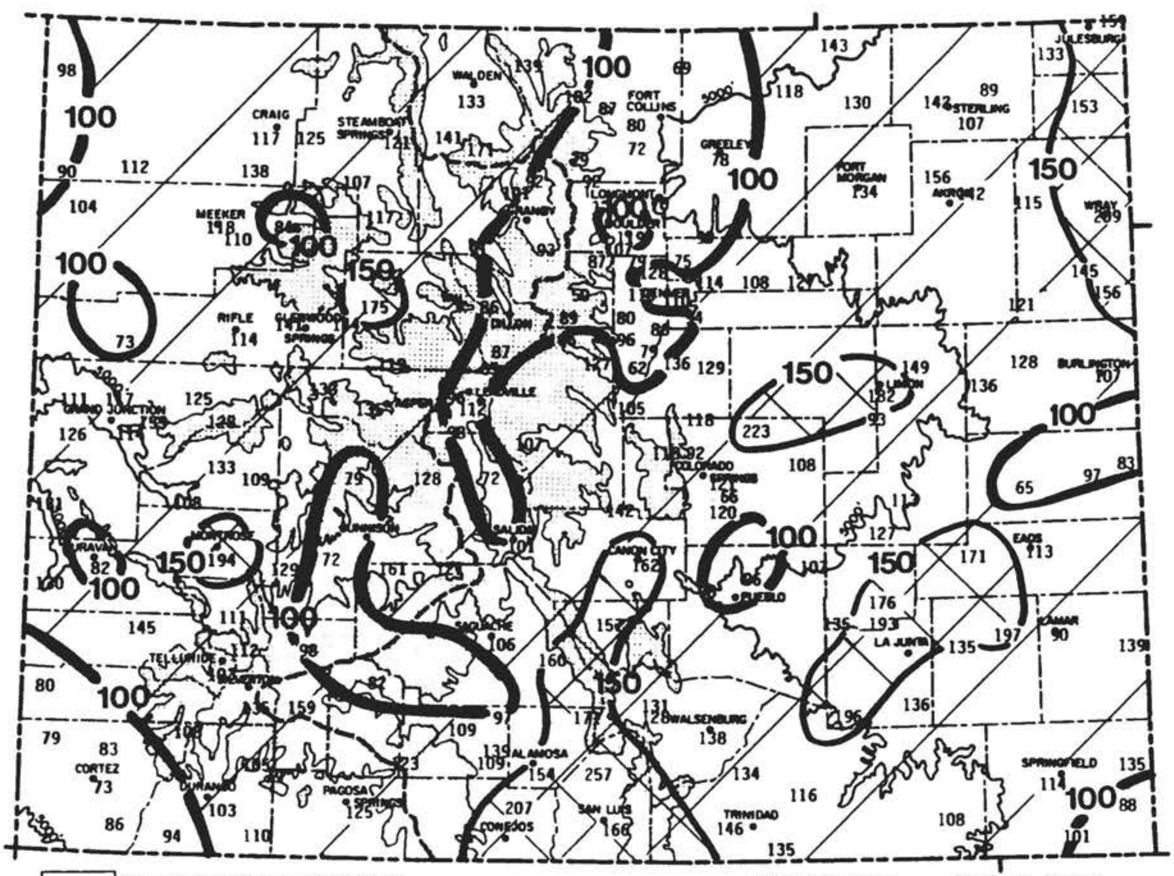


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

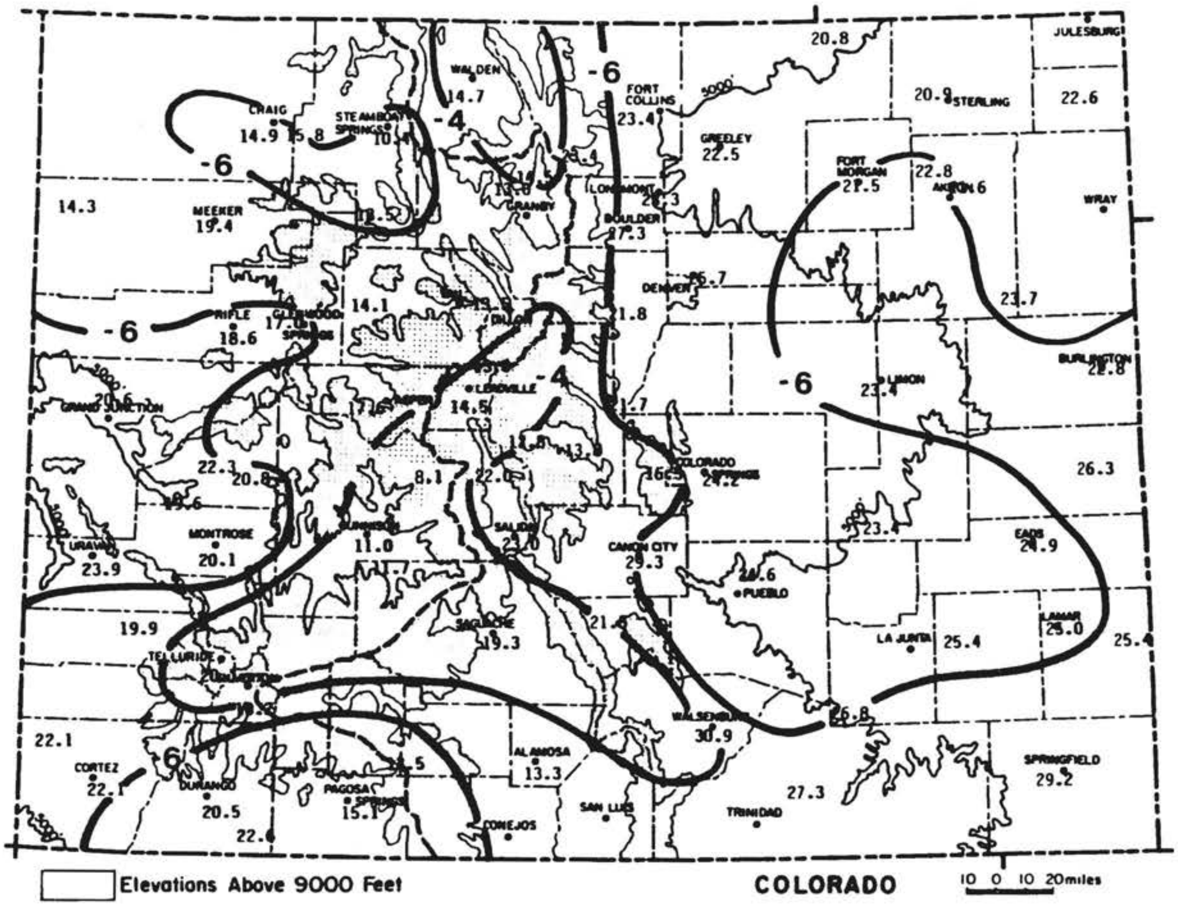
Index	Interpretation
	extremely wet
+4	----------------
+3	ample moisture
+2	----------------
+1	
0	near normal
-1	
-2	----------------
	moderate drought
-3	----------------
	severe drought
-4	----------------
	extreme drought



Precipitation for October 1990 through December 1990
as a percent of the 1961-1980 average.

DECEMBER 1990 TEMPERATURES AND DEGREE DAYS

Despite a mild start, temperatures in Colorado ended up significantly colder than average as a result of the cold wave that engulfed the entire western U.S. during the last 13 days of December. Most individual weather stations were 4 to 8 degrees F colder than average. By no means was this the coldest December on record, but for several areas and the State as a whole it ranked among the 10 coldest Decembers during the past century. It is actually quite unusual to have the entire State so uniformly cold. The last time Colorado experienced a similar December temperature pattern with abnormally cold temperatures statewide was back in 1978.



December 1990 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

DECEMBER 1990 SOIL TEMPERATURES

The December cold wave was accompanied by only a little snow cover. As a result, soil temperatures dropped quickly, and frost reached deeper into the ground by the end of the month than is normally expected this early in the winter season.

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.

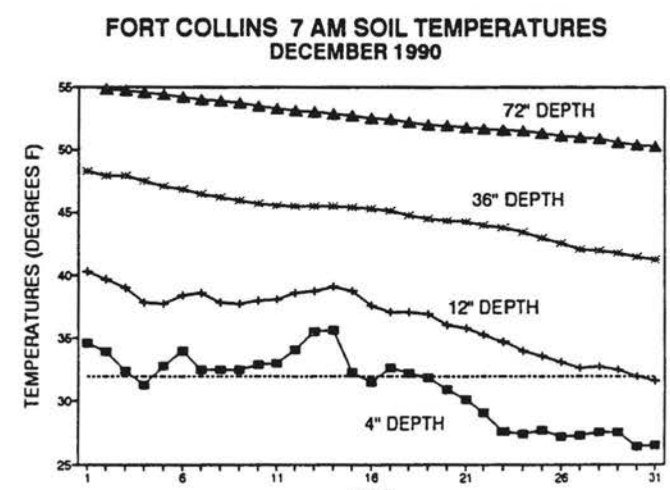


Table 1. Heating Degree Day Data through December 1990 (base temperature, 65°F).

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
	89-90	17	82	271	698	1001	1400	1554	1089	880	640	480	105	8217
	90-91	59	118	201	633	990	1597							3598
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	89-90	68	176	303	671	974	1365	1365	1086	915	697	543	171	8334
	90-91	134	146	234	652	964	1462							3592
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	89-90	1	0 E	139	M E	567 E	1064 E	776 E	925 E	760	502	321	21	M
	90-91	32	13	81	338	589	1161							2214
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	89-90	39	112	270	628	812	1202	1184	991	857	660	518	106	7379
	90-91	66	130	226	641	905	1326							3294
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	89-90	0	4 E	130	415	684	1229	990	957	757	459	280	3	5908
	90-91	10	4	76	407	M	1249							M
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	89-90	0	0	131	379	584	1076	859	827	687	421	325	22	5311
	90-91	14	12	58	382	548	1098							2112
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	89-90	0	4	172	473	699	1163	966	928	805	526	345	24	6105
	90-91	28	21	83	473	663	1256							2524
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	89-90	0	16	142	494	850	1166	1222	959	776	490	377	59	6551
	90-91	1	6	151	539	774	1321							2792
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	89-90	4	46	235	586	892	1420	1319	1257	879	530	453	144	7765
	90-91	14	18	116	606	876	1547							3177
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	89-90	M	M	M	330	M	M	1161	865	626	355	237	22	M
	90-91	0	2	58	416	751	1400							2627
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	89-90	0	0	153	424	658	1160	879	882	781	469	265	7	5678
	90-91	12	3	64	388	623	1209							2299
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	89-90	226	357	502	861	1124	1495	1506	1271	1124	886	764	349	10465
	90-91	284	355	430	858	1071	1587							4585
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	89-90	2	19	106	520	789	1133	1278	965	724	479	359	44	6418
	90-91	4	28	118	481	832	1373							2836
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	89-90	1	60	217	593	896	1348	1286	986	806	545	269	68	7075
	90-91	15	23	134	583	934	1568							3257
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	89-90	49	118	325	657	818	1221	1115	1030	932	662	513	140	7580
	90-91	120	131	219	591	803	1330							3194
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	89-90	0	3	169	458	711	1166	930	910	848	495	307	19	6016
	90-91	19	6	74	460	690	1284							2533
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	89-90	0	2	156	416	721	1285	1087	1010	776	450	274	10	6187
	90-91	18	7	63	421	730	1343							2582
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	89-90	0	0	40	316	729	1103	1124	820	557	271	139	20	5119
	90-91	0	0	28	360	759	1370							2517

* = 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
	89-90	168	306	427	768	1132	1449	1401	1205	1043	833	689	266	9687
	90-91	264	268	350	774	1071	1605							4332
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	89-90	1	2	166	454	729	1230	985	922	787	449	275	9	6009
	90-91	14	2	62	450	723	1309							2560
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	89-90	61	155	341	749	1069	1574	1647	1254	906	672	540	188	9156
	90-91	65	179	264	771	1059	1664							4002
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	89-90	0	0	99	323	684	1176	1030	887	638	309	188	2	5336
	90-91	4	0	21	308	624	1220							2177
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	89-90	285	412	545	880	1138	1507	1499	1265	1188	920	793	377	10809
	90-91	331	402	464	861	1141	1556							4755
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	89-90	1	6	204	508	762	1252	1078	991	815	555	364	33	6569
	90-91	36	11	96	491	745	1280							2659
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	89-90	2	8	200	484	749	1302	1048	994	917	552	319	25	6600
	90-91	24	11	101	481	727	1284							2628
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	89-90	0	41	198	543	869	1261	1169	1071	795	507	387	91	6932
	90-91	9	23	121	511	885	1406							2955
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	89-90	0	10	110	439	768	1156	1186	895	654	425	285	27	5955
	90-91	0	3	81	470	804	1385							2743
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	89-90	24	118	284	646	964	1298	1491	1160	873	630	524	164	8176
	90-91	44	108	177	608	910	1538							3385
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	89-90	0	0	94	373	676	1204	964	877	695	394	233	2	5512
	90-91	1	0	34	360	610	1243							2248
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	89-90	0	2	103	473 E	830	1130	1191	923	657	392	281	37	6019
	90-91	0	4	69	474	824	1433							2804
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	89-90	18	117	315	M	974	1533	1580	1332	971	658	576	M	M
	90-91	129 E	110	255	700	1013	1683							3890
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	89-90	0	3	144	428	719	1254	1074	1026	760	427	275	8	6118
	90-91	17	7	68	437	725	1359							2613
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	88-89	72	175	270	644	869	1264	1273	1023	922	664	509	145	7830
	89-90	117	179	267	635	972	1384							3554
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	89-90	0	1	111	369	633	1153	980	874	681	420	266	8	5496
	90-91	4	6	46	334	654	1160							2204
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	89-90	132	279	461	802	1075	1490	1359	1287	1068	796	674	273	9696
	90-91	202	258	332	794	1028	1550							4164
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	89-90	0	2	117	345	581	1047	848	800	666	408	289	10	5113
	90-91	15	8	53	311	543	1047							1977

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

DECEMBER 1990 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	33.5	8.0	20.8	-8.0	68	-31	1363	0	37	0.16	-0.10	61.5	4
STERLING	33.5	8.4	20.9	-6.1	60	-24	1359	0	13	0.09	-0.22	29.0	3
FORT MORGAN	35.4	7.7	21.5	-5.8	71	-23	1343	0	36	0.03	-0.22	12.0	1
AKRON FAA AP	34.6	10.9	22.8	-5.8	65	-20	1299	0	29	0.09	-0.16	36.0	4
AKRON 4E	34.5	8.8	21.6	-6.0	67	-28	1338	0	33	0.08	-0.20	28.6	3
HOLYOKE	35.7	9.5	22.6	-7.1	70	-23	1308	0	40	0.13	-0.24	35.1	3
JOES	37.2	10.2	23.7	-6.3	71	-26	1270	0	53	0.04	-0.31	11.4	1
BURLINGTON	35.6	13.4	24.5	-7.4	67	-18	1249	0	38	0.00	-0.32	0.0	0
LIMON WSMO	37.2	9.5	23.4	-5.3	66	-22	1280	0	38	0.05	-0.15	25.0	3
CHEYENNE WELLS	40.4	12.3	26.3	-4.4	69	-18	1190	0	53	0.13	-0.09	59.1	2
EADS	38.4	11.4	24.9	-6.3	70	-18	1236	0	59	0.51	0.17	150.0	2
ORDWAY 21N	40.5	6.2	23.4	-6.8	70	-29	1283	0	65	0.12	-0.07	63.2	3
LAMAR	42.2	7.8	25.0	-6.6	71	-21	1233	0	77	0.52	0.14	136.8	5
LAS ANIMAS	42.2	8.5	25.4	-6.3	69	-20	1220	0	72	0.25	0.01	104.2	4
HOLLY	40.4	10.5	25.4	-5.4	68	-16	1221	0	63	0.36	0.11	144.0	6
SPRINGFIELD 7WSW	44.5	13.9	29.2	-5.0	72	-18	1099	0	69	0.41	0.10	132.3	7
TIMPAS 13SW	40.8	12.8	26.8	-5.7	70	-16	1174	0	61	0.94	0.48	204.3	5

Foothills/Adjacent Plains

Name	Max	Min	Temperature Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
FORT COLLINS	37.0	9.8	23.4	-6.5	66	-24	1284	0	37	0.25	-0.21	54.3	6
GREELEY UNC	34.9	10.1	22.5	-7.2	65	-22	1309	0	26	0.26	-0.21	55.3	5
ESTES PARK	35.5	11.3	23.4	-5.2	62	-22	1283	0	13	0.07	-0.39	15.2	4
LONGMONT 2ESE	38.4	8.3	23.3	-6.2	68	-31	1284	0	53	0.59	0.16	137.2	5
BOULDER	40.4	14.2	27.3	-7.8	67	-24	1161	0	49	0.75	0.12	119.0	9
DENVER WSFO AP	39.5	11.9	25.7	-6.3	68	-25	1209	0	54	0.27	-0.27	50.0	8
EVERGREEN	39.0	4.7	21.8	-6.4	65	-29	1330	0	38	0.29	-0.46	38.7	6
CHEESMAN	39.3	4.1	21.7	-7.7	62	-29	1336	0	31	0.30	-0.33	47.6	5
LAKE GEORGE 8SW	29.8	-2.2	13.8	-4.6	46	-25	1578	0	0	0.19	-0.18	51.4	4
ANTERO RESERVOIR	28.5	-2.9	12.8	-3.1	47	-27	1611	0	0	0.11	-0.23	32.4	3
RUXTON PARK	29.4	3.7	16.5	-5.9	52	-24	1495	0	1	0.36	-0.40	47.4	5
COLORADO SPRINGS	37.7	10.8	24.2	-6.5	66	-24	1256	0	36	0.27	-0.12	69.2	6
CANON CITY 2SE	44.8	13.7	29.3	-6.7	69	-25	1098	0	76	0.38	-0.20	65.5	5
PUEBLO WSO AP	42.3	6.9	24.6	-7.4	72	-25	1243	0	70	0.22	-0.13	62.9	6
WESTCLIFFE	39.4	3.7	21.5	-3.4	59	-29	1340	0	19	0.36	-0.45	44.4	6
WALSENBURG	45.1	16.8	30.9	-3.6	66	-20	1047	0	60	0.78	0.03	104.0	7
TRINIDAD FAA AP	43.9	10.6	27.3	-5.9	70	-19	1160	0	71	0.58	0.01	101.8	7

Mountains/Interior Valleys

Name	Max	Min	Temperature Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
WALDEN	28.8	0.6	14.7	-3.5	50	-36	1550	0	0	0.32	-0.30	51.6	7
LEADVILLE 2SW	28.9	0.1	14.5	-3.5	48	-31	1556	0	0	0.35	-0.75	31.8	6
SALIDA	38.3	7.7	23.0	-5.8	59	-28	1296	0	22	0.15	-0.46	24.6	2
BUENA VISTA	36.6	7.5	22.0	-4.2	59	-16	1326	0	12	0.07	-0.51	12.1	3
SAGUACHE	33.5	1.9	17.7	-3.0	52	-22	1459	0	3	0.04	-0.39	9.3	3
ALAMOSA WSO AP	31.5	-4.9	13.3	-4.2	52	-33	1597	0	4	0.75	0.30	166.7	7
STEAMBOAT SPRINGS	24.5	-3.6	10.4	-6.8	49	-40	1683	0	0	1.46	-1.08	57.5	14
YAMPA	25.5	1.5	13.5	-7.3	44	-36	1590	0	0	0.73	-0.39	65.2	7
GRAND LAKE 1NW	29.4	-0.5	14.5	-2.9	48	-35	1561	0	0	1.44	-0.20	87.8	14
GRAND LAKE 6SSW	27.0	-1.1	13.0	-4.6	44	-35	1605	0	0	0.91	0.04	104.6	10
DILLON 1E	28.8	-1.8	13.5	-5.2	49	-30	1587	0	0	0.55	-0.32	63.2	11
CLIMAX	25.6	0.4	13.0	-2.4	42	-33	1606	0	0	0.93	-1.18	44.1	11
ASPEN 1SW	31.4	3.9	17.6	-4.4	50	-21	1462	0	0	1.82	-0.59	75.5	17
TAYLOR PARK	25.7	-9.5	8.1	1.6	41	-49	1754	0	0	0.95	-0.70	57.6	10
TELLURIDE	35.4	4.8	20.1	-3.1	52	-23	1384	0	2	0.86	-0.85	50.3	9
PAGOSA SPRINGS	35.5	-5.3	15.1	-8.4	55	-34	1538	0	8	2.72	0.83	143.9	11
SILVERTON	30.7	-10.4	10.2	-3.8	48	-35	1692	0	0	2.15	0.21	110.8	10
WOLF CREEK PASS 1	26.2	0.9	13.5	-8.3	50	-27	1589	0	0	7.29	2.06	139.4	12

Western Valleys

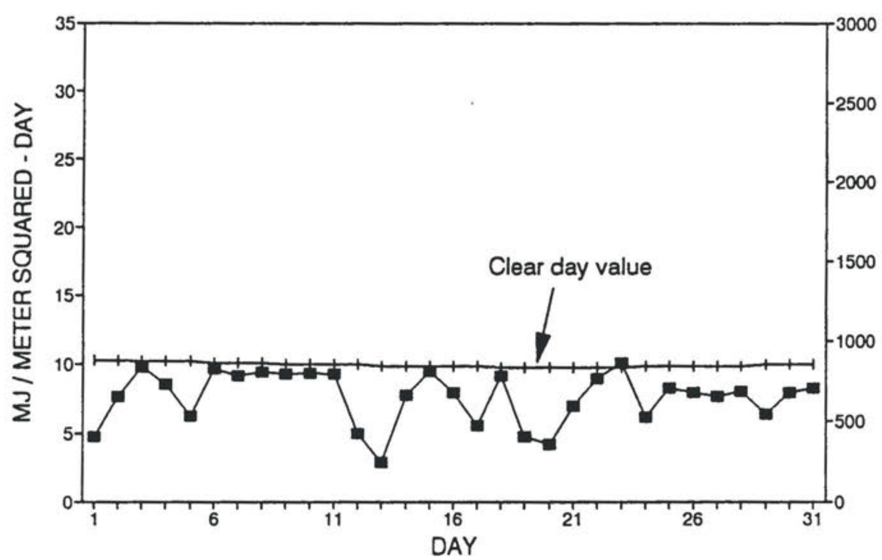
Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	27.8	1.9	14.9	-6.4	58	-31	1547	0	8	1.04	-0.61	63.0	10
HAYDEN	28.2	3.5	15.8	-4.2	54	-33	1518	0	3	1.15	-0.50	69.7	10
MEEKER NO. 2	33.6	5.1	19.4	-5.5	58	-29	1406	0	10	0.49	-0.32	60.5	4
RANGELY 1E	28.2	0.4	14.3	-4.9	49	-26	1563	0	0	0.24	-0.31	43.6	5
EAGLE FAA AP	29.3	-1.0	14.1	-5.8	45	-29	1568	0	0	1.09	0.15	116.0	7
GLENWOOD SPRINGS	30.6	3.4	17.0	-8.0	51	-20	1481	0	1	1.19	-0.26	82.1	8
RIFLE	34.5	2.7	18.6	-6.0	55	-25	1433	0	5	1.07	-0.06	94.7	7
GRAND JUNCTION WS	32.0	9.1	20.6	-7.2	47	-17	1370	0	0	0.98	0.38	163.3	8
CEDAREDGE	35.5	9.0	22.3	-6.0	57	-15	1317	0	5	0.71	-0.29	71.0	9
PAONIA 1SW	33.9	7.6	20.8	-7.8	54	-14	1365	0	3	0.76	-0.75	50.3	9
DELTA	32.7	6.5	19.6	-8.8	47	-17	1400	0	0	0.29	-0.28	50.9	4
GUNNISON	27.4	-5.3	11.0	-2.7	46	-27	1664	0	0	0.40	-0.37	51.9	3
COCHETOPA CREEK	29.2	-5.9	11.7	-2.3	47	-30	1646	0	0	0.60	-0.23	72.3	5
MONTROSE NO. 2	32.1	8.1	20.1	-7.3	48	-16	1385	0	0	0.89	0.19	127.1	7
URAVAN	38.7	9.1	23.9	-6.4	51	-15	1267	0	1	0.45	-0.58	43.7	7
NORWOOD	33.4	6.4	19.9	-4.1	53	-25	1392	0	2	0.93	-0.11	89.4	2
YELLOW JACKET 2W	34.5	9.7	22.1	-5.2	53	-20	1323	0	2	0.87	-0.28	75.7	10
CORTEZ	38.0	6.3	22.1	-5.9	53	-20	1321	0	2	0.52	-0.75	40.9	5
DURANGO	34.6	6.3	20.5	-7.0	55	-21	1373	0	5	2.17	0.18	109.0	12

* 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 1990 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	14	9	8	--	--
Denver	12	13	6	76%	67%
Fort Collins	11	13	7	--	--
Grand Junction	16	8	7	77%	60%
Limon	13	9	9	--	--
Pueblo	14	9	8	64%	72%

FT. COLLINS TOTAL HEMISPHERIC RADIATION
DECEMBER 1990



The Climate of Iraq:

Prior to January 16th I knew embarrassingly little about Iraq. I knew it had a colorful history that puts Colorado's to shame. I had heard of the Tigris and Euphrates Rivers and knew of ancient irrigation systems that even now would amaze us, but that was about it. Now, after hours of intensive television watching and hours of atlas, encyclopedia and other reference reading I have learned a little. Since this is supposed to be a climate report, let me pass along some information I have gathered about the geography and climate of Iraq.

Iraq lies in southwest Asia and shares borders with Iran, Turkey, Syria, Jordan, Saudi Arabia, Kuwait and the Persian Gulf. It extends as far north as 37° N latitude (the same as the southern border of Colorado) and extends south to nearly 29° N latitude (about the same as San Antonio, Texas). The area of Iraq is about 168,000 square miles, a little smaller than Colorado and Nebraska combined. Two famous ancient Rivers, the Tigris and Euphrates, originate north of Iraq in the highlands of eastern Turkey but flow through the entire country from northwest to southeast before eventually joining and spilling into the Persian Gulf. These rivers provide water for extensive irrigated agriculture. The Persian Gulf itself is quite shallow -- only a little deeper than Lake Erie. Much of the country lies at elevations between sea level and about 1000 feet. Elevations rise toward the borders of each surrounding country. Near the Jordanian border elevations are as high as 3000 feet above sea level. High mountains edge the northern border of Iraq with Turkey and northern Iran. A few peaks reach above 12,000 feet.

The climate of Iraq is unlike anything we are familiar with here in Colorado. Summer conditions are painfully hot except in the high elevations in the extreme north. July and August are the hottest months of the year. Daytime high temperatures average between 110° and 115°F at most locations at elevations below 3000 feet. Temperatures will occasionally climb into the 120s. Nighttime brings much cooler temperatures, but lows generally remain in the 70s and sometimes in the 80s except at higher elevations. Cloudiness is rare from June through September and precipitation is almost unheard of. Humidity is very low in many areas, but increases toward the southeast in the river valleys and near the Persian Gulf. Near the Gulf, summer dewpoint temperatures may reach into the 80s making life truly miserable. One might think that with such abundant atmospheric moisture and such strong surface heating that thunderstorms would erupt. However, the summer atmosphere is very thermally stable which almost totally suppresses convection. Also, the prevailing summer winds in Iraq (which are a part of the large Asian monsoon wind pattern) blow from the northwest and keep the moist air from advecting toward the higher elevation areas where convection might be more easily initiated. During the daytime, these winds (which have the common Arabic name "shamal") can be strong enough to carry clouds of dust and sand. At night, however, the winds are often calm. Duststorms, which have their greatest likelihood in July, are probably Iraq's most noteworthy weather phenomenon.

Autumn brings a transition toward more comfortable climatic conditions and also marks the beginning of the "wet" season. Temperatures drop gradually and typically are coolest in January. Midwinter daytime temperatures average in the 40s and 50s in northern parts of the country. Sixties are more typical for southeastern parts of Iraq in January. Minimum temperatures average in the 30s and 40s, but episodic subfreezing temperatures can be expected from November into March. About the coldest it ever gets in the Basrah vicinity is the mid to low 20s. In northern and higher elevation areas of the country, temperatures in the single digits and teens have been reported.

Annual precipitation in Iraq varies from less than 4" along most of the Saudi Arabian border to locally 25-40" in limited high mountain areas along the Iranian border in extreme northeastern Iraq. Basrah and Bagdad each average between 5 and 6" per year (less than Phoenix, AZ), while Mosul averages close to 15" (about the same as Denver, CO). At least 90% of their precipitation falls during the November through April period when storms sweep in from the Mediterranean with reasonable frequency. This is similar to areas of California which also rely on winter precipitation for most of their water supplies. The number of precipitation days each year ranges from less than 20 in the south to more than 60 in the north. Almost 1 day in 3 brings at least scant rainfall to Mosul in January, for example. Most precipitation falls as rain, but intense rainfall rates such as we experience with our summer thunderstorms, are not common. In fact, thunder is only heard a few days each year. Most, if not all, of the country has experienced snowfall. Baghdad gets a snow about one year in five. Mosul gets a taste of snow almost every year. In their northern mountains, snow is commonplace. Snow accumulation can be compared to that in the southern Rockies in New Mexico. It is extremely important for providing surface water supplies but is highly variable from year to year. Fortunately, much of their water supplies originate in eastern Turkey where snow accumulation is somewhat more consistent from year to year.

No place in the United States has a climate that is identical to Iraq. The closest match I can find would be the interior deserts of southern California including places like Palm Springs and Needles. I hope you find this comparison interesting. Next month, I will return to the joys of Colorado climate.

HOW COLD IS COLD

When we speak of temperature, we often refer to it as an object. In reality temperature is a measurement of the relative energy of a system. That system may be some sort of scientific experiment, the air around us, or the coffee in your cup. All of these substances effect our lives in different ways, but it is often the difference in stored energy which concerns us most. Who wants a cold cup of coffee anyway.

Scientist have developed several different measurement scales to define the energy of an object. Each of the scales is based on some sort of constant point which can be recreated in any laboratory. These are most often described as the point where an object changes its physical state. The triple point of water is a good example. This is the temperature where pure water exists as a solid(ice), a liquid, and a gas(water vapor). Most ordinary people know this as 32 degrees Fahrenheit, or zero degrees Celsius. Scientist also refer to this point as 273.15 degrees kelvin, or 491.67 degrees Rankine. In 1954 the International Committee on Weights and Measures adopted this as the zero point for the Celsius scale.

The Fahrenheit and Celsius temperature scales use fixed points of water as there calibration points. The low calibration point is the triple point at a standard pressure. This is officially 0.01 degrees C, and 32.0 degrees F. The upper calibration point is referred to as the boiling point of water at sea level. This point equates to 100 degrees C, and 212.0 degrees F. All thermometers are calibrated so that these points are the same no matter what type of method is used in the temperature measurement. The temperature levels between these fixed points is the divided into equal segments known as degrees.

The kelvin and Rankine scales are referred to as absolute scales. The zero point on these scales is meant to reflect the point where all molecular movement has ceased. This point is useful in that it produces a scale which is always positive. For thermodynamic equations it is very helpful. The Rankine scale can be thought of as a extension of the Fahrenheit scale because one degree of rankine temperature difference is equal to one degree of temperature difference in the Fahrenheit scale. The difference is that the zero for the Rankine scale is equal to -459.67 degrees F. This is the same type of difference in for the kelvin and Celsius scales with the exception that 0 degrees kelvin is equal to -273.15 degrees C.

deg. F = 32.0 + (9/5)*deg. C
deg. R = (9/5)*deg. K
deg. R = deg. F + 459.67
deg. K = deg. C + 273.15

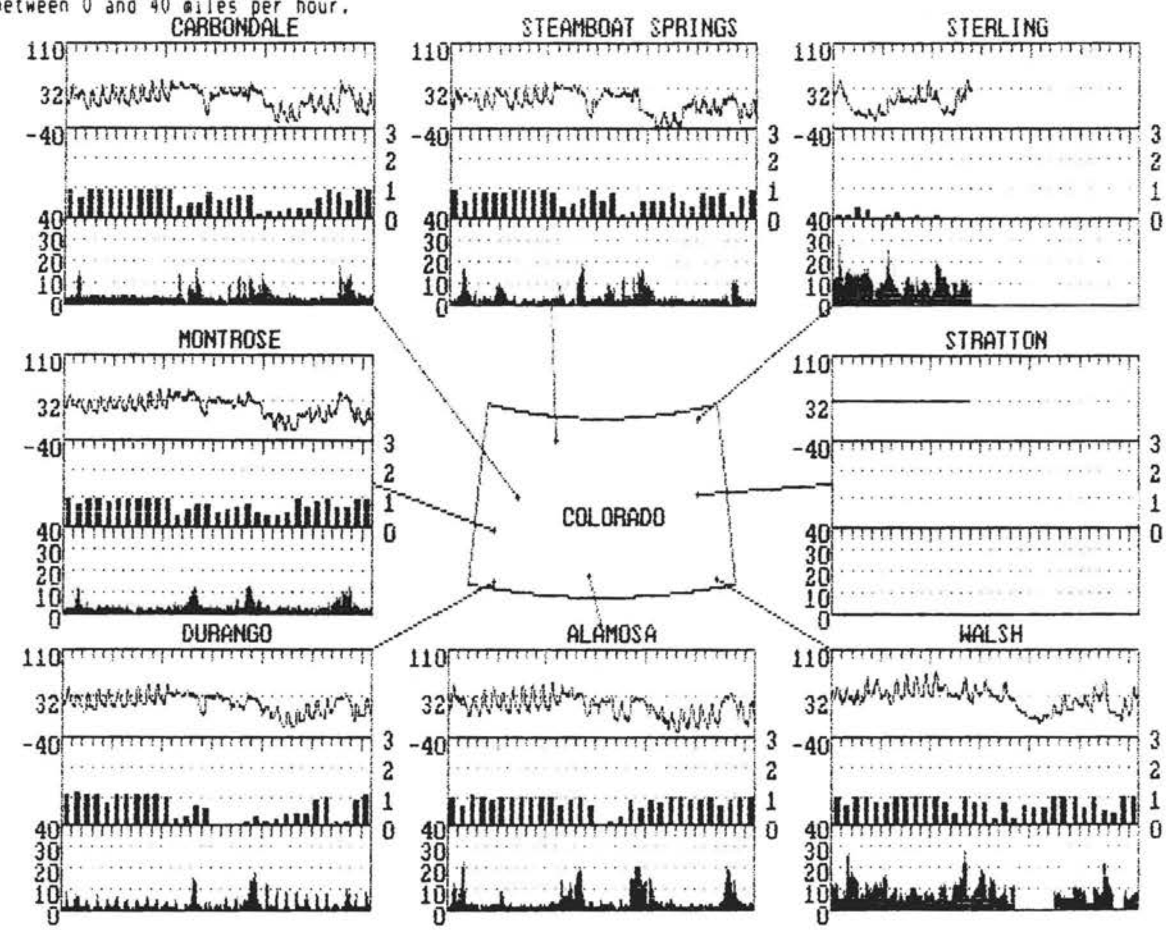
These conversion equations for temperature are useful to remember when working in the scientific community. They also help the average person understand the incredible temperatures used in research. Without the ability to accurately gauge temperature in the extreme ranges scientific research into superconductors, genetics, and nuclear physics would not be possible. Next time you see an article on superconductors, or the sun, stop and think about the level of temperature involved.

This article was written by Carl Rogers of the Joint Center for Energy Management. Information on acquiring our weather data for the state of Colorado can be obtained by writing Carl Rogers at the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder Co. 80309-0428.

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature ('F)								
	13.0	17.0	12.9	18.1	6.8	20.6	32.0	25.7
monthly temperature extremes and time of occurence ('F day/hour)								
maximum:	51.8 11/15	50.5 10/15	44.8 10/16	49.8 11/15	41.5 11/15	66.0 11/15	32.0 1/ 1	71.6 11/15
minimum:	-32.3 24/ 7	-22.5 23/ 8	-28.3 22/ 8	-23.3 24/ 8	-39.5 23/ 8	-26.7 22/ 7	32.0 1/ 1	-15.0 22/ 2
monthly average relative humidity / dewpoint (percent / 'F)								
5 AM	77 / -4	86 / 6	86 / 2	62 / 7	84 / -3	37 / -8	0 /-40	71 / 9
11 AM	55 / 6	57 / 13	68 / 8	60 / 12	75 / 3	29 / -4	0 /-40	55 / 15
2 PM	41 / 5	56 / 14	48 / 9	51 / 12	60 / 6	27 / -1	0 /-40	47 / 16
5 PM	42 / 3	59 / 12	57 / 8	52 / 9	63 / 4	29 / -6	0 /-40	53 / 13
11 PM	65 / -2	82 / 8	92 / 5	78 / 9	82 / 1	35 / -7	0 /-40	68 / 9
monthly average wind direction (degrees clockwise from north)								
day	200	202	204	214	143	215	0	168
night	186	84	182	146	117	222	0	207
monthly average wind speed (miles per hour)								
	4.43	2.67	3.07	2.99	2.60	8.87	0.00	7.70
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	443	530	533	491	559	47	744	80
3 to 12	226	181	194	243	153	538	0	486
12 to 24	75	20	13	6	20	150	0	93
> 24	0	0	0	0	0	9	0	5
monthly average daily total insolation (Btu/ft²·day)								
	801	609	629	752	631	5961	0	765
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	185	103	126	151	124	0	0	138
40-60%	45	28	42	44	65	1	0	75
20-40%	39	51	54	75	55	0	0	43
0-20%	25	105	68	12	34	0	0	23

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

JANUARY 1991

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 14 Number 4

January in Review:

Snow storms were few and far between in January, and no frigid polar outbreaks affected all of Colorado. However, there was also a shortage of mild days. The snow that fell was slow to melt, and fog formed on several days. The month ended up colder than average over most of the State, especially on the Western Slope. There was very little precipitation in the mountains and across the northeastern plains. However, lower elevation areas from Meeker to Montrose in west central Colorado and a few areas east of the mountains ended up snowier than average.

Colorado's March Climate:

You will be pleased to know that you won't be hearing as many weather forecasts calling for air pollution in March. We've had plenty of light winds and stagnant air this winter, but now that should decrease. Increasing daylength and solar energy join together with increased atmospheric water vapor and episodic storm systems to keep the atmosphere stirred up. You've probably heard this piece of weather folklore before, but it is well worth repeating since it carries so much truth: "As the days grow longer, the storms grow stronger." That is always a good forecast for March.

March can bring dangerous blizzards to the Colorado eastern plains. But it also brings very important moisture that benefits the entire State. Snows are usually quite heavy over all mountainous areas of Colorado, and moisture at lower elevations both east and west of the mountains (mostly wet snow but also some rain) is normally on the increase. The result is that a typical March contributes more toward statewide water supplies than any other winter month. March of 1990 was a good example. Rains and heavy snows lifted several parts of Colorado out of the grip of developing drought. There is a flip side, however. Occasionally the March snows fail to materialize as was the case in 1989. Under those infrequent circumstances, parts of the State can quickly move toward drought. Assuming near normal conditions, March precipitation ranges from a low of 0.25-0.50" (3-8" snow) in the San Luis Valley and 0.50-1.00" (5-15" snow) in the western valleys to 0.60-2.00" (7-30" snow) on the eastern plains up into the foothills and tops out at 2.00-5.00" (30-80" snow) in the high mountains.

Temperatures are on the rise in March, but Colorado temperatures (especially in the mountains and along the Front Range) rise more gradually than in many areas of the central U.S. Low elevation areas can look forward to some lovely sunny and mild days with temperatures reaching the 70° mark. But there are also going to be some cloudy, damp and uncomfortably cold days. Big day-to-day changes are a trademark of this time of year. For the month as a whole, daytime temperatures average in the 50s at elevations below 6,000 feet with nighttime lows mostly in the 20s. Areas between 6000 and 9000 feet average in the 40s during the day and in the teens at night. Higher areas above 9000 feet remain firmly in winter's grip with highs averaging in the 30s with lows typically in the single digits and sometimes below zero.

Cooperative Weather Observers -- It's Your Centennial:

I warned you a few months ago that I would bombard you with a few stories about the history of weather observations in Colorado. Well folks, the time has come. This is, afterall, the Centennial of the Cooperative Weather Observing Program--that unique system of thousands of volunteers and cooperators who observe and record the weather each and every day from all across our country--urban and rural, mountains and plains, coastal and continental. Back in fiscal year 1891, the U.S. Weather Bureau was formed within the U.S. Department of Agriculture. That marked the start of a consistent nationwide climate monitoring effort. Some weather data were being collected prior to that date. But that was the year the commitment was made to systematically monitor our nation's climate, recognizing it as a true natural resource. Sometime I'll tell you about the earlier weather observations -- Fort Massachusetts, Fort Lyons, the U.S. Signal Service, the first telegraphic weather observation from Denver in 1871, the Pikes Peak observatory, etc., etc. There are lots of good stories to tell. But for now, we'll start in the 1880s, just a few years before the U.S. Weather Bureau was established.

(continued on page 52)

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

Date	Event
1-10	Skies were clear statewide on the 1st and temperatures climbed into the 50s and 60s east of the mountains. But cold air remained locked in western Colorado with lows below zero and highs mostly in the 20s. While western Colorado enjoyed more cold sunshine on the 2nd, the first of 3 successive invasions of shallow arctic air slipped quickly across eastern Colorado. "Upslope" conditions developed producing widespread fog with local light snow and some freezing drizzle. Fog and cold persisted 3-4th with local picturesque rime icing. Clouds also increased in the west as warmer but moist air advanced eastward from a storm over California. Wet snow fell heavily on the 4th depositing 6" at Grand Junction, 11" at Glenwood Springs, 16" at Yellow Jacket and more than 2 feet in parts of the San Juan Mountains. Dillon received only 1" and just a few flakes fell east of the mountains. Skies began clearing on the 5th. Fog left the plains only to return again on the 6th with the next brief push of arctic air. Temperatures were seasonally chilly statewide 7-8th. Cold air again backed onto the plains later on the 8th, and a little snow fell in the mountains. The 9th was chilly and some snowflakes fell as a low pressure trough moved eastward across New Mexico. About 2" of snow fell over extreme southeastern Colorado as the storm reorganized.
11-14	High pressure persisted over the Colorado plateau and a low pressure trough prevailed east of the mountains. Westerly "downslope" breezes produced mild temperatures east of the mountains, especially on the 12-13th with highs in the 50s and 60s. Disturbances aloft triggered a little snow each day in the northern and central mountains. Steamboat Springs totalled about 8" of snow during the period. On the 14th parts of southeastern Colorado picked up close to 1/3 of an inch of moisture as an area of rain and snowshowers spread eastward.
15-18	A jetstream disturbance over the Pacific northwest quickly formed a low pressure area over the 4-corners area which then dropped southward away from Colorado on the 17th. The northern and central mountains picked up a few inches of snow 15-16th and parts of the Front Range had a brief burst of snow late on the 15th. Denver received 2-5" of snow but Pueblo and Colorado Springs were barely dusted. With northerly winds aloft, Colorado's western valleys again filled with cold, stable air. Cold temperatures east of the mountains on the 17th began to moderate on the 18th.
19-21	A strong and fast-moving cold front approached Colorado from the northwest. Parts of the state warmed briefly in advance of the front with the help of downslope winds. Canon City and Trinidad both hit 60°F on the 19th. Snow began in the mountains during the day. Several inches fell in the northern and central mountains. Snow moved southward along the Front Range during the evening. Two to six inches of snow fell along most of the Front Range but was generally less than 2" over the plains. Skies cleared on the 20th and cold remained in place statewide on the 21st.
22-27	Cold and wintery weather continued as the jet stream directed air from Alaska southeastward toward the Rockies and the Great Plains. New cold fronts dropped southward on the 22nd and again on the 24th. Moisture was in short supply, but some snow accompanied each system. Boulder added 3" of snow early on the 25th. The cold was also accompanied by strong winds in the mountains and breezy periods across the plains especially 25-27th. Single digit minimum temperatures were common at lower elevations with many subzero readings in the mountains. Taylor Park Reservoir had the coldest temperature in the State with -32°F early on the 26th.
28-31	Temperatures were just starting to moderate on the 28th when one last arctic airmass blasted into Colorado accompanied by 1-3" of fluffy snow. Temperatures on the plains stayed in the teens on the 29th, and subzero readings were widespread early on the 30th. Fort Morgan dipped to -6°, Grand Junction -7° and Fraser reached -25°. As the month ended, frigid air remained trapped in the western valleys, but a sharp warming trend began east of the mountains. Pueblo soared to 66°F on the 31st, the warmest in the state.

January 1991 Extremes

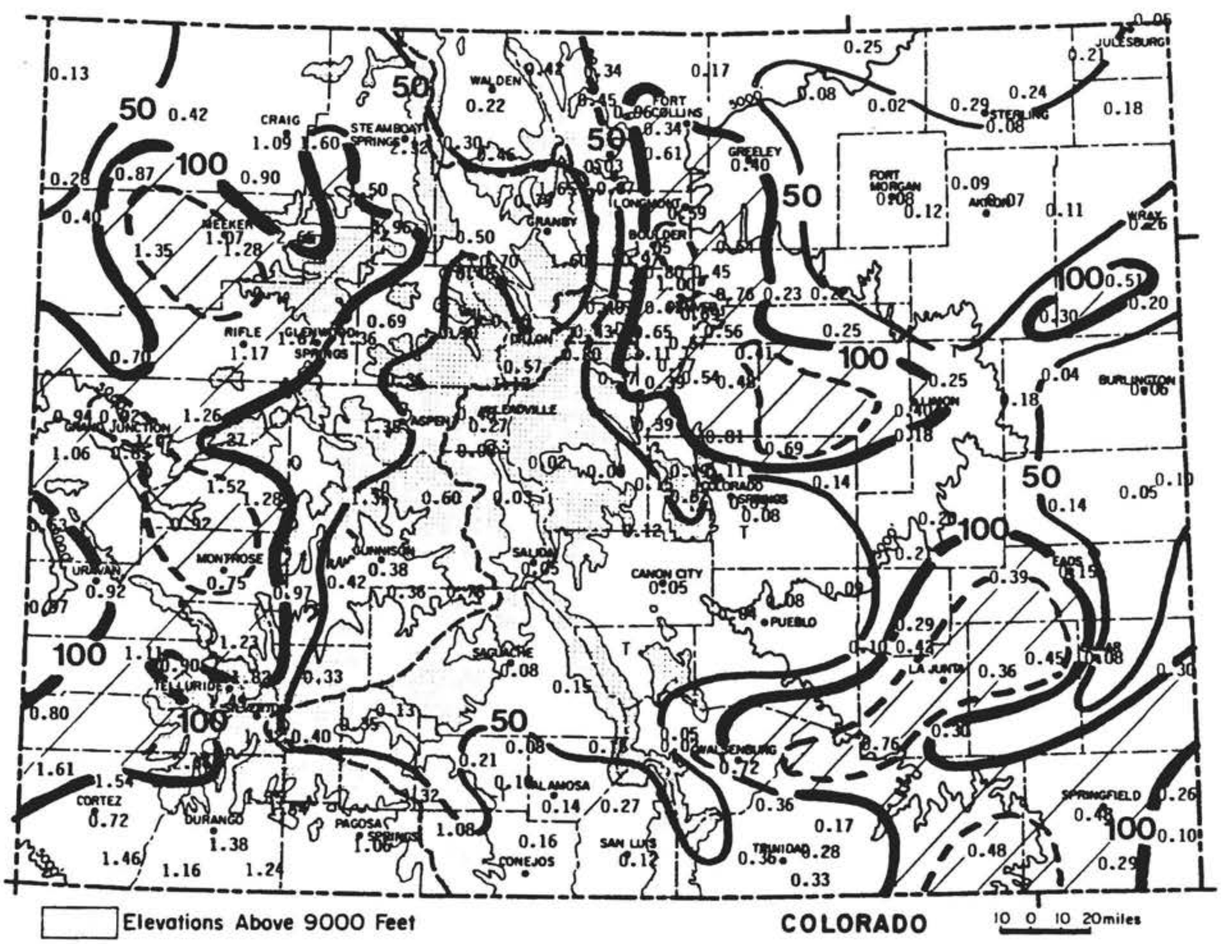
Highest Temperature	66°F	January 31	Pueblo WSO AP
Lowest Temperature	-32°F	January 26	Taylor Park Reservoir
Greatest Total Precipitation	3.32"		Wolf Creek Pass 1E
Least Total Precipitation	Trace		Westcliffe and several other locations
Greatest Total Snowfall*	43"		Marvine Ranch
Greatest Depth of Snow*	69"	January 29	Pinos Mill

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

<u>J A N U A R Y   1 9 9 1   P R E C I P I T A T I O N</u>

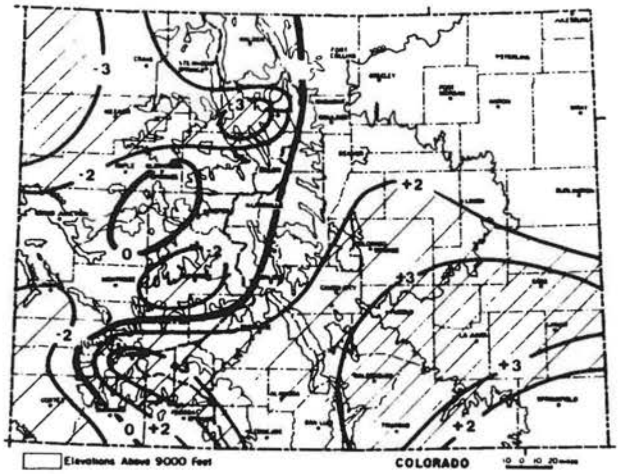
January delivered a very unusual pattern of precipitation to Colorado. Nearly all mountain areas and most of the northeastern plains were well below average with several stations reporting less than 50% of average. But at the same time, low elevation precipitation was above average in a number of locations both east and west of the mountains. Most Western Slope weather stations from Massadona to Ouray reported above average precipitation. The majority of the moisture there fell from just one storm on January 4th. There were no big storms east of the mountains. Several small snows in late January brought monthly totals above their average from Loveland south to Monument. Areas of southeastern Colorado were also above average due mostly to a nice rain on the 14th. Please remember that so little moisture normally falls east of the mountains in January that above average numbers don't mean that much. John Martin Dam, for example, reported 321% of their January average even though their monthly total was only 0.45".

Greatest		Least	
Wolf Creek Pass 1E	3.32"	Monte Vista Refuge, Shaw, Fort Carson Westcliffe	Trace
Rico	2.66"	Antero Reservoir	0.02"
Marvine Ranch	2.65"	Sheep Mountain	0.02"
Steamboat Springs	2.32"	New Raymer	0.02"
Bonham Reservoir	2.27"		
Yampa	1.96"		



Precipitation amounts (inches) for January 1991 and contours of precipitation as a percent of the 1961-1980 average.

Drier than average areas expanded a little in January, but most of Colorado remains near or above average in terms of accumulated precipitation since October 1, 1990. Of the 208 official weather stations with complete water year statistics, 45 stations were quite wet (>130% of average), 53 locations were a little wetter than average (111-130%), 58 sites were near average (90-110% of average), 42 stations were drier than average (70-89%) and only 10 locations were very dry (<70% of average). The only areas that are noticeably drier than average are extreme southwestern Colorado, parts of the upper Gunnison Valley, and a larger area extending from Buena Vista, Leadville and Breckenridge northward to Winter Park, Estes Park and Fort Collins. While precipitation totals look pretty good, snowpack accumulation is lagging behind. As of the end of January, statewide mountain snowpack as reported by the Soil Conservation Service was just 77% of average.

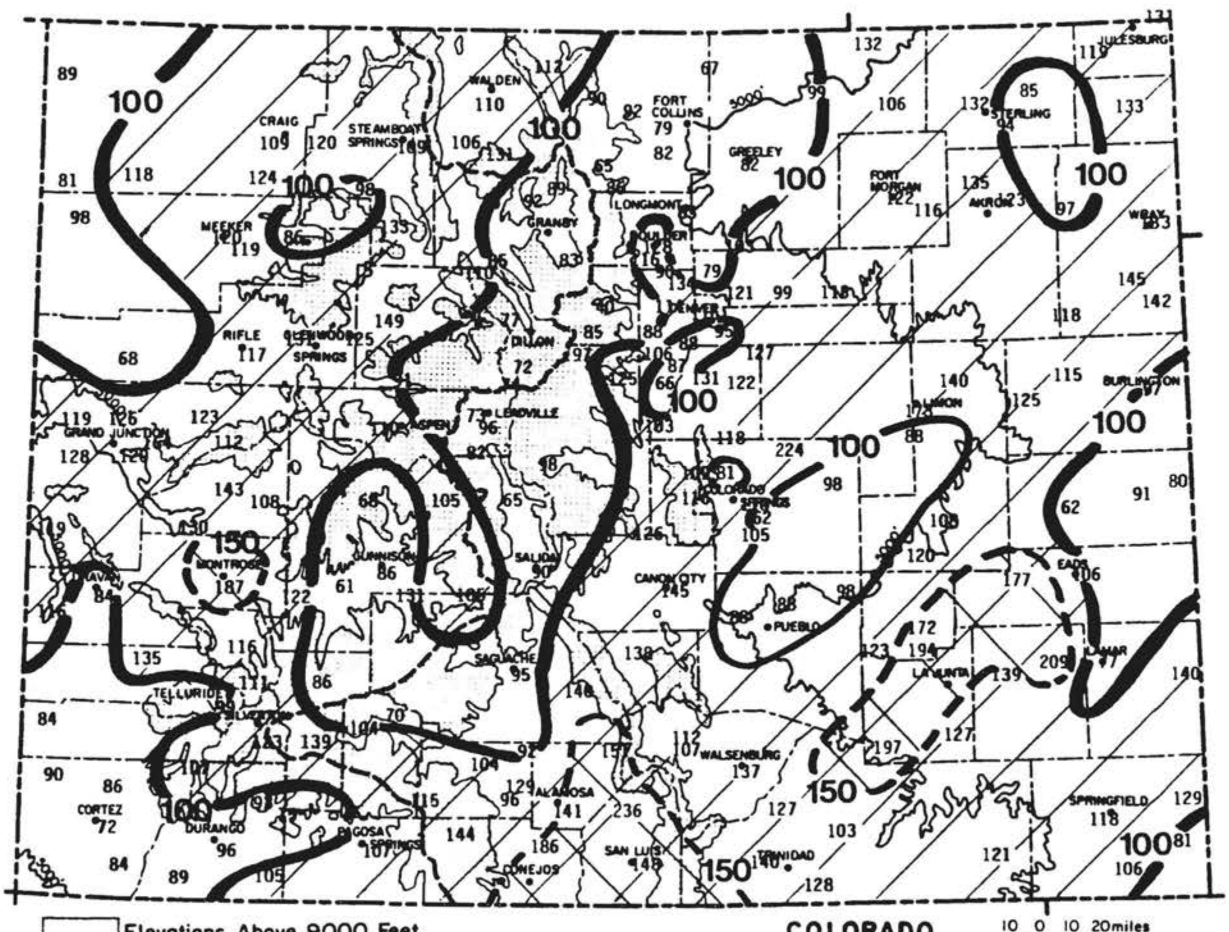


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

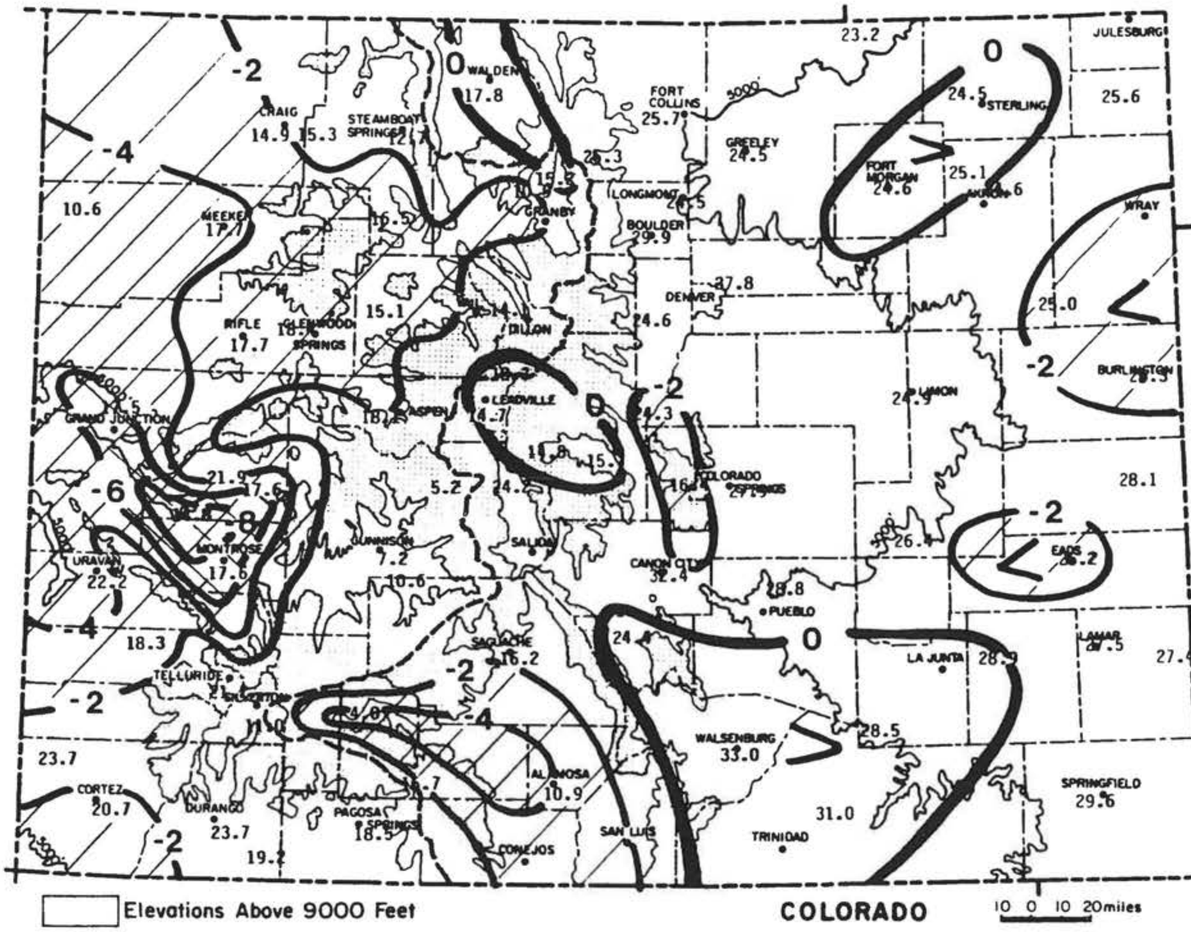
Index	Interpretation
	extremely wet
+4	----------------
+3	ample moisture
+2	----------------
+1	
0	near normal
-1	
-2	----------------
	moderate drought
-3	----------------
	severe drought
-4	----------------
	extreme drought



Precipitation for October 1990 through January 1991 as a percent of the 1961-1980 average.

JANUARY 1991 TEMPERATURES AND DEGREE DAYS

There were few days in January that were severely cold, but there was also a shortage of warm days. East of the mountains the mercury managed to surpass the 50-degree mark on a few days, but on the Western Slope warm days were very hard to come by. The highest temperature all month at Grand Junction was only 35°F. Even Climax and Wolf Creek Pass got warmer than that indicating the presence of strong midwinter temperature inversions which were frequent all month. For the month as a whole, temperatures ended up near or a little below average east of the mountains. The higher mountains stayed near average. Meanwhile, on the Western Slope, many valleys remained unusually cold. Grand Junction and Montrose were each about 6 degrees below their respective averages. Delta, which had unusually deep snowcover all month, had 17 nights with subzero temperatures, almost as many as Fraser, and ended up more than 10 degrees colder than average.



December 1990 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

JANUARY 1991 SOIL TEMPERATURES

Soil temperatures remained cold in January, and frost penetration was a little deeper than average.

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.

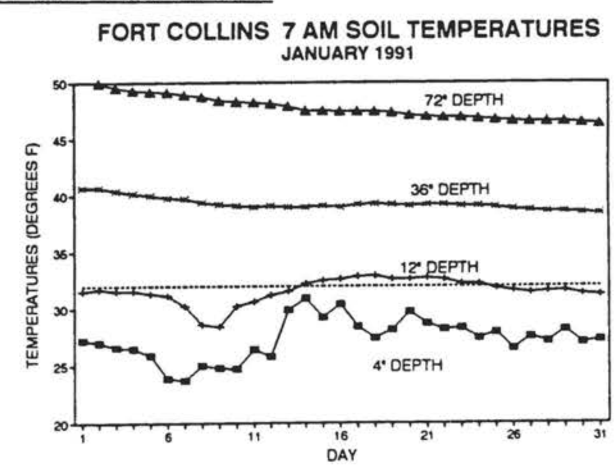


Table 1. Heating Degree Day Data through January 1991 (base temperature, 65°F).

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

STATION		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	ANN
GRAND LAKE 6SSW	AVE	214	264	468	775	1128	1473	1593	1369	1318	951	654	384	10591
	89-90	168	306	427	768	1132	1449	1401	1205	1043	833	689	266	9687
	90-91	264	268	350	774	1071	1605	1668						6000
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	89-90	1	2	166	454	729	1230	985	922	787	449	275	9	6009
	90-91	14	2	62	450	723	1309	1246						3806
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	89-90	61	155	341	749	1069	1574	1647	1254	906	672	540	188	9156
	90-91	65	179	264	771	1059	1664	1787						5789
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	89-90	0	0	99	323	684	1176	1030	887	638	309	188	2	5336
	90-91	4	0	21	308	624	1220	1113						3290
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	89-90	285	412	545	880	1138	1507	1499	1265	1188	920	793	377	10809
	90-91	331	402	464	861	1141	1556	1550						6305
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	89-90	1	6	204	508	762	1252	1078	991	815	555	364	33	6569
	90-91	36	11	96	491	745	1280	1237						3896
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	89-90	2	8	200	484	749	1302	1048	994	917	552	319	25	6600
	90-91	24	11	101	481	727	1284	1249						3877
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	89-90	0	41	198	543	869	1261	1169	1071	795	507	387	91	6932
	90-91	9	23	121	511	885	1406	1458						4413
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	89-90	0	10	110	439	768	1156	1186	895	654	425	285	27	5955
	90-91	0	3	81	470	804	1385	1460						4203
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	89-90	24	118	284	646	964	1298	1491	1160	873	630	524	164	8176
	90-91	44	108	177	608	910	1538	1432						4817
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	89-90	0	0	94	373	676	1204	964	877	695	394	233	2	5512
	90-91	1	0	34	360	610	1243	1116						3364
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	89-90	0	2	103	473	E 830	1130	1191	923	657	392	281	37	6019
	90-91	0	4	69	474	824	1433	1462						4266
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	89-90	18	117	315	M	974	1533	1580	1332	971	658	576	M	M
	90-91	129	E 110	255	700	1013	1683	1613						5503
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	89-90	0	3	144	428	719	1254	1074	1026	760	427	275	8	6118
	90-91	17	7	68	437	725	1359	1244						3857
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	88-89	72	175	270	644	869	1264	1273	1023	922	664	509	145	7830
	89-90	117	179	267	635	972	1384	1351						4905
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	89-90	0	1	111	369	633	1153	980	874	681	420	266	8	5496
	90-91	4	6	46	334	654	1160	1048						3252
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	89-90	132	279	461	802	1075	1490	1359	1287	1068	796	674	273	9696
	90-91	202	258	332	794	1028	1550	1459						5623
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	89-90	0	2	117	345	581	1047	848	800	666	408	289	10	5113
	90 91	15	8	53	311	543	1047	985						2962

* = 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
ALAMOSA	AVE	40	100	303	657	1074	1457	1519	1182	1035	732	453	165	8717
	89-90	17	82	271	698	1001	1400	1554	1089	880	640	480	105	8217
	90-91	59	118	201	633	990	1597	1671						5269
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	89-90	68	176	303	671	974	1365	1365	1086	915	697	543	171	8334
	90-91	134	146	234	652	964	1462	1444						5036
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	89-90	1	0	E 139	M	E 567	E1064	E 776	E 925	E 760	502	321	21	M
	90-91	32	13	81	338	589	1161	1081						3295
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	89-90	39	112	270	628	812	1202	1184	991	857	660	518	106	7379
	90-91	66	130	226	641	905	1326	1256						4550
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	89-90	0	4	E 130	415	684	1229	990	957	757	459	280	3	5908
	90-91	10	4	76	407	M	1249	1223						M
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	89-90	0	0	131	379	584	1076	859	827	687	421	325	22	5311
	90-91	14	12	58	382	548	1098	1004						3116
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	89-90	0	4	172	473	699	1163	966	928	805	526	345	24	6105
	90-91	28	21	83	473	663	1256	1142						3666
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	89-90	0	16	142	494	850	1166	1222	959	776	490	377	59	6551
	90-91	1	6	151	539	774	1321	1364						4156
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	89-90	4	46	235	586	892	1420	1319	1257	879	530	453	144	7765
	90-91	14	18	116	606	876	1547	1544						4721
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	89-90	M	M	M	330	M	M	1161	865	626	355	237	22	M
	90-91	0	2	58	416	751	1400	1549						4176
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	89-90	0	0	153	424	658	1160	879	882	781	469	265	7	5678
	90-91	12	3	64	388	623	1209	1143						3442
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	89-90	226	357	502	861	1124	1495	1506	1271	1124	886	764	349	10465
	90-91	284	355	430	858	1071	1587	1569						6154
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	89-90	2	19	106	520	789	1133	1278	965	724	479	359	44	6418
	90-91	4	28	118	481	832	1373	1274						4110
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	89-90	1	60	217	593	896	1348	1286	986	806	545	269	68	7075
	90-91	15	23	134	583	934	1568	1536						4793
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	89-90	49	118	325	657	818	1221	1115	1030	932	662	513	140	7580
	90-91	120	131	219	591	803	1330	1244						4438
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	89-90	0	3	169	458	711	1166	930	910	848	495	307	19	6016
	90-91	19	6	74	460	690	1284	1212						3745
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	89-90	0	2	156	416	721	1285	1087	1010	776	450	274	10	6187
	90-91	18	7	63	421	730	1343	1248						3830
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	89-90	0	0	40	316	729	1103	1124	820	557	271	139	20	5119
	90-91	0	0	28	360	759	1370	1464						3981

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

JANUARY 1991 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	36.8	9.6	23.2	-2.0	56	-9	1289	0	9	0.25	-0.06	80.6	7
STERLING	38.0	11.1	24.5	1.6	59	-3	1244	0	11	0.29	-0.05	85.3	5
FORT MORGAN	38.5	10.6	24.6	1.9	58	-6	1248	0	13	0.08	-0.10	44.4	2
AKRON FAA AP	37.9	12.3	25.1	0.2	64	-2	1229	0	20	0.09	-0.19	32.1	4
AKRON 4E	38.3	10.9	24.6	-0.2	58	-6	1249	0	15	0.07	-0.19	26.9	2
HOLYOKE	38.5	12.7	25.6	-0.7	61	-4	1214	0	20	0.18	-0.20	47.4	3
JOES	37.8	12.2	25.0	-3.0	60	-3	1234	0	17	0.30	0.00	100.0	2
BURLINGTON	36.2	14.4	25.3	-3.4	60	2	1223	0	13	0.06	-0.18	25.0	2
LIMON WSMO	39.2	10.6	24.9	0.4	59	-4	1237	0	15	0.40	0.11	137.9	5
CHEYENNE WELLS	40.2	16.1	28.1	0.0	62	1	1133	0	19	0.05	-0.11	31.2	2
EADS	36.7	13.7	25.2	-2.5	55	4	1225	0	5	0.15	-0.12	55.6	4
ORDWAY 21N	40.6	12.2	26.4	-1.5	61	1	1190	0	20	0.21	-0.02	91.3	4
LAMAR	41.0	14.1	27.5	-0.7	61	3	1153	0	16	0.08	-0.30	21.1	4
LAS ANIMAS	41.8	15.9	28.9	0.6	63	5	1113	0	22	0.36	0.15	171.4	4
HOLLY	40.3	14.4	27.4	0.5	62	-2	1160	0	18	0.30	0.10	150.0	4
SPRINGFIELD 7WSW	41.6	17.7	29.6	-1.2	61	4	1088	0	24	0.48	0.14	141.2	3
TIMPAS 13SW	39.3	17.8	28.5	-1.8	57	5	1124	0	11	0.76	0.39	205.4	5

Foothills/Adjacent Plains

	Temperature						Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
FORT COLLINS	38.8	12.6	25.7	-0.7	54	-2	1212	0	5	0.34	-0.10	77.3	4
GREELEY UNC	36.1	12.9	24.5	-1.6	55	-2	1246	0	4	0.40	0.02	105.3	5
ESTES PARK	35.6	17.0	26.3	-0.5	49	-9	1192	0	0	0.03	-0.41	6.8	3
LONGMONT 2ESE	38.1	10.8	24.5	-1.2	54	-6	1249	0	7	0.59	0.18	143.9	5
BOULDER	42.3	17.5	29.9	-1.6	58	-2	1081	0	17	1.05	0.42	166.7	6
DENVER WSFO AP	41.4	14.3	27.8	-0.7	59	-4	1143	0	17	0.76	0.25	149.0	11
EVERGREEN	41.6	7.5	24.6	-1.5	59	-7	1244	0	10	0.65	0.17	135.4	6
CHEESMAN	43.5	5.0	24.3	-2.1	56	-6	1253	0	5	0.39	-0.03	92.9	5
LAKE GEORGE 8SW	33.2	-1.7	15.7	0.2	43	-14	1519	0	0	0.06	-0.17	26.1	1
ANTERO RESERVOIR	32.9	-3.3	14.8	0.5	43	-11	1549	0	0	0.02	-0.13	13.3	1
RUXTON PARK	31.6	1.2	16.4	-4.1	45	-17	1497	0	0	0.52	-0.02	96.3	7
COLORADO SPRINGS	40.7	15.2	27.9	0.0	58	2	1142	0	13	0.09	-0.15	37.5	2
CANON CITY 2SE	46.7	18.0	32.4	-1.1	61	0	1004	0	39	0.05	-0.23	17.9	1
PUEBLO WSO AP	43.8	13.7	28.8	-0.2	66	1	1116	0	43	0.08	-0.14	36.4	2
WESTCLIFFE	41.9	6.9	24.4	2.4	54	-6	1252	0	3	0.00	-0.38	0.0	0
WALSENBURG	46.6	19.4	33.0	1.1	63	-1	985	0	28	0.72	0.18	133.3	6
TRINIDAD FAA AP	45.5	16.5	31.0	0.5	61	5	1048	0	29	0.17	-0.24	41.5	5

Mountains/Interior Valleys

	Temperature						Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
WALDEN	30.3	5.3	17.8	2.7	41	-18	1459	0	0	0.22	-0.41	34.9	7
LEADVILLE 2SW	29.0	0.5	14.7	0.2	42	-11	1550	0	0	0.27	-0.93	22.5	9
BUENA VISTA	39.5	9.0	24.2	-1.5	50	-2	1256	0	0	0.03	-0.24	11.1	1
SAGUACHE	31.8	0.7	16.2	-1.7	40	-10	1502	0	0	0.08	-0.19	29.6	3
HERMIT 7ESE	22.6	-14.6	4.0	-6.3	38	-30	1821	0	0	0.35	-0.47	42.7	2
ALAMOSA WSO AP	28.3	-6.6	10.9	-3.9	37	-19	1671	0	0	0.14	-0.11	56.0	5
STEAMBOAT SPRINGS	27.9	-2.5	12.7	-1.8	40	-25	1613	0	0	2.32	-0.41	85.0	15
YAMPA	27.5	5.5	16.5	-2.4	36	-14	1495	0	0	2.12	1.05	198.1	14
GRAND LAKE 1NW	28.7	1.7	15.2	0.4	42	-21	1537	0	0	1.65	-0.34	82.9	19
GRAND LAKE 6SSW	24.2	-2.4	10.9	-2.1	33	-28	1668	0	0	0.79	-0.32	71.2	14
DILLON 1E	29.1	-0.9	14.1	-1.4	47	-15	1569	0	0	0.46	-0.40	53.5	8
CLIMAX	25.8	0.6	13.2	0.5	37	-17	1601	0	0	1.12	-1.11	50.2	13
ASPEN 1SW	32.0	4.2	18.1	-1.9	44	-7	1444	0	0	1.35	-1.15	54.0	11
TAYLOR PARK	25.3	-14.9	5.2	3.1	33	-32	1847	0	0	0.60	-0.84	41.7	7
TELLURIDE	38.4	4.0	21.2	0.1	49	-8	1351	0	0	1.49	-0.21	87.6	10
PAGOSA SPRINGS	37.6	-0.5	18.5	-1.7	48	-20	1432	0	0	1.06	-0.82	56.4	5
SILVERTON	34.8	-12.7	11.0	-0.4	43	-25	1666	0	0	1.32	-0.29	82.0	7
WOLF CREEK PASS 1	30.7	0.6	15.7	-1.2	41	-9	1521	0	0	3.32	-0.41	89.0	7

Western Valleys

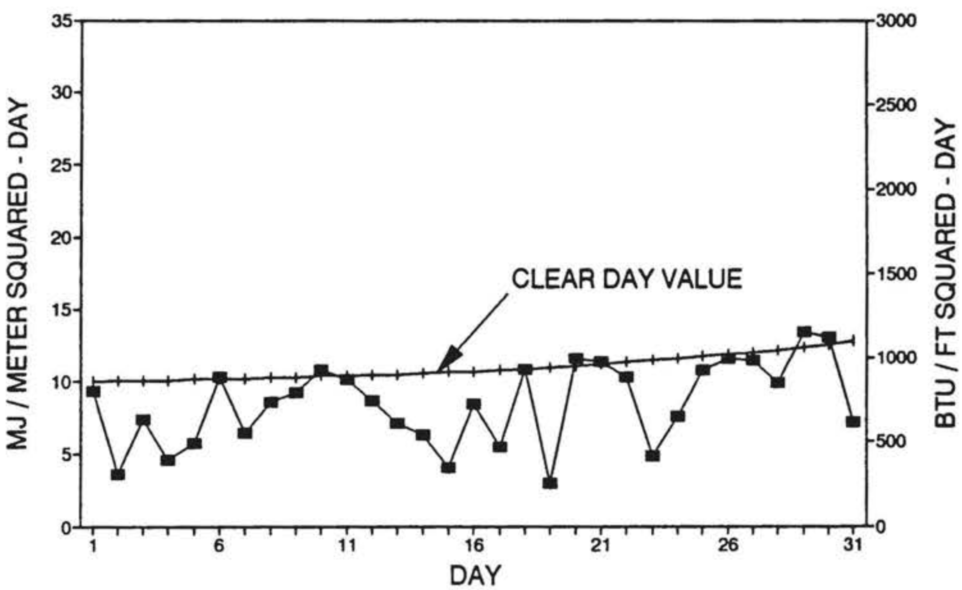
Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	26.5	3.4	14.9	-2.1	36	-15	1544	0	0	1.09	-0.21	83.8	12
HAYDEN	27.4	3.2	15.3	-1.0	38	-26	1531	0	0	1.60	0.11	107.4	12
MEEKER NO. 2	31.2	4.3	17.7	-4.5	39	-16	1458	0	0	1.07	0.26	132.1	5
RANGELY 1E	22.6	-1.4	10.6	-5.0	35	-17	1680	0	0	0.40	-0.13	75.5	5
EAGLE FAA AP	31.0	-0.7	15.1	-3.0	40	-15	1536	0	0	0.69	-0.19	78.4	5
GLENWOOD SPRINGS	31.3	5.5	18.4	-4.2	37	-8	1435	0	0	1.67	0.09	105.7	11
RIFLE	33.4	1.9	17.7	-3.3	43	-10	1462	0	0	1.17	0.27	130.0	8
GRAND JUNCTION WS	28.9	6.2	17.5	-6.2	35	-7	1464	0	0	0.92	0.34	158.6	7
CEDAREDGE	35.7	8.2	21.9	-3.5	44	-4	1327	0	0	1.52	0.66	176.7	6
PAONIA 1SW	31.5	3.8	17.6	-6.7	39	-10	1463	0	0	1.28	0.06	104.9	8
DELTA	27.8	1.8	14.8	-10.2	36	-10	1549	0	0	0.92	0.57	262.9	2
GUNNISON	23.5	-9.2	7.2	-1.1	36	-17	1787	0	0	0.38	-0.47	44.7	4
COCHETOPA CREEK	28.4	-7.1	10.6	2.0	42	-17	1679	0	0	0.36	-0.45	44.4	4
MONTROSE NO. 2	28.0	7.2	17.6	-6.3	41	-4	1460	0	0	0.75	0.25	150.0	6
URAVAN	36.5	8.0	22.2	-5.3	48	-3	1320	0	0	0.92	-0.08	92.0	7
NORWOOD	32.6	4.0	18.3	-3.1	38	-10	1441	0	0	1.11	0.03	102.8	3
YELLOW JACKET 2W	36.9	10.5	23.7	-0.2	45	-1	1273	0	0	1.61	0.35	127.8	5
CORTEZ	35.9	5.4	20.7	-3.8	43	-11	1364	0	0	0.72	-0.31	69.9	6
DURANGO	36.4	11.0	23.7	-0.8	47	-4	1274	0	0	1.38	-0.42	76.7	5
IGNACIO 1N	31.9	6.5	19.2	-1.5	39	-4	1410	0	0	1.24	-0.13	90.5	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.

JANUARY 1991 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	12	9	10	--	--
Denver	12	8	11	63%	72%
Fort Collins	12	12	7	--	--
Grand Junction	10	7	14	60%	58%
Limon	13	8	10	--	--
Pueblo	10	13	8	65%	75%

FT. COLLINS TOTAL HEMISPHERIC RADIATION
JANUARY 1991



In Colorado's first decade of statehood, interest in climate was growing. The railroad brought more people to our young state, agriculture expanded, mining was booming, water disputes were common, and people were discovering health benefits from our high-elevation, low humidity climate. In 1885 the Colorado Meteorological Association (CMA) was chartered. This group, composed primarily of learned men of science and medicine, set out to establish a network of volunteer weather observers from across Colorado. Names of some of the original members of the CMA included Prof. F.H. Loud from Colorado Springs, Charles Denison, M.D. from Denver, W.A. Jayne, M.D. from Georgetown, Professor C.F. Davis from Fort Collins and R.B. Arbogast, M.D. from Breckenridge. One woman's name was listed as a member in 1888 -- Mrs. S.J. Dunbar of Colorado Springs. By the end of 1888, at least 25 volunteer weather stations had been established. With the help of a State appropriation of $2000 in 1889, more weather instruments were purchased and additional weather observers were recruited across the State.

The CMA put out an interesting monthly report called COLORADO WEATHER that was similar our current publication, COLORADO CLIMATE. I wish I had the space to reprint some of their editorials and features. Their admonitions to those early weather observers were especially interesting. Let me quote from the lead paragraph of the December 1888 issue of COLORADO WEATHER. "It is unquestionably the case that the people of Colorado are awaking to a sense of the advantage which may be gained from our climate, by knowing about it ourselves and by letting others know it. And the demand for such knowledge must enable us to organize better means of supply. Let the observers who have given such excellent evidence of their own interest .... set out upon the new year with an enlarged motive for perseverance, and take each for his motto, 'Exactness, Continuity, Thoroughness.'"

Many of the early observers had trouble living up to this motto. Only a few of those earliest volunteers continued for many years. But it was the beginning, and when the Weather Bureau took over the program in 1891 there was already nearly 90 "official" weather stations mailing in their reports at the end of each month. With a budget for purchasing new instruments and a staff to visit prospective weather observers and train them in proper technique, the network in Colorado expanded to more than 150 stations by 1910. The first Golden Age of climatology ensued (we may be experiencing our second right now) as the U.S. Department of Agriculture took seriously their commitment to defining the climate of our vast nation. With 20 to 30 years of data available, the USDA compiled a number of excellent climate summaries and atlases, some of which have never yet been improved upon.

Priorities then changed. U.S. involvement in two wars reduced the number of cooperative weather observers and the national commitment to the Cooperative Program. But with the technological era that followed World War II, climate data again rose in national importance. By 1970 there were more than 300 official weather stations in Colorado. In more recent years, fiscal constraints have essentially ended expansion of the network of "official" cooperative weather stations. However, general interest in observing our weather is still high and growing. Literally thousands of Coloradans now own weather instruments and at least casually monitor our climate.

As we mark the 100th year of national commitment to the Cooperative Program, it is fitting to recognize the important contribution made by these weather observers. Taking quality weather observations is no trivial matter. Setting aside time each day, every day of the year, year after year, to read thermometers, raingages, snow stakes, etc. and record the readings is not very glamorous. But because people have been willing to give their time in this way, we now have many decades of valuable data that are used for countless purposes. I plan to dedicate a feature story in the very near future to list just a few very important ways that data collected by the Cooperative Program helps Colorado. You may be surprised.

Please join the National Weather Service, the Colorado Climate Center and the Colorado Agricultural Experiment Station in celebrating this special Centennial. Throughout the coming months we will be publicizing the Cooperative Program as much as we can as we lead up to a centennial celebration and awards ceremony in Fort Collins on June 8, 1991. This centennial will honor all weather observers and cooperators. Special awards are being planned for communities where cooperative weather stations have been maintained for a full 100 years. This includes Canon City, Rocky Ford, Las Animas, Lamar, Cheyenne Wells, Greeley, Fort Collins, Gunnison, Delta, Montrose and Durango. In addition, several individual weather observers who have committed many years of their lives to the Cooperative Program will be recognized. Believe it or not, we have several people in Colorado who have been taking official weather observations for more than 40 years.

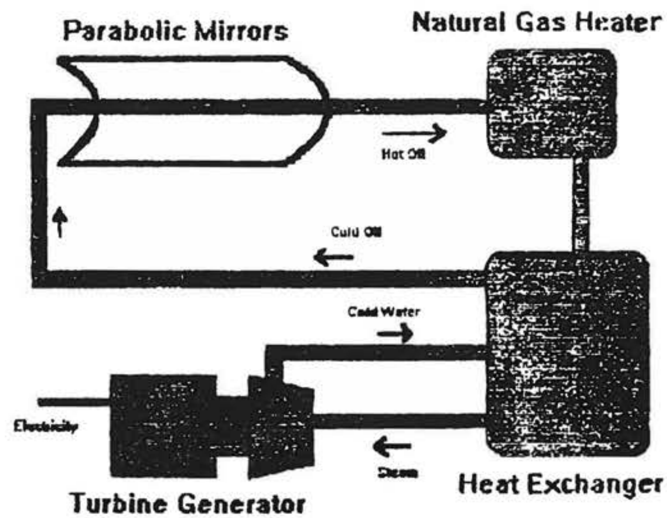
Plan on participating in this unique celebration in whatever way you can. If you are a weather observer, a friend, or just someone who loves Colorado's climate, plan on attending the Centennial this summer (we will be providing a schedule of activities in the weeks ahead). We are lining up some very interesting speakers including some of the observers themselves. You won't want to miss it. If you, your agency or your business rely on the climate data that these cooperators gather, figure out a way to express your gratitude to these fine individuals. Perhaps you could offer to drive an observer here to Fort Collins. Let us know and we'll match you up with an observer from your area. All expenses for this Centennial will be covered by co-sponsors and private contributions, so that's another important way you can help. All contributions are fully tax-deductible. (Contact the Colorado Climate Center at (303) 491-8545 for details on how to make contributions). Just do whatever you can to let these people know how much we appreciate them.

Let's Talk LUZ

The next time you land your space shuttle at Edwards Air Force Base, watch out for the light of Luz's 2 million mirrors. They can be quite blinding. Also, try not to roar your engines too much and cause the mirrors to break. The mirrors cost about $100 each.

Two million mirrors at $100 each, is somebody that vain? No, they are that smart. They are using the biggest nuclear fusion reactor within ninety three million miles of us, without worry. They do not even have to worry about the storage of nuclear waste. The sun supplies the 400 acres of mirrors with enough energy to produce ninety percent of the world's solar thermal power production.

As shown in the picture to the right, the mirror focuses the suns energy on a pipe suspended above the mirror. The pipe, which is glass enclosed, carries Therminol, a synthetic oil. The oil is heated to 735 degrees Fahrenheit and is sent to a heat exchanger where it boils water and creates steam. The steam then spins a turbine which creates the electricity. At times when the Therminol can not be completely heated by the sun, it is further heated by a natural gas heater. The system works in much the same way as coal, oil, or nuclear power plants.



The obvious plus of the LUZ system is that it creates no waste and does not depend on foreign countries for its power. LUZ stations could feasibly be built throughout the southwest and western United States. They would not be as effective in the southeast because of haze and cloud cover. Considering that the nine operating plants are enough to supply roughly half a million American homes with power, plants throughout the U.S. would drastically cut the use of none renewable energy sources.

Another obvious plus of the LUZ station is that it has the greatest output when southern California needs the energy most. Its peaks performance is when the demand for air conditioning is the greatest.

Solar generating stations like those designed by LUZ are win win situations. We are using a renewable energy source without causing any damage to the enviornment. For every acre LUZ uses, it buys and sets aside five acres. LUZ generating stations makes it a little easier to live in comfort without damaging the enviornment.

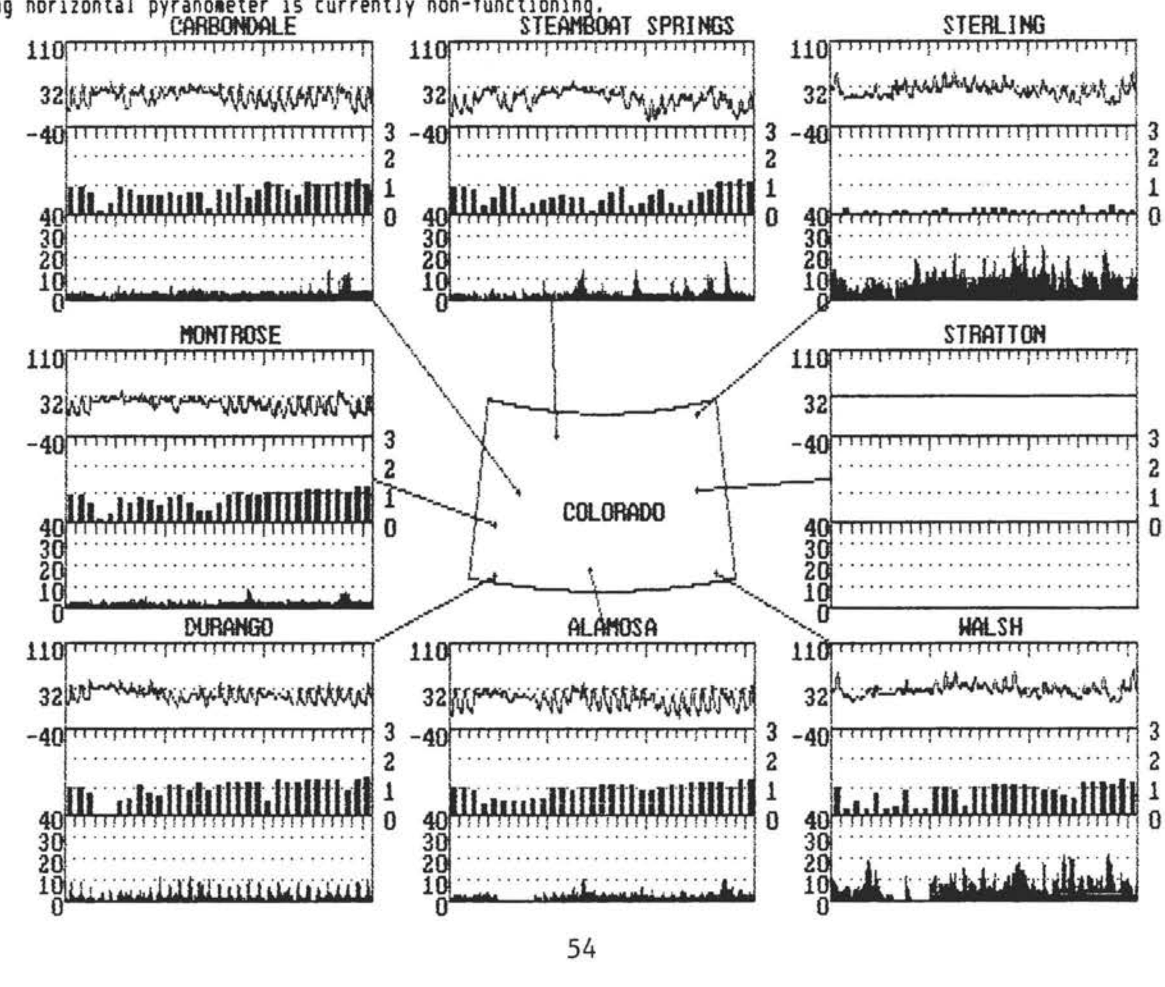
This article was written by Erika Komito of the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, CO. 80309-0428. Information in acquiring our weather data can be obtained by writing Carl Rogers at this address, or using your PC to call the Wthrnet Bulletin Board, (303)492-3525.

WTHRNET WEATHER DATA JANUARY 1991

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (xF)	13.0	17.0	12.9	18.1	6.8	20.6		25.7
monthly temperature extremes and time of occurence (xF day/hour)								
maximum:	51.8 11/15	50.5 10/15	44.8 10/16	49.8 11/15	41.5 11/15	66.0 11/15		71.6 11/15
minimum:	-32.3 24/ 7	-22.5 23/ 8	-28.3 22/ 8	-23.3 24/ 8	-39.5 23/ 8	-26.7 22/ 7		-15.0 22/ 23
monthly average relative humidity / dewpoint (percent / xF)								
5 AM	77 / -4	86 / 6	86 / 2	82 / 7	84 / -3	37 / -8		71 / 9
11 AM	55 / 6	57 / 13	68 / 8	60 / 12	75 / 3	29 / -4		55 / 15
2 PM	41 / 5	56 / 14	48 / 9	51 / 12	60 / 6	27 / -1		47 / 16
5 PM	42 / 3	59 / 12	57 / 8	52 / 9	63 / 4	29 / -6		53 / 13
11 PM	65 / -2	82 / 8	82 / 5	78 / 9	82 / 1	35 / -7		68 / 9
monthly average wind direction (degrees clockwise from north)								
day	200	202	204	214	143	215		168
night	186	84	182	146	117	222		207
monthly average wind speed (miles per hour)	4.43	2.67	3.07	2.99	2.60	8.87		7.70
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	443	530	533	491	559	47		80
3 to 12	226	181	194	243	153	538		486
12 to 24	75	20	13	6	20	150		93
> 24	0	0	0	0	0	9		5
monthly average daily total insolation (Btu/ft}yday)	801	609	629	752	631			765
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	185	103	126	151	124			138
40-60%	45	28	42	44	65			75
20-40%	39	51	54	75	55			43
0-20%	25	105	68	12	34			23

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 -40xF to 110xF, the middle one gives the daily total solar radiation on a horizontal surface, up to 4000 Btu/ft)/day, and the bottom graph illustrates the hourly average wind speed between 0 and 40 miles per hour. Stratton station is currently non-functioning and all data should be disregarded. Sterling horizontal pyranometer is currently non-functioning.



COLORADO CLIMATE

FEBRUARY 1991

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 14 Number 5

February in Review:

February was unusually dry and sunny over most of Colorado. The majority of the State received less than 50% of average precipitation. Several areas on the plains received no moisture at all. A pair of mid-month mountain storms and a minor snowstorm for the Front Range and eastern plains on the 24th were the only opportunities for moisture all month. Strong temperature inversions remained over the Western Slope during the first half of February, and temperatures there ended up near average for the month. The rest of Colorado enjoyed February temperatures 4 to 8 degrees warmer than average.

Colorado's April Climate:

It is a safe bet that April weather will give us something to talk about. It is, perhaps, the most climatically creative month of the year. A combination of winterlike snowstorms, springlike showers and wind, summerlike thunderstorms, and temperatures which cannot make up their mind will definitely keep us on our toes. Weather changes occur rapidly and sometimes with little warning. There have been days in April when temperatures were in the 70s and 80s during the afternoon and by night it was snowing. We can expect some lovely mild and sunny days when you'll think you are in heaven. But April is also known for its occasional episodes of cloudy, chilly, dreary weather when you will think you're in Michigan. All-in-all, it is a pretty fun month.

April precipitation is very important to Colorado. Most April precipitation in the mountains falls as snow, but at lower elevations storms begin as rain and sometimes change to snow. Precipitation intensities tend to be light to moderate, and temperatures are usually cool during moisture episodes. As a result, most of the moisture sinks into the ground. The Western Slope typically receives from 0.75" to 1.50" of moisture in April which helps "green up" the native vegetation. Rains and wet snows usually contribute 1-2" of moisture east of the mountains bringing the wheat and the rangeland to life. In the mountains, 2-5" of moisture add to the winter snowpack. April is the snowiest month of the year in parts of the eastern foothills. One-day snowfalls of 1-2 feet are not too unusual. Colorado's remarkable 24-hour snowfall record of 75.8" was set at Silver Lake back on April 15, 1921. April moisture is usually reliable, but when it fails to dampen the plains then we become vulnerable to one of our least favorite type of April storms -- duststorms.

Temperatures in April are on their way up, but huge day-to-day changes tend to hide the seasonal rise. Averaged over the month, expect daytime temperatures to be in the 50s and 60s at elevations below 7,500 with 30s at night. From 7,000 to 9,000 feet, 40s and 50s are most likely with 20s at night. The higher mountains are still wintery with highs in the 30s and 40s and lows still in the teens. The mountain snows begin to melt below 10,000 feet, but the main spring runoff usually waits until May.

Climatic Data -- Who Uses It?

The phone rings in our office thousands of times each year as people call for information about our climate. We try to answer those questions as best we can while still performing our primary Climate Center functions of statewide climate monitoring, data archiving, research, publication and coordination. We use any source of data we can get our hands on as we answer these climate requests, but in many cases the best available data are the records that have been collected by the Cooperative Weather Observers in Colorado.

(continued on page 63)

F E B R U A R Y   1 9 9 1   D A I L Y   W E A T H E R

Date	Event
1-11	A dry period statewide with lots of sunshine, little wind, and low humidity as a large ridge of high pressure covered the Western U.S. Strong nocturnal radiational cooling helped maintain a cold, stable airmass across western Colorado. Temperatures dropped to near or below zero each night in many valleys, but daytime temperatures rebounded nicely. Day-night temperature differences of 40 to 50 degrees were common. Meanwhile, eastern Colorado enjoyed consistently above average temperatures with highs in the 50s and 60s and lows in the teens and 20s. Weak upper-air disturbances delivered no precipitation but did increase cloudiness over the State on the 1st, 3rd, and 6-8th.
12-13	Clouds increased on the 12th in advance of a strong but fast moving upper level storm system. Snows developed during the day in the northern and central mountains and became quite heavy in several northwest-facing basins. A surface low pressure area developed but quickly passed east of Colorado by early on the 13th. Dry winds swept across the eastern foothills and plains on the 13th as mountain snows continued. Climax received 17" of fluffy snow. Winter Park added 13" and Yampa 10". Little snow reached the southern mountains.
14-15	Strong northwest winds aloft continued and produced some lingering snows in the northern mountains. Then an arctic cold front slipped into northeastern Colorado on the 14th and created a few hours of upslope breezes along the Front Range. Only a trace of snow fell before the cold air quickly retreated on the 15th replaced by more sunshine and mild temperatures.
16-19	Dense clouds spread over Colorado as a developing storm system took shape west of the Rockies. Eastern Colorado enjoyed mild temperatures on the 16th. Lamar's temperature shot up to 77°, and Las Animas enjoyed the hottest temperature in the State for the month, 79°F. Rain began by evening on the Western Slope and spread as snow into the mountains. By the morning of the 17th a deep low pressure area was directly over Colorado, but it moved too quickly eastward to draw much moisture to the Front Range and eastern plains. Most mountain areas received 3-12" of new snow with the heaviest snows mostly in the southwestern mountains. Cedaredge received 12" of snow. Ouray picked up 14.7" of wet snow with 1.36" of water content. Cold rains developed during the afternoon in northeast Colorado -- 0.35" fell near Sedgwick. The main storm system was east of Colorado by the 18th, but the upper level trough remained overhead producing cold, unsettled weather with local snowshowers. A small area of moderate snow developed along the southern Front Range. Westcliffe was the big winner with 11" of new snow. Skies cleared on the 19th. Several areas awoke to their coldest temperature of the month. Taylor Park hit -27°, the coldest in the State, but Crested Butte was right behind with -26°.
20-22	Warm temperatures made a comeback, but strong winds swept across the Front Range and eastern plains on the 20th. Temperatures climbed into the 50s and 60s at lower elevations with even some 70s in southeast Colorado.
23-25	Shallow cold air slipped into eastern Colorado on the 23rd while the Western Slope enjoyed a lovely day. Then a disturbance dropped down from the north on the 24th bringing colder temperatures statewide and periods of snow (mostly light) in the northern and central mountains and along the Front Range and eastern plains. Denver got about 1" of sloppy snow but as much as 6" fell west of Boulder and 3-4" from Trinidad out across parts of Las Animas County. Brisk northerly winds and cold temperatures continued on the 25th. It was 4° in Pueblo that morning and -11° at Antero Reservoir.
26-28	Dry with seasonal temperatures 26-27th. Then increasing clouds and warmer as a strong storm system, the first in a long time, pushed inland across California on the 28th. Low elevation rains and mountain snows began late in the day in Western Colorado.

February 1991 Extremes

Highest Temperature	79°F	February 16	Las Animas
Lowest Temperature	-27°F	February 19	Taylor Park Reservoir
Greatest Total Precipitation	1.51"		Bonham Reservoir
Least Total Precipitation	0.00		Fort Morgan, Briggsdale and other locations
Greatest Total Snowfall*	29.4"		Climax
Greatest Depth of Snow**	67"		Pinos Mill

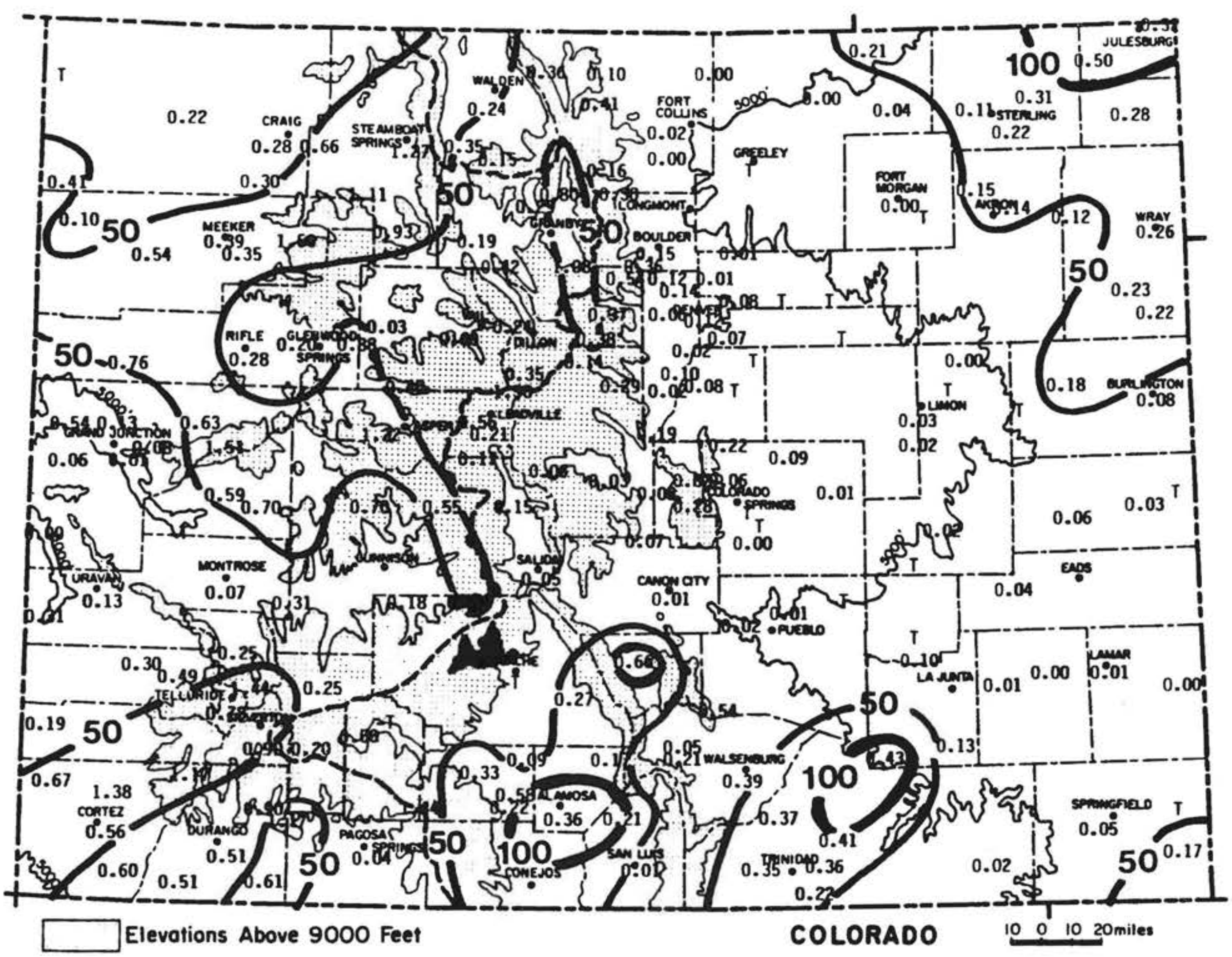
* For existing weather stations with complete daily records. Higher values are likely for unmonitored locations.

** From Soil Conservation Service Snowcourses.

F E B R U A R Y   1 9 9 1   P R E C I P I T A T I O N

February does not have a reputation in Colorado for delivering lots of moisture. This year, a couple of snowstorms in mid February helped keep the ski industry happy. Otherwise, snow was in very short supply over the entire State. The majority of Colorado ended up with less than 50% of February's average precipitation. Numerous weather stations east of the mountains received no measurable moisture during the month. A few locations did end up close to average: parts of the San Luis Valley, a small area northeast of Trinidad, Westcliffe (where a single storm dropped 11" of snow late on the 18th), and extreme northeastern Colorado. These areas usually receive less than 0.50" of moisture in February, so being near normal still didn't mean that much moisture fell. Two locations in the mountains, Yampa and Ouray, ended up close to average for the month. But other locations like Pagosa Springs and Eagle nearly missed out on any precipitation. Pagosa Springs' 0.04" total tied for the driest February in their recorded history.

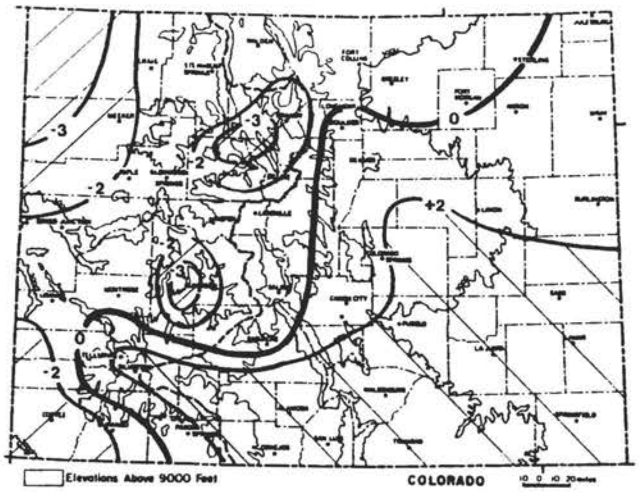
Greatest		Least	
Bonham Reservoir	1.51"	Briggsdale, Fort Morgan, Holly, John Martin Dam, Nunn	0.00"
Marvine Ranch	1.50"		
Climax	1.50"		
Wolf Creek Pass 1E	1.44"	Bennett 2ESE, Brush, Byers and many others	Trace
Ouray	1.44"		



Precipitation amounts (inches) for February 1991 and contours of precipitation as a percent of the 1961-1980 average.

1991 WATER YEAR PRECIPITATION

After getting off to a good start in the fall, precipitation has been declining during the past 3 months. Precipitation totals for the first 5 months of the 1991 water year are still above average in several areas, and near LaJunta a few stations have had more than 150% of their average precipitation. However, areas that are below average have been expanding and now include most of the northern and central mountains, the northwest and southwest corners of the State, most of the Front Range, and parts of the eastern plains. Estes Park, Crested Butte and Breckenridge have received only 62%, 62%, and 63% of their average water year precipitation, respectively.

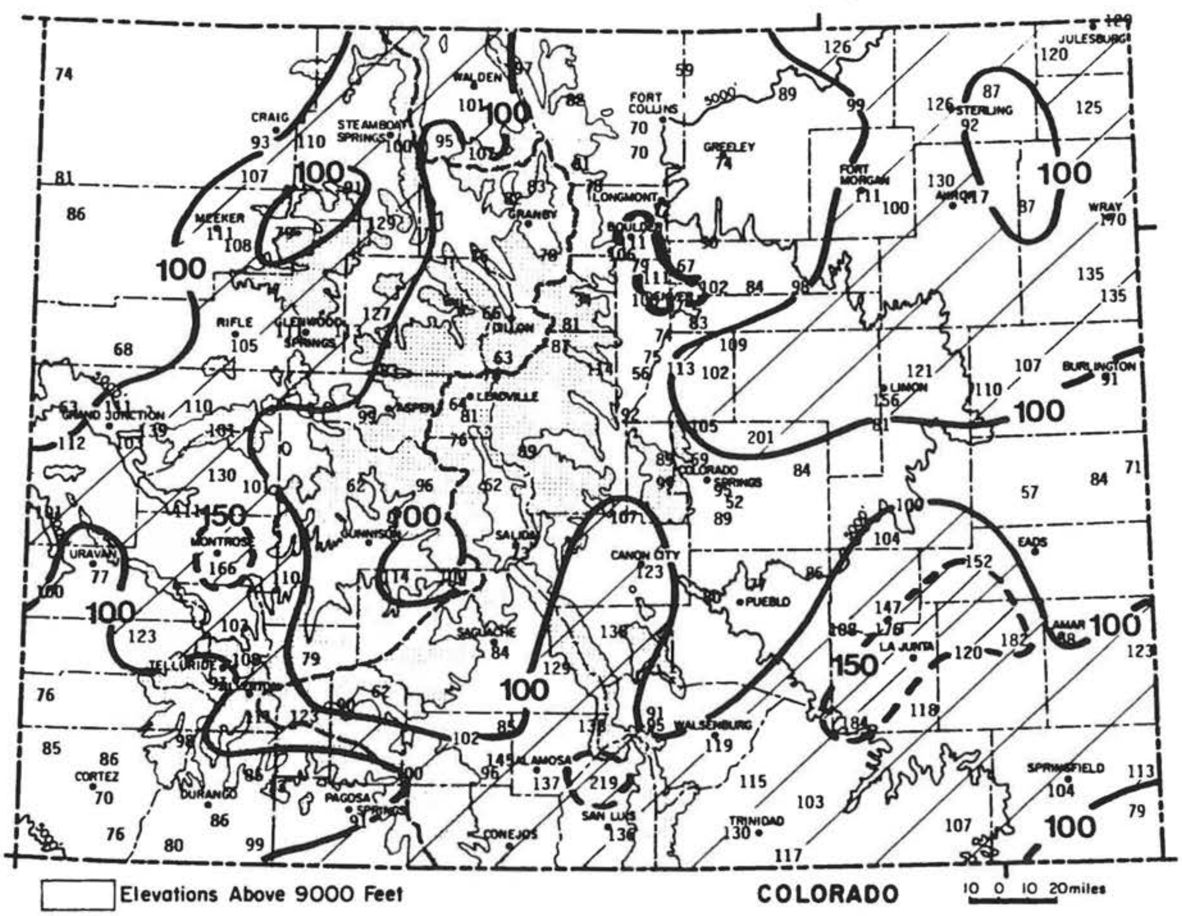


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

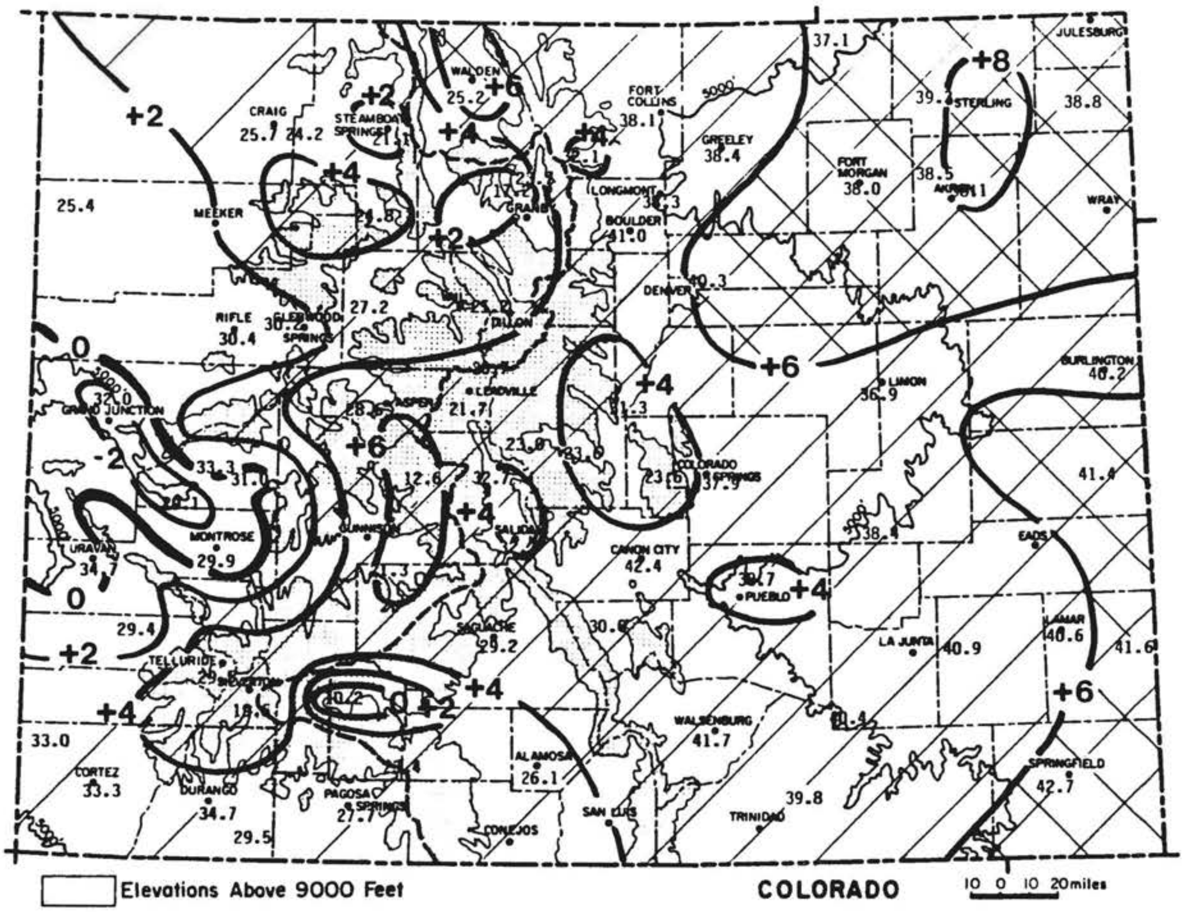
Index	Interpretation
	extremely wet
+4	----------------
+3	ample moisture
+2	----------------
+1	
0	near normal
-1	
-2	----------------
	moderate drought
-3	----------------
	severe drought
-4	----------------
	extreme drought



Precipitation for October 1990 through February 1991 as a percent of the 1961-1980 average.

FEBRUARY 1991 TEMPERATURES AND DEGREE DAYS

Radiational cooling permitted some very cold nighttime temperatures in the mountain valleys, but east of the mountains there were no episodes of subzero temperatures all month. Even in the mountains, temperatures rose above the freezing point nearly every day. February temperatures ended up slightly below average in the valleys of west central Colorado but were much above average from the mountains eastward across the plains. Denver's monthly mean temperature of 40.3°F was more than six degrees above the average and was 18 degrees warmer than Feb. 1989, the year of the "Alaska Blaster." This ranked as the 6th warmest February in Denver since 1900. Sterling's 39.3° monthly temperature was almost 9 degrees warmer than average, second only to 1954. Grand Lake 1 NW was more than 5 degrees warmer than average, also second only to 1954 as the warmest February since their station was started in 1939.



February 1991 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

FEBRUARY 1991 SOIL TEMPERATURES

Soil temperatures had been running colder than usual this winter, but the warm weather in February nearly got the frost out of the ground before the end of 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
FEBRUARY 1991

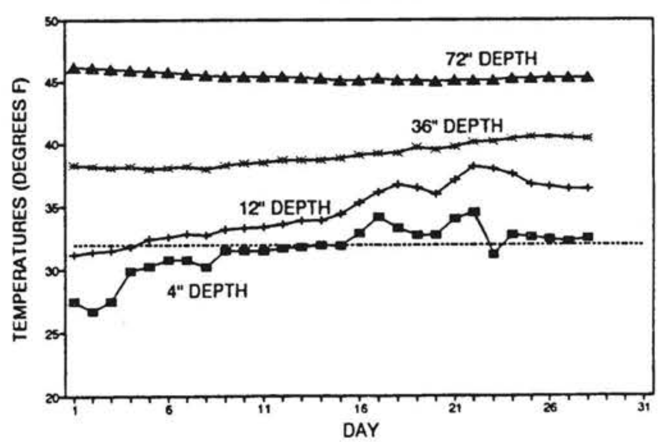


Table 1. Heating Degree Day Data through February 1991 (base temperature, 65°F).

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
	89-90	17	82	271	698	1001	1400	1554	1089	880	640	480	105	8217
	90-91	59	118	201	633	990	1597	1671	1081					6350
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	89-90	68	176	303	671	974	1365	1365	1086	915	697	543	171	8334
	90-91	134	146	234	652	964	1462	1444	1013					6049
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	89-90	1	0 E	139	M E	567 E	1064 E	776 E	925 E	760	502	321	21	M
	90-91	32	13	81	338	589	1161	1081	667					3962
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	89-90	39	112	270	628	812	1202	1184	991	857	660	518	106	7379
	90-91	66	130	226	641	905	1326	1256	896					5446
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	89-90	0	4 E	130	415	684	1229	990	957	757	459	280	3	5908
	90-91	10	4	76	407	M	1249	1223	688					M
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	89-90	0	0	131	379	584	1076	859	827	687	421	325	22	5311
	90-91	14	12	58	382	548	1098	1004	626					3742
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	89-90	0	4	172	473	699	1163	966	928	805	526	345	24	6105
	90-91	28	21	83	473	663	1256	1142	750					4416
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	89-90	0	16	142	494	850	1166	1222	959	776	490	377	59	6551
	90-91	1	6	151	539	774	1321	1364	879					5035
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	89-90	4	46	235	586	892	1420	1319	1257	879	530	453	144	7765
	90-91	14	18	116	606	876	1547	1544	1095					5816
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	89-90	M	M	M	330	M	M	1161	865	626	355	237	22	M
	90-91	0	2	58	416	751	1400	1549	998					5174
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	89-90	0	0	153	424	658	1160	879	882	781	469	265	7	5678
	90-91	12	3	64	388	623	1209	1143	684					4126
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	89-90	226	357	502	861	1124	1495	1506	1271	1124	886	764	349	10465
	90-91	284	355	430	858	1071	1587	1569	1220					7374
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	89-90	2	19	106	520	789	1133	1278	965	724	479	359	44	6418
	90-91	4	28	118	481	832	1373	1274	842					4952
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	89-90	1	60	217	593	896	1348	1286	986	806	545	269	68	7075
	90-91	15	23	134	583	934	1568	1536	1052					5845
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	89-90	49	118	325	657	818	1221	1115	1030	932	662	513	140	7580
	90-91	120	131	219	591	803	1330	1244	937					5375
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	89-90	0	3	169	458	711	1166	930	910	848	495	307	19	6016
	90-91	19	6	74	460	690	1284	1212	747					4492
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	89-90	0	2	156	416	721	1285	1087	1010	776	450	274	10	6187
	90-91	18	7	63	421	730	1343	1248	750					4580
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	89-90	0	0	40	316	729	1103	1124	820	557	271	139	20	5119
	90-91	0	0	28	360	759	1370	1464	919					4900

* = 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 6SSW	AVE	214	264	468	775	1128	1473	1593	1369	1318	951	654	384	10591
	89-90	168	306	427	768	1132	1449	1401	1205	1043	833	689	266	9687
	90-91	264	268	350	774	1071	1605	1668	1148					7148
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	89-90	1	2	166	454	729	1230	985	922	787	449	275	9	6009
	90-91	14	2	62	450	723	1309	1246	741					4547
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	89-90	61	155	341	749	1069	1574	1647	1254	906	672	540	188	9156
	90-91	65	179	264	771	1059	1664	1787	M					M
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	89-90	0	0	99	323	684	1176	1030	887	638	309	188	2	5336
	90-91	4	0	21	308	624	1220	1113	667					3957
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	89-90	285	412	545	880	1138	1507	1499	1265	1188	920	793	377	10809
	90-91	331	402	464	861	1141	1556	1550	1207					7512
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	89-90	1	6	204	508	762	1252	1078	991	815	555	364	33	6569
	90-91	36	11	96	491	745	1280	1237	779					4675
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	89-90	2	8	200	484	749	1302	1048	994	917	552	319	25	6600
	90-91	24	11	101	481	727	1284	1249	740					4617
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	89-90	0	41	198	543	869	1261	1169	1071	795	507	387	91	6932
	90-91	9	23	121	511	885	1406	1458	1047					5460
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	89-90	0	10	110	439	768	1156	1186	895	654	425	285	27	5955
	90-91	0	3	81	470	804	1385	1460	974					5177
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	89-90	24	118	284	646	964	1298	1491	1160	873	630	524	164	8176
	90-91	44	108	177	608	910	1538	1432	1038					5855
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	89-90	0	0	94	373	676	1204	964	877	695	394	233	2	5512
	90-91	1	0	34	360	610	1243	1116	730					4094
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	89-90	0	2	103	473 E	830	1130	1191	923	657	392	281	37	6019
	90-91	0	4	69	474	824	1433	1462	964					5230
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	89-90	18	117	315	M	974	1533	1580	1332	971	658	576	M	M
	90-91	129 E	110	255	700	1013	1683	1613	1223					6726
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	89-90	0	3	144	428	719	1254	1074	1026	760	427	275	8	6118
	90-91	17	7	68	437	725	1359	1244	713					4570
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	88-89	72	175	270	644	869	1264	1273	1023	922	664	509	145	7830
	89-90	117	179	267	635	972	1384	1351	987					5892
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	89-90	0	1	111	369	633	1153	980	874	681	420	266	8	5496
	90-91	4	6	46	334	654	1160	1048	697					3949
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	89-90	132	279	461	802	1075	1490	1359	1287	1068	796	674	273	9696
	90-91	202	258	332	794	1028	1550	1459	1105					6728
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	89-90	0	2	117	345	581	1047	848	800	666	408	289	10	5113
	90-91	15	8	53	311	543	1047	985	646					3608

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

Eastern Plains

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
NEW RAYMER 21N	53.0	21.2	37.1	6.5	64	8	774	0	81	0.21	0.08	161.5	2
STERLING	56.0	22.6	39.3	8.4	68	10	713	0	103	0.11	-0.06	64.7	2
FORT MORGAN	56.0	20.0	38.0	7.1	67	8	750	0	105	0.00	-0.14	0.0	0
AKRON FAA AP	53.2	23.8	38.5	7.6	64	12	735	0	83	0.15	-0.03	83.3	2
AKRON 4E	54.7	21.5	38.1	8.9	66	5	745	0	101	0.14	-0.07	66.7	2
HOLYOKE	56.5	21.0	38.8	6.2	68	1	728	0	124	0.28	-0.06	82.4	2
JOES	55.6	21.6	38.6	5.6	70	4	707	0	95	0.10	-0.15	40.0	2
BURLINGTON	54.9	25.5	40.2	5.6	67	7	688	0	102	0.08	-0.12	40.0	1
LIMON WSMO	52.0	21.9	36.9	5.8	63	6	779	0	63	0.03	-0.15	16.7	2
CHEYENNE WELLS	57.9	24.9	41.4	7.8	70	5	654	0	128	0.03	-0.13	18.7	1
ORDWAY 21N	58.0	18.8	38.4	5.0	70	6	737	0	124	0.00	-0.21	0.0	0
LAMAR	61.6	19.6	40.6	5.1	77	12	676	0	169	0.01	-0.28	3.4	1
LAS ANIMAS	60.5	21.3	40.9	4.6	79	11	667	0	154	0.01	-0.25	3.8	1
HOLLY	61.1	22.0	41.6	7.9	73	9	649	0	167	0.00	-0.26	0.0	0
SPRINGFIELD 7WSW	59.2	26.1	42.7	6.9	70	9	619	0	140	0.05	-0.28	15.2	1
TIMPAS 13SW	56.2	24.5	40.4	5.6	68	7	680	0	110	0.43	0.04	110.3	1

Foothills/Adjacent Plains

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
FORT COLLINS	53.0	23.2	38.1	5.6	64	12	747	0	63	0.02	-0.35	5.4	2
GREELEY UNC	53.7	23.0	38.4	4.6	67	13	741	0	75	0.00	-0.28	0.0	0
ESTES PARK	46.6	17.6	32.1	2.7	57	-2	914	0	18	0.16	-0.22	42.1	1
LONGMONT 2ESE	53.1	23.4	38.3	6.4	62	13	740	0	68	0.00	-0.37	0.0	0
BOULDER	53.2	28.7	41.0	4.8	65	8	667	0	72	0.15	-0.49	23.4	3
DENVER WSFO AP	54.0	26.6	40.3	6.6	64	13	684	0	82	0.08	-0.50	13.8	1
EVERGREEN	49.5	13.2	31.4	2.4	63	-1	937	0	51	0.14	-0.62	18.4	2
CHEESMAN	51.4	11.3	31.3	2.1	61	-2	933	0	63	0.19	-0.38	33.3	2
LAKE GEORGE 8SW	41.2	5.9	23.6	3.9	51	-5	1153	0	2	0.03	-0.28	9.7	1
ANTERO RESERVOIR	41.7	4.3	23.0	5.7	50	-11	1169	0	0	0.06	-0.17	26.1	2
RUXTON PARK	40.5	6.8	23.6	1.6	52	-12	1153	0	1	0.28	-0.61	31.5	2
COLORADO SPRINGS	52.6	23.2	37.9	5.4	64	11	750	0	66	0.00	-0.30	0.0	0
CANON CITY 2SE	57.6	27.2	42.4	5.2	71	9	626	0	125	0.01	-0.41	2.4	1
PUEBLO WSO AP	59.1	18.3	38.7	3.3	71	4	730	0	139	0.01	-0.24	4.0	1
WESTCLIFFE	49.2	10.7	30.0	4.3	59	-10	973	0	37	0.66	0.09	115.8	2
WALSENBURG	56.8	26.6	41.7	6.2	66	3	646	0	115	0.39	-0.43	47.6	3
TRINIDAD FAA AP	57.6	22.0	39.8	4.8	68	1	697	0	129	0.41	0.00	100.0	2

Mountains/Interior Valleys

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
WALDEN	41.5	9.0	25.2	6.8	50	-7	1105	0	0	0.24	-0.22	52.2	5
LEADVILLE 2SW	38.1	5.3	21.7	5.2	52	-10	1207	0	1	0.21	-0.79	21.0	5
SALIDA	51.9	13.6	32.7	2.6	60	-2	895	0	53	0.05	-0.59	7.8	1
BUENA VISTA	49.6	15.9	32.7	4.0	57	-5	896	0	31	0.15	-0.20	42.9	1
SAGUACHE	45.6	12.9	29.2	4.3	54	2	994	0	7	0.00	-0.26	0.0	0
HERMIT 7ESE	24.6	-4.3	10.2	-4.3	35	-20	1531	0	0	0.00	-0.72	0.0	0
ALAMOSA WSO AP	44.1	8.1	26.1	3.7	53	-12	1081	0	6	0.36	0.06	120.0	3
STEAMBOAT SPRINGS	37.6	4.5	21.1	1.6	53	-11	1223	0	2	1.27	-0.77	62.3	8
YAMPA	36.6	12.9	24.8	4.4	46	-4	1120	0	0	0.93	0.06	106.9	2
GRAND LAKE 1NW	41.6	5.8	23.7	5.6	52	-11	1148	0	1	0.80	-0.60	57.1	9
GRAND LAKE 6SSW	34.1	0.3	17.2	1.1	43	-15	1331	0	0	0.29	-0.52	35.8	6
DILLON 1E	37.6	4.9	21.2	2.7	50	-4	1220	0	0	0.24	-0.65	27.0	4
CLIMAX	34.3	7.1	20.7	5.8	43	-6	1231	0	0	1.50	-0.34	81.5	8
ASPEN 1SW	42.6	14.5	28.6	5.9	54	4	1013	0	3	1.22	-0.88	58.1	8
TAYLOR PARK	35.7	-10.6	12.6	6.6	45	-27	1458	0	0	0.55	-0.51	51.9	4
TELLURIDE	48.2	10.7	29.5	5.5	58	-6	987	0	26	0.78	-0.69	53.1	5
PAGOSA SPRINGS	49.3	6.2	27.7	2.1	58	-8	1038	0	28	0.04	-1.30	3.0	1
SILVERTON	44.4	-5.2	19.6	5.7	54	-19	1265	0	3	0.90	-0.69	56.6	3
WOLF CREEK PASS 1	38.8	8.1	23.4	5.3	48	-7	1157	0	0	1.44	-2.47	36.8	3

Western Valleys

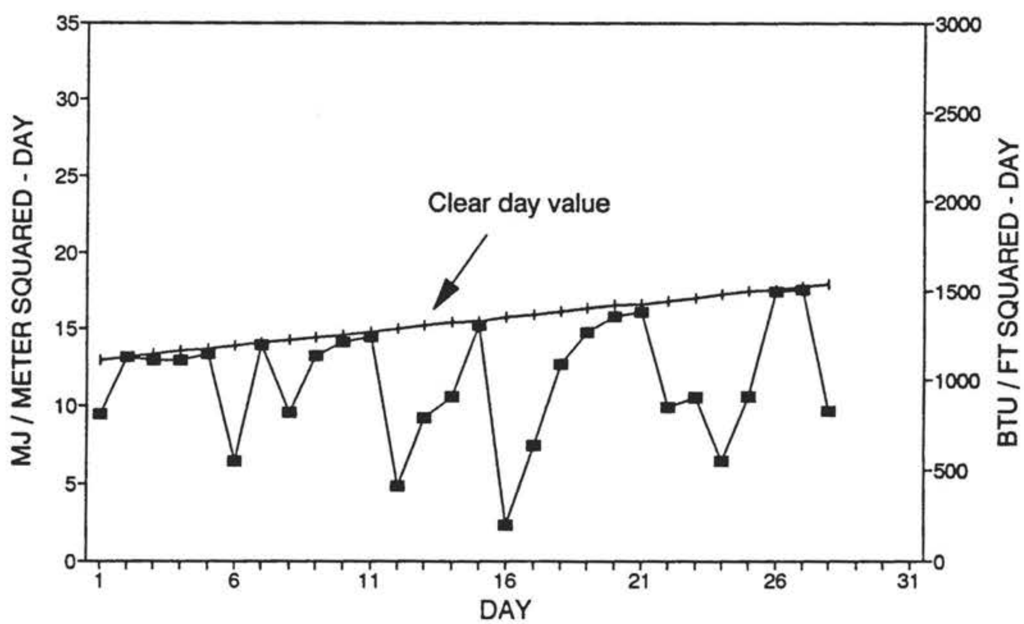
Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	38.4	12.9	25.7	3.8	49	0	1095	0	0	0.28	-0.92	23.3	3
HAYDEN	36.9	11.5	24.2	2.5	48	-1	1139	0	0	0.66	-0.49	57.4	4
MEEKER NO. 2	42.3	12.3	27.3	-0.2	55	-3	1047	0	6	0.39	-0.30	56.5	1
RANGELY 1E	40.3	10.5	25.4	1.1	53	-15	1104	0	4	0.10	-0.39	20.4	1
EAGLE FAA AP	43.6	10.7	27.2	2.3	57	-9	1052	0	9	0.03	-0.57	5.0	1
GLENWOOD SPRINGS	45.1	15.2	30.2	0.4	57	-5	969	0	10	0.20	-0.93	17.7	2
RIFLE	47.4	13.4	30.4	0.7	61	-6	964	0	21	0.28	-0.47	37.3	2
GRAND JUNCTION WS	44.6	19.4	32.0	-2.0	58	-2	919	0	13	0.13	-0.34	27.7	3
CEDAREDGE	47.5	19.1	33.3	1.1	56	8	881	0	16	0.59	-0.23	72.0	3
PAONIA 1SW	44.8	17.2	31.0	-0.9	57	-2	944	0	12	0.70	-0.38	64.8	3
DELTA	43.6	14.5	29.1	-4.5	61	-8	998	0	19	0.00	-0.41	0.0	0
COCHETOPA CREEK	40.0	2.5	21.3	7.0	49	-14	1220	0	0	0.18	-0.45	28.6	2
MONTROSE NO. 2	42.3	17.4	29.9	-1.6	54	3	974	0	3	0.07	-0.34	17.1	1
URAVAN	51.2	18.2	34.7	-1.1	64	2	842	0	50	0.13	-0.43	23.2	2
NORWOOD	43.9	15.0	29.4	1.8	50	-3	990	0	0	0.30	-0.40	42.9	2
YELLOW JACKET 2W	46.0	19.9	33.0	3.7	55	11	890	0	13	0.67	-0.44	60.4	3
CORTEZ	48.4	18.2	33.3	2.8	56	8	879	0	16	0.56	-0.37	60.2	2
DURANGO	50.5	19.0	34.7	3.8	58	12	842	0	35	0.51	-0.87	37.0	3
IGNACIO 1N	44.1	14.9	29.5	1.5	52	1	988	0	2	0.61	-0.33	64.9	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.

FEBRUARY 1991 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	13	4	11	--	--
Denver	9	9	10	68%	71%
Fort Collins	12	10	6	--	--
Grand Junction	5	17	6	84%	64%
Limon	13	5	10	--	--
Pueblo	15	2	11	74%	74%

FT. COLLINS TOTAL HEMISPHERIC RADIATION
FEBRUARY 1991



<u>Climatic Data -- Who Uses It?</u> continued

Most requests for climate information fall into a few categories. More than 90% of our requests can be traced to the following users: university and federal researchers, teachers/students, libraries, cooperative extension, engineers, natural resources consultants, architects, agribusinesses, utilities, insurance companies, attorneys, media, business organizations (trade groups, chambers of commerce, etc.), manufacturers, contractors and developers, government administrators and land/resource managers, and private individuals.

Climate data are most often used for policy making, education, research, planning (short and long range), investment, design and construction, operations, management, marketing, hazard reduction and historical documentation. The majority of climate information in Colorado is applied to agriculture, water resources, energy, land use and general business efficiency and productivity.

I could easily give you 300 pages of specific examples of how climate information is used here in Colorado. But since I'm only allowed one page (and I'm using that up very fast), let me just give you a few examples of the kind of questions we receive each year.

What does the future of Colorado hold -- are we getting warmer and drier? How often can we expect drought? Are we having a drought? Which parts of the State are dry? Do droughts occur in the mountains and on the plains at the same time? Are there drought cycles? Where and when is flooding most likely? What rainfall intensity produces flooding? What is the 100-year storm? Are 100-year storms occurring more frequently than they used to? How unusual was the Big Thompson flood? Are floods more likely during dry cycles? What is the maximum 5-minute rainfall rate? How often is microwave communication disrupted by heavy rain? How often does rain fall on saturated, isothermal snow? What is the maximum observed 24-hour rainfall? What are typical rainfall rates from summer thunderstorms?

How much weight of snow accumulation should I expect for designing a roof? How much water will evaporate each year from Horsetooth Reservoir? How much water will flow off the Rocky Mountain Arsenal during a heavy rain? We had damage from frozen pipes -- was the ground frozen deeper than normal last winter? We need to install a new water main -- how deep does the ground usually freeze? What area of Colorado is most prone to hail? How often does damaging hail occur? What is the typical movement of Colorado tornadoes, and what is the chance that my business will be hit? What areas of Colorado receive the most thunderstorms? Is lightning-caused computer damage more likely in downtown Denver or at the Denver Tech Center? What months of the year are most likely to have windstorms and how strong are the winds? We are designing a new landfill -- what is the prevailing wind direction? Was the climate experienced by the Indians at Mesa Verde 1000 years ago different than today's climate?

Was the frost that ruined the peach crop unusually late or were the spring temperatures unusually warm? Do wind machines help reduce frost damage? Where in Colorado can grapes grow? How many growing degree days does Lamar get? Are our growing degree days behind or ahead of average? Our sorghum crop did lousy last summer -- was there anything unusual about last July or August weather that caused the problem? We have a new pesticide application model -- can you give us a year's worth of hourly weather data to test the model? How much evaporation can I expect from my alfalfa each month? We are testing a new tillage system -- how much rain fell at Eads the past 3 years? My sheep got sick last spring -- what were the weather conditions at that time? Certain insect pests are only a problem under particular weather conditions -- how often do these conditions occur?

Did the insulation I put in the attic really help me, or was last winter just warmer than usual? Can I operate a wind generator in Evergreen? I am thinking about putting up some solar panels -- how much sunshine do we get? We are putting in new power lines to the Western Slope -- how often do high winds and icing conditions occur at the same time? We are planning a ski trip to Colorado -- when are we most likely to have good snow, sunshine and nice temperatures? I have allergies -- where in Colorado is the best place to live? A man wants to borrow money from our bank to set up a small snow-removal business -- how often do we get at least 4" of snow each winter. We are planning a new airport -- what are the wind and weather conditions in that area? We are filming a new movie and we need deep snow and land that look like tundra -- where can we find those conditions? By the way, we need to shoot this in June. We are bidding a construction job -- how many days of bad weather can we expect in April and May? We are designing a system to melt sidewalks -- how often does it snow and what is the typical temperature during snowstorms? We are planning an international conference -- what weather should we expect in early June? We would like to buy a major ski resort -- which areas of Colorado have the most consistent and reliable snowfall? I need to design the heating and cooling system for a major office building -- what are the ranges of temperature, humidity, wind and sunshine that we will likely experience over the lifetime of the building? Aircraft weight capacities and runway requirements are determined by temperature -- how often does the temperature exceed 90 degrees at Aspen?

This is just a sample of the questions that we receive. Quite frankly, we need a lot of data from all parts of the State for many, many decades to answer these questions. I am glad that someone had the foresight 100 years ago to set up the Cooperative Program. That has given us a good start.

Trash Turns Turbines

Solid waste is not technically a renewable energy source by is so abundant in the United States that it can be considered to be in the same class as solar and wind energy discussed earlier in this column. This month we will discuss on example of a successful waste-to-energy plant. Connecticut has finally found out what to do with its trash besides sending it west. They burn their trash. This will not seem like a novel idea to anyone, but the Mid-Connecticut Resource Recovery facility is making energy from the refuse that usually sits in landfills.

Since its opening in October 1988, the facility has processed 1,470,000 tons of waste. The trash that actually gets burned must be combustible so glass, dirt and metals are be removed. These materials are then recycled.

The process of getting the waste ready for burning is done in five main steps: inspection/picking, flail shredding, magnetic separation, screening, and secondary shredding. Inspection and separating the trash is very important and is manually watched for the best accuracy. The first shredding is fundamental to preparing the waste for final combustion. It is done by a flail type mill in a blast-resistant bunker. The bunker has already proved its worth by safely dissipating the explosion of three gas grill propane tanks without damage. After its first shredding the waste is sent through a double-drum magnetic separation system to recover the materials containing iron. The screening process discharges the sand, glass, dirt, rocks, and a small portion of combustible material. Any of the oversized pieces are then sent to the secondary shredder for further crunching. The waste is finally ready for combustion and is stored until needed.

The waste is sent to a boiler where it can make 231,000 pounds of steam per hour while firing 100 percent. The steam is sent to one of two 45-megawatt 465,000-pound-per-hour turbine generators. Considering that the facility usually accepts 2000 tons of waste per day, a significant amount of energy is generated from an easily accessible source.

The facility is also very conscious of their emissions. The emissions level when running on 100 percent waste, is bellow the state of Connecticut's standards. The water used is collected in the same pond and recycled for use in the plant. This means no water containing ash, coal fines, or chemicals is discharged. Twelve thousand tons of trash is recovered every week to make electricity.

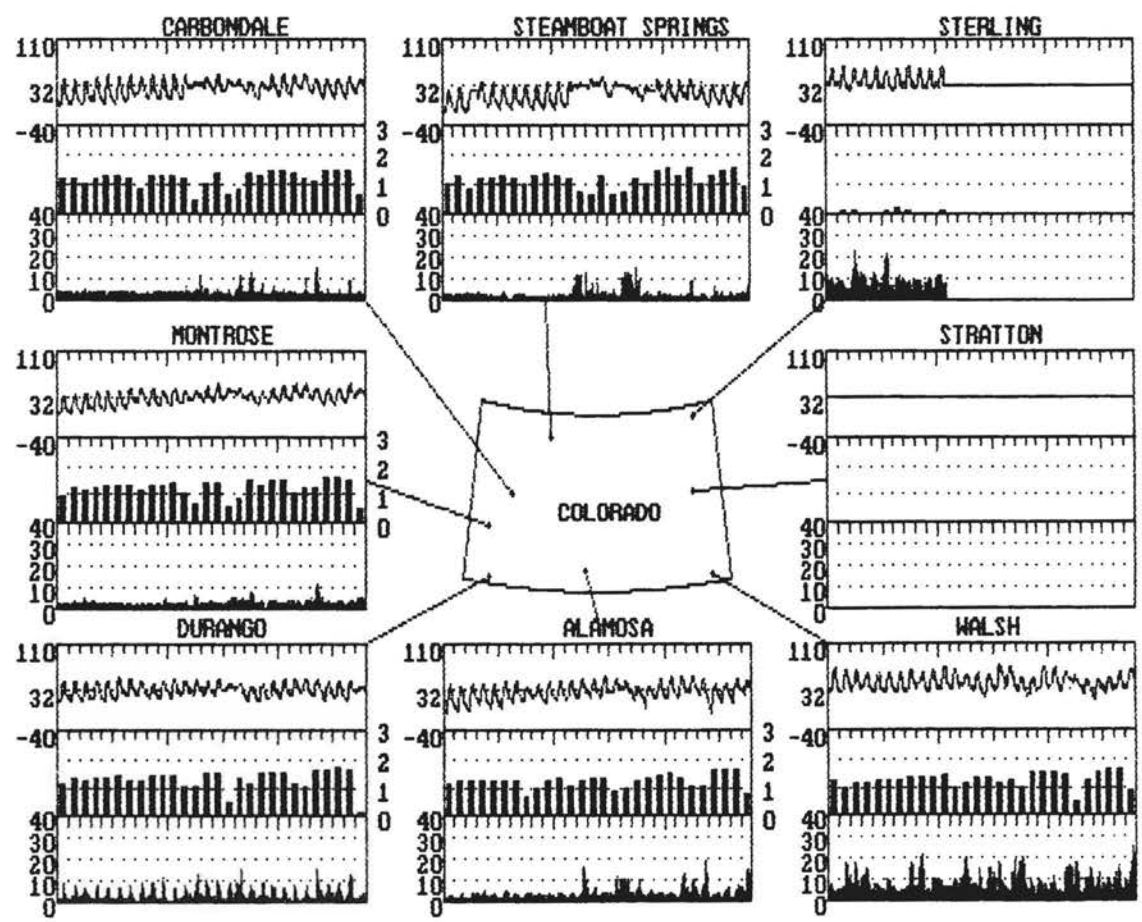
This article was written by Erika Komito of the Joint Center for Energy Management. Information on acquiring our weather data can be obtained by writing Carl Rogers at the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, CO. 80309-0428 or using your PC to call the Weathernet Bulletin Board at (303) 492-3525.

WTHRNET WEATHER DATA FEBRUARY 1991

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (°F)								
	25.6	29.5	25.6	28.8	16.0	34.9	32.0	40.6
monthly temperature extremes and time of occurence (°F day/hour)								
maximum:	52.5 21/16	51.8 6/14	52.2 15/16	53.2 23/16	46.4 15/16	64.6 11/15	32.0 1/ 1	71.1 16/14
minimum:	-12.3 25/ 7	10.2 3/ 7	-6.3 1/ 7	0.7 1/ 8	-16.1 1/ 6	19.8 3/ 5	32.0 1/ 1	13.1 25/ 5
monthly average relative humidity / dewpoint (percent / °F)								
5 AM	89 / 10	73 / 12	91 / 11	82 / 15	90 / 3	11 /-25	0 /-40	65 / 17
11 AM	52 / 16	46 / 18	50 / 15	50 / 19	73 / 13	7 /-21	0 /-40	31 / 20
2 PM	39 / 16	43 / 20	36 / 15	44 / 19	54 / 16	6 /-19	0 /-40	22 / 17
5 PM	39 / 16	41 / 19	39 / 15	44 / 19	60 / 17	6 /-20	0 /-40	22 / 15
11 PM	83 / 17	71 / 17	80 / 17	78 / 20	91 / 11	10 /-25	0 /-40	49 / 15
monthly average wind direction (degrees clockwise from north)								
day	196	218	209	237	163	92	0	204
night	199	99	173	140	115	104	0	273
monthly average wind speed (miles per hour)								
	3.45	2.84	2.58	2.48	1.80	2.81	0.00	8.09
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	386	466	505	498	557	429	672	27
3 to 12	273	200	166	174	93	228	0	522
12 to 24	13	6	1	0	2	15	0	122
> 24	0	0	0	0	0	0	0	1
monthly average daily total insolation (Btu/ft²·day)								
	1216	1286	1149	1228	1136	12	0	1258
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	191	99	162	171	119	0	0	192
40-60%	58	50	57	34	59	0	0	54
20-40%	34	31	52	43	52	0	0	25
0-20%	6	32	16	12	9	0	0	8

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. Horizontal insolation inSTerling is unavailable, and the station was not functioning after February 10th. Disregard all data for Stratton. Both station have yet to be repaired by Nebraska.



COLORADO CLIMATE

MARCH 1991

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 14 Number 6

March in Review:

A lively progression of moisture-bearing Pacific storm systems crashed into Colorado in March after first delivering huge quantities of much-needed rain and snow to California. The storms consistently delivered heavy precipitation to the western slopes of each mountain range but eastern slopes were often missed. As a result, the Front Range, San Luis Valley and Arkansas Valley all remained very dry while at the same time many mountain areas received more than double the average March precipitation. With Pacific air masses dominating, temperatures for the month ended up near average on the Western Slope and warmer than average east of the mountains.

Colorado's May Climate:

Daylength in May is already very long and the sun very powerful (May solar energy on clear days is more than double what it was in February). However, the atmosphere responds slowly to this increased energy, especially in the atmosphere above the top of our mountains. At the same time, warmer temperatures near the ground and weaker westerly winds aloft mean that more moisture is in the air, especially east of the mountains. As a result, the atmosphere is unstable and very energetic and thunderstorms can erupt easily. Suddenly, Coloradans need to take the threat of hail and tornadoes seriously.

With moisture reaching Colorado periodically from the Gulf of Mexico, episodes of heavy widespread rain and thunderstorms are also possible especially in the foothills and across the eastern plains. But at the same time, Pacific storm systems become less frequent. Sunny, dry weather becomes more common in western Colorado (especially the southwest) and the mountain snowpack begins its rapid melt. In May, the areas of Colorado expecting the greatest precipitation and cloudcover shifts from the mountains and Western Slope to the Front Range and northeastern plains. Typical May precipitation totals are only 0.50" to 1.00" over western Colorado and 1-2" in the southern mountains. From the northern mountains to the Nebraska border 2-4" of moisture can be expected. Additional mountain snows are expected. Snow, while uncommon, can still fall at lower elevations as well. This moisture is extremely important in assuring a good winter wheat crop. Snowpack has not been excessive in most areas of Colorado this winter so the threat of snowmelt flooding is not great. However, cold temperatures in late April with additional snowfall has greatly increased the late-season high elevation snowpack. If this trend continues into May, runoff could be concentrated into a shorter period, thus increasing the expected peak flows.

May temperatures are quite pleasant. An occasional heatwave is possible with low-elevation temperatures soaring into the 80s (90s in the southeast). But most days see temperatures in the 70s during the day and 40s at night (50s and 60s in the mountains with 20s and 30s at night). Still, due to our high elevation, farmers and gardeners must be prepared for occasional freezing temperatures at night in many parts of Colorado.

The Colorado Cooperative Weather Observer Hall of Fame:

I regret to say that there is no such thing as a "Hall of Fame" for weather observers, but I'm beginning to wish there was. As we (the Colorado Climate Center, Colorado Agricultural Experiment Station and the National Weather Service) continue to prepare for the special June 7-8, 1991 program to recognize and honor Colorado Weather Observers, I have become ever more impressed by the amazing long-term commitment that many individuals, families, businesses and public organizations have made over the past century to help monitor, document and study our Colorado climate.

(continued on page 74)

MARCH 1991 DAILY WEATHER

Date	Event
1-2	The first in a series of March storms crossed Colorado. Abundant Pacific moisture helped produce heavy precipitation over southwest Colorado on the 1st which ended on the 2nd. Wolf Creek Pass totalled 3.13" of precipitation (28" snow). Durango reported 1.71" (9" snow). Precipitation decayed rapidly to the east and north. Steamboat Springs got 0.32". Trace amounts fell east of the mountains despite chilly "upslope" flow on the 2nd associated with an Arctic airmass over southern Canada.
3-4	Dry, warm and windy. Pueblo reached 75° on the 4th.
5-6	The next storm, composed of a complex system of fronts and upper air disturbances, traversed the Rockies. The jet stream dropped south into New Mexico allowing cold air into Colorado. Several areas of the mountains were hit hard. Wolf Creek Pass received another 2.44" of moisture. Crested Butte picked up 1.25" (15.5" snow). Winter Park reported 18" of snow in 24 hours (1.52" of moisture) ending early on the 6th. This storm spilled over onto the Front Range leaving 8" of wind-driven snow at Allenspark and a few inches from Denver to Colorado Springs with only rain at lower elevations.
7-9	Breezy and very cold 7-8th with mountain snowshowers as upper winds shifted to the northwest. Many areas had their coldest temperatures of the month. Dillon only reached 19° for a high on the 7th. Taylor Park Dam's -33°F reading early on the 9th was the coldest in the State. Then temperatures rapidly moderated.
10-12	Clouds increased and pressures plummetted on the 10th as a new potent storm moved inland across California. The storm crossed Colorado on the 11th, moving too quickly to drop heavy precipitation and totally missing some areas. Aspen managed to pick up 10" of new snow and much of the State had strong winds. Thunderstorms developed in northeastern Colorado late on 11th as the deep low pressure center headed toward Kansas. Winds were clocked over 60 mph on the eastern plains overnight causing blowing dust. Areas near Akron experienced blizzard conditions from only 1-2" of snow.
13-16	With hardly a break, another storm developed over Nevada and California pushing scattered snow back into the mountains by the 14th and drawing cool upslope breezes across eastern Colorado. Lamar awoke to 6" of fresh snow on the 15th. Much of eastern Colorado had another episode of snow on the 16th with 2-4" in some areas and 6" at Haswell.
17-22	Some eastern Colorado fog early on the 17th. Then skies cleared and weather remained pleasant until a new storm approached from the southwest on the 19th. The first storm impulse 19-20th only dusted most of the mountains although Silverton reported 7" of new snow on the 20th. A second impulse 21-22nd brought heavier and more widespread precipitation. Steamboat Springs got 0.87" of moisture from wet snow late on the 21st. Strong winds accompanied both storm episodes.
23-25	Warm spring weather. Lamar's 81° on the 25th was the warmest in the State for March.
26-29	A strong push of moist air form a storm over California set off heavy precipitation in southern Colorado on the 26th. Areas from Creede to Silverton picked up 1-2 feet of snow with nearly 2" of water content. That evening some thunderstorms developed on the plains and changed to snow. Blizzard conditions developed overnight from the Palmer Divide northeastward to Holyoke. Limon reported 8" of wind-driven snow and 1.03" of moisture, which closed most highways. Sunny and seasonal on the 28th, but then a strong upper level disturbance approached rapidly from the northwest triggering a modest snowstorm on the 29th. Walsenburg received 9" of snow that evening.
30-31	A stormy March ended like a lamb with sunshine and moderating temperatures.

March 1991 Extremes

Highest Temperature	81°F	March 25	Lamar
Lowest Temperature	-33°F	March 9	Taylor Park Dam
Greatest Total Precipitation	11.93"		Wolf Creek Pass 1E
Least Total Precipitation	0.06"		Nunn
Greatest Total Snowfall*	133.5"		Wolf Creek Pass 1E
Greatest Depth of Snow**	129"		Wolf Creek Pass

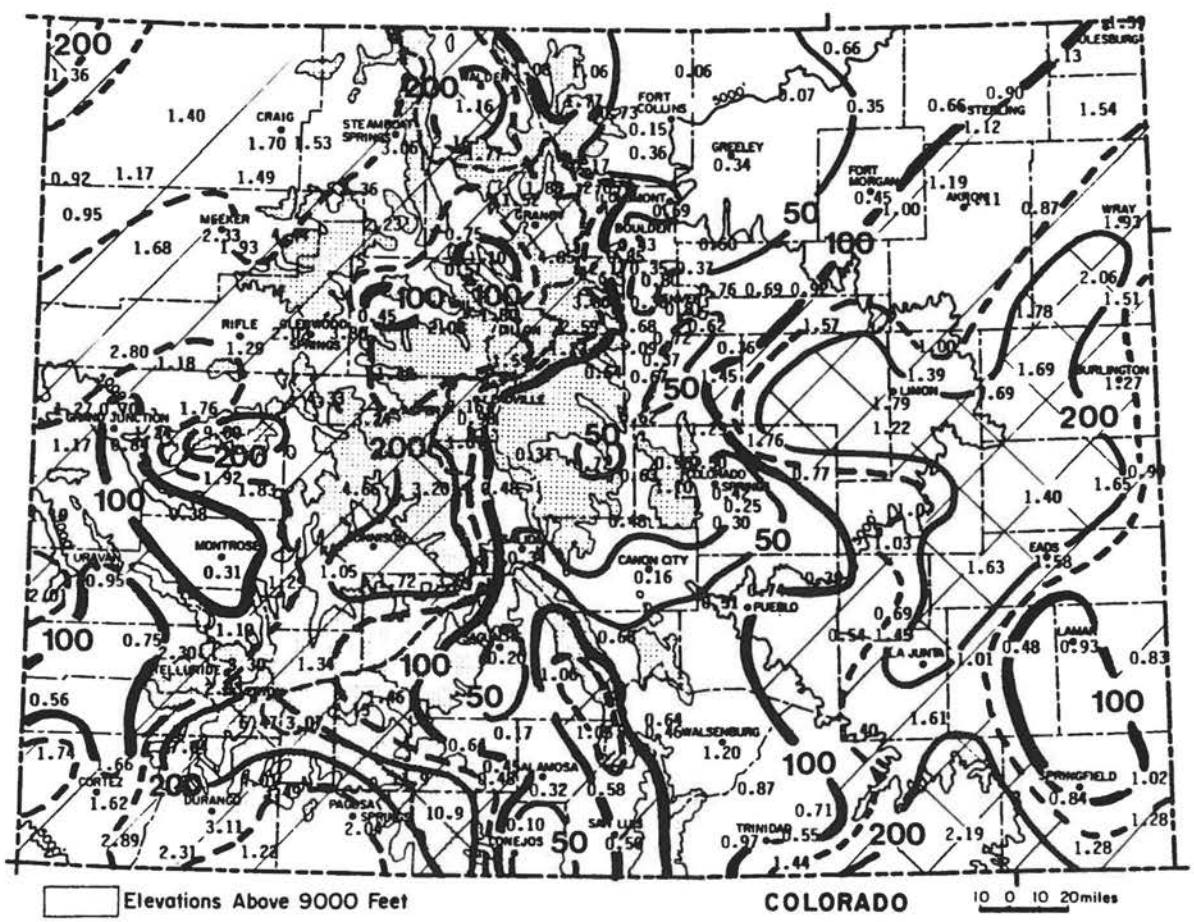
* For existing weather stations with complete daily records. Higher values are likely for unmonitored locations.

** From Soil Conservation Service Snowcourses.

<u>MARCH 1991 PRECIPITATION</u>

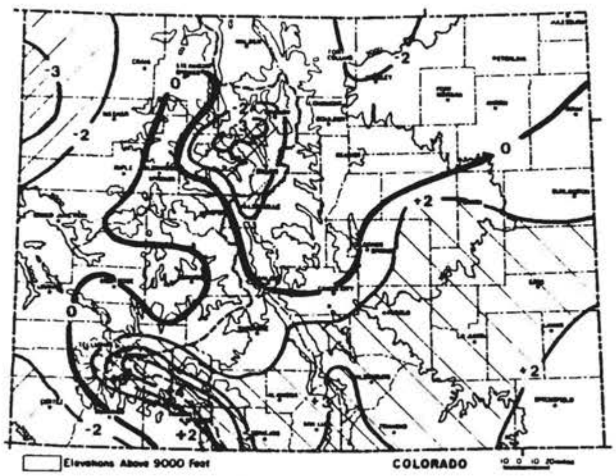
A steady succession of storms delivered locally heavy but highly variable precipitation to Colorado in March. With few exceptions, most storms traversed the State from southwest to northeast. The resulting precipitation pattern demonstrated vividly the rain/show shadowing effect that our mountains so often produce. Most mountain areas received from 150% to 300% of the average March precipitation. At the same time, downwind valleys were surprisingly dry. Parts of the San Luis Valley and much of the Front Range foothills and urban corridor received less than half of average. Amazing local contrasts appeared. Platoro, for example, reported nearly 11" of moisture for the month, more than 5 times their average. Meanwhile, Manassa in the valley to the east received a mere 0.10", 32% of average. Precipitation patterns were also very interesting on the plains. While precipitation totals near the Front Range were very low (0.15" at Fort Collins and 0.16" at Canon City), a narrow band across the plains received more than double their average with locally more than 2" reported.

<u>Greatest</u>		<u>Least</u>	
Wolf Creek Pass 1 E	11.93"	Nunn	0.06"
Platoro Dam	10.97"	Briggsdale	0.07"
Bonham Reservoir	9.00"	Manassa	0.10"
Rico	7.04"	Fort Collins	0.15"
Silverton	6.47"	Canon City	0.16"



Precipitation amounts (inches) for March 1991 and contours of precipitation as a percent of the 1961-1980 average.

With the help of a very stormy March, about 2/3 of Colorado's official precipitation stations are now at or above average through the first 6 months of the 1991 water year. Colorado mountain areas and portions of northwestern and east central Colorado benefitted the most from the March moisture. In the San Juan mountains, a number of locations have now received more than 130% of their normal accumulated precipitation for this time. But several dry areas persist. Lower elevations of southwestern Colorado still haven't caught up to average. The primary dry spot, however, runs from Larimer and Weld county southward along the Front Range to Pueblo and Salida. In a few local areas, precipitation has been less than 70% of average. Potential spring fire danger remains higher than usual in those regions.

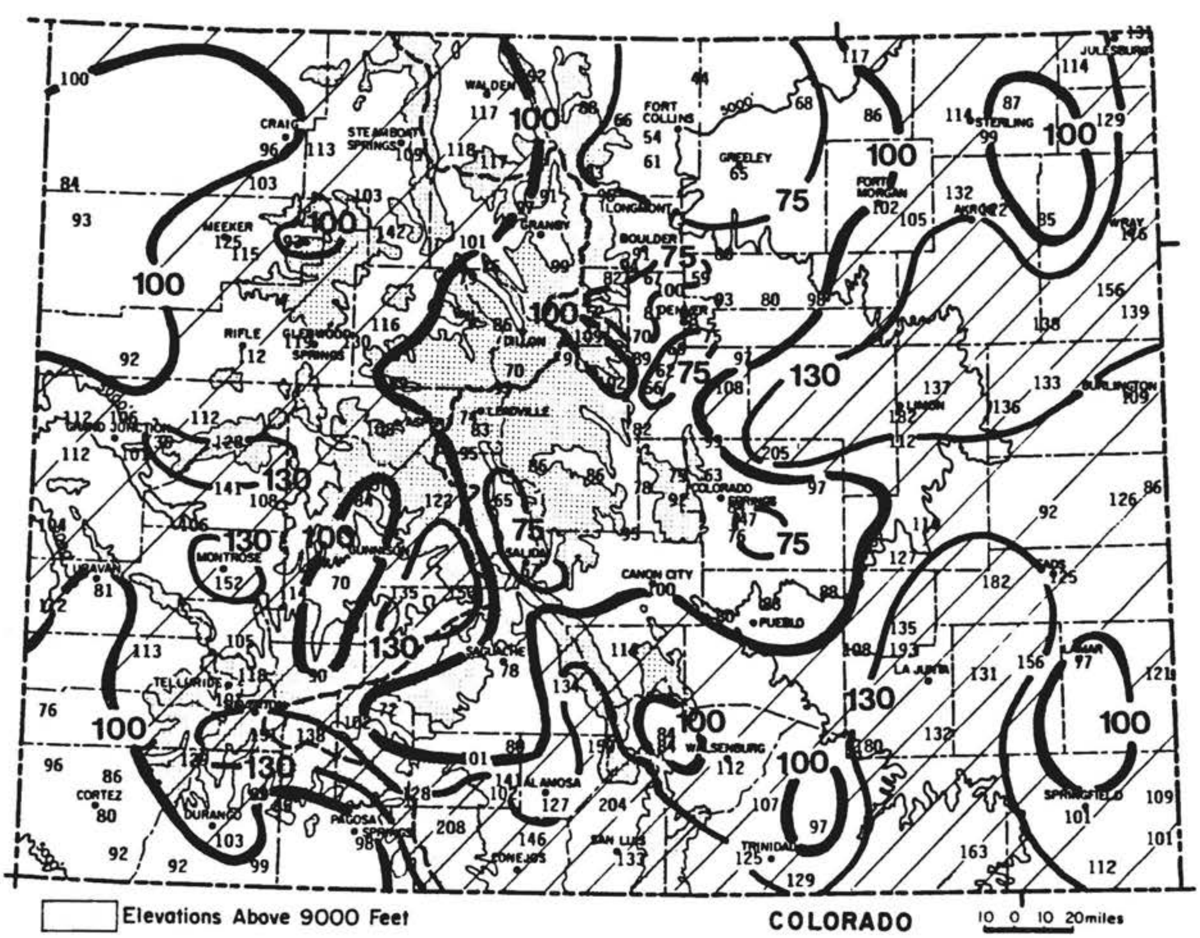


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

	extremely wet
+4	----------------
+3	ample moisture
+2	----------------
+1	
0	near normal
-1	
-2	----------------
	moderate drought
-3	----------------
	severe drought
-4	----------------
	extreme drought

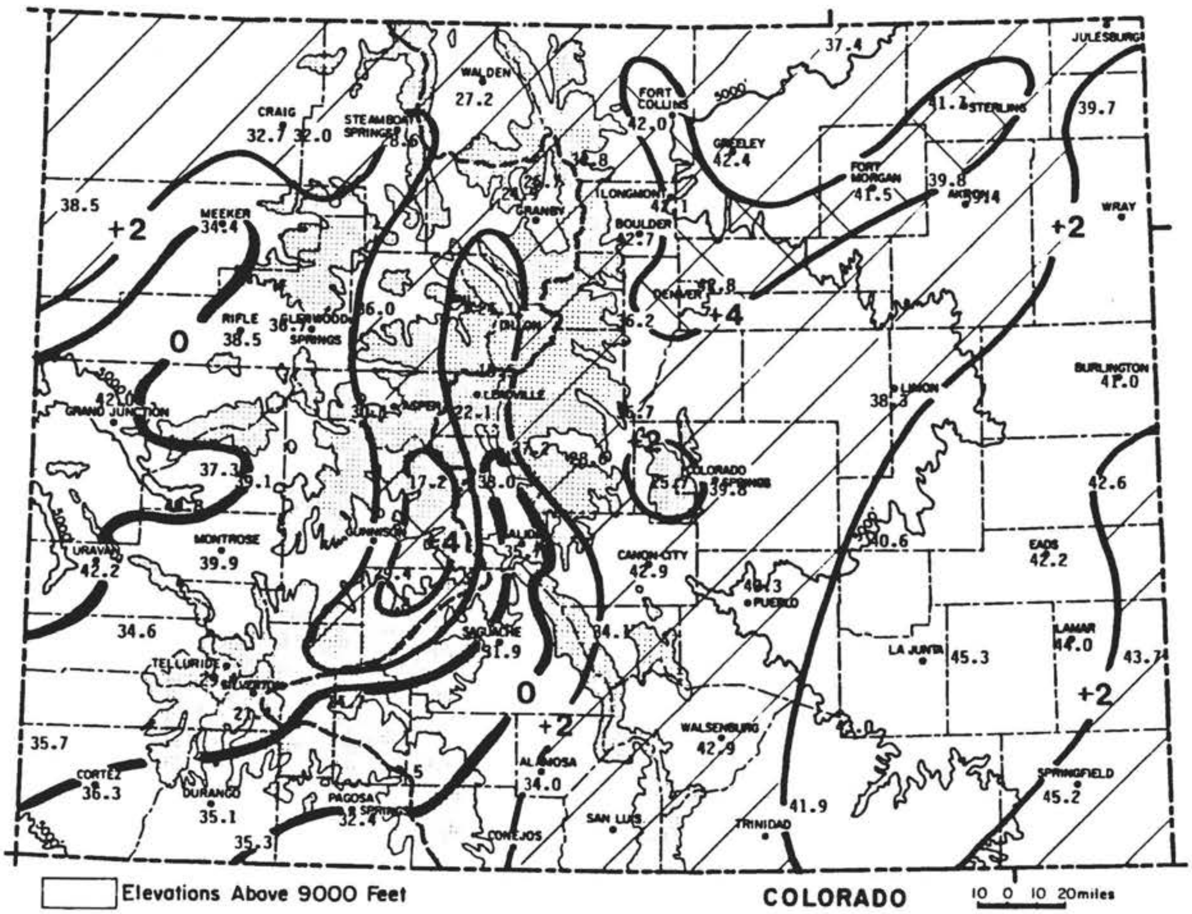


Precipitation for October 1990 through March 1991
as a percent of the 1961-1980 average.

M A R C H   1 9 9 1   T E M P E R A T U R E S

A N D   D E G R E E   D A Y S

There were many airmass changes and temperature ups and downs in March, as usual. However, there was a distinct absence of arctic air and severe cold and also a limited number of extremely warm days. The coldest temperature all month in Denver was only 20°. Fraser dropped below -10° on only one morning. For the month as a whole, temperatures ended up a few degrees above average in most parts of Colorado. A few locations in northeastern Colorado and the central mountains were as much as 4 degrees warmer than average. The coolest area of the State, relative to average, was the Western Slope where some weather stations were 1-2 degrees F cooler than average.



March 1991 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

M A R C H   1 9 9 1   S O I L   T E M P E R A T U R E S

With no episodes of severe cold, the frost left the soil early and did not return. Otherwise, soils warmed at a fairly normal pace.

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.

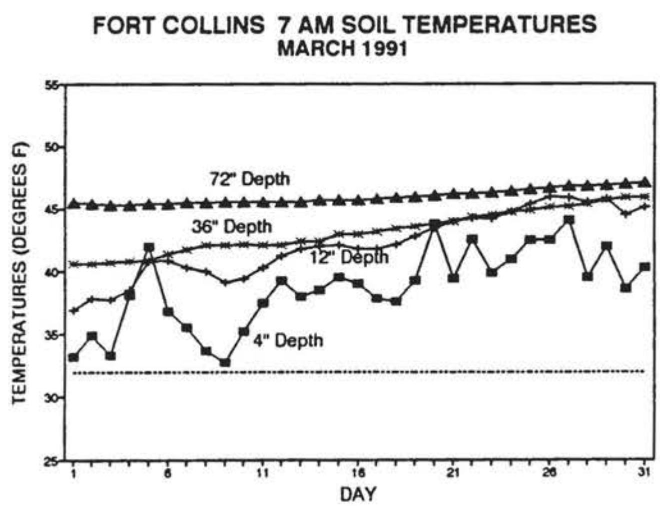


Table 1. Heating Degree Day Data through March 1991 (base temperature, 65°F).

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
	89-90	17	82	271	698	1001	1400	1554	1089	880	640	480	105	8217
	90-91	59	118	201	633	990	1597	1671	1081	954				7304
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	89-90	68	176	303	671	974	1365	1365	1086	915	697	543	171	8334
	90-91	134	146	234	652	964	1462	1444	1013	1077				7126
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	89-90	1	0 E	139	M E	567 E	1064 E	776 E	925 E	760	502	321	21	M
	90-91	32	13	81	338	589	1161	1081	667	685				4647
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	89-90	39	112	270	628	812	1202	1184	991	857	660	518	106	7379
	90-91	66	130	226	641	905	1326	1256	896	983				6429
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	89-90	0	4 E	130	415	684	1229	990	957	757	459	280	3	5908
	90-91	10	4	76	407	M	1249	1223	688	737				M
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	89-90	0	0	131	379	584	1076	859	827	687	421	325	22	5311
	90-91	14	12	58	382	548	1098	1004	626	679				4421
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	89-90	0	4	172	473	699	1163	966	928	805	526	345	24	6105
	90-91	28	21	83	473	663	1256	1142	750	773				5189
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	89-90	0	16	142	494	850	1166	1222	959	776	490	377	59	6551
	90-91	1	6	151	539	774	1321	1364	879	882				5917
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	89-90	4	46	235	586	892	1420	1319	1257	879	530	453	144	7765
	90-91	14	18	116	606	876	1547	1544	1095	995				6811
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	89-90	M	M	M	330	M	M	1161	865	626	355	237	22	M
	90-91	0	2	58	416	751	1400	1549	998	742				5916
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	89-90	0	0	153	424	658	1160	879	882	781	469	265	7	5678
	90-91	12	3	64	388	623	1209	1143	684	682				4808
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	89-90	226	357	502	861	1124	1495	1506	1271	1124	886	764	349	10465
	90-91	284	355	430	858	1071	1587	1569	1220	1257				8631
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	89-90	2	19	106	520	789	1133	1278	965	724	479	359	44	6418
	90-91	4	28	118	481	832	1373	1274	842	919				5871
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	89-90	1	60	217	593	896	1348	1286	986	806	545	269	68	7075
	90-91	15	23	134	583	934	1568	1536	1052	889				6734
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	89-90	49	118	325	657	818	1221	1115	1030	932	662	513	140	7580
	90-91	120	131	219	591	803	1330	1244	937	885				6260
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	89-90	0	3	169	458	711	1166	930	910	848	495	307	19	6016
	90-91	19	6	74	460	690	1284	1212	747	703				5195
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	89-90	0	2	156	416	721	1285	1087	1010	776	450	274	10	6187
	90-91	18	7	63	421	730	1343	1248	750	722				5302
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	89-90	0	0	40	316	729	1103	1124	820	557	271	139	20	5119
	90-91	0	0	28	360	759	1370	1464	919	706				5606

* = 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 6SSW	AVE	214	264	468	775	1128	1473	1593	1369	1318	951	654	384	10591
	89-90	168	306	427	768	1132	1449	1401	1205	1043	833	689	266	9687
	90-91	264	268	350	774	1071	1605	1668	1148	1233				8381
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	89-90	1	2	166	454	729	1230	985	922	787	449	275	9	6009
	90-91	14	2	62	450	723	1309	1246	741	692				5239
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	89-90	61	155	341	749	1069	1574	1647	1254	906	672	540	188	9156
	90-91	65	179	264	771	1059	1664	1787	M	M				M
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	89-90	0	0	99	323	684	1176	1030	887	638	309	188	2	5336
	90-91	4	0	21	308	624	1220	1113	667	602				4559
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	89-90	285	412	545	880	1138	1507	1499	1265	1188	920	793	377	10809
	90-91	331	402	464	861	1141	1556	1550	1207	1210				8722
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	89-90	1	6	204	508	762	1252	1078	991	815	555	364	33	6569
	90-91	36	11	96	491	745	1280	1237	779	820				5495
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	89-90	2	8	200	484	749	1302	1048	994	917	552	319	25	6600
	90-91	24	11	101	481	727	1284	1249	740	699				5316
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	89-90	0	41	198	543	869	1261	1169	1071	795	507	387	91	6932
	90-91	9	23	121	511	885	1406	1458	1047	939				6399
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	89-90	0	10	110	439	768	1156	1186	895	654	425	285	27	5955
	90-91	0	3	81	470	804	1385	1460	974	768				5945
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	89-90	24	118	284	646	964	1298	1491	1160	873	630	524	164	8176
	90-91	44	108	177	608	910	1538	1432	1038	1002				6857
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	89-90	0	0	94	373	676	1204	964	877	695	394	233	2	5512
	90-91	1	0	34	360	610	1243	1116	730	667				4761
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	89-90	0	2	103	473 E	830	1130	1191	923	657	392	281	37	6019
	90-91	0	4	69	474	824	1433	1462	964	814				6044
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	89-90	18	117	315	M	974	1533	1580	1332	971	658	576	M	M
	90-91	129 E	110	255	700	1013	1683	1613	1223	1120				7846
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	89-90	0	3	144	428	719	1254	1074	1026	760	427	275	8	6118
	90-91	17	7	68	437	725	1359	1244	713	716				5286
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	88-89	72	175	270	644	869	1264	1273	1023	922	664	509	145	7830
	89-90	117	179	267	635	972	1384	1351	987	1093				6985
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	89-90	0	1	111	369	633	1153	980	874	681	420	266	8	5496
	90-91	4	6	46	334	654	1160	1048	697	709				4658
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	89-90	132	279	461	802	1075	1490	1359	1287	1068	796	674	273	9696
	90-91	202	258	332	794	1028	1550	1459	1105	1164				7892
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	89-90	0	2	117	345	581	1047	848	800	666	408	289	10	5113
	90-91	15	8	53	311	543	1047	985	646	674				4282

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

Eastern Plains

	Temperature						Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
NEW RAYMER 21N	51.9	22.9	37.4	2.2	69	12	849	0	87	0.66	0.02	103.1	8
STERLING	57.2	26.2	41.7	4.9	76	14	716	0	149	0.66	-0.14	82.5	5
FORT MORGAN	55.4	27.5	41.5	4.1	72	13	722	0	129	0.45	-0.11	80.4	3
AKRON FAA AP	52.9	26.7	39.8	3.5	70	13	775	0	108	1.19	0.32	136.8	8
AKRON 4E	53.2	25.5	39.4	4.0	71	12	790	0	108	1.11	0.29	135.4	10
HOLYOKE	53.7	25.7	39.7	1.1	73	13	774	0	119	1.54	0.41	136.3	9
BURLINGTON	54.0	27.9	41.0	1.0	73	15	737	0	124	1.27	0.45	154.9	7
LIMON WSMO	51.7	24.8	38.3	2.1	67	13	820	0	87	1.79	1.05	241.9	10
CHEYENNE WELLS	56.8	28.5	42.6	3.2	75	15	686	0	151	1.65	0.96	239.1	9
EADS	56.4	28.0	42.2	0.7	75	17	699	0	151	1.58	0.74	188.1	4
ORDWAY 21N	57.3	23.8	40.6	1.8	74	13	749	0	149	1.03	0.50	194.3	7
LAMAR	61.9	26.1	44.0	1.3	81	9	648	0	212	0.93	-0.00	100.0	5
LAS ANIMAS	61.6	29.0	45.3	1.8	80	18	602	0	215	1.01	0.39	162.9	8
HOLLY	60.5	26.9	43.7	3.0	80	13	649	0	204	0.83	0.13	118.6	5
SPRINGFIELD 7WSW	62.1	28.3	45.2	3.6	79	16	606	0	206	0.84	-0.07	92.3	6
TIMPAS 13SW	58.1	27.8	43.0	1.8	74	21	672	0	162	1.40	0.56	166.7	2

Foothills/Adjacent Plains

	Temperature						Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
FORT COLLINS	55.9	28.2	42.0	4.5	69	15	703	0	123	0.15	-0.95	13.6	3
GREELEY UNC	56.7	28.2	42.4	2.4	72	14	692	0	134	0.34	-0.61	35.8	5
ESTES PARK	45.9	23.7	34.8	2.3	63	1	929	0	21	0.17	-0.56	23.3	3
LONGMONT 2ESE	56.1	28.2	42.1	4.7	71	15	699	0	130	0.69	-0.22	75.8	3
BOULDER	54.9	30.4	42.7	2.4	69	20	685	0	111	0.43	-0.93	31.6	7
DENVER WSFO AP	56.1	29.5	42.8	4.4	70	20	682	0	125	0.76	-0.38	66.7	10
EVERGREEN	51.7	20.7	36.2	4.0	69	6	885	0	75	0.68	-0.62	52.3	8
CHEESMAN	51.8	21.5	36.7	3.0	62	4	871	0	60	0.62	-0.60	50.8	4
LAKE GEORGE 8SW	41.9	15.2	28.6	2.1	53	-3	1121	0	6	0.72	0.17	130.9	6
ANTERO RESERVOIR	40.5	13.9	27.2	3.8	50	-12	1169	0	0	0.31	-0.10	75.6	5
RUXTON PARK	39.1	12.3	25.7	0.1	52	-6	1213	0	3	1.10	-0.45	71.0	8
COLORADO SPRINGS	52.3	27.4	39.8	3.2	67	15	773	0	88	0.42	-0.38	52.5	7
CANON CITY 2SE	56.3	29.4	42.9	2.2	70	19	679	0	127	0.16	-0.67	19.3	2
PUEBLO WSO AP	59.5	27.2	43.3	2.3	75	14	667	0	171	0.74	0.01	101.4	4
WESTCLIFFE	47.3	20.9	34.1	2.6	59	4	950	0	28	0.65	-0.60	52.0	8
WALSENBURG	56.4	29.5	42.9	3.0	68	19	674	0	120	1.20	-0.12	90.9	6
TRINIDAD FAA AP	58.4	25.4	41.9	1.6	73	14	709	0	151	0.71	-0.18	79.8	5

Mountains/Interior Valleys

	Temperature						Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
WALDEN	39.5	15.0	27.2	3.1	54	-9	1164	0	2	1.16	0.59	203.5	10
LEADVILLE 2SW	36.4	7.8	22.1	1.1	50	-18	1323	0	0	0.98	-0.32	75.4	12
SALIDA	49.4	22.1	35.7	-0.5	62	7	899	0	43	0.34	-0.44	43.6	4
BUENA VISTA	46.0	20.1	33.0	-0.6	56	6	983	0	18	0.48	-0.15	76.2	9
SAGUACHE	46.4	17.5	31.9	-1.0	60	7	1018	0	23	0.20	-0.22	47.6	4
HERMIT 7ESE	26.3	3.1	14.7	-4.6	48	-10	1553	0	0	2.15	0.69	147.3	3
ALAMOSA WSO AP	49.1	18.9	34.0	2.4	60	7	954	0	37	0.32	-0.11	74.4	6
STEAMBOAT SPRINGS	41.0	16.3	28.6	1.8	54	-9	1120	0	4	3.06	1.14	159.4	16
GRAND LAKE 1NW	41.1	12.3	26.7	3.5	53	-8	1180	0	3	1.88	0.48	134.3	20
GRAND LAKE 6SSW	38.3	11.5	24.9	2.5	50	-11	1233	0	0	1.52	0.67	178.8	15
DILLON 1E	36.9	11.3	24.1	0.8	48	-12	1257	0	0	1.80	0.69	162.2	15
CLIMAX	32.0	7.0	19.5	1.1	42	-7	1403	0	0	3.64	1.51	170.0	19
ASPEN 1SW	41.8	18.5	30.1	2.6	56	0	1077	0	5	3.24	1.04	147.3	15
TAYLOR PARK	34.8	-0.4	17.2	5.0	45	-33	1472	0	0	3.20	1.94	254.0	16
TELLURIDE	43.2	15.6	29.4	1.0	57	-1	1093	0	14	2.83	0.88	145.1	20
PAGOSA SPRINGS	47.4	17.5	32.4	0.1	60	6	1002	0	22	2.04	0.60	141.7	10
SILVERTON	39.4	3.5	21.4	1.4	52	-21	1341	0	2	6.47	4.56	338.7	16
WOLF CREEK PASS 1	30.9	8.1	19.5	-1.7	42	-3	1403	0	0	11.93	7.07	245.5	20

Western Valleys

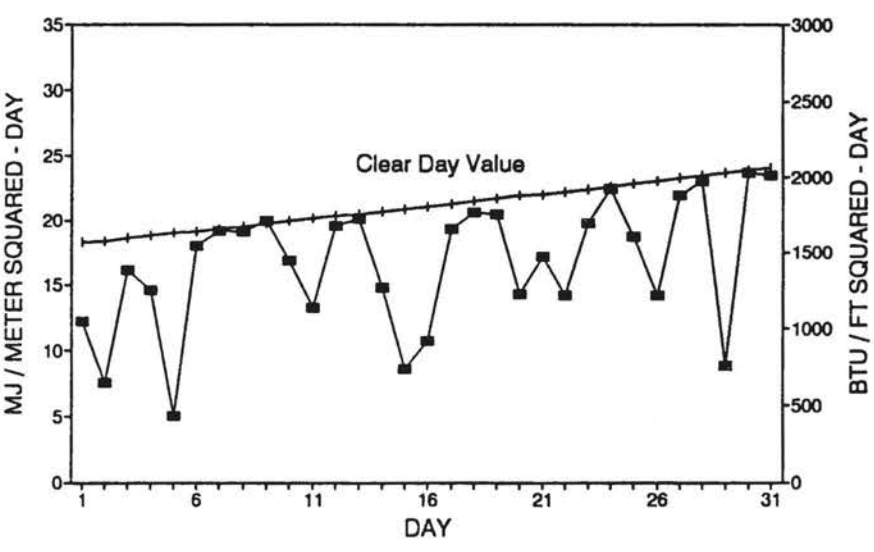
Name	Max	Min	Temperature Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	43.7	21.6	32.7	2.3	60	6	995	0	15	1.70	0.15	109.7	11
HAYDEN	43.1	21.0	32.0	3.6	57	3	1016	0	11	1.53	0.35	129.7	12
MEEKER NO. 2	46.3	22.5	34.4	-0.2	59	3	939	0	22	2.33	1.01	176.5	12
RANGELY 1E	50.7	26.3	38.5	3.5	63	10	814	0	51	0.95	0.18	123.4	11
EAGLE FAA AP	48.7	23.3	36.0	3.1	62	11	889	0	34	0.45	-0.32	58.4	7
GLENWOOD SPRINGS	48.0	25.4	36.7	0.6	65	15	869	0	35	2.02	0.78	162.9	16
RIFLE	51.8	25.1	38.5	0.8	67	16	814	0	75	1.29	0.44	151.8	12
GRAND JUNCTION WS	52.5	31.5	42.0	-0.2	65	24	706	0	66	0.70	-0.12	85.4	9
CEDAREDGE	50.1	24.5	37.3	-1.5	64	13	852	0	48	1.92	0.92	192.0	13
PAONIA 1SW	50.3	28.0	39.1	0.2	65	18	792	0	49	1.83	0.55	143.0	11
DELTA	53.3	28.3	40.8	-0.2	67	17	742	0	76	0.38	-0.10	79.2	2
COCHETOPA CREEK	42.3	16.5	29.4	4.4	55	-3	1096	0	7	1.72	1.06	260.6	12
MONTROSE NO. 2	52.1	27.7	39.9	1.3	63	18	768	0	72	0.31	-0.22	58.5	6
URAVAN	54.3	30.1	42.2	-1.0	67	20	701	0	93	0.95	-0.02	97.9	13
NORWOOD	45.8	23.4	34.6	0.8	58	6	936	0	23	0.75	-0.36	67.6	6
YELLOW JACKET 2W	46.8	24.6	35.7	0.7	59	13	900	0	21	1.74	0.68	164.2	10
CORTEZ	48.6	23.9	36.3	-1.0	61	14	882	0	41	1.62	0.28	120.9	6
DURANGO	47.8	22.5	35.1	-2.2	59	12	919	0	24	3.11	1.48	190.8	13
IGNACIO 1N	47.2	23.4	35.3	0.1	59	13	911	0	23	1.22	0.02	101.7	9

* 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 1991 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	10	11	10	--	--
Denver	13	6	12	79%	71%
Fort Collins	11	11	9	--	--
Grand Junction	6	7	18	56%	64%
Limon	13	6	12	--	--
Pueblo	12	8	11	77%	75%

FT. COLLINS TOTAL HEMISPHERIC RADIATION
MARCH 1991



I have had the opportunity to spend many hours going through the history of the Cooperative Weather Observing Program in Colorado. I have tried to look up all the names and places where official weather stations have been operated during the past century. Please let me share some of this with you. Also, please forgive me for any omissions -- I'm sure I will overlook someone.

To begin with, we should all applaud the current volunteer weather observer in Westcliffe, Mr. Marvin O. Rankin. He became the official observer there in November 1939 and has been going strong ever since. To the best of my knowledge, with 51 ½ years of service, this is the longest any single individual has served as a Cooperative Observer here in Colorado. What is truly amazing is that Mr. Rankin will need to keep up this good work for another 25 years if he wants to match the efforts of Mr. Edward H. Stoll of Elwood, Nebraska. Mr. Stoll began observing in 1905 at age 19 and continued daily until just before his death in 1981. He was given numerous awards for his incredible 76-year commitment and contribution.

A handful of other Coloradans have reached the 50-year mark. Robert E. Trimble is credited for maintaining the Fort Collins weather station from 1887 to 1937. Charlie Green enthusiastically observed the weather from 1889 to 1939 on his farm southeast of Sterling. Most recently, Thyra Nelson took daily observations for 49 years in the windswept country 14 miles east of Grover. She retired as observer there in 1987.

At this very moment, two more Coloradans are closing in on their Golden Anniversary of weather observing for the National Weather Service's Cooperative Program. Lynn K. Woods took over the Del Norte weather station in March 1942. Orville Altenbern began his official weather observing career northwest of DeBeque in November 1942.

We also have a few other Colorado youngsters who have taken their fair share of weather observations. Mabel Wright has been observing on her ranch southwest of Creede since 1944. She is 92. Harold Kreuger has maintained flawless daily weather reports southeast of Gunnison for a mere 44 years. Layton Munson took over the Sedgwick weather station in 1947 and is still going strong.

Weather observing is not always an individual responsibility. Often, it is a family affair, and sometimes it is passed on from generation to generation. Currently, Neil Lindstrom of the Leroy 5WSW weather station southeast of Sterling, continues a family tradition that began 102 years ago. Other family traditions that continue are the Shutt family west of Dove Creek (1937-present), the Hass Family near Limon (1941-present) and the Shannon family near Kim (1944-present). Two generations of the Boothroyd family maintained the Waterdale weather station west of Loveland from 1895-1968. The Chesebro family kept precipitation records in Eldorado Springs from 1908-1976.

To obtain the best long-term observations of our climate it is very important that weather stations be maintained in the exact same locations with unchanging surroundings. Individuals occasionally lose interest in weather observations, sometimes they move away, and sometimes they even grow old and die. As a result, new observers must be recruited and weather stations need to be relocated. For this reason, some weather stations are established as a part of major institutions that plan to be around for a long, long time.

Currently, close to half of Colorado's official cooperative weather stations are associated with institutions. Over the years, a few individual organizations stand out as being especially cooperative. For example, the Denver Water Department currently provides daily weather observations from 13 sites from Denver to Dillon. Stations at Cheesman Dam and Kassler date back nearly to the turn of the Century. The U.S. Bureau of Reclamation operates 9 cooperative weather stations at various dams that they maintain in Colorado. The National Park Service and Colorado State University each maintain 7 cooperative stations in various parts of Colorado. Many other organizations have one or more stations. Public Service Company, Greeley Gas Company, city water departments, fire departments, sewage treatment plants, radio stations, mines, motels, feedlots, the Southern Ute Agency, Colorado Highway Department, other universities ... there is just no limit to where you might find one of Colorado's 240 official cooperative weather stations.

I would love to tell you more, but I've used up my space. Governor Romer will soon be declaring the week of June 2-8, 1991 as COLORADO WEATHER OBSERVER APPRECIATION WEEK. Please join with us in extending a huge "thank you" to these many people who have provided us the data over the past century to discover the beauties and complexities of our Colorado climate and who continue to help us monitor our interesting climate today.

SPECIAL NOTE to Weather Observers: We hope that as many weather observers as possible come to Fort Collins on June 7-8 for our special Centennial Program. It will be a unique opportunity to meet fellow weather observers and also meet the scientists, media, business and government leaders who rely on your climate data. If by any chance you have not received your official invitation please call us (303-491-8545) or the National Weather Service (303-361-0666) immediately.

THE WEATHER HANDBOOK

The Colorado Office of Energy Conservation and the Joint Center for Energy Management are producing a Standard Data Set Weather Handbook for the state of Colorado. This handbook will provide a standard data set for various energy studies. It will be comprised of tables of collected weather data in several different formats conforming to the different types of studies available. It will also contain sections with tables of the standard assumptions and inputs for various types of energy calculation studies.

The weather data for the state will be placed into three different formats. There will be a section with monthly averaged temperature, degree-days, relative humidity, wind speed, wind direction, and insolation for approximately 150 of the major cities and towns in Colorado. A second section will be a collection of hourly bin data with 5 degree temperature bins with mean coincident wetbulb temperatures, and insolation. In addition to these data sets the handbook will also contain a collection of continuous hourly data for temperature, relative humidity, wind speed, wind direction, and insolation. The hourly data will come from the applicable TMY (typical meteorological year) sites of: Denver, Colorado Springs, Pueblo, Grand Junction, Eagle, Rock Spring WY., Cheyenne WY., North Platte NEB., Goodland KS., and Clayton NM., and the Wthrnet sites of: Alamosa, Carbondale, Durango, Montrose, Steamboat Springs, Sterling, Stratton, and Walsh CO (the wthrnet sites will be for the last three years of data).

The standard method of determining infiltration in residential construction is to use the Sherman-Grimsrud infiltration model. The Sherman-Grimsrud infiltration model requires a number of inputs depending on site location, building type, and topography. This handbook will contain a standard set of the values to be used in this model for various generic sites around the state.

The handbook will also include several tables of standard parameters for energy calculations. There will be a set of standard soil heat transfer properties, soil temperatures, and water source temperatures for various locations in Colorado. A section with values of foreground surface reflectance, and clear sky solar radiation profiles for various orientations to be used with solar calculations will be included. A list of the major cities and towns in Colorado (approximately 150) with the altitude and correction factors for HVAC systems will be presented. There will also be a summary of the normals, means, and extremes of temperature, precipitation, humidity, wind, and cloud cover for these cities, also included will be the standard seasonal diurnal temperature profiles.

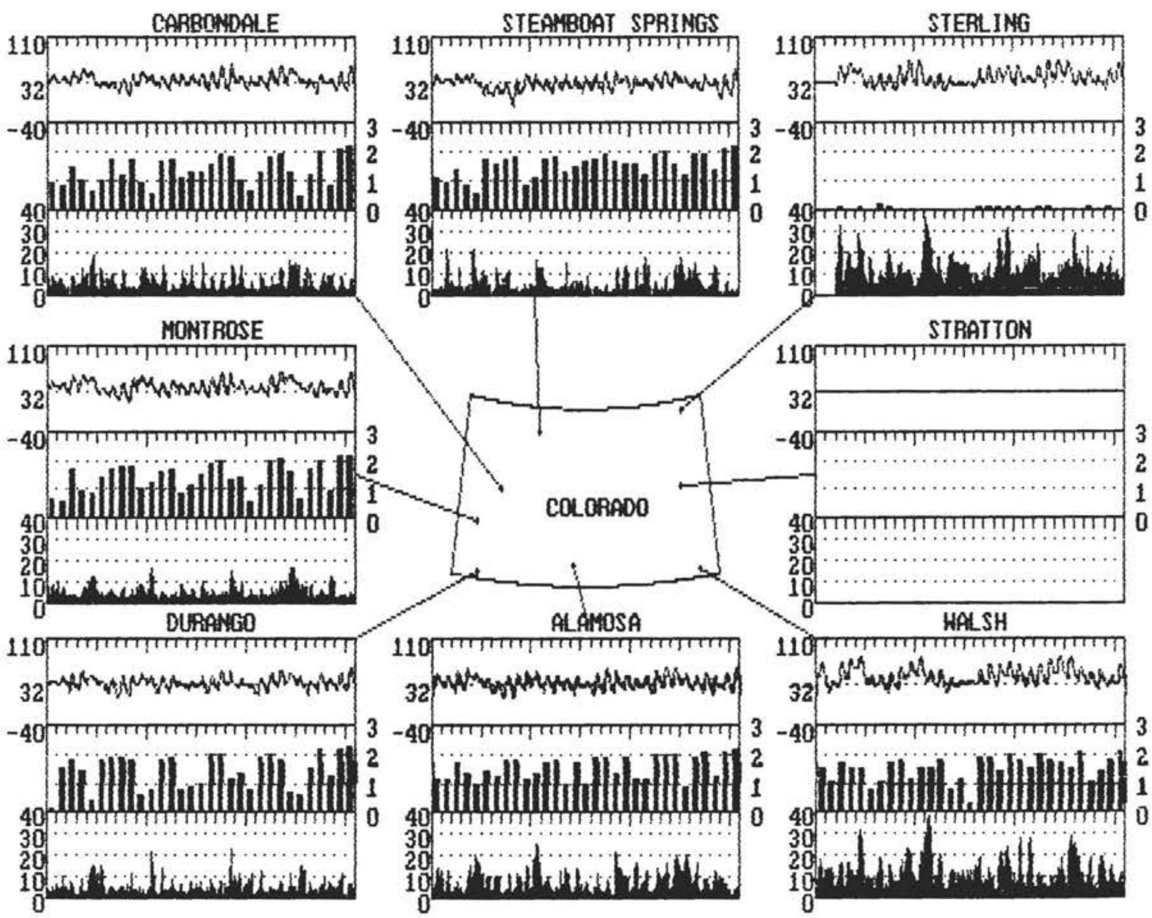
For information on the publication of this handbook contact the Colorado Office of Energy Conservation in Denver. The expected completion date of this project is September 1991.

This article was written by Carl Rogers of the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, CO. 80309-0428. Information in acquiring our weather data can be obtained by writing Carl Rogers at this address, or using your PC to call the Wthrnet Bulletin Board (303) 492-3525.

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (°F)	33.3	32.6	34.7	37.9	28.6	38.9	32.0	43.8
monthly temperature extremes and time of occurence (°F day/hour)								
maximum:	59.4 24/15	56.3 31/16	61.9 19/14	62.2 24/15	54.3 31/16	69.6 10/14	32.0 1/ 1	77.2 25/16
minimum:	7.5 8/ 7	8.8 8/ 3	10.2 9/ 7	13.1 9/ 7	-10.3 9/ 7	15.1 14/ 2	32.0 1/ 1	16.7 14/ 6
monthly average relative humidity / dewpoint (percent / °F)								
5 AM	74 / 14	75 / 17	85 / 22	67 / 18	88 / 18	38 / 3	0 /-40	67 / 20
11 AM	37 / 13	50 / 19	48 / 20	43 / 20	61 / 21	25 / 7	0 /-40	41 / 22
2 PM	29 / 12	45 / 18	41 / 19	36 / 18	45 / 19	21 / 9	0 /-40	33 / 22
5 PM	32 / 12	44 / 17	44 / 19	36 / 17	55 / 19	22 / 7	0 /-40	35 / 21
11 PM	53 / 13	64 / 18	69 / 22	58 / 19	82 / 21	31 / 3	0 /-40	56 / 20
monthly average wind direction (degrees clockwise from north)								
day	207	211	252	223	186	208	0	189
night	187	110	199	155	149	212	0	230
monthly average wind speed (miles per hour)	6.93	4.38	4.34	4.75	3.76	10.36	0.00	11.13
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	147	316	351	228	439	70	744	30
3 to 12	485	392	365	490	258	423	0	444
12 to 24	111	32	24	26	43	214	0	230
> 24	1	0	0	0	0	37	0	40
monthly average daily total insolation (Btu/ft²·day)	1539	1402	1304	1416	1507	11	0	1495
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	202	57	100	119	99	0	0	202
40-60%	76	61	77	64	67	0	0	85
20-40%	62	69	96	83	78	1	0	57
0-20%	16	75	47	32	29	0	0	26

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. Nebraska has still not repaired the Stratton station or replaced the horizontal pyranometer at Sterling so the data should be disregarded. Also, Sterling station was non-functioning April 1 and 2.



COLORADO CLIMATE

APRIL 1991

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 14 Number 7

April in Review:

Cold, unsettled weather in late April delayed the mountain snowmelt, produced heavy snows in the central mountains and along parts of the Front Range and brought a severe damaging freeze to Colorado's Western Slope fruit industry. For the month as a whole, precipitation was highly variable ranging from well above average in the northern and central mountains to much below average over portions of the eastern plains and southwestern Colorado. Temperatures ended up near average east of the mountains but were as much as four degrees cooler than average on the Western Slope.

Colorado's June Climate:

Colorado's climate is always one of contrast, even in summer. June is reliably a sunny and very dry month across the mountains and Western Slope. Snowmelt runoff usually proceeds in an orderly fashion, removing the mountain snow fields and replacing them with grasses and wildflowers. Soggy forests and meadows dry out, to the delight of high-elevation hikers and campers. At the same time, eastern Colorado is at the peak of the severe weather season. Tornadoes and damaging hail can be expected on 4 to 7 days, most numerous over northeastern Colorado. The first two weeks of June have traditionally been the period with the greatest likelihood for damaging tornadoes. In extreme northeastern Colorado, June is the wettest month of the year with more than 3" of rain expected. Flash floods are a possibility from the Front Range on across the plains as heavy rains can fall on watersheds already saturated with snowmelt runoff.

About the time of the summer solstice, an interesting transition occurs in Colorado. Intense sunshine prevails statewide and temperatures often soar into the 90s (100s in lower elevation areas). A few afternoon thundershowers may still appear but they tend to be small and localized. The humidity is often very low. Sometimes in just a matter of a few days, forests and grasslands that had been green and moist suddenly become dry. By the end of June, the threat of wildfires can become very great.

Daytime temperatures in June average in the low to mid 80s below 6,000 feet with nighttime readings mostly in the 50s. However, northeastern Colorado often sees several days early in the month with highs only in the 60s and 70s accompanying wet weather. Later in the month, as the State drys out, persisting heatwaves often set in with temperatures at least in the 90s. The mountains become a logical place to escape summer's heat. You can count on daytime temperatures decreasing about 4 degrees Fahrenheit for each 1000 feet of elevation. At 10,000 feet, temperatures struggle to exceed 70 degrees until the end of June.

June precipitation averages only 0.50-1.00 inches in western and southwestern Colorado. Totals increases to 1-2 inches in the mountains, 1.50-2.50" along the Front Range and across southeastern Colorado and reach a maximum in excess of 3" over extreme northeastern Colorado. The majority of June precipitation usually falls in the first half of the month.

Climate Highlights of the Past 100 Years

The Centennial Celebration is close at hand. At long last, our cooperative weather observers here in Colorado are going to receive a well-deserved "Thanks!!" Over the past 100 years we have counted a total of more than 2,000 Colorado citizens who have served as official weather observers for the National Weather Service's Cooperative Program. So much of what we know about our interesting and exciting Colorado climate can be attributed directly to the efforts of these weather observers whose daily records now form the historical database from which we examine our climate.

This is a fine time to sit back and reflect upon what we have lived through during the past century -- the droughts, the floods, the blizzards, the hailstorms, and the gushing sunshine. This may help us appreciate our current climate and may also give us fair warning of what may await us.

(continued on page 85)

APRIL 1991 DAILY WEATHER

Date	Event
1-3	A strong low pressure area aloft marched quickly across the central Rockies. It was generally mild and dry on the 1st but clouds increased from west to east. Showers, thunderstorms, mountain snows and colder temperatures spread across the State on the 2nd. Joes picked up 0.75" of rain. An area of showers developed again on the 3rd over the plains, but precipitation totals were mostly light.
4-6	The jet stream shifted north of Colorado and produced the only real heatwave of the month. Lower elevation areas experienced temperatures in the 70s and 80s on the 5th and 6th with a few 90s in the southeast. Lamar's 92° reading on the 5th was the hottest in the State for April. A number of areas set or matched daily record highs on both the 5th and 6th such as Denver's 83° on the 6th.
7-8	Another strong storm moved directly over Colorado but moved too quickly to deposit much precipitation. Most locations received less than 0.25" of moisture, but some parts of the Central Mountains were hit harder. Climax, for example, received nearly 9" of new snow.
9-15	After a 1-day interlude of pleasant weather, a new and very strong storm system developed west of Colorado on the 10th. The upper level storm cut off and stalled just west of Colorado, but cold surface air gradually invaded the entire State. Rain and snow began in western Colorado on the 10th, and strong winds developed over much of Colorado. Wet snows began along the Northern Front Range early on the 11th with 4" or more in the foothills. At the same time, temperatures in SE Colorado were still approaching 80° and winds there were averaging 30 mph and gusting to 60 mph or greater. As colder air pushed in on the 12th, heavier snows developed in the northern mountains and especially near the Front Range. Boulder and Monument each picked up 8" of new snow, while 18" fell at Echo Lake near Mount Evans. The 13th dawned very cold with subzero readings in the mountains. The -10° at Bonham Reservoir was the coldest in the State for April. It was still cold, breezy and unsettled 13-14th as the upper-level storm finally moved northeast. One last round of snowshowers dusted some of the eastern plains late on the 13th. Rush reported 4" of snow. Finally on the 15th, dry and mild weather returned to all of Colorado.
16-24	Low pressure tarried over the Great Basin while high pressure over the Northern Plains pushed cool, damp air into eastern Colorado. This weather pattern produced delightful spring weather on the Western Slope and seasonal weather in the mountains. But east of the mountains it was a cool period with episodes of low clouds and fog that appeared nearly every morning followed by scattered afternoon and evening showers. Precipitation was generally light, but some moderate thundershowers occurred on the 18th. Steady, cold rains, with a little slush mixed in, fell on the 21st over NE Colorado with temperatures close to 40°F. The northern and central mountains received a light dusting of new snow. Then late on the 22nd into the 23rd an area of significant precipitation formed near Pikes Peak. The Ruxton Park weather station recorded 0.84" of moisture from 8" of snow.
25-30	More cool and unsettled weather occurred as a low pressure trough remained in place over the Rockies. It was fairly warm on the 25th with highs in the 60s and 70s (low 80s in the SE) but low pressure, strong winds and mountain snows buffeted Colorado on the 26th. The brunt of the storm then swung northward into Montana, but cold unsettled weather covered much of Colorado. Light snows continued in the mountains. Freezing temperatures on the Western Slope 27-28th produced serious damage to fruit crops. A disturbance passed south of Colorado on the 28th but dropped 6" of snow at Walsenburg and 0.80" of rain at Holly. A final upper-level disturbance dropped down from the northwest overnight on the 29th bringing more mountain snows but dropping an unexpected heavy snowfall on the Denver area. Boulder awoke to 7" of wet snow. Lakewood reported 8" with 1.02" of water content. Grass greened quickly as this spring snow melted.

April 1991 Extremes

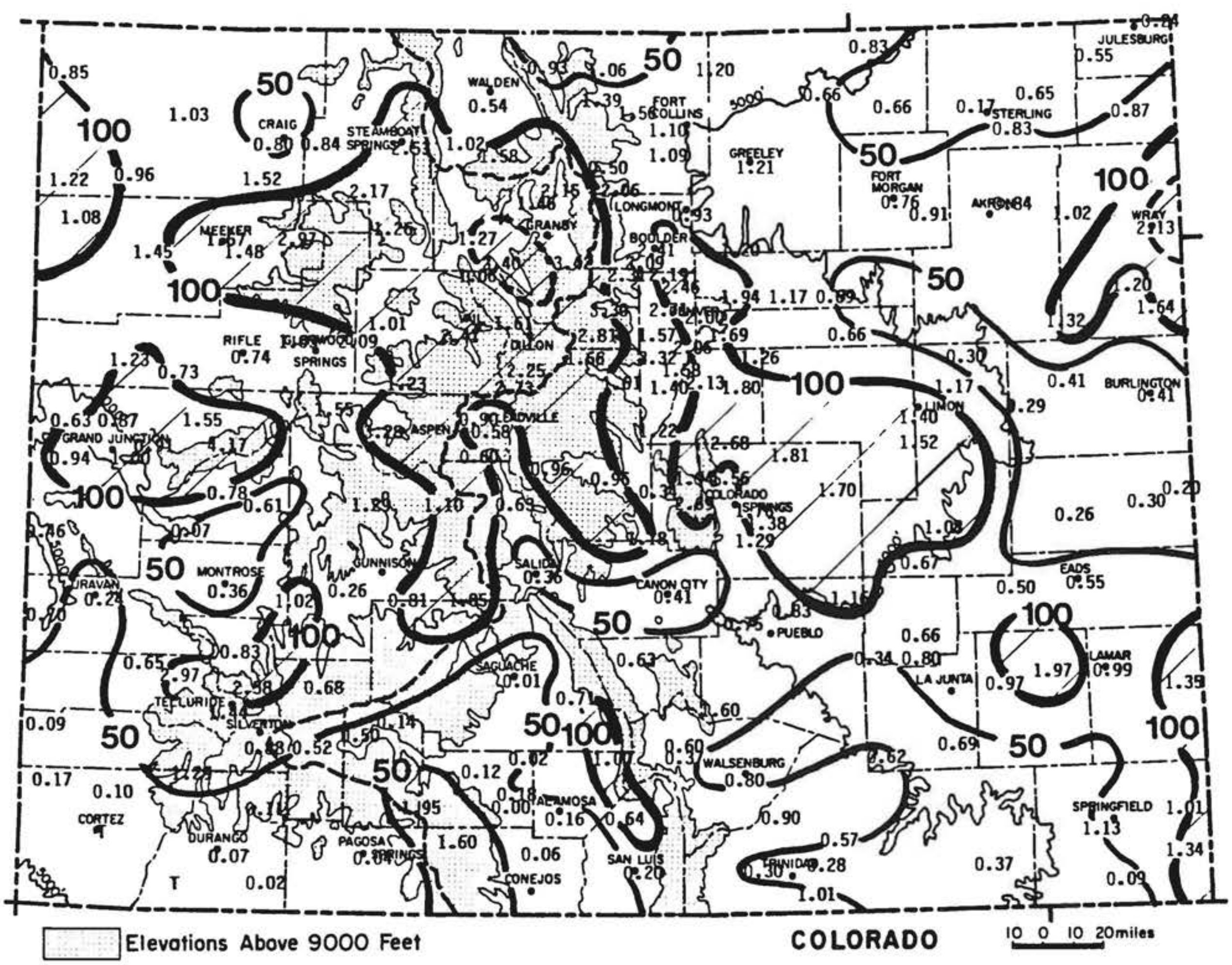
Highest Temperature	92°F	April 5	Lamar
Lowest Temperature	-10°F	April 13	Bonham Reservoir
Greatest Total Precipitation	4.17"		Bonham Reservoir
Least Total Precipitation	0.00"		Monte Vista Refuge
Greatest Total Snowfall*	52"		Winter Park
Greatest Depth of Snow	117"		Wolf Creek Pass 1E

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

APRIL 1991 PRECIPITATION

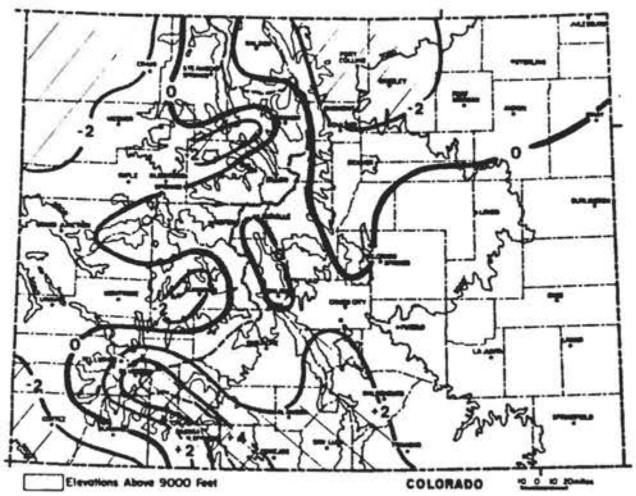
There were several excellent opportunities for precipitation in April, and moisture fell somewhere in the State on at least 23 days during the month. However, no storms struck all areas of Colorado. As a result, precipitation totals for the month were highly variable ranging from just a trace at some stations in southwest Colorado to more than 3 inches of water content at several sites in the central and northern mountains. Relative to April averages, precipitation was near or above average in most of the northern and central mountains, on and near the Grand Mesa, on the northwestern slopes of the San Juan Mountains, along the Front Range from Boulder south to Colorado Springs and eastward to Limon, and in a few spots on the extreme eastern plains. A number of areas were very dry in April including southwestern Colorado, local valley areas such as Montrose, Delta, Glenwood Springs and Craig, and a number of areas east of the Continental Divide. Statewide, 26% of the reporting stations received less than half of the April average. Only 17% of the weather stations received more than 120% of average.

Greatest		Least	
Bonham Reservoir	4.17"	Monte Vista Refuge	0.00"
Winter Park	3.42"	Vallecito Dam	Trace
Mount Evans Research Center	3.30"	Fort Lewis	Trace
		Cortez	Trace
Aspen 1 SW	3.28"	Saguache	0.01"
Marvine Ranch	2.97"	Ignacio 1 N	0.02"



Precipitation amounts (inches) for April 1991 and contours of precipitation as a percent of the 1961-1980 average.

With seven months of the 1991 water year already past, most areas of Colorado are fairly close to their average accumulated precipitation since October 1, 1990. 100-125% of average water-year precipitation totals are common west of the Continental Divide. A number of areas east of the mountains are also in good shape including much of Yuma, Washington, Elbert, Lincoln, Crowley, Kiowa, Otero and Bent counties. But many dry areas can be found especially in northeastern Colorado, along the Front Range from the Wyoming border south to about Pueblo and in extreme southwestern Colorado. Estes Park, Fort Collins, Nunn, Loveland and Salida have all received less than 60% of average.

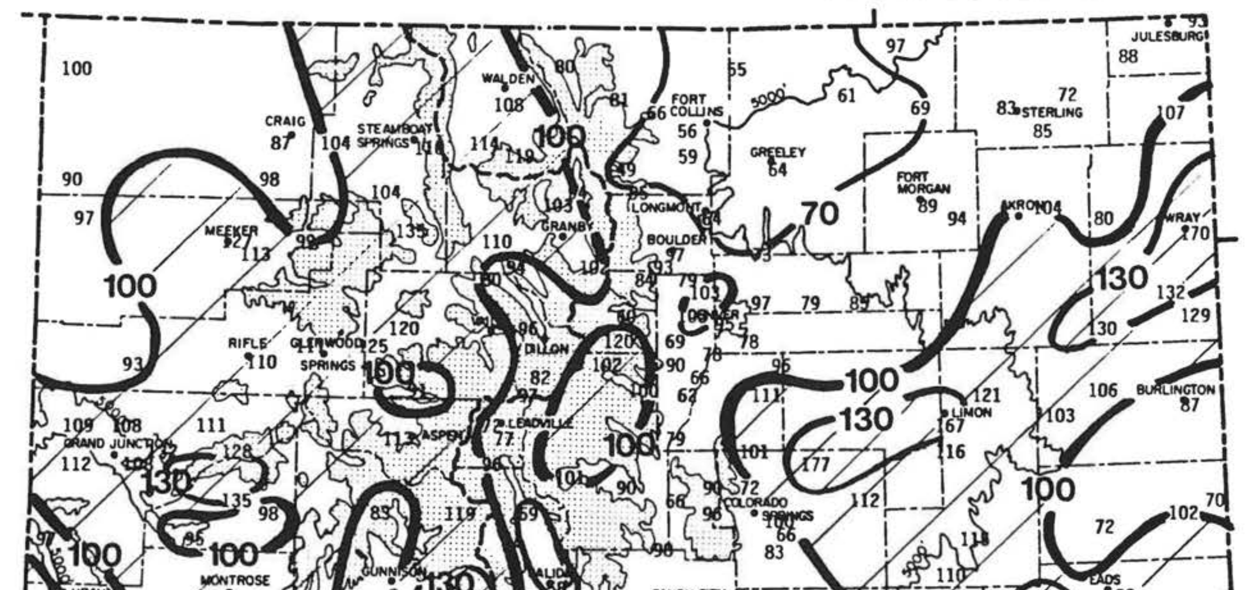


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

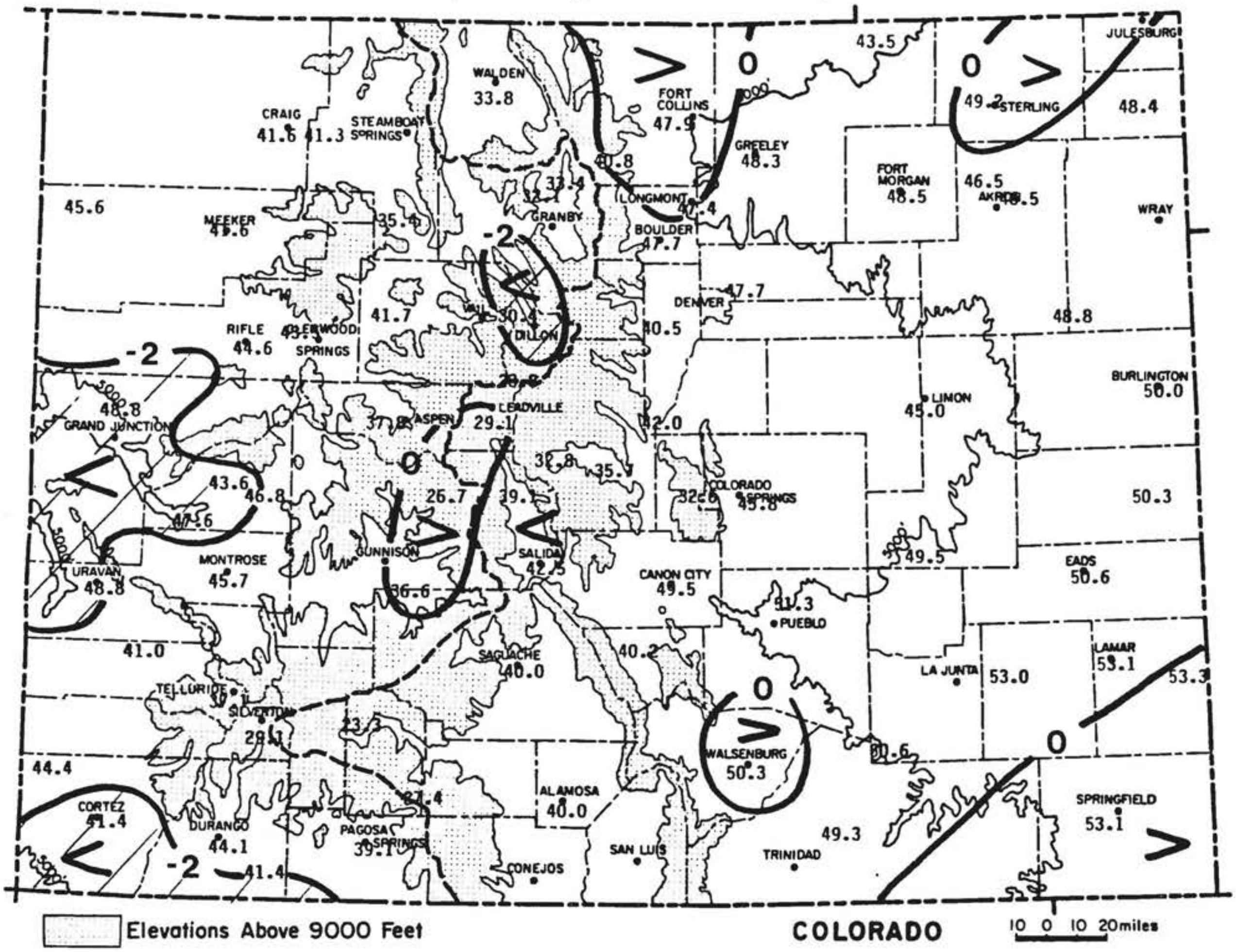
	extremely wet
+4	----------------
+3	ample moisture
+2	----------------
+1	
0	near normal
-1	
-2	----------------
	moderate drought
-3	----------------
	severe drought
-4	----------------
	extreme drought



Precipitation for October 1990 through April 1991
as a percent of the 1961-1980 average.

APRIL 1991 TEMPERATURES AND DEGREE DAYS

April temperatures got off to a mild start but didn't warm up much through the month. For much of the State the hottest weather of the entire month occurred in the first 7 days. Cool weather late in the month distinctly slowed the snowmelt and raised the hopes for adequate summer water supplies. April mean temperatures ended up near average over the eastern plains. From the mountains westward, cooler temperatures prevailed and some areas ended up 2 to 4 degrees F cooler than expected.



April 1991 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

APRIL 1991 SOIL TEMPERATURES

Soil temperatures warmed slowly but steadily through the month and tracked fairly close to the averages 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.

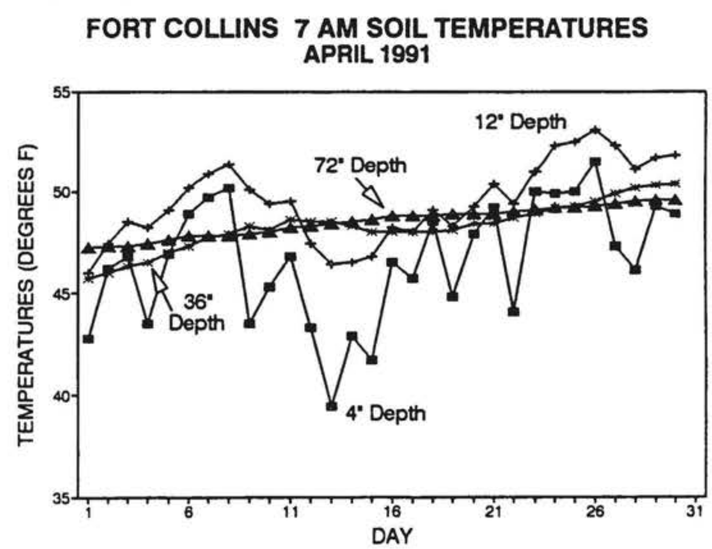


Table 1. Heating Degree Day Data through April 1991 (base temperature, 65°F).

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
	89-90	17	82	271	698	1001	1400	1554	1089	880	640	480	105	8217
	90-91	59	118	201	633	990	1597	1671	1081	954	742			8046
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	89-90	68	176	303	671	974	1365	1365	1086	915	697	543	171	8334
	90-91	134	146	234	652	964	1462	1444	1013	1077	811			7937
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	89-90	1	0 E	139	M E	567 E	1064 E	776 E	925 E	760	502	321	21	M
	90-91	32	13	81	338	589	1161	1081	667	685	511			5158
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	89-90	39	112	270	628	812	1202	1184	991	857	660	518	106	7379
	90-91	66	130	226	641	905	1326	1256	896	983	771			7200
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	89-90	0	4 E	130	415	684	1229	990	957	757	459	280	3	5908
	90-91	10	4	76	407	M	1249	1223	688	737	438			M
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	89-90	0	0	131	379	584	1076	859	827	687	421	325	22	5311
	90-91	14	12	58	382	548	1098	1004	626	679	459			4880
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	89-90	0	4	172	473	699	1163	966	928	805	526	345	24	6105
	90-91	28	21	83	473	663	1256	1142	750	773	568			5757
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	89-90	0	16	142	494	850	1166	1222	959	776	490	377	59	6551
	90-91	1	6	151	539	774	1321	1364	879	882	702			6619
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	89-90	4	46	235	586	892	1420	1319	1257	879	530	453	144	7765
	90-91	14	18	116	606	876	1547	1544	1095	995	693			7504
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	89-90	M	M	M	330	M	M	1161	865	626	355	237	22	M
	90-91	0	2	58	416	751	1400	1549	998	742	512			6428
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	89-90	0	0	153	424	658	1160	879	882	781	469	265	7	5678
	90-91	12	3	64	388	623	1209	1143	684	682	510			5318
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	89-90	226	357	502	861	1124	1495	1506	1271	1124	886	764	349	10465
	90-91	284	355	430	858	1071	1587	1569	1220	1257	1031			9662
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	89-90	2	19	106	520	789	1133	1278	965	724	479	359	44	6418
	90-91	4	28	118	481	832	1373	1274	842	919	619			6490
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	89-90	1	60	217	593	896	1348	1286	986	806	545	269	68	7075
	90-91	15	23	134	583	934	1568	1536	1052	889	693			7427
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	89-90	49	118	325	657	818	1221	1115	1030	932	662	513	140	7580
	90-91	120	131	219	591	803	1330	1244	937	885	727			6987
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	89-90	0	3	169	458	711	1166	930	910	848	495	307	19	6016
	90-91	19	6	74	460	690	1284	1212	747	703	508			5703
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	89-90	0	2	156	416	721	1285	1087	1010	776	450	274	10	6187
	90-91	18	7	63	421	730	1343	1248	750	722	489			5791
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	89-90	0	0	40	316	729	1103	1124	820	557	271	139	20	5119
	90-91	0	0	28	360	759	1370	1464	919	706	478			6084

* = 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 6SSW	AVE	214	264	468	775	1128	1473	1593	1369	1318	951	654	384	10591
	89-90	168	306	427	768	1132	1449	1401	1205	1043	833	689	266	9687
	90-91	264	268	350	774	1071	1605	1668	1148	1233	979			9360
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	89-90	1	2	166	454	729	1230	985	922	787	449	275	9	6009
	90-91	14	2	62	450	723	1309	1246	741	692	492			5731
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	89-90	61	155	341	749	1069	1574	1647	1254	906	672	540	188	9156
	90-91	65	179	264	771	1059	1664	1787	M	M	M			M
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	89-90	0	0	99	323	684	1176	1030	887	638	309	188	2	5336
	90-91	4	0	21	308	624	1220	1113	667	602	352			4911
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	89-90	285	412	545	880	1138	1507	1499	1265	1188	920	793	377	10809
	90-91	331	402	464	861	1141	1556	1550	1207	1210	1068			9790
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	89-90	1	6	204	508	762	1252	1078	991	815	555	364	33	6569
	90-91	36	11	96	491	745	1280	1237	779	820	592			6087
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	89-90	2	8	200	484	749	1302	1048	994	917	552	319	25	6600
	90-91	24	11	101	481	727	1284	1249	740	699	520			5836
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	89-90	0	41	198	543	869	1261	1169	1071	795	507	387	91	6932
	90-91	9	23	121	511	885	1406	1458	1047	939	696			7095
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	89-90	0	10	110	439	768	1156	1186	895	654	425	285	27	5955
	90-91	0	3	81	470	804	1385	1460	974	768	571			6516
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	89-90	24	118	284	646	964	1298	1491	1160	873	630	524	164	8176
	90-91	44	108	177	608	910	1538	1432	1038	1002	767			7624
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	89-90	0	0	94	373	676	1204	964	877	695	394	233	2	5512
	90-91	1	0	34	360	610	1243	1116	730	667	406			5167
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	89-90	0	2	103	473 E	830	1130	1191	923	657	392	281	37	6019
	90-91	0	4	69	474	824	1433	1462	964	814	605			6649
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	89-90	18	117	315	M	974	1533	1580	1332	971	658	576	M	M
	90-91	129 E	110	255	700	1013	1683	1613	1223	1120	851			8697
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	89-90	0	3	144	428	719	1254	1074	1026	760	427	275	8	6118
	90-91	17	7	68	437	725	1359	1244	713	716	466			5752
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	88-89	72	175	270	644	869	1264	1273	1023	922	664	509	145	7830
	89-90	117	179	267	635	972	1384	1351	987	1093	828			7813
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	89-90	0	1	111	369	633	1153	980	874	681	420	266	8	5496
	90-91	4	6	46	334	654	1160	1048	697	709	462			5120
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	89-90	132	279	461	802	1075	1490	1359	1287	1068	796	674	273	9696
	90-91	202	258	332	794	1028	1550	1459	1105	1164	931			8823
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	89-90	0	2	117	345	581	1047	848	800	666	408	289	10	5113
	90-91	15	8	53	311	543	1047	985	646	674	437			4719

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

A P R I L 1 9 9 1 C L I M A T I C D A T A

Eastern Plains

			Temperature				Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
NEW RAYMER 21N	57.6	29.5	43.5	-2.0	82	13	636	0	139	0.83	-0.36	69.7	8
STERLING	63.4	35.0	49.2	1.4	85	19	466	0	215	0.17	-1.11	13.3	3
FORT MORGAN	62.0	35.0	48.5	0.1	84	20	489	0	196	0.76	-0.41	65.0	5
AKRON FAA AP	59.6	33.3	46.5	-0.2	83	16	551	0	158	0.23	-1.09	17.4	5
AKRON 4E	60.4	32.7	46.5	0.4	83	14	548	0	171	0.84	-0.43	66.1	6
HOLYOKE	61.2	35.5	48.4	-1.0	85	21	491	1	183	0.87	-0.65	57.2	4
JOES	62.7	34.9	48.8	1.8	84	21	480	0	203	1.32	0.12	110.0	5
BURLINGTON	64.0	36.1	50.0	-0.2	87	22	438	0	220	0.41	-0.79	34.2	5
LIMON WSMO	57.7	32.2	45.0	-0.1	79	20	592	0	132	1.40	0.35	133.3	9
CHEYENNE WELLS	64.9	35.7	50.3	0.4	85	21	436	0	233	0.30	-0.58	34.1	5
EADS	65.2	36.1	50.6	-1.2	86	25	422	0	235	0.55	-0.43	56.1	3
ORDWAY 21N	66.1	33.0	49.5	0.6	86	21	456	0	250	0.67	-0.26	72.0	8
LAMAR	70.9	35.4	53.1	-0.8	92	23	349	0	317	0.99	-0.27	78.6	5
LAS ANIMAS	68.9	37.1	53.0	-0.8	89	23	352	0	286	0.97	-0.03	97.0	10
HOLLY	69.3	37.4	53.3	0.8	90	27	345	2	293	1.35	0.38	139.2	9
SPRINGFIELD 7WSW	70.2	36.0	53.1	1.5	86	21	352	0	308	1.13	-0.33	77.4	10
TIMPAS 13SW	65.9	35.4	50.6	-0.7	85	22	425	0	247	0.62	-0.30	67.4	5

Foothills/Adjacent Plains

			Temperature				Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
FORT COLLINS	60.4	35.4	47.9	0.9	78	25	508	0	169	1.10	-0.69	61.5	9
GREELEY UNC	61.0	35.6	48.3	-0.5	84	22	492	0	182	1.21	-0.73	62.4	7
ESTES PARK	53.0	28.5	40.8	1.1	68	11	721	0	88	0.50	-0.80	38.5	4
LONGMONT 2ESE	60.1	34.7	47.4	0.1	84	24	520	1	172	0.93	-0.99	48.4	6
BOULDER	59.9	35.6	47.7	-1.0	80	19	511	1	168	2.41	0.25	111.6	10
DENVER WSFO AP	59.8	35.7	47.7	0.1	83	20	510	1	168	1.94	0.12	106.6	7
EVERGREEN	54.3	26.7	40.5	0.1	76	8	727	0	97	1.57	-0.70	69.2	10
CHEESMAN	57.8	26.2	42.0	-0.0	78	11	683	0	137	1.22	-0.48	71.8	11
LAKE GEORGE 8SW	49.4	22.0	35.7	-0.8	65	10	873	0	49	0.95	0.03	103.3	8
ANTERO RESERVOIR	47.5	18.2	32.8	-0.4	63	6	959	0	29	0.96	0.33	152.4	7
RUXTON PARK	46.9	18.3	32.6	-1.1	67	3	967	0	35	2.69	0.20	108.0	11
COLORADO SPRINGS	58.6	33.0	45.8	-0.5	82	19	568	0	143	1.76	0.48	137.5	14
CANON CITY 2SE	64.6	34.5	49.5	-0.3	85	17	459	3	226	0.41	-0.71	36.6	5
PUEBLO WSO AP	67.7	34.8	51.3	-0.3	90	19	406	0	271	0.83	-0.11	88.3	6
WESTCLIFFE	56.2	24.2	40.2	-0.2	74	12	735	0	111	0.63	-0.33	65.6	5
WALSENBURG	66.2	34.3	50.3	1.9	83	16	437	1	252	0.80	-0.83	49.1	6
TRINIDAD FAA AP	66.4	32.3	49.3	-0.4	84	18	462	0	254	0.57	-0.44	56.4	7

Mountains/Interior Valleys

			Temperature				Degree Days			Precipitation			
Name	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
WALDEN	48.0	19.5	33.8	-0.6	63	3	931	0	48	0.54	-0.25	68.4	8
LEADVILLE 2SW	42.6	15.6	29.1	0.1	58	-6	1068	0	8	0.58	-0.82	41.4	12
SALIDA	58.4	26.6	42.5	-1.8	73	16	667	0	145	0.36	-0.89	28.8	2
BUENA VISTA	54.0	24.1	39.1	-2.0	69	14	771	0	102	0.63	-0.07	90.0	5
SAGUACHE	56.0	24.0	40.0	-1.2	73	13	742	0	121	0.01	-0.50	2.0	1
HERMIT 7ESE	35.6	11.0	23.3	-7.3	51	-2	1245	0	1	0.50	-0.66	43.1	2
ALAMOSA WSO AP	58.8	21.2	40.0	-0.7	76	8	742	0	152	0.16	-0.26	38.1	6
STEAMBOAT SPRINGS	49.7	23.1	36.4	-1.6	68	10	851	0	73	2.53	0.38	117.7	14
YAMPA	46.9	23.9	35.4	-1.1	63	-1	882	0	37	1.26	0.03	102.4	12
GRAND LAKE 1NW	47.8	19.0	33.4	0.7	62	7	939	0	45	2.15	0.23	112.0	14
GRAND LAKE 6SSW	46.6	17.6	32.1	-1.2	60	2	979	0	31	1.46	0.36	132.7	16
DILLON 1E	44.6	16.1	30.4	-2.4	62	-1	1031	0	24	1.61	0.49	143.7	14
CLIMAX	37.2	10.3	23.8	-1.9	55	-5	1230	0	5	2.73	0.33	113.7	15
ASPEN 1SW	52.0	23.7	37.8	-0.2	67	8	811	0	85	3.28	0.98	142.6	15
TAYLOR PARK	42.2	11.2	26.7	3.4	55	-7	1139	0	7	1.10	0.01	100.9	9
TELLURIDE	50.4	23.9	37.1	0.6	70	11	828	0	54	1.44	-0.46	75.8	16
PAGOSA SPRINGS	58.8	19.5	39.1	-1.4	74	11	767	0	154	0.04	-0.99	3.9	2
SILVERTON	45.5	12.7	29.1	-0.7	60	-9	1068	0	29	0.88	-0.56	61.1	8
WOLF CREEK PASS 1	40.5	14.3	27.4	-1.6	53	-1	1121	0	7	1.95	-1.00	66.1	11

Western Valleys

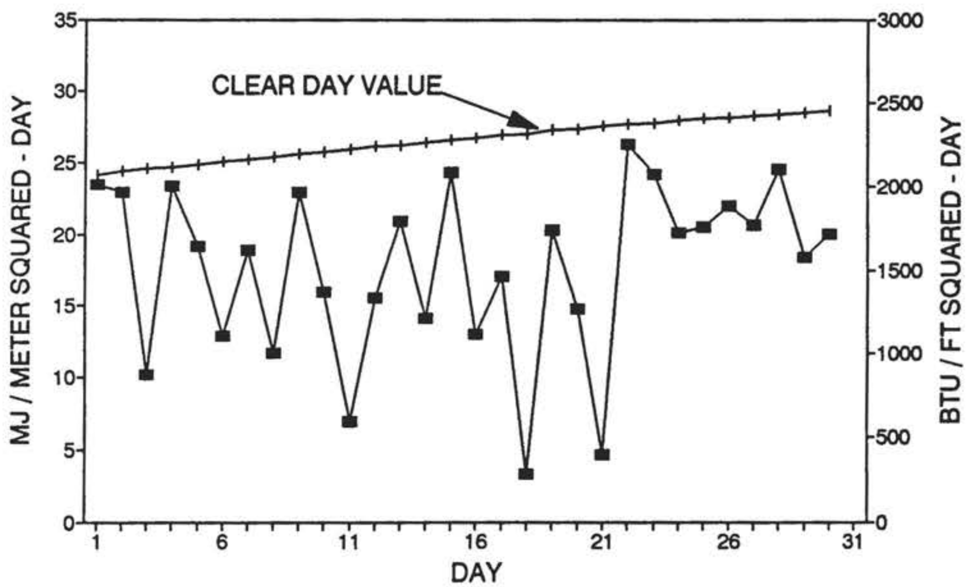
Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	54.9	28.3	41.6	-0.4	71	17	693	0	119	0.80	-1.00	44.4	11
HAYDEN	54.4	28.2	41.3	-0.2	73	18	703	0	112	0.84	-0.65	56.4	15
MEEKER NO. 2	54.6	28.5	41.6	-1.0	71	12	696	0	117	1.67	0.46	138.0	10
RANGELY 1E	60.1	31.1	45.6	-1.2	76	19	573	0	178	1.08	0.14	114.9	7
EAGLE FAA AP	56.4	26.9	41.7	-0.0	75	19	693	0	130	1.01	0.34	150.7	11
GLENWOOD SPRINGS	57.7	29.3	43.5	-1.8	74	21	640	0	144	1.03	-0.45	69.6	11
RIFLE	60.6	28.5	44.6	-1.7	77	17	605	0	184	0.74	-0.02	97.4	10
GRAND JUNCTION WS	61.2	36.4	48.8	-2.6	79	25	478	0	189	0.87	0.13	117.6	9
CEDAREDGE	59.5	27.6	43.6	-3.3	73	20	636	0	160	0.78	-0.03	96.3	7
PAONIA 1SW	60.8	32.9	46.8	-0.3	75	22	534	0	181	0.61	-0.73	45.5	7
DELTA	63.2	32.0	47.6	-2.3	80	23	512	0	213	0.07	-0.39	15.2	2
COCHETOPA CREEK	52.4	20.8	36.6	0.5	68	10	844	0	86	0.81	0.18	128.6	8
MONTROSE NO. 2	59.2	32.2	45.7	-1.5	75	21	571	0	163	0.36	-0.38	48.6	6
URAVAN	64.5	33.1	48.8	-2.7	79	22	475	0	229	0.24	-0.81	22.9	6
NORWOOD	55.0	27.0	41.0	-0.5	71	8	711	0	114	0.65	-0.31	67.7	5
YELLOW JACKET 2W	59.8	29.0	44.4	1.1	70	17	611	0	162	0.17	-0.68	20.0	4
CORTEZ	61.0	21.7	41.4	-3.5	75	14	702	0	187	0.00	-0.74	0.0	0
DURANGO	60.6	27.6	44.1	-0.7	75	17	619	0	175	0.07	-0.98	6.7	2
IGNACIO 1N	59.3	23.5	41.4	-2.1	72	14	700	0	156	0.02	-0.77	2.5	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 1991 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	5	13	12	--	--
Denver	4	13	13	67%	67%
Fort Collins	1	15	14	--	--
Grand Junction	4	15	11	73%	69%
Limon	4	11	15	--	--
Pueblo	7	13	10	74%	74%

FT. COLLINS TOTAL HEMISPHERIC RADIATION
APRIL 1991



Many interesting and sometimes frightening climatic events and extremes have left their mark on Colorado. I will mention some of them. You may remember some others. As usual, I could probably write a book on this, but for now we'll have to settle for the condensed version.

1898 Sep — Worst forest fires in recorded Colorado history.

1899 Jan 26-30 — Huge mountain snow halted railroad traffic. Several deaths.

1900-03 — Severe drought, especially SW Colorado. Animas River nearly went dry.

1905-29 — Good years for Colorado agriculture with predominantly cool temperatures and abundant precipitation.

- 1911 Oct — Severe flooding in the San Juan mountains.
- 1913 Dec 2-6 — Incredible Front Range snowstorm dumped 30-50" of fairly wet snow everywhere from Trinidad to Fort Collins.
- 1921 Apr 14-15 — Foothills snowstorm dropped 75.8" of snow at Silver Lake (above Boulder) in just 24 hours -- a North American record.
- 1921 Jun 3-4 — The great Pueblo flood occurred following cloudbursts of up to 12" of rain in upstream tributaries to the Arkansas.
- 1924 Aug 10 — 10 people in Thurman were killed by a tornado.

1930-39 — The wildest climate decade of the century in Colorado. While best known for the heat, drought, and dust storms, there was also lots of hail, tornadoes and extreme cold.

- 1934 — The hottest, driest year in Colorado's recorded history.
- 1935-39 — The years of dust, worst in 1935-36.
- 1939 — The last, but not least, of the dustbowl years. Only 1.69" of precipitation fell all year at Buena Vista.

1940-49 — Moisture returns to Colorado with fewer extremes but some terrible blizzards.

- 1946 Nov 2-6 — Lengthy blizzard clobbered eastern Colorado with 20-50" of snow and high winds. At least 13 people died.
- 1949 Jan 2-5 — Severe cold and high winds accompanied a modest snowfall claiming 7 human lives and thousands of animals in NE CO.

1951 Feb 1 — Temperatures of -40°F killed many Front Range cherry orchards.

1952-56 — Severe heat and drought again. 1954 was especially bad with lousy crops and summer temperatures soaring into the 100s.

1957 — Drought-breaker -- wettest year on record for Pueblo and the 3rd wettest statewide.

1963 Jan 12 — The coldest day of the century for much of western Colorado. Fruita hit -34°F. Widespread fruit tree mortality.

1965 Jun 14-18 — Excessive rains produced widespread and extreme flooding in eastern Colorado. Bijou Creek at Wiggins "was as big as the Mississippi."

1972 — One of the worst years of the century for severe downslope windstorms along the Front Range.

1976 Jul 31 — The Big Thompson flood wrought destruction to the canyon from Estes Park to Loveland and claimed at least 139 lives.

1976-77 — The least winter snowfall of the past century in the mountains culminated in a terrible March blizzard on the eastern plains which killed 9 people and created roof-high snow drifts.

1978-present — This period has has been marked by an increase in big snowstorms, heatwaves, coldwaves and severe weather.

- 1978 Feb — A wild "fog storm" frosted eastern Colorado and gradually deposited enough rime ice to take down numerous power lines.
- 1979 Jul 30 — Huge hailstones punctured roofs and killed a baby in Ft. Collins.
- 1982 Dec 24 — Christmas Eve blizzard shuts down Denver and parts of NE CO.
- 1983-86 — Successive years of heavy mountain snows and abundant summer water supplies -- some snowmelt flooding, especially 1983-84.
- 1989 Feb 1-7 — The "Alaska Blaster" brought an unusual combination of extreme cold and very heavy snow to much of Colorado.
- 1990 — A blistering June heatwave was followed by a cool, stormy July. On July 11 a severe hailstorm moved directly across Denver. The result was dozens of minor injuries and more than $0.5 billion damage, the greatest ever in the U.S.

The Art of a Snowball

At this time of year, the only kind of snowballs around are the ones in the freezer, but soon the snow will be back. With the snow comes the search for ultimate snowball snow.

As any five year old can tell you, it takes a special kind of snow to hit a person...and stick for the next fifteen minutes. Slush would be great except that it soaks the your gloves. Dry snow won't even stick together to form a snowball. So, what conditions make it possible for the supreme wet snow?

Samuel C. Colbeck researched the basic differences in snow types for the U.S. Army Cold Regions Research and Engineering Laboratory. He systematically looked at the ice clusters and their surroundings for different types of snow. All the types of snow look something like the picture to the right. The ice particles, shown as the round spots in the picture, are all connected by a water bond. The differences in the types of snow are in how strong the clusters are attached and the nature of their surroundings. For example, the spaces or openings between the ice crystals of dry snow are filled with moist air. At the other end of the spectrum, the pores of slush are completely occupied by liquid water.

Cluster of Ice Particles in Snow

Wet snow is a combination of dry snow and slush - like slush that has been drained of water. The space between the ice crystals of wet snow is mostly moist air like dry snow, but there is also liquid water present. In fact, wet snow never has a liquid content below 3%. It is the extra liquid that makes wet snow easily snowballed. Wet snow is not dense compared to slush so it can be compacted easily. When the snow is squeezed together, the extra liquid is used to create bonds that link more ice particles together. The ice clusters behave like ice cubes. Ice cubes in the freezer do not join together. However, if they are put in a drink, they adhere to each other.

The driving force in the production of wet or dry snow is of course temperature. A higher temperature would cause more water to be present in the snow. Therefore, fall and spring are the optimal snow ball throwing seasons.

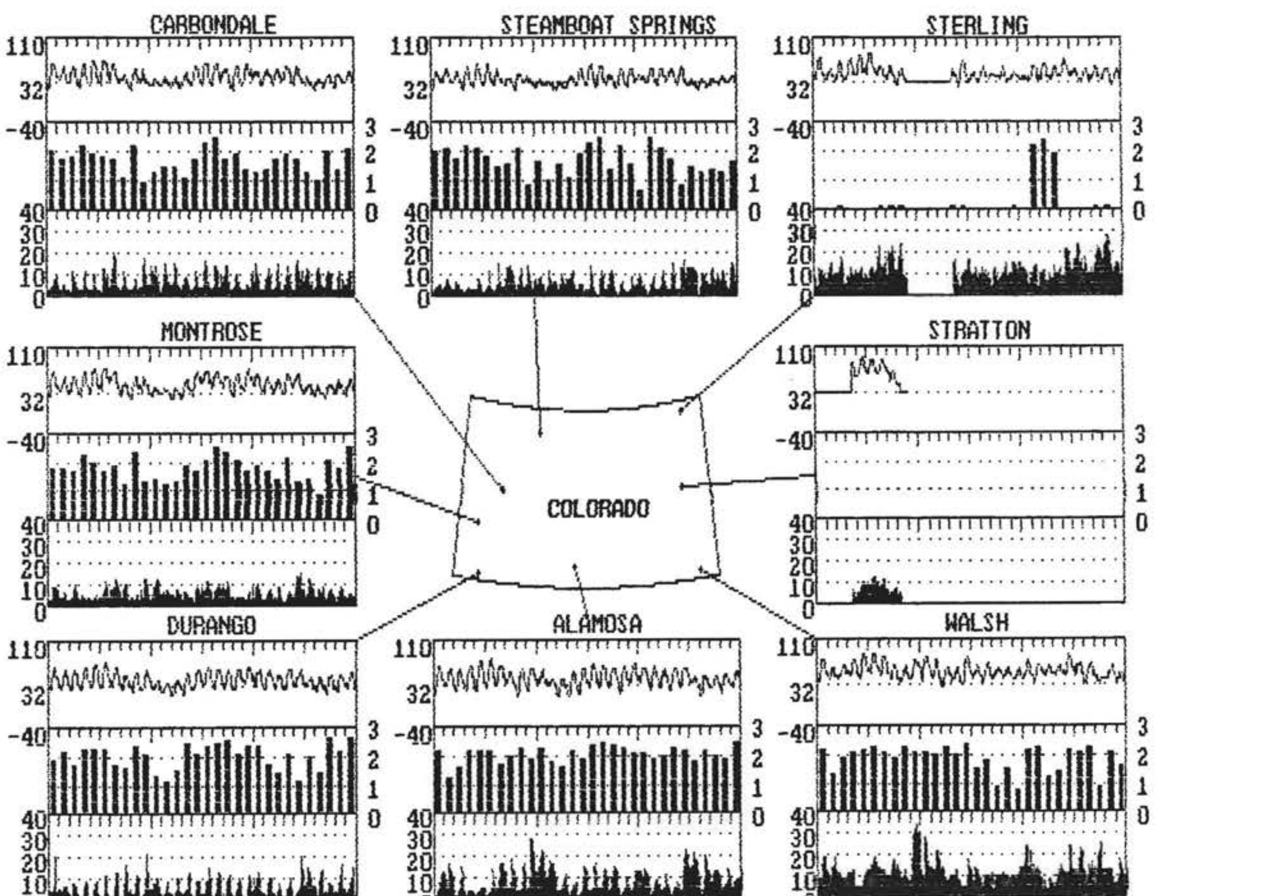
This article was written by Erika Komito of the Joint Center for Energy Management. Information on acquiring our weather data can be obtained by writing Carl Rogers at the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, CO. 80309-0428.

WTHRNET WEATHER DATA APRIL 1991

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (°F)								
	41.0	40.2	40.3	44.2	36.2	44.9	37.7	51.7
monthly temperature extremes and time of occurence (°F day/hour)								
maximum:	74.7 6/15	69.8 6/15	70.5 6/14	73.8 6/15	63.5 6/15	82.2 6/16	88.3 5/17	82.6 6/14
minimum:	9.3 27/ 4	14.2 14/ 6	18.0 9/ 6	18.5 13/ 4	15.4 1/ 6	22.6 15/ 6	32.0 1/ 1	24.1 13/ 6
monthly average relative humidity / dewpoint (percent / °F)								
5 AM	59 / 10	60 / 14	88 / 25	61 / 18	91 / 24	38 / 7	13 / 3	75 / 32
11 AM	22 / 11	27 / 15	41 / 21	33 / 20	52 / 25	23 / 8	7 / 0	43 / 31
2 PM	17 / 11	23 / 14	34 / 20	29 / 19	47 / 22	19 / 9	6 / 3	33 / 28
5 PM	19 / 12	22 / 13	34 / 19	33 / 20	47 / 22	19 / 9	5 / 2	33 / 28
11 PM	37 / 9	45 / 13	64 / 24	53 / 20	76 / 25	31 / 6	9 / 2	61 / 31
monthly average wind direction (degrees clockwise from north)								
day	230	224	243	227	202	165	21	178
night	189	105	186	150	146	174	24	229
monthly average wind speed (miles per hour)								
	7.11	4.86	4.82	4.93	4.04	8.51	1.14	10.20
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	183	328	315	200	345	130	611	22
3 to 12	401	355	368	503	347	415	106	501
12 to 24	130	37	37	17	24	170	3	173
> 24	6	0	0	0	0	5	0	24
monthly average daily total insolation ($Btu/ft^2 \cdot day$)								
	2040	1996	1660	1775	1651	237	0	1843
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	240	107	124	131	101	27	0	201
40-60%	62	74	86	81	93	5	0	77
20-40%	45	80	112	87	93	3	0	47
0-20%	12	23	31	31	38	0	0	43

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. Horizontal insolation is unavailable, and the station was not functioning at times. Disregard data for Stratton. Both stations have yet to be repaired by Nebraska.



COLORADO CLIMATE

MAY 1991

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 14 Number 8

May in Review:

Colorado experienced frequent and strong south-southwesterly winds in May as one storm system after another developed and lingered over the Great Basin. This persisting weather pattern produced temperatures that were near average over the Western Slope and warmer than average to the east. Humidity increased, and thunderstorms became very numerous in the last half of May along and east of the mountains. Precipitation totals were above average in northeastern Colorado and in a north-south band across the center of the State. The remainder of Colorado was drier than usual.

Colorado's July Climate:

There is more consistency and predictability to Colorado's July climate than any other month of the year. But there are always a few surprises both for visitors and long-term residents.

July is best known for its heat. Climatic records show that July is reliably the hottest month of the year. Even last year, which had an unusually hot June and a cooler than average July, still fit the traditional pattern. Heatwaves -- several consecutive days with low-elevation temperatures in the 90s or greater -- are also a normal element of our climate. They can occur at any time from mid June well into August but are most likely to occur in the first half of July. Fortunately, Coloradans always have an easy escape. Summer afternoon temperatures cool with elevation about 4 degrees F per thousand feet. When Denver is close to 100°F, the temperature up on Trail Ridge Road in Rocky Mountain National Park is probably only approaching 70 degrees. And don't overlook the humidity. Dryness is not always a blessing, but it certainly contributes to the relative comfort of our summer climate. High elevation and low humidity is the combination which allows evening temperatures to cool quickly. Except during severe heatwaves, temperatures usually drop below 70 degrees by around midnight allowing for comfortable sleeping.

Visitors, especially campers, are often surprised at how cool it can get in Colorado in the middle of summer. Even in July, it is quite common to see temperatures dip into the 30s at night up in the mountains, and 20s are not rare.

Clouds are the most beautiful part of Colorado's July climate. Most days dawn clear, especially early in the month. By late morning, puffy cumulus clouds appear over the mountain peaks. If enough moisture is present, these clouds will explode into spectacular cumulonimbus clouds with sparking lightning, echoing thunder and cool, fresh rains. July is also rainbow month in the Colorado Rockies as the storms typically drift eastward in the late afternoon out over the valleys and plains. Sunshine can then sneak in under the clouds to strike the falling raindrops. Thunderstorms occur everywhere in Colorado, but they are most frequent in the eastern and southern mountains and near the Palmer Ridge and Raton Mesa. The Pikes Peak area may hear thunder on 20 or more days during July. Thunderstorms are to be enjoyed, but they must be respected. An average of 3 people die from lightning in Colorado each year. Also remember that July thunderstorms can produce local flooding. This is especially true during the last 2 weeks of the month when subtropical moisture often advances into Colorado and fuels larger and more numerous thunderstorms.

The 1991 Weather Observer Centennial Celebration:

On 7-8 June 1991 more than 175 people gathered on the Colorado State University campus to celebrate the 100th birthday of the National Weather Service and 100 years of continuous weather observing in Colorado as a part of the United States' Cooperative Program. Fifty weather observers representing more than 20 percent of the official cooperative weather stations in Colorado were on hand along with community leaders and many meteorologists, climatologists, government and business representatives who use and rely on climate data.

(continued on page 96)

MAY 1991 DAILY WEATHER

Date	Event
1-5	A chilly morning on the 1st brought the last freeze of the spring to several low-elevation areas. Sunshine then brought warming temperatures. A deep low pressure area approached western Colorado on the 2nd bringing clouds and very strong winds. A strong cold front moving across the eastern plains triggered large thunderstorms late on the 2nd. Holyoke received 1.33" of rain while Julesburg reported 2.71". There were numerous reports of hail and possible tornadoes. Cold, unsettled weather remained over Colorado 3-4th as the upper-level storm system drifted slowly northeastward. Scattered showers with some thunder gave way to more widespread precipitation on the 4th from the northern mountains southeastward. Rains changed to snow in some areas. Steamboat Springs, Lakewood and Colorado Springs all measured 1-2" of wet snow, but as much as 10" fell at Monument and in the eastern foothills. Skies cleared on the 5th, but cold temperatures remained. Platoro awoke to 5°F, the coldest in the State.
5-7	A warming trend began, but a few showers and mountain flurries continued on the 6th from the northern mountains to the Front Range. A new upper-level disturbance crossed Colorado on the 7th. Temperatures were barely affected, but scattered light thundershowers with small hail developed, especially in northern counties. Sterling received 0.40".
8-12	A very deep low pressure area formed over Nevada and Utah 8-9th and moved very slowly eastward. Low-elevation temperatures soared into the 80s with some 90's in the Arkansas Valley. But with the warmth came strong, dry southerly winds, gusting at times to 40-60 mph 9-11th over many areas of the State. Blowing dust was common in several areas, and warm nights helped initiate the mountain snowmelt. A few thunderstorms formed near the Kansas border on the 10th and 11th. Cooler air reached the Western Slope late on the 10th and pushed gradually across the entire State by the 12th.
13-18	A pleasant day on the 13th was followed by increased clouds and winds on the 14th marking the next storm's approach. Much cooler air moved into Colorado on the 15th as the storm tracked directly overhead. Snow developed in the northern and central mountains followed by explosive hail-producing thunderstorms across the northern 2/3 of the eastern plains. Some much-appreciated steady rains and mountain snows continued on the 16th over north-central Colorado. Some impressive precipitation totals occurred: 2.60" (13" snow) near Echo Lake, 2.02" (17" snow) at Winter Park, 1.90" at Evergreen and 1.20" of rain near Akron. By the 17th, most of Colorado was back in mild spring weather, but northeastern counties remained cool, cloudy and breezy.
18-25	Still another large upper-level low pressure area moved into the western U.S. and became nearly stationary over Nevada. Strong southerly winds swept across the State 18-19th bringing very warm temperatures to most areas. This time, humid air preceded the storm. As cooler temperatures aloft moved over Colorado, the atmosphere became unstable. Thunderstorms developed each day 19-25th and were locally heavy. The moist southerly winds even delivered significant moisture to parts of the San Juan Mountains where dry weather usually prevails this time of year. Precipitation totals 19-25th included 1.41" at Saguache (double their entire monthly average) and 1.98" at Wolf Creek Pass. Storms were also a daily occurrence from the Front Range across the plains. Except for local hail damage, the rains were a boon to the winter wheat. More than 2" of moisture fell at Holly, Holyoke and Joes.
26-31	Two more storms dropped into the Great Basin. Moderate to strong south-southwest winds aloft continued with seasonal temperatures in northwest Colorado and hot weather in the southeast. Holly reported a high of 105° on the 31st, the hottest in the State. Western Colorado remained dry through the period, but thunderstorms (some locally severe) erupted each day in northeast Colorado. Storms were especially strong on the 28th. By the 31st, very humid air (by Colorado standards) covered much of the State.

May 1991 Extremes

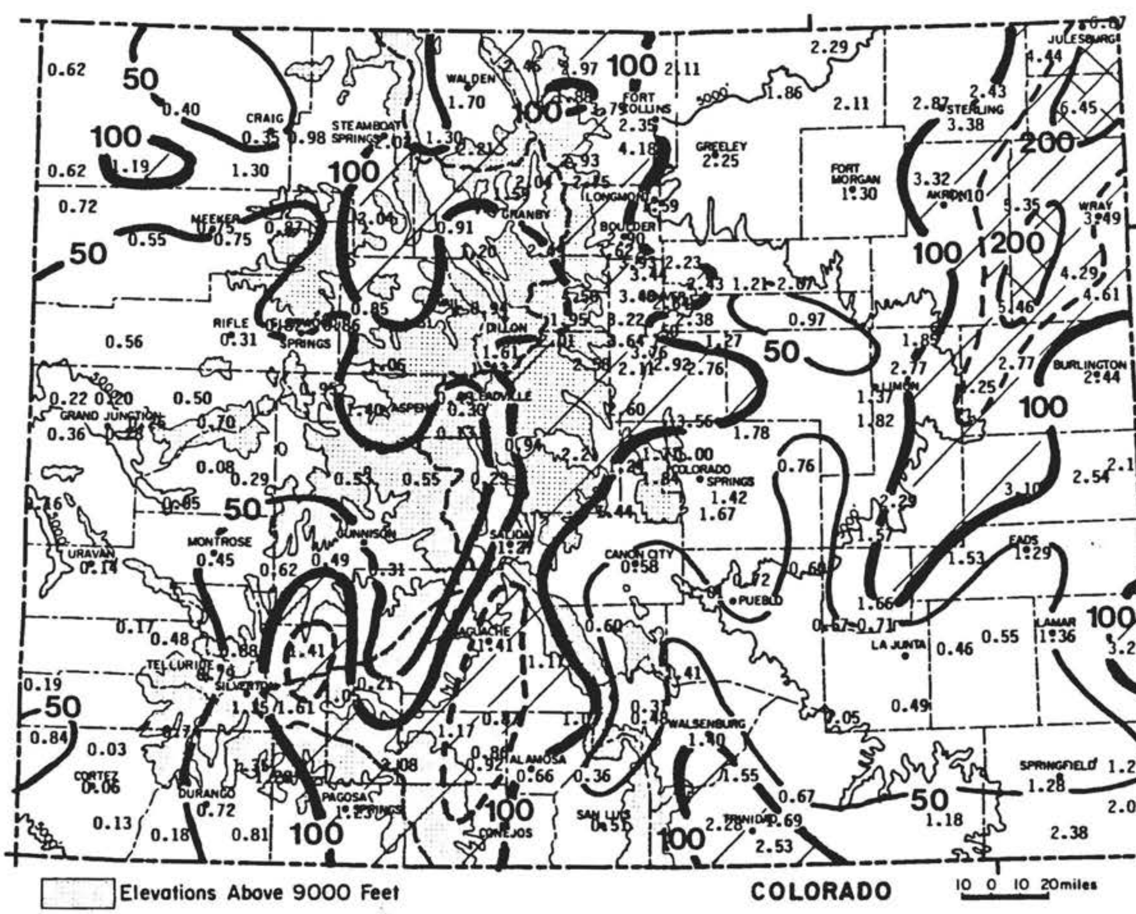
Highest Temperature	105°F	May 31	Holly
Lowest Temperature	5°F	May 5	Platoro Dam
Greatest Total Precipitation	6.87"		Julesburg
Least Total Precipitation	0.03"		Dolores
Greatest Total Snowfall*	23.5"		Mount Evans Res. Cntr
Greatest Depth of Snow on Ground*	63"	May 1	Bonham Reservoir

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

MAY 1991 PRECIPITATION

Major upper-level storm systems flirted with the State throughout May. But dry air intrusions from the Southwest ahead of those upper-level storms limited their capacity to produce much moisture over Colorado even though most surrounding states enjoyed a wet May. Two north-south regions of Colorado were wetter than average in May. A band from Ordway north-northeastward to Julesburg was very wet with selected areas receiving 4-7" of rain for the month. A larger area of above average moisture extended from the Rio Grande Valley northeastward to South Park and then northward into the northern mountains and along the Front Range. This area received about 130% of the average precipitation but with locally greater amounts. Areas that came up short for the month included most of the Western Slope and much of southeastern Colorado. Isolated areas such as Cortez, Delta, Cedaredge and Timpas received less than 10% of their average. Overall, 28% of the official reporting stations received less than half the normal May rainfall. Ten percent of Colorado weather station received 150% or more of average.

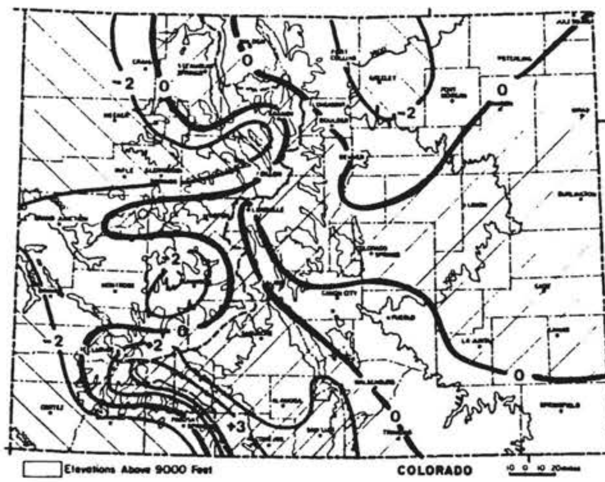
Greatest		Least	
Julesburg	6.87"	Dolores	0.03"
Holyoke	6.45"	Delta	0.05"
Joes 2SE	5.46"	Timpas 13SW	0.05"
Yuma	5.35"	Cortez	0.06"
Marston Treatment Plant	4.89"	Cedaredge	0.08"



Precipitation amounts (inches) for May 1991 and contours of precipitation as a percent of the 1961-1980 average.

1991 WATER YEAR PRECIPITATION

Accumulated precipitation since October 1, 1990 is running fairly close to average for much of the State. 35% of Colorado's official weather stations have received between 90% and 110% of the average accumulated precipitation. Of the remainder of the State, 40% of the stations have received less than 90% of average while only 25% of the weather stations have received more than 110% of average. The drier areas are found from Sterling and Fort Morgan west into the northern foothills, in portions of southeast Colorado and the Arkansas Valley from Fowler to Leadville, and over portions of the Western Slope from Cortez to Dinosaur. The wettest areas of Colorado are scattered portions of the mountainous areas such as Wolf Creek Pass, Silverton, Ouray, the Grand Mesa and Yampa and the portions of the eastern plains reaching northeastward from Ordway and Limon up to Julesburg.

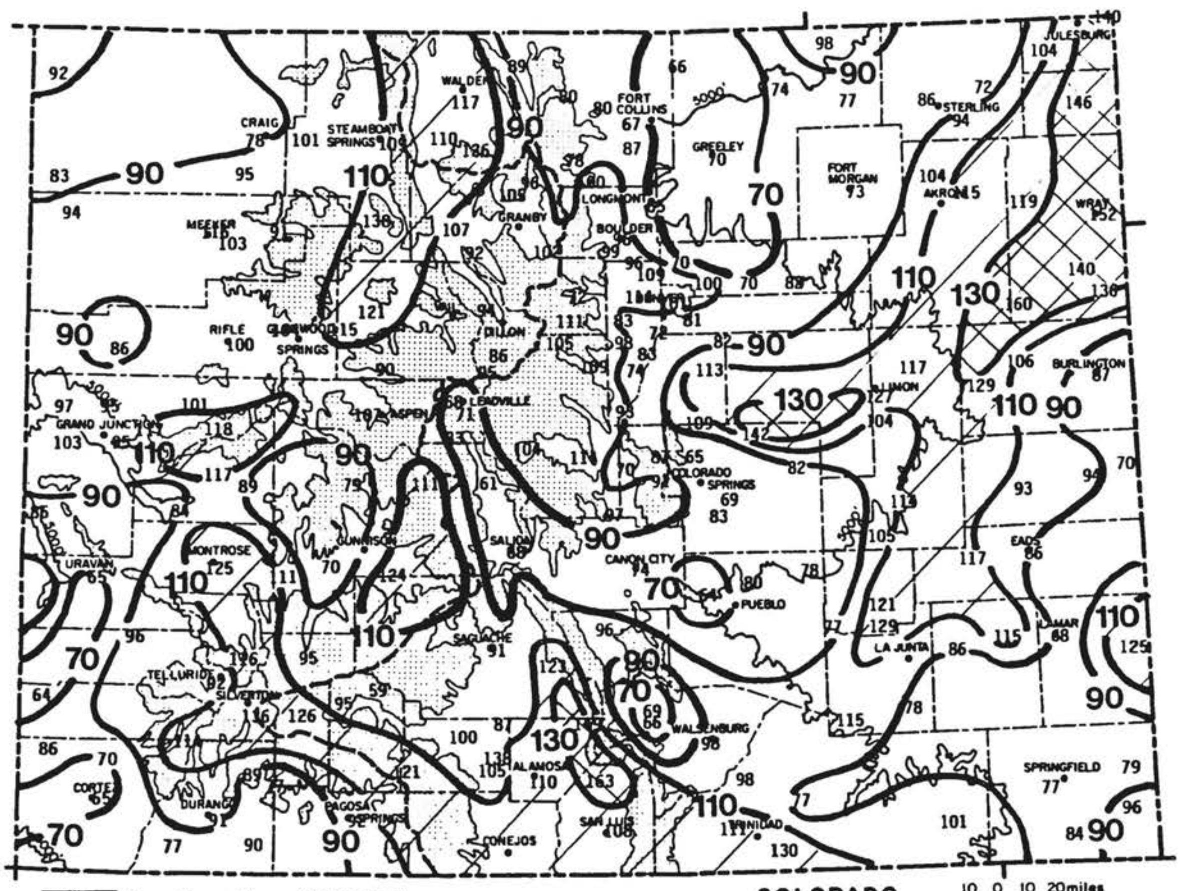


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

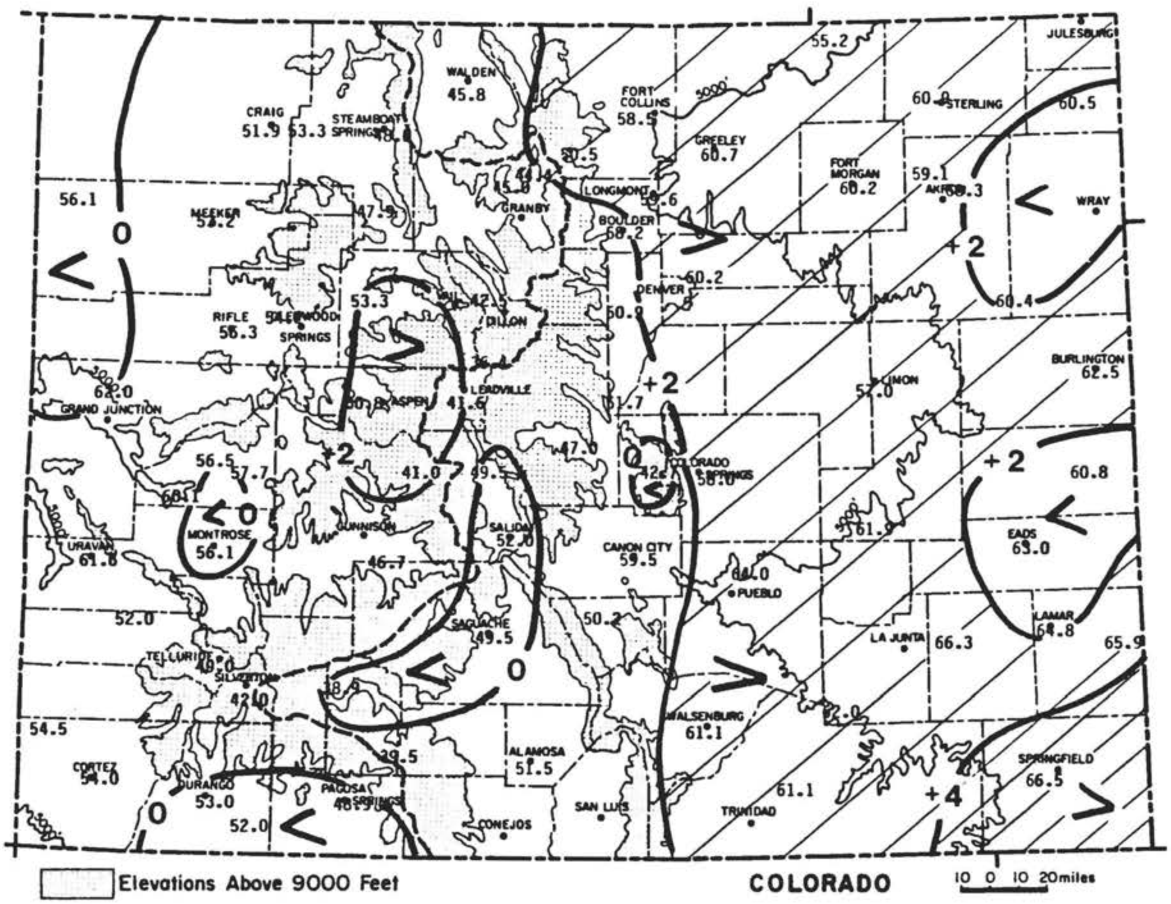
Index	Interpretation
	extremely wet
+4	
+3	ample moisture
+2	
+1	
0	near normal
-1	
-2	
	moderate drought
-3	
	severe drought
-4	
	extreme drought



Precipitation for October 1990 through May 1991
as a percent of the 1961-1980 average.

MAY 1991 TEMPERATURES AND DEGREE DAYS

Low pressure areas lingered over the Great Basin throughout May. This consistent pattern produced above average temperatures in eastern Colorado, especially in the southeast. Meanwhile, mountain and Western Slope temperatures were very close to average for May. Day to day temperatures were well within the normal range for this time of year throughout the month except for the heat of May 9-11 which approached record levels in some areas.



May 1991 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

MAY 1991 SOIL TEMPERATURES

Soil temperatures made a steady and dramatic climb in May. As is always the case in the spring, the temperature gradient reversed and now the warmest temperatures are found near the surface and temperatures cool steadily 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.

FORT COLLINS 7 AM SOIL TEMPERATURES
MAY 1991

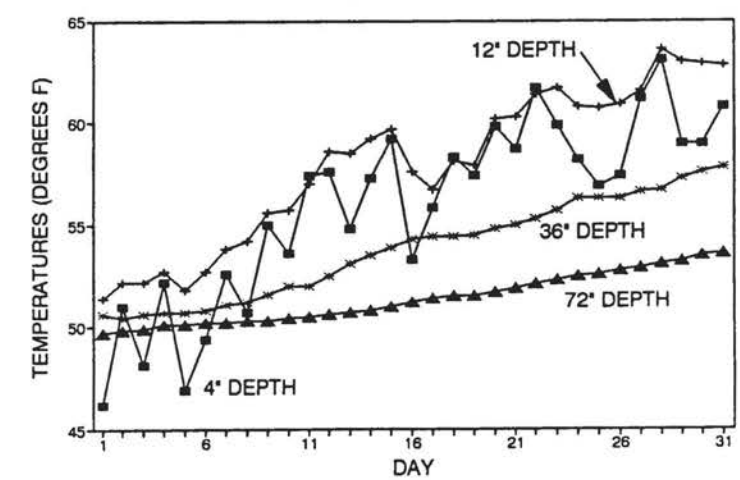


Table 1. Heating Degree Day Data through May 1991 (base temperature, 65°F).

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
	89-90	17	82	271	698	1001	1400	1554	1089	880	640	480	105	8217
	90-91	59	118	201	633	990	1597	1671	1081	954	742	410		8456
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	89-90	68	176	303	671	974	1365	1365	1086	915	697	543	171	8334
	90-91	134	146	234	652	964	1462	1444	1013	1077	811	432		8369
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	89-90	1	0 E	139	M E	567 E	1064 E	776 E	925 E	760	502	321	21	M
	90-91	32	13	81	338	589	1161	1081	667	685	511	211		5369
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	89-90	39	112	270	628	812	1202	1184	991	857	660	518	106	7379
	90-91	66	130	226	641	905	1326	1256	896	983	771	472		7672
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	89-90	0	4 E	130	415	684	1229	990	957	757	459	280	3	5908
	90-91	10	4	76	407	M	1249	1223	688	737	438	136		M
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	89-90	0	0	131	379	584	1076	859	827	687	421	325	22	5311
	90-91	14	12	58	382	548	1098	1004	626	679	459	182		5062
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	89-90	0	4	172	473	699	1163	966	928	805	526	345	24	6105
	90-91	28	21	83	473	663	1256	1142	750	773	568	219		5976
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	89-90	0	16	142	494	850	1166	1222	959	776	490	377	59	6551
	90-91	1	6	151	539	774	1321	1364	879	882	702	335		6954
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	89-90	4	46	235	586	892	1420	1319	1257	879	530	453	144	7765
	90-91	14	18	116	606	876	1547	1544	1095	995	693	398		7902
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	89-90	M	M	M	330	M	M	1161	865	626	355	237	22	M
	90-91	0	2	58	416	751	1400	1549	998	742	512	170		6598
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	89-90	0	0	153	424	658	1160	879	882	781	469	265	7	5678
	90-91	12	3	64	388	623	1209	1143	684	682	510	174		5492
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	89-90	226	357	502	861	1124	1495	1506	1271	1124	886	764	349	10465
	90-91	284	355	430	858	1071	1587	1569	1220	1257	1031	691		10353
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	89-90	2	19	106	520	789	1133	1278	965	724	479	359	44	6418
	90-91	4	28	118	481	832	1373	1274	842	919	619	364		6854
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	89-90	1	60	217	593	896	1348	1286	986	806	545	269	68	7075
	90-91	15	23	134	583	934	1568	1536	1052	889	693	355		7782
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	89-90	49	118	325	657	818	1221	1115	1030	932	662	513	140	7580
	90-91	120	131	219	591	803	1330	1244	937	885	727	430		7417
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	89-90	0	3	169	458	711	1166	930	910	848	495	307	19	6016
	90-91	19	6	74	460	690	1284	1212	747	703	508	203		5906
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	89-90	0	2	156	416	721	1285	1087	1010	776	450	274	10	6187
	90-91	18	7	63	421	730	1343	1248	750	722	489	180		5971
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	89-90	0	0	40	316	729	1103	1124	820	557	271	139	20	5119
	90-91	0	0	28	360	759	1370	1464	919	706	478	136		6220

* = 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 6SSW	AVE	214	264	468	775	1128	1473	1593	1369	1318	951	654	384	10591
	89-90	168	306	427	768	1132	1449	1401	1205	1043	833	689	266	9687
	90-91	264	268	350	774	1071	1605	1668	1148	1233	979	615		9975
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	89-90	1	2	166	454	729	1230	985	922	787	449	275	9	6009
	90-91	14	2	62	450	723	1309	1246	741	692	492	159		5890
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	89-90	61	155	341	749	1069	1574	1647	1254	906	672	540	188	9156
	90-91	65	179	264	771	1059	1664	1787	M	M	M	M		M
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	89-90	0	0	99	323	684	1176	1030	887	638	309	188	2	5336
	90-91	4	0	21	308	624	1220	1113	667	602	352	81		4992
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	89-90	285	412	545	880	1138	1507	1499	1265	1188	920	793	377	10809
	90-91	331	402	464	861	1141	1556	1550	1207	1210	1068	714		10504
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	89-90	1	6	204	508	762	1252	1078	991	815	555	364	33	6569
	90-91	36	11	96	491	745	1280	1237	779	820	592	245		6332
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	89-90	2	8	200	484	749	1302	1048	994	917	552	319	25	6600
	90-91	24	11	101	481	727	1284	1249	740	699	520	186		6022
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	89-90	0	41	198	543	869	1261	1169	1071	795	507	387	91	6932
	90-91	9	23	121	511	885	1406	1458	1047	939	696	358		7453
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	89-90	0	10	110	439	768	1156	1186	895	654	425	285	27	5955
	90-91	0	3	81	470	804	1385	1460	974	768	571	268		6784
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	89-90	24	118	284	646	964	1298	1491	1160	873	630	524	164	8176
	90-91	44	108	177	608	910	1538	1432	1038	1002	767	489		8113
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	89-90	0	0	94	373	676	1204	964	877	695	394	233	2	5512
	90-91	1	0	34	360	610	1243	1116	730	667	406	103		5270
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	89-90	0	2	103	473 E	830	1130	1191	923	657	392	281	37	6019
	90-91	0	4	69	474	824	1433	1462	964	814	605	265		6914
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	89-90	18	117	315	M	974	1533	1580	1332	971	658	576	M	M
	90-91	129 E	110	255	700	1013	1683	1613	1223	1120	851	518		9215
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	89-90	0	3	144	428	719	1254	1074	1026	760	427	275	8	6118
	90-91	17	7	68	437	725	1359	1244	713	716	466	173		5925
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	88-89	72	175	270	644	869	1264	1273	1023	922	664	509	145	7830
	89-90	117	179	267	635	972	1384	1351	987	1093	828	486		8299
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	89-90	0	1	111	369	633	1153	980	874	681	420	266	8	5496
	90-91	4	6	46	334	654	1160	1048	697	709	462	156		5276
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	89-90	132	279	461	802	1075	1490	1359	1287	1068	796	674	273	9696
	90-91	202	258	332	794	1028	1550	1459	1105	1164	931	587		9410
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	89-90	0	2	117	345	581	1047	848	800	666	408	289	10	5113
	90-91	15	8	53	311	543	1047	985	646	674	437	141		4860

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

MAY 1991 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	69.3	41.2	55.2	0.2	86	19	306	10	312	2.32	-0.05	97.9	11
STERLING	74.3	47.5	60.9	2.9	88	26	173	54	419	2.87	-0.32	90.0	14
FORT MORGAN	74.8	45.7	60.2	1.9	88	29	180	40	414	1.30	-1.16	52.8	12
AKRON FAA AP	71.8	46.3	59.1	2.6	86	31	203	29	369	3.32	0.22	107.1	14
AKRON 4E	71.5	45.1	58.3	1.9	86	22	222	22	360	4.10	0.90	128.1	14
HOLYOKE	71.8	49.1	60.5	1.4	87	26	175	43	393	6.45	3.41	212.2	13
JOES	73.2	47.5	60.4	1.9	86	24	174	39	398	5.46	2.86	210.0	8
BURLINGTON	76.4	48.7	62.5	3.1	88	30	136	68	463	2.44	-0.32	88.4	8
LIMON WSMO	70.7	43.2	57.0	3.9	81	29	245	2	338	1.37	-0.81	62.8	8
CHEYENNE WELLS	77.5	44.1	60.8	1.1	88	33	147	22	439	2.54	-0.46	84.7	9
EADS	78.2	47.9	63.0	1.8	91	31	120	68	465	1.29	-1.30	49.8	6
ORDWAY 21N	78.4	45.4	61.9	2.2	90	27	142	53	454	1.57	-0.05	96.9	10
LAMAR	81.5	48.0	64.8	1.7	94	28	109	108	512	1.36	-1.25	52.1	8
LAS ANIMAS	83.8	48.8	66.3	3.0	94	29	81	130	539	0.46	-1.49	23.6	7
HOLLY	81.6	50.3	65.9	3.7	105	30	79	117	535	3.27	0.63	123.9	8
SPRINGFIELD 7WSW	84.3	48.6	66.5	6.2	95	30	68	121	542	1.28	-1.41	47.6	10
TIMPAS 13SW	80.5	43.6	62.0	1.2	94	29	153	67	475	0.05	-1.56	3.1	1

Foothills/Adjacent Plains

Name	Temperature						Degree Days			Precipitation			
	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
FORT COLLINS	71.9	45.2	58.5	2.2	85	29	203	11	366	2.35	-0.28	89.4	14
GREELEY UNC	74.9	46.5	60.7	2.9	91	29	159	36	414	2.25	-0.40	84.9	9
ESTES PARK	64.6	36.5	50.5	2.5	78	19	441	0	232	2.93	0.96	148.7	10
LONGMONT 2ESE	73.5	45.7	59.6	2.5	89	31	186	27	382	1.59	-0.77	67.4	12
BOULDER	71.6	44.8	58.2	-0.2	84	29	211	9	349	2.90	-0.14	95.4	12
DENVER WSFO AP	73.6	46.9	60.2	3.1	87	32	174	34	402	2.43	0.24	111.0	11
EVERGREEN	66.2	35.6	50.9	1.9	79	20	430	0	266	3.22	0.64	124.8	11
CHEESMAN	68.7	34.6	51.7	1.1	80	21	404	0	303	2.60	0.84	147.7	9
LAKE GEORGE 8SW	61.5	32.5	47.0	0.8	73	17	552	0	193	2.21	1.02	185.7	8
RUXTON PARK	58.2	27.1	42.7	-0.6	71	9	684	0	156	1.84	-0.69	72.7	10
COLORADO SPRINGS	72.1	43.9	58.0	2.5	83	29	219	8	353	0.80	-1.17	40.6	7
CANON CITY 2SE	74.6	44.4	59.5	1.2	87	27	182	19	393	0.58	-0.85	40.6	5
PUEBLO WSO AP	81.6	46.3	64.0	2.8	93	31	103	78	494	0.72	-0.37	66.1	8
WESTCLIFFE	67.3	33.1	50.2	0.8	76	18	450	0	276	0.60	-0.65	48.0	5
WALSENBURG	77.4	44.7	61.1	3.6	85	27	141	24	445	1.40	-0.01	99.3	10
TRINIDAD FAA AP	78.5	43.8	61.1	2.1	88	22	156	43	458	0.67	-0.87	43.5	7

Mountains/Interior Valleys

Name	Temperature						Degree Days			Precipitation			
	Max	Min	Mean	Dep	High	Low	Heat	Cool	Grow	Total	Dep	%Norm	# days
WALDEN	63.2	28.5	45.8	1.7	74	13	587	0	218	1.70	0.58	151.8	10
LEADVILLE 2SW	57.9	25.4	41.6	2.1	68	12	714	0	145	0.30	-0.90	25.0	7
SALIDA	69.2	34.8	52.0	-0.3	78	18	393	0	304	1.27	0.15	113.4	7
BUENA VISTA	66.5	32.5	49.5	-0.4	78	20	472	0	264	0.23	-0.67	25.6	2
SAGUACHE	66.3	32.6	49.5	-0.8	76	19	477	0	259	1.41	0.72	204.3	6
HERMIT 7ESE	55.1	22.7	38.9	-2.6	69	8	804	0	121	1.05	0.04	104.0	4
ALAMOSA WSO AP	70.1	33.0	51.5	1.0	80	17	410	0	318	0.66	-0.03	95.7	7
STEAMBOAT SPRINGS	64.6	31.5	48.0	0.5	78	19	518	0	243	2.02	0.01	100.5	14
YAMPA	63.1	32.7	47.9	1.0	73	20	522	0	215	2.04	0.74	156.9	11
GRAND LAKE 1NW	61.7	27.1	44.4	2.1	71	7	630	0	197	2.04	0.14	107.4	11
GRAND LAKE 6SSW	62.8	27.1	45.0	1.3	71	12	615	0	210	1.59	0.25	118.7	12
DILLON 1E	57.8	27.1	42.5	0.2	68	11	691	0	147	0.94	-0.26	78.3	7
CLIMAX	49.0	23.8	36.4	0.8	58	10	878	0	46	1.43	-0.42	77.3	4
ASPEN 1SW	67.5	34.2	50.8	3.8	77	24	432	0	283	1.40	-0.70	66.7	11
TAYLOR PARK	56.7	25.3	41.0	4.7	67	9	736	0	130	0.55	-0.61	47.4	4
TELLURIDE	65.6	32.5	49.0	2.9	74	20	486	0	251	0.79	-0.84	48.5	7
PAGOSA SPRINGS	68.9	28.8	48.9	-0.2	78	17	489	0	304	1.23	0.17	116.0	5
SILVERTON	56.8	27.2	42.0	1.1	67	13	703	0	122	1.35	-0.03	97.8	10
WOLF CREEK PASS 1	52.8	26.2	39.5	0.4	64	10	782	0	79	2.08	0.15	107.8	5

Western Valleys

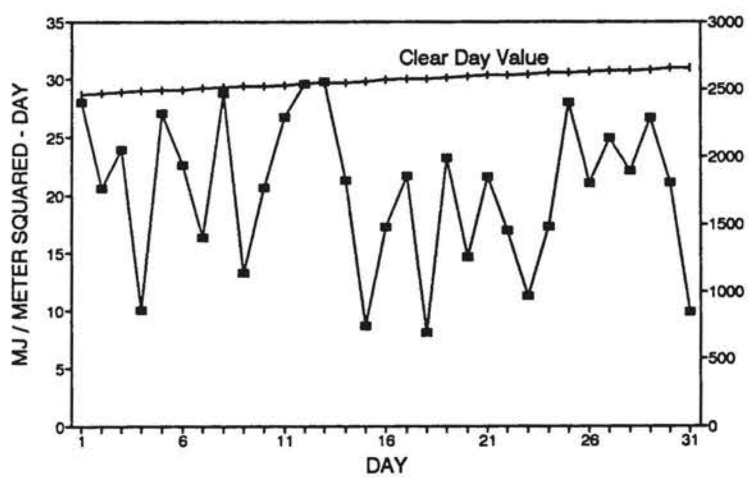
Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	66.8	37.0	51.9	0.4	80	22	398	0	269	0.35	-1.30	21.2	8
HAYDEN	69.6	36.9	53.3	1.8	82	23	357	0	309	0.98	-0.30	76.6	9
MEEKER NO. 2	69.5	36.9	53.2	1.8	80	24	358	0	310	0.75	-0.62	54.7	8
RANGELY 1E	70.9	41.4	56.1	-0.3	83	28	259	3	321	0.72	-0.19	79.1	5
EAGLE FAA AP	72.1	34.6	53.3	2.2	83	21	355	0	351	0.85	0.18	126.9	8
GLENWOOD SPRINGS	70.7	37.6	54.2	-0.3	83	26	329	0	331	0.82	-0.63	56.6	6
RIFLE	74.8	37.7	56.3	0.9	85	23	265	2	395	0.31	-0.65	32.3	6
GRAND JUNCTION WS	76.1	47.8	62.0	-0.0	87	32	136	50	443	0.20	-0.62	24.4	5
CEDAREDGE	75.0	38.1	56.5	0.0	85	26	258	0	393	0.08	-1.04	7.1	2
PAONIA 1SW	73.9	41.6	57.7	0.9	85	29	221	5	378	0.29	-1.00	22.5	6
DELTA	76.7	43.5	60.1	0.6	88	30	170	25	424	0.05	-0.51	8.9	1
COCHETOPA CREEK	66.2	27.2	46.7	0.8	77	16	558	0	262	0.31	-0.37	45.6	3
MONTROSE NO. 2	72.1	40.1	56.1	-0.7	83	30	268	2	353	0.45	-0.31	59.2	3
URAVAN	78.5	44.8	61.6	0.3	95	30	140	45	460	0.14	-0.87	13.9	4
NORWOOD	68.3	35.6	52.0	0.9	78	24	398	0	289	0.17	-0.84	16.8	1
YELLOW JACKET 2W	70.8	38.3	54.5	0.8	80	25	317	0	330	0.84	-0.35	70.6	4
CORTEZ	71.9	36.1	54.0	0.6	83	21	335	2	348	0.06	-0.86	6.5	1
DURANGO	71.0	35.1	53.0	-0.3	82	23	364	0	332	0.72	-0.40	64.3	3
IGNACIO 1N	69.8	34.1	52.0	-0.4	80	21	394	0	315	0.81	-0.05	94.2	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.

MAY 1991 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	11	12	8	--	--
Denver	5	15	11	57%	65%
Fort Collins	4	14	13	--	--
Grand Junction	7	15	9	72%	71%
Limon	7	15	9	--	--
Pueblo	14	11	6	79%	73%

FT. COLLINS TOTAL HEMISPHERIC RADIATION
MAY 1991



The 1991 Weather Observer Centennial Celebration:

The celebration began with an evening reception on June 7 in the Lory Student Center West Ballroom. The guests were treated to bountiful food and beverage and an extensive display of climate information and old weather reports highlighting the climatic trends and events of the past century in Colorado. Exhibits were provided by the Colorado Climate Center, the National Weather Service, the National Center for Atmospheric Research, the National Oceanic and Atmospheric Administration Environmental Research Labs and EarthInfo, a small Boulder environmental information company. Gradually people got acquainted, and the volume of conversation rose. The ballroom's huge curtains were opened to reveal a spectacular Colorado sunset over the Rocky Mountains. Then, as the room grew dark, Grant Goodge -- climatologist at the National Climatic Data Center, Asheville, NC, fellow cooperative weather observer, and dedicated weather photographer -- gave a motivating slide and video show about weather in action and the role of cooperative weather observers.

On Saturday morning, the main program began. Everyone who attended received a special Centennial booklet and a variety of other items ranging from lapel pins to Colorado Vacation Guides. These and other items were provided as an expression of thanks by program co-sponsors.

The formal program began at 10 a.m. with an enthusiastic University welcome by Dr. Helen McHugh, Interim Director of the Agricultural Experiment Station at CSU. The morning program consisted of a number of short talks on the importance of weather observations in Colorado. Larry Mooney, Colorado Area Manager for the National Weather Service (NWS), served as master of ceremonies.

Dr. Tom McKee, State Climatologist at CSU, described some of the unique features of Colorado's climate.

Jerry Sherlin, NWS Cooperative Program Manager for the western two-thirds of Colorado described the unique cooperative and largely volunteer program used to gather climate information in the United States.

Larry Tunnell, NWS Hydrologist for Colorado, talked about the importance of weather observations for flood and water supply forecasting.

Nolan Doesken, Assistant State Climatologist at CSU described the history of weather observations in Colorado and the role of observers as local historians.

Dr. Howard Schwartz of CSU gave an informative talk on climate and Colorado agriculture.

Richard Augulis, Central Region Director for the NWS, spoke on the importance of weather observers to the National Weather Service.

Dr. Ken Hadeen, who was born and raised in NE Colorado and now serves as Director of the National Climatic Data Center, emphasized the great value of climate data from a national perspective.

Bob McLavey, Deputy Commissioner, Colorado Department of Agriculture shared his feelings about the importance of weather observations to the State.

Jack Edwards, president of EarthInfo, one of the many organizations which co-sponsored the Centennial celebration, described the importance of climate data in private industry.

Then the fun began. Following a generous buffet luncheon, Jerry Sherlin and Nolan Doesken teamed up to distribute door prizes ranging from cloud charts and zipper thermometers to a $100 bill and a fancy electronic wind vane and anemometer. E.W. (Joe) Friday, Director of the National Weather Service from Washington D.C., gave a delightful and humorous talk. Congressman Wayne Allard followed with comments emphasizing the great benefit our nation reaps from the Cooperative Program. Then came the awards ceremony. Centennial plaques were presented to 11 Colorado cities where cooperative weather stations have been maintained for at least 100 years: Canon City, Cheyenne Wells, Delta, Durango, Fort Collins, Greeley, Gunnison, Lamar, Las Animas, Montrose and Rocky Ford.

The emotional highlight of the weekend was the presentation of the distinguished service awards. Several of Colorado's absolute best, most committed and oldest weather observers came forward to receive recognition for their special contributions to the Cooperative Program. These included Marvin Rankin from Westcliffe (52 years of service), Lynn Woods of Del Norte (49 years), Harold Krueger from near Gunnison (44 years), and Layton Munson from near Sedgwick (44 years). Orville Altenbern (49 years of observing NW of DeBeque) and Mabel Wright (47 years observing near Creede) were unable to attend. A family service award went to the Neil Lindstrom family southeast of Sterling where weather observations have been taken without interruption since 1889. The Denver Water Department was cited for their special institutional contribution -- currently maintaining 13 cooperative weather stations with some of their stations dating back nearly 90 years.

The Colorado Weather Centennial was a success. New friendships were made, information was exchanged, appreciation was expressed -- but most of all, cooperation and volunteerism were shown to still be alive and well in Colorado. The great value of cooperative weather observations was shown, and statewide support for the Cooperative Program was demonstrated. At least 20 of Colorado's weather observers were featured in local newspapers in the weeks leading up to the celebration. More than three dozen businesses and organizations stepped forward to co-sponsor the celebration and cover most of the expenses. It was truly a thrill for me to be a part of this event. I hope we can get together again before 2091.

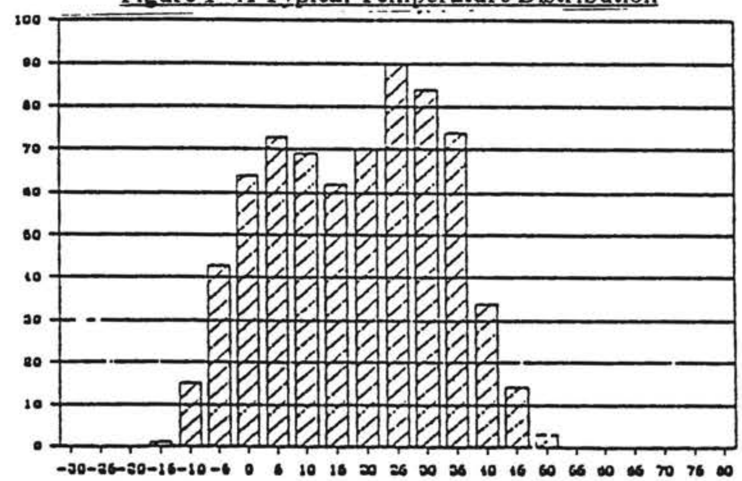
APPLICATIONS OF WEATHER DATA TO ENERGY RELATED TOPICS

How does the weather affect energy use? We all know that when the temperature starts dropping the energy use for space heating goes up. Similarly on a hot summer day the utilities must bring more generators on-line to accommodate our air conditioners. But also consider that the evapotranspiration rate determines the amount of energy required to run irrigation pumps, or that the effectiveness of economizer cycles in large buildings depends on the relative humidity and corresponding air enthalpy.

Of course, after the energy use comes the utility bill. Here at JCEM we look for ways to reduce those bills by studying energy conservation, energy utilization techniques and the applications of renewable energy resources. For example, when designing a building HVAC system, it is important to know the ranges of yearly temperature and solar data before sizing chillers, heating plants, glazing areas, etc.

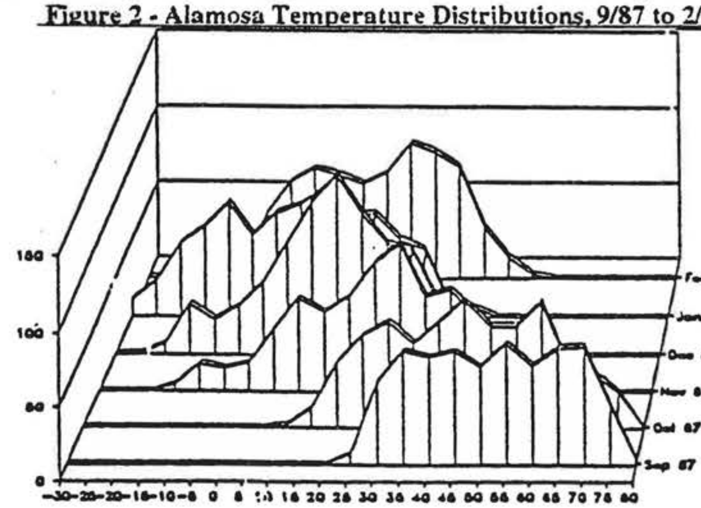
This month we will look at temperature distributions and what they can show us. Figure 1 shows the span of air temperatures in Alamosa for February. the horizontal axis is broken down into 5 degree (F) temperature bins, while the vertical axis shows the number of hours per month that the temperature was within that bin range. The two "peaks" in the graph represent the daytime and nighttime averages. These averages (and standard deviations) can be useful in determining a building heating (or cooling) load at different periods of the day, as well as for anticipating extremes.

Figure 1 - A Typical Temperature Distribution



By looking at the distributions for 6 months, we can get a feel for the temperature trends on a monthly and seasonal scales. Figure 2 shows Alamosa temperatures from September, 1987 (front graph) to February, 1988 (rear graph). Notice that for certain months the temperatures are evenly distributed across a wide range. This can occur when a frontal system moves across the region, expanding the range of temperatures during that month. This effect is noticed more during the swing seasons of spring and fall.

Figure 2 - Alamosa Temperature Distributions, 9/87 to 2/88



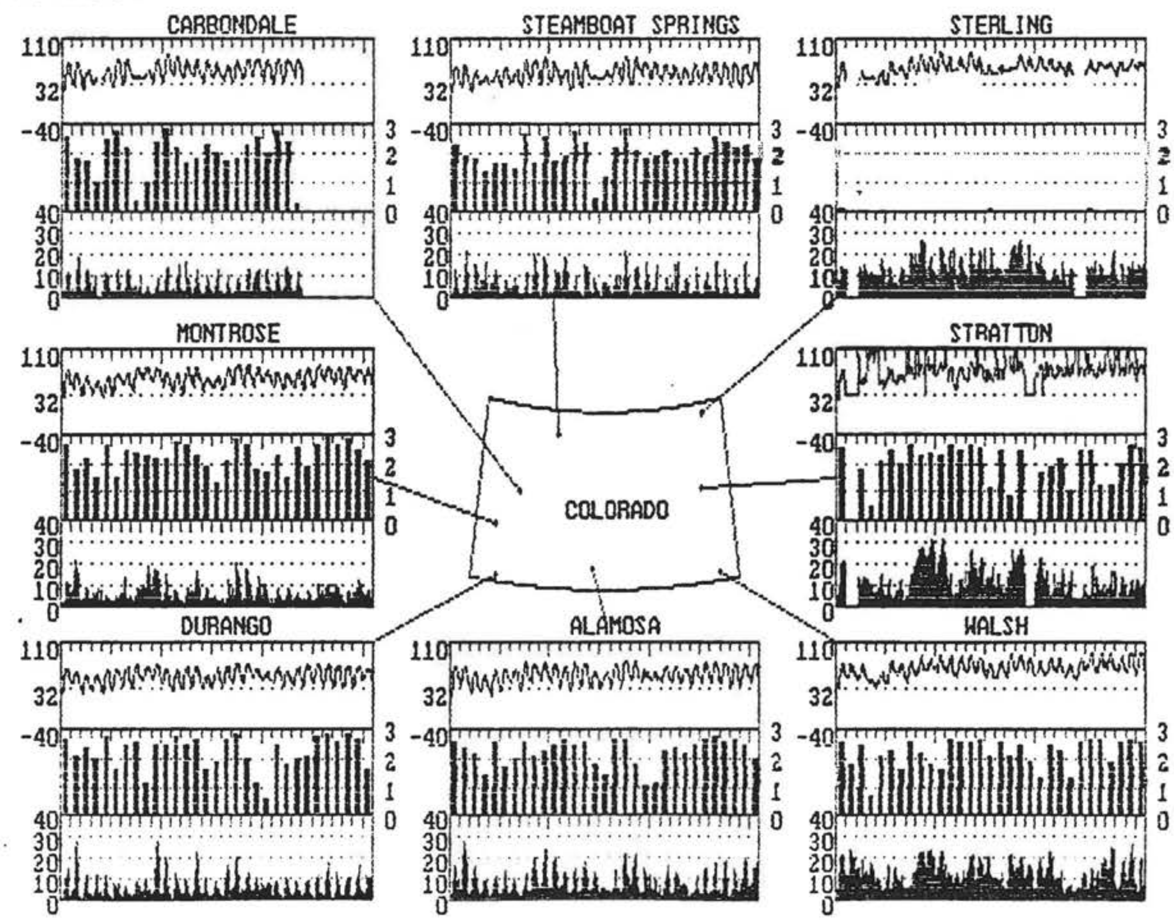
On a bright note, also notice that February was generally warmer than January, a sure sign that spring is coming! That makes sense: if you wake up on a cold but sunny morning it takes a few hours for the Earth to "warm up". Similarly, the seasonal lag time between the shortest day of the year (December 21) and the coldest is about a month. On the other end of the thermometer, we experience the hottest days of the year in July, about one month after the summer solstice (June 21).

This article is a reprint of the April, 1988 article for the Colorado Climate. Information on acquiring our weather data can be obtained by writing Carl Rogers at the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, Co. 80309-0428, or phoning at (303) 449-4547. The WTHRNET BBS phone number is (303) 492-3525.

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (°F)								
	52.4	50.5	48.1	57.4	48.9	56.6		64.7
monthly temperature extremes and time of occurence (°F day/hour)								
maximum:	78.6 18/15	73.2 18/16	80.8 18/15	81.1 19/16	77.4 18/15	86.5 11/14		91.2 27/17
minimum:	16.7 5/ 5	21.9 3/ 5	21.0 3/ 5	27.0 5/ 5	19.6 1/ 5	24.3 1/ 5		31.3 1/ 5
monthly average relative humidity / dewpoint (percent / °F)								
5 AM	59 / 19	58 / 20	62 / 23	50 / 22	92 / 30	50 / 24	81 /	77 / 44
11 AM	23 / 21	27 / 23	26 / 24	25 / 25	37 / 29	29 / 25	57 /	42 / 44
2 PM	21 / 21	24 / 22	23 / 23	20 / 23	32 / 27	24 / 24	45 /	28 / 39
5 PM	20 / 20	21 / 20	24 / 23	19 / 22	32 / 26	26 / 23	48 /	30 / 36
11 PM	36 / 18	40 / 20	41 / 23	32 / 20	65 / 31	39 / 25	77 /	57 / 41
monthly average wind direction (degrees clockwise from north)								
day	205	227	144	206	211	141	137	168
night	172	89	130	128	128	153	166	208
monthly average wind speed (miles per hour)								
	7.49	5.42	3.28	5.80	4.48	10.20	10.75	11.54
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	171	303	475	190	389	85	69	23
3 to 12	418	373	238	495	279	407	401	393
12 to 24	151	62	17	59	68	240	227	321
> 24	4	6	0	0	0	12	47	7
monthly average daily total insolation (Btu/ft²·day)								
	2211	2203		2226	1969		1950	2176
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	267	136	121	182	138		198	240
40-60%	81	89	62	85	95		64	88
20-40%	54	56	55	58	75		65	54
0-20%	28	53	33	24	63		53	40

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 a station move Carbondale is missing data from the fourth to the elleventh of May. The Sterling and Stratton stations have experienced trouble in the past. They were repaired but Sterling now has a bad horizontal insolation sensor, and Stratton is having trouble with its temperature sensors. Data from other sensors seems be reliable however.



COLORADO CLIMATE

JUNE 1991

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 14 Number 9

June in Review:

June behaved as expected with an abundance of strong storms, heavy rains and hail followed by predominantly hot and dry weather near the end of the month. Several tornadoes and funnel clouds were reported, but most storm damage came from hail and local flooding. Rainfall was more plentiful than average, especially in the mountains, along the Front Range and near the Kansas border. Some dry areas persisted on the eastern plains and Western Slope. Temperatures were warmer than average except over southwest and extreme western parts of Colorado.

Colorado's August Climate:

August seems like just another enjoyable summer month similar to June and July, but their are a number of subtle and not so subtle differences that makes August weather special. Except near thunderstorms, winds are often very light as pressure patterns are typically weak and stagnant. Decreasing daylength becomes obvious and begins to have an effect both on temperatures and precipitation late in the month.

Mountain-initiated afternoon and evening thunderstorms are a daily occurrence over Colorado in August whenever atmospheric water sources are available. The Southwest Monsoon has supplied abundant summer moisture in recent years and is expected to do so again this year. Storms often dissipate as they move away from the mountains, but at other times they blossom into storm complexes as they drift out onto the High Plains. Storms tend to produce greater rainfall totals early in the month and become weaker as the month progresses. Hail and tornadoes continue to be possible but are much less of a threat than earlier in the summer. Lightning also begins to decrease, but is still a significant threat. August precipitation totals tend to be greatest over the southern mountains where averages are as much as 4.00"or more. Precipitation decreases with elevation and latitude in August. Northwestern Colorado averages less than 1.00" for the month. The Longmont-Greeley area averages less than 1.25". The remainder of the State can usually expect 1.50-2.50".

Temperatures in August are often quite similar to those of late June and July, but extreme heat is less likely and shorter lived. Major heatwaves are not common early in the month since monsoon moisture and afternoon cloudiness often suppress temperatures. Bursts of hot temperatures occur later in the month as the atmosphere becomes drier and more stable, but these heatwaves tend to be short. As always in the summer, the mountains provide a nearby escape from low-elevation heat. In late August, mountains and western valleys almost always begin to notice cooler days and nights. For the month as a whole, daily high temperatures average in the 80s or low 90s at low elevations decreasing with elevation to 60s and 70s in the high mountains. Lows in the 50s are most common with 30s and 40s in the mountains. Subfreezing temperatures are a near certainty in many mountain valleys.

Is the Drought Over?:

During the mid-1980s heavy winter snows, adequate summer rains, full reservoirs and high streamflows temporarily removed the word "drought" from the Colorado vocabulary. In fact, for much of Colorado the years of 1982-86 became the years with the greatest and most reliable water supply since the 1920s. Ski resorts became accustomed to ski seasons that began early and lasted long without much help from man-made snow. Irrigators got used to having more water than what was needed. Colorado delivered plenty of excess water to downstream states such as Nebraska, New Mexico and the lower Colorado basin states.

(continued on page 107)

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

June got off to a stormy start. Thunderstorms were reported daily from the 1st to the 22nd with many storms producing hail. Hot, dry weather then gradually took over to complete the month. Here are some of the highlights.

Date	Event
1-3	Strong low pressure aloft over the Four Corners drifted slowly northeastward. Cool rains and mountain snows fell over portions of western Colorado. Numerous heavy storms, some with hail and intense rains, fell across northeastern Colorado. The worst storms occurred on the 1st along the Front Range. Boulder reported 2.33" of rainfall that day. Significant flooding occurred in parts of Denver, and as much as 4-8" of rain may have fallen northwest of Fort Collins. More storms dumped on the same area early on the 2nd. Fraser reported 1.50" of rain in 24 hours -- unusually heavy for that area. The Hermit 7 ESE weather station dropped to 22° on the 2nd, the coldest in Colorado for June.
4-6	Warmer and drier weather on the 4th was quickly replaced by more storms and some mountain snow 5-6th. This time the heaviest rains fell over southeastern Colorado. Many areas from Colorado Springs and Pueblo eastward received at least an inch of rain on the 6th. Hail reports were common. Joes and Stonington each received more than 2" of rain and hail.
7-11	Warmer and drier weather was the rule but scattered thunderstorms, some producing hail, were still a daily occurrence especially in eastern Colorado. A tornado was spotted near Grover on the 9th, and Fleming (east of Sterling) recorded 2.25" of rain. More tornadoes were seen on the 10th, and Wootton Ranch south of Trinidad measured 2.28" of rain.
12-14	Western Colorado took its turn for storms as moisture moved into the State from the southwest. Northdale was soaked with 1.10" of rain and hail in a short period on the 12th. Storms were widespread on the 13th, and rain continued overnight in some mountain areas. Rainfall totals exceeded 1" at Telluride. Glenwood Springs got 1.32".
15-16	A cool high pressure area moved over Colorado on the 15th, but a few thunderstorms still managed to develop. More numerous storms appeared on the 16th. A damaging tornado was observed near Saguache. Holly received more than an inch of rain.
17-19	Summer heat began to establish itself across Colorado. Many locations exceeded 90 degrees F for the first time this summer on the 17th. A few thunderstorms still managed to erupt, primarily out on the plains.
20-22	Cooler air wedged into northern Colorado on the 20th and triggered some strong thunderstorms over the northeastern plains. More storms developed near Denver on the 21st producing hail and local rains in excess of 1". The last gasp of June severe weather occurred on the 22nd as strong storms stepped eastward across the Colorado plains.
23-30	A late June heatwave developed over eastern Colorado while the mountains and Western Slope enjoyed warm days but chilly nights. An abnormally rapid summer jetstream helped produce strong southwesterly surface winds that surprised mountain climbers and kicked up dust over the Western Slope. Grand Junction reported a 66 mph gust on the 27th. Temperatures climbed into the 90s each day at lower elevations 24-30th. Denver and Greeley each reached 100° on the 25th. The 106° reading at Las Animas on the 28th was the hottest in the State. Mountain areas enjoyed highs in the 70s with lows dipping into the 30s. A few storms developed each afternoon 26-30th. On the 30th, 0.53" of rain and hail fell at the Wolf Creek Pass weather station.

June 1991 Extremes

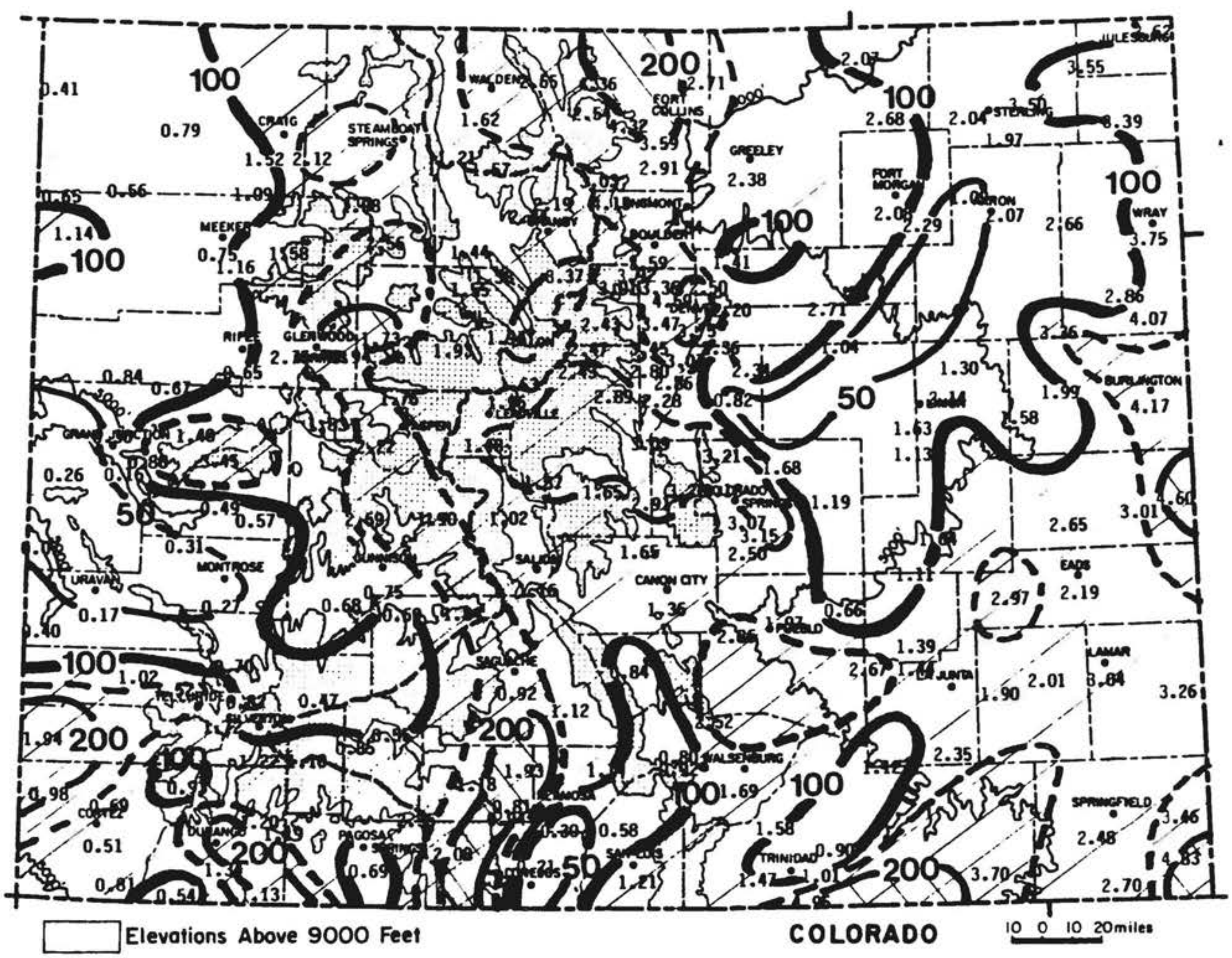
Highest Temperature	106°F	June 28	Las Animas
Lowest Temperature	22°F	June 2	Hermit 7 ESE
Greatest Total Precipitation	4.95"		Wootton Ranch
Least Total Precipitation	0.07"		Gateway 1SW
Greatest Total Snowfall*	5.5"		Climax
Greatest Depth of Snow on Ground*	4"	June 2	Climax

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

JUNE 1991 PRECIPITATION

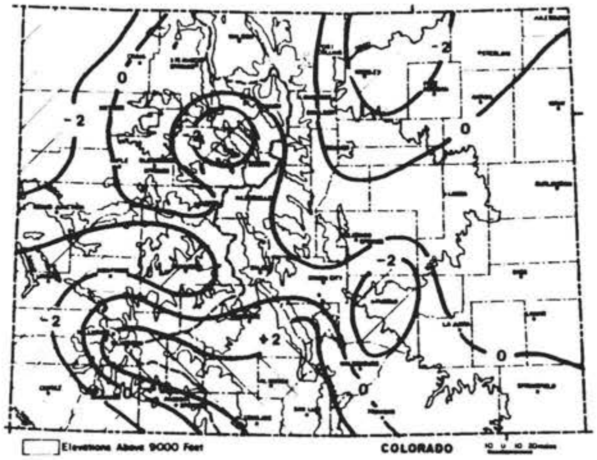
Precipitation totals were highly variable, but for most of Colorado June brought above average rainfall. The wettest portions of the State, compared to average, were found along the Front Range, the central mountains, selected areas east, south and west of the San Juan mountains and over parts of southeastern Colorado. Nearly 10% of the official weather stations reported at least 200% of the average June rainfall. An additional 18% of the weather stations received from 150% to 200% of average. Meanwhile, several pockets of the State remained dry. In western Colorado, rainfall was below normal from western Moffat County south to Montrose and Uravan. Gateway only received 0.07", 11% of their average. It was also dry over south central parts of the San Luis Valley, over a small area near Trinidad and in parts of the eastern plains from extreme northeastern Pueblo County northeastward to Sterling.

Greatest		Least	
Wootton Ranch	4.95"	Gateway 1 SW	0.07"
Stonington	4.83"	Grand Junction 6 ESE	0.16"
Arapahoe	4.60"	Uravan	0.17"
Wheat Ridge	4.59"	Manassa	0.21"
Red Feather Lakes	4.36"	Colorado Natl. Mon.	0.26"



Precipitation amounts (inches) for June 1991 and contours of precipitation as a percent of the 1961-1980 average.

June rainfall helped to bring precipitation totals since 1 October 1990 closer to average as some of the drier parts of the State like the Front Range received beneficial rains. Totals for the last 9 months are still below average over much of Logan, Morgan, Weld and Larimer counties and over the Western Slope counties which border on Utah. There are also limited dry areas near Gunnison and in the Arkansas drainage. Wetter than average conditions are found in the high elevations of the San Juans, in parts of the central and northern mountains, in much of the San Luis Valley and in a band from east of Trinidad northeastward to Wray. In all, just over half of Colorado's weather stations have received less than average moisture. 10% of the weather stations have received less than 80% of average water year precipitation while 17% of the stations have received 120% or more of average.

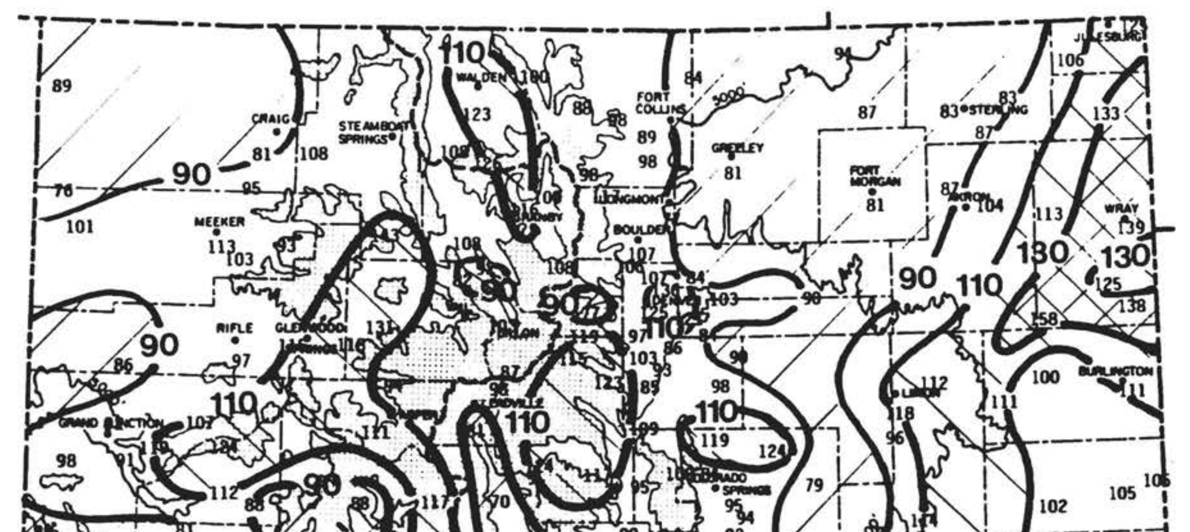


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

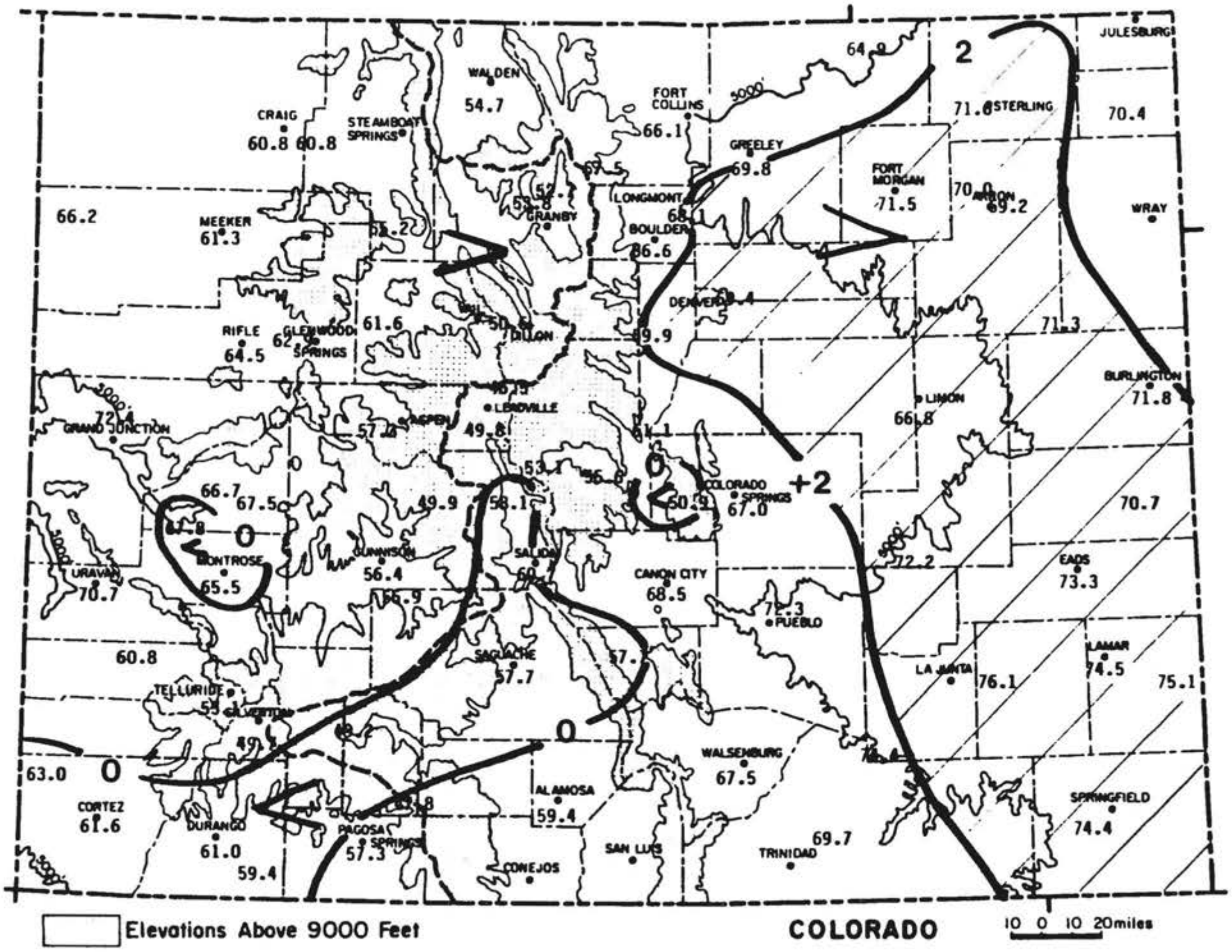
	extremely wet
+4	----------------
+3	ample moisture
+2	----------------
+1	
0	near normal
-1	
-2	----------------
	moderate drought
-3	----------------
	severe drought
-4	----------------
	extreme drought



Precipitation for October 1990 through June 1991
as a percent of the 1961-1980 average.

JUNE 1991 TEMPERATURES AND DEGREE DAYS

Despite a heatwave late in June, temperatures for the month as a whole were really quite comfortable. The majority of Colorado was warmer than average, but heat was not nearly so oppressive than at this same time last year. A few stations in central and southwestern Colorado indicated slightly cooler than average conditions. The warmest areas were found east of the mountains. The South Platte Valley was about 3 degrees F warmer than average. Southeastern Colorado ended up about 2 degrees above average. Most of western Colorado was within a degree of their long-term average.



June 1991 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

JUNE 1991 SOIL TEMPERATURES

Soil temperatures responded to air temperatures and solar heating and continued to rise at all depths throughout June. Temperatures remained very near the expected values 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.

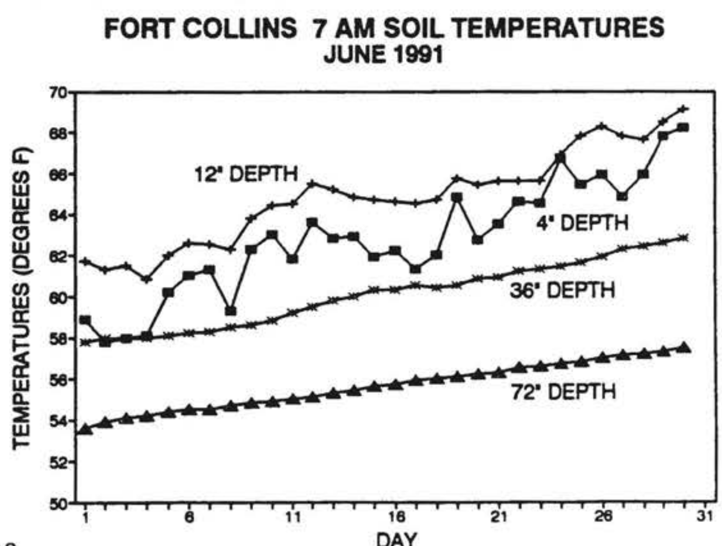


Table 1. Heating Degree Day Data through June 1991 (base temperature, 65°F).

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
	89-90	17	82	271	698	1001	1400	1554	1089	880	640	480	105	8217
	90-91	59	118	201	633	990	1597	1671	1081	954	742	410	172	8628
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	89-90	68	176	303	671	974	1365	1365	1086	915	697	543	171	8334
	90-91	134	146	234	652	964	1462	1444	1013	1077	811	432	224	8593
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	89-90	1	0	E 139	M	E 567	E1064	E 776	E 925	E 760	502	321	21	M
	90-91	32	13	81	338	589	1161	1081	667	685	511	211	44	5413
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	89-90	39	112	270	628	812	1202	1184	991	857	660	518	106	7379
	90-91	66	130	226	641	905	1326	1256	896	983	771	472	207	7879
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	89-90	0	4	E 130	415	684	1229	990	957	757	459	280	3	5908
	90-91	10	4	76	407	M	1249	1223	688	737	438	136	1	M
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	89-90	0	0	131	379	584	1076	859	827	687	421	325	22	5311
	90-91	14	12	58	382	548	1098	1004	626	679	459	182	26	5088
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	89-90	0	4	172	473	699	1163	966	928	805	526	345	24	6105
	90-91	28	21	83	473	663	1256	1142	750	773	568	219	33	6009
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	89-90	0	16	142	494	850	1166	1222	959	776	490	377	59	6551
	90-91	1	6	151	539	774	1321	1364	879	882	702	335	113	7067
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	89-90	4	46	235	586	892	1420	1319	1257	879	530	453	144	7765
	90-91	14	18	116	606	876	1547	1544	1095	995	693	398	127	8029
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	89-90	M	M	M	330	M	M	1161	865	626	355	237	22	M
	90-91	0	2	58	416	751	1400	1549	998	742	512	170	26	6624
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	89-90	0	0	153	424	658	1160	879	882	781	469	265	7	5678
	90-91	12	3	64	388	623	1209	1143	684	682	510	174	16	5508
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	89-90	226	357	502	861	1124	1495	1506	1271	1124	886	764	349	10465
	90-91	284	355	430	858	1071	1587	1569	1220	1257	1031	691	425	10778
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	89-90	2	19	106	520	789	1133	1278	965	724	479	359	44	6418
	90-91	4	28	118	481	832	1373	1274	842	919	619	364	125	6979
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	89-90	1	60	217	593	896	1348	1286	986	806	545	269	68	7075
	90-91	15	23	134	583	934	1568	1536	1052	889	693	355	99	7881
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	89-90	49	118	325	657	818	1221	1115	1030	932	662	513	140	7580
	90-91	120	131	219	591	803	1330	1244	937	885	727	430	152	7569
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	89-90	0	3	169	458	711	1166	930	910	848	495	307	19	6016
	90-91	19	6	74	460	690	1284	1212	747	703	508	203	41	5947
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	89-90	0	2	156	416	721	1285	1087	1010	776	450	274	10	6187
	90-91	18	7	63	421	730	1343	1248	750	722	489	180	8	5979
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	89-90	0	0	40	316	729	1103	1124	820	557	271	139	20	5119
	90-91	0	0	28	360	759	1370	1464	919	706	478	136	18	6238

* = 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 6SSW	AVE	214	264	468	775	1128	1473	1593	1369	1318	951	654	384	10591
	89-90	168	306	427	768	1132	1449	1401	1205	1043	833	689	266	9687
	90-91	264	268	350	774	1071	1605	1668	1148	1233	979	615	330	10305
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	89-90	1	2	166	454	729	1230	985	922	787	449	275	9	6009
	90-91	14	2	62	450	723	1309	1246	741	692	492	159	11	5901
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	89-90	61	155	341	749	1069	1574	1647	1254	906	672	540	188	9156
	90-91	65	179	264	771	1059	1664	1787	M	M	M	M	249	M
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	89-90	0	0	99	323	684	1176	1030	887	638	309	188	2	5336
	90-91	4	0	21	308	624	1220	1113	667	602	352	81	0	4992
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	89-90	285	412	545	880	1138	1507	1499	1265	1188	920	793	377	10809
	90-91	331	402	464	861	1141	1556	1550	1207	1210	1068	714	449	10953
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	89-90	1	6	204	508	762	1252	1078	991	815	555	364	33	6569
	90-91	36	11	96	491	745	1280	1237	779	820	592	245	38	6370
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	89-90	2	8	200	484	749	1302	1048	994	917	552	319	25	6600
	90-91	24	11	101	481	727	1284	1249	740	699	520	186	28	6050
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	89-90	0	41	198	543	869	1261	1169	1071	795	507	387	91	6932
	90-91	9	23	121	511	885	1406	1458	1047	939	696	358	110	7563
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	89-90	0	10	110	439	768	1156	1186	895	654	425	285	27	5955
	90-91	0	3	81	470	804	1385	1460	974	768	571	268	49	6833
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	89-90	24	118	284	646	964	1298	1491	1160	873	630	524	164	8176
	90-91	44	108	177	608	910	1538	1432	1038	1002	767	489	227	8340
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	89-90	0	0	94	373	676	1204	964	877	695	394	233	2	5512
	90-91	1	0	34	360	610	1243	1116	730	667	406	103	3	5273
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	89-90	0	2	103	473	E 830	1130	1191	923	657	392	281	37	6019
	90-91	0	4	69	474	824	1433	1462	964	814	605	265	52	6966
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	89-90	18	117	315	M	974	1533	1580	1332	971	658	576	M	M
	90-91	129	E 110	255	700	1013	1683	1613	1223	1120	851	518	262	9477
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	89-90	0	3	144	428	719	1254	1074	1026	760	427	275	8	6118
	90-91	17	7	68	437	725	1359	1244	713	716	466	173	8	5933
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	88-89	72	175	270	644	869	1264	1273	1023	922	664	509	145	7830
	89-90	117	179	267	635	972	1384	1351	987	1093	828	486	293	8592
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	89-90	0	1	111	369	633	1153	980	874	681	420	266	8	5496
	90-91	4	6	46	334	654	1160	1048	697	709	462	156	12	5288
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	89-90	132	279	461	802	1075	1490	1359	1287	1068	796	674	273	9696
	90-91	202	258	332	794	1028	1550	1459	1105	1164	931	587	300	9710
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	89-90	0	2	117	345	581	1047	848	800	666	408	289	10	5113
	90-91	15	8	53	311	543	1047	985	646	674	437	141	23	4883

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

JUNE 1991 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	79.2	50.7	64.9	0.5	97	45	66	71	458	2.07	-0.43	82.8	12
STERLING	85.7	57.6	71.6	3.5	98	50	8	213	605	2.04	-0.69	74.7	16
FORT MORGAN	86.0	57.0	71.5	3.1	101	52	8	210	607	2.08	0.06	103.0	9
AKRON FAA AP	83.9	56.1	70.0	3.1	99	49	21	180	577	1.09	-1.55	41.3	6
AKRON 4E	83.3	55.2	69.2	2.7	102	48	29	164	552	2.07	-0.64	76.4	12
HOLYOKE	81.4	59.5	70.4	1.4	96	53	11	181	602	3.39	0.03	100.9	9
JOES	85.1	57.5	71.3	2.3	9999	47	11	200	577	3.36	1.16	152.7	7
BURLINGTON	86.0	58.0	71.8	2.1	100	53	1	208	602	4.17	1.85	179.7	8
LIMON WSMO	82.0	51.6	66.8	2.8	97	44	38	99	495	1.63	-0.17	90.6	11
CHEYENNE WELLS	87.0	54.4	70.7	1.2	101	42	13	192	583	3.01	0.86	140.0	11
EADS	87.9	58.6	73.3	2.3	104	50	2	258	646	2.19	0.15	107.4	5
ORDWAY 21N	89.3	55.2	72.2	2.6	101	46	8	234	607	1.11	-0.42	72.5	6
LAMAR	90.9	58.1	74.5	1.3	104	47	1	292	655	3.04	0.72	131.0	9
LAS ANIMAS	92.1	60.1	76.1	2.7	106	45	0	338	683	1.90	0.16	109.2	11
HOLLY	89.3	60.9	75.1	2.5	103	52	0	309	687	3.26	0.19	106.2	9
SPRINGFIELD 7WSW	91.3	57.6	74.4	4.3	103	49	1	292	654	2.48	0.37	117.5	7
TIMPAS 13SW	90.0	58.9	74.4	4.1	102	47	3	292	665	1.12	-0.36	75.7	4

Foothills/Adjacent Plains

Name	Max	Min	Temperature Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
FORT COLLINS	79.6	52.7	66.1	0.8	92	44	41	86	492	3.59	1.75	195.1	12
GREELEY UNC	84.3	55.3	69.8	1.9	100	50	11	164	570	2.38	0.57	131.5	11
ESTES PARK	72.2	42.8	57.5	0.9	87	36	217	0	339	3.03	1.27	172.2	14
LONGMONT 2ESE	83.3	53.0	68.1	2.2	97	47	28	131	529	2.54	0.54	127.0	12
BOULDER	79.9	53.2	66.6	-0.6	95	47	44	101	497	3.59	1.33	158.8	13
DENVER WSFO AP	84.1	54.7	69.4	3.0	100	49	16	156	556	2.20	0.33	117.6	11
EVERGREEN	76.6	43.1	59.9	2.2	92	37	152	7	405	3.45	1.34	163.5	18
CHEESMAN	79.1	43.1	61.1	1.3	99	36	137	28	438	3.09	1.48	191.9	12
LAKE GEORGE 8SW	70.5	40.7	55.6	0.5	81	33	275	1	319	1.65	0.37	128.9	11
ANTERO RESERVOIR	69.3	36.9	53.1	1.5	79	28	349	0	296	1.87	0.95	203.3	12
RUXTON PARK	66.9	34.8	50.9	-0.5	85	27	417	0	262	3.40	1.04	144.1	14
COLORADO SPRINGS	80.5	53.5	67.0	1.8	95	44	33	101	504	3.07	0.75	132.3	13
CANON CITY 2SE	83.0	54.0	68.5	0.8	97	45	26	141	543	1.36	0.06	104.6	11
PUEBLO WSO AP	89.4	55.1	72.3	1.4	103	45	3	232	606	1.97	0.65	149.2	6
WESTCLIFFE	75.7	39.8	57.7	-0.2	85	29	229	18	406	0.84	-0.24	77.8	9
WALSENBURG	82.9	52.1	67.5	0.9	94	43	23	105	526	1.69	0.47	138.5	7
TRINIDAD FAA AP	85.8	53.6	69.7	1.2	98	40	12	160	582	0.90	-0.63	58.8	5

Mountains/Interior Valleys

Name	Max	Min	Temperature Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
WALDEN	72.4	37.1	54.7	1.6	81	30	300	0	343	1.62	0.60	158.8	12
LEADVILLE 2SW	66.7	32.8	49.8	1.3	77	27	449	0	258	1.48	0.48	148.0	9
SALIDA	77.1	44.3	60.7	0.2	87	37	144	24	424	1.16	0.25	127.5	8
BUENA VISTA	75.1	41.2	58.1	-0.5	88	32	207	7	385	1.02	0.21	125.9	8
SAGUACHE	73.4	42.0	57.7	-0.7	85	37	212	0	357	0.92	0.35	161.4	10
HERMIT 7ESE	68.4	30.1	49.2	-0.1	76	22	468	0	286	0.85	0.13	118.1	4
ALAMOSA WSO AP	78.0	40.8	59.4	0.2	88	31	172	12	429	0.30	-0.42	41.7	6
STEAMBOAT SPRINGS	75.7	36.4	56.0	1.3	87	28	262	0	392	1.70	0.25	117.2	11
YAMPA	69.9	40.5	55.2	0.3	77	35	285	0	307	2.56	1.03	167.3	13
GRAND LAKE 1NW	70.7	34.8	52.7	2.4	82	29	359	0	317	2.19	0.56	134.4	13
GRAND LAKE 6SSW	70.9	36.7	53.8	1.9	81	31	330	0	319	2.34	1.04	180.0	11
DILLON 1E	67.2	34.1	50.6	0.1	77	28	425	0	266	1.94	0.78	167.2	13
CLIMAX	59.2	33.9	46.5	1.5	71	25	547	0	155	1.96	0.48	132.4	11
ASPEN 1SW	72.4	42.2	57.3	2.3	84	34	224	0	344	2.22	0.81	157.4	9
TAYLOR PARK	65.6	34.1	49.9	2.9	75	30	446	0	246	1.90	0.84	179.2	8
TELLURIDE	72.4	37.8	55.1	1.0	80	30	293	0	343	1.72	0.50	141.0	11
PAGOSA SPRINGS	76.6	38.0	57.3	0.2	86	30	227	3	405	0.69	-0.08	89.6	9
SILVERTON	65.6	33.8	49.7	1.7	73	28	453	0	242	1.22	-0.03	97.6	13
WOLF CREEK PASS 1	61.5	34.1	47.8	0.4	71	24	507	0	189	2.35	0.71	143.3	14

Western Valleys

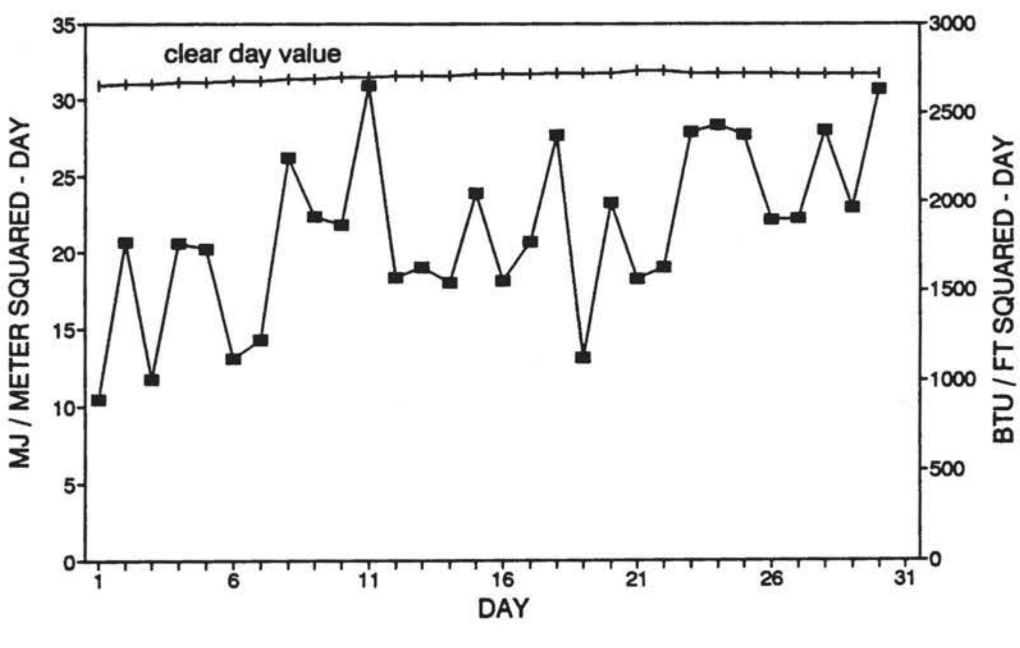
Name	Max	Min	Temperature Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Total	Precipitation Dep	%Norm	# days
CRAIG 4SW	76.4	45.2	60.8	1.4	85	39	127	7	403	1.52	0.17	112.6	9
HAYDEN	78.2	43.5	60.8	1.0	86	37	117	1	431	2.12	0.90	173.8	8
MEEKER NO. 2	78.9	43.8	61.3	0.3	85	37	110	8	443	0.75	-0.10	88.2	5
RANGELY 1E	82.9	49.6	66.2	0.2	90	37	52	98	512	1.14	0.41	156.2	6
EAGLE FAA AP	80.2	43.0	61.6	2.1	89	37	99	5	460	1.73	0.88	203.5	10
GLENWOOD SPRINGS	79.9	45.9	62.9	-0.2	91	40	81	25	455	2.75	1.44	209.9	7
RIFLE	83.7	45.3	64.5	0.9	92	38	52	44	493	0.65	-0.18	78.3	7
GRAND JUNCTION WS	87.1	57.8	72.4	0.4	95	44	18	247	636	0.30	-0.20	60.0	6
CEDAREDGE	83.9	49.6	66.7	1.3	92	37	42	103	523	0.49	-0.24	67.1	5
PAONIA 1SW	84.4	50.7	67.5	2.0	94	40	35	118	515	0.57	-0.23	71.2	9
DELTA	85.3	50.4	67.8	-0.1	92	45	26	117	533	0.31	-0.24	56.4	3
GUNNISON	75.4	37.4	56.4	1.3	85	31	249	0	390	0.75	0.21	138.9	12
COCHETOPA CREEK	75.2	36.5	55.9	1.6	85	30	266	0	386	0.69	-0.03	95.8	10
MONTROSE NO. 2	80.4	50.7	65.5	-0.4	87	40	49	72	490	0.27	-0.34	44.3	3
URAVAN	88.3	53.2	70.7	0.6	96	45	17	193	582	0.17	-0.25	40.5	6
NORWOOD	76.8	44.9	60.8	0.7	85	35	126	8	412	1.02	0.16	118.6	5
YELLOW JACKET 2W	79.6	46.5	63.0	-0.2	88	33	86	33	458	0.98	0.49	200.0	3
CORTEZ	80.1	43.0	61.6	-1.0	90	36	113	18	459	0.51	0.10	124.4	3
DURANGO	78.2	43.8	61.0	-0.4	86	33	125	8	429	1.34	0.77	235.1	12
IGNACIO 1N	77.1	41.6	59.4	-1.8	86	34	170	8	417	1.13	0.60	213.2	9

* 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 1991 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	7	16	7	--	--
Denver	7	17	6	66%	71%
Fort Collins	3	19	8	--	--
Grand Junction	13	12	5	78%	79%
Limon	4	16	10	--	--
Pueblo	5	16	9	76%	79%

FT. COLLINS TOTAL HEMISPHERIC RADIATION
JUNE 1991



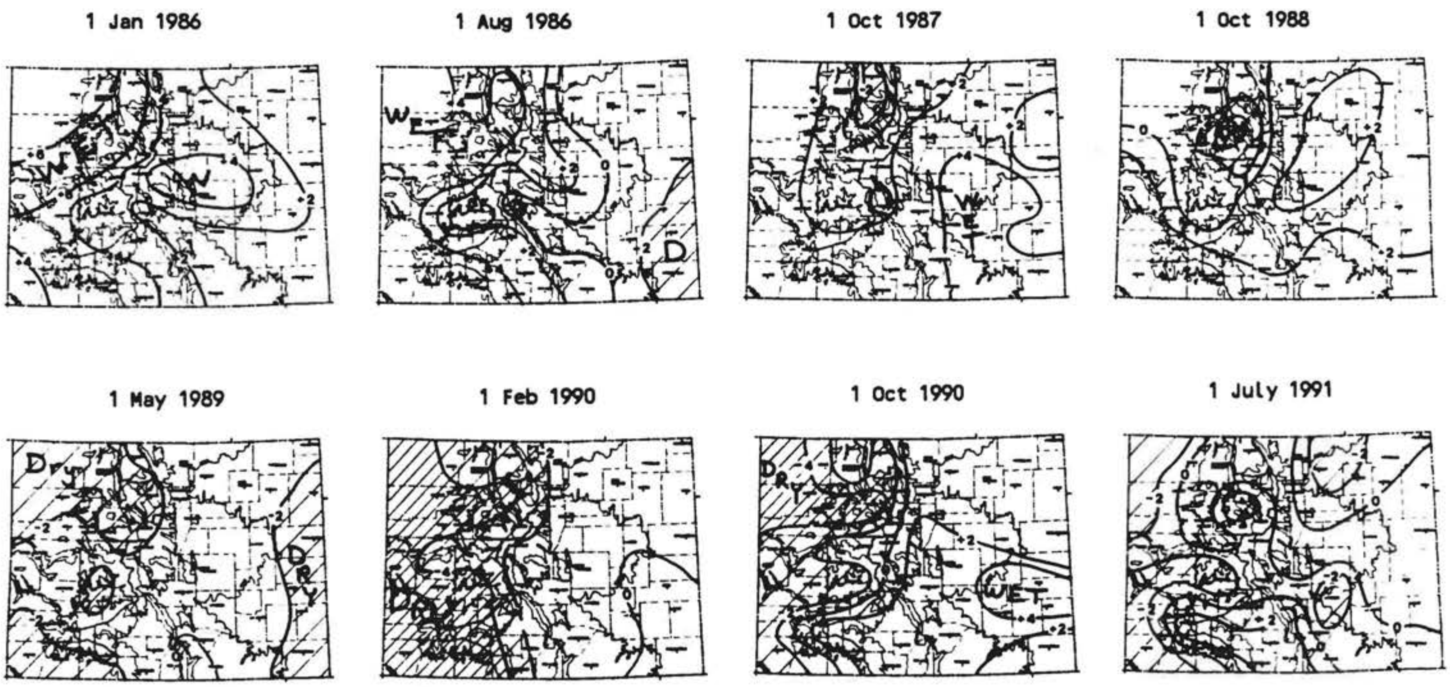
Is the Drought Over?:

Drier weather then started to sneak up on us. The summer of 1986 was very dry in eastern Colorado. The northern mountains were quite dry during the winter of 1987. Summer brought only limited improvement. While much of the country suffered through drought in 1988, Colorado fared reasonably well. Winter precipitation was below average in central and northwest Colorado. Summer moisture was extremely variable, but northwest Colorado was again on the short end of the stick. Dry winter and early spring weather in 1989 was widespread over Colorado and convinced most water experts that Colorado was once again experiencing drought. A wet summer on the eastern plains fortunately spared that area disastrous drought impacts, but dry weather continued in the mountains. Drought conditions became serious in early 1990 as mountain snowfall was much below average. It was most fortunate that many areas did receive plentiful spring and summer moisture. 1990 streamflow was well below average in many Colorado watersheds, but drought impacts were not excessive. Since last summer, precipitation has been fairly normal although the Front Range was unusually dry through the winter and spring of 1991.

Beginning in about May of 1990 and continuing up to the present time we have been asked (several times each month) "Is the drought over?" I know that sounds like a fair and simple question, and it is. The problem is coming up with an appropriate answer. In practice, drought means different things to different people. One person's drought is fine weather to someone else.

The following set of maps represent relative drought conditions over time in Colorado as indicated by the Palmer Drought Index. This index has been used nationally with varying degrees of success for about 25 years and was adapted by the Colorado Climate Center a few years ago for use in monitoring Colorado drought severity. Experience over the past 2 years with Colorado's Water Availability Task Force has shown this index to describe drought patterns with reasonable accuracy. Please note that index values greater than +2 indicate ample moisture, values near 0 indicate average moisture. Anything below -2 suggests the presence of drought. Values below -4 identify severe drought conditions.

Palmer Drought Severity Index (Adapted for use in Colorado)



As these maps show, the marvelous abundance of moisture of the mid 1980s is a thing of the past. Likewise, the drought conditions that spread nearly statewide in 1989 and continued into 1990 on the Western Slope have diminished. Despite locally heavy summer rains, the Palmer Index suggests that several areas of Colorado remain in marginal drought. There are also only limited areas of the State with abundant moisture as of the end of June 1991. Therefore, the most appropriate response to our question is, "No, the drought is not yet over." Although current moisture conditions are fairly normal, soil moisture reserves are not great in most of Colorado. Under these present climatic conditions, it will only require a few dry months (including a poor start to the 1992 snow accumulation season) and we will be right back into more serious drought. Long range forecasters are currently optimistic that this may be a wet fall and spring in the West, but unfortunately the track record of even the best long-range forecasters is rarely better than 60%. Let's hope for the best -- and we'll keep you posted.

NIGHT PRECOOLING

Summer is here and with it the potential for some very 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 the house durring the day. This pre-cooling of the house has been touted by many as an inexpensive way of lowering utility bills, but is it really?

There are many varibles that go into this determination. A calculation of the savings considers all sides of the issue. For example a typical house anyware in the U.S. is not nessarly "typical". Houses cannot be lumped together as the norm for the country. The majority of houses in this country are wood framed with a plaster paneling, and the thermal storage capacity for this type of house can easily be determined. The landscaping arround the "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 themselfs also change the parameters for a savings analysis; if the doors are always beeing opened and closed by little kids running about (as they tend to do in summer), the hot air has more of a chance of filtering into the house than one that is closed up for the day. This type of varible may make only a slight difference in the determination 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 durring the winter that caulking is needed. The insulation in the roof and walls also 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 feasable.

In what type of house is pre-cooling mostt effective? Houses which "hold on" to temperature are better (i.e. more massive homes such as brick or stone). This allows the coller air which is absorbed at night to be retained in the house longer. An example of this is the differance between adobe and wood homes. Adobe tends to retain temperature, thus cusing a slower passage of heat or coolness from the outside as compared to a stud framed wall. Houses which have trees that shade it from the sun actualy prevent a percentage of the direct energy of the sun from warming the house. Houses with good insulation, both in the attic and in the walls are more effective in pre-cooling. Pre-cooling can also be quite effective in larger buildings and offices.

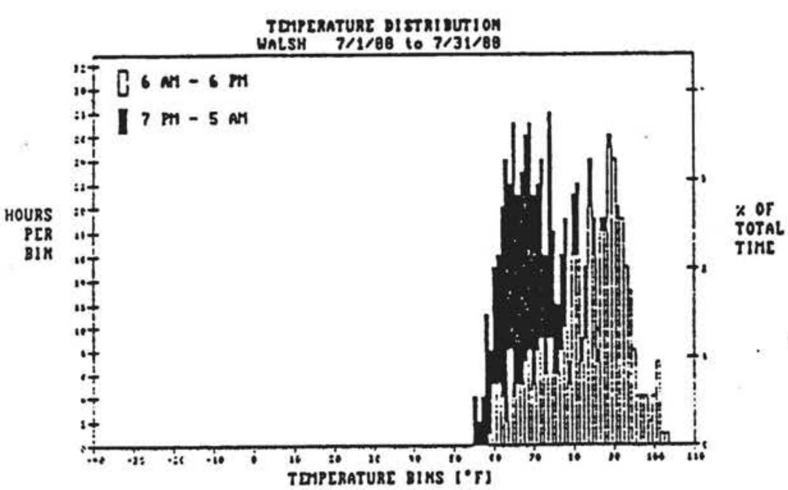


FIGURE 2.

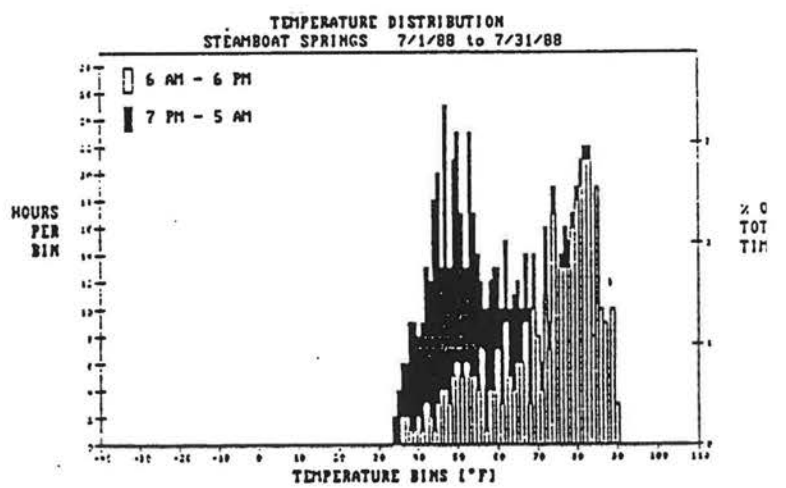


FIGURE 1.

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.

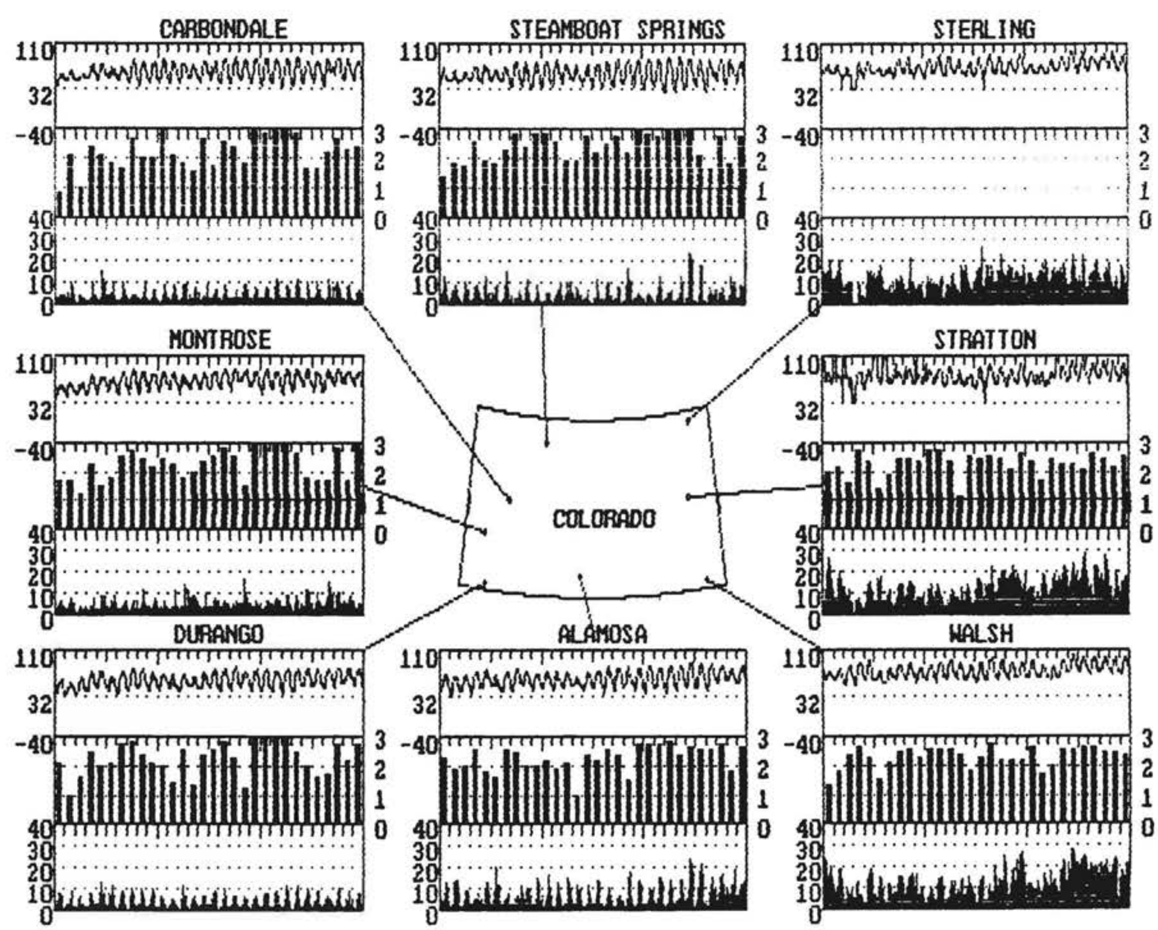
This article is a reprint of the April, 1989 article for the colorado climate. Information on acquiring our weather data can be obtained by writing Carl Rogers at the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, Co. 80309-0428, or phoning at (303) 449-4547. The WTHRNET BBS phone number is (303) 492-3525.

WTHRNET WEATHER DATA JUNE 1991

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (°F)								
	59.1	56.9	60.3	65.8	56.8	68.6	77.3	72.8
monthly temperature extremes and time of occurence (°F day/hour)								
maximum:	85.3 25/14	79.5 18/16	86.7 24/15	86.0 21/15	87.6 24/15	96.4 25/15		98.6 25/16
minimum:	30.9 2/ 5	32.7 3/ 5	33.8 23/ 5	39.2 2/ 5	28.0 24/ 5			48.7 4/ 3
monthly average relative humidity / dewpoint (percent / °F)								
5 AM	81 / 36	72 / 32	89 / 39	48 / 27	94 / 36	47 / 34	86 /	78 / 53
11 AM	27 / 32	38 / 37	42 / 44	25 / 32	33 / 37	20 / 27	46 / 56	40 / 50
2 PM	23 / 27	28 / 31	35 / 40	21 / 29	28 / 33	18 / 29	39 / 52	29 / 45
5 PM	23 / 27	29 / 30	35 / 39	20 / 28	29 / 32	18 / 28	39 / 51	29 / 43
11 PM	51 / 32	59 / 34	60 / 40	29 / 25	80 / 41	34 / 32	73 / 59	61 / 51
monthly average wind direction (degrees clockwise from north)								
day	184	220	220	119	220	162	165	163
night	163	106	160	110	112	160	176	189
monthly average wind speed (miles per hour)								
	5.88	3.44	2.86	4.39	3.00	9.64	11.08	11.40
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	233	404	498	236	458	42	20	36
3 to 12	405	315	221	475	225	459	412	374
12 to 24	82	1	1	9	21	218	279	289
> 24	0	0	0	0	0	1	9	21
monthly average daily total insolation ($Btu/ft^2 \cdot day$)								
	2244	2215	2172	2237	2384	0	2260	2282
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	249	144	157	167	175	0	228	235
40-60%	88	79	87	97	64	0	92	93
20-40%	51	65	78	72	45	0	53	57
0-20%	30	49	31	21	36	0	44	31

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. The Sterling station has a faulty horizontal radation sensor and that data should not be relied upon. There is also some problem with the relative humidity sensor on the Stratton station and its data is suspect for this month.



COLORADO CLIMATE

JULY 1991

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 14 Number 10

<u>July in Review:</u>

Colorado enjoyed a combination of cooler than average temperatures along with frequent and plentiful precipitation in July. Moist subtropical air invaded Colorado throughout much of the month helping to fuel daily thunderstorm development. Overall, nearly 80% of the State received near or above average rainfall. There were a number of hot days, but there were no prolonged heatwaves. The most impressive weather event for the month came July 22-24th when a strong cold front collided with monsoon moisture. The result was dense, low clouds, very chilly temperatures and heavy rainfall over much of eastern Colorado.

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

September weather seems to always inspire talk of early winters among the citizenry of Colorado. Changing aspen leaves always seem earlier than usual. September cold fronts, wind storms and snowfalls always seem unprecendented. Chilly mornings with frost on rooftops and open fields always seem to arrive before we are prepared. But when we investigate the climate data for Colorado gathered statewide over the past century, we find that this has always been the norm. Like it or not, Colorado summers are short. No matter what we do or say, colder weather is on its way. It inevitably begins to reveal itself in September. But don't let that lure you into thinking you know what lies ahead for the winter. September weather has been found to offer little or no insight into the coming winter.

Summer weather usually lasts into early September with low elevation temperatures in the 80s (sometimes 90s) during the day and 50s at night. A few thunderstorms are still likely, but they are rarely severe. By mid-month, the first strong autumn cold front usually brings a sudden change. The northern mountains often pick up their first measurable snowfall, but it melts quickly. Occasionally (about 1 or 2 years in 10) snow will even fall on the cities of the Front Range. By the end of the month, temperatures may drop into the 30s at night and parts of the State have killing freezes. There are exceptions, of course. Grand Junction stays much warmer and rarely sees frost until October or early November.

A feature of September climate here is the "all-or-nothing" nature of cloudiness and precipitation. Skies are often clear. Most of the State is clear on close to half of the days in the month. There are routinely strings of many consecutive days with low humidity and bright sunshine. Periodically, however, cool, damp weather takes aim on Colorado. When that happens, clouds may linger for many days, and soaking rains can occur. There is even a chance for hurricane remnants from storms over the Pacific to be swept northeastward toward Colorado. That only happens a few times each decade, but when it does, very heavy rains can fall especially over southwest Colorado.

For the month as a whole, daytime temperatures average in the 70s or low 80s with 60s in the mountains. Day-night temperature differences are large with low temperatures averaging in the 40s at low elevations (50s in a few preferred locations). Low temperatures in the mountains are typically in the 20s and 30s. Precipitation varies greatly from year to year but averages 1.00-1.50" over much of Colorado. The San Juan Mountains are the exception and can expect 2-4 inches.

<u>The Effect of New Electronic Thermometers on Apparent Climate Changes:</u>

I just attended a major international conference on applied climatology. As expected, many papers were presented about climate change. The concensus among scientists is that human activities continue to change the composition of the earth's atmosphere sufficiently to modify the global climate. However, the answers to key questions are still elusive. How much will the climate change? How quickly will it change? How much has it changed already? What impact will these changes have?

(continued on page 118)

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

Date	Event
1-3	A large high pressure ridge over the western U.S. gave most of Colorado sunny, dry weather with cool nights. Some thunderstorms rumbled over parts of eastern Colorado each day. Las Animas, Hugo and Stonington each received more than 1.00" of rain.
4-6	Perfect 4th of July weather was observed statewide, but it was followed by two of the hottest days of the summer. Many low elevation stations recorded 100°F or greater 5-6th with 70s and 80s in the high mountains. Alamosa recorded 91° on the 6th. Holly reached 108° on the 6th, the hottest in the State. Humidity was low so temperatures were bearable. Thundersprinkles teased a few parts of Colorado.
7-12	It stayed very hot on the 7th over much of Colorado, but brisk northerly winds gradually pushed cooler air southward across the plains. Humidity also increased, and thunderstorms erupted over most of Colorado 8-10th with some areas receiving hail and heavy rains. Marvine Ranch (east of Meeker) reported 1.86" of rain on the 8th. Areas south and east of La Junta picked up 1-3" rains that same evening. Thunderstorms on the 9th again continued late into the night dropping 1.75" on the Byers weather station. Rains were lighter but still widespread on the 10th as a low pressure trough crossed the region. The 11th was drier with pleasant temperatures allowing most Coloradoans a clear view of the midday partial solar eclipse. Thunderstorms exploded again on the 12th especially over the northeast quarter of the State. Brighton measured 1.81" of rain and hail.
13-17	A mostly dry period with a statewide warming trend as an extensive high pressure ridge dominated the central U.S. Temperatures 15-17th climbed into the 90s with some 100s over southeastern counties. A little monsoon moisture appeared from the southwest and helped spawn a few localized storms. Red Feather Lakes was surprised by a 1.12" shower on the 15th. Crested Butte and Rico reported 0.81" and 1.14", respectively, on the 16th.
18-21	Abundant subtropical moisture covered Colorado. Thunderstorms became a part of the daily routine over and near the mountains. Temperatures were near average across the State, but heavy cloudcover on the 20th on the Western Slope held daytime temperatures well below average. Grand Junction only reached a high of 75°. Moderate to heavy rains were reported each day from scattered areas of the State.
22-24	Storms developed along the Front Range on the 22nd and spread east and southward overnight as a strong summer cold front out of Canada crossed the High Plains colliding with the moist monsoon airmass. Much of the eastern plains received soaking rains. Temperatures stayed in the 50s and 60s on the 23rd east of the mountains with dense low clouds, fog and rain. Rains diminished but developed again over parts of the State on the 24th as cool, damp air lingered. Three-day rain totals exceeded 1" at 1/3 of Colorado's official weather stations. More than 4" fell on parts of several east-central counties. Road and bridge damage was reported in some areas, and soil erosion was widespread. Westcliffe totalled 5.95" for the period making this the wettest recorded July in that town's history. Rainfall averaged 1.35" over the entire eastern plains, more than 8% of the total moisture expected for the entire year.
25-31	The month ended with a gradual return to summer heat with less humidity and fewer storms. Patchy morning fog on the 25th was followed by plenty of late day storms. The Denver airport was doused with 1.85" of rain and hail. A few heavy storms formed again on the 26th. Canon City reported 1.13". Winds aloft then turned to the northwest bringing dry weather with only isolated afternoon buildups. Temperatures climbed back into the 90s at low elevations for the rest of the month. Some moisture slipped back into the State 30-31st producing more showers especially over southwestern counties.

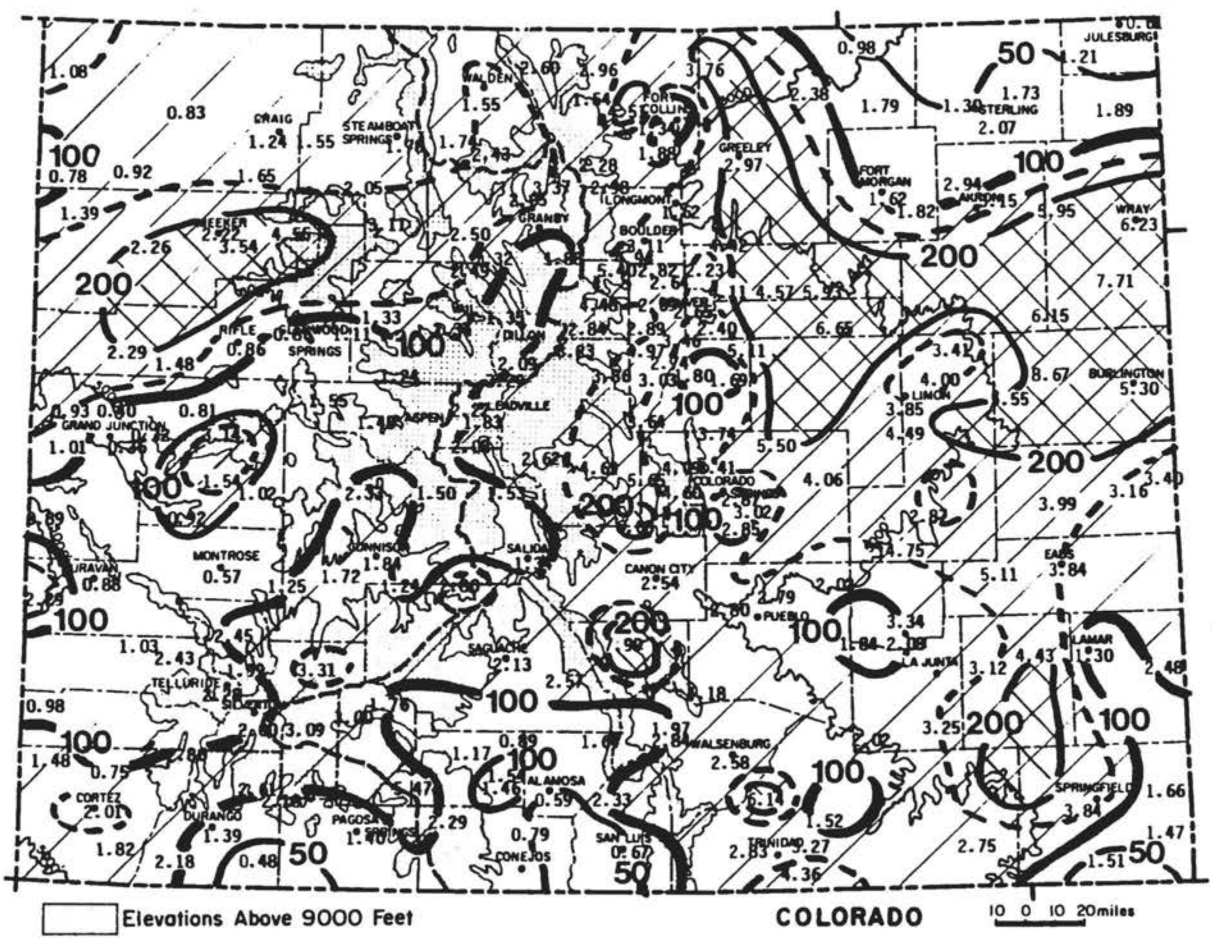
July 1991 Extremes

Highest Temperature	108°F	July 6	Holly
Lowest Temperature	22°F	July 4	Dillon 1 E
Greatest Total Precipitation	8.67"		Stratton
Least Total Precipitation	0.32"		Palisade
Greatest Total Snowfall	0		

J U L Y   1 9 9 1   P R E C I P I T A T I O N

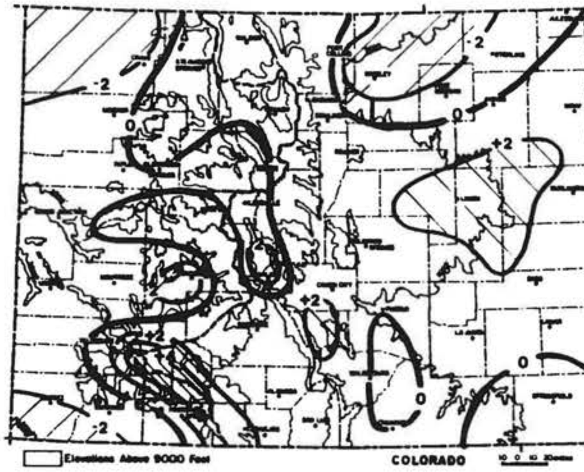
Thunderstorms formed somewhere within the border of Colorado almost every day in July but were especially common and widespread 7-12th and 17-27th. A few locations in and near the mountains received rainfall on as many as 21 individual days. That is actually not unusual for mid summer. Precipitation totals ended up near or above average for the month over most of Colorado. A few areas experienced a very wet July. More than double the average moisture fell from the Piceance basin eastward to the Flattops, over a small area south of Las Animas, on the Westcliffe area, in spotty foothills areas along the Front Range, and over an extensive region on the plains including Greeley, Byers, Burlington and Wray. Drier than average conditions were limited to the extreme northeastern and southeastern corners of Colorado, the south end of the San Luis Valley, a small area southeast of Durango, and a band across western Colorado from Uravan and Norwood northeast to Aspen and Dillon.

Greatest		Least	
Stratton	8.67"	Palisade	0.32"
Westcliffe	7.99"	Grand Junction 6 ESE	0.36"
Idalia 4 NNE	7.71"	Grand Junction WSO AP	0.40"
Deer Trail	6.65"	Ignacio 1 N	0.48"
Wray	6.23"	Montrose	0.57"
Joes	6.15"	Alamosa WSO AP	0.59"



Precipitation amounts (inches) for July 1991 and contours of precipitation as a percent of the 1961-1980 average.

Abundant July rainfall in parts of Colorado brought continued improvement to Colorado's moisture supplies. A number of areas are still running behind their water year average precipitation, but these areas continue to diminish both in size and in precipitation deficit. The driest areas, compared to average, are found in Moffat County, some parts of southwest Colorado, the Upper Arkansas valley bottom, a small area south of Alamosa, isolated portions of extreme southeastern Colorado, and across portions of Larimer, Weld, Morgan and Logan counties in northeast Colorado. The wettest areas are now found over parts of the northern mountains, high elevations of the San Juan Mountains, and over much of east central Colorado. Southern Yuma county is now more than 50% wetter than average for the past 10 months combined.

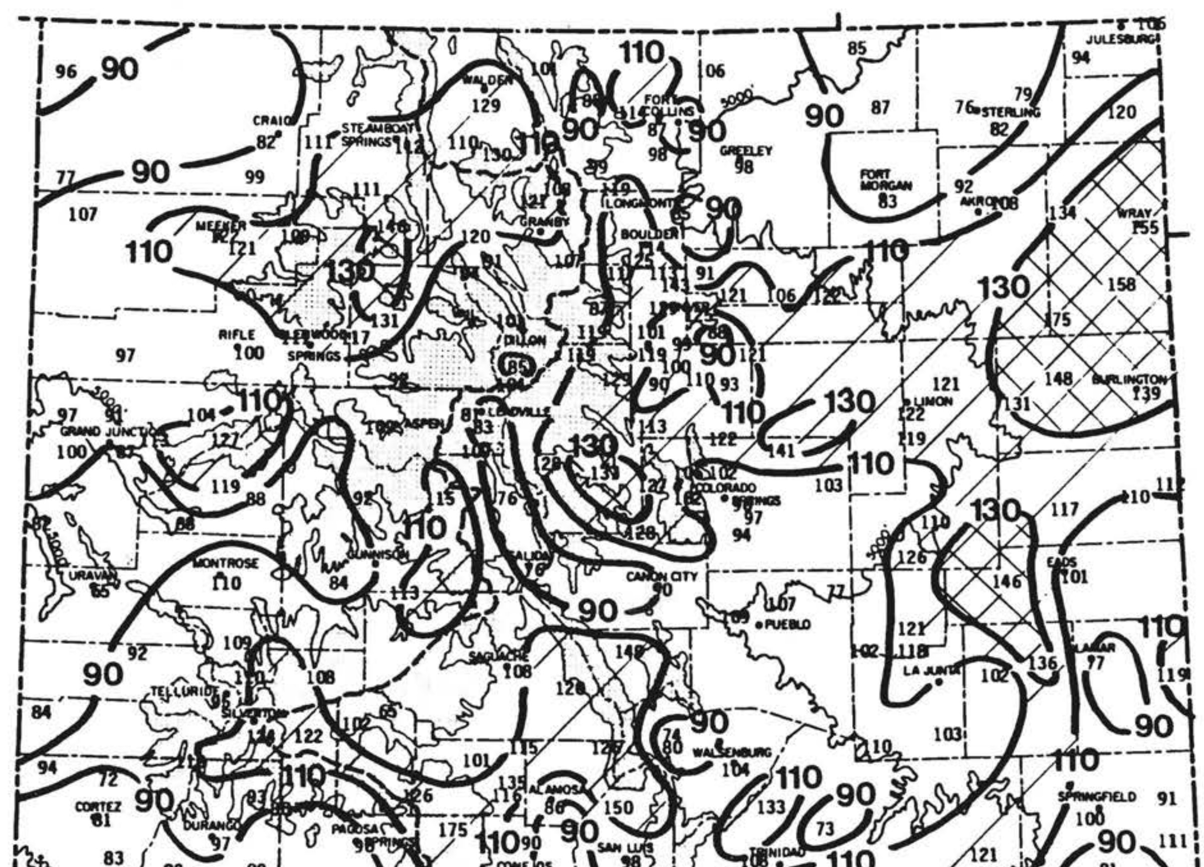


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

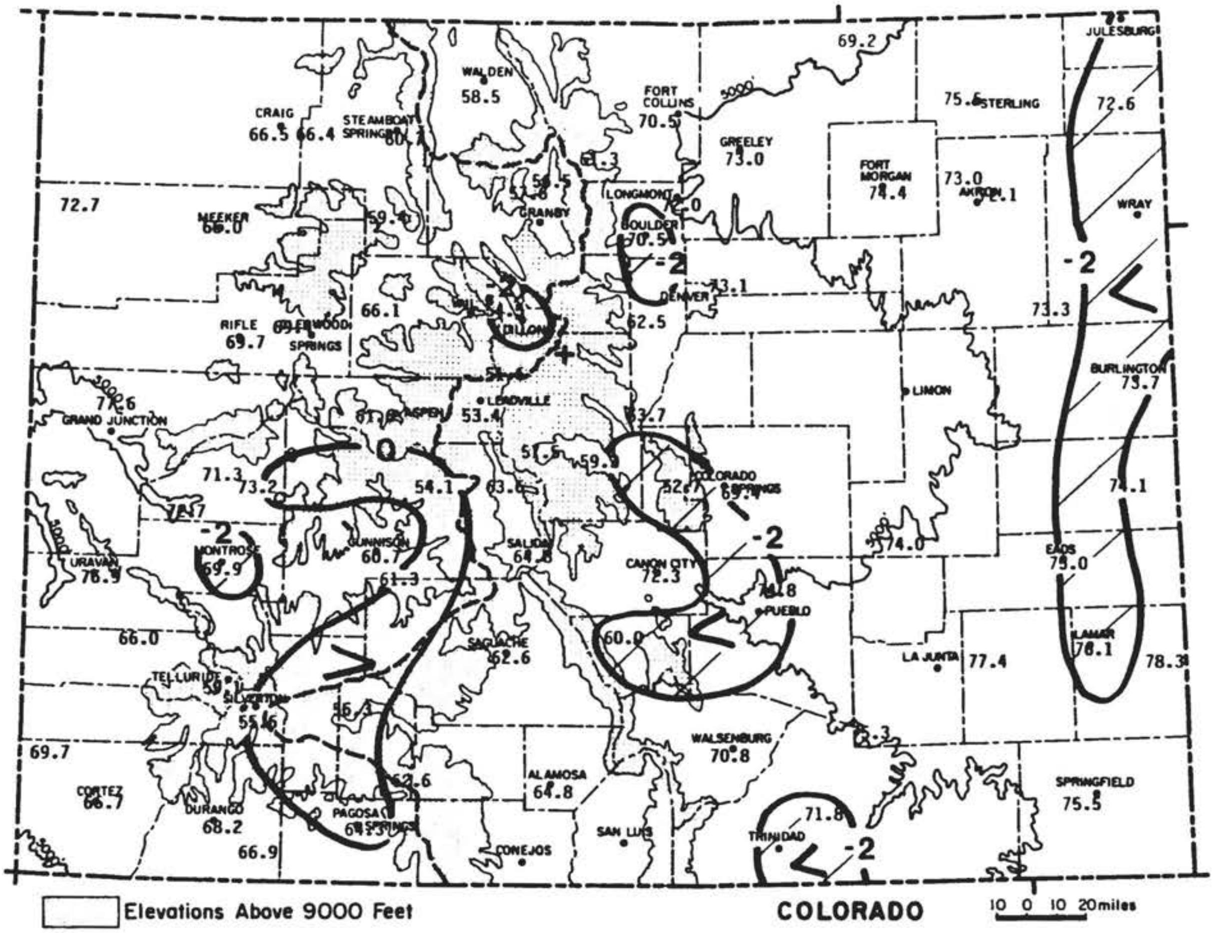
Index	
	extremely wet
+4	
+3	ample moisture
+2	
+1	
0	near normal
-1	
-2	
	moderate drought
-3	
	severe drought
-4	
	extreme drought



Precipitation for October 1990 through July 1991
as a percent of the 1961-1980 average.

JULY 1991 TEMPERATURES AND DEGREE DAYS

Temperatures were uniformly a degree or two cooler than average over practically the entire State in July. The coolest areas, compared to average were noted in the Pikes Peak region and in extreme eastern Colorado from Lamar northward. The only areas with above average temperatures for the month were found in the central and southern mountains. These locations were only slightly above average. Despite a few very hot days, July temperatures were quite pleasant for most of the State. Cooling requirements were noticeably less than expected for mid summer.



July 1991 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

JULY 1991 SOIL TEMPERATURES

Near-surface soil temperatures reached their peak for the year and then cooled noticeably in response to the cooler, cloudier and damper weather of late July. Temperatures deeper in the ground continued to rise steadily.

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 1991

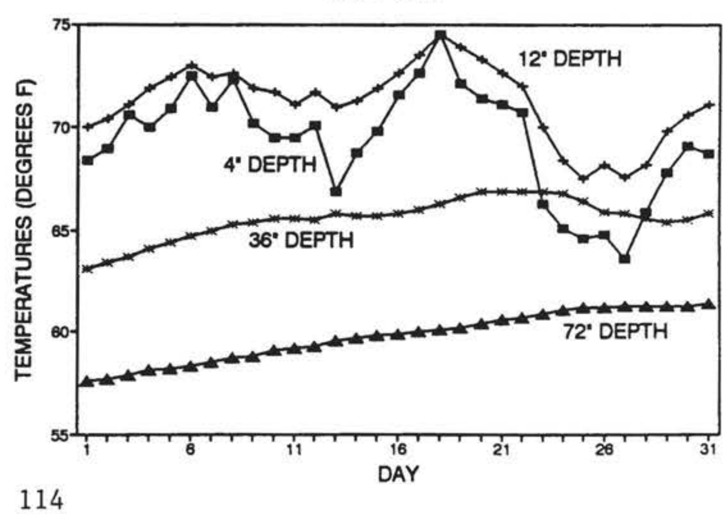


Table 1. Heating Degree Day Data through July 1991 (base temperature, 65°F).

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
	90-91	59	118	201	633	990	1597	1671	1081	954	742	410	172	8628
	91-92	33												33
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	90-91	134	146	234	652	964	1462	1444	1013	1077	811	432	224	8593
	91-92	104												104
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	90-91	32	13	81	338	589	1161	1081	667	685	511	211	44	5413
	91-92	17												17
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	90-91	66	130	226	641	905	1326	1256	896	983	771	472	207	7879
	91-92	63												63
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	90-91	10	4	76	407	M	1249	1223	688	737	438	136	1	M
	91-92	13												13
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	90-91	14	12	58	382	548	1098	1004	626	679	459	182	26	5088
	91-92	8												8
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	90-91	28	21	83	473	663	1256	1142	750	773	568	219	33	6009
	91-92	16												16
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	90-91	1	6	151	539	774	1321	1364	879	882	702	335	113	7067
	91-92	13												13
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	90-91	14	18	116	606	876	1547	1544	1095	995	693	398	127	8029
	91-92	27												27
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	90-91	0	2	58	416	751	1400	1549	998	742	512	170	26	6624
	91-92	0												0
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	90-91	12	3	64	388	623	1209	1143	684	682	510	174	16	5508
	91-92	6												6
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	90-91	284	355	430	858	1071	1587	1569	1220	1257	1031	691	425	10778
	91-92	316												316
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	90-91	4	28	118	481	832	1373	1274	842	919	619	364	125	6979
	91-92	6												6
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	90-91	15	23	134	583	934	1568	1536	1052	889	693	355	99	7881
	91-92	26												26
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	90-91	120	131	219	591	803	1330	1244	937	885	727	430	152	7569
	91-92	83												83
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	90-91	19	6	74	460	690	1284	1212	747	703	508	203	41	5947
	91-92	11												11
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	90-91	18	7	63	421	730	1343	1248	750	722	489	180	8	5979
	91-92	5												5
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	90-91	0	0	28	360	759	1370	1464	919	706	478	136	18	6238
	91-92	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 6SSW	AVE	214	264	468	775	1128	1473	1593	1369	1318	951	654	384	10591
	90-91	264	268	350	774	1071	1605	1668	1148	1233	979	615	330	10305
	91-92	220												220
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	90-91	14	2	62	450	723	1309	1246	741	692	492	159	11	5901
	91-92	8												8
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	90-91	65	179	264	771	1059	1664	1787	M	M	M	M	249	M
	91-92	131												131
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	90-91	4	0	21	308	624	1220	1113	667	602	352	81	0	4992
	91-92	1												1
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	90-91	331	402	464	861	1141	1556	1550	1207	1210	1068	714	449	10953
	91-92	343												343
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	90-91	36	11	96	491	745	1280	1237	779	820	592	245	38	6370
	91-92	19												19
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	90-91	24	11	101	481	727	1284	1249	740	699	520	186	28	6050
	91-92	12												12
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	90-91	9	23	121	511	885	1406	1458	1047	939	696	358	110	7563
	91-92	24												24
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	90-91	0	3	81	470	804	1385	1460	974	768	571	268	49	6833
	91-92	0												0
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	90-91	44	108	177	608	910	1538	1432	1038	1002	767	489	227	8340
	91-92	44												44
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	90-91	1	0	34	360	610	1243	1116	730	667	406	103	3	5273
	91-92	1												1
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	90-91	0	4	69	474	824	1433	1462	964	814	605	265	52	6966
	91-92	1												1
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	90-91	129 E	110	255	700	1013	1683	1613	1223	1120	851	518	262	9477
	91-92	127												127
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	90-91	17	7	68	437	725	1359	1244	713	716	466	173	8	5933
	91-92	5												5
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	89-90	117	179	267	635	972	1384	1351	987	1093	828	486	293	8592
	91-92	175												175
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	90-91	4	6	46	334	654	1160	1048	697	709	462	156	12	5288
	91-92	3												3
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	90-91	202	258	332	794	1028	1550	1459	1105	1164	931	587	300	9710
	91-92	193												193
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	90-91	15	8	53	311	543	1047	985	646	674	437	141	23	4883
	91-92	6												6

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

JULY 1991 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	85.0	53.4	69.2	-1.9	96	47	15	157	566	0.98	-1.18	45.4	7
STERLING	91.2	59.8	75.5	0.8	104	52	5	340	696	1.30	-1.27	50.6	8
FORT MORGAN	89.2	59.5	74.4	-0.8	101	55	5	304	689	1.62	-0.08	95.3	8
AKRON FAA AP	86.5	59.5	73.0	-0.6	100	51	12	268	668	2.94	0.31	111.8	12
AKRON 4E	87.5	56.6	72.1	-1.3	103	51	15	245	631	3.15	0.58	122.6	13
HOLYOKE	84.6	60.7	72.6	-2.4	99	54	10	255	671	1.89	-0.89	68.0	8
JOES	87.2	59.4	73.3	-1.7	102	46	9	274	679	6.15	3.55	236.5	7
BURLINGTON	87.3	60.1	73.7	-2.1	101	51	13	288	680	5.30	3.33	269.0	11
LIMON WSMO	83.9	54.8	69.4	-1.3	97	50	19	163	577	3.85	0.95	132.8	12
CHEYENNE WELLS	89.7	58.5	74.1	-1.3	105	46	8	295	671	3.16	0.69	127.9	10
EADS	88.9	61.1	75.0	-2.0	103	54	8	326	702	3.84	1.01	135.7	7
ORDWAY 21N	90.5	57.6	74.0	-1.2	102	51	8	295	655	4.75	2.43	204.7	12
LAMAR	93.1	59.1	76.1	-2.8	105	50	6	358	685	1.30	-1.10	54.2	8
LAS ANIMAS	92.7	62.0	77.4	-1.9	107	53	1	393	737	3.12	0.87	138.7	9
HOLLY	93.7	62.9	78.3	-0.4	108	54	0	420	749	2.48	0.41	119.8	6
SPRINGFIELD 7WSW	91.5	59.5	75.5	0.2	103	50	6	340	686	3.84	1.40	157.4	11
TIMPAS 13SW	90.6	60.0	75.3	-0.5	102	51	5	322	674	2.02	0.33	119.5	5

Foothills/Adjacent Plains

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
FORT COLLINS	84.2	56.8	70.5	-1.0	95	52	11	189	612	1.34	-0.43	75.7	8
GREELEY UNC	87.7	58.3	73.0	-0.5	99	53	8	263	661	2.97	1.76	245.5	10
ESTES PARK	76.1	46.5	61.3	-1.0	86	40	118	9	418	2.28	0.11	105.1	14
LONGMONT 2ESE	87.5	56.4	72.0	-0.4	101	51	12	237	629	1.62	0.56	152.8	8
BOULDER	84.0	57.0	70.5	-3.0	96	50	17	193	610	3.11	1.22	164.6	11
DENVER WSFO AP	87.5	58.7	73.1	-0.2	97	53	6	267	669	4.11	2.21	216.3	11
EVERGREEN	78.6	46.4	62.5	-1.3	90	42	83	13	451	2.89	0.64	128.4	13
CHEESMAN	81.7	45.7	63.7	-1.8	92	41	62	30	485	3.64	0.81	128.6	17
LAKE GEORGE 8SW	73.7	44.9	59.3	-2.0	83	37	170	0	376	4.61	2.08	182.2	21
ANTERO RESERVOIR	74.5	40.6	57.5	-0.3	83	31	224	0	385	2.62	0.73	138.6	16
RUXTON PARK	68.9	36.5	52.7	-3.6	84	29	374	0	300	4.60	0.36	108.5	18
COLORADO SPRINGS	83.2	55.6	69.4	-1.8	96	50	16	161	582	2.87	-0.03	99.0	15
CANON CITY 2SE	86.2	58.5	72.3	-1.3	97	52	8	244	657	2.54	0.63	133.0	16
PUEBLO WSO AP	91.3	58.4	74.8	-2.4	105	52	1	314	677	2.79	0.85	143.8	15
WESTCLIFFE	76.0	44.0	60.0	-3.4	84	38	108	3	296	7.99	5.70	348.9	13
WALSENBURG	84.8	56.7	70.8	-1.4	97	50	6	195	624	2.58	0.18	107.5	13
TRINIDAD FAA AP	86.7	56.9	71.8	-2.2	100	50	3	221	634	1.52	-0.65	70.0	9

Mountains/Interior Valleys

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
WALDEN	77.5	39.5	58.5	-0.4	88	31	193	0	430	1.55	0.62	166.7	10
LEADVILLE 2SW	70.8	36.1	53.5	-1.0	78	29	352	0	329	1.83	-0.47	79.6	15
SALIDA	82.3	47.2	64.8	-0.9	91	40	41	40	504	1.34	-0.35	79.3	10
BUENA VISTA	80.2	47.0	63.6	-1.3	89	41	63	27	479	1.53	-0.04	97.5	14
SAGUACHE	77.5	47.6	62.6	-1.4	87	42	85	17	442	2.13	0.52	132.3	15
HERMIT 7ESE	74.6	37.9	56.3	0.5	82	30	267	0	392	3.00	0.68	129.3	12
ALAMOSA WSO AP	82.5	47.1	64.8	-0.3	91	38	33	33	513	0.59	-0.75	44.0	8
STEAMBOAT SPRINGS	81.3	40.2	60.7	-0.9	91	32	127	2	484	1.78	0.50	139.1	12
YAMPA	73.8	45.0	59.4	-1.9	81	34	167	1	380	3.11	1.22	164.6	13
GRAND LAKE 1NW	75.1	37.9	56.5	0.2	86	29	255	0	396	3.37	1.33	165.2	12
GRAND LAKE 6SSW	74.5	40.6	57.6	-0.5	83	32	220	0	389	2.05	0.70	151.9	16
DILLON 1E	71.4	37.6	54.5	-2.4	80	22	316	0	341	1.35	-0.20	87.1	13
CLIMAX	64.4	38.8	51.6	-0.1	71	33	410	0	230	3.29	1.21	158.2	14
ASPEN 1SW	77.9	45.3	61.6	-0.4	85	40	104	5	442	1.45	-0.25	85.3	14
TAYLOR PARK	69.2	39.0	54.1	0.7	78	31	329	0	303	1.50	-0.04	97.4	11
TELLURIDE	77.5	40.6	59.1	-0.9	89	33	175	0	431	2.28	-0.14	94.2	17
PAGOSA SPRINGS	84.7	43.9	64.3	0.2	93	35	44	30	531	1.40	-0.34	80.5	21
SILVERTON	72.4	38.7	55.6	1.7	79	32	285	0	356	2.00	-0.73	73.3	15
WOLF CREEK PASS 1	66.7	38.6	52.6	-0.5	74	34	375	0	267	5.47	2.24	169.3	19

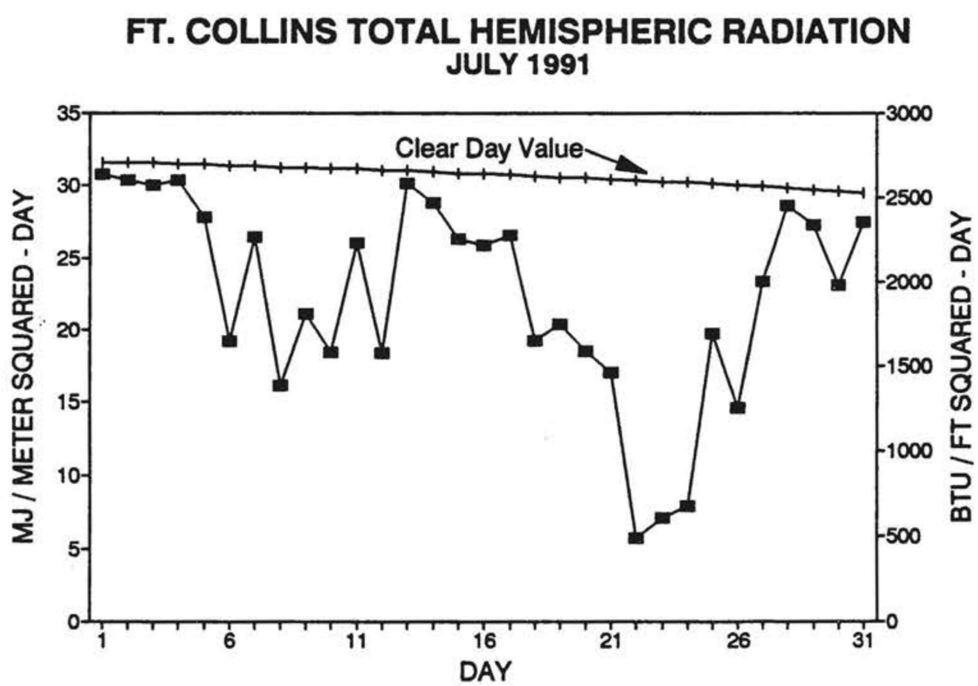
Western Valleys

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	83.1	50.0	66.5	-0.2	91	42	27	84	528	1.24	-0.06	95.4	5
HAYDEN	83.7	49.0	66.4	-0.4	90	38	29	81	528	1.55	0.47	143.5	10
MEEKER NO. 2	83.2	48.7	66.0	-1.2	91	41	24	61	522	2.22	1.11	200.0	9
RANGELY 1E	89.1	56.3	72.7	-0.6	98	49	1	247	648	1.39	0.45	147.9	6
EAGLE FAA AP	85.0	47.1	66.1	-0.4	95	38	26	67	527	1.33	0.30	129.1	10
GLENWOOD SPRINGS	87.4	51.4	69.4	-0.5	95	42	7	151	572	0.86	-0.41	67.7	6
RIFLE	89.2	50.3	69.7	-0.6	99	40	1	155	577	0.86	0.17	124.6	8
GRAND JUNCTION WS	92.4	62.8	77.6	-1.5	101	56	0	398	758	0.40	-0.16	71.4	4
CEDAREDGE	90.2	52.5	71.3	-0.6	98	45	1	204	602	1.54	0.70	183.3	5
PAONIA 1SW	89.8	56.5	73.2	0.8	98	50	0	262	657	1.02	-0.11	90.3	8
DELTA	90.0	55.4	72.7	-1.0	99	46	0	247	637	0.92	0.26	139.4	7
GUNNISON	80.0	41.4	60.7	-0.5	87	32	131	6	473	1.84	0.53	140.5	13
COCHETOPA CREEK	80.4	42.1	61.3	0.2	89	32	121	12	478	1.24	-0.33	79.0	10
MONTROSE NO. 2	84.6	55.2	69.9	-2.4	93	48	0	159	609	0.57	-0.31	64.8	5
URAVAN	94.5	59.3	76.9	-0.3	102	50	0	375	706	0.88	-0.28	75.9	7
NORWOOD	82.2	49.8	66.0	-0.3	90	40	21	59	526	1.03	-0.73	58.5	4
YELLOW JACKET 2W	86.5	52.8	69.7	-0.9	95	45	1	153	591	1.48	0.18	113.8	9
CORTEZ	87.3	46.1	66.7	-2.1	95	42	13	76	546	2.01	0.98	195.1	6
DURANGO	84.8	51.7	68.2	-0.6	91	47	6	115	563	1.39	-0.12	92.1	14
IGNACIO 1N	84.6	49.2	66.9	-1.3	92	40	12	77	549	0.48	-0.87	35.6	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 1991 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	10	15	6	--	--
Denver	14	10	7	67%	71%
Fort Collins	12	10	9	--	--
Grand Junction	14	14	3	79%	78%
Limon	11	15	5	--	--
Pueblo	12	12	7	75%	78%

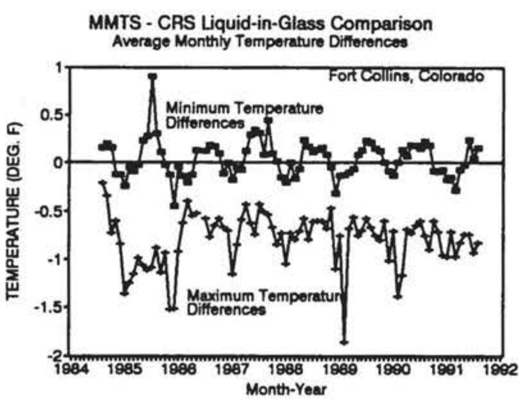


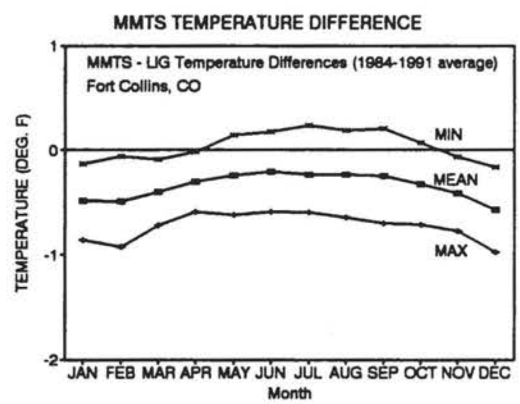
The Effect of New Electronic Thermometers on Apparent Climate Changes:

Many climatologists place the burden of proof concerning climate change on our monthly and seasonal observations of climate here and abroad. Temperature trends over the past century suggest that the globe is warming. But there are many complicating factors. Cities have grown up around existing long-term weather stations greatly affecting the local climate measurements. Many weather stations have been relocated. Weather stations have changed the time of day when observations are taken and recorded. In the 1970s, the quality of newly manufactured glass thermometers deteriorated. All of these factors influence the consistency of long-term temperature records. Most recently, during the past 7 years, new electronic thermometers have been introduced. More than half of the official National Weather Service cooperative weather stations now use these new thermometers. MMTS, which stands for Maximum-Minimum Temperature System, is the name given by the National Weather Service to these new measurement devices.

We obtained one of the first MMTS units brought to Colorado back in 1984 and have been testing it ever since. Several times each day MMTS temperatures are read and recorded along with the daily maximum and minimum readings. These are compared to the readings obtained from traditional liquid-in-glass thermometers in the old-fashioned white wooden weather shelter (same basic equipment in use at the Fort Collins weather station since 1889 to measure air temperatures).

Our 7-year comparison has found some interesting results that have caught the attention of many climatologists. Over the past 7 years, the MMTS maximum temperatures have read 0.8°F cooler than traditional maximum readings. Minimum temperatures have shown no difference. However, there is a distinct seasonal cycle in temperature differences with MMTS temperatures reading consistently colder than traditional temperature measurements in the winter. Differences become less during the summer. The largest daily differences noted during this comparison have all occurred during midday and early afternoon hours (near the time of the maximum temperature). Most of the big temperature differences have been observed on days when temperatures are cold, fresh snow is on the ground, winds are light and the sun is shining. A total of 53 days in the past 7 years have had MMTS maximum temperatures reading 2.5°F or more cooler than the old thermometer in its shelter. On 51 of those days, fresh snow covered the ground. Curiously, there is a period about 2-3 hours after sunrise on many mornings without snowcover when the MMTS briefly reads warmer than the traditional temperature measurement.

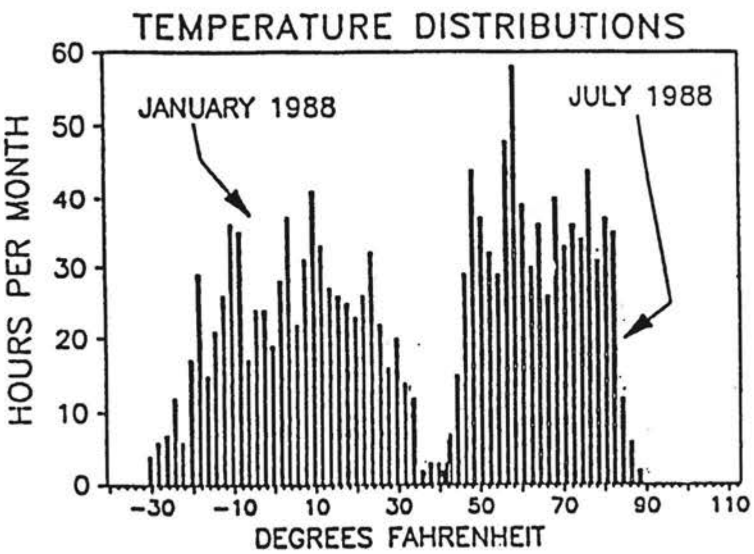




For most practical applications of climate information, a differences of one or two degrees makes little difference. But for scientists studying what may be a period of change in the earth's climate, every degree matters. In fact, a systematic change in how we measure our climate could introduce significant error in our global climate time series. In recent years, there is evidence that U.S. daily maximum temperatures have leveled off while nighttime temperatures continue to rise. It is very possible that some of this trend is the direct result of replacing old thermometers and wooden shelters with the new MMTS. From our study, it appears that the new temperature measurement system is probably more accurate than traditional measurements -- but it is not consistent.

No data set is ever totally free of problems. Our climatic data certainly are not perfect. When it comes to monitoring our climate what matters most is consistency. If you plan on conducting any research on local or regional climatic trends and changes, please take into account any weather station changes that may have affected the data. Our office retains historical documentation on many of Colorado's weather stations that may help answer these critical questions. Also, if you plan to set up your own weather instruments you may wish to check with us regarding proper siting and operation of weather stations.

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.



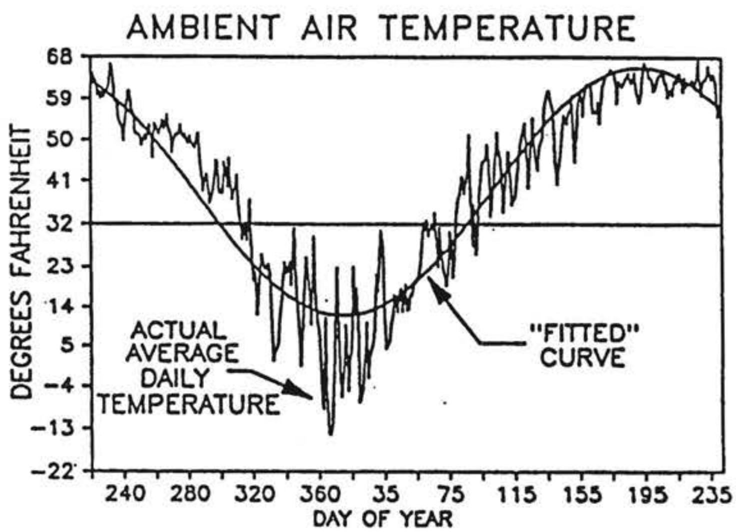
Bin Distributions

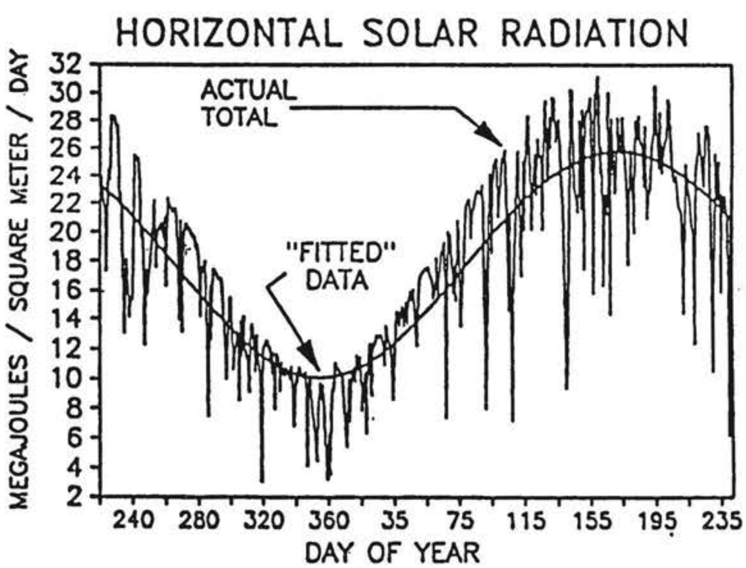
A very effective way to simulate temperature data is through the so-called "bin method": hourly data is distributed into a predetermined range of bins, usually five degrees Fahrenheit wide, and totaled up for a given time period. This typically results in eight to ten bins per month. The rate of heat 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?

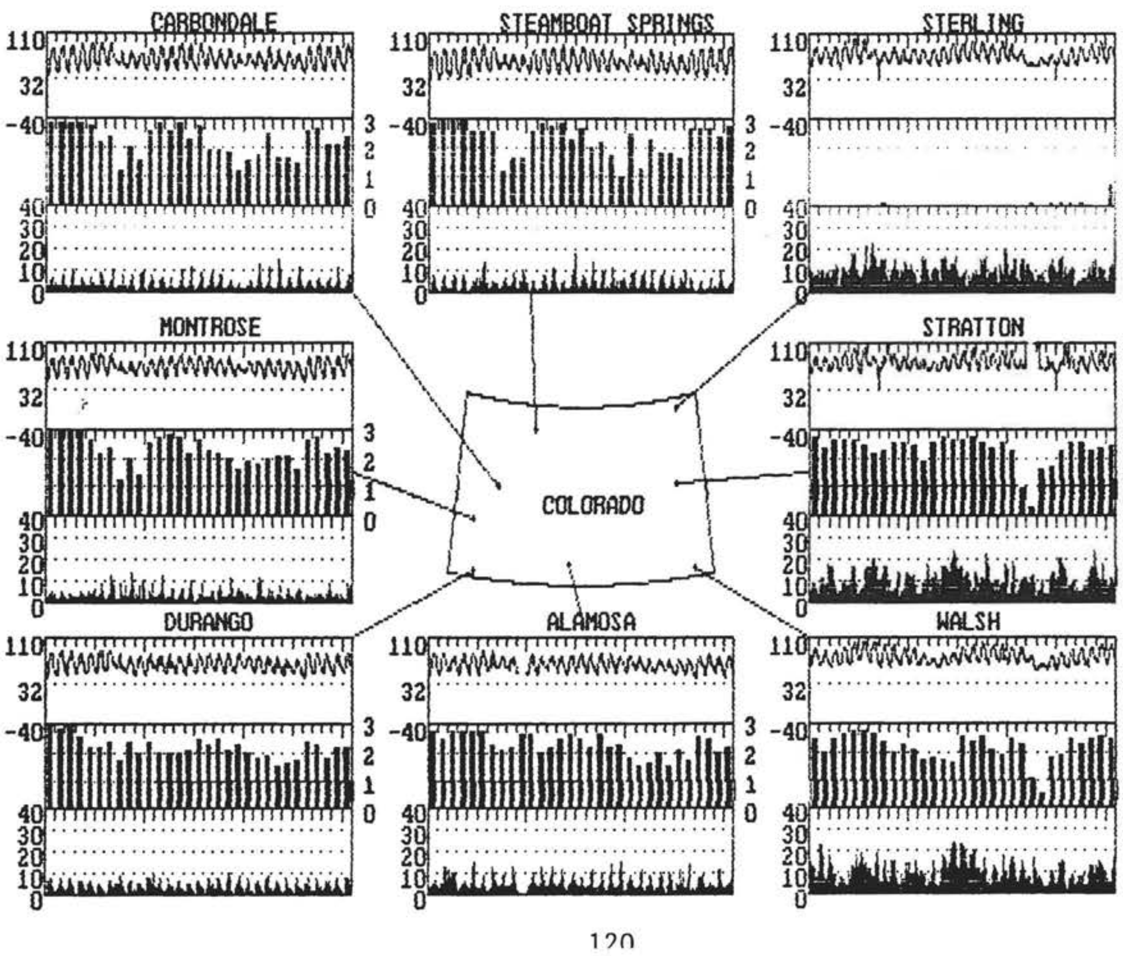
As you undoubtably have noticed from the graphs shown here, the "fitted" data does not always match the actual data very well. This problem can be reduced by defining a standard deviation of the fitted data, but not eliminated completely. Nonetheless, modeling data is preferred over using hourly data 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.

This article is a reprint of the November, 1988 article for the Colorado Climate. Information on acquiring our weather data can be obtained by writing Carl Rogers at the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, Co. 80309-0428, or phoning at (303) 449-4547. The WTHRNET BBS phone number is (303) 492-3525.

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (°F)	62.9	63.8	65.3	68.1	61.9	72.6	76.0	74.9
monthly temperature extremes and time of occurence (°F day/hour)								
maximum:	85.5 7/14	86.5 7/14	93.0 7/13	90.5 5/14	91.4 6/14	101.3 5/14		101.5 7/15
minimum:	38.3 27/ 5	41.2 1/ 5	36.1 1/ 5	43.5 1/ 3	32.0 1/ 5			52.2 26/ 4
monthly average relative humidity / dewpoint (percent / °F)								
5 AM	87 / 44	82 / 43	92 / 45	73 / 43	93 / 40		81 / 57	78 / 54
11 AM	39 / 43	34 / 44	42 / 50	35 / 45	35 / 42		46 / 57	37 / 49
2 PM	26 / 35	30 / 38	32 / 44	26 / 39	24 / 35		37 / 53	28 / 45
5 PM	28 / 34	33 / 39	33 / 44	26 / 37	29 / 35		36 / 51	29 / 44
11 PM	56 / 41	61 / 43	66 / 47	49 / 41	75 / 46		68 / 60	57 / 51
monthly average wind direction (degrees clockwise from north)								
day	160	184	218	147	218	146	128	156
night	170	102	166	151	102	196	210	218
monthly average wind speed (miles per hour)	4.53	3.23	2.27	2.96	2.42	7.79	8.74	8.90
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	240	402	556	449	476	54	21	45
3 to 12	465	342	183	292	236	587	576	521
12 to 24	17	0	1	3	3	103	147	177
> 24	0	0	0	0	0	0	0	1
monthly average daily total insolation (Btu/ft²·day)	2242	2162	2206	2276	2288		2280	2143
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	258	151	191	179	175		276	237
40-60%	61	74	64	71	71		75	98
20-40%	56	76	65	71	69		38	49
0-20%	36	45	37	26	21		40	49

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. The Sterling station horizontal radation detector is non functioning, and the Stratton dry bulb temperature sensor seems to be giving bad readings from time to time. Therefore neither of these readings should be trusted. The stations should be attended to soon by the Nebraska technicians.



COLORADO CLIMATE

AUGUST 1991

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 14 Number 11

August in Review:

Thunderstorms were a regular daily event throughout much of August. Two episodes of cool, damp weather east of the mountains dropped significant amounts of rain. The majority of Colorado ended up wetter than average for the month, and statewide drought concerns continued to diminish. The last one-third of the month was very warm and compensated for cooler than average weather earlier in August. Temperatures ended up a little above average in western Colorado and near to a little below average in the east.

Colorado's October Climate:

Just as autumn reliably reveals itself in September, so too does winter show its early signs in October. October is not a winter month, mind you. Colorado enjoys plentiful sunshine and many mild days. But it is the arrival of the first lasting snow in the high mountains, the freezing nights in the valleys, and the occasional strong cold fronts sweeping across the plains -- with sullen gray clouds and swirls of dry leaves and corn husks -- that foretell of the winter weather that lies ahead.

Daylength continues to diminish rapidly during October. Daytime sunlight is still strong and warm, but short evenings and long nights allow the temperatures to drop sharply and steadily from their afternoon peaks. Day-night temperature differences of 40 degrees F or greater are common during the first half of October, especially in mountain valleys. Winter jackets may be necessary as the kids leave for school in the morning, but by early afternoon t-shirts may suffice. Early in the month, low elevation temperatures often reach into the 70s during the day and drop back into the 30s at night. By the end of the month, 50s and 60s are the rule with a few much cooler days. In the mountains, the month begins with 50s and 60s for daytime temperatures falling to 20s at night. By month's end, many days only reach into the 40s with lows in the teens. Temperatures below zero at night become a possibility following a snowstorm.

October is known for its many days of clear, dry and calm weather. Joggers and outdoor workers love this invigorating weather. But just when you begin to get used to the fine days, dramatic changes occur. Four typical October weather events to watch for are: 1) a final thunderstorm to mark the end of Colorado's warm season, 2) a mid-month mountain snowstorm covering the high country with its first lasting snow (a boon to hunters but also sometimes requiring a few search and rescue operations as well), 3) a late-month snow at lower elevations, often close to Halloween, and 4) one or two episodes of damp, chilly weather lingering for a few days. October precipitation totals are normally light averaging just 0.50-0.80" across the plains and about 1.00" along the Front Range and across the Western Slope. Mountain precipitation averages 1.0-2.5" in most areas reaching as much as 4.00" in parts of the San Juans. Interestingly, monthly precipitation ends up below average in at least 60% of all years. But when it gets wet, it can really get wet. The scenario we watch for that can bring flooding rains to parts of Colorado in October is the infrequent combination of a late-season Pacific hurricane being swept northward into a developing intermountain storm system.

New Climatic Averages -- or, What is the Best Average?

For the past decade, we have used the 20-year period, 1961-1980, to define the "average" climate of Colorado for the purpose of climate monitoring and description. The climatic data for Colorado through the year 1990 are now merged into our data base, and we are ready to compute new averages. But first, there are some important questions that should be answered. What period should we now choose to define "average"? How much will the new averages differ from what we have been using? How significant are the changes?

(continued on page 129)

AUGUST 1991 DAILY WEATHER

Date	Event
1-4	The month began with typical hot summer weather and a few scattered thunderstorms. The mercury climbed to 106° at Holly on the 1st, the hottest in the State. A fairly strong summer cold front then dropped southward across Colorado on the 2nd bringing much cooler temperatures, especially east of the mountains. Thunderstorms developed on the 2nd and gave way to chilly upslope rains along the Front Range early on the 3rd. Rains spread southward and diminished on the 4th. High temperatures only reached into the 60s and low 70s across eastern Colorado both days with low clouds and some fog. Some mountain locations stayed in the 50s while the Western Slope enjoyed pleasant 70s and 80s. Rainfall totals for the period were quite heavy. Longmont, Denver (airport), Colorado Springs and Walsenburg all received in excess of 2.00". The Bennett weather station totalled 3.31" in 24 hours.
5-7	Plenty of low-level moisture remained over Colorado. Afternoon thunderstorms, some locally heavy, erupted each day. Brush received 1.04" of rain on the 6th. Temperatures stayed near or a little below the seasonal average.
8-13	Drier air moved into western Colorado 8-10, but a large high pressure area over the northern U.S. helped direct comfortably cool but fairly humid air into eastern Colorado. Afternoon thundershowers appeared each day over the mountains and were especially active in the Pikes Peak region. Some storms drifted out onto the plains. The Tacony 10 SE weather station northeast of Pueblo reported 1.16" from a storm on the 8th. The southeasterly flow of moist air strengthened 11-13 producing low clouds, local fog and more widespread rains and heavy storms. Large hail was reported near Fort Morgan on the 11th, and Limon received a 1.97" drenching. More than 2.00" fell near Yuma. Storms were heavy again on the 12th. Dillon got 0.48", and 1-3" rains were common across southeast Colorado. The Eads weather observer measured 2.72". Lamar had a daily high temperature of only 66° F on the 13th, 25° cooler than average.
14-20	Normal August weather occurred statewide with warm temperatures and scattered afternoon and evening thundershowers. Weak cold fronts crossed Colorado on the 16th and again late on the 18th bringing only minor changes in temperature but increasing storm activity. Several locations reported hail on the 16th. Lively storms affected both the mountains and the plains 18-19th. A localized flash flood took place near Idaho Springs from a storm on the 18th. Lake George 8 SW received 1.62" of rain that evening. Lamar was soaked with a 1.72" shower late on the 19th.
21-28	A week-long heatwave brought 90°+ temperatures to much of the lower elevations of Colorado while mountain temperatures were very delightful. Some late-day thundershowers formed each day but were light and very widely scattered 21-24th. A little more moisture then slipped northward into the State helping to fuel more thunderstorm activity. Mesa Verde enjoyed a 0.81" shower on the 25th followed by 0.92" on the 26th. The Denver airport received a 0.91" dousing on the 27th. A disturbance in the upper atmosphere triggered numerous storms over northern Colorado on the 28th. Akron collected 0.71" of beneficial moisture late on the 28th.
29-31	Drier and a little cooler air brought a comfortable ending to the month of August. A few scattered thundershowers still managed to develop each day, but most areas of the State remained dry.

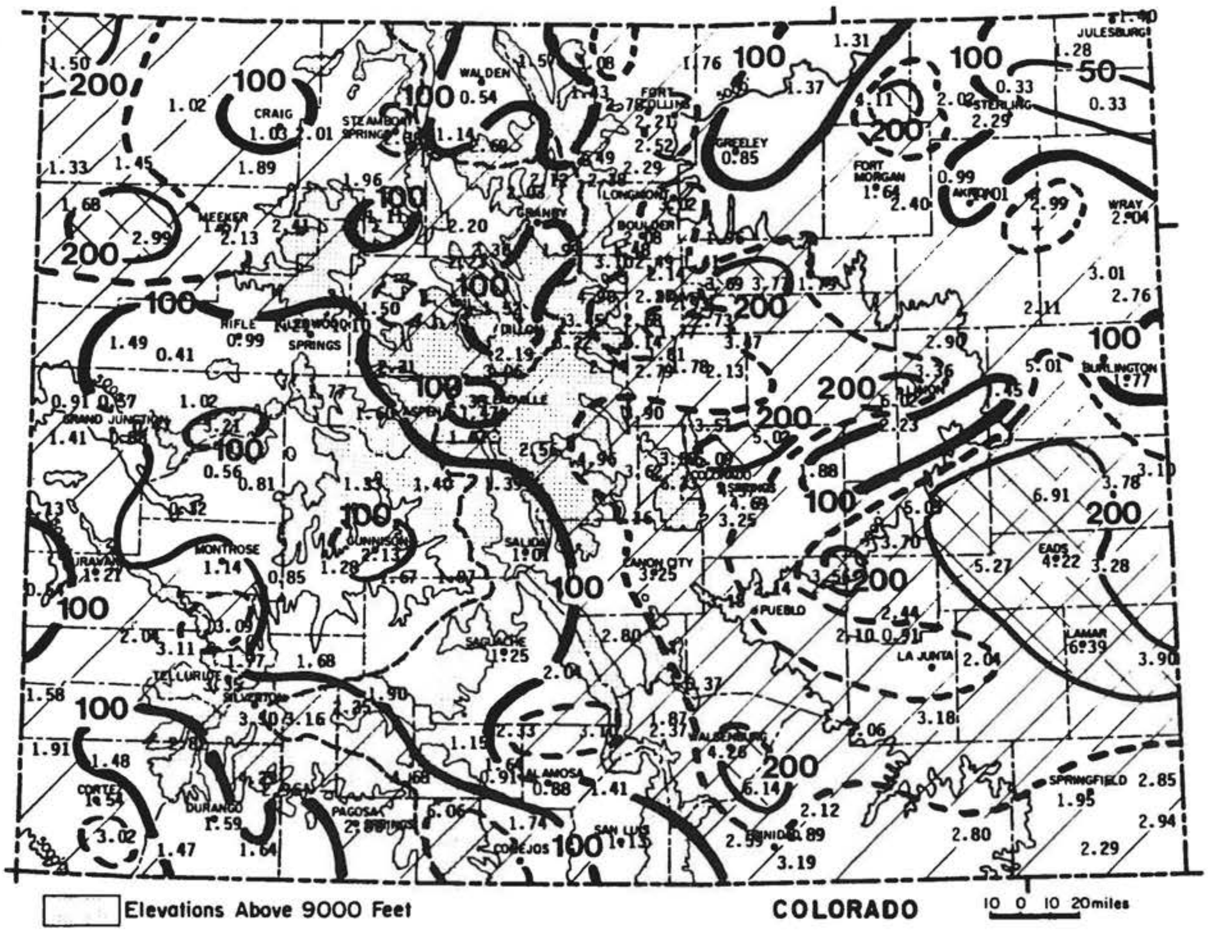
August 1991 Extremes

Highest Temperature	106°F	August 1	Holly
Lowest Temperature	21°F (?)	August 20	Climax
	30°F	Various dates	Fraser, Mt. Evans Research Center, and Platoro
Greatest Total Precipitation	6.91"		Kit Carson 6 SE
Least Total Precipitation	0.32"		Delta
Greatest Total Snowfall	0		

<u>A U G U S T   1 9 9 1   P R E C I P I T A T I O N</u>

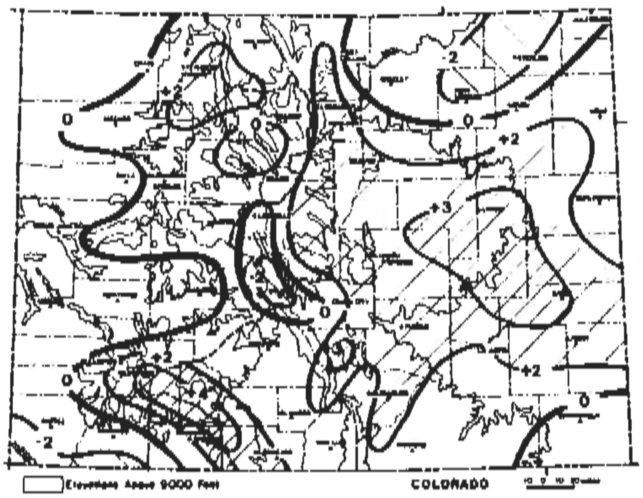
Thunderstorms formed somewhere within the border of Colorado every day in August and were especially common during the first three weeks of the month. Wolf Creek Pass received measurable rainfall on 23 days. The majority of Colorado ended up wetter than average for the month. The wettest areas, relative to average, were found along the Front Range (Denver Stapleton's 3.69" total ranked as the 4th wettest August since Denver records began in 1872), across parts of east central and southeastern Colorado (Kit Carson's 6.91" total was 332% of average and ended up the 2nd wettest monthly rainfall total in that station's 50-year history) and over portions of northwest Colorado. As usual, there were some dry spots. Only five rain days were reported in extreme northeast Colorado. Holyoke received just 0.33" of rain, 17% of average. Other drier than average areas were found in Weld County and small areas out on the plains, some parts of the San Luis Valley and over scattered portions of the northern and central mountains and western valleys.

Greatest		Least	
Kit Carson 6 SE	6.91"	Delta	0.32"
Lamar	6.39"	Holyoke	0.33"
Rye	6.37"	Fleming 1 S	0.33"
Ruxton Park	6.33"	Parachute	0.41"
Aguilar 1 SE	6.14"	Palisade	0.47"
Platoro	6.06"	Paradox 1 W, Walden	0.54"



Precipitation amounts (inches) for August 1991 and contours of precipitation as a percent of the 1961-1980 average.

Close to 70% of Colorado's weather stations received above average rainfall in August. This continued to improve statewide accumulated precipitation totals for the current water year. A few dry spots remain. Seventeen percent of Colorado's official weather stations have received less than 90% of the average October-August precipitation including the upper Arkansas Valley, the South Platte valley northeast from Fort Morgan, southwest and extreme northwest Colorado and a few other isolated locations. Forty percent of the weather stations are close to average for the year. The other 43% of the State has received at least 10% more moisture than usual. The wettest areas the State, compared to average, include the Denver area and much of east central Colorado. Haswell, Kit Carson, Joes, and Idalia all have received more than 150% of their average precipitation since last October.

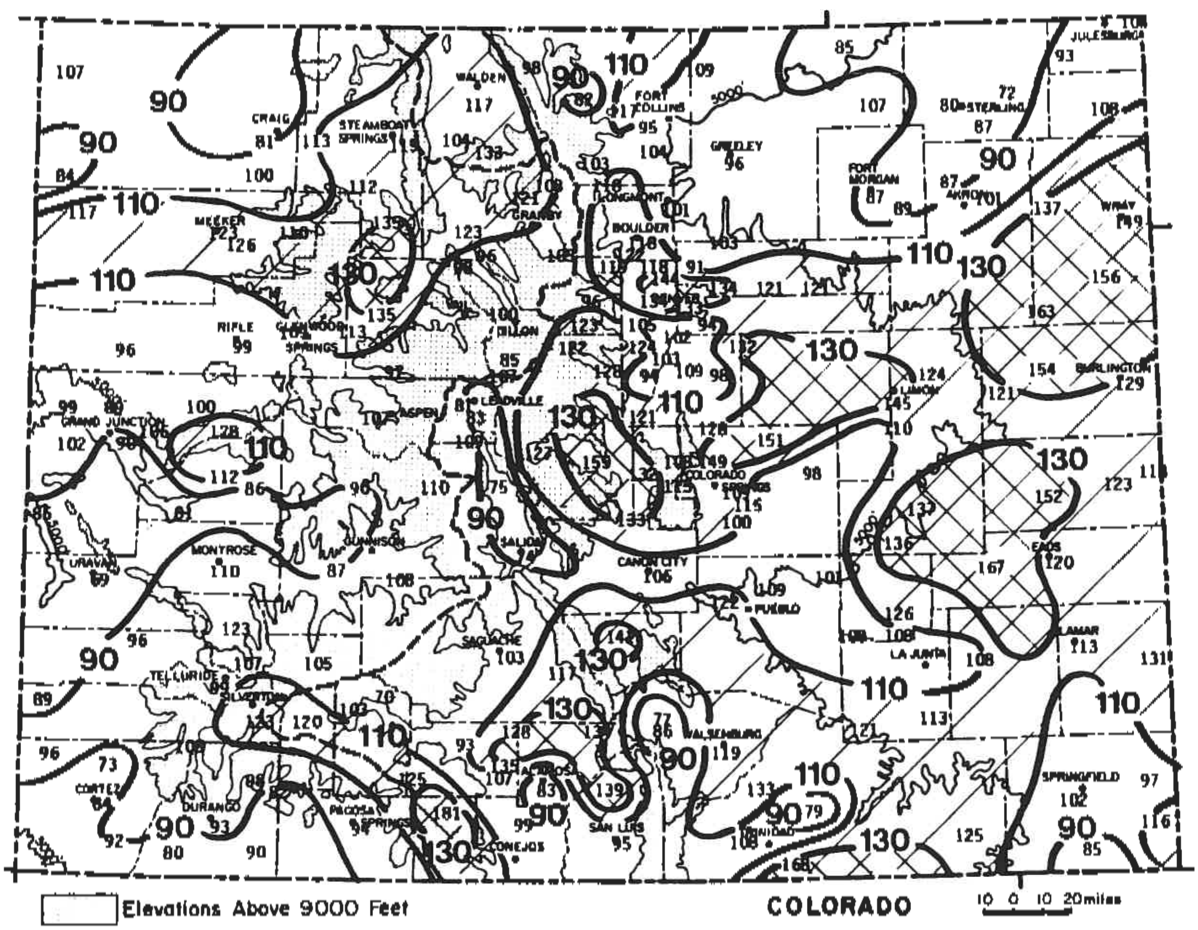


PALMER INDEX:

The Palmer Index is a relative indicator of soil moisture. It uses regional temperature and precipitation data as inputs to a soil moisture budget. It is best suited for unirrigated non-mountainous locations.

Interpretation of Index

	extremely wet
+4	----------------
+3	ample moisture
+2	----------------
+1	
0	near normal
-1	
-2	----------------
	moderate drought
-3	----------------
	severe drought
-4	----------------
	extreme drought

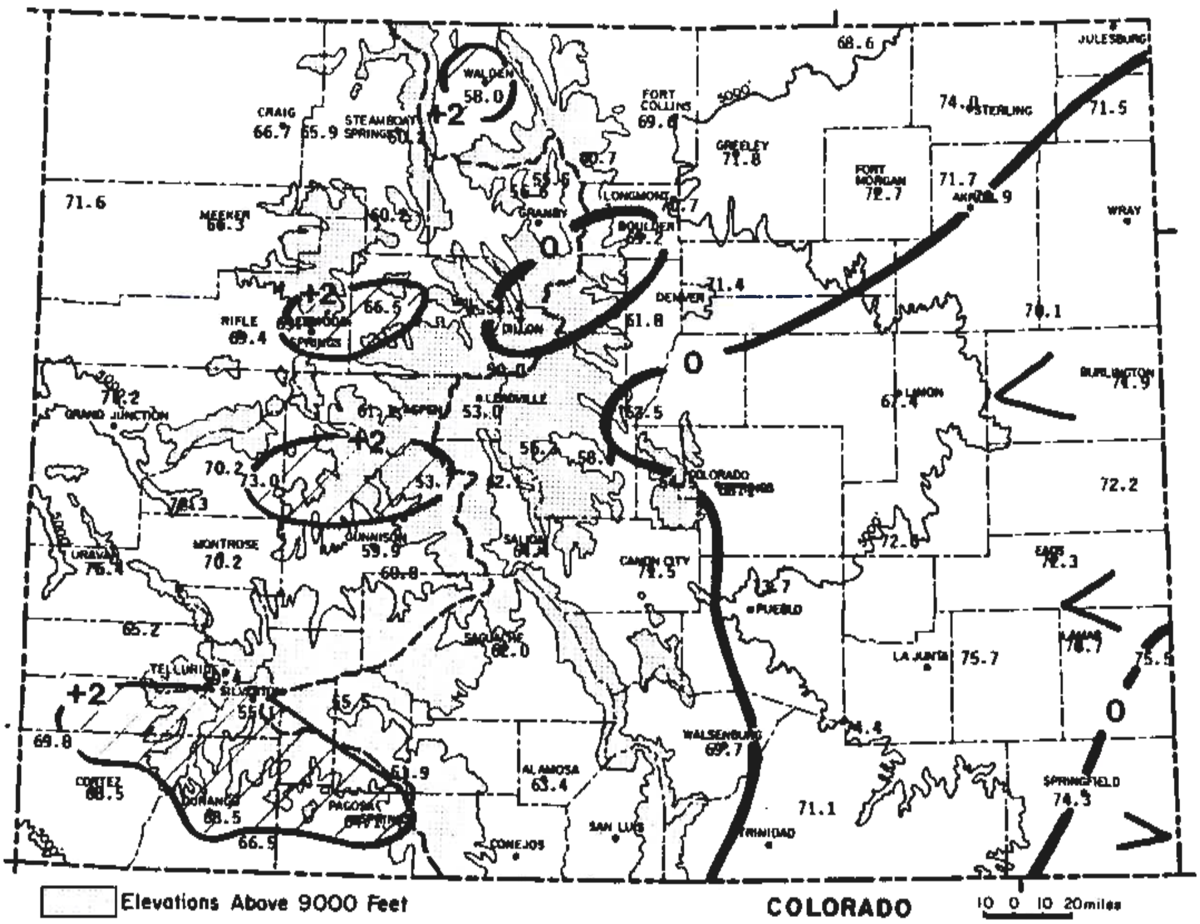


Precipitation for October 1990 through August 1991
as a percent of the 1961-1980 average.

AUGUST 1991 TEMPERATURES

AND DEGREE DAYS

Temperatures were cooler than average on many days early in August but rebounded with the help of several consecutive hot days later in the month. There were few complaints offered even during the hot spell as temperatures stayed below 100° statewide except on 1st and 24th. There also were no unusually cold nighttime temperatures except for the 21° reading at Climax on August 20 (which was likely an erroneous reading). Otherwise the coldest mountain temperatures during the month were in the 30s -- very typical. For the month as a whole, temperatures ended up near or slightly cooler than average over the eastern plains while most of western Colorado was a little warmer than average.



August 1991 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

AUGUST 1991 SOIL TEMPERATURES

Near-surface soil temperatures remained steady during August but fluctuated with the variations in air temperature. The deeper soil temperatures continued to rise as is expected at 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
AUGUST 1991

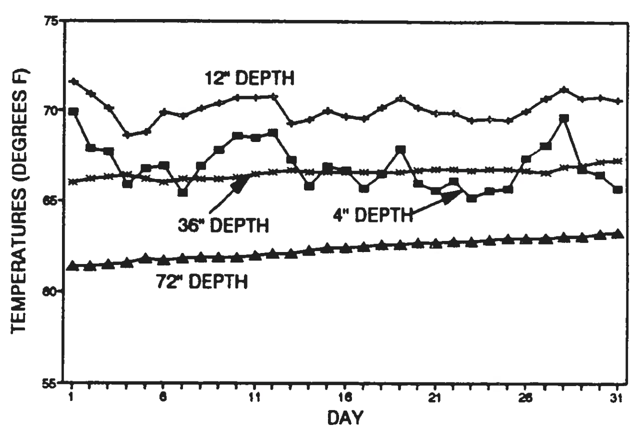


Table 1. Heating Degree Day Data through August 1991 (base temperature, 65°F).

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
	90-91	59	118	201	633	990	1597	1671	1081	954	742	410	172	8628
	91-92	33	51											84
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	90-91	134	146	234	652	964	1462	1444	1013	1077	811	432	224	8593
	91-92	104	112											216
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	90-91	32	13	81	338	589	1161	1081	667	685	511	211	44	5413
	91-92	17	7											24
BUENA VISTA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
	90-91	66	130	226	641	905	1326	1256	896	983	771	472	207	7879
	91-92	63	87											150
BURLING-TON	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
	90-91	10	4	76	407	M	1249	1223	688	737	438	136	1	M
	91-92	13	14											27
CANON CITY	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
	90-91	14	12	58	382	548	1098	1004	626	679	459	182	26	5088
	91-92	8	0											8
COLORADO SPRINGS	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
	90-91	28	21	83	473	663	1256	1142	750	773	568	219	33	6009
	91-92	16	16											32
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	90-91	1	6	151	539	774	1321	1364	879	882	702	335	113	7067
	91-92	13	8											21
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	90-91	14	18	116	606	876	1547	1544	1095	995	693	398	127	8029
	91-92	27	13											40
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	90-91	0	2	58	416	751	1400	1549	998	742	512	170	26	6624
	91-92	0	2											2
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	90-91	12	3	64	388	623	1209	1143	684	682	510	174	16	5508
	91-92	6	4											10
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	90-91	284	355	430	858	1071	1587	1569	1220	1257	1031	691	425	10778
	91-92	316	321											637
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	90-91	4	28	118	481	832	1373	1274	842	919	619	364	125	6979
	91-92	6	2											8
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	90-91	15	23	134	583	934	1568	1536	1052	889	693	355	99	7881
	91-92	26	6											32
EVER-GREEN	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
	90-91	120	131	219	591	803	1330	1244	937	885	727	430	152	7569
	91-92	83	92											175
FORT COLLINS	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
	90-91	19	6	74	460	690	1284	1212	747	703	508	203	41	5947
	91-92	11	1											12
FORT MORGAN	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
	90-91	18	7	63	421	730	1343	1248	750	722	489	180	8	5979
	91-92	5	4											9
GRAND JUNCTION	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
	90-91	0	0	28	360	759	1370	1464	919	706	478	136	18	6238
	91-92	0	2											2

* = 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 6SSW	AVE	214	264	468	775	1128	1473	1593	1369	1318	951	654	384	10591
	90-91	264	268	350	774	1071	1605	1668	1148	1233	979	615	330	10305
	91-92	220	255											475
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	90-91	14	2	62	450	723	1309	1246	741	692	492	159	11	5901
	91-92	8	5											13
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	90-91	65	179	264	771	1059	1664	1787	M	M	M	M	249	M
	91-92	131	151											282
LAS ANIMAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
	90-91	4	0	21	308	624	1220	1113	667	602	352	81	0	4992
	91-92	1	3											4
LEAD-VILLE	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
	90-91	331	402	464	861	1141	1556	1550	1207	1210	1068	714	449	10953
	91-92	343	364											707
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	90-91	36	11	96	491	745	1280	1237	779	820	592	245	38	6370
	91-92	19	14											33
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	90-91	24	11	101	481	727	1284	1249	740	699	520	186	28	6050
	91-92	12	6											18
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	90-91	9	23	121	511	885	1406	1458	1047	939	696	358	110	7563
	91-92	24	7											31
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	90-91	0	3	81	470	804	1385	1460	974	768	571	268	49	6833
	91-92	0	0											0
PAGOSA SPRINGS	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
	90-91	44	108	177	608	910	1538	1432	1038	1002	767	489	227	8340
	91-92	44	37											81
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	90-91	1	0	34	360	610	1243	1116	730	667	406	103	3	5273
	91-92	1	0											1
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	90-91	0	4	69	474	824	1433	1462	964	814	605	265	52	6966
	91-92	1	1											2
STEAMBOAT SPRINGS	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
	90-91	129 E	110	255	700	1013	1683	1613	1223	1120	851	518	262	9477
	91-92	127	141											268
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	90-91	17	7	68	437	725	1359	1244	713	716	466	173	8	5933
	91-92	5	1											6
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	89-90	117	179	267	635	972	1384	1351	987	1093	828	486	293	8592
	91-92	175	163											338
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	90-91	4	6	46	334	654	1160	1048	697	709	462	156	12	5288
	91-92	3	2											5
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	90-91	202	258	332	794	1028	1550	1459	1105	1164	931	587	300	9710
	91-92	193	209											402
WALSEN-BURG	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
	90-91	15	8	53	311	543	1047	985	646	674	437	141	23	4883
	91-92	6	5											11

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

AUGUST 1991 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	83.7	53.6	68.6	0.0	94	47	19	142	561	1.31	-0.15	89.7	11
STERLING	89.3	58.8	74.0	2.5	100	54	1	290	672	2.02	0.19	110.4	7
FORT MORGAN	87.9	57.5	72.7	0.8	99	53	4	250	646	1.64	0.14	109.3	7
AKRON FAA AP	84.8	58.6	71.7	0.6	97	53	9	223	642	0.99	-0.79	55.6	5
AKRON 4E	86.8	54.9	70.9	-0.7	97	48	12	201	597	1.01	-0.76	57.1	7
HOLYOKE	83.9	59.0	71.5	-0.9	95	53	9	218	643	0.33	-1.60	17.1	5
JOES	83.6	56.6	70.1	-2.4	93	51	13	180	602	2.11	-0.09	95.9	8
BURLINGTON	85.4	58.3	71.9	-0.8	96	55	14	232	638	1.77	-0.42	80.8	8
LIMON WSMO	80.0	54.8	67.4	-1.1	91	51	14	98	546	6.02	3.57	245.7	11
CHEYENNE WELLS	86.2	58.3	72.2	-0.5	100	52	3	235	653	3.78	1.86	196.9	6
EADS	85.1	59.6	72.3	-1.7	97	56	8	244	661	4.22	2.49	243.9	6
ORDWAY 21N	88.6	56.6	72.6	-0.2	101	53	3	247	638	3.70	1.60	176.2	11
LAMAR	90.2	57.2	73.7	-2.2	102	53	2	279	653	6.39	4.45	329.4	7
LAS ANIMAS	90.8	60.6	75.7	-0.3	103	54	3	346	711	2.04	0.61	142.7	7
HOLLY	89.2	61.7	75.5	0.3	106	55	0	330	719	3.90	2.03	208.6	8
SPRINGFIELD 7WSW	89.5	59.1	74.3	1.5	98	54	0	299	688	1.95	0.27	116.1	8
TIMPAS 13SW	89.4	59.4	74.4	0.6	99	55	2	303	693	3.06	1.43	187.7	7

Foothills/Adjacent Plains

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
FORT COLLINS	83.2	56.1	69.6	0.9	92	51	1	153	601	2.21	0.84	161.3	13
GREELEY UNC	86.3	57.3	71.8	0.9	96	54	5	224	640	0.85	-0.30	73.9	9
ESTES PARK	75.3	46.0	60.7	0.5	81	38	135	6	412	2.49	0.43	120.9	20
LONGMONT 2ESE	86.3	55.1	70.7	1.0	95	51	6	190	606	3.02	1.85	258.1	8
BOULDER	82.4	56.0	69.2	-1.8	91	51	7	144	589	2.08	0.82	165.1	15
DENVER WSFO AP	85.0	57.9	71.4	0.4	94	53	4	211	642	3.69	2.16	241.2	11
EVERGREEN	78.1	45.5	61.8	0.3	89	42	92	2	443	2.68	0.68	134.0	13
CHEESMAN	80.4	44.6	62.5	-0.8	89	40	82	10	474	3.90	1.52	163.9	15
LAKE GEORGE 8SW	72.9	44.8	58.9	0.1	79	39	184	0	365	4.96	2.77	226.5	19
ANTERO RESERVOIR	72.7	39.8	56.3	0.8	80	34	265	0	359	2.56	0.48	123.1	14
RUXTON PARK	70.8	38.2	54.5	0.2	79	34	315	0	330	6.33	2.75	176.8	21
COLORADO SPRINGS	81.1	55.1	68.1	-0.5	91	50	16	120	558	4.57	1.76	162.6	14
CANON CITY 2SE	85.1	57.9	71.5	0.4	91	49	0	206	646	3.25	1.54	190.1	13
PUEBLO WSO AP	89.5	57.8	73.7	-0.5	101	53	0	276	667	2.14	0.34	118.9	10
WALSENBURG	83.3	56.1	69.7	0.3	91	49	5	158	607	4.26	2.23	209.9	14
TRINIDAD FAA AP	86.0	56.2	71.1	-0.4	93	51	2	199	630	2.12	0.27	114.6	12

Mountains/Interior Valleys

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
WALDEN	77.0	38.9	58.0	2.1	86	33	209	0	428	0.54	-0.66	45.0	11
LEADVILLE 2SW	69.3	36.7	53.0	0.5	75	31	364	0	309	1.47	-0.53	73.5	17
SALIDA	82.5	46.2	64.4	0.4	88	39	39	24	511	1.01	-0.51	66.4	9
BUENA VISTA	78.6	45.6	62.1	0.0	84	39	87	4	453	1.39	-0.59	70.2	12
SAGUACHE	77.2	46.8	62.0	0.7	83	41	87	1	428	1.25	-0.29	81.2	7
HERMIT 7ESE	73.0	38.0	55.5	1.7	78	33	288	0	366	2.25	0.13	106.1	8
ALAMOSA WSO AP	80.9	45.8	63.4	1.1	86	38	51	8	493	0.88	-0.36	71.0	6
STEAMBOAT SPRINGS	78.8	41.6	60.2	0.6	85	36	141	0	454	2.38	0.88	158.7	15
YAMPA	74.5	45.9	60.2	0.9	80	41	143	3	394	1.11	-0.65	63.1	12
GRAND LAKE 1NW	73.3	37.7	55.5	1.5	80	34	288	0	366	2.12	0.03	101.4	20
GRAND LAKE 6SSW	72.1	41.0	56.6	0.4	79	36	255	0	351	2.03	0.44	127.7	20
DILLON 1E	70.6	38.2	54.4	-0.3	77	34	321	0	327	1.52	-0.12	92.7	14
CLIMAX	62.4	37.6	50.0	0.7	66	21 (?)	456	0	198	3.06	0.75	132.5	17
ASPEN 1SW	76.6	45.6	61.1	1.6	82	42	112	0	420	1.60	-0.30	84.2	13
TAYLOR PARK	68.4	39.0	53.7	2.3	73	34	343	0	291	1.40	-0.45	75.7	7
TELLURIDE	77.5	41.4	59.4	1.5	85	34	163	0	434	3.35	0.65	124.1	18
PAGOSA SPRINGS	82.4	45.8	64.1	2.2	89	40	37	17	508	2.86	0.37	114.9	12
SILVERTON	71.1	39.2	55.1	2.6	78	33	299	0	334	3.50	0.52	117.4	20
WOLF CREEK PASS 1	65.3	38.6	51.9	0.7	77	34	398	0	243	4.68	0.76	119.4	23

Western Valleys

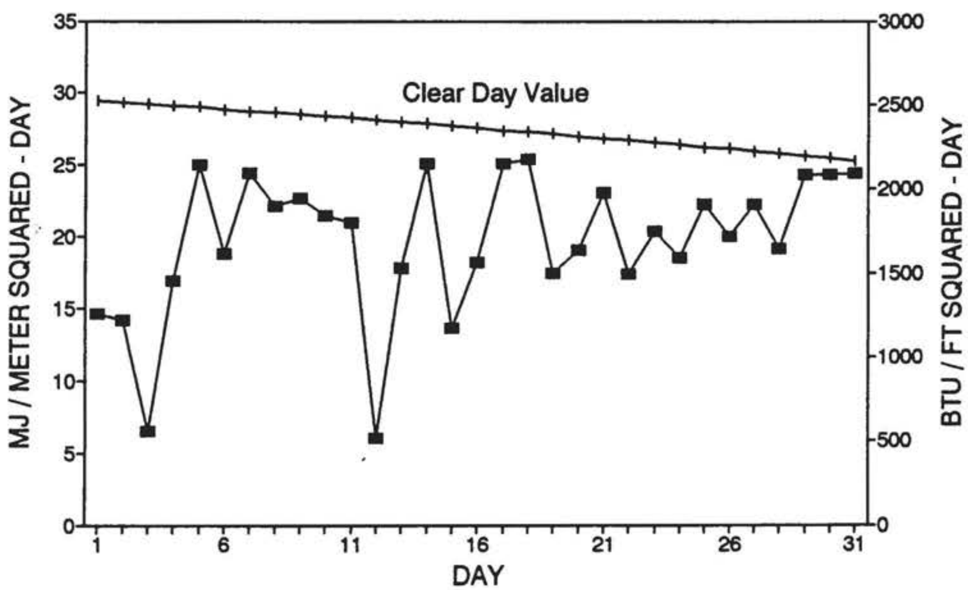
Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	82.8	50.5	66.7	1.8	90	45	13	73	533	1.03	-0.57	64.4	7
HAYDEN	82.7	49.1	65.9	1.7	90	41	12	49	519	2.01	0.52	134.9	10
MEEKER NO. 2	83.2	49.4	66.3	1.5	87	44	7	54	535	1.57	0.41	135.3	8
RANGELY 1E	87.7	55.5	71.6	1.6	94	49	3	211	609	1.68	0.87	207.4	9
EAGLE FAA AP	84.6	48.4	66.5	2.7	91	42	6	61	541	1.50	0.62	170.5	8
GLENWOOD SPRINGS	87.0	51.9	69.4	2.1	94	45	8	155	580	1.21	-0.12	91.0	8
RIFLE	88.3	50.5	69.4	1.4	95	43	1	145	569	0.99	-0.05	95.2	8
GRAND JUNCTION WS	89.5	62.8	76.2	0.2	97	55	2	356	749	0.57	-0.19	75.0	7
CEDAREDGE	88.3	52.1	70.2	0.8	95	42	4	172	589	0.56	-0.51	52.3	4
PAONIA 1SW	89.2	56.7	73.0	3.1	95	52	1	254	659	0.81	-0.41	66.4	8
DELTA	88.8	55.8	72.3	1.3	95	50	2	234	640	0.32	-0.54	37.2	6
GUNNISON	79.2	40.6	59.9	1.5	84	35	151	0	458	2.13	0.69	147.9	13
COCHETOPA CREEK	79.8	41.8	60.8	1.8	85	35	121	1	471	1.67	-0.17	90.8	13
MONTROSE NO. 2	85.0	55.3	70.2	0.6	90	48	0	168	625	1.14	0.10	109.6	7
URAVAN	93.1	59.6	76.4	1.8	101	52	2	362	709	1.21	0.02	101.7	10
NORWOOD	80.7	49.7	65.2	1.2	87	45	26	39	498	2.04	0.41	125.2	10
YELLOW JACKET 2W	85.7	53.8	69.8	2.0	92	47	0	156	602	1.91	0.21	112.4	11
CORTEZ	85.5	51.5	68.5	1.1	91	42	8	126	582	1.54	0.19	114.1	6
DURANGO	84.3	52.7	68.5	2.4	91	49	2	119	570	1.59	-0.72	68.8	15
IGNACIO 1N	82.7	50.4	66.5	0.8	89	44	6	60	535	1.64	-0.06	96.5	11

* 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 1991 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	11	13	7	--	--
Denver	10	12	9	64%	73%
Fort Collins	8	14	9	--	--
Grand Junction	10	14	7	79%	76%
Limon	15	8	8	--	--
Pueblo	18	6	7	75%	78%

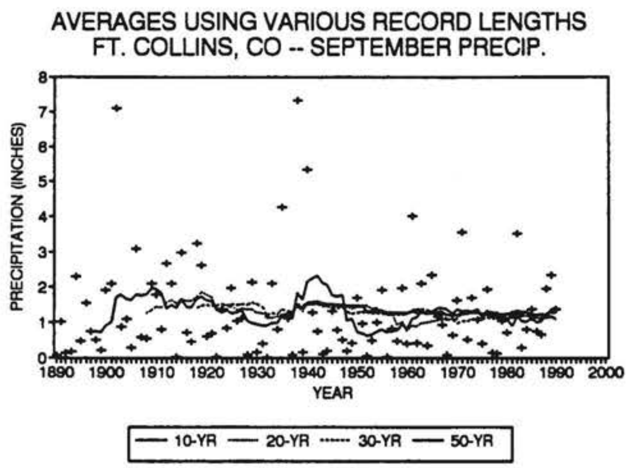
FT. COLLINS TOTAL HEMISPHERIC RADIATION
AUGUST 1991

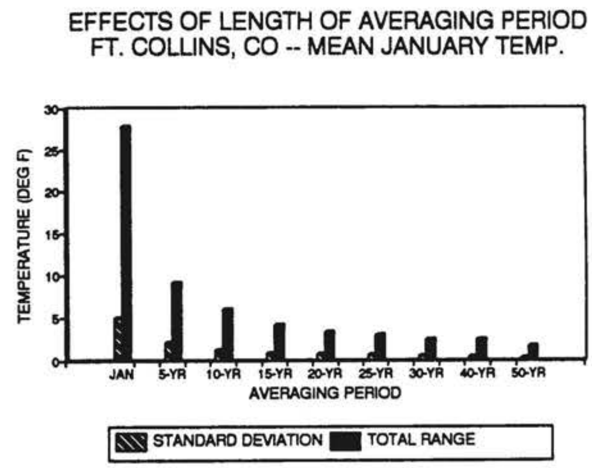


New Climatic Averages -- or, What is the Best Average?

We plan to switch this year from using 20-year averages, as we have done throughout the 15-year history of "Colorado Climate," to a 30-year average. The main purpose for changing is to become consistent with the National Climatic Data Center. They compute "climatic normals" for the country which are simply the averages of the data over the past 3 complete decades. Their new 1961-1990 "normals" will be published next year. But is a 30-year average really better than any other average? Do we have enough stations with consistent 30-year records from which averages can truly be computed? The questions never stop.

"When in doubt, try it out," a science teacher once told me -- so we looked at how the choice of the length of averaging period really does influence the computed average. We examined several parts of Colorado, but I will only present results for our local Fort Collins weather station. The following graphs (which as always are too small due to our space limitations) show aspects of how climatic averages change with time based on the number of years used to compute them. The first figure shows September precipitation for the past 100 years. September is known for great year-to-year variations in rainfall. The four lines on the graph show averages computed based on the previous 10, 20, 30 and 50 years, respectively. As you might expect, the longer the period over which we average, the less variation there is in computed average values. The 10-year averages have shown large variations ranging from 2.32" (1933-42) to a low of 0.62" (1943-52). Even 50-year averages show significant changes -- a peak of 1.53" (1894-1943) and a low of 1.09" during the most recent 50 years, 1941-1990. The average for the entire 1889-1990 period is 1.28".





The second graph shows similar information about temperature but presented in a different way. We chose January temperatures since winter is the season of greatest variability. Individual Januarys have seen mean monthly temperatures as low as 9.0°F in 1930 and as high as 36.9° in 1953 (a range of 27.9°). The standard deviation of January monthly temperature is about 5° over the past 100 years. Ranges and standard deviations drop off quickly with increasing length of the averaging period. The 15-year averages have a standard deviation of only 0.9° with values that have stayed within a total range of 4°F. By 30 years, the standard deviation drops to 0.6° with a maximum observed range of 2.5°F. For summer temperatures (not shown), it only takes 5-10 years to obtain comparably stable climatic averages.

What are we learning from this exercise? First of all, it is obvious that our climate is always in transition. No two years or periods of years are ever just alike. There is no absolute average or "climatic normal," although certain climate elements and certain times of year are more consistent than others. Precipitation variations are always great. As a result, averages can vary considerably from one period of years to another even when you average over several decades. Temperature is more stable. Fewer years of data are required to give a reasonable estimate of expected temperatures, especially during the summer.

Why don't we just use the entire period of record of data for each station and be done with it -- 100+ years for our best long-term stations and perhaps only 5-10 years for some of the newer weather stations. For some purposes, that's ok, but when we are monitoring comparative climate we must make sure we are comparing apples to apples. The selection of averaging periods, in the end, is arbitrary. Thirty years is more than adequate for temperatures. Longer averages would be nice for precipitation. But it is a reasonable compromise, and we will go along with it. Stay tuned in the months ahead for information on how the new averages differ from our previous values.

Saving Energy By Keeping Score

Glancing at the calendar we see that fall is rapidly approaching. As the days shorten and the nights become colder, many of us will be turning on our furnaces and bringing the space heaters down from the attic. Although it is nice to see the snow once again, it is not so nice when the utility bill arrives at the end of the month. Many people try to "weather-proof" their homes by installing storm windows, sealing leaks where cold air enters and adding insulation to areas that need it. While this undoubtedly increases the energy efficiency of a house, it is often unknown just how much energy is actually saved. Also, since no two winters are the same, it is difficult to estimate how the weather affects these conservation measures. Utility companies which offer retrofit assistance programs usually do not keep track of records which could relate to their customers how much energy - and money - their conservation efforts are saving.

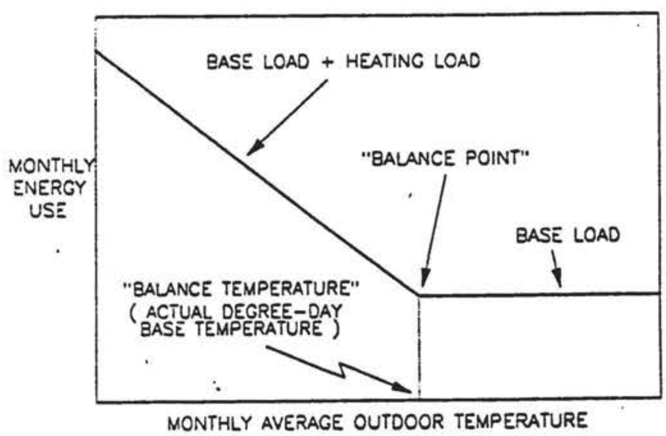
Unfortunately, these problems can discourage homeowners who spend money weather-proofing then end up with higher utility bills because the temperatures are lower than the previous season. It be nice if there was a way for a homeowner to account for the weather in his/her energy use, hence "keeping score" becomes a viable and accurate way of communicating the effectiveness of an energy conservation measure.

The PRInceton Scorekeeping Method (or PRISM) is a statistical procedure which uses records of utility bills and weather data to produce accurate estimates of weather-adjusted energy consumption. The data required for this method is easily obtained - PRISM uses monthly utility bills and average daily temperatures from a nearby weather station to determine a weather adjusted index of consumption. This relates the level of energy used to the severity of the weather at the time. Once the house has been weatherized, energy savings are found by taking the difference between figures in the pre and post-retrofit periods. This way, conservation effects are not distorted by an unusually cold or warm winter.

How does it Work?

PRISM is based upon three physical parameters which relate to the billing data for the heating fuel (natural gas, fuel oil, electricity) of an individual house. What is unique about PRISM is that the first parameter, being the house's breakeven temperature, is treated as a variable rather than a constant such as 65°F. This parameter can be thought of as the base temperature for measuring degree-days. Next is the house's base-level consumption or the amount of fuel used to run appliances in the home. This parameter is basically independent of the outside temperature. Finally, for each additional degree drop below the reference temperature, a constant amount of heating fuel is required. These parameters can provide indications of the sources of conservation: insulating, turning down thermostats, more efficient appliance usage, etc., and thus define an "energy signature" of a house.

Relationship Between the Three PRISM Parameters



If a home's reference temperature is not accurately determined, or if it changes over the time period studied, the error or change will inversely affect the other parameters as well. Therefore, an assumed (incorrect) reference temperature, such as the value of 65°F so commonly used, is likely to lead to less physically meaningful values of the base level and the heat-loss rate. It is better to calculate this parameter, usually between 60° to 75°F, depending on the ability of the house to keep heat inside. A well insulated house will have a lower balance temperature, and vice versa. This makes sense: the outdoor temperature must drop farther before the well-insulated house begins to "feel" the effect. Just as no two homes are exactly alike, the same goes for the energy demands and heat loss rates between households.

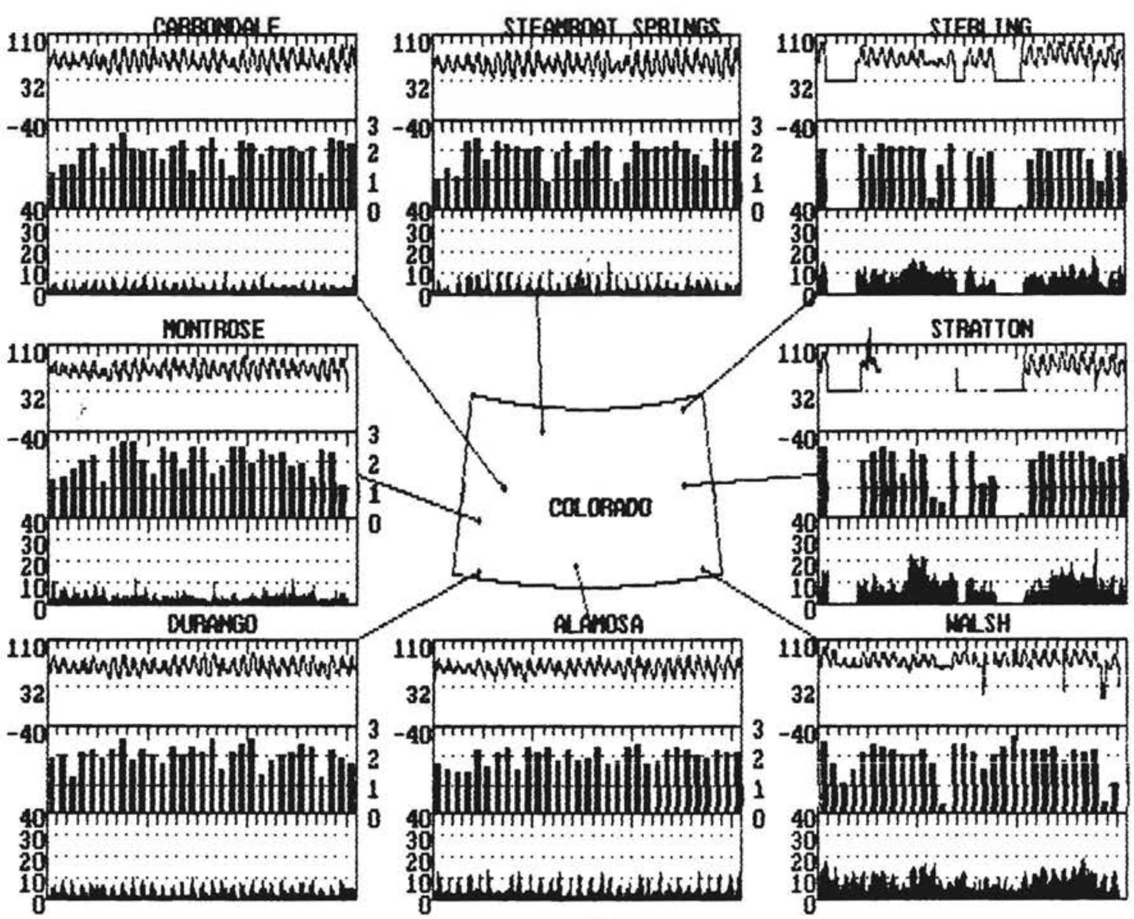
This report prepared by Mike O Shea and Peter Curtiss of the Joint Center for Energy Management, a collaboration between Colorado State University and the University of Colorado at Boulder.

WTHRNET WEATHER DATA AUGUST 1991

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton	Walsh
monthly average temperature (°F)								
	61.5	63.2	64.1	65.3	60.1			71.5
monthly temperature extremes and time of occurence (°F day/hour)								
maximum:	82.2 25/16	86.0 21/15	90.0 31/15	88.7 21/17	88.9 31/16	96.4 25/14		95.5 1/14
minimum:	39.2 29/ 6	42.1 8/ 6	42.3 8/ 6		34.3 30/ 6			
monthly average relative humidity / dewpoint (percent / °F)								
5 AM	93 / 45	86 / 46	95 / 47	79 / 45	92 / 41	/	/	63 / 44
11 AM	46 / 48	37 / 46	46 / 52	38 / 47	40 / 45	/	/	38 / 45
2 PM	31 / 40	31 / 40	37 / 48	30 / 41	30 / 38	/	/	35 / 50
5 PM	36 / 39	35 / 40	39 / 48	33 / 41	30 / 37	/	/	36 / 49
11 PM	67 / 45	71 / 47	70 / 49	59 / 45	83 / 47	/	/	69 / 56
monthly average wind direction (degrees clockwise from north)								
day	174	194	188	151	214	119	115	141
night	175	101	165	233	100	151	161	193
monthly average wind speed (miles per hour)								
	3.97	3.09	1.87	2.58	2.14	5.34	6.68	7.56
wind speed distribution (hours per month for hourly average mph range)								
0 to 3	343	429	606	477	524	243	193	81
3 to 12	390	315	134	267	203	462	445	545
12 to 24	11	0	0	0	1	39	105	118
> 24	0	0	0	0	0	0	1	0
monthly average daily total insolation (Btu/ft²·day)								
	1958	2006	1908	1957	1905			1877
"clearness" distribution (hours per month in specified clearness index range)								
60-80%	236	135	174	159	175	165	204	218
40-60%	64	86	82	48	67	74	51	59
20-40%	74	63	55	63	83	33	30	37
0-20%	32	46	46	35	39	47	34	44

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. Nebraska has still not fully repaired the Sterling and Stratton stations so out of limit data must be disregarded. Also, the Walsh station had communication errors this month which resulted in the loss of some data.



COLORADO CLIMATE

SEPTEMBER 1991

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 14 Number 12

<u>September in Review:</u>

The first half of September felt like summer. Temperatures were warm, thunderstorms developed frequently, and locally heavy rains were reported. But a strong mid-month cold front brought sudden changes. From then on it seemed like autumn -- the air was dry, nights were chilly, and the weather east of the mountains became more changeable. For the month as a whole, temperatures ended up warmer than average in western Colorado and near average in the east. Precipitation was above average over the western quarter of the State and the extreme northeastern and southeastern corners. Most of the rest of Colorado had a dry September.

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

November is a messy month to describe. Usually it snows a little. Sometimes it snows a lot. Some people hope for snow -- especially skiers and farmers. Others dread the snow. Often November is cloudy, dreary and cold. But just as often we enjoy many bright, sunny and delightfully mild days. I wish I could tell you exactly what will happen this year. Unfortunately, I cannot. But I can describe some of the important factors that help make our climate.

The most important factor is daylength and solar radiation. It is in short supply in November, as I am sure you all realize. In a typical November, we receive only about 37% of the solar energy that we get in mid summer. Since we don't have a warm ocean nearby, this simply means colder temperatures. It also means stronger winds in the atmosphere above Colorado blowing predominantly from the west and northwest as the mid-latitude jet stream strengthens in direct response to the large differences in temperature between the subtropics and the high latitudes. Stronger winds aloft mean that weather systems move more rapidly. It also means that the mountains have an increasing effect on the weather as the air from the west is forced to rise over the barrier and then descends on the eastern side. The solar energy is predictable, but the position, strength and changes in the jet stream are much more variable. It is these changes that determine whether it will be sunny or snowy, calm or gusty.

Put this information in a pot, stir it up good and what we end up with is a month in which we will likely have several storms cross the State, more clouds than in October, and changeable temperatures. With increased airflow from the west, the mountains and Western Slope become cloudier and wetter (whiter) while eastern Colorado becomes windier and drier. Precipitation is most likely to fall as snow statewide with only 3 precipitation days in the San Luis Valley, 3-5 days east of the mountains, 5-7 days on the Western Slope and in the eastern foothills, while 7-15 days may bring snow to the mountains. Almost always the northern mountains experience more snowy days than the southern mountains. November precipitation averages about 0.50" (2-8" snow) over the eastern plains, 0.60-1.00" (6-14" snow) along the Front Range, and about 0.75" (3-8" snow) on the Western Slope. In the mountains, 1-4" of moisture (15-60" of snow) is likely. Temperatures will have their ups and downs, especially east of the mountains. But overall, they will drop. Some 60s and 70s at lower elevations should still be expected, but these mild days become rare later in the month.

<u>1991 Water Year Wrap-Up:</u>

Persistent drier than average conditions along parts of the Front Range throughout the fall, winter and early spring combined with a shortage of mountain snowfall during the midwinter months to keep water experts in Colorado nervous during the 1991 precipitation and water supplies. Fortunately, well-timed spring and summer precipitation made up for most of the previous shortages. Annual streamflow on several of Colorado's major rivers still ended up less than average, but was offset by a reduced demand for surface water resulting from plentiful summer rains.

(Continued on pages 135)

SEPTEMBER 1991 DAILY WEATHER

Date	Event
1-4	September began with sunshine and warmth. Sterling hit 97°F on the 2nd. Some afternoon thunderstorms developed over the mountains 1-2nd. A cold front then dropped down from the north on the 3rd accompanied by brisk northerly winds and rising pressure. Some thundershowers formed in the mountains, but the heaviest storms occurred in southeastern Colorado. Pueblo reported 0.97" of rain and hail on the 3rd and the Kim 15 NNE weather station measured 1.43". A few storms erupted again on the 4th and became severe over portions of northeast Colorado. Hail, hard rains and damaging winds lashed the Fleming area.
5-13	A slow-moving trough of low pressure in the atmosphere developed over the western U.S. bringing moist SW winds aloft into Colorado. Temperatures continued summerlike over most of the State (Las Animas hit 98° on the 8th, the hottest in Colorado) but cooled to below average in western Colorado as the storm got closer. Nighttime temperatures were especially mild for September. Humidities remained high, and storms developed daily. Most of the State received some rain during the period, but rains were heaviest over western and southern Colorado -- particularly 5-7th and 10-13th. Pagosa Springs registered 1.32" on the 6th. Wolf Creek Pass reported 1" rains on three separate days. Grand Junction picked up .77" on the 7th, nearly 10% of their expected annual precipitation, and then got an additional 1.16" 11-13th. Durango totalled nearly 3" of rain 5-7th and 4.74" for the entire 9-day period. Rainfall was more scattered east of the mountains. Drizzle and fog were noted on the plains on the 10th when upslope winds developed behind a cold front. Several strong storms also occurred. The Trinidad area received more than 1" of rain late on the 9th, and the Brandon weather station got 1.56". New Raymer, Julesburg and Yuma all reported at least 1" of rain on their daily report for the 12th, and several areas reported hail. Holyoke got 1.50" of rain and small hail on the 13th. Drier air moved in on the 13th ending this damp episode.
14-16	A powerful early-autumn cold front rushed across Colorado on the 14th. Ahead of the front, temperatures climbed into the 80s over eastern Colorado. Then clouds and winds increased as the cold front swept through. Winds gusted to over 50 mph in the Fort Collins area. The first snow of the season fell in the northern and central mountains. Breckenridge and Rand each measured 3" of fresh snow. It was sunny and fallish on the 15th over northern and western Colorado, but clouds and rain lingered over parts of southeast Colorado. Skies then cleared statewide and temperatures dropped to their lowest levels in months early on the 16th. Killing freezes occurred in several western valleys while light frost was noted in parts of northeast Colorado.
17-24	Mild days, cool nights, brilliant sunshine, and low humidities were the rule over western Colorado. A little rain fell in southern Colorado on the 20th as moisture briefly intruded from the south and then retreated again. At the same time, a series of cold fronts on the 17th, 21st and 23rd brought changeable weather and threats of frost to the eastern half of the State. Upslope clouds with local drizzle and light rain were reported along the Front Range 17-18th. Very chilly temperatures with local frost were observed on the 18th and 19th across the plains. Limon only reached a high of 51°F on the 18th. Temperatures rebounded into the 80s 20-21st but dropped again late on the 21st.
24-30	A high pressure ridge dominated the western United States 25-30th, but one storm system managed to cut through late in the month. Skies over Colorado were cloudless 25-26th. High clouds increased on the 27th, and by the 28th a few showers fell in the mountains. Day-night temperatures differences were very large, but daily highs remained warm -- 80s at lower elevations with 60s and 70s in the mountains. Hohnholz Ranch reached 73° on the 26th after a morning low of 12°F, the coldest in the State so far this autumn. A cold front then advanced into Colorado on the 29th triggering scattered thunderstorms. Beneficial rains of 0.20-1.00" fell along the Front Range and over parts of the eastern plains late on the 29th ending on the 30th. The month ended on a cool note east of the mountains but mild and delightful in the mountains and western valleys.

September 1991 Extremes

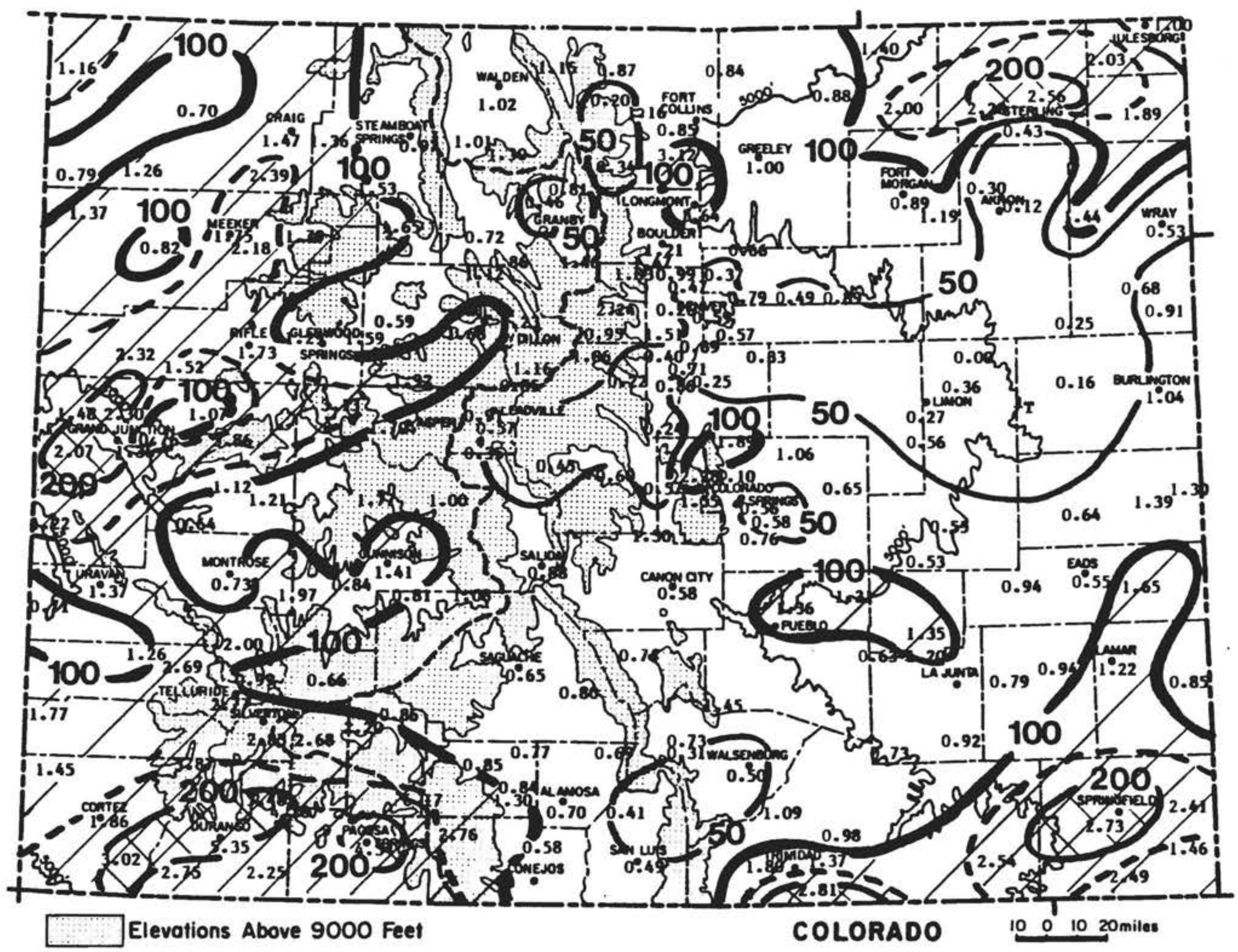
Highest Temperature	98°F	September 8	Las Animas
Lowest Temperature	12°F	September 26	Hohnholz Ranch
Greatest Total Precipitation	6.17"		Wolf Creek Pass 1E
Least Total Precipitation	0.00"		Shaw 2E
Greatest Total Snowfall	3.0"		Rand, Keystone 5E, Breckenridge
Greatest Depth of Snow on Ground	3"	September 14, 15	Rand, Keystone 5E, Breckenridge

SEPTEMBER 1991 PRECIPITATION

Warm and moist air was channeled into Colorado throughout the first two weeks of September. A number of heavy storms developed, and several locations had soaking rains. But these storms dropped little moisture on many parts of Colorado. Except for one storm system near the end of the month, the remainder of September was dry.

Total precipitation for the month was below average over the majority of Colorado. Out of 220 reporting stations, 43 received less than 50% of average and 97 received 50-99% of average. The driest areas were found over central and eastern Colorado. Bailey, for example, reported only 0.22" (14% of average) while Flagler received just a trace of rain. However, 80 stations received more September rainfall than average, and 13 locations at least doubled their average. The wettest areas were found over southwest, west central, extreme northeast and extreme southeast Colorado. Durango's 5.35" total was 309% of average, their second wettest September in the past century.

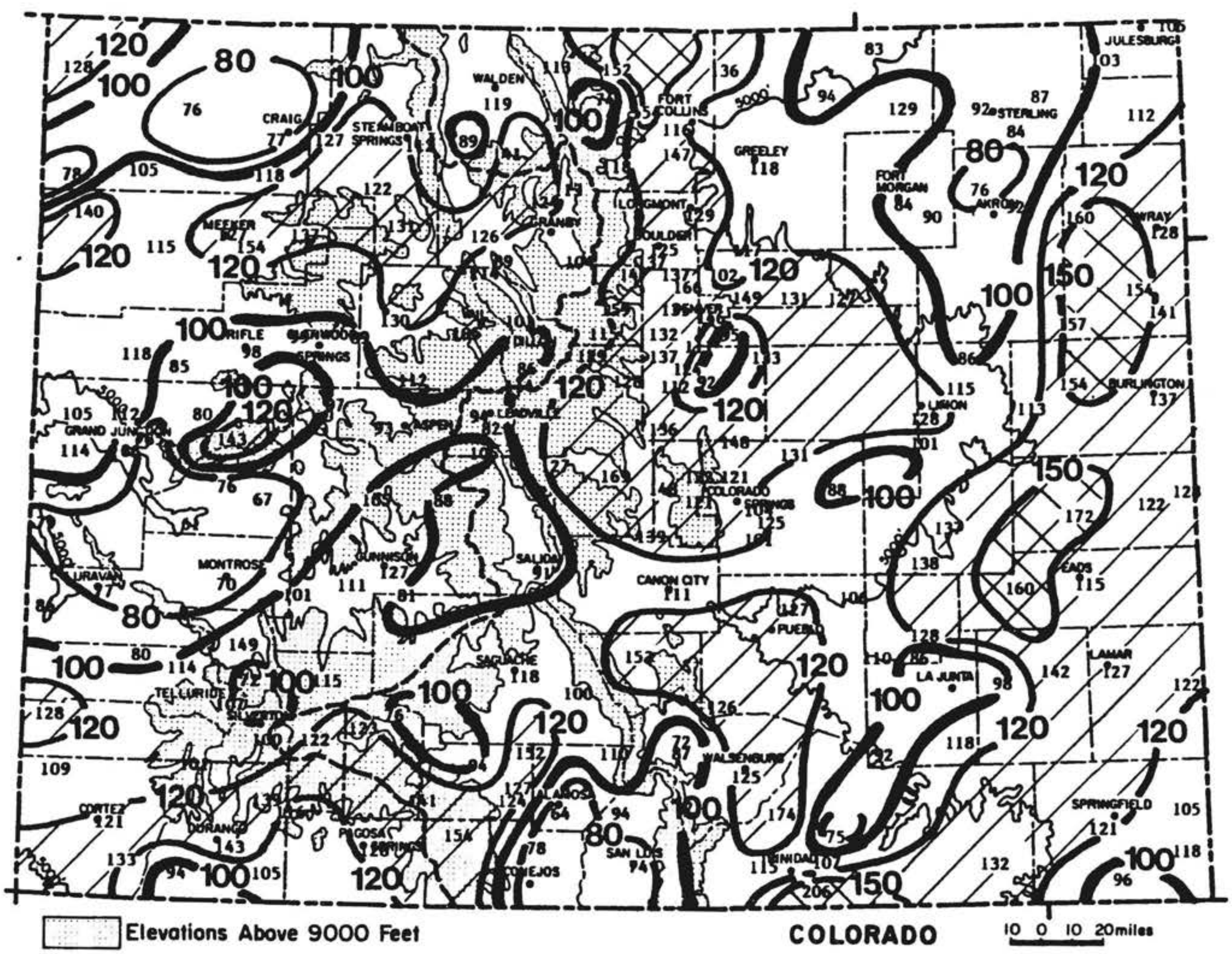
Greatest		Least	
Wolf Creek Pass 1E	6.17"	Shaw 2E	0.00"
Lemon Dam	5.48"	Flagler 2NW	Trace
Durango	5.35"	Akron 4E	0.12"
Vallecito Dam	4.78"	Stratton	0.16"
Pagosa Springs	4.34"	Hourglass Lake	0.20"



Precipitation amounts (inches) for September 1991 and contours of precipitation as a percent of the 1961-1980 average.

The 1991 water year got off to a very good start with the help of several storms in October and early November. The frequency of moisture-bearing storms diminished through the mid-winter period but delivered enough snow to the mountains to keep Colorado's winter recreation industry satisfied. February was very dry and warm statewide, once again stimulating drought concern. March put those fears to rest for the moment as one storm after another pounded the State. However, these storms managed to drop little moisture over the Front Range and some interior valleys. April appeared to be a good month for moisture. Precipitation fell very frequently. However, there were few large, widespread storms, and much of Colorado ended up drier than average. Fortunately, cool temperatures late in the month retarded mountain snowmelt. At the end of April, water-year precipitation totals were less than average over the northeastern plains, much of the Front Range and in extreme southwest Colorado. Average or above precipitation had accumulated over much of western and southeastern Colorado. Overall, winter precipitation was adequate for most areas while at the same time having less adverse effects on winter transportation, wildlife, and outdoor work than it often does. It was an especially easy winter for Front Range commuters and snowshovelers.

The summer growing season (May-September) began with persisting threats of heavy rain during May. For the most part, these storms fizzled, but some of the areas of the State that needed moisture the most got it. Starting on June 1 and continuing until mid September, summer thunderstorms came and stayed. As always, some areas got hit more than others, but overall it was a wet and stormy summer for Colorado. The only persisting hot, dry weather came in late June and early July. Several areas experienced record or near record rainfall during the summer, and local flooding occurred in a few areas. Rainfall was especially great in July and August. The Denver airport totalled 7.80" for those two months, their wettest July-August combined in 120 years of recorded history. Stratton's 13.68" July-August total was also a record, and several locations in east central Colorado exceeded 10".

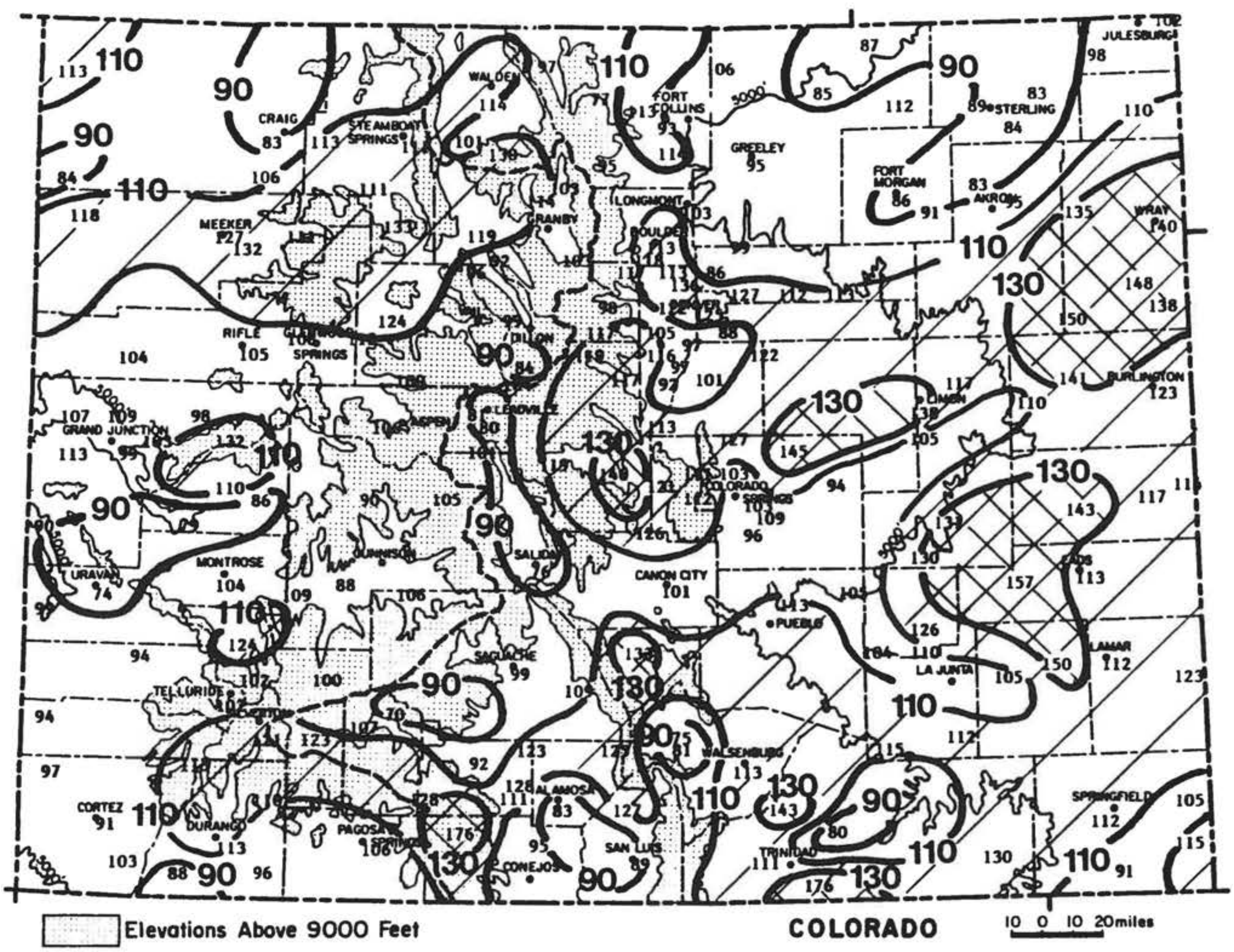


Precipitation for May through September 1991
as a percent of the 1961-1980 average.

May-September growing season precipitation was above average over most of Colorado. A few local dry pockets were scattered across the State. The Akron airport, for example, received 76% of their average and the Trinidad airport collected 75%. Much of Logan, Delta, and Montrose counties were dry, and Alamosa totalled just 3.13" for the summer, 64% of average. Other areas were much wetter. 43% of Colorado's weather stations received at least 20% more rainfall than average for the summer. The wettest areas, compared to average, were found in parts of the Denver metro area, along the Front Range foothills, and over much of the east central plains. Kit Carson accumulated 17.29" of rain for the growing season, 172% of average.

For the entire 1991 water year, statewide precipitation was 109% of average, resulting in an overall improvement in statewide moisture conditions. More than 2/3 of the reporting stations enjoyed above average moisture for the year. Wet areas were scattered throughout the State but covered some of the northern mountains, portions of the San Juan Mountains and much of eastern Colorado. Only 29 weather stations reported less than 90% of their average water-year precipitation. These dry areas were scattered throughout Colorado (see map below).

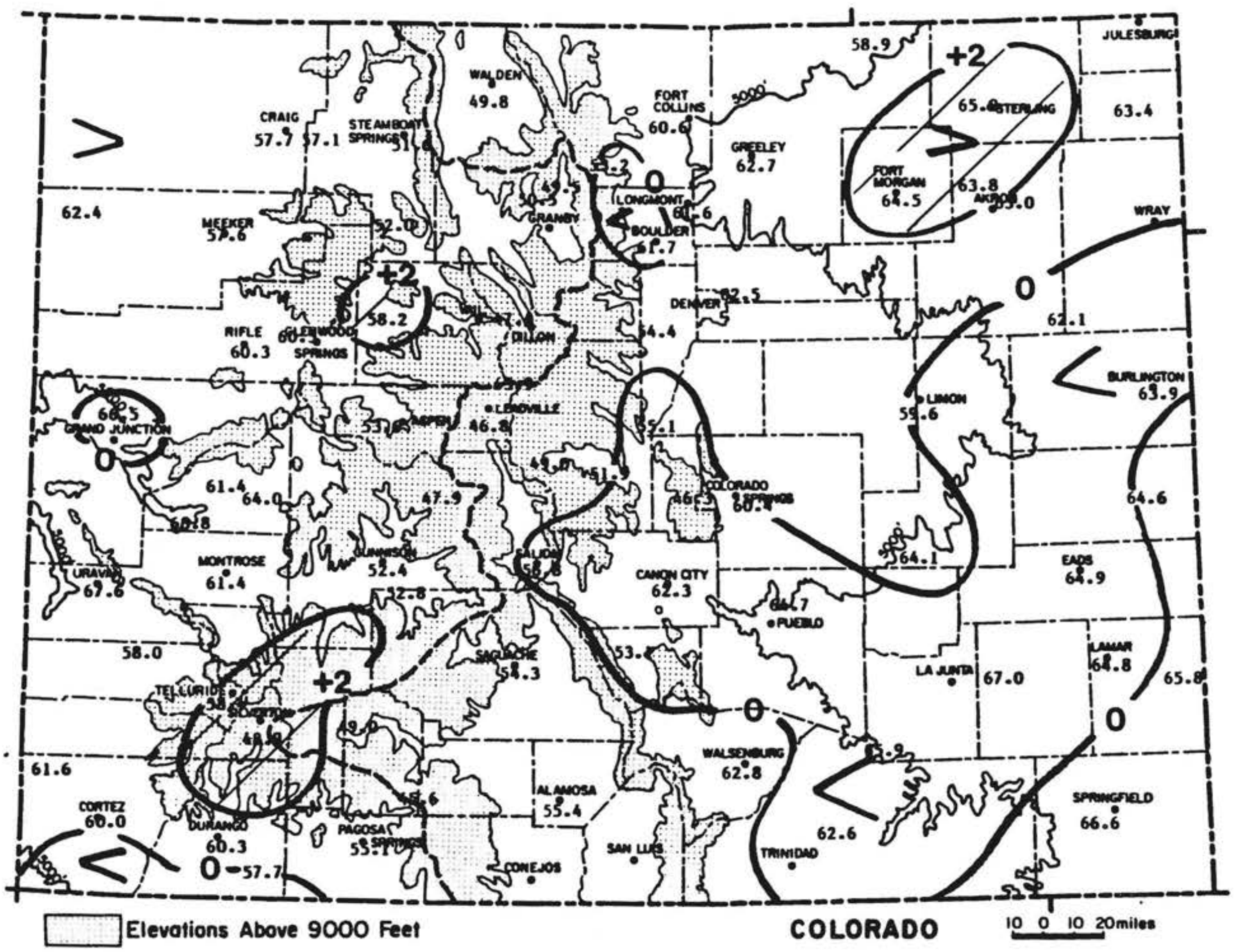
Temperatures for the year were fairly typical. The most significant features of 1991 water year temperatures were a severe coldwave in December, very little severe cold at other times during the winter, abnormal warmth in February and a handful of chilly midsummer episodes east of the mountains. Growing season temperatures were very close to average. For what it's worth, annual temperatures ended up close to average over western Colorado while areas east of the mountains were somewhat warmer than usual.



Precipitation for October 1990 through September 1991
as a percent of the 1961-1980 average.

SEPTEMBER 1991 TEMPERATURES AND DEGREE DAYS

Temperatures stayed within the normal range for September, and no daily records were set at stations with long histories. The first frost came a little earlier than usual to parts of western and northeastern Colorado, but there was no widespread premature freeze. Large day-night temperature differences of 50 degrees or more were observed, but this is expected at this time of year. For the month as a whole, temperatures ended up just a bit cooler than average over southeastern and east central Colorado. The remainder of Colorado including the mountains and Western Slope were a degree or two warmer than average.



September 1991 temperatures (degrees Fahrenheit) and contours of departures from 1961-1980 averages.

SEPTEMBER 1991 SOIL TEMPERATURES

Soil temperatures remained warm early in the month but then decreased quickly in response to cooler air temperatures and reduced solar radiation. By the end of the month, temperatures were nearly uniform with depth -- a condition that typically occurs during the spring and autumn each 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.

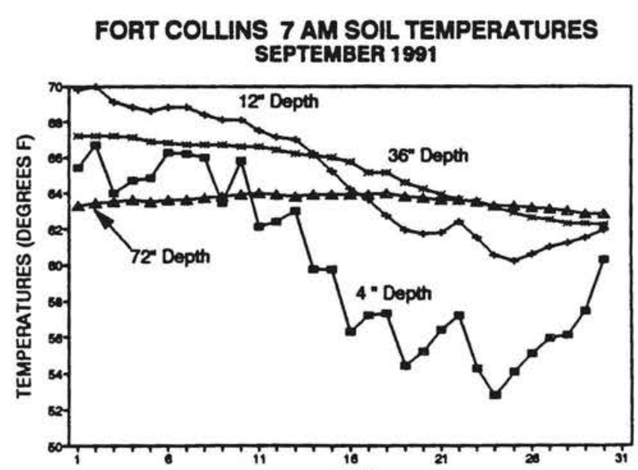


Table 1. Heating Degree Day Data through September 1991 (base temperature, 65°F).

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
	90-91	59	118	201	633	990	1597	1671	1081	954	742	410	172	8628
	91-92	33	51	280										364
ASPEN	AVE	95	150	348	651	1029	1339	1376	1162	1116	798	524	262	8850
	90-91	134	146	234	652	964	1462	1444	1013	1077	811	432	224	8593
	91-92	104	112	335										551
BOULDER	AVE	0	6	130	357	714	908	1004	804	775	483	220	59	5460
	90-91	32	13	81	338	589	1161	1081	667	685	511	211	44	5413
	91-92	17	7	121										145
BUENA	AVE	47	116	285	577	936	1184	1218	1025	983	720	459	184	7734
VISTA	90-91	66	130	226	641	905	1326	1256	896	983	771	472	207	7879
	91-92	63	87	M										M
BURLING-	AVE	6	5	108	364	762	1017	1110	871	803	459	200	38	5743
TON	90-91	10	4	76	407	M	1249	1223	688	737	438	136	1	M
	91-92	13	14	106										133
CANON	AVE*	0	10	100	330	670	870	950	770	740	430	190	40	5100
CITY	90-91	14	12	58	382	548	1098	1004	626	679	459	182	26	5088
	91-92	8	0	105										113
COLORADO	AVE	8	25	162	440	819	1042	1122	910	880	564	296	78	6346
SPRINGS	90-91	28	21	83	473	663	1256	1142	750	773	568	219	33	6009
	91-92	16	16	145										177
CORTEZ	AVE*	5	20	160	470	830	1150	1220	950	850	580	330	100	6665
	90-91	1	6	151	539	774	1321	1364	879	882	702	335	113	7067
	91-92	13	8	161										182
CRAIG	AVE	32	58	275	608	996	1342	1479	1193	1094	687	419	193	8376
	90-91	14	18	116	606	876	1547	1544	1095	995	693	398	127	8029
	91-92	27	13	230										270
DELTA	AVE	0	0	94	394	813	1135	1197	890	753	429	167	31	5903
	90-91	0	2	58	416	751	1400	1549	998	742	512	170	26	6624
	91-92	0	2	88										90
DENVER	AVE	0	0	135	414	789	1004	1101	879	837	528	253	74	6014
	90-91	12	3	64	388	623	1209	1143	684	682	510	174	16	5508
	91-92	6	4	118										128
DILLON	AVE	273	332	513	806	1167	1435	1516	1305	1296	972	704	435	10754
	90-91	284	355	430	858	1071	1587	1569	1220	1257	1031	691	425	10778
	91-92	316	321	521										1158
DURANGO	AVE	9	34	193	493	837	1153	1218	958	862	600	366	125	6848
	90-91	4	28	118	481	832	1373	1274	842	919	619	364	125	6979
	91-92	6	2	152										160
EAGLE	AVE	33	80	288	626	1026	1407	1448	1148	1014	705	431	171	8377
	90-91	15	23	134	583	934	1568	1536	1052	889	693	355	99	7881
	91-92	26	6	208										240
EVER-	AVE	59	113	327	621	916	1135	1199	1011	1009	730	489	218	7827
GREEN	90-91	120	131	219	591	803	1330	1244	937	885	727	430	152	7569
	91-92	83	92	311										486
FORT	AVE	5	11	171	468	846	1073	1181	930	877	558	281	82	6483
COLLINS	90-91	19	6	74	460	690	1284	1212	747	703	508	203	41	5947
	91-92	11	1	145										157
FORT	AVE	0	6	140	438	867	1156	1283	969	874	516	224	47	6520
MORGAN	90-91	18	7	63	421	730	1343	1248	750	722	489	180	8	5979
	91-92	5	4	89										98
GRAND	AVE	0	0	65	325	762	1138	1225	882	716	403	148	19	5683
JUNCTION	90-91	0	0	28	360	759	1370	1464	919	706	478	136	18	6238
	91-92	0	2	37										39

* = 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	AVE	214	264	468	775	1128	1473	1593	1369	1318	951	654	384	10591
LAKE	90-91	264	268	350	774	1071	1605	1668	1148	1233	979	615	330	10305
6SSW	91-92	220	255	427										902
GREELEY	AVE	0	0	149	450	861	1128	1240	946	856	522	238	52	6442
	90-91	14	2	62	450	723	1309	1246	741	692	492	159	11	5901
	91-92	8	5	119										132
GUNNISON	AVE	111	188	393	719	1119	1590	1714	1422	1231	816	543	276	10122
	90-91	65	179	264	771	1059	1664	1787	M	M	M	M	249	M
	91-92	131	151	371										653
LAS	AVE	0	0	45	296	729	998	1101	820	698	348	102	9	5146
ANIMAS	90-91	4	0	21	308	624	1220	1113	667	602	352	81	0	4992
	91-92	1	3	59										63
LEAD-	AVE	272	337	522	817	1173	1435	1473	1318	1320	1038	726	439	10870
VILLE	90-91	331	402	464	861	1141	1556	1550	1207	1210	1068	714	449	10953
	91-92	343	364	538										1245
LIMON	AVE	8	6	144	448	834	1070	1156	960	936	570	299	100	6531
	90-91	36	11	96	491	745	1280	1237	779	820	592	245	38	6370
	91-92	19	14	171										204
LONGMONT	AVE	0	6	162	453	843	1082	1194	938	874	546	256	78	6432
	90-91	24	11	101	481	727	1284	1249	740	699	520	186	28	6050
	91-92	12	6	133										151
MEEKER	AVE	28	56	261	564	927	1240	1345	1086	998	651	394	164	7714
	90-91	9	23	121	511	885	1406	1458	1047	939	696	358	110	7563
	91-92	24	7	221										252
MONTROSE	AVE	0	10	135	437	837	1159	1218	941	818	522	254	69	6400
	90-91	0	3	81	470	804	1385	1460	974	768	571	268	49	6833
	91-92	0	0	135										135
PAGOSA	AVE	82	113	297	608	981	1305	1380	1123	1026	732	487	233	8367
SPRINGS	90-91	44	108	177	608	910	1538	1432	1038	1002	767	489	227	8340
	91-92	44	37	289										370
PUEBLO	AVE	0	0	89	346	744	998	1091	834	756	421	163	23	5465
	90-91	1	0	34	360	610	1243	1116	730	667	406	103	3	5273
	91-92	1	0	76										77
RIFLE	AVE	6	24	177	499	876	1249	1321	1002	856	555	298	82	6945
	90-91	0	4	69	474	824	1433	1462	964	814	605	265	52	6966
	91-92	1	1	143										145
STEAMBOAT	AVE*	90	140	370	670	1060	1430	1500	1240	1150	780	510	270	9210
SPRINGS	90-91	129 E	110	255	700	1013	1683	1613	1223	1120	851	518	262	9477
	91-92	127	141	394										662
STERLING	AVE	0	6	157	462	876	1163	1274	966	896	528	235	51	6614
	90-91	17	7	68	437	725	1359	1244	713	716	466	173	8	5933
	91-92	5	1	92										98
TELLURIDE	AVE	163	223	396	676	1026	1293	1339	1151	1141	849	589	318	9164
	89-90	117	179	267	635	972	1384	1351	987	1093	828	486	293	8592
	91-92	175	163	339										677
TRINIDAD	AVE	0	0	86	359	738	973	1051	846	781	468	207	35	5544
	90-91	4	6	46	334	654	1160	1048	697	709	462	156	12	5288
	91-92	3	2	107										112
WALDEN	AVE	198	285	501	822	1170	1457	1535	1313	1277	915	642	351	10466
	90-91	202	258	332	794	1028	1550	1459	1105	1164	931	587	300	9710
	91-92	193	209	452										854
WALSEN-	AVE	0	8	102	370	720	924	989	820	781	501	240	49	5504
BURG	90-91	15	8	53	311	543	1047	985	646	674	437	141	23	4883
	91-92	6	5	90										101

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

SEPTEMBER 1991 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	75.0	42.9	58.9	-0.5	88	27	195	21	391	1.40	0.23	119.7	10
STERLING	81.9	48.1	65.0	3.9	97	35	92	101	505	2.28	1.18	207.3	8
FORT MORGAN	80.6	48.4	64.5	2.3	93	34	89	84	499	0.89	-0.29	75.4	6
AKRON FAA AP	77.7	49.9	63.8	2.1	90	34	105	77	465	0.30	-0.78	27.8	2
AKRON 4E	79.5	46.5	63.0	0.9	93	33	112	58	464	0.12	-0.93	11.4	3
HOLYOKE	77.2	49.7	63.4	0.6	89	36	109	69	459	1.89	0.60	146.5	7
JOES	77.5	46.8	62.1	-0.8	88	34	142	66	453	0.25	-1.15	17.9	2
BURLINGTON	77.8	50.0	63.9	-0.2	89	37	106	81	465	1.04	-0.46	69.3	3
LIMON WSMO	74.0	45.3	59.6	-0.1	84	32	171	16	383	0.27	-0.63	30.0	3
CHEYENNE WELLS	79.6	49.7	64.6	0.6	90	38	91	87	489	1.39	-0.40	77.7	6
EADS	79.1	50.7	64.9	-0.4	90	37	94	97	486	0.55	-0.77	41.7	2
ORDWAY 21N	82.3	45.9	64.1	0.6	92	33	91	70	492	0.53	-0.34	60.9	2
LAMAR	83.0	46.7	64.8	-1.9	94	33	94	97	503	1.22	0.09	108.0	5
LAS ANIMAS	83.6	50.5	67.0	-0.3	98	38	59	128	528	0.79	-0.25	76.0	5
HOLLY	80.7	50.8	65.8	0.4	94	36	69	101	522	0.85	-0.70	54.8	5
SPRINGFIELD 7WSW	82.3	50.9	66.6	1.3	93	38	47	104	529	2.73	1.56	233.3	5
TIMPAS 13SW	82.0	49.8	65.9	1.0	91	38	59	92	509	0.73	-0.44	62.4	2

Foothills/Adjacent Plains

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
FORT COLLINS	74.9	46.3	60.6	0.6	85	33	145	21	402	0.85	-0.39	68.5	4
GREELEY UNC	78.7	46.7	62.7	0.5	90	33	119	56	462	1.00	-0.13	88.5	7
ESTES PARK	68.5	37.9	53.2	-0.1	77	24	347	0	292	0.34	-1.01	25.2	8
LONGMONT 2ESE	78.6	44.6	61.6	1.0	90	32	133	38	444	1.64	0.21	114.7	5
BOULDER	75.7	47.6	61.7	-0.9	85	35	121	28	418	1.21	-0.65	65.1	5
DENVER WSFO AP	77.0	47.9	62.5	0.6	88	35	118	50	443	0.79	-0.59	57.2	8
EVERGREEN	71.3	37.5	54.4	0.5	81	27	311	0	327	1.51	0.06	104.1	9
CHEESMAN	74.7	35.6	55.1	-1.3	84	23	290	0	377	0.24	-1.03	18.9	6
LAKE GEORGE 8SW	67.0	36.7	51.9	0.1	75	27	387	0	264	0.60	-0.48	55.6	10
ANTERO RESERVOIR	67.7	30.4	49.0	0.5	76	18	472	0	271	0.45	-0.47	48.9	8
RUXTON PARK	62.3	30.2	46.3	-1.5	71	20	552	0	194	1.55	-0.33	82.4	11
COLORADO SPRINGS	74.1	46.8	60.4	0.1	84	35	145	15	386	0.56	-0.80	41.2	7
CANON CITY 2SE	76.9	47.7	62.3	-0.4	86	34	105	32	438	0.58	-0.51	53.2	6
PUEBLO WSO AP	81.2	48.2	64.7	-0.9	92	36	76	75	491	1.36	0.47	152.8	4
WESTCLIFFE	70.8	35.4	53.1	-0.6	77	22	347	0	321	0.74	-0.53	58.3	9
WALSENBURG	78.1	47.4	62.8	0.3	85	34	90	30	452	0.50	-0.72	41.0	5
TRINIDAD FAA AP	77.5	47.8	62.6	-1.0	89	32	107	43	445	0.98	-0.09	91.6	6

Mountains/Interior Valleys

Name	Temperature Max	Min	Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
WALDEN	68.8	30.8	49.8	1.7	80	16	452	0	292	1.02	-0.10	91.1	8
LEADVILLE 2SW	63.4	30.2	46.8	0.3	73	18	538	0	207	0.57	-0.83	40.7	6
SALIDA	74.3	39.3	56.8	-0.1	84	26	240	2	373	0.88	-0.04	95.7	7
SAGUACHE	71.0	37.6	54.3	0.2	80	29	314	0	321	0.65	-0.30	68.4	11
HERMIT 7ESE	66.8	31.3	49.0	1.6	76	20	474	0	259	2.20	0.77	153.8	9
ALAMOSA WSO AP	73.7	37.1	55.4	0.7	82	27	280	0	362	0.70	-0.13	84.3	7
STEAMBOAT SPRINGS	71.5	31.7	51.6	0.0	85	18	394	0	331	0.97	-0.63	60.6	6
YAMPA	66.8	37.1	52.0	0.2	77	23	383	0	260	1.65	0.17	111.5	8
GRAND LAKE 1NW	68.1	31.0	49.5	2.2	79	20	454	0	278	0.81	-0.81	50.0	12
GRAND LAKE 6SSW	67.4	33.7	50.5	1.6	76	21	427	0	269	0.46	-0.78	37.1	9
DILLON 1E	64.3	30.5	47.4	-0.5	74	22	521	0	221	1.23	-0.11	91.8	12
CLIMAX	56.6	31.3	43.9	1.0	67	18	627	0	114	0.85	-0.71	54.5	9
ASPEN 1SW	68.4	38.8	53.6	1.1	81	28	335	0	282	1.70	-0.10	94.4	9
TAYLOR PARK	63.4	32.5	47.9	4.1	73	23	505	0	207	1.00	-0.54	64.9	6
TELLURIDE	71.2	35.7	53.4	2.0	81	24	339	0	327	2.77	0.63	129.4	15
PAGOSA SPRINGS	73.6	36.7	55.1	0.5	85	26	289	0	363	4.34	2.24	206.7	11
SILVERTON	65.2	32.6	48.9	3.4	73	24	473	0	237	2.83	0.29	111.4	15
WOLF CREEK PASS 1	58.4	32.8	45.6	0.4	72	23	574	0	139	6.17	2.18	154.6	13

Western Valleys

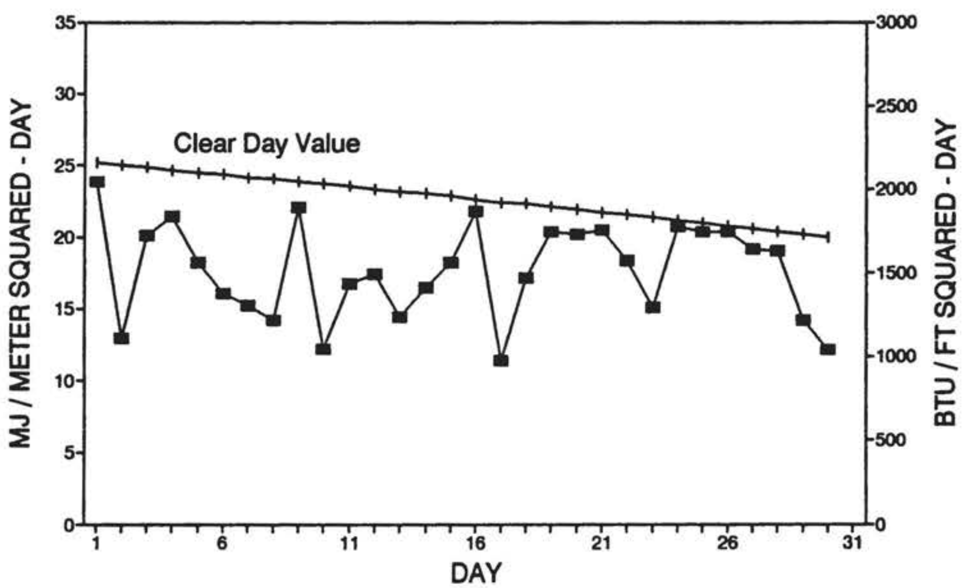
Name	Max	Min	Temperature Mean	Dep	High	Low	Degree Days Heat	Cool	Grow	Precipitation Total	Dep	%Norm	# days
CRAIG 4SW	74.2	41.2	57.7	1.6	88	28	230	20	374	1.47	0.17	113.1	9
HAYDEN	73.8	40.3	57.1	1.5	86	27	237	7	370	1.36	0.15	112.4	12
MEEKER NO. 2	74.5	40.8	57.6	0.6	86	29	221	8	381	1.75	0.73	171.6	9
RANGELY 1E	78.4	46.4	62.4	2.1	91	35	118	46	449	1.37	0.28	125.7	7
EAGLE FAA AP	76.6	39.8	58.2	2.9	87	27	208	10	413	0.59	-0.59	50.0	10
GLENWOOD SPRINGS	78.0	42.7	60.3	1.6	95	33	157	30	407	1.29	-0.30	81.1	9
RIFLE	79.6	41.1	60.3	1.2	90	30	143	12	454	1.73	0.65	160.2	10
GRAND JUNCTION WS	79.9	53.1	66.5	-0.2	94	45	37	88	503	2.30	1.58	319.4	7
CEDAREDGE	80.4	42.4	61.4	0.1	92	32	127	26	454	1.12	-0.07	94.1	9
PAONIA 1SW	80.0	48.0	64.0	2.0	93	38	80	59	471	1.21	-0.14	89.6	9
DELTA	81.9	45.6	63.8	1.5	92	35	88	57	493	0.64	-0.35	64.6	9
GUNNISON	72.6	32.2	52.4	1.1	82	21	371	0	345	1.41	0.50	154.9	11
COCHETOPA CREEK	73.0	32.7	52.8	1.9	83	20	354	0	353	0.93	-0.07	93.0	9
MONTROSE NO. 2	77.0	45.7	61.4	0.3	87	35	135	33	432	0.73	-0.44	62.4	6
URAVAN	85.1	50.2	67.6	1.9	96	40	21	108	554	1.37	0.30	128.0	9
NORWOOD	73.5	42.6	58.0	1.6	83	33	203	2	364	1.26	-0.34	78.7	7
YELLOW JACKET 2W	76.8	46.4	61.6	1.3	90	35	114	19	418	1.45	0.07	105.1	6
CORTEZ	78.1	41.9	60.0	-0.2	87	30	161	19	434	1.86	0.66	155.0	10
DURANGO	76.0	44.6	60.3	1.8	86	37	152	17	404	5.35	3.62	309.2	13
IGNACIO 1N	73.5	42.0	57.7	-0.0	86	32	217	6	366	2.25	0.72	147.1	7

* 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 1991 SUNSHINE AND SOLAR RADIATION

Station	Number of Days clear	partly cloudy	cloudy	% of possible sunshine	average % of possible
Colorado Springs	11	12	7	--	--
Denver	11	9	10	73%	75%
Fort Collins	10	12	8	--	--
Grand Junction	14	12	4	85%	76%
Limon	11	10	9	--	--
Pueblo	14	7	9	82%	80%

FT. COLLINS TOTAL HEMISPHERIC RADIATION
SEPTEMBER 1991



HYDRO-ELECTRIC POWER

Mankind has used rivers and streams to do work for him for centuries. The old watermill used to grind grain was a common sight. With the advent of electricity, water was again put to use in the production of power. At the turn of this century, nearly half of the production of electricity in the U.S. was from turbines turned by the movement of water. Fossil fuels, being cheaper, soon took over the job of electrical production. Those fuels also allowed electricity to be produced in areas without rivers and the expansion of towns and commerce did not have to rely on the location of water. With current prices of fossil fuels increasing and concern emerging regarding the impact of burning those fuels, the circle is beginning to close as we once again look to rivers and streams to produce electricity. However, the old watermill will not make a comeback. New technologys allows greater efficiency and streamlined production. Hyrdro-electric plants can produce thousands of kilowatts of electricty or micro-hydro-systems can produce from one to 100 kilowatts.

The city of Boulder's hydro facilities are examples of larger scale hydro-electric production. The situation here is a marvelous blending of usage of water. The water supply for the city is high in the mountains. Barker Reservoir, located approximately 3000 feet above Boulder near Nederland, is one location where water is stored prior to being piped down to Boulder. Until recently, this energy potential of the water behind Barker Dam was being thrown away by using energy-disapating valves. Between March 1985 and December 1987, 5 hydro-electric facilities were brought on line and are using this excess energy to produce electricity. The water continues to be used by the city for all the original purposes, yet it also creates clean energy which is sold to the Public Service Company and benefits all Boulderites. Small-scale hydro can be found on many homesites in the mountains. The production and consumption of electricity on site has major economic benefits for people who are located far from electrical grids.

The two components of power production are flow and head. Flow in a stream is the measure in cubic feet per second of how much water passes a spot in a specific time. Head is the vertical drop of the stream. The unit of head is in feet and can be thought of as the potential power in the water. As water flows downstream, it can be diverted into a pipe which runs into a nozzle. This nozzle creates high velocity. By placing a turbine into the path of the high velocity stream, the water turns the turbine whose rotating axis is attached to a generator thereby creating electricity. The efficiencies of small-scale-hydro can vary from 25 to 80 percent depending on the type of turbine or water wheel used and how the power is transmitted.

Hydropower plants are clean sources of energy which can be installed into existing water piplines or constructed in a stand alone environment. Hydropower can possibly supply all of the electricity consumed by a household. However, in many micro-hydro case , the supply of water from the nearby stream is variable with the seasons and the year. The knowledge of annual flow along with possible lows and dry years allows for proper sizing of the equipment to assure high efficiencies.

This paper was written by Mary Sutter of the Joint Center for Energy Management, University of Colorado, Campus Box 428, Boulder, CO 80309-0428. Monthly data from the stations shown on our summary can be purchased. Contact Mary Sutter for further information.

WTHRNET WEATHER DATA SEPTEMBER 1991

	Alamosa	Durango	Carbondale	Montrose	Steamboat Springs	Sterling	Stratton
monthly average temperature (°F)							
	54.1	54.6	55.2	58.0	50.5	61.0	63.0
monthly temperature extremes and time of occurence (°F day/hour)							
maximum:	79.0 2/14	79.7 3/15	87.4 3/16	83.3 3/15	84.4 4/15	93.9 2/15	90.0 8/15
minimum:	25.3 24/ 6	30.9 16/ 6	27.1 23/ 6	31.8 16/ 6	16.9 23/ 5	32.0 8/ 0	32.0 8/ 0
monthly average relative humidity / dewpoint (percent / °F)							
5 AM	90 / 36	82 / 37	93 / 39	80 / 38	91 / 32	35 / 20	83 / 45
11 AM	42 / 37	38 / 36	46 / 41	40 / 39	34 / 32	15 / 20	48 / 50
2 PM	27 / 30	31 / 34	33 / 37	29 / 35	27 / 29	12 / 16	37 / 47
5 PM	30 / 31	37 / 36	33 / 36	28 / 33	30 / 28	12 / 14	38 / 44
11 PM	60 / 35	69 / 38	70 / 39	54 / 36	76 / 34	22 / 16	65 / 44
monthly average wind direction (degrees clockwise from north)							
day	174	207	232	158	242	161	143
night	169	95	164	229	114	212	201
monthly average wind speed (miles per hour)							
	4.28	2.97	1.85	2.49	2.76	7.68	9.70
wind speed distribution (hours per month for hourly average mph range)							
0 to 3	285	443	604	492	492	67	14
3 to 12	409	271	112	223	207	542	488
12 to 24	26	6	0	5	13	111	218
> 24	0	0	0	0	0	0	0
monthly average daily total insolation (Btu/ft²·day)							
	1652	1644	1562	1651	1605	1453	1712
"clearness" distribution (hours per month in specified clearness index range)							
60-80%	221	104	150	134	145	179	235
40-60%	54	56	58	55	72	79	61
20-40%	53	66	62	52	48	43	34
0-20%	30	51	39	34	25	41	14

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. Walsh data was not included in this report because of recent changes to the station equipment.