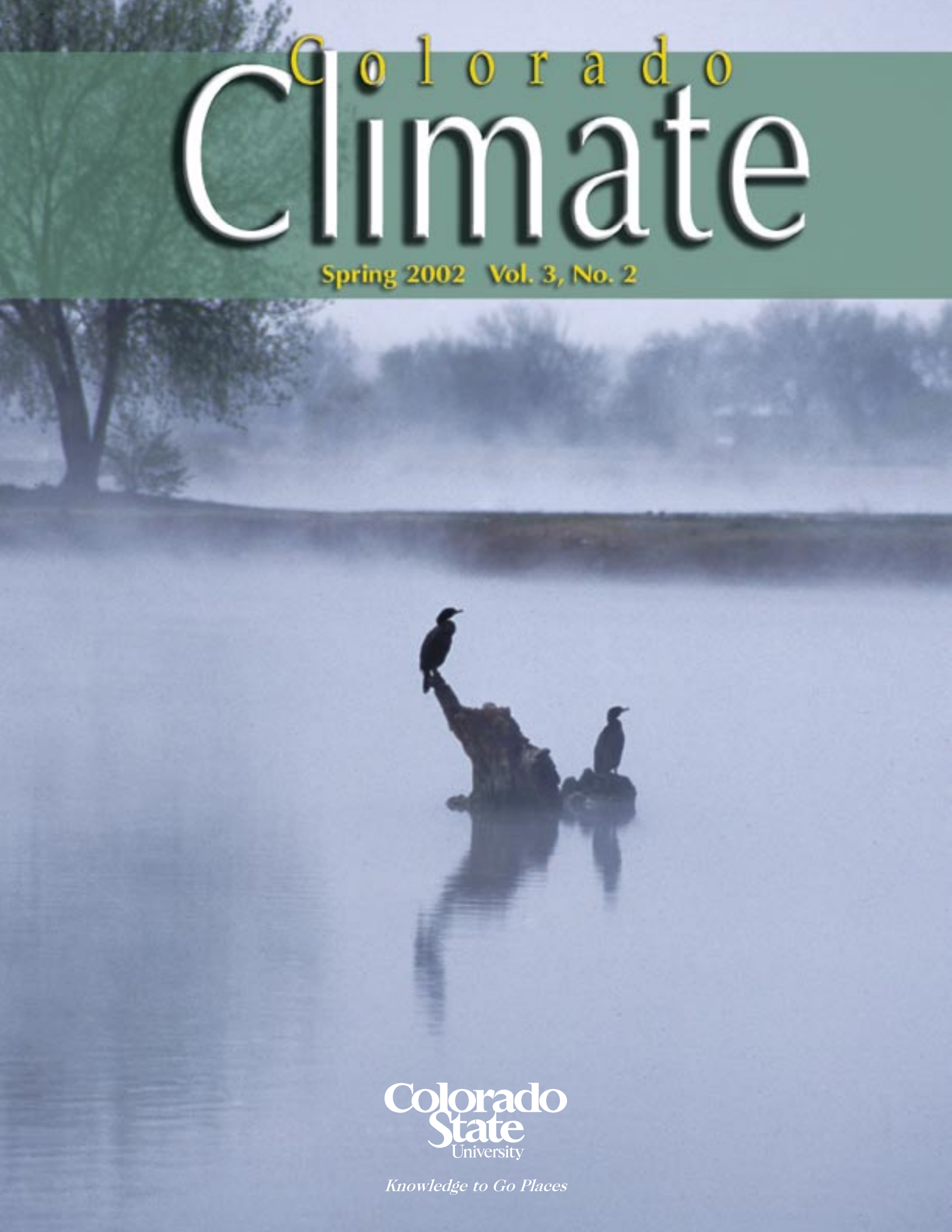
Colorado Climate

Spring 2002 Vol. 3, No. 2



Colorado State University

Knowledge to Go Places

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Cover Photo: Cormorants in the fog during an early spring rain at Barber Lakes, off I-25. Photo by Ken Driese

If you have a photo or slide that you would like considered for the cover of *Colorado Climate,* please submit it to the address at right. Enclose a note describing the contents and circumstances including location and date it was taken. Digital photographs can also be considered. Submit digital imagery via attached files to: odie@atmos.colostate.edu. Unless otherwise arranged in advanced, photos cannot be returned.

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Web: http://climate.atmos.colostate.edu

Lightning in Colorado

Ronald L. Holle [1,3] and Raul E. López [2,3]

Lightning in Colorado has been studied in more detail than most other states because of the large number of meteorologists along the Front Range with NOAA, NCAR, Colorado State University, and the University of Colorado. In addition, two unique organizations devoted to lightning are in the same area. The Lightning Center at Centura-Health St. Anthony Hospital in Denver holds monthly meetings to discuss all aspects of lightning (www.stanthonyhosp.org/services_info/lightning/). The National Lightning Safety Institute in Louisville disseminates lightning safety information on the web (www.lightningsafety.com), in workshops, and other venues.

Colorado Lightning

The frequency and location of cloud-to-ground lightning in Colorado has become quite well known in the last decade. The increased knowledge has been mainly due to the operation of automatic real-time lightning detection networks. The National Lightning Detection Network® (NLDN®) is owned and operated over the continental U.S. by Vaisala-GAI (formerly Global Atmospherics, Inc.). The NLDN consists of 114 sensors across the U.S.; three are in Colorado. A cloud-to-ground lightning strike emits a low-frequency electromagnetic signal that is unique to such flashes. The signal from a cloud-to-ground flash travels both in and on the surface of the earth and can be detected up to several hundred miles away. A typical Colorado flash is detected by 4 to 8 sensors that may be within and outside the state. Each sensor measures two features. One is the angle to the flash in tenths of a degree. The other is the time in microseconds when the signal arrives at the sensor using the Global Positioning System (GPS). Angles and times are sent to Vaisala-GAI in Tucson, where locations are calculated to the nearest 500 meters (or approximately 1/3 of a mile). Positions are then sent to users within 30 seconds after the strike to ground. Lightning data are not free due to the commercial nature of the network. All flashes shown on the Weather Channel and local television stations come from the NLDN.

From 1997 to 2001, an average of 500,000 cloud-to-ground flashes occurred per year in Colorado. Annual totals varied from 445,000 to 537,000 ground strikes during these years. Colorado has a density of 4.8 flashes per square mile, 27th among the 48 states.

What about flashes that don't strike the ground? Cloud flashes are more difficult to measure because their signals are weaker and do not travel through the ground. Estimates range from 3 to 10 cloud flashes for every cloud-to-ground flash. For Colorado, that comes out to 3 million flashes per year using a ratio of 5 cloud flashes for every ground strike.

This spectacular lightning photo was taken at Pueblo Reservoir by Stephen Hodanish, http://www.crh.noaa.gov/pub/ltg.shtml. This photo is copyrighted but you can own a copy by contacting him directly at Steve.Hodanish@noaa.gov, or by snail mail at Colorado Lightning Resource Center, NOAA/National Weather Service, 3 Eaton Way, Pueblo, CO, 81007.

The highest lightning frequency in Colorado is located east of the Continental Divide between Denver and Colorado Springs. This region is along and north of the Palmer Lake Divide where thunderstorms form frequently in the summer. There is a broad maximum from New Mexico to Wyoming east of the Front Range. Thunderstorms in this region feed on the moisture from the plains to the east that are then lifted by vertical circulations induced by slopes and mountains.

The lowest frequency is in the San Luis Valley. Thunderstorms form during many summer days over the surrounding mountains and produce lightning, but they seldom move over the valley. Lightning frequencies are also low over west-central Colorado because the amount of moisture available for thunderstorms is limited at these high altitudes.

During the year, two-thirds of all cloud-to-ground flashes occur during June, July, and August.

(continued on page 2)

[1] *Vaisala-GAI, Tucson, Arizona*
[2] *Simpsonville, South Carolina*
[3] *Formerly National Severe Storms Laboratory, NOAA, Boulder, Colorado and Norman, Oklahoma*

Lightning in Colorado

(continued from page 1)

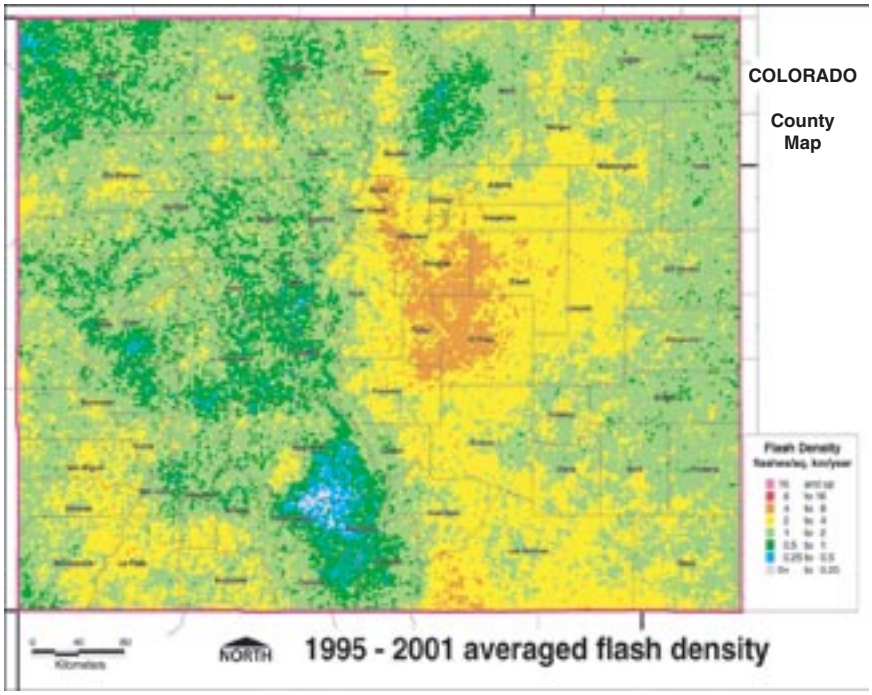

Figure 1. Flash density over Colorado from 1995 to 2001 based on the National Lightning Detection Network. Map shows the number of cloud-to-ground flashes per square kilometer per year.

During the day, most cloud-to-ground lightning along the Front Range occurs between noon and 6 p.m. However, flashes begin as early as 11 a.m. in the high mountains, which is a challenge for safe climbing and hiking. It is common for storms to form in late morning to early afternoon over the elevated regions west of the Front Range cities, move across the cities in late afternoon, then continue eastward to produce a maximum before midnight on the Eastern Plains.

Colorado Lightning Deaths, Injuries, and Damages

Lightning-caused deaths and injuries are tabulated in NOAA's *Storm Data* publication. Most events consist of only one person killed or injured at a time, so such events are not reported as widely as tornadoes and hurricanes. As a result, the number of lightning casualties has been found to be significantly underreported. However, *Storm Data* is the only consistent national source for such information over the last several decades.

There were 132 lightning deaths in Colorado reported by *Storm Data* from 1959 to 2001, an average of 2 to 3 deaths per year. The Colorado death rate of 1.04 deaths per million people is the 6th highest in the U.S.

Lightning injuries during the same years averaged 8 per year in Colorado; the reported number has risen steadily in recent years. The reported increase is probably due to the growth in population, and perhaps an increased awareness resulting from the efforts of people studying lightning in Colorado! An important study by the Lightning Center at Centura-Health St. Anthony Hospital used a wide range of hospital records to find that 10 people are injured for every death in Colorado.

After taking into account these factors, the conclusion is that an average of 3 people are killed and 30 are injured per year in Colorado.

Storm Data has an average of five damage events per year in Colorado. However, another unique study involving the Lightning Center at Centura-Health St. Anthony Hospital analyzed Colorado insurance data from 1989 to 1993 for policies that were mostly held by homeowners. There were 367 times as many insurance claims filed as *Storm Data* indicates. About 5,000 lightning claims a year were paid in Colorado in those years, at an average of $1,000 per claim. Both the number and value of payments have probably increased over the last decade. Nearly half of the claims were from the Denver metropolitan area. A thought-provoking statistic from the study is that an insurance claim is filed for about every 75 cloud-to-ground flashes in Colorado.

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Lightning Safety Outdoors

National Weather Service

Each year, about 400 children and adults in the U.S. are struck by lightning while working outside, at sports events, on the beach, mountain climbing, mowing the lawn or during other outdoor activities. About 80 people are killed and several hundred more are left to cope with permanent disabilities. Many of these tragedies can be avoided. Finishing the game, getting a tan, or completing a work shift aren't worth death or crippling injury.

- **All thunderstorms produce lightning and are dangerous.** Lightning kills more people each year than tornadoes.
- **Lightning often strikes as far as 10 miles away from any rainfall.** Many deaths from lightning occur ahead of the storm because people try and wait to the last minute before seeking shelter.
- **You are in danger from lightning if you can hear thunder.** If you can hear thunder, lightning is close enough that it could strike your location at any moment.
- **Lightning injuries can lead to permanent disabilities or death.** On average, 20% of strike victims die; 70% of survivors suffer serious long term effects.
- **Look for dark cloud bases and increasing wind.** Every flash of lightning is dangerous, even the first. Head to safety before that first flash. If you hear thunder, head to safety!
- **Lightning can travel sideways for up to 10 miles.** Even when the sky looks blue and clear, be cautious. If you hear thunder, take cover. At least 10% of lightning occurs without visible clouds in the sky.

The Single Most Dangerous Place

Outdoors is the most dangerous place to be during a lightning storm. When lightning is seen or thunder is heard, or when dark clouds are observed, quickly move indoors or into a hard-topped vehicle and remain there until well after the lightning storm ends. Listen to forecasts and warnings through NOAA Weather Radio or your local TV and radio stations. If lightning is forecast, plan an alternate activity or know where you can take cover quickly.

The U.S. lightning season is summer but lightning can strike year round! The Fourth of July is historically one of the most deadly times of the year for lightning. In summer, more people are outside, on the beach, golf course, mountains or ball fields. Outdoor jobs such as construction and agriculture, and outdoor chores such as lawn mowing or house painting are at their peak, putting those involved in danger.

(continued on page 4)

Don't let lightning ruin your outdoor activities. Know the safety rules and have a plan.

Photo by Stephen Hodanish

Photo collage from NWS Lightning Safety Web page http://www.lightningsafety.noaa.gov.

Each year, about 400 children and adults in the U.S. are struck by lightning while working outside, at sports events, on the beach, mountain climbing, mowing the lawn or during other outdoor activities.

Lightning Safety Rules

1. **Postpone activities promptly. Don't wait for rain.**
   Many people take shelter from the rain, but most people struck by lightning are not in the rain! Go quickly inside a completely enclosed building, not a carport, open garage or covered patio. If no enclosed building is convenient, get inside a hard-topped all-metal vehicle. A cave is a good option outside but move as far as possible from the cave entrance.
2. **Be the lowest point. Lightning hits the tallest object.**
   In the mountains if you are above treeline, you *are* the highest object around. Quickly get below treeline and get into a grove of small trees. Don't be the second tallest object during a lightning storm! Crouch down if you are in an exposed area.
3. **Keep an eye on the sky.**
   Look for darkening skies, flashes of lightning, or increasing wind, which may be signs of an approaching thunderstorm.
4. **Listen for the sound of thunder.**
   If you can hear thunder, go to a safe shelter immediately.
5. **If you see or hear a thunderstorm coming or your hair stands on end, immediately suspend your game or practice and instruct everyone to go inside a sturdy building or car.**
   Sturdy buildings are the safest place to be. Avoid sheds, picnic shelters, baseball dugouts, and bleachers. If no sturdy building is nearby, a hard-top vehicle with windows closed will offer some protection. The steel frame of the vehicle provides some protection if you are not touching metal.
6. **Listen to NOAA Weather Radio.**
   Coaches and other leaders should listen for a tone-alert feature during practice sessions and games.
7. **If you can't get to a shelter, stay away from trees.**
   If there is no shelter, crouch in the open, keeping twice as far away from a tree as it is tall.
8. **Avoid leaning against vehicles.**
   Get off bicycles and motorcycles.
9. **Get out of the water. It's a great conductor of electricity.**
   Stay off the beach and out of small boats or canoes. If caught in a boat, crouch down in the center of the boat away from metal hardware. Swimming, wading, snorkeling and scuba diving are *not* safe. Lightning can strike the water and travel some distance beneath and away from its point of contact. Don't stand in puddles of water, even if wearing rubber boots.
10. **Avoid metal!**
    Drop metal backpacks, stay away from clothes lines, fences, exposed sheds and electrically conductive elevated objects. Don't hold on to metal items such golf clubs, fishing rods, tennis rackets or tools. Large metal objects can conduct lightning. Small metal objects can cause burns.
11. **Move away from a group of people.**
    Stay several yards away from other people. Don't share a bleacher bench or huddle in a group.

What to Do If Someone Is Struck by Lightning

- **Call for help.** Call 9-1-1 or your local ambulance service. Get medical attention as quickly as possible.
- **Give first aid.** If the victim has stopped breathing, begin rescue breathing. If the heart has stopped beating, a trained person should give CPR. If the person has a pulse and is breathing, address any other injuries.
- **Check for burns in two places.** The injured person has received an electric shock and may be burned. Being struck by lightning can also cause nervous system damage, broken bones, and loss of hearing or eyesight. People struck by lightning carry no electrical charge that can shock other people. You can examine them without risk.

Stay Informed About the Storm

Listen to NOAA Weather Radio or local media for the latest severe thunderstorm **WATCHES** and **WARNINGS**. Severe thunderstorms are those storms with winds in excess of 58 mph or hail larger than 3/4 inches in diameter. When conditions are favorable for severe weather to develop, a severe thunderstorm **WATCH** is issued.

Weather Service personnel use information from weather radar, satellite, lightning detection, spotters, and other sources to issue severe thunderstorm **WARNINGS** for areas where severe weather is imminent. *Remember, however, that **ALL** thunderstorms produce deadly lightning.*

Taken from the National Weather Service Lightning Safety Page at http://www.lightningsafety.noaa.gov/

Colorado Climate in Review *by Nolan Doesken*

January 2002

Climate in Perspective

January 2002 brought Colorado, a few winter storm systems, several periods of snow, some strong winds and some abrupt weather changes, and large swings in temperature. But as mid-winter months go, it was mild and easy and not out of the ordinary. The most startling feature was the lack of significant moisture over southwestern Colorado and the northeastern plains.

January 2002 Precipitation

For the month as a whole, most of the mountains and Western Slope were much drier than average. Southwest Colorado was exceptionally dry with many sites reporting less than 10% of their monthly average. Northwest Colorado fared better with some stations coming in close to average for the most part. Eastern Colorado typically receives very little precipitation in midwinter. Totals there were above average up and down the Front Range and out across southeastern Colorado. Several locations even doubled their average. Northeast Colorado missed the few storm opportunities, however, and ended much below average. Sterling and Holyoke reported no measurable precipitation for the month.

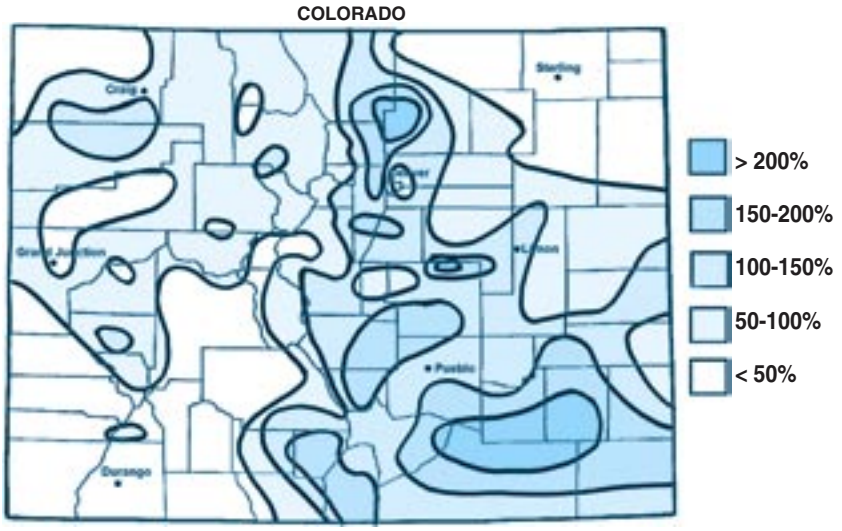
January 2002 Temperature

January temperatures were near to a little above average over the mountains and western valleys and 2-4 degrees F above average across Eastern Colorado. A few valley sites in the upper Colorado and Yampa valleys ended up slightly below average as a result of periods of clear dry weather where cold heavy air pooled in the valleys.

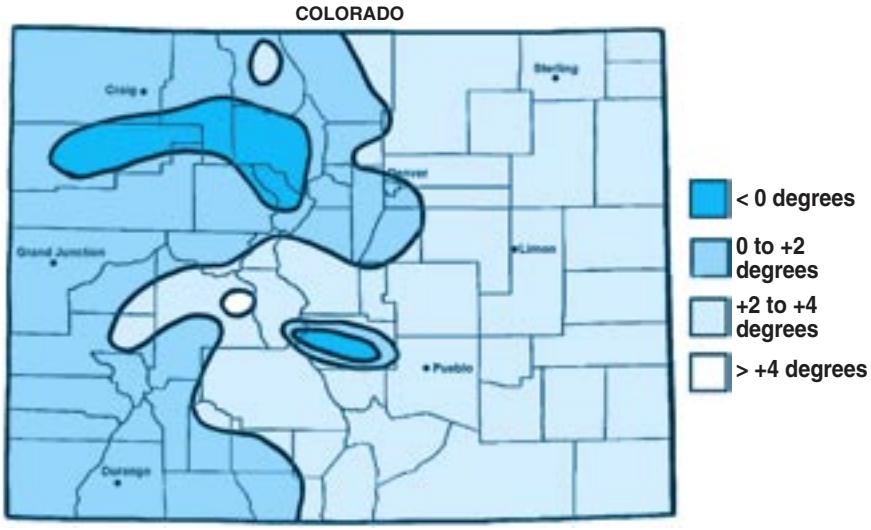
January 2002 Daily Highlights

1-2 Light snow over northern Colorado early on New Year's Day. Very cold as arctic air gripped most of Colorado. Low near zero east of mountains and well below zero in the mountains. Antero Reservoir reached -21°F, Kremmling -22°F, Fraser -24°F, Sargents and Taylor Park Dam -25°F, and Hohnholz Ranch -33°F, the coldest in the state.

3-5 Dry and much warmer on the 3rd, but another fast moving upper air disturbance moved down from the northwest. Some light snows developed in the Northern and Central mountains. Heavier snows up to 8 inches fell along the southern foothills near Rye and Walsenburg late on the 4th. Strong westerly winds scoured the northern mountains and foothills.

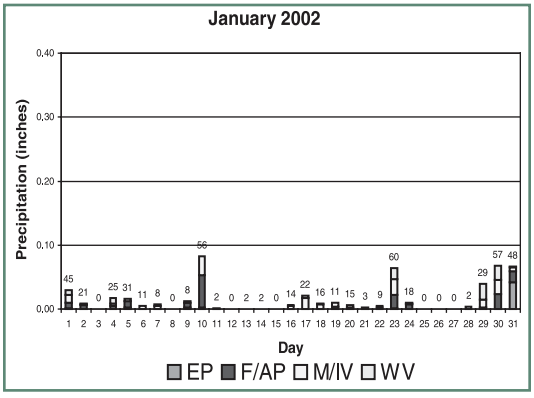


January 2002 precipitation as a percent of the 1961-1990 average.



January 2002 temperature departure from the 1961-1990 average, degree F.

Statewide average daily precipitation graph(s) (right and throughout this article) shows relative amounts of precipitation for each region. Label on each column indicates percent of stations with measurable precipitation for each day.



6-8 More strong northwesterly winds and a little snow in the northern mountains on the 6th. Then much warmer especially east of the mountains. Fort Collins reached 64°F on the 7th. Colorado saw temperatures near 70°F across the Eastern Plains on the 8th.

9-10 A Pacific cold front arrived. A few inches of snow fell in the northern and Central mountains and then spilled over to the Front Range. Estes Park got close to 6 inches by early on the 10th. Little or no snow over Southern Colorado or the Eastern Plains. Temperatures returned to average for this time of year.

11-12 Dry and seasonally cool with winds aloft from the northwest.

13-14 A low pressure system raced across Colorado early on the 13th. It moved too quickly to bring much moisture but was accompanied by some very strong winds and chilly temperatures.

15-20 Warmer on the 15th as winds aloft became westerly (zonal). A little Pacific moisture reached western Colorado with a few inches of snow here and there on the 16th. Cold and dry over the northern plains. Clear weather on the 19th allowed temperatures to drop well below zero on the 19th. Then another fast-moving disturbance early on the 20th brought another dusting of snow and winds up to 70 mph in some exposed locations in the mountains.

21-23 Coloradans enjoyed a mild and dry midwinter day on the 21st, but a cold front moved in from the northwest on the 22nd with snow developing in the mountains. The storm system hustled eastward on the 23rd with windy and much colder across the plains with a few light snow showers ending early. Subzero temperatures returned to the mountains.

24-27 Moderate temperatures with dry weather statewide. Eastern Colorado enjoyed 3 consecutive mild days with high temperatures in the 60s or higher. Clouds increased from the west as a Pacific storm approached on the 27th.

28-31 Winterlike weather returned as a broad trough of low pressure moved slowly eastward from California and crossed the Rockies bringing several inches of much needed snow. Cold Canadian air backed up along the Front Range 29-30th and helped trigger a substantial snowfall of up to 10" of fluffy low-density snow which was heaviest in SE Colorado and along the Front Range. Skies cleared in the mountains 31st allowing temperatures to drop into the -20s in some mountain valleys.

January 2002 Monthly Extremes

Description	Station	Extreme	Date
Precipitation (day)	Julesburg	0.75"	Jan 23
Precipitation (total)	Winter Park	2.13"	
High Temperature	Campo 7S	78°F	Jan 9
	Arapahoe 14N	78°F	Jan 9
Low Temperature	Hohnholz Ranch	-33°F	Jan 2

February 2002

Climate in Perspective

February 2002 was a dry but cold month for Colorado. Weather disturbances crossed the state every few days, but most brought little or no moisture. The most significant weather events of the month included frigid mountain temperatures on February 1, an extreme wind and duststorm across the plains on February 9th and a sharp Arctic cold front which dropped temperatures over 70 degrees in 36 hours 23-25th.

February 2002 Precipitation Summary

No widespread moisture-laden storms struck Colorado in February. Most of Colorado ended up with much less moisture than average. Little or no moisture fell over Colorado's southeast plains. Southwest and extreme western Colorado were also extremely dry. Durango, for example, only had light snow on three days each of which quickly melted. Total water content for the month was only 0.17 inches, barely 10% of average. The only areas of the State receiving near average precipitation was a portion of the Sangre de Cristo Mountains, a few areas of Colorado's northern mountains and an area east of the mountains between Colorado Springs and Limon.

February 2002 Temperature Summary

Clear skies prevailed during much of February allowing dense cold air to settle into the Great Basin. Much of western Colorado ended up several degrees below the 1961-1990 February average. Granby and Meeker in northwest Colorado both were more than five degrees below average for the month. Temperatures dropped below zero and 22 out of 28 days in Gunnison. Numerous lows dipped below -20°F in the mountains. Eastern Colorado enjoyed temperatures near average. In fact, much of the month was warmer than average until the later-month cold wave arrived.

February 2002 Daily Highlights

1-3 High pressure covered the Rockies. Mostly clear and dry with cold nighttime temperatures. Steamboat Springs awoke to a low of -28°F on February 1.

4-7 A minor weather disturbance moved down from Montana on the 4th bringing a little snow over-

night mostly along the Front Range foothills and colder daytime temperatures on the 5th. Then continued mostly sunny with seasonal temperatures and subzero nighttime temperatures in the mountains.

8-9 A strong low pressure center developed over Colorado as a disturbance moved in from California. Very strong winds swept over the mountains Front Range and Eastern Plains with gusts to 80 mph in some areas. A severe dust-storm brought visibilities to near zero across portions of the Eastern Plains. Snow accompanied the storm in the mountains but with mostly light amounts. Winds across eastern Colorado averaged over 40 mph in some areas on the 9th making this one of their windiest days in several years.

10-13 Dry and much warmer again 10-11th. Another cold front pushed swiftly across the state early on the 12th but with no precipitation.

14-15 A cold front dropped down from the northwest accompanied by some Pacific moisture. Colorado's mountains picked up a little snow – but only a precious little.

16-17 Mild and dry.

18-21 A low pressure trough crossed the central Rockies bringing much needed snow over several days. Totals of 6 - 12 inches were common in the higher mountains. Silverton measured more than one foot of fresh snow. A little snow also spilled over the Front Range. Elizabeth and Castle Rock reported several inches. A period of heavy snow fell in the Sangre de Cristo Mountains of southern Colorado 20-21st.

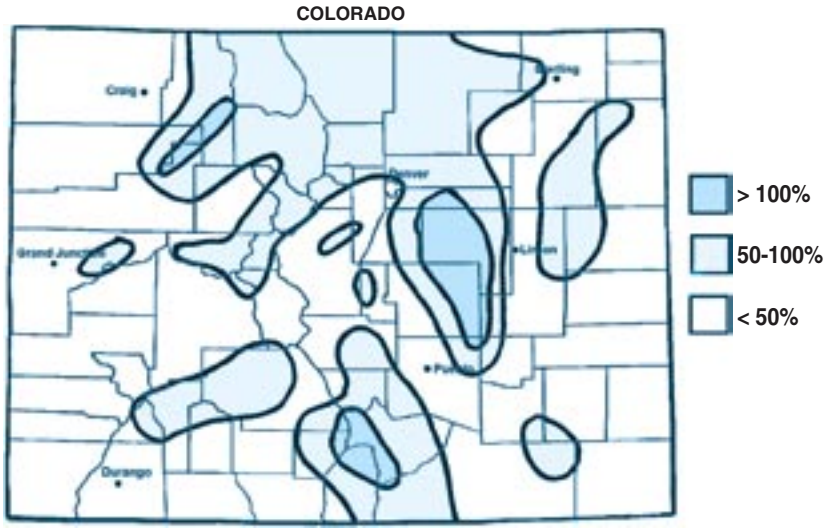
22-23 Dry statewide and very warm east of the mountains as a high pressure dominated the region. Temperatures soared into the 70s including a reading of 77°F in downtown Denver.

24-26 The spring heatwave was short lived. The strongest arctic cold front of the winter sent temperatures plummeting with high temperatures only in the teens and low 20s east of the mountains by the 25th. Snow accompanied the Arctic front with 1-3 inches of snow on the Front Range and northeast plains. Western Colorado remained dry and southwest Colorado was totally spared from this cold wave. Temperatures at the Denver airport dipped to -8°F on the 26th.

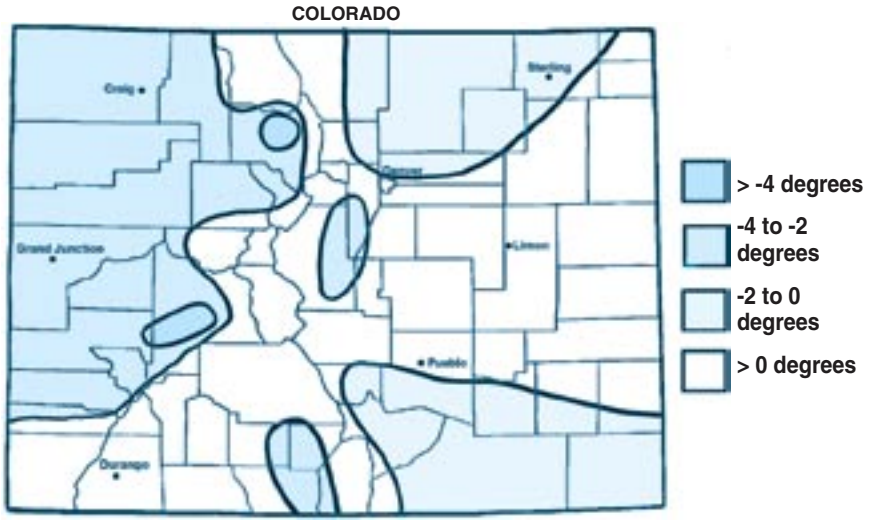
27-28 A slow warming trend began but a new storm system moved in quickly from the northwest. Heavy snow developed late on the 28th.

February 2002 Monthly Extremes

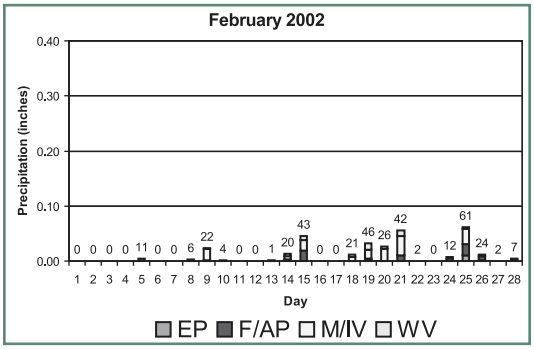
Description	Station	Extreme	Date
Description	Station	Extreme	Date
Precipitation (day)	Bonham Reservoir	0.75"	Feb 19
Precipitation (total)	Silverton	1.74"	
High Temperature	LaJunta	80°F	Feb 24
	Pueblo Reservoir	80°F	Feb 24
Low Temperature	Fraser	-31°F	Feb 26



February 2002 precipitation as a percent of the 1961-1990 average.



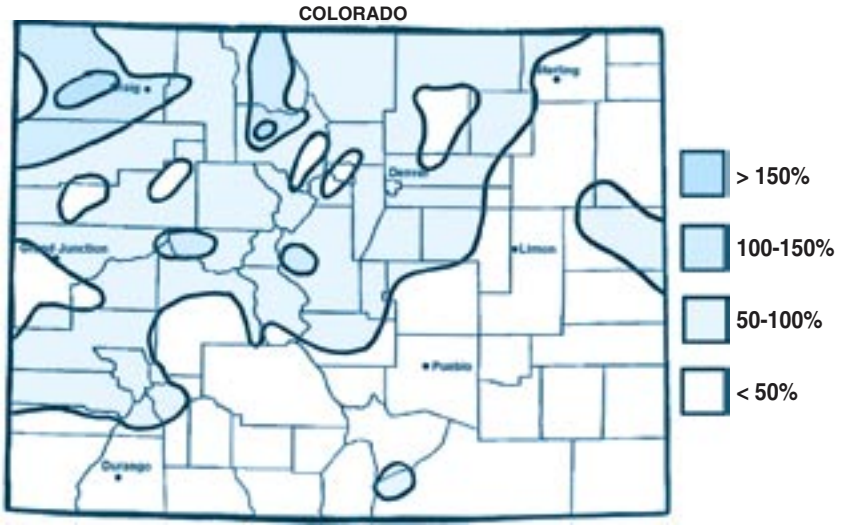
February 2002 temperature departure from the 1961-1990 average, degree F.



March 2002

Climate in Perspective

March came in like a lion with a major snow storm across northern Colorado and an arctic cold wave statewide on the 1st. The month went out very lamb-like with dry weather and seasonally mild temperatures. In between was a rollercoaster of alternating spring warmth and Arctic blasts as a stubborn Canadian air mass perched just northeast of Colorado most of the month. What was lacking was moisture laden Pacific storm systems or storms pulling moisture up from the Gulf. Therefore, while the battle between winter and spring was fierce, heavy spring precipitation was largely absent.



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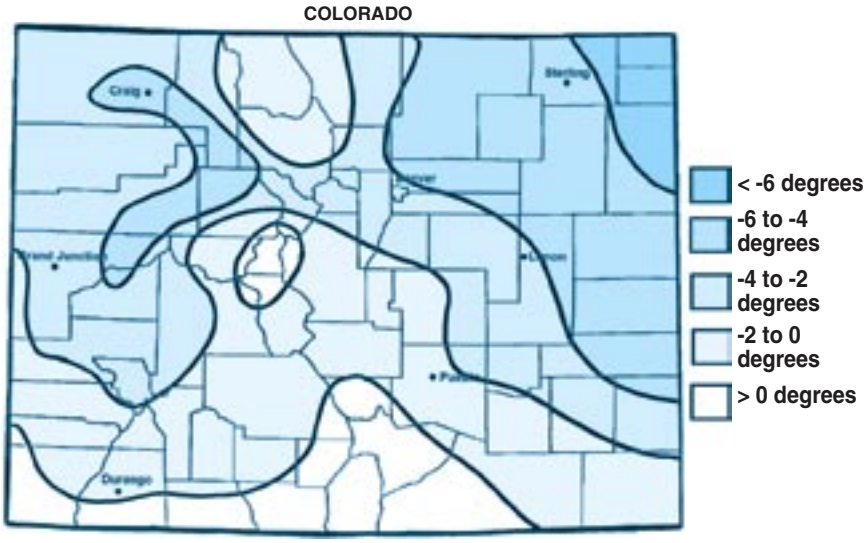

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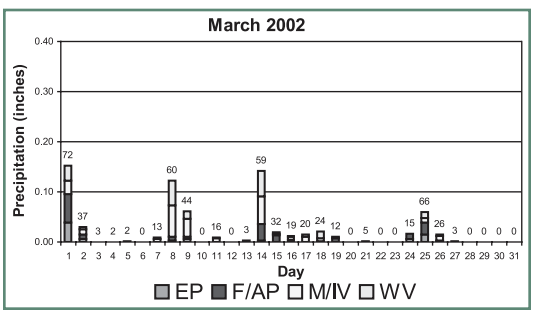


March 2002 Precipitation

Despite cold temperatures and several shots of snow, the month still ended up much drier than average. With the exception of last November, every month has been below to much below average in terms of precipitation since last summer. March precipitation as a percent of average ranged from near zero over portions of southeastern Colorado and less than 50% of average over most of the southern and eastern half of the state to locally above average in a few areas of northern Colorado such as Kremmling and Walden.

March 2002 Temperatures

For the month of March 2002 as a whole, temperatures were below average but ranged from near average over extreme southern Colorado to four to five degrees below average at Craig, Yampa and Rifle. The coldest area of the state compared to average was the northeastern plains. Near the Nebraska border, Holyoke ended the month nine degrees F below average.

March 2002 Daily Weather

1-3 March came in like a lion with a powerful Arctic blast and moderate snow. Some schools were closed in northern Colorado on the 1st. Up to 9" of fresh snow fell in Boulder and Fort Collins, with lesser amounts over the mountains and eastern plains. Temperatures plummeted well below zero as skies cleared on the 2nd. Sterling recorded a low of -15°F while up in the mountains frigid readings were reported. Temperatures of -20s and -30s were common over the valleys of northern and central Colorado. Antero Reservoir and Taylor Park Reservoir each dipped to -38°F. It was very cold again on the 3rd with increasing winds aloft out of the northwest and slowly moderating temperatures.

4-6 A dry period over Colorado with continued moderating temperatures. Strong winds continued to blow over the higher terrain. A shallow cold air mass from over Canada slipped into extreme northeast Colorado on the 6th while other parts of the state were quite mild.

7-9 Locally strong westerly "downslope" winds brought much warmer temperatures east of the mountains on the 7th. Highs reached into the 60s and 70s across the plains. Meanwhile

clouds and precipitation began spreading into western Colorado as a Pacific storm system approached. Wintery weather returned on the 8th as another surge of very cold Canadian air move back into eastern Colorado while snow spread over the mountains. The heaviest snows fell near Crested Butte, Aspen, and the Grand Mesa where up to two feet of new snow fell in two days. Most areas, however, just got a few inches with lesser amounts out across the plains. Skies cleared on the 9th. Temperatures were very cold again with lows dipping into the single digits on the plains and well below zero up in the mountains.

10-12 Still chilly on the 10th but with moderating temperatures. A quick moving disturbance aloft brought some mountain snow showers early on the 11th and more strong winds. The warming trend encompassed the whole state by the 12th, with daytime temperatures in the 60s and 70s at lower elevations.

13-17 Windy and warm in western Colorado on the 13th in advance of a strong developing storm system. Then sharply colder with widespread snow developing beginning later in the day. 2-10" of snow accumulated, especially over northern Colorado on the 14th, but little spread out to the eastern plains. The main storm raced eastward towards the Great Lakes, but chilly, unsettled weather lingered over Colorado 15-17th with occasional mountain snow showers and much below average temperatures for this time of year.

18-20 Moderating temperatures and mostly dry, but arctic air still lurking up over Montana and an upper air disturbance passed south of Colorado. Near average temperatures by the 20th.

21-25 A temperature roller coaster for eastern Colorado. A Canadian air mass slipped into eastern Colorado early on the 21st with much colder temperatures and a few snowflakes. Then temperatures climbed rapidly 22-23rd (highs back up into the 70s and 80s by the 23rd out over the plains) only to plummet again by as much as 50 degrees on the 24th as the Arctic air sloshed back up against the eastern slope of the Rockies. At the Pueblo airport, temperatures dropped from a high of 78 to a low of 18 in a matter of hours. Several inches of snow accompanied this surge over a portion of east-central Colorado near Burlington while other areas received only a dusting. Temperatures remained unseasonably chilly on the 25th with a few mountain snow showers.

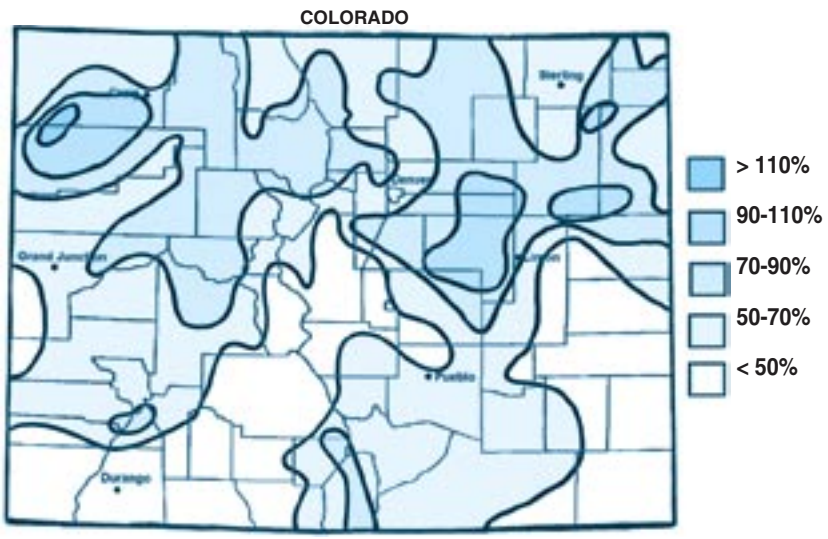
26-31 March went out like a lamb with dry weather statewide and near to above average temperatures. Some strong winds swept the state 27-28th as a high pressure ridge built to our west. Temperatures climbed into the 80s at lower elevations in southeastern Colorado on the 28th. Cooler on the 29th as a Pacific cold front moved through but with no big weather changes. With warm mountain days with temperatures in the 50s and some mild nights, the spring snow melt got off to an early start.

March 2002 Monthly Extremes

Description	Station	Extreme	Date
Precipitation (day)	Denver Water Dept	1.06"	Mar 14
Precipitation (total)	Bonham Reservoir	3.25"	
High Temperature	Campo 7S	86°F	Mar 24
Low Temperature	Taylor Park	-38°F	Mar 2
	Antero Reservoir	-38°F	Mar 2

Water Year 2002 in Review, October 2001 – March 2002

Extremely warm temperatures early in the winter have given way to cold weather. This is helpful for retarding early snowmelts and evaporation as well as stretching the winter recreation season in the mountains. Unfortunately, precipitation for the 2002 Water Year continues to lag behind average. With the exception of a few small areas in northeastern and northwestern Colorado, all of the state is dry. Much of the southern half of Colorado has accumulated less than half of the average precipitation for the first half of the 2002 Water Year. For example, Saguache only 1.01" has fallen since October 1, 2001 compared to an average of 2.44" (41% percent of average). For southwestern Colorado, this has been the driest winter since the infamous 1976-77 winter drought. Campo in extreme southeast Colorado has totaled just 33% of average.



Water Year 2002 (October 2001 through March 2002) as a percent of the 1961-1990 average.

Blizzards in Northeastern Colorado

Roger A. Pielke Sr., Nolan Doesken, Odie Bliss and Dallas Staley

Snow mounded around house in Keota, Weld County, Colorado, January 8, 1949. Courtesy of Denver Public Library, Western History Collection, Clyde L. Stanley photographer, call number X-10150.

The winter of 1948-49 was particularly severe in eastern Colorado. Repeated periods of severe cold and snow occurred. January was the third coldest since the beginning of records in the state, according to the Department of Commerce *Climatological Data* publication for Colorado. In early January, an especially dangerous blizzard occurred. As many as 6,000 head of cattle and 4,000 sheep were lost in this storm.

As documented in the book *The Blizzard in Black and White: Winter of 1948-49* by Loretta Jewell, Editor, a diary entry by Cecelia Shandera, just to the east of Colorado near Pine Bluff, Nebraska, the blizzard began toward the evening of January 2 and lasted for 72 hours. All roads were blocked. In Colorado, Fleming in Logan County recorded snow and strong winds for 4 days. In Fort Morgan, the observer marked in their notes:

Blizzard conditions started Sunday, Jan 2 and continued for 3 days. Snow drifted so badly that it was impossible to get any satisfactory measurements of depth or amt. of precipitation – some roads still blocked as of the 31st.

In Greeley, the observer wrote:

Blizzard of Jan 3, 4, covered NE Colorado blocking roads and causing considerable damage to livestock,

while in Grover, also in Weld County, the remarks in the observations were:

...snow drifts from bare ground to 20 ft with 50 mile per hour wind.

Coupled with the snow and wind, were very cold temperatures. Greeley recorded minimums of 0°F, 2°F and 6°F on January 3, 4, and 5, respectively. Byers in Arapahoe County reported minimums of -3°F, -1°F and 4°F on these three days. Together with the strong winds, intense wind chill temperatures occurred.

Figures 1 and 2 show the weather maps during the peak of the storm. The observed pattern, with a cut-off low pressure system in the southwest United States, is more typical of a spring eastern Colorado snowstorm. However, in 1949, this pattern happened associated with the normally colder temperatures of early January.

(continued on page 11)

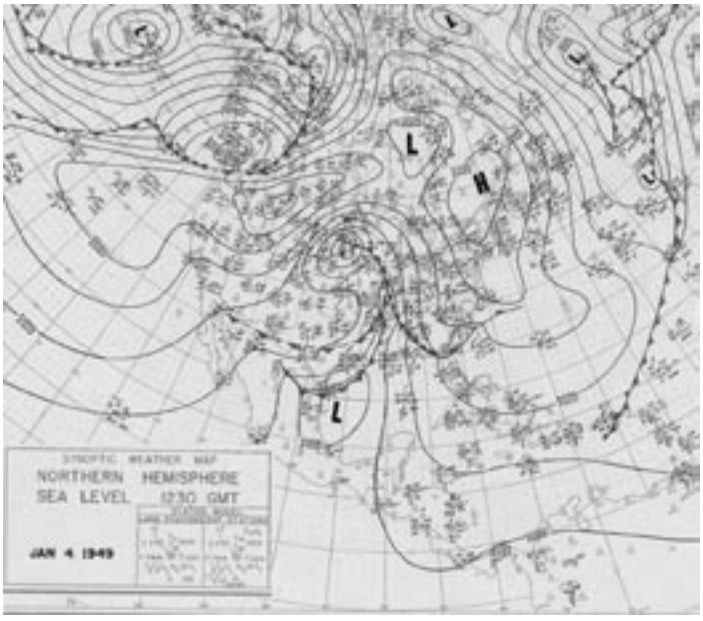


Figure 1. Synoptic Weather Map at Sea Level on January 4, 1949 at 1230 GMT.

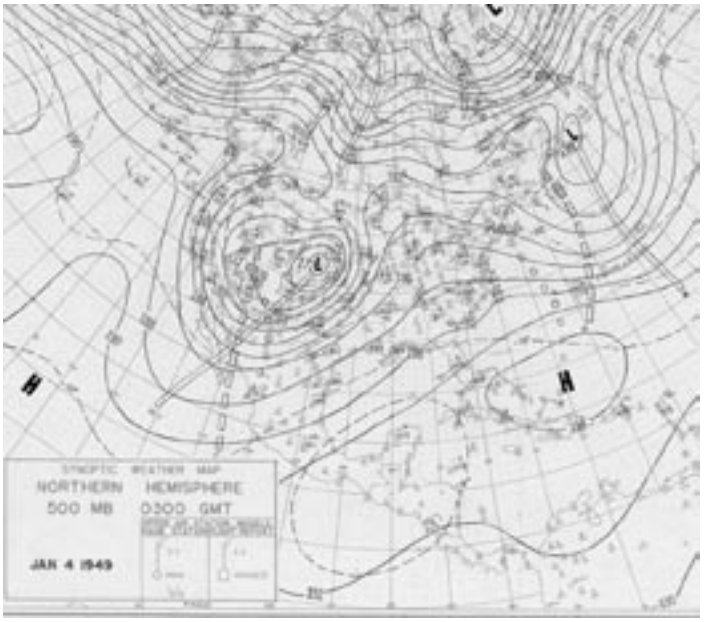


Figure 2. Synoptic weather map at 500 mb level on January 4, 1949 at 0300 GMT.

Blizzards in Northeastern Colorado

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What if this type of blizzard occurred this winter? Are we prepared for such an extreme storm? From the weather maps, there is nothing unusual about the temperatures and pressure fields that could not happen in the winter of 2003-04.

To assist in planning for a blizzard, Table 1 provides recommended winter storm preparation tips from the American Red Cross. While a storm of the severity of January 3-5 would threaten the lives of travelers even with the winter survival equipment in their cars and trucks, they would provide some insurance to reduce their vulnerability to freezing to death. The time to prepare, of course, is before the blizzard season arrives, which in Colorado can be even in October, as we found out in 1997.

It is also imperative to stay tuned to the National Weather Service forecasts. Table 2 provides the NWS list of watches and warnings and their meaning. These forecasts provide the best tool available to avoid becoming stranded in a Colorado blizzard.

Table 1: Winter Storm Preparation

Prepare a Winter Storm Plan:	Have extra blankets on hand. Ensure that each member of your household has a warm coat, gloves or mittens, hat, and water-resistant boots.
Assemble a Disaster Supplies Kit:	Include first-aid kit and essential medications; battery-powered NOAA weather radio, flashlight, and extra batteries; canned food and can opener; bottled water (at least one gallon of water per person per day to last at least 3 days); extra warm clothing, including boots, mittens, and a hat. Assemble a Disaster Supplies Kit for your car, too. Have your car winterized before winter storm season.
Stay Tuned for Storm Warnings:	Listen to NOAA Weather Radio and your local radio and TV stations for updated storm information.
Know What Winter Storm Watches and Warnings Mean:	A winter storm WATCH means a winter storm is possible in your area. A winter storm WARNING means a winter storm is headed for your area. A blizzard WARNING means strong winds, blinding wind-driven snow and dangerous wind chill are expected. Seek shelter immediately! (See Table 2.)
When a Winter Storm Watch is Issued:	Listen to NOAA Weather Radio, local radio, and TV stations, or cable TV such as The Weather Channel for further updates. Be alert to changing weather conditions. Avoid unnecessary travel.
When a Winter Storm Warning is Issued:	Stay indoors during the storm. If you must go outside, several layers of lightweight clothing will keep you warmer than a single heavy coat. Gloves (or mittens) and a hat will prevent loss of body heat. Cover your mouth to protect your lungs. Understand the hazards of wind chill, which combines the cooling effect of wind and cold temperatures on exposed skin. Walk carefully on snowy, icy sidewalks. Avoid traveling by car in a storm, but if you must, carry a Disaster Supplies Kit in the trunk. Keep your car's gas tank full to keep the fuel line from freezing and for emergency use. Let someone know your destination, your route, and when you expect to arrive.
Know What to Do if You Get Stranded:	Stay with your car. Do not try to walk to safety. Tie a brightly colored cloth (preferably red) to the antenna for rescuers to see. Start the car and use the heater for about 10 minutes every hour. Keep the exhaust pipe clear so fumes won't back up in the car. Leave the overhead light on when the engine is running so that you can be seen. As you sit, keep moving your arms and legs to keep blood circulating and to stay warm. Keep one window away from the blowing wind slightly open to let in air.
After the Storm:	If you shovel snow, be extremely careful. It is physically strenuous work, so take frequent breaks. Avoid overexertion.
This information was obtained from The American Red Cross website at: http://www.redcross.org/services/disaster/Info	

continued on Page 12

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Table 2. National Weather Service Winter Watch and Warnings Definitions

Winter Storm Watch	Issued when winter storm conditions are possible within the next 12 - 36 hours, but the timing, intensity, or occurrence may still be uncertain. It rarely will be issued for the fourth forecast period (36 to 48 hours).
Winter Storm Warning	Issued when heavy snow is occurring or will develop in the next 18 hours (east of the Continental Divide) and 12 hours (west of the Continental Divide). The heavy snow may be accompanied by wind and blowing snow. Heavy snow is defined by the following amounts: • east of Continental Divide for the mountains 8 inches in 12 hours or 10 or more inches in 24 hours and at lower elevations 6 inches in 12 hours or 8 or more inches in 24 hours. • west of the Continental Divide for the mountains more than 12 inches within 24 hours and at lower elevations more than 6 inches within 24 hours.
Blizzard Storm Warning	Occurs when the following conditions are expected for at least 3 hours: sustained winds of 35 mph or greater with considerable falling and/or drifting snow, lowering visibilities to less than ¼ mile.
Winter Weather Advisory for Snow	Issued when general snow accumulations are expected: • for east of the Continental Divide, 4-8 inches in 12 hours in the mountains and 3-6 inches in 12 hours at lower elevations. • for west of the Continental Divide, 5-12 inches within 24 hours and 3-6 inches within 24 hours at lower elevations.
Snow and Blowing Snow Advisory	Issued when falling snow is accompanied by blowing snow to cause travel problems due to lower visibilities and drifting snow.
Blowing Snow Advisory	Issued when wind-blown snow will occasionally reduce visibility and create a hazard for travelers.
Taken from Public Information Statement by Bob Glancy and Jim Pringle, NWS Warning Coordination Meteorologists for Boulder and Grand Junction, respectively.	

Figure 3. National Weather Service forecast area for winter storm watches and warnings for west and east of the Continental Divide (dotted line).

Cooperative Weather Observer at Sedgwick Receives Benjamin Franklin Award

By National Weather Service, Denver-Boulder

Mr. Layton Munson, weather observer five miles south of Sedgwick, Colorado, has received the Benjamin Franklin award from the National Weather Service (NWS) on September 17, 2002. He is the first person to receive this award in Colorado.

Recipient of the Ben Franklin award, Layton Munson (center), and his wife (left) pose with Carl Burroughs, NWS Hydrometeorological Technician.

The award, named after the nation's first weather observer, is presented to members of the NWS cooperative weather network who demonstrate a remarkable level of dedication and service. This is the highest award that the NWS can bestow on an observer.

Since 1947, Mr. Munson has been recording weather and climate observations for the Sedgwick area. When making the presentation, NWS Meteorologist-In-Charge Larry Mooney noted that Mr. Munson was taking weather observations before most of the meteorologists in Colorado were even born. Fifty-five years of volunteer service to his community and nation is an amazing accomplishment and testimony to Mr. Munson's dedication and public service.

The NWS cooperative weather observer network is made up of volunteers, like Mr. Munson, who take daily measurements of temperature and precipitation in Colorado and throughout the nation. Their observations are the foundation of the nation's climate records.

National Weather Observer Length-of-Service Awards

25 Years

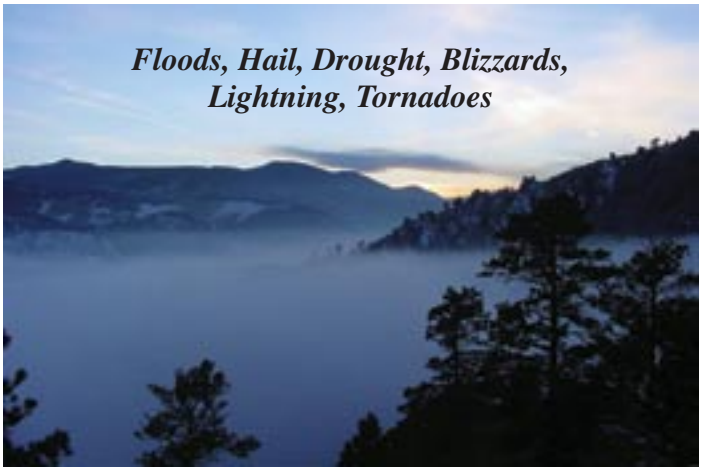
Kent Moyrer (left), Colorado Department of Agriculture Insectary in Palisade, Colorado, accepts the 25-year-length-of-service Award from John Kyle, NWS Data Area Program Manager (DAPM), Grand Junction, CO.

20 Years

Larry Adams (left), representing the Town of Crested Butte, CO, accepts the 20-year-length-of-service award. The award was presented by John Kyle, NWS DAPM, Grand Junction, CO.

15 Years

Dale E. Anderson (center), observer at Holyoke, CO, received a 15-year-length-of-service award. The award was presented by Byron Louis (left) DAPM, Weather Service Forecast Office (WSFO) Denver/Boulder and Carl Burroughs (right) Hydrology Technician, WSFO Denver.



"Our Backyard – Peaceful Sea of Fog" Photo by Chris Schillig.

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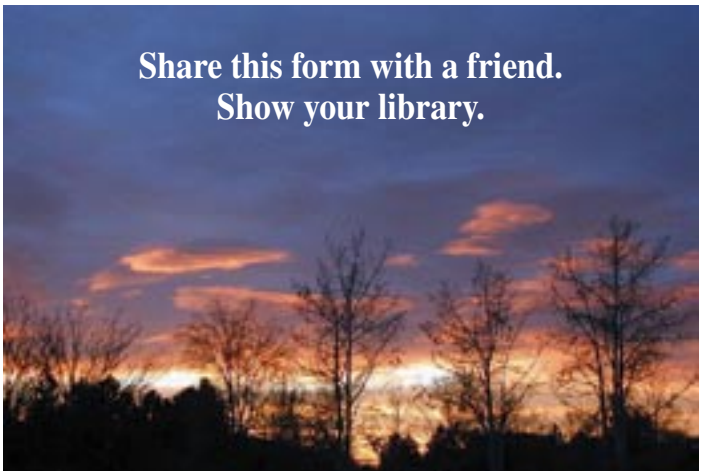

Photo by Lynn Kral, Sunrise over Loveland, Colorado.

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Knowledge to Go Places