CHAPTER 4 – WEATHER

By Joe Griffith, March 2008

> "Storm clouds on the mountains – how truly beautiful they are! – floating fountains bearing water for every well; the angels of streams and lakes…"
>
> – John Muir, *Snow-Storm on Mount Shasta*

Objectives – Upon completion of this chapter, you will be able to:

- **Anticipate** the weather that you are likely to encounter on your hikes.
- **Cope** with what actually happens.

Much of the enchantment, and adventure, of alpine hiking arises from the weather. The abundant life we find in the wilderness would not be possible without the water brought to the mountains by those powerful floating fountains. Our presence in Colorado depends on that water, too. The atmosphere's ever-changing moods make each hike a unique experience. When those moods turn dark, however, the weather can create deadly hazards for an unprepared hiker.

Figure 1: August in the Indian Peaks Wilderness.

The clouds in Figure 1 provided a beautiful backdrop for our lunch, but they were part of a thunderstorm that had formed astride our path homeward. Fortunately, the hiker in the photo was well prepared. He was already exposed to one hazard, ultraviolet (UV) radiation, but his hat, sunglasses, long-sleeve shirt, and sunscreen gave him good protection. The thunderstorm also became a problem. Rain made the trail muddy and slick, but our hiker's trekking poles helped him avoid falls. His waterproof boots and the rain jacket in his pack kept him dry and warm, so he did not succumb to hypothermia. A good lunch also helped keep the cold at bay. We began our hike early, so we could start our descent before the storms reached the high point of our trip. The path back to the trailhead was through a valley, so lightning did not become a significant hazard. Had it done so, our hiker's ensolite pad would have helped provide protection in a manner that we will explain later. Most important of all, he was well-trained in the ways of the weather. He returned home safely because he was properly prepared.

Weather is, of course, an immense, complicated subject, so what follows is only the beginning of your education in mountain meteorology. The web sites and references listed are among the most important elements of this chapter.

ANTICIPATING

Colorado's Mountain Climate

The Southern Rocky Mountains are blessed with a mild, relatively dry continental climate that is ideal for outdoor activities. The cool summer days are punctuated by occasional thunderstorms. In winter, there is plenty of powder snow for a snowpack that often lasts into late spring. Blue skies and abundant sunshine prevail throughout the year.

Because of the wide variations in the state's topography, Colorado's climate is strongly affected by the location as well as the season. In their description of the state's climate, Doesken, Pielke, and Bliss point out: "The difference (35°F) in annual mean temperature between Pikes Peak and Las Animas, 90 miles to the southeast, is about the same as that between southern Florida and Iceland." This excellent article can be found at http://ccc.atmos.colostate.edu/climateofcolorado.php. It is just one of many valuable resources at the Colorado Climate Center at http://ccc.atmos.colostate.edu/.

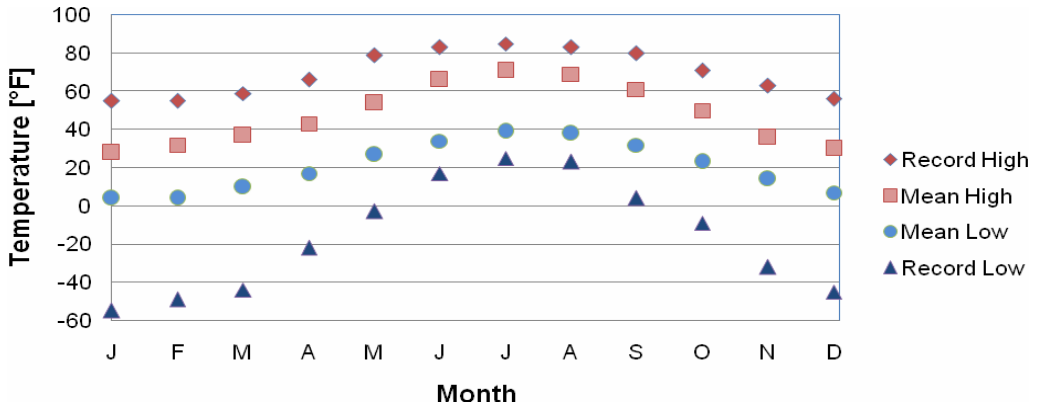

Figure 2: Temperatures in Leadville, CO

The National Climatic Data Center, www.ncdc.noaa.gov, maintains climate data for the entire country. Historical temperature and precipitation amounts for many sites in Colorado are available there. Figure 2 is derived from data taken at the Sugarloaf Reservoir at Leadville (9738 ft elevation). Note that all of the record lows are below freezing – even for July. Summertime temperatures typically decrease 4-5 °F for every 1000 ft of elevation gain. (This is called the lapse rate.) Cold air tends to pool in mountain valleys, and a clear sky allows heat to rapidly radiate out into space. Even on a midsummer hike, you should be prepared to endure subfreezing temperatures if an overnight stay is planned or if it becomes necessary in an emergency. Snow can fall during any month in Colorado.

Since Colorado is far from major bodies of water, average precipitation throughout the year is fairly light. For Leadville it is typically one to two inches of water equivalent per month. In the summer, water comes mainly from the Gulf of Mexico, while in the winter the jet stream brings it in from the Pacific Ocean. Again, local topography strongly affects it. Mountain peaks can get twice as much as neighboring valleys. The mountains squeeze water out of the air by forcing it upward, causing it to cool. (Rain and snow in Denver are often associated with easterly "upslope winds.") Rain in the summer usually

comes from thunderstorms, which often begin to form by midmorning. The mountains affect them, too. Doesken, Pielke, and Bliss call Pikes Peak a "thunderstorm machine."

Tomorrow's Weather

Weather forecasting has improved dramatically in recent decades. Remote sensing, sophisticated atmospheric models, and high speed computing have given meteorologists powerful tools for predicting the weather many days in advance. The Internet gives us unprecedented access to the information generated:

- National Weather Service Central Region Headquarters – www.crh.noaa.gov
- Storm Prediction Center – www.spc.noaa.gov
- University Corporation for Atmospheric Research – www.rap.ucar.edu/weather/
- Hydrometerological Prediction Center – www.hpc.ncep.noaa.gov
- National Weather Radio (coverage maps) – www.weather.gov/nwr/
- Local broadcasters such as 7News – www.thedenverchannel.com/weather/

The Colorado Department of Transportation (CDOT) provides valuable information on road conditions at http://www.cotrip.org/. Forecasts for some of Colorado's 14ers can be found at 14erWorld http://www.fourteenerworld.com/ColoradoWeather/Weather.htm.

Forecasters can provide valuable information about large weather systems. If they predict high pressure, then expect good weather. If they warn of low pressure or the arrival of an advancing front, then be prepared for precipitation. Actually, you should always be prepared for precipitation.

Those Clouds on the Horizon

In the mountains, weather tends to be local, and it can change with amazing rapidity. Forecasters still have difficulty predicting the weather on a fine scale in such complicated terrain. A wise wilderness traveler vigilantly observes the sky and stays alert to the possibility that the terrain is hiding the approach of bad weather. As conditions change, you need to be aware of how they may affect the remainder of your day. Will that thunderstorm reach the summit before you do? Will the developing snowstorm obscure your vision and cover your tracks in the snow? Being able to interpret what is happening in the atmosphere is an important survival skill. Jim Woodmency's *Reading Weather* offers useful instruction for sharpening that skill.

COPING

Most of us know how to cope with beautiful weather, so this section will concentrate on those aspects of the weather that cause problems. Problematic weather can put on an

awesome show. Our purpose here is to teach you how to enjoy the show – as John Muir did – and survive.

Rain

Rain presents several hazards: **slippery conditions**, **hypothermia**, and **flash flooding**.

Water can be a powerful lubricant. Mud and wet rocks – especially those covered with lichen – can make your footing unreliable. On most trails, it is mainly a nuisance. In a boulder field or in an area requiring friction walking, slippery rocks can make an area impassible. If your path to safety becomes slippery when wet, then you should be especially cautious about avoiding thunderstorms.

Wet clothing conducts heat from your body very fast. Wind and lack of sunshine make the situation worse. Staying dry is essential to avoid hypothermia. A rain jacket, rain pants, waterproof boots, and weather resistant gloves will keep you comfortable and warm. A change of clothes in a waterproof bag is also useful. Some use ponchos to protect themselves from rain. A poncho can double as a tarp, and it can also protect your pack from rain. The main disadvantage is that it tends to billow out in the wind, so it is difficult to see the trail at your feet.

Occasionally a rainstorm will stall over a valley or canyon and dump an enormous amount of water into a confined space. One of the best known examples in Colorado happened on July 31, 1976 when nearly a foot of rain fell in Big Thompson Canyon. The flood killed 144 people. Mike Nelson describes the weather conditions that caused it in his *Colorado Weather Almanac.* If you are in a canyon, you may not be able to see or hear the storm upstream, so you have to be alert to rapidly rising water. Camping in a low-lying area during thunderstorm season can be hazardous. If you choose to do so, think ahead about your escape route to high ground.

Lightning

Thunderstorms can occur in winter, but they are most likely from late April through late September. In an average year, cloud-to-ground lightning strikes Colorado a little over a half million times, killing three Coloradans and sending eight more to the hospital. A lightning strike may seem like a frightfully random event, but much of its behavior is predictable.

Thunderstorms often begin to form by late morning. It is essential to start hikes early so you will be descending from the summit if a storm strikes. A storm announces its arrival with billowing white clouds, wind, and changing temperature. Thunder is a useful tool. If you see a flash, you can measure its distance by counting the seconds between the flash and the arrival of the thunder. The speed of light is so high that the flash arrives essentially instantaneously. Sound, on the other hand, takes five seconds to travel a mile. By counting the seconds between flash and bang and dividing by five you get the distance in miles to the strike. This technique has given rise to the **30/30 lightning safety rule**: seek shelter, in a vehicle or a building, if the flash is less than 30 seconds away (six miles) and stay there until 30 minutes have passed since the last thunderclap. Partial buildings, tents, shallow caves, lone trees, and ledges **do not** offer protection from

lightning. You should also avoid streams, wet ground, wet snow, and long or tall conductors.

In the wilderness, you may be far from shelter, but there are ways to reduce your exposure. Lightning tends to strike the tallest objects under the cloud because the tops of these objects are closest to the cloud. Mountain peaks, ridges, and tall trees standing alone are among lightning's preferred targets, so you will want to be far from them. Seek a low elevation, preferably below tree line. In a stand of trees of uniform height, you are relatively safe as long as the tree next to you is not significantly taller than its neighbors.

Lightning does not have to hit you directly to cause severe injuries. A nearby strike can harm you in many ways. The flash may be bright enough to damage your vision and the sound loud enough to damage your ears. The shock wave can hurl debris at you or even directly cause trauma. Induced electric currents generated by the strike may heat metal objects hot enough to burn your skin. The current flowing through the ground may enter your body and cause severe internal injuries.

If you are caught out in a thunderstorm, your group should spread out with 50 ft spacing and everyone should assume **the lightning position**. The need to do so may become urgent if you see hair standing on end or if you hear a buzzing sound. Your lecturer and your instructor will show you this position. A drawing of it can be found in figure 4 of the "NOLS Backcountry Lightning Safety Guidelines" by John Gookin, which can be found at www.nols.edu/resources/research/pdfs/lightningsafetyguideline.pdf. Squatting on an ensolite pad with your boots on and with your feet close together will reduce the current flowing through your body if there are strong currents in the ground. We recommend one change from what is shown in this otherwise fine article: cover your ears with your hands. A pair of earplugs would also help protect your ears.

Snow

The main hazards in the wilderness associated with snow are avalanche, frostbite, hypothermia, and UV reflectivity (sunburn and snow blindness). These are all discussed elsewhere. On well-traveled trails, the snow often turns to ice after being packed down. In the spring, many thawing trails alternate between stretches of mud and ice, both of which are slippery. Traction devices for your boots, such as STABILicers™ or Yaktrax®, will help you avoid falls. Snow melts quicker around exposed rocks, which absorb plenty of heat from the sun. Be careful around those rocks. The snow next to them may not support you.

Wind

Mountain topography strongly affects the wind. In the winter, when the jet stream often blows directly across the Southern Rocky Mountains, wind speeds can reach 50-100 mph on mountain peaks. Such winds can produce dangerous wind chills. Valleys offer shelter if their orientation relative to the wind direction is favorable. Otherwise, they may simply funnel the wind toward you. Trees usually provide a lot of protection unless the wind is strong enough to topple the weak ones. It is a complex topic. Renner's *Mountain Weather* and Whiteman's *Mountain Meteorology* have extensive discussions of wind behavior.

Ultraviolet Radiation

The UV part of the spectrum lies between visible light and x-rays – more energetic than visible light but not as energetic as x-rays. The problem with UV is that it is powerful enough to damage protein and DNA molecules. As we all know, a heavy dose of UV will produce a burn, on your skin or in your eyes, which you will feel within a few hours. A small dose does permanent harm more stealthily. The cumulative effect of many doses – large and small – many not appear for years or even decades, but the possible result, blindness or skin cancer, can be devastating.

We cannot see or feel UV light, so to protect ourselves we have to learn how it behaves. UV light is a component of sunlight, and the worst of it is filtered out by the ozone layer in the stratosphere. The lower atmosphere also removes some, so the amount of UV at the Earth's surface increases by about 4% per 1000 ft of elevation gain. The biggest factors affecting its intensity are the height of the sun in the sky and the reflectivity of the ground. At sunrise and sunset, almost no UV reaches the surface; the time of high intensity is midday. Snow and water reflect UV light, so they can significantly increase your exposure. Thick clouds filter out some UV but not all of it.

Clothing and UV-blocking sunglasses provide the best protection. The brim of a hat shades your face when the UV is most intense, at midday. Sunscreens, especially those containing physical blockers such as zinc oxide or titanium oxide, work well but they need to be reapplied regularly.

UV light is not all bad, however. It provides a service by helping our skin make vitamin D. In winter especially, it is possible to get so little UV that you become deficient in vitamin D. If you are careful to avoid UV exposure, you may want to supplement your diet; 400 IU is presently the recommend daily allowance.

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