Colorado CoCoRaHS Fall Newsletter

Welcome to Fall: The days are growing shorter, the leaves are turning, you or somebody you know has taken up a strange habit of yelling at the TV for three hours every Sunday. It's one of the prettiest times of year to be outside in Colorado. Who knows? You might even see some wildlife. This picture of a moose and its calf was taken in Rocky Mountain National Park last month.

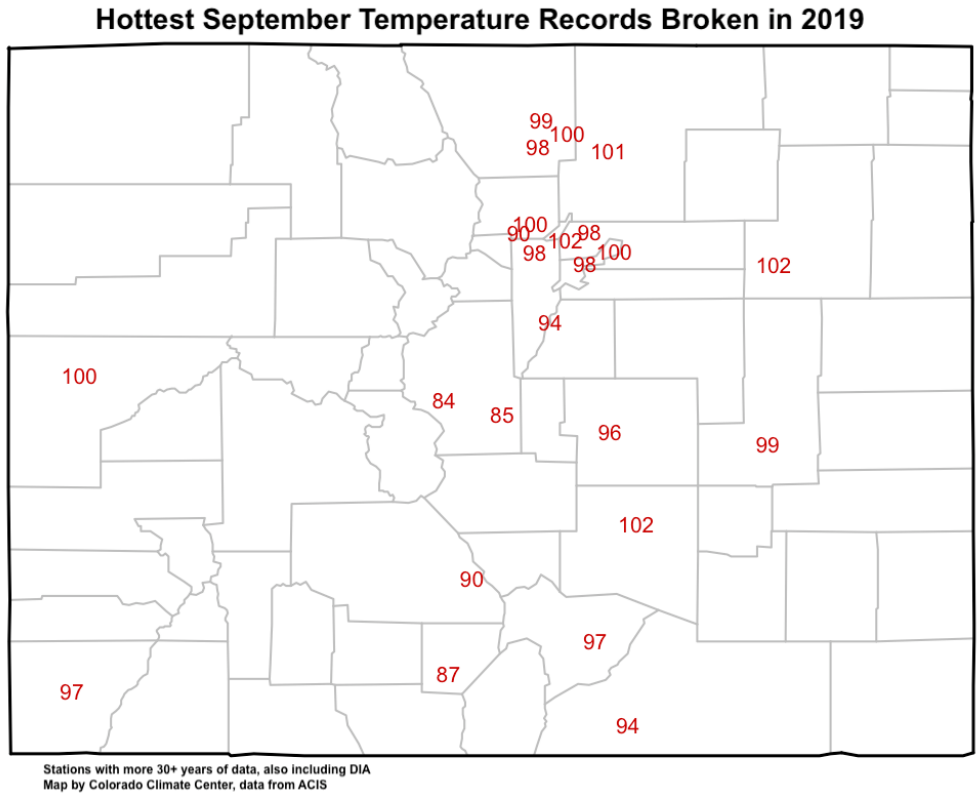
I'll level with you, this newsletter is not as directly related to CoCoRaHS as a typical newsletter. This is in part because Colorado has been drier than normal since my summer edition. The northeast quadrant of the state saw its fair share of precipitation by and large, and some impressive hail along with it. For most of us, however, the biggest weather story the last three months has been heat, which we don't measure, and to a lesser extent drought, which we indirectly measure. In this newsletter, I'll recap some interesting statewide weather statistics of late, including two new state records, and then I'll move on to discussing something else that has been on my mind a lot lately; seasonal forecasting. The seasonal forecasting discussion goes a little further into the weeds than we typically go in these newsletters, but if you're up for it, the text is there for your enjoyment.

Measuring Snow: Before straying too far from the CoCoRaHS mold, let's talk about the imminent snow measurement season. It looks like nobody in the state has measured snow yet this fall. While the short and medium range forecasts do still look warm and dry, we can still expect things to change relatively soon climatologically. Somebody in the state will be measuring snow before October is over; that much is certain. Measuring snow is a little trickier than rain. It's not rocket science, but it is like a card game. The basics are easy, but the finer points can take a little time to master. For those new to the network, don't be afraid to try submitting snow reports. We have plenty of resources if you find yourself with questions. Hopefully you can find something to fit your learning style.

1. Follow our snow training pdf - https://cocorahs.org/media/docs/measuringSnow2.1.pdf

2. Use our snow training animations - https://www.youtube.com/watch?v=sj37JQnArX4&t=21s (there are six animations in total. If you start with the one linked here, the six videos will play in series automatically)
3. Check out our measurement tutorial - https://www.youtube.com/watch?v=eWbbj57fOcA
4. Call or email me. I'm always happy to field questions!

Summer Heat and Drought: We transitioned from a cooler than average May and June to a hot July and August. The pinnacle of Colorado summer heat was a report of 115 F that came from John Martin Dam near Las Animas. This report has been verified as a new state record, breaking the old record of 114 F. We had fun testing the thermometer's legitimacy using precise ovens in the engineering department. Then came September. Summer didn't want to let go this year! It was like a child protesting going back to school. Here in Fort Collins, we hit 99 F on Labor Day. Boulder and Denver hit triple digits for the first time ever recorded in September! This year was one of only four times going back to 1893 that Fort Collins had its warmest temperature of the calendar year in September.



September 2019 Colorado Temperatures

	Average Temperature (F)	2019 Rank	Top 10 Septembers in Last 10 Years	Recording Since
Fort Collins	66.8	2	7	1894
Boulder	67.9	8	3	1897
Denver Stapleton	69.2	1	4	1948
Colorado Springs	68.7	1	6	1948
Pueblo	72.8	1	5	1954
Burlington	70.8	3	2	1904
Lamar	73.2	4	3	1893
Dillon	51.2	3	2	1910
Alamosa	58.6	2	5	1948
Steamboat Springs	56.9	5	3	1908
Grand Junction	69.2	21	1	1900
Cortez	66	5	7	1929

Record Hail: Colorado set a new state record this summer: largest hailstone. The whopper you see below fell on August 13th of this year in eastern Colorado. Hey look! That's a CoCoRaHS scale being used to measure it! The previous record largest hailstone was 4.5" in diameter. This one officially measured 4.83". Unfortunately the woman who captured it was not a CoCoRaHS observer, but you folks also recorded some impressive hailstones this summer. As recently as September 11th, 2" diameter hail was recorded by CoCoRaHS in Weld County. That's pretty late in the season for big hail around here.

Seasonal Forecasts: For me, October seems to be the time of year everyone starts asking me what kind of winter we're in for. Remember how you felt when the teacher said "pop quiz?" That's how I feel

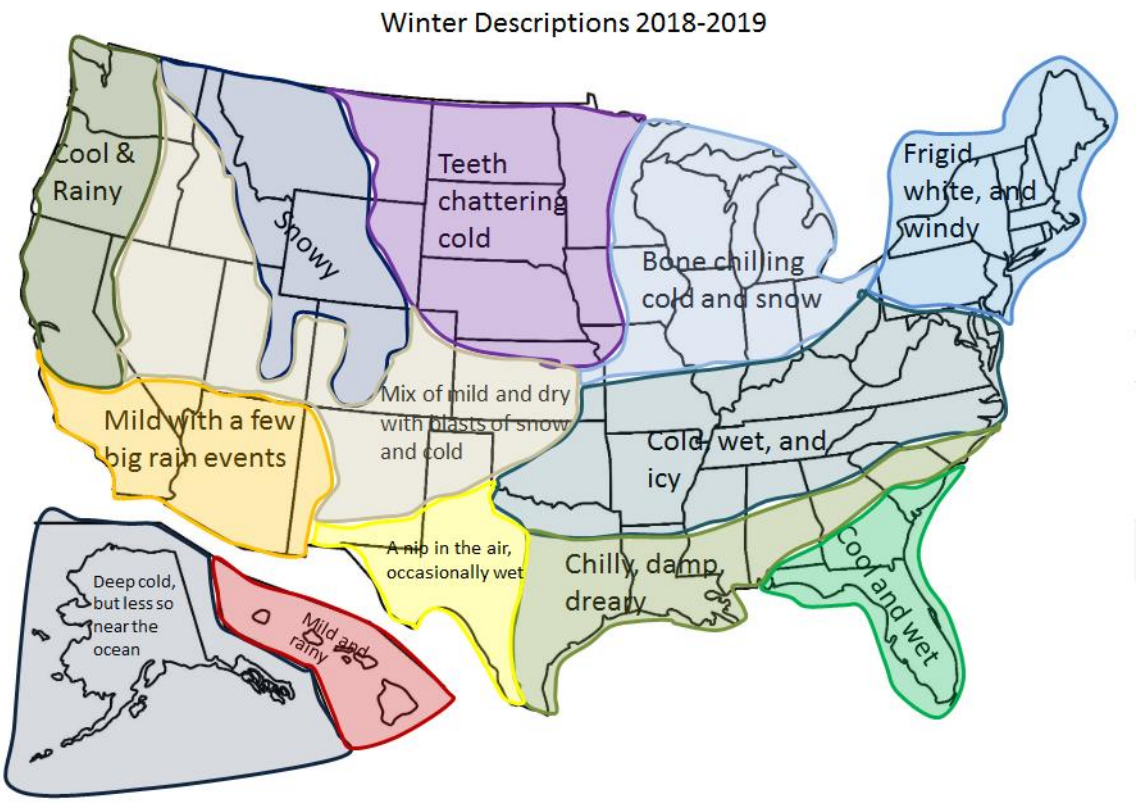
when somebody asks about the winter forecast in October. The feeling is especially strong this year. To be honest, I have no idea what this winter will bring.

Seasonal forecasting is arguably more difficult that both short-term forecasting and making long-term climate projections. Why is this? To understand, let's think about each passing weather system as a roll of a die. Imagine trying to predict these rolls. Your forecast for this weekend is like predicting one roll, but to do so, you get to use a model that has detailed information about the die's momentum, and has some understanding of how it will bounce. Your model, albeit imperfect, allows you to forecast one roll much better than guessing randomly. In the real world, this is accomplished using land surface, weather balloon, and satellite data as well as supercomputers with momentum and thermodynamic equations. Making long term climate projections is like being asked to predict how the average of hundreds of rolls of the die will change over time. Thankfully you're no longer predicting individual rolls; that's good because it would be impossible to say skillfully that you'll roll a six 40 years and 5 days from now. But you might have some idea of how the die's loading is being changed, and be able to say that the average roll will go from a 3.5 to a 3.8.

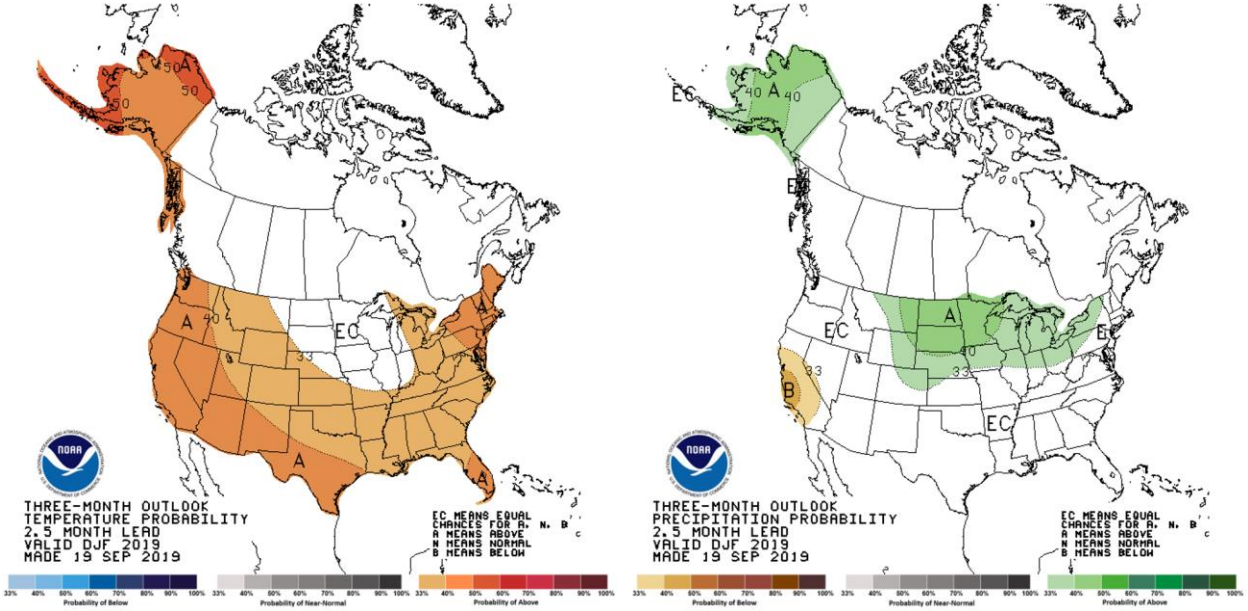
Giving a seasonal forecast is like predicting the net result of ten rolls of the die. Sure, your model can provide information about the first two rolls. One sensible strategy is to build what your model knows about the first two rolls into your forecast, and bet on average rolls from there on out. This strategy is still problematic; the net result of ten, or even eight rolls is highly variable. You could easily roll low or high for a series of four or five rolls and suddenly the forecast is very wrong. Furthermore, let's suppose "average" was the correct forecast. Was that obtained by rolling 3's and 4's, or 1's and 6's? A long run of average weather, vs a back-and-forth between heat waves and cold spells might not impact the average, but it makes a large difference in how people experience a season. Seasonal precipitation forecasting is even more difficult than temperature forecasting. In Colorado, a season is often made or broken by two or three good storms we can "hang our hats on." So imagine that rather than "1,2,3,4,5,6" the sides of your die are "0,0,1,2,4,10."

But Peter, don't we know anything about how the metaphorical dice might be loaded on a seasonal basis? The atmosphere may be chaotic, but after all, it responds to oceanic and land surface patterns, doesn't it? That is true. One of our go-to tricks for winter forecasting you've probably heard of, the El Niño Southern Oscillation (ENSO). Sea surface temperatures over the central Pacific impact what weather patterns are most likely to set up over the US, particularly in winter. However, circulation models are suggesting this winter will be neither El Niño nor La Niña. Admittedly, forecasting skill based on ENSO in Colorado is modest, but making a winter forecast in a neutral year is more of a craps shoot than usual.

What about the Farmer's Almanac? It's not a scientific tool, but it will often appear accurate. How is that possible? Typically, the Farmer's Almanac utilizes descriptive, but non-scientific, language to describe how the climate of different regions of the US normally behaves in winter. Its skill can't be scientifically evaluated, but will likely ring true in our memories. Here's an example I cooked up last year using January climate normal maps, and a little bit of seasonal forecast guidance from NOAA's Climate Prediction Center. The "Winter Descriptions 2018-2019" map was NOT AN ACTUAL FORECAST; it's just an example of how somebody who understands a little bit about climatology can easily rip off the Farmer's Almanac. Is predicting "teeth chattering cold" for winter in North Dakota really a risk?



What does a real seasonal forecast look like? Below is an example: It's the NOAA Climate Prediction Center's outlook for this coming December, January, and February. What the map shows is the probability of temperature (left) and precipitation (right) being above or below normal. Increased probability of above normal temperature is shaded in oranges and reds, below in blue. Increased chance of above normal precipitation is shown in greens, below in browns. For average December-February temperature to qualify as "above normal" it must be in the upper tercile, or top third of the historic distribution. To qualify as "below normal" temperature or precipitation must be in the lower tercile, or bottom third of the distribution. The orange shading in CPC's temperature forecast means there is a greater than 33% chance that winter temperatures will be in the upper tercile. We see up to a 50% chance of upper tercile temperatures in northern and western Alaska. The white-shaded area represent "EC," or "equal chances" of above and below normal. We like to call this "equally clueless!"



I couldn't tell you exactly how these forecast are produced, but know enough to be dangerous. They use physical and statistical models to gain insight into how sea surface temperature patterns and land patterns will "load the dice" or "stack the deck" for the next series of weather systems. Long-term trends are an important ingredient in the forecast as well. Let's talk about that Alaska example. Confidence in above normal temperatures is bolstered because offshore ocean temperatures around Alaska are much warmer than normal right now. That will delay sea ice formation, and likely influence their winter. Remember all of this information is relative to what is normal. Alaska will not be warm this winter. Don't pack your swimsuit for a Barrow, AK getaway just yet!

Fall Colors Pictures? Well then, seasonal forecasting turned into a bit of a rant, now didn't it? How about those beautiful fall colors?! Fall foliage colors "peak" in late September at high elevation, and in early-to-mid October down in the valleys. Every year is different, but here is a webpage that shows when "peak" colors are predicted across the county in an average year: https://smokymountains.com/fall-foliage-map/. Have you been on an excursion to see the changing leaves? Do you have pictures to prove it? We would love to see them!