Jet Stream Jargon

National Weather Service
Billings, MT

October 2017 Fall Issue

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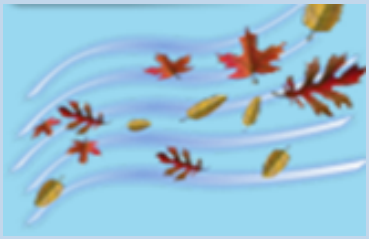


From the Desk of the Meteorologist in Charge

As I write this article, I'm struck by the fact that the perspectives I share below are very common to those that I shared last fall about this same time.

Last September, I was discussing the quick transition from hot summer days to cool, cloudy fall weather during the month of September. I also mentioned the welcome moisture in September, a secondary wet period across the Northern Rockies, which helped squelch the wildfire threat and also provided moisture we missed in April, May and June. Well, what do you know - we saw the same sort of transition this year during the overnight hours of September 13th, going from daytime high temperatures mainly in the 80s and 90s leading up to September 13th, down to the 40s, 50s and 60s in the period after that. This moisture certainly didn't make up for the complete moisture deficit across many portions of eastern Montana from April through August, but it did help dampen existing wildfires and defer the threat for new ones at least for a while. The September transition is so typical of the climatology of the Northern Rockies. Not every September sees this sort of transition, but the vast majority of them do. As we continue through the fall season, we will see each of the subsequent months bring us another stair-step transition toward winter.

Looking back over the last six months, we certainly experienced an unusually dry spring and summer, with severe thunderstorm activity being very minimal. Despite the phenomenal amount of snowpack in the mountains this past spring, the absence of typical spring rainfall across the area allowed the snowpack to melt off with very little impact in most areas, other than the high flows we anticipate each spring from May through June.

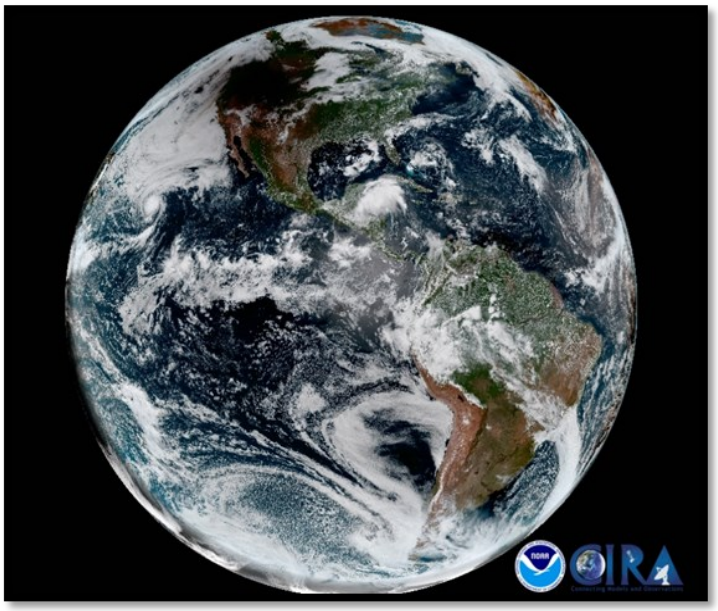
As we contemplate what the remainder of fall and winter may have in store for us, you'll find some information later in the newsletter to help you understand what our seasonal forecasts suggest. Keep in mind that the Fall and Winter Outlooks sometimes cannot provide a strong signal as to what to expect for the upcoming season. In these cases, the honest answer is that we really can't say with any certainty. You'll find some sources of information that may be willing to be more specific, but keep in mind there may be little or no science behind some of the predictions you may find floating around the internet.

I again want to thank the countless volunteer weather observers (COOP, CoCoRaHS) and spotters that help us in the quest to deliver on our mission of protection of lives and property and the enhancement of the national economy. I also want to remind everyone that we are here 24x7x365 to answer any weather, water and climate questions you may have. If the forecast isn't making sense – give us a call; we'd be happy to provide more detailed information to help you make a decision based on the forecast. Also, feel free to engage us via social media (i.e. Facebook or Twitter). We provide a wealth of information via these mediums as well.

Keith W. Meier

The 2017 Great American Solar Eclipse

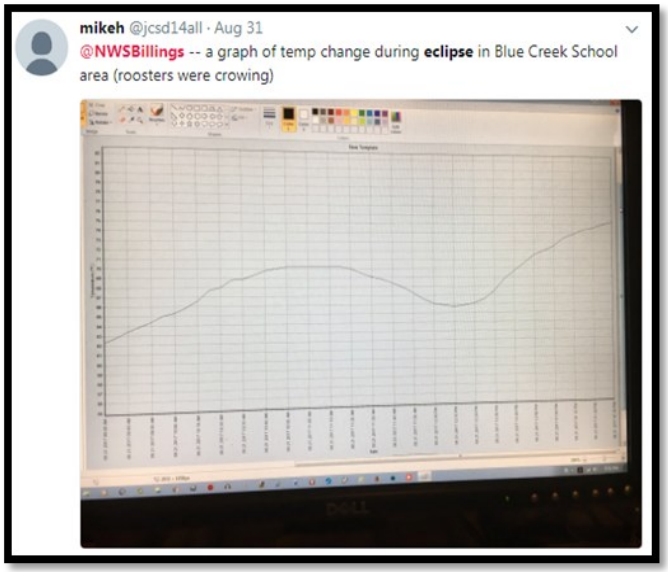
Submitted by Wright Dobbs



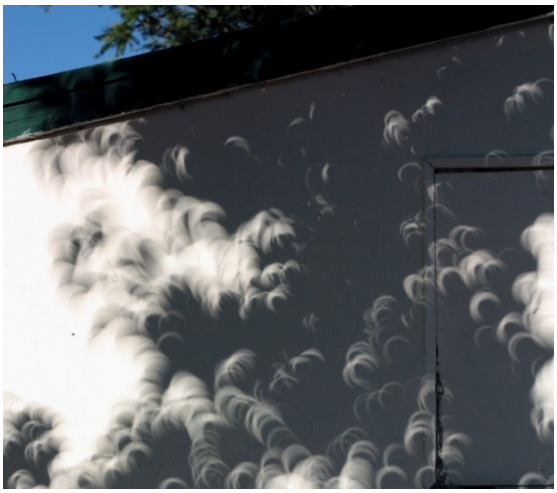
The shadow of the eclipse makes its way across North America. In this image it is currently over the northwestern US.

The Total Solar Eclipse of August 21, 2017 brought a once in a lifetime experience for many folks across the United States. Unlike its cousin, the lunar eclipse, the effects of a solar eclipse are much more noticeable to the observer. Most of us, in our forecast area, experienced 90 to 95% coverage of the sun during the moment of maximum eclipse. In this article we'll go through two interesting observations the majority of folks from our region experienced.

One thing people noticed about the solar eclipse was the drop in temperatures leading up to, and during, the maximum eclipse. Folks in Billings noted a several degree drop in temperatures as the eclipse moved over the region. One of our Facebook followers noted that she needed to put a sweatshirt on during the peak eclipse. One of our Twitter followers in Billings created a graph (right) to show the drop in temperatures at his location as the eclipse moved on by. Cool stuff! Some of our neighbors to the south in Wyoming, under the totality, reported temperature drops as much as 10 degrees.



One of our Twitter followers showed us the drop in temperatures of around 2 to 3 degrees at the point of maximum eclipse. Thanks Mike!



Crescent shadows beneath the trees mimic the solar eclipse as it progresses.

Another cool observation, many folks reported, was oddly shaped shadows on the ground/objects beneath trees. These shadows are caused by the same phenomenon that allows you to see the solar eclipse through a pinhole camera. As the sun's light moves through the very small space in between the tree leaves, the light from the sun then shows up as a circle on whatever object is beneath the tree, much like a dot of light appears on the back of a pinhole projector. As the eclipse progresses, the dot of light beneath the tree begins to become darker, and appear more crescent-like. At the maximum eclipse, many shadows beneath the trees appeared like the one in the photo on the left. If you want to make your own pinhole projector for future solar eclipses, check out the NASA website below:

https://www.jpl.nasa.gov/edu/learn/project/how-to-make-a-pinhole-camera/

CoCoRaHS & Spotter Networks

Submitted by Vickie Stephenson

Happy Fall Everyone!

Another summer has come and gone. Wow, it was hot and dry, but we appreciate the precipitation reports, though few and far between, due to our extremely dry conditions. Your reports are very important to our nation's climate!

Pictured from left to right: Virgil Middendorf, Vickie Stephenson, Wright Dobbs, Shawn Palmquist, Tom Frieders, Henry Regis

This summer our office was happy to host the Community, Collaborative Rain Hail and Snow Network (CoCoRaHS) National Coordinator, Henry Regis, from Fort Collins. Henry conducted an informative presentation for our staff. We appreciate the time and effort Henry spent with us. Thanks, Henry!

HELP WANTED: Weather Spotters and CoCoRaHS Observers across SE Montana & Sheridan County, Wyoming

We are looking for precipitation observers to fill in some major gaps across our area, i.e. Northern Rosebud, Wheatland, Big Horn, & Northern Yellowstone counties. Sign up and join the fun! As a CoCoRaHS observer, you would be reporting your precipitation (rain, hail, & snow), electronically, to the National Weather Service. The data received from you will be used by many important agencies and individuals alike, including Emergency Managers, insurance adjusters, farmers and ranchers, just to name a few. So if you would like to make your mark on our nation's climate history, read below and see how to join.

The CoCoRaHS program network can be found at www.cocorahs.org, where you can learn all about the program, its origin, and its importance to our nation's climate. If you are interested in joining us, please feel free to open the web page, review the short training videos and click on "Join CoCoRaHS" under the Main Menu. I am the local coordinator for the program here in Billings. Feel free to contact me at the phone/email listed below, if you have any questions at all. Currently, I am working with our State Climatologist in Missoula (UM) for rain gauge sponsorship. Some rain gauges have been procured with grant money and our observers may need only pay a minimal shipping cost. For Wyoming observers the WY State Climatologist is providing gauges for Sheridan County observers.

Current & New CoCoRaHS Observers

Thank you all for your continued dedication in reporting your precipitation, ***and*** lack thereof, every day of the year. Our CoCoRaHS Network in southeast Montana & northeast Wyoming continues to have the best reporting record across the region, thanks to you all. Once again it is time to prepare for the winter season. Once you learn the first snowfall is on the way, set out your snowboards, and remove your tubes and funnels from your rain gauges, leaving only the canister. This should be done by mid-October, possibly earlier if the snow flies early, like this year. For a quick refresher on measuring snow, click here to watch the 5-minute snow measuring video.

Feel Free To Contact Us:

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tom.frieders@noaa.gov
Work Phone 406-652-0851 ext 2

COOP Corner

Submitted by Larry Dooley

University of Wyoming, Sheridan Research and Extension Center, Serving Sheridan, Wyoming and Surrounding Areas For Over 100 Years!

NOAA's National Weather Service (NWS) presented a 100 year Honored Institution Award to the University of Wyoming, Sheridan Research and Extension Center in Sheridan, Wyoming. This Award is presented for outstanding service in the Cooperative Weather Observing Program for more than 100 years.

Pictured left to right: Brian Mealor, Rochelle Koltiska, Dan Smith, Bret Hess, Jeff Zimmerman, Marc Singer, and Mike Albrecht

Jeff Zimmerman, Chief of the Integrated Services Division of NWS Western Region Office in Salt Lake City, along with Science and Operations Officer Marc Singer, Observing Program Leader Larry Dooley, and Hydrometeorological Technician Vickie Stephenson, from the NWS forecast office in Billings, MT, presented the award to Dr. Bret Hess and the staff in a July ceremony, at the UW Watt Agriculture Building.

This Cooperative station is located at Wyarno and is one of the oldest stations in Wyoming. In it's 100 year history, the staff has taken more than 38,000 daily observations, with a variety of extremes. This area has experienced temperatures ranging from a low of 44 degrees below zero in December of 1989, to a very hot 109 degrees in July of 2002. Precipitation extremes include a record daily rainfall of 2.85 inches in July of 1948 and a record daily snowfall of 17 inches in March of 2011.

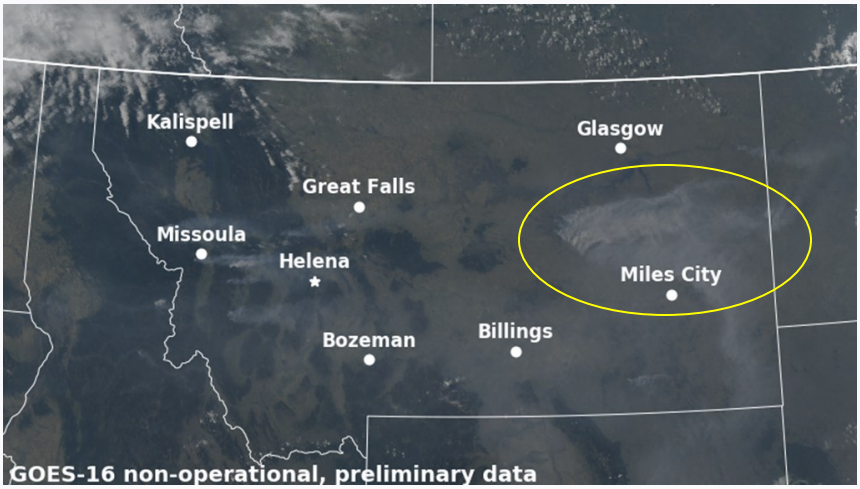
This station is also one of only a few in the region that are part of the Historical Climate Network (HCN), producing a high quality data set of daily and monthly records. The HCN is a network of stations providing basic meteorological variables from 1218 observing stations across the 48 contiguous United States.

The pictures to the right show some of the standard equipment used for these stations. From left to right they include; a Maximum/Minimum Temperature System, a Standard Rain Gauge, and a Fisher Porter Rain Gauge (weighing precipitation as it falls in a large bucket).

Fire Weather - A Summer of Fire & Smoke

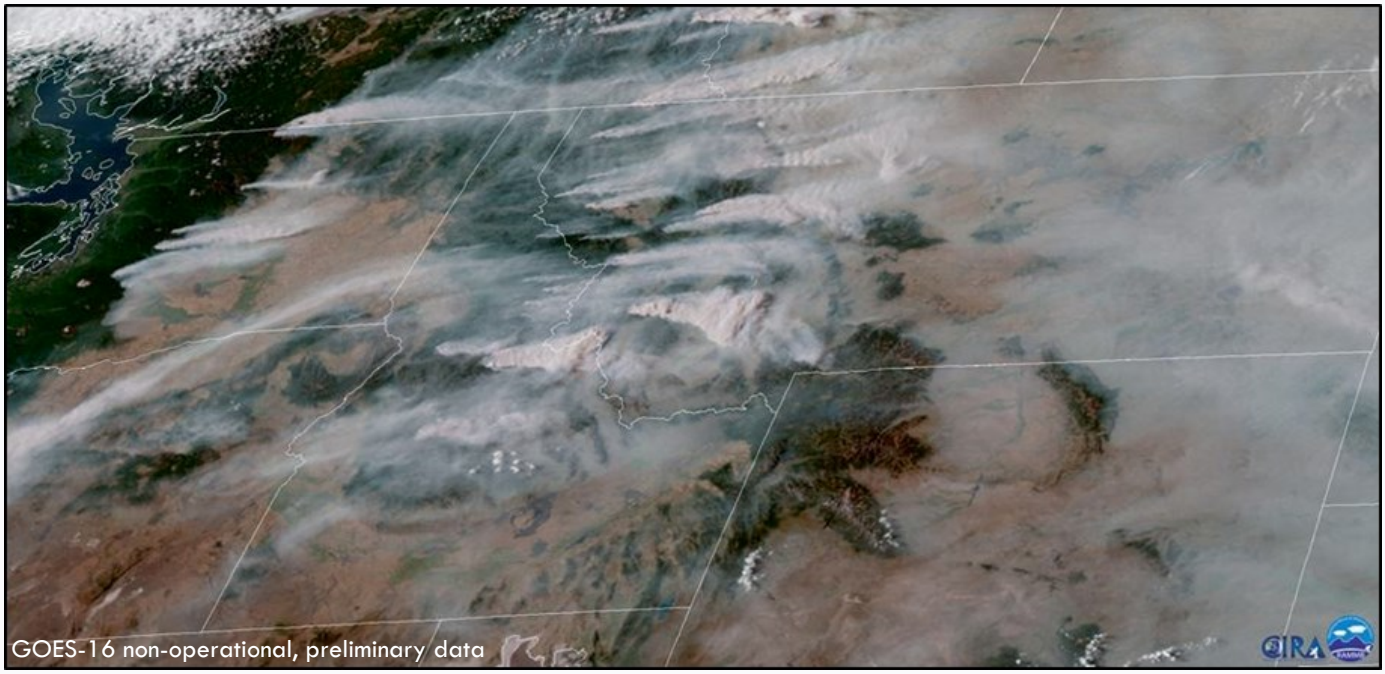
Submitted by Nickolai Reimer

Wildfires, flash drought, air quality alerts, are words that described our past summer. Last winter may have been a wet one for much of the area, but by late spring and early summer, that abundance of moisture was gone. Drought developed in a couple of months due to the lack of rainfall and hot conditions, during what is normally the wettest time of year. This kind of drought is known as a "flash drought," and set the stage for a very active fire season. Over 1 million acres burned this year in Montana, making it one of the most extreme fire seasons in the past two decades. Many of the fires were west of the Continental Divide, but eastern Montana also had it's share. One such fire, the Lodgepole Complex, southwest of Glasgow, burned over 200,000 acres.



July 21, 2017: Satellite image showing smoke from the Lodgepole Complex

Montanans are accustomed to hazy summer days with a little smoke lingering in the air. Then there are those days where it smells like a camp fire, and its more than haze. On these days you may start to think there must be a fire nearby, but this may not always be true. The Lodgepole Complex pictured above produced unhealthy air quality over 150 miles away in Broadus after midnight on July 22nd. The fires burning between Missoula and Helena were also producing smoke plumes well to the east of the fires. Smoke from west of the Divide, Idaho, and even British Columbia can be blown by the wind into eastern Montana. In the picture below, thick smoke plumes are visible all across the Pacific Northwest, pushing smoke into all areas of the Northern Rockies. Mountain valleys, like those around Missoula, can trap the smoke, making the air quality even worse and lasting for long periods of time.



September 2, 2017: Satellite image of smoke plumes across western Montana, northern Idaho, southern British Columbia

Fire Weather - A Summer of Fire & Smoke...cont'd

The Montana Department of Environmental Quality (DEQ) tracks the amount of fine particles, including smoke in the air at several locations across the state. The department will also issue Air Quality Alerts when the amount of smoke exceeds the National Ambient Air Quality Standard, which is unhealthy for those with conditions such as asthma.

The Department of Environmental Quality uses these air quality categories:

Good: No health impacts are expected when air quality is in this range.

Moderate: Unusually sensitive people should consider limiting prolonged outdoor exertion.

Unhealthy for Sensitive Groups: Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.

Unhealthy: Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children, should limit prolonged outdoor exertion.

Very Unhealthy: Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.

Hazardous: Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.

The current air quality conditions across the state can be found at:

http://svc.mt.gov/deq/todaysair/AirDataMap.aspx

Smoke from area wildfires led to colorful sunrises, sunsets, and even affected the color of the Moon.

September 2, 2017: Smoke colored Moon over Billings. Photo by Nickolai Reimer

Summer Review

Quiet Season For Severe Thunderstorms Leads To Extreme Drought

The Spring and Summer of 2017 will go down as one of the quietest severe thunderstorm seasons on record for the region. This was good news in terms of the lack of typical damage the area receives from such storms. However, these same thunderstorms would have also brought beneficial rains, so the quiet thunderstorm season translated into worsening drought conditions.

July 10, 2017: High winds produce tree and house damage in Miles City. Photo by Big Sky Weather

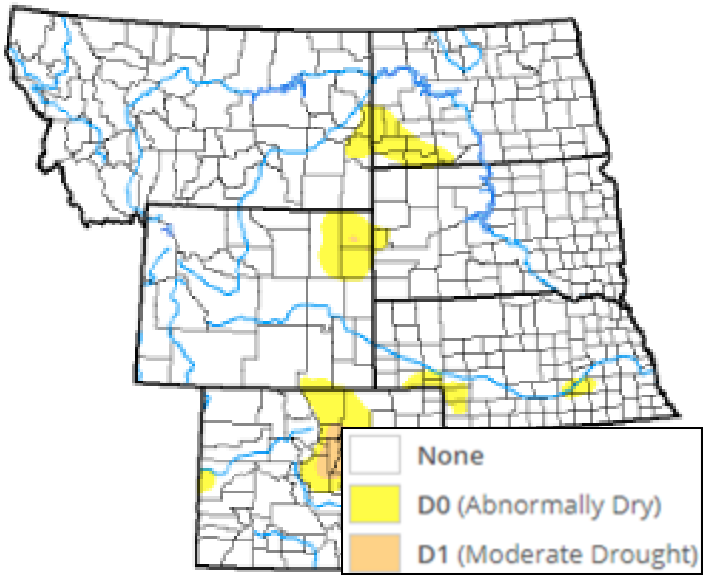
Our NWS Office in Billings issued just 31 Severe Thunderstorm Warnings this season. This is well below the average when nearly 120 warnings are issued in a typical season. This is the second quietest season on record over the past 25 years, ranked just behind 2012 when only 29 warnings were issued.

There were 12 reports of large hail received. The largest hailstone reported was 1.5 inches in diameter on July 10th, reported near Pine Creek, south of Livingston, MT.

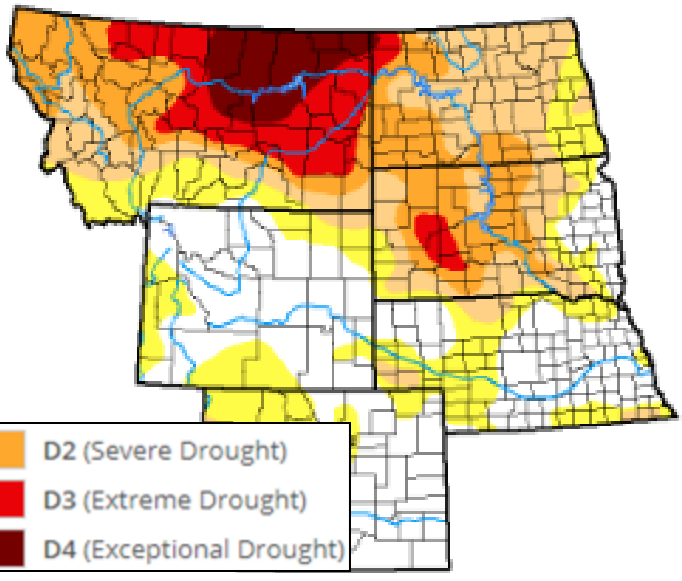
There were 37 reports of damaging microburst winds. Miles City seemed to receive the brunt of these storms throughout the season. One such storm in Miles City on July 10th produced a peak wind gust of 71 mph, downing trees and powerlines and even starting a wildfire due to the dry vegetation.

Drought conditions expanded rapidly across the region this summer given the lack of appreciable precipitation. Besides the impacts of wildfires, there were considerable impacts to crops and livestock for the agricultural community. Below are two maps showing the progression of the drought from early May to the end of September. You can monitor the latest drought conditions at: http://www.drought.gov

Drought Monitor:
May 2, 2017



Drought Monitor:
September 19, 2017



From the Hydrology Desk

Submitted by Todd Chambers

A heavy mountain snowpack (Yellowstone River Basin 182 percent of normal on June 1st) late in the spring raised concerns for river flooding across the Northern Rockies heading into the snowmelt runoff season. Locally, the Clarks Fork of the Yellowstone River was the main concern, draining the southern Beartooth/Absaroka Mountains (164 percent of normal). Other rivers and streams flowing across southern Montana had at least some potential for flooding but would need ideal conditions to spill out of their banks.

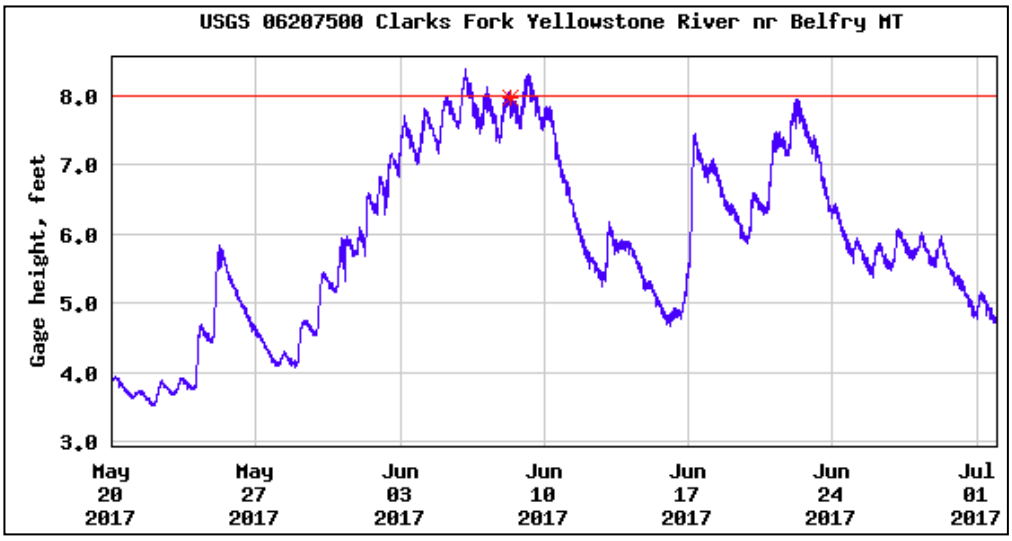
The snowpack over Wyoming was particularly heavy, with record amounts documented in the Wind River Range in the central portion of the state. This heavy snowpack over central Wyoming prompted record releases from Yellowtail dam into the Bighorn River starting very early in the spring in an effort to keep releases in the summer from flooding areas downstream as this record snowpack melted. By April 27th, releases were at 4 times normal levels. Flows were high enough that Paddle Fish were caught by trout anglers on the upper river near Ft. Smith. By August 1st the Bureau of Reclamation reported that inflows into Bighorn Lake had reached 270 percent of normal, at just under 3 million acre-feet of water. This was the highest inflow on record since the dam was established in 1967. The Bighorn Mountains trailed the rest of the state in snowpack until March when a series of wet storms boosted snowpack to above normal levels for the Tongue and Powder River drainages.

Flooding of most rivers and streams across our area requires a combination of events (Snowpack/Temperatures/Precipitation/Soil Moisture) to come together in just the right way, and at just the right time. The snowpack this season was certainly heavy enough to produce flooding if prolonged hot temperatures developed, and/or if strong storm systems produced widespread heavy rainfall.

June 5, 2017: Swollen Boulder River

Fortunately for us, this combination of events did not materialize and the snowpack melted out in a gradual enough manner to avoid big flushes of water. The wet winter/spring quickly transitioned to a dry pattern that saw no prolonged heavy rainfall events, with drought conditions developing as the summer progressed. The lack of rainfall on top of snowmelt swollen rivers and streams kept the vast majority within their banks.

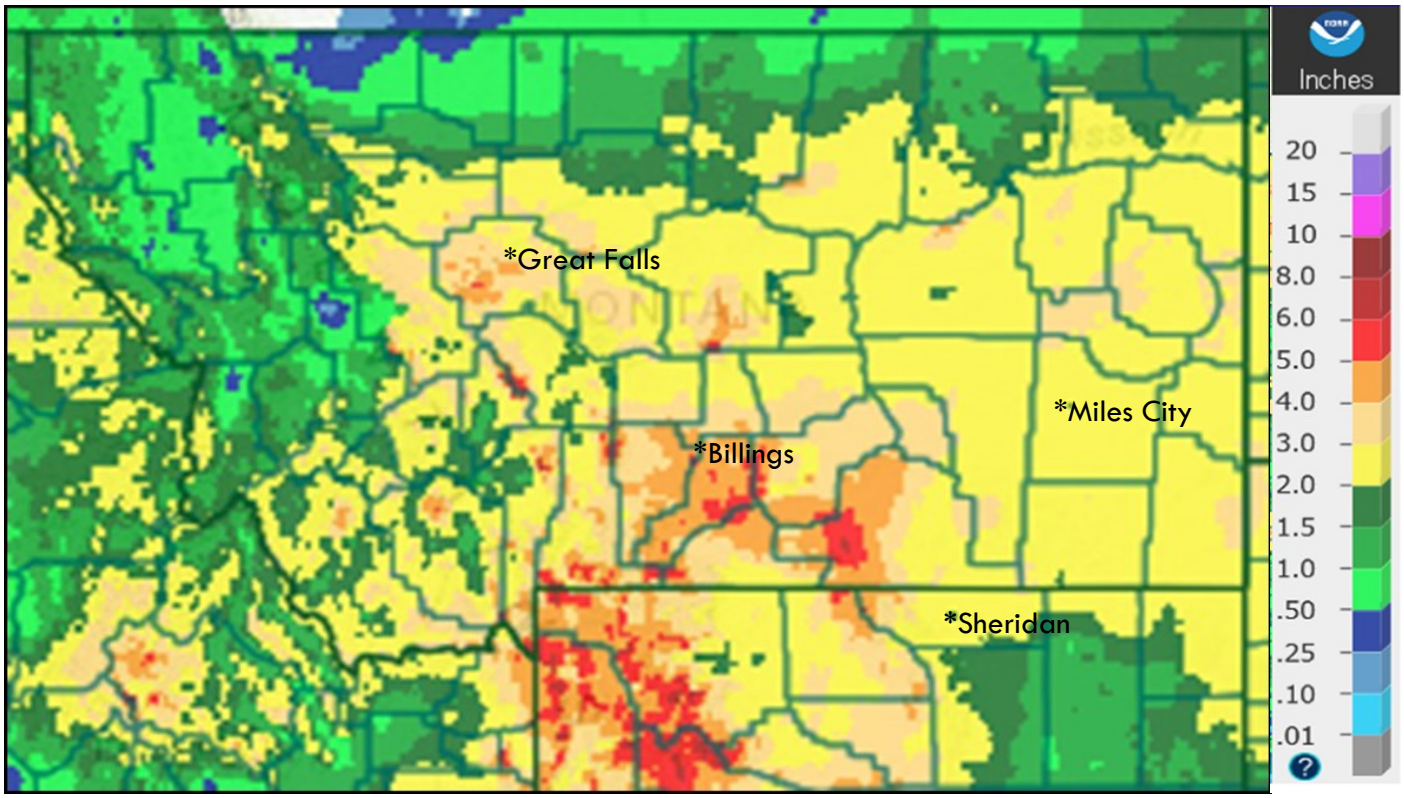
From the Hydrology Desk...cont'd



May 20 to July 1, 2017: USGS Hydrograph of the river stages on the Clarks Fork Yellowstone River Near Belfry, MT. Red line denoting the Flood Stage.

There was some minor flooding reported along the Clarks Fork of the Yellowstone, the Stillwater, and the Boulder Rivers, and most rivers and streams saw very high flows through the runoff season. Thankfully, no significant damage was reported from this flooding. There were some reports of bank erosion encroaching on homes in some locations including along the Yellowstone and Bighorn rivers.

As summer came to a close, several fall storm systems brought welcome precipitation to the region mid-September, bringing an end to the worst of the fire season. This precipitation added the first snowpack of the season, to the mountains, helping to recharge groundwater depleted by the dry summer.



September 11-25, 2017 Observed Precipitation. Shades of yellow, orange and red are observed precipitation of greater than 2 inches.

Fall and Winter Data Tables

Fall Normals

Meteorological fall is considered the months of September, October and November. Here are the normal temperatures and precipitation for Billings, Miles City and Sheridan for the fall season. Normals are 30-year averages calculated from 1981 to 2010. All temperatures are in degrees Fahrenheit and all precipitation amounts are in inches.

Billings					
Date	**High**	**Low**	**Average**	**Precipitation**	**Snowfall**
9/1 – 9/30	73.1	47.5	60.3	1.30	1.1
10/1 – 10/31	59.4	37.1	48.2	1.18	4.1
11/1 – 11/30	45.3	26.3	35.8	0.63	6.5
9/1 – 11/30	59.3	37.0	48.2	3.11	11.7

Miles City				
Date	**High**	**Low**	**Average**	**Precipitation**
9/1 – 9/30	74.2	46.1	60.1	1.08
10/1 – 10/31	59.2	33.8	46.5	0.92
11/1 – 11/30	43.2	20.9	32.0	0.39
9/1 – 11/30	59.3	34.7	47.0	2.39

Sheridan				
Date	**High**	**Low**	**Average**	**Precipitation**
9/1 – 9/30	74.2	41.6	57.9	1.43
10/1 – 10/31	60.1	30.9	45.5	1.41
11/1 – 11/30	45.9	19.4	32.7	0.71
9/1 – 11/30	59.9	31.5	45.7	3.55

Fall and Winter Data Tables...cont'd

Winter Normals

Meteorological winter is considered the months of December, January and February. Here are the normal temperatures and precipitation for Billings, Miles City and Sheridan for the winter season. Normals are 30 year averages calculated from 1981 to 2010. All temperatures are in degrees Fahrenheit and all precipitation amounts are in inches.

Billings					
Date	**High**	**Low**	**Average**	**Precipitation**	**Snowfall**
12/1-12/31	35.2	17.8	26.5	0.50	8.2
1/1-1/31	36.4	17.8	27.1	0.48	8.4
2/1-2/28	40.2	20.6	30.4	0.48	6.2
12/1-2/28	37.2	18.7	28.0	1.46	22.8

Miles City				
Date	**High**	**Low**	**Average**	**Precipitation**
12/1-12/31	30.9	9.7	20.3	0.29
1/1-1/31	30.0	8.9	19.5	0.32
2/1-2/28	35.5	13.2	24.4	0.23
12/1-2/28	32.4	11.5	22.0	0.84

Sheridan				
Date	**High**	**Low**	**Average**	**Precipitation**
12/1-12/31	35.2	10.6	22.9	0.56
1/1-1/31	36.2	11.4	23.8	0.56
2/1-2/28	39.0	14.2	26.6	0.54
12/1-2/28	36.7	12.9	24.8	1.66

Average Frost and Freeze Dates

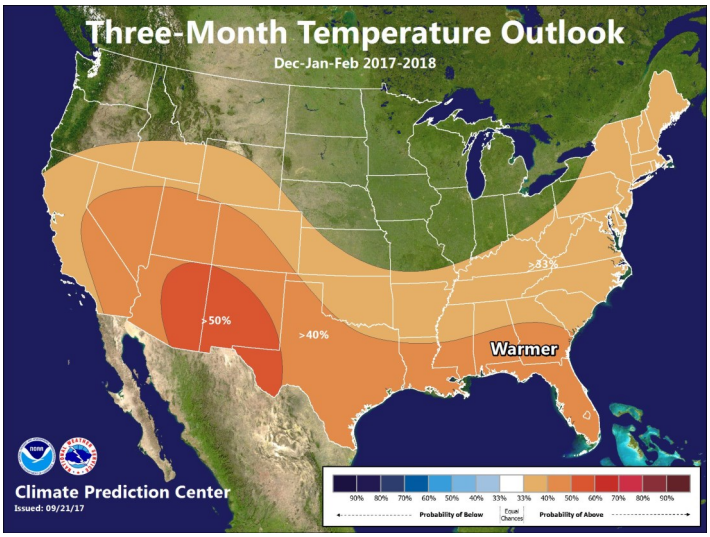
The following are the normal first frost, freeze and hard freeze dates for Billings, Miles City and Sheridan. The frost temperature is based on 36 degrees Fahrenheit, the freezing temperature is based on 32 degrees Fahrenheit and the hard freeze temperature is based on 28 degrees Fahrenheit. The normal dates are based on a 30 year average from 1981 to 2010. The earliest frost, freeze and hard freeze dates are based on a period of record. Recordkeeping began for the Billings Airport in 1934, the Miles City Airport in 1937 and at the Sheridan Airport in 1907.

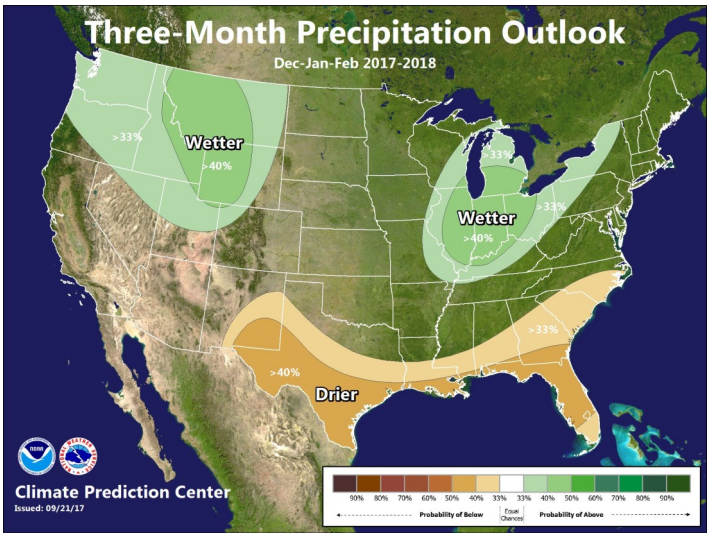
City	Normal First Frost	Earliest Frost on Record	Normal First Freeze	Earliest Freeze on Record	Normal First Hard Freeze	Earliest Hard Freeze on Record
Billings	Sep 24	Aug 24	Oct 4	Sep 4	Oct 11	Sep 11
Miles City	Sep 21	Aug 22	Sep 29	Sep 2	Oct 7	Sep 11
Sheridan	Sep 11	Jul 2	Sep 20	Aug 17	Oct 3	Aug 25

Winter Outlook

2017-18 Winter Outlook

The official December-January-February outlook from the Climate Prediction Center, issued on September 21st, calls for equal chances of near, above or below normal temperatures, and a hedge toward wetter than normal conditions across our region. The primary reason for this outlook is the relatively cooler sea surface temperatures in the tropical eastern Pacific Ocean. A weak La Nina is possible for the second season in a row, which historically favors a stronger polar jet stream and increased storminess across the northern Rockies during the winter. Due to our location on the eastern slopes of the mountains (regardless of whether or not La Nina develops), the climatology of our winter season is characterized by alternating periods of cold and snowy Canadian air, and warm and dry chinook winds. As always, be prepared for both extremes during the upcoming winter.





Prepare For Winter! Build Your Emergency Supply Kit!

Information Stop

Learn More About the National Weather Service
http://www.weather.gov/about/

Winter Weather Information & Safety
http://www.nws.noaa.gov/om/winter/index.shtml

Red Cross Winter Storm Safety Checklist
http://www.redcross.org/images/MEDIA_CustomProductCatalog/m4240231_WinterStorms.pdf

CDC Extreme Cold Prevention Guide
https://www.cdc.gov/disasters/winter/index.html

Climate Prediction Center Outlooks
http://www.cpc.ncep.noaa.gov/

Local Climate Records
http://www.nws.noaa.gov/climate/index.php?wfo=byz

Kids!

NWS Education
http://www.weather.gov/owlie/

Owlie Skywarn Winter Weather Book
https://www.weather.gov/media/owlie/owlie-winter.pdf

Winter Safety Quiz
https://www.meted.ucar.edu/emgmt/wxreadynation/launch.htm?course=elementary&lesson=winter

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