From the Desk of the Meteorologist In Charge

John Wetenkamp

Welcome to the Spring season and the variety of weather it brings to our region! For those of you that may not know me I moved into the Meteorologist In Charge position from Science and Operations Officer position late last spring following the retirement of Keith Meier. Thank you all for your reports throughout the year and know that these are vital to the National Weather Service Mission. I hope to see you all over the coming years at local spotter training events, office visits, or perhaps speak to you over the phone during impactful weather events.

We have had some additional staffing changes over the past year due to retirements and promotions. Please welcome our new Science and Operations Officer, Robert Setzenfand, and Warning Coordination Meteorologist, Nick Vertz. Bob and Nick were both promoted from on-station and we are excited to have them onboard in their new Management positions.

Late last summer the NWS Billings WSR-88D radar underwent major upgrades including a generator and pedestal replacement. This work was part of four major upgrades that will ensure our radar continues to operate reliably well into the 2030's. A time-lapse of the pedestal swap can be viewed here: https://youtu.be/FJnOwrQJNNI

Our team at NWS Billings put together an excellent overview of our office. If you are interested in learning more about our office and local area please check out our office storymap here: https://storymaps.arcgis.com/stories/dccc3dd63e7845518ca657b559652097

I hope you find the articles in this version of Jetstream Jargon interesting and informative. We welcome your feedback on this publication as we are considering some changes. Please reach out to us via email or give us a call if you have comments or questions: nws.billings@noaa.gov.

Observing Program Leader

Kurt Hooley

2023 was another great year in the COOP program and I hope this article finds you all well. As always, I enjoyed my annual and bi-annual trips this past year and visiting with those that were home. I also appreciate the occasional pie and coffee or lunch invite during a visit. It is much appreciated and I enjoy hearing about all the happenings with you and your families.

Overall, the weather during the 2023 calving season was cooperative and it was another year of abundant spring and early summer rains. Many locations received close to their annual precipitation between late May and late June. As a result, there was again enough grass for cattle to graze, as well as, water for ponds and reservoirs. In addition, some observers were able to get 2 or 3 cuttings of hay.

Last year I had the honor of presenting the two highest awards in the COOP program, as well as a Family Heritage Award. (Due to COVID, getting the actual awards with signatures was delayed.) Dian Giesick of Bridger, Montana and David Paugh of Ryegate, Montana both received the 2021 John Campanius Holm Award, and Ennis Geraghty of Columbus, Montana was presented the 2022 John Campanius Holm Award. The Holm Award is the second highest award given in the COOP program. Only 25 of these awards are given nationally each year. Dian, David and Ennis all report daily high and low temperature and precipitation. To be nominated for this award, an observer must have a minimum of 20 years as a COOP observer. These observers are meticulous in their reporting and rarely, if ever, miss a day of observations. In addition, letters of reference from members of the community are recommended.

The highest award in the COOP program is the Thomas Jefferson Award. Last year I had the distinct honor of presenting the 2022 Thomas Jefferson Award to Bill Schwarzkoph of Forsyth, Montana. Bill also provides the daily high and low temperature, along with precipitation observations. In order to receive this award, an observer must have already won the John Campanius Holm Award plus have an additional 5 years thereafter as a COOP observer. Only 5 of these awards are given nationally each year and the competition is stiff. As with the John Campanius Holm Award, letters of recommendation from the community are not only encouraged, but expected.

Last but not least, I had the honor of presenting the 2022 Family Heritage Award for 50 years of distinguished service to the Howard Family of Hysham, Montana. The Howards also record the daily high and low temperature, as well as the daily precipitation. This award is granted to a family upon achieving 50 years of continuous cooperative observations. Additional recognition is presented every 25 years thereafter.

I hope you all made it through the winter safely and your spring precipitation is timely. I look forward to seeing and visiting with you again this year. Thank you for the dedication you give to your daily weather reporting for the National Weather Service COOP Program!

Dian Giesick with her 2021 John Campanius Holm Award

David Paugh with his 2021 John Campanius Holm Award (alongside John Wetenkamp Meteorologist-In-Charge, Billings Weather Forecast Office)

Ennis Geraghty with his 2022 John Campanius Holm Award

Bill Schwarzkoph with his 2022 Thomas Jefferson Award

Lee Howard with his 2022 Family Heritage Award

From the Fire Weather Desk

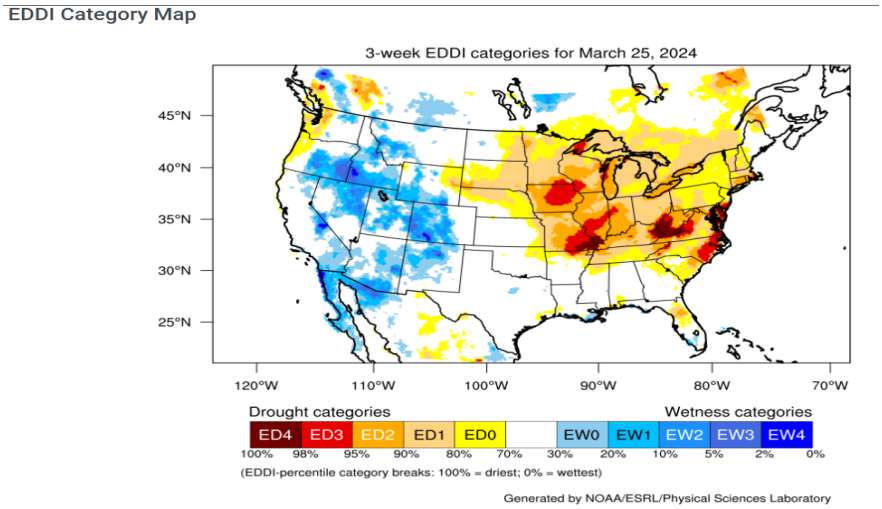
Shawn Palmquist, Lead Meteorologist

Taking a brief look back at the fire season from this past year (2023), fire activity remained low over the area, thanks in part to a cool and very wet June, where some areas saw in excess of 10 inches of rainfall. After a winter that was mostly dry and mild, with expanding areas of drought, we will be dependent on a cool and wet spring in order to lessen the wildfire potential during the upcoming summer.

Pryor Creek Road Fire in Yellowstone County, MT, August 2023 - Courtesy of Larry Meyer - Billings Gazette

One of the tools forecasters can use to help with identifying emerging areas of drought, is the Evaporative Drought Demand Index (EDDI). It takes into account the entire “thirst” of the landscape based on moisture deficits and other elements which dry out the landscape (wind, temperatures, lack of cloud cover etc.). The time scale of the maps can be changed (weeks, months), along with looking at archived images.

The EDDI can be found at: https://psl.noaa.gov/eddi/



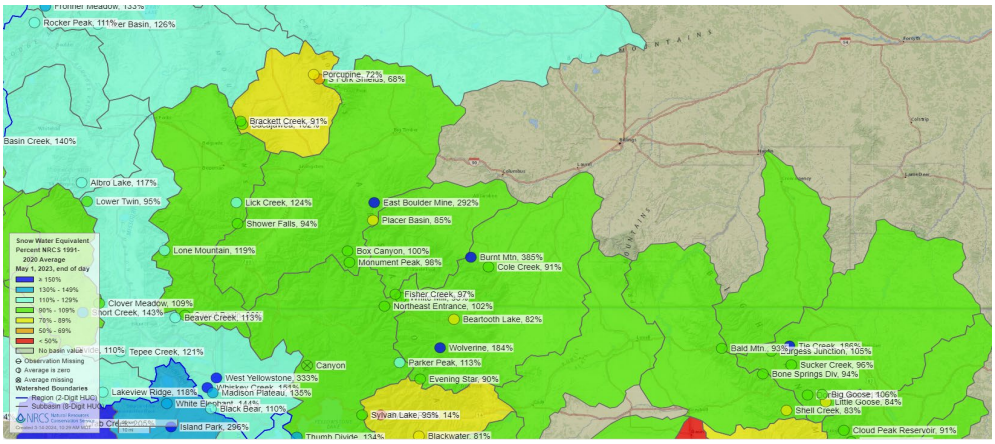
Evaporative Drought Index (EDDI) for the 3-week period ending on March 25, 2024.

From the Hydrology Desk *odd*

Todd Chambers, Lead Meteorologist

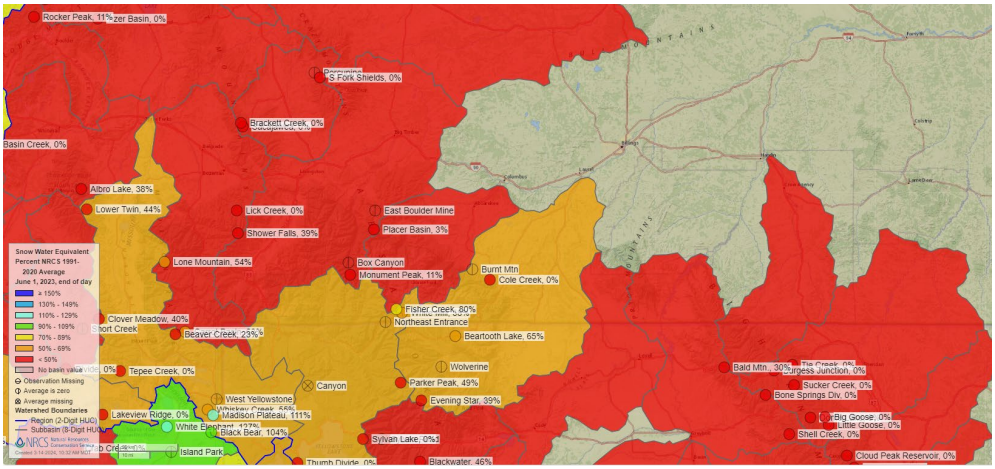
The past year has been active on the hydrology front, though a bit different than what we normally see in the Northern Rockies. Usually, the higher elevations of area mountains drive the water season for our part of the world. However, 2023 was the year of heavy slow-moving thunderstorms producing copious amounts of rainfall, mainly in June but also extending into August.

To start last year the snowpack overall was good, but what really stood out was that while the high elevations were near normal, the lower foothills were really where a well above normal snowpack existed. On May 1st the Beartooth foothills showed 300 to 400 percent of normal snow, and the Bighorn foothills were at 200 percent of normal.



May 1st, 2023 Snow Water percent of average (NRCS Data)

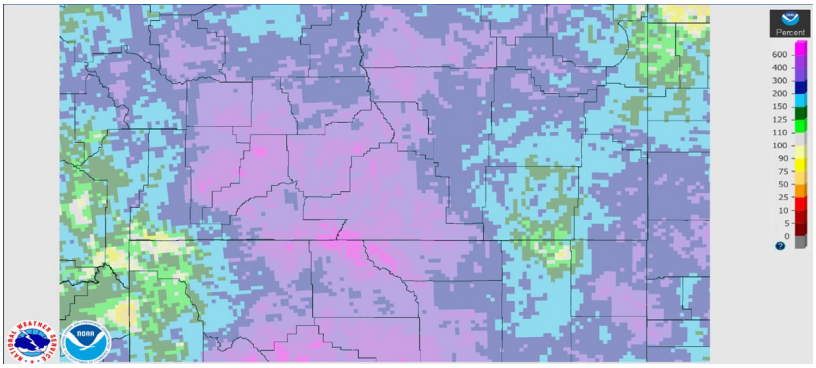
By June 1st, the effects of a warm and dry May melted that excessive low to mid level snowpack quickly, leaving the snowpack well below normal for the date. Luckily, a good deal of the snowmelt percolated into the soil preventing much in the way of flooding impacts despite the rapid melt-off.



June 1st, 2023 Snow Water percent of average (NRCS Data)

The snowmelt worked into area rivers and streams with runoff induced streamflow peaks arriving in the last week of May, a few weeks earlier than normal. We did not see any significant river flooding in 2023 despite the rapid snowmelt, though some smaller creeks and streams did flow out of their banks in a few areas.

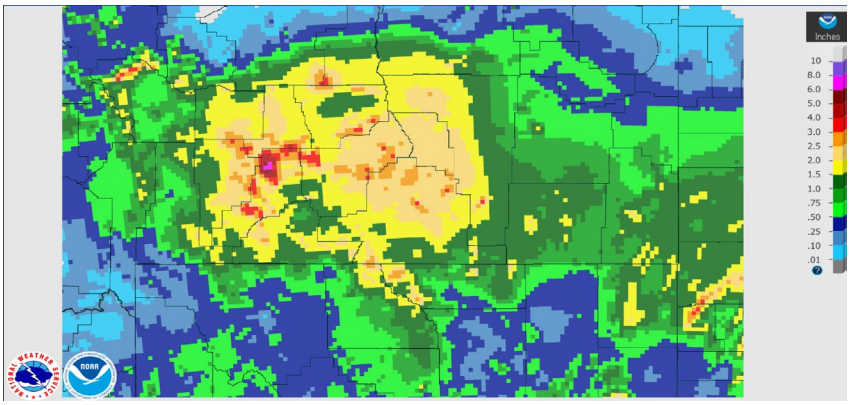
Just as it looked like rivers would fall and we might get into a period with some water worries after that warm and dry May, June arrived with excessive amounts of moisture falling across the forecast area. June precipitation was 300 to 600 percent of normal over a broad area of the forecast area along and west of a Miles City to Ashland line.



June 2023 Percent of Normal Precipitation (NWS)

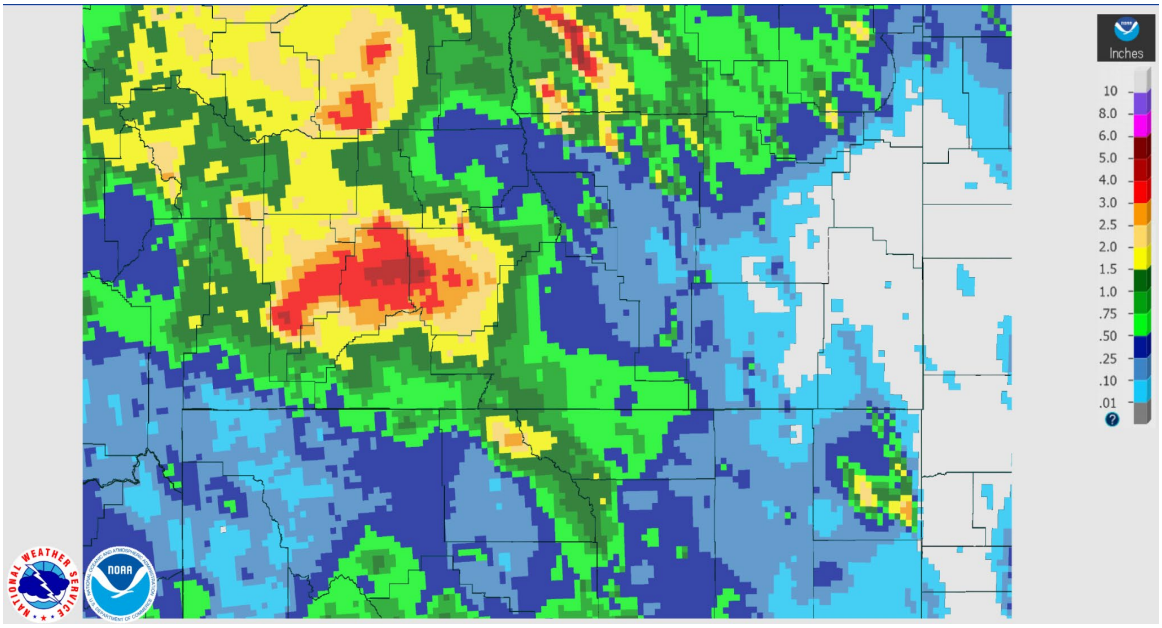
June is one of the 3 wettest months in our part of the world, so picking up 3 to 6 times the normal amount of precipitation really sets up the area nicely for the rest of the year water wise. An impressive 43 Flash Flood Warnings were issued during 2023, with most being issued in the month of June. Normally around 5 Flash Flood Warnings are issued, and for many years there are none posted. 51 Flood Advisories were also issued in 2023 for less impactful flooding.

June 23rd was a notable Flash Flood day. Heavy slow moving thunderstorms produced over 2 inches of precipitation across most of South Central Montana, including pockets of 3 to 7 inches in Stillwater county. The 7+ inches fell just southeast of Rapelje, with a spotter in Rapelje measuring 6.02 inches of rain. Flash Flooding was reported in Absarokee that evening where 3.5 inches of rain was measured.



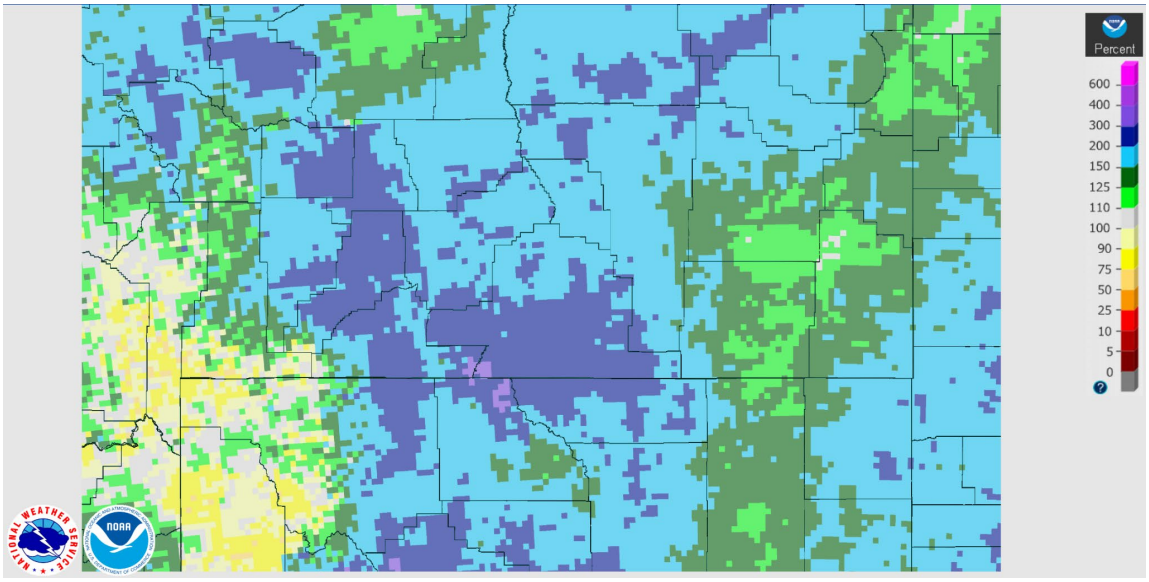
June 23, 2023 radar observed precipitation (NWS)

In and around Billings 2 to 3 inches of rain was measured on June 23rd, but the heaviest precipitation day in Billings for 2023 was June 2nd. On that day 3 to 5 inches of rain was measured from Stillwater county east across Yellowstone county, including Billings where one automated site measured over 5 inches of rain, and a record daily rainfall record fell at the airport (2.19 in). [NWS Billings write up on the heavy rainfall.]



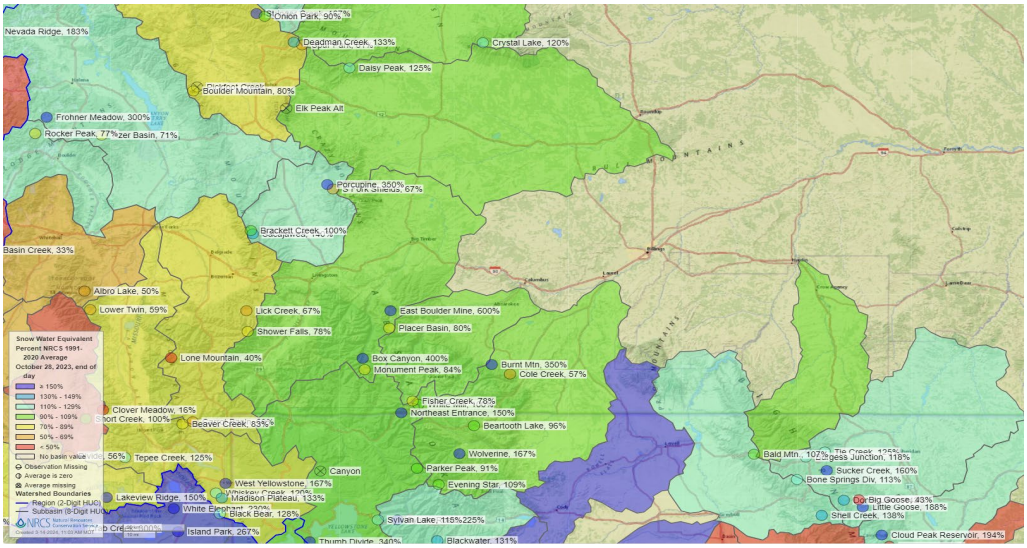
June 2, 2023 Observed Precipitation (NWS)

Having one event of this magnitude is unusual for our area, 2 in a matter of weeks was very impressive, and devastating for those that experienced flood damage. Precipitation for the year ended between 150 and 300 percent of normal for most of the forecast area, with southeast Montana being right around normal on the drier end.



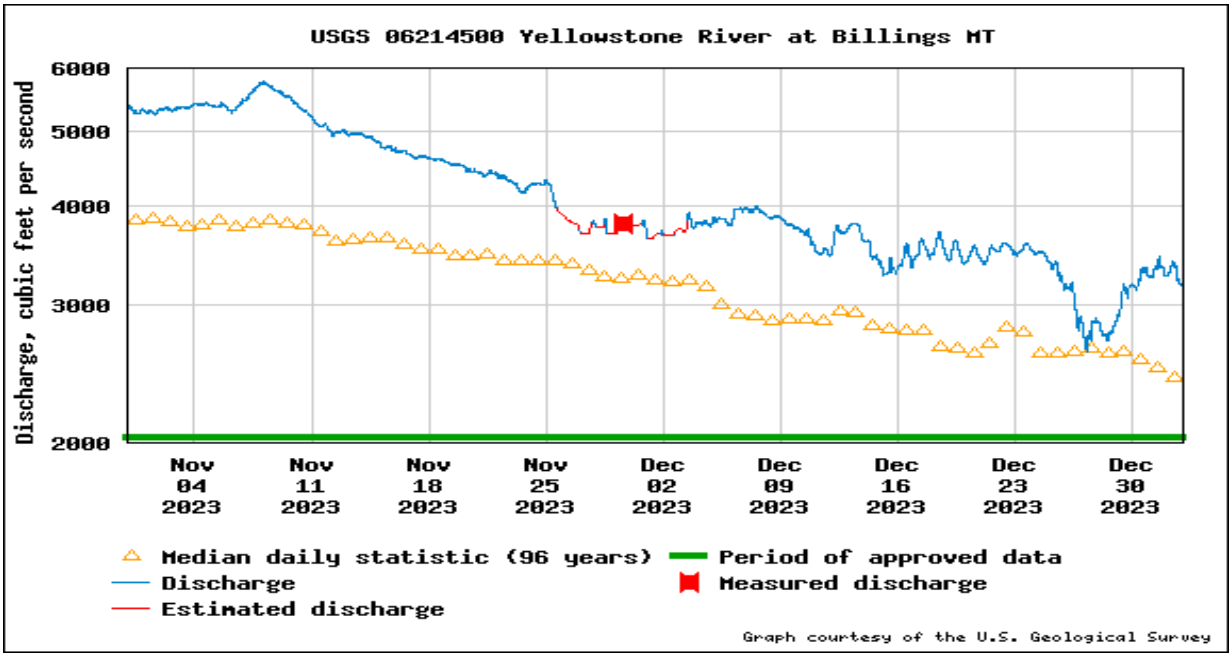
2023 Observed Precipitation Percent of Normal (NWS)

The 2023-24 snow season started off impressively with a storm system putting down feet of heavy wet snow in the mountains, and impressive rain in the lower foothills. Another snow system arrived late in the Month (24-27th) with another 1 to 2 feet of heavy wet snow for the high country. This was a great start to the new water year, laying down a strong snow base for the rest of the Winter.



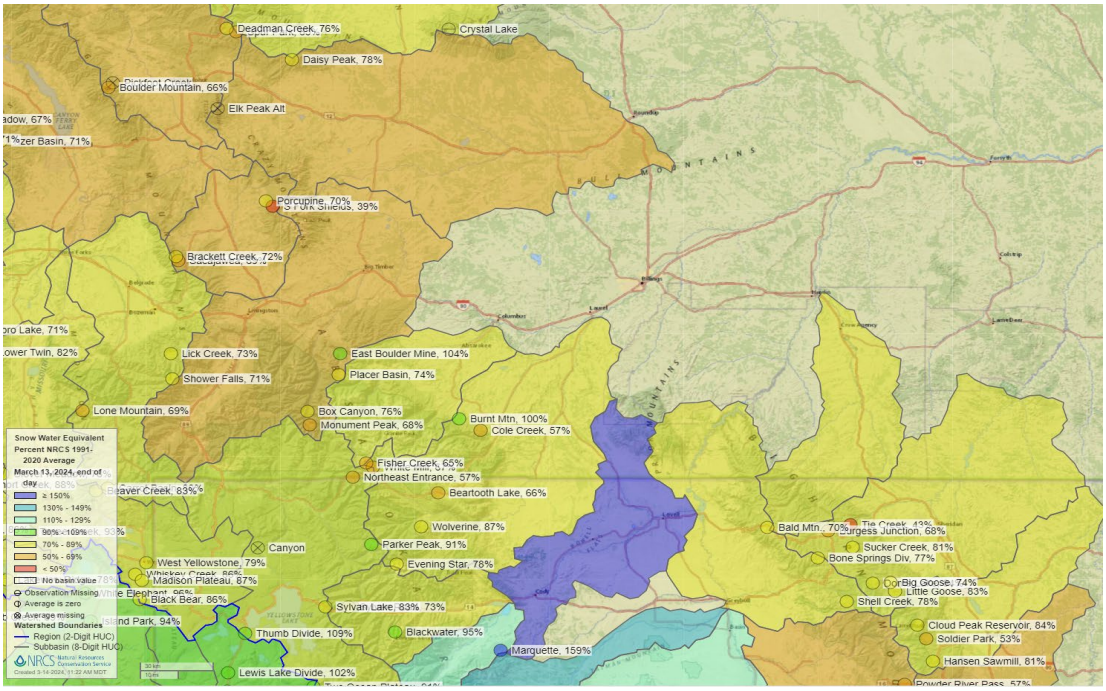
Snow Water Percent of Average end of October 2023 (NRCS Data)

Unfortunately, November into early January were warm and dry. From mid November into late December stream gages showed well above normal to even record flows, as the October snowpack melted out through the Holiday season. That water flowing past us was the water that should have flowed through the area in the mid to late summer 2024.



Well above normal flow of the Yellowstone River @ Billings Nov-Dec 2023 (USGS)

A cold snowy period in January, along with several Pacific Atmospheric River events in February and early March, helped to rebuild some of the snowpack. However, by mid March the readings from automated mountain stations (SNOTEL) are still well below normal, with record to near record low snow readings at many locations. Check out the latest [water supply outlook report] from the NRCS for more details on the latest snowpack trends.



March 13, 2024 Snow Water Percent of Average (NRCS Data)

What is expected going into this Summer? First, unless something drastically changes, there will be a deficit of water in area waterways this year, which will have impacts on irrigation and recreation activities. Second, given a normal precipitation and temperature progression through the rest of the Spring, the potential for river based flooding is very low. The latest [Climate Prediction Center] seasonal outlooks for the Spring and Summer show temperatures trending normal to above normal, with Spring Precipitation leaning toward normal and Summer leaning below normal. The [U.S. Drought Monitor] is already starting to reflect the dry winter and these forecast trends with D1 to D2 drought now over the southern half of the forecast area, including our mountains.

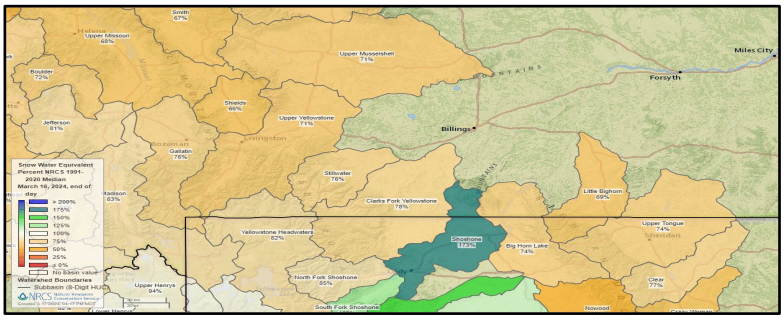
To wrap this past year up:

- Benign snowpack to start 2023
- Conditions trended drier early spring
- Epic precipitation producing flash flooding June into August
- A good start to the snow water season in October
- A lot of this snow melted during the warm dry Holiday season
- Added snow January into March but still well below normal
- Forecast heading into Summer is not showing a lot of promise for improvement but also not much chance for river flooding

A Recap of the 2023-24 Winter

Joe Lester, Lead Meteorologist

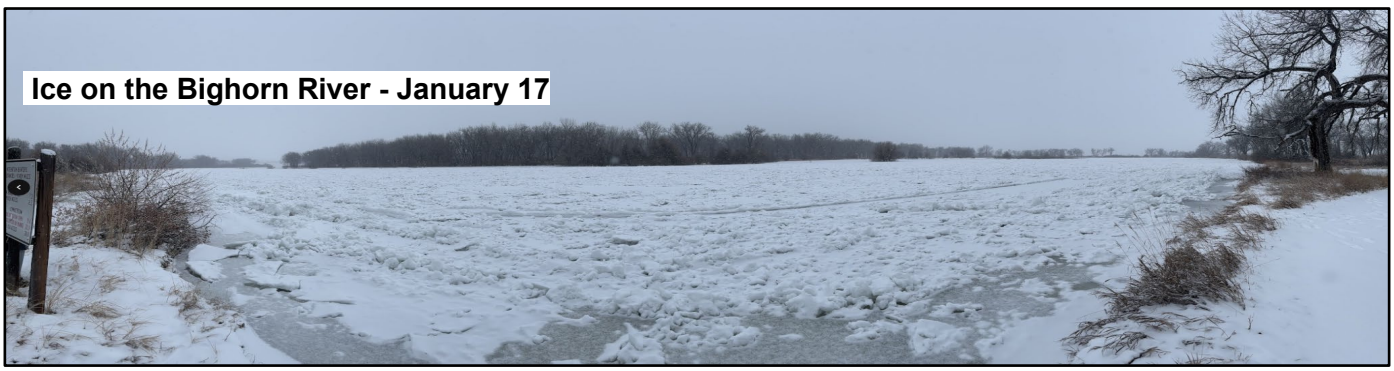
The 2023-24 winter was warm and dry overall. In fact, Sheridan had its 6th warmest winter on record dating back to 1907. Not only was lower elevation precipitation below normal, mountain snowfall suffered. Through March 16th, snow water in the mountain snowpack was running 65% to 75% below median, and near record low at some sites. The combination of warm temperatures and below normal precipitation also led to increasing drought concerns. At the beginning of December, after a wet fall, there were no signs of drought whatsoever. By mid March, areas near the Wyoming and South Dakota borders were experiencing Moderate to Severe Drought. To put it simply, there were a large number of very warm days. The following table shows how many 50° days were observed at our main climate stations, along with the historical ranking of each.



Dec - Feb	Billings	Livingston	Miles City	Sheridan	Baker
# 50° Days	29	37	19	39	21
Ranking	5th most	2nd most	9th most	#1 most	#1 most

Despite the overall warm winter, a brutal cold snap impacted the region during the middle of January. Several coop stations reached 40 below, and a few touched -40° TWICE. During the peak of the cold, wind chills were widespread in the 50s and 60s below zero. A weather station 12 miles northwest of Albion reported a wind chill of -69°. The coldest air temperature observed was a whopping -52° at Huntley. Here are how the numbers stack up at our main climate stations from December through February.

December through February	Average Temp (°F)	Departure from Normal	Total Precip (inches)	Departure from Normal	Total Snowfall (inches)	Departure from Normal	Period of Record Began
Billings	31.7	+ 3.1	1.58	- 0.11	19.1	- 10.4	1934
Livingston	31.5	+ 3.3	0.90	- 0.51	These stations do not report snowfall		1948
Miles City	26.0	+ 4.2	0.44	- 0.32			1937
Sheridan	30.1	+ 5.3	1.25	- 0.55			1907
Baker	25.0	+ 5.3	0.70	+ 0.05			1998



Ice on the Bighorn River - January 17

2024 Summer Outlook

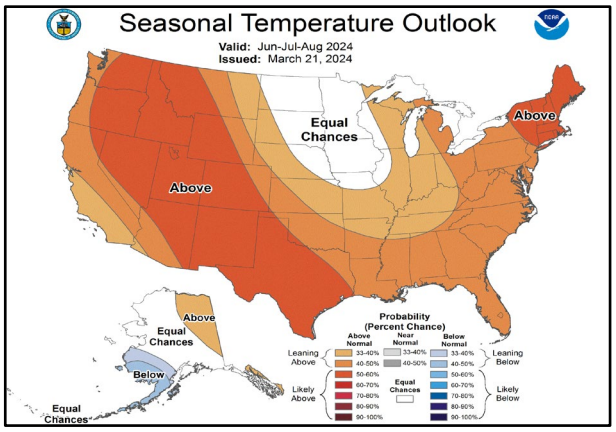
Joe Lester, Lead Meteorologist

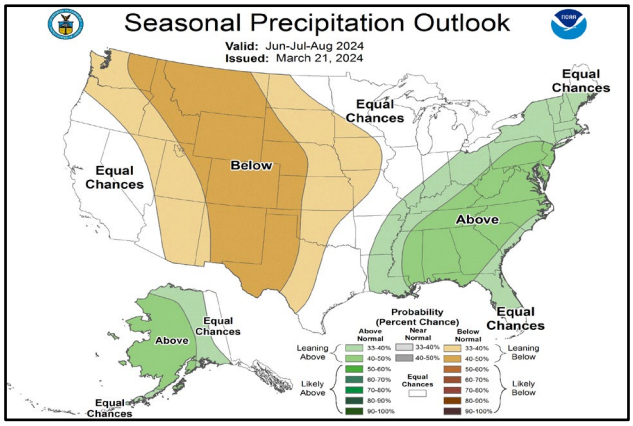
After a winter that was mostly dry and mild, and has led to increasing levels of drought, we will be dependent on a cool and wet spring in order to lessen water supply issues and wildfire potential during the upcoming summer. Climatologically, our region receives nearly half of its annual precipitation during

	Billings	Livingston	Miles City	Sheridan	Baker
Normal April-May-June Precipitation	6.30”	6.79”	6.78”	6.53”	6.82”
Normal Annual Precipitation	14.31”	14.55”	12.88”	14.93”	14.58”
Percentage of annual that occurs in April-May-June	44%	47%	53%	44%	47%

the months of April, May and June. Even a “normal” spring would be beneficial in 2024.

Seasonal temperature and precipitation outlooks are made by the Climate Prediction Center (CPC) in College Park, MD. Here are the latest temperature and precipitation outlooks for June-July-August, issued on March 21st.The outlook currently calls for increased probabilities of warmer and drier than normal. Keep in mind that these are slight hedges, and a lot will be determined by spring precipitation.





Finally, if you are planning to have a garden or outdoor plants, keep in mind that our region can see a frost or freeze well into the spring. Here are normal and extreme frost and freeze dates at a few locations. Frost is based on 36°, freeze 32°, and hard freeze 28°.

	Normal Last Hard Freeze	Latest Hard Freeze	Normal Last Freeze	Latest Freeze	Normal Last Frost	Latest Frost
Billings	April 18	May 28	May 5	June 13	May 17	June 13
Livingston	May 13	June 5	May 27	June 29	June 14	June 30
Miles City	April 26	May 28	May 10	June 8	May 17	June 18
Sheridan	May 6	June 3	May 19	June 24	June 5	June 30

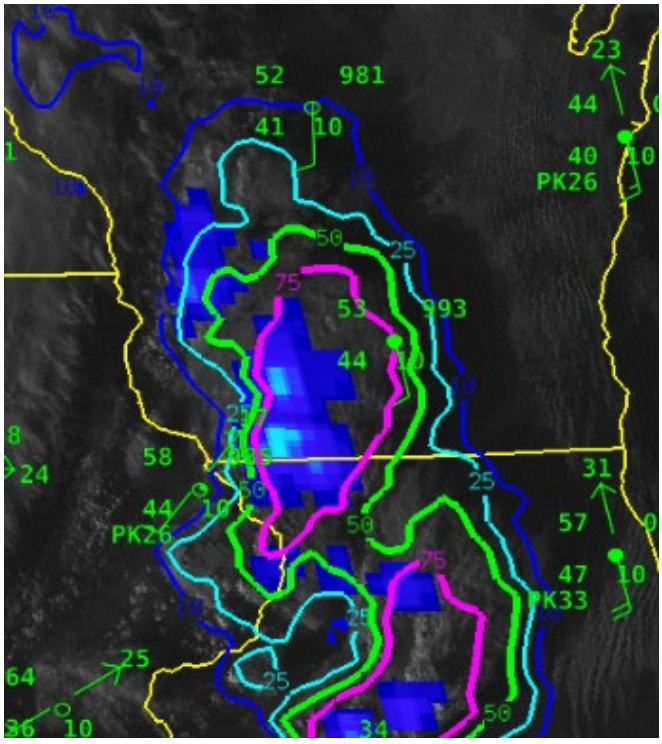
Lightning and Artificial Intelligence

Bob Setzenfand, Science and Operations Officer

You may have heard about Artificial Intelligence (AI) in the news media recently. Meteorologists now have a tool that utilizes AI available to them. The tool is called LightningCast and uses historical satellite cloud and lightning data to construct an AI model. This AI model can then use data in real-time to produce lightning probability values over the next 60 minutes. Researchers have noted that a lead time for the beginning of lightning activity of at least 20 minutes can be achieved when LightningCast probability values reach 20 to 50%. (Source: "LightningCast Quick Guide," https://cimss.ssec.wisc.edu/goes/OCLOFactSheetPDFs/GOESR_LightningCastProbability_Quickguide.pdf, CIMSS/University of Wisconsin-Madison)

LightningCast is just one of many tools available to meteorologists in thunderstorm environments to alert users of hazardous weather. We continue to use other data from satellites, radar, automated surface observations and, of course, your ground-truth reports communicated to us via phone, e-mail, or social media, to produce alerts of hazardous weather with the goal of protecting life and property.

Below is an example of LightningCast data displayed on a map of the Wisconsin and Illinois area on February 8, 2024.



Visible satellite image (black and gray shading) from February 8, 2024 with Global Lightning Mapper flash extent density (blue shading) and LightningCast 60 minute lightning probability values (colored contour lines) overlaid. Image from CIMSS/University of Wisconsin-Madison.

Severe Weather Preparedness

Are you “Weather-Ready” for this upcoming spring?

Know Your Risk: Don’t leave home without knowing the forecast. Check our website each and every morning.
Take Action: Have an emergency supply kit. This includes a 72-hour supply of food and water. Also, develop a plan to ensure family and friends know how they can reach you in an emergency. This plan would include meeting places and alternate ways to communicate in case of an emergency.
Be A Force of Nature: Inspire others by sharing your preparedness activities with family and friends.

For more information, visit our severe weather preparedness website at:

https://www.weather.gov/byz/SevereWxAware

Severe Thunderstorms produce:
* Tornadoes
* Hail one inch in diameter or larger
* Damaging wind in excess of 58 mph

Know the difference:

Funnel Cloud: A funnel-shaped cloud, extended outward or downward from a thunderstorm, that corresponds to a rotating column of air. If the rotation is violent and reaches the ground, the funnel cloud is associated with a tornado.

Tornado: A violently rotating column of air, in contact with the ground, that extends from the base of a thunderstorm to the ground. This is often visible as a funnel cloud with swirling dust or debris near the surface.

Know the difference:

Watch: The potential exists for severe weather to occur within the next 8 hours but the exact location and timing is not known. Action can be taken to protect property such as putting your vehicle in the garage, putting away patio furniture, etc.

Warning: Severe weather is either occurring or will be shortly. Immediate action should be taken to protect yourself by going to the lowest portion of a sturdy building, or into a closet, hallway, or room without windows.

Information Stop

Education
JetStream - An Online School for Weather
Local Climate Records

Kids!
SciJinks. It's all about weather!
Learn Science and Safety with Owlie Skywarn!

Severe Weather Preparedness:
https://www.weather.gov/byz/SevereWxAware

Lightning Safety:
https://www.weather.gov/safety/lightning

Flood Safety:
https://www.weather.gov/safety/flood

National Water Prediction Service
(Rivers and Lakes Observations and Forecasts):
http://water.noaa.gov/

How Do You Stay Informed?

Here are some options to stay informed on incoming hazardous weather:
NOAA Weather Radio: This is your direct link to NWS warnings! Specially built receivers will alert you when watches and warnings are issued for your area and also keep you informed on the latest forecast 24/7. Weather Radio receivers can be purchased in most electronic and many department stores for $30 dollars or less.
More information at: https://www.weather.gov/nwr/montana

Wireless Emergency Alerts: If you have a newer smartphone that is Wireless Emergency Alert Capable, you are already signed up! Your phones will alert you for Tornado Warnings, Flash Flood Warnings, AmberAlerts, or critical Presidential Alerts during national emergencies.
More Information: https://www.fema.gov/frequently-asked-questions-wireless-emergency-alerts

Red Cross Apps: Apps available for all types of emergencies. Specifically for severe weather, a Tornado App is available. This app will alert you for both Tornado and Severe Thunderstorm watches and warnings. Check out the wide variety of apps available.
More information: http://www.redcross.org/get-help/prepare-for-emergencies/mobile-apps

FEMA App: Receive National Weather Service Alerts for up to 5 locations along with safety reminders and tips.
More information: https://www.fema.gov/mobile-app