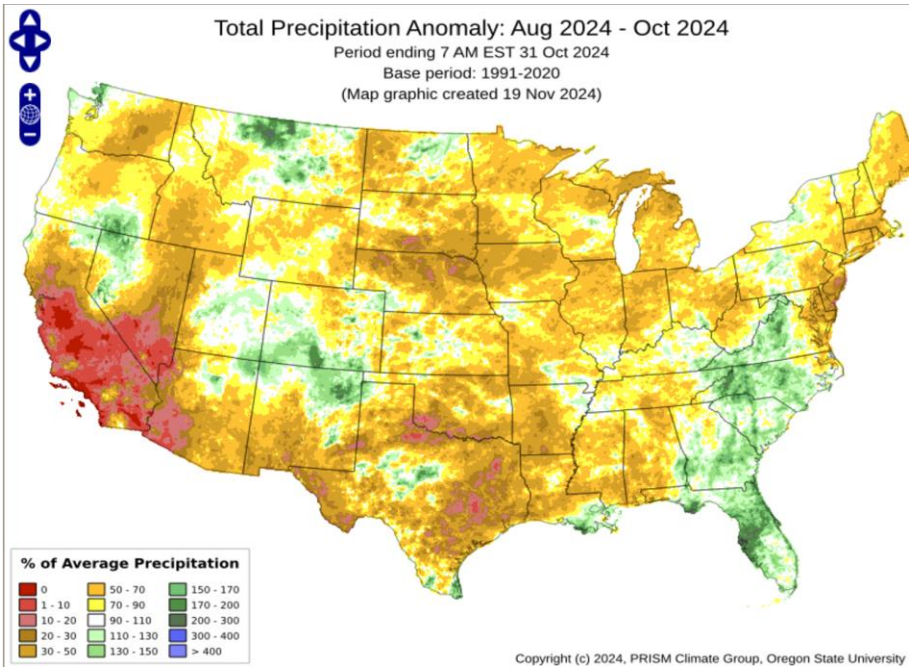
One Storm with So Many Benefits – and the benefits will be felt for a while.
With hurricane strength winds, very low pressure, 20+ inches of precipitation, and snowfall measured in feet, you can call it what you want, bomb cycle, typhoon, hurricane, but the Category 4 Atmospheric River (AR), is just want we needed. Let's look at the big picture – the hydro conditions before the storm and where we are now that the stage is set, and dinner is being served.

With western and unusual eastern fires still burning in October and November, rivers were running at their typical low Fall baseflow levels following the extremely dry summer that continued into Fall. The image below shows the dryness as a Percent of Average Aug-Oct Precipitation across the nation to close Water Year 2024 and start WY 2025. Near zero precipitation fell in California and only 30-50% of average in SW Idaho, Iowa, Ohio, New Jersey/York and more.

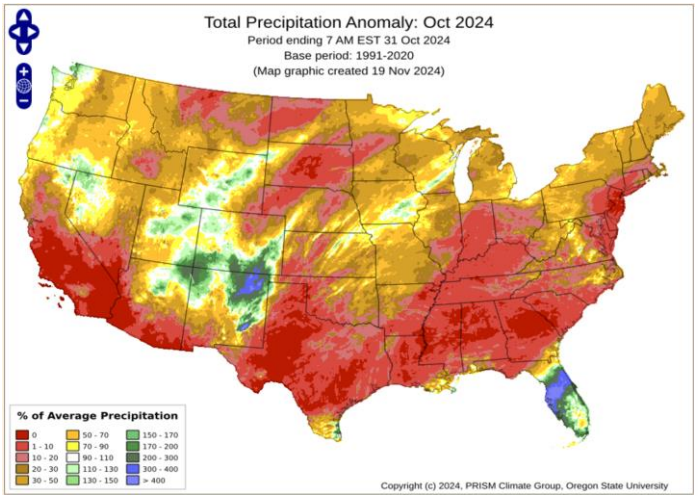


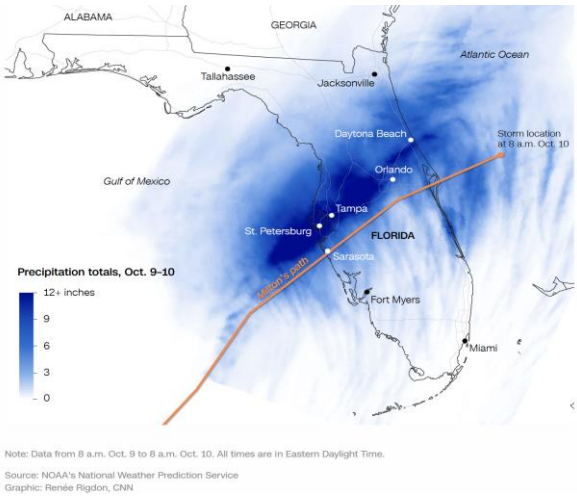
You can also see in the image above the above normal precipitation in NC from Category 4 Hurricane Helene in late September. It was interesting reading about NWS's accuracy to predict the abundant rainfall for this event and how the Appalachian Mountains acted like our western mountains, forcing the clouds to rise and drop their moisture to get over the mountains. Orographic precipitation as we call it, and several other factors produced this historic event. Here's a NOAA summary of the event for those who like details…
Hurricane Helene's extreme rainfall and catastrophic inland flooding
https://www.climate.gov/news-features/event-tracker/hurricane-helenes-extreme-rainfall-and-catastrophic-inland-flooding

And another summary from American Rivers to better understand what people went though.
Miraculous Community Amidst an Incomprehensible Magnitude of Devastation
A first-hand account of the wide-spread devastation left by Hurricane Helene
https://www.americanrivers.org/2024/11/miraculous-community-amidst-an-incomprehensible-magnitude-of-devastation/

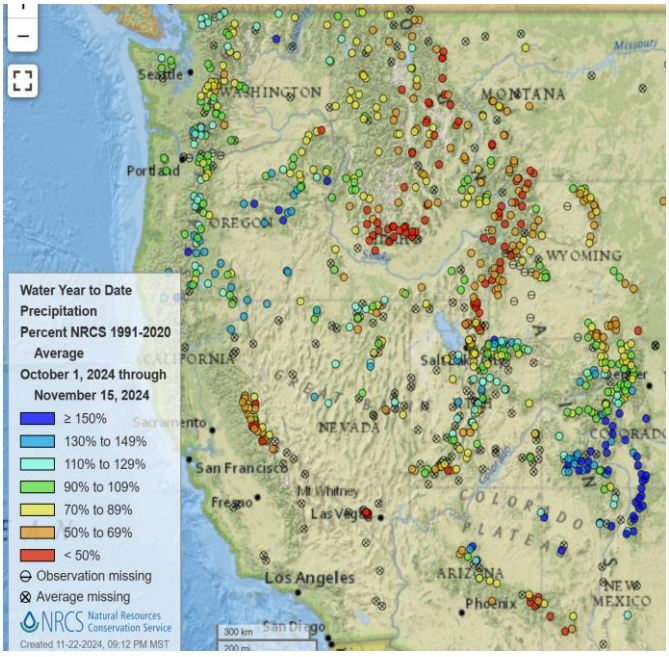
The image below shows October's dryness across the lower 48 except for the wet streak in Florida where Category 5 Hurricane Milton zipped across and maybe a few lingering

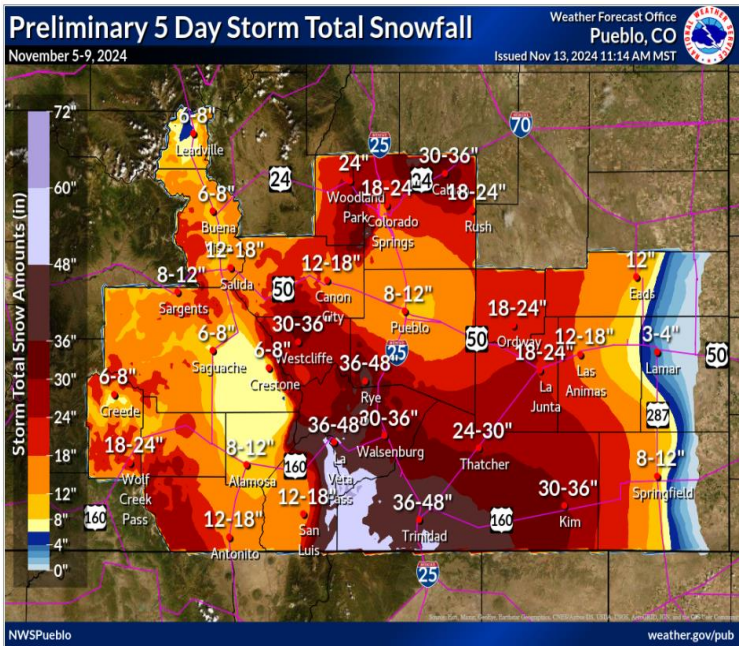
monsoon rains. Wow - back-to-back Category 4+ hurricanes. I was wondering how often this happens, and learned it happens more often than I thought. 2017 hurricane season was the most recent with Harvey and Irma, both Category 4 storms, followed by one more, Hurricane Maria, a Category 5 storm that hit Puerto Rico.





Moving on to November, the image below shows the SNOTEL Oct 1-Nov 15 Water Year Precipitation and dryness in Idaho, Montana and Wyoming before the AR arrival. You can also see the major storm hitting southern and eastern Colorado Nov 5-9 with totals pushing 55 inches. Here's a storm report summary but no mention of using SNOTEL data. I wonder if they do in their total snowfall estimation. https://www.weather.gov/pub/November2024WinterStorm





Now this is when it gets exciting with the AR arrival and that doesn't stand for Abramovich.Ron. A Category 4 AR with precipitation totals pushing 20+ inches in northern California and snow measured in feet. This wasn't the first AR of the season. Why don't they name AR events? Who wants to name this one? This AR was not even on the radar at first, developed quickly and continued spinning off the coast before finally moving inland to the PNW.

cliffmass.blogspot.com

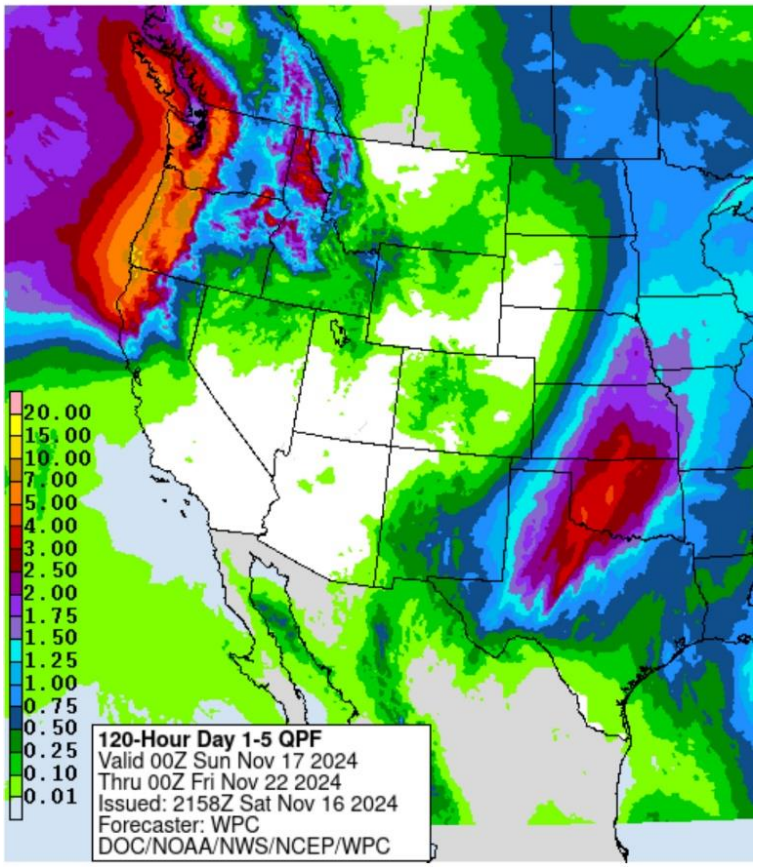
Ready to be impressed? Such low-pressure centers are consistent with the central pressures of a category 4 hurricane as shown by the official Saffir-Simpson scale (below). No need to head to Florida for big storms!

SAFFIR-SIMPSON HURRICANE WIND SCALE

CAT	Wind Speed mph	Wind Speed kt	Old SS Scale mb	Old SS Scale surge
TD	0-38	0-33		
TS	39-73	34-64		
1	74-95	65-83	980-994	4-5'
2	96-110	84-95	965-979	6-8'
3	111-129	96-112	945-964	9-12'
4	130-156	113-136	920-944	13-18'
5	>157	>137	<920	>18'

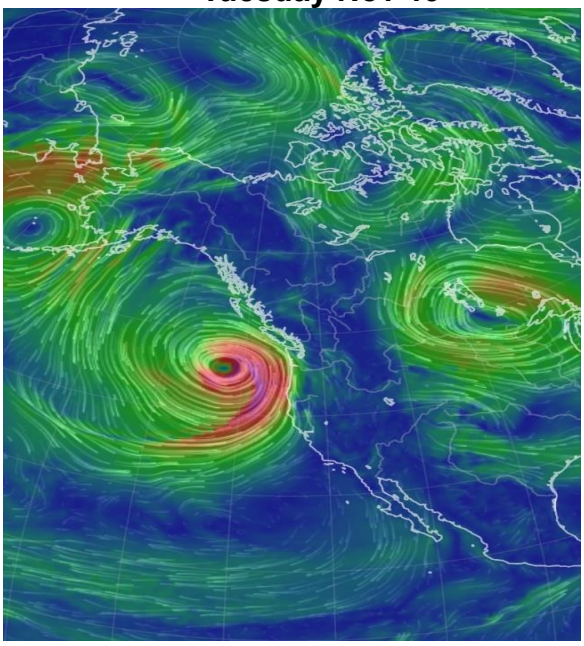
This offshore storm and its associated front will bring major winds to the coast, with coastal winds gusting to 50-65 mph around 6-8 PM tomorrow evening (see predicted winds at 7 PM Tuesday, kt). Winds will be even stronger over the western portion of the Strait of Juan de Fuca, with gusts above 70 mph.

Below is a 5-day Total Precipitation Forecast for Nov 19-22 and seems to be fairly accurate.

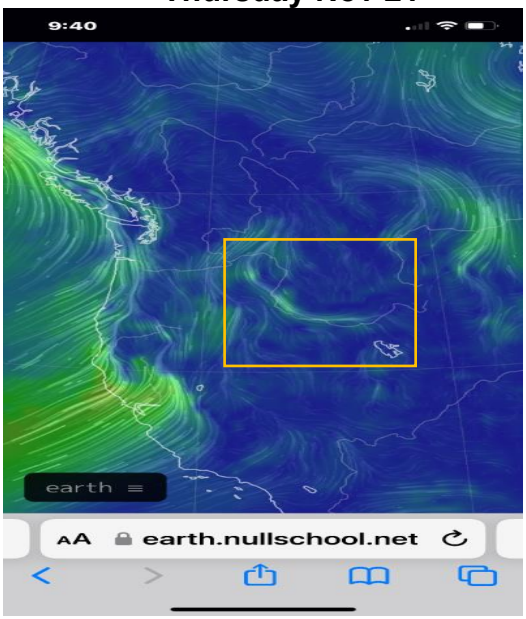


A couple of pics of surface winds and AR spinning off coast on Nov 19. Nov 21 shows the low-pressure gradient pulling winds down the Snake River Canyon.

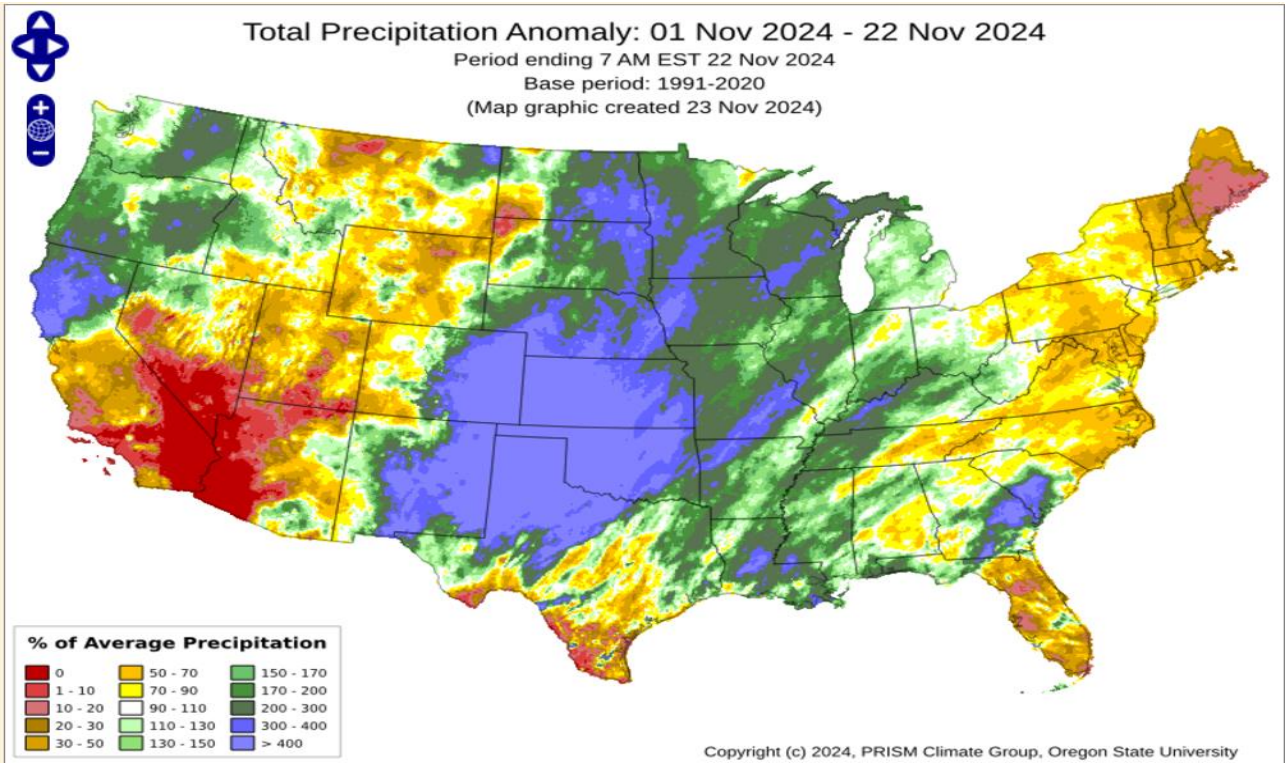
Tuesday Nov 19



Thursday Nov 21

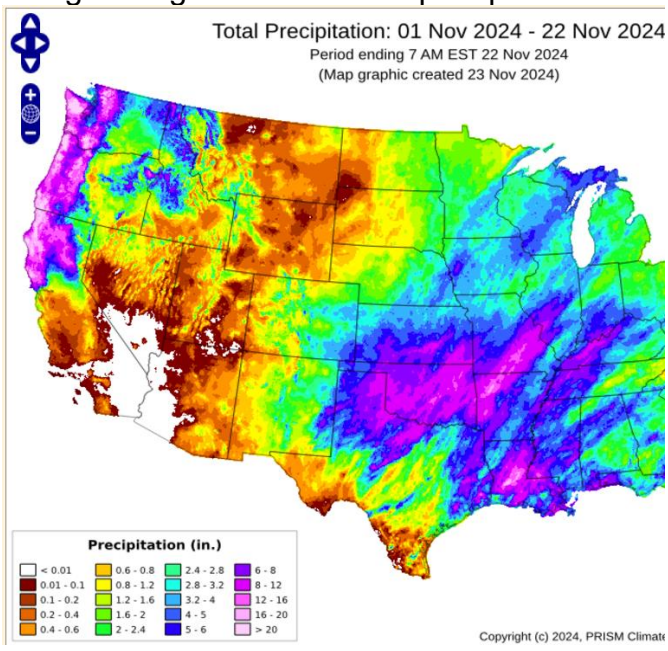


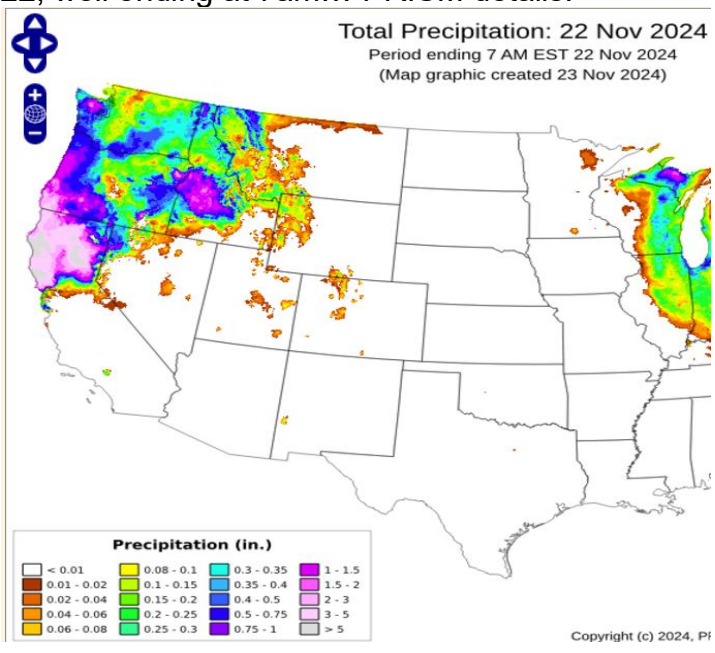
Below is the Total Precipitation for Nov 1-22 as a Percent of Average.



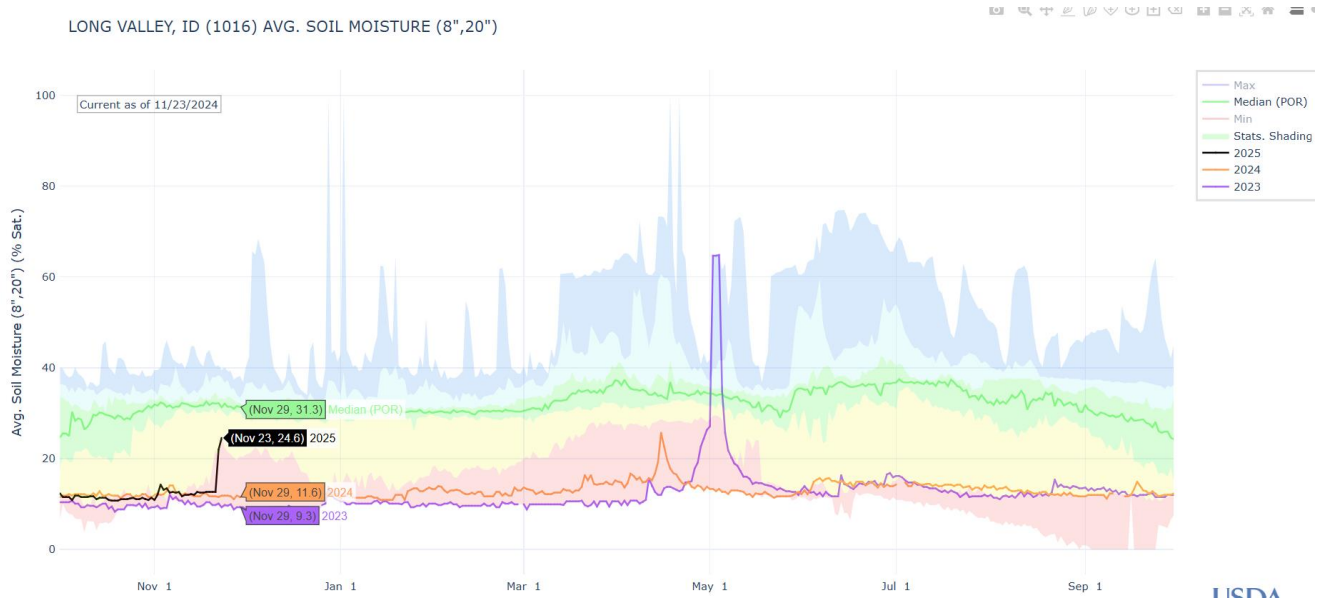
The left image below shows the Cascades were on the receiving end, receiving 20+ inches moisture. Even Idaho mountains received 5-10” during this period with Bear Mountain SNOTEL site in north Idaho receiving 13.3” for Nov, however this is just normal for the month of November. Brundage Reservoir SNOTEL received 7.7” while 6.1” is the November normal. Good precipitation amounts fell in Idaho with the West-Central and Central Mountain from the Weiser to the Big Lost basins receiving 120-160% of their normal November precipitation amounts with 10 days still to go in November.

The right image is the 24-hour precipitation for Nov 22, well ending at 7am… PRISM details.



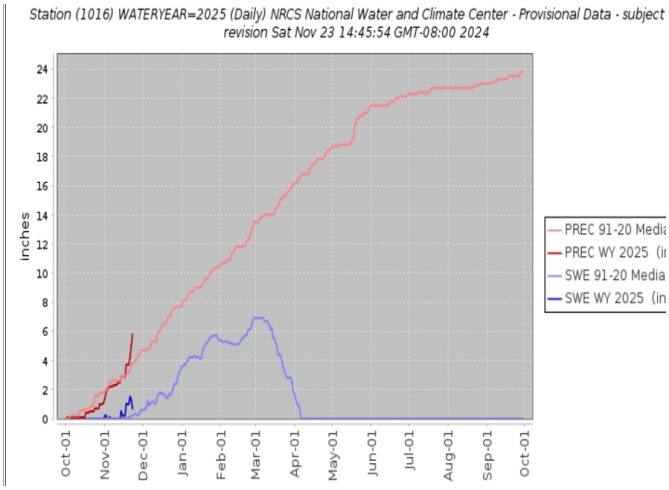


The intense rainfall also increased soil moisture after the long dry Summer and Fall in many valleys and even mid-elevation areas. Long Valley SNOTEL, located in Long Valley (makes sense) between Cascade and McCall, soil moisture graphs are below. Check out the black line jump in soil moisture for this year, 2025, compared to a year ago, 2024 (orange line) when soils remained dry under the seasonal snowpack until April.

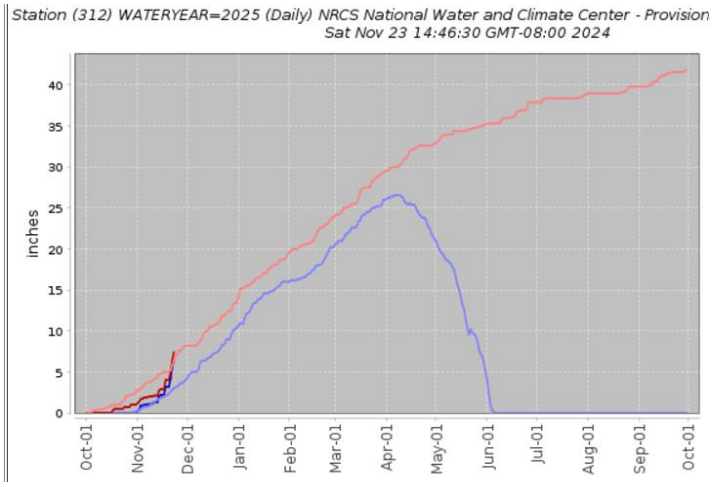


The SWE (blue lines) and Precipitation (red lines) in graphs below help to explain what happened. Below left, Long Valley, elevation 4890 ft, shows rainwater passing through the snowpack and some snow melting. At a much higher elevation, Banner Summit is located off Highway 21 at 7040 ft. and shows snow continued increasing and being stored as water on the surface in the snow.

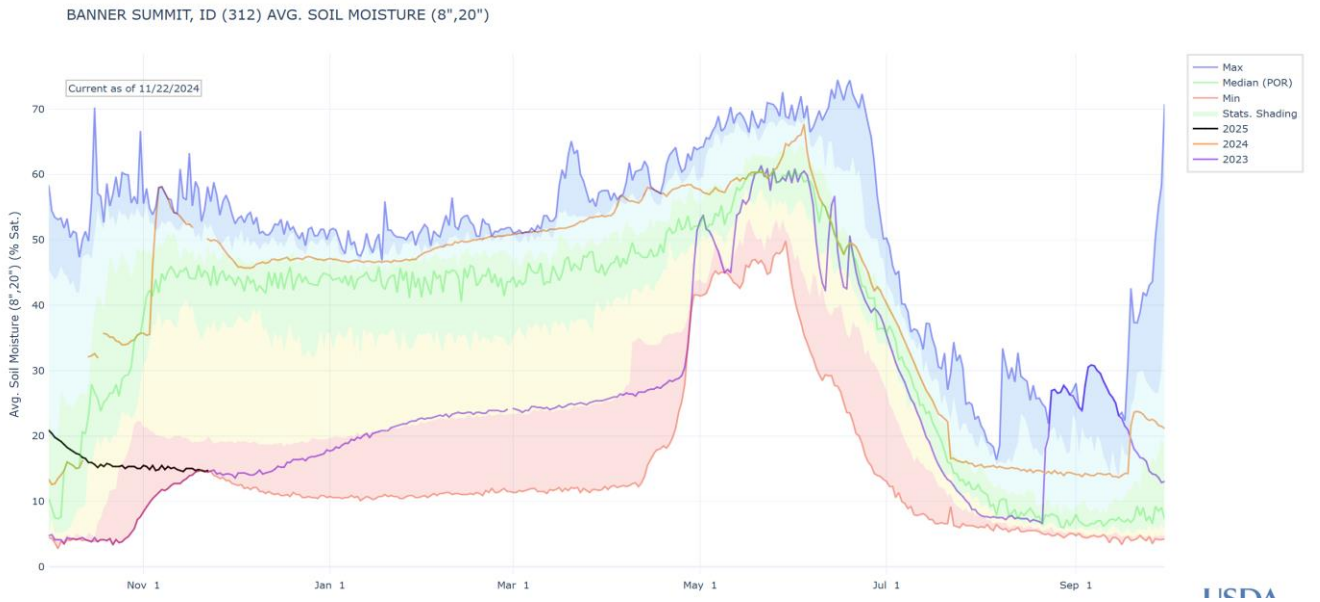
Long Valley, elevation 4890 ft.

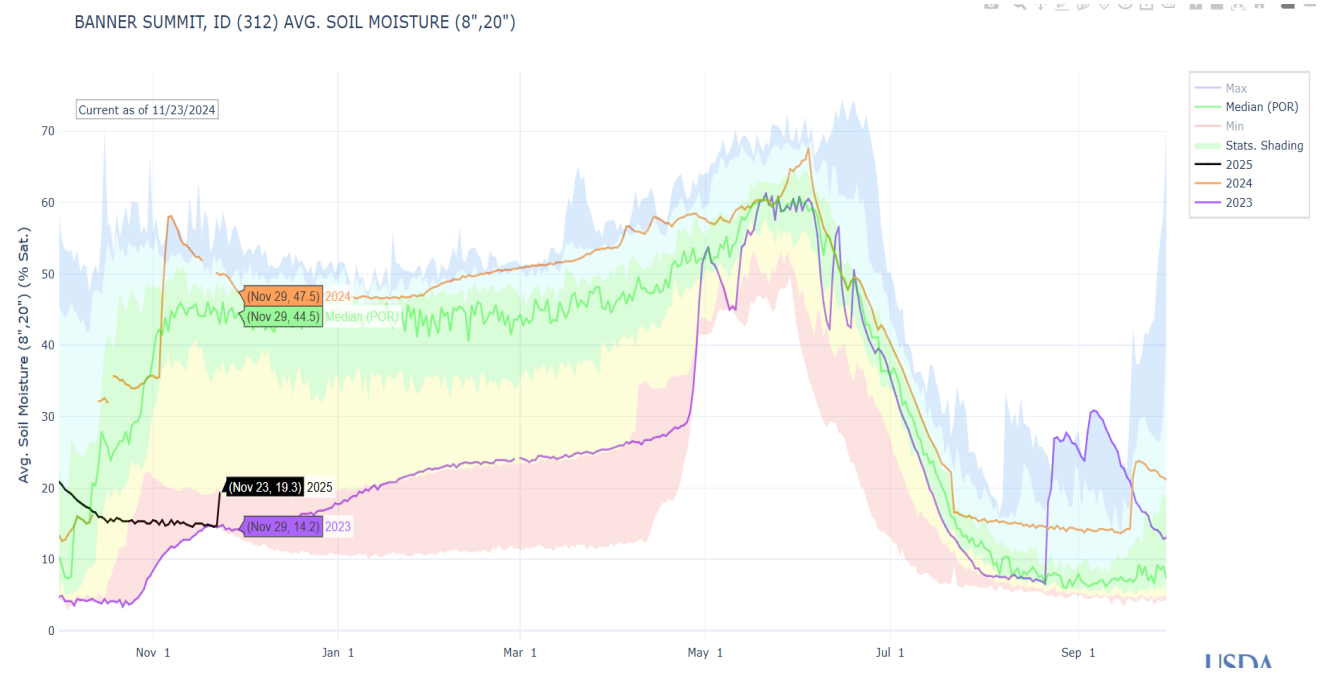


Banner Summit at 7040 ft.



Below is the Banner Summit soil moisture graph from Nov 22 and shows no change in the 2025 black line soil moisture. When I first saw this, I thought the dry soil trend would continue into winter as no rain or melt water had percolated into the ground yet…
It is a good thing I went back and updated this soil moisture graph on Nov 23.
BINGO – there's the water now percolating into those dry forest soils at 7000 ft in elevation.





This is cool stuff if you are an old snow hydrologist or soil scientist. Back in the summer of 1989 when I started my career with SCS/NRCS we were installing soil moisture sensors and dreaming about data like this. If you look at the old snow survey notes from Idaho's Snow Survey Supervisor, Morley Nelson, and crew, you can see they even tried to collect soil moisture data back in the 1950s because they understood the need to understand the relationship between soil moisture and water supply prediction / runoff.

To better understand what happened at Banner Summit during this event, here is a quick recap: Banner's temps bottomed out at 5F on Nov 19 before the AR. Temps gradually increased to 35F for a high on Nov 22 and remained around 32F for a day and a half. Luckily on Nov 23, cool temps returned dropping temps down to 22F along with another 6" of snow as shown in Banner's table below. For those backcountry skiers next time you are up there digging a pit in the central mountains, see if there is a crust about 28" above the ground that will gradually settle with additional weight and snow accumulation. Let us know what you find so we can all keep learning about this major Atmospheric River event.
https://wcc.sc.egov.usda.gov/nwcc/site?sitenum=312

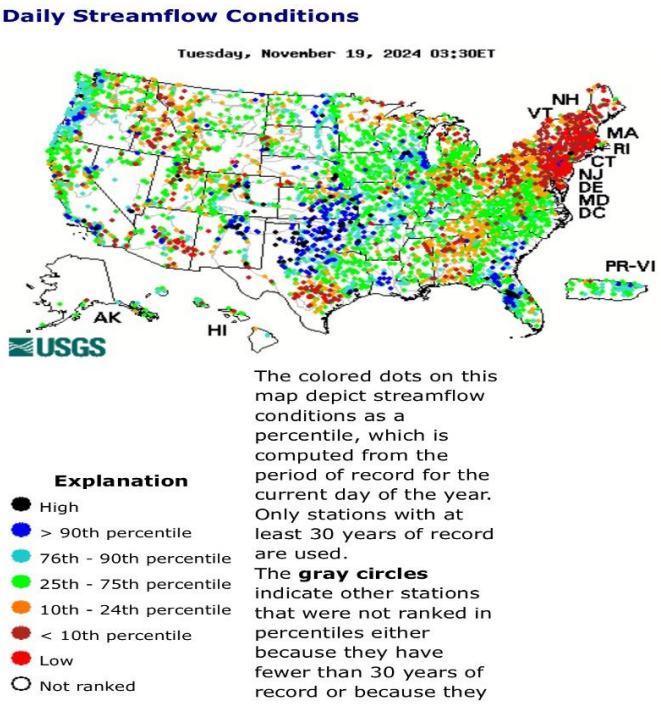
Banner Summit (312)
Idaho SNOTEL Site - 7040 ft
Reporting Frequency: Daily; Date Range: 2024-11-17 to 2024-11-24

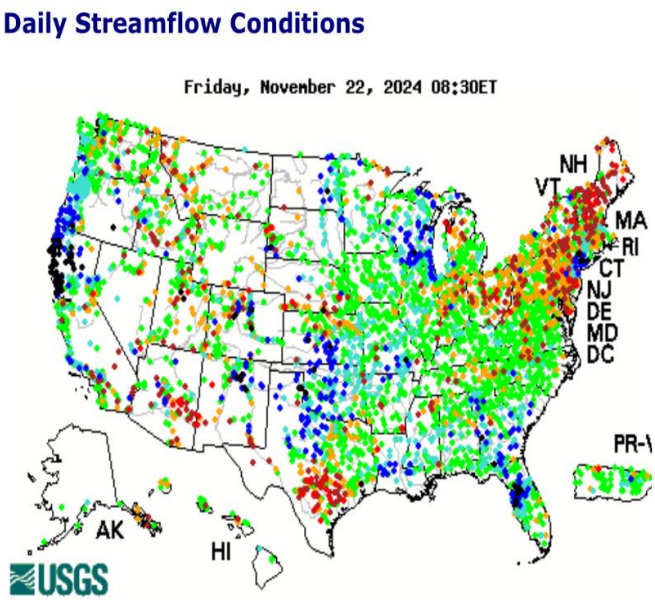
(As of: Sun Nov 24 20:26:34 GMT-08:00 2024)
Provisional data, subject to revision

Date	Snow Water Equivalent (in) Start of Day Values	Snow Depth (in) Start of Day Values	Precipitation Accumulation (in) Start of Day Values	Air Temperature Observed (degF) Start of Day Values	Air Temperature Maximum (degF)	Air Temperature Minimum (degF)	Air Temperature Average (degF)
2024-11-17	2.2	10	2.9	18.1	31.3	16.9	24.8
2024-11-18	3.2	21	4.0	27.1	27.1	12.7	18.9
2024-11-19	3.2	21	4.0	12.7	25.0	5.4	12.2
2024-11-20	3.2	19	4.0	12.2	31.6	12.2	24.8
2024-11-21	4.2	23	5.0	29.8	33.3	29.5	31.5
2024-11-22	5.6	30	6.4	32.0	35.4	31.8	32.7
2024-11-23	6.4	28	7.4	31.8	34.5	22.5	28.6
2024-11-24	7.0	34	8.2	23.5			

How rain and water move through a snowpack and densities change during rain-on-snow events like this is always challenging to figure out and explain. I'm not going to try to explain how it happens… just accept it. Maybe someone else can explain… Sometimes the water seems to percolate through the pack into the ground or flow across the snow surface. Add a little wind and the equation changes. Never stop learning about snow, water, and the power of them combined.

Let's keep moving forward by going back in time to look at river flow levels before the AR.
This image from Nov 19 shows the percentage of average streamflow across the nation. Idaho's red pinheads are for individual gaging stations and means the rivers are at or near record low flow for the given day, but nowhere near the carpet of red along the east coast rivers from lack of precipitation and reason fires were active. Or maybe this map also shows the greater density of gages in the East compared to our huge open remote watersheds in the West.





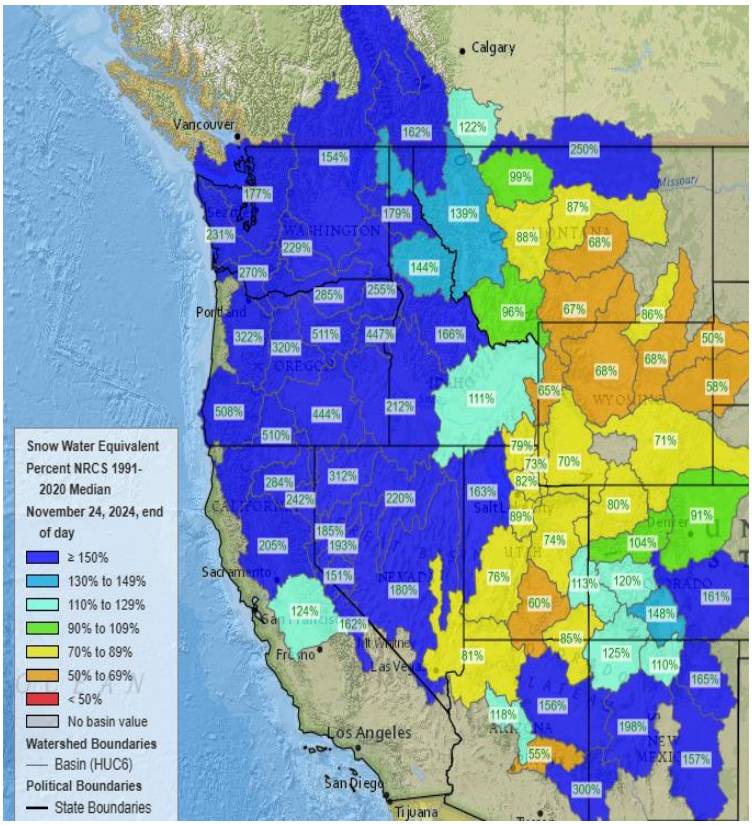
Now after the AR, you can see CA and OR rivers jumped up to record or near record high levels (black & blue pinheads). Improvements were felt in Idaho rivers and the east coast from Thursday's Night Football snow storm in Cleveland that tracked east. Increases in soil moisture and baseflow are both good news to improve snowmelt runoff efficiency come spring. I bet the salmon, steelhead, chum and all the fish are loving the higher flows after the dry summer/fall.
So many benefits!

We'll keep our eye on soil moisture for more changes this winter especially in higher elevations where the seasonal snowpack will remain until Spring's arrival.

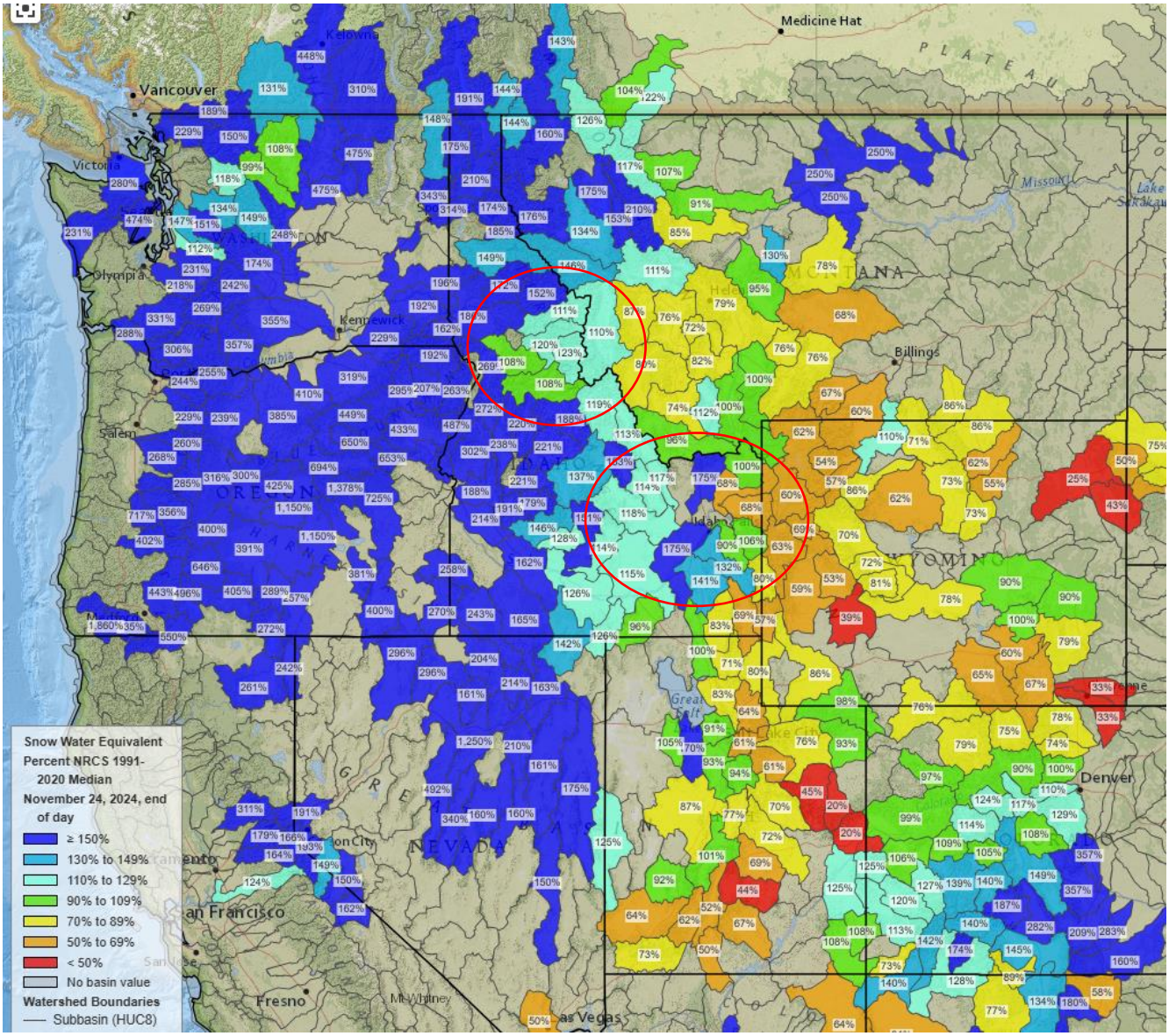
Where's the snow?
Here's a quick and easy snapshot of the Snow Water Equivalent (SWE) for Nov 23 and shows the benefits the western half of the West received from this AR event. This map uses the 6-Digit HUC and is lumper, not a splitter, lumps the Tetons in with Salmon Falls basin to display 111%.

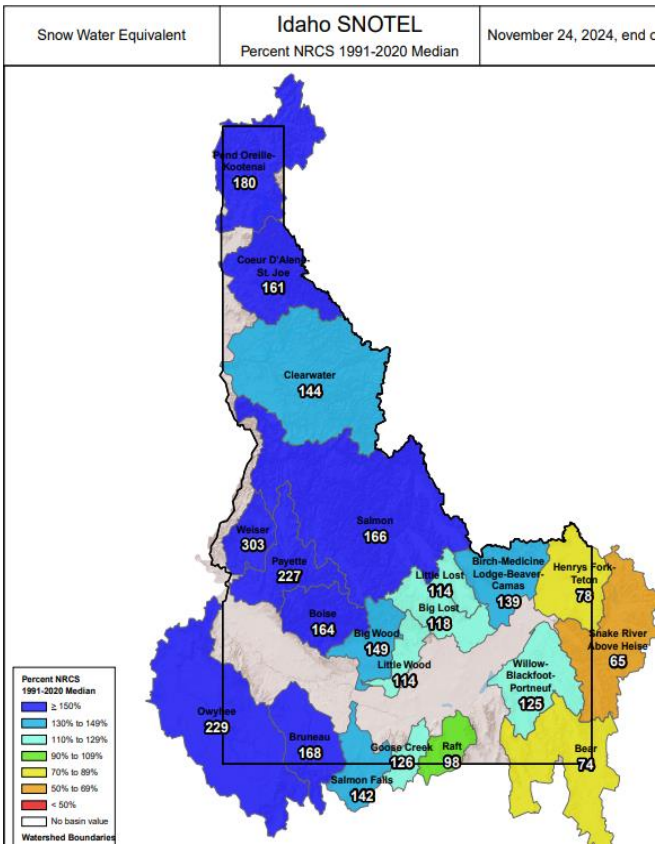
Below is another try to look at the details on a west-wide biases using the 8-Digit HUC but gets busy with the labels.

If you have suggestions or a favorite map you use to look at the big picture / Western snowpack, please share.



Interesting pocket of lower snow percentages in the Clearwater basin map below. We'll keep an eye on this or do a more detailed analysis to see what is going on. Maybe rain in lower elevations melted some of the low elevation snow. Need more time to analyze all this fun data now that is now available at your fingertips.





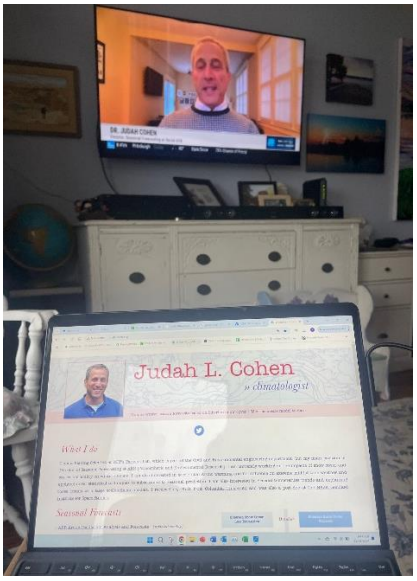
State SWE maps are useful to look at individual basins but don't always show the details, or big picture and how neighboring basins are tracking.

You can see here how the AR didn't make it all the way to the Upper Snake Headwaters as the snow is 65%. Soil moisture probably remains as dry as it was going into winter because the streams didn't pop either.

With taller mountains and higher valley floors, usually the Upper Snake holds on to colder temperatures better than eastern Idaho. In Idaho rain-on-snow runoff events typically happen below 5000 ft from mid-Nov to mid-Feb. We'll see if this trend rises with a changing climate but also need to understand the topography of the watershed.

Looking out the next few weeks… Cold returns and will provide better temps for those who make can snow and seed clouds.

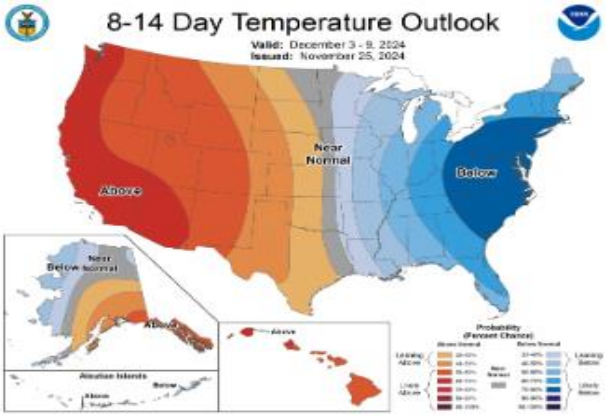
As mentioned in previous post Judah watches the Siberian snow cover and influences on the jet stream. He was The Weather Channel Nov 21 talking about how high pressure over Greenland is a 2-week precursor to cause polar vortex to dip down in North America. As a result, cold temps are coming to the states in early Dec. He may not understand why the high-pressure builds, but understands it acts as a blocking ridge that allows the cold air and polar vortex to dip.

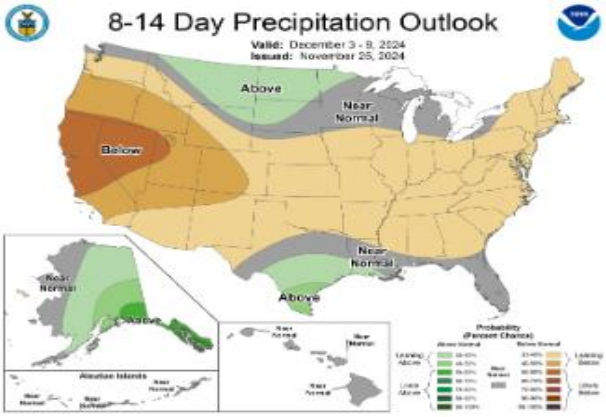


It's all about relationships, figuring out what pushes what and why or the result. Never stop learning…

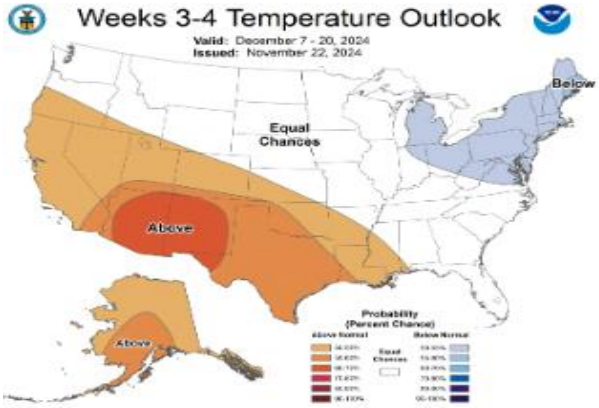
Here's a few of NOAAs short and long term outlooks. Hopefully we'll get our fair share of cold air gushing down the westside of the contintental divide. Cold is good!

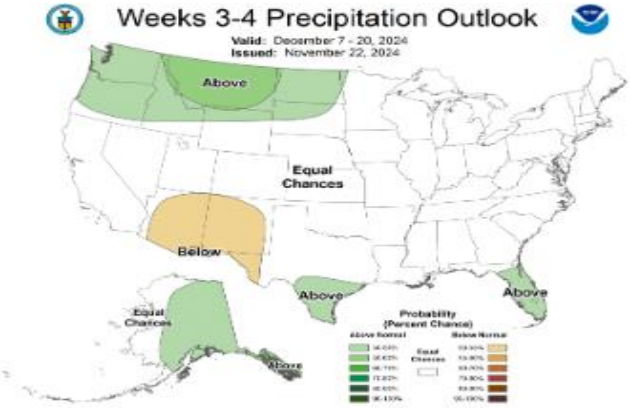
Dec 3-9 Outlook



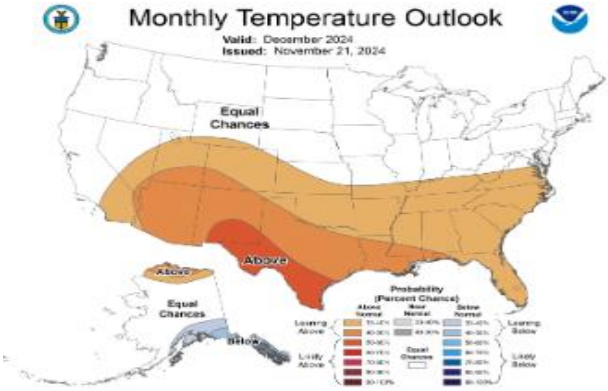


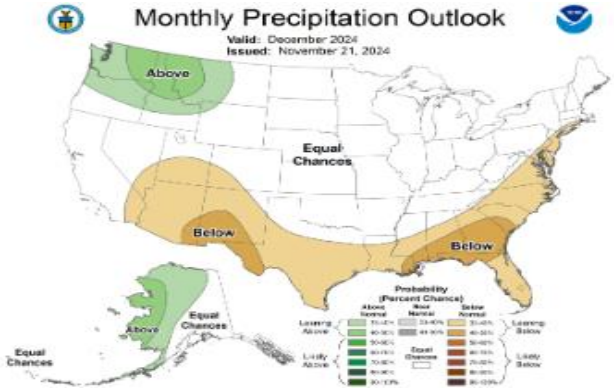
Dec 7-20 Outlook



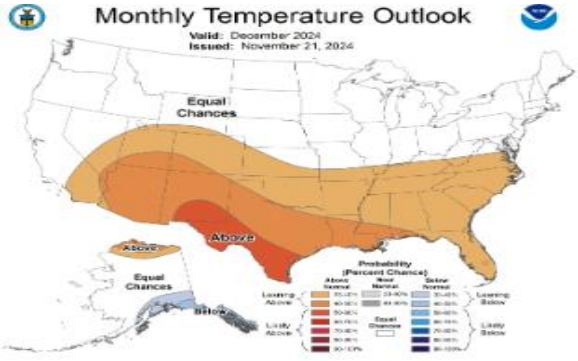


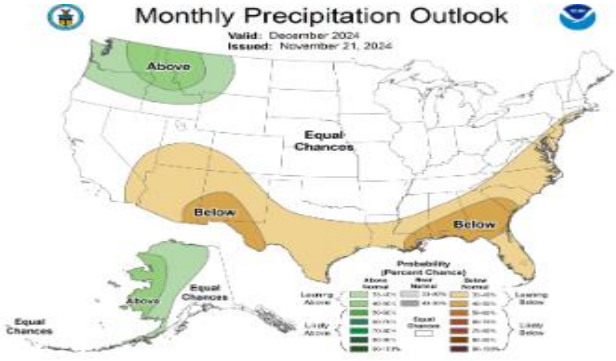
December Outlook from Nov 21





December Outlook from Nov 21





Pete Parson, Oregon Dept of Ag, November update is out with same analog years (below) as last month. We'll look at how the snowpack started in these years and compare it to this year in the next post, which will be sooner than later. And see if there is any overlap with years in table below that follow a strong El Nino year like last year.

Current Analog Years	Winter of	Water Year
1965-66 =>	1966-67	**1967**
1991-92 =>	1992-93	**1993**
2015-16 =>	2016-17	**2017**

Oregon Department of Agriculture / Programs / Natural Resources / Weather
https://www.oregon.gov/oda/programs/NaturalResources/Pages/Weather.aspx?utm_medium=email&utm_source=govdelivery

Years that follow a Strong El Nino Years and resulting streamflow.

Analysis of Streamflow for a year like 2017 that follows a Strong El Nino Year like 2016

sorted

				Streamflow as % of 1981-2010 Average					
	ENSO		ENSO	Feb-Sep	Apr-Sep	Apr-Sep	Apr-Sep	Apr-Sep	Apr-Sep
Year	SE Strong El Nino	Year Following a Strong El Nino		Owyhee River blw Dam	Salmon Falls Creek	Boise River nr Boise	Big Wood River blw Magic Dam	Snake River nr Heise	Spokane River nr Post Falls
1978	SE	1979	N	97	116	63	34	90	105
1941	SE	1942	SE	122	173	91	117	86	77
1988	SE	1989	SL	145	100	97	75	102	116
1966	SE	1967	N	69	88	105	151	109	113
1947	SE	1948	LN	58	86	105	66	97	176
1952	SE	1953	N	56	76	124	92	92	108
1998	SE	1999	SL	100	108	135	158	131	129
1994	SE	1995	SE	124	135	138	195	118	70
1995	SE	1996	N	124	115	152	132	148	116
1983	SE	1984	N	363	369	158	206	133	112
1973	SE	1974	SL	120	111	181	184	147	193
1942	SE	1943	N	137	150	209	259	144	150
2016	SE	2017	LN	155	161	180	266	163	112
12 years				Color coded streamflow as % of average					
				<60					
				60-90					
				90-110					
				~111-130					
				>130					

1998/1999 Mt Baker set word snowfall with 95 feet of snowfall

Here's a good winter summary from the Winter Wildlands Alliance:
By Kerry McClay, WWA SnowSchool Director (November 6, 2024)

Weak Winter or Feeling Snow-ptimistic? Seasonal Predictions from SnowSchool
Whatever amount of snowfall Old Man Winter (or in this case La Niña) decides to bring forth this season, we are keeping our mittens crossed for deep snow!
https://winterwildlands.org/2024-snowschool-predictions/

Nov 17 at 5:05 pm rainbow before the storm over Boise's Black Hills.