Office of the Washington State Climatologist

March 2021 Report and Outlook

March 8, 2021 http://www.climate.washington.edu/

February Event Summary

February featured below normal mean temperatures across the state, which set the stage for statewide snow in the middle of the month. Low temperatures and snowfall may have been reminiscent of the prolonged cold in February 2019, but the departure from normal was twice as great two years ago. Precipitation totals were variable with western Washington and mountainous regions experiencing above normal precipitation, while dry pockets existed in eastern Washington.

Active weather was found throughout the month with 23 days of recorded precipitation at the Vancouver Pearson Airport marking the most ever for the month of February in its 22-year history.

In this Issue

Temperatures through the first week hovered around normal as several systems brought volumes of moisture to the state. Areas directly east of the Cascades were largely rain shadowed. Wenatchee

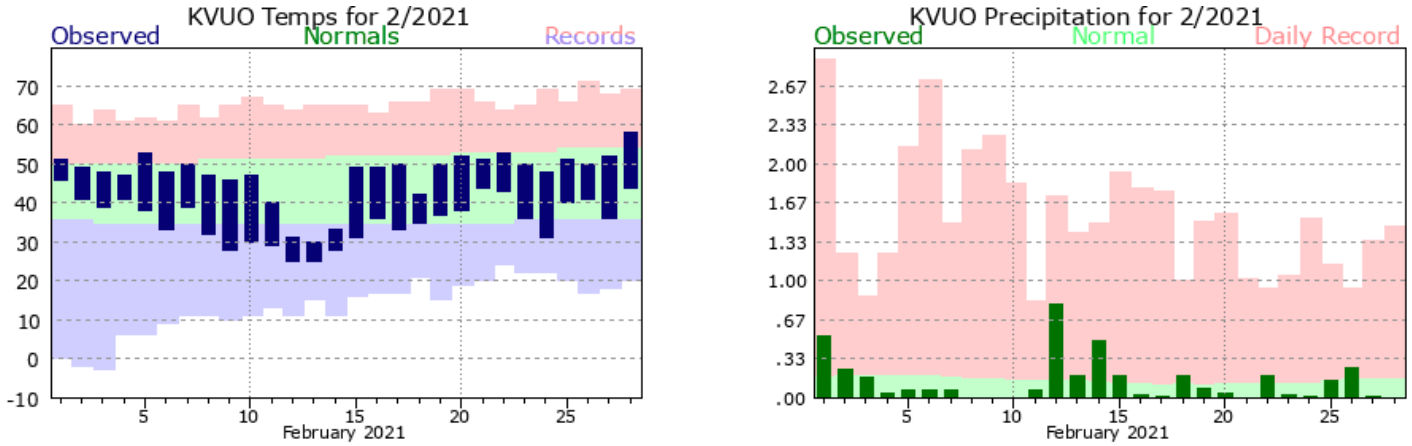

Figure 1: February 2021 daily temperatures and precipitation for Vancouver Pearson AP compared to normal (green envelope) and record (red and blue envelopes).

only saw two days of precipitation during the first ten days, but Pullman recorded precipitation on seven occasions during that time period.

By the 8th, cooler air entered the region marked by Quillayute observing a daily low temperature record of 23 °F. A low-pressure system moved through southern Washington on the 11th bringing snow totals of 4 to 6" between Olympia and Yakima, while stations further north received little to no snow even in the Cascades at Snoqualmie Pass. However, northwest Washington did not escape without weather impacts as cold air flowed through the Fraser River Valley and produced gusts up to 71 MPH on the Lummi Reservation, dropping Bellingham's temperature to 21 °F, a minimum for the month.

system on the 12th brought the highest one-day snowfall total for February at SeaTac with 8.9", breaking a record from 1962 and achieving the third snowiest month of February. Figure 2 shows 24-hr snowfall totals around the state.

Even though warmer air returned rain to western Washington by the 15th, freezing temperatures lingered in eastern Washington bringing a daily low temperature record of 14 °F to Wenatchee on the 16th and 5.6" of snowfall at Spokane Geiger Airport through the 21st. Rising snow levels on the 21st brought instability to the mountain snowpack prompting the Northwest Avalanche Center to issue extreme avalanche danger warnings due to the potential of historically large avalanches.

The end of the month mirrored the beginning of

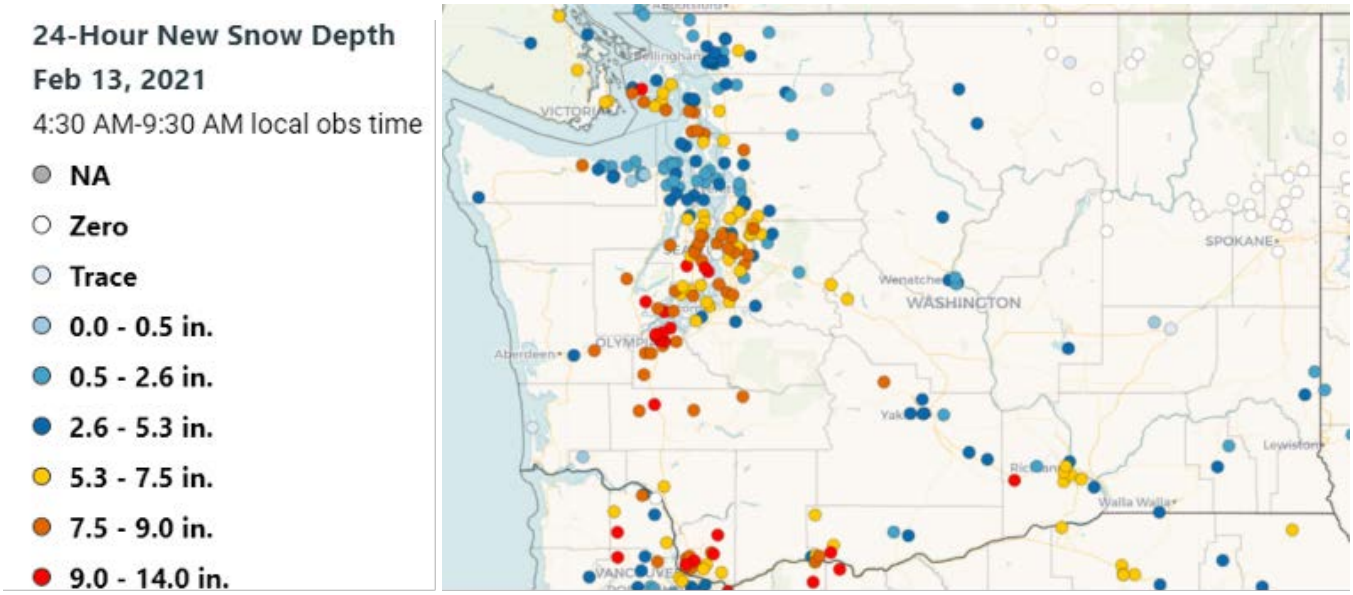

Figure 2: CoCoRaHS new snow depth reports on February 13th for the previous 24 hours. CoCoRaHS observers are citizen scientists who measure rain, snow, and hail in their backyards (CoCoRaHS).

As cold air lingered, a larger shot of moisture arrived on the 12th producing record breaking snow in western Washington. Once again, snow totals were enhanced in Olympia with reports of close to a foot of new snow and total snow depths reaching as high as 16". While there was greater snow overall at SeaTac in 2019, the intensity of the

the month with westerly flow bringing consistent precipitation to western Washington with near-normal temperatures. Once again, rain shadowing failed to produce measurable precipitation in Wenatchee, but Spokane did receive two more doses of light snowfall.

Snowpack and Drought Monitor Summary

Cooler than normal February temperatures and well above normal precipitation in the Cascade Mountains caused huge growth in snowpack around the state. The basin average snow water equivalent (SWE) percent of normal from the Natural Resources Conservation Service (NRCS) as of March 1 is shown in Figure 3. Snowpack is well above normal in the Olympic and Cascade Mountains, ranging between 116 and 167%. The Lower Pend Oreille and Spokane basins are closer to normal with 98 and 102% of normal, respectively. The gains in SWE (in inches) in February (Figure 4) are impressive. Paradise (32.1") and Skookum Creek (30.5"), which set a total February precipitation record at 36.4", appear to be the leaders in SWE growth increases between 10 and 25" were common throughout the Cascades.

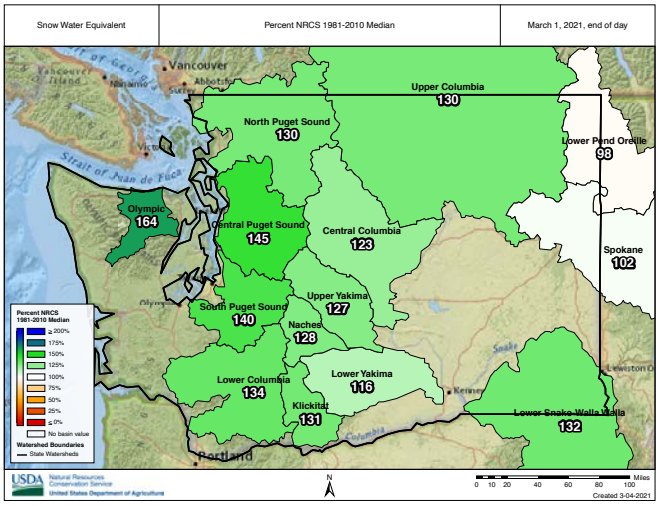

Figure 3: Snowpack (in terms of snow water equivalent) percent of normal for Washington as of March 1, 2021 (from NRCS).

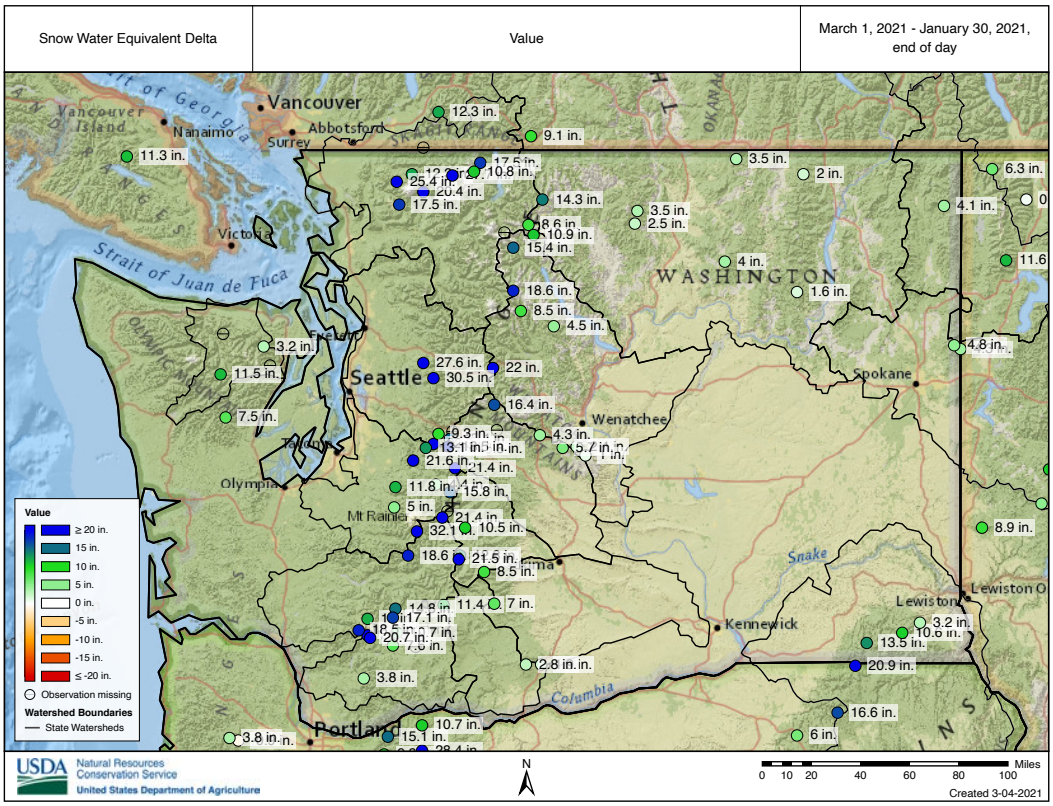

Figure 4: The change in snow water equivalent (in inches) from January 30, 2021 to March 1, 2021 (from NRCS).

More improvements were made to the U.S. Drought Monitor (Figure 5) depiction over the course of February. Most of the areas in drought in the Lower Columbia Basin actually received below normal precipitation for the month, but the ample snowpack has justified improvements. The areas of "severe drought" (D2) and "moderate drought" (D1) have been reduced. Even so, below normal water year precipitation in this region for both the current water year (2021) and previous water year (2020) and low soil moisture have resulted in the current drought depiction. As we look towards spring and summer, this drought is likely to be felt more by non-irrigated agriculture in the region considering there is likely to be ample water supply for irrigators (through melting snowpack).

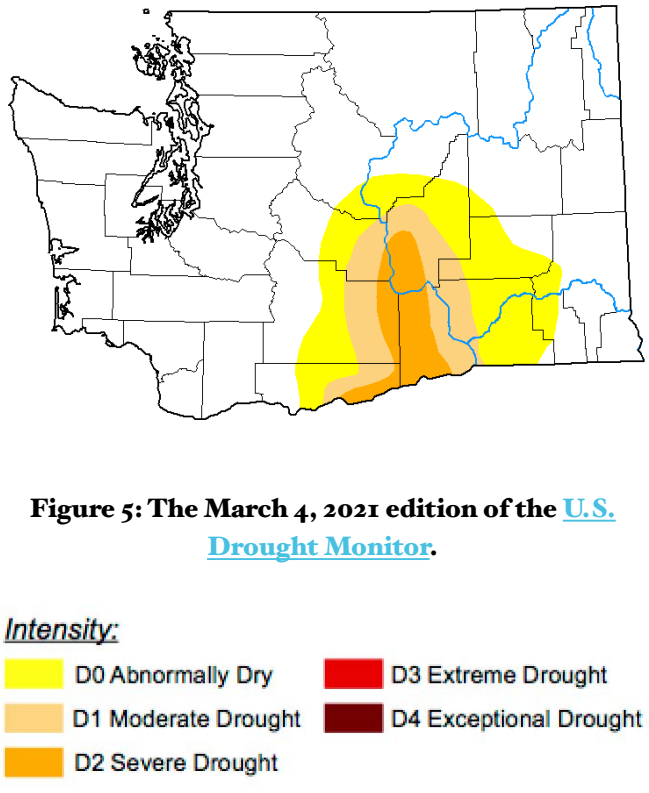

Figure 5: The March 4, 2021 edition of the U.S. Drought Monitor.

The CoCoRaHS Corner

While some are animated by the prospect of college basketball tournaments in March, weather observers mind their rain gauges in anticipation of enhanced springtime convection. As days grow longer, solar heating causes the surface to warm much more quickly than the atmosphere above it. The associated decrease in atmospheric stability, along with periods of vigorous weather disturbances, results in occasional thunderstorms for much of the US. The spatial coverage of CoCoRaHS captures the variability of convective systems allowing for better weather forecasts and water resource management. To spur even greater capability of our network, CoCoRaHS has a March Madness of our own where each state jockeys for the most new observers per capita added in March. While our convective season is not as active as other regions, there is still plenty of fascinating variability to be captured on a daily basis. Last March, very few had weather on their horizon and we only managed to recruit three new observers. We are expecting to easily beat that number, but it always is best to join along with someone else such as a friend, neighbor, or family member.

Mountain Snow Depth Gets a New Display

A message from the State Climatologist

OWSC is pleased to release a new web tool that displays the bi-monthly snow depth data from the Northwest Avalanche Center (NWAC). Partially supported by Tableau, this was a collaboration between NWAC and OWSC and was recently featured in a UW News piece.

For years, NWAC has provided a text product (known as CLISNO), which shows the snow depth at 11 stations (9 in Washington and 2 in Oregon) two times a month from November 15 through May 1. Note that this is *snow depth* (i.e., the measurement of the depth of the snow on the ground) and not *snow water equivalent* (i.e., the amount of liquid in the snow if all the snow is melted). Regardless, snow depth behaves similarly, in that it builds throughout the season with a peak usually in April. One benefit of viewing the snow depth at the NWAC (and partners) stations is that these stations are located where people actually go to recreate, as opposed to the more remote SNOTEL sites where most of our snow water equivalent information comes from.

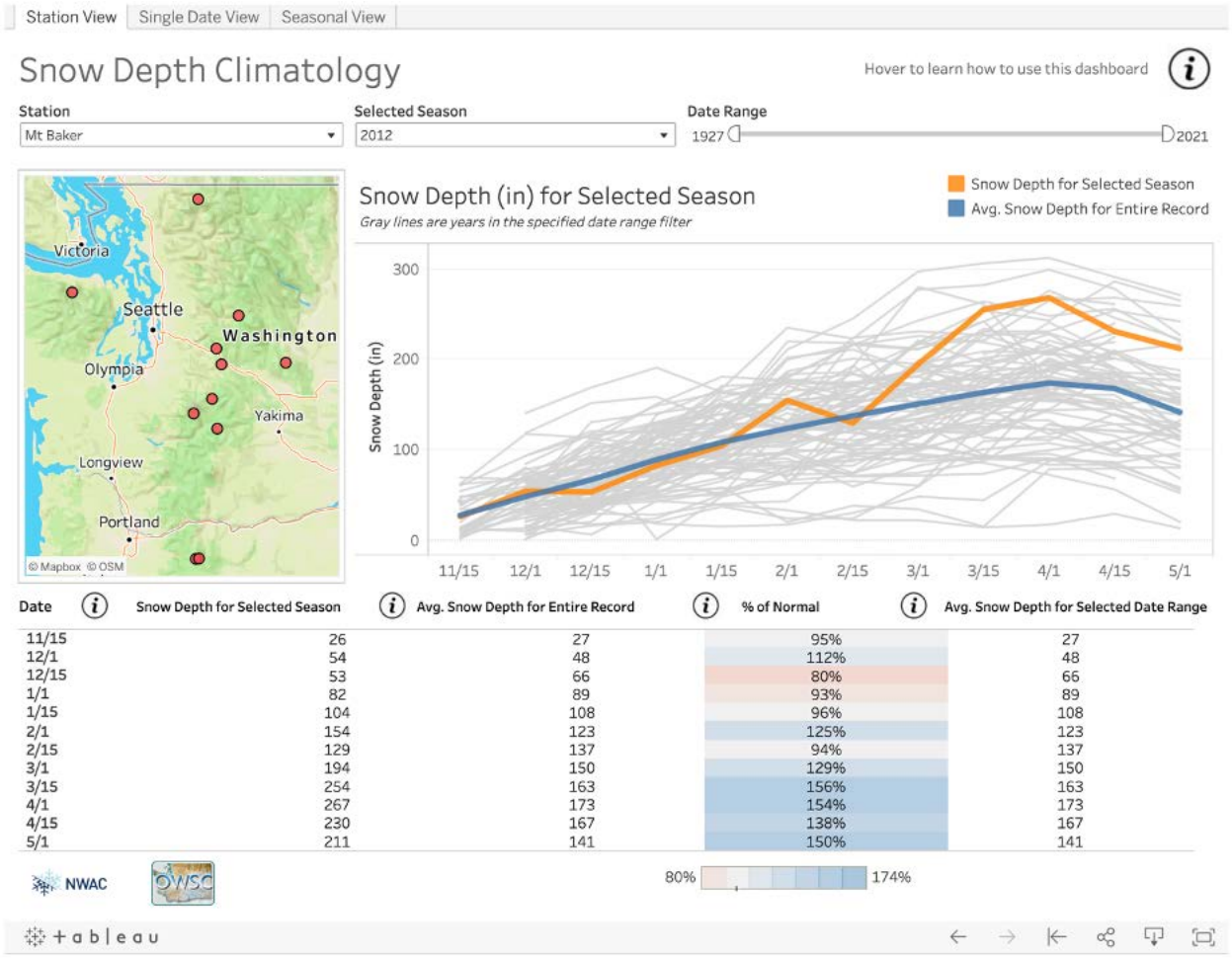

Figure 6: Snow depth on Mt. Baker from the 2011-12 winter season (orange line) compared to average (blue line) and historical seasons (gray lines) dating back to 1927. This display is from "Station View" tab.

2012

Date: 2/15

Station Name	Snow Depth (in)
Crystal Mountain	60
Hurricane Ridge	78
Mission Ridge	35
Mt Baker	129
Mt Hood Meadows	101
Paradise	125
Snoqualmie Pass	78
Stampede Pass	72
Stevens Pass	90
Timberline	122
White Pass	56

2021

Date: 2/15

Station Name	Snow Depth (in)
Crystal Mountain	76
Hurricane Ridge	99
Mission Ridge	46
Mt Baker	172
Mt Hood Meadows	120
Paradise	159
Snoqualmie Pass	116
Stampede Pass	96
Stevens Pass	113
Timberline	139
White Pass	83

Figure 7: The snow depth values on 2/15/2012 (left) and 2/15/2021 (right). These images were pulled from the "Seasonal View" tab.

The new tool displays these snow depth measurements graphically in a few different ways. The "Station View" shows the complete Nov 15-May 1 season for one particular station along with a user-selected range of historical seasons. The "Seasonal View" also shows the data in a complete season, but for only one season and for all 11 stations. The "Single Date View" is a bit different, and allows the user to see the historical variability for one station on a specific date. Let's look at some examples.

As most of our readers are likely aware, the current winter has included a moderately strong La Niña in the tropical Pacific. The last La Niña of comparable intensity, with SST anomalies more than 1°C below normal, was during the winter of 2011-12. The WA snowpack actually got off to a slow start during that winter but ended the season much above normal. Mt. Baker (Figure 6), with snow depth records back to 1927, shows that 4/1/2012 had the 6th greatest 4/1 snow depth with 267" (154% of normal). Interestingly, the 2/15/2021 snow depth observations are greater than the 2/15/2012 observations for all 11 stations (Figure 7).

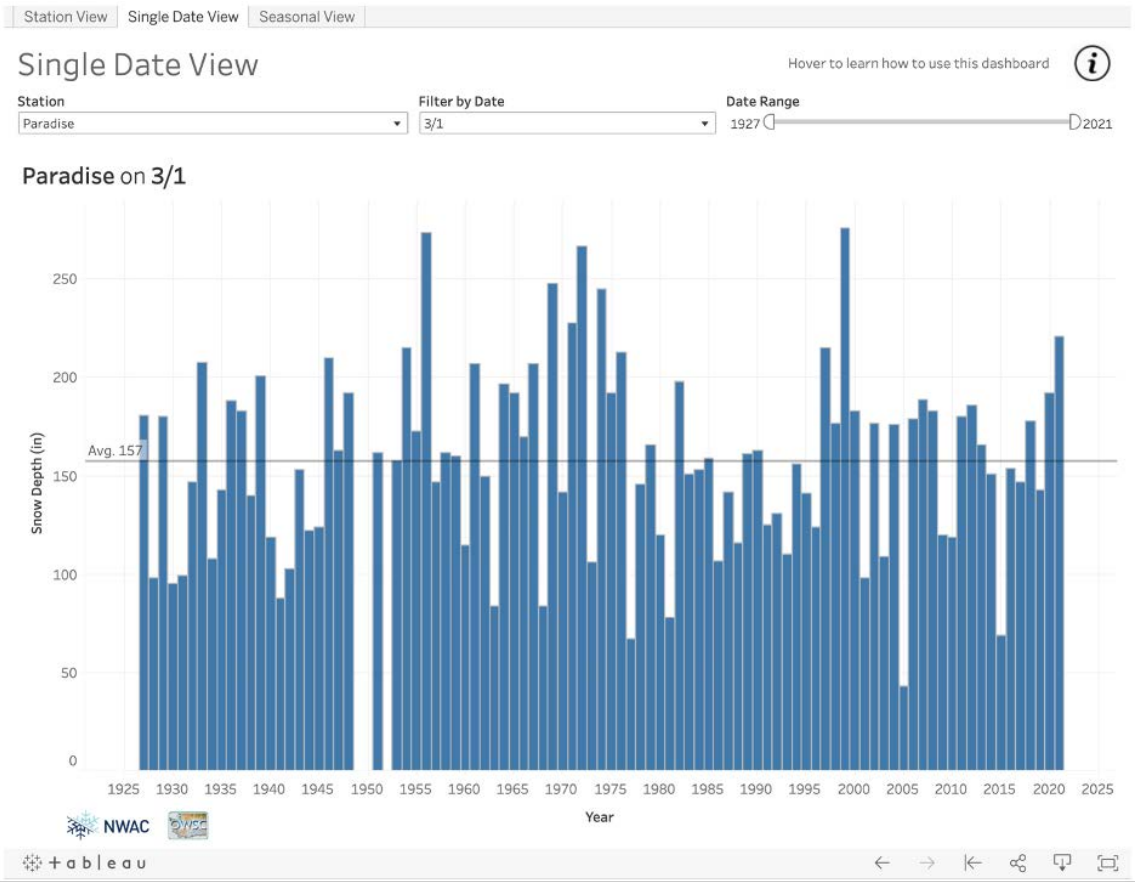

Figure 8: March 1 snow depth measurements for the 95-year record at Paradise using the "Single Date View" tab. There are some missing data in the early 1950s.

This does not mean we're guaranteed to rival the impressive snow depth of 2012 by April, but given that the seasonal forecast indicates cooler and wetter than normal conditions for the spring, we have a fair shot. The latest 3/1 observations show above normal snow depth for all 11 stations (between 109 to 167% of normal).

Historical snow depth measurements on 3/1 are shown for Paradise using the "Single Date View" tab (Figure 8). The 3/1/2021 measurement of 221" ranks as the 7th greatest in the 95-year record. There are some missing data (1949, 1950, and 1952), and we know that those were rather snowy years, so the ranking of 7th greatest may be a bit inflated. In addition to the record high seasons, the low snow depth measurements jump out on this graph as well. The March 1 snow depth measurements in 1977, 2005, and 2015 of only 67", 43", and 69", respectively, are indicative of major drought years in WA history. The point here is that this is a tool that can be used to examine extremes on both sides.

Future work on this visualization will involve adding the ability to parse out seasons depending on their La Niña or El Niño classification and potentially adding a few more stations. We are open to other suggestions and feedback on the tool. In the meantime, enjoy digging into this historical data!

Climate Summary

To the dismay of no Washington resident, mean February temperatures were well below normal statewide. The last month to feature below normal temperatures across the entire state was March of 2020. Areas downwind of the Cascade Range were closer to normal such as Omak and Ephrata, which were both 1.4 °F cooler than normal (Table 1). The Pullman Airport was in a particularly cold spot in the SE corner of Washington experiencing temperatures 5.7 °F below normal. An even greater departure from normal occurred in NE Washington along the Canadian border- best highlighted by the town of Northport in Stevens County, which observed an average temperature of 7.3 °F below normal. While temperatures appear to be slightly above normal in south-central Washington, every station in Washington recorded below normal mean temperatures.

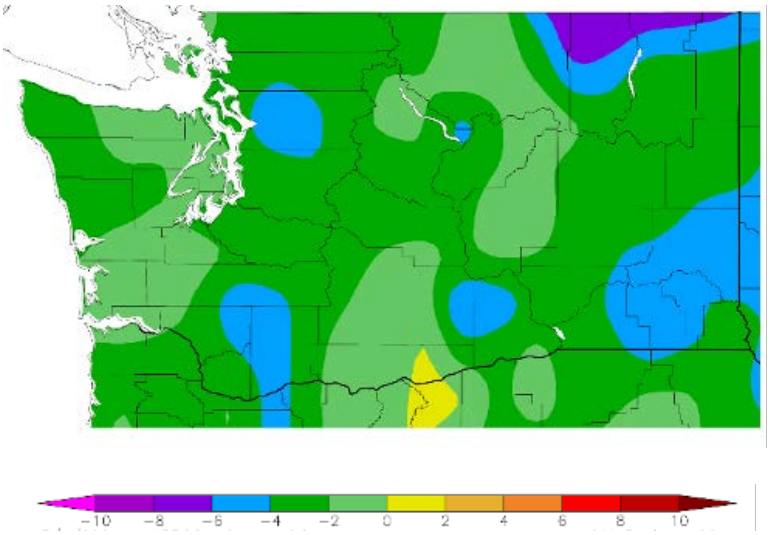

Figure 9: February temperature (°F) departure from normal relative to the 1981-2010 normal

Total February precipitation featured high spatial variability with well above normal values in generally rugged areas such as the Cascades, NE Washington, and SE Washington. The eastern Washington lowland areas sat in the other end of the spectrum with precipitation totals as low as 33% of normal in Ephrata. The arrival of snow further complicated precipitation reports as some stations omitted the snow water equivalent from the precipitation totals. This accounts for the extreme lack of precipitation in Benton County, where Prosser only noted a trace of precipitation, but 11" of new snow. Close by in Pasco, a more realistic value of 0.65" was recorded (76% of normal for the month). Along the same lines SeaTac, Seattle WFO, and Bellingham Airport all received above normal precipitation at 133, 134, and 124 %, but less reliable stations nearby under-reported precipitation during the mid-month snow event. The really wet regions were the western slopes of the central and northern Cascades, and the lowlands stretching from south of Puget Sound to the mouth of the Columbia River. Notably, Olympia recorded 7.84"- nearly 50 % more than their normal February value.

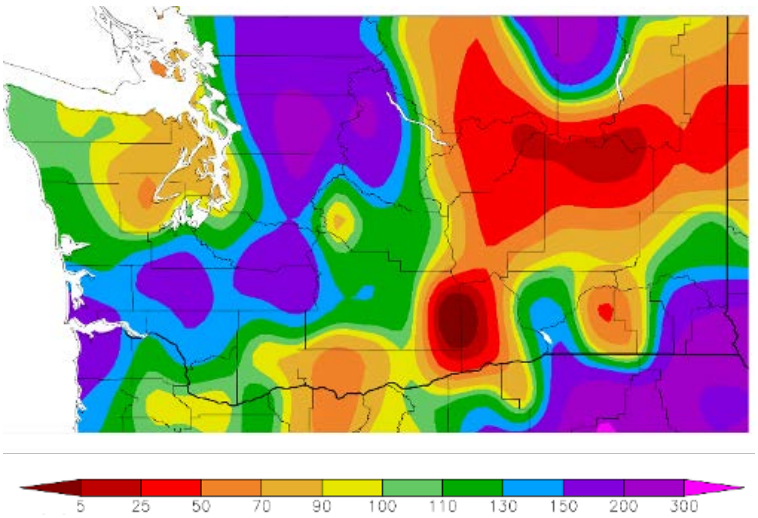

Figure 10: February total precipitation as a percentile of the 1981-2010 normal (HPRCC).

Station	Mean Temperature (°F)			Precipitation (inches)			Snowfall (inches)		
	Average	Normal	Departure from Normal	Total	Normal	Percent of Normal	Total	Normal	Percent of Normal
Western Washington									
Olympia	39.7	41.0	-1.3	7.84	5.27	149	M	4.7	M
Seattle WFO	41.6	43.4	-1.8	4.41	3.31	133	9.0	0.6	1500
SeaTac AP	41.4	43.4	-2.0	4.68	3.50	134	12.4	1.7	729
Quillayute	39.5	42.1	-2.6	11.54	10.35	112	M	2.6	M
Hoquiam	41.3	43.7	-2.4	8.75	7.21	121	M	0.8	M
Bellingham AP	38.6	40.8	-2.2	3.75	3.02	124	M	2.4	M
Vancouver AP	41.5	43.5	-2.0	3.78	4.03	94	M	M	M
Eastern Washington									
Spokane AP	29.1	33.0	-3.9	0.84	1.33	63	3.5	6.8	174
Wenatchee	32.0	34.8	-2.8	0.91	0.81	112	M	4.4	M
Omak	30.4	31.8	-1.4	0.74	1.41	53	M	M	M
Pullman AP	29.2	34.9	-5.7	2.38	1.52	157	0.0	M	M
Ephrata	32.7	34.1	-1.4	0.25	0.74	34	M	3.1	M
Pasco AP	36.3	38.9	-2.6	0.65	0.86	76	M	M	M
Hanford	35.3	38.2	-2.9	0.70	0.70	100	9.7	2.3	422

Table 1: February 2021 climate summaries for locations around Washington with a climate normal baseline of 1981-2010. Note that the Vancouver Pearson Airport and Seattle WFO 1981-2010 normals involved using surrounding stations in estimating the normal, as records for these station began in 1998 and 1986, respectively.

Climate Outlook

According to the Climate Prediction (CPC), La Niña conditions are still present in the equatorial Pacific due to below normal sea surface temperatures (SST) and enhanced near-surface easterly winds. Indications of La Niña forming for the winter of 2020-2021 first appeared in May of 2020. La Niña conditions arrived by September, and peaked a month later, with conditions moderating in late 2020, as indicated by the Oceanic Nino Index (ONI). Since January, the ONI has mostly remained steady between -0.5 and -1.0. While the greatest negative SST anomalies exist in the central equatorial Pacific, that region has undergone warming over the past month. This warming has been offset by cooling in the eastern equatorial Pacific, which has returned to below normal SST. ENSO forecast models suggest that it is more likely than not that there is a return to neutral conditions by April-May-June, but the ONI value is still expected to remain negative (Figure 10).

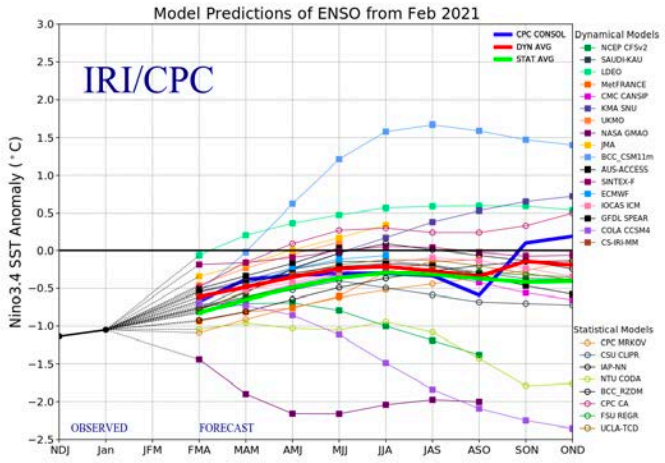

Figure 10: Plume diagram of ENSO models for the SST anomaly in the region Nino 3.4 (IRI).

The the CPC one month outlook for March (Figure 11) has increased chances of below normal temperatures statewide with greater chances in western Washington. The precipitation outlook is a mixed bag with equal chances of above, below, and near-to normal precipitation for the entirety of the state.

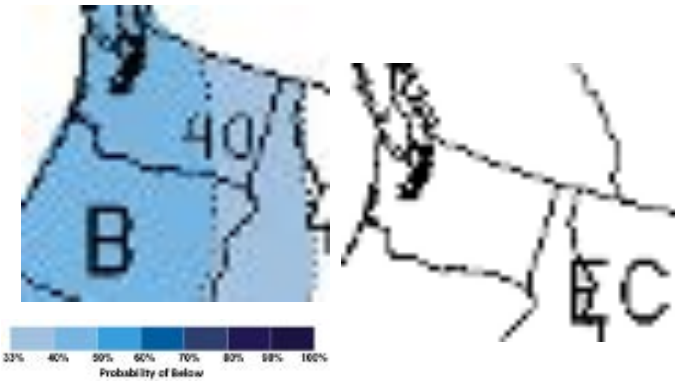

Figure 11: March outlook for temperature (left) and precipitation (right).

The three-month outlook for March through May (Figure 12) has increased chances of below normal temperatures for the entire state with greater odds further north. The precipitation outlook mimics the temperature outlook with increased chances of above normal precipitation statewide, but higher chances in the northern half.

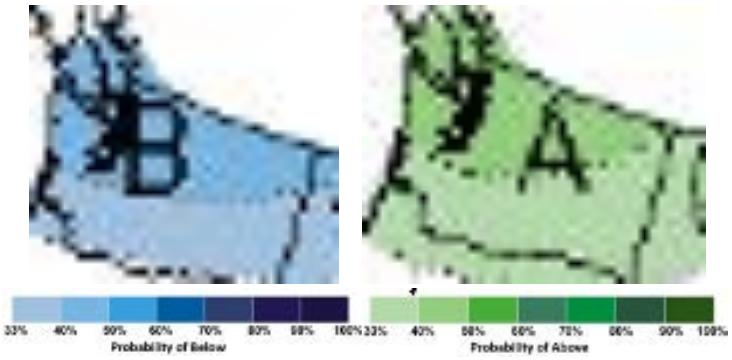

Figure 12: March-April-May outlook for temperature (left) and precipitation (right) (Climate Prediction Center).