Office of the Washington State Climatologist

January 2024 Report and Outlook

January 9, 2024

http://www.climate.washington.edu/

December Event Summary

Mean December temperatures were much above normal statewide. Averaged statewide, it was the 3rd warmest December on record, with anomalies 5.3˚F above normal (records began in 1895). Temperatures were near-record or record warm across much of the state. Figure 1 shows the temperature percentiles compared to the 1979-2015 record, showing that nearly all of the state was above the 90th percentile. December precipitation was generally above normal across the state, with a few exceptions (more in the Climate Summary on page 9). Averaged statewide, total precipitation was near-normal and ranked as the 45th wettest December since 1895.

The bulk of the month's precipitation fell at the beginning of the month, as illustrated by the daily temperature and precipitation time series for SeaTac International Airport (Figure 2). Three atmospheric rivers were responsible for this heavy precipitation. The first brought snow in the mountains but then the following two brought snow levels much higher, causing precipitation to fall as rain. Between 4 and 8" of rain fell in the lowlands of western WA over these storms; the Center for Western Weather and Water Extremes has an event summary with more detail (Figure 3).

In this Issue

Moderate to major river flooding in western WA was associated with these systems, including what may have been record flooding on the Stillaguamish at Arlington. Impacts also included landslides with one particularly disruptive one

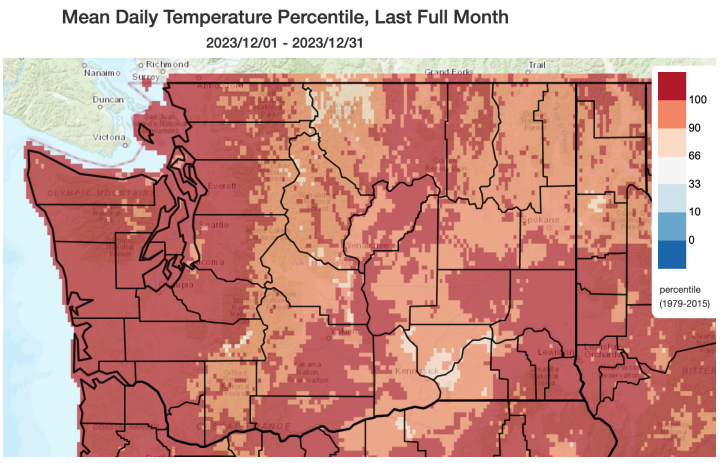


Figure 1: December 2023 temperature percentiles compared to the 1979-2015 record (Climate Toolbox).

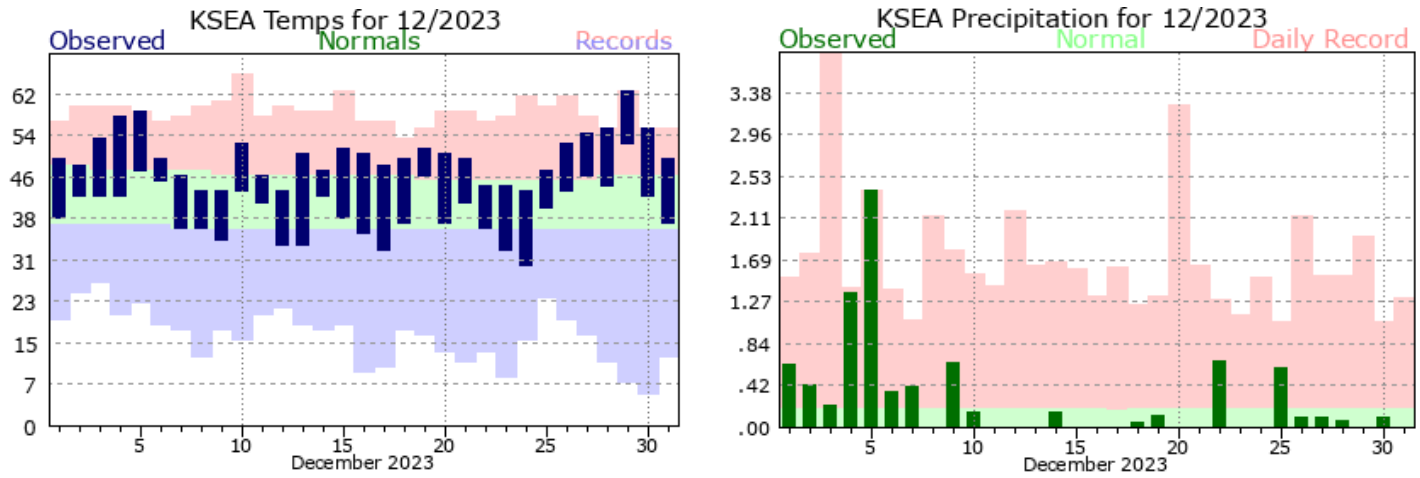


Figure 2: December 2023 daily temperatures (left) and precipitation (right) for Seattle International Airport compared to the 1991-2020 normal (green envelope) and previous records (blue and red envelopes; NWS).

blocking the Amtrak route from Seattle to Portland (KOMO news).

Local maximum precipitation and high temperature records were set over this period as well. On the 4th, maximum rainfall daily records were set at Quillayute (4.19"), Hoquiam (2.93"), and the Seattle Weather Forecasting Office (1.51") and high maximum temperature records were set at Vancouver (66˚F) and Walla Walla (64˚F - tie). On the 5th, Olympia (2.96"), SeaTac (2.39"), and Seattle WFO (1.88") set maximum rainfall records and Walla Walla (66˚F), Vancouver (64˚F), Olympia (62˚F), Yakima (60˚F), SeaTac AP (59˚F), and Bellingham AP (59˚F) had record high temperatures. On the 6th, record maximum rainfall fell at Yakima (0.55") and Wenatchee (0.27") and both high maximum temperature records (Yakima - 59˚F) and high minimum temperature records (Spokane - 44˚F; Omak - 42˚F) were set.

While temperatures were consistently above normal for nearly the entire month (Figure 2), there was another period at the end of the month (the 28th through the 31st) that set record high

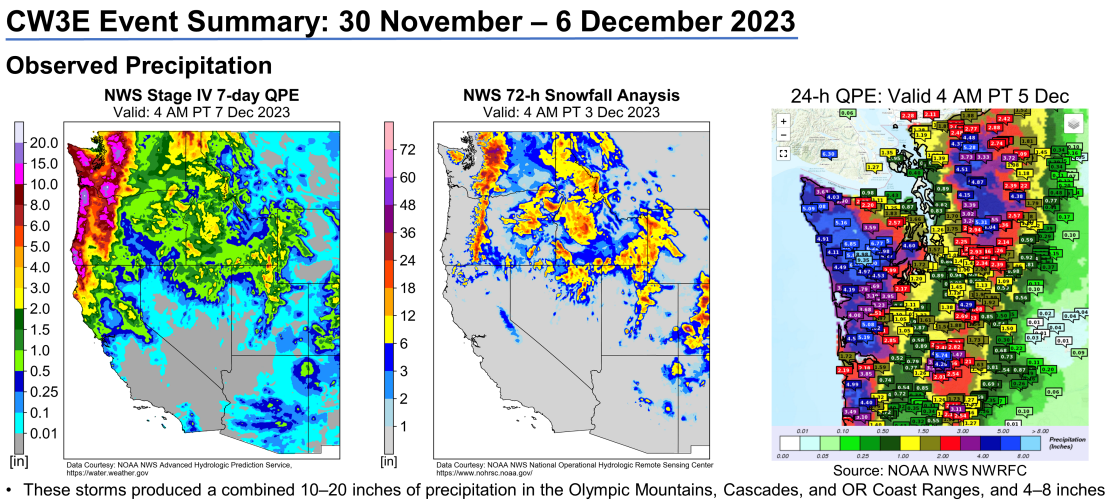


Figure 3: Observed 7-day precipitation, 72-hour snowfall, and 24-hour precipitation for different time periods during early December from CW3E Summary.

temperatures at many western WA stations. For example, on the 29th, record high maximum temperatures were set at Seattle WFO (64°F), SeaTac AP (63°F), Olympia (57°F), Hoquiam (56°F - tie) and record high minimum temperatures were set at SeaTac (53°F), Hoquiam (50°F), and Bellingham (49°F).

Finally, considering it's a new calendar year, we want to briefly review the temperature averages and precipitation totals for the 2023 calendar year. Figure 4 shows that the year was between 1 and 3°F above normal across the entire state. It was also drier than normal (between 70 and 90% of normal) for a majority of the state. An important exception is parts of eastern WA where annual precipitation was near-normal. Averaged statewide, 2023 ranks as the 7th warmest year in WA history and as the 19th driest. The record extends back 129 years to 1895.

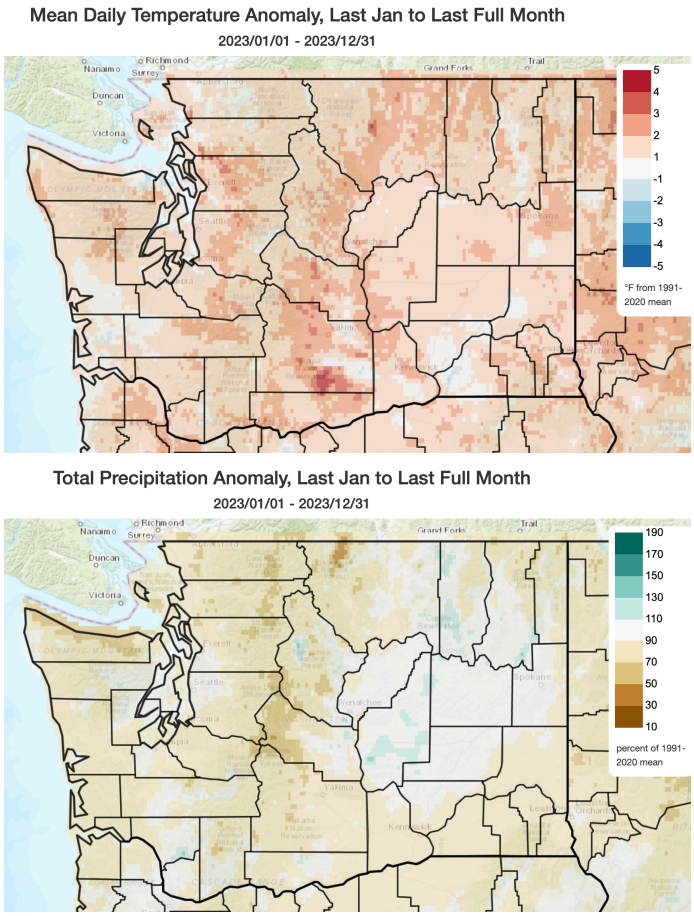


Figure 4: 2023 mean temperature anomalies (top) and precipitation percent of normal compared to the 1991-2020 period (Climate Toolbox).

Snowpack and Drought Summary

Due to the warm December temperatures, the basin average snow water equivalent (SWE) percent of median from the Natural Resources Conservation Service (NRCS) as of January 4 (Figure 5) was much below normal across Washington State. In general, there was significant mountain snow early in the month, but the warm temperatures that accompanied the second and third atmospheric rivers actually reduced the SWE throughout much of the state. Aside from another big snow-building period the second week of the month, the rest of the month just had small increases, allowing basin average SWE to fall even more below median values. As of January 4, the Olympics are in the worst shape with only 24% of median SWE. The North Puget Sound, Lower Columbia, Klickitat, Lower Yakima, and Spokane basins have between 39 and 48% of median SWE. The rest of the basins have slightly more SWE, between 50 and 67% of median. December and January are typically the largest snow-building months of the accumulation season so here's to hoping we see better SWE numbers by the end of January.

The normal to above normal monthly precipitation, with most of that falling as rain, sustained streamflow improvements that began in early November (Figure 6). Along with the increased streamflows, increased precipitation brought on some improvements to the drought depiction on the U.S. Drought Monitor (Figure 7).

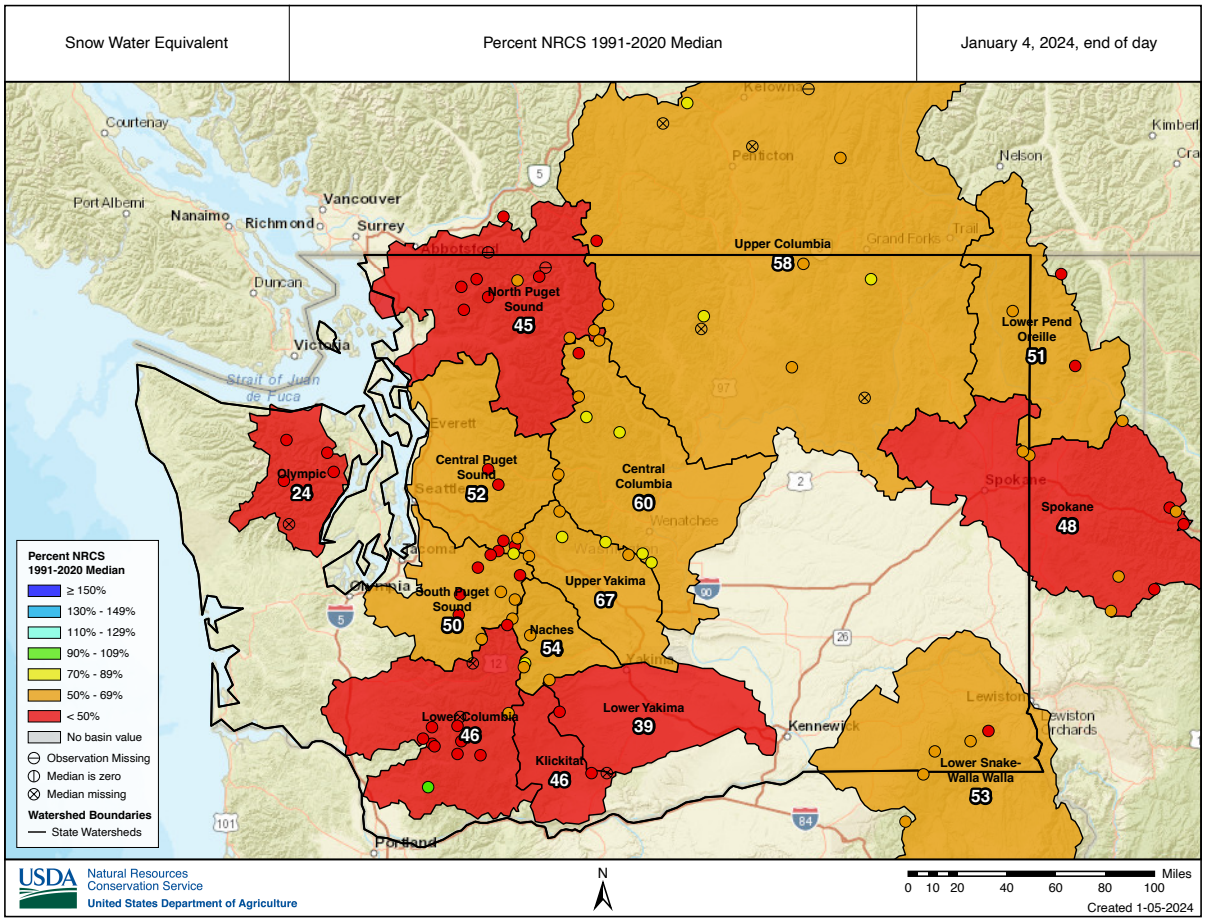


Figure 5: Snowpack (in terms of snow water equivalent) as of January 4, 2024 (NRCS).

Most of the "severe drought" (D2) has been removed from Washington, and some areas of "moderate drought" and "abnormally dry" have also been improved statewide. Seattle Public Utilities is not requesting voluntary water conservation efforts anymore due to the rain in early December filling reservoirs back to their normal levels. The combined reservoir storage for SPU has since dropped slightly below average, however. Notably, the Yakima Basin reservoir system remains both below average and below last year (USBR).

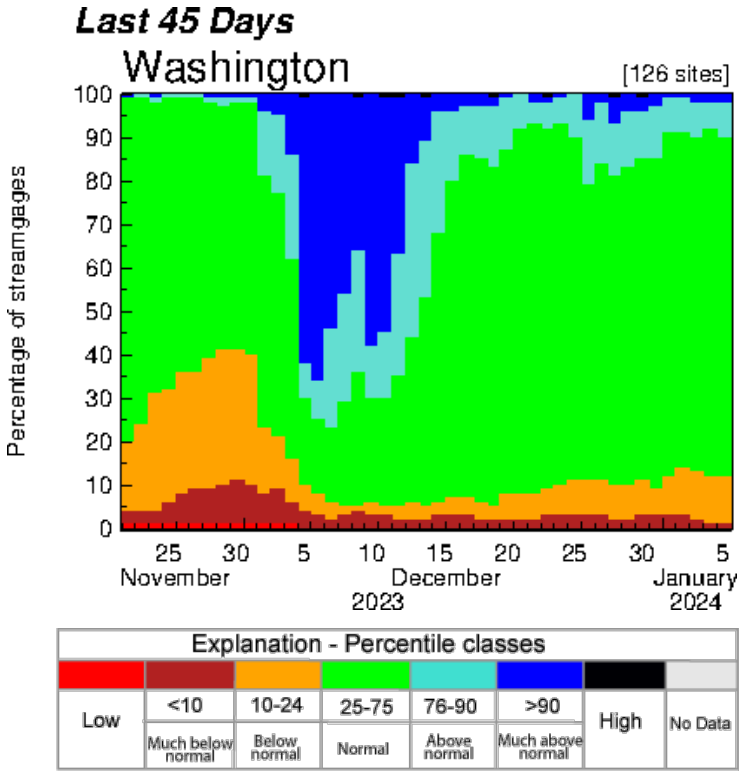


Figure 6: The percentage of stream gauges in WA in each percentile category from late October through November (USGS).

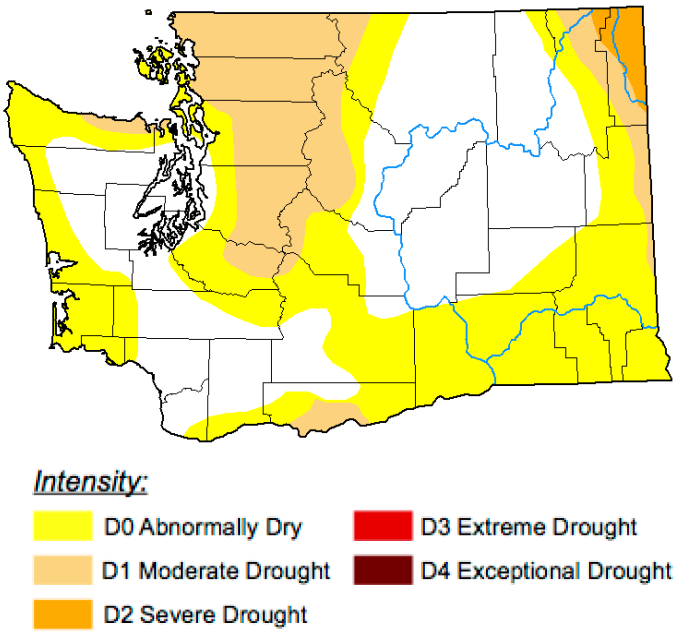


Figure 7: The January 2, 2024 edition of the U.S. Drought Monitor.

Report Your Drought Impacts

Are you experiencing a drought impact? Your on-the-ground observations are critical in helping us understand the broad picture of drought in the state. The National Drought Mitigation Center and partners have developed Condition Monitoring Observer Reports on Drought (CMOR-drought), a short survey that allows the public to enter their observations regarding crops, water supply, fire, etc. We would greatly appreciate your input, and these reports help experts assess drought impacts for both the U.S. Drought Monitor depiction and on the state level.

ENSO's Effects on Snow Water Equivalent over the Years

A Message from the State Climatologist

We trust that most everybody interested in the climate variability of Washington state is already aware that El Niño conditions are present in the tropical Pacific. At the very least, discussions of the prospects for the winter of 2023-24 during the last few months have generally included this element. In addition, El Niño tends to be accompanied by warmer than normal temperatures in the Pacific Northwest, and often, if not as consistently, suppressed precipitation totals. An important consequence of El Niño therefore is the tendency for a sub-par snowpack at the end of winter. Nevertheless, we have wondered whether the relationship between El Niño-Southern Oscillation (ENSO) and winter snowpack has varied over time, and thought it merited a look.

As is usually the case with these pieces, we have taken a simple as opposed to a comprehensive approach. We use the 1 April snow water equivalent (SWE) at Stampede Pass with an elevation of 3959 feet in the central Cascade Mountains as an index for the end-of-winter snowpack. Presumably it is representative of the moderately high elevations of WA state as a whole; we recognize that there are surely some years that are exceptions. Moreover, the east side of Stampede Pass is part of the watershed for the Yakima River, which is a primary source for irrigation in the Yakima Valley. Poor snowpacks in the central Cascades frequently result in curtailments for junior water rights holders in the Yakima Valley during the following summer. We specify the state of ENSO using the NINO3.4 averaged over the months of October through March. For present purposes, we have examined the relationship between this index for ENSO, and the 1 April SWE at Stampede Pass, for the years of 1950 through 2023, focusing on how the first half compares with the second half of this interval.

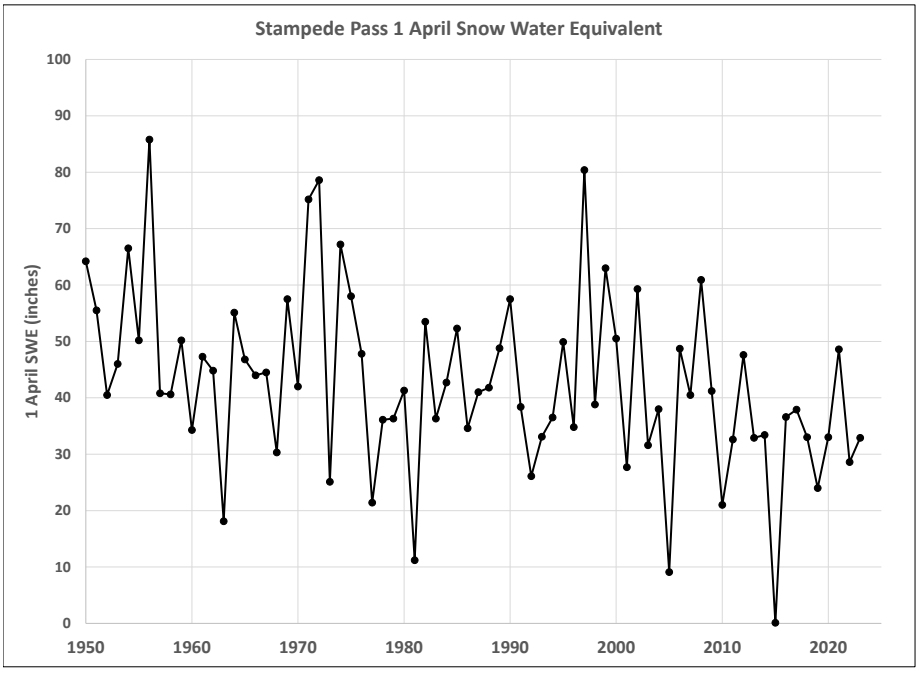


Figure 8: April 1 snow water equivalent (SWE) at Stampede Pass from 1950 through 2023 (data from NRCS).

Towards setting the stage, a time series of 1 April SWE at SMP for 1950 through 2023 is plotted in Figure 8. The highest value in this record is 85.8 inches in 1956 with the 80.4 inches in 1997 not far behind. The lowest value is a miserly 0.1 inch in 2015 when the snowpack statewide was the

worst on record. We note that bad snow years also occurred in the early part of the record, with the 18.1 inches of 1963 being a low point. There is also an overall downward trend during the 74 years shown, as is typical for stations in the Pacific Northwest near Stampede Pass's elevation, where modest increases in temperature can result in a greater proportion of precipitation falling as rain. The year-to-year variability in SWE has changed negligibly over the interval.

Scatterplots of NINO3.4 versus 1 April SWE at SMP for the years of 1950 through 1986, and the years of 1987 through 2023 are shown in Figures 9 and 10, respectively. An obvious difference between these plots is a stronger relationship between NINO3.4 and SWE in the earlier as compared with the later set of years. In more quantitative terms, the best-fit linear slope in the SWE relative to NINO3.4 is about half as strongly negative during the first 37 years as the slope during the second half. In other words, at least for 1 April SWE at Stampede Pass, it appears that ENSO in recent decades has had less of an influence than it did in the past, with the very real possibility this is due to extenuating factors not considered here. We are struck by the nature of the scatter plot in Figure 3 and in particular how most of the recent winters have ended up with about 30 to 50 inches of SWE at Stampede Pass,

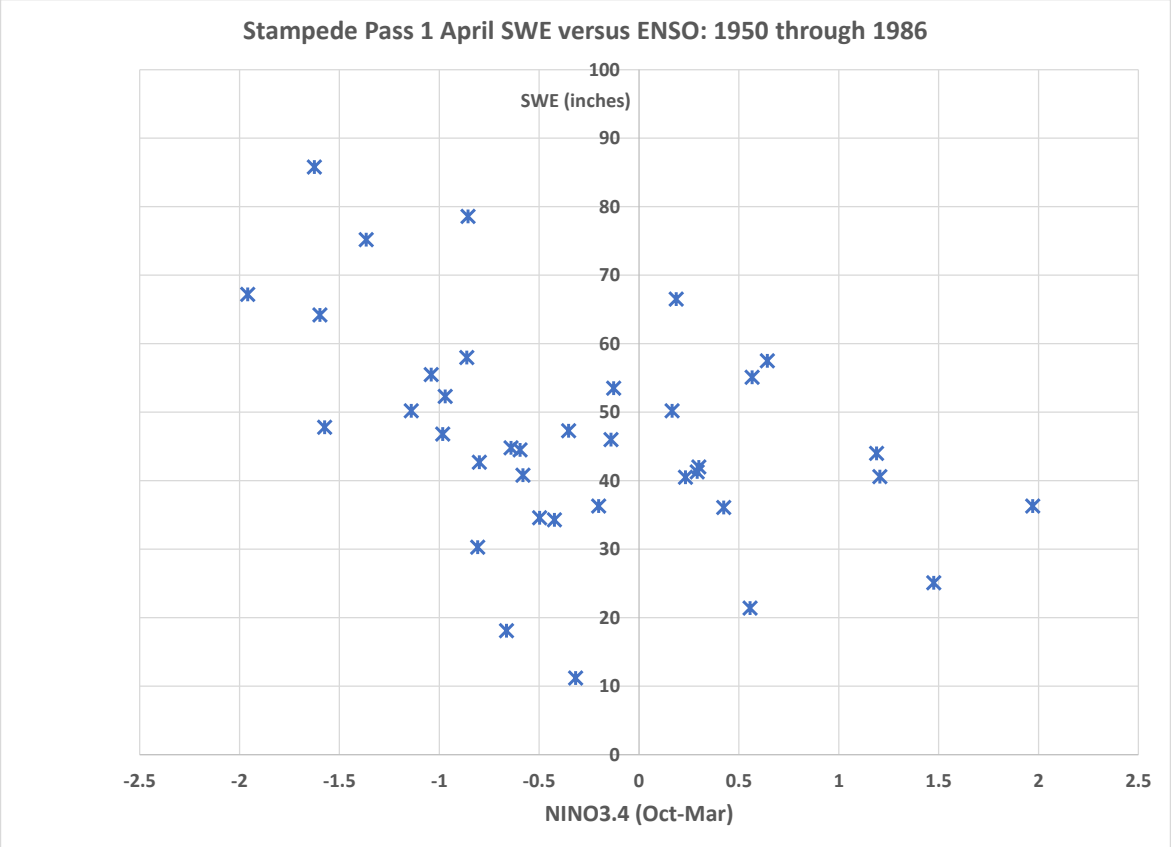


Figure 9: April 1 snow water equivalent (SWE) in inches at Stampede Pass (y-axis) vs. the October-March NINO3.4 index (x-axis) for 1950 through 1986. Positive NINO3.4 indices represent El Niño-like conditions: roughly between 0.5 and 1 are weak, 1 and 1.5 are moderate, and above 1.5 is strong. This scaling applies to the La Niña conditions as well, except those numbers are negative.

irrespective of the state of ENSO. Apparently, negative values of NINO3.4 essentially prevent really terrible snowpacks, but by no means guarantee robust values. Similarly, positive values of NINO3.4 have not been accompanied by any snowpacks above the 30 to 50 inch SWE band. Moreover, the extremely poor snowpack years of 2005 and 2015 were when the NINO3.4 index barely reached 0.5, i.e., only weak El Niño territory by even generous standards. And the intense El Niño events of 1998 and 2016 included typical rather than unusually low SWE values for the 2nd part of the record.

We would like to be able to reconcile the seemingly weaker ENSO signal in recent years here, but doing so is no cinch and well beyond the scope of this piece. There are regional atmospheric circulation differences between the two sets of years. For example, the 500 hPa flow anomalies during the moderate La Niña (NINO3.4 < -1) winters of the first set of years were about twice as strong from the northwest in a composite sense compared with their counterparts for the second set of years (not shown). It makes sense that the former set of winters were snowier. But it does not account for why the response in terms of regional weather/circulation patterns has been weaker lately. We can blame the internal variability of the circulation over the North Pacific and western North America, which certainly modulates the remote connections to ENSO, but that feels more like an excuse than an explanation.

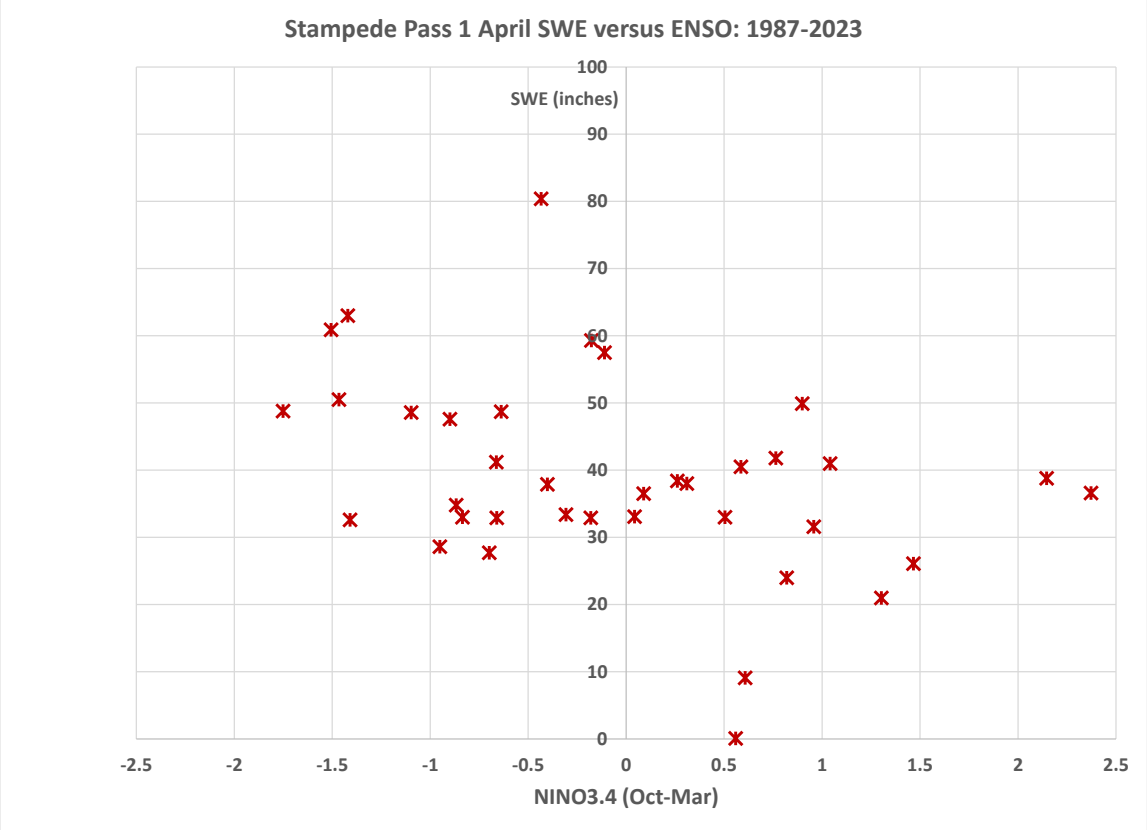
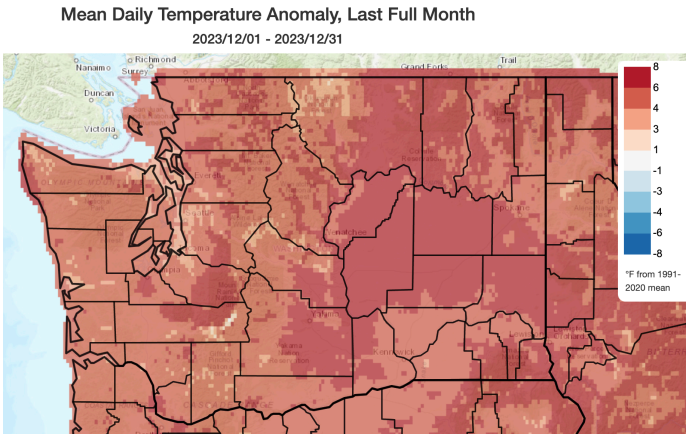


Figure 10: The same as Figure 3, except for 1987 to 2023.

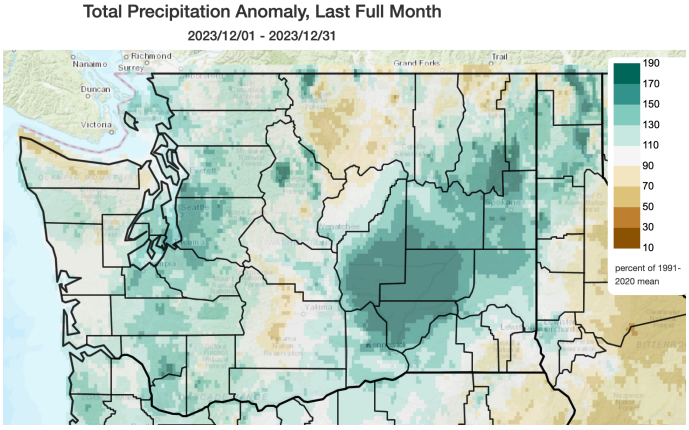
Climate Summary

Mean December temperatures were much above normal statewide. Temperature anomalies were largest in eastern WA, where monthly averages were 4 to 7˚F above normal. Omak, in particular, was warm, with temperatures 7.0˚F above normal (Table 1). Temperatures in western WA were also above normal, and most anomalies ranged between 3 and 4˚F above normal. Several individual stations recorded their warmest December on record, including SeaTac Airport.

December precipitation was above normal for a majority of the state, with the Puget Sound region and the Lower Columbia Basin being the wettest relative to normal, with between 130 and 170% of normal precipitation. Other areas - such as the southern part of the WA coast - received near-normal precipitation; Hoquiam received 103% of normal, for example (Table 1). There were a few areas with below normal precipitation, with parts of Okanogan, Yakima, and Clallam counties the driest in the state. Omak received only 65% of normal precipitation, for example. Lower elevation snow was completely lacking in western WA, and below normal in Spokane and Hanford as well (Table 1).



December temperature (˚F) departure from normal relative to the 1991-2020 normal (Climate Toolbox).



December total precipitation percent of the 1991-2020 normal (Climate Toolbox).

Station	Mean Temperature (°F)			Precipitation (inches)			Snowfall (inches)		
	Avg	Norm	Departure from Normal	Total	Norm	Percent of Normal	Total	Norm	Percent of Normal
Western Washington									
Olympia	45.5	38.9	6.6	10.72	7.85	134	-	-	-
Seattle WFO	45.2	41.8	3.4	8.82	5.55	159	0	1.7	0
SeaTac AP	45.5	42.0	3.5	8.48	5.72	148	0	1.7	0
Quillayute	48.0*	41.0	M	15.42	13.84	111	-	-	-
Hoquiam	45.7	42.0	3.7	10.88	10.52	103	-	-	-
Bellingham AP	43.3	39.8	3.5	5.67	4.33	131	-	-	-
Vancouver AP	44.8	40.8	4.0	8.40	6.07	138	-	-	-
Eastern Washington									
Spokane AP	34.6	29.1	5.5	3.34	2.34	143	11.8	13.8	86
Wenatchee	34.4	29.0	5.4	1.23	1.31	94	-	-	-
Omak	34.9	27.9	7.0	1.28	1.95	65	-	-	-
Pullman AP	36.7	31.7	5.0	2.48	2.21	112	-	-	-
Ephrata	36.2	29.6	6.6	1.30	1.13	115	-	-	-
Pasco AP	38.2	34.1	4.1	1.44	1.03	140	-	-	-
Hanford	37.4	32.6	4.8	1.83	1.08	169	1.4	4.4	32

Table 1: December 2023 climate summaries for locations around Washington with a climate normal baseline of 1991-2020. *Quillayute appears to be warmer than some of the other surrounding stations so data are pending a temperature sensor check.

Climate Outlook

According to the Climate Prediction Center (CPC), a strong El Niño is present in the equatorial Pacific Ocean and an "El Niño Advisory" is in effect. Over the last month, the strength of the above normal sea surface temperatures (SST) anomalies have generally persisted. There has been some slight cooling in the eastern equatorial Pacific, but the SSTs are still about 1°C above normal. ENSO models are certain that El Niño will persist through the winter; the chances of El Niño for the February-April period are 97%. The odds of neutral conditions are higher in April-June (60%), with the likelihood of El Niño reduced to 37%.

The CPC January temperature outlook (Figure 11) has slightly increased chances of above normal temperatures for the Olympic Peninsula, southwest Washington, and the southern Puget Sound region. Those same locations have slightly higher odds of above normal January precipitation as well. The remainder of the state has equal chances of below, equal to, or above normal temperatures and precipitation.

The January-February-March (JFM) temperature outlook (Figure 12) has high odds (between 50 and 60% on the three tier scale) of above normal temperatures statewide. JFM precipitation is more likely to be below normal across eastern Washington, while there are equal chances of below, equal to, or above normal precipitation for western Washington.

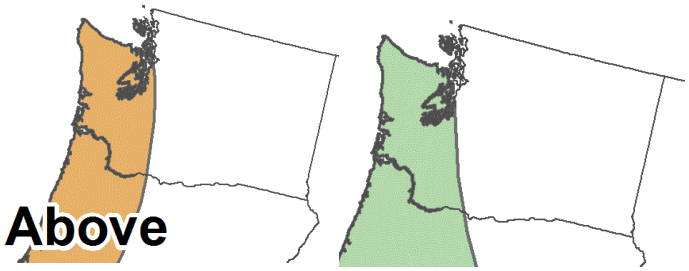


Figure 11: January outlook for temperature (left) and precipitation (right).

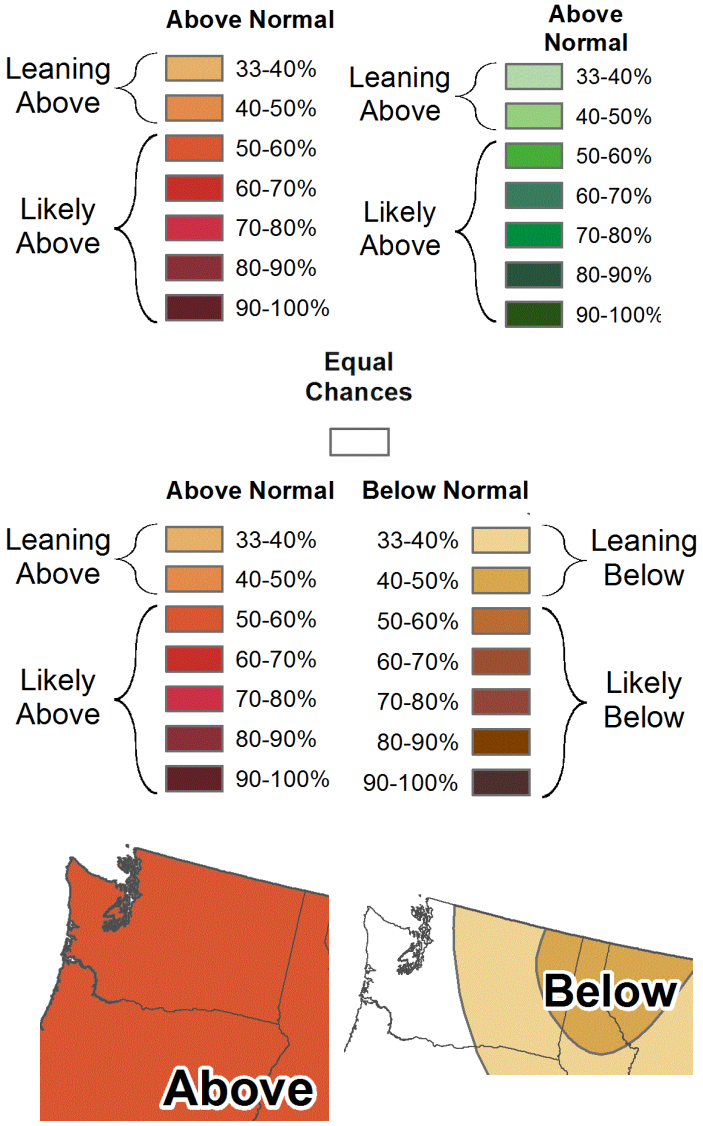


Figure 12: January-February-March outlook for temperature (left) and precipitation (right) (Climate Prediction Center).