Office of the Washington State Climatologist

October 2024 Report and Outlook

October 14, 2024 http://www.climate.washington.edu/

September Event Summary

Mean September temperatures were above-normal overall, but some locations experienced near-normal conditions. September precipitation was below-normal across a majority of the state, especially in eastern Washington. The statewide average rankings for temperature and precipitation from the National Centers for Environmental Information (NCEI) are not available due to the impacts of Hurricane Helene in Asheville. However, we estimate that averaged statewide, September temperatures were 3.2˚F above normal and September precipitation was 43% of normal.

A glimpse into the 2024 water year review! The water year in our region begins on October 1st and goes until September 30th. By starting the water year in October, winter snow accumulation and fall and spring rainfall are accounted for in the annual precipitation measurements. During the 2024 water year, we estimate that the averaged statewide temperatures were about 1.3˚F above normal and the averaged statewide precipitation was about 90% of normal. Figure 1 shows the 2024 water year average temperature and total precipitation over the whole state.

In this Issue

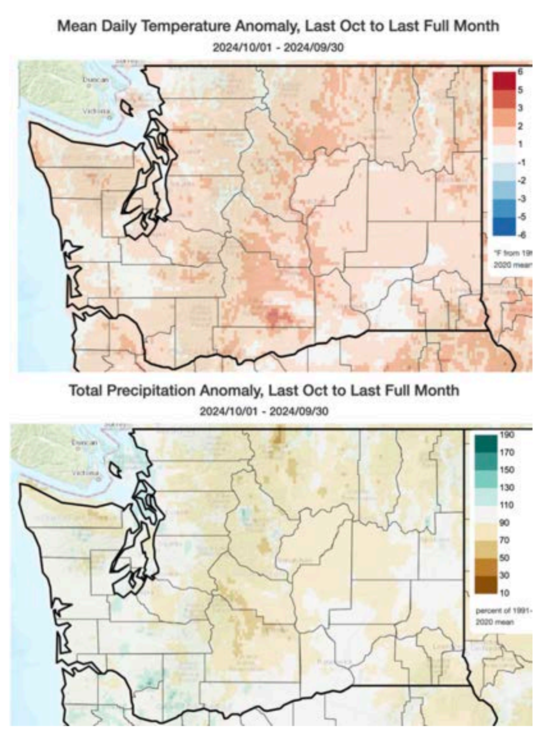


Figure 1: 2024 water year average temperature and precipitation statewide.

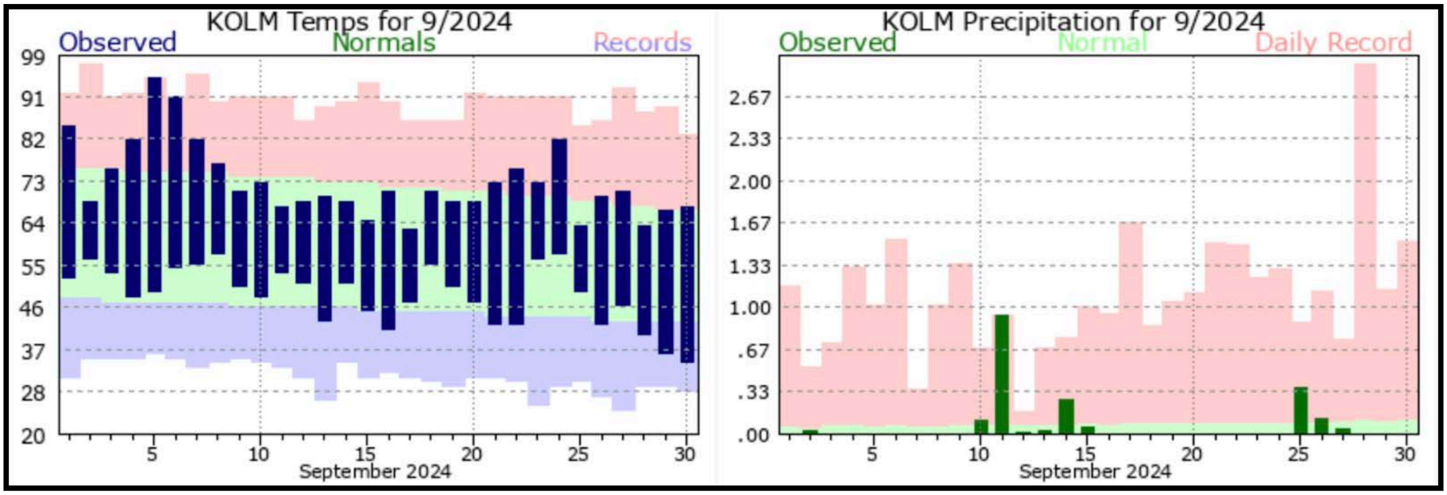


Figure 2: September 2024 daily temperatures (left) and precipitation (right) for Olympia Airport compared to the 1991-2020 normal (green envelope) and previous records (blue and red envelopes; NWS).

You can see from these maps why drought was a concern this year. Locations in the south central region were the most anomalous in average temperature and total precipitation (warmer than normal; drier than normal).

Figure 2 shows the daily September maximum and minimum temperatures and precipitation for Olympia. At the start of the month, maximum temperatures were well above normal for Olympia with some dips of below-normal temperatures. Many other western Washington locations such as Bellingham and SeaTac had this same pattern. Exceptions included some coastal locations such as Hoquiam and Quillayute that began the month with below-normal temperatures. On the flip side, Spokane and Wenatchee experienced above-normal temperatures, but the duration of the period was longer.

After the warm spell early in the month, conditions mid-month consisted of near-normal temperatures throughout the state. This period also included wet conditions for many western Washington locations. Figure 3 shows the precipitation totals measured by volunteer observers on the morning of September 11th. The heaviest precipitation fell in the Olympia region. A daily record maximum precipitation total of 0.93" was set on September 11th for Olympia. Notably, Pullman also broke the daily record for September 12th by receiving 0.79". The rest of the month temperatures stayed consistently near-normal in western Washington, whereas eastern locations experienced near-normal to above-normal temperatures. Soggy conditions returned near the end of the month for many locations in western Washington especially around coastal areas like Quillayute.

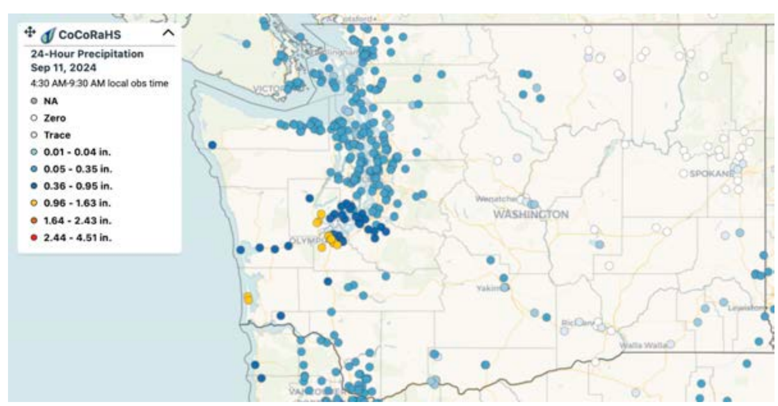


Figure 3: Accumulated precipitation in inches from September 11, 2024 from CoCoRaHS volunteer observers.

Streamflow and Drought Summary

Below normal streamflow aligned with below normal September precipitation overall. This is reflected in the average September streamflows (Figure 4), which ranged from "below normal" to "much normal below normal" for the majority of the state. Stream gauges along the southern coast and central Puget Sound regions averaged below normal to normal for September. Much below normal streamflows were present in the Olympic Mountain region, central Washington, Southern Puget Sound region, and along the northeastern border of Washington.

The latest U.S. Drought Monitor Map (Figure 5) has improved drought conditions in central Washington from the last edition of our newsletter, but similar or worse conditions in some parts of eastern Washington. There are now more locations of "severe drought" (D2) that were previously "moderate drought" (D1) in the east-central portion of the state and along the eastern border.

The Washington state drought emergency was extended in mid-April for most of the state and is still in effect. More information can be found **here**. Worth noting: Washington State has a drought definition written into state law. While that statute isn't changing, the Department of Ecology is beginning the process to amend their Emergency Drought Relief rule (173-166 WAC). There are several engagement efforts occurring this fall, and more information can be found **here**. In addition, the Department off Ecology is looking for feedback to inform the rule update. A short six question survey will be open until November 22 to provide your comments.

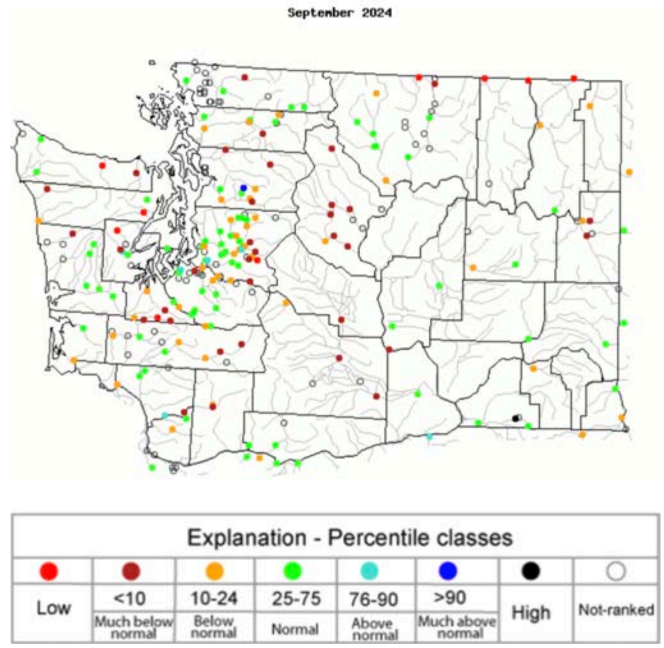


Figure 4: The average September streamflow percentiles (USGS).

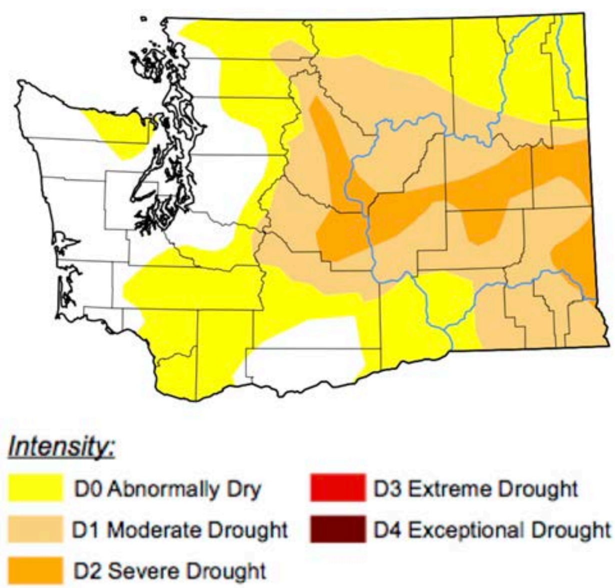


Figure 5: The October 10, 2024 edition of the US Drought Monitor.

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.

2024 Water Year Impacts Survey

Happy 2025 Water Year! Now that water year 2024 is complete, we want to hear from you! How was the Pacific Northwest (Washington, Oregon, and Idaho) impacted?

We encourage you to fill out the Water Year Impacts Survey. The goal of this survey is to gather information about impacts and response actions that were implemented during the 2024 water year (October 1, 2023 - September 30, 2024) due to either abnormally dry or abnormally wet conditions.

The anonymous survey should take about 15 minutes to complete and your responses are **vital** for informing both the Water Year meeting and PNW Water Year Impacts Assessment. The survey will remain open until Wednesday, November 27, 2024.

We greatly appreciate your contributions!

If you are interested in learning more about the Water Year and the results from this survey, we encourage you to register for this year's virtual Water Year meeting on October 29 and 30.

Trends in the Flooding for Washington State

Climate Matters Series Author: Guillaume Mauger

As we head into the flood season we thought we would dig up a USGS study from a few years back that took a look at past trends in floods (full citation below). This isn't the only study on the topic, but it's a classic so we thought it would be valuable to focus just on this one.

Before we dig in to the study, let's back up to discuss two key points:

First, we like to refer to "peak flows" instead of "floods" for analyses of streamflow like this one. We're being picky here, but we do this because flooding is affected by other factors, including the elevation and width of the floodplain, the amount of vegetation and other factors acting to slow flows, and the ability of floodwaters to drain downstream. In this and many studies on flooding, we're actually looking at the amount of water coming down the river, which is one step removed from understanding where the water goes.

Second, it's helpful to first talk about what might cause a change in peak flows. Peak flows are affected by both the weather conditions that bring rain (or cause snowmelt) and how that water moves across the landscape and through the river network. Both of these factors can change in ways that affect peak flows. For example, warmer conditions lead to more rain and less snow, which should lead to bigger peak flows when all else remains equal. Studies so far have not found a trend in heavy rain events, but more intense rainfall would also generally lead to bigger floods.The same is true for landscape changes - wildfires or logging can lead to larger peak flows downstream. Similarly, landslides and erosion upstream can cause sediment to accumulate in areas downriver; as the river channel fills in it becomes easier to flood.

Now back to the study. They analyzed streamflow observations from hundreds of gauges across Washington State, focusing only on sites that are not affected by reservoirs or other major flow modifications upstream. Because they were looking at long-term trends, they also narrowed things down to only the sites with at least 50 years of observations (through 2014, when their analysis was done), bringing the total down to 83 gauges across the state. Most of the analysis was done by taking the maximum flow for each water year, then seeing if it changed over time ("water years" go from Oct-Sep). (*Note:* the study also looked at other aspects of peak flows in the region; we're focusing on the trends analysis)

Figure 6 shows the peak flow record for four example sites. You can see right away that there are different factors affecting peak flows at each site. For the Leach Creek and Stillaguamish River sites, there is clear evidence of an increasing trend, whereas the Nisqually River shows a weak decreasing trend. Crab Creek shows a period of higher flows around 1960, but no clear long-term trend. Both the Nisqually River and Crab Creek sites are odd examples to choose from this analysis, since there are dams upstream of the Nisqually River site, and Crab Creek is heavily influenced by irrigation and the nearby Potholes Reservoir. In both cases the reservoirs began operating in the mid- to late 1940s. For the Nisqually site, we'd expect the dam to hold peak flows steady, since flood control is one of the main functions of many reservoirs. Crab Creek is not as straightforward because irrigation could lead to elevated flows, whereas groundwater withdrawals – mostly for irrigation – could bring flows down. These competing effects make it hard to know what is behind the changes in peak flows at Crab Creek.

The other thing these plots highlight is that peak flows are highly variable from year-to-year. At the Nisqually site, for example, the annual peak flow can range from less than 1,000 to more than 30,000 cubic feet per second – a nearly 3,000% difference! This highlights a key reason why it's hard to estimate trends in peak flows: they're rare. What this boils down to is a sample size problem – if events don't happen often, it's hard to observe enough of them to know if they're changing.

What about other sites? As I mentioned they analyzed trends for 83 gauges across Washington State. Figure 7 shows where they found a positive, negative, or no statistically-significant trend. Their statistics are based on a two-sided Kendall's tau test. Like a correlation, this test measures how well two quantities rise and fall together. But unlike a correlation, this test is agnostic about the probability distribution of each variable. With extremes the probability distribution is often skewed (with a so-called 'heavy tail'), which can

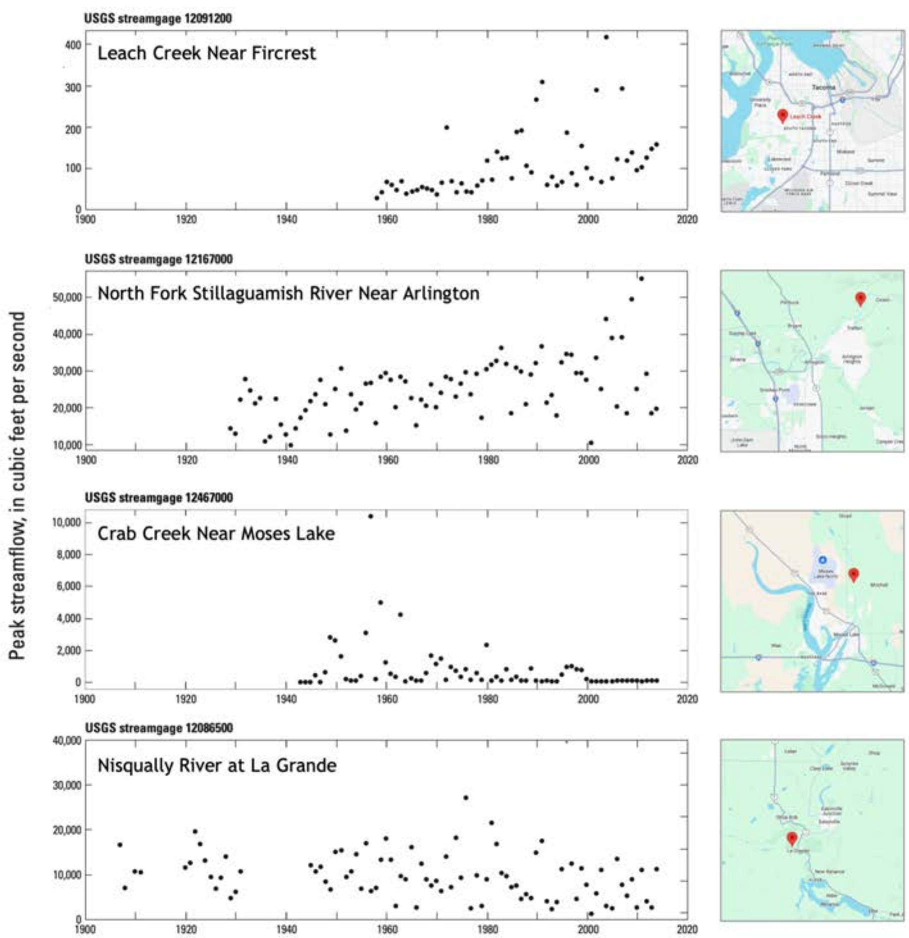


Figure 6. ***Different locations show different trends.*** **Example peak streamflow records included in the USGS report (Mastin et al. 2018). Maps on the right show the location for each streamgage.**

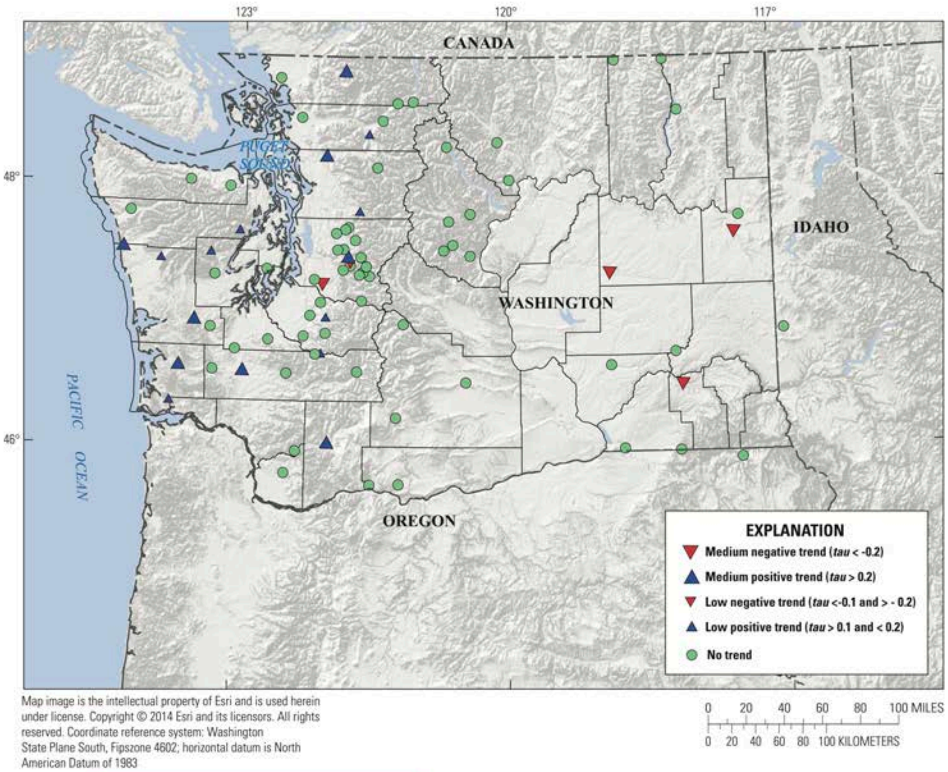


Figure 7. *Not many statistically-significant trends.* Map showing the trend in annual peak flows for stream gages with at least 50 years of observations (Mastin et al. 2018, reproduced with permission).

cause big outlier events to define the statistics. By using the Kendall's tau test, the results are less sensitive to outliers. They defined "statistically significant" as any trend with greater than 95% confidence.

Of the 83 sites, only 21 showed statistically significant trends. Of those, 16 showed positive trends and 5 showed negative trends. You can see from the map that the positive trends are all in western Washington.

So what should we make of these results? First, we can see right away that it's hard to definitively identify trends in rare events. This study examined trends through 2014. It's possible the results could be different with ten more years of data, but trends in extremes will always be noisy. Second, it's clear that there are multiple factors affecting peak flow changes, each of which could lead to trends in peak flows. In eastern Washington, for example, widespread irrigation could raise the water table or lower it, depending on when and where the water is coming from. Similarly, changes to forests or rivers could affect peak flows. To better understand the link to climate, it might be helpful to examine trends in heavy rain intensity and snowpack, the two primary weather conditions that contribute to flooding. We hope to look at those in a future newsletter.

Reference:

Mastin, M. C., Konrad, C. P., Veilleux, A. G., & Tecca, A. E. (2016). Magnitude, frequency, and trends of floods at gaged and ungaged sites in Washington, based on data through water year 2014 (No. 2016-5118). US Geological Survey. https://doi.org/10.3133/sir20165118

Climate Summary

September average temperatures were generally above-normal but there were also areas that had near-normal temperatures (Figure 8). Near-normal average temperatures were present in parts of some western Washington counties such as Grays Harbor, Pacific, Clallam, and Whatcom. The Southeastern region of Washington also experienced near-normal temperatures around Walla Walla and Benton county. Otherwise, the majority of the state had above-normal temperatures, some notable locations in western Washington include Olympia, Seattle WFO, Vancouver, and Quillayute. September temperatures across eastern WA ranked as the warmest on record for many locations (e.g., Wenatchee, Omak, Yakima, Pullman), and the monthly anomalies were large. For example, Spokane Airport, Wenatchee, and Omak were 5.6˚F, 5.5˚F, and 5.2 ˚F above normal, respectively (Table 1).

Total September precipitation was below-normal for majority of the state, but there were also some locations with normal or above-normal conditions (Figure 9). Western Washington precipitation ranged from about 38% and 99% of normal (Table 1). Some areas in eastern Washington were exceptionally dry, but Pullman was an exception with 209% of normal precipitation. Hanford, Ephrata, Spokane, and Omak all received less than 10% of normal September precipitation.

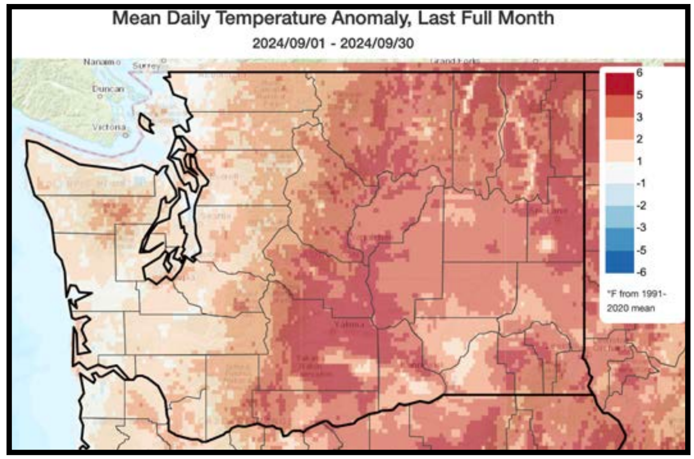


Figure 8: September temperature (˚F) departure from normal relative to the 1991-2020 normal (Climate Toolbox).

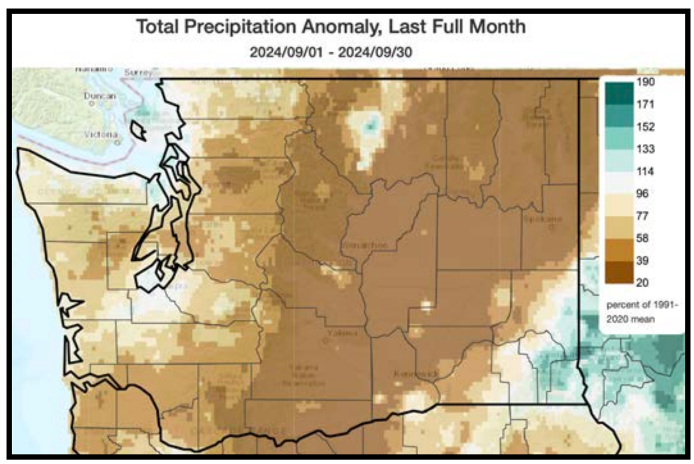


Figure 9: September precipitation departure from normal relative to the 1991-2020 normal (Climate Toolbox).

Station	Mean Temperature (°F)			Precipitation (inches)		
	Average	Normal	Departure from Normal	Total	Normal	Percent of Normal
Western Washington						
Olympia	61.2	59.1	2.1	1.91	2.04	94
Seattle WFO	63.8	62.3	1.5	1.02	1.74	59
SeaTac AP	62.6	62.6	0	0.62	1.61	38
Quillayute	59.6	57.1	2.5	4.28	4.56	94
Hoquiam	59.1	59.1	0	1.75	2.53	69
Bellingham AP	58.3	58.9	-0.6	2.00	2.01	99
Vancouver AP	65.9	63.9	2.0	0.72	1.43	50
Eastern Washington						
Spokane AP	66.7	61.1	5.6	0.4	0.58	7
Wenatchee	70.1	64.6	5.5	0.03	0.23	13
Omak	68.5	63.3	5.2	0.03	0.40	8
Pullman AP	62.6	59.8	2.8	1.36	0.65	209
Ephrata	68.5	64.5	4.0	0.01	0.22	4
Pasco AP	68.5	64.2	4.3	0.11	0.31	35
Hanford	71.3	67.1	4.2	0.01	0.23	4

Table 1: September 2024 climate summaries for locations around Washington with a climate normal baseline of 1991-2020.

Climate Outlook

According to the Climate Prediction Center (CPC), conditions in the equatorial Pacific Ocean remain ENSO-neutral, and a “La Niña Watch” is still in effect. Eastern and east-central Pacific Ocean sea surface temperatures (SSTs) ranged between near and below average, whereas the SSTs in the western Pacific Ocean were above average. It is expected that in the next several months ENSO neutral conditions will continue, but La Niña is favored to make its appearance during October-December (71% chance) and persist through January-March 2025. According to ENSO models, by the October-December period, there’s a 29% chance of neutral conditions and no chance (0%) of El Niño.

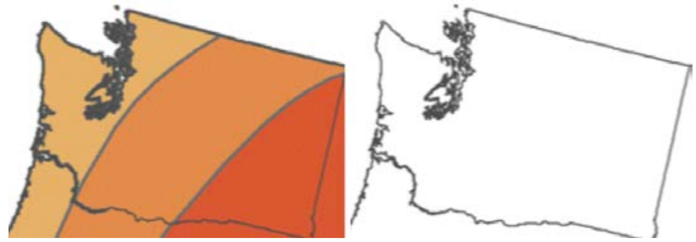
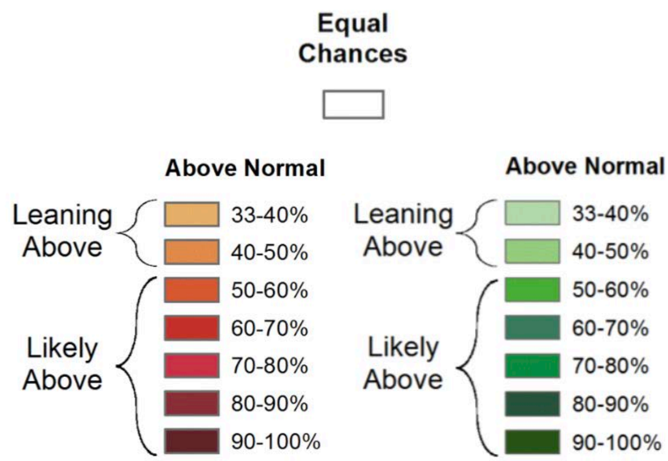


Figure 10: October outlook for temperature (left) and precipitation (right).



The CPC October temperature outlook (Figure 10) is above-normal statewide. The probabilities of Above-average temperatures range between 33 and 40% for western Washington, 40 and 50% for central Washington, and 60% and 70% for eastern Washington. The precipitation outlook for the coming month shows equal chances of above-normal, near-normal, and below-normal precipitation.

The three-month fall (October-November-December; OND) temperature outlook (Figure 11) shows equal chances of above-normal, near-normal, or below-normal temperatures statewide. The OND precipitation outlook indicates elevated chances of above-normal precipitation statewide, with chances between 40 and 50% on the three-tiered scale.

Figure 11: October-November-December outlook for temperature (left) and precipitation (right).
(Climate Prediction Center)