



Office of the Washington State Climatologist

October 2021 Report and Outlook

October 8, 2021

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

September Event Summary

Average September temperatures were near-normal and total precipitation was above normal for a majority of WA State. There were a few exceptions, as usual, with below normal temperatures in the northern Cascades and drier than normal conditions east of the northern and central Cascades.

September began with warmer than normal temperatures for most locations around the state and continued summer dryness. Figure 1 shows the September daily maximum and minimum temperatures and daily precipitation for SeaTac Airport. Weather traditionally associated with fall came a bit early this year compared to astronomical autumn (Sept 22), with precipitation

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falling in portions of the state on the 10th. Wenatchee Pangborn Field (0.21”) and Ephrata (0.63”) set new daily rainfall records on the 10th.

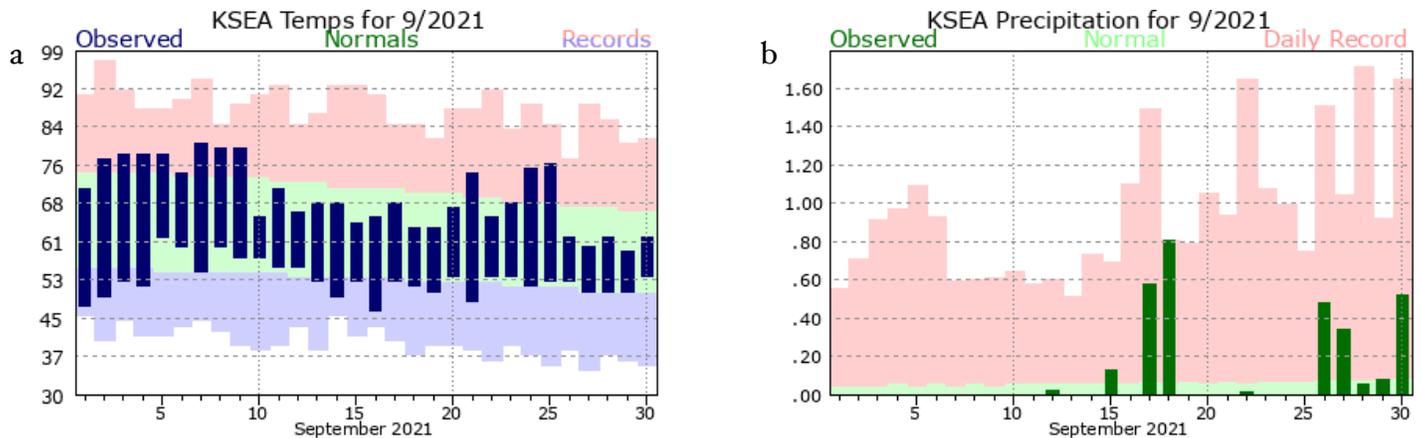


Figure 1: September 2021 daily (a) maximum and minimum temperatures and (b) precipitation at SeaTac Airport ([NWS](#)).

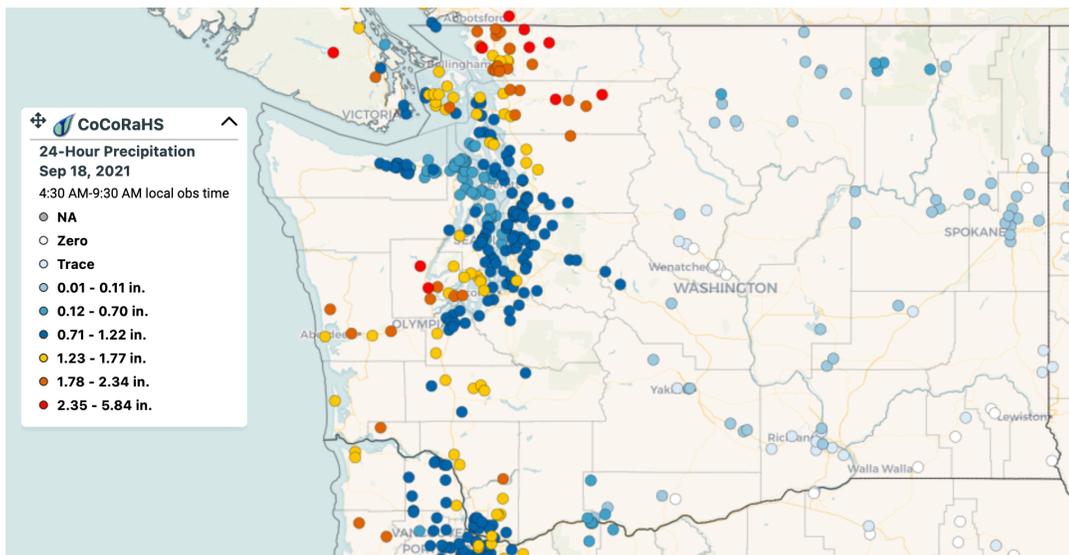


Figure 2: 24-hr precipitation observations ending on the morning of September 18, 2021 (CoCoRaHS).

normal precipitation (Figure 3). Water year precipitation was below normal in eastern WA, especially in the Lower Columbia Basin where water year totals were between 45 and 60% of normal. The average water year temperature was above normal throughout eastern WA and near-normal in western WA.

But the atmospheric river event that occurred on the 17th and 18th is what really made it feel like fall. Rain fell statewide; Figure 2 features the CoCoRaHS 24-hr precipitation totals around the state on the morning of the 18th. Diablo Dam and Newhalem, stations in the northern Cascades, recorded 3.08 and 3.17” of precipitation on the 18th, which was a record 1-day maximum precipitation for September at those stations. Spokane AP also recorded a maximum rainfall record for the date on the 18th with 0.42”.

The last week of the month was also on the wet side (Figure 1). Another system that moved through on the 26th and 27th was notable in that peak wind gusts for western WA were between 30 and 50 mph with rainfall totals between 1 and 2.5”. Hoquiam (1.67”) and Quillayute (2.14”) recorded maximum daily rainfall record on the 26th, for example.

We would be remiss to not also mention that we are now in the new 2022 water year (Oct 1, 2021-Sep 30, 2022). Despite the unprecedented spring and summer drought, a majority of western WA locations will end the 2021 water year with near-

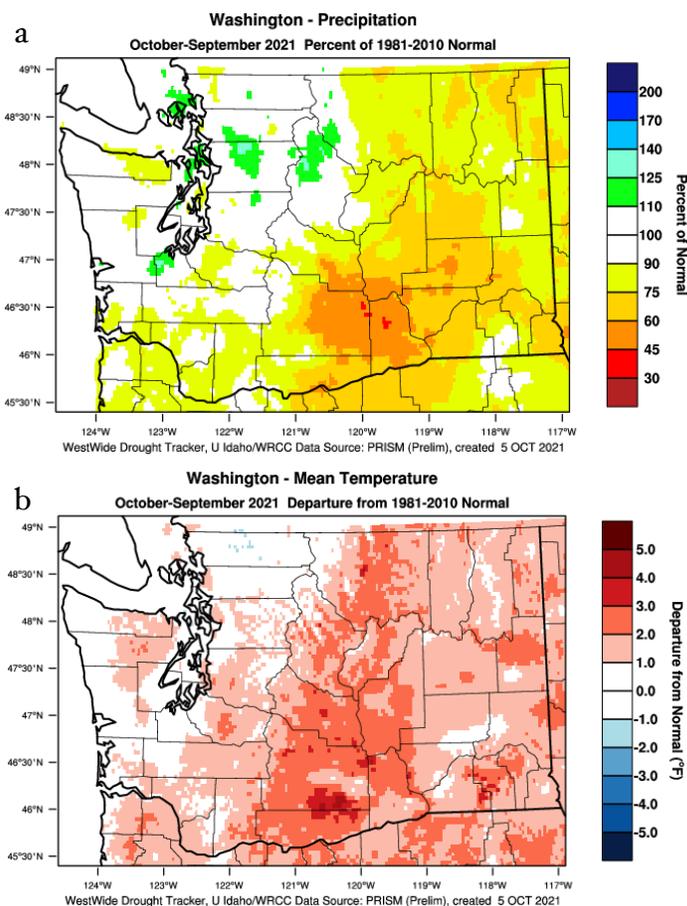


Figure 3: Water year 2021 (Oct 1, 2020-Sept 30, 2021) (a) precipitation percent of normal and (b) mean temperature departures from normal (Westwide Drought Tracker).

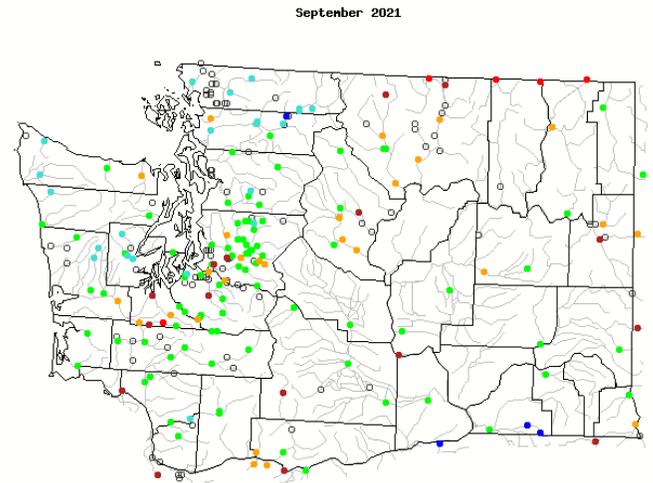
Streamflow and Drought Summary

Above normal September precipitation for a majority of WA State has improved streamflows throughout much of the state. Compared to August, the monthly average streamflow for September has many more rivers in the “normal” to “above normal” categories, particularly in western WA (Figure 4). Flows remain low on the Canadian border east of the Cascade crest and Thurston county continues to see streamflows between the 3rd to 20th percentiles.

Recent precipitation and improvements in both streamflow and soil moisture have prompted some improvements to the U.S. Drought Monitor (Figure 5). Compared to the map presented in last month’s newsletter, a region in northeastern WA that had been placed in the “exceptional drought” (D4) category is now in “extreme drought” (D3). In addition, there has been a shrinking in the area of “severe drought” (D2) and “moderate drought” (D1) for the northern Olympic Peninsula and northwestern WA. Assuming our early fall rains continue, we expect to see further improvements in the coming weeks.

Report Your Drought Impacts

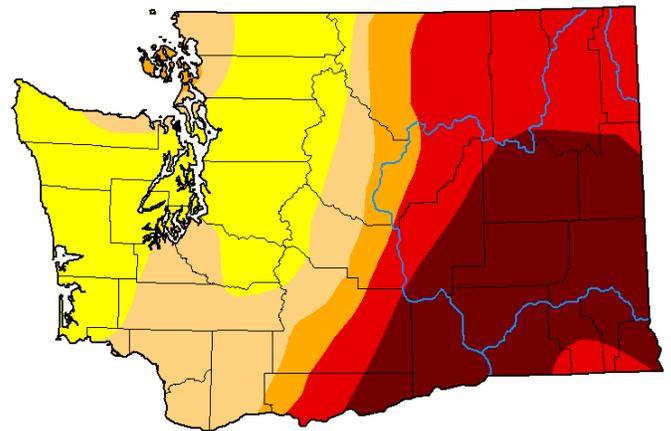
Are you experiencing a drought impact? Your on-the-ground observations are critical in helping us understand the broad picture of drought in the state. The National Drought Mitigation Center and partners have developed Condition Monitoring Observer Reports on Drought ([CMOR-drought](#)), a short survey that allows the public to enter their observations regarding crops, water supply, fire, etc.



USGS

| Explanation - Percentile classes | | | | | | |
|----------------------------------|-------------------|--------------|--------|--------------|-------------------|------|
| ● | ● | ● | ● | ● | ● | ● |
| Low | <10 | 10-24 | 25-75 | 76-90 | >90 | High |
| | Much below normal | Below normal | Normal | Above normal | Much above normal | |

Figure 4: September average streamflow for WA (from USGS).



Intensity:

- D0 Abnormally Dry
- D3 Extreme Drought
- D1 Moderate Drought
- D4 Exceptional Drought
- D2 Severe Drought

Figure 5: The October 7, 2021 edition of the [U.S. Drought Monitor](#).



Community, Collaborative Rain, Hail, and Snow (CoCoRaHS) Corner

Washington CoCoRaHS observers made a total of 10,383 observations in September – 425 more than in August. The increase in observations was, unsurprisingly, correlated with an increase in precipitation. 36% of observations recorded precipitation of some amount, which is nearly double the fraction of August observations that recorded precipitation. In addition, 11 new stations joined the ranks of WA CoCoRaHS stations in September. This was the highest number of new WA CoCoRaHS stations in a month since March 2021. Reporting zeros is just as important as reporting precipitation totals, but even so, CoCoRaHS observers are likely glad to once again have something to look at when they check their rain gauges each morning.

The highest one-day total for the state comes from a small town in Clark county, northeast of Vancouver. At 7 am on September 19th, an observer near Yacolt, WA measured 3.37” of rain at 7 am from the atmospheric river that arrived on the 18th. Other high one-day totals came from Mason, Skagit, and Whatcom Counties and totals often surpassed one or two inches.

CoCoRaHS Condition Monitoring Reports were slightly more cheerful to read this month as compared to the preceding summer months. A good number of the 29 reports submitted spoke of wetter conditions, reduced fire risk, and the return of green lawns. Others reported that, despite a spot of rain, dry conditions persist. Indeed, a few September storms cannot make up for many months of drought. Said one observer from Stevens County, “Even with this remaining moisture, creeks and small streams remain critically low in flow volume. Some farmer's [sic] have planted winter wheat but many are waiting for more rain.” Said another observer from San Juan County regarding reportedly severely dry conditions, “We will really need a wet rainy winter to recover from this.” Thankfully, as discussed in [last month's newsletter](#), the predicted La Niña may provide that rain – but only time will tell.

Oregon-Washington 2021 Water Year Recap and 2022 Outlook Meeting

A Different Way to Visualize Maximum and Minimum Temperature Distributions

Message from the State Climatologist

Happy New Water Year! Registration for the [16th annual OR/WA Water Year 2021 Recap and 2022 Outlook meeting](#) is [now open](#). The meeting will be held virtually on the mornings of November 16 and November 17, 2021. Registration is free but required. The goal of this meeting is to share and gather information regarding climate impacts of the 2021 water year, with a focus on the exceptional drought that was widespread across the region. This meeting will also offer the opportunity to learn from others about mitigation actions that were taken. Both days will include time for discussion and peer-to-peer learning, in addition to hearing from the forecast experts about the 2022 water year.

In addition, the end-of-water-year [survey](#) that focuses on collecting PNW water year impacts due to either abnormally dry or abnormally wet conditions is now open. This survey helps inform an annual [PNW Water Year Impacts Assessment](#) and will also be discussed at the water year meeting.

Mean temperatures are often used to characterize the climate on time scales of weeks to millennia, but they are not the whole story. Belaboring the obvious, the variations in temperature also matter. There are a variety of ways to display temperature distributions, with violin plots gaining some popularity because they can add more information than a traditional box-and-whisker plot within a similar amount of plotting space. The objective of this piece is to illustrate how violin plots can be used to compare maximum and minimum temperature distributions in different parts of WA state, considering winter and summer separately. There are a variety of resources online that delve into the characteristics of violin plots; [here](#) is an example featuring air temperatures in Mexico City.

For present purposes we consider daily maximum and minimum temperatures from 1991 through August 2021 for Quillayute, Sea-Tac Airport (Seattle), Spokane Airport and the Pasco Tri-Cities. We focus on the present climate recognizing the statistics of daily temperatures in WA are not stationary. Violin plots may be an effective way to visualize climate change impacts on temperature variability in WA, but that is beyond our scope here.

Violin plots for temperatures during the winter months of December through February and the summer months of June through August are shown in Figures 6 and 7, respectively. Median

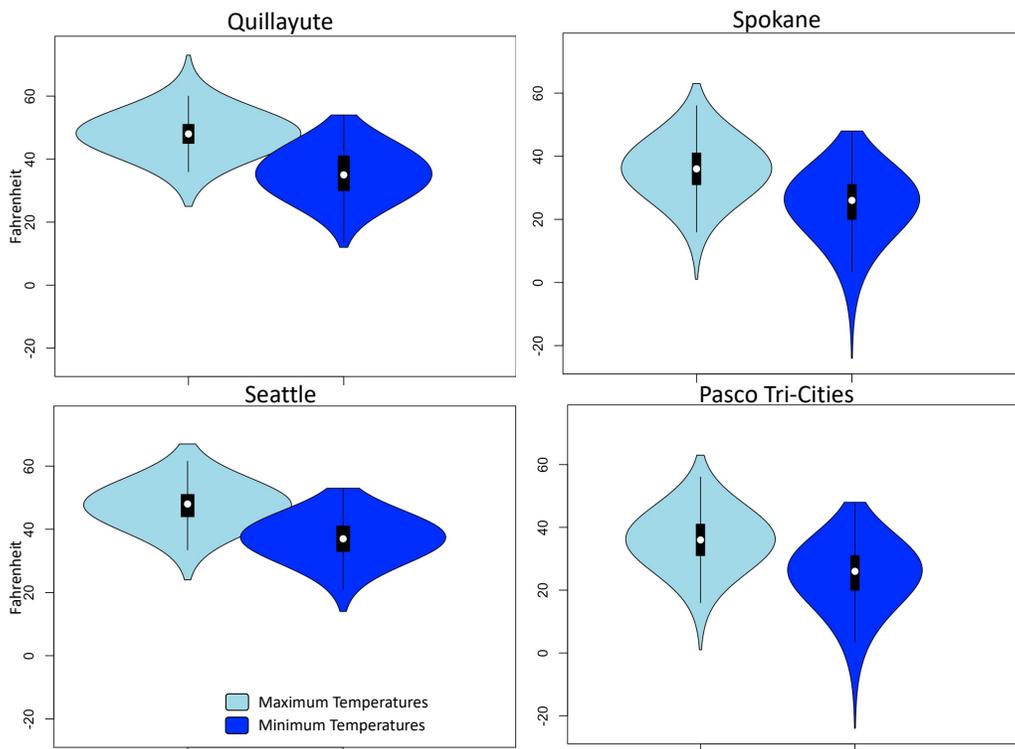


Figure 6: Violin plots of 1991-2021 December-January-February (winter) maximum (light blue) and minimum (dark blue) temperatures at Quillayute, Seattle, Spokane, and Pasco Tri-Cities.

temperatures are indicated with the white dots, and traditional box-and-whisker representations of the data by quartile are also included. The curve that makes the violin shape is essentially just a histogram of the entire temperature distribution on its side and mirrored.

In our examples, the violin plots for winter clearly show that the ranges of temperatures for the west side stations are much less than their counterparts for the east side. The west side also does not often experience extremes of either sense in both maximum and minimum temperatures. In contrast, Spokane and the Tri-Cities are more likely to have extreme cold temperatures, particularly in their minimum temperatures, as illustrated by the long tails of the violins.

The violin plots for summer have some similarities and some differences with those in winter.

Quillayute and Seattle have long tails on the high side with respect to maximum temperatures, recall the record setting temperatures of late June 2021 are included in the mix. They also exhibit relatively small ranges in minimum temperatures. The coldest maximum temperatures are essentially the median minimum temperatures at each station. Presumably this occurs on those “June gloom” days with persistent stratus cloud decks that prevent much solar heating. On the other hand, Spokane and the Tri-Cities have somewhat longer tails on the low end in their

maximum temperatures, and greater overall spreads between their maximum and minimum temperatures.

Violin plots seem well-suited for a host of meteorological plotting applications. Readers interested in producing some for themselves may want to check out [the plotting tool](#) on a web site maintained by Iowa State University (the Cyclones! – a mascot our readers should appreciate). It has a database that includes a number of long-term stations in Washington state. Another useful way of displaying temperature data is through ridgeline plots, which are particularly well-suited for visualizing changes in distributions in time. Perhaps in a future newsletter we will use that technique to examine how temperatures have varied over the years in our neck of the woods.

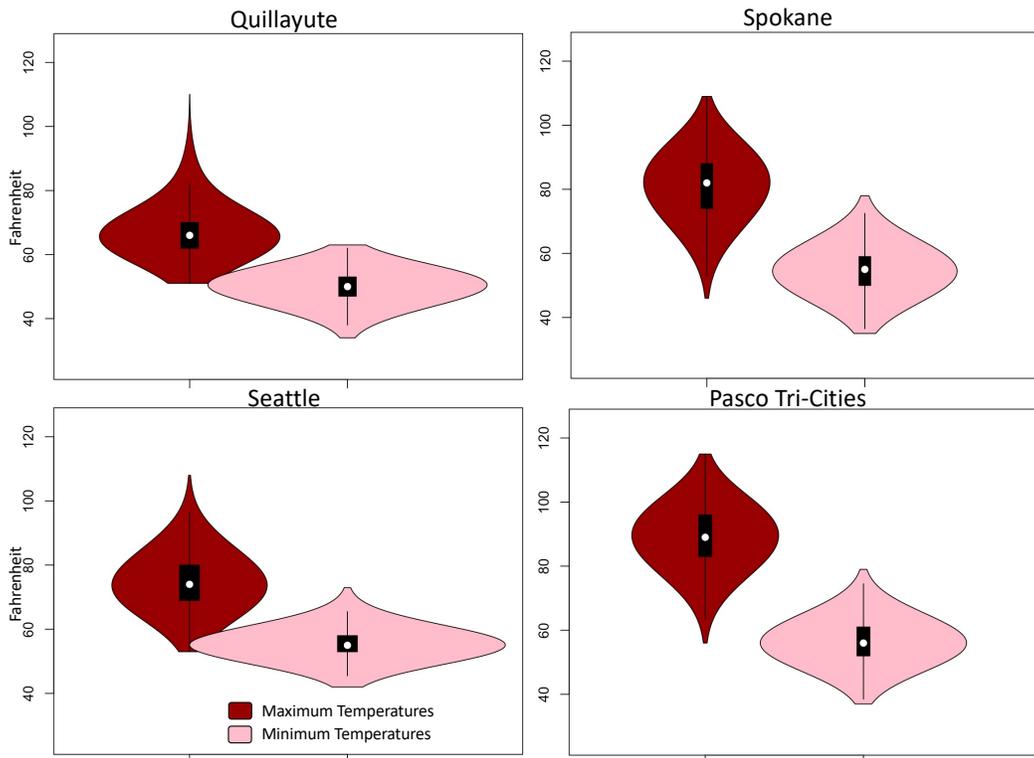
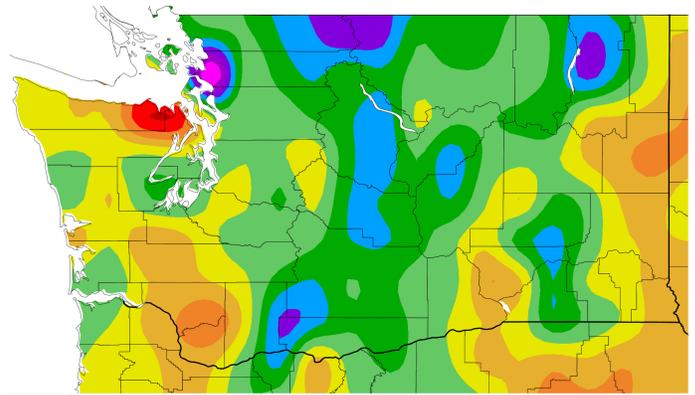


Figure 7: Violin plots of 1991-2021 June-July-August (summer) maximum (dark red) and minimum (pink) temperatures at Quillayute, Seattle, Spokane, and Pasco Tri-Cities.

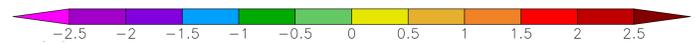
Climate Summary

Average September temperatures were near-normal throughout much of WA State. Note that the temperatures on the map from the High Plains Regional Climate Center on the right-hand-side are on a relatively small bar scale, with the dark green, light green, yellow, and light orange all representing near-normal September temperatures. Olympia, Seattle, Spokane, Omak, Pullman, and others (Table 1) all had near-normal monthly temperatures. There were a few exceptions. Ephrata (-1.2°F below normal) and southwestern Whatcom county had a cooler than normal station observation, and the northern Cascades also had below normal temperatures (between 1 and 2.5°F below normal). On the other hand, Sequim, Hoquiam, and Pasco were warmer than normal with average September temperatures between 1 and 2.5°F above normal.

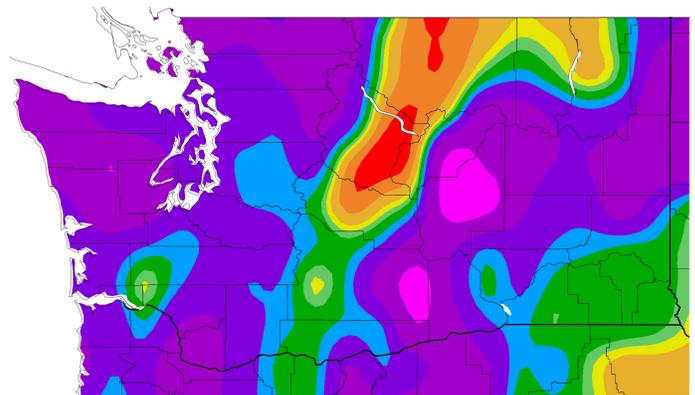
At long last, for the month of September 2021 a majority of WA State was wetter than normal. Broadly speaking, precipitation was between 110 and 300% of normal for most of the state. For example, total September precipitation for Hoquiam and Spokane was 225 and 233% of normal, respectively (Table 1). Precipitation normals are still relatively small in eastern WA during September (Ephrata's total precipitation of 0.85" was an impressive 386% of normal, for example), but the above normal totals are still very much welcome after the record dryness this spring and summer. Locations just east of the central and northern Cascade Mountains were drier than normal, according to the map. Omak, for example, received 73% of normal precipitation for the month.



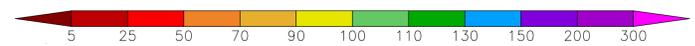
Temperature (°F)



September temperature (°F) departure from normal relative to the 1991-2020 normal (HPRCC).



Precipitation (%)



September total precipitation percent of 1991-2020 normal (HPRCC).

| Station | Mean Temperature (°F) | | | Precipitation (inches) | | |
|--------------------|-----------------------|--------|-----------------------|------------------------|--------|-------------------|
| | Average | Normal | Departure from Normal | Total | Normal | Percent of Normal |
| Western Washington | | | | | | |
| Olympia | 59.7 | 59.1 | 0.6 | 3.31 | 2.04 | 162 |
| Seattle WFO | 62.5 | 62.3 | 0.2 | 2.97 | 1.74 | 171 |
| SeaTac AP | 61.9 | 62.6 | -0.7 | 3.02 | 1.61 | 188 |
| Quillayute | 57.1 | 57.1 | 0.0 | 9.68 | 4.56 | 212 |
| Hoquiam | 60.3 | 59.1 | 1.2 | 5.68 | 2.53 | 225 |
| Bellingham AP | 59.4 | 58.9 | 0.5 | 4.49 | 2.01 | 223 |
| Vancouver AP | 64.6 | 63.9 | 0.7 | 3.87 | 1.43 | 271 |
| Eastern Washington | | | | | | |
| Spokane AP | 61.8 | 61.1 | 0.7 | 1.35 | 0.58 | 233 |
| Wenatchee | 64.0 | 64.6 | -0.6 | 0.24 | 0.23 | 104 |
| Omak | 62.8 | 63.3 | -0.5 | 0.29 | 0.40 | 73 |
| Pullman AP | 60.1 | 59.8 | 0.3 | 0.84 | 0.65 | 129 |
| Ephrata | 63.3 | 64.5 | -1.2 | 0.85 | 0.22 | 386 |
| Pasco AP | 65.8 | 64.2 | 1.6 | 0.41 | 0.31 | 132 |
| Hanford | 67.3 | 67.1 | 0.2 | 0.62 | 0.23 | 270 |

Table 1: September 2021 climate summaries for locations around Washington with a climate normal baseline of 1991-2020.

Climate Outlook

According to the Climate Prediction Center (CPC), neutral ENSO conditions are still present in the equatorial Pacific Ocean. There has been continued cooling over the last month in the central equatorial Pacific Ocean, and most of the region has had near-normal to below normal sea surface temperatures (SSTs). The “La Niña Watch” issued by the CPC is still in effect. According to ENSO models, for the October through December period, the chances of La Niña are 78%, while chances of neutral conditions remaining are 22%, and the chance of El Niño are essentially nil.

The CPC outlook for October-November-December (Figure 8) shows increased chances of below normal temperatures for western WA extending through the Cascades Mountains. Eastern WA has equal chances of below, equal to, or above normal temperatures. The October precipitation outlook, on the other hand, is consistent throughout the entire state, and is calling for increased chances of above normal precipitation.

The three-month outlook for October-November-December (OND; Figure 9) gives little indication for how the temperatures during the remainder of the calendar year are liable to play out; there are equal chances of below, equal to, or above normal values. There are increased odds of above normal precipitation statewide for OND, and so presumably our raincoats will be getting plenty of use.

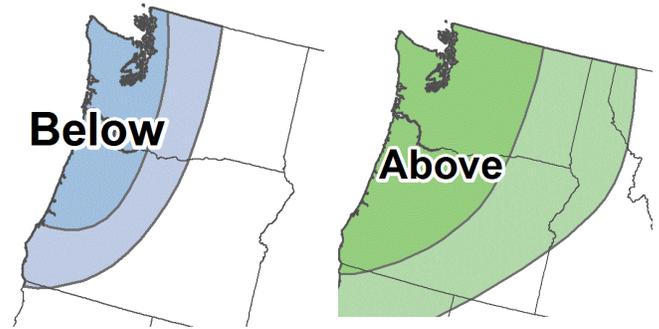


Figure 8: October outlook for temperature (left) and precipitation (right).

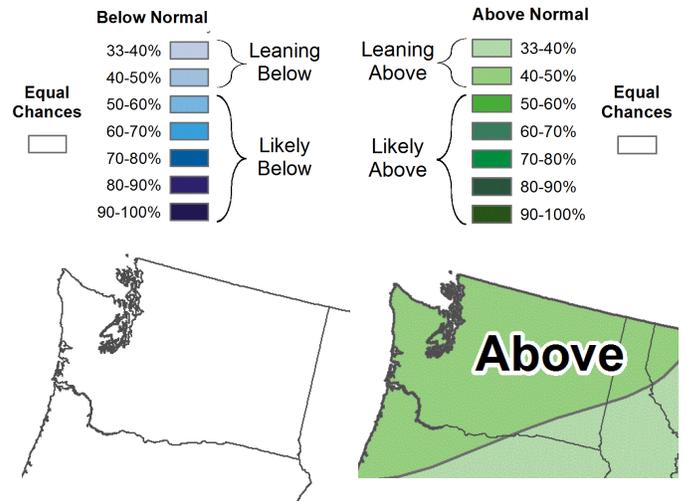


Figure 9: October-November-December outlook for temperature (left) and precipitation (right) ([Climate Prediction Center](#)).