Office of the Washington State Climatologist

October 2023 Report and Outlook

October 10, 2023

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

September Event Summary

Mean September temperatures were below normal to near-normal for a majority of the state, with some exceptions. Those slightly cooler areas and slightly warmer areas balanced out because averaged statewide, the mean September temperature was equal to 1991-2020 average. (58.4˚F). September precipitation was above normal for most of the state, with a small area from the northern Olympic Peninsula to western Whatcom County, and a larger area in the Lower Columbia Basin, not faring as well with below normal totals. Still, the statewide average total September precipitation was above normal, averaging to 133% of the 1991-2020 normal.

In this Issue

Even though the total September precipitation was above normal for many Washington locations, most of that rain fell at the very end of the month. Figure 1 shows the daily maximum and minimum

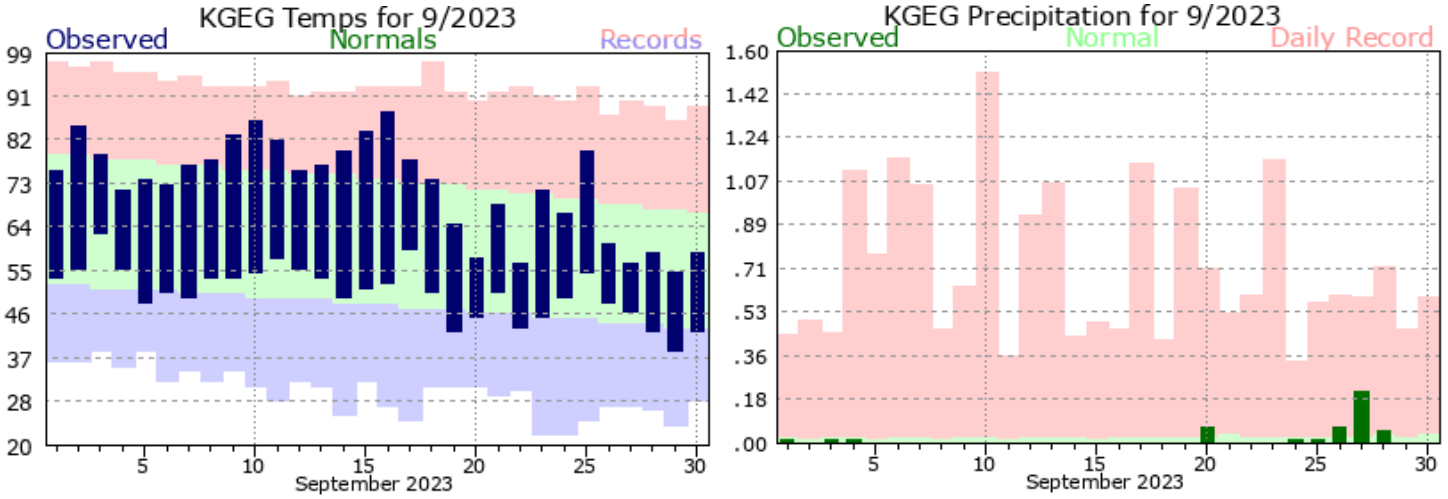


Figure 1: September 2023 daily temperatures for Spokane Airport compared to the 1991-2020 normal (green envelope) and previous records (blue and red envelopes; NWS).

temperatures and total precipitation for Spokane for September. The month began on a warm note and featured several periods of above normal temperatures. None of these broke daily temperature records, and most would call the first 3 weeks of September quite pleasant.

Rain returned right on schedule, however! Unlike the extended summer of 2022, our fall rains returned fairly close to the fall equinox (Sept 22), depending on the location around the state. Most of the state had 5-6 days of rain, ushering in the fall feeling and all things pumpkin spice. This rainy period greatly reduced the wildfire risk. On the 25th, both SeaTac Airport (0.82") and Ellensburg Bowers Field (0.23") set maximum daily rainfall records. Otherwise, it was a relatively quiet month weather-wise.

Streamflow and Drought Summary

Despite the above normal precipitation at the end of September, the average September streamflows (Figure 2) were still "below normal" to "much below normal" for a majority of the state. There was a greater response in streamflow in the central Puget Sound region, and accordingly, the U.S. Drought Monitor has showed some improvement in that area. Figure 3 shows the percentage of stream gauges in each percentile category over the last 45 days. The improvement and response to precipitation at the end of September was short-lived from a streamflow perspective, as about 85% of Washington's stream gauges remain in the below normal category at the time of this writing.

The most recent drought depiction of the U.S. Drought Monitor (valid on October 3) is shown in Figure 4. Aside from the one-category improvement in the central Puget Sound region, the coast is now in the "severe drought" percentile category. The National Drought Mitigation Center has released a new short-term and long-term drought indicator composite that is one of the products consulted in determining the drought depiction for Washington. The short-term indicator is showing wet percentiles for most of the state in this particular product, while the long-term indicators have very dry percentiles in western WA. The short-term wetter conditions are very much welcomed, and continued wet conditions will be required for further drought improvement. The drought declared by the Washington State Department of Ecology in 12 watersheds on July 24 (press release) is still in effect. Seattle Public Utilities requested voluntary efforts to conserve water on September 21.

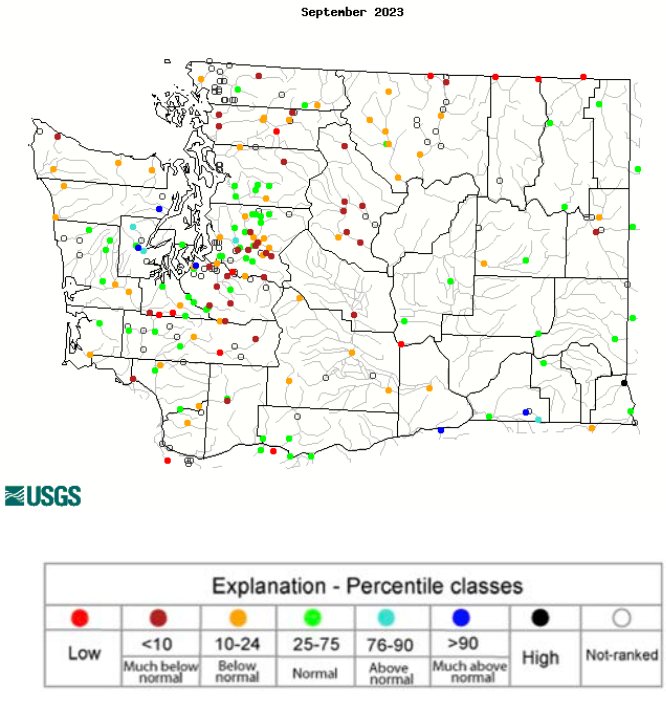


Figure 2: September 2023 average streamflow (USGS).

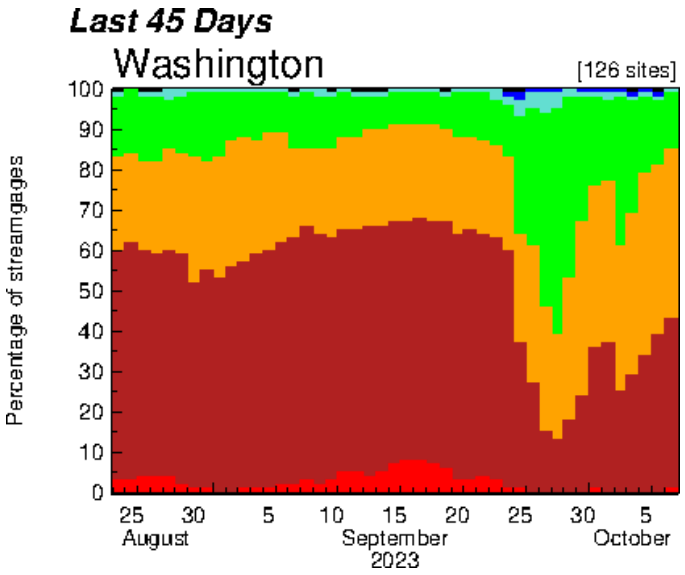


Figure 3: The percentage of stream gauges in WA in each percentile category shown in Figure 3 from late August through early October (USGS).

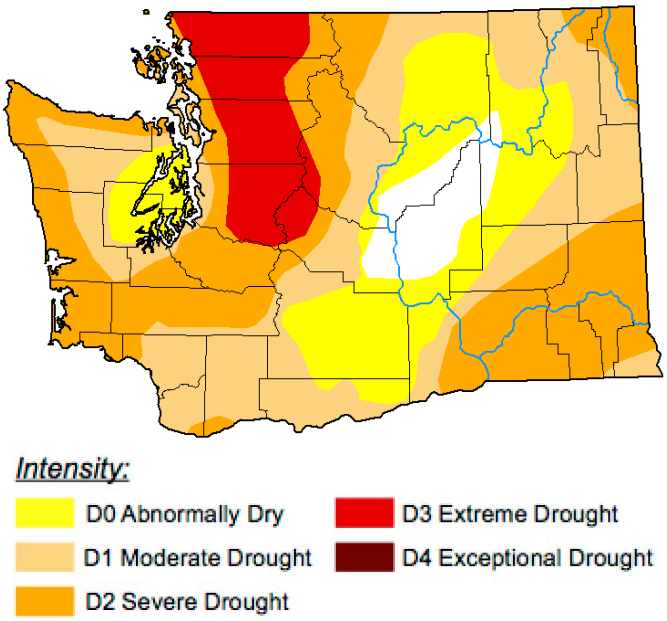


Figure 4: The October 3, 2023 edition of the U.S. Drought Monitor.

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.

The 2023 Water Year Survey is now available!

Happy 2024 Water Year! Now that water year 2023 is complete, we want to hear from you! How was the Pacific Northwest 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 2023 water year (October 1, 2022 - September 30, 2023) due to either abnormally dry or abnormally wet conditions across Washington, Oregon, or Idaho. This survey differs from the CMOR-drought survey in that it encompasses information for the entire water year, and not what you are experiencing at this very moment.

The 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.

We greatly appreciate your contributions!

If you are interested in learning more about the 2023 water year and the results from this survey, we encourage you to register for this year's virtual Oregon-Washington Water Year 2023 Recap and 2024 Outlook meeting on November 1 and 2.

Is it getting less foggy this time of year?

A Message from the State Climatologist

Based not just on my own perceptions, arguably of dubious trustworthiness, but also conversations with long-time residents of WA state, I have the sense that it is not as frequently foggy during early fall as it was in the past. This time of year is relatively favorable for the formation of low visibilities. Calm and clear conditions occur regularly, and the nights are long enough for radiative cooling to lower surface temperatures to the dewpoint, resulting in fog and low-level stratus that can persist well into the following day. But there are reasons why that may not be occurring as often. With increasing concentrations of greenhouse gases, the downward longwave radiative fluxes are also increasing; in general we are experiencing especially robust upward trends in minimum temperatures. Water vapor is a potent greenhouse gas, and hence trends in this constituent play a role here, and sometimes a prominent one. We surmise that is the case regionally in that the NCEP Reanalysis indicates a rise of about 10% over the last 50 years in precipitable water (vertically integrated water vapor content) for WA state during the month of October. A more humid atmosphere generally means less cooling at night. But if much of that additional water vapor is at low levels, perhaps higher dewpoints mean it does not require as much cooling for late night/early morning temperatures to dip down enough to produce fog. Therefore, it is worth taking a look at what actual visibility observations are telling us.

The cli-MATE application maintained by the Midwestern Regional Climate Center (MRCC) was used to assess the frequency the fog in past years at various locations in WA state. More specifically, the "Frequency Distribution" option in the "Hourly Observed Data" section was used to determine the frequency of hours with visibilities less than 1 mile during the month of October, with statistics compiled separately for the years of 1972 through 1992, and the years of 2002 through 2022. These two periods were chosen arbitrarily to be far enough apart to reveal a potential signal, but also include a sufficient number of years to minimize the effects of interannual variability. This method neglects to account for any changes in observation practices. Formerly, visibilities were estimated by human observers at hourly intervals, with supplemental reports when conditions changed significantly between the standard observations. Landmarks, or known light sources at night, specific to a

	Quillayute Airport	Bellingham Airport	Olympia Airport	Yakima Airport	Spokane Felts Field	Walla Walla Regional Airport
1972-1992	10.9	14.4	24.5	4.4	10.6	7.7
2002-2022	5.6	9.4	15.1	2.0	4.9	4.2

Table 1: The frequency of reports (%) with horizontal visibilities less than 1 mile for 1972-1992 and 2002-2022. Note: Felts Field is near the Spokane River, and at an elevation about 400 feet lower than Spokane International Airport. It was selected because it may be a relatively foggy spot for that part of the state.

particular station formed the basis for estimating visible ranges. Presently, visibilities are determined continuously by unattended instruments through the scattering of light in small volumes of air passing between a source and a sensor. The transition from human to automatic observations occurred mostly in the late 1990s, and hence the two periods considered here are different from measurement perspectives. We examined counts of low visibility hours for the years around this change, and did not notice sudden and obvious changes in the frequency of low visibilities (not shown). Given the above caveat(s), we forge ahead.

The average frequency of hours with visibilities less than 1 mile for the early period of 1972 through 1992 and the late period of 2002 through 2022 at 6 stations in WA state is summarized in Table 1.

All six stations that were queried featured substantial decreases in the frequency of low visibilities. Conceivably the human observers were sensitive to periods of visibilities less than 1 mile, i.e, in the low instrument flight rules (LIFR) category, and those conditions were preferentially reported in the earlier period. But there is another reason aside from climate change that might account for at least part of the drop-off. For the Central Valley of California, Gray et al. (2019) documented a 76% decline in the frequency of fog from 1980 to 2016 and attributed this decrease to

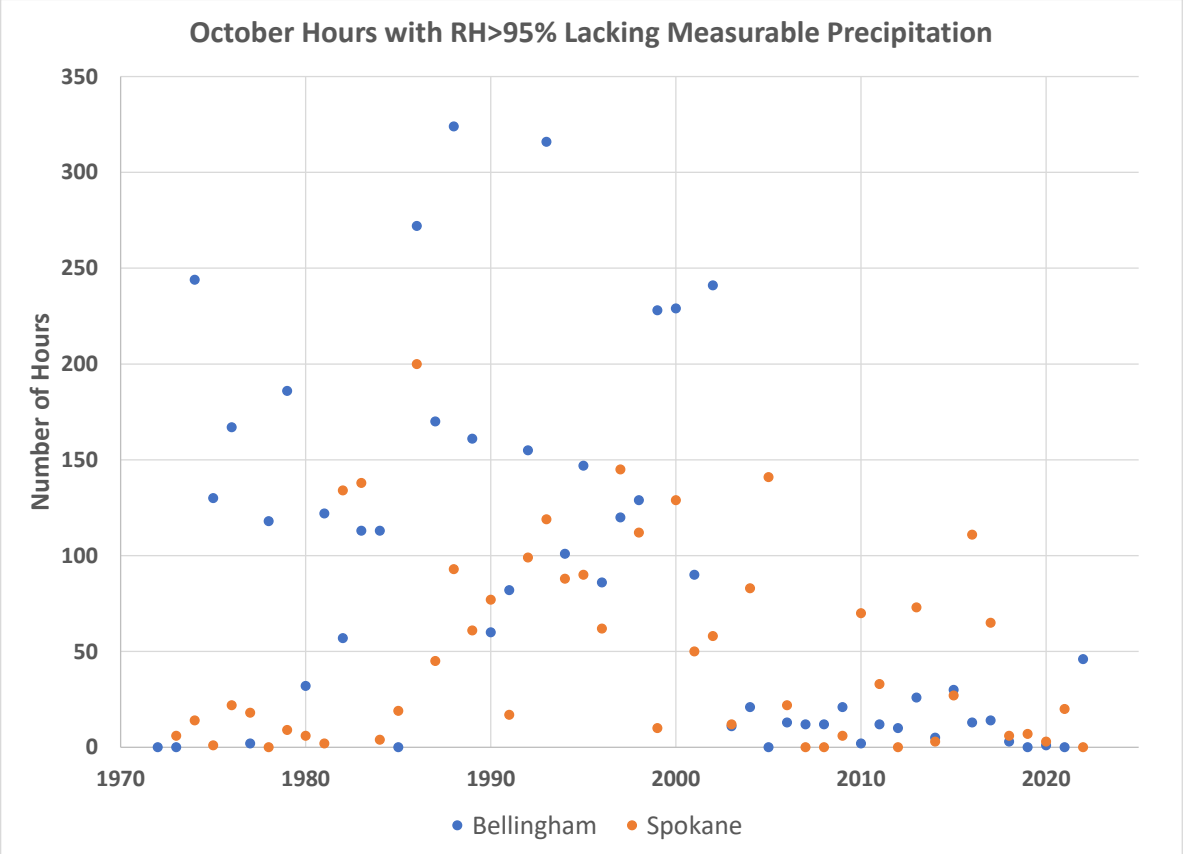


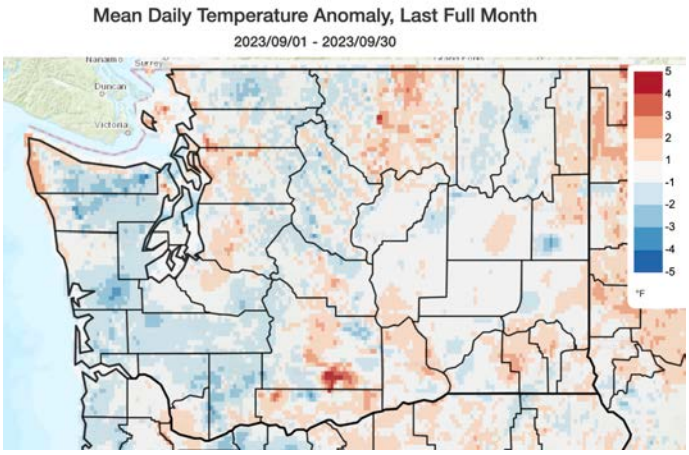
Figure 5: The number of October hours per year (1972-2022) with relative humidity exceeding 95% without measurable precipitation for Bellingham (blue) and Spokane Felts Field (orange).

pollution controls resulting in steadily lower NOx emissions, and ultimately fewer cloud condensation nuclei (CCN) for fog formation. They found that the dew point depression, which is akin to the relative humidity, influenced year-to-year fluctuations in fog frequency but did not explain the overall trend. Motivated by the idea of changing aerosol concentrations, we carried out our own quick and dirty analysis of humidity trends. More specifically, and again using hourly data from cli-MATE, we tabulated the number of hours with reports of the relative humidity exceeding 95% that also lacked measurable precipitation (the latter criterion was aimed at excluding periods of heavier rain), using Bellingham and Spokane (KSFF) as crash-test dummies. The counts for those two stations for the October months of 1972 through 2022 are shown in Figure 5. Those two stations suggest that the relative humidity approaches 100% more rarely in October since the turn of the century than previously, with Bellingham showing an especially dramatic drop.

In summary, there are indications, if not definitive proof, that indeed it has tended to be less foggy in WA state during the month of October over the last couple of decades compared with the late 1900s. Our treatment here is too superficial to establish the primary cause(s), but it does appear that near-saturated conditions also occur less frequently, at least at a couple of places we checked. While fewer fogs are good news for aviation and road safety, we sympathize with all those that are now hampered in their reenactments of the climactic scene from "The Hound of the Baskervilles".

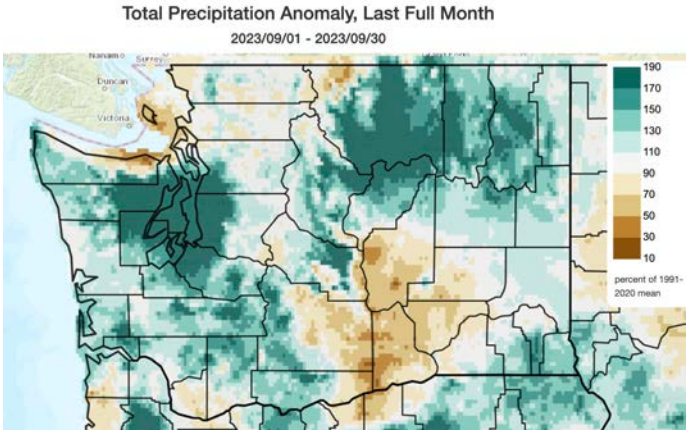
Climate Summary

In a reversal of the temperatures over the previous four months (May-August), mean September temperatures were near-normal or below normal for a majority of the state. Western WA tended to have the cooler than normal spots, as illustrated by the map on the right. SeaTac Airport, for example, was 0.6°F below normal. Both Hoquiam and Bellingham had exactly normal mean monthly temperatures. Quillayute was an exception, with temperatures 2.7°F above normal. Similarly, Pasco was a warm location east of the Cascades, with temperatures 1.6°F above normal (Table 2). Otherwise, most of eastern WA had near-normal temperatures, including Spokane, Wenatchee, Pullman, and Hanford (Table 2).



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

Most locations in Washington State had near-normal to above normal September precipitation. Notably, most of western WA received above normal precipitation, a welcomed change from the last several months. SeaTac Airport and Olympia received 214 and 113% of normal precipitation, respectively. Bellingham was an exception, receiving only 57% of normal precipitation. Most of the Lower Columbia Basin was also drier than normal; for example, Pasco and Wenatchee recorded only 65 and 78% of their normal monthly precipitation (Table 2). The rest of eastern WA was wetter than usual, with the total of 1.74" (435% of normal) at Omak taking the top prize.



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

Station	Mean Temperature (°F)			Precipitation (inches)		
	Average	Normal	Departure from Normal	Total	Normal	Percent of Normal
Western Washington						
Olympia	59.6	59.1	0.5	2.30	2.04	113
Seattle WFO	62.1	62.3	-0.2	3.69	1.74	212
SeaTac AP	62.0	62.6	-0.6	3.44	1.61	214
Quillayute	59.8	57.1	2.7	5.52	4.56	121
Hoquiam	59.1	59.1	0.0	2.42	2.53	96
Bellingham AP	58.9	58.9	0.0	1.15	2.01	57
Vancouver AP	64.8	63.9	0.9	1.34	1.43	94
Eastern Washington						
Spokane AP	61.9	61.1	0.8	0.43	0.58	74
Wenatchee	64.9	64.6	0.3	0.18	0.23	78
Omak	65.2	63.3	1.9	1.74	0.40	435
Pullman AP	60.1	59.8	0.3	1.01	0.65	155
Ephrata	64.1	64.5	-0.4	0.27	0.22	123
Pasco AP	65.8	64.2	1.6	0.20	0.31	65
Hanford	67.6	67.1	0.5	0.22	0.23	96

Table 2: September 2023 climate summaries for locations around Washington with a climate normal baseline of 1991-2020.

Climate Outlook

According to the Climate Prediction Center (CPC), El Niño is present in the equatorial Pacific Ocean and an "El Niño Advisory" is in effect. Over the last month, the above normal sea surface temperatures (SSTs) have cooled slightly but the event is still very much in place. ENSO models are virtually certain that El Niño will persist through the winter of 2023-24, with the dynamical and statistical model mean projections showing that it will likely be a moderate-to-strong event.

The CPC October temperature outlook (Figure 6) has increased chances (between 40 and 50% on the three-tiered scale) of above normal temperatures statewide. October precipitation is likely to be below normal across western WA. There are equal chances of below, equal to, or above normal October precipitation across eastern WA.

The October-November-December (OND) temperature outlook (Figure 7) is also calling for higher chances of above normal temperatures statewide. Odds of above normal temperatures are higher in western WA (between 50 and 60%) compared to eastern WA (between 40 and 50%). The OND precipitation outlook indicates elevated chances of below normal precipitation statewide. The odds of drier than usual weather are highest for western WA. Many previous El Niño years have been accompanied by relatively dry fall seasons in our region, but there have also been exceptions. A notable recent example is the fall of 2015, which featured a strong El Niño and considerably greater than normal precipitation totals, especially in western WA.

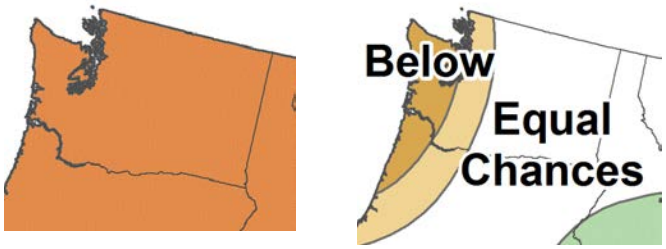
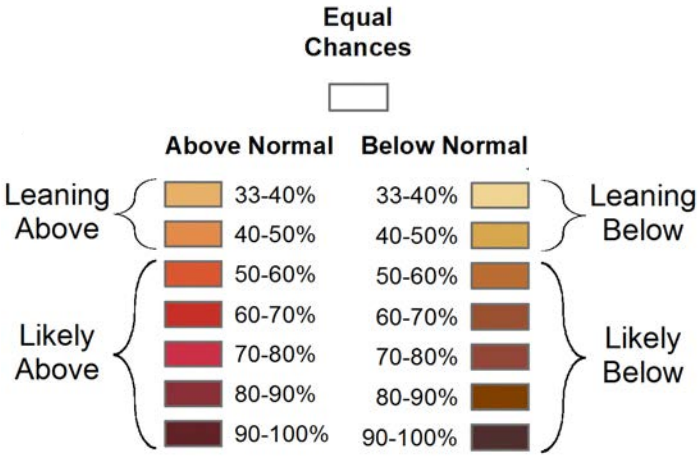


Figure 6: October outlook for temperature (left) and precipitation (right).



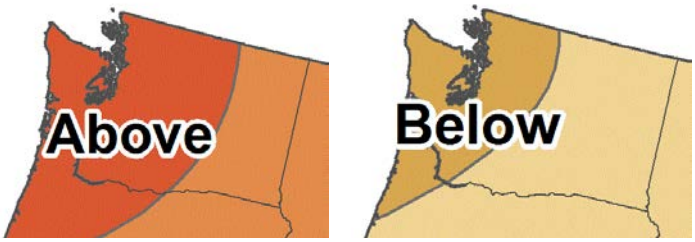


Figure 7: October-November-December outlook for temperature (left) and precipitation (right) (Climate Prediction Center).