Office of the Washington State Climatologist

December 2020 Report and Outlook

December 7, 2020

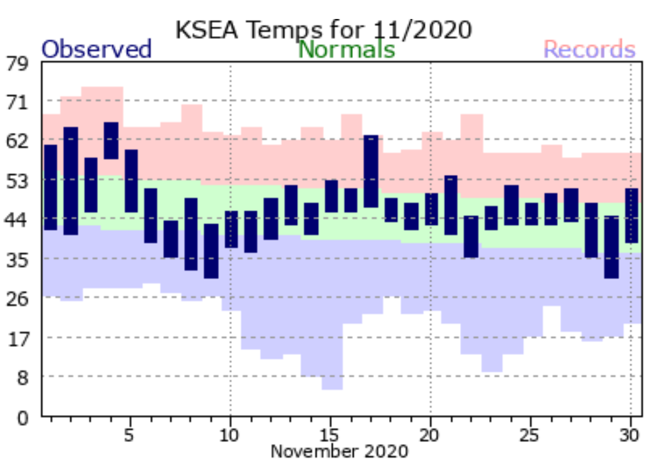
http://www.climate.washington.edu/

November Event Summary

Mean November temperatures were near-normal for a majority of WA state while precipitation was near-normal to below normal for most locations. Figure 1 shows the November daily temperature and precipitation time series at SeaTac Airport. There were only two periods of dry conditions throughout the month and 22 days with measurable precipitation (long-term average is 15 days), but SeaTac precipitation was still below normal. This is a testament to how wet the month is supposed to be. Spokane International Airport, for example, had 15 days of measurable precipitation (long-term average is 13 days) and was also below normal for the month.

In this Issue

The month began with mild temperatures and widespread precipitation. Wenatchee measured a record high daily temperature of 65°F on the 5th, for example. Maximum daily precipitation records



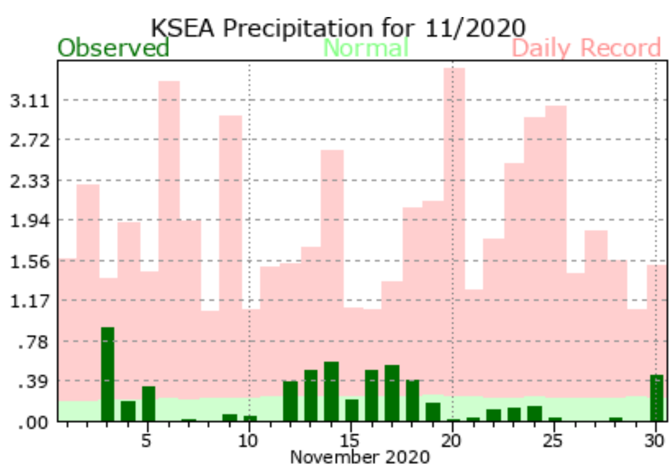


Figure 1: Daily November 2020 maximum and minimum temperatures (left) and precipitation (right) for SeaTac International Airport compared to normal (green envelope) and historical records (red and blue envelopes).

were set at Whitman Mission (0.98”) and Kennewick (0.64”) on the 6th. But then the coldest temperatures of the month set in from the 7th to about the 12th as anomalous northerly flow dominated the weather pattern. Record low daily temperatures were set at Ephrata (13˚F), Yakima (16˚F), Olympia (22˚F), the Seattle Weather Forecasting Office (28˚F), and Hoquiam (29˚F), for example, on the 9th.

Precipitation returned on the 12th as an active weather pattern remained for the next week. Gusty winds, precipitation, and snow in the mountains was common, with the North Cascades Highway closing for the season on the 16th. Notably, a warm frontal passage resulted in record warm daily high temperatures at Quillayute (62˚F), SeaTac AP (63˚F), and Walla Walla (68˚F) on the 17th. Another strong system impacted the state on the 24th and 25th, but after that the remainder of the month was relatively quiet until the 30th, when there were more gusty winds.

We also want to take this opportunity to review the meteorological fall conditions (September through November; Figure 2). Overall, temperatures were warmer than normal, particularly in the central and southern Cascades where SON anomalies were between 2 and 4˚F above normal. Precipitation was mostly near-normal for the fall, except for western Okanogan and Chelan counties where conditions were wetter than normal (between 115 and 180% of normal). Conversely, south central WA experienced a drier than normal fall (between 40 and 85% of normal).

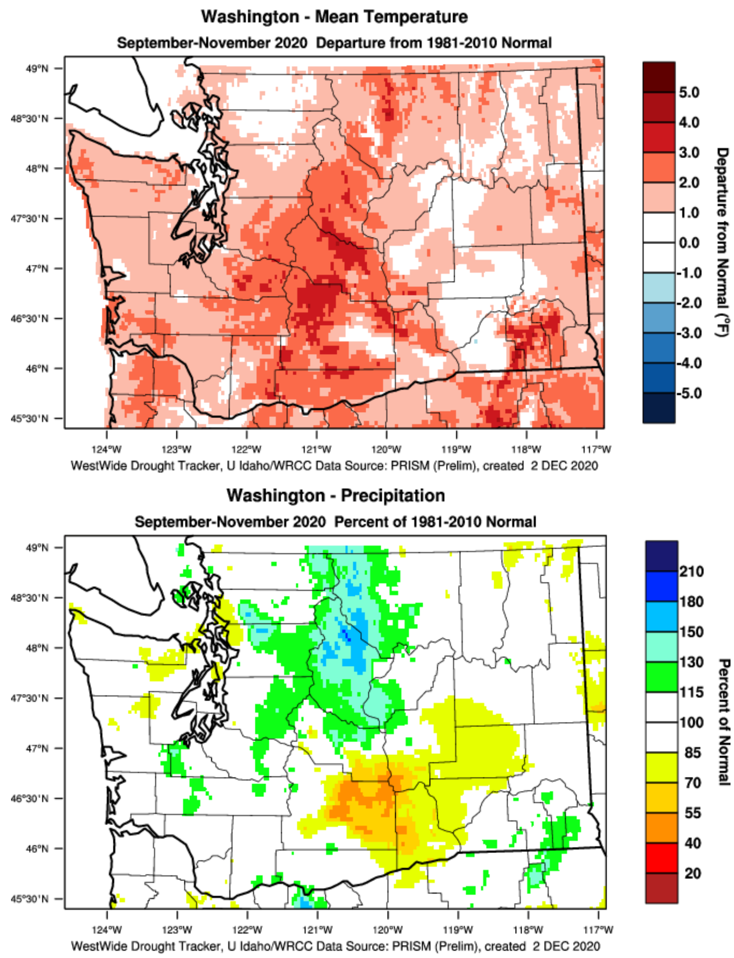


Figure 2: Average temperature departure from normal (top) and precipitation percent of normal (bottom) for September through November 2020. Relative to the 1981-2010 average (WWDT).

Snowpack and Drought Monitor Update

Despite November being slightly drier than normal overall, there were enough weather disturbances to bring quite a bit of snow to higher elevations, resulting in above normal snowpack for a majority of WA State. The basin average snow water equivalent (SWE) percent of normal from the Natural Resources Conservation Service (NRCS) as of December 1 is shown in Figure 3. Average snowpack through the Olympic and Cascade Mountains range between 95 and 149% of normal, a healthy start to the snowpack building season. The Lower Pend Orielle and Spokane basins are below normal at 70 and 80% of normal, respectively.

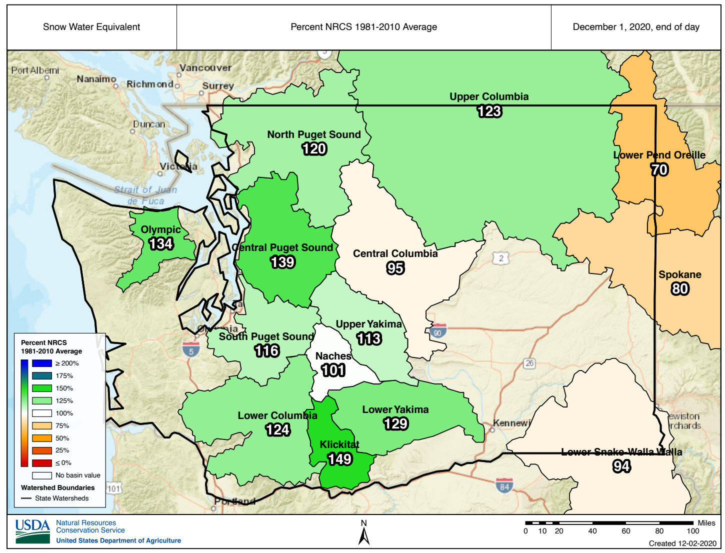


Figure 3: Snowpack (in terms of snow water equivalent) percent of normal for Washington as of December 1, 2020 (from NRCS).

Improvements in the U.S. Drought Monitor (Figure 4) were made since our last edition of the newsletter. The areas of "abnormally dry", "moderate drought", "severe drought", and "extreme drought" were all reduced east of the Cascades. The drought depiction in the U.S Drought Monitor continues to represent longer term conditions as the short-term indicators continue to improve, particularly with the start of SWE building in the mountains.

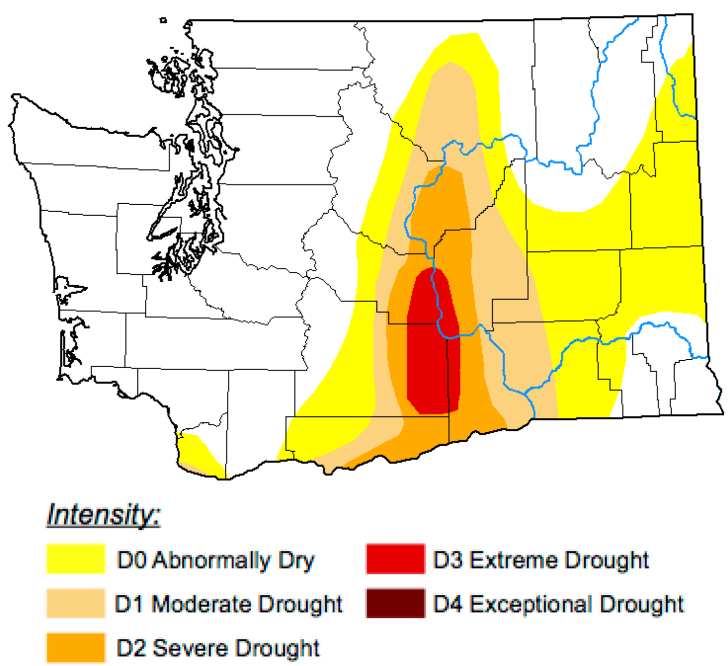


Figure 4: The 3 December 2020 edition of the [U.S. Drought Monitor](#).

The CoCoRaHS Corner

photo by Henry Reges, CoCoRaHS

The climatologically wettest month in Washington seems to have caught the attention of quite a few as 14 new observers joined the network over November. Precipitation reports slightly dropped from 10,681 in October to 10,542, but 184 stations still submitted precipitation reports for each day. November also tends to bring in some impressive one-day totals as seen by WA-MS-28 in Hoodsport, which measured the highest 1-day total of 3.63" on November 13^{th}. Cooler air with this system brought snow levels down and accounted for 14" of snow at Snoqualmie Pass 2.6 SSE.

Recently, CoCoRaHS received a request from a hydrology graduate student about using our network for a research project. Phillip Moffat of Washington State University is measuring water isotopes (water with extra neutrons) from precipitation samples to track the trajectory of storms moving across the Cascades and replenishing hydrologic basins. An email was sent out to some 800 active CoCoRaHS observers in Washington and Oregon asking whether they would be willing to store samples of daily precipitation to be analyzed in a laboratory. Your coordinators are absolutely stunned that 165 observers offered their help. This level of participation is truly extraordinary, and we salute your commitment. We will pass your contact information to Philip.

Surface Radiative Heat Fluxes

A message from the State Climatologist

Meteorologists and climatologists go to considerable effort to figure out from where air masses originate, because of course that has a great deal to do with the weather. A good example pertains to the upcoming winter's weather. La Niña conditions will likely prevail which tends to result in anomalous flow from the northwest out of the Gulf of Alaska, bringing cooler and wetter conditions, with a healthy mountain snowpack. But clearly that is not the only and even necessarily the most important factor controlling our weather, especially temperatures. Radiative heat fluxes can be crucial, as is obvious in association with the downward shortwave flux (incoming solar radiation from the sun) in summer and the downward longwave flux in winter because of its relationship to surface-based inversions. These fluxes are not measured nearly as much as temperature and precipitation, and time series for them are not as easily available.

With that in mind, here we present some sample time series of radiative fluxes, mostly for illustrative purposes. These results are from current work being carried out in development of a real-time system featuring fundamental, but previously unavailable, environmental metrics for Puget Sound, with the support of the Puget Sound Environmental Monitoring Program (PSEMP). As mentioned above, direct measurements of radiative heat fluxes, especially the longwave component, can be hard to come by. It turns out that our friends just north of the border in Richmond, BC collected a full suite of high-quality observations at Delta Burns Bog from 2014 into 2018 as part of the AmeriFlux network (ameriflux.lbl.gov/sites/siteinfo/CA-DBB). Two excerpts from this data set are shown here: a pair of 13-day time series of the net radiative heat fluxes (balance between the incoming and outgoing radiation) at the surface during the summer of 2016 (Fig. 5) and the following winter (Fig. 6). The summer time series features a distinct diurnal cycle with prominent positive peaks in the middle of the day when the sun is high in the sky, and lesser negative fluxes in the nighttime hours as the surface loses heat by the net emission of longwave radiation. The day of 3 August was evidently quite cloudy as indicated by the much reduced heating; those clouds stuck around through the following night when there was essentially no loss of energy due to the ground and atmosphere apparently being in radiative equilibrium. The sample time series in winter (Fig. 6) also includes a diurnal cycle, but of much reduced amplitude, which is no surprise whatsoever. It is striking how little

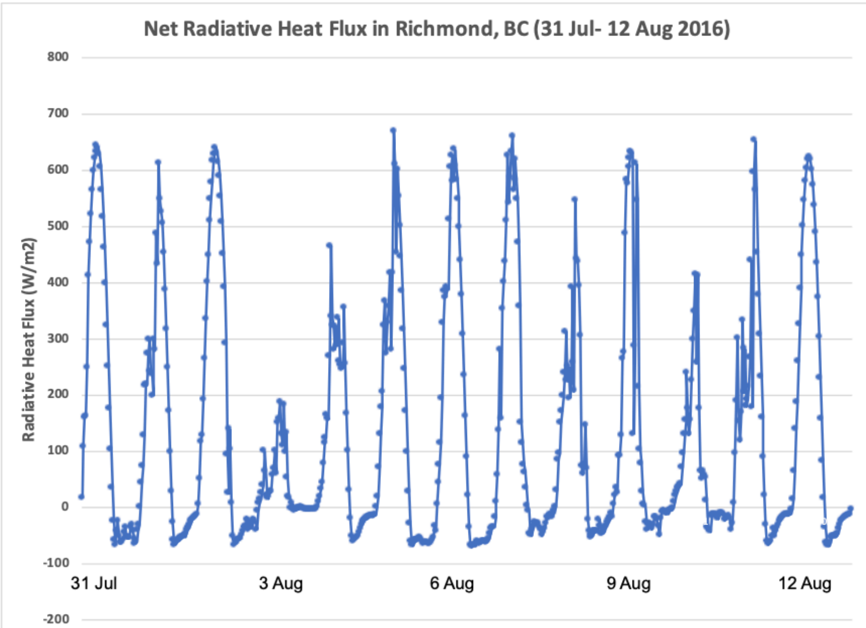


Figure 5: Net radiative heat fluxes (W/m²) from Delta Burns Bog in Richmond, BC for the period of 31 July through 12 August 2016.

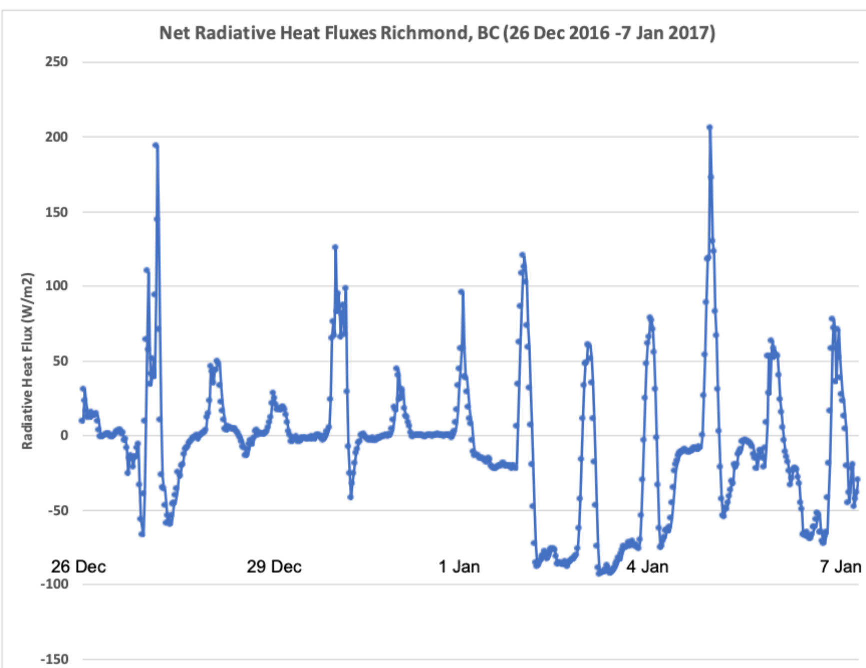


Figure 6: As in Figure 5, but for the period of 28 December 2016 through 7 January 2017.

incoming solar radiation at the surface the Pacific NW can receive in the wintertime, as shown by the paltry maximum of about 25 W/m^2 in the net radiative heating on 29 December. The period near the end of 2016 included nights with close to zero net radiative heat fluxes, which occurs with low, thick clouds. The time series also includes 4 sunny days at the beginning of the calendar year with a couple of cold and dry nights, resulting in enhanced loss of heat from the surface. These time series are just examples, of course. But hopefully they are useful in that most of us do not look at this kind of data very often, and show in a quantitative way how clouds tend to result in it being cool in summer and warm in winter.

We are using the Delta Burns Bog data as means of characterizing the downward longwave radiative fluxes for our PSEMP project. There have been a variety of schemes developed to estimate this component based on cloud cover and surface values of temperature and humidity; we have begun calibrating and validating the method suggested by Crawford and Duchon (1999), and the initial results look promising. The cloud cover itself can be characterized using ASOS-based observations or from insolation measurements (solar energy that actually reaches the Earth's surface), which can then be used to infer cloud fractions based on the differences between actual and clear-sky irradiances. There

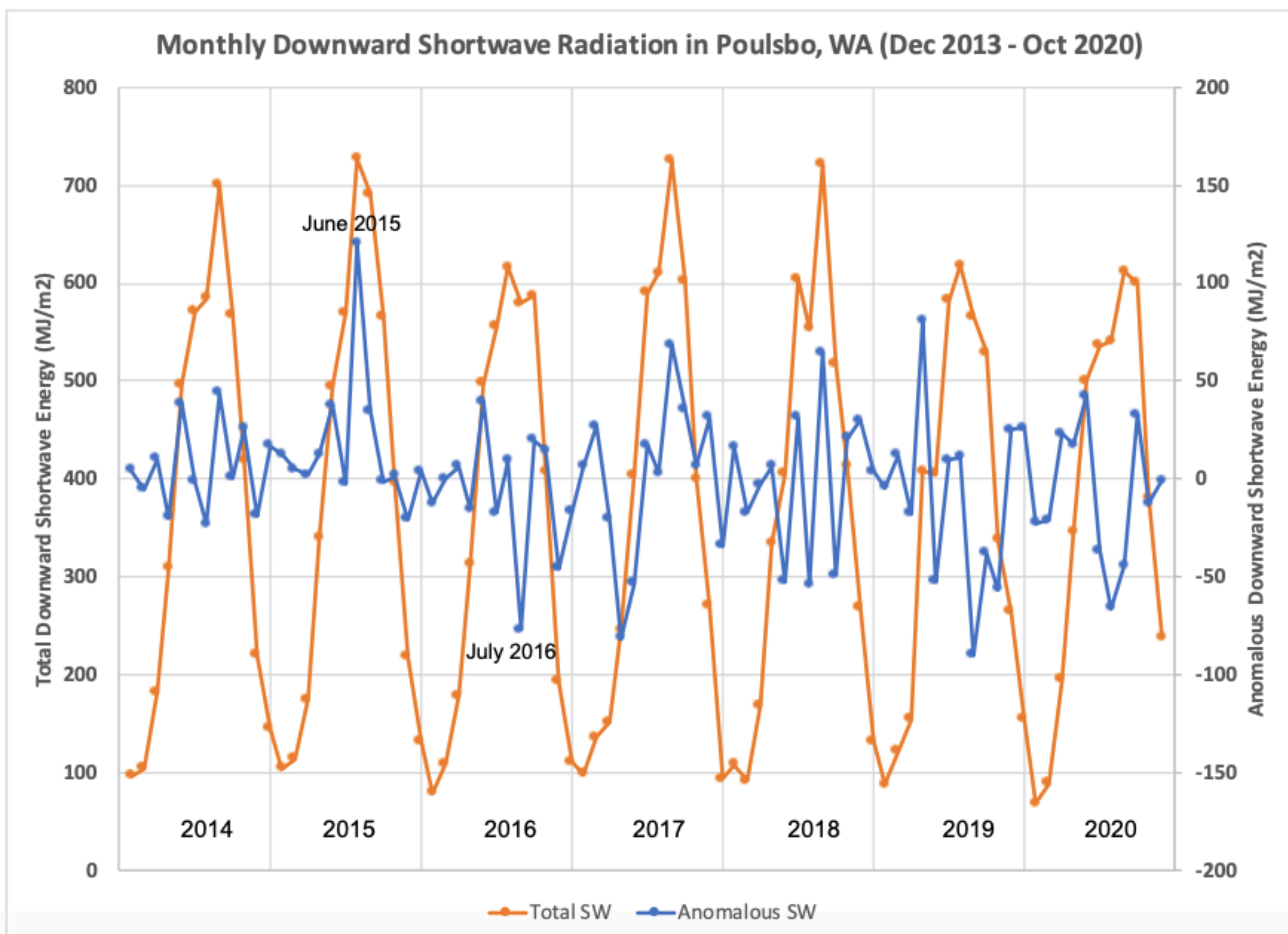


Figure 7: Monthly mean total (orange) and anomalous (blue) downward solar radiation energy in MJ/m^2 at "Poulsbo.S" for the period of December 2013 through October 2020. The anomalies are based on the December 2013-October 2020 record.

happen to be quite a few locations around WA state, especially in the agricultural regions on the east side of the Cascades, where the downward solar radiation is directly measured, in large part in association with the network of stations maintained by WSU's AgWeatherNet program. An example of these data are shown here (Fig. 7), specifically monthly totals of the downward solar energy measured at the "Poulsbo.S" station on the west side of Puget Sound for the period of December 2013 through October 2020. The variability in this component of the radiative heat fluxes is considerably greater during the summer months, naturally. Prominent anomalies in this record include the positive value exceeding 100 MJ/m^2 (equivalent to an average rate of about 40 W/m^2) for the month of June 2015; the following summer of 2016 featured a negative anomaly of 75 MJ/m2 in the month of July. The summers of 2019 and 2020 were on the cloudy side, at least relative to the mean over this admittedly short record. Back to the original motivation for our inquiry into the subject, the surface radiative fluxes definitely matter to Puget Sound in terms of their impacts on heating rates, with consequences for the marine ecosystem. Presumably they also matter to other things such as forest productivity and crop yields, either directly from a photosynthetic perspective or indirectly through impacts on factors such as soil moisture.

Reference

Crawford, T.M. and C.E. Duchon (1999): An improved parameterization for estimating effective atmospheric emissivity for use in calculating daytime downwelling longwave radiation. J. Appl. Meteor., 38, 474-480.

Climate Summary

November average temperatures were mostly near-normal to slightly above normal though there were warmer and colder pockets as well (Figure 8). Generally, eastern Washington and the Puget Sound lowlands were on the warmer than normal side while cool anomalies existed in the Chehalis River Valley and the North Cascades. The greatest positive departures from normal were in the Columbia River Basin and along the Washington-Idaho border where Pullman recorded temperatures 2.1˚F warmer than normal (Table 1). Twisp was one of colder stations (when compared to normal) in the state with a -2.3˚F departure from normal. While Washington's North and South Cascades were near-to or cooler than normal, the Central Cascades were warmer than normal. Lastly, the coldest pocket in Western Washington was centered around Centralia with temperatures -1.9˚F cooler than normal.

The November percent of normal precipitation map might raise an eyebrow due to a striking correspondence with the above temperature anomaly map (Figure 8). Many areas that featured temperatures on the warmer side also received below normal precipitation such as eastern WA, the Puget Sound, and coastal SW Washington. When compared to normal, the Central Cascades were drier than their wetter northern and southern counterparts. While most of Washington seemed to have followed this wet and cold or dry and warm pattern, southern WA along the Oregon border clearly deviates from this orientation. Warmer than normal Pullman recorded 2.78" or 121% of their normal precipitation (Table 1) and cooler than normal Centralia received 4.4" of precipitation, but this only accounted for 56% of normal. November precipitation anomalies were not extreme; all of the sites monitored by OWSC received between about 70 and 120% of normal precipitation.

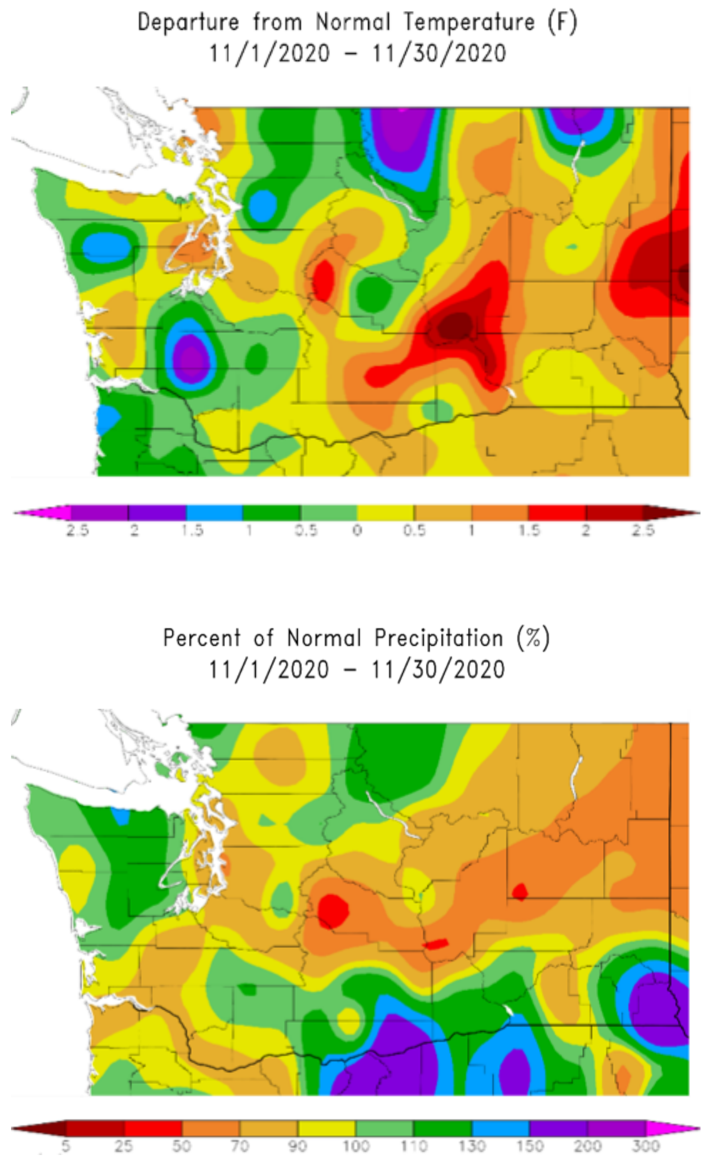


Figure 8: November temperature (˚F) departure from normal (top) and precipitation percent of normal (bottom).

([High Plains Regional Climate Center]; relative to the 1981-2010 normal).

	Mean Temperature (°F)			Precipitation (inches)		
	Average	Normal	Departure from Normal	Total	Normal	Percent of Normal
Western Washington						
Olympia	43.3	43.3	0.0	9.07	8.63	105
Seattle WFO	46.6	46.2	0.4	5.38	5.84	92
SeaTac AP	46.3	45.4	0.9	5.58	6.57	85
Quillayute	43.9	44.2	-0.3	16.32	15.52	106
Hoquiam	45.9	45.8	0.1	11.60	11.17	104
Bellingham AP	44.6	43.2	1.4	6.23	5.80	107
Vancouver AP	46.0	46.4	-0.4	5.45	5.91	92
Eastern Washington						
Spokane AP	37.1	35.7	1.4	1.65	2.30	72
Wenatchee	37.5	37.6	-0.1	1.19	1.11	107
Omak	36.6	35.9	0.7	1.51	1.61	94
Pullman AP	39.1	37.0	2.1	2.78	2.29	121
Ephrata	37.9	37.0	0.9	0.72	1.06	68
Pasco AP	42.4	41.3	1.1	1.21	1.09	111
Hanford	41.4	40.1	1.3	0.57	0.85	67

Table 1: November 2020 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 Center (CPC) La Niña is currently present in the equatorial Pacific and is expected to remain in place through the Spring. The tropical atmospheric circulation is consistent with La Niña as above normal near surface easterly trade winds created a stronger Walker Circulation. Sea surface temperatures (SST) are below normal from 160°E to the west coast of South America. Since the last OWSC climate outlook, SSTs in the western equatorial Pacific have cooled slightly, but are still anomalously warm. Over the past month, the Oceanic Niño Index (ONI) has hovered around -1.3°C after having increased from -1.7°C in late October. The CPC meteorologist/model blend forecast rates a 69% chance of a strong La Niña (ONI less than -1.0°C) for January through March. La Niña's lifespan looks to last into the spring until April-May-June when neutral conditions are favored.

The CPC one-month temperature and precipitation outlooks for December (Figure 9) both have an equal chance of above, below or near-normal temperature and precipitation for the entirety of Washington. The forecasted probability is a departure from the previous forecast in mid-November, which had increased chances of below normal temperatures and above normal precipitation.

The three-month (December-January-February) temperature outlook has increased chances of below normal temperatures with the greatest chances in the northwestern half of the state (Figure 10). The precipitation outlook has increased chances of above normal precipitation statewide with the greatest chances in the NE corner of the state.

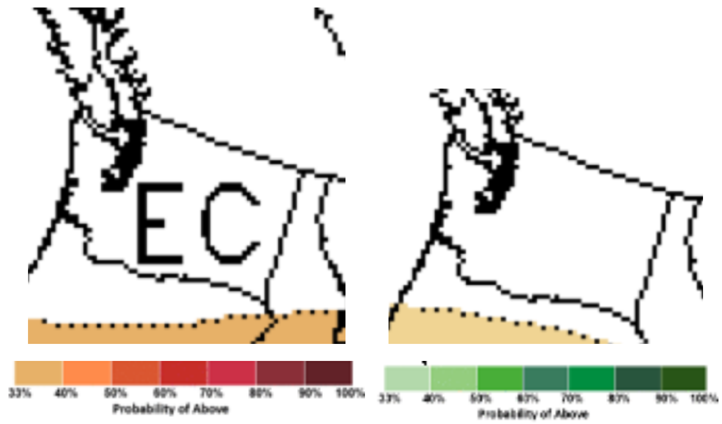


Figure 9: December outlook for temperature (left) and precipitation (right)

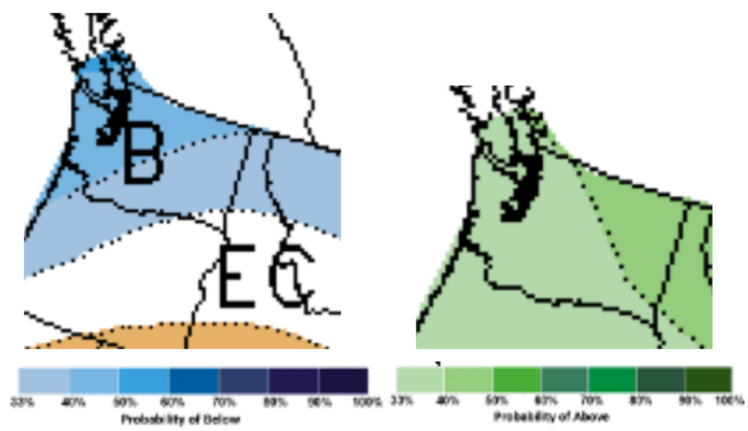


Figure 10: December-January-February outlook for temperature (left) and precipitation (right)

([Climate Prediction Center]())