Office of the Washington State Climatologist

August 2020 Report and Outlook

August 6, 2020 http://www.climate.washington.edu/

July Event Summary

Mean July temperatures were near normal for most of Washington state. Lower than normal temperatures dominated the first half of the month, but higher than normal temperatures arrived around July 14th. The month culminated with above normal temperatures. Not all of Washington experienced normal mean July temperatures. Notably, a pocket between Benton and Grant County was 2-4 F above normal from record breaking heat late in the month. Precipitation totals are more striking, namely due to the lack of any measurable precipitation in the central Columbia Basin, as evidenced by the record low precipitation totals in Figure 1. Wenatchee experienced its 6th rain-free July in its 70-year-old record, although this is not uncommon as of recently, due to its complete lack of rain in July of 2017 and 2018.

Large scale low-pressure brought fairly consistent onshore flow up until July 13th. Sites in eastern Washington such as Spokane and Omak experienced their only day of precipitation on July 1st. Western Washington saw more frequent showers during the first two weeks of July with Coastal sites such as Quillayute and Hoquiam seeing light precipitation for eight days, though

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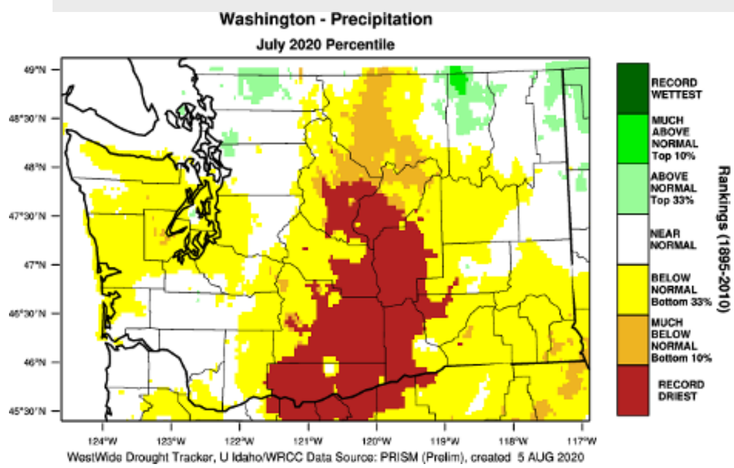

Figure 1: July 2020 precipitation total percentiles for WA state based on rankings from 1895-2010 (Westwide Drought Tracker).

rain held off on the 4th of July. Onshore flow kept temperatures seasonally cooler than normal

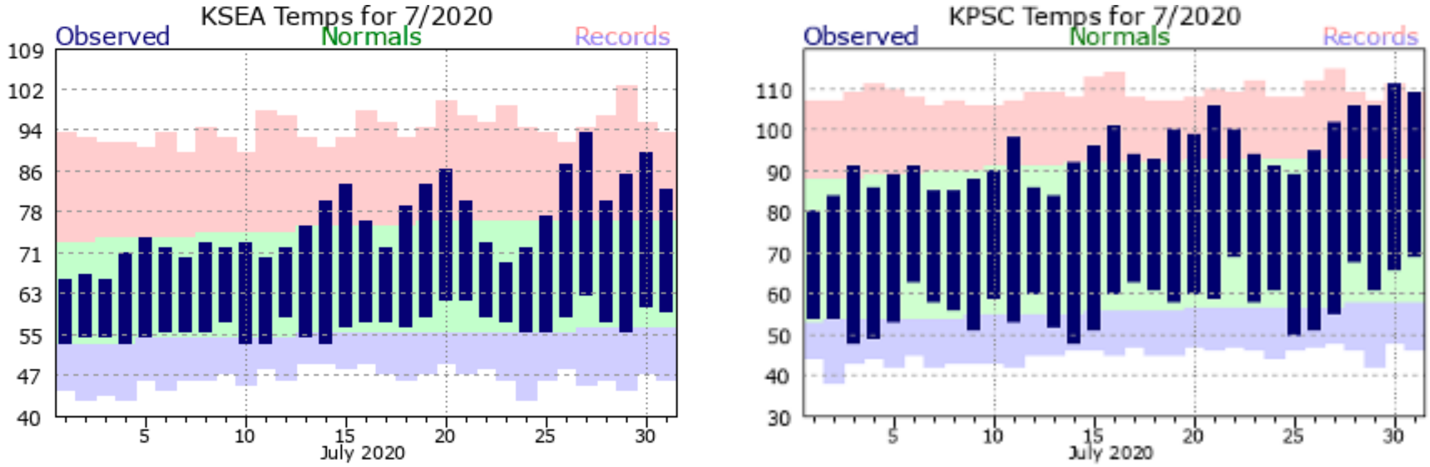

Figure 2: Daily July 2020 maximum and minimum temperatures compared to normal (green envelope) and records (red and blue bars) for (a) SeaTac Airport and (b) Pasco ([NWS](NWS)).

statewide. The Seattle WFO observed their first daily maximum temperature higher than the climatological normal on July 14th, which marked the beginning of an offshore dominant flow shown in Figure 2a.

Temperatures steadily rose and were largely above normal up until a weak onshore push on the 23rd brought relief from warmer temperatures and a trace of rain at SeaTac Int'l and Bellingham. High pressure resumed and spiked temperatures to daily record levels on July 26th at Vancouver, and July 27th at Seattle WFO, which recorded 100 and 92 F, respectively. While temperatures slightly backed down from near daily record levels in Western Washington, warming continued to brutal levels for many areas east of the Cascade Crest (Fig. 3). The NWS weather service reported daily maximum temperature records for 11 cities in eastern Washington on July 30th, which included Yakima, Wenatchee, Walla Walla, and each of the three Tri-Cities. Temperatures briefly spiked to 113 F at Richland and Hanford. Pasco observed another daily temperature record on the 31st on its way to a record breaking four consecutive days with temperatures greater than 105 F for its first time in its history; yet the average high temperature for July did not even rank in the top 10 (94.2 F at 13th). An uncontained wildfire did appear on the 31st in the Wenatchee National Forest, but has so far only burned 250 acres. As of

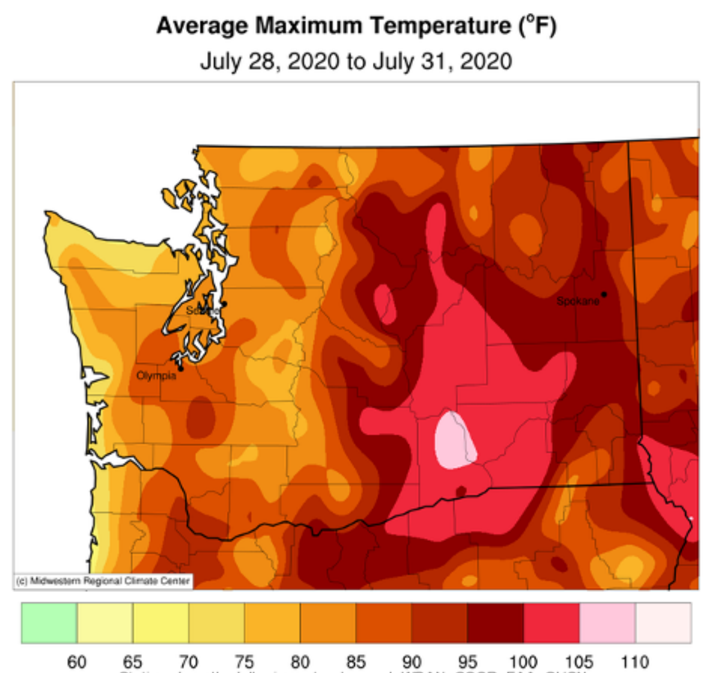

Figure 3: Map of average high temperature between July 28th-July 31st based on interpolation [(Cli-Mate)](Cli-Mate).

August 5th, only 1361 acres have been burned by wildfires marking a tame start to the smoke season.

Streamflow and Drought Monitor Update

Although July was an abnormally dry month, drought conditions slightly improved in WA state. The US Drought Monitor Map (figure 4) released on July 28th shows D2 “Severe Drought” conditions retreating from northern Okanagon County since the last issue of the climate newsletter, but is otherwise the same. July averaged streamflows were near normal for most rivers in the state (figure 5). Streamflows were below normal on the Olympic Peninsula and in Klickitat in the 10-20% percentile. The streamflow forecast from the NWS Northwest River Forcast Center predicts near normal streamflows statewide through September except for the Olympics, which could see slightly below normal water supply.

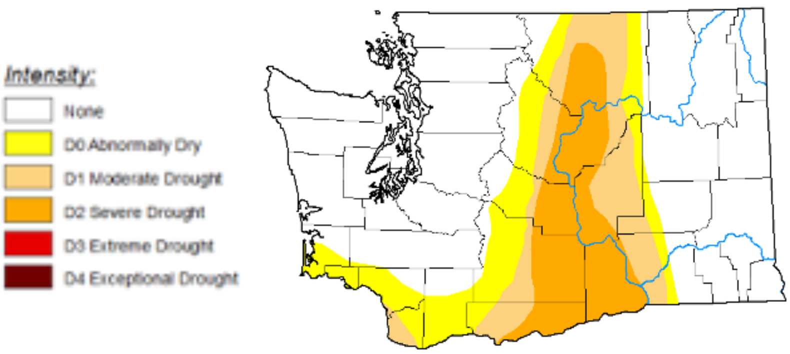

Figure 4: The August 2020 edition of the U.S.

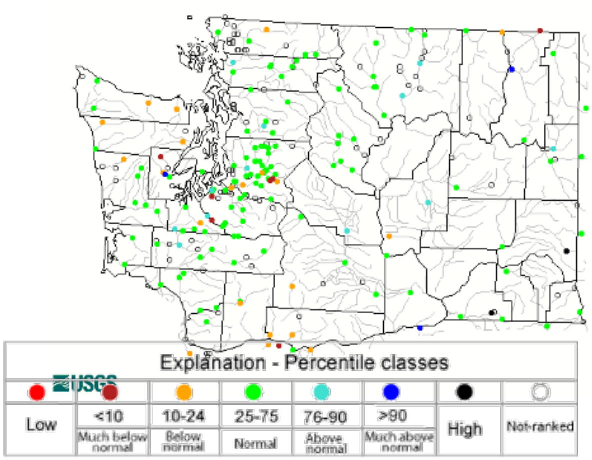

Figure 5: July average streamflows for WA from USGS.

The CoCoRaHS Corner

Thanks to our stalwart observers, CoCoRaHS is not limited to capturing soggy storms and hit or miss thunderstorms, but also the particular dry seasons we experienced this past July. Of the 389 volunteers who made observations in July, 28 entered a “0” for every single day of the month, and earned themselves the (tongue-in-cheek) highly-lauded moniker of “zero hero”, which contrasts the greatest CoCoRaHS precipitation total of 2.38” at Deming 4.2 NE. While those observers had the luck of the draw, in total, 185 stations or 47% of observers made observations every day of the month. This dedication is commendable and plays a significant role in understanding our local water condition. For example, Bremerton 3.9 NE received 0.04” in July and Port Orchard 1.9 SE recorded 0.79”- yet these stations are merely 6.2 miles away from each other. Lastly, condition monitoring reports represent a valuable tool to provide context beyond the quantitative side, and for those who already submit conditions reports, please keep it up!

Recently, the OWSC has been seeking to connect with our observers and share stories about their personal experiences with weather and climate. We heard from Al Latham over at Chimacum 5.1 S in Jefferson County, who has 40 years of precipitation records! Al produces his own local email-based newsletter called the “Weather or not report” that is distributed to his community (and a certain author of this newsletter). A recent topic covered was an assessment of the local lore that for every mile north between Quilcene and Pt. Townsend, This is similar to another rainshadow-related legend in Clallam County, with the precipitation dropping off to the east instead, but Al's analysis did lend some credibility to this concept in Jefferson County. OWSC sees it as fitting to intervene and spur rivalry in neighborly climate fodder, and so dug a little bit deeper into these claims.

Using Al's methodology, 2019 water year data was gathered for CoCoRaHS stations in the two counties using this link: https://www.cocorahs.org/WaterYearSummary/. Distances were calculated between stations in their respective counties with respect to the furthest southern station in eastern Jefferson Co. and furthest west station in northern Clallam Co. The result is seen in Figure 6, showing a strong dependence on these north and east orientations for yearly precipitation totals. The regression coefficient of 0.893 for Jefferson Co. slightly beats out Clallam's 0.828, but both values indicate that most of the precipitation variability is dependent on these axes. The average change in precipitation per mile was 1.37 for Clallam Co. and 0.94 for Jefferson Co., implying a slightly greater gradient in precipitation for the set of stations in Clallam Co., but as noted above, a bit more linear relationship for Jefferson Co. Stations in Clallam County encompass more variance in their site elevations, distance, and, ultimately, precipitation totals, all of which open up potential for other factors to come into play.

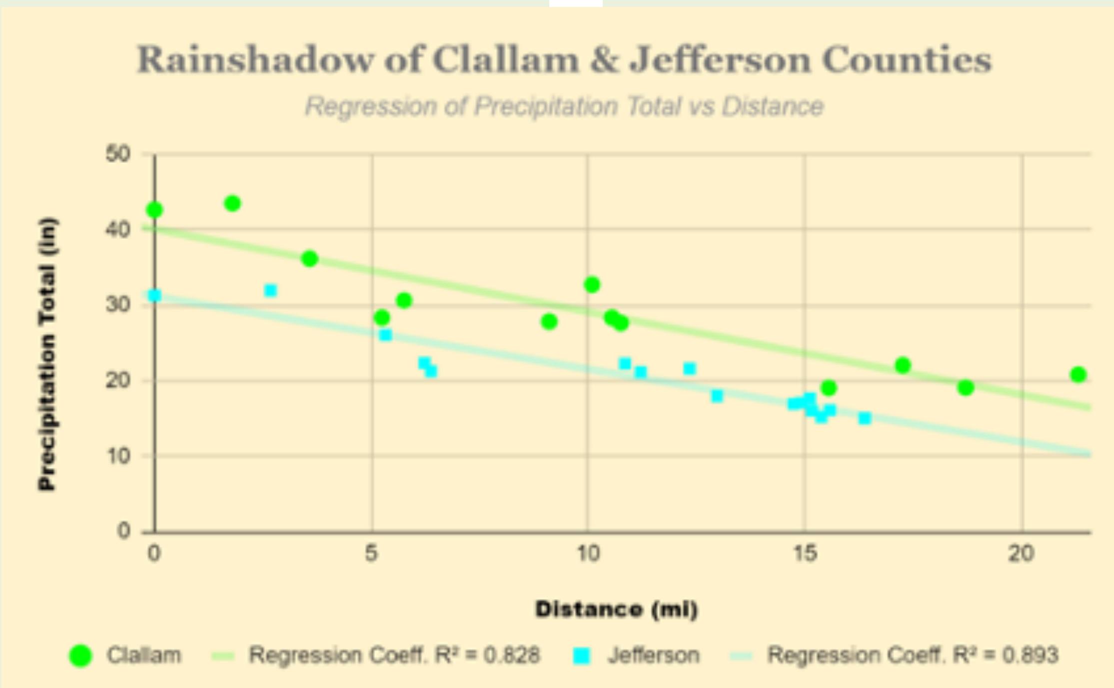

Figure 6: Scatter plot of precipitation total for the 2019 water year vs. distance between a station and the reference station. The reference station is the westernmost station in Clallam Co. and the southernmost in Jefferson County.

Thunderstorms in WA during the Summers of 1990-2019

A message from the State Climatologist

Summers have been gradually getting warmer and more humid in WA state, with plenty of variability, but has that been accompanied by a tendency for more thunderstorms? We don't get many thunderstorms compared to elsewhere in the US, especially east of the Continental Divide. In fact, Washington state experiences fewer lightning strikes per unit area than any of the other lower 48 states. But it would be reasonable to hypothesize that the warming and moistening would lead to an overall environment favoring reduced static stability and hence more thunderstorms. The summer of 2020 so far has been on the quiet side. That being said, there have been some more lively summers in recent years and so we felt it worthwhile to take a look.

We begin by simply counting the number of thunderstorm days at three lowland locations in WA, specifically SEA, YKM and GEG during the months of June through September for the years of 1990 through 2019 (Fig 7). The source of this information is NOAA's Local Climatological Data report that is compiled for about 40 locations across the state. Perhaps a better way to quantify thunderstorm activity is through time series of lightning strikes, but this data is not easily accessible, and so here we will go with the thunderstorm days at the three spots representing the western, central and eastern portions of WA state. Not surprisingly, Spokane is the big winner with an average of 7.4 thunderstorm days a summer, with Yakima and Seattle checking in with 3 and 2.5 days, respectively. With respect to overall trends, 30 years is a short interval, especially for this kind of potentially climate-related variable that is inherently noisy. At any rate, counts of thunderstorm days tended to be greater in Spokane in the first few years of the record considered here; no systematic changes are apparent for Yakima and Seattle. In terms of the correspondence between year-to-year variations at the three locations, the linear correlation coefficients between the thunderstorm days at Seattle with the thunderstorm days at Yakima and Spokane are 0.36 and 0.37, respectively. The two stations east of the Cascade crest have a substantially greater correlation coefficient of 0.64.

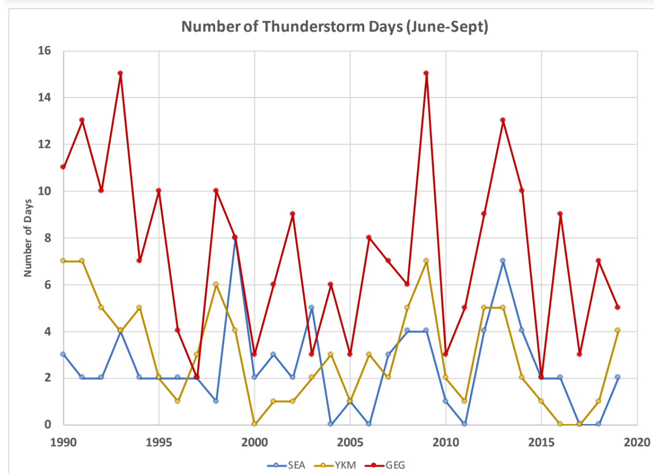

Figure 7: Thunderstorm days during June through September in Seattle (KSEA; blue trace), in Yakima (KYKM; gold trace) and Spokane (KGEG; red trace) for the years of 1990-2019.

Now, let us direct our attention to the overall environment for deep convection in WA state over the last 30 years. We do this here in an admittedly crude way by simply showing summer averages of near-surface and of upper tropospheric properties for an area encompassing WA state. More specifically, using the NCEP Reanalysis data set, we have formed time series for the wet-bulb temperature at 925 hPa (typically about 750 meters above sea level) and air temperature at 300 hPa, which is near the tropopause, as plotted in Figure 8. The 925 hPa wet bulb temperature is dependent on both the air temperature and humidity, and is directly related to the air temperature of a parcel that is lifted from that level to saturation. For present purposes, tatic stability is dependent on the difference between the 925 hPa wet bulb temperature and the 300 hPa air temperature. The higher the 925 hPa wet bulb temperature and the lower the 300 hPa air temperature, the lesser the overall static stability, and all other factors being equal, the more favorable for thunderstorms. It bears emphasizing that the aforementioned omitted factors, in particular related to the regional circulation, are absolutely key for thunderstorms to occur, so a lot here is being swept under the rug.

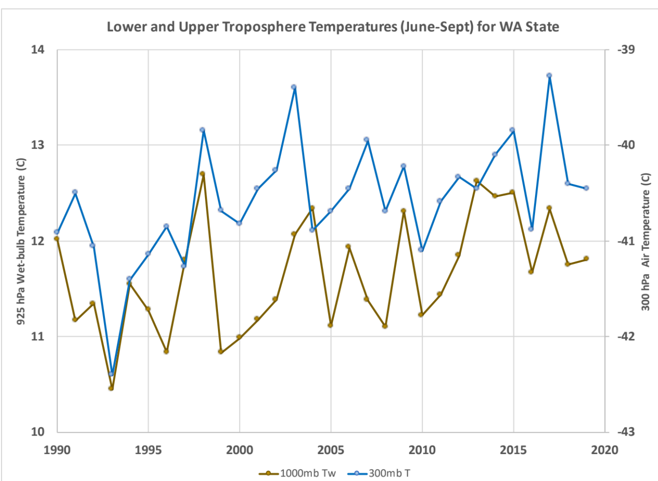

Figure 8 Mean summer (June-September) 925 hPa wet-bulb temperatures (brown; scale at left) and 300 hPa air temperatures (blue; scale at right) over the region of 45-50 N, 125-117.5 W for 1990-2019 from the NCEP Reanalysis.

Forging ahead, we note the general tendency for increases in both the 925 hPa wet-bulb and 300 hPa air temperatures. Importantly, the difference between them is not changing to any noticeable extent, and by inference, the thermodynamic environment for thunderstorms as indexed by our measure of the moist static stability. This is actually an expected result. Frierson (2006) showed that climate model simulations of global warming in the midlatitudes indicate a robust signal of upper tropospheric warming and little change in the moist static stability. Frierson focused on zonal mean properties; it appears that the atmosphere's tendency to maintain a quasi-equilibrium state even applies on relatively small spatial scales such as WA state at least after averaging over the year to year variations. The variations in the two temperatures, and their difference representing static stability, are considerable (Fig. 8). It turns out that none of these variables correspond with the number of thunderstorm days in Seattle (correlation coefficients are < 0.1). On the other hand, there is a linkage for Yakima and Spokane, with the temperature difference being a better predictor of the number of thunderstorm days than either of the two individual temperatures. One implication of this result is that if we could predict the moist static stability for eastern WA in summer on seasonal time scales – which is a big "if" – we would also have a heads-up on probable thunderstorm activity and perhaps an important element of the risk of wildfires.

Reference:

Frierson, D., (2006): Robust increases in midlatitude static stability in simulations of global warming. Geophys. Res. Lett. 33(24), doi:10.1029/2006GL027504.

Climate Summary

Mean July temperatures were near normal for a majority of the state with warm pockets in the central Columbia Basin, and cold pockets in northeast and southeast Washington. While the month began with largely below normal temperatures, a ridge stationed over the western United States in the second half of July brought above normal temperatures statewide. Temperatures were only 0.1 F below normal at Olympia and Seattle WFO, but were 1.3 F above normal at nearby SeaTac Int'l. The anomalously warm bulls eyes in the southern Columbia Basin contained Pasco and Hanford, which saw temperatures 2.3 and 2.9 F above normal, respectively. The cold anomaly in NE Washington is largely due to a large diurnal cycle with low temperatures being much cooler than normal. For example, Colville saw overnight lows 4.4 F lower than normal.

July was largely a very dry month across the state aside for a few select areas that received convective downpours. Eastern Washington featured very few days of precipitation, with totals amounting to well below normal precipitation. Omak saw a mere 0.01" and Pasco AP saw 0.04". Wenatchee, Ephrata, and Hanford failed to record any measurable precipitation for the entire month. Most of Western Washington saw well below normal precipitation except for the North Puget Sound where substantial precipitation fell early in the month, with Bellingham receiving 75% of normal precipitation. The wet near-normal bull's eye in the center of Kitsap County perfectly illustrates the variability of convective showers. A station in downtown Bremerton was the sole observer of above normal precipitation largely due to 0.55" of water falling on July 9th. The convective cell tracked further southeast providing 0.10" to 0.39" for CoCoRaHS stations between Bremerton and Puyallup, yet CoCoRaHS stations in East Bremerton recorded a mere 0.01" of precipitation. Another example of convective precipitation is the localized precipitation bull's eye in Adams County in eastern WA. This recording came from a single station receiving 0.36" on July 1st or 106% of normal. The west slopes of the Cascades in Cowlitz and Lewis County recorded near-to and slightly above normal precipitation from showers early in July.

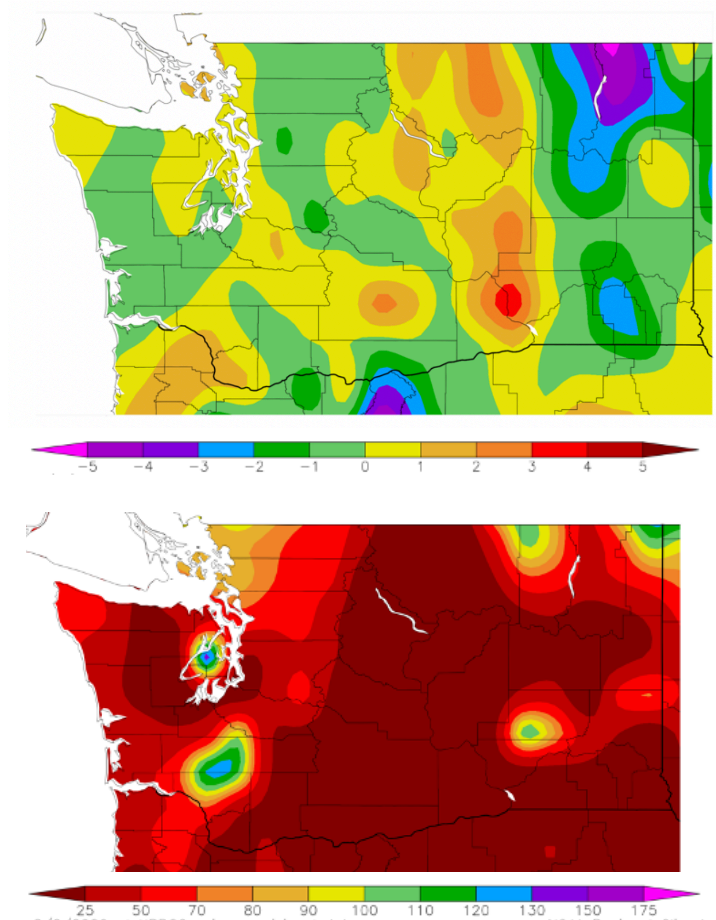

Figure 9: July temperature (°F) departure from normal (top) and precipitation percent of normal (bottom). ([High Plains Regional Climate Center](); relative to the 1981-2010 normal).

	Mean Temperature (°F)			Precipitation (inches)		
	Avg	Norm	Departure from Normal	Total	Norm	% of Norm
Western Washington						
Olympia	63.7	63.8	-0.1	0.18	0.63	29
Seattle WFO	65.8	65.9	-0.1	0.16	0.79	20
SeaTac AP	67.0	65.7	1.3	0.17	0.70	24
Quillayute	59.3	58.9	0.4	1.02	1.98	52
Hoquiam	59.9	59.9	0.0	0.50	1.14	44
Bellingham AP	63.4	62.3	1.1	0.86	1.18	75
Vancouver AP	69.8	68.4	1.4	0.08	0.69	12
Eastern Washington						
Spokane AP	70.6	69.8	0.8	0.05	0.64	8
Wenatchee	75.2	74.2	1.0	T	0.27	0
Omak	74.8	72.7	2.1	0.01	0.81	1
Pullman AP	66.0	65.6	0.4	0.11	0.69	16
Ephrata	74.9	74.2	0.7	T	0.40	0
Pasco AP	75.8	73.5	2.3	0.04	0.28	14
Hanford	81.0	77.1	3.9	0.00	0.23	0

Table 1: July 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), neutral El Niño Southern Oscillation (ENSO) are currently present in the equatorial Pacific. Sea surface temperatures (SST) are near normal in the central equatorial Pacific sandwiched between below normal SST further east, and above normal SST further west. Slight warming in the eastern Pacific and slight cooling in the western Pacific has decreased both SST anomalies, and the central equatorial Pacific has undergone little SST change in the past month. The Oceanic Niño Index (ONI) used by CPC to indicate El Nino or La Nina conditions, with a threshold of 0.5 C for a period of 3 months. The ONI reached a maximum value of 0.6 early in 2020 and is now slightly below zero. ENSO forecast models predict neutral conditions to persist through the rest of the summer months. For next winter, the models are split between La Niña and neutral conditions with a slight favoring of La Niña between December to February at 51% to 41%, respectively.

The CPC outlook for August show increased chances of above normal temperatures- though the chances are only slightly increased for a majority of the state, The odds of below normal precipitation are increased statewide with 40-50% chances across all of Washington excluding the Olympic Peninsula and SW Washington.

The three-month CPC temperature outlook for August-September-October has increased chances of above normal temperatures statewide, though chances are only slightly increased in the northeast sector of the state at 30-40%.   The precipitation outlook is neutral giving equal chances of above, near and below normal precipitation totals across the state.

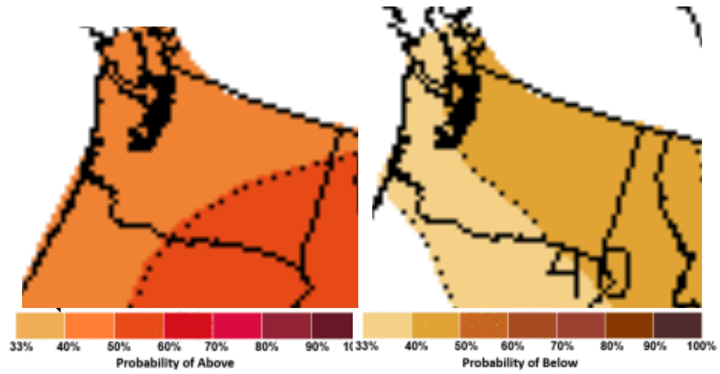

Figure 10: August outlook for temperature (left) and precipitation (right) (Climate Prediction Center).

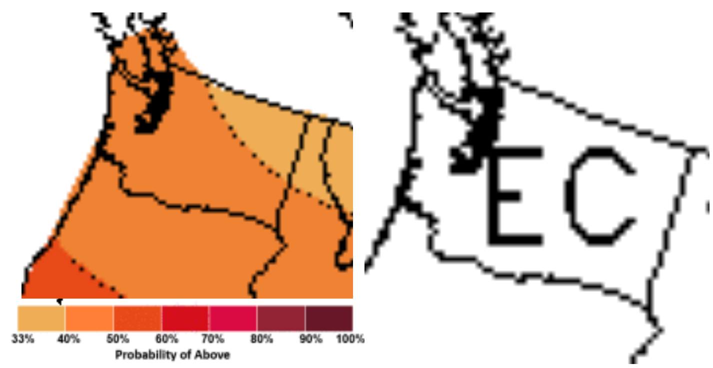

Figure 11: August outlook for temperature (left) and precipitation (right) (Climate Prediction Center).