Office of the Washington State Climatologist

August 2018 Report and Outlook

August 6, 2018

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

July Event Summary

Mean July temperatures were above normal, with precipitation below normal throughout WA State. While usually dry anyway, this past July was the 3rd consecutive month in which precipitation has been below normal. For many stations, the 2018 May through July precipitation is now among the top 5 driest on record (Table 1). 2018 precipitation at both Olympia and Battle Ground were beaten out by 2015, but SeaTac and Bellingham had their driest May-July this year. Figure 1 shows May-July precipitation percent of normal for the state, with the precipitation deficits for this period being more pronounced in western WA.

The rankings for July temperature and July precipitation are also listed in Table 1, showing higher rankings for temperature in western WA compared to eastern WA. July precipitation was at the lowest possible point (0") for many eastern WA locations, so it should be noted that even though the ranking is listed at the driest July, there are other Julys that were just as dry or very close ("trace" or 0.01").

As for the progression of weather through July, there were 3 warm periods punctuated with near-normal or below normal temperatures (see Figure 2 for Olympia daily July temperatures). The first was just in time for the 4th of July, and a record daily maximum temperature was set at Bellingham Airport (86°F). The second was mid-month, bringing the first 90°F+ day of the season to some

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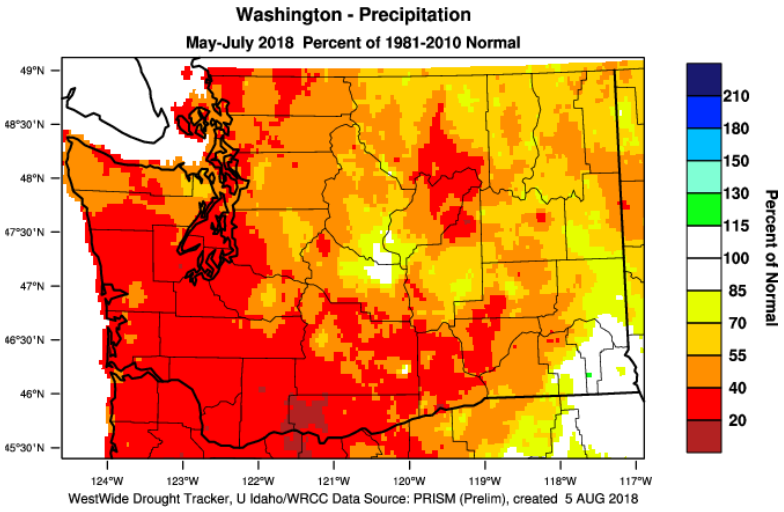


Figure 1: May-July 2018 precipitation percent of normal for WA State (from WWDT).

Station	May-June-July Precipitation (Rank; Precipitation)	July Precipitation (Rank; Precip)	July Temperature (Rank; Temp)	Records Began
SeaTac AP	1; 0.80”	6; 0.05”	2; 70.7˚F	1945
Bellingham AP	1; 1.22”	12; 0.16”	4; 66.3˚F	1949
Olympia AP	2; 0.96”	11; 0.07”	7; 66.6˚F	1941
Battle Ground	2; 1.31”	13; 0.01”	6; 67.7˚F	1928
Hoquiam	4; 2.33”	5; 0.06”	7 (tie); 61.7˚F	1953
Walla Walla	2; 0.97”	1 (tie); 0"	10; 79.0˚F	1949
Yakima	13; 0.66”	1 (tie); 0”	12; 74.2˚F	1946
Richland	13*(tie); 0.62”	1 (tie); 0"	19 (tie); 76.7˚F	1944
Spokane AP	28 (tie); 2.06	24; 0.06”	17; 73.3˚F	1881

Table 1: The May-July 2018 precipitation, July 2018 precipitation, and July 2018 average temperature and ranking in the historical record for selected WA stations. *denotes 1 missing day

western WA locations. SeaTac Airport, for example, recorded a daily record maximum temperature of 93˚F on the 15th. The final stretch of heat occurred at the end of July, bringing the warmest temperatures of the month for most locations. Maximum daily temperature records were tied at Olympia (93˚F) on the 25th and Ellensburg (102˚F) on the 29th.

Wildfires were more active in Oregon during the month of July, but several fires were ignited in WA on the 29th or 30th that we're monitoring closely. The landscape is certainly primed for more fires, an we are just entering the peak of the wildland fire season.

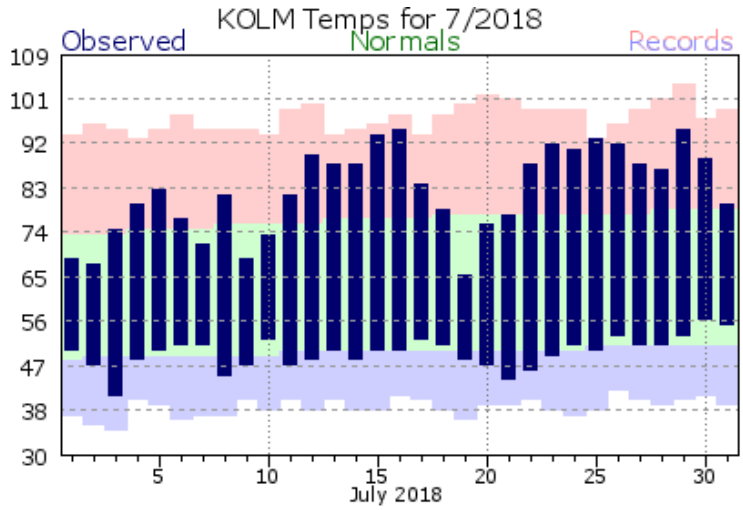


Figure 2: Daily July 2018 maximum and minimum temperatures (blue bars) at Olympia Airport along with the daily record warm (red) and cold (blue) temperatures. The green envelope represents the 1981-2010 normal (from NWS).

Drought Monitor and Streamflow Update

The continued dry and warm July, in combination with low streamflows and dry soils, has led to continued degradation on the US Drought Monitor over the last month (Figure 3). Severe drought - "D2" - has been introduced to southwestern WA, where streamflows are particularly low and soils are dry. The "abnormally dry" and "moderate drought" categories have also been introduced to parts of eastern WA in the last month to reflect the precipitation deficits (30-, 60-, and 90-day time scales). With that said, we are **not** in an official emergency drought declaration from the state. We are helping the state monitor the emerging conditions, and updated information can be found on the Department of Ecology's Water Resources page, which is updated more frequently than our newsletter releases.

The average July streamflows are shown in Figure 4, showing much below normal streamflows throughout southwestern WA and on the Canadian border. The Chehalis and Skookumchuck Rivers in Thurston county are in the 1st percentile (i.e., record low flows) for this time of year. Many others are below the 10th percentile and still more are below the 25th percentile. Improvement in streamflow at this point in the dry season is unlikely since we have yet to reach the time of year in which streamflows are the lowest annually. We will continue to monitor conditions, and closely follow for impacts to fish, some of which are beginning to emerge.

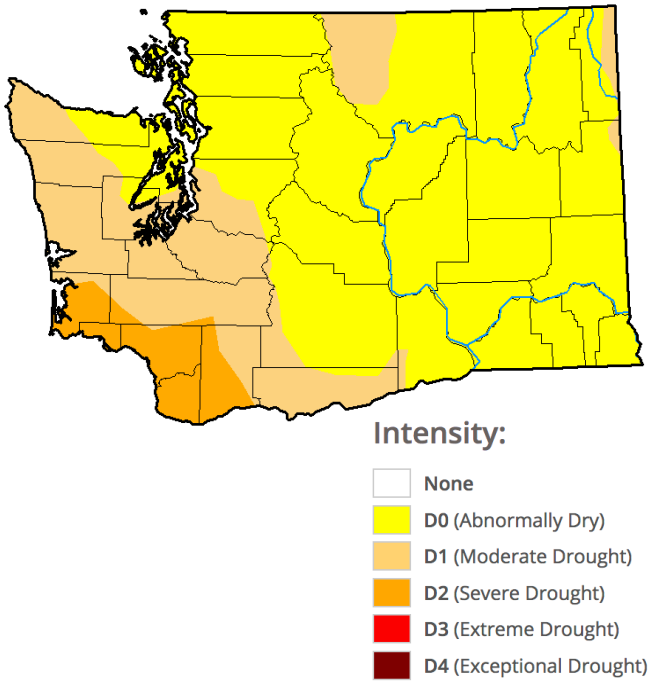


Figure 3: The August 2, 2018 version of the U.S. Drought Monitor.

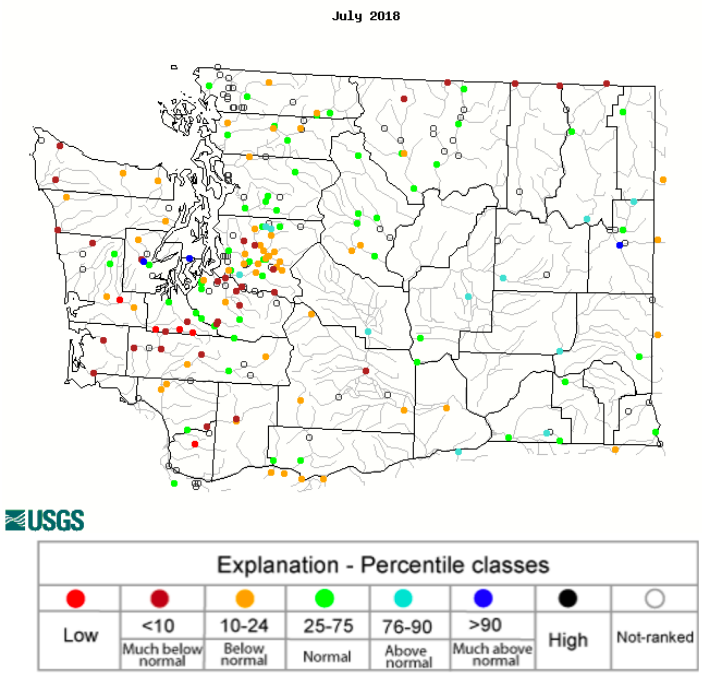


Figure 4: WA State average July streamflows from USGS.

Climatology of WA's West Olympic Coast Climate Division (#1)

A message from the State Climatologist

It has long been a vision of OWSC to feature a 10-part "Climate Division of WA" series in our newsletter, describing the climate of the 10 NOAA Climate Divisions, individually. This is the first in such series, and we expect to have intermittent installments for the remaining climate divisions over the next few years. We start, appropriately, with Climate Division 1 – the West Olympic Coast Climate Division. This division covers the entire WA coast to the west and southwest side of the Olympic Mountains (Figure 5), ranging in elevation from sea level to 7969' on Mount Olympus, the tallest peak in the Olympic Mountains. The heavily forested climate division includes much of Olympic National Forest and Quinault Lake, Wynoochee Lake, and Lake Cushman, but splits Lake Crescent, only including the western half. It also contains the towns and reservations of Neah Bay, Forks, Quinault, Moclips, Hoquiam/Aberdeen, Ocean Shores, Montesano, and Long Beach.

Figure 6 illustrates the monthly total precipitation, and maximum and minimum temperatures averaged over the climate division for 1981-2010. Annual precipitation for this division totals a staggering 108" (9 feet), ranking the West Olympic Coast division as the wettest in the contiguous US by a comfortable margin. But even with large annual precipitation total, the coastal division still experiences a marked seasonality in its precipitation, with July and August on average receiving only about 2". November is the wettest month, with about 18" in the mean. With regards to temperature, August is the warmest month with maximum temperatures at about 70°F and minimum temperatures at about 50°F. December is the coldest month, but the temperatures are still relatively mild with the average minimum temperature just above freezing (32.7°F).

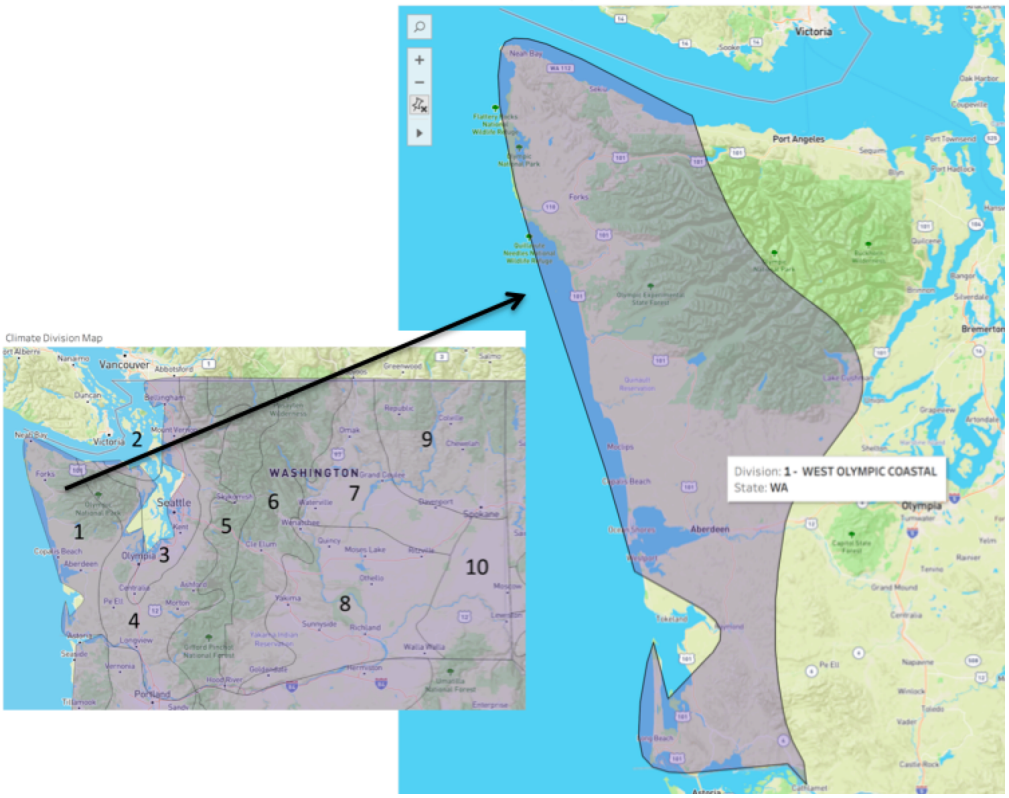


Figure 5: Climate Division 1 – the West Olympic Coast – overlaid onto a topographical map. The purple polygon follows a rough coastline but should encompass the entire coast.

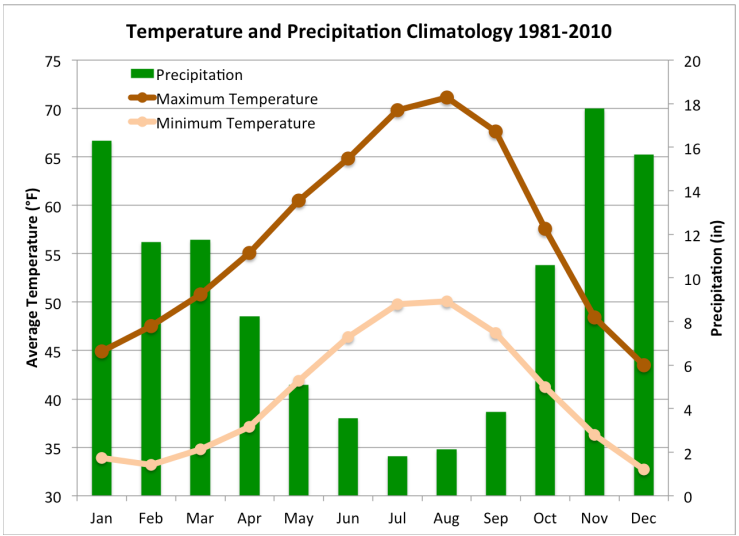


Figure 6: Monthly maximum temperature (°F), minimum temperature (°F), and total precipitation (inches) climatology for the 1981-2010 period for Climate Division 1.

Extremes in this climate division are perhaps more interesting, however, and we used the monthly climate division data to tabulate the warmest, coldest, wettest, and driest months since the record began in 1895 (Table 2). The warmest (July 1958) and coldest (Jan 1950) months are extreme months for the state overall. The cold anomaly is impressive in terms of its magnitude, 14.2°F colder than the 1981-2010 normal. Two months tied for the most precipitation – Dec 1933 and Jan 1953 – with nearly 38" in a month, 22" above normal. The entry for the driest month of July 1922 has a total precipitation of zero; we confirmed that several stations that were reporting that early in the record recorded no measurable precipitation.

Seasonal wind rose charts for Quillayute Airport are shown here as an example of the wind climatology for the climate division (Figure 7). Light winds from the northeast are prominent in fall, winter, and spring, and are likely a result of drainage from locally higher terrain to the northeast of this particular station. The strongest winds during those same seasons are from the south or southeast due to the regional effects of the Olympic Mountains as fronts and low pressure systems approach the coast. During summer, the ridge of high pressure that persists off the WA coast results in light northwesterly, westerly, or southwesterly winds. Regardless of the season, the coastal division, which is not necessarily well-represented by the Quillayute station, often includes an onshore component to the low-level flow due to the prevailing large-scale atmospheric circulation.

Time series of the annual average air temperature anomalies and total precipitation anomalies, using a long baseline of 1901-2000, for WA Climate Division 1 are plotted in Figure 8. For this figure, we define the 12-month averages based on the water year (October through September) rather than the calendar year. A time series of nearshore sea surface temperature (SST) anomalies for the area of 40-50°N, 135-125°W is also plotted. The precipitation record for the division includes some extended periods of relatively dry (for the region) and wet conditions and lots of year-to-year

Monthly Record	Value (Anomaly)	Month
Warmest	63.7°F (+3.9°F)	July 1958
Coldest	25.2°F (-14.2°F)	January 1950
Wettest	37.87" (+22.20" & +21.58")	December 1933 & January 1953
Driest	0" (-1.82")	July 1922

Table 2: The warmest, coldest, wettest, and driest month for Climate Division 1 using the period of record (1895-2018).

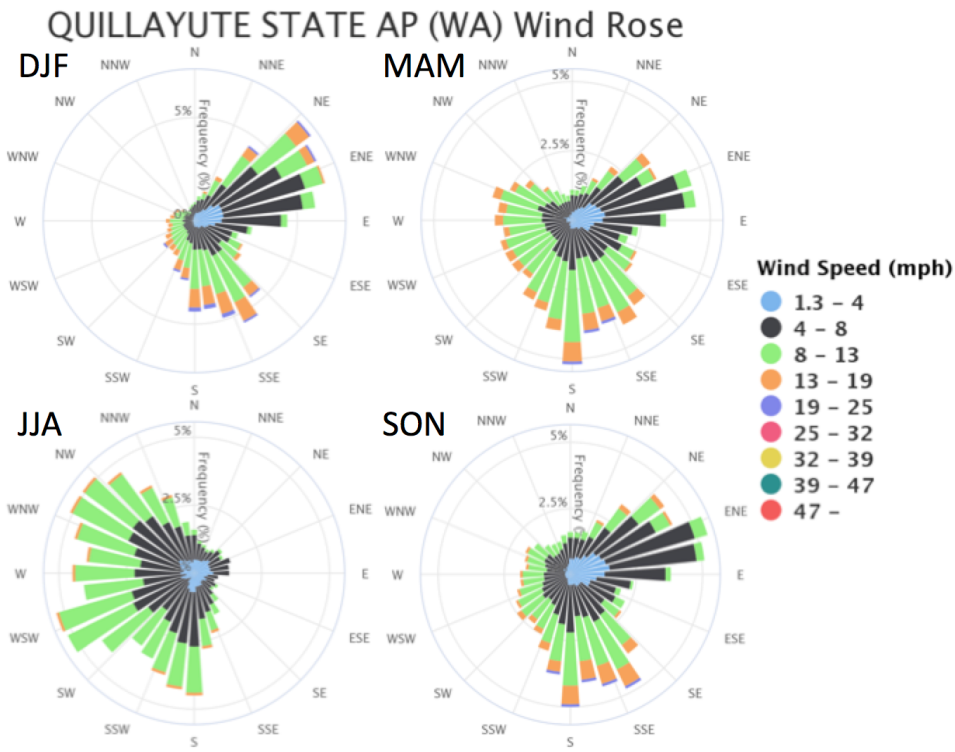


Figure 7: Quillayute Airport seasonal (DJF, MAM, JJA, SON) winds for the period of record (1966-2018) from MRCC's [CLI-Mate tool](#).

variability. The overall trend in annual total precipitation is negligible. The temperature record is more interesting.

First and perhaps foremost, the division air temperatures indicate an overall warming during the second half of the record after a more-or-less flat trend during the first half. Another way of looking at it is that during recent decades, the cool years are relatively rare, and of modest intensity (less than 1°F colder than normal) compared with their counterparts earlier in the record. There is essentially no relationship between the interannual fluctuations in the air temperatures and total precipitation amounts.

On the other hand, we are impressed by the strength of the correspondence between the air temperatures and regional mean SSTs. In more specific terms, the linear correlation coefficient between these two time series is about 0.8. Distinguishing between cause and effect can be tricky here in that the atmospheric circulation patterns that produce warmer ocean temperatures can also favor warmer weather. Nevertheless, this climate division's air temperatures should be expected to be sensitive to the regional SST because the low-level winds often have an onshore-directed component. Because of the thermal inertia of the upper ocean, once substantial temperature anomalies are established they can persist for months. It turns out that the yearly values of precipitation are actually slightly negatively correlated (r ~ -0.2) with the regional SST. This result is consistent with the idea that the regional atmospheric circulation patterns that tend to cause elevated SSTs also suppress precipitation, at least in this particular climate division.

To summarize, WA's West Olympic Coast climate division is the wettest in both the state and the continental US, yet still has a distinct seasonality of a dry and wet period. There is a relatively modest seasonal variation in temperatures, as might be expected for a region subject to maritime air masses. The low-level flow often has an onshore-directed component most of the year, but the strongest winds tend to be from the south. The most recent monthly extreme for the entire division was 60 years ago in July 1958, when the warmest month was recorded. Despite the long ago set record, temperatures are increasing for the

division, along with SSTs off our coast. Finally, please feel free to provide feedback on the first installment of our Climate Division Series. Is there any special topic you'd like to see in subsequent series? Email/tweet/Facebook us (climate@atmos.washington.edu; @WAStateClimate).

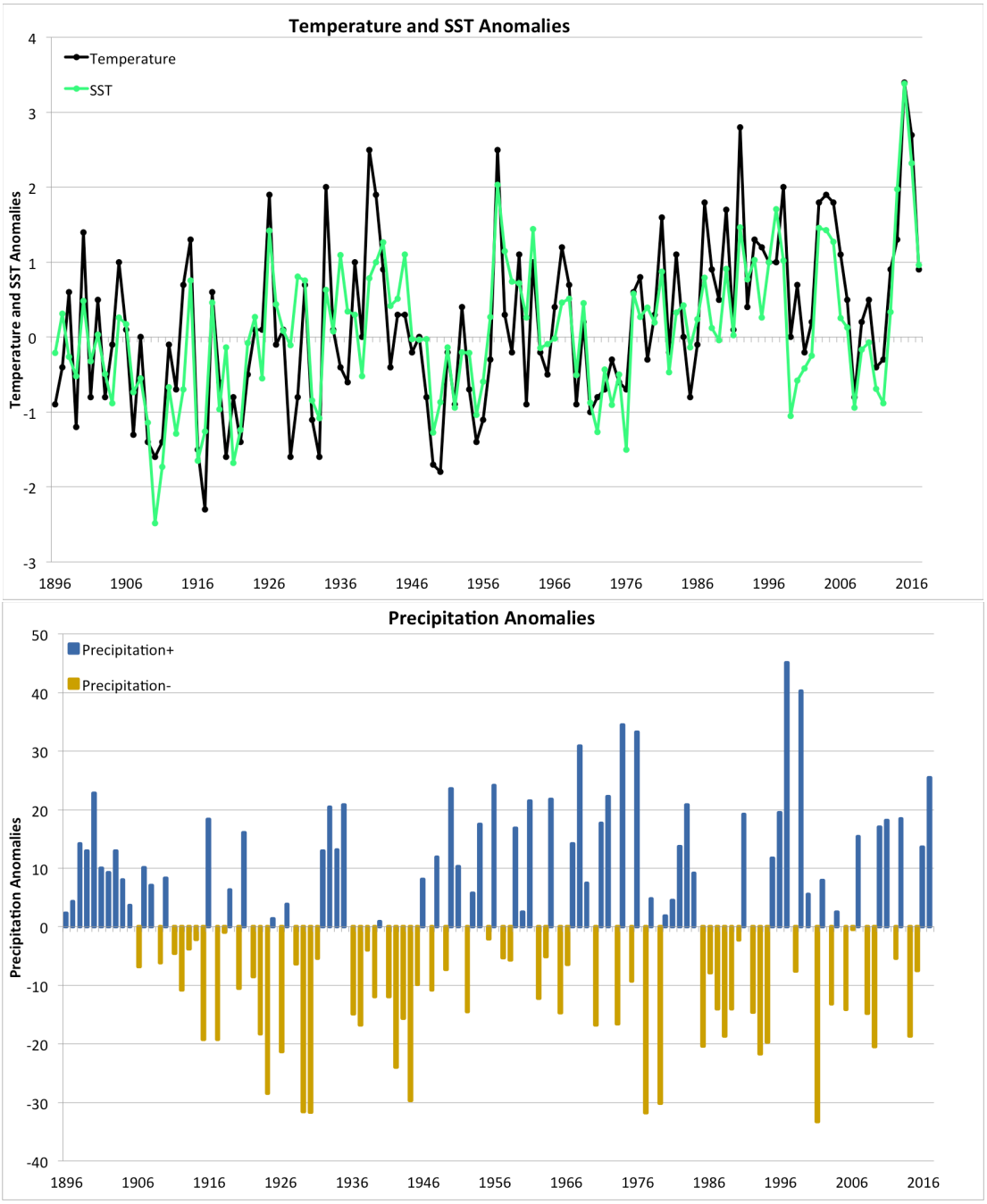
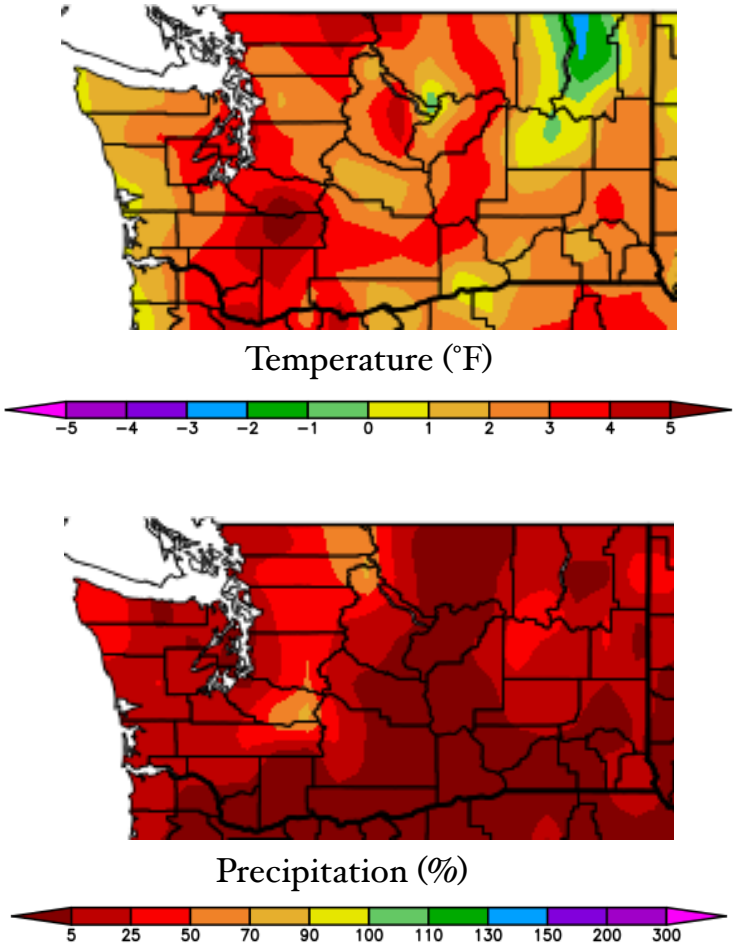


Figure 8: Climate division water year average temperature (top) and water year total precipitation (bottom) anomalies based on a 1901-2000 baseline for the period of record (1895-2017). Sea surface temperature anomalies from the Kaplan Extended V2 dataset off the WA coast are also included (top).

Climate Summary

Mean July temperatures were warmer than normal for nearly the entire state. The southern Puget Sound region and the southern I-5 corridor had the warmest anomalies relative to normal, with average temperatures between 4 and 6°F above normal. Vancouver and SeaTac Airport were 4.0 and 5.0°F above normal, respectively (Table 3). Temperatures in eastern WA were mostly between 2 and 4°F above normal, with Hanford having the warmest average July temperature of all the locations listed in Table 3 (80.9°F). According to the HPRCC map on the right, the exception was Stevens county - in northeastern WA - where cooler than normal July temperatures (between 1 and 3°F below normal) were recorded.

Total July precipitation was below normal statewide, with much of the state receiving less than 25% of normal. Wenatchee, Omak, Ephrata, Pasco and Hanford were even more extreme, all recording either a trace or no precipitation at all for the month (Table 3). Some locations did receive precipitation, such as Quillayute, but it was still only 36% of normal. According to the HPRCC map on the right, a few locations in the Cascades received between 50 and 70% of normal precipitation, likely from isolated thunderstorms. While little precipitation fell during the month of July, it is a very dry month climatologically, with most of the monthly precipitation deficits at about an inch or an inch and a half for the month.



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)		
	Average	Normal	Departure from Normal	Total	Normal	% of Normal
Western Washington						
Olympia	66.6	63.8	2.8	0.07	0.63	11
Seattle WFO	70.0	65.9	4.1	0.02	0.79	3
SeaTac AP	70.7	65.7	5.0	0.05	0.70	7
Quillayute	59.8	58.9	0.9	0.71	1.98	36
Hoquiam	61.7	59.9	1.8	0.06	1.14	5
Bellingham AP	66.3	62.3	4.0	0.16	1.18	14
Vancouver AP	72.4	68.4	4.0	0.02	0.69	3
Eastern Washington						
Spokane AP	73.3	69.8	3.5	0.06	0.64	9
Wenatchee	77.1	74.2	2.9	T	0.27	0
Omak	75.9	72.7	3.2	T	0.81	0
Pullman AP	68.5	65.6	2.9	0.05	0.69	7
Ephrata	78.4	74.2	4.2	T	0.40	0
Pasco AP	75.8	73.5	2.3	0	0.28	0
Hanford	80.9	77.1	3.8	0	0.23	0

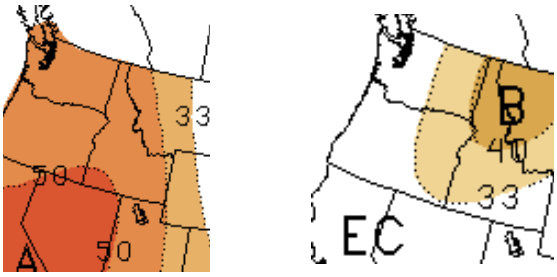
Table 3: July 2018 climate summaries for locations around Washington with a climate normal baseline of 1981-2010. Note that the Vancouver Pearson Airport and Seattle WFO 1981-2010 normals involved using surrounding stations in estimating the normal, as records for these station began in 1998 and 1986, respectively.

Climate Outlook

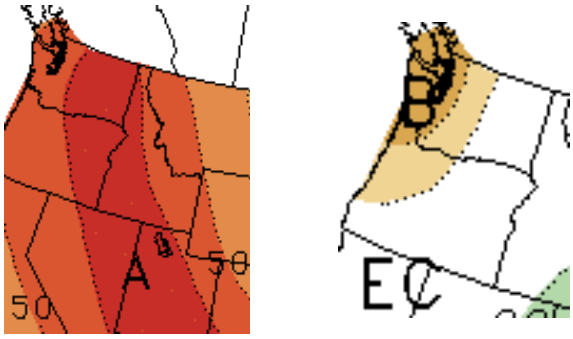
ENSO-neutral conditions are present in the tropical Pacific Ocean. Over the last 4 weeks, equatorial sea surface temperatures (SSTs) near the South American coast were below normal while the SSTs in the remainder of the equatorial Pacific were near-normal to above normal. Neutral ENSO conditions are expected to persist through the summer. Forecast models show about a 70% chance of El Niño developing during the September-November period and persisting into winter 2018-19, and neutral conditions until then.

The August temperature outlook from the CPC has increased chances of above normal temperatures for the entire state. The CPC August precipitation outlook calls for equal chances of below, equal to, or above normal precipitation for western WA. Chances are elevated for below normal precipitation in eastern WA for August.

The August-October CPC seasonal outlook is similar to the August outlook for temperature, as the CPC is showing increased chances of above normal temperatures. For precipitation the seasonal outlook calls for equal chances of above, equal to, or below normal precipitation for eastern WA. There are increased chances of below normal seasonal (ASO) precipitation for western WA.



August outlook for temperature (left) and precipitation (right)



August-September-October outlook for temperature (left) and precipitation (right)

(Climate Prediction Center)