Office of the Washington State Climatologist

April 2020 Report and Outlook

April 3, 2020

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March Event Summary

Mean March temperatures were below normal for nearly the entire state with the exception being the eastern slopes of the central and northern Cascades where temperatures were near-normal. March precipitation was below normal statewide. In some portions of the state - such as parts of the coast, the eastern slopes of the Cascades, and southeastern WA - March precipitation ranked in the bottom 10th percentile. Table 1 shows a sample of stations with total March precipitation ranking among the top ten driest on record.

March began with above normal temperatures for most of the state, as shown in daily temperature record for Spokane Airport (Figure 1). Both Wenatchee and Omak observed daily high temperature records of 62°F on the 3rd. On the 5th, Pullman (61°F) recorded a record high daily temperature as well.

But the spring-like temperatures were short lived. Beginning on the 13th, northerly flow set up an unusually cold pattern for March that impacted the state through the 15th. Spokane Airport measured a daily record snowfall for the 13th with 3.4", and had more snow on the 14th. Figure 2 shows the 24-hr snowfall accumulations on the morning of the 14th from WA CoCoRaHS observers, showing even some light snow in western WA. Spokane recorded a high temperature of only 23°F on the 14th, which was both a record cold high temperature for the date

Station	March Total Precipitation (in)	Rank	Record (Amount; Year)	Records Began
Aberdeen	2.03"	3 (tie)	1.36"; 1992	1892
Walla Walla AP	0.89"	5	0.42"; 1965	1949
Pullman 2 NW	0.88"	6	0.45"; 1992	1941
Hoquiam AP	4.48"	9	1.39"; 1965	1954

Table 1: A sample of stations in WA with total March precipitation rankings in the top ten driest on record.

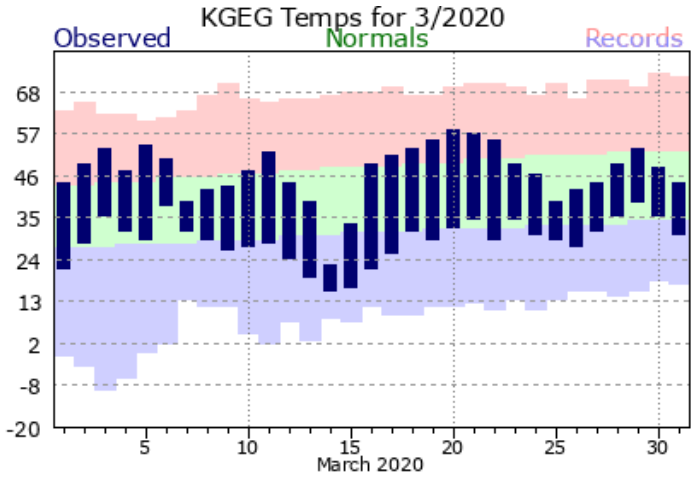


Figure 1: Daily March 2020 maximum and minimum temperatures compared to normal (green envelope) and records (red and blue bars) for Spokane Airport (NWS).

and the coldest high temperature recorded that late in the season on record (since 1881). Low minimum temperature records were set over the next several days as well. For example, there was a record low daily minimum temperature for Walla Walla (26°F) on the 14th, for Ephrata (23°F) and Wenatchee (21°F) on the 15th, for Olympia (23°F) and the Seattle Weather Forecasting Office (WFO; 30°F) on the 16th, and for Olympia (22°F) on the 17th.

The low minimum temperatures in western WA on the 16th and 17th were due to clear skies overnight as we transitioned to a relatively warm, dry and sunny stretch from the 16th through the 22nd. The warm temperatures were in the daytime, of course, with highs in the 50s or 60s throughout the state.

Finally, March ended with some needed precipitation across the state. On the 30th, Olympia (0.89") and the Seattle WFO (0.46") recorded maximum daily rainfall records.

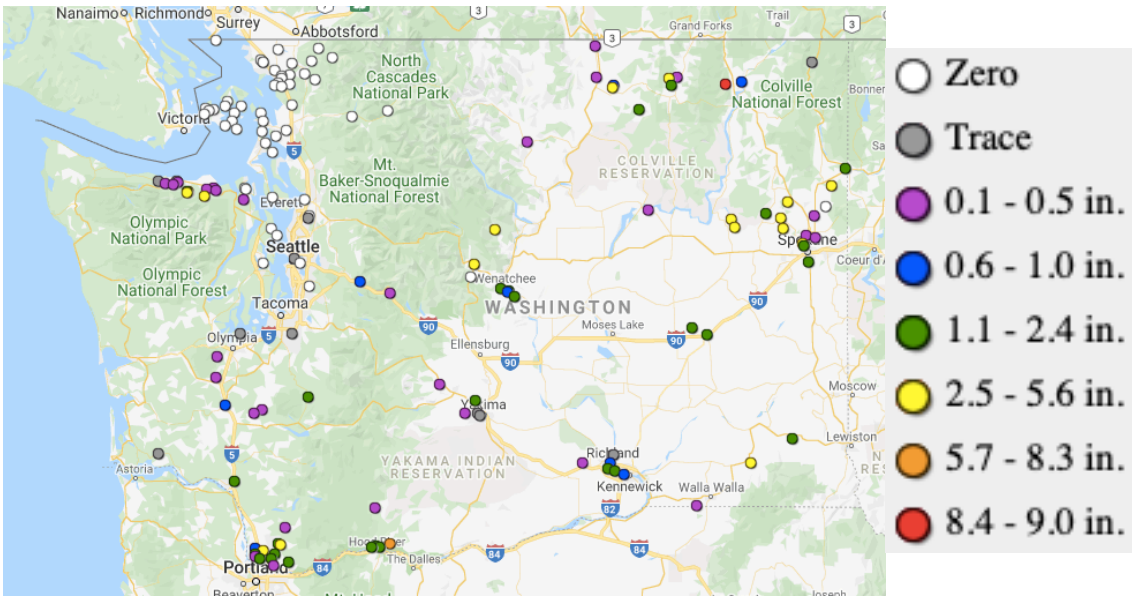


Figure 2: 24-hr snowfall observations ending the morning (between 7 and 9 am) of March 14, 2020 from CoCoRaHS observers.

Snowpack and Drought Monitor Update

Despite the drier than normal month, snowpack still built in the mountains, mostly during the wetter period at the end of March. The cooler than normal temperatures also helped preserve the snowpack that was already in the mountains, showing promising April 1 snow water equivalent (SWE) values. The basin average SWE percent of normal as of April 1 from the Natural Resources Conservation Service is shown in Figure 3. The basin averages are showing near-normal to above normal SWE for almost the entire state. The exception is the Upper Yakima basin with a basin average of 89% of normal. This is due to some of the lower elevation sites, such as Blewett Pass (4,240') having below normal SWE (59% of normal).

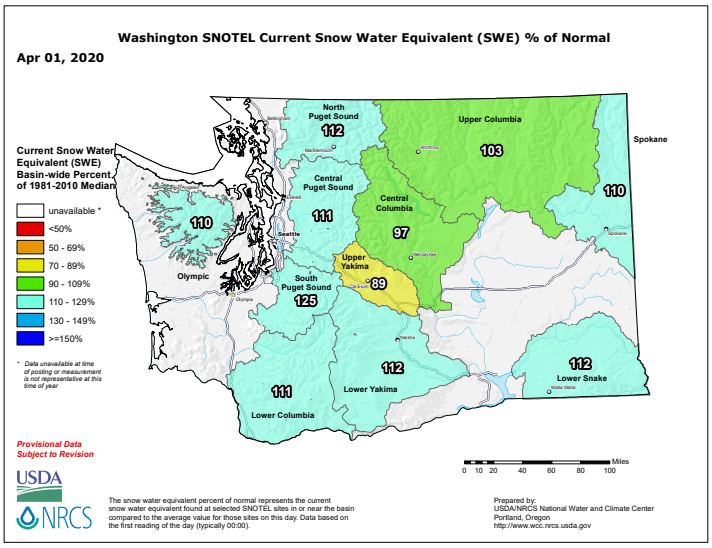


Figure 3: Snowpack (in terms of snow water equivalent) percent of normal for Washington as of 1 April 2020 (from NRCS).

Even with fairly good snowpack in the mountains, conditions east of the Cascades have continued to be drier than normal. The latest U.S. Drought Monitor (Figure 4) has severe drought ("D2") depicted in parts of Kittitas, Yakima, Klickitat, and Benton counties due to the drier than normal conditions on both short and long time scales, below normal streamflows, and below normal soil moisture. Major water shortages aren't anticipated for summer at this time due to the healthy snowpack, but we will continue to monitor through spring. Western WA continues to be drought-free.

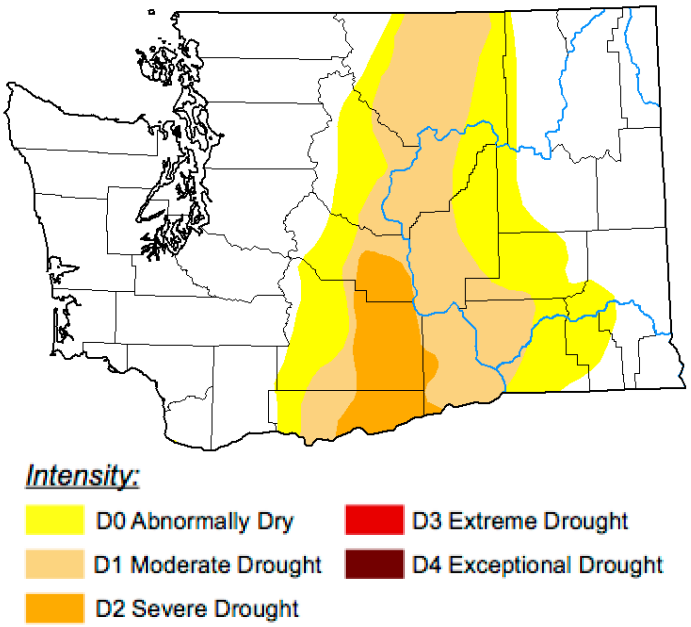


Figure 4: The 2 April 2020 edition of the U.S. Drought Monitor.

Sheltering in Place - Does it Impact Air Quality?

A message from the State Climatologist

We have all noticed marked changes in activities due to the COVID-19 outbreak. One obvious one is the scarcity of aircraft overhead, as indicated by Alaska Airlines planning to reduce its flights by 70% for April and May (*Seattle Times*, 26 March 2020). Another one is reduced automobile traffic, especially involving personal vehicles. Is this having any noticeable impacts on pollution levels? Let's see.

Before we really get started, it is worth recognizing the relevant improvements in automobile technology over the last few decades. Most of the credit goes to the development and installation of catalytic converters, which reduce the emission of noxious by-products such as carbon monoxide, hydrocarbons, and nitric oxides (NOx) by something like 90%. The Los Angeles basin has certainly benefited from the adoption of this technology; air quality these days is far superior to that of the 1960s and 1970s even though there are many more vehicle miles per day. That being said, cars still produce NOx among other pollutants, and so we thought it might be interesting to look at recent data and see how levels compare with those before we were all hunkering down. Credit is given here to Lynda Mapes of the *Seattle Times*, who brought up the subject during a recent interview.

The data we use here was extracted from the application maintained by the Puget Sound Clean Air Agency at the following web site: https://secure.pscleanair.org/airgraphing. The two locations for which NOx data are available are Seattle (10th and Weller) and Tacoma (S 36th). In a way it is too bad there is not another more pristine location for comparison, but so be it. Of course Seattle and Tacoma are places where the effects of automobiles, and associated impacts of changes in use, should be more evident.

One way to gauge the typical effects of automobile traffic on NOx concentrations is to consider how NOx values vary with time of day, using past hourly data. Towards this end, we grabbed the data from the last week of March 2019. This period was generally warmer than what the region has experienced in late March of 2020, but it did include a couple of days with measurable rain, and hopefully it is representative of typical NOx conditions during the time of year. The average concentrations of NOx at Tacoma and Seattle as a function of time of day for the period of 25 March through 1 April 2019 are plotted in Figure 5. The record from both stations features a peak early in the day, specifically 8 AM local time in Tacoma and 11 AM in Seattle. We interpret these peaks due to the enhanced emissions accompanying the morning rush hour; we have no explanation for the difference in timing save that it is liable to relate to local effects such as winds, mixing heights, and station siting. We reckon that the greater atmospheric mixing causes the declines over the course of the afternoon found for both locations. Minor bumps show up at 6 PM in Tacoma and 5 PM in Seattle. We also looked at the daily peaks in NOx at the Seattle station over the last week of March and first week of April of 2019 (not shown). Over that period, 11 of the peaks occurred in the morning, and 3 occurred from 1 PM to 7 PM. The important point here is that

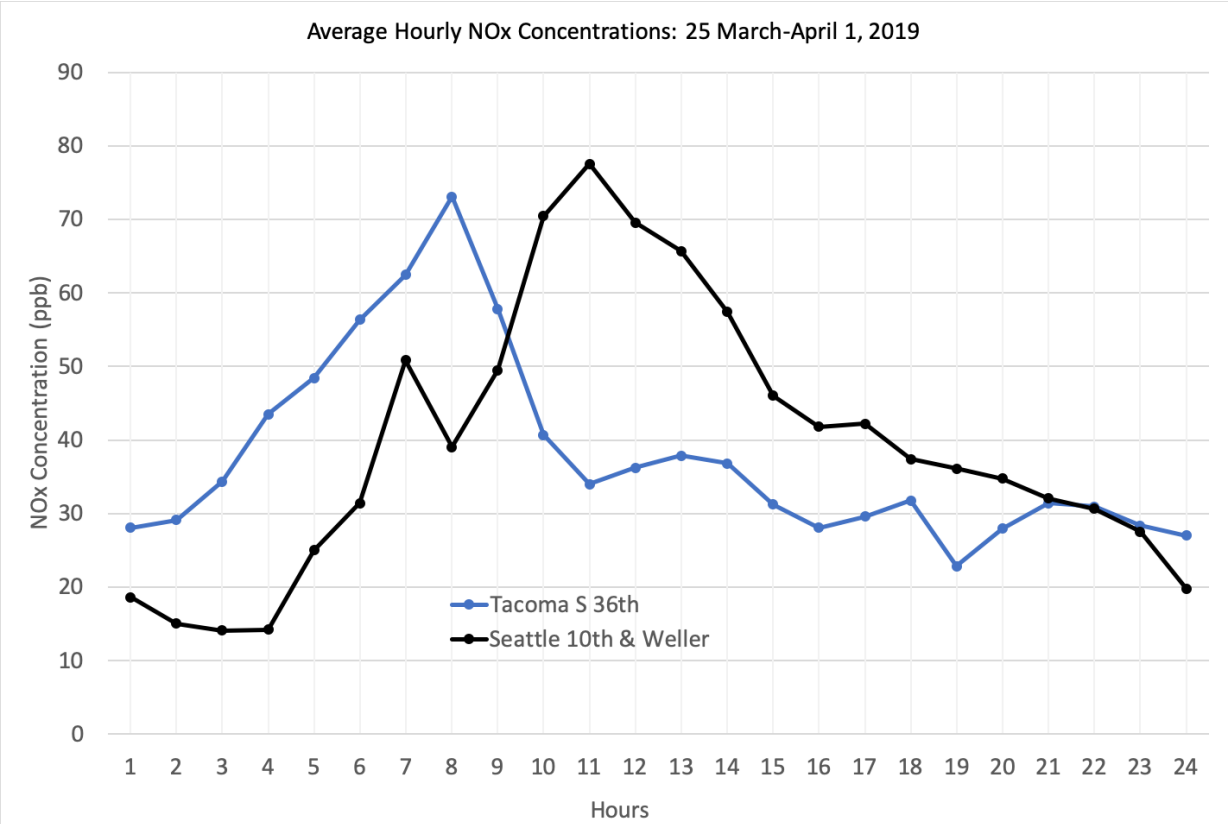


Figure 5: Average hourly NOx concentrations (ppb) for Seattle and Tacoma for the week of 25 March through 1 April , 2019 (from PSCAA).

NOx concentrations in the higher population areas of the Puget Sound region are reduced during the evening and late night hours when traffic is lighter.

Given that cars impact NOx levels, has there actually been a reduction in recent days? You can see for yourself in the time series of daily mean NOx concentrations at the two stations in Tacoma and Seattle for the month of March 2020 plotted in Figure 6. The last week of the month has included generally lower values, and a slight decreasing trend in NOx is apparent if you squint at the plot, but there has not been that much of a decline. It may be too soon to tell if our sheltering in place has made much difference in air quality. There is inherent variability in day to day mean values having to do with the local weather. For example, the high values from 17 through 20 March coincided with a period of relatively low wind speeds. There were especially high concentrations during the early morning of those days; the pollutants emitted those days must have been trapped within a shallow layer near the surface to a greater extent than usual. As an aside, carbon monoxide (CO) concentrations from the Seattle station (not shown) have varied in a similar way to NOx over the month of March 2020. Lots of us are trying to cope with cabin fever by walking, running, and biking in our neighborhoods, and while it is by no means a saving grace, at least there is some hint that the air quality could be improved in urban areas in the coming weeks.

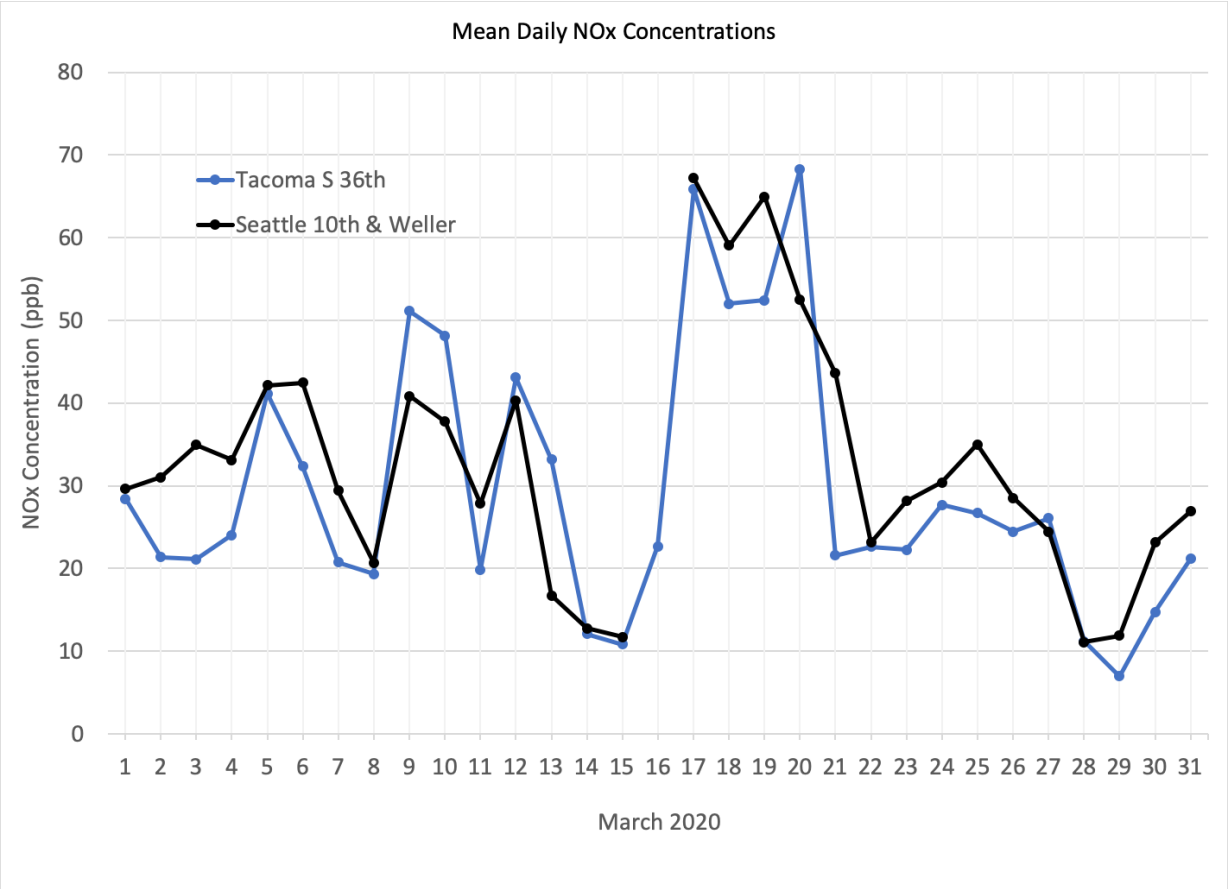
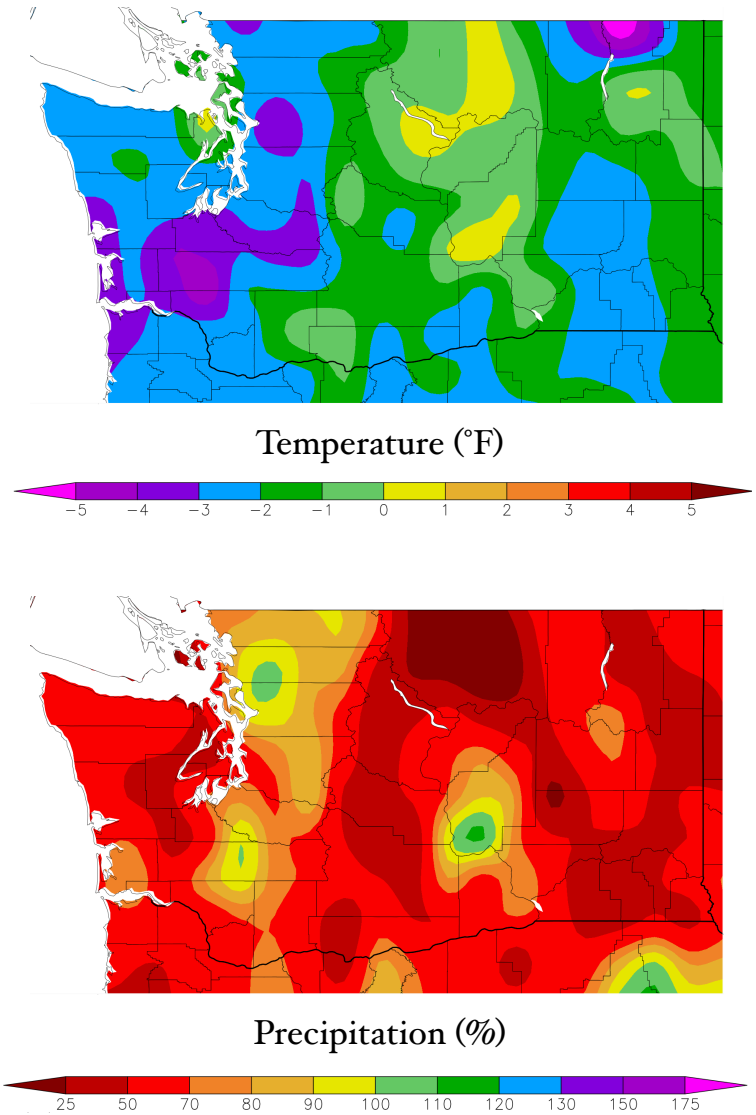


Figure 6: Mean daily NOx concentrations (ppb) for Seattle and Tacoma for March 2020 (from PSCAA).

Climate Summary

Mean March temperatures were near to or below normal for the entire state according to the map from the High Plains Regional Climate Center. Below normal temperatures dominated areas west of the Cascade crest with temperatures between -2 and -5 °F below normal. The cold anomaly in the western portion of Lewis county has March temperatures between -4 and -5 °F below normal. Nearby stations in Vancouver and Hoquiam captured the periphery of this anomalous low with average temperatures ringing in at -3.2 and -3.0 °F below normal, respectively (Table 2). East of the Cascades, temperatures were slightly below normal except for the Okanogan Valley south to Hanford where temperatures were near-normal; for example, Omak and Hanford had anomalies of +0.4 °F and +0.3°F, respectively (Table 2). The coldest temperature anomaly in NE Washington should be viewed with caution as only a single station reported such a cold anomaly.

Most areas statewide recorded below normal precipitation for March, with totals between 50 and 70% of normal. Central Puget Sound into Whatcom county had closer to normal precipitation with 92% of normal reported in Bellingham and 96% of normal at the Seattle WFO. Another bull's eye of near-normal precipitation is located near the middle of the state with 91 and 82% of normal precipitation measured at Hanford and Ephrata, respectively, but this accounted for only 0.5" of rain. The statewide low anomaly with respect to normal occurred in the Okanogon Valley. Omak observed a mere 0.04" of rain or 3% of their normal March precipitation. While most lowland observation sites on the west side of the state saw small amounts of snowfall, sites in eastern Washington recorded above normal snowfall from the cold system that passed through on March 13th-14th. This snow event brought 6.4" of accumulation to Spokane when normal March snowfall is 3.5".



March 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)			Snowfall (inches)		
	Avg	Norm	Departure from Normal	Total	Norm	% of Norm	Total	Norm	% of Norm
Western Washington									
Olympia	42.1	44.5	-2.4	3.35	5.29	63	M	0.7	M
Seattle WFO	44.6	46.6	-2.0	3.38	3.51	96	0.0	0.0	-
SeaTac AP	44.8	46.5	-1.7	3.17	3.72	85	0.0	0.8	0
Quillayute	41.1	44.1	-3.0	7.42	10.83	69	0.0	0.7	0
Hoquiam	42.8	46.0	-3.2	4.48	6.99	64	0.0	0.0	-
Bellingham AP	42.6	44.2	-1.6	2.96	3.22	92	0.0	0.7	0
Vancouver AP	45.8	48.0	-3.2	2.55	3.57	71	M	M	-
Eastern Washington									
Spokane AP	38.7	40.2	-2.5	0.81	1.61	50	6.4	3.5	183
Wenatchee	42.8	44.1	-1.3	0.41	0.64	64	M	M	-
Omak	41.9	41.5	0.4	0.04	1.19	3	M	M	-
Pullman AP	38.6	40.6	-2.0	1.17	2.05	57	M	M	-
Ephrata	42.0	43.0	-1.0	0.56	0.68	82	M	M	-
Pasco AP	45.9	46.3	-0.4	0.49	0.79	62	M	M	-
Hanford	46.8	46.5	0.3	0.52	0.57	91	1.4	0.4	350

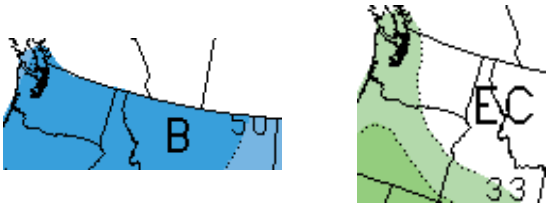
Table 2: March 2020 climate summaries for locations around Washington with a climate normal baseline of 1981-2010. Note that the Vancouver Pearson Airport and Seattle WFO 1981-2010 normals involved using surrounding stations in estimating the normal, as records for these station began in 1998 and 1986, respectively.

Climate Outlook

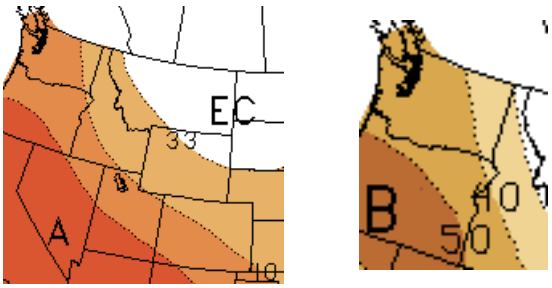
According to the Climate Prediction Center (CPC), neutral ENSO conditions continue to persist in the equatorial Pacific. Slightly above normal sea-surface temperatures (SSTs) exist across the entire basin, but the warmest anomaly positioned near the international dateline has cooled since the last OWSC newsletter. ENSO neutral conditions are expected to persist through the spring and summer. Forecast models have about a 65% chance of ENSO neutral conditions continuing through the spring dropping down to about a 55% chance for an ENSO-neutral summer.

The CPC April outlook shows increased chances of below normal temperatures for the entire state. This outlook has higher chances of below normal temperatures than the previous outlook issued by the CPC on March 19th. As for precipitation, the outlook shows slightly increased chances of above normal precipitation for the western half of the state, and equal chances of above, below, or normal precipitation for the eastern half of the state.

The CPC April-May-June (AMJ) outlook shows increased chances of above normal temperatures for the entire state. The outlook has only a slight chance of increased temperatures for the northeast quarter of the state. The precipitation outlook follows suit to the temperature outlook giving increased chances of below normal precipitation for the entire state with a slightly lower chance for the northeast quarter of the state.



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



April-May-June outlook for temperature (left) and precipitation (right)

(Climate Prediction Center)