Office of the Washington State Climatologist

November 2019 Report and Outlook

November 8, 2019 http://www.climate.washington.edu/

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October Event Summary

Mean October temperatures were much below normal statewide, ranking as the 2nd coldest October (-4.0°F below 1981-2010 normal) on record for WA. The coldest October occurred in 1905 so it has been quite some time since temperatures have been this cold so early in the water year. Many individual stations in eastern WA recorded their coldest October on record; Table 1 includes several examples, along with the record length. October precipitation was near to above normal in some locations and below normal in others. These differences essentially average out, resulting in a near-normal precipitation total for WA as a whole.

The month began on a quiet note until the second week, when temperatures were much colder than usual due to anomalous northerly flow over the state. Figure 1 shows the below normal maximum daily temperatures for SeaTac Airport at this time, with near-record minimum temperatures. On the 8th, Spokane received some additional early season snow, with 3.3" and then another 0.3" on the 9th, both daily record snowfalls. Stevens Pass and Snoqualmie Pass received snow on the 8th as well. On the 9th, record low daily temperature records were set at Olympia (26°F), Quillayute (29°F), and Hoquiam (34°F). More occurred east of the Cascades on the 10th, with Yakima (21°F), Ephrata (25°F), Wenatchee (27°F), and Walla Walla

Station	October Average Temperature (°F)	Rank	Records Began
Spokane AP	42.3	1	1881
Holden Village	37.4	1	1962
Chewelah	39.9	1	1926
Ritzville	42.7	1	1917
Ephrata AP	45.8	1	1949
Wenatchee AP	45.5	1	1960

Figure 1: Several eastern WA stations that recorded their coldest October on record.

(30°F) all setting daily low minimum temperature records.

A wet period for most of the state occurred from the 16 through the 22nd. In terms of records, some eastern WA locations recorded maximum daily precipitation records on the 19th: Wenatchee (0.30”), Ephrata (0.41”), Walla Walla (0.63”), and Pullman-Moscow AP (1.19”). West of the Cascades, an impressive 5.08” fell at Quillayute on the 21st and 1.87” in Bellingham (daily records). The heavy rain on the 21st produced flooding on many western WA rivers. There was a log jam on the Snohomish River that caused intermittent closures on Highway 2 for days after the flooding while the logs were cleared out below (KOMO; Seattle Times).

Despite the cold weather of October 2019 in an overall sense, a few high temperature records were set. On the 25th, Wenatchee (72°F), Yakima (75°F), and Pasco (76°F) set daily record maximum temperatures. But the month ended on a cold note, with a record “trace” of snow on the 28th at Quillayute and more record low minimum temperatures set at Pullman-Moscow AP (13°F), Ephrata (13°F), and Walla Walla (19°F) on the 29th.

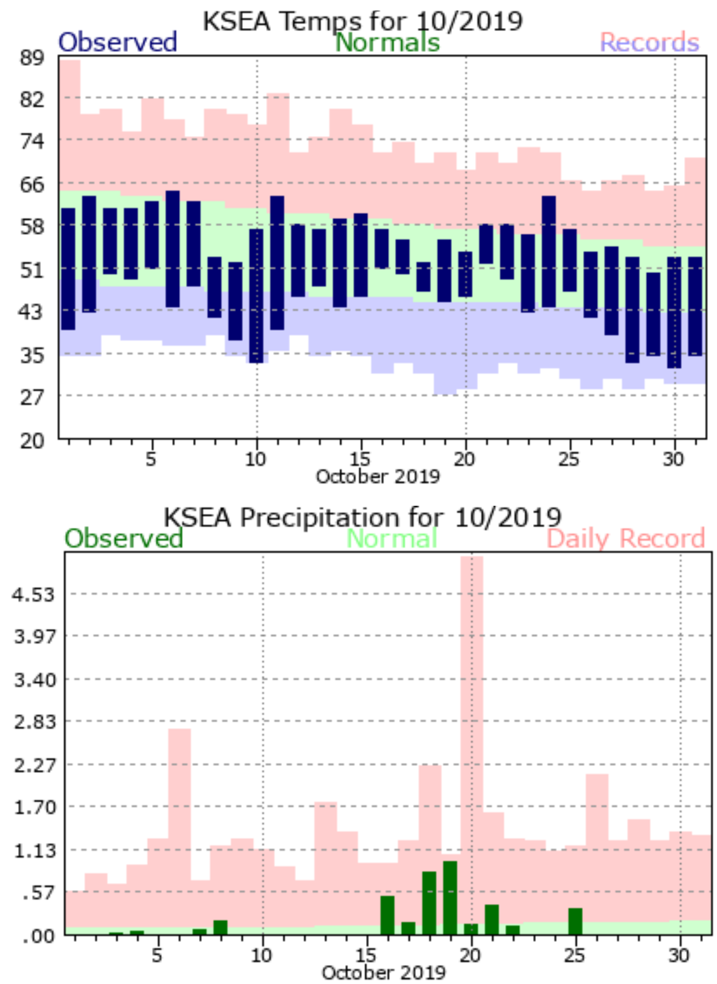


Figure 1: Daily October (top) maximum and minimum temperatures and (bottom) total precipitation for SeaTac Airport compared to normal (green envelope) and historical records (red and blue envelopes). NWS

Drought and Streamflow Update

Cooler than normal October conditions and above normal precipitation on the 60-day time scale helped justify further improvements to the U.S. Drought Monitor (Figure 3) since our last newsletter was published. WA is now virtually drought-free, with "abnormally dry" - D0 - conditions remaining only for a small area in the San Juan Islands. Monthly October streamflows (Figure 4) were also back up into the normal range, with even some "much above normal" for the month due to some heavy rain events.

The state drought declaration remains in effect for the 27 watersheds as declared in April and May of this year. Whether the drought declaration will be allowed to run out to its designated deadline or ended early remains to be seen. The deadline for emergency drought relief grant applications expired on October 2.

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 has developed a Drought Impact Reporter that allows the public to enter their observations regarding crops, water supply, fire, etc. in a short survey and we would appreciate your input.

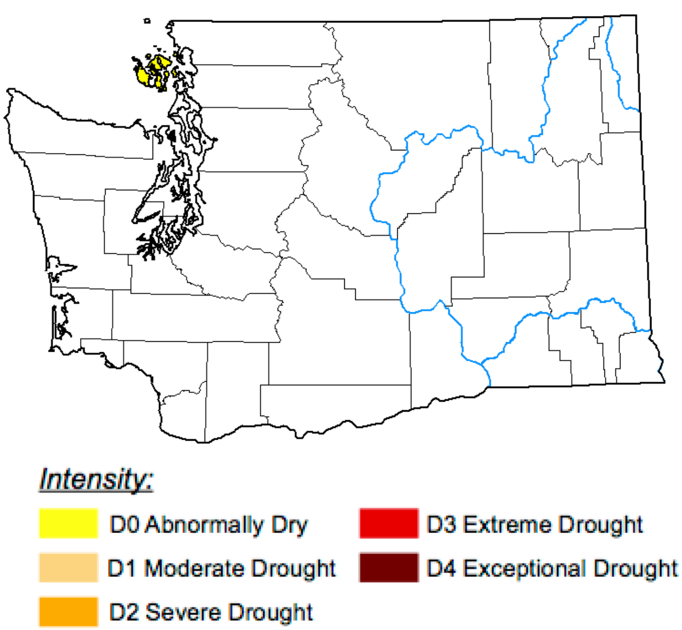


Figure 3: The 7 November 2019 edition of the U.S. Drought Monitor.

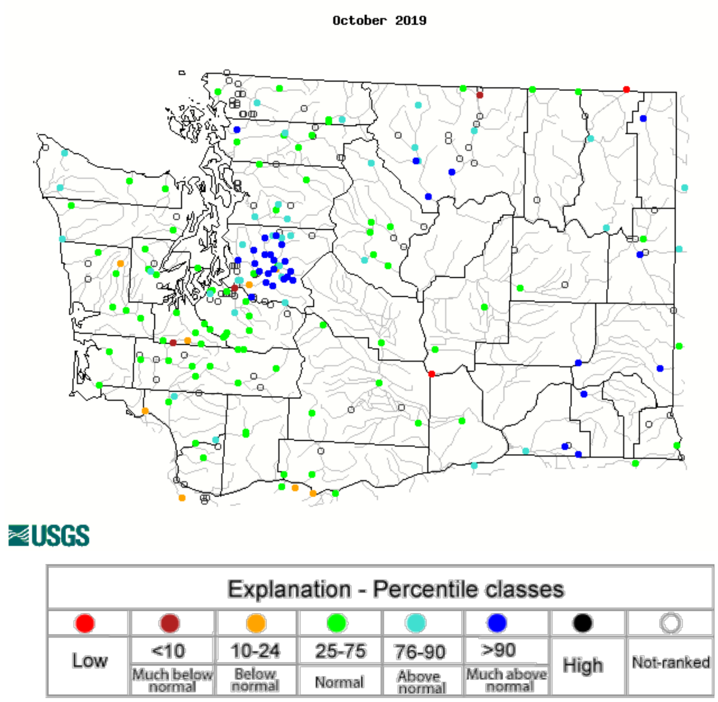


Figure 4: Average October streamflow (USGS).

Easterly Flow in the Passes of the Washington Cascades

A message from the State Climatologist

The Summit at Snoqualmie Pass has the lowest base elevation (2,840') of any ski resort in the western US. Given its low elevation and proximity to the Pacific Ocean and hence maritime air masses – the mean 850 hPa flow during winter is from the southwest at about 5 m/s – how is it cold enough to stay in business? The answer is no big secret, but then again, people are born every day that do not know why. The title of this piece is a giveaway and that is the common occurrence of easterly flow. During the winter, there is a tendency for lower pressure on the west side of the Cascades, the down-gradient flow that results draws relatively cold air from the interior of WA state through the Cascade Passes and locally lowers freezing levels. But that is by no means always the case during winter; the Cascades can also be subject to bouts of milder conditions and rain on the ski slopes (yuck!). How large are the variations from winter to winter in the extent of cold, easterly flow in the passes? Are there any long-term trends in this aspect of the winter weather of WA state? Here we take a crack at these questions.

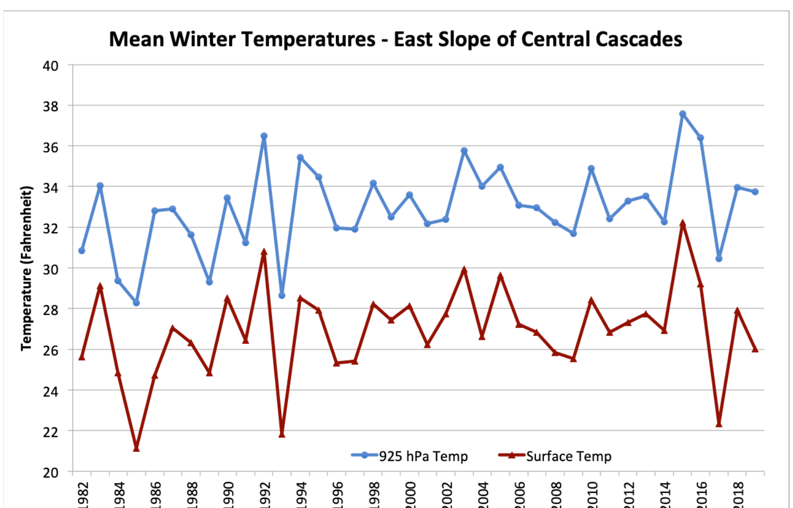


Figure 5: Mean winter (Dec-Feb) temperatures (Fahrenheit) at 47.5°N, 120°W at 925 hPa from MERRA (blue) and for WA Climate Division #6 (red) for the years of 1981-82 through 2018-19.

Our quick look into this matter relies primarily on data from NASA's Modern-Era Retrospective analysis for Research and Applications (MERRA) atmospheric reanalysis. We generally use the NCEP/NCAR Reanalysis for describing regional circulation patterns. Here we chose to use MERRA because of its superior horizontal resolution; the model representing its backbone has an approximate resolution of 50 km, or about 4-5 times finer than its counterpart for the NCEP/NCAR Reanalysis. In particular, we have examined air temperature and zonal (east-west) wind profiles from MERRA at 6-hour intervals for the winters of 1981-82 through 2018-2019 at 47.5°N, 120°W, a location just north of Wenatchee, WA in the foothills on the east side of the Cascades. Surface temperatures for the East Slope Cascades Climate Division (#6) of WA are also considered.

We begin by examining winter (December through February) average temperatures at the 925 hPa level from MERRA at our reference point, along with the directly-observed surface temperatures in Climate Division #6, as shown in Figure 5. Not surprisingly, there is a strong correspondence between the two time series; the linear correlation coefficient between the two time series is ~0.91. More intriguing are that the surface temperatures are about 6°F colder than those from MERRA at the 925 hPa level, which is at an altitude of about 2700' or very roughly 1000-1500' above the mean elevation of Division #6. In other words, it makes sense that air temperatures in Snoqualmie Pass, and for that matter the other Cascades passes, are relatively cold when the chilly air near the surface is forced up the east flank of the Cascades and through the gaps in the terrain. While the 38-year record is rather short to say anything meaningful about long-term trends, fitting lines to each series indicates an overall increase of about 2.8°F in the 925 hPa free air temperature and about 1.8°F in the surface temperature, with plenty of year to year fluctuations. OK, the climate is warming...but what about the frequency of east winds keeping the passes cold?

Measures of the overall duration of east winds each winter from 1981-82 to 2018-19 for our reference point has been determined using MERRA. More specifically, we counted up the number of hours for which the winds at 900 hPa had an easterly component **and** the temperatures at the 925 hPa were below 0°C. We also counted the number of hours for which these conditions were met **and** the temperatures at 850 hPa were warmer than -2°C. These are situations with a statically-stable temperature profile and the potential (but by no means the guarantee) for multiple freezing levels and freezing rain. The latter conditions are no picnic for folks out for some winter recreation, and a real headache for the WA State Department of Transportation from a road safety perspective. Seasonal totals for the two categories of east winds are plotted in Figure 6. Note the large year-to-year swings in the measures chosen to characterize the duration of east winds in the central Cascades. As an aside, the years with more east winds are not that snowy. For example, the winter of 1998-99 had the lowest duration of cold easterlies; this winter featured a strong La Niña and the highest total snowfall at Snoqualmie Pass, and record snowfalls elsewhere, notably at the Mt. Baker Ski area. The correlation coefficient between the duration of easterly flow (top trace in Fig. 6) and the total snowfall at Snoqualmie Pass is about -0.4. This stands to reason in that big snow dumps in the Cascades generally occur with northwesterly flow. But back to the question posed above: Figure 6 indicates that the trends in duration of easterly flow over the 38-year record considered are negligible, at least with respect to the measures used here. The bottom line is that the central Cascades still seem to be experiencing about as many hours of cold, easterly flow during winter as they were a few decades ago. That being said, we are expecting the tendency for those east winds to be not as cold in future decades, simply because of continued warming of near-surface temperatures east of the Cascades.

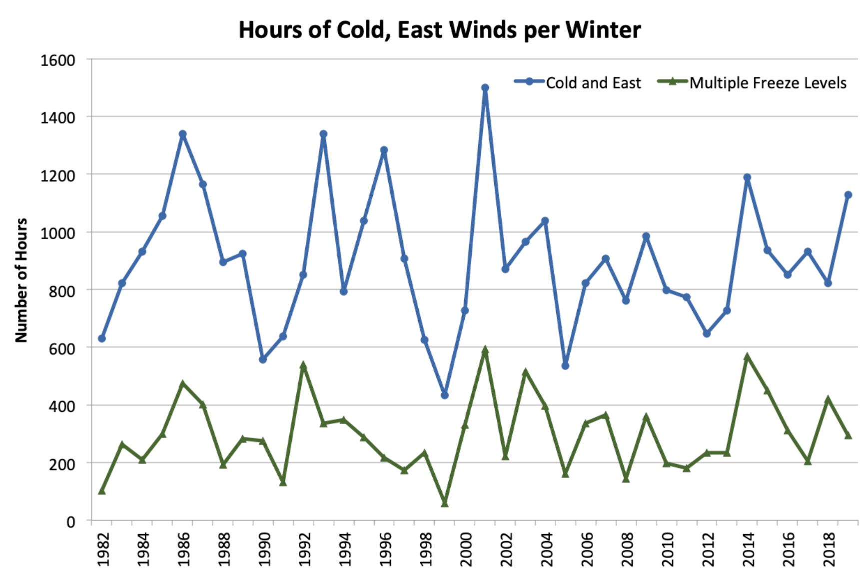
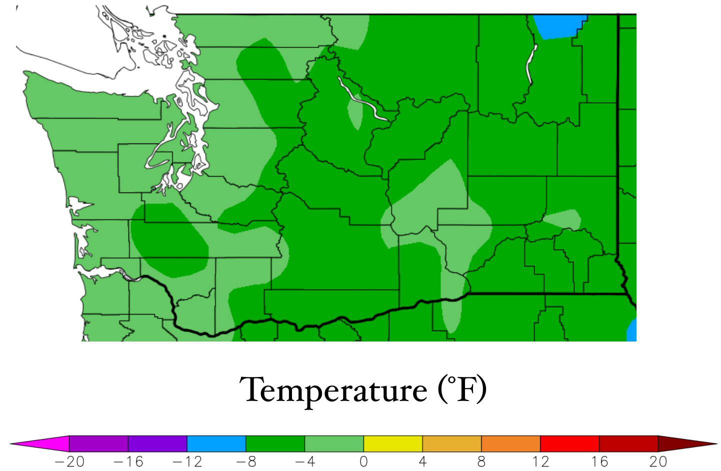


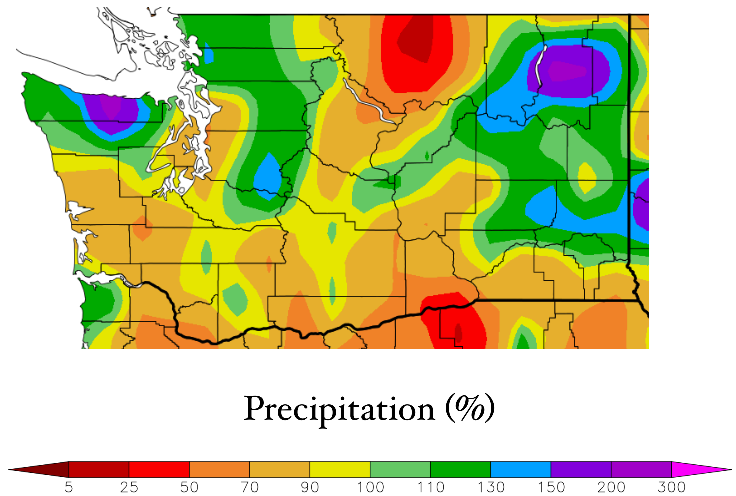
Figure 6: Total duration in hours of cold, easterly flow at 47.5°N, 120°W from MERRA (blue) and for that subset of hours including air temperatures greater than -2°C at 850 hPa (green). See text for details.

Climate Summary

Mean October temperatures were much colder than normal throughout the state, as highlighted in the opening of this newsletter. According to the High Plains Regional Climate Center map on the right-hand side, temperatures were between 4 and 8°F below normal in eastern WA. Of the locations listed in Table 2, temperatures were between 3.2 (Pasco) and 5.4°F (Wenatchee) below normal. Temperature anomalies west of the Cascade Mountains were not as large, but still about 2-3°F colder than normal.

Total precipitation values as percentages of normal varied across WA. Parts of the Olympic Peninsula, northern Puget Sound, central Cascades, and northeastern and eastern WA had near-normal to above normal precipitation. Bellingham Airport and Pullman received 123 and 142% of normal precipitation, respectively, for example (Table 2). Other locations, such as southeastern WA, the central Puget Sound, north central WA, and the Yakima basin received below normal precipitation though. Vancouver and Pasco, for example, only received 65 and 74% of normal precipitation, respectively. Some light amounts of snow (mostly traces) occurred at a few lower elevation stations around the state, with Spokane Airport being the big winner with a total of 3.6" (Table 2).





October 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	46.9	50.3	-3.4	5.26	4.60	114	0	0.0	-
Seattle WFO	50.9	53.3	-2.4	2.61	3.41	77	0	0.0	-
SeaTac AP	50.8	52.8	-2.0	3.67	3.48	105	0	0.0	-
Quillayute	48.0	50.0	-2.0	12.81	10.49	122	T	0.0	-
Hoquiam	49.9	52.2	-2.3	5.12	6.53	78	0	0.0	-
Bellingham AP	49.1	49.8	-0.7	4.53	3.68	123	0	0.1	0
Vancouver AP	50.1	53.8	-3.7	1.99	3.07	65	M	M	-
Eastern Washington									
Spokane AP	42.3	47.6	-5.3	1.53	1.18	130	3.6	0.1	3600
Wenatchee	45.5	50.9	-5.4	0.49	0.44	111	M	0.2	-
Omak	44.7	48.9	-4.2	0.37	1.08	34	M	M	-
Pullman AP	43.6	47.5	-3.9	1.90	1.34	142	M	M	-
Ephrata	45.8	50.5	-4.7	0.58	0.53	109	M	M	-
Pasco AP	48.7	51.9	-3.2	0.48	0.65	74	M	M	-
Hanford	48.2	53.1	-4.9	0.50	0.49	102	T	0.0	-

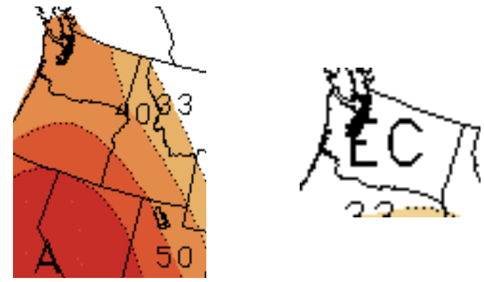
Table 2: October 2019 climate summaries for locations around Washington with a climate normal baseline of 1981-2010. Note that the Vancouver Pearson Airport and Seattle WFO 1981-2010 normals involved using surrounding stations in estimating the normal, as records for these station began in 1998 and 1986, respectively.

Climate Outlook

According to the Climate Prediction Center (CPC), neutral ENSO conditions are still present in the equatorial Pacific. Over the last month, sea surface temperatures (SSTs) in the central and eastern equatorial Pacific have increased, but neutral conditions remain. ENSO forecast models suggest a continuation of ENSO-neutral conditions through the fall and winter. For the December-January-February period, there is a 62% chance of neutral conditions compared to much lower chances of El Niño (29%) or La Niña (9%) development.

The CPC November temperature outlook calls for increased chances of above normal temperatures statewide. For precipitation, there are equal chances of below, equal to, or above normal November precipitation statewide.

The CPC November-December-January (NDJ) seasonal temperature outlook is also showing higher chances of above normal temperatures statewide, with the likelihood higher in southern Washington. Similar to the November outlook, precipitation is more uncertain, with equal chances of below, equal to, or above normal precipitation for the entire state.



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

November-December-January outlook for temperature (left) and precipitation (right)

([Climate Prediction Center](#))