Office of the Washington State Climatologist

December 2021 Report and Outlook

December 8, 2021 http://www.climate.washington.edu/

November Event Summary

Average November conditions can be summed up succinctly; temperatures were warmer than normal and precipitation amounts were above normal throughout Washington state. Average November temperatures rank among the warmest third in the historical record for much of WA. Moreover, November 2021 ranked among the top 10 warmest for a few stations. For example, Bellingham AP (6th warmest), Yakima AP (8th), Pullman (8th), and SeaTac AP (10th) all had November temperature rankings in the top 10. The warmest November on record for many of these stations is 2016. November precipitation ranked among the wettest third of the record for much of WA, with some stations in coastal and northwestern WA ranking higher (Table 1).

According to the Center for Western Weather and Water Extremes, there were 5 atmospheric river events that impacted WA in November, each bringing heavy precipitation to parts of WA. Figure 1 shows the daily temperature and precipitation for November at SeaTac AP. Note that there were 25 days of measurable precipitation at SeaTac, which ties a few other years (1953, 1963, and 1973) as the most on record.

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Station	Nov Precipitation (in)	Rank	Record	Records Began
Bellingham AP	14.57	1	-	1949
Friday Harbor	8.93	1	-	1998
Quillayute	27.56*	2	29.14"; 1983	1966
Hoquiam	17.23	4	21.17"; 2006	1953
SeaTac AP	10.26	5	15.63"; 2006	1945

Table 1: November 2021 precipitation and the ranking (wettest to driest) for selected WA stations. *2 days are missing from Quillayute.

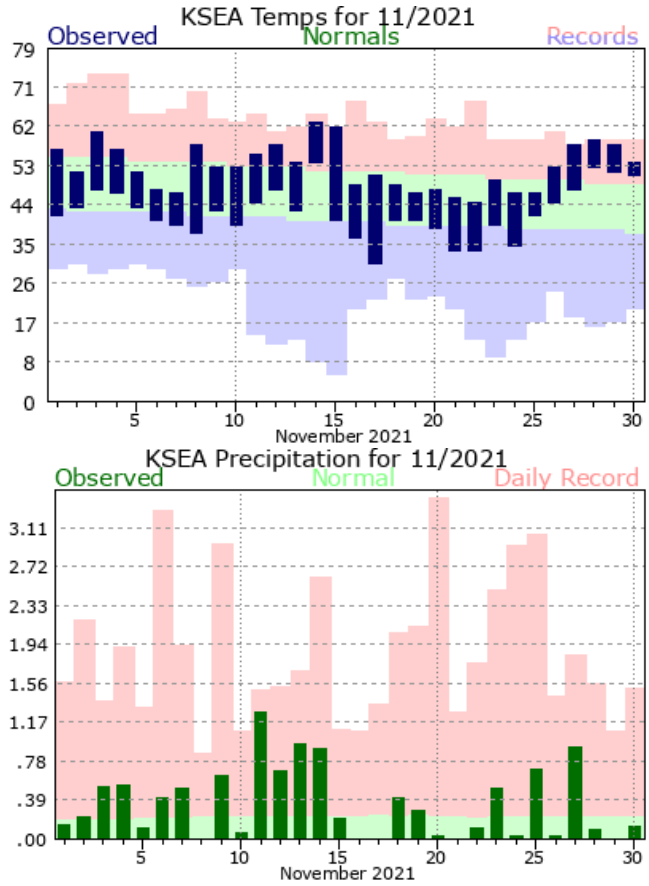


Figure 1: November 2021 daily temperature and precipitation for SeaTac Airport (NWS).

The heavy precipitation from the 1st of 5 atmospheric rivers began on the November 11, and the second came shortly thereafter on the 13th and continued to impact the state through the 15th. Along with setting maximum daily precipitation records (examples: Bellingham with 2.78" on the 14th and 1.89" on the 15th; Quillayute with 4.01" on the 15th), temperatures were extremely mild, with some daily high temperature records as well. For example, on the 14th, Yakima (72°F), Pasco (71°F), and Ellensburg (69°F) set daily high temperature records and more were set on the 16th at Yakima (67°F) and Ellensburg (64°F).

This period of warm weather with heavy precipitation caused major flooding on the Nooksack and Skagit Rivers as well as minor or moderate flooding on other rivers throughout western WA. Figure 2 shows flooding in downtown Bellingham from the City of Bellingham's drone footage. Mudslides were also reported, with one blocking I-5 near Bellingham on the 16th (KUOW). A landslide on Highway 112 and debris over 101 near Lake Crescent effectively cut off the Makah Reservation near Neah Bay on the 16th and 17th (Seattle Times). Figure 3 shows the gauge height for the Skagit River near Mount Vernon for November, illustrating two periods of flooding during the month.

Figure 2: Flooding on Iowa Street in Bellingham on November 15, 2021 (City of Bellingham).

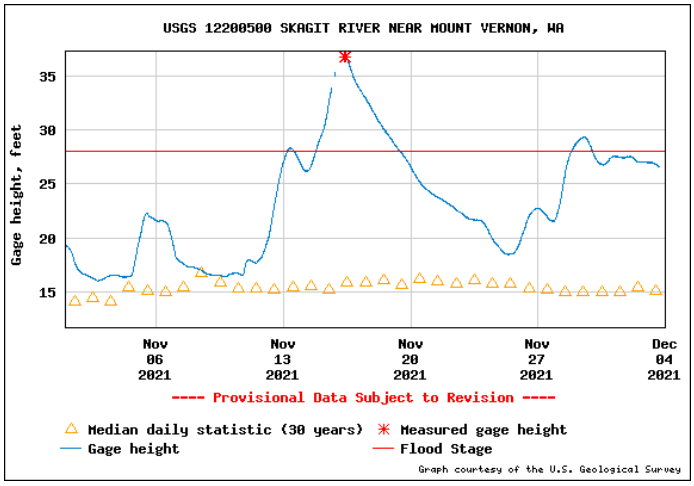


Figure 3: Gauge height (blue trace) for the Skagit River near Mount Vernon during November. The median flow is represented by the yellow triangles and flood stage is the red line (USGS).

The second period of heavy rain occurred from November 24 through the end of month. Figure 4 shows the integrated water vapor transport for the final 3 atmospheric rivers that occurred at the end of the month. Once again, daily maximum rainfall and high temperature records were set with additional flooding. For example, Quillayute (3.16") and Bellingham (1.43") set maximum rainfall records on the 25th. Daily high temperature records were set at Wenatchee (65°F), Walla Walla (65°F), Omak (62°F), Vancouver (62°F), SeaTac AP (59°F - tie), Olympia (58°F) and Spokane (56°F) on the 28th, with similar daily high temperature records in the 50s and 60s set on the 29th and 30th.

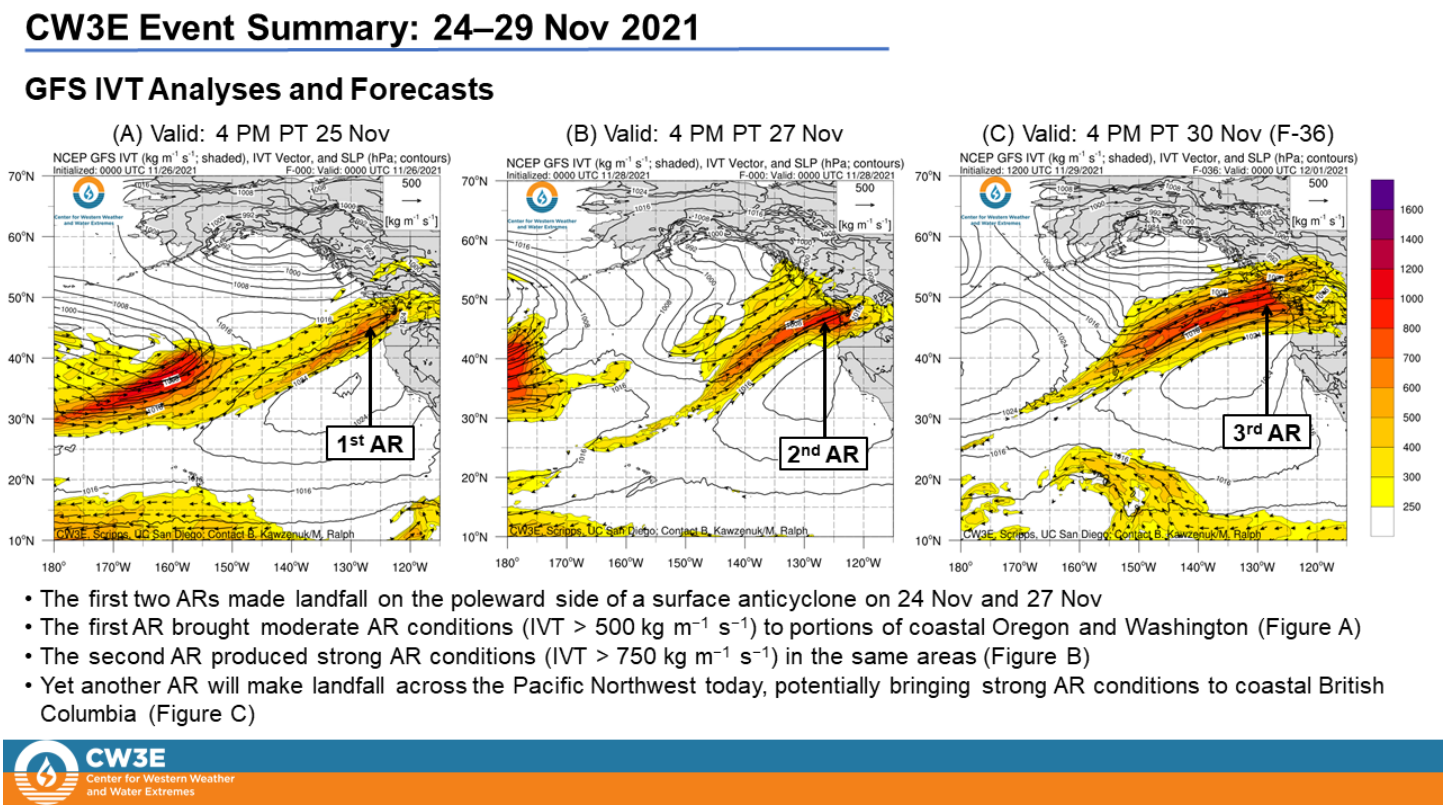


Figure 4: Maps of integrated water vapor transport for the 3 atmospheric rivers (ARs) that impacted WA from Nov 24-30 (Center for Western Weather and Water Extremes).

Snowpack and Drought Summary

The warm and wet November conditions did not bode well for snow in our mountains. The basin average snow water equivalent (SWE) percent of median from the Natural Resources Conservation Service (NRCS) as of December 1 is shown in Figure 5. SWE is below normal statewide. The North Puget Sound (82% of normal) and Upper Columbia (91% of normal) fared slightly better over the month, but the warm temperatures caused most of our precipitation to fall as rain rather than build as snow in the mountains. It is still early in our snow-building season, however.

Nevertheless, the above normal November precipitation resulted in improvements to the drought depiction on the U.S. Drought Monitor over the last month. Figure 6 shows the December 2 edition of the U.S. Drought Monitor with most of the "abnormally dry" conditions removed from western WA. The drought depiction in eastern WA was also slightly improved.

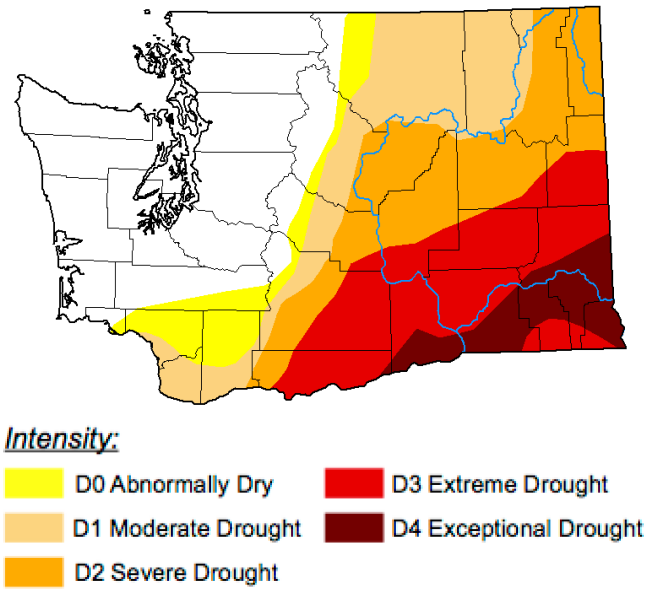


Figure 6: The December 2, 2021 edition of the U.S. Drought Monitor.

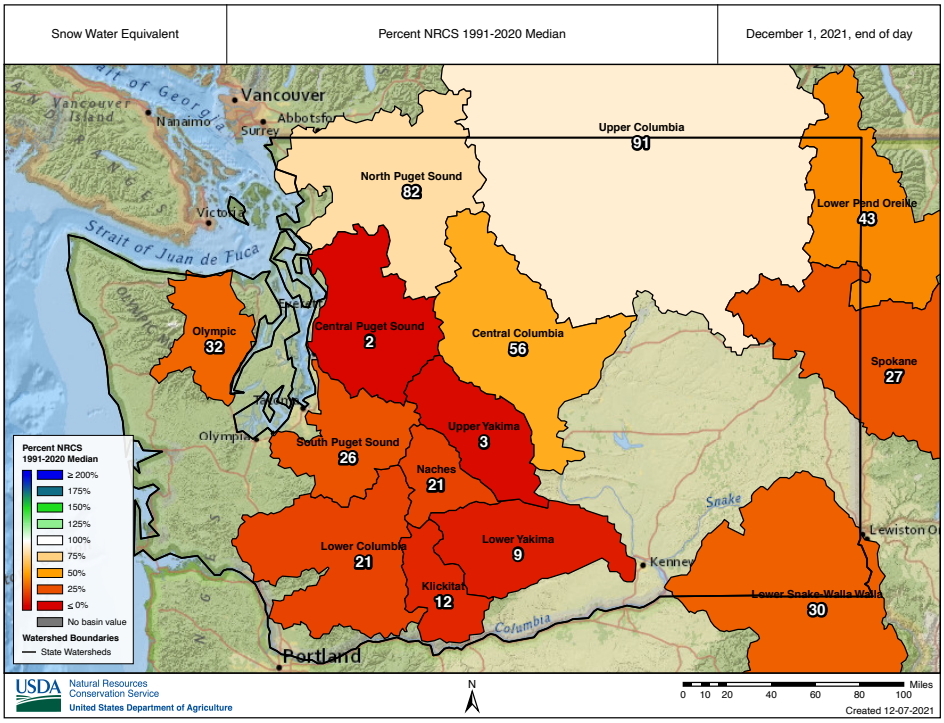


Figure 5: Snowpack (in terms of snow water equivalent) percent of median for WA as of December 1, 2021. The median is based on the 1991-2020 period (NRCS).

photo by Henry Reges, CoCoRaHS

Community, Collaborative Rain, Hail, and Snow (CoCoRaHS) Corner

Perhaps no one can appreciate how wet November was quite like Washington CoCoRaHS observers. Members of the CoCoRaHS network made 93 more observations in November compared to October, ending with a grand total of 11,122 observations. Some of these were contributed by the nine new members the network gained in November, who certainly joined us at a busy time. There was barely a dull moment in November, as a whopping 78% of observations recorded some amount of precipitation, up from 65% in October.

Some observers found something other than rain in their gauges! On November 19th, an observer hailing from Easton, WA recorded 7 inches of snow, enough for a proper snowball fight. Only a few other areas were nearly so lucky. The majority of stations reporting snow only reported a dusting of an inch or less – hardly enough to get excited over. Snow was the exception to the norm, though, and most of the state enjoyed plenty of rain alongs with their 4:30 PM sunsets. True to form, the highest one-day total for the month came from Forks, WA, with 6.67 inches of rain.

After a long summer of drought, many CoCoRaHS observers were grateful for the continued rainfall of November. Rural observers noted that aquatic life, plants, and birds seemed to welcome the influx of moisture. Some humans across the state, in contrast, were not so thrilled. One observer in San Juan County spoke of flooding and overwhelmed septic systems. Another observer hailing from Okanogan County noticed the above-average temperatures and worried about the winter recreation tourism that the area relies so much on.

Strong Winds in WA Over the Years

A Message from the State Climatologist

Daily temperature and precipitation data are available going back many years, and are generally used to summarize the variability in the climate, including long-term trends. There are other aspects of the weather and climate that are interesting and important, however, but are often more difficult to procure and are not widely disseminated. Here we consider the frequency of strong winds in three locations, based on hourly data, for the period of 1981 through 2020, using the slick app provided by the Midwestern Regional Climate Center. In particular, we have counted the number of hours per month for which the mean wind speed, and separately, the gust wind speed exceeded prescribed thresholds at Hoquiam (KHQM), SeaTac (KSEA), Tri-Cities (KPSC), and Spokane (KGEG). The results of this exercise are summarized below.

For starters, we consider the seasonality in the occurrence of strong winds, as gauged by the total number of hours of gust speeds exceeding 39 MPH during each month over the 40 years of 1981 through 2020. The results are plotted in Figure 7. It should come as absolutely no surprise that Hoquiam has the highest overall total, due to the storminess of the coastal zone from October through March. As a bit of an aside, Quillayute (KUIL) near the northwest corner of the state had far fewer (about one-fifth as many) hours with gust speeds of this magnitude, presumably because it is a few miles inland. Perhaps it is also no surprise that SeaTac is the least stormy spot, but the extent to which this is the case may not be well appreciated. Even in the more lively fall and winter seasons it only registers an hour or so a month on average with gust speeds of 40 MPH and higher. Seasonal cycles in high gust speed frequencies are evident but less pronounced at the Tri-Cities and Spokane locations. It is probably a fluke but the Tri-Cities ended up having the greatest total number of hours with strong gust speeds for the month of June.

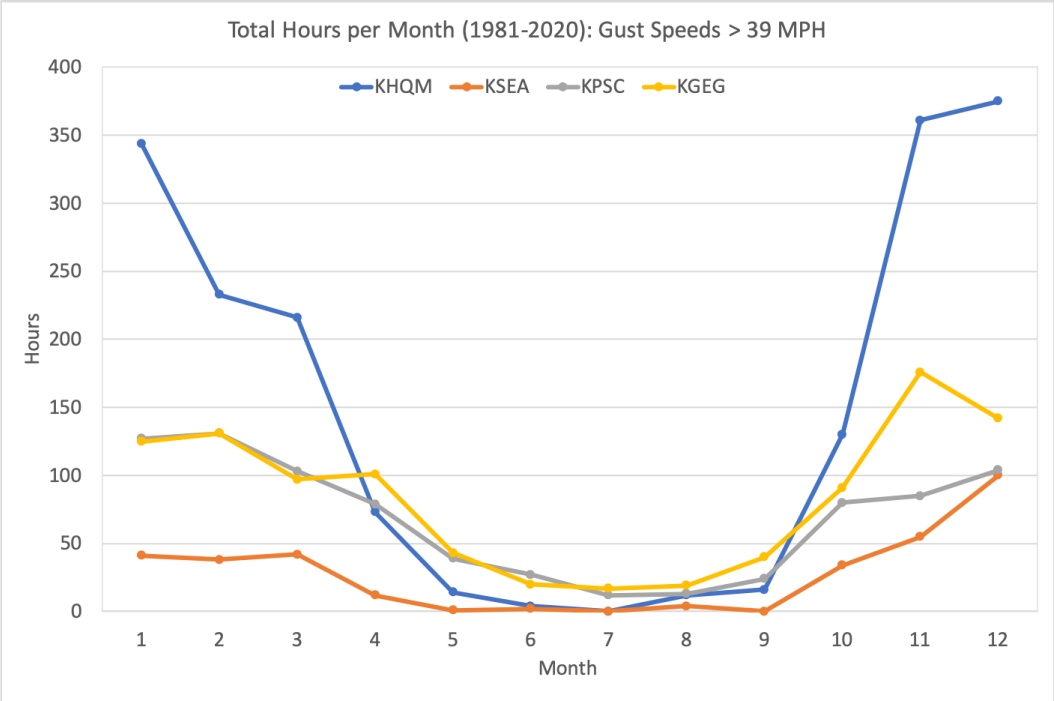


Figure 7: Total hours per month with wind gusts greater than 39 mph (1981-2020) for Hoquiam (KHQM), SeaTac (KSEA), Tri-Cities (KPSC), and Spokane (KGEG).

How have the number of hours with strong winds varied with time? The yearly totals of hours with mean wind speeds exceeding 29 MPH are

shown in Figure 8. The traces reveal a great deal of interannual variability, with stormy years having 10 to 20 times as many hours of high mean wind speeds as relatively calm years. With regards to long-term trends, Hoquiam and the Tri-Cities seem to be getting windier by the present measure but given the background variability, these trends may not be very robust (analysis of the statistical significance of these trends is beyond the scope of the present piece). Both SeaTac and Spokane appear to lack any sort of systematic change over the period of 1981-2021.

While we were at it, we thought it worthwhile to also count up the number of hours each year with gust speeds exceeding 39 MPH (Fig. 9). In many applications it is the maximum gust speeds that really matter in that the force of the wind is approximately proportional to the square of the wind speed, meaning that wind damage can often be attributed to the highest speed short-duration gusts rather than the lower velocity sustained winds. At least by eye, the time series of hours of strong gust speeds suggests greater upward trends than their counterparts for the hours of strong mean winds. How could this be? We wonder whether this may be attributable to changes in instrumentation and reporting practices. A period of modernization occurred during the early 2000s when cup anemometers were phased out and replaced by sonic anemometers. The former can be prone to the phenomenon "cup anemometer overspeeding" during periods of strong, turbulent winds, resulting in overestimation of mean wind speeds. Moreover, in past decades during which gust speeds were specified by human observers rather than continuous, high-frequency digital records, it is plausible that the strongest gust speeds could be missed. Additionally, without getting into the gory details, protocols for assigning gust speeds have evolved. The bottom line is that it is possible that the early part of the record considered here includes overestimates of the hours with high mean wind speeds and underestimates of the hours with high gust speeds, but that is speculation.

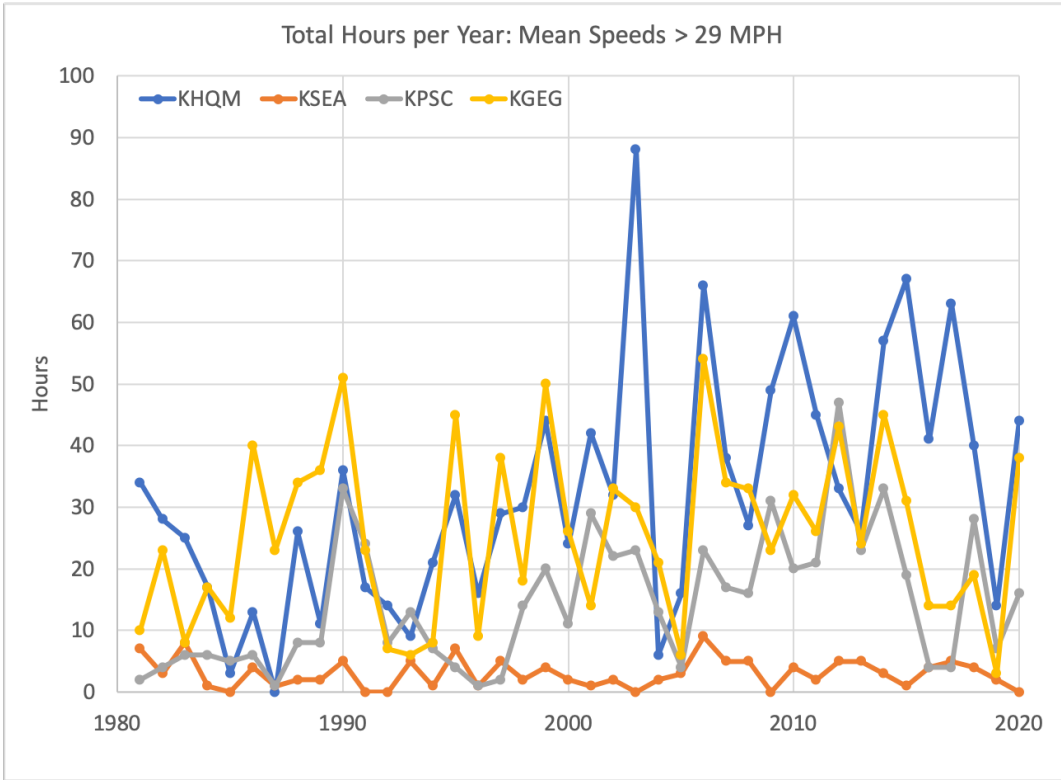


Figure 8: A time series of total hours per year (1981-2020) of mean winds greater than 29 mph for Hoquiam (KHQM), SeaTac (KSEA), Tri-Cities (KPSC), and Spokane (KGEG).

One possible interpretation of the results shown here is that Hoquiam has experienced

a real increase in the frequency of strong winds. But that conjecture may be tempered by the result from our examination of another aspect of the hourly data and that is the number of hours with sea-level pressure (SLP) reports of less than 992 hPa at Quillayute, assuming that landfalling storm systems account for most of the high winds. An upward trend in this measure is absent over the period of 1981-2020 (not shown). Given the inherent "noisiness" of the data sets considered here, a much more comprehensive analysis is required to say anything definitive about trends in windiness.

There are other topics related to strong winds that would seem worth pursuing. For example, how do periods of especially strong winds relate to periods of heaviest precipitation? Our greatest precipitation events tend to include brisk winds and vice versa, but their occurrences are not necessarily synonymous. If readers of this newsletter have any ideas about what should (and feasibly can) be looked into regarding hourly weather data from a climate perspective, we would like to hear about them.

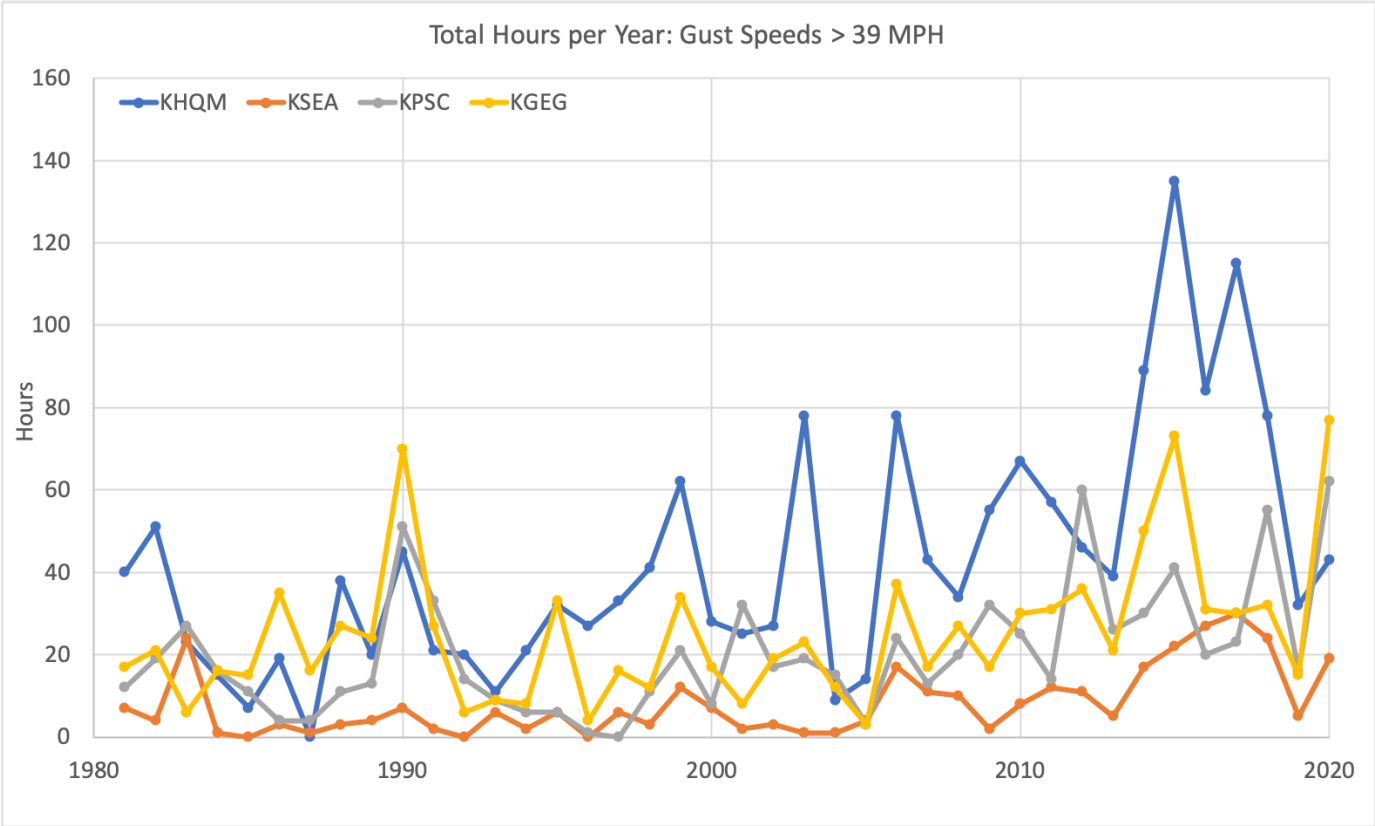
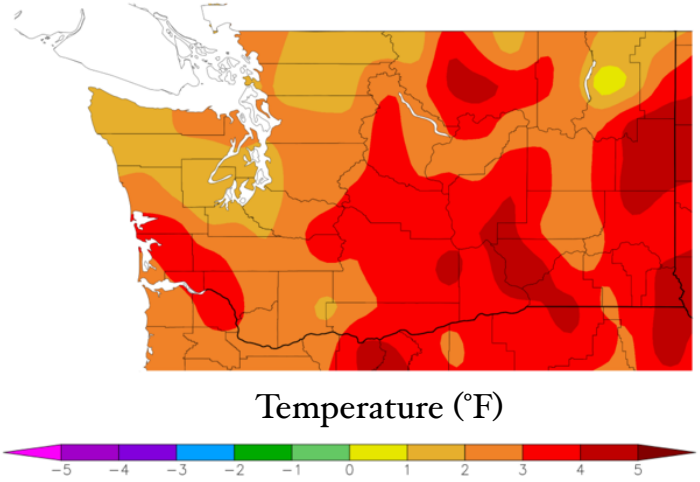


Figure 9: A time series of total hours per year (1981-2020) of wind gusts greater than 39 mph for Hoquiam (KHQM), SeaTac (KSEA), Tri-Cities (KPSC), and Spokane (KGEG).

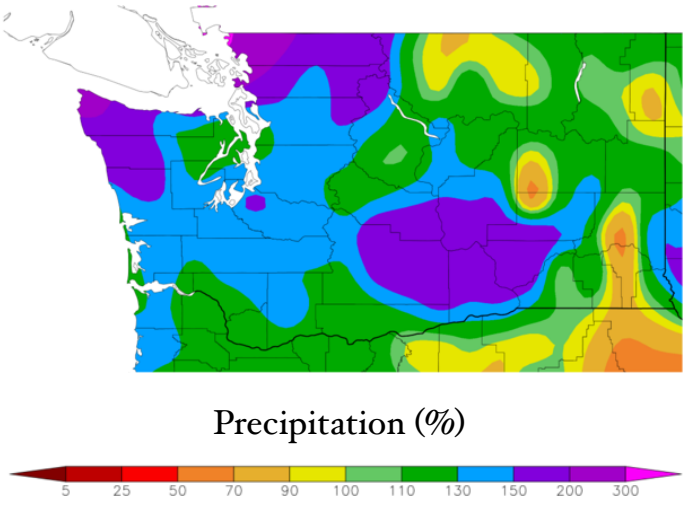
Climate Summary

Average November temperatures were above normal across the state. According to the map from the High Plains Regional Climate Center, western and northern Washington experienced temperatures between 1 and 4˚F above normal, though most locations in Table 2 are between 1 and 2.5˚F above normal. In general, eastern and southern Washington were slightly warmer, with temperature anomalies reaching up to 5˚F (Table 2). Spokane County and the area surrounding the city of Pasco had especially dense distributions of stations reporting temperatures greater than 4˚F above normal. Other notably warm stations relative to normal included Okanogan, Asotin, and Sunnyside.



November temperature (˚F) departure from normal relative to the 1991-2020 normal (HPRCC).

As temperatures were above normal statewide, so too were precipitation totals. Nearly the entire state saw between 100 and 200% of normal precipitation. Western and central Washington totals were decidedly above normal, while eastern Washington totals had some variation. The western tip of the Olympic Peninsula, Whatcom and Skagit Counties, and a large area between Yakima County and Franklin County recorded precipitation between 150 and 300% of normal. Two stations in the northern Puget Sound area, one in the San Juan Islands and one on the coast of Whatcom County, recorded precipitation over 300% of normal. Meanwhile, a few small areas near Okanogan, Pend Oreille, and Lincoln Counties, as well as the southeastern corner of the state, saw precipitation totals between 70 and 100% of normal.



November total precipitation percent of 1991-2020 normal (HPRCC).

Station	Mean Temperature (°F)			Precipitation (inches)		
	Average	Normal	Departure from Normal	Total	Normal	Percent of Normal
Western Washington						
Olympia	52.0	50.6	1.4	11.88	8.21	145
Seattle WFO	53.7	51.9	1.8	7.72	5.85	132
SeaTac AP	53.1	52.1	1.0	10.26	6.31	163
Quillayute	51.7	51.2	0.5	27.56*	15.26	181
Hoquiam	53.8	51.6	2.2	17.23	10.95	157
Bellingham AP	52.4	51.0	1.4	14.57	5.20	280
Vancouver AP	55.4	53.0	1.4	6.53	5.51	119
Eastern Washington						
Spokane AP	46.1	42.3	3.8	2.60	2.06	126
Wenatchee	47.7	43.8	3.9	1.31	0.85	154
Omak	47.1	43.0	4.1	1.72	1.24	139
Pullman AP	47.7	44.7	3.0	3.48	2.14	163
Ephrata	49.1	45.7	3.4	1.17	0.86	136
Pasco AP	55.2	49.9	5.3	1.46	0.87	168
Hanford	44.8	40.3	4.5	1.80	0.80	225

Table 2: November 2021 climate summaries for locations around Washington with a climate normal baseline of 1991-2020. *2 days are missing from the November precipitation total at Quillayute.

Climate Outlook

According to the Climate Prediction Center (CPC), La Niña conditions are present in the tropical Pacific Ocean, and a "La Niña Advisory" is still in effect. Over the last 4 weeks, sea surface temperatures (SSTs) in most of the equatorial Pacific Ocean have been decreasing further below average. SSTs near Indonesia in the western Pacific Ocean were warmer than average. La Niña conditions of moderate strength are expected to continue through the end of winter (90% chance for the Dec-Feb season). With less confidence, La Niña may persist into the spring (50% chance during the March-May season).

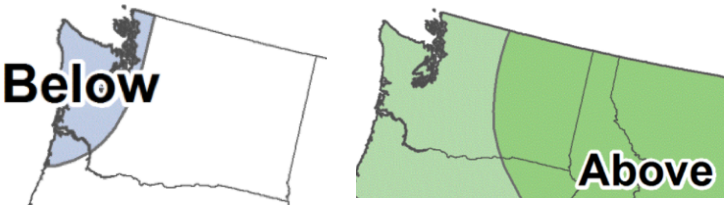


Figure 10: December outlook for temperature (left) and precipitation (right).

The CPC outlook for December (Figure 10) shows increased chances (between 33 and 40%) of below normal temperatures for western Washington. The eastern half of the state stands equal chances of temperatures above, below, or at normal for the month. In support of this outlook, the first week of December featured some cooler, if not frigid weather in WA, and there is little indication that we will revert back to the balmy temperatures of November anytime soon. The entire state is likely to experience higher than normal precipitation.

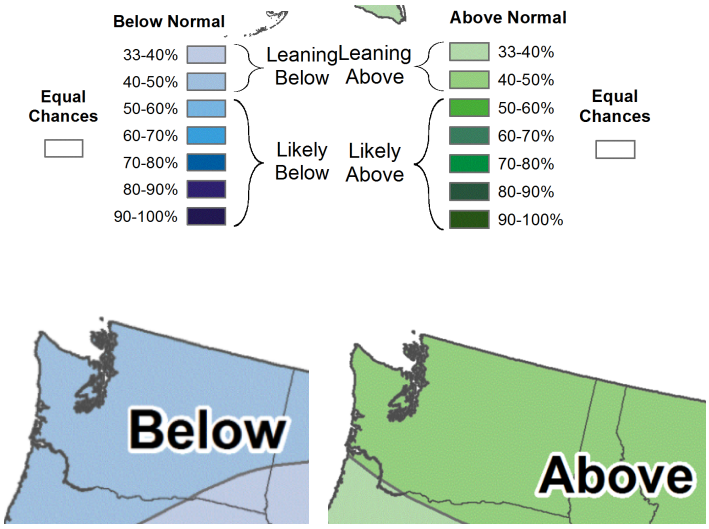


Figure 11: December-January-February outlook for temperature (left) and precipitation (right) (Climate Prediction Center).

The three-month outlook for December-January-February (DJF) shown in Figure 11 predicts below normal temperatures statewide, with chances between 40 and 50% for most of the state. The southeastern corner of the state is slightly less likely to see temperatures below normal, with chances between 33 and 40%. The entire state is forecast to see precipitation rates above normal, with chances between 40 and 50%.