Office of the Washington State Climatologist

March 8, 2016

February Event Summary

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Mean February temperatures were warmer than normal across the entire state. Precipitation, on the other hand, was divided across the Cascade Mountains with western WA receiving more than usual and eastern WA receiving less than usual. The wetter than normal February on the west side of the state helped set some rainfall near-records for December through February. Table 1 shows the total Dec-Feb precipitation for 6 western WA sites, the ranking (wettest to driest), and the period of record. SeaTac AP has seen its wettest December through February on record, while many other sites are within the top ten wettest. Bellingham is the notable exception; the drier than normal January drops the 2016 DJF ranking to 16th. Even considering eastern WA, the total DJF precipitation averaged statewide ranks as the 7th wettest winter on record, according to NOAA.

There are several notable weather events that occurred in February. While in general the month was drippy in western WA, there was a break statewide as a ridge of high pressure dominated the weather from the 6th through the 9th. This resulted in temperatures typical of late spring, with a daily record maximum temperature of 70°F at Quillayute on the 8th. Quillayute set another daily record high temperature the next day, with the thermometer reaching 73°F - which tied the all-time high temperature record for the entire month of February at that station. Olympia (66°F), SeaTac Airport (63°F), Bellingham (61°F), and Pullman (56°F) all recorded daily maximum temperature records on the 9th. Many of those prone to seasonal allergies could appreciate the impacts of the warm temperatures on tree pollen. This mild stretch turned into an extended period of fog caused by a temperature inversion in eastern WA beginning on the 10th, but western WA saw the return of rain.

Station	DJF Total Precip (in)	Rank	Records Began
SeaTac AP	24.54	1	1945
Arlington	24.77	2	1922
Hoquiam	38.39	5	1953
Quillayute	50.51	7	1966
Olympia AP	29.39	8	1948
Bellingham	14.76	16	1949

Table 1: Total December through February precipitation, the ranking (wettest to driest), and the period of record for selected western WA sites.

On the subject of rain, an atmospheric river event on the 15th brought heavy rain and minor flooding to western WA. Seattle was rain shadowed in comparison to some other western WA locations. Both Bellingham (1.64") and Quillayute (3.34") set daily maximum rainfall records for the 15th. Figure 1 shows the 24-hour precipitation observations ending the morning of the 16th in Grays Harbor and Mason counties. Finally, there was another warm and dry period on the 23rd to about the 25th, with more record daily maximum temperatures recorded on the 25th in western WA and the 26th in eastern WA.

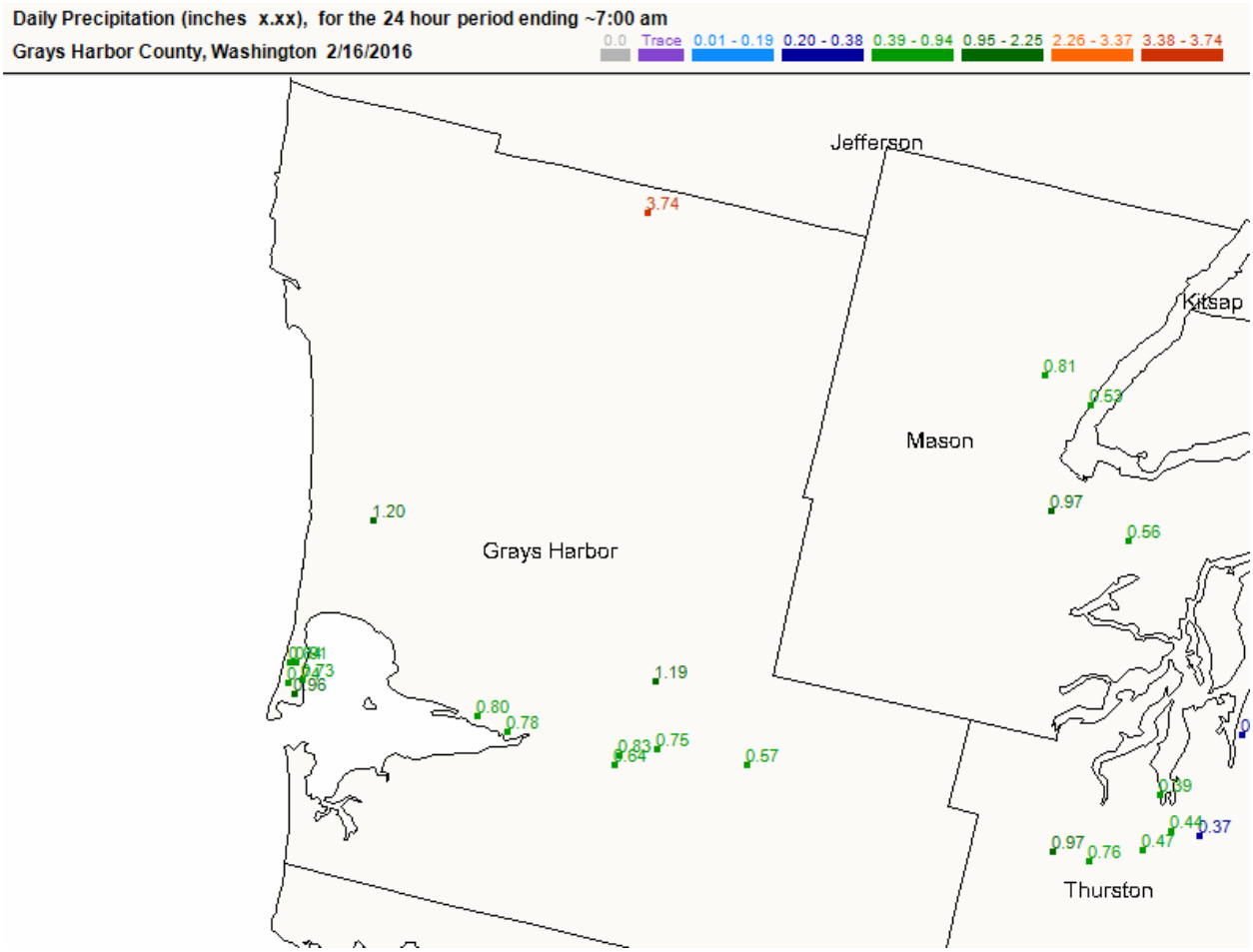


Figure 1: 24-hr CoCoRaHS (Community Collaborative Rain, Hail, and Snow network) observations on the WA coast ending between 7 and 9 am on February 16.

Snowpack and Drought Update

While the west slopes of the Cascade Mountains received above normal precipitation during February, many of those systems were warm, causing much of the precipitation to fall as rain rather than snow. As a result, there were some temporary losses in snow water equivalent (SWE) throughout February, but overall, SWE has increased through the month for most mid and high-elevation sites. The percentage of snow water equivalent relative to normal is lower in all basins as of March 1 compared to February 1 because the snow did not build quite as much as usual. Figure 2 shows the snow water equivalent (SWE) percent of normal

averaged for each basin in WA as of March 1 from the National Resources Conservation Service. The Upper Columbia and the Central Columbia have the most snowpack in a relative sense, with 119 and 114% of normal, respectively. The North Puget Sound, South Puget Sound, Upper Yakima, Lower Yakima, Lower Columbia, Olympic, and Lower Snake all have normal SWE, with values between 93 and 102% of normal. The Central Puget Sound and Spokane basins are a little lower, with 88 and 87% of normal, respectively. Even though eastern WA was on the drier side during February, there were some slight improvements to the depiction of drought conditions in WA since the last newsletter (Figure 3). The D0 designation was removed from some parts of eastern WA, supported by some of the longer-term indicators.

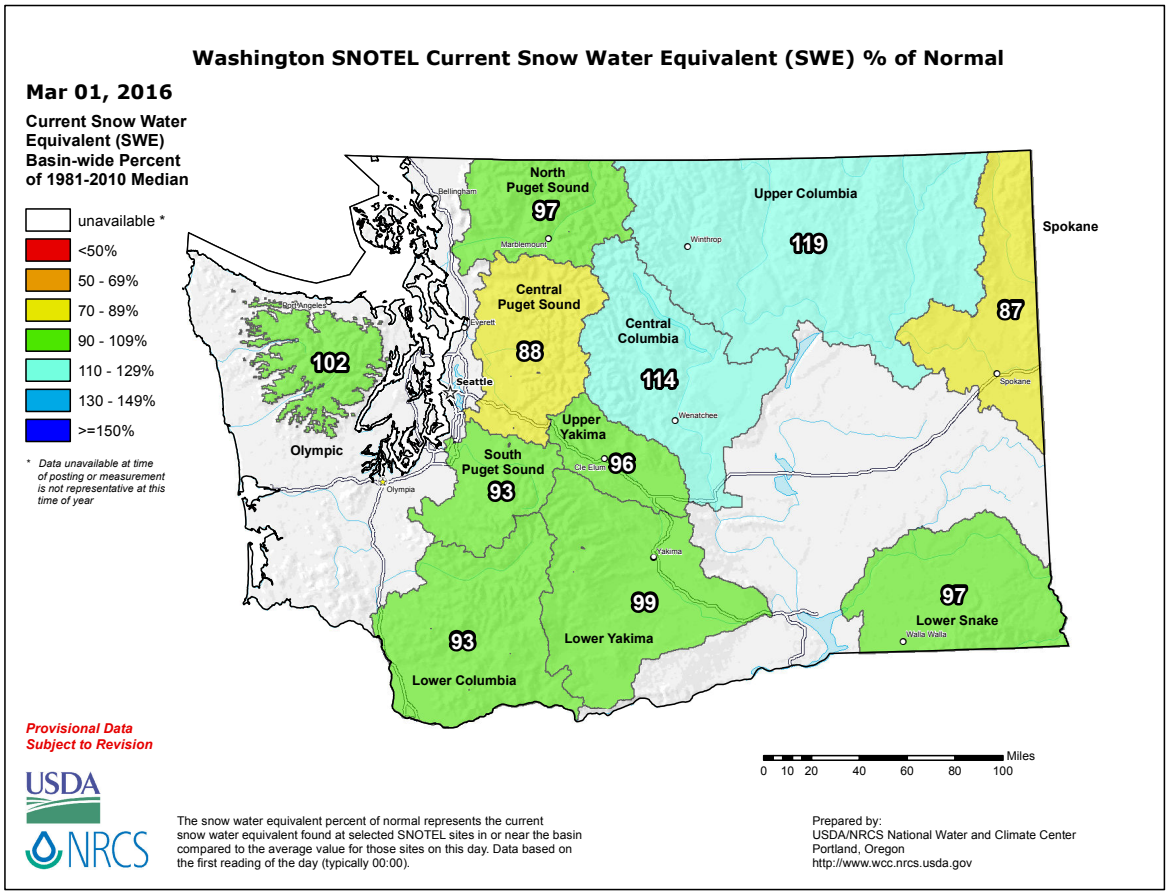


Figure 2: Snowpack (in terms of snow water equivalent) percent of normal for Washington as of March 1, 2016 (from the National Resources Conservation Service).

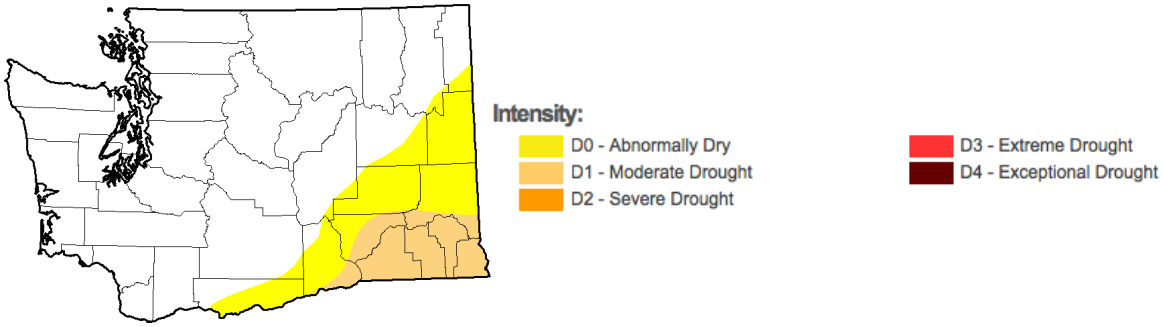


Figure 3: The March 1, 2016 edition of the US Drought Monitor (http://droughtmonitor.unl.edu/).

High Mortality of Cassin's Auklets in the Pacific NW During the Winter of 2014-15

A message from the State Climatologist

The waters off the coast of the Pacific Northwest have been unusually warm during the last couple of years, and this has had widespread and major impacts on the marine ecosystem. One of the more notable and publicized effects has been a harmful algal bloom (HAB) of unprecedented geographic scope, duration, and intensity. Here we will focus on a different sort of impact, and that is a Cassin's auklet mortality event that occurred during the winter of 2014-15, as revealed by observations collected by the Coastal Observation and Seabird Survey Team (COASST). This mortality event provides clues about the recent state of the regional ocean because seabirds can be effective sentinels for the marine ecosystem.

COASST is a citizen science project organized by the University of Washington under the leadership of Prof. Julia Parrish. It features data collected by trained coastal residents of three types: beached birds, marine debris, and evidence of human impacts on the beach environment. It has been in existence for 17 years and is accumulating valuable time series for evaluating variations and trends in the coastal environment from Northern California to Alaska. It serves to provide not just unique data, but also promotes environmental stewardship through the regular interactions between citizens and scientists. Documenting the number and types of bird carcasses (sometimes called "wrecks") while walking along the beach may not be everyone's idea of a good time. Nevertheless, the experience from COASST is that its volunteers are generally very dedicated and thorough, resulting in high-quality data sets that can and have been subjected to rigorous scientific analysis. More information on COASST is available at the following website: http://depts.washington.edu/coasst/

Figure 4: Cassin's Auklet carcasses found during a single survey along an Oregon beach on 8 January 2015 (photograph courtesy of the Coastal Observation and Seabird Survey Team, COASST).

Cassin's auklet carcasses began appearing in large numbers on the beaches of the Pacific Northwest during October 2014 continuing into early 2015. Figure 4 shows the 53 individuals that were found on a single beach in Oregon during January 2015. It is not obvious from this photograph but these birds were generally emaciated. It bears emphasizing that these kinds of numbers are extraordinary. In past years, volunteers would generally encounter a dead Cassin's auklet every few kilometers, but during the peak period of this event, on some surveys it was as frequently as every 10 meters! This is illustrated in a more quantitative way in Figure 5. The ratios of the encounter rates during the winter months of 2014-15 to those of the winter months of previ

ous years are indicated by the areas of the reddish-brown circles relative to those of the blue circles. These ratios are stunning. Additional analysis based on the sampling protocol, and the proportions of birds that likely sunk at sea rather than washed up on beaches, suggests that this may have been the largest sea bird mortality event ever documented (J. Parrish, personal communication).

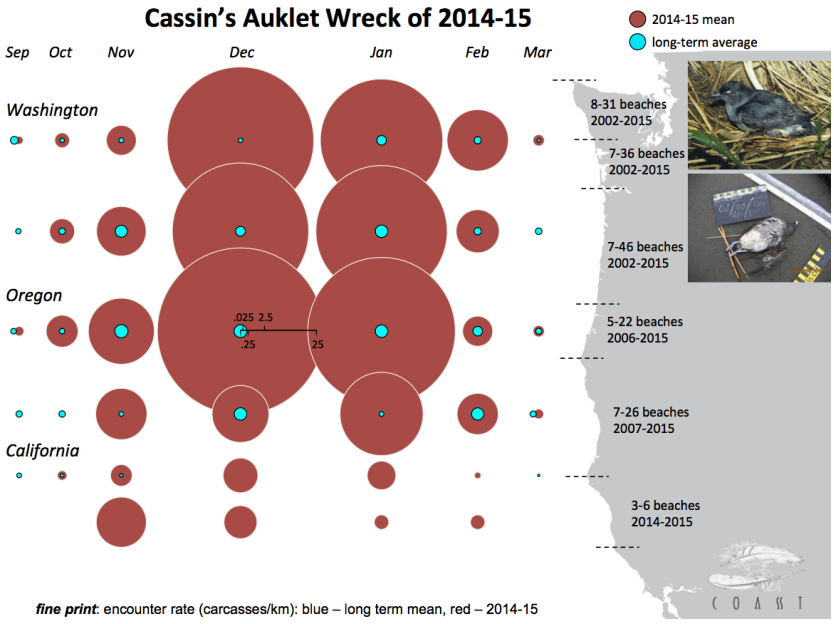


Figure 5: Encounter rates of Cassin's auklet carcasses during the cool season months of 2014-2015 (reddish-brown disks) versus long-term mean (blue disks). Note that the long-term average is 14 years for the WA beaches. Figure courtesy of Julia Parrish of UW/SAFS and COASST.

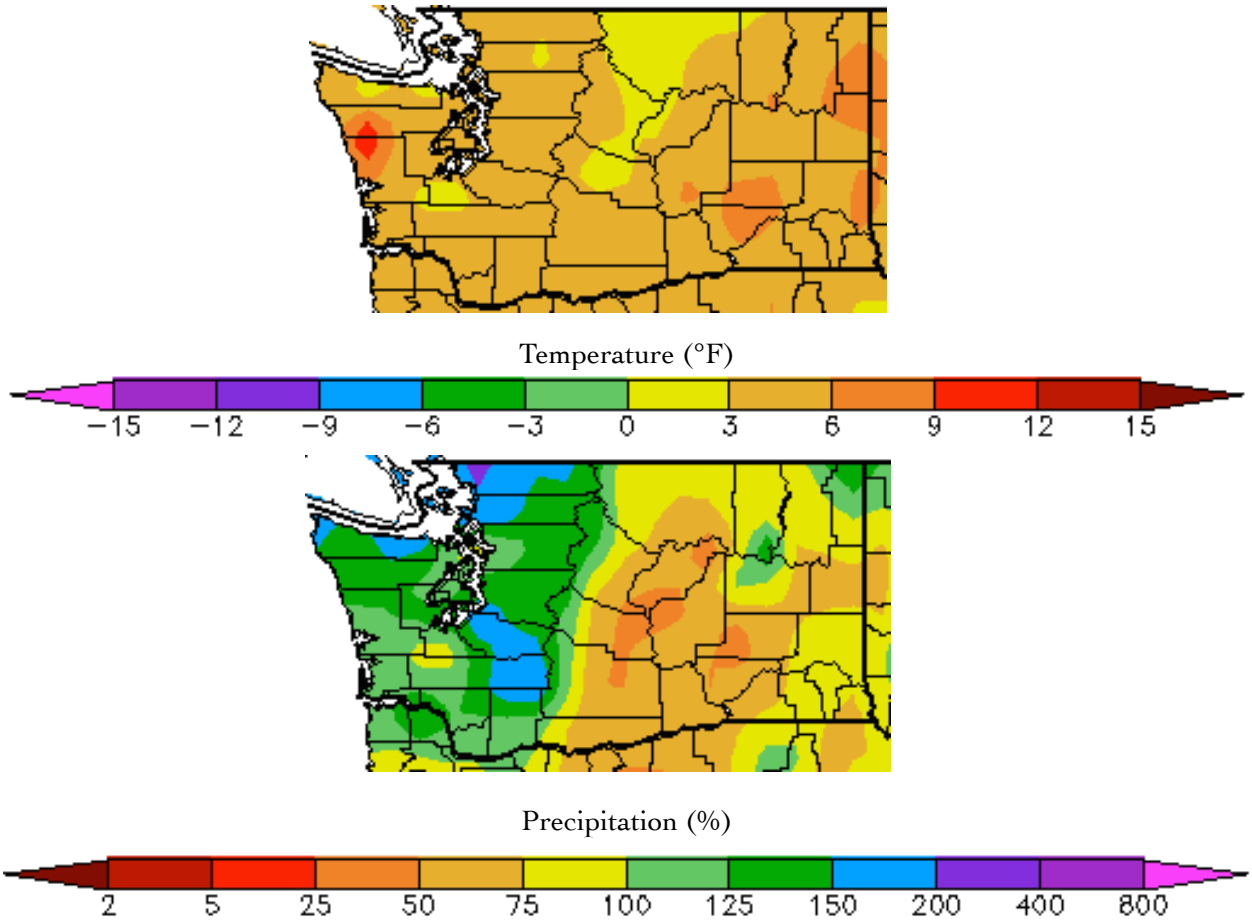
Why were there so many dead Cassin's auklets on beaches during the winter of 2014-15? Variations in carcass counts occur for four basic reasons: (1) overall populations related to recent breeding success, (2) the weather in their foraging region (strong storms are associated with elevated mortality rates), (3) habitat expansion/contraction (birds dying nearer the coast are more likely to be beached), and (4) the availability of suitable prey/feeding conditions. During the winter of 2014-15, all of the factors except for (2) appear to have played a role. Regarding (1), there was enhanced breeding success in prior years, leading to a relatively high number of younger birds. With respect to (3), there was almost certainly compression of the suitable habitat for Cassin's auklets due to water of more moderate temperatures near the coast. It is apparent, however, that the primary factor was the lack of food. Specifically, these birds target krill and other zooplankton, and to a certain extent forage fish, that are adapted to cooler water. These species were in short supply; the much warmer than normal water meant a preponderance of sub-tropical species at lower trophic levels that are generally less nutritious. This had implications not just for the Cassin's auklets but rather for the entire ecosystem. For example, juvenile salmon prefer many of the same species, and the salmon that went to sea in 2015 found slim pickings. As a result, coho salmon returns in 2016 are expected to be lower than normal (http://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/g-forecast.cfm).

Not surprisingly, the recent Cassin's auklet mortality event is of considerable scientific interest, and a journal publication on it is being prepared by Julia Parrish and others. While upper ocean temperatures continue to be anomalously warm, global climate models are indicating a slow trend towards more normal physical conditions over the course of 2016. It will be interesting to see how the ecosystem responds and in particular whether there will be much in the way of prolonged effects to this recent extreme climate event.

Climate Summary

Mean February temperatures were warmer than normal for the entire state. The month was well above normal, with most anomalies between 3 and 6°F warmer than normal, according to the map from the High Plains Regional Climate Center. Table 2 lists the departure from normal temperature for several WA sites, and most of the locations have warm anomalies of 4 or 5°F. Pullman was a warm spot, with temperatures 6.3°F above normal. The other warm bull's eye on the Olympic Peninsula (9-12°F above normal) should be ignored as it is a result of a faulty temperature sensor that is undergoing tests and slated to be fixed. Averaged statewide, average February temperatures were the 6th warmest on record, according to NOAA.

Total February precipitation was vastly different across the Cascade Mountains. Western WA saw normal to above normal precipitation for the month, with most locations with at least 125% of normal precipitation. Bellingham was a wet spot with 184% of normal precipitation (Table 2). Meanwhile, eastern WA was drier than normal, with most locations receiving less than 70% of normal precipitation. Hanford and Pasco were especially dry spots, with only 39 and 44% of normal precipitation, respectively (Table 2).



February temperature (°F) departure from normal (top) and precipitation % 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	44.9	41.0	3.9	6.66	5.27	126	0	4.7	0
Seattle WFO	47.7	43.4	4.3	4.07	3.31	123	0	0.6	0
SeaTac AP	47.4	43.4	4.0	5.97	3.50	171	0	1.7	0
Quillayute	47.5	42.1	5.4	15.74	10.35	152	0	2.6	0
Hoquiam	47.9	43.7	4.2	8.19	7.21	114	0	0.8	0
Bellingham AP	46.0	40.8	5.2	5.56	3.02	184	0	2.4	0
Vancouver AP	47.6	43.5	4.1	3.81	4.03	95	0	M	-
Eastern Washington									
Spokane AP	38.8	33.0	5.8	0.72	1.33	54	1.3	6.8	19
Wenatchee	38.7	34.8	3.9	0.43	0.81	53	M	4.4	-
Omak	35.3	31.8	3.5	0.91	1.41	65	M	M	-
Pullman AP	41.2	34.9	6.3	1.40	1.52	92	M	M	-
Ephrata	39.7	34.1	5.6	0.38	0.74	51	M	3.1	-
Pasco AP	43.5	38.9	4.6	0.38	0.86	44	0	M	-
Hanford	43.3	38.2	5.1	0.27	0.70	39	0.2	2.3	9

Table 2: February 2016 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 NCDC's new normal release, as records for these station began in 1998 and 1986, respectively. "M" denotes missing data.

Climate Outlook

El Niño conditions in the tropical Pacific Ocean are still present, according to the Climate Prediction Center (CPC), though the weekly sea surface temperature (SST) anomalies have decreased over the last month. In the last week, the SST anomalies were just under 2°C in the central tropical Pacific Ocean, with the event still easily classifying as a strong El Niño. The "El Niño Advisory" released by the CPC over a year ago (5 March 2015) is still in effect, and the ENSO forecast models show the El Niño will continue to decrease through the spring. By the 3-month period of May through July, the chances of El Niño (just over 40%) finally drop below the chances of neutral conditions. Neutral conditions are most likely during summer.

The CPC seasonal outlook for March is calling for increased chances of above normal temperatures statewide, with the chances of warmer than normal temperatures exceeding 50% on the three-tiered system. For precipitation, the March outlook shows a switch to higher chances of above normal precipitation on the coast, but equal chances of below, equal to, or above normal precipitation for the rest of the state. This is the first CPC forecast calling for wetter than normal conditions in WA state all winter.

The spring (March-April-May; MAM) CPC outlook also has increased chances of above normal temperatures for the period. Precipitation, on the other hand, is expected to be below normal for the entire state, though the chances are only tilted slightly (just above a 33% chance on the three-tier scale).

March outlook for temperature (left) and precipitation (right) from the CPC.

March-April-May outlook for temperature (left) and precipitation (right) from the CPC.