Office of the Washington State Climatologist

January 4, 2013

December Event Summary

In an overall sense, December was warm and wet throughout the state of Washington. The warmth can be attributed mostly to relatively high minimum temperatures. While December was a wet month, the **amount** of December precipitation was not record-breaking. Instead, the frequency of the precipitation was what was remarkable in many locations.

In this Issue

SeaTac Airport had 27 days in December with measurable rain (plus 1 day with a trace) which broke the record of the most wet days during December that was previously set in 1971 (26 days). Olympia also had 27 days with measurable precipitation, but the all-time record there is 29 days, so no record was set for December 2012. Hoquiam and Battleground (near Vancouver, WA) had even more days with measurable rain last month - 29 - which tied previous records of 29 days in 1974 and 1979 at Hoquiam and in 1933 at Battleground.

But these dubious awards are not reserved only for western WA; Spokane Airport had 23 days with measurable precipitation which is the first time in over a century that many wet days were measured in December. The last time that occurred was in 1906 (24 days occurred in December 1886). Omak also set a record with 22 days of measurable precipitation (previous record was 21 days in 1952 and 1973). Though those were the only records/near records we found in eastern WA, other locations did have more wet days than normal in December despite not breaking records.

Figure 1: Waves crashing into west Seattle on Dec 17 (from Seattle Times; photo credit Nick Adams).

Some notable monthly highlights include the record high sea level measured in Seattle on December 17th. The Seattle tidal station, in operation since 1901, measured its highest water level with 14.51'. The high water level occurred due to the combination of a high astronomical tide, strong winds, and a low

pressure (~980 mb) system that was coming onshore in the early morning hours of the 17th. Figure 1 (courtesy of the Seattle Times) shows the waves crashing into west Seattle. The high water level impacted shorelines across western WA. Relatively high winds were measured on that day as well: 94 mph on top of Crystal Mountain, 68 mph at Pasco Airport, 60 mph at Hoqiuam AP, 59 mph at SeaTac AP, 53 mph at Whidbey Island, 46 mph at Tacoma Narrows AP, 43 mph at Shelton AP, and 40 mph at Friday Harbor AP.

Otherwise, abundant mountain snow and some western WA flooding was the main storyline throughout the month. Eastern WA had frequent snow, and a white Christmas that would make Bing Crosby proud (as a Spokane native). Even some parts of southwestern WA had a white Christmas, and a few other lowland western WA locations enjoyed a flurry or two.

Snowpack Summary

Heavy mountain snow, especially mid-month, built the snowpack to above normal amounts for much of the state. According to the snow water equivalent (SWE) percent of normal WA map as of January 2, 2013 (Figure 2), the Cascades and Olympic Mountains are between 118 and 207% of normal SWE. Only two basins in eastern WA, Spokane and Lower Snake, have below normal snowpack, with 88 and 84% of normal SWE, respectively.

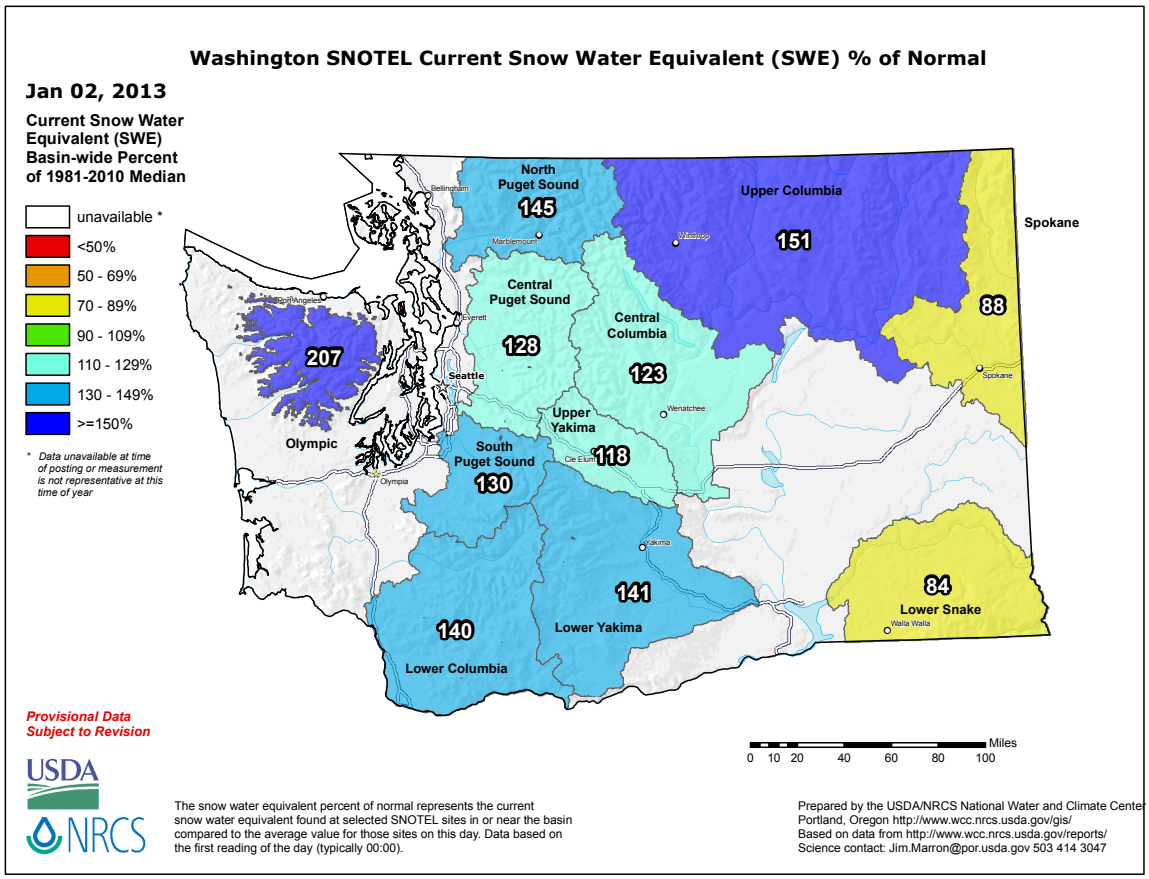


Figure 2: Snowpack (in terms of snow water equivalent) percent of normal for Washington as of January 2, 2013. Image is from the National Resources Conservation Service (NRCS).

Black Ice: A Serious Meteorological Threat

A message from the State Climatologist

Big weather events get a lot of attention for good reason. Our major rain, snow, and wind storms are noticed by everyone and can produce substantial monetary damages and safety risks. Episodes of black ice are much less dramatic, but arguably their impacts are disproportionate to the overall excitement that accompany them. To be fair, their importance is recognized by the Washington State Department of Transportation (WSDOT), which often pretreats roadways in threatening situations, and to an increasing extend by NWS and broadcast meteorologists. Nevertheless, it is still probably a rather ho-hum situation for the man/woman in the street. But that changes in an instant once one loses traction, with your shoes or your tires!

A severe black ice episode that occurred in December 2008 led to a series of automobile accidents, with a fatality, in the Tri-Cities area. Another freezing fog incident in the following month caused 2 million dollars of damage to power lines in the eastern part of WA, principally Lincoln County.

These two events were noteworthy because of their severity but by no means is that typically the case. Much more commonly, temperatures can be marginal and fog is absent, leading to a very patchy distribution of ice. These situations are maybe even more insidious, in that a hazard may not be perceived. What kind of weather can lead to black ice? In brief, relatively clear and calm conditions that promote cooling of the surface, including roads and sidewalks, to the frost point. This tends to occur first and to greater extent in low spots in the local terrain, and on overpasses and bridges. It bears emphasizing that black ice can form when air temperatures (which are measured at 4-6 feet above ground) are above freezing; frosted windshield and lawns are often a good indicator of the possibility. Readers interested in a much more complete discussion of the factors determining the formation and distribution of black ice are encouraged to refer to a tutorial composed by Professor Cliff Mass and Rick Steed of the Department of Atmospheric Sciences at the UW (www.atmos.washington.edu/cliff/Roadway2.htm).

Our purpose here is to look into the recent observational record for the type of weather associated with black ice, with a focus on the more severe events associated with air temperatures at 32°F and below. We consider two west-side stations, SeaTac (SEA) and Olympia (OLM), and two east-side stations, Spokane (GEG) and Moses Lake (MWH). Both daily and hourly data have been examined. The daily data has been used to identify the days during the cool season (October through March) during which there was a combination of minimum temperatures less than or equal to 32°F, heavy fog (visibility less than or equal to 1/4 mile) at some point in the day, and a lack of measurable precipitation. These days were considered to be those with the strong **potential** of freezing fog in the vicinity of the reporting station, and if not, conducive to the deposition of water vapor into ice on cold surfaces. The hourly data has been used to ascertain the number of hours per year with temperatures at 32°F and below, and the subsets of these hours that lacked precipitation (of trace as well as measurable amounts), and horizontal visibilities less than 1 mile, and less than 3 miles. The period of

record considered is December 2007 through November 2012.

A chart illustrating monthly averages of the number of potential freezing fog days is shown in Figure 3. Note that SeaTac comes in a distant last in the frequency of these kinds of days. Olympia actually has more of them than Spokane and Moses Lake, especially in fall and late winter, even though its mean minimum temperatures are 3-10°F higher. SeaTac is a known local hot spot due to its location on a high bluff; the cold air that develops near the surface in those kinds of locations tends to drain away into nearby low-lying areas. Olympia is appreciated as one of the iceboxes of western Washington (Arlington is another one) due to its low elevation, and distance from the moderating influence of Puget Sound. Nevertheless, it may be surprising how often Olympia has experienced the combination of cold temperatures and fog. We also did not expect that Spokane would have more potential freezing fog days than Moses Lake. While the mean minimum temperatures during the winter months are comparable at the two sites, Spokane receives about double the mean precipitation, and so it might be surmised that cold weather is much more likely to be accompanied by snow. Moreover, Moses Lake is subject to the notorious "cold pool" that forms in the Columbia basin, with its attendant freezing temperatures, low visibilities, and poor air quality. Apparently this has not happened enough, at least during the last 5 years, to raise the threat of widespread, freezing fog/black ice events above that of Spokane. We were also struck by the large degree of year-to-year variability in the occurrence of these weather conditions (not shown). For example, during the month of December, Olympia has had as many as 12 of these kinds of days in 2011, and as few as 1 in 2007. We recognize the limitations of daily data, specifically involving the coincidence of fog and freezing temperatures, which motivated us to also examine hourly data.

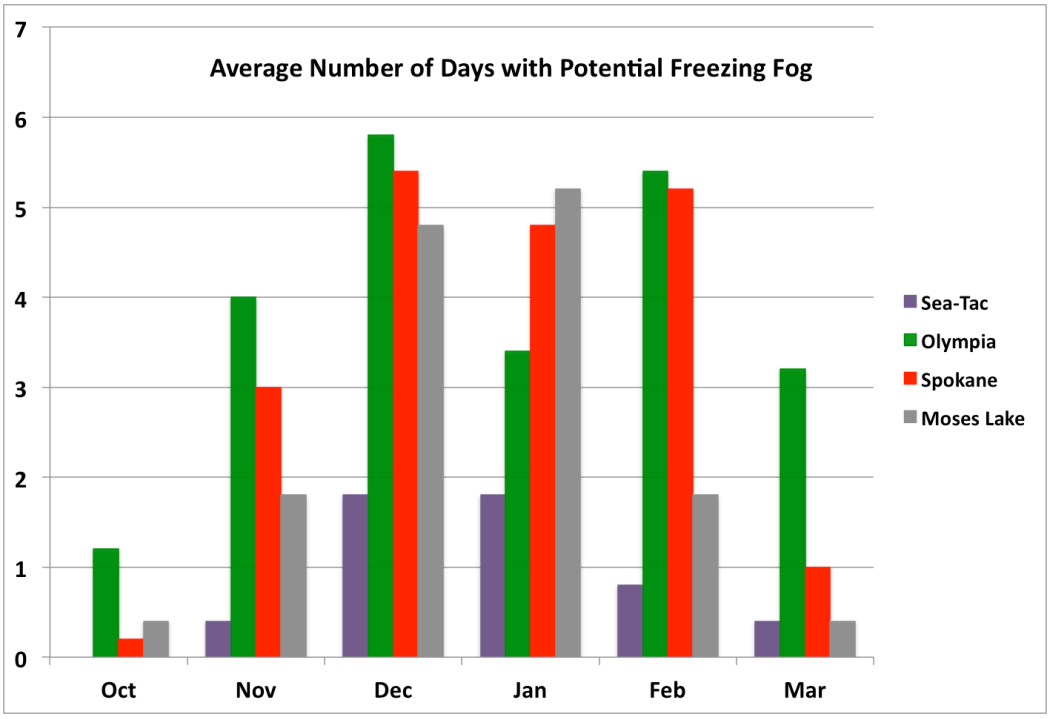


Figure 3: The average number of potential freezing fog days (temperatures less than or equal to freezing, heavy fog, and no measurable precipitation) for 4 WA locations. The averages are based on data from December 2007 through November 2012.

Averages of the number of hours per year with freezing temperatures at the four stations, along with other criteria, are shown in Figure 4. Again, SeaTac is the place to be if you hate cold temperatures, especially in combination with low visibilities. The latter conditions are generally associated with high relative humidities and hence better chances of significant icing. Olympia experiences roughly one-third as many hours of freezing temperatures as Spokane and Moses Lake, but a greater proportion of these hours are accompanied by lower visibilities. The result is something like 120-150 hours a year with the unholy trinity of freezing temperatures, no precipitation, and low visibilities/high relative humidities. Spokane and Moses Lake check in with about 1800 and 1650 hours of freezing temperatures, respectively. Of those totals, there has been precipitation during an average of about 150 hours a year in Spokane, and only 50 hours in Moses Lake. As also suggested by the daily data, the combination of freezing temperatures, lack of precipitation and low visibilities is considerably greater at Spokane than Moses Lake.

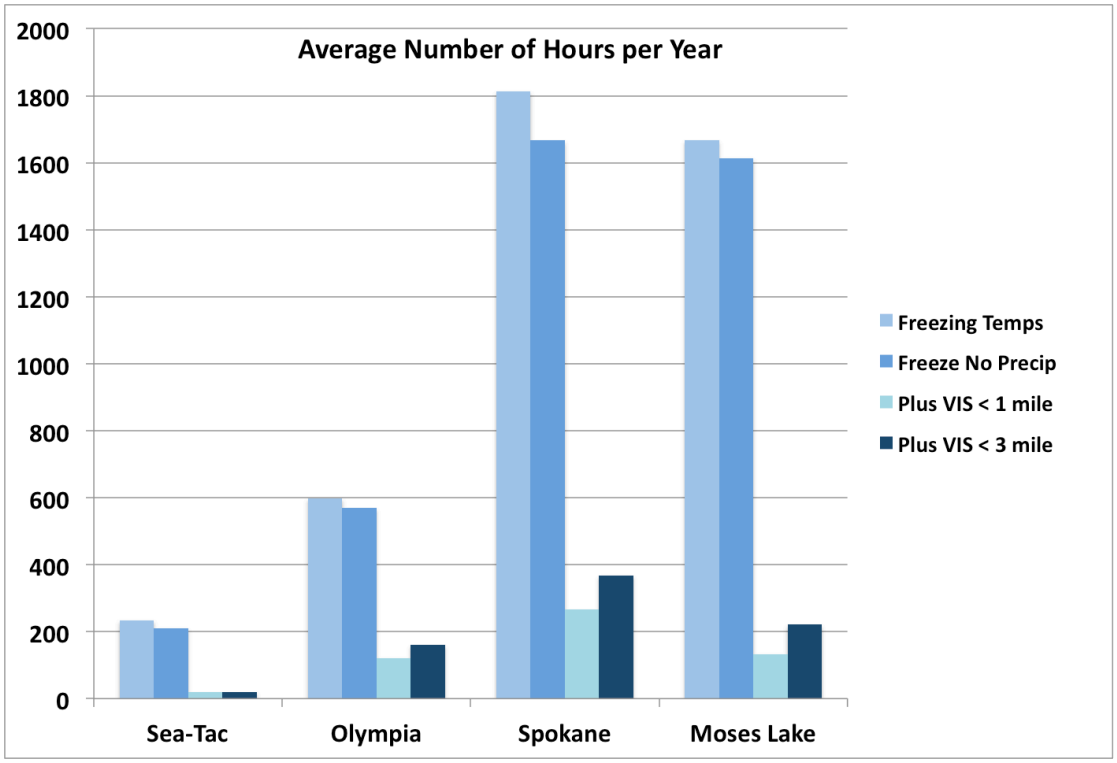


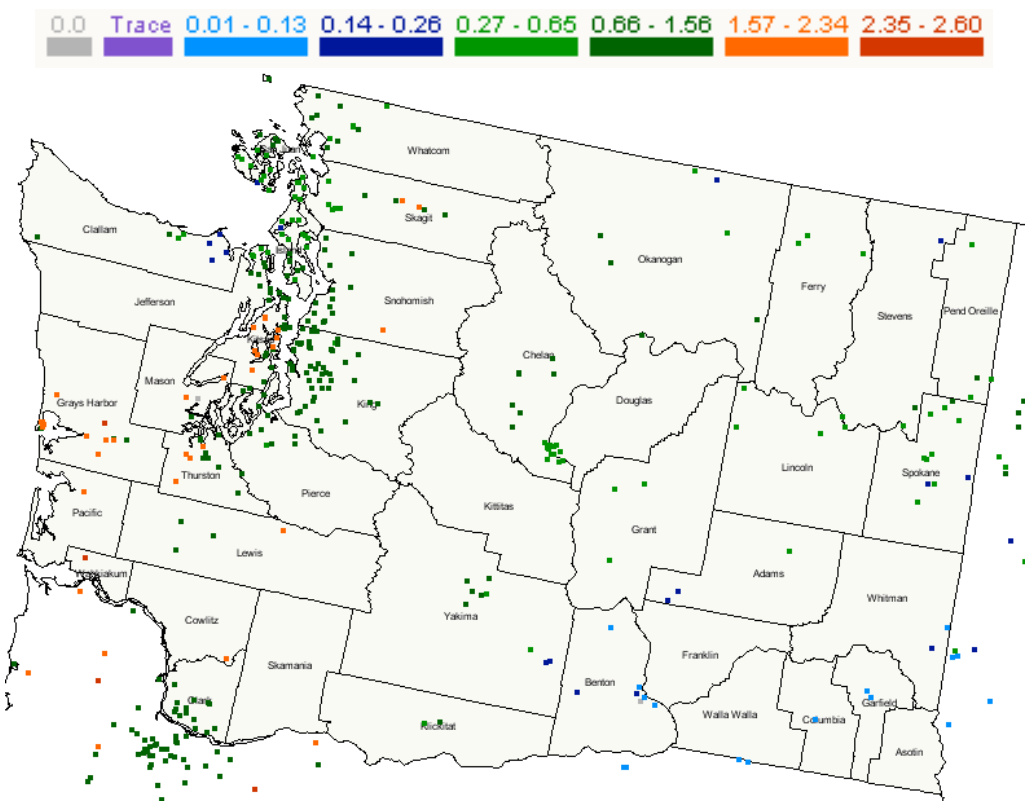
Figure 4: The average number of hours per year each station experiences freezing temperatures, freezing temperatures without any precipitation, freezing temperatures without any precipitation and visibilities less than 1 mile, and freezing temperatures without any precipitation and visibilities less than 3 miles.

The composite results shown here are intended to illustrate the frequency of the threat of significant black ice in various locations in WA. The results are not definitive; this would require a longer data record and a more sophisticated analysis. It is possible that inclusion of just the last 5 years, with the preponderance of La Niña, has skewed the results. A quick inspection of the data suggests that the weak-moderate El Niño winter of 2009-10 included fewer freezing days but not necessarily fewer freezing days with low visibilities, than the other

years. It would be interesting to determine whether there are significant trends in the frequency of occurrence of freezing fog events, but again, that would require analysis of a longer data record and proper account for the large interannual variability. A final point worth repeating: while the present analysis has focused on the more severe conditions associated with air temperatures at or below freezing, black ice can occur when air temperatures are in the mid or even upper 30s, which is more common in the populated regions of Puget Sound. You can see for yourself whether such a threat exists by checking out roadway temperature maps provided by WSDOT at the following website:
http://www.wsdot.wa.gov/traffic/Roadtemps/default.aspx.

CoCoRaHS

There certainly were a lot of rainy and snowy days during December - thank you, CoCoRaHS observers, for your frequent measurements! We measured about 5.70" here at OWSC for the month which is slightly higher than the two official measurements to the north and south of our location on the University of Washington campus. This is an estimate, however, since our first observation for the month was a multi-day report on Dec 3rd, which included precipitation that fell on the last day of November. We subtracted 1.50" from our monthly total to account for the heavy rain day on Nov 30, but of course there is some uncertainty with that. We plan to do a more in-depth comparison with surrounding stations as we gather more data for our location, so stay tuned for that. In the meantime, please help spread the word about CoCoRaHS! Shown below is the Dec 17 morning map showing the previous 24-hr precipitation ending that morning. Heavy rain fell west of the Cascade Mountains while the measurements in eastern WA are the liquid equivalent of the snow that fell.

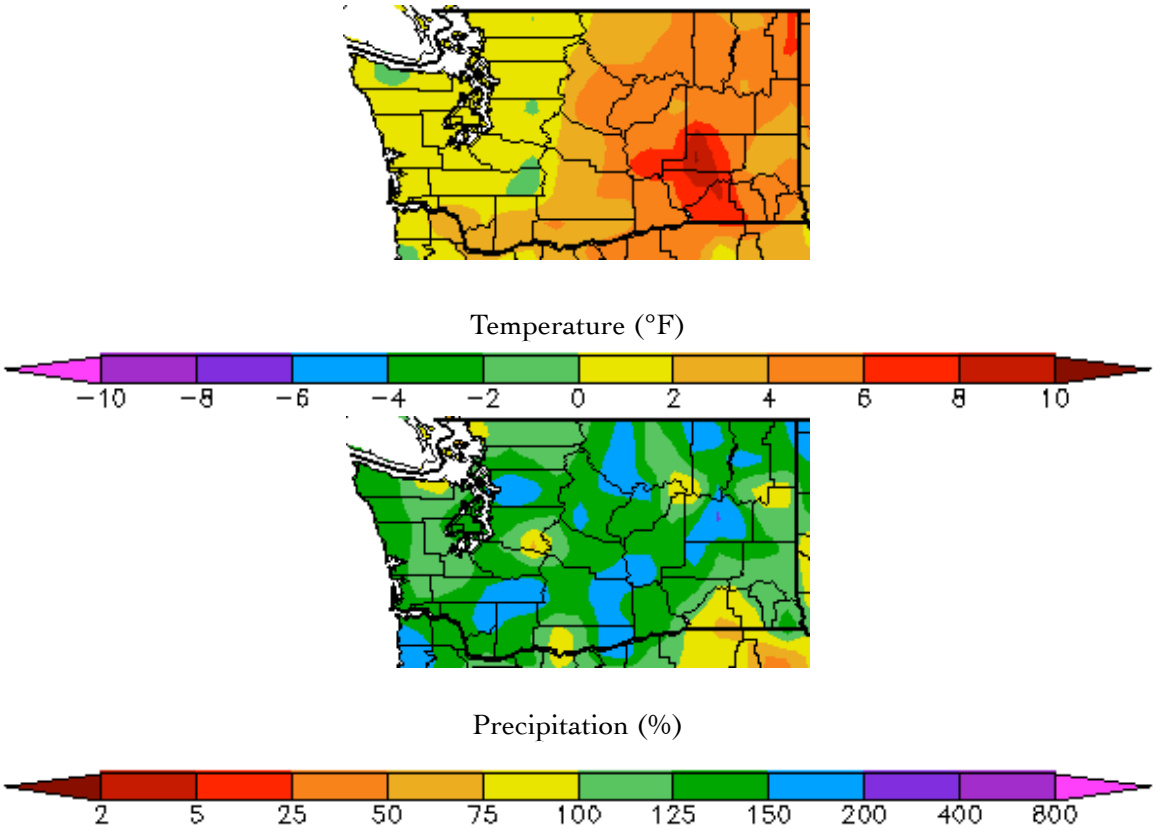


Climate Summary

Mean December temperatures were above normal statewide, as illustrated by the High Plains Regional Climate Center (HPRCC) temperature departure from normal map below. The departures from normal were larger east of the Cascade Mountains, where mean temperatures were between 2 and 6°F above normal for most of the area. Pasco was 5.5°F above normal, for example (Table 1). West of the Cascades, December temperatures were within 2°F of normal, with most cities about 1°F above normal for the month.

December precipitation was higher than normal statewide. Table 1 and the HPRCC percent of normal precipitation map below shows that December precipitation was between 100 and 150% of normal for most of the state. There are a few bullseyes of below normal precipitation that should be viewed with suspicion: preliminary data are used for the map which can allow faulty measurements to influence the map. The below normal precipitation shown in eastern King County, for example, is very likely an error.

As for snowfall, western WA did receive a modest amount of lowland snow during December, most notably on the 18th. East of the Cascade Mountains received snow as well, and Spokane received an above normal amount (Table 1).



December temperature (°F) departure from normal (top) and December precipitation % of normal (bottom).
(High Plains Regional Climate Center (http://www.hprcc.unl.edu); 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	39.7	38.4	1.3	9.74	7.46	131	0.3	2.6	12
Seattle WFO	42.3	41.1	1.2	7.03	5.43	129	0.0	2.3	0
Sea-Tac	41.5	40.6	0.9	6.85	5.35	128	0.6	1.7	35
Quillayute	41.1	40.4	0.7	17.53	12.99	135	0.0	2.1	0
Bellingham AP	40.4	38.1	2.3	M	4.22	M	M	2.9	M
Vancouver	42.0	40.6	1.4	7.67	6.77	113	M	M	M
Eastern Washington									
Spokane AP	31.2	27.4	3.8	2.58	2.30	112	18.1	14.6	124
Wenatchee	32.2	27.9	4.3	1.71	1.40	122	M	12.9	M
Omak	30.5	25.7	4.8	2.95	2.54	116	M	M	M
Pullman AP	32.2	30.1	2.1	2.19	1.57	139	M	M	M
Ephrata	32.6	27.4	5.2	1.69	1.24	136	M	7.6	M
Pasco AP	38.6	33.1	5.5	1.21	1.21	100	M	0.4	M
Yakima AP	33.4	28.5	4.9	2.13	1.53	139	13.5	9.4	144

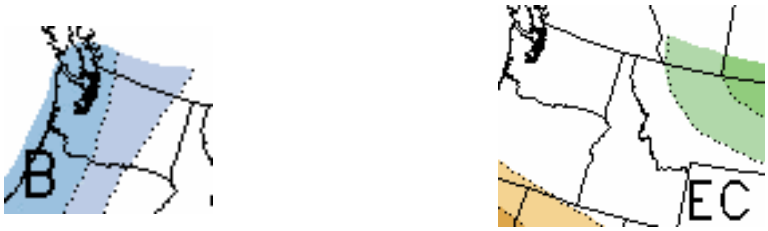
Table 1: December climate summaries for locations around Washington with a climate normal baseline of 1981-2010. Note that the Vancouver Pearson Airport and Seattle WFO 1981-2010 normals involved using surrounding stations in NCDC's new normal release, as records for these station began in 1998 and 1986, respectively.

Climate Outlook

The conditions in the equatorial Pacific Ocean continue to be ENSO-neutral, according to the Climate Prediction Center (CPC): http://www.cpc.ncep.noaa.gov/. During the month of December, sea-surface temperatures (SSTs) have continued to be above normal in the western Pacific Ocean while SSTs in the eastern tropical Pacific have been below normal. The consensus of the model predictions is a continuation of near-neutral conditions through the winter and spring of 2013.

The CPC three-class temperature outlook for January has increased odds of below normal temperatures for the western two-thirds of the state. The eastern third of the state has equal chances of below, equal to, or above normal temperatures. Regarding precipitation, there are equal chances of below, equal to, or above normal precipitation for January statewide.

The CPC 3-month seasonal outlook for January-February-March (JFM) is essentially a toss up. There are equal chances of below, equal to, or above normal temperature and precipitation for the three-month period. An exception is represented by the northeastern corner of WA, where there are higher chances of above normal precipitation for JFM.



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

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