



# Office of the Washington State Climatologist

September 4, 2014

## August Event Summary

Mean August temperatures were warmer than normal statewide, which in combination with the warm July, has set some records for the warmest July through August for several weather stations around the state. Table 1 shows the average temperature from July through August 2014 for a sample of stations, and the ranking from warmest to coldest for the period of record. Precipitation, on the other hand, was more varied across the state with a tendency for higher than normal amounts. The higher precipitation was a result of several periods of active weather that produced some very heavy rain from thunderstorms.

### In this Issue

August Event Summary....	1
Drought Update.....	2
Hops in WA State.....	3
Climate Summary.....	5
Climate Outlook.....	7

Station	Jul-Aug Avg Temperature (°F)	Ranking	Previous Record Temp/Year	Record Temp/Year
SeaTac AP	69.2	1	68.8; 1967	-
Walla Walla	78.8	1	78.6; 1967	-
Spokane AP	74.0	1	73.5; 1998	-
Wenatchee	78.9	1	77.8; 1961	-
Everett	67.2	1	67.1; 1998	-
Hanford	81.0	1	80.3; 1958	-
Olympia	66.8	2	-	67.7; 1958
Pullman	70.8	2	-	71.0; 1998
Bellingham AP	65.8	2	-	66.5; 1958
Quillayute	61.0	5	-	62.2; 2013

**Table 1: The average July-August 2014 temperature, ranking (from warmest to coldest), the prior record and year if applicable, and the current record holder for selected WA stations.**

One of these heavy rain events occurred in the evening of August 21 and caused considerable damage in Okanogan County. Thunderstorms dropped intense rain on the recent burn scars

southeast of Twisp, causing flash flooding and mudslides that damaged houses and blocked state highways. The highest confirmed precipitation report came from a NWS Weather Spotter in the area that recorded 1.15" in about an hour. Most of the other precipitation reports ranged between 0.20" and 0.75". Other thunderstorms popped up in eastern WA at this time, but fortunately were not as damaging, mostly because they did not occur over recently burned areas. Governor Inslee declared a state of emergency for Okanogan County on August 28 because of this event, which is on the heels of federal disaster assistance approval for Okanogan County on August 11 in response to the property losses from the Carlton Complex Fire earlier this summer.

Heavy rain fell in the same area and throughout the rest of the Columbia Basin on August 13 and 14 as well. For the 24 hours ending at 8 am on August 14, 0.70" of precipitation fell at Chelan, which set a 24-hour precipitation record for that date. Omak recorded a daily record of 0.27" on the 14th while stations west of the Cascade crest set daily precipitation records on the 13th at SeaTac Airport (0.85"), Olympia (0.57"), Bellingham (0.51"), and the Seattle Weather Forecasting Office at Sandpoint (0.48"). Thunderstorms again were associated with these high precipitation amounts, and on the heels of another warm and dry period, there was much concern about more fires being started. There was actually a fire started in western WA (northwest of Olympia) on the 11th when high temperatures in western WA were in the upper 90s, but the rain that followed aided in containment. There are no large fires burning in WA at the time of this writing.

## Drought Update

There have been a few changes to the US Drought Monitor (Figure 1) since the last edition of the newsletter. The recent lack of precipitation on the Olympic Peninsula combined with extremely low streamflows and the continued precipitation deficit on longer time scales has led to the introduction of "abnormally dry" conditions on the northern Olympic Peninsula. The area of "moderate drought" was also adjusted further west into the east slopes of the Cascade Mountains in early August to better match the short and long-term precipitation deficits there. While there has been recent precipitation in most of the drought area, it has done little to alleviate dry conditions. The intense, but short duration rainfall is typically quick to runoff without saturating the soils, and has not been enough to make up the precipitation deficits. Hopefully, the upcoming months will include the onset of fall precipitation and improvements.

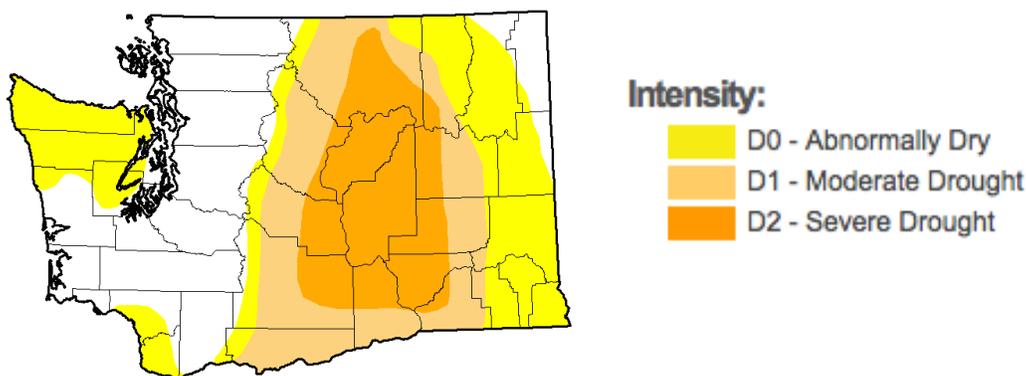


Figure 1: The 26 August 2014 version of the US Drought Monitor (from the National Drought Mitigation Center).

## Growing Hops in Washington State

### A message from the State Climatologist

Due to the passage of I-502 by Washington state voters in November 2012, legal agricultural production has commenced for a notorious member of the family Cannabaceae. This highlight is about another member of this family that WA state is known for and that is hops (*Humulus lupulus*). The female flowers, also known as cones, from hops constitute an essential flavoring ingredient for most beers. Hops have been grown in the Pacific Northwest since the late 1800s, and presently about 75% of the commercial production of hops in the United States occurs in the Yakima Valley. What makes this place so special for this particular crop, and should we worry about how its suitability may be impacted by expected changes in the climate?

Hop vines are rather demanding. They are vigorous climbers with as much as a couple feet of growth per week. This kind of growth requires abundant sunshine, nutrients and lots of water, typically 20-30" per season. But consistently low humidity is also needed to suppress the development of fungal diseases such as downy mildew that are favored in warm, wet conditions. The Yakima area certainly fits that bill with average relative humidity values of about 25-30% in the afternoon and only about 70% during the late night and early morning hours. The prevailing winds are from the west-northwest, which means downslope flow off the Cascade Mountains. While the Cascades produce a rain shadow in the Yakima Valley, they also serve as a sort of water tower, with mountain reservoirs fed by the winter snowpack generally providing sufficient water for a variety of agricultural and recreational interests, including the growers of hops.

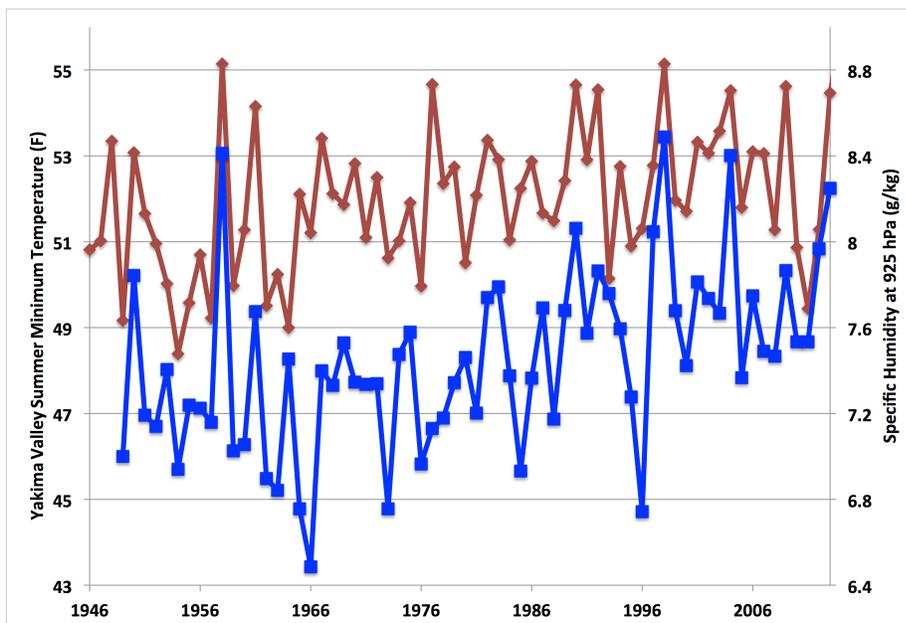


Figure 2: Average summer (June-August) minimum temperatures at Yakima Airport, Moxee and Sunnyside, WA (F; red trace) and specific humidity at 925 hPa (g/kg; blue trace) for the same region from the NCEP Reanalysis.

On the subject of climate change and its potential impacts on the farming of hops in the Yakima Valley, we will take two approaches. First, we examine the historical record of summer conditions in the region. Here the focus is on the trends, or lack thereof, in two related parameters, average minimum temperatures from three stations in the Yakima Valley (Yakima Airport, Moxee, and Sunnyside) and low-level

specific humidity from the 925 mb level of the NCEP/NCAR Reanalysis over a similar region. Time series of these parameters are shown in Figure 2. The record of the June-August average minimum temperatures as a whole includes a slight upward trend but primarily features considerable year-to-year variability. Most of the summers with especially high minimum temperatures are coincident with positive anomalies in specific humidity. There is a more prominent upward trend in the latter parameter, at least over the last two-thirds of the 60+ year record considered here. It is unknown whether this rise in humidity has been accompanied by more frequent incidences of fungal diseases and other pathogens with respect to hops, but it is still typically quite dry in a relative sense. It would therefore seem unlikely that even a continued increase in humidity would have substantial near-term (on climate time scales) effects on Yakima Valley hops. The longer-term changes in the summer weather of the region could be a different story, upon which we speculate in the second part of this summary.

The future climate may lead to both a greater need, and a reduced supply, of water for the Yakima Valley in summer. Climate model projections of precipitation in the Pacific Northwest are suggesting wetter winters and drier summers, with plenty of uncertainty, as illustrated in the ensemble of model results for the middle of the 21<sup>st</sup> century in Figure 3 (from Dalton et al. 2013). There is greater confidence that there will be warming, which is expected to lead to reduced snowpack, and hence less water in that part of the Northwest's "water bank". The bottom line is that trade-offs may be necessary among the various competing interests that rely on the water available for the Yakima Valley. Presumably hops will continue to get their share, at least if beer aficionados have anything to do with it.

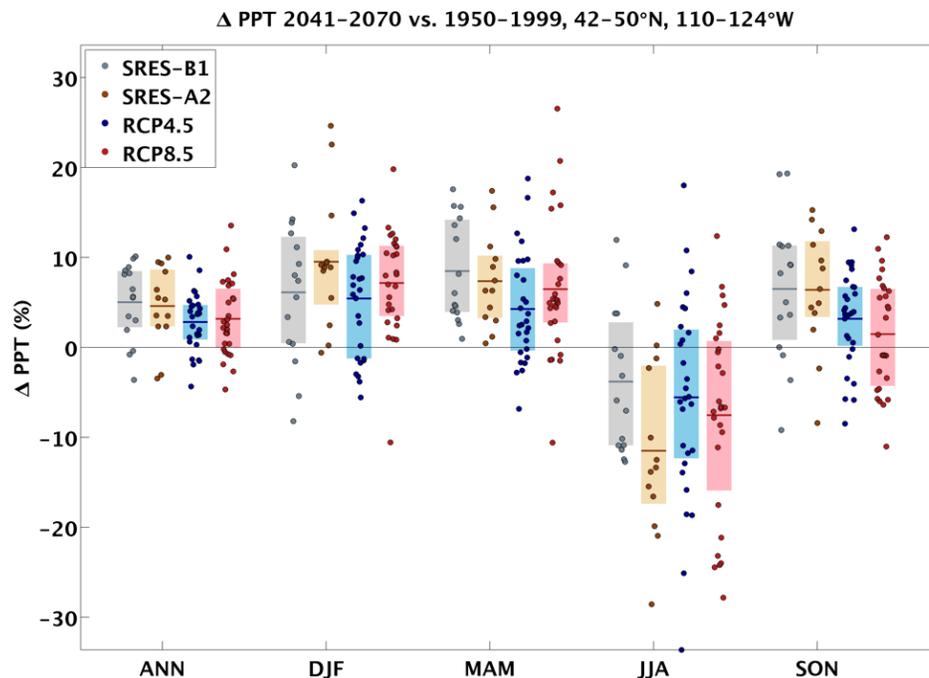


Figure 3: Modeled changes (%) in precipitation in the Pacific Northwest from a collection of global climate model simulations carried out for the 4<sup>th</sup> and 5<sup>th</sup> Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC). Individual model results for each season are shown by circles; the means and standard deviations in these results are indicated with the horizontal lines and rectangle (from Dalton et al. 2013).

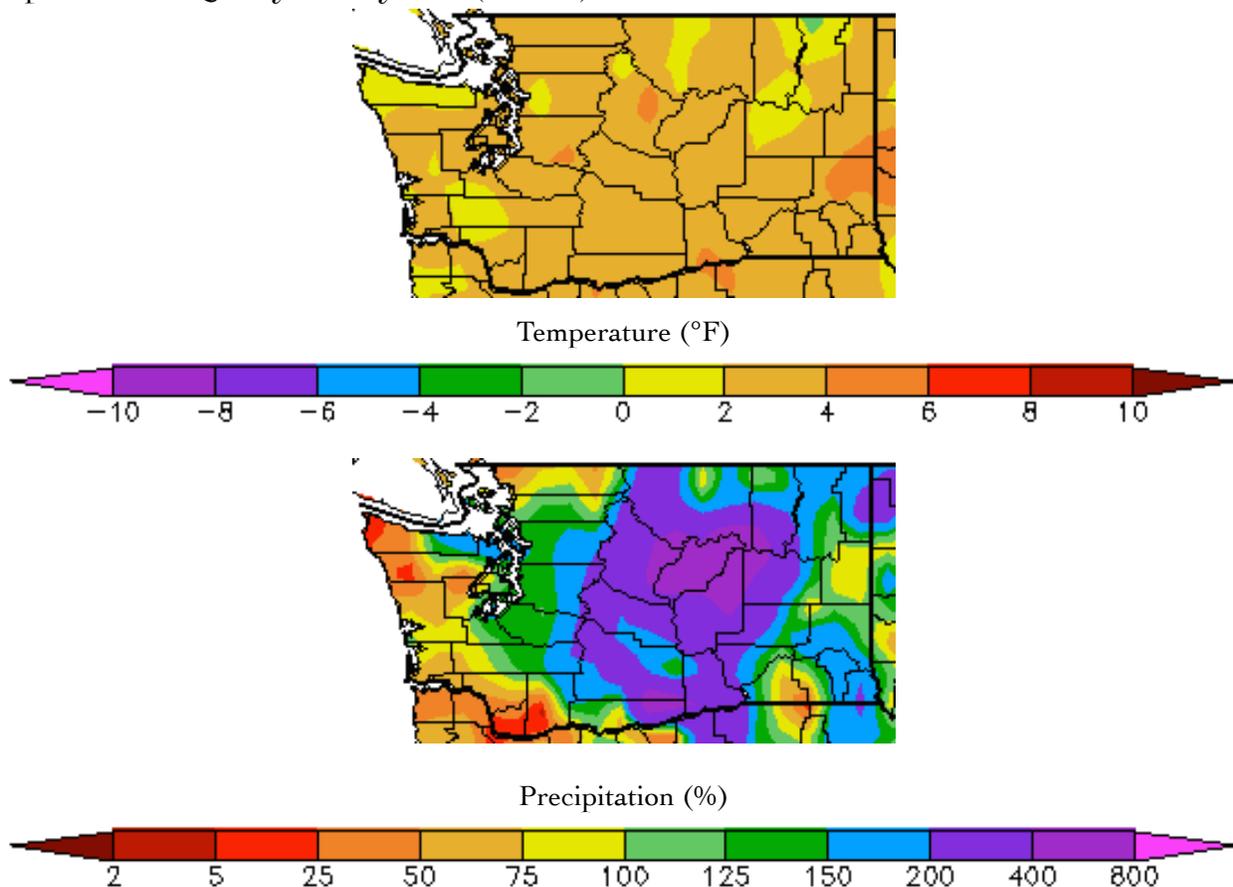
## Reference

Dalton, M.M., P.W. Mote, and A.K. Snover [Eds.], 2013: *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*. Washington, DC: Island Press.

## Climate Summary

Mean August temperatures were generally 2 to 4°F warmer than normal across the entire state, as shown in the High Plains Regional Climate Center map below. Wenatchee, Bellingham, and Ephrata had the largest warm anomalies out of all the locations listed in Table 2, and were 3.7 and 3.8°F warmer than normal, respectively. August marks the second consecutive month with temperatures uniformly above normal statewide.

Total August precipitation varied across the state, but a majority of the state received near to above normal precipitation for the month. A few heavy rain events in central and eastern WA caused total precipitation to be above 200% of normal. Precipitation is typically very light this time of year, especially east of the Cascade Mountains, so not much precipitation is needed to have amounts much greater than normal on a percentage basis. Total August precipitation was generally between 0.5 and 2" statewide. On the other hand, the coast and parts of western WA was much drier than normal. Vancouver, for example, only received 5% of its normal precipitation and Quillayute only 28% (Table 2).



*August temperature (°F) departure from normal (top) and August 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)		
	Average	Normal	Departure from Normal	Total	Normal	Percent of Normal
Western Washington						
Olympia	66.8	64.1	2.7	1.45	0.94	154
Seattle WFO	69.5	66.5	3	1.38	0.97	142
SeaTac AP	69.1	66.1	3	1.81	0.88	206
Quillayute	61.4	59.6	1.8	0.69	2.49	28
Hoquiam	62.4	60.6	1.8	1.99	1.31	152
Bellingham AP	66.3	62.5	3.8	0.68	1.23	55
Vancouver AP	71.9	69.2	2.7	0.04	0.77	5
Eastern Washington						
Spokane AP	72.2	69.3	2.9	0.58	0.59	98
Wenatchee	77.2	73.5	3.7	0.83	0.2	415
Omak	75.2	72.4	2.8	0.85	0.46	185
Pullman AP	68.6	65.7	2.9	0.5	0.63	79
Ephrata	76.7	72.9	3.8	0.83	0.19	437
Pasco AP	75.6	72.8	2.8	0.47	0.27	174
Hanford	79.2	75.8	3.4	0.88	0.18	489

**Table 2: August climate summaries for locations around Washington with a climate normal base-line 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 equatorial Pacific Ocean is still in the ENSO-neutral category, according to the Climate Prediction Center (CPC): <http://www.cpc.ncep.noaa.gov>. Averaged over the last month, the sea-surface temperatures (SSTs) are above normal throughout the entire eastern equatorial Pacific. There is a consensus among model predictions that El Niño will develop. Such an eventuality is assigned a probability of 65% by CPC, reflecting less confidence than earlier this summer. Moreover, it now appears that it is liable to be only of weak-moderate strength. Nevertheless, the “El Niño Watch” that was initially released by the CPC in early March is still in effect.

The Climate Prediction Center seasonal outlook for September is indicating increased chances of above normal temperatures for nearly the entire state. For precipitation, there are increased chances of below normal precipitation for the western half of WA and equal chances of below, equal to, or above normal precipitation for the remainder of the state.

The three-month fall (September-October-November; SON) outlook is reflecting conditions associated with the projected El Niño event. The outlook is calling for higher chances of above normal temperatures and below normal precipitation statewide.



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



*September-October-November outlook for temperature (left) and precipitation (right) from the CPC.*