Office of the Washington State Climatologist

September 4, 2015

August Event Summary

Average August temperatures were warmer than normal across the entire state for the 4th consecutive month. Precipitation, on the other hand, was vastly different for the two sides of the state: western WA received well above normal for the month while eastern WA was drier than usual. Despite SeaTac Airport's high ranking compared to precipitation during historical Augusts (4th wettest), the rankings for the rest of western WA do not end up being too impressive (Table 1). The temperature rankings for average August temperature are actually higher, as all listed in Table 1 were among the top 8 warmest Augusts for the selected western WA locations. Stations in eastern WA were also ranked among the top ten warmest Augusts (e.g., Pullman - 4th, Omak - 5th, Wenatchee - 6th).

In this Issue

The month started out warm, with daily record high temperatures in the upper 80s, 90s and 100s around the state on August 1. It wasn't long before temperatures cooled statewide, however, and cloudier mornings were the rule for western WA. Thunderstorms were common from the 8th through the 14th, and ignited several fires throughout the state. Daily high temperature records were set in eastern WA on the 12th (e.g., Wenatchee - 103°F and Omak - 104°F), and then again on the 13th (e.g., Spokane Airport - 100°F). A lightning-caused fire near Chelan started overnight on the 13th/14th, forcing evacuations of hundreds of homes in the area; 21 residences were destroyed and the fire is 70% contained at the time of this writing. The Okanogan Complex fire -

Station	August Precipitation (inches)	Rank	August Temp (°F)	Rank	Records Began
SeaTac	3.28	4	68.7	4	1945
Olympia	2.84	6	66.2	7	1948
Quillayute	4.05	10	62.8	2	1966
Everett	2.11	16	67.3	8	1894
Arlington	2.23	20	64.0	6	1923
Hoquiam	1.77	21	63.3	4	1953
Bellingham	1.53	22	65.8	4	1949

Table 1: August total precipitation and ranking (ascending) and August average temperature and ranking (descending), along with the period of record for selected western WA stations.

now the largest fire in state history and only 60% contained - was also started on the same day and 123 residences and 72 other structures have been destroyed. On the west side of the Cascades, the thunderstorms on the 14th were associated with a cold frontal passage, and brought some heavy rain, especially in the central Puget Sound region. Daily maximum rainfall records were set at Olympia (0.93") and the Seattle Weather Forecast Office (0.90"), but there were localized totals well over an inch. Strong winds on that day also caused widespread dust storms east of the Cascades. Even stronger winds occurred in eastern WA on the 21st, resulting in extreme fire behavior.

The large, active fires in eastern WA produced a great amount of smoke, and an air quality alert was issued for all of eastern WA during the latter part of the month. For the most part, the weather for the remaining two weeks of the month was typical of summer with warm temperatures and little precipitation, until a series of frontal systems impacted the state beginning on the 27th, bringing rain and strong winds. The storm on the 29th caused widespread power outages in western WA from broken limbs and downed trees. Wind gusts were between 40 and 65 mph in western WA, and mostly in the 30s and 40s in eastern WA. It was a very strong system for the time of year, and there were even two deaths due to falling trees. Both the recent drought conditions and the summer foliage on trees likely exasperated the damage (see article). Daily rainfall records were set at SeaTac Airport (1.28") and the Seattle Weather Forecast Office (1.28") on the 29th, and then again at SeaTac on the 30th (0.40"). Rain even fell in eastern WA on the 30th, with as much as 0.30" in Spokane county, though totals elsewhere were much less.

Drought Update

Though the recent precipitation has certainly helped the drought situation, especially in western WA, we are by no means in the clear. Despite the wet August, summer precipitation deficits still reach up to 6" in some parts of western WA and the increased streamflows are expected to be temporary. The Seattle, Everett, and Tacoma utility districts are still urging voluntary water conservation efforts, for example. Still, the recent precipitation in western WA has prompted some improvement on the US Drought Monitor for the drought designation on the Olympic Peninsula; the Peninsula is now in "severe drought" as opposed to "extreme drought". Since the last edition of the OWSC newsletter, however, the area of "extreme drought" has been expanded to include all of eastern WA due to continued low streamflows, little precipitation, and warm summer temperatures. OWSC produces a weekly drought monitoring report on statewide weather and hydrological conditions as well as drought impacts, which can be referenced for more details.

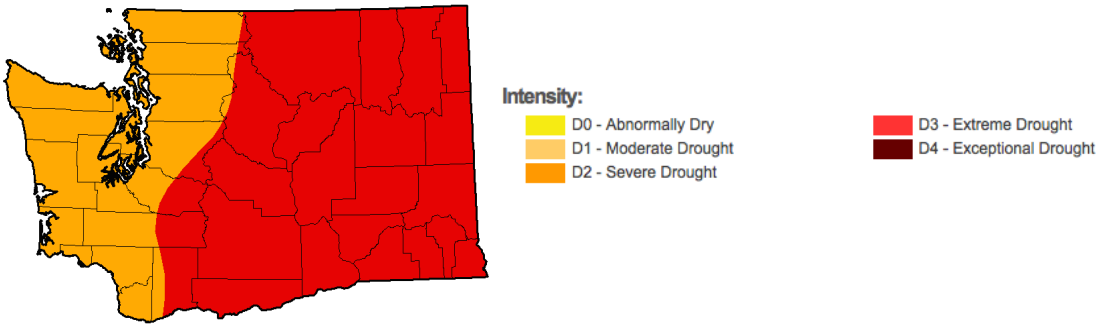


Figure 1: The 1 September 2015 edition of the US Drought Monitor (http://droughtmonitor.unl.edu/).

The Yacolt Burn of 1902

A message from the State Climatologist

This summer has included the largest fire (the Okanogan Complex) in WA state history and the most acres burned since at least 2002. The vast majority of wildfires in WA occur east of the Cascade Range crest but that is not the only part of state that can face a serious threat. In particular, prior to 2014, the largest fire in state history burned on the west flank of Cascades, the so-called Yacolt Burn of September 1902, which burned over 238,000 acres. There was little capability to fight large wildfires at that time, and the property damages and loss of life were exacerbated by the lack of reliable communication. On the other hand, the weather generally plays a critical role in severe fires in the Pacific Northwest (Gedalof et al. 2005) and it appears the Yacolt Burn was no exception. Our objective here is to briefly summarize conditions during the Yacolt Burn and determine how often similar conditions have arisen in recent decades.

The history of the Yacolt Burn is not fully known. It appears that the first fires may have begun in Oregon on 8 September, with embers crossing the Columbia into Washington state. Another fire started a day or two later near Stevenson, WA in the Columbia River gorge. It definitely seems that there were multiple points of ignition with separate fires merging into the conflagration. More detail on the Yacolt Burn is available at the following websites, among others: Clark County Government and History Link.

The temperatures in the region of interest were abnormally warm but not extremely hot before and during the fire. The maximum temperatures from three nearby stations, Centralia and Vancouver, WA and Hood River, OR during the first 12 days of month were typically in the 80s or 6 to 8°F above normal, and no daily records were set. The historical accounts of this event generally include mention of strong east winds, and one description used the term "devil wind from eastern Washington". Because of the probable importance of the east winds to the severity of the Yacolt Burn, here we will focus on that aspect of the regional weather conditions.

The NCEP 20th Century Reanalysis is used to document the regional flow at 850 hPa for the Yacolt Burn, and to identify other strong easterly events in the recent record (back to late 1940s). This product has a coarse spatial resolution and cannot be used to specify details in the specific location of the fire. Presumably it is suitable for comparing regional aspects of the circulation during the Yacolt Burn with similar events in the historical record. The distribution of mean 850 hPa geopotential height (Z) for the 3 days of 9-11 Sept 1902 is shown in Figure 2. This pattern was associated with a mean easterly wind of ~5 m/s in the general region of the fire. There was also a thermally-induced trough of low sea level pressure (SLP) at the coast (not shown); a hint of this feature is in the 850 hPa Z map included here.

As indicated above, the zonal winds at 850 hPa are used to ascertain when conditions comparable to those of the Yacolt Burn have occurred in recent decades. Specifically, 3-day average values of the zonal winds (U) at 850 hPa in SW WA were computed during the period of 15 August through 15 September for the years 1948 through 2014 in the region of the Yacolt fire.

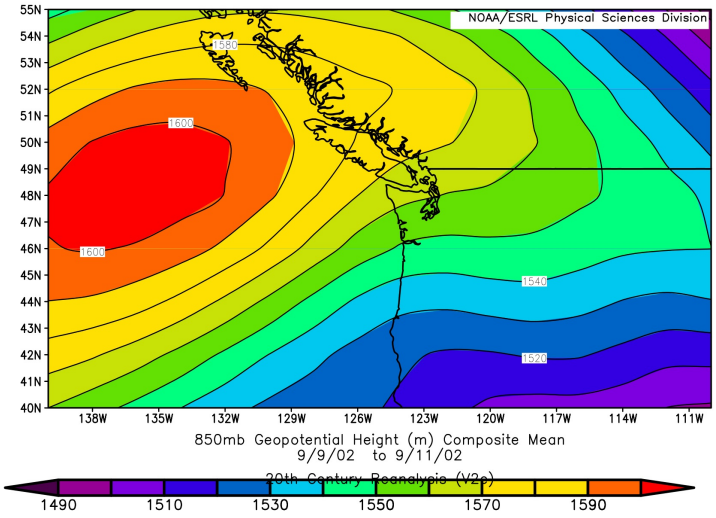


Figure 2: The 850 hPa geopotential heights (Z) for 9-11 September 1902 from the NCEP 20th Century Reanalysis.

Date	850 hPa U (m/s)	500 hPa Z (m)	1000 hPa Temperature (°C)
10 Sept 1902	-5	5910	27
8 Sept 1948	-4	5870	23
5 Sept 1949	-4	5860	27
14 Sept 1951	-4	5870	26
8 Sept 1960	-4.5	5880	21
12 Sept 1961	-4.5	5780	24
24 Aug 1966	-4	5850	26
14 Sept 1967	-6	5860	22
12 Sept 1988	-5	5890	22
8 Sept 1989	-4	5880	23
12 Sept 2014	-5	5840	20

Table 2: The historical cases of strong 850 hPa zonal winds during August 15 to September 15. Note: The 850 hPa U and 1000 hPa T refer to the region of southwest WA in the vicinity of the Yacolt Burn; the 500 hPa Z refers to the maximum Z at the axis of the ridge (typically west of the coastline).

The 3-day periods with the 10 strongest mean easterly flow were examined individually. Table 2 itemizes the dates of these events, and approximate values for the 3-day means of the easterly flow (U) at 850 hPa, peak magnitude of 500 hPa ridge (Z), and 1000 hPa air temperature.

The cases identified on the basis of 850 hPa zonal winds can give insight into the conditions present during the Yacolt Burn. The atmospheric conditions during Yacolt Burn were more extreme than might be supposed based on surface air temperatures alone. There was one event found since the late 1940s with stronger east winds at the 850 hPa level (14 Sept 1967), but this case also included more moderate air temperatures. Our selection process revealed that strong easterlies are much more likely in early September than in late August. While temperatures are cooling off this time of year on average, the increased likelihood of winds promoting the growth of fires, and in many cases the continued drying of the landscape, may make early September the period of greatest fire threat west of the Cascade crest. Perhaps the rain we are receiving from the end of August into September 2015 is especially timely.

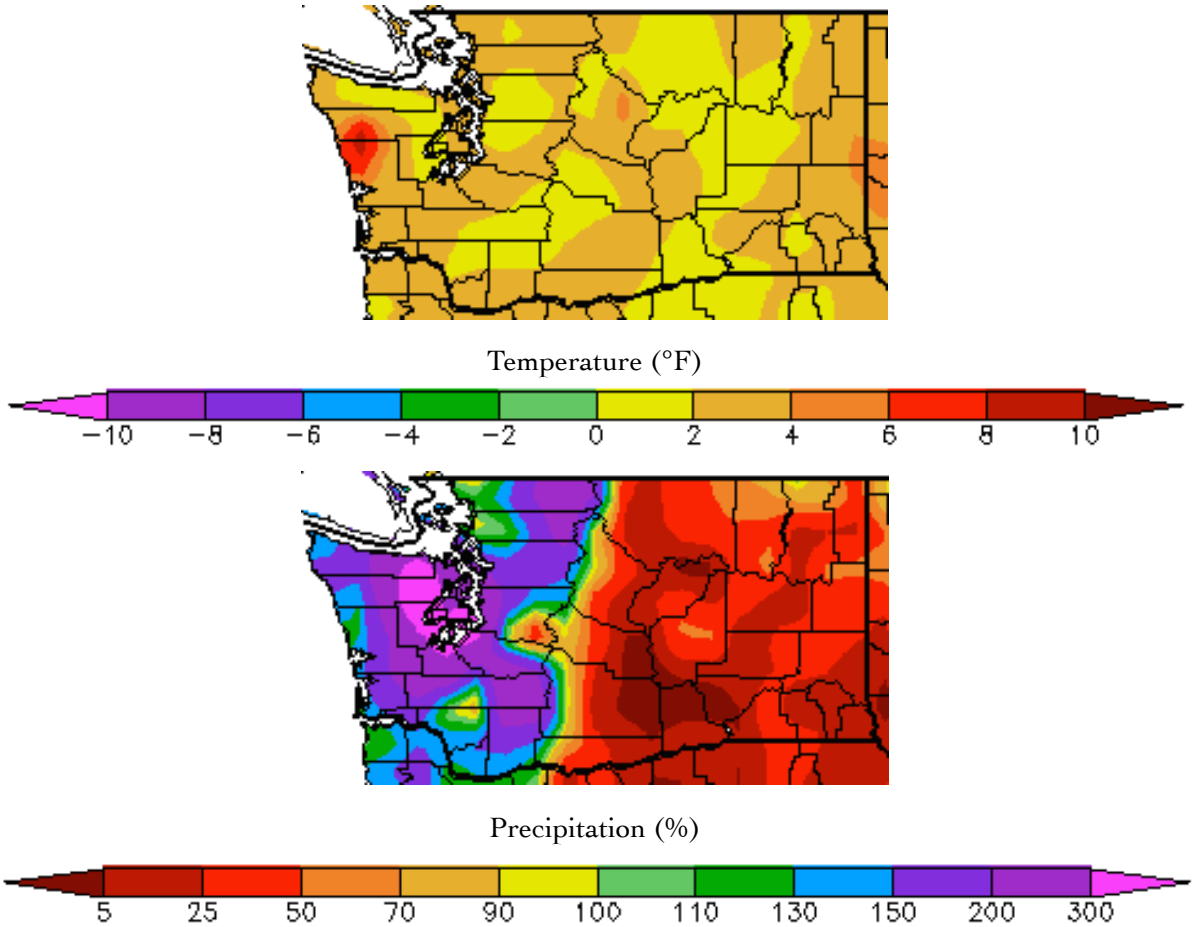
Reference:

Gedalof, Z., D.L. Peterson and N.J. Mantua (2005): Atmospheric, climatic and ecological controls on extreme wildfire years in the northwestern United States. *Ecological Applications*. 15: 154-174.

Climate Summary

Mean monthly August temperatures were warmer than normal throughout the entire state, but the anomalies are not as large in magnitude as previous months this summer. According to the map from the High Plains Regional Climate Center, average August temperatures were between 2 and 4°F above normal for most of the state. A few of the locations in listed in Table 3 were closer to normal, with Omak and Pasco only 1.2 and 1.0°F above normal, respectively. The smoke in the former location may have been dense enough to limit solar heating.

Total August precipitation was drastically different for the two halves of WA State: western WA received well above normal precipitation, with values exceeding 300% of normal, while eastern WA remained much drier than normal, receiving less than half of typical August precipitation. Hanford was a dry spot, and didn't receive any precipitation during the month. Wenatchee and Pasco only received 10 and 11% of normal precipitation, respectively. Meanwhile, two periods of heavy rain in western WA during the month brought totals to over 300% of normal at Olympia, Seattle, and the eastern Olympic Peninsula. The rest of western WA received between 130 and 300% of normal August precipitation.



August 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)		
	Average	Normal	Departure from Normal	Total	Normal	Percent of Normal
Western Washington						
Olympia	66.2	64.1	2.1	2.84	0.94	302
Seattle WFO	68.4	66.5	1.9	2.70	0.97	278
SeaTac AP	68.7	66.1	2.6	3.28	0.88	372
Quillayute	62.8	59.6	3.2	4.05	2.49	163
Hoquiam	63.3	60.6	2.7	1.77	1.31	135
Bellingham AP	64.5	65.8	3.3	1.53	1.23	124
Vancouver AP	71.2	69.2	2.0	0.55	0.77	71
Eastern Washington						
Spokane AP	72.5	69.3	3.2	0.18	0.59	31
Wenatchee	76.9	73.5	3.4	0.02	0.20	10
Omak	73.6	72.4	1.2	0.17	0.49	35
Pullman AP	67.8	65.7	2.1	0.15	0.63	24
Ephrata	75.2	72.9	2.3	0.09	0.19	47
Pasco AP	73.8	72.8	1.0	0.03	0.27	11
Hanford	77.9	75.8	2.1	0	0.18	0

Table 3: August 2015 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 is alive and well in the tropical Pacific, and sea surface temperature (SST) anomalies in each of the Niño monitoring regions are above normal, according to the Climate Prediction Center (CPC). The weekly SST anomalies exceed 2°C in the central and eastern equatorial Pacific and these anomalies have persisted over the last 4 weeks as well. The "El Niño Advisory" released on 5 March is still in effect. There is about a 90% chance that El Niño conditions will continue through next winter (2015-16), and most ENSO models have the Niño3.4 anomaly staying above 1°C.

The CPC seasonal outlook for September is calling for increased chances of above normal temperatures statewide. September precipitation is more uncertain: there are equal chances that there will be below, equal to, or above normal precipitation for most of the state. In other words, each outcome is assigned a 33% chance of occurring. The odds of below normal precipitation are slightly elevated for the southern portion of the state.

The September-October-November (SON) CPC outlook is calling for higher than normal temperatures statewide, with the odds of warmer temperatures exceeding 60% for the western two-thirds of the state. For precipitation, there are higher chances of below normal precipitation for the entire state.

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

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