



Office of the Washington State Climatologist

October 2017 Report and Outlook

October 5, 2017

<http://www.climate.washington.edu/>

September Event Summary

Average September temperatures were above normal for nearly the entire state, marking the 5th consecutive month with unusually warm conditions. The temperature anomalies were larger in western WA, while there were a few locations in eastern WA with near-normal temperatures. In fact, several locations in western WA had average monthly temperatures in the top 10 (Table 1), with coastal WA being an exception. As for precipitation, a majority of the state was drier than normal for September. Some locations, such as the southern portion of WA and some eastern WA locations, had near to above normal precipitation (specific information can be found in the “Climate Summary” section below).

With the warm and dry conditions, there’s little weather to discuss for the month. Figure 1 shows the September daily temperatures and precipitation totals from Spokane Airport. The main highlights for the month are the warm periods over Labor Day weekend and at the end of the month (27 & 28th), as well as the cool/wet period from the 17th to the 21st, as shown in the Figure. Some daily record high temperatures were broken over Labor

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Day weekend, and SeaTac Airport recorded two 90 degree days, tying 1967 and 1988 with the highest number of 90 degree days in September on record. A rapid change in weather at the end of the second warm period on the 29th was accompanied by a shelf cloud that moved through

| Station | Average Sept Temperature (°F) | Rank | Record (Temperature/Year) | Records Began |
|---------------------------|-------------------------------|------|---------------------------|---------------|
| SeaTac | 64.7 | 3 | 65.7; 1967 | 1945 |
| Olympia | 61.5 | 7 | 63.2; 1974 | 1948 |
| Elma | 64.4 | 3 | 65.2; 1967 | 1896 |
| Bellingham Airport | 60.9 | 4 | 60.9 | 1949 |

Table 1: Average September temperature, the ranking (warm to cold), the warmest September on record, and the record length for some Western WA stations.

the Olympic Peninsula with the cool air replacing the warm air. Pictures can be found on Scott Sistek's (KOMO) [blog](#).

During the cooler period mid-month, some records were set in eastern WA. Spokane Airport tied their record low maximum temperature on the 19th (51°F), a high temperature that was 21°F below the normal. Kennewick had a record daily maximum precipitation amount of 0.38" on the 21st.

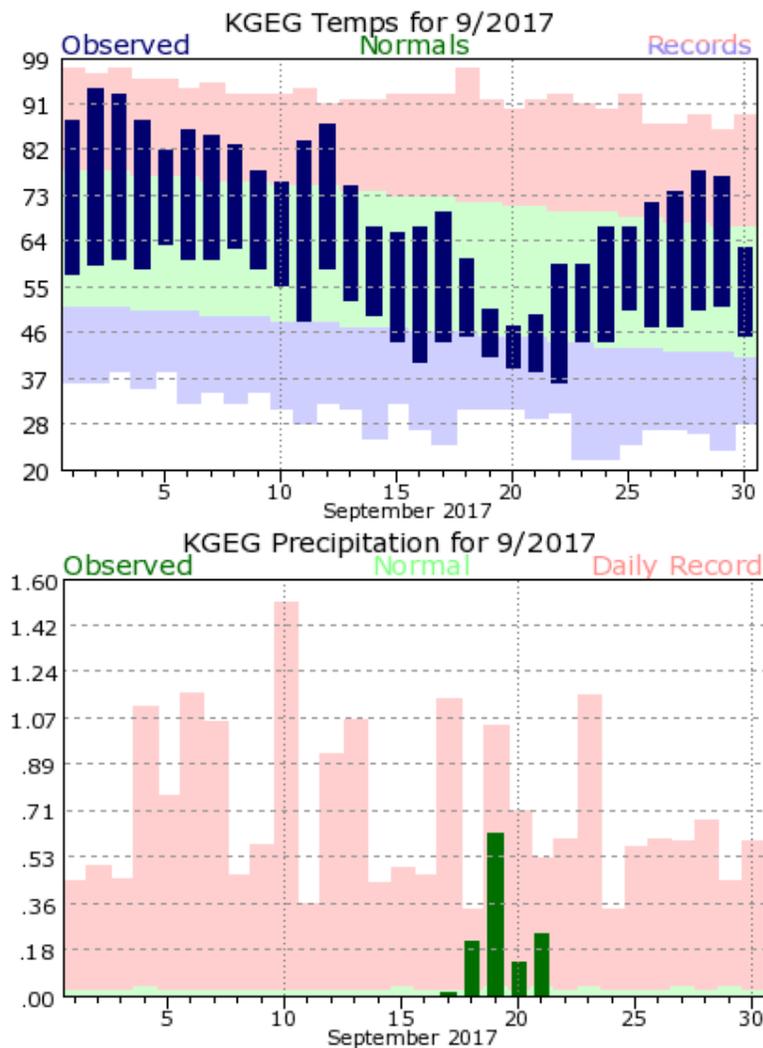


Figure 1: September 2017 daily maximum and minimum temperatures (blue bars; top) and daily total precipitation (green bars; bottom) for Spokane Airport. The green envelope represents the daily normals while the red and blue envelopes show the records (from NWS).

Drought and Streamflow Update

Continued warm and dry conditions in September worsened the depiction of WA state on the US Drought Monitor (Figure 2). The entire state was covered with the “abnormally dry” category in last month’s newsletter, but “moderate drought” was introduced into most of the state in September. This was primarily due to lack of precipitation, low soil moisture, warm temperatures, and low streamflows. The latest (5 October) Drought Monitor scaled back the level of drought on the coast and in southwest WA present in mid-September due to some long awaited precipitation.

The 28-day average streamflows ending on October 3 from USGS are depicted in Figure 3. There are still below normal to much below normal streamflows throughout western WA as we wait for consistent fall rains to return to our region.

● D0 (Abnormally Dry) ● D2 (Severe Drought) ● D4 (Exceptional Drought)
● D1 (Moderate Drought) ● D3 (Extreme Drought)

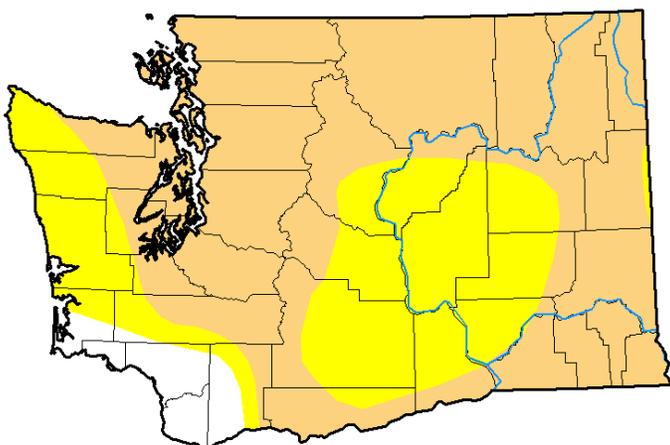


Figure 2: The 5 October 2017 edition of the US Drought Monitor.

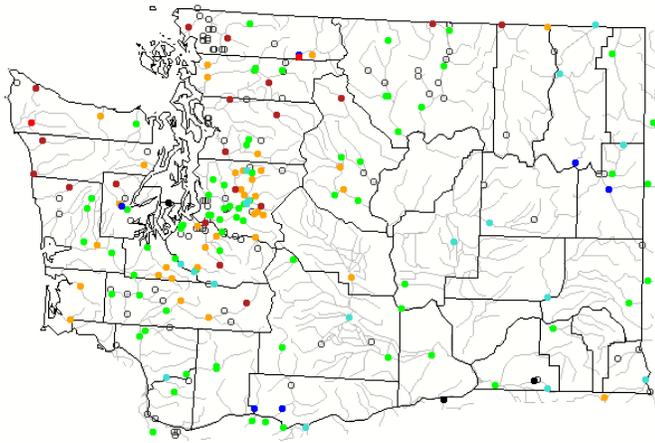


photo by Henry Reges, CoCoRaHS

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

Happy New Water Year!

October 1 marks the beginning of the 2018 water year, which will run through the end of September 2018. The fresh water year is the perfect time to start recording your precipitation observations if they’ve lapsed. With fall rain on the way, there should be plenty of opportunities to read your rain gauge. As always, if you know someone that may be interested in measuring precipitation in their backyard, please encourage them to visit www.cocorahs.org to sign up as a volunteer. And thank you to all of our CoCoRaHS volunteers for entering those summer zeros!



| Explanation - Percentile classes | | | | | | | |
|----------------------------------|--------------------------|-----------------------|-----------------|-----------------------|--------------------------|------|------------|
| ● | ● | ● | ● | ● | ● | ● | ○ |
| Low | <10 Much below normal | 10-24 Below normal | 25-75 Normal | 76-90 Above normal | >90 Much above normal | High | Not-ranked |



Figure 3: The 28-day average streamflow as of 3 October 2017 for WA (from USGS).

Western WA Summer Smoke and Air Quality

A message from the State Climatologist

The past summer has been quite remarkable in the Pacific Northwest. Averaged over WA State, the June through August average temperatures ranked as the 4th warmest in the historical record with temperatures 2.6°F above the 1981-2010 normal. Total June through August precipitation also ranked in the top 10, coming in as the 7th driest for WA State with over a 2” rainfall deficit compared to normal. But aside from the temperature and precipitation stats, this past summer was also distinct for the amount of wildfire smoke that lingered over the state. The summer air quality is explored here.

While smoke is present at least somewhere in the state in a typical summer, the smoke and associated poor air quality for this past summer was certainly the worst its been in recent memory for western WA. There were more smoky, hazy days than usual, with ash from fires settling outside on

vehicles and on open windowsills on several occasions. The concentration of PM_{2.5}, or particulates less than 2.5 micrometers in size, is one measure of air quality and is explored here. These small particles are hazardous to human health, and their small size allows them to get deep into a person’s lungs where they can cause a variety of health problems.

An example of PM_{2.5} concentrations for a monitoring station in Kent is shown in Figure 4. Hourly PM_{2.5} values are shown from July 1 through September 24 for both 2017 and 2015. 2015 is used as a comparison because it is the worst fire season in WA since the National Interagency Fire Center (https://www.nifc.gov/fireInfo/fireInfo_statistics.html) started keeping comparable records in 2002. The final fire acreage numbers for WA fires in 2017 are not yet available at the time of this writing, but we do not expect 2017 to be a record

year. There were serious fires, but many of the poor air quality days in western WA were actually due to fires in British Columbia or Oregon. Figure 4 also shows the air quality index (AQI) on the y-axis that corresponds to the PM_{2.5} concentration, ranging from “good” (green), to “moderate” (yellow), to “unhealthy for sensitive groups” (orange), to “unhealthy” (red) levels.

The difference between 2015 and 2017 is marked. There were 3 separate incidences of PM_{2.5} values reaching levels that were either unhealthy for sensitive groups or unhealthy for all groups during the 3-month period in 2015, and those events lasted 2 days at most. On the other hand, 2017 had 5 separate incidences of unhealthy air as defined by PM_{2.5}, and one of those events lasted for 11 days (August 1-11 with 1 day of lower pollution on the 5th). So, those of us in western WA weren’t imagining it – the smoke and air quality really was worse than usual this past summer.

Despite the poor air quality this summer, annual average PM_{2.5} levels have been improving in the long-term. The declines are due to winter declines in PM_{2.5} as there is little systematic change in summer trends. Figure 5 doesn’t include 2017, but Northwest annual PM_{2.5} has decreased since 2000 by 40%. This is largely due to national and local monitoring and regulations such as those in place by the EPA. More information on winter PM_{2.5} levels was presented in our November 2016 newsletter, and includes a longer local record winter PM_{2.5} time series.

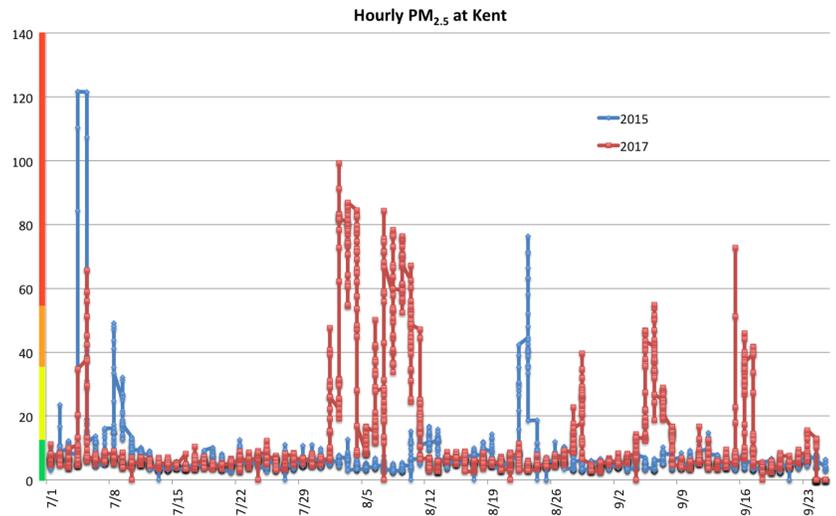
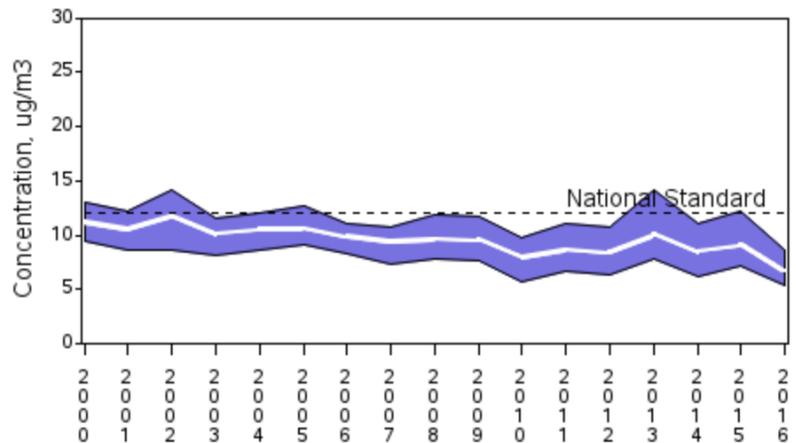


Figure 4: Hourly PM_{2.5} concentrations (in micrograms/m³) at Kent for 2015 (blue) and 2017 (red) from July 1 through September 24 from the Puget Sounds Clean Air Agency. The colors on the y-axis show the Air Quality Index that corresponds to the PM_{2.5} concentration. Green is “good”, yellow is “moderate”, orange is “unhealthy for sensitive groups”, and red is “unhealthy”.

PM_{2.5} Air Quality, 2000 - 2016
(Seasonally-Weighted Annual Average)
Northwest Trend based on 11 Sites



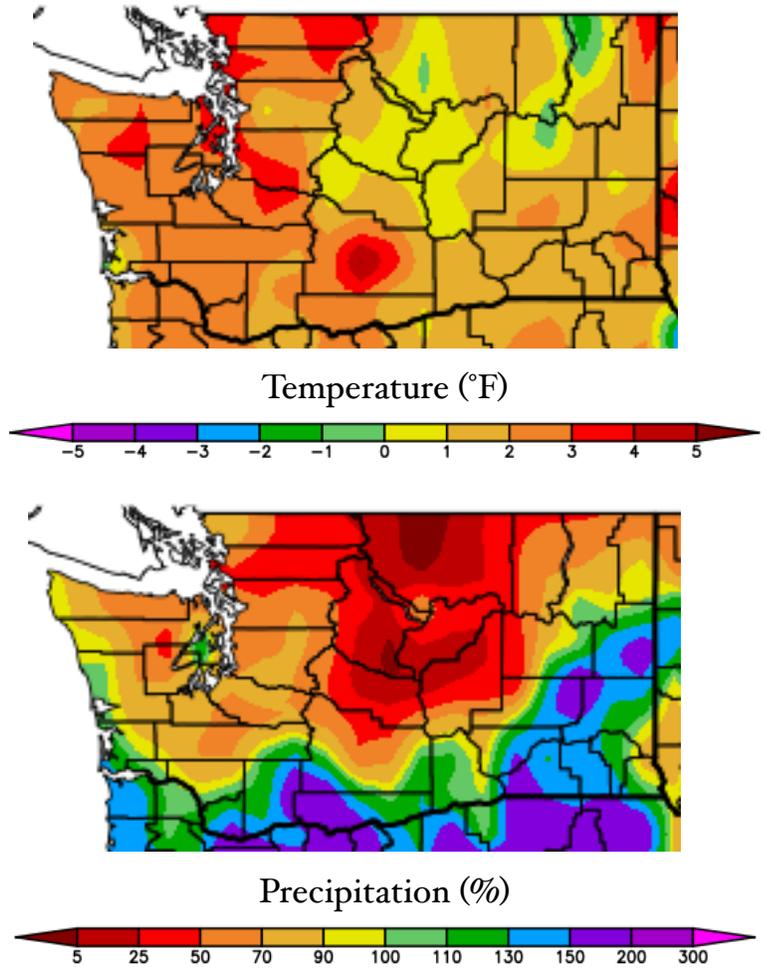
2000 to 2016 : 40% decrease in Regional Average

Figure 5: Annual average PM_{2.5} concentrations (micrograms/m³) for the Northwest (WA, OR, and ID) from 2000 through 2016 from the [EPA](#).

Climate Summary

Mean September temperatures were above normal throughout WA State. Western WA temperature anomalies were larger, with temperatures between 2 and 4°F above normal (Table 2). Temperatures east of the Cascades were closer to normal, but still elevated. Pullman was a warm spot, with September temperatures 3.1°F above normal, while temperatures in Spokane were 2.0°F above normal.

Total September precipitation was below normal for a large majority of the state. North central WA, for example, received less than 25% of normal precipitation. Wenatchee and Omak only recorded 6 and 17% of normal precipitation, respectively (Table 2). On the other hand, coastal WA, the southern portion of the state, and parts of Eastern WA saw normal to above normal precipitation for the month - a welcome change from the dry summer. Vancouver and Spokane received 164 and 181% of their normal precipitation, respectively (Table 2).



September temperature (°F) departure from normal (top) and precipitation percent 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 | % of Normal |
| Western Washington | | | | | | |
| Olympia | 61.5 | 58.9 | 2.6 | 1.24 | 1.71 | 73 |
| Seattle WFO | 64.9 | 61.6 | 3.3 | 1.10 | 1.52 | 72 |
| SeaTac AP | 64.7 | 61.3 | 3.4 | 0.59 | 1.50 | 39 |
| Quillayute | 59.1 | 56.6 | 2.5 | 3.79 | 3.82 | 99 |
| Hoquiam | 61.1 | 58.7 | 2.4 | 2.63 | 2.28 | 115 |
| Bellingham AP | 60.9 | 57.2 | 3.7 | 1.76 | 1.78 | 99 |
| Vancouver AP | 66.1 | 63.6 | 2.5 | 2.56 | 1.56 | 164 |
| Eastern Washington | | | | | | |
| Spokane AP | 62.2 | 60.2 | 2.0 | 1.21 | 0.67 | 181 |
| Wenatchee | 65.1 | 64.4 | 0.7 | 0.02 | 0.34 | 6 |
| Omak | 63.9 | 62.6 | 1.3 | 0.10 | 0.58 | 17 |
| Pullman AP | 61.3 | 58.2 | 3.1 | 0.68 | 0.78 | 87 |
| Ephrata | 64.6 | 63.8 | 0.8 | 0.09 | 0.36 | 25 |
| Pasco AP | 65.2 | 63.4 | 1.8 | 0.13 | 0.40 | 33 |
| Hanford | 67.6 | 66.4 | 1.2 | 0.29 | 0.31 | 94 |

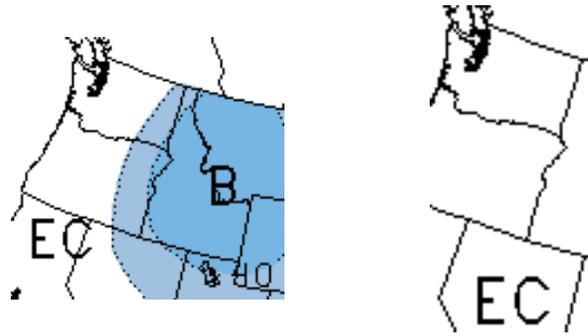
Table 2: September 2017 climate summaries for locations around Washington with a climate normal baseline of 1981-2010. Note that the Vancouver Pearson Airport and Seattle WFO 1981-2010 normals involved using surrounding stations in estimating the normal, as records for these station began in 1998 and 1986, respectively.

Climate Outlook

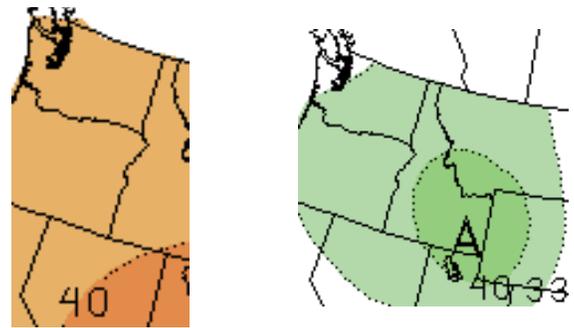
According to the Climate Prediction Center (CPC), ENSO-neutral conditions are still present in the equatorial Pacific. Sea-surface temperatures (SSTs) are below normal throughout the region, and have been that way for several weeks. There has been some cooling in the eastern tropical Pacific over that time period as well. A “La Niña Watch” was issued by the CPC in mid-September due to cooling sub-surface ocean temperatures, stronger than usual easterly trade winds, and several key ENSO forecast models beginning to favor La Niña development. There is currently a 55-60% chance that a La Niña will develop in the coming months, which is a change from the neutral conditions initially expected for winter 2017-18.

The CPC seasonal outlook for October is calling for increased chances of below normal temperatures for a portion of eastern Washington. The rest of the state has equal chances of below, equal to, or above normal temperatures for October. October precipitation is also a toss up: there are equal chances of below, equal to, or above normal precipitation.

The October-November-December (OND) CPC outlook is calling for above normal temperatures for the entire state and for nearly the entire U.S. The CPC outlook is calling for above average precipitation for almost the entire state for OND. The exception is the Olympic Peninsula and northern Puget Sound regions, where there are equal chances of below, equal to, or above normal precipitation totals for the 3-month period.



October outlook for temperature (left) and precipitation (right)



October-November-December outlook for temperature (left) and precipitation (right)