Office of the Washington State Climatologist

November 4, 2013

October Event Summary

The average October conditions in WA State were the opposite of those experienced in September. Records were set for the wettest September last month in some locations; in contrast, October was very dry statewide. In addition, September was warm across the state on average, while October was colder than normal. Table 1 shows some examples of stations around the state that ranked in at least the top twelve driest Octobers. The lack of October precipitation at Pasco (0.04") ranked as the driest October on record there since records began in 1945. Also note that October 1987 was the record driest for many of the stations listed in Table 1. That year featured a particularly long summer that stretched into October for many locations.

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Station	Oct 2013 Precipitation	Rank	Record Low Precip/Year	Records Began
Pasco	0.04"	1	-	1945
Spokane AP	0.09"	5	T; 1895	1881
Hoquiam	2.26"	5	0.06"; 1987	1953
Mazama	0.19"	5	0.01"; 1987	1950
Quillayute	3.15"	8	1.37"; 1987	1966
Pullman 2 NW	0.46"	9	0"; 1987	1940
Omak	0.07"	9	0.01"; 1978	1909
SeaTac	1.54"	11 (tie)	0.31"; 1987	1948
Yakima	0.13"	11	0"; 1978	1946
Everett	1.43"	12	0.08"; 1987	1894
Olympia	2.13"	12	0.39"; 1987	1948

Table 1: October 2013 precipitation, the ranking (driest to wettest), the record driest and year of occurrence, and the year that records began at each station.

This year, an extensive period with high pressure at upper levels over us resulted in a dry spell for much of the month. Rather than summer-like conditions, this pattern brought colder than normal temperatures at the surface along with persistent fog. The strong temperature inversion at the surface (where temperatures

increase with height) resulted in warm and sunny days in the mountains at locations above the fog and low clouds. This pattern persisted for two weeks; for example SeaTac had 14 consecutive days without even a trace of precipitation. According to the National Weather Service Seattle Office, that ranked as the 3rd longest streak of completely dry days in October. The longest was 21 days in October 1986.

As noted in the last edition of the OWSC newsletter, October tends to be the foggiest month of the year in WA. This was certainly the case this year. Spokane Airport reported 9 days of heavy fog (visibilities less than a quarter mile) - typically, that station averages about 3 days of dense fog during October. The SeaTac Airport observations are even more impressive. There were 12 days in October that included a period of heavy fog, which is a much higher total than the typical 4 days. But finally, Olympia wins the dubious honor of foggiest location: 24 days of heavy fog were recorded there in October, well above the typical 11 days.

The Fifth Assessment Report (AR5) from the Intergovernmental Panel on Climate Change

A message from the State Climatologist

The Intergovernmental Panel on Climate Change (IPCC) has produced a series of reviews of the state of the global climate and its expected changes. Portions of the Fifth Assessment Report (AR5) from the IPCC have been made available recently. In particular, a summary for policy makers and a draft report from Working Group 1 entitled "Climate Change 2013: The Physical Science Basis" were released on 27 September 2013. These publications represent the tremendous effort of hundreds of international scientists with a wide range of expertise, and involve an elaborate process of review and revision. The draft report from Working Group 1 runs more than 2000 pages; the technical summary alone exceeds 100 pages (available here: http://www.ipcc.ch/). We expect that most of the readers of this newsletter will not be plowing through the entire report and while any sort of summary we can include here could not possibly do it justice, we hope that providing a few tidbits might be appreciated. These excerpts pertain to both the global climate system as a whole, and the Pacific Northwest from a regional perspective.

In terms of the big picture, AR5 features the strong statement that warming of the climate system since the late 19th century is "unequivocal". An interesting wrinkle here is that the warming of the ocean accounts for more than 90% of the increase in energy stored in the atmosphere-ocean climate system since 1970. The state of the cryosphere (i.e., snow, ice sheets, glaciers, etc.) has received considerable recent attention, and there is high confidence that over the last two decades there have been declines in the mass of the Greenland and Antarctic ice sheets, shrinkage in glaciers in a global sense, a decrease in Arctic sea ice during summer, and less snow cover in the Northern Hemisphere in spring. Projections of the future climate rely primarily on the output from global climate models. It is asserted that these models have been improved since the last report (AR4) in 2007. That being said, while they are able to reproduce observed temperature patterns on continental scale they are not as ca-

pable with respect to precipitation. On the topic of precipitation, projected changes in the water cycle will be far from uniform, with a consensus of the models suggesting increases in general at higher latitudes and mostly decreases in already dry regions in the sub-tropics. The expected rises in sea level will occur at a greater rate than indicated in AR4 due to better account of contributions from glaciers and ice sheets. While there is substantial uncertainty in the rate of warming over the next century, the eventual total response with respect to global mean temperatures will be determined by the cumulative emissions of greenhouse gases.

The hiatus in global warming over the last 15 years is a hot topic (pun intended). In more concrete terms, the linear trend in global mean surface temperatures over that period was only about 1/3 to 1/2 of the trend for 1951-2012 as a whole. The recent weakening in the warming of the global climate (which was also manifested in the Pacific Northwest) was poorly simulated by the present generation of global climate models. AR5 attributes this discrepancy to a combination of internal climate variability, improper handling of the radiative forcing and other errors due to the models being too sensitive (by about 10%) to greenhouse gases, and other anthropogenic effects. It will be interesting, of course, to see how long this hiatus continues.

The model projections for the PNW indicate the likelihood of an increase in winter precipitation, and a decrease in summer precipitation, with a weaker consensus for the latter (Figure 1). The model results may be resolution-dependent, as illustrated by the differences found in an ensemble of runs from a single higher resolution model (right panels of Fig. 1). There is very little to go on with regards to any systematic changes in regional storm tracks (i.e., wind storms) in next few decades. A poleward shift in the storm track is more likely than not over the North Pacific by the latter half of the century. It is a good bet that there will be increases in the temperatures accompanying both heat waves and cold snaps. But our ability to project changes in frequency and magnitude of extreme events is limited because of shortcomings in the models' ability to simulate changes in key features of the circulation such as blocking. The various climate models used by IPCC have different historical climatologies in terms of blocking frequency vs. longitude (Figure 2). This matters to WA State because during winter for example, blocking at 130 W (230 E) usually means dry, stagnant conditions while blocking at 160 to 150 W (200 to 210 E) is often accompanied by the delivery of cold air out of Canada. Many of the models do not replicate the observed climatology of blocking particularly well, which may compromise the reliability of their projections of changes in blocking and other sorts of high-amplitude circulation features associated with extreme events in all seasons.

In closing, we would like to make a point we have made before, and that we feel is worth making again. It relates to the issue of the recent hiatus in warming brought up above. The intrinsic variability of the climate is substantial, especially for any particular region. This source of variability is liable to dominate the climate signal in the Pacific Northwest over the next couple of decades.

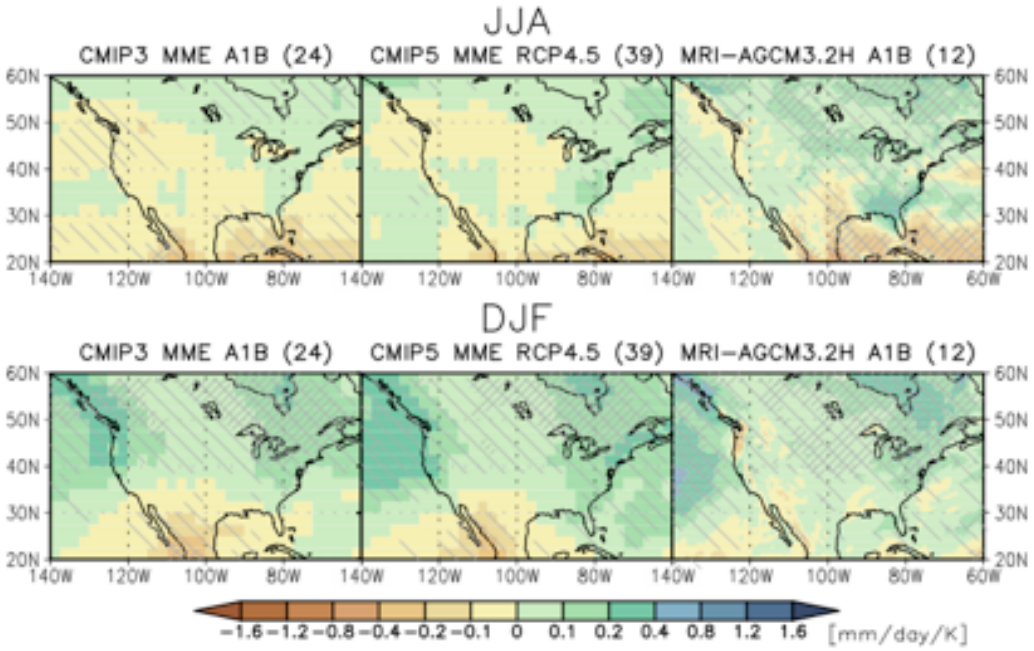


Figure 1: Changes in precipitation from the period of 1986-2005 to the period of 2080-2099 from ensembles of 24 CMIP3 models (left), 39 CMIP5 models (middle), and 12 members of the 60 km mesh MRI-AGCM3.2 model (right). All changes are normalized by the global mean temperature change in each scenario. The hatched lines show statistical significance. Adapted from Figure 14.8 from Chapter 14 of Working Group 1 (AR5).

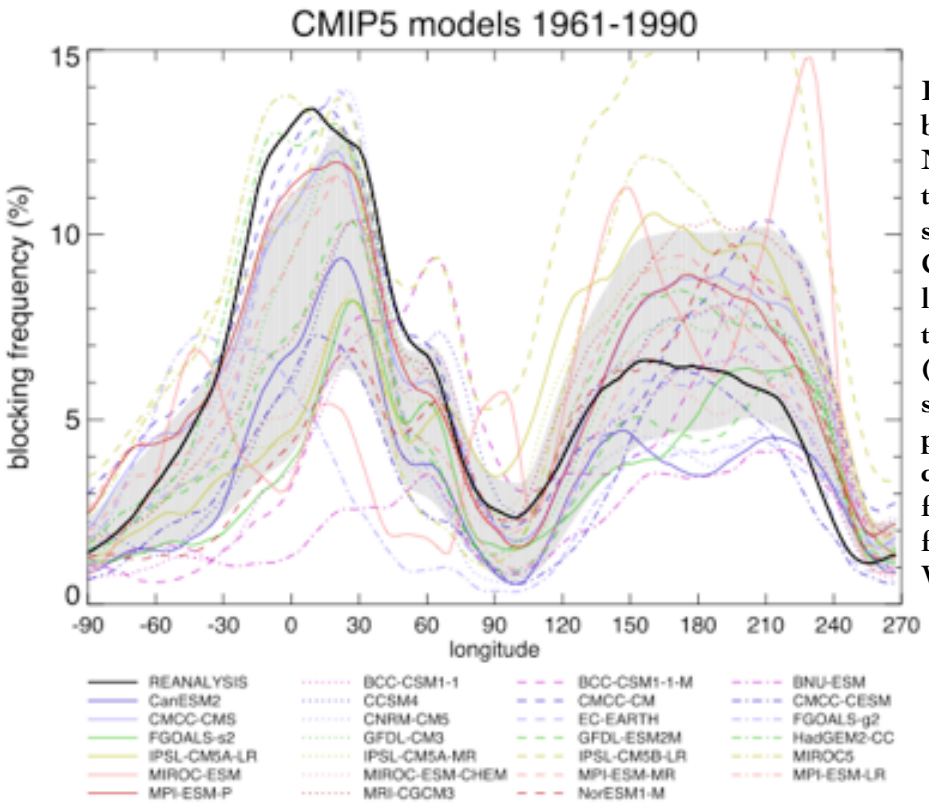
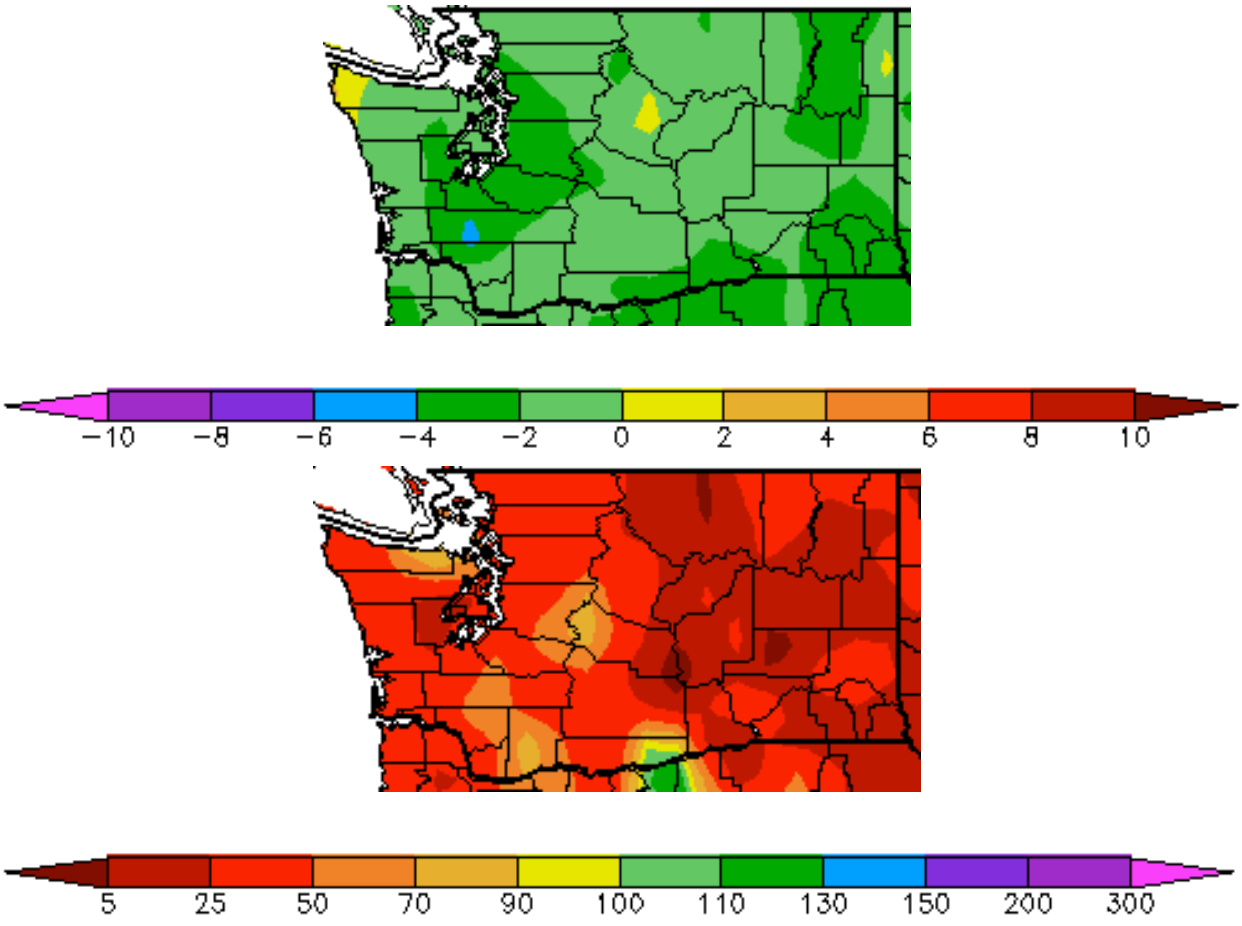


Figure 2: Annual mean blocking frequency in the Northern Hemisphere for the period of 1961-1990 as simulated by a set of CMIP5 models (color lines), and as derived from the NCEP Reanalysis (thick black line). Gray shading shows model mean plus and minus one standard deviation. Adapted from Box 14.2, Figure 1 from Chapter 14 of Working Group 1 (AR5).

Climate Summary

Mean October temperatures were generally below normal across WA State, according to the High Plains Regional Climate Center map below. Temperatures were particularly cool (between 2 and 4°F below normal) in the Puget Sound region where the fog and temperature inversion persisted for about two weeks. The Cascade Mountains and coast were closer to normal with a few spots even above normal for the month; the mountains were generally above the temperature inversion and fog, and the coast often experienced clearing of the low clouds. Quillayute, for example, had an average temperature that was 2.2°F above normal for the month (Table 2).

Total October precipitation was much lower than normal statewide, which is a stark contrast to the wetter than normal conditions experienced in September. The precipitation percent of normal ranged between 5 and 50% of normal for nearly the entire state. Pasco and Omak received a mere 6% of their normal October precipitation while areas west of the Cascades that typically receive much more October precipitation ranged between 30 and 50% of normal precipitation (Table 2).



October temperature (°F) departure from normal (top) and October 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	48.4	50.3	-1.9	2.13	4.60	46
Seattle WFO	51.2	53.3	-2.1	1.11	3.41	33
Sea-Tac	51.7	52.8	-1.1	1.54	3.48	44
Quillayute	52.2	50.0	2.2	3.15	10.49	30
Hoquiam	51.3	52.2	-0.9	2.27	6.53	35
Bellingham AP	49.1	49.8	-0.7	2.17	3.68	59
Vancouver AP	52.1	53.8	-1.7	1.12	3.07	36
Eastern Washington						
Spokane AP	45.7	47.6	-1.9	0.09	1.18	8
Wenatchee	50.2	50.9	-0.7	0.15	0.44	34
Omak	47.8	48.9	-1.1	0.07	1.10	6
Pullman AP	44.8	47.5	-2.7	0.15	1.34	11
Ephrata	50.0	50.5	-0.5	0.14	0.53	26
Pasco AP	49.1	51.9	-2.8	0.04	0.65	6
Hanford	52.5	53.1	-0.6	0.38	0.49	77

Table 2: October 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.

CoCoRaHS

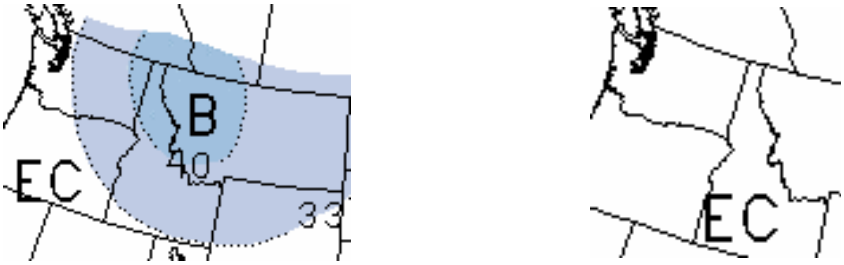
Thank you, Community, Collaborative, Rain, Hail, and Snow (CoCoRaHS) observers, for continuing to measure precipitation. The eastern WA Regional CoCoRaHS Coordinators are hosting a web-meeting on Tuesday, November 12 at 6 pm. The webinar will review winter precipitation measurement techniques and include a question-and-answer period. Registration is free, but required: https://www1.gotomeeting.com/register/186469761.

Climate Outlook

The conditions in the equatorial Pacific Ocean are ENSO-neutral, according to the Climate Prediction Center (CPC): http://www.cpc.ncep.noaa.gov/. Averaged over the last 4 weeks, sea-surface temperatures (SSTs) have been above normal in the western equatorial Pacific Ocean, and near-normal to below normal from the central to eastern equatorial Pacific. There is a consensus among the model predictions that near-neutral ENSO conditions will persist through the upcoming winter and into spring 2014.

The CPC three-class outlook for November has increased chances of below normal ("B" on the plot) temperatures for central and eastern WA. On the other hand, western WA has equal chances ("EC") of below, equal to, or above normal temperatures for November. The outlook for November precipitation is a toss up: there are equal chances of above, equal to, or below normal precipitation statewide. We would like to recognize that the CPC outlook got one wrong for the last edition of the OWSC newsletter. The precipitation outlook had high chances of above normal conditions for October, perhaps in the expectation that the extremely wet September conditions would persist, but it did not play out that way, to say the least.

The three-month temperature and precipitation outlook for November-December-January (NDJ) does not provide much to go on one way or another. The CPC outlook is indicating equal chances of below, equal to, or above normal temperatures and precipitation for the period.



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

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