August Event Summary

Average August temperatures were warmer than normal and total precipitation was greater than normal. This was especially the case in eastern WA where the abundant precipitation was a result of frequent thunderstorms. While on some occasions, these thunderstorms produced heavy rain, in other instances, they were dry and started wildfires. On August 9, for example, several lightning-caused wildfires started, and two of those large fires are still burning as of this writing - the Manastash Ridge fire (24 mi west of Ellensburg) and the Conrad Lake fire (35 mi SW of Naches).

The most interesting weather story of the month is the remarkably warm overnight temperatures experienced throughout the state. Table 1 shows the average August minimum temperature for several WA locations, the ranking (from warmest to coolest), and the year of either the record or subsequent record. Seattle Boeing Field, Kent, SeaTac Airport, and Quillayute all had the warmest monthly minimum temperatures since records began at each, with temperatures of 61.5, 60.1, 59.9, and 54.6°F, respectively. SeaTac Aiport, for example, had 16 nights where low temperatures did not get below 60°F, with the highest overnight temperature of 65°F (August 29). Vancouver measured a record daily high low temperature of 67°F on August 15. Nighttime temperatures were warm in eastern WA as well, with the average August minimum temperature in Spokane and Winthrop ranking as the 3rd warmest. Walla Walla had the warmest minimum temperature in our sample, 63.6°F, ranking 7th warmest since records began. It was quite
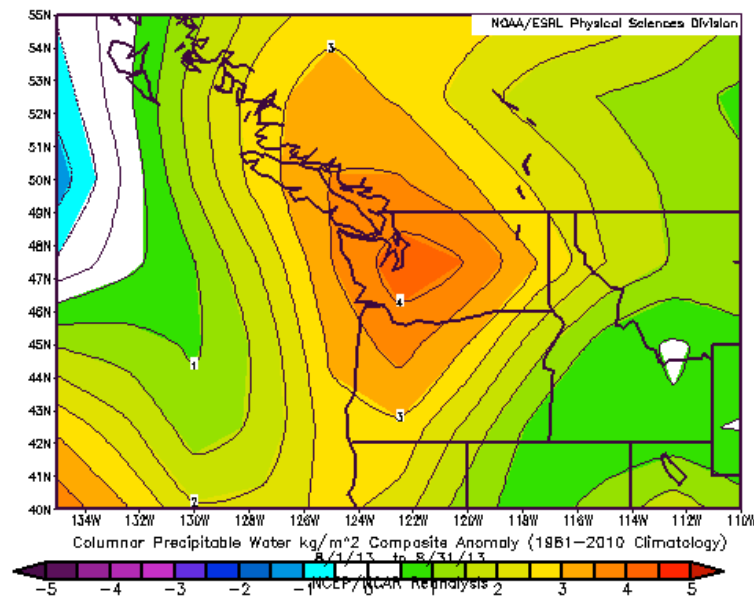

Figure 1: The precipitable water anomaly (kg m^{-2}) for August (from NOAA/ESRL).

humid for the region during much of the month, and this humidity contributed to both the warm nights and aforementioned thunderstorms. In quantitative terms, precipitable water content anomalies for August 2013 (Figure 1) were well above normal for the entire state. The magnitudes of these anomalies are equivalent to about 3-4 mm of rainfall, and indicate total water contents about 15-20% greater than usual.

Station	2013 Average Min T	Rank	Record; Year	Next Record; Year
SeaTac	59.9	1	-	58.4; 1967
Kent	60.1	1*	-	59.5; 2004
Seattle Boeing Field	61.5	1	-	60.2; 2004
Quillayute	54.5	1	-	54.1; 2004
Olympia	53.8	2	54.5; 2004	-
Spokane AP	59.4	3	59.7; 1915	-
Bellingham	56.5	3	57.6; 1977	-
Winthrop	52.4	3	58.6; 1917	-
Walla Walla	63.6	7	66.5; 1977	-
Omak	58.2	7	61.1; 2004	-

Table 1: The average August minimum temperature (in °F) and ranking for several WA stations. If August 2013 ranks as the warmest, the record that was broken is listed in the "Next Record" column. If the rank is greater than 1, the warmest average minimum temperature and year is listed in the "Record" column. *Note that Kent has 8 missing days of data so the record should be viewed with caution.

<u>C</u>ommunity <u>C</u>ollaborative <u>R</u>ain, <u>H</u>ail, and <u>S</u>now Network

Thank you, CoCoRaHS observers, for your reports during the thunderstorms in August - both the precipitation amounts and the comments are extremely valuable for building the historical weather record. As our rainy season approaches, be sure to spread the word about the program. We would love to have more observers throughout the state. Interested folks can sign up at www.cocorahs.org. All that is needed is a 4-inch diameter manual precipitation gauge (which can be purchased for less than $30) and internet access to submit reports. The CoCoRaHS gauge located at OWSC at the University of Washington recorded 1.23" for August - most of which fell during the last week of the month.

JISAO's Seasonal Ocean Prediction of the Ecosystem

A message from the State Climatologist

A coastal ocean prediction system, named J-SCOPE, has been recently developed for the coastal waters of the Pacific Northwest. J-SCOPE has been designed to provide quantitative forecasts of physical, chemical, and biological ocean properties on time horizons of up to 9 months. It represents a collaborative effort between researchers at the Joint Institute for the Study of the Atmosphere and Ocean (JISAO) and the Applied Physics Laboratory (APL) of the University of Washington, and at the Northwest Fisheries Science Center (NWFSC) of NOAA. The information from J-SCOPE is being used by NWFSC in its annual Integrated Ecosystem Assessment (IEA) for the waters of the Pacific Northwest. While a number of people have contributed to the development and implementation of J-SCOPE, Samantha Siedlecki of JISAO gets the lion's share of the credit for making it a reality.
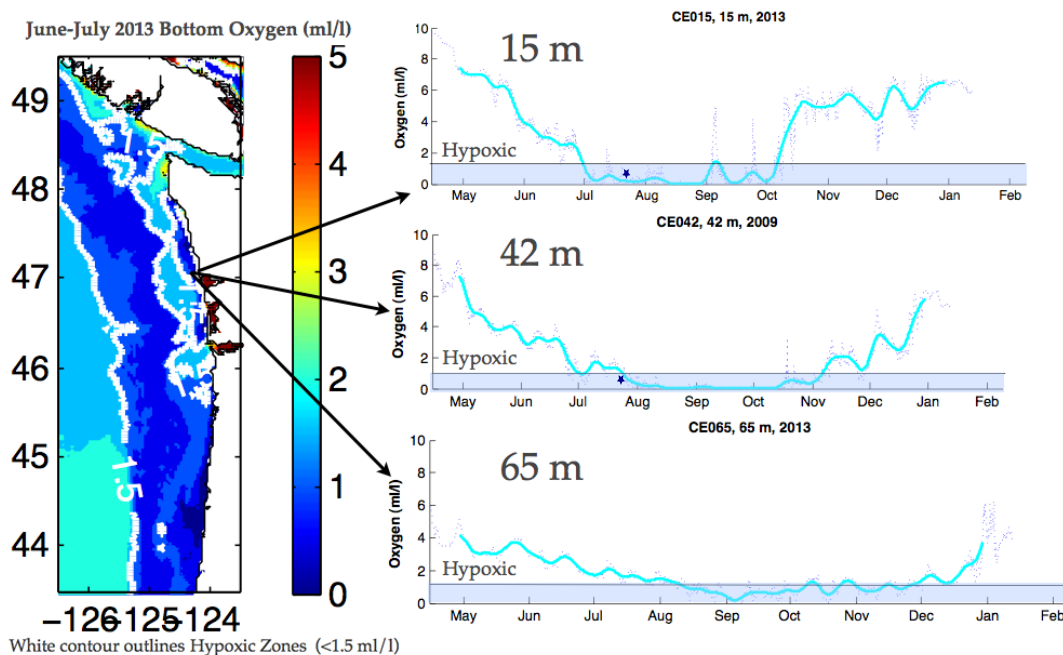
Figure 2: Oxygen concentrations (ml/liter) from the J-SCOPE model run of April 2013. The left panel indicates the distribution at near bottom depths for June-July 2013; the time series at the right show the projected declines in oxygen concentration at 3 depths in association with the up-welling winds of summer, and the recovery in fall. The stars on the forecasts for 15 and 42 meters represent observed values.

The J-SCOPE forecasts are based on numerical ocean model simulations using a high-resolution (grid spacing ~5 km) version of the Regional Ocean Modeling System (ROMS) with a biochemical component that simulates nutrient and oxygen concentrations and plank-

ton distributions. The initial and boundary conditions for the ROMS runs are from the Coupled Forecast System (CFS), which is a global coupled atmosphere-ocean model that is run operationally by NOAA/NCEP/CPC for use in seasonal weather prediction (occasionally mentioned in the "Climate Outlook" section of this newsletter). More information on J-SCOPE is available at the following website:
http://www.nanoos.org/products/j-scope/home.php. The projections from J-SCOPE are subject to limitations associated with the ROMS model, and by errors in the specification of the future large-scale forcing by the CFS. Nevertheless, the early results are promising, as illustrated below.

A sample set of J-SCOPE forecasts made in April 2013 is shown in Figure 2. Included here are time series of oxygen concentrations at three different depths, and a map of bottom oxygen concentrations for June-July 2013. Values less than 1.5 ml/liter, as signified on the map by the deeper blue colors, represent hypoxic (low oxygen) conditions stressful to many species. The model predictions were for hypoxia to form along the Washington coast sometime during July depending on depth, which is relatively early in the season. This projection turned out to be fairly accurate, as evidenced by measurements of oxygen concentrations from a moored buoy near Cape Elizabeth maintained by the Olympic Coast National Marine Sanctuary (shown with stars on the forecasts for the depths of 15 and 42 meters). In addition, there have been reports of unusually large numbers of dead Dungeness crabs on some Washington state beaches (Fig. 3). The forecasts begun in February 2013 indicated a similar timing for the onset of hypoxia. Perhaps it was a case of beginner's luck, but maybe it should be no surprise. As long as the climate forcing from the CFS is reasonably good, which has been found to be the case much of the time, ROMS should provide useful projections for the future chemical and biological states of our coastal waters.

J-SCOPE is more of an experimental rather than operational forecast system. Its principals are keen on acquiring the financial support necessary to not just maintain it beyond 2013, but to enhance it. Based on hindcasts of past conditions, as well as the forecasts for the summer of 2013, it should be feasible to make predictions for the coastal waters of the Pacific Northwest in terms of their quality as a habitat for sardines and juvenile salmon, among other organisms higher in the food chain. This information should be valuable to a broad range of groups (tribes, commercial and recreational fishers, managers, conservation organizations, etc.) with marine interests.

Figure 3: Dead crabs washed up on Washington coast near Ruby Beach on 15 August 2013 (Photo: Ellen Starr).

Climate Summary

Mean August temperatures were above normal across most of the state, with temperatures generally between 1 and 3°F above normal. King County and the northwestern tip of the Olympic Peninsula were the warmest locations shown in Table 2; Quillayute and SeaTac were 3.5 and 3.3°F above normal, respectively. According to the High Plains Regional Climate Center map below, there were a few areas of the state that had closer to normal August temperatures (within 1°F of normal), such as parts of the Olympic Peninsula and north central WA. Omak, for example, was only 0.4°F above normal.

Total August precipitation was much higher than the nearly nonexistent precipitation measured in July. While normal August precipitation is low, with averages of about a quarter inch to about 2 inches for most locations, last month exceeded these typical amounts throughout the state. North central WA into eastern WA received much above normal precipitation (about 200% of normal), which is mostly a result of thunderstorm activity. Wenatchee, for example, received an impressive 955% of normal for August with 1.91" of precipitation; most of that fell in about a 40-minute window during a thunderstorm on August 1 (1.09"), setting a daily maximum rainfall record.

Temperature (°F)
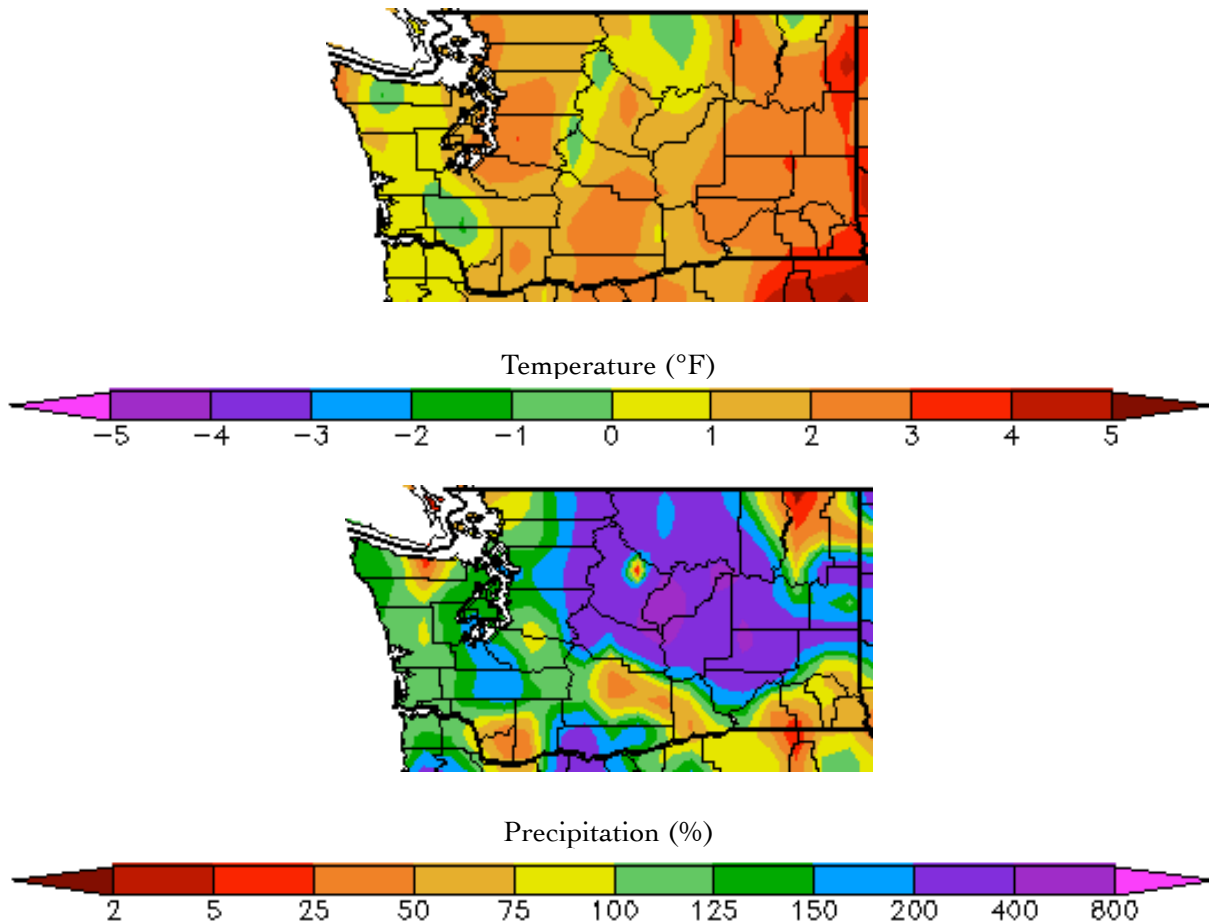
Precipitation (%)

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	65.9	64.1	1.8	1.84	0.94	196
Seattle WFO	69.0	66.5	2.5	1.07	0.97	110
Sea-Tac	69.4	66.1	3.3	1.35	0.88	153
Quillayute	63.1	59.6	3.5	3.01	2.49	121
Hoquiam	61.6	60.6	1.0	1.78	1.31	136
Bellingham AP	65.3	62.5	2.8	1.17	1.23	95
Vancouver AP	70.2	69.2	1.0	0.85	0.77	110
Eastern Washington						
Spokane AP	72.2	69.3	2.9	0.68	0.59	115
Wenatchee	74.3	73.5	0.8	1.91	0.20	955
Omak	72.8	72.4	0.4	1.32	0.46	287
Pullman AP	67.8	65.7	2.1	0.45	0.63	71
Ephrata	74.7	72.9	1.8	0.63	0.19	332
Pasco AP	75.1	72.8	2.3	0.38	0.27	141
Hanford	77.7	75.8	1.9	0.24	0.18	133

Table 2: August 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 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, near-normal in the central equatorial Pacific, and below normal in the eastern equatorial Pacific. There is a consensus among the model predictions that near-neutral ENSO conditions will persist through autumn 2013 and into winter 2014. While both low, the probability of a La Niña developing during winter 2014 is higher (~25%) than that for an El Niño (less than 20%).

On the heels of a warm August, the CPC three-class outlook for September has increased chances for warmer than normal temperatures for the entire state, with higher chances of warm temperatures for the eastern half of the state. It's a toss up for precipitation: there are equal chances of below, equal to, or above normal precipitation statewide.

The three-month temperature outlook for autumn (September-October-November; SON) lacks predictability for WA State. There are equal chances of below, equal to, or above normal temperatures and precipitation for SON.
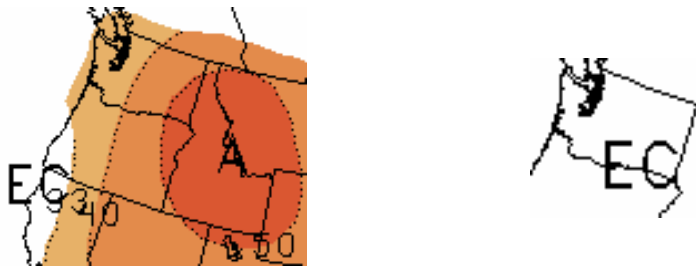
September outlook for temperature (left) and precipitation (right) from the CPC.

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

These outlooks are based on a tercile system with three classes: below normal, near normal, and above normal, with the thresholds for these categories such that each class occurs, on average, one-third of the time. In situations for which there are equal chances of each outcome, "EC" is denoted on the map. When the odds are tilted one way or another, "A" and "B" is used to denote above-normal and below-normal, respectively.