Office of the Washington State Climatologist

June 3, 2011

Cool & Wet May

In this Issue

May was generally cooler and wetter than normal for most of the state adding another cool and wet chapter to the soggy spring story. Figure 1 shows the temperature and precipitation compared to normal for the last 90 days at SeaTac International Airport, illustrating the persistently cool and wet conditions. As of May 30, there was a surplus of 6.1" of precipitation at SeaTac for the 90-day period. This picture was consistent across the state, and for similar charts for different locations use the links on the 4th and 5th bullet on this site: http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/us_prec.shtml.

May has been noted in the record books for several locations. Quillayute, for example, had its coldest May on record, Ephrata tied 2010 for the 3rd coldest May, and Olympia had its 3rd coldest May on record. Table 1 shows the May 2011 mean temperature, the ranking when compared to the record, and the length of the record for several WA locations. Table 2 shows the same statistics except for May total precipitation. The most impressive rankings for precipitation were for Yakima (2), Ephrata (3), and Bellingham (3). While Olympia and SeaTac made it to the top ten, some of the other locations were not ranked as extreme for precipitation as for temperature.

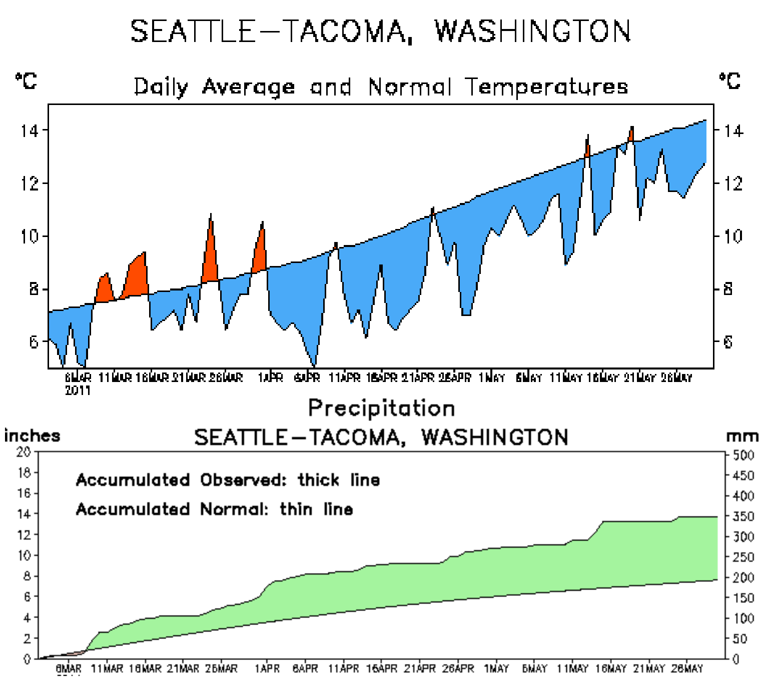


Figure 1: Daily temperature and accumulated precipitation at SeaTac for the past 90 days compared to normal (CPC).

Besides consistent rain and cool temperatures, other May highlights include the widespread flooding that started at about mid-month resulting from a combination of rain and mountain snowmelt. The confirmation of an EF0 western WA tornado should also be noted. The weak tornado touched down near Napavine on the afternoon of Friday, May 27. Damage was minimal and no injuries were reported.

Station	ID	Rank (Coldest)	May Mean Temperature (°F)	Record Length (years)
Quillayute	456858	1	48.0	45
Ephrata	452614	3*	55.4	63
Olympia	456114	3	50.3	63
Vancouver	458773	4	51.9	115
Hoquiam	453807	5	50.4	57
Mazama	455133	6	50.9	41
SeaTac AP	457473	6	52.3	64
Yakima	459465	12	54.8	65
Bellingham AP	24217	13	52.2	61

Table 1: The average May temperature, the rank when compared to the record, and the record length for several WA stations. The * denotes a tie.

Station	Rank (Wettest)	May Total Precipitation (in)	Record Length (years)
Yakima	2	2.55	65
Ephrata	3	1.65	63
Bellingham AP	3	4.35	61
Olympia	6	4.16	64
SeaTac AP	7	3.20	64
Mazama	11	1.49	44
Hoquiam	14	4.44	58
Quillayute	17	5.56	45
Vancouver	32	2.79	114

Table 2: Same as Table 1, except for precipitation.

Snowpack & Projected Streamflow

The cool and wet spring conditions have delayed significant melting of the snowpack, causing the percent of normal snow water equivalent (SWE) to be very high across the state. Figure 2 shows the SWE percent of normal for 11 WA basins from the National Resources Conservation Service as of June 1, 2011. All of the basins have greater than 150% of normal snowpack currently, with the highest amount in the Olympic Peninsula with 431% of normal. The Northwest River Forecast Center issued its most recent water supply forecast on May 19 for projected streamflow from now through September (Figure 3), and is expecting normal (90-110%) to much above normal (>175%) streamflow throughout the state.

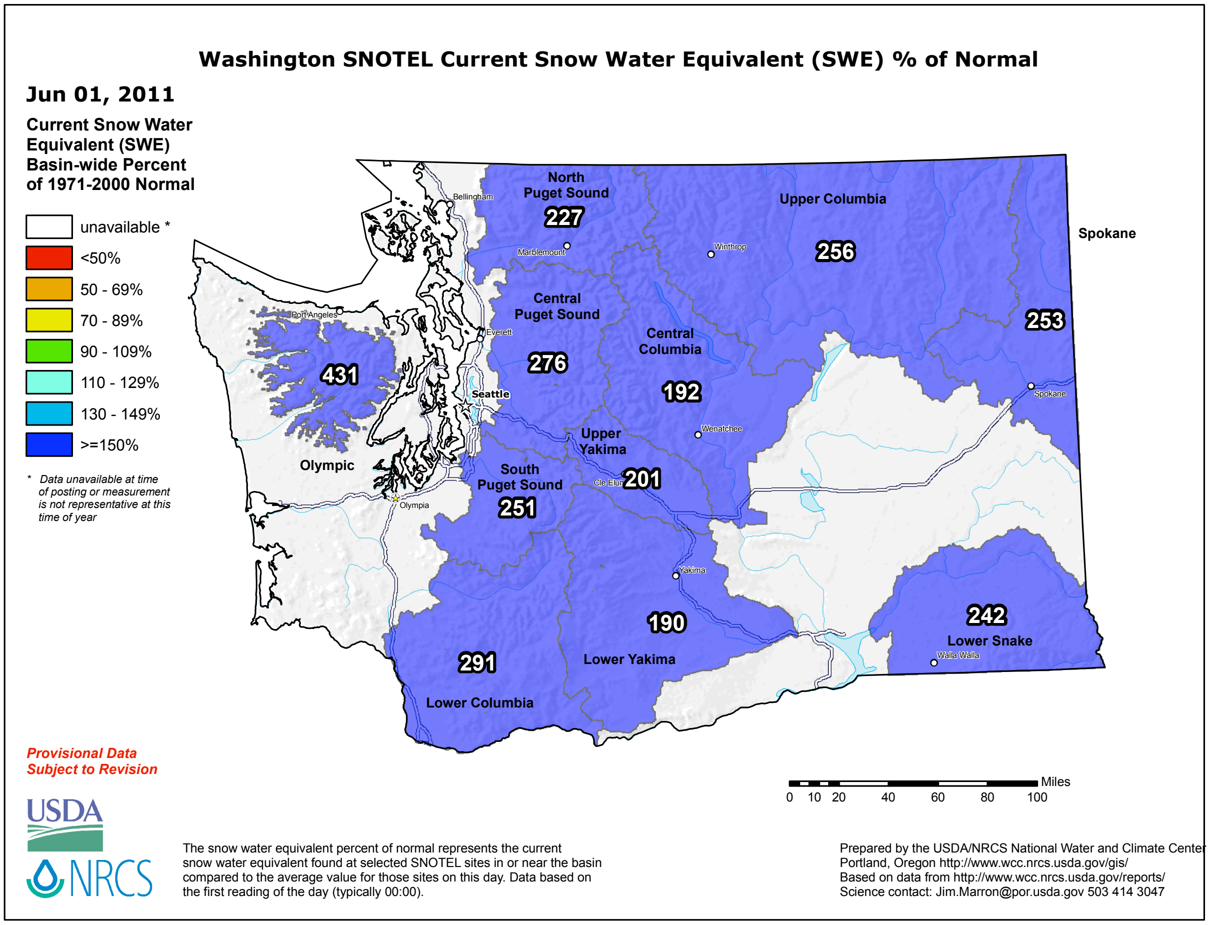


Figure 2: Snowpack (in terms of snow water equivalent) percent of normal for WA as of June 1, 2011 (from NRCS).

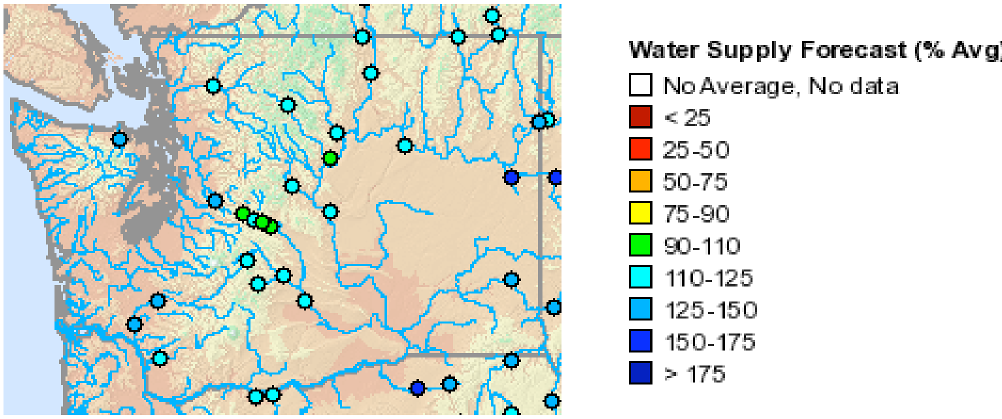
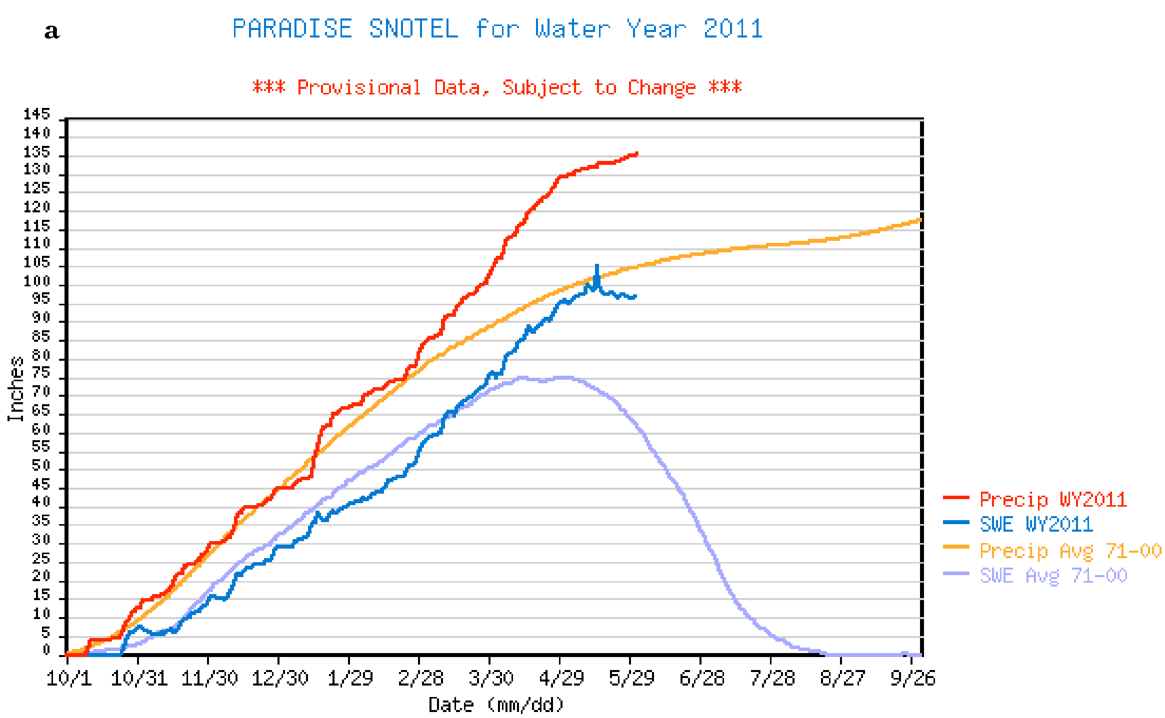


Figure 3: June through September water supply forecast for WA as of May 19, 2011 from the National Weather Service Northwest River Forecast Center (http://www.nwrfc.noaa.gov/water_supply/ws_fcst.cgi).

Typically, April 1st is used as the date representing the maximum snowpack in the season, but the snowpack continued to grow after that date this year. Figure 4a shows the precipitation and SWE at Paradise compared to the 1971-2000 normal, illustrating the late-season snow-pack growth. While unusual, it is not unprecedented. The winter of 1998/99 (water year 1999), for example, had similar snowpack growth through May at Paradise (Figure 4b). It is also interesting to note the differences between the early winter for these years; the snowpack was much slower to build in water year 2011.

a



b

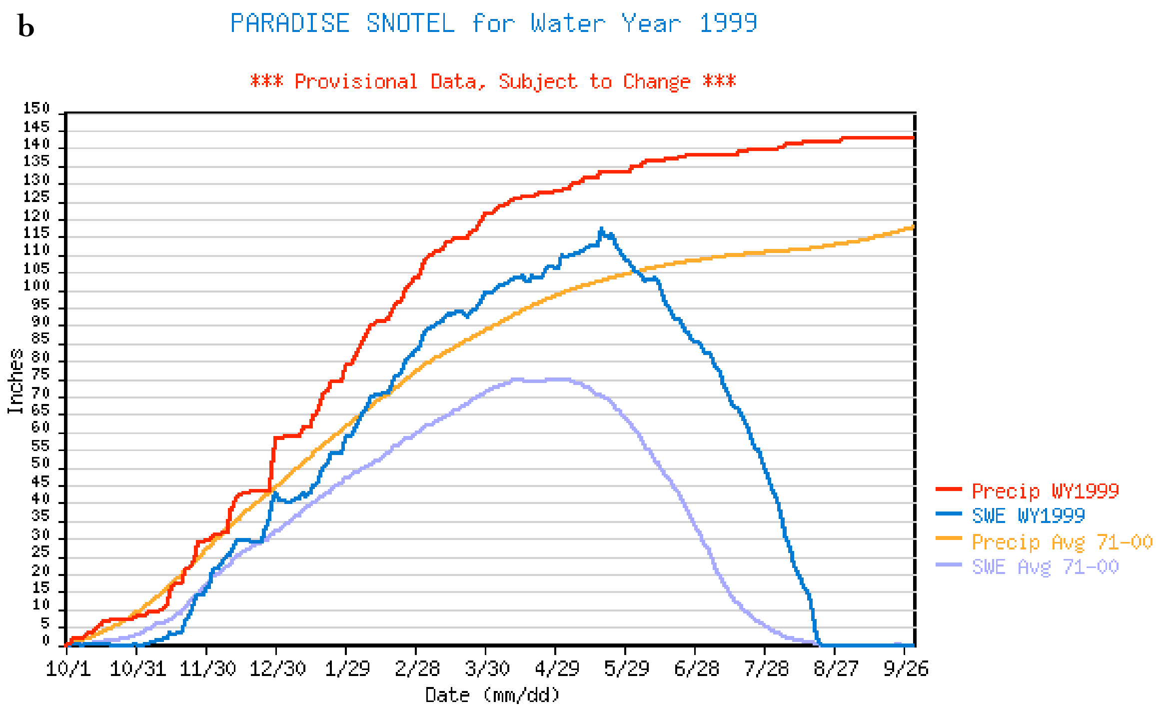


Figure 4: 2011 (a) and 1999 (b) water year precipitation and snow water equivalent for the Paradise SNOTEL station compared to the 1971-2000 normal (from NRCS).

The Spring Transition in the Winds Along the Washington Coast and its Effects on the Coastal Ocean

A message from the State Climatologist

There is a seasonal cycle in the prevailing winds along the coast of Washington. Winter winds are generally from the southwest, with considerable variability due to the passage of storms, and summer winds are generally from the northwest, with intermittent periods of southerlies. Oceanographers call the switch in the winds the "spring transition", and it has important consequences for the coastal ocean.

The flow in the upper ocean occurs to the right of the wind in the Northern Hemisphere due to the earth's rotation. This effect, known as Ekman transport, causes onshore-directed flow in conditions of southerly winds along the Washington coast, and off-shore-directed flow during northerlies. Since the lateral movement of water is restricted by the coastline, onshore-directed flow induces downwelling in the coastal zone, while offshore-directed flow induces upwelling. A review of this mechanism is available at the following website: http://oceanmotion.org/html/background/upwelling-and-downwelling.htm. This is a matter of much more than just academic interest.

The chemical properties of the water in the coastal zone are strongly dependent on whether there is downwelling or upwelling. The water at depth tends to feature relatively high concentrations of nutrients such as nitrate and phosphate that are essential for the growth of phytoplankton, and a low concentration of dissolved oxygen. This water can be brought close to the surface during upwelling and serves to sustain photosynthesis, i.e., the growth of phytoplankton supporting the food web. For this reason, regions of coastal upwelling generally support very productive fisheries and large populations of seabirds and marine mammals.

Information on present and past upwelling along the US west coast is provided by NOAA's Pacific Fisheries Environmental Laboratory at http://las.pfeg.noaa.gov/. It bears noting that on average, upwelling is considerably stronger to the south of Washington State. While our beaches tend to be breezy in the summer, their counterparts from south-central Oregon to central California generally experience much stiffer north winds. One might imagine that these beaches would represent delightful places to be on sunny summer afternoons, but that depends on one's tolerance to getting sandblasted. The upwelling winds south of WA are strong and persistent enough that the coldest sea surface temperatures at the coast occur in the summer rather than the winter!

There are variations in the seasonal mean winds along the Washington coast, of course. A time series of an index of the upwelling at 48 N, 125 W near Forks, WA during spring (April-June) is plotted in Fig. 5. This time series indicates that the spring upwelling was anomalously weak in the early 1990s and then relatively strong in 1998. Since then most years have been near normal except for 2005. The delayed upwelling that year was particularly pronounced to our south along the Oregon and California coasts, and had profoundly negative impacts on the survival rates of juvenile salmon and the fledgling success of seabirds, along with other marine organisms. As an aside, the summer and early fall of 2006 demonstrated what can happen when there is too much of a good thing. The abnormally strong and persistent upwelling that occurred during that period caused massive die-offs of Dungeness crabs and other species due to the continued transport of water with especially low oxygen content onto the shelf.

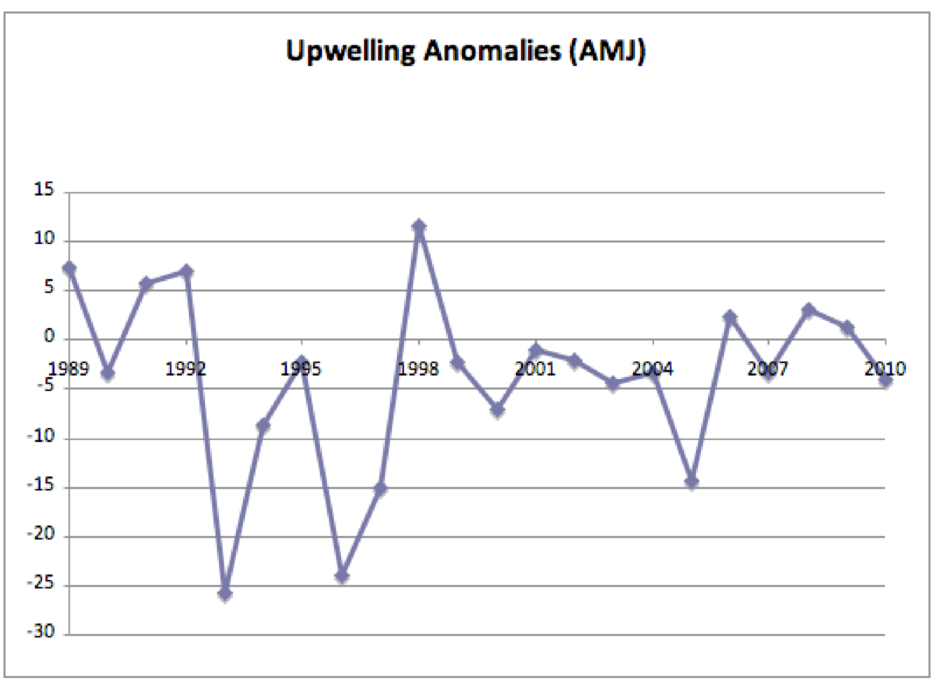


Figure 5: Upwelling anomalies at 48°N, 125°W (expressed in metric tons per 100 m of coastline). Positive anomalies indicate stronger North winds and upwelling.

The cool and inclement weather of this spring has been accompanied by more southerly winds than usual during the last month or so, and hence a slow start to upwelling season. This has resulted in low phytoplankton levels, as is vividly demonstrated by comparing a map of surface chlorophyll-a concentrations for late May 2011 (Fig. 6a) with its counterpart from 2009 (Fig. 6b), which had near normal upwelling. There is little indication one way or another about how the weather and winds will play out over the next few months. The onset of consistent northerlies along the coast and upwelling would boost the productivity of the coastal marine ecosystem. Other parts of the state are liable to know when it happens because those conditions tend to be associated with less rain and more sunshine in the western part of the state and warmer temperatures on the east side. Unfortunately, we cannot anticipate when that should occur since we have little understanding of the causes of climate variations in the Pacific Northwest during the spring into summer. As discussed here, progress on this issue would be particularly relevant for fishers and managers and others with coastal ecosystem interests.

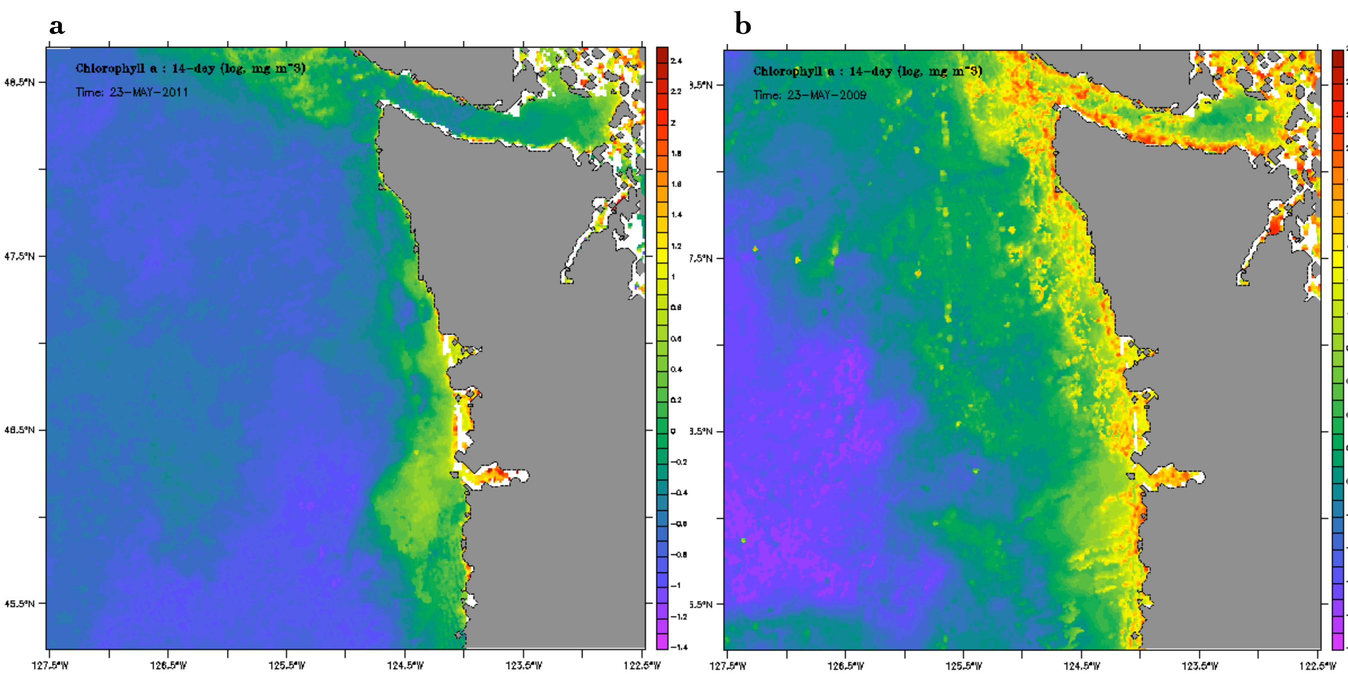


Figure 6: Chlorophyll-a concentrations (log mg m^{-3}) along the WA coast in late May 2011 (a) and 2009 (b). The scale is logarithmic; regions indicated in red have concentrations roughly 1000 times higher than those in dark blue (from NOAA CoastWatch).

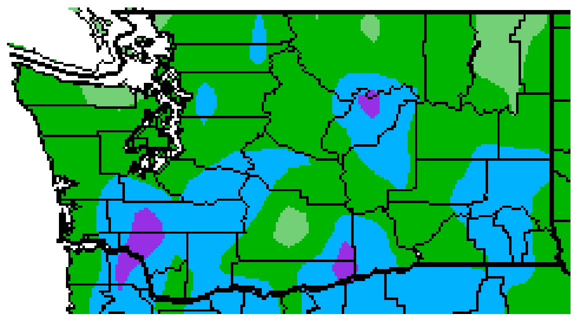
CoCoRaHS

Thank you, CoCoRaHS observers, for continuing to get out there and measure during our soggy spring. We have a new challenge for you: in an attempt to get over 10,000 CoCoRaHS reports in one day to break the record, June 6-9 is "CoCoRaHS Hits 10,000" Challenge Week. If you haven't reported for a while, now would be a good time to start up again! Make sure to even report those zeros and we'll see if we can tally 10,000 reports nationwide on a single day.

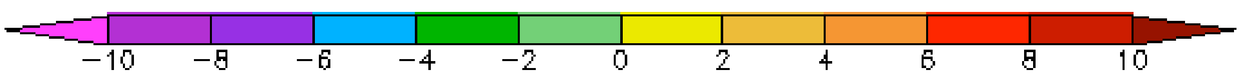
Climate Summary

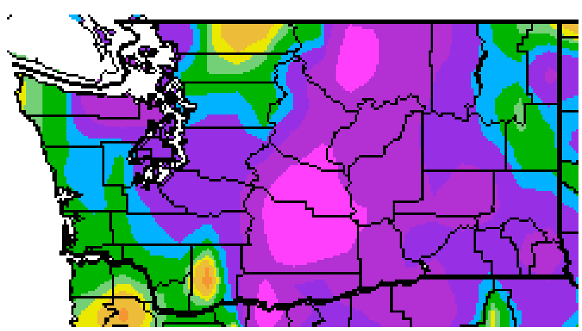
As mentioned above, average May temperatures were below normal across the state, continuing the pattern seen in April. The coolest spots were in southwestern WA and a few locations east of the Cascades (e.g., Ephrata was 5°F below normal; Table 3) but most of the state was between 2 and 4°F below normal.

With respect to precipitation, particularly prominent anomalies occurred on the eastern slopes of the Cascades/central WA during May with some locations exceeding 300% of normal (e.g., Wenatchee & Yakima; Table 3). A majority of the rest of the state was at least 150% above normal while the coastal locations and northern Puget Sound received near-normal precipitation.

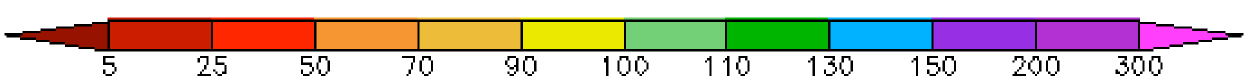


Temperature (°F)





Precipitation (%)



May temperature (°F) departure from normal (top) and May precipitation % of normal (bottom). Source: High Plains Regional Climate Center (http://www.hprcc.unl.edu).

	Mean Temperature (°F)			Precipitation (inches)		
	Average	Normal	Departure from Normal	Total	Normal	% of Normal
Western Washington						
Olympia	50.3	53.3	-3.0	4.16	2.27	183
Seattle WFO	52.9	55.9	-3.0	2.95	2.10	140
Sea-Tac	52.3	55.8	-3.5	3.20	1.78	180
Quillayute	48.0	51.2	-3.2	5.56	5.51	101
Bellingham Airport	52.2	54.4	-2.2	4.35	2.31	188
Vancouver	54.1	57.1	-3.0	3.09	2.50	124
Eastern Washington						
Spokane AP	52.0	54.4	-2.4	1.83	1.60	114
Wenatchee	55.5	59.4	-3.9	1.89	0.61	310
Omak	54.8	57.6	-2.8	2.96	1.08	274
Pullman	50.5	53.2	-2.7	2.93	1.77	166
Ephrata	55.4	60.4	-5.0	1.65	0.64	258
Yakima	54.8	56.2	-1.4	2.55	0.51	500

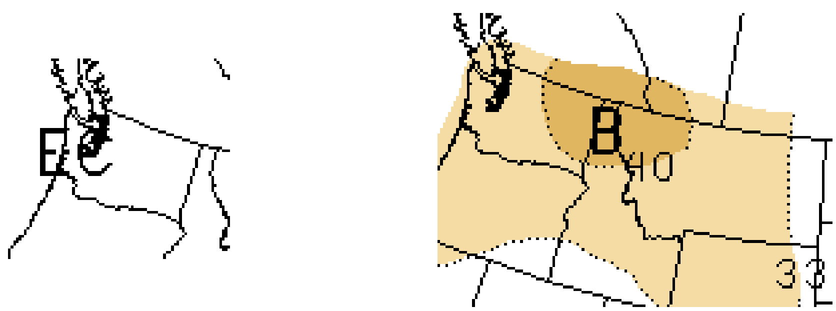
Table 3 - May climate summaries for locations around Washington. The climate normal baseline is 1971-2000 except for Seattle WFO (1986-2000) and Vancouver (1998-2010). Please be aware that the Seattle WFO and Vancouver climate normal periods are shorter than the 30-year period that is typically used for climatology.

Climate Outlook

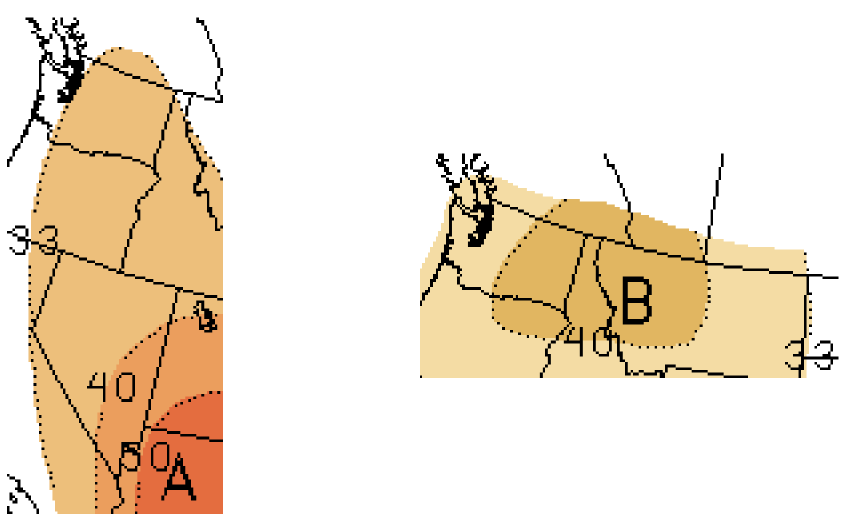
La Niña conditions are continuing to weaken across the equatorial Pacific Ocean. Positive sea surface temperature anomalies have developed further in the eastern Pacific during the last 4 weeks, (http://www.cpc.noaa.gov/products/precip/CWlink/MJO/enso.shtml) according to the Climate Prediction Center (CPC), while the SSTs in the western equatorial Pacific remain negative. The La Niña is expected to continue to weaken with models indicating near-neutral ENSO conditions by summer.

The summer (June-July-August; JJA) outlook has equal odds of below, equal to, or above normal temperatures. The JJA precipitation forecast, on the other hand, indicates below normal precipitation for the entire state, with higher chances (exceeding 40%) in northeastern WA.

The late summer (July-August-September; JAS) outlook calls for at least a 33% chance of above normal temperatures for most of the state. The Olympic Peninsula and southwestern WA have equal chances of above, equal to, or below normal temperatures. Below normal precipitation is expected for JAS, with chances exceeding 40% in eastern WA.



June-July-August outlook for temperature (left) and precipitation (right) from the CPC.



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