Office of the Washington State Climatologist

July 2024 Report and Outlook

July 12, 2024

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

June Event Summary

Mean June temperatures were largely near-normal across the state though there were locations with below normal (e.g., the coastal areas) and above normal (e.g., the Vancouver area) temperatures. Averaged statewide, June 2024 was equal to the 1991-2020 normal of 58.3°F and tied as the 47th warmest in the 130-year record. June precipitation was largely variable and generally above normal on the west slopes of the Olympic and Cascade Mountains and below normal across eastern Washington. Averaged statewide, those anomalies canceled out to near-normal total June precipitation (+0.16") at 108% percent of normal, ranking as the 49th wettest June.

As mentioned in last month's OWSC newsletter, June began with a winter-like storm that brought several days of wind and rain. On the 1st, record daily maximum rainfall records were set at Hoquiam (1.87"), Olympia (1.08"), and SeaTac Airport (0.65"). Pullman Moscow Airport set a daily maximum rainfall record of 0.87" on the 3rd as well. Figure 1 shows the total precipitation measured by volunteer observers from the morning of June 2 through June 5, with totals above one inch widespread. Wind gusts between 35 and 55 mph were reported across western WA

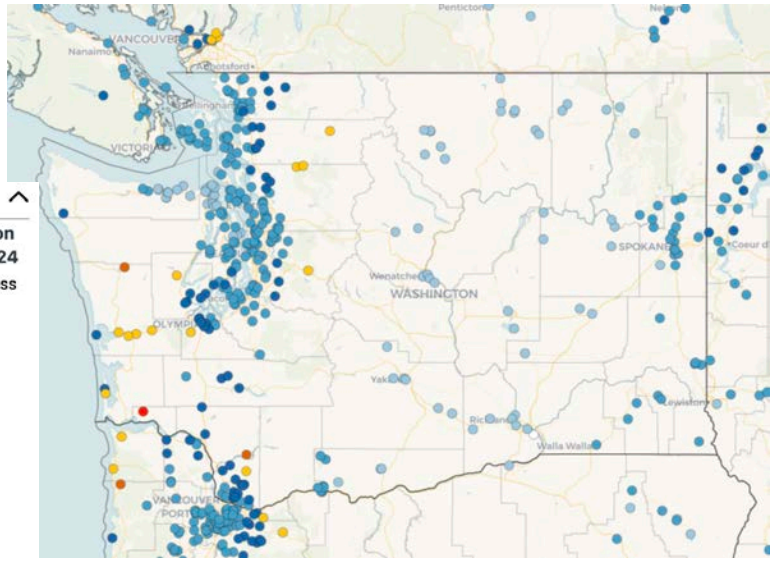

Figure 1: 72-hour precipitation totals (inches) ending on the morning of June 5, 2024 from CoCoRaHS volunteer observers.

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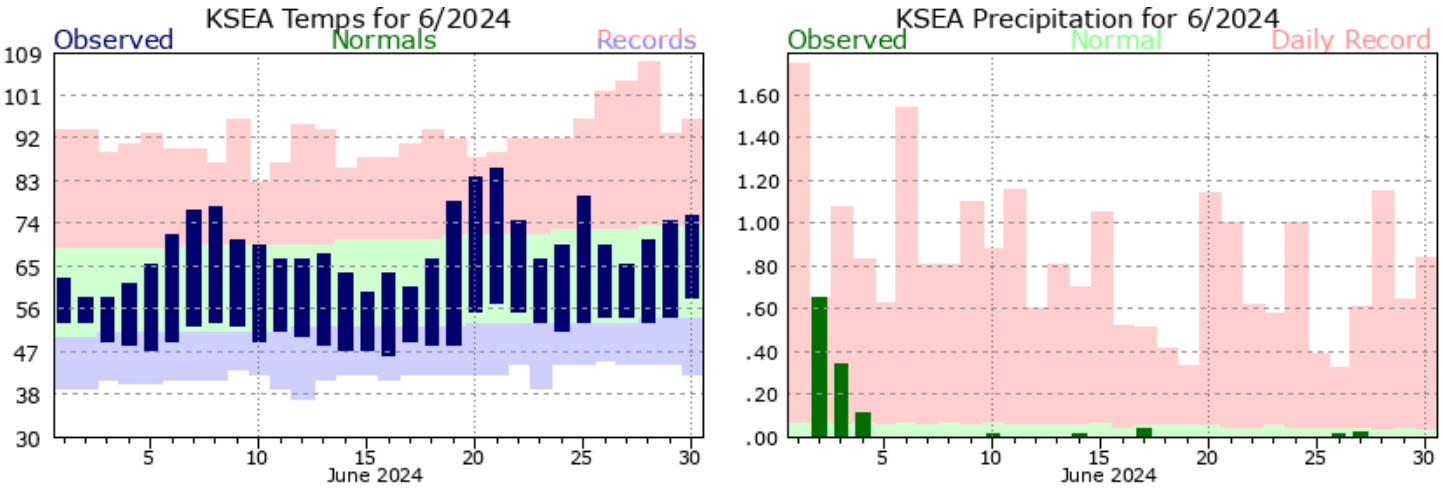


Figure 2: June 2024 daily temperatures (left) and precipitation (right) for SeaTac International Airport compared to the 1991-2020 normal (green envelope) and previous records (blue and red envelopes; NWS).

on the mornings of the 3rd and 4th, and many power outages were associated with these events.

Figure 2 shows the daily maximum and minimum temperatures and precipitation for SeaTac Airport for June. Aside from two distinct periods, daily maximum temperatures were consistently below normal for not just SeaTac but also many other locations in western Washington. For example, Hoquiam had mostly below normal temperatures as well. Its temperature departures from normal during the last two months are plotted in Figure 3, revealing that the two warmer than normal periods in June weren't nearly as warm as the early heat in mid-May.

The remainder of the month was relatively uneventful; note that for most of the state, the majority of June precipitation fell during the event at the start of the month. The rest of the month was mostly dry. There were also some cool temperatures in eastern Washington mid-month, associated with an upper level trough. On the 16th, record daily low minimum temperatures were set at Pullman Moscow Airport (34 - tie), Yakima (35°F - tie), and Dallesport (43°F). On the 19th, Pasco set a daily record minimum temperature of 42°F. As of the end of June, the wildfire season has been generally quiet, with activity picking up in early July.

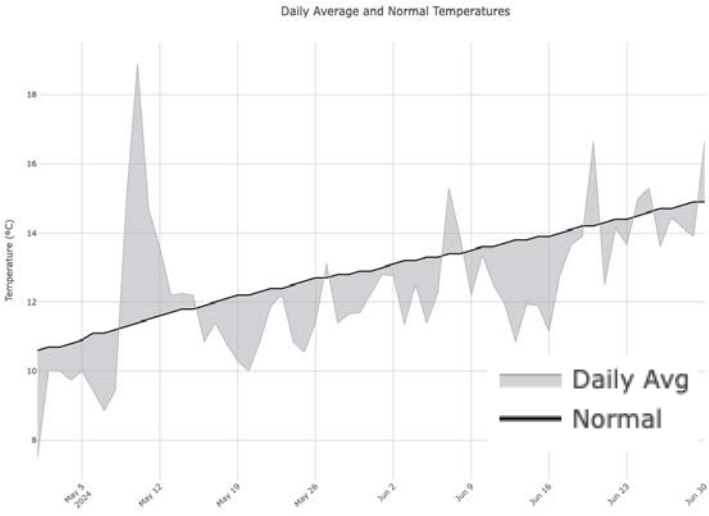


Figure 3: May-June 2024 daily average temperatures difference (°C) from the 1991-2020 normal for Hoquiam (CPC).

Streamflow and Drought Summary

Average June streamflow was bolstered by the early June precipitation, particularly in western Washington. Stream gauges along the coast, southwestern Washington, and parts of the southern and central Puget Sound regions averaged normal to above normal for June (Figure 4). Below normal June streamflow was common elsewhere in the state, including the region in the Olympic Mountain rain shadow, and watersheds in eastern Washington where both the mountain snowpack had melted out and June precipitation was below normal.

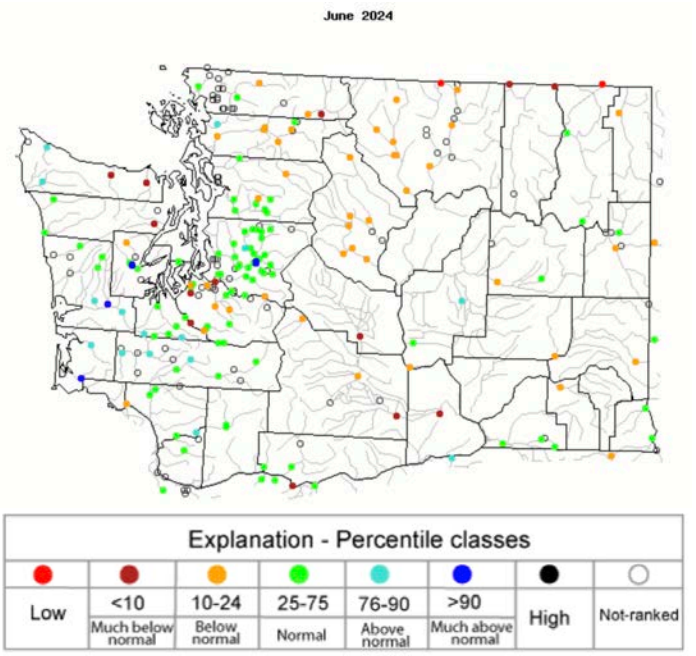


Figure 4: The average June streamflow percentiles (USGS).

The latest U.S. Drought Monitor map (Figure 5) remained the same in western Washington as it was in the last edition of our newsletter (the early June precipitation was already taken into account at the time of OWSC publication). But drought conditions have worsened in parts of eastern WA since our previous newsletter. In addition to the drier than usual June, a majority of eastern WA has had below normal precipitation since April and some areas even below normal precipitation since January. As a result, there is now an area of "severe drought" (D2) in Washington. As a reminder, the categories of the U.S. Drought Monitor are based on percentiles so for D2 to be depicted in Washington, a majority of the drought indicators should be between the 5th and 10th percentile in the historical record.

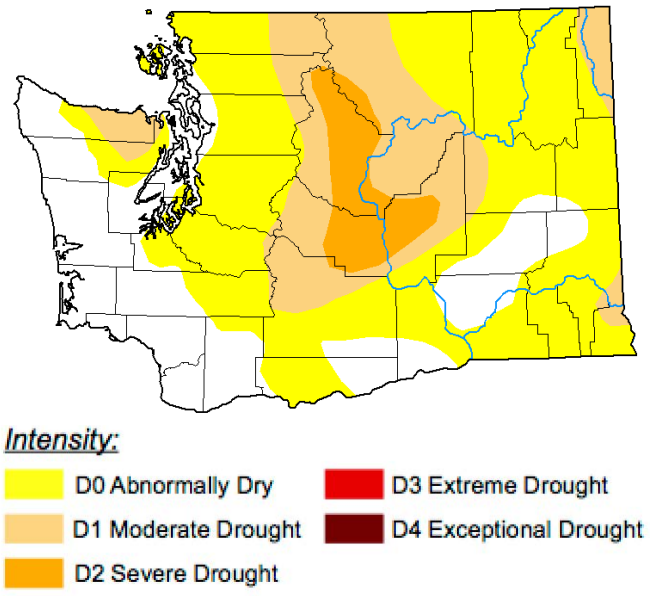


Figure 5: The July 3, 2024 edition of the U.S. Drought Monitor.

The Washington State drought emergency that extended in mid-April for a majority of Washington State is still in effect. The benefits of declaring drought early in the spring were recently highlighted by OWSC collaborators at the NOAA National Integrated Drought Information System. Check out the story here.

Report Your Drought Impacts

Are you experiencing a drought impact? Your on-the-ground observations are critical in helping us understand the broad picture of drought in the state. The National Drought Mitigation Center and partners have developed Condition Monitoring Observer Reports on Drought (CMOR-drought), a short survey that allows the public to enter their observations regarding crops, water supply, fire, etc. We would greatly appreciate your input, and these reports help experts assess drought impacts for the U.S. Drought Monitor maps.

Upwelling Winds Along the Coast

Climate Matters Series Author: Nick Bond

Jack Barth and collaborators have published a recent journal article entitled "Widespread and increasing near-bottom hypoxia in the coastal ocean off the United State Pacific Northwest" (see citation below). This article shows that ocean oxygen concentrations have tended to decline over the historical record, with the summer of 2021 in particular featuring large areas with values low enough to be harmful to many marine animals. They find this change is associated with increases in upwelling-favorable winds in the summertime and hypothesize that the increases may be attributable to climate change. Their analysis of the winds focused on Newport, Oregon, which is located on the central Oregon coast. We feel that it is worthwhile here to take a look at what the data show for the summertime winds along the Washington coast.

Our analysis relies on three sources of information. The first source is hourly wind data from a C-MAN station on Destruction Island at 47.68°N, 124.48°W, about 6 kilometers off the coast of Washington near Ruby Beach. These data are used to specify the frequency of upwelling-favorable winds during the years of 1985 through 2023, for the peak summer period of July and August, and separately for the longer season of June through September. Periods of upwelling are defined as those with wind directions ranging from 310 degrees to 30 degrees, i.e., ranging from northwest and north-northeast, and wind speeds of 3 meters/sec (6.7 mph) and greater. We examine the frequency of these conditions during July and August and June through September. The second type of data we use are monthly values of the coastal upwelling transport index (CUTI) as provided by the Environmental Research Data Services of NOAA's Southwest Fisheries Science Center. CUTI estimates vertical transports at the base of the upper ocean mixed layer based on a combination of the surface wind stress, sea surface height and upper ocean mixed layer depth, with the alongshore winds being responsible for most

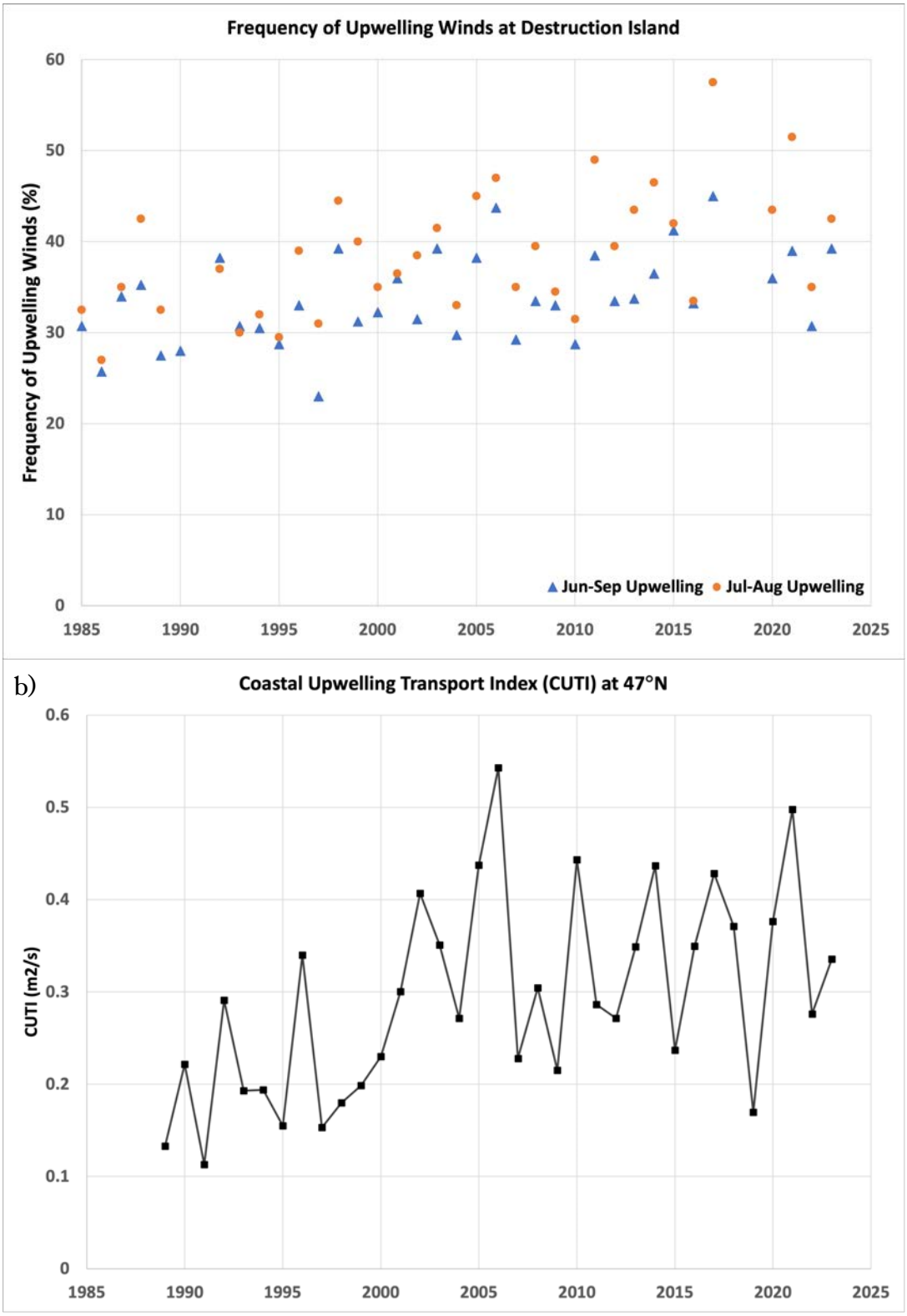


Figure 6: (a) The frequency of upwelling winds (%) at Destruction Island for June-August (blue triangles) and July-August (orange circles) from 1985 to 2023 and (b) the July-August Coastal Upwelling Transport Index (CUTI) at 47°N.

of the variability. Here we focus on CUTI estimates for the months of July and August, at the latitude of 47°N. Third, we created wind roses from Quillayute for the months of June through September for two 20-year periods, namely 1966-1985 and 2004-2023, which represent the earliest and latest 20-year periods available through the cli-MATE application hosted by the Midwestern Regional Climate Center (MRCC).

Time series of the frequency of upwelling winds at Destruction Island, and CUTI at 47°N, are shown in Figures 6a and 6b, respectively. The frequency of upwelling winds, as defined here, during the two-month period of July and August is almost always higher than that for the four-month period of June through September, with the years of 1992 and 1993 the only exceptions. There was an overall increase in the frequency of upwelling winds from the mid-1980s to the early to mid-2000s at Destruction Island. But in the last two decades or so, the trends are small relative to the year-to-year variability. The results based on the winds at Destruction Island are mostly consistent with the time series of CUTI at 47°N. The latter time series features a greater relative increase from values near 0.2 m^2/s before 2000 to values averaging a bit more than 0.3 m^2/s after the early 2000s. Since then, the overall trend in CUTI is negligible. There is a positive correspondence between the frequency of upwelling winds at Destruction Island and CUTI at 47°N but these two measures are by no means in lockstep. The linear correlation coefficient between the July-August upwelling and CUTI is about 0.62. It makes sense that the two measures differ, in that CUTI includes information related to oceanographic conditions, and a more complete perspective on the winds. This last point is elaborated upon using the Quillayute wind roses.

Wind roses for the months of June through September for the years of 1965 through 1984, and 2004 through 2023, are shown in Figures 7a and 7b, respectively. While Quillayute is a few miles inland from the coast, we expect that its wind directions are representative of what occurs over the nearby coastal waters (the speeds at Quillayute will generally be lower than over the ocean due to greater surface roughness over land). With regards to the frequency of upwelling winds in summer, again here considered to be for winds blowing from between the northwest and north-northeast, was about 20% during the years of 1966 through 1985 and 15% during the years of 2004 through 2023. There has been a noticeable decrease in summer downwelling favorable winds: the frequency of southerly winds in the earlier record is about double that of the later record. Periods of southerly winds are reflected in CUTI, and have important implications for the marine ecosystems. Southerly winds direct ocean surface waters towards the coast through Ekman transport, bringing with it planktonic (free-floating) organisms and pushing surface waters near the coast downward, bringing higher oxygen concentrations and relief from hypoxic conditions at depth.

Our findings suggest that the evidence for more upwelling along the Washington coast is mixed, with Destruction Island and CUTI suggesting an increase but no discernible trend at Quillayute. A more in-depth look across the coasts of Oregon and Washington would be needed to fully examine the Barth hypothesis. There does, however, appear to be less downwelling now than in the past, but again these results are preliminary. How do our results square with the projections from global climate models? That may be a fruitful line of inquiry for a future edition.

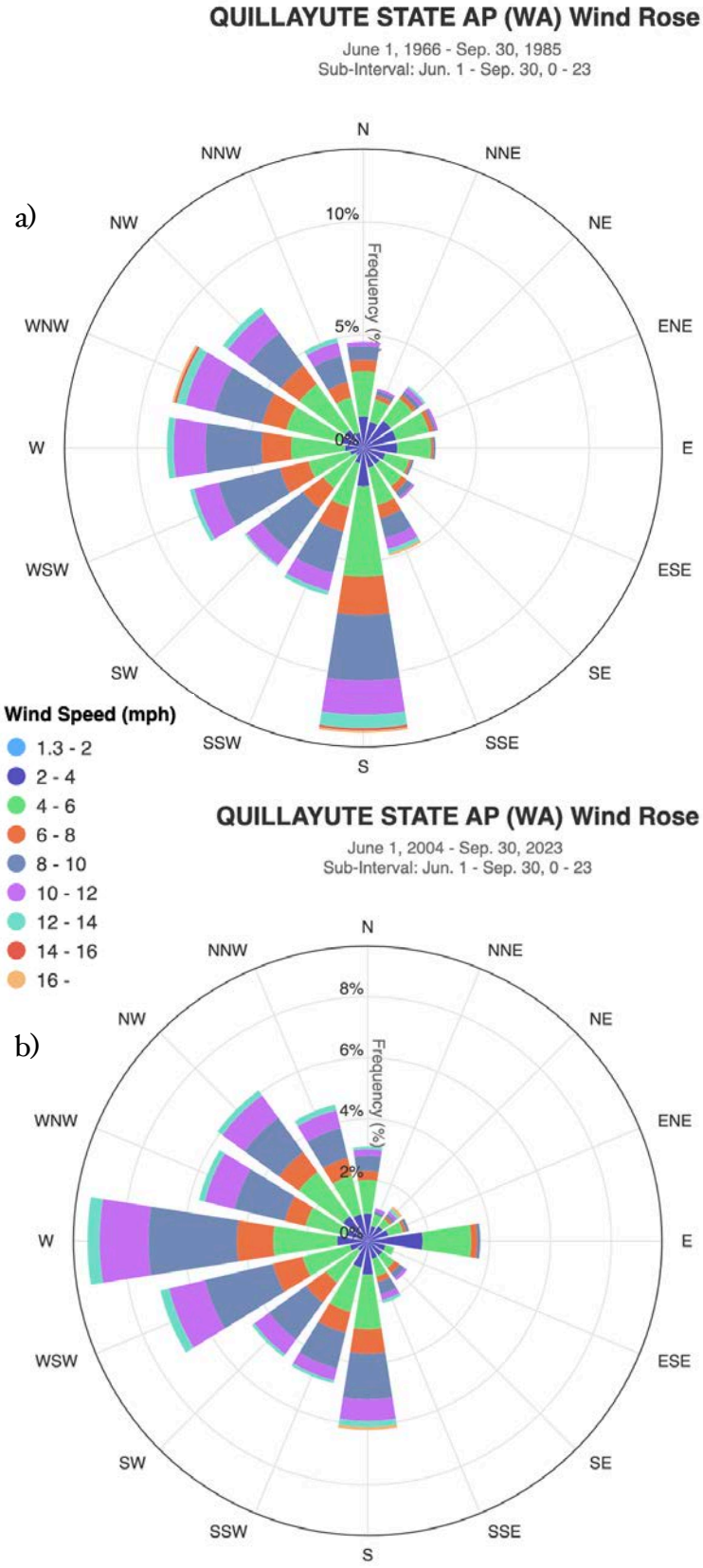


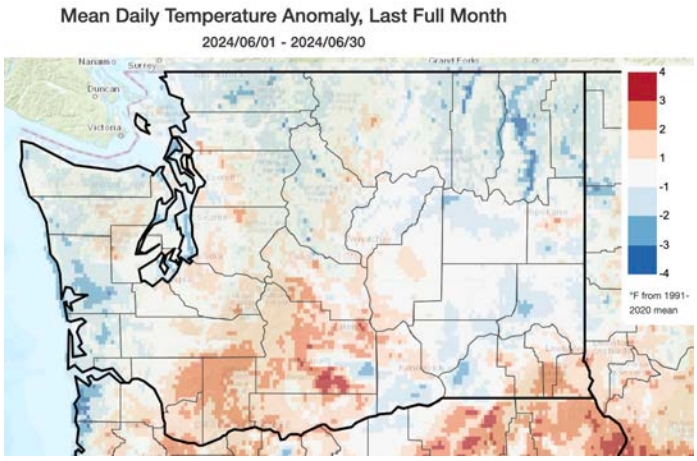
Figure 7: Wind roses for the months of June through September for (a) 1966-1984 and (b) 2004-2023 for Quillayute Airport. Both the speed (color-coded) and direction ("S" winds are from the south, for example) of the winds are depicted in wind roses (MRCC cli-MATE).

Reference:

Barth, J.A., S.D. Pierce, B.R. Carter and Coauthors (2024): Widespread and increasing near-bottom hypoxia in the coastal ocean off the United State Pacific Northwest. *Sci Rep.*, **14**: https://doi.org/10.1038/s41598-024-54476-0

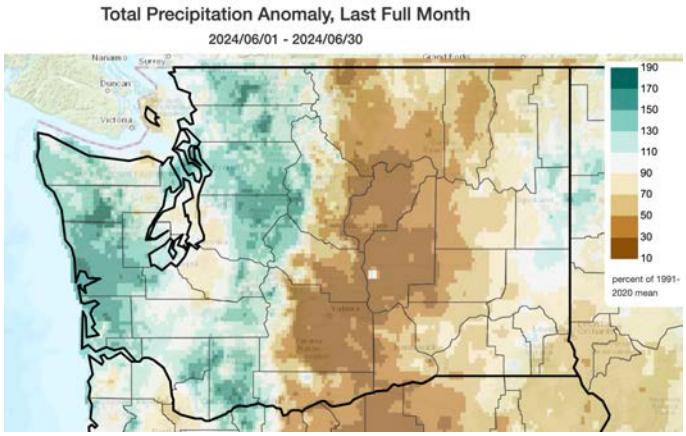
Climate Summary

June average temperatures were not extremely anomalous. Near-normal temperatures were common across the state, as indicated by the white areas on the map to the right. The mean temperature during June 2024 was exactly normal in Olympia; many of the other stations in Table 1, such as Wenatchee, Omak, and Ephrata, for example, were within 1°F of normal. There were also some parts of the state with below normal temperatures, such as the coast, the northern Puget Sound area, and northeastern Washington. For example, Hoquiam and Bellingham were 1.2 and 1.7°F below normal, respectively. In contrast, parts of the southern Puget Sound area and the southern Cascade Mountains had above normal temperatures. Vancouver, for example, was 1.2°F above normal (Table 1).



June temperature (°F) departure from normal relative to the 1991-2020 normal (Climate Toolbox).

Total June precipitation varied across Washington, with a majority of eastern WA receiving below normal precipitation. Hanford and Ephrata measured just 7 and 9% of their normal June precipitation. Climatological normals for June start to get quite dry for the Lower Columbia Basin so note that the deficits for those two stations are only about 0.50" of precipitation. June precipitation deficits for some of the driest areas east of the Cascade Mountains range between 1 and 2". Some areas in western WA were drier than normal as well, but not to an extreme. Vancouver and SeaTac Airport, for example, received 77 and 82% of normal precipitation, respectively. Otherwise, most of western WA had above normal June precipitation ranging between 110 and 200% of normal. This was mostly due to the winter-like storm in early June. Hoquiam was especially anomalous, receiving 197% of normal precipitation (Table 1).



June total precipitation percent of the 1991-2020 normal (Climate Toolbox).

Station	Mean Temperature (°F)			Precipitation (inches)		
	Average	Normal	Departure from Normal	Total	Normal	Percent of Normal
Western Washington						
Olympia	59.1	59.1	0.0	2.24	1.46	153
Seattle WFO	61.5	61.4	0.1	1.50	1.57	96
SeaTac AP	61.0	62.0	-1.0	1.19	1.45	82
Quillayute	56.7	55.5	1.2	4.32	3.30	131
Hoquiam	55.9	57.1	-1.2	3.96	2.01	197
Bellingham AP	58.1	59.8	-1.7	2.03	1.61	126
Vancouver AP	64.5	63.3	1.2	1.24	1.61	77
Eastern Washington						
Spokane AP	64.3	62.3	2.0	0.85	1.17	72
Wenatchee	66.8	66.5	0.3	0.20	0.50	40
Omak	65.3	65.1	0.2	0.67	0.98	68
Pullman AP	59.6	59.8	-0.2	1.38	1.17	118
Ephrata	67.5	67.2	0.3	0.06	0.65	9
Pasco AP	67.9	67.8	0.1	0.53	0.61	87
Hanford	70.5	69.9	0.6	0.04	0.57	7

Table 1: June 2024 climate summaries for locations around Washington with a climate normal baseline of 1991-2020.

Climate Outlook

According to the Climate Prediction Center (CPC), conditions in the equatorial Pacific Ocean are now ENSO-neutral. The El Niño of 2023-24 is officially over. Neutral conditions are not expected to last long as a "La Niña Watch" remains in effect, with the expected development of La Niña sometime in the late summer/early fall. According to ENSO models, by the August-October period, there's a 75% chance of La Niña conditions, 24% chance of neutral conditions, and only 1% chance of El Niño. The possible development of La Niña later this summer may be why the projections for temperature and precipitation during the late summer are now looking more mild than in previous outlooks.

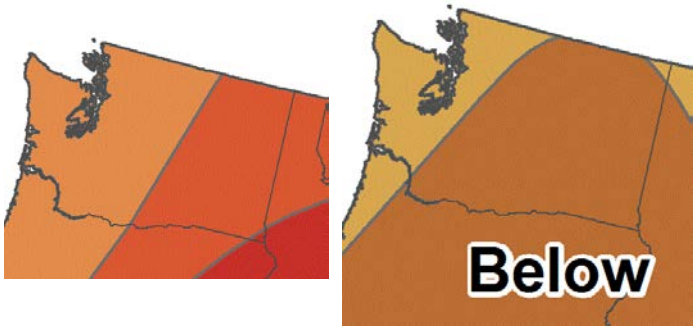
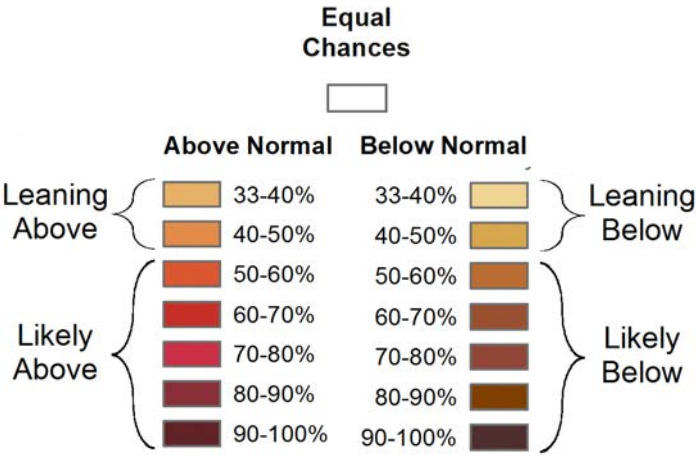


Figure 8: July outlook for temperature (left) and precipitation (right).

The CPC July outlook (Figure 8) has higher odds of above normal temperatures statewide. The odds of warmer than normal temperatures are higher in the eastern part of the state, ranging between 50 and 60% on the three tiered scale. For precipitation, there are higher odds of below normal precipitation statewide with a majority of the state falling between the 50 and 60% range.



The late summer (July-August-September; JAS) temperature outlook (Figure 9) decreased the area of Washington expected to have above normal temperatures compared to seasonal predictions made earlier in the spring. A majority of the state now has equal chances (33.3% chance of each outcome) of below, equal to, or above normal temperatures. Only the far eastern third of Washington has higher odds of above normal JAS temperatures. The JAS precipitation outlook is similar: there is an enhanced chance of below normal precipitation for the far eastern portion of the state while precipitation for the remainder of the state is uncertain.

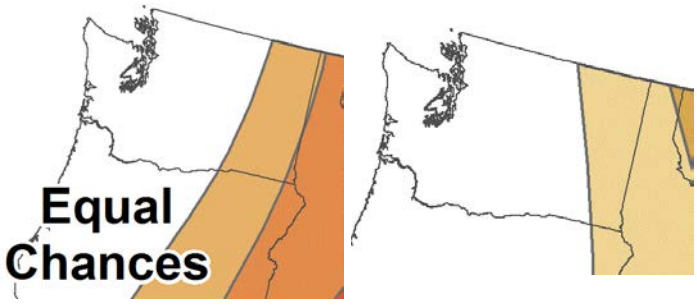


Figure 9: July-August-September outlook for temperature (left) and precipitation (right) (Climate Prediction Center).