

Weather and Climate Summary and Forecast

March 2023 Report

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Summary:

- Persistent hemispheric blocking events have upended the second half of winter for many. Blocking over the North Pacific has allowed storm systems to extend further southward along the west coast and supported colder air masses migrating south out of the Arctic. The result has been rare snowfall for many and historic amounts for numerous western US regions.
- Much colder than average¹ February for nearly the entire western US.
- Even with a very wet last week of February, a dry first half of the month dominated the monthly statistics, with most locations drier than average overall, especially the PNW. A wetter than average month was observed in central California, scattered areas of the southwest, and the northern Rockies.
- The short-term forecast is calling for continued cooler and wetter than average conditions in the west, with further hints at early to mid-March being overall cool and wet for much of the west. Warming to seasonal is forecast for the end of the month.
- The winter has brought continued improvement in drought conditions across the west. Snowpacks range from 90-120% of normal in the PNW and 100-250% above average in California, the Basin, and much of the Rockies. The unexpected is oh-so welcome, and continued improvement in drought conditions is forecast into spring.
- The spring forecast has the odds pointing to a cool period at least through April for the western US with California likely closer to seasonal while the PNW is likely to be cooler. Precipitation amounts are expected to be closer to average, continuing to lower drought concerns. The CPC is forecasting La Niña to slowly fade away with some hints at El Niño in late summer or fall. Cold near-shore SSTs along the western coast of North America are expected to keep the PDO in a strong negative phase, upping the cool spring likelihood and frost risk.

Past Month and Water Year to Date:

Western US temperature and precipitation conditions were dominated by cold air outbreaks out of the Arctic and persistent blocking over the Pacific. Combined the circulation allowed storms to ride down along the west coast over the colder air producing record-breaking snow events for California and rare snow for locations at or near sea level. February temperatures ended the month well below average for nearly the entire western US (Figure 1). The Rockies experienced the coldest deviation from normal with temperatures 6-8°F below average. While large precipitation events

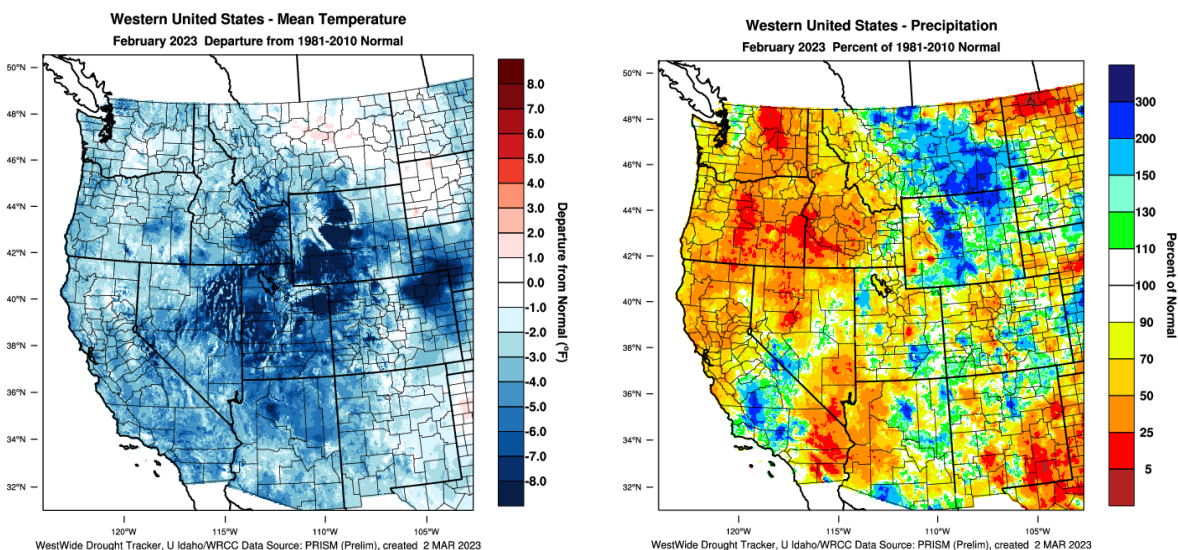


Figure 1 – Western US February 2023 temperature departure from normal (left) and percent of normal precipitation (right; images from WestWide Drought Tracker, Western Region Climate Center; University of Idaho).

¹ Note that all references to normal or averages in this report are to the 1981-2010 climate normal for each weather/climate parameter unless stated otherwise. Also, note that the 1991-2020 climate normals are starting to become available across reporting agencies and will be used in this report when possible.

were evident later in the month, dry conditions prevailed for most areas of the west for the first three weeks of February. The map of precipitation over the west shows that most areas were below average except portions of central to southern California, the northern Rockies, and scattered other areas in the southwest and southern Rockies (Figure 1).

The normal east-west flip-flop held true in February ... when the west is cold the east is warm. From the center of the country eastward, temperatures were substantially above average (3 to 10°F) for the month of February (not shown). In terms of precipitation, the rest of the country was mixed with a very wet month along the Mississippi River valley into the Great Lakes and slightly wetter than average in the southeast (not shown). A dry month was experienced across in the northern Plains, Texas, and Florida (not shown).

Water year-to-date (October through February) temperature and precipitation is shown in Figure 2. The western US temperatures have so far been near average to slightly above average for California, Oregon, and Washington, while the Great Basin, southwest, and Rockies have largely seen below average temperatures. The precipitation pattern for the water year continues to show the major inputs that came from the atmospheric rivers of late December and first half of January and historic snowfall in late February. Much of central to southern California into the Great Basin and the Rockies is running roughly 120-200% more than normal to date. The PNW has remained between 70% of normal to near average or even slightly above normal for eastern areas of Oregon, Washington, and Idaho (Figure 2). For the rest of the US, the eastern half of the country has been much warmer than average for the water year with the warmest conditions (up to 6°F above average) experienced in New England. Precipitation amounts for the water year are mixed across the eastern half of the country with drier than normal amounts experienced in the Plains, much of Texas, and Florida, while the southeast and portions of the eastern seaboard have been closer to average or slightly wetter than average (not shown).

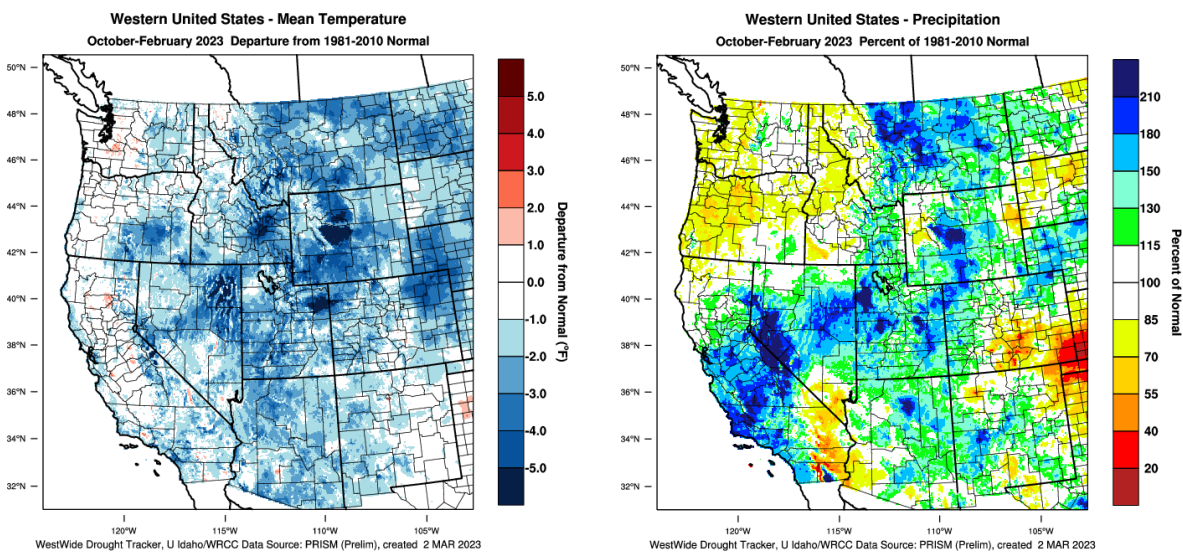


Figure 2 – Western US Water Year (October 1, 2022 to February 28, 2023) temperature departure from normal (left) and percent of normal precipitation (right; images from WestWide Drought Tracker, Western Region Climate Center; University of Idaho).

Drought Watch – Continued anomalous precipitation events in the western US and especially California have lowered drought concerns for many (Figure 3). While the western US is still categorized as largely in drought, the level and extent have continued dropping. The Northern Plains south to Texas is now the driest region in the country, while the eastern US is now largely free from drought. The drought area coverage in the continental US is now at 55% and slightly down month over month according to the U.S. Drought Monitor. Major improvements in drought conditions have continued across California, the Great Basin states, and the Rockies where record-breaking precipitation (both snow and rain) fell across the region. Drought conditions have declined over the western US, from over 90% in some level of drought two months ago to just over 75% now. Recovery from the most extreme categories of drought (extreme and exceptional) has continued to drop with the level at 3% over the west, the lowest level in many years. By state, reductions in drought areas occurred in Washington where 50% of the state is in drought but all of it is in the lowest category level. Oregon

has not improved as much as Washington, even increasing in some levels, and now stands at 92% of the state remaining in some level of drought and 15% remaining in the most extreme categories. Idaho also remains mostly in drought with nearly 98% of the state seeing drought conditions but none at extreme levels. For California, the state has dropped from nearly 100% of the state in some level of drought to 83% currently, with the more extreme drought categories remaining off the map for the first time in many years.

Continued good news appears in the seasonal drought outlook for the rest of the second half of winter and early spring where the forecast is for improvement (Figure 3, right panel). Most of California, Oregon, the Great Basin, and northern Rockies are forecast to see drought status removal or at least improve into spring. Small areas in southern California, the Great Basin, and the Four Corners region are expected to remain in drought into spring. The area of the country expected to experience worsening drought conditions continues to focus on the central Plains south into Texas and portions of the southeast coast and Florida. The forecast for the next 90 days is supporting the drought forecast (Figure 3 and see forecast section below) with a wet northern tier of states and a drier southern tier of states.

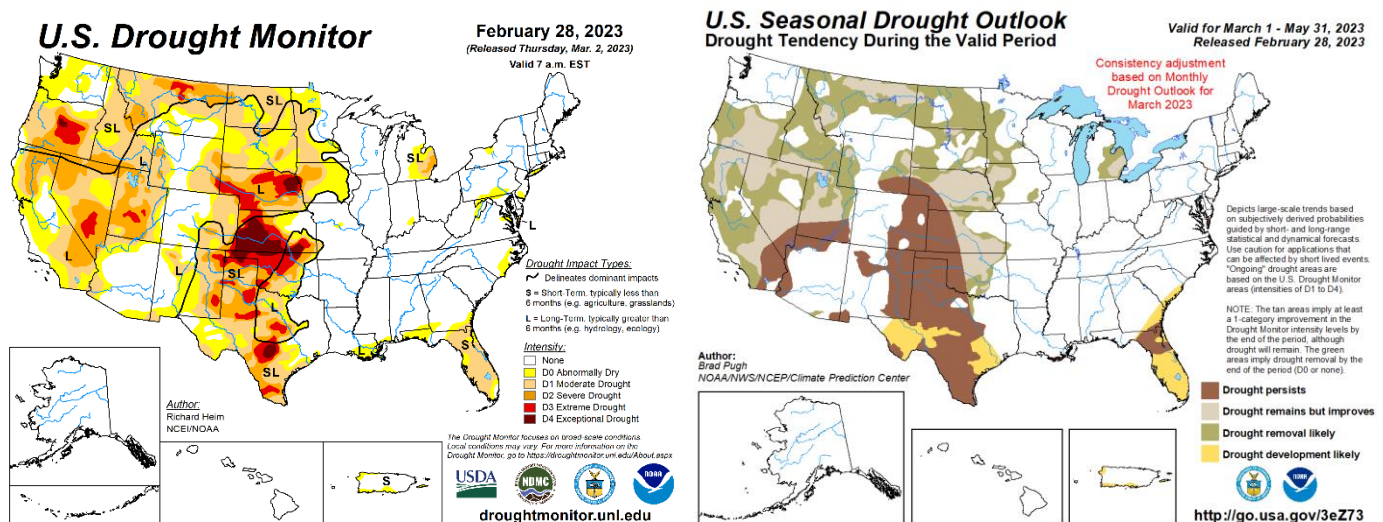


Figure 3 – Current US Drought Monitor and seasonal drought outlook.

ENSO Watch – Weakening sea surface temperatures (SSTs) in the central-eastern equatorial Pacific have continued as the forecast has been pointing to for many months now. However, SSTs are still cool enough to remain at the level for La Niña conditions (Figure 4). Regional circulation in both the ocean and atmosphere also remains consistent with La Niña

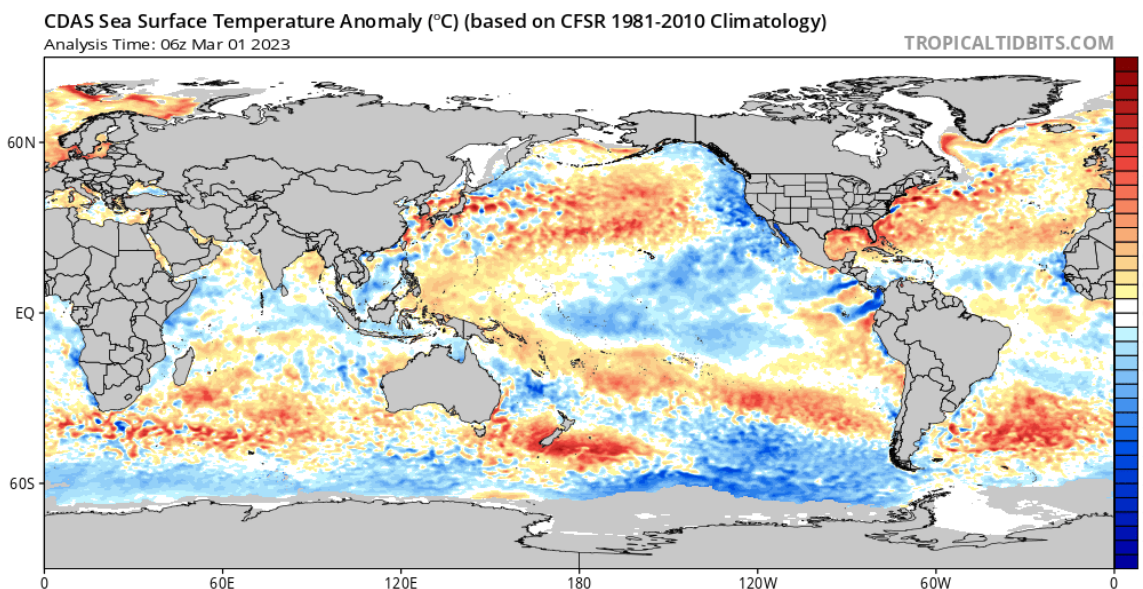


Figure 4 – Global sea surface temperatures (°C) for the period ending March 1, 2023 (image from Tropicaltubits.com).

conditions at this time with the Climate Prediction Center (CPC) continuing the La Niña Advisory for the time being. Modeling efforts also continue to predict SSTs remaining below average over the short term but point to warming that will shift the Tropical Pacific to ENSO-neutral levels during spring (March to May). The official outlook from numerous agencies affirms this forecast. Models and forecasters continue to point to El Niño developing later in 2023 with the probability currently low through May-July 2023 (47% chance) but increasing thereafter with probabilities in the 56-59% range by late summer and likely higher into early winter 2023.

As mentioned last month, the wild weather of 2023 with extreme precipitation (atmospheric rivers and historic snow events) southward into California is not indicative of historic relationships with typical La Niña conditions. They continue to be driven by amplified meridional circulation created from hemispheric blocking events. The result is extreme cold and widespread record-breaking snow in the west while the eastern US has seen record setting warmth. The forecast for March and the 90-day period (see the Forecast section below) is showing that this pattern will continue in general. From what I can tell, the extreme blocking out over the North Pacific and the colder SSTs along the coast of North America (see below) have had an outsized role in the seasonal forecast compared to what would be the expected conditions from La Niña. This framework will likely shift some as the blocking pattern gives way, it's just clear when it will transition.

North Pacific Watch – Not much change from last month with colder than average sea surface temperatures continuing along the entire North American coast (Figure 4). As such the Pacific Decadal Oscillation remains strongly negative. Continuing the pattern that we have had for many months now, cooler SSTs along the continent are in contrast with the overall pattern continuing to exhibit broad warmer than normal conditions over much of the central to western ocean basin (Figure 4). The cooler near-shore areas remain extended southward along the west coast to Baja California and connect with the La Niña cooler waters in the Tropical Pacific. The strong blocking high out over the North Pacific with circulation from troughing along the eastern edge of the block has helped to mix cooler waters to the surface all along the coast. The strong negative phase in the PDO has been in place since late 2019. This type of pattern in cooler North Pacific SSTs continues to support the seasonal forecast showing the tendency for a cooler/wetter PNW, transitioning to cool and near average precipitation in northern California and to slightly cool and dry overall during the second half of winter and early spring in most of the rest of California.

Forecast Periods:

Next 5 Days: Continued cool over the western US with only southern California and the southwest seeing a move to more seasonally average temperatures. No dominant storm on the radar, but a cut-off low spinning off the coast will provide plenty of generally unsettled conditions with off and on showers from central California north into Canada. Snow is in play at relatively low levels, but not likely very much at sea level in the western valleys.

6-10 Day (valid March 9-13): Generally cool across the majority of the US with the coldest air likely dominating the middle of the country but extending from coast to coast. Western US will remain cool for this time of year but inch toward temperatures closer to average as the month progresses. Precipitation will be widespread across the US with central California northeast into the PNW likely to see above average precipitation into this forecast period. The desert southwest and western Great Lakes are forecast to be dry during this period while Florida and the southeast are forecast for above average precipitation.

8-14 Day (valid March 11-17): Cold air mass continues to dominate the country into the middle of the month. For the western US, conditions will likely remain seasonal to cool for most everyone except closer to normal temperatures for the desert southwest. Cold air will bring very cold conditions to the eastern third of the country, after having an extremely warm period of the last month or so. Precipitation for the western US will likely continue above average due to flow off the Pacific bringing off and on-again rain and snow through mid-month. Precipitation amounts for the west are expected to be moderate instead of extreme during this period. Greater than average precipitation is likely for much of the US, except for the Great Lakes region which is forecast to see below average amounts into mid-month.

30 Day (valid March 1-31): The March outlook is calling for a cooler than average month from southern California, into the PNW, and across the northern tier of US states (Figure 5). This is largely from a colder first half of the month, with later in the month currently trending to near average temperatures. The desert southwest across the middle of the

country to the mid-Atlantic are forecast to have equal chances of slightly above to below average temperatures during the month, while from Texas, across the Gulf Coast to the southeast are forecast for a warm month. March precipitation is forecast to be above average over most of the west, across the northern Rockies and Plains, into the Ohio River valley with the Great Lakes likely to see below average precipitation for the month (Figure 5).

90 Day (valid March-April-May): Moving into spring the forecast for the western US continues to show cooler conditions across the northern states while California, much of Oregon, and central Rockies across the Great Lakes will likely be closer to average (Figure 5). Warmer than average conditions into spring are likely from the southwest across much of the south, the Gulf Coast, and along the eastern seaboard. The three-month forecast for precipitation is calling for most of the western US to have equal chances to see slightly above to slightly below amounts, while the desert southwest is forecast to see a dry period. Higher than average precipitation amounts are expected in and around the Great Lakes while much drier conditions are forecast for Florida (Figure 5). Continuing the trend for the last few months, all forecasting agencies are anticipating relatively large month to month variation from now through the end of May.

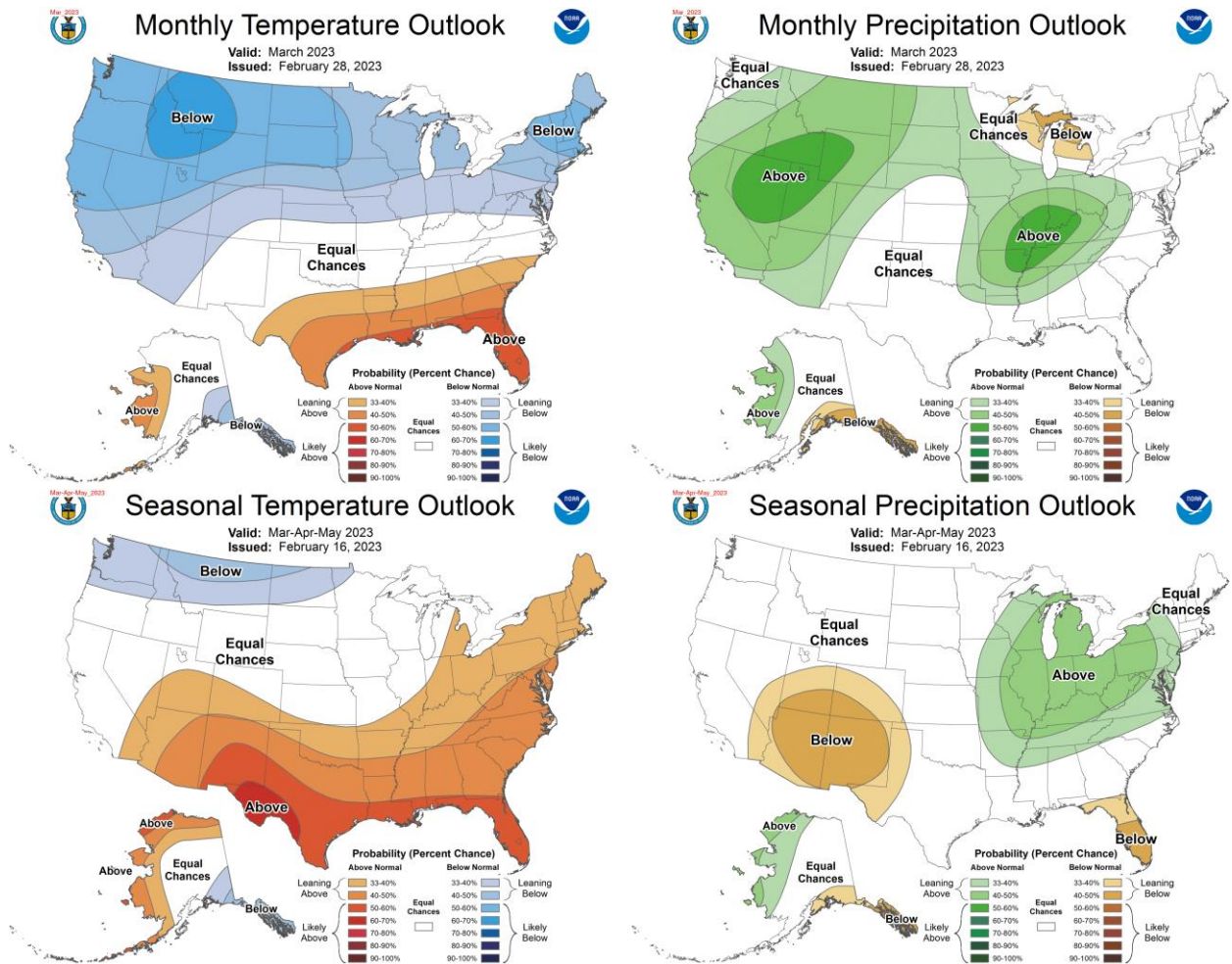


Figure 5 – Temperature (left panel) and precipitation (right panel) outlooks for the month of March (top panel) and March, April, and May (bottom panel) (Climate Prediction Center, climate.gov).

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