Office of the Washington State Climatologist

January 2022 Report and Outlook

January 12, 2022

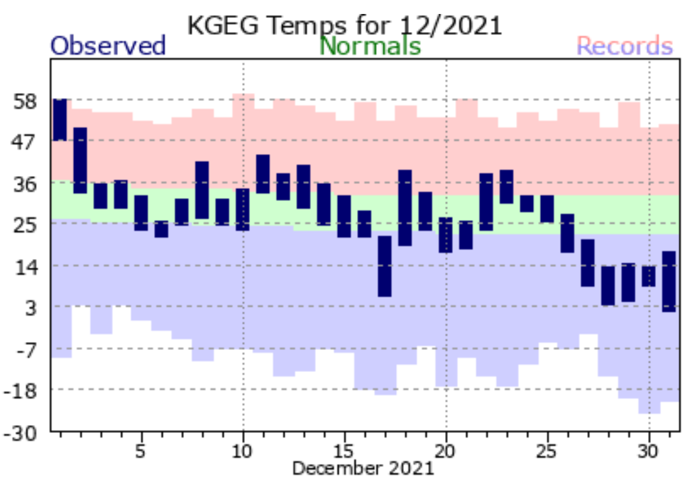
http://www.climate.washington.edu/

December Event Summary

There was considerable spatial variability in the average December temperatures and total precipitation across the state. A majority of Washington State had December temperatures that were below normal with near-normal to above normal precipitation. But parts of eastern WA had above normal temperatures and below normal precipitation; more details are provided in the "Climate Summary" section on page 9.

In this Issue

December began with mild temperatures statewide. Record high daily temperatures were set across the state on the 1st, with some high temperatures warm enough to set all-time high temperature records for the month of December. Omak (74˚F), Yakima (72˚F), Pasco (71˚F) Wenatchee (70˚F), Ephrata (69˚F), and Ellensburg (66˚F) are examples of daily and all-time



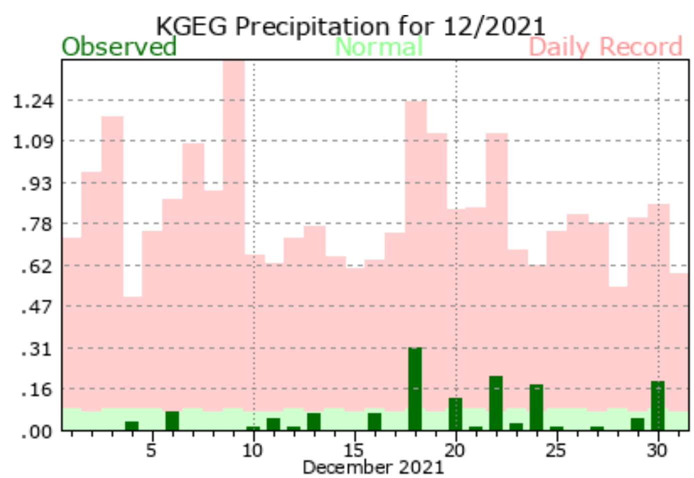


Figure 1: December 2021 daily temperature and precipitation for Spokane Airport compared to the 1991-2020 normal (green envelope)and previous records (blue and red envelopes; NWS).

December high temperature records set on the 1st, breaking previous all-time records by 5-18°F.

Figure 1 shows the December 2021 daily temperature and precipitation time series for Spokane Airport. Notable on the temperature time series is that the warmest maximum temperature for the month was on the 1st and the coldest minimum temperature was on the 31st. The month certainly ended on a much colder note, but we'll get to that.

Temperatures and precipitation for a majority of the month were near-normal with a few instances of warmer than normal temperatures (e.g., record high daily temperature set at Olympia of 63°F on the 15th). Precipitation was also typical, with a few daily high precipitation records set (e.g., maximum precipitation record of 2.57" at Quillayute on the 18th) and snow finally building in the higher elevations. Strong winds also made an appearance with gusty winds between 30 and 50 mph in western Washington on the 10th into the 11th.

The most notable weather of month occurred between Christmas and New Year's as northerly flow aloft brought much colder than normal temperatures and snow across the state. Figure 2 shows the 24-hr snowfall observations from the morning of the 26th, just one day shy of a classic white Christmas. Temperatures were quite frigid as well. Several record low temperatures were set on the 26th (9°F at Bellingham, 19°F at Quillayute, 20°F at SeaTac, and 25°F at Hoquiam) and the 27th (7°F at Bellingham, 11°F at Walla Walla, 17°F at SeaTac, and 21°F at Hoquiam). The cold temperatures caused much of the snow on the ground to persist until the new year.

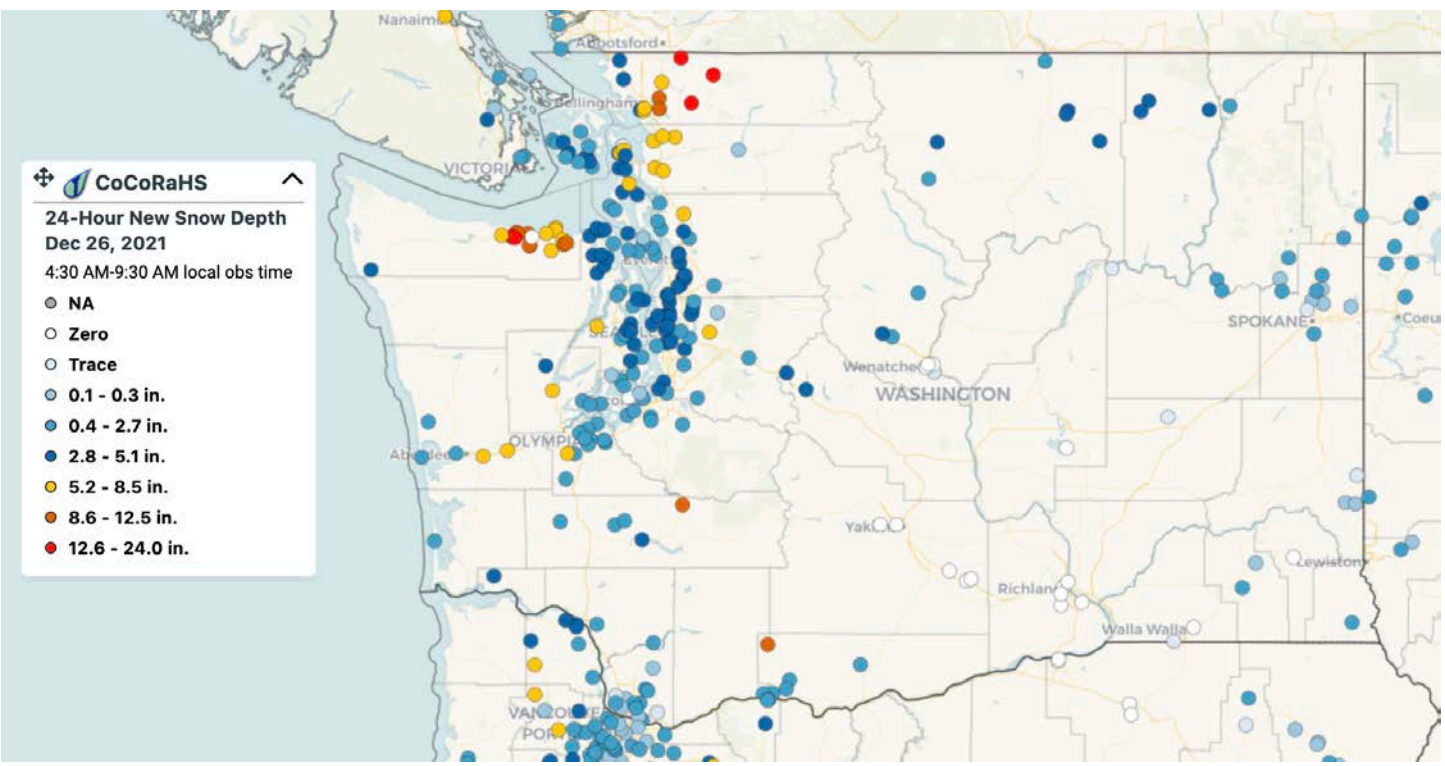


Figure 2: 24-hour snow depth measurements on the morning of December 26, 2021 from the CoCoRaHS network.

Snowpack and Drought Summary

Snowpack grew substantially over the month of December, and more snow accumulated in the mountains compared to typical Decembers. The WA State Drought Coordinator, Jeff Marti, used NRCS data and found that the statewide average snow water equivalent (SWE) increased by 11.11" this December, compared to an average December gain of 7.56". The basin average SWE percent of median from NRCS as of January 3 (Figure 3) indicates normal to above normal SWE statewide. The Lower Columbia and Central Puget Sound basins have the highest SWE relative to normal, with 133 and 129% of normal, respectively. Basin average SWE is slightly lower on the eastern slopes of the Cascades but is still normal to above normal for this point in the season (between 96 and 108% of normal).

Above normal snowpack, above normal streamflows, and above normal precipitation for parts of the state prompted more improvement to the U.S. Drought Monitor (Figure 4). The "exceptional drought" that was from our extremely dry spring and summer is now gone and the areas of "extreme drought" and "severe drought" have been greatly reduced. With continued rain and snow, we expect to see more improvement, but there are still long-term precipitation deficits in the region.

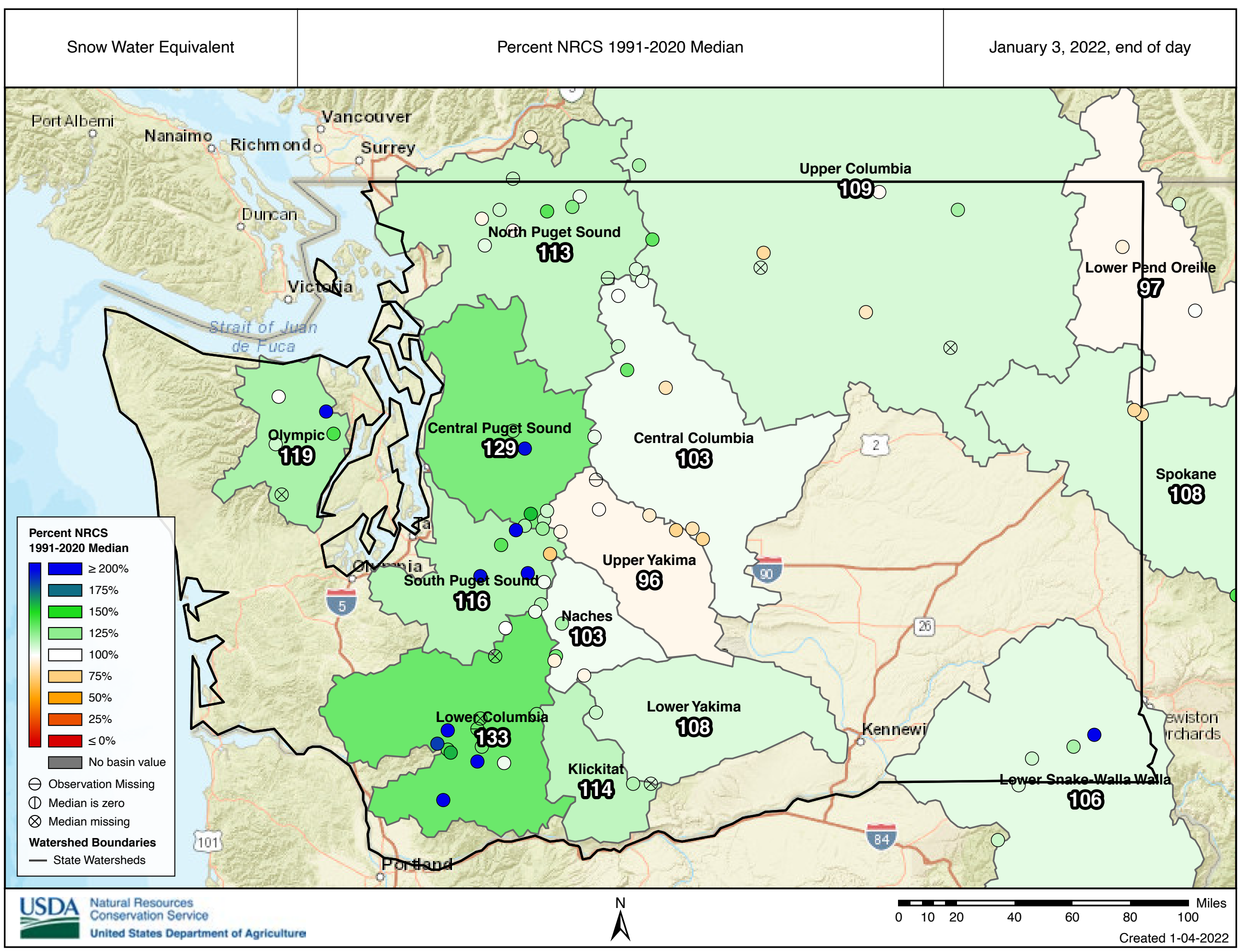


Figure 3: Snowpack (in terms of snow water equivalent) percent of median for WA as of January 3, 2022. The median is based on the 1991-2020 period (NRCS).

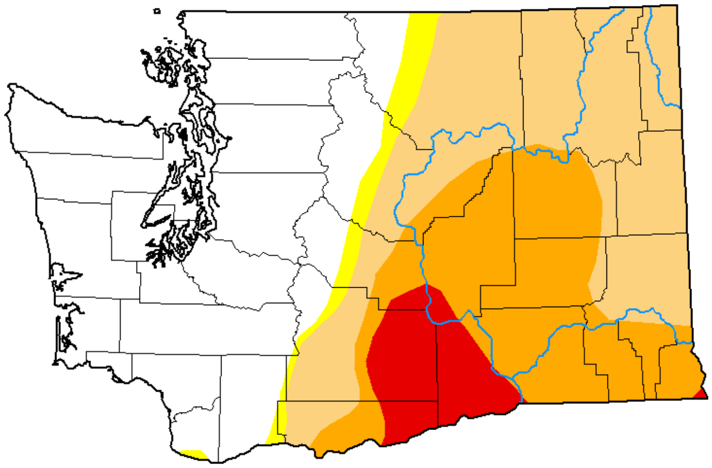


Figure 4: The January 2, 2022 edition of the U.S. Drought Monitor.

Community, Collaborative Rain, Hail, and Snow (CoCoRaHS) Corner

Washington CoCoRaHS observers were out in full force during the month of December. Interestingly enough, two of our statistics for December are the same as last month's: 78% of observations recorded some amount of precipitation, and nine new members joined our ranks. Members of the CoCoRaHS network made 25 more observations this month than last, ending with a grand total of 11,147 observations. Clearly, the number of observations didn't decrease from the previous month, but we were nonetheless curious to see how the holidays impacted the number of observations recorded each day (Figure 5).

As expected, not everyone in the network who travels during the holidays hired a house-sitter to record precipitation measurements in their absence. Even so, over three hundred citizen scientists showed up every single day over the month of December. That's impressive! We're grateful to those who made CoCoRaHS part of their holiday traditions. We also suspect that the snow and icy conditions after Christmas contributed to the drop in observations. We know that snow observations can be a bit intimidating – especially for the westsiders who may be out of practice. You can brush up on best practices for measuring snow

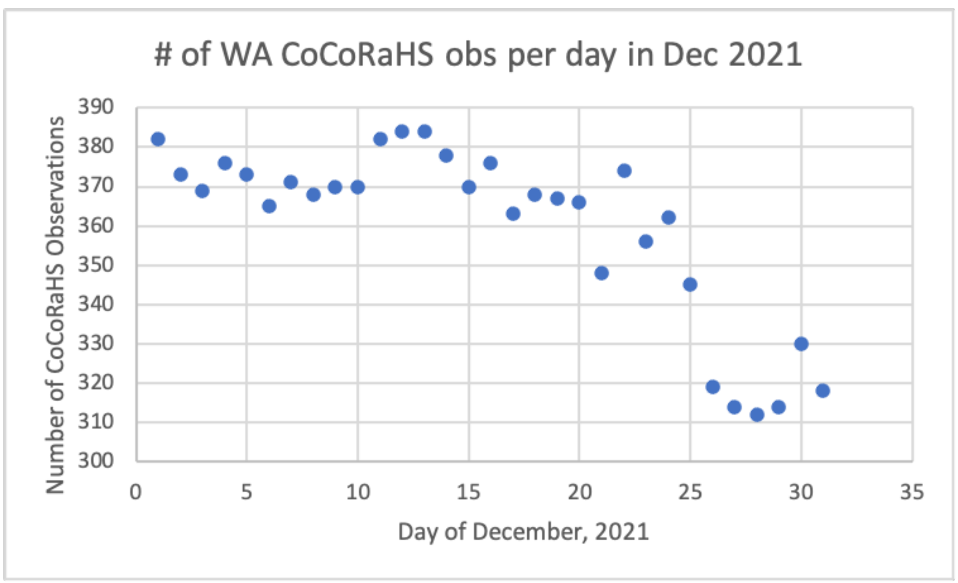


Figure 5: A scatterplot showing the number of observations made by WA CoCoRaHS observers each day of December 2021.

and the liquid water content of that snow in our "In Depth" Snow Measuring guide.

The highest one-day precipitation total for the month comes from Hoodsport, WA with 3.71 inches recorded on 12/11/2021. Some Washingtonians who were dreaming of a white Christmas saw that dream come true, but for many, the snow was a day or two late. The highest one-day new snow total for the late-December event comes from Glacier, WA, with 18.4 inches of snow on 12/26. Lots of observers reported on their accumulated snow totals. One observer hailing from Stevens County spoke of eight and a half feet of snow on the ground and said that they hadn't been able to leave the house for a week. Another Okanogan County observer reported that temperatures swung from the upper 60s on December 1st down to 34°F three days later. Many observers reported slippery conditions! We hope everyone stayed safe and warm.

How Do Plants Affect the Climate?

Written by: Haley Staudmyer

Washington – or at least, those parts of it not situated in rain shadows – is known for its greenery hence the nickname of the "Evergreen State". The pervasive rain and mild temperatures allow plants to thrive during the rainy season. Have you ever stopped to ask, though, not what the climate does for plants, but what plants do for the climate?

On a global scale, plants have a big impact on the carbon cycle by way of photosynthesis. As you likely learned in grade school, with sunlight, water, and carbon dioxide, plants create oxygen and food for themselves. This process allows plants to be a significant sink for anthropogenic carbon emissions. Figure 6 shows data from the longest record of direct atmospheric CO_2 measurements in the world, taken at the Mauna Loa Observatory in Hawaii. The thick black line shows average monthly CO_2 measurements corrected for the seasonal cycle; the red line shows the same, but without the correction. The red line moves up and down as plants in the northern hemisphere blossom and wilt with the seasons. The net effect of plants is to remove CO_2 from the atmosphere and store it safely away in soils and plant tissues, where it does not act to heat up the Earth. In fact, about 25% of all fossil fuel emissions from humans have been taken up by plants and soils.

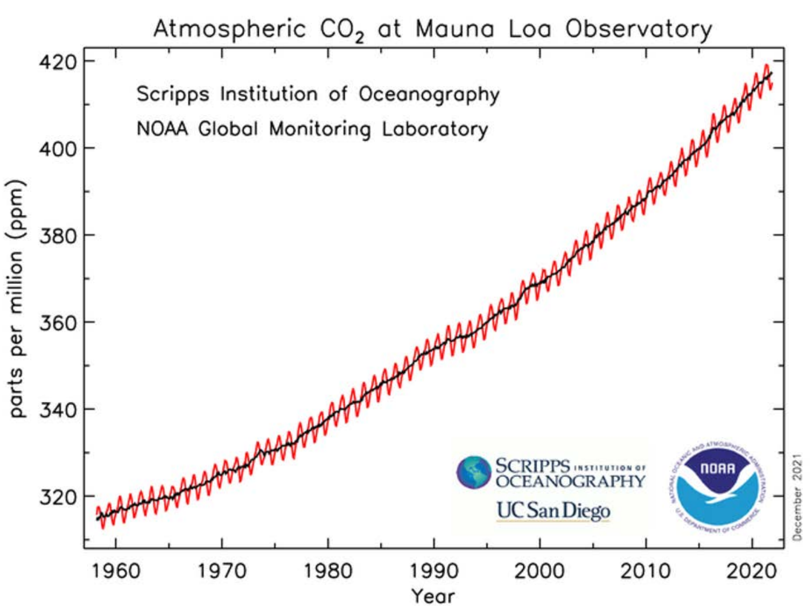


Figure 6: Monthly mean carbon dioxide measured at Mauna Loa Observatory, Hawaii (NOAA).

Plants can have a big impact on local climates, too. In the rainier regions of the Pacific Northwest, plants have plenty of water and warm enough temperatures to survive, so they are mostly limited by sunlight in the amount they can grow. This has an impact on the characteristics of the plants that grow here. Take the three most common trees in the Pacific Northwest as examples: The Douglass Fir, the Western Red Cedar, and the Western Hemlock. All of these trees are needleleaf trees. According to a study by Dorman and Sellers (1989), needleleaf trees reflect less and absorb more sunlight than broadleaf trees, grasses, and crops (Table 1). Thus, the widespread growth of dark, needleleaf trees in Western Washington allows for more sunlight to be absorbed on average, which helps to increase the surrounding temperature. In contrast, the sunnier areas of Eastern Washington are more sparsely vegetated. With fewer forests and vast swaths of farmlands, prairies, and even deserts, more sunlight is reflected. This helps to keep Eastern Washington cooler than it would otherwise be.

Changing surface reflectivity is not the only way that plants impact local temperatures. Plants may heat up an area by absorbing more sunlight, but they can also cool down an area

Vegetation	Leaf Orientation	Reflected	Absorbed
Needleleaf Tree	Spherical	0.07	0.88
Broadleaf tree	Semi-horizontal	0.10	0.85
Grass, crop	Semi-vertical	0.11	0.82

Table 1: The fraction of incoming visible light that is reflected or absorbed by three different kinds of vegetation: needleleaf trees, broadleaf trees, and grasses or crops. The "leaf orientation" describes the direction the leaves point with respect to the incoming sunlight (adapted from Dorman and Sellers, 1989).

by something called transpiration. When a plant photosynthesizes, it opens valves on leaves (called stomata) to take in the surrounding air. This allows the plant to acquire the carbon dioxide necessary for photosynthesis, but in doing so, the plant loses some of its internal water stores to the air. This evaporation of water through foliage is called transpiration. Transpiration helps to cool the local climate down for the same reason that sweating cools humans down. Energy is required to change liquid water from a plant (or on your skin) into water vapor. If incoming solar energy is being used to complete this phase change, it cannot also be used to heat up the surrounding air. Plants draw up water from the soil that would otherwise not be available to moderate the surrounding climate, so in this way, plants can help to keep the local area cooler than it would otherwise be without plants.

So, which is it? Do plants absorb enough extra sunlight to have a net heating effect on a local area, or do they transpire enough to have a net cooling effect? According to Dr. Abigail Swann, Associate Professor of both Atmospheric Science and Biology at the University of Washington, the answer depends on the specifics of the locale in question. At higher latitudes in the Arctic, plants are much darker than the surrounding bright and snowy landscapes, so their impact on reflectivity is much more pronounced. There, plants may help to warm the environment. In the tropics, plants do a lot more photosynthesizing, allowing for more transpiration that cools the surrounding area.

In the mid-latitudes, and specifically the Pacific Northwest, these two effects are harder to disentangle from one another to determine a net effect. Additionally, given the very different climates and vegetation patterns of Eastern and Western Washington, the net impact of plants is likely very different on either side of the Cascades. Some studies and experiments have been done in the Pacific Northwest describing the climatological impacts of plants on the area, but the OWSC could find no synthesis of the existing literature. While creating such a synthesis is beyond the scope of this article, there is at least one impact of plants in Washington State we can be more certain of. Evidence suggests that a lack of plants is at least part of the reason that our largest population centers experience an "urban heat island effect." Studies show that densely populated, urban areas are, on average, warmer than the surrounding outlying areas. The recent results of a heat mapping project conducted by King County and the City of Seattle show that areas with more vegetation and natural landscaping experience a smaller urban heat island effect than those without. These results are supported by other studies that show that vegetation can reduce the urban heat island effect.

We at the OWSC are grateful for everything plants do to keep our world and our cities more comfortable. We also give thanks to Dr. Swann and her graduate students, Greta Shum and Claire Zarakas, for their assistance with this article.

References:

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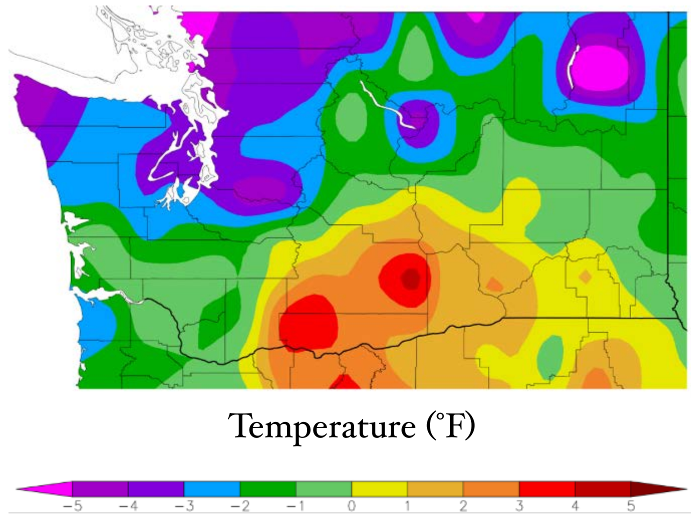
Dorman, J.L and Sellers, P.J., 1989: A Global Climatology of Albedo, Roughness Length and Stomatal Resistance for Atmospheric General Circulation Models as Represented by the Simple Biosphere Model (SiB). *J. Appl. Meteor. Climatol.*, **28**, 833-855.

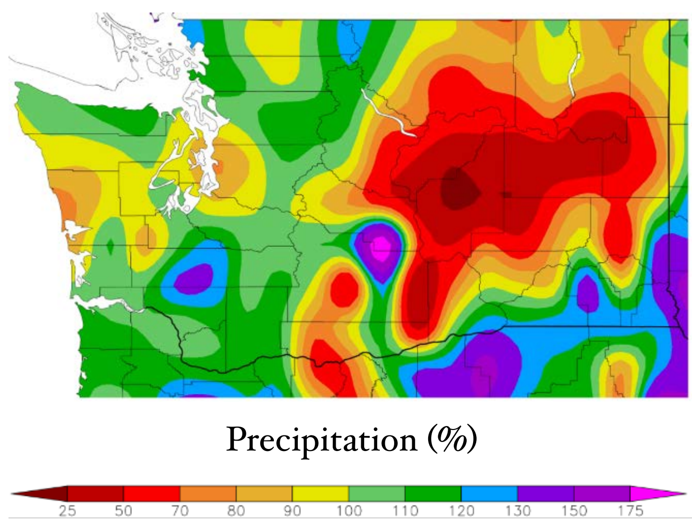
Climate Summary

According to the map from the High Plains Regional Climate Center, average December temperatures were at or below normal for most of the state. Northwestern Washington experienced below normal temperatures that accompanied their snowfalls, with departures from the norm ranging anywhere between 2 and 5°F below the normal. Bellingham, for instance, recorded an average temperature of 34.6°F, 5.2°F below normal (Table 2). Areas south of the Olympic Peninsula or east of the Cascades recorded temperatures within 2°F of normal in either direction, with some exceptions. Klickitat, Yakima, and Benton Counties, along with some of the surrounding areas, were a bit warmer than normal, reaching between 2 and 5°F above normal. In contrast, Stevens County and the junction between Chelan, Douglas, and Okanogan Counties were both chilly, with stations clocking in at 4 or 5°F below normal.

It is important to draw attention to the colorbar for the December percentage of normal precipitation map. Since August of 2021, the HPRCC has generated this map using a colorbar stretching down to 5% and up to 300% of normal precipitation. For December 2021, the map was instead generated using the much narrower colorbar pictured here, indicating that precipitation totals were closer to normal than in other recent months. This was especially true for Western Washington, which generally hovered between 90% and 110% of normal precipitation. Eastern Washington, in contrast, was decidedly drier. Nearly everywhere east of the Cascades received between 25% and 70% of normal precipitation. Pasco and Pullman Airports were far enough away from the heart of the dry conditions to see 97% and 149% of normal precipitation, respectively.



December temperature (°F) departure from normal relative to the 1991-2020 normal (HPRCC).



December total precipitation percent of 1991-2020 normal (HPRCC).

Station	Mean Temperature (°F)			Precipitation (inches)		
	Average	Normal	Departure from Normal	Total	Normal	Percent of Normal
Western Washington						
Olympia	38.1	38.9	-0.8	9.11	7.85	116
Seattle WFO	38.9	41.8	-2.9	4.71	5.55	85
SeaTac AP	38.0	42.0	-4.0	4.08	5.72	71
Quillayute	36.6	41.0	-4.4	13.48	13.84	97
Hoquiam	40.7	42.0	-1.3	8.24	10.52	78
Bellingham AP	34.6	39.8	-5.2	3.58	4.33	83
Vancouver AP	38.7	40.8	-2.1	6.75	6.07	111
Eastern Washington						
Spokane AP	27.5	29.1	-1.6	1.35	2.34	58
Wenatchee	26.9	29.0	-2.1	0.60	1.31	46
Omak	25.8	27.9	-2.1	1.10	1.95	56
Pullman AP	30.0	31.7	-1.7	3.30	2.21	149
Ephrata	28.5	29.6	-1.1	0.26	1.13	23
Pasco AP	35.9	34.1	1.8	1.00	1.03	97
Hanford	34.1	32.6	1.5	0.36	1.08	33

Table 2: December 2021 climate summaries for locations around Washington with a climate normal baseline of 1991-2020.

Climate Outlook

According to the Climate Prediction Center (CPC), La Niña conditions are present in the Pacific Ocean, and a "La Niña Advisory" remains in effect. Over the last 4 weeks, sea surface temperatures (SSTs) in most of the equatorial Pacific Ocean have been below average, but the anomaly weakened near the International Date Line. Though the predicted strength of the La Niña conditions has weakened since last month, the conditions are still expected to persist through the end of winter (95% chance for the January-February season). Neutral ENSO conditions are expected to emerge in the springtime (60% chance for the April-June season).

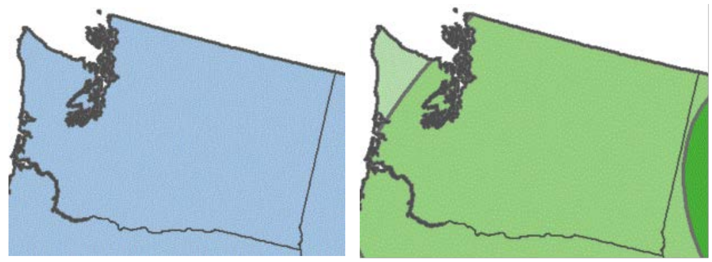
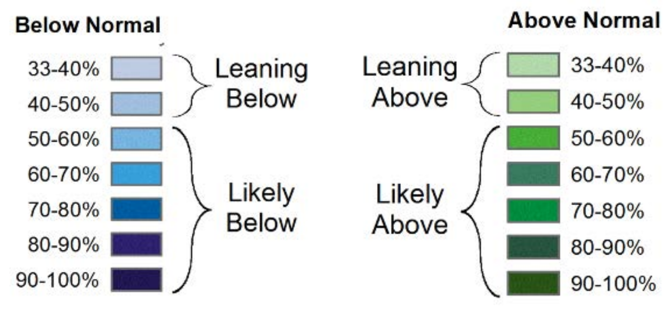


Figure 7: January outlook for temperature (left) and precipitation (right).



The CPC outlook for January (Figure 7) shows a 40-50% chance of below normal temperatures for all of Washington state. The entire state is likely to experience higher than normal precipitation. The probability of above normal precipitation is between 33 and 40% for a small northwestern portion of the Olympic Peninsula and between 40 and 50% for the rest of Washington.

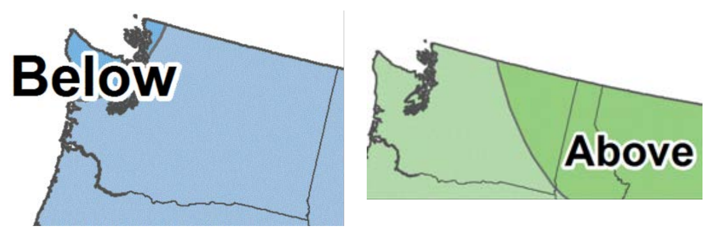


Figure 8: January-February-March outlook for temperature (left) and precipitation (right) ([Climate Prediction Center](#)).

The three-month outlook for January-February-March (JFM) shown in Figure 8 predicts below normal temperatures statewide, with chances between 40 and 50% for most of the state. The northwestern corner of the state, including the northern Puget Sound region and the northern Olympic Peninsula, is slightly more likely to see temperatures below normal, with chances between 50 and 60%. The entire state is forecast to see above normal precipitation. Most of the state has a 33 to 40% chance of experiencing below normal precipitation, but the northeastern region of the state has slightly higher odds (40 to 50% chances).