



Weather Summary

Mount Rainier National Park – Water Year 2021

The North Coast and Cascades Network (NCCN) Inventory and Monitoring Program monitors climate in order to compare current and historic data to understand long-term trends, to provide data to model future impacts to park facilities and resources, and to provide park staff with information needed to make management decisions. This brief summarizes climate data collected and notable weather events that occurred during water year¹ 2021 in Mount Rainier National Park.

Significant Weather Events

The heat wave that hit the Pacific Coast of the US and Canada between June 25th and 30th, 2021, was historic in several aspects: geographic extent (Figure 1), elevational extent, occurrence early in summer, and overall temperature records met or exceeded.

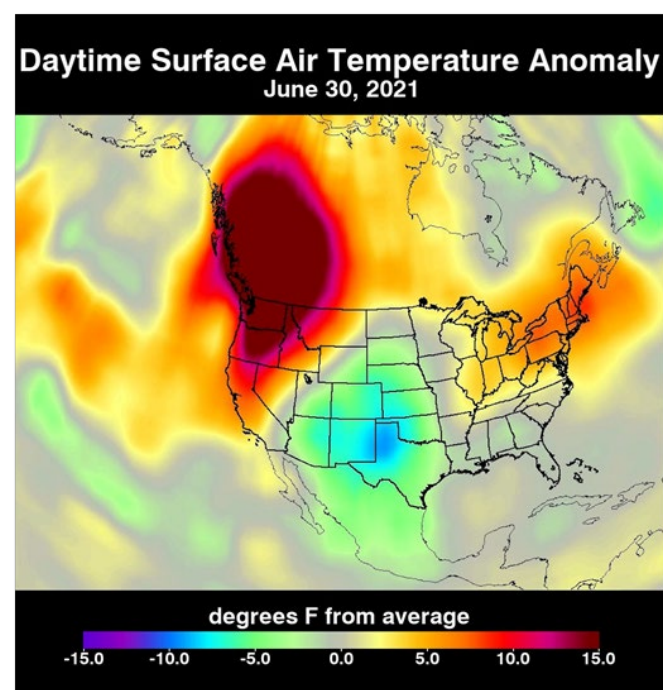


Figure 1. Atmospheric Infrared Sounder (AIRS) captures surface air temperatures at the apex of the event (NASA/JPL-Caltech).

¹ Water year (WY) is defined as the period from October 1 to September 30 of the following year, to encompass a full cycle of precipitation accumulation.

Mount Rainier's elevation (14,100' at the summit) typically provides protection against high temperature anomalies; however, during this event the height of warm air mass extended into the troposphere. A weather balloon launched from western Washington on June 25th recorded freezing levels at 18,000'.²

Temperatures recorded at Paradise COOP station (90°F) and Longmire COOP station (105°F) were near or matched the all-time records (Table 1). All values were the highest ever recorded for the month of June. All-time high temperature values were logged at two high elevation weather stations with shorter periods of record: Sunrise and Camp Schurman (Table 1).

Table 1. Maximum air temperatures (°F) measured at four weather stations within Mount Rainier National Park during the June heat wave.

Weather Stations	Record Temp June 29, 2021	All-time High Temp / Date
Paradise COOP (5,450')	90	92 / July 11, 1990
Sunrise (6,420')	87*	84 / August 8, 2018
Camp Muir (10,100')	66	67 / July 24, 2010
Camp Schurman (9,500')	64*	63 / September 6, 2020
Longmire COOP (2,700')	105	105 / July 14, 1935

*Asterisks indicate all-time high temperatures recorded (also shown in bold).

High temperatures affected Park resources, including damage to asphalt on Highway 410 east of Chinook Pass. Rapid snowmelt associated with the heat event resulted in downstream flooding (Figure 2). The Nisqually River passing the Longmire Bridge stream gauge showed a 57% increase in maximum daily water volume (when compared to averaged daily maximum values recorded earlier in the month) (Figure 3). Swollen rivers damaged many trail bridges in the Park.

² National Weather Service Seattle (@NWSSeattle). "The weather balloon launched from Quillayute this afternoon reported a freezing level of 18,000 feet. In my 22 years at this office, I've never seen anything that high. #wawx" Twitter, June 25, 2021. <https://twitter.com/nwsseattle/status/1408583437217271808>



Figure 1. A foot log on the Wonderland Trail crossing the Nisqually River in Mount Rainier National Park, is damaged by high water during the heat event. NPS Photo.

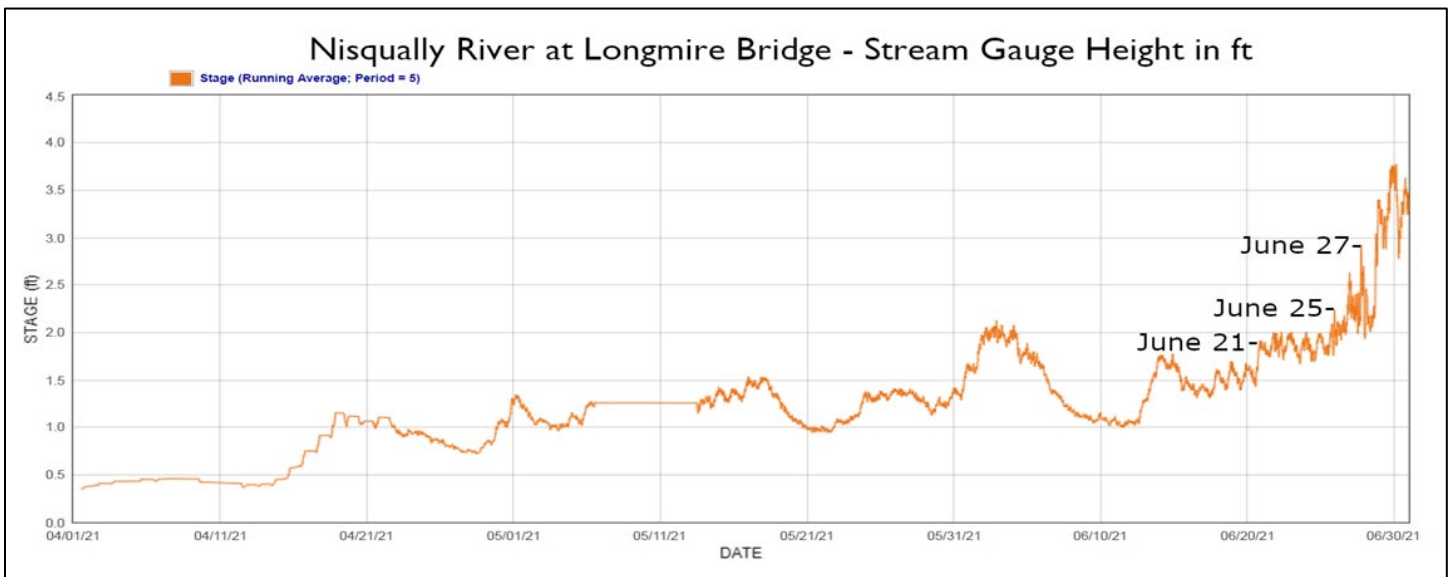


Figure 2 Hourly stream height at the Longmire Bridge stream gauge. This gauge is located approximately two river miles below the foot log pictured in Figure 2.

Temperature

Annual values for air temperature were close to normal for WY2021. The colder than normal period January–March (-3.2°F) and warmer than normal June–August ($+4.3^{\circ}\text{F}$), came close to balancing, with an annual temperature departure of $+0.9^{\circ}\text{F}$ at the Paradise COOP

and $+1.5^{\circ}\text{F}$ at the Longmire COOP station. Significant deviations from normal air temperatures at Paradise included a monthly deviation of 6.4°F below normal in February to a positive deviation of 7.0°F above normal in June (Figure 4). The June monthly value was heavily influenced by the heat event late in the month.

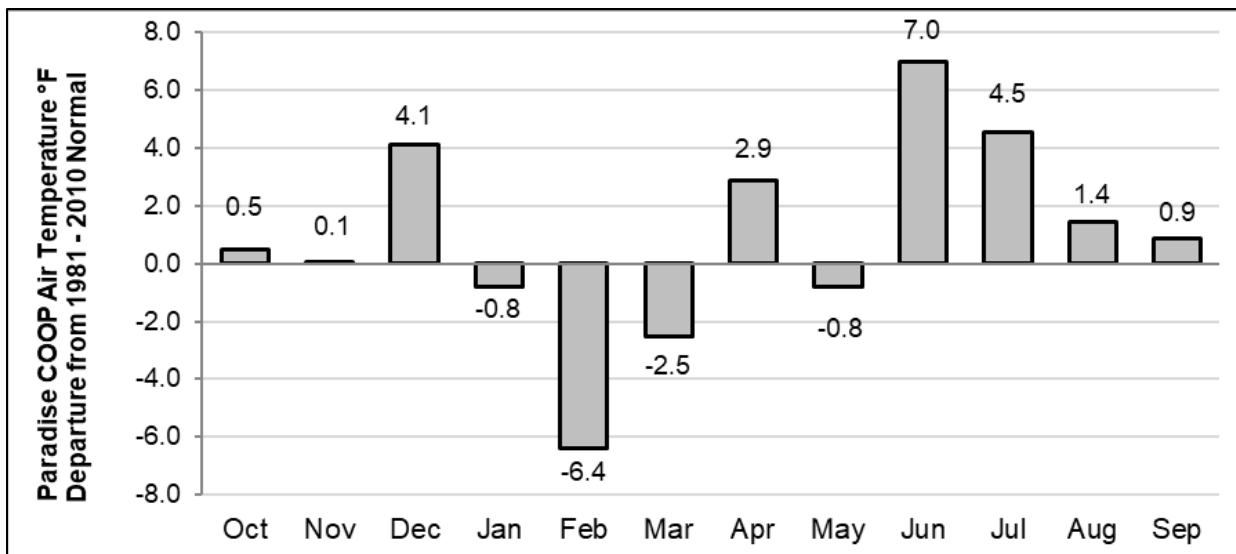


Figure 3. Comparison of average monthly temperature (°F) for Paradise (COOP) in Water Year 2021 against monthly averages for the climatological normal 1981–2010.

Table 3. Average monthly air temperature (°F) from weather stations in Mount Rainier National Park in Water Year 2021

Season	Month & Year	Camp Muir	Camp Schurman NPS	Carbon River NPS	Cayuse Pass SNOTEL	Longmire COOP	Ohanapecoh RAWs	Paradise COOP	Sunrise NPS
Fall	October 2020	32.2	32.7	43.0	44.0	45.3 ³	45.9	40.6 ⁴	39.6
	November 2020	18.5	20.8	45.3	38.0	34.4	36.8	31.1	27.8
Winter	December 2020	19.7	22.6	40.0	32.5	33.1 ⁵	34.3	31.5	28.0
	January 2021	15.3	18.1	34.4	29.0	34.6	35.1	27.9	24.7
	February 2021	11.8	14.0	39.2	20.0	29.7	30.2	22.5 ⁶	19.4
Spring	March 2021	14.8	17.2	49.0	32.0	35.0	34.6	28.3	25.1
	April 2021	22.6	25.0	57.4	39.5	43.2	43.3	36.9	32.5
	May 2021	26.2	29.4	71.7	44.0	48.0	50.1	39.7 ⁷	36.7
Summer	June 2021	38.5	41.3	67.3	61.0	60.2	62.3	52.5	49.7
	July 2021	47.0	48.2	66.4	58.0	64.2	67.2	57.5	55.7
	August 2021	43.8	44.4	56.9	58.5	62.1	63.9	55.6	52.3
Fall	September 2021	37.2	42.5	46.3	54.5	53.9	56.2	49.8	45.8
Annual		27.3	29.7	51.4	42.6	45.3	46.7	39.5	36.4

Precipitation

The beginning of the water year was wetter than normal with the Paradise COOP station recording 172% and the Longmire COOP station recording 131% of normal precipitation in October (Figure 5). The following months of November–January were unremarkable, hovering just above or below normal. February was particularly wet at the Longmire station, with 8.85" of water received in seven days. This wetter than normal fall/winter turned into the fourth-driest spring on record for Washington. A drought emergency was declared in mid-July for the majority of the state. At the Paradise COOP station and Longmire COOP station,

April was exceptionally dry at 18% and 23% of normal, respectively. Dry conditions affected Park operations and Mount Rainier issued a recreational fire ban beginning July 16, 2021. Drought conditions and lingering precipitation deficits from the period March through August were countered by regionally heavy rains in September, which was 183% of normal for the Paradise COOP station (Figure 5). Again, significant deviations from normal were balanced, and annual precipitation ended near normal for the water year at 108% at Paradise and 103% at Longmire. Monthly precipitation totals from three representative weather stations in the Park are presented in Table 6.

³ Temperature data missing 5 days, substituted co-located telemetered data.

⁴ Temperature data missing 10 days, substituted co-located telemetered data.

⁵ Temperature data missing 5 days, substituted co-located telemetered data.

⁶ Temperature data missing 6 days, substituted co-located telemetered data.

⁷ Temperature data missing 6 days, substituted co-located telemetered data.

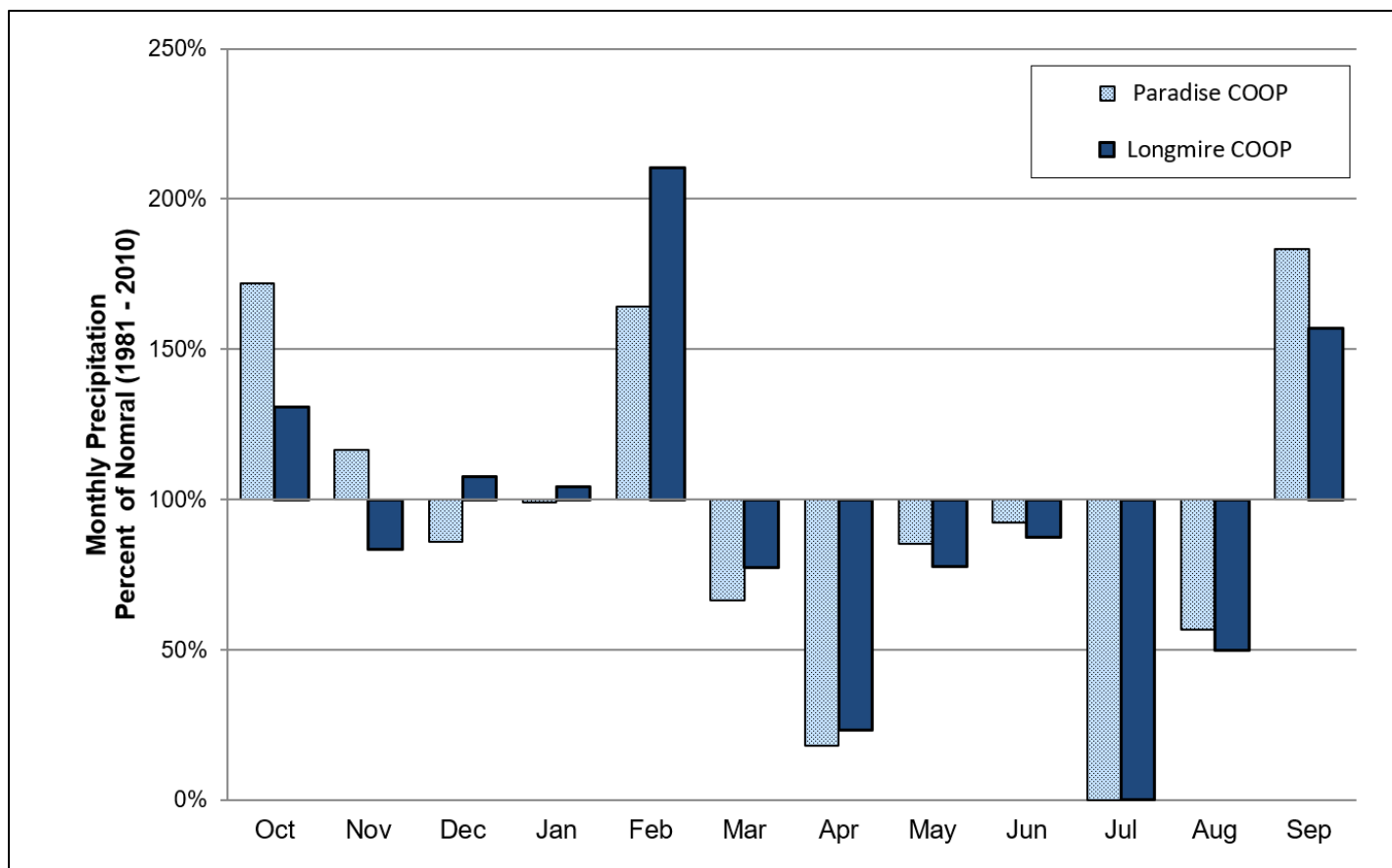


Figure 4. Comparison of monthly total precipitation (inches) as a percent of normal at Longmire and Paradise (COOP) in Water Year 2021 against the climatological normal 1981–2010.

Table 6. Total Monthly precipitation (inches) from weather stations within Mount Rainier National Park in Water Year 2021

Season	Month & Year	Carbon River NPS	Longmire COOP	Paradise COOP
Fall	October 2020	7.10 ⁸	10.3	17.9
	November 2020	11.6 ⁹	11.2	23.6 ¹⁰
Winter	December 2020	9.9	11.3	14.8
	January 2021	12.0	12.2	18.1
	February 2021	12.5	16.6	20.8
Spring	March 2021	2.6	5.8	8.4
	April 2021	4.9	1.3	1.5
	May 2021	4.1	3.8	5.0
Summer	June 2021	0.0	3.4	3.8
	July 2021	0.9	0.0	0.0
	August 2021	5.8	0.8	1.1
Fall	September 2021	9.9	5.6	8.6
Annual		77.1	82.2	127.7

⁸ Precipitation data missing, substituted Burnt Mountain SNOTEL for entire month.

⁹ Precipitation data missing, substituted Burnt Mountain SNOTEL for 11/1 – 11/17.

¹⁰ Precipitation data inaccurate, substituted co-located telemetered data for 1 day.

Snowpack

The southern Pacific Ocean surface water temperature pattern known as La Nina influenced our region bringing sustained wetter and cooler than normal weather in the winter months of WY2021. Snow water equivalent (SWE, a measure of water in the snowpack) at the Paradise SNOTEL weather station (5,400') was above normal every month. On April 1, SWE was 138% of normal. Snow water equivalent reached a maximum of 93" of water, or 133% of normal, at the site on April 10, 2022 (Figure 6). Snow height as measured from the ground at the Paradise COOP station reached 66" by December 1. Snow accumulation through February and March, fueled by much cooler and slightly wetter than normal conditions, reached a maximum height of 236" on March 26, 2021.

Snowmelt at the Paradise COOP station from April 1 through June 25th averaged about 2" every day. On June 25 (early in the heat event), snow height was 64" at Paradise. Only five days later it measured 24", melting 8" per day, four times the previous rate of melt. Due to warmer than normal temperatures, the above normal snowpack melted rapidly by early summer. At the Longmire COOP station, 0" of snow was reported as early as April 25. The snow melt out date at Paradise was July 12, only one day later than average (period of record 1917–2017) (Figure 6). The snowpack melted slightly earlier on the eastside of the Park, with the last snow melting at the Sunrise weather station on June 21, followed closely by the Cayuse Pass SNOTEL on June 23.

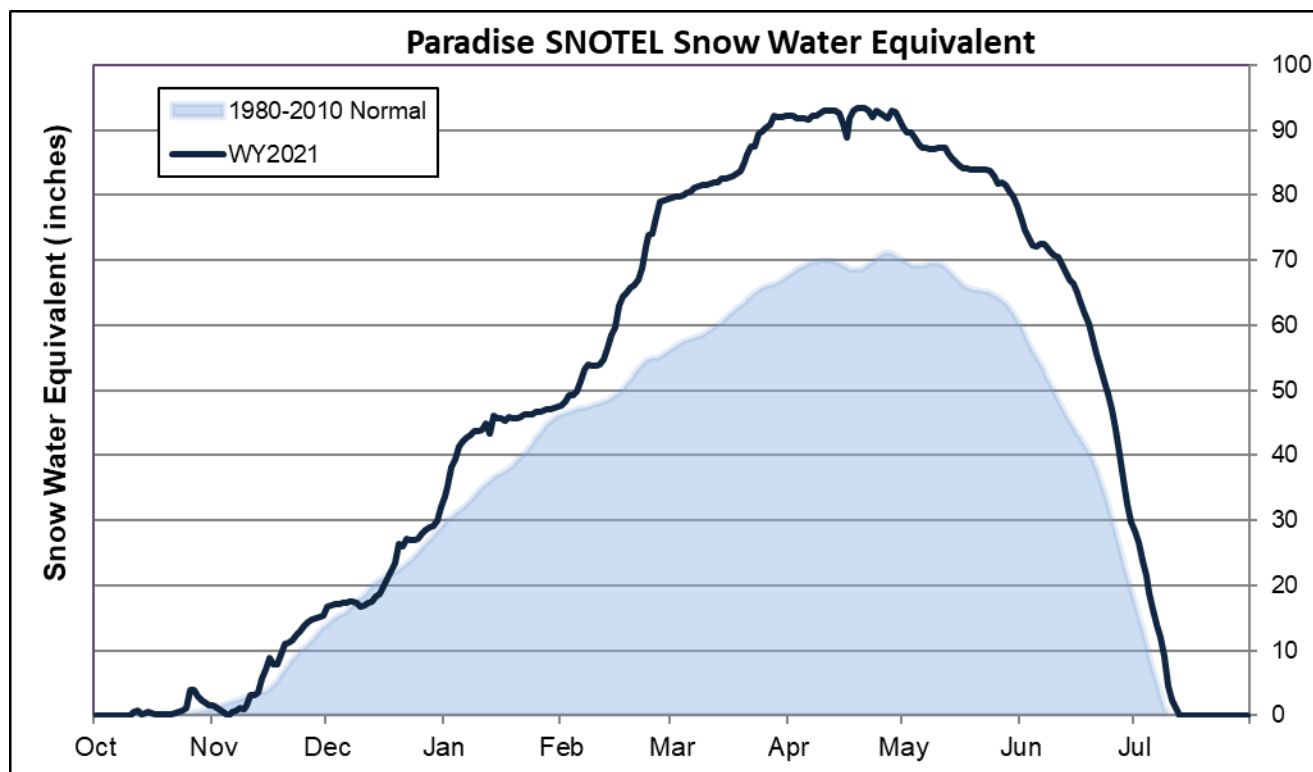


Figure 6. Daily snow water equivalent at the Paradise SNOTEL in Water Year 2021 against the 1981–2010 climatological normal.

While the above average snowpack is thought to have been protective of glacial ice during the heat wave, observationally, the rapid melt combined with the higher temperatures throughout the summer months of 2021 influenced the melt and radiation effects on the upper mountain glaciers (Figure 7). Crevasses were open as low as 9,000' in elevation on the Muir Snowfield, a low-angle glacier. Both prevalence and size of the

crevasses in 2021, while not historic, were unusual for that location. Penitentes were well developed above Camp Muir (Figure 7), and rockfall was a common occurrence on popular climbing routes. Commercial climbing concessions cancelled trips in the late summer/early fall citing rockfall hazard. This is the first time in history that all climbing concessions ended the Rainier climbing season early.



Figure 7. Open crevasses and running water created hazardous conditions on the Muir Snowfield during late summer months (left). Difficult to navigate penitentes above 11,000' at (right), are created by above normal temperatures, dry air and abundant solar radiation.

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