

## Sakhalin Region Temperature and Rainfall Observations for the Summer Months of 2021 Relative to Previous Years

This report provides a review and analysis of temperature and precipitation data for the Sakhalin region recorded during the summer of 2021 with an emphasis on comparison to previous years. This comparison is intended to assess whether the observations for 2021 were within the range of normal historical fluctuations or whether they were truly extreme and unprecedented as has been suggested by residents living in this region of Russia.

Two sources were used to make this assessment. The first source was accessed online from the WeatherSpark website. Located from this website are the graphs that contain 2021 temperature and precipitation observations for Yuzhno-Sakhalinsk, Khabarovsk, and Petropavlovsk-Kamchatsky. Included with each graph are percentile bands that show the range of temperatures on these dates based on historical data for previous years.

The second source of information was weather data collected at the airport in Okha for the period 2005 through 2021. These data were downloaded from an online source and provided in raw form for synthesis and analysis. These data, in their original form, contained numerous errors and a substantial number of corrections and assumptions about missing or doubled values had to be made. Eventually a database suitable for analysis was resolved and daily values for minimum temperature, maximum temperature, average temperature, and precipitation were available for comparative analysis.

With regard to the WeatherSpark data (the first source of information), for both Yuzhno-Sakhalinsk (Figure 1) and Khabarovsk (Figure 2) graphs illustrate that July 2021 was an exceptionally warm year with temperatures (the gray bars) exceeding the 90th percentile values for the historical record. For Kamchatka (Figure 3) it does not appear that 2021 was quite as extreme. Also, worth noting that following this July heat wave, the first half of August was substantially cooler. In some cases, the cool temperatures dropped below the 10th percentile bands.

The precipitation data for 2021 are also consistent with what we heard from local residents. Presented in Figure 4, is a profile of the range of monthly precipitation values based on historical data (they are actually moving 31-day averages). Overlaying this graph are two red diamond symbols which represent the July and August monthly precipitation totals for 2021. Notice that for July there was only 0.43 inches of precipitation, exceptional dry conditions. Less rainfall than the 10<sup>th</sup> percentile of the historical data. However, in August the rainfall amount (3.6 inches) seemed to return to normal with it almost being the same as the average for this location. With respect to impact on migrating and spawning salmon, without this early August rainfall (and a coinciding of cooler temperatures) the summer of 2021 probably would have been even worse for fish.

Yuzhno-Sakhalinsk Weather Station Data  
Via WeatherSpark: <https://weatherspark.com>  
Accessed online 9/24/2021

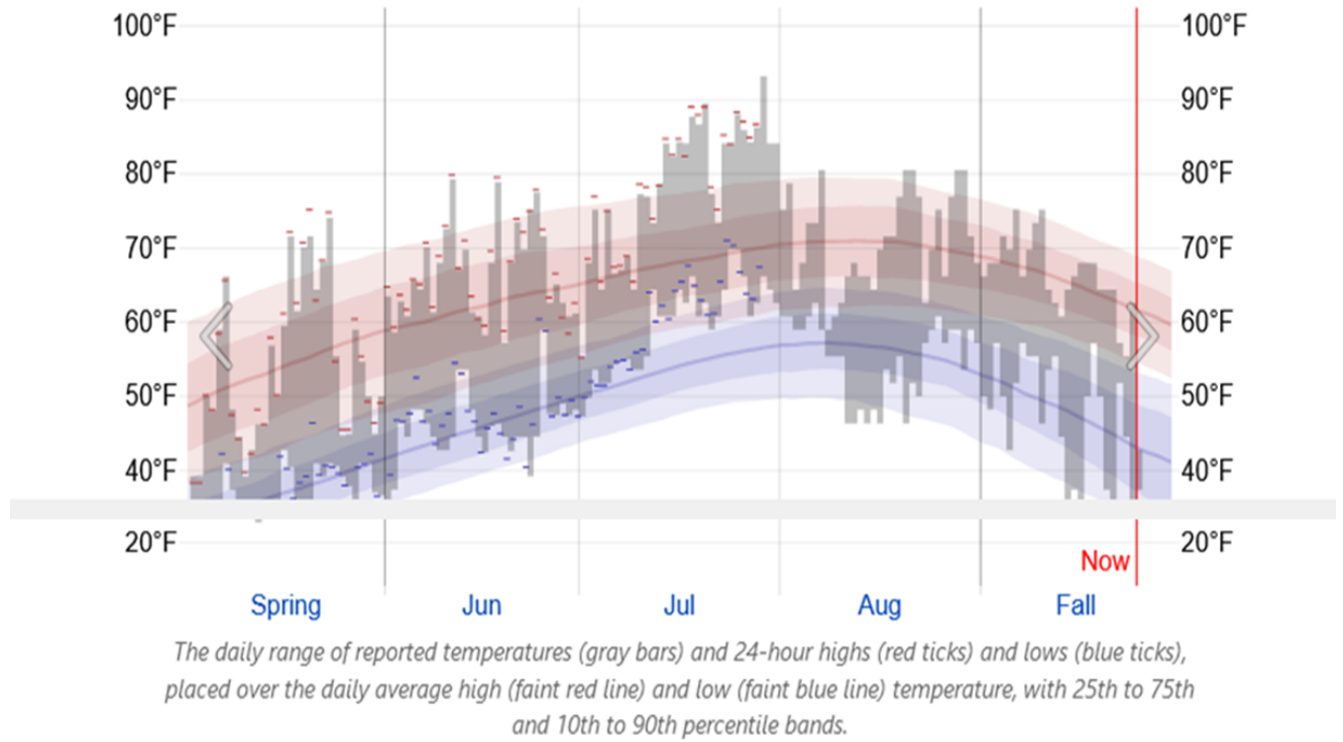


Figure 1. **Yuzhno-Sakhalinsk Temperature History** (gray bars are daily temperature data for 2021)

Via WeatherSpark: <https://weatherspark.com>  
Accessed online 9/24/2021

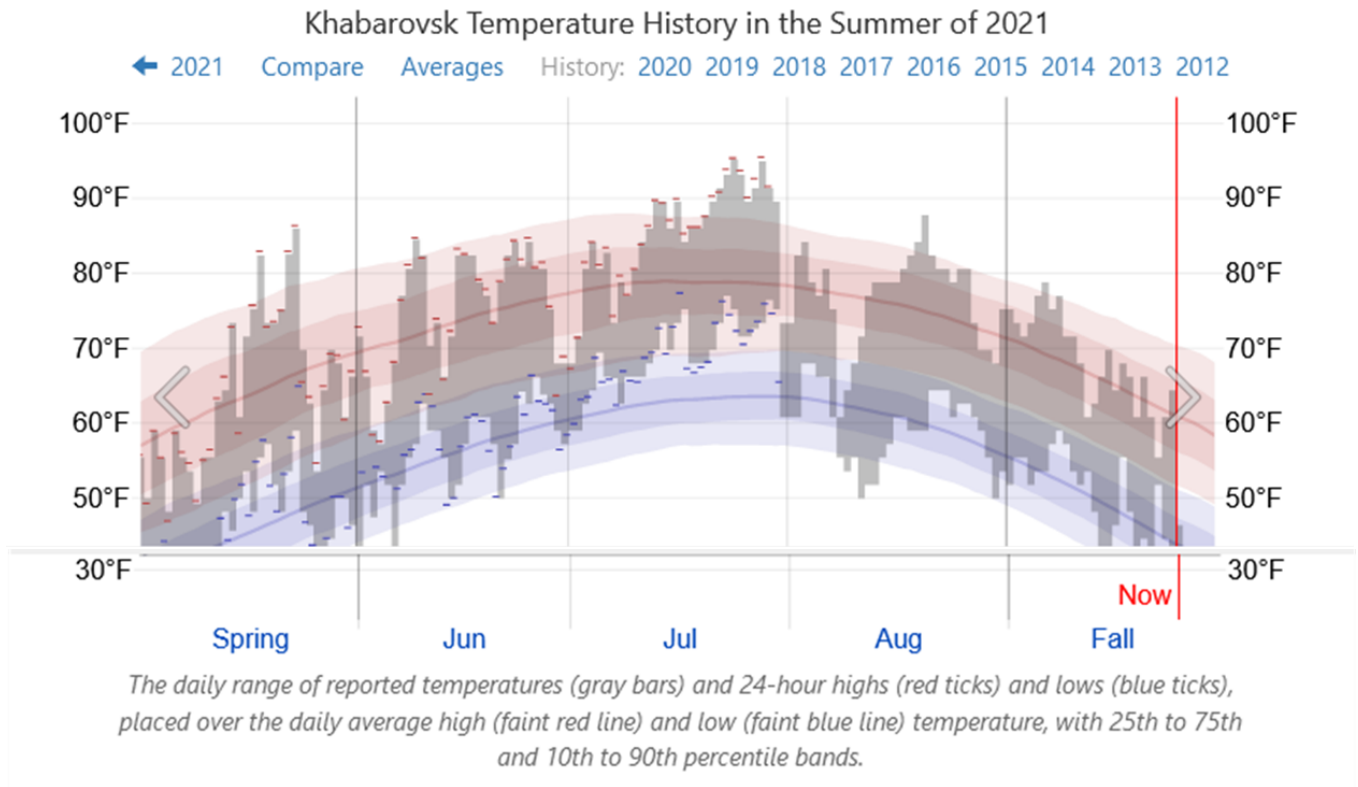


Figure 2. **Khabarovsk temperature data** (gray bars are daily temperature data for July 2021)

Via WeatherSpark: <https://weatherspark.com>  
Accessed online 9/24/2021

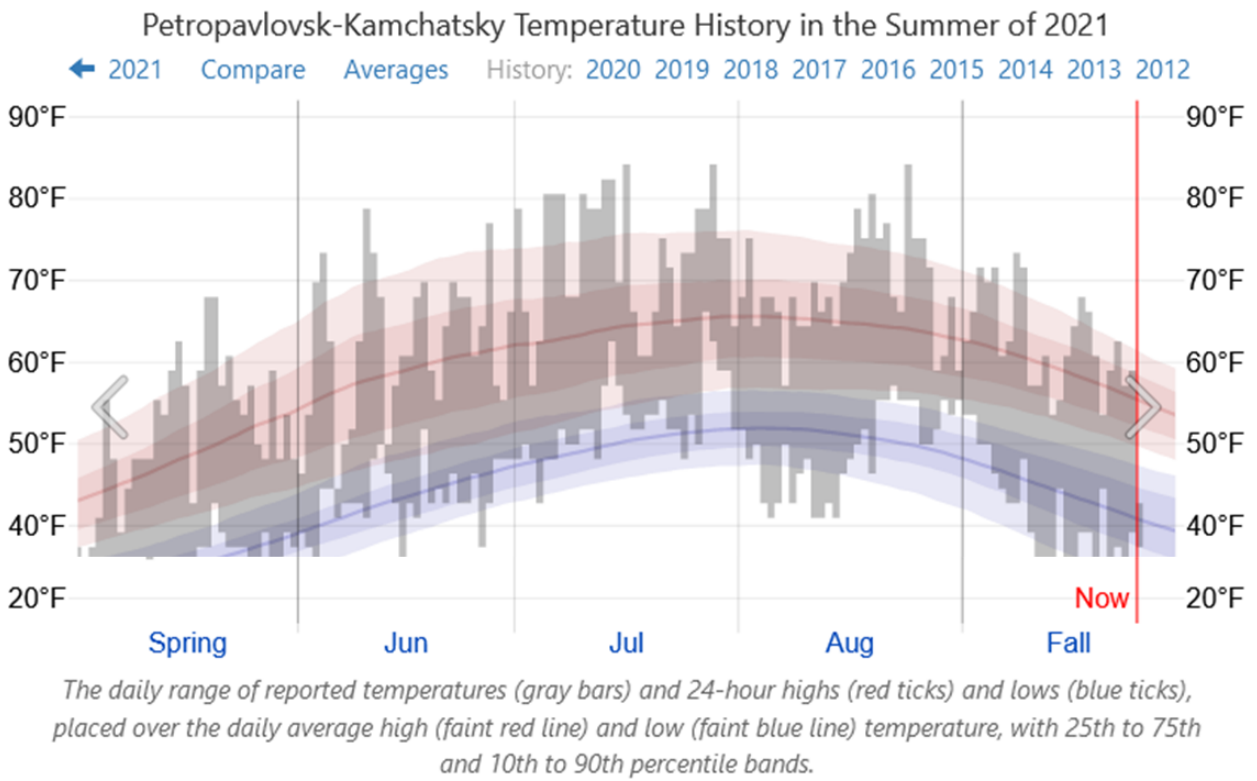


Figure 3. **Petropavlovsk-Kamchatsky Temperature data** (gray bars are daily temperature data for July 2021)

### Average Monthly Rainfall at Yuzhno-Sakhalinsk Airport

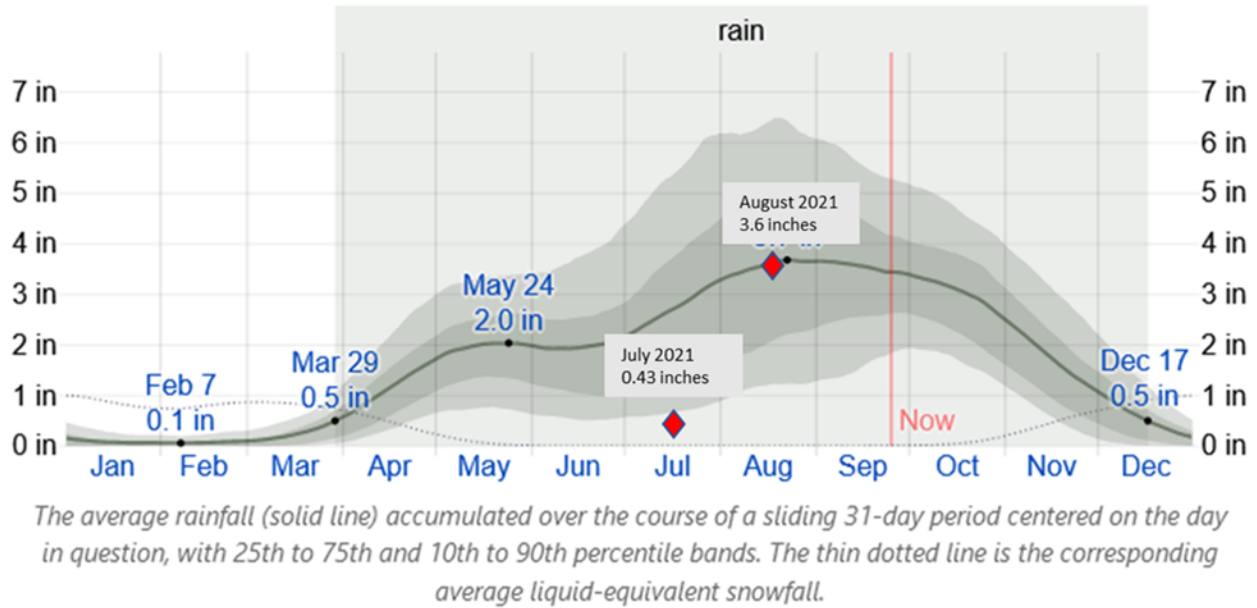


Figure 4. Historical monthly rainfall moving averages (black line) and percentiles for Yuzhno-Sakhalinsk as accessed from WeatherSpark website: <https://weatherspark.com>. Graph includes monthly total rainfall during July and August of 2021 (represented by red diamond symbols) as accessed from online website: <https://freemeteo.ru/weather/yuzhno-sakhalinsk/history/monthly-history/>.

As noted earlier, the second source of information was the data collected from the location of Okha. As illustrated in the following temperature graphs calculated are the 90<sup>th</sup> percentile, median, and 10<sup>th</sup> percentile daily values over the period 2005 to 2021. So, for example, in Figure 5, which represents the minimum observed temperatures, the red line is the 90<sup>th</sup> percentile value (90 percent of the values for this day, across all years were less than this level). The green line represents the median values and the blue line represents the 10<sup>th</sup> percentile values (only 10 percent of the values were less than this level). Finally, the heavy black line in each graph represents the observations for 2021.

As Figures 5,6 and 7 illustrate, July was exceptionally warm in 2021, with an extreme peak at the end of the month. Interestingly, this was followed in early August by a strong cooling shift for the first two weeks before returning to much warmer than normal temperatures for the latter part of the month. This pattern was much like the pattern illustrated in the temperature graphs presented above from the WeatherSpark data source.

Data for precipitation observations was presented as the cumulative amounts throughout the summer season for the Okha location. Because of missing information and unresolvable errors, precipitation data for 2015, 2016, and 2017 were omitted from the analysis. However, the pattern of cumulative precipitation for the summer of 2021 as illustrated in Figure 8 confirms that the summer period was extremely dry. Cumulative precipitation levels in 2021 were at or below the 10<sup>th</sup> percentile (red line on the graph) for nearly the entire period. The lines

representing the median precipitation pattern (green line) and 90<sup>th</sup> percentile precipitation (very wet years) were dramatically higher and steeper in slope than observed for 2021 (black line). These observations likely represent adverse conditions for spawning and migrating salmon.

In conclusion, the data support local observations that the summer of 2021 was exceptionally dry (in terms of rainfall) and warm. The month of July, in particular, was extremely warm, followed by a cooling period in early August and then a return to atypically warm temperatures for the rest of the month.

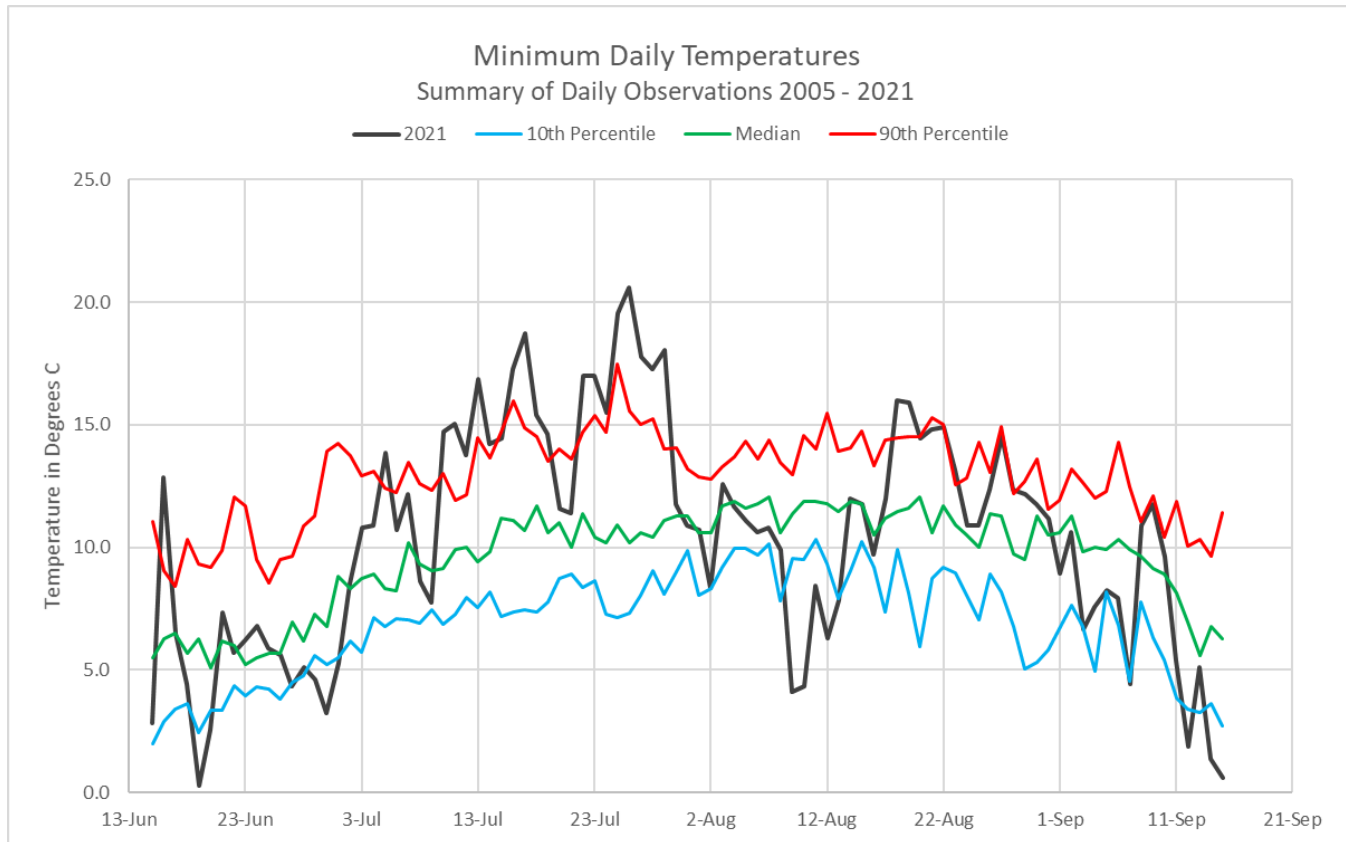


Figure 5. Minimum daily temperature

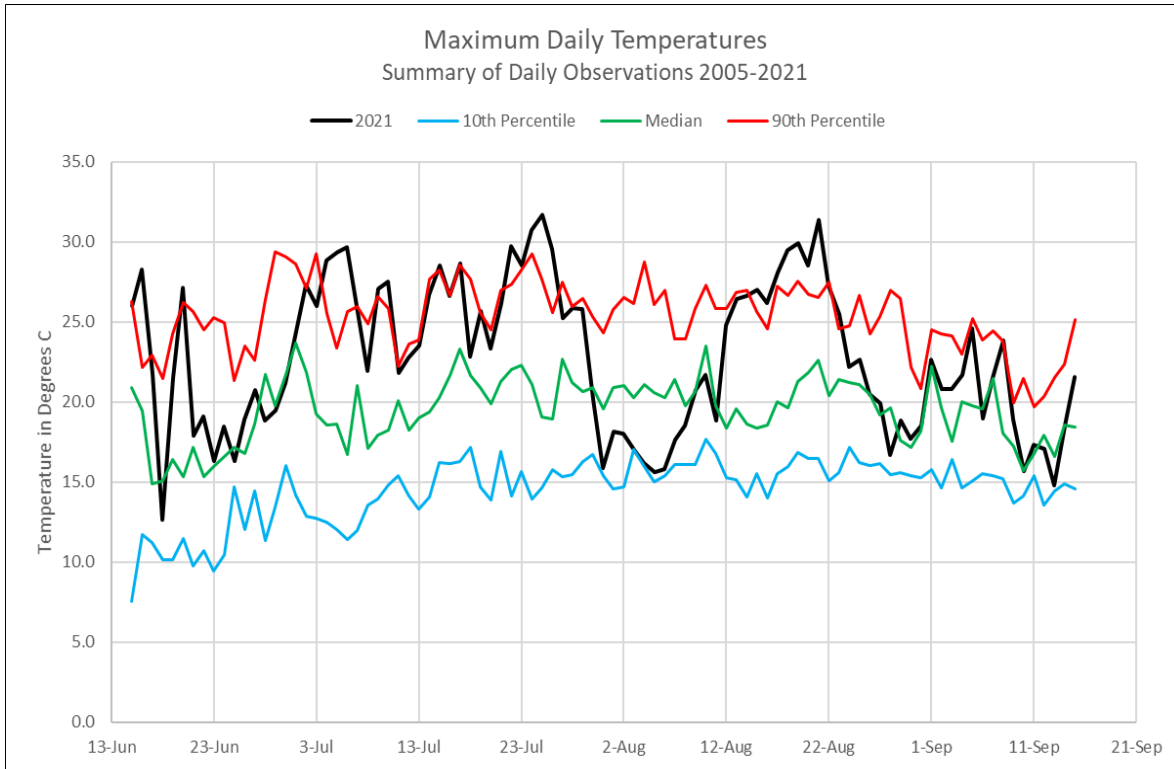


Figure 6. Maximum daily temperature

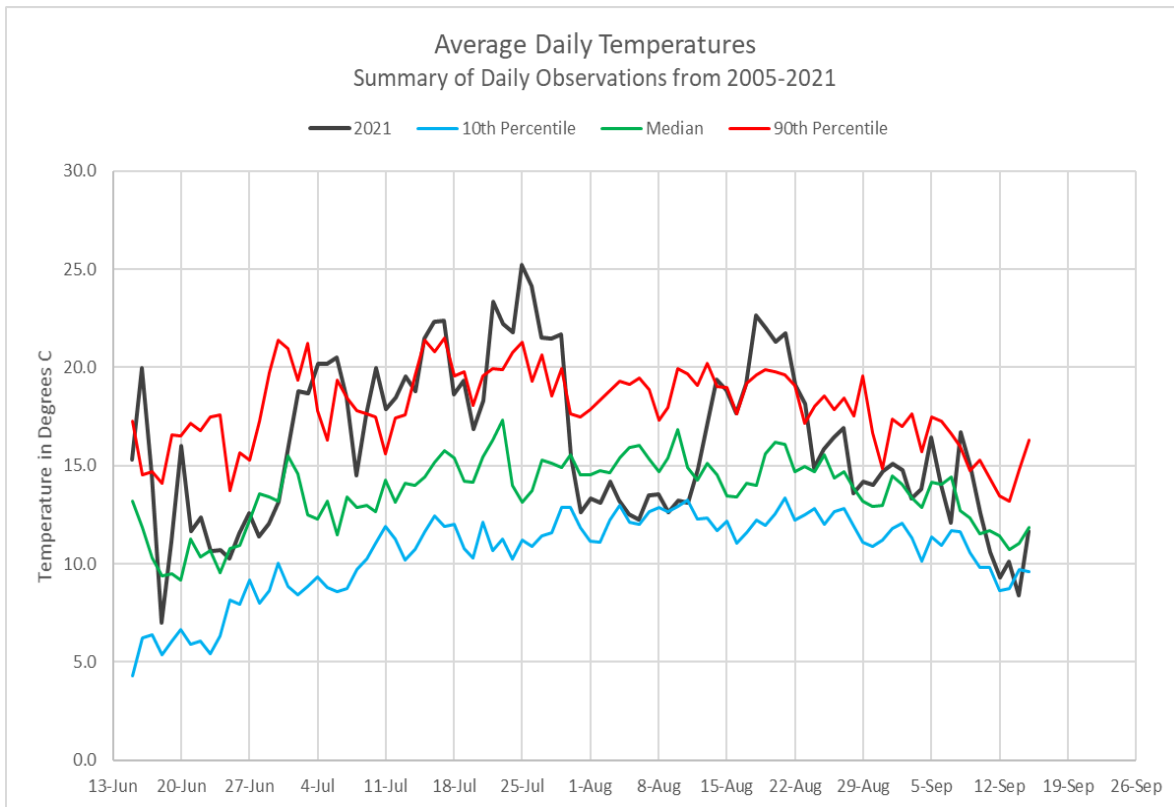


Figure 7. Average daily temperature

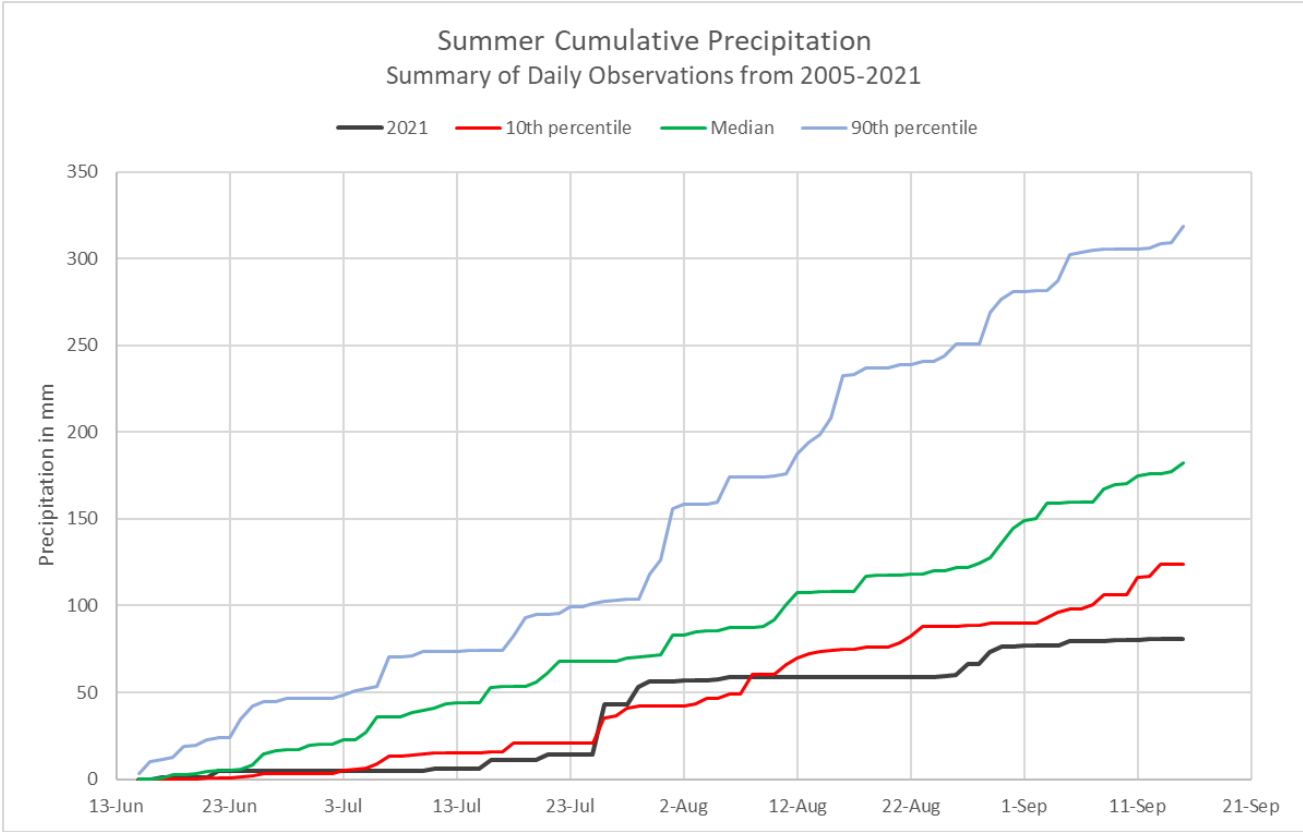


Figure 8. Cumulative summer precipitation

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