

Evaluation of selected Climate Extreme Indices (CEIs) from BC climate extremes app

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1. Background

This document presents an evaluation of selected Climate Extremes Indices (CEIs) generated and visualized in the [bc_climate_extremes_app](#) (called [CEIapp](#) hereafter). The primary objectives are twofold: (1) to clarify the calculation methods for specific CEIs whose definitions or computational procedures are not sufficiently detailed in their definition and description (Appendix 1), and (2) to assess the consistency and performance of CEIs produced by the app in comparison with similar indices from established source or input data.

The [CEIapp](#) provides a suite of over 70 CEIs, derived from the Multi-Source Weather ([MSWX](#)) gridded dataset (Beck et al., 2022) of daily minimum and maximum temperatures and precipitation across western North America. Several CEIs also incorporate spatial coordinates (latitude and longitude) and the month of the year in their calculations to account for spatial and seasonal variability. This dataset has a spatial resolution of $0.1^\circ \times 0.1^\circ$ and spans the period from 1979 to present. For the current analysis, we limit the temporal extent to 2024, the most recent year for which complete data were available. The app will be updated periodically to incorporate indices for subsequent years.

Although the app includes over 70 CEIs, as listed in Appendix 1, the scope of this evaluation is limited to a subset of sector-relevant indices as many of the indices are already well-defined and sufficiently described in their definition and description. Selected indices evaluated here include drought index SPEI, the Heatwave related indices and the total precipitation index.

2. Standardized Precipitation-Evapotranspiration Index (SPEI)

We calculated the Standardized Precipitation-Evapotranspiration Index (SPEI) drought index using [climpact R package](#) that internally uses [SPEI R package](#) to calculate SPEI values. The SPEI is calculated as the climatic water balance obtained at various time scales (here 3-months, 6-months and 12-months) as in the *equation (i)* (Vicente-Serrano et al., 2010)

$$D_i = P_i - PET_i \quad (i)$$

where P_i is accumulated precipitation for the period i while D_i is climate water balance and PET_i is potential evapotranspiration. Further the timeseries of D_i values are

standardized with mean 0 and standard deviation 1 following the log-logistic distribution to obtain unitless SPEI values (Vicente-Serrano et al., 2010) . The standardized values of SPEI, therefore account for seasonal and regional variations making it comparable with other SPEI values over time and space.

There are different ways to calculate PET (e.g., Thornthwaite, Penman-Monteith, Hargreaves). In the [CEIapp](#) the ET_o which is equivalent to PET is calculated following the modified Hargreaves method, an empirical approach that requires less data and primarily relies on air temperature range (mean, maximum, and minimum) and extraterrestrial radiation (Ra), which can be calculated from latitude and Julian day as in equation (ii)

$$ET_o = 0.0023 \times Ra \times (T_{avg} + 17.8) \times (T_{max} - T_{min})^{0.5} \quad (ii)$$

where ET_o = evapotranspiration ,

Ra = extraterrestrial radiation,

$T_{avg}, T_{max}, T_{min}$ = Average , Maximum and Minimum daily temperatures.

The calculated SPEI can be used to indicate the severity of drought with negative and positive SPEI indicating dry and wet conditions as in Table 1 .

Table 1: Category of drought based on SPEI values

SPEI value	Drought Conditions
≤ -2.00	Extremely Dry
-1.50 - -1.99	Severely Dry
-1.00 - -1.49	Moderate Dry
-0.99 – 0.99	Normal
1.00 – 1.49	Moderately wet
1.50 – 1.99	Very Wet
≥ 2.00	Extremely wet

We compare our SPEI values with the [global SPEI database](#) that offers long-term (1950-2025) SPEI values at $1^\circ \times 1^\circ$ spatial resolution across globe. The global SPEI database is calculated using the CRU TS 4.09 dataset (Harris et al., 2020) and provides SPEI values for 1 to 48 months period. We compared our MSWX data-based SPEI with global SPEI for a 3, 6 and 12- months period. We subset the global SPEI database for BC and compare this with our SPEI value to explore how well they represent the drought condition in the province through SPEI.

Figure 1 shows a spatial comparison of SPEI across BC at three temporal scales—3, 6, and 12 months—for July 2023, one of the highest drought months. The figure indicates detailed drought conditions as shown by SPEI with the higher resolution outputs of the [CElapp](#) (left panel) than the coarser-resolution global SPEI (right panel). Although the pattern of SPEI is captured well across BC especially for 3-months period, it differs substantially for 6 and 12 months especially along the Coast Mountains region of BC. Furthermore, the SPEI calculated for [CElapp](#) consistently indicates widespread drought conditions across BC for all three accumulation periods (3, 6, and 12 months). Drought severity intensifies with increasing accumulation periods, a pattern particularly evident in the 12-month SPEI map (Figure 1a), which depicts pervasive drought throughout the province. In contrast, the global SPEI dataset exhibits greater spatial variability, with certain regions not indicating drought. While the SPEI from [CElapp](#) suggests a more uniform and widespread drought pattern, the global SPEI database illustrates localized areas—particularly along the western coast—where drought conditions are less pronounced or absent in the global SPEI data. Given the inherently regional nature of drought, the extreme app's SPEI appears to provide a more consistent and regionally appropriate representation of drought conditions in BC compared to the global dataset.

Similarly, we calculated the correlation and other comparison metrics—including Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and the Integrated Quadratic Distance (IQD) which quantifies the difference between two distribution functions by integrating the squared differences across their range (Thorarinsdottir et al., 2013)—between the extreme app's SPEI and the global SPEI datasets. These metrics assess the degree of agreement and error between the SPEIs from the extreme app and global SPEI database.

The 3-month accumulation of the SPEI shows higher correlation and lower RMSE and IQD between the extreme app and global SPEI datasets (Figure 2). This indicates relatively strong agreement at shorter accumulation timescales. However, as the accumulation period increases (e.g., to 6 or 12 months), the correlation weakens and error metrics increase, suggesting greater discrepancies between the datasets. This divergence is likely attributable to differences in dataset resolution (MSWX (0.1°) versus CRU TS (1°)) and methodological differences in the estimation of PET used to calculate SPEI. For instance, the [CElapp](#) employs the Hargreaves method, while global SPEI products use alternative methods such as Thornthwaite or Penman-Monteith. These factors are likely to contribute to the reduced comparability of SPEI values at longer accumulation periods.

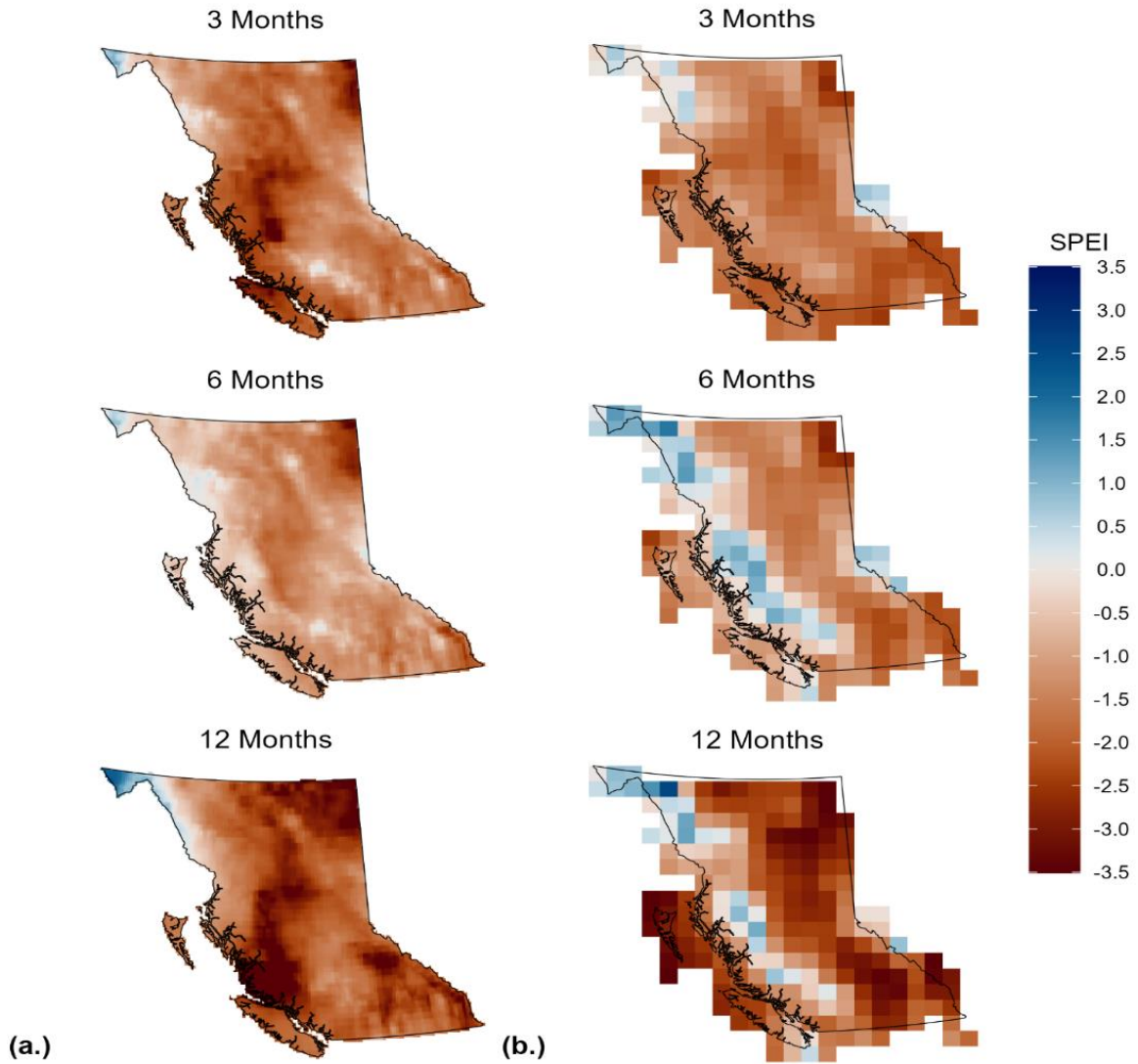


Figure 1: Spatial pattern of 3, 6 and 12-month SPEI calculated from (a.) MSWX based CEI database from the [bc_climate_extremes_app](#) and (b.) using global drought monitor database for July 2023.

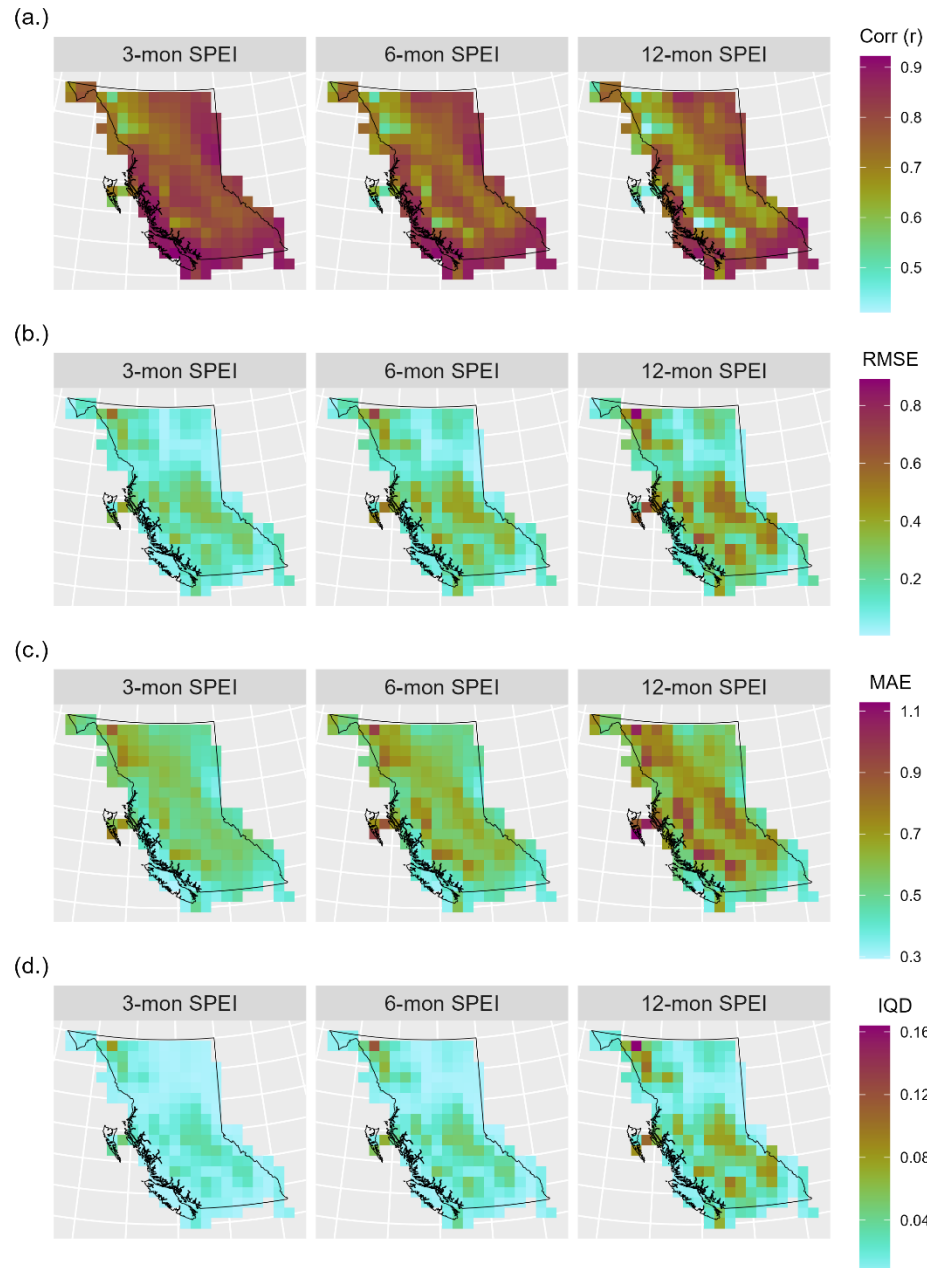


Figure 2: Spatial comparison coefficients between *CEIapp* SPEI and global SPEI database over the period of 1979 to 2025 for 3- 6- and 12- months.

3. Heatwave

We calculated the heatwave number, frequency and duration using the [climpact R package](#) and the heatwave aspects are defined based on minimum and maximum temperature thresholds and the Excess Heat Factor (EHF). The maximum (minimum) temperature heatwaves are defined as any period of three or more days when daily maximum (minimum) temperature (TX(TN)) exceeds the 90th percentile for the corresponding calendar day. EHF heatwaves are defined as any period of three or more days when the EHF is positive. The EHF is calculated as in equation (iii) where $EHI_{sig.}$ and $EHI_{accl.}$ are two excess heat indices (EHI) representing the potential to acclimatize to and the climatological significance of the heat on a particular day and calculated as in equations (iv) and (v) following (Nairn & Fawcett, 2013).

$$EHF = EHI_{sig.} \times \max(1, EHI_{accl.}) \quad (iii)$$

$$EHI_{sig.} = \frac{(T_i + T_{i+1} + T_{i+2})}{3} - T_{95} \quad (iv)$$

$$EHI_{accl} = \frac{(T_i + T_{i+1} + T_{i+2})}{3} - \frac{(T_{i-1} + \dots T_{i-30})}{30} \quad (v)$$

where T_i is the daily temperature for day i and T_{95} is the 95th percentile of T_i over all days within the specified base period i.e., 1981-2010.

Since heatwave indices are directly derived from daily minimum and maximum temperatures, we first evaluate the MSWX daily temperature data against observed station data across BC. This comparison serves to assess the representativeness of the MSWX dataset, and the reliability of the heatwave indices computed in the [CElapp](#). We focus on two key comparisons: (1) the 2021 heatwave event, one of the most significant in BC's recent history and (2) a long-term evaluation across three stations located at different elevations and different parts of BC. These analyses provide insights into how accurately MSWX data captures daily temperature, and, by extension, the robustness of heatwave-related indices presented in the [CElapp](#).

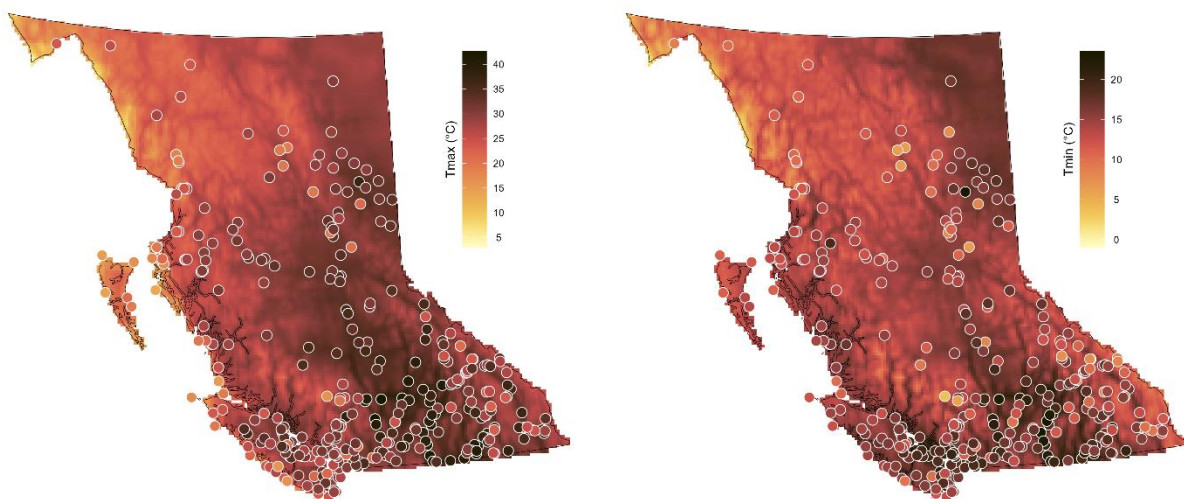


Figure 3: Comparison of daily minimum and maximum temperatures from the MSWX gridded dataset and observed station data across BC, averaged over the 2021 heatwave period i.e., June 25 to July 2, 2021.

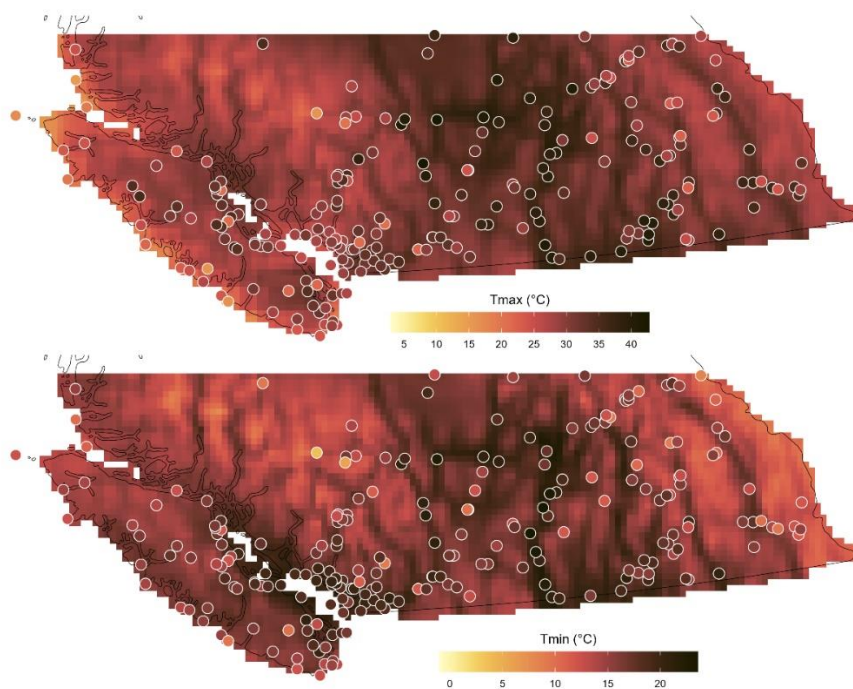


Figure 4: Same as Figure 3 but focused on the lower-latitude region of BC that experienced the most severe impacts of the 2021 heatwave. This zoomed-in view allows for a more detailed comparison of daily minimum and maximum temperatures from MSWX and station observations and shows how well MSWX daily data captures localized heatwave.

Figures 3 (for all of BC) and 4 (focused on lower-latitude regions of BC) provide a visual comparison of how daily minimum and maximum temperatures were captured by the MSWX dataset relative to observed station data during the peak of the June 2021 heatwave (June 25 to July 2, 2021). Overall, the MSWX data shows strong agreement with observations, with an average difference of only 0.2°C for maximum temperatures and – 1.5°C for minimum temperatures across all stations.

A long-term comparison of daily MSWX and observed temperature from three selected stations in BC spanning a range of elevations (Stn: 1095018 (elevation 1133 masl), Stn: 1103332 (elevation 147 masl), and Stn: EAC (elevation 2030 masl)) over the period 1980 to 2014 demonstrates good agreement between these two datasets (Table 2 and Figure 5). Correlation coefficients (r) are consistently strong for both Tmin (0.93) and Tmax (0.95) on average. Average MAE values are 2.12 for Tmin and 2.25 for Tmax, indicating good accuracy. While minor biases exist, the overall consistency and low IQD values suggest the MSWX daily temperature is reliable for heatwave indices.

Table 2: Comparison coefficients between observed and MSWX data for the period of 1980 to 2024 across selected three stations in BC.

Station ID		MAE	RMSE	Bias	Corr (r)	IQD
1095018	Tmin	2.47	3.49	-0.75	0.92	0.03
	Tmax	2.25	3.21	0.05	0.95	0.01
1103332	Tmin	1.37	1.87	0.17	0.95	0.05
	Tmax	1.72	2.30	-0.03	0.96	0.01
EAC	Tmin	2.51	3.20	-0.27	0.93	0.06
	Tmax	2.78	3.50	0.40	0.95	0.07
Average	Tmin	2.12	2.85	-0.28	0.93	0.05
	Tmax	2.25	3.00	0.14	0.95	0.03

The 1:1 scatter plot of both minimum (Tmin) and maximum (Tmax) temperatures shows that the MSWX temperatures closely align with observation, as indicated by the tight clustering of points around the 1:1 line (Figure 5). This strong linear agreement suggests that MSWX effectively captures daily temperature variability and extremes across different elevations and regions. Despite minor discrepancies, especially at lower temperatures for station 1095018, the overall consistency underscores the reliability of MSWX for representing historical daily temperature and their extremes.

These results, based on both the detailed comparison of the 2021 heatwave and the long-term evaluation, indicate that the MSWX dataset reliably represents extreme temperature conditions. Consequently, the heatwave indices derived from the CEI app can be considered a reliable representation of heatwave conditions in BC.

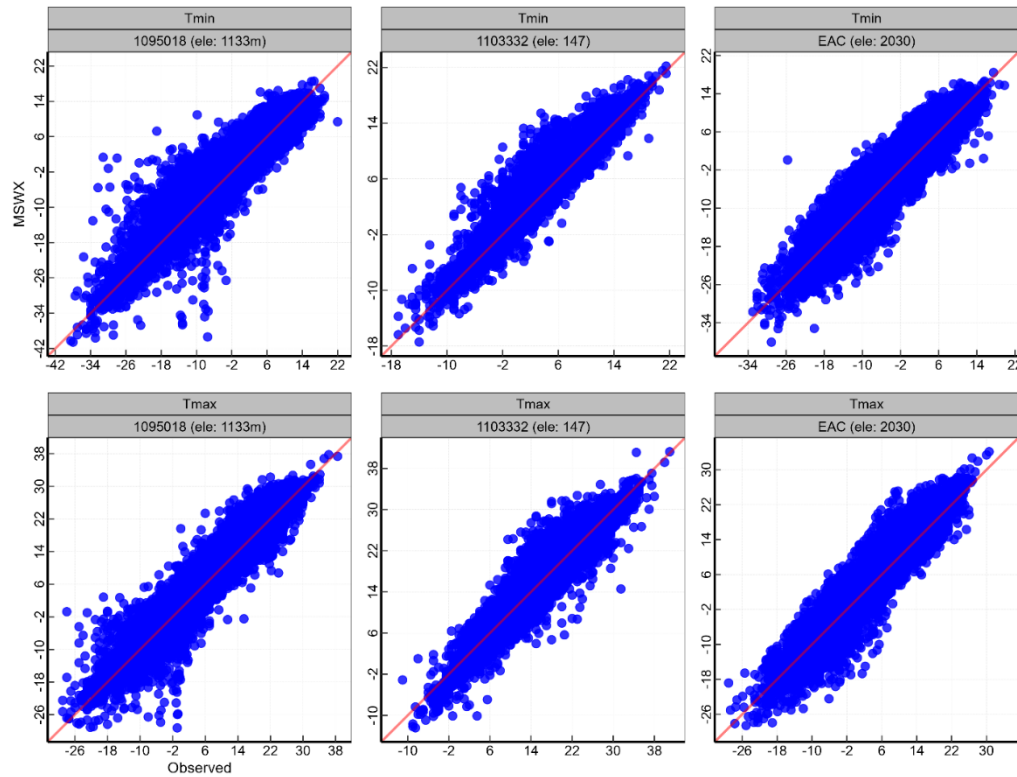


Figure 5: One on one plot of daily temperature between MSWX and observation for selected 3 stations covering different elevations across BC.

4. Summary

Based on the analysis of SPEI and heatwave indices from the [CElapp](#), the following conclusions can be drawn:

- Although the SPEI for the 3-month period is represented similarly in both datasets, the [CElapp](#)-based SPEI provides greater detail and better aligns with regional drought patterns. Moreover, it shows greater consistency across the 6- and 12-month accumulation periods. Therefore, it more accurately represents drought conditions across BC compared to the global regional SPEI database.
- The MSWX daily temperature data captures the extreme 2021 heatwave very well, with only a 0.5°C difference in maximum temperature compared to station observations. Similarly, long-term comparisons show good agreement between MSWX and observed temperatures. Therefore, it reasonably represents the heatwave conditions present across the province.

References:

- Beck, H. E., Van Dijk, A. I. J. M., Larraondo, P. R., McVicar, T. R., Pan, M., Dutra, E., & Miralles, D. G. (2022). Global 3-Hourly 0.1 Bias-Corrected Meteorological Data Including Near-Real-Time Updates and Forecast Ensembles. *Bulletin of the American Meteorological Society*, 103(3), E710–E732. <https://doi.org/10.1175/BAMS-D-21-0145.1>
- Nairn, J. R. ., & Fawcett, Robert. (2013). *Defining heatwaves : heatwave defined as a heat-impact event servicing all community and business sectors in Australia*. Centre for Australian Weather and Climate Research.
- Thorarinsdottir, T. L., Gneiting, T., & Gissibl, N. (2013). Using proper divergence functions to evaluate climate models. *SIAM-ASA Journal on Uncertainty Quantification*, 1(1), 522–534. <https://doi.org/10.1137/130907550>
- Vicente-Serrano, S. M., Beguería, S., & López-Moreno, J. I. (2010). A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index. *Journal of Climate*, 23(7), 1696–1718. <https://doi.org/10.1175/2009JCLI2909.1>

Appendix

Appendix 1: List of the CEIs with their definition, units and descriptions. Modified from [climpack R package user guide](#)

Index	Index_name	Units	Definition	Description	Timescale
CDD (cdd)	Consecutive Dry Days	days	Maximum number of consecutive dry days (when PR < 1)	Longest dry spell	Ann
CDDcoldn (cddcold18)	Cooling Degree Days	degree-days	Annual sum of TM - n (where n , n = 18)	A measure of the energy demand needed to cool a building	Ann
CSDI (csdi)	Cold spell duration indicator	days	Annual number of days contributing to events where 6 or more consecutive days experience TN < 10th percentile	Number of days contributing to a cold period (where the period has to be at least 6 days long)	Ann
CSDId (csdi5)	User-defined CSDI	days	Annual number of days contributing to events where d or more consecutive days experience TN < 10th percentile	Number of days contributing to a cold period (where the minimum length is 5)	Ann
CWD (cwd)	Consecutive Wet Days	days	Maximum annual number of consecutive wet days (when PR >= 1)	The longest wet spell	Ann
DTR (dtr)	Daily Temperature Range	degrees_C	Mean difference between daily TX and daily TN	Average range of maximum and minimum temperature	Mon/Ann
DTR (dtr)	Daily Temperature Range	degrees_C	Mean difference between daily TX and daily TN	Average range of maximum and minimum temperature	Mon/Ann
FD (fd)	Frost Days	days	Number of days when TN < 0 C	Days when minimum temperature is below 0C	Mon/Ann
FD (fd)	Frost Days	days	Number of days when TN < 0 C	Days when minimum temperature is below 0C	Mon/Ann
GDDgrown (gddgrow10)	Growing Degree Days	degree-days	Annual sum of TM - n (where n is a user-defined location-specific base temperature and TM > n)	A measure of heat accumulation to predict plant and animal developmental rates	Ann
GSL (gsl)	Growing Season Length	days	Annual length of days plant can growth	Length of time in which plants can grow (Annual number of days between the first occurrence of 6 consecutive days with TM > 5 degrees_C and the first occurrence of 6 consecutive days with TM < 5 C)	Ann
HDDheatn (hddheat18)	Heating Degree Days	degree-days	Annual sum of n - TM (where n is a user-defined location-specific base temperature and TM < n)	A measure of the energy demand needed to heat a building	Ann
HW (hw)	Heatwave magnitude for Tx90 heatwaves	degC	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Heatwave magnitude for Tn90 heatwaves	degC	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Heatwave magnitude for EHF heatwaves	degC^2	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Coldwave magnitude for ECF coldwaves	degC^2	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Heatwave amplitude for Tx90 heatwaves	degC	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Heatwave amplitude for Tn90 heatwaves	degC	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Heatwave amplitude for EHF heatwaves	degC^2	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Coldwave amplitude for ECF coldwaves	degC^2	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Heatwave number for Tx90 heatwaves	heatwaves	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann

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HW (hw)	Heatwave number for EHF heatwaves	heatwaves	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Coldwave number for ECF coldwaves	heatwaves	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
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HW (hw)	Heatwave duration for EHF heatwaves	days	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Coldwave duration for ECF coldwaves	days	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Heatwave frequency for Tx90 heatwaves	days	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Heatwave frequency for Tn90 heatwaves	days	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Heatwave frequency for EHF heatwaves	days	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
HW (hw)	Coldwave frequency for ECF coldwaves	days	Heatwave and Coldwave duration (HWD), magnitude (HWD), Frequency (HWF) based on tempearture.	Annual Heat wave and Cold wave magnitude amplitude number duration and frequency calculated from TX and TN	Ann
ID (id)	Ice Days	days	Number of days when TX < 0 C	Days when maximum temperature is below 0C	Mon/Ann
ID (id)	Ice Days	days	Number of days when TX < 0 C	Days when maximum temperature is below 0C	Mon/Ann
PRCPTOT (prcptot)	Annual total wet-day precipitation	mm	Sum of daily PR >= 1	Total wet-day rainfall	Mon/Ann
PRCPTOT (prcptot)	Annual total wet-day precipitation	mm	Sum of daily PR >= 1	Total wet-day rainfall	Mon/Ann
R10mm (r10mm)	Number of heavy rain days	days	Number of days when PR >= 10 mm	Days when rainfall is at least 10mm	Mon/Ann
R10mm (r10mm)	Number of heavy rain days	days	Number of days when PR >= 10 mm	Days when rainfall is at least 10mm	Mon/Ann
R20mm (r20mm)	Number of very heavy rain days	days	Number of days when PR >= 20 mm	Days when rainfall is at least 20mm	Mon/Ann
R20mm (r20mm)	Number of very heavy rain days	days	Number of days when PR >= 20 mm	Days when rainfall is at least 20mm	Mon/Ann
Rnnmm (r30mm)	Number of customised rain days	days	Number of days when PR >= nn	Days when rainfall is at least a user-specified number of mm	Mon/Ann
Rnnmm (r30mm)	Number of customised rain days	days	Number of days when PR >= nn	Days when rainfall is at least a user-specified number of mm	Mon/Ann
R95p (r95p)	Total annual precipitation from heavy rain days	mm	Annual sum of daily PR > 95th percentile	Amount of rainfall from very wet days	Ann
R95pTOT (r95ptot)	Contribution from very wet days	%	100*r95p / PRCPTOT	Fraction of total wet-day rainfall that comes from very wet days	Ann
R99p (r99p)	Total annual precipitation from very heavy rain days	mm	Annual sum of daily PR > 99th percentile	Amount of rainfall from extremely wet days	Ann
R99pTOT (r99ptot)	Contribution from extremely wet days	%	100*r99p / PRCPTOT	Fraction of total wet-day rainfall that comes from extremely wet days	Ann
Rx1day (rx1day)	Max 1-day precipitation	mm	Maximum 1-day PR total	Maximum amount of rain that falls in one day	Mon/Ann

Rx1day (rx1day)	Max 1-day precipitation	calendar day	Maximum 1-day PR total	Maximum amount of rain that falls in one day	Mon/Ann
Rx1day (rx1day)	Max 1-day precipitation	mm	Maximum 1-day PR total	Maximum amount of rain that falls in one day	Mon/Ann
Rx1day (rx1day)	Max 1-day precipitation	calendar day	Maximum 1-day PR total	Maximum amount of rain that falls in one day	Mon/Ann
Rx5day (rx5day)	Max 5-day precipitation	mm	Maximum 5-day PR total	Maximum amount of rain that falls in five consecutive days	Mon/Ann
Rx5day (rx5day)	Max 5-day precipitation	calendar day	Maximum 5-day PR total	Maximum amount of rain that falls in five consecutive days	Mon/Ann
Rx5day (rx5day)	Max 5-day precipitation	mm	Maximum 5-day PR total	Maximum amount of rain that falls in five consecutive days	Mon/Ann
Rx5day (rx5day)	Max 5-day precipitation	calendar day	Maximum 5-day PR total	Maximum amount of rain that falls in five consecutive days	Mon/Ann
RXdday (rx7day)	User-defined consecutive days PR amount	mm	Maximum d-day PR total	Maximum amount of rain that falls in a user-specified period i	Mon/Ann
RXdday (rx7day)	User-defined consecutive days PR amount	calendar day	Maximum d-day PR total	Maximum amount of rain that falls in a user-specified period i	Mon/Ann
RXdday (rx7day)	User-defined consecutive days PR amount	mm	Maximum d-day PR total	Maximum amount of rain that falls in a user-specified period i	Mon/Ann
RXdday (rx7day)	User-defined consecutive days PR amount	calendar day	Maximum d-day PR total	Maximum amount of rain that falls in a user-specified period i	Mon/Ann
SDII (sdii)	Daily precipitation intensity	mm/day	Annual total PR divided by the number of wet days (when total PR >= 1)	Average daily wet-day rainfall intensity	Ann
SPEI (spei)	Standardised Precipitation Evapotranspiration Index	unitless	Standardised Precipitation Evapotranspiration Index	Measure of 'drought' using the Standardised Precipitation Evapotranspiration Index on time scales of 3 months 6 months and 12 months	Mon
SPEI (spei)	Standardised Precipitation Evapotranspiration Index	unitless	Standardised Precipitation Evapotranspiration Index	Measure of 'drought' using the Standardised Precipitation Evapotranspiration Index on time scales of 3 months 6 months and 12 months	Mon
SPEI (spei)	Standardised Precipitation Evapotranspiration Index	unitless	Standardised Precipitation Evapotranspiration Index	Measure of 'drought' using the Standardised Precipitation Evapotranspiration Index on time scales of 3 months 6 months and 12 months	Mon
SPI (spi)	Standardised Precipitation Index	unitless	Standardised Precipitation Index	Measure of 'drought' using the Standardised Precipitation Index on time scales of 3 months 6 months and 12 months	Mon
SPI (spi)	Standardised Precipitation Index	unitless	Standardised Precipitation Index	Measure of 'drought' using the Standardised Precipitation Index on time scales of 3 months 6 months and 12 months	Mon
SPI (spi)	Standardised Precipitation Index	unitless	Standardised Precipitation Index	Measure of 'drought' using the Standardised Precipitation Index on time scales of 3 months 6 months and 12 months	Mon
SU (su)	Summer days	days	Number of days when TX > 25 C	Days when maximum temperature exceeds 25C	Mon/Ann
SU (su)	Summer days	days	Number of days when TX > 25 C	Days when maximum temperature exceeds 25C	Mon/Ann
TMge10 (tmge10)	Mean temperature of at least 10C	days	Number of days when TM >= 10 C	Days when average temperature is at least 10C	Mon/Ann
TMge10 (tmge10)	Mean temperature of at least 10C	days	Number of days when TM >= 10 C	Days when average temperature is at least 10C	Mon/Ann
TMge5 (tmge5)	Mean temperature of at least 5C	days	Number of days when TM >= 5 C	Days when average temperature is at least 5C	Mon/Ann
TMge5 (tmge5)	Mean temperature of at least 5C	days	Number of days when TM >= 5 C	Days when average temperature is at least 5C	Mon/Ann
TMIlt10 (tmilt10)	Mean temperature below 10C	days	Number of days when TM < 10 C	Days when average temperature is below 10C	Mon/Ann

TMlt10 (tm1t10)	Mean temperature below 10C	days	Number of days when TM < 10 C	Days when average temperature is below 10C	Mon/Ann
TMlt5 (tm1t5)	Mean temperature below 5C	days	Number of days when TM < 5 C	Days when average temperature is below 5C	Mon/Ann
TMlt5 (tm1t5)	Mean temperature below 5C	days	Number of days when TM < 5 C	Days when average temperature is below 5C	Mon/Ann
TMm (tmm)	Mean daily mean temperature	degrees_C	Mean daily mean temperature	Average daily temperature	Mon/Ann
TMm (tmm)	Mean daily mean temperature	degrees_C	Mean daily mean temperature	Average daily temperature	Mon/Ann
TN10p (tn10p)	Amount of cold nights	%	Percentage of days when TN < 10th percentile	Fraction of days with cold night time temperatures	Ann
TN10p (tn10p)	Amount of cold nights	%	Percentage of days when TN < 10th percentile	Fraction of days with cold night time temperatures	Ann
TN90p (tn90p)	Amount of warm nights	%	Percentage of days when TN > 90th percentile	Fraction of days with warm night time temperatures	Ann
TN90p (tn90p)	Amount of warm nights	%	Percentage of days when TN > 90th percentile	Fraction of days with warm night time temperatures	Ann
TNlt2 (tnlt2)	Minimum temperature below 2C	days	Number of days when TN < 2 C	Days when minimum temperature is below 2C	Mon/Ann
TNlt2 (tnlt2)	Minimum temperature below 2C	days	Number of days when TN < 2 C	Days when minimum temperature is below 2C	Mon/Ann
TNltm2 (tnltm2)	Minimum temperature below -2C	days	Number of days when TN < -2 C	Days when minimum temperature is below -2C	Mon/Ann
TNltm2 (tnltm2)	Minimum temperature below -2C	days	Number of days when TN < -2 C	Days when minimum temperature is below -2C	Mon/Ann
TNltm20 (tnltm20)	Minimum temperature below -20C	days	Number of days when TN < -20 C	Days when minimum temperature is below -20C	Mon/Ann
TNltm20 (tnltm20)	Minimum temperature below -20C	days	Number of days when TN < -20 C	Days when minimum temperature is below -20C	Mon/Ann
TNm (tnm)	Mean daily minimum temperature	degrees_C	Mean daily minimum temperature	Average daily minimum temperature	Mon/Ann
TNm (tnm)	Mean daily minimum temperature	degrees_C	Mean daily minimum temperature	Average daily minimum temperature	Mon/Ann
TNn (tnn)	Min daily minimum temperature	degrees_C	Coldest daily TN	Coldest night	Mon/Ann
TNn (tnn)	Min daily minimum temperature	calendar day	Coldest daily TN	Coldest night	Mon/Ann
TNn (tnn)	Min daily minimum temperature	degrees_C	Coldest daily TN	Coldest night	Mon/Ann
TNn (tnn)	Min daily minimum temperature	calendar day	Coldest daily TN	Coldest night	Mon/Ann
TNx (tnx)	Max daily minimum temperature	degrees_C	Warmest daily TN	Hottest night	Mon/Ann
TNx (tnx)	Max daily minimum temperature	calendar day	Warmest daily TN	Hottest night	Mon/Ann
TNx (tnx)	Max daily minimum temperature	degrees_C	Warmest daily TN	Hottest night	Mon/Ann
TNx (tnx)	Max daily minimum temperature	calendar day	Warmest daily TN	Hottest night	Mon/Ann
TR (tr)	Tropical nights	days	Number of days when TN > 20 C	Days when minimum temperature exceeds 20C	Mon/Ann

TR (tr)	Tropical nights	days	Number of days when TN > 20 C	Days when minimum temperature exceeds 20C	Mon/Ann
TX10p (tx10p)	Amount of cool days	%	Percentage of days when TX < 10th percentile	Fraction of days with cool day time temperatures	Ann
TX10p (tx10p)	Amount of cool days	%	Percentage of days when TX < 10th percentile	Fraction of days with cool day time temperatures	Ann
TXdTNd (tx3tn3)	User-defined consecutive number of hot days and nights	events	Annual count of d consecutive days where both TX > 95th percentile and TN > 95th percentile, where 10 >= d >= 2	Total consecutive hot days and hot nights (where consecutive periods are 3 days)	Ann
TX90p (tx90p)	Amount of hot days	%	Percentage of days when TX > 90th percentile	Fraction of days with hot day time temperatures	Ann
TX90p (tx90p)	Amount of hot days	%	Percentage of days when TX > 90th percentile	Fraction of days with hot day time temperatures	Ann
TX95t (tx95t)	Value of 95th percentile of maximum temperature	degrees_C	Value of 95th percentile of TX	Daily Value of 95th percentile of TX	Daily
TXbdTNbd (txb3tnb3)	User-defined consecutive number of cold days and nights	events	Annual number of d consecutive days where both TX < 5th percentile and TN < 5th percentile, where 10 >= d >= 2	Total consecutive cold days and cold nights (where consecutive periods are 3 days)	Ann
TXge30 (txge30)	Maximum temperature of at least 30C	days	Number of days when TX >= 30 C	Days when maximum temperature is at least 30C	Mon/Ann
TXge30 (txge30)	Maximum temperature of at least 30C	days	Number of days when TX >= 30 C	Days when maximum temperature is at least 30C	Mon/Ann
TXge35 (txge35)	Maximum temperature of at least 35C	days	Number of days when TX >= 35 C	Days when maximum temperature is at least 35C	Mon/Ann
TXge35 (txge35)	Maximum temperature of at least 35C	days	Number of days when TX >= 35 C	Days when maximum temperature is at least 35C	Mon/Ann
TXgt50p (txgt50p)	Fraction of days with temperatures above the median	%	Percentage of days where TX > 50th percentile	Fraction of days with above-median temperature	Mon/Ann
TXgt50p (txgt50p)	Fraction of days with temperatures above the median	%	Percentage of days where TX > 50th percentile	Fraction of days with above-median temperature	Mon/Ann
TXm (txm)	Mean daily maximum temperature	degrees_C	Mean daily maximum temperature	Average daily maximum temperature	Mon/Ann
TXm (txm)	Mean daily maximum temperature	degrees_C	Mean daily maximum temperature	Average daily maximum temperature	Mon/Ann
TXn (txn)	Min daily maximum temperature	degrees_C	Coldest daily TX	Coldest day	Mon/Ann
TXn (txn)	Min daily maximum temperature	calendar day	Coldest daily TX	Coldest day	Mon/Ann
TXn (txn)	Min daily maximum temperature	degrees_C	Coldest daily TX	Coldest day	Mon/Ann
TXn (txn)	Min daily maximum temperature	calendar day	Coldest daily TX	Coldest day	Mon/Ann
TXx (txx)	Max daily maximum temperature	degrees_C	Warmest daily TX	Hottest day	Mon/Ann
TXx (txx)	Max daily maximum temperature	calendar day	Warmest daily TX	Hottest day	Mon/Ann
TXx (txx)	Max daily maximum temperature	degrees_C	Warmest daily TX	Hottest day	Mon/Ann
TXx (txx)	Max daily maximum temperature	calendar day	Warmest daily TX	Hottest day	Mon/Ann

WSDI (wsdi)	Warm spell duration indicator	days	Annual number of days contributing to events where 6 or more consecutive days experience TX > 90th percentile	Number of days contributing to a warm period (where the period has to be at least 6 days long)	Ann
WSDId (wsdi5)	User-defined WSDI	days	Annual number of days contributing to events where d or more consecutive days experience TX > 90th percentile	Number of days contributing to a warm period (where the minimum length is 5)	Ann