

# A Long-Term Analysis of the Moose Jaw Climate Station (4015322/4015320): Temporal Trends and Frequency Analyses for Temperatures, Precipitation, and Wind Speed



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## Introduction

- the climate of Moose Jaw, Saskatchewan, Canada and surrounding regions plays a significant role in agricultural activities
- major crops include wheat, oats, barley, flaxseed, canola, peas, and lentils
- risk-based design criteria of engineered municipal, rural, and industrial infrastructure and resource extraction projects dependent on frequency distributions for climate variables
- previous climate research work for southern Saskatchewan indicates temporal trends towards generally warmer and drier conditions, particularly in winter and early spring, as well as reduced wind speeds [1-9]



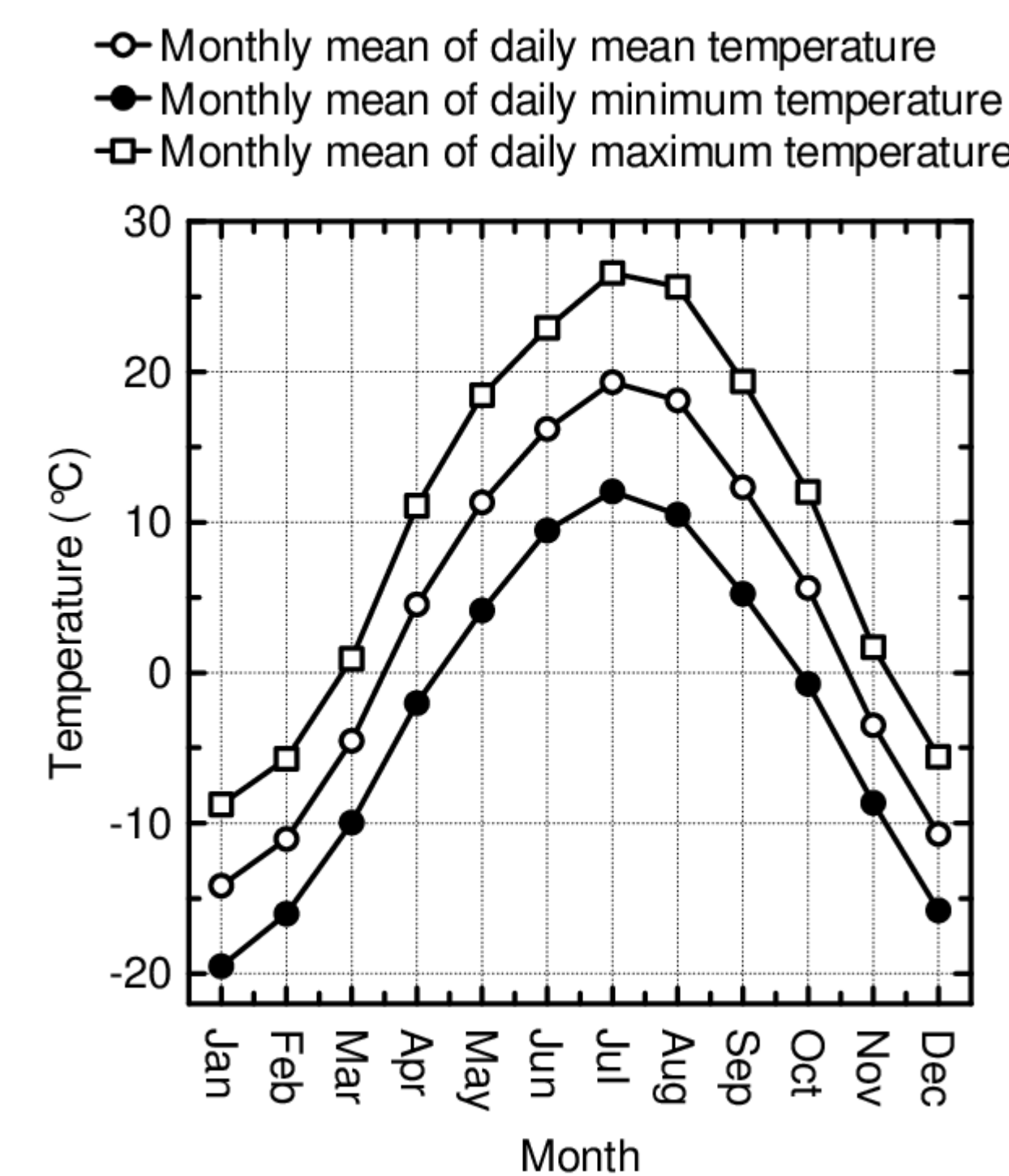
## Methods

- climate data was obtained from the online Adjusted and Homogenized Canadian Climate Data database (<http://ec.gc.ca/dcha-ahccd/default.asp>)
- the Moose Jaw (4015322/4015320) climate station has been in operation since 1894 for temperature (4015322), 1895 for precipitation (4015322), and 1954 for wind speed (4015320)
- multiple station data was joined for the long-term temperature and precipitation records, but not joined for the wind speed record
- stations location at latitude 50.3°N, longitude -105.6°W and an elevation of 577 masl
- statistical analyses of streamflow data were conducted using the nonparametric Mann-Kendall test for the trend and the nonparametric Sen's method for the magnitude of the trend [10-12]
- frequency analyses were performed with DISTRIB 2.13 Statistical Distribution Analysis software [13]

## Results and Discussion

### Temperature

- July is the warmest month (avg. T = 19.3°C [min / max = 12.0°C / 26.6°C]), January is the coldest month (avg. T = -14.2°C [min / max = -19.5°C / -8.8°C])
- largest diurnal temperature variation during the summer (~14-15°C), less during the winter (~10-11°C)



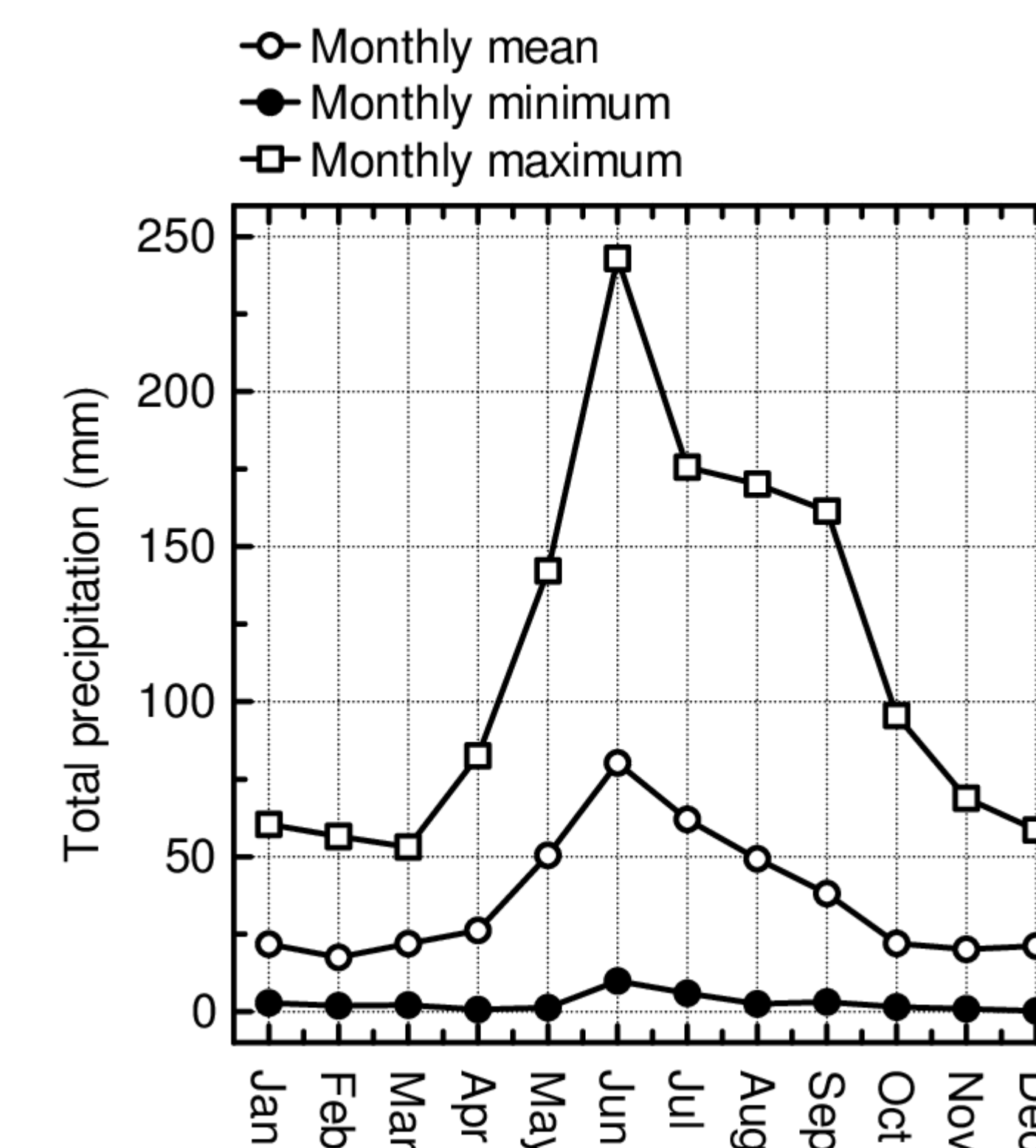
**Figure 1.** Monthly mean of daily mean, daily minimum, and daily maximum temperatures at the Moose Jaw climate station (4015322) over the available climate record (1913-2010).

- monthly mean of daily mean temperatures is increasing during March (+3.2°C/century<sup>a</sup> [+0.4 to +5.6; 95% CL]), as are the mean of daily mean temperatures on an annual basis (+1.1°C/century<sup>\*\*</sup> [+0.3 to +1.9]) and during spring (+1.8°C/century<sup>\*\*</sup> [+0.5 to +3.0])  
<sup>a</sup> note: \* = p < 0.05; \*\* = p < 0.01; \*\*\* = p < 0.001
- monthly mean of daily maximum temperatures are increasing on an annual basis (+1.0°C/century<sup>\*</sup> [+0.0 to +1.9]) and during spring (+1.8°C/century<sup>\*</sup> [+0.0 to +3.4])
- monthly mean of daily minimum temperatures are increasing during February (+4.0°C/century<sup>\*</sup> [+0.4 to +7.4]), March (+3.1°C/century<sup>\*</sup> [+0.5 to +5.6]), August (+1.4°C/century<sup>\*\*</sup> [+0.4 to +2.6]), and September (+1.4°C/century<sup>\*\*</sup> [+0.5 to +2.2]), as well as on an annual basis (+1.3°C/century<sup>\*\*\*</sup> [+0.6 to +2.0]) and during spring (+1.7°C/century<sup>\*\*</sup> [+0.7 to +2.7]) and summer (+1.3°C/century<sup>\*\*\*</sup> [+0.5 to +1.9])
- no other statistically significant (p < 0.05) temperature trends
- growing degree days base 5.5°C (GDD<sub>5.5</sub>), 8°C (GDD<sub>8</sub>), and 10°C (GDD<sub>10</sub>) average 1570, 1148, and 849 between 1913-2010
  - GDD<sub>8</sub> (+115/century<sup>\*</sup> [+40 to +233]) and GDD<sub>10</sub> (+116/century<sup>\*</sup> [+95 to +220]) are increasing
  - no temporal change in GDD<sub>5.5</sub>

## Results and Discussion

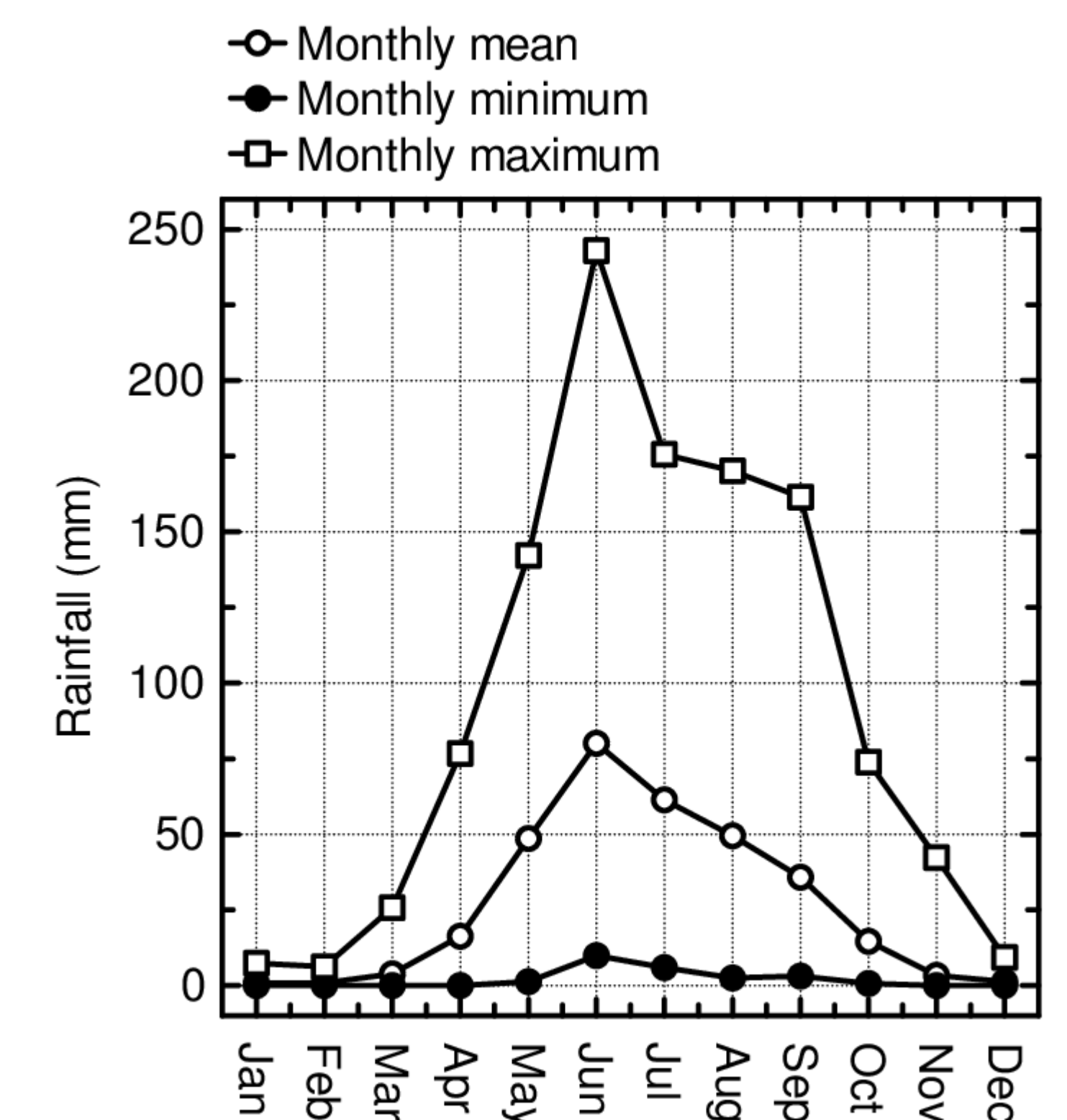
### Precipitation

- June is the wettest month (avg. total precip. = 80.2 mm [min / max = 9.9 mm / 243 mm]), February is the driest month (avg. total precip. = 17.5 mm [min / max = 1.9 mm / 56.5 mm])

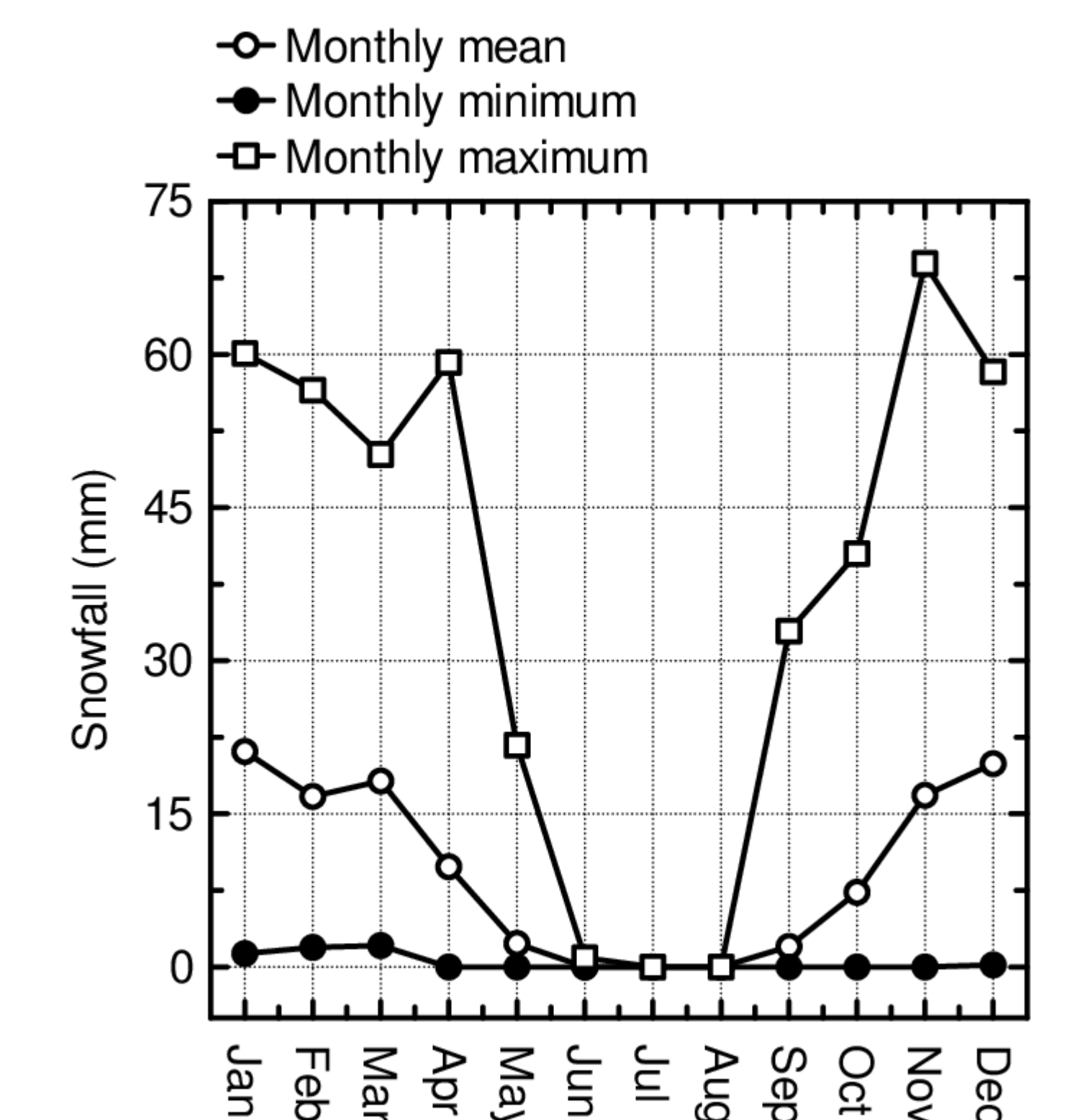


**Figure 2(a).** Monthly, minimum, and maximum total precipitation at the Moose Jaw climate station (4015322) over the available climate record (1909-2010).

- with a single exception, there are no significant temporal trends in monthly, seasonal, or annual total precipitation
  - total precipitation in October is decreasing (-15.6 mm/century<sup>\*\*</sup> [-25.4 to -4.3])
- June has the most rainfall (avg. = 80.1 mm [min / max = 9.9 mm / 243 mm]), January/February have the least rainfall (avg. = 0.8 mm [min / max = 0.0/0.0 mm / 7.4/6.2 mm])
- rainfall has been increasing over time during March (+3.1 mm/century<sup>\*\*\*</sup> [+1.3 to +5.3]), decreasing during October (-9.7 mm/century<sup>\*\*</sup> [-16.6 to -2.4]), and increasing during the winter season (+2.6 mm/century<sup>\*\*\*</sup> [+1.1 to +4.2])
  - there are no other statistically significant monthly, seasonal, or annual rainfall trends
- there are no significant temporal trends in monthly, seasonal, or annual snowfall



**Figure 2(b).** Monthly, minimum, and maximum rainfall at the Moose Jaw climate station (4015322) over the available climate record (1909-2010).



**Figure 2(c).** Monthly, minimum, and maximum snowfall at the Moose Jaw climate station (4015322) over the available climate record (1909-2010).

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## Results and Discussion

### Wind Speed

- wind speed data available between 1954-1996

**Table 1.** Average monthly mean ( $\pm$ std. dev.) of homogeneous wind speeds over the available climate record at the Moose Jaw climate station (4015320). Values are in km/h.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
19.3	19.3	18.6	18.9	18.8	17.6	15.6	15.5	17.8	18.7	18.4	19.4
$\pm 2.4$	$\pm 2.8$	$\pm 2.0$	$\pm 2.1$	$\pm 2.5$	$\pm 2.1$	$\pm 1.5$	$\pm 1.7$	$\pm 2.2$	$\pm 1.9$	$\pm 2.5$	$\pm 1.9$

- average mid-winter wind speeds are about 25% higher than mid-summer ( $p < 0.001$ )
- average annual windspeed is  $18.1 \pm 1.1$  km/h
- seasonal variation in average windspeeds (Tukey Test of pairwise comparisons for one-way layout design; values with different superscript letters differ at  $p < 0.05$ ):
  - winter:  $19.3 \pm 1.4$  km/h<sup>a</sup>
  - spring:  $18.8 \pm 1.6$  km/h<sup>a,c</sup>
  - summer:  $16.2 \pm 1.4$  km/h<sup>b</sup>
  - autumn:  $18.3 \pm 1.5$  km/h<sup>c</sup>
- significant declines in the mean of homogeneous wind speeds during April ( $-5.7$  km/h/century\* [-10.4 to 0.0]), May ( $-10.0$  km/h/century\*\* [-15.5 to -3.7]), June ( $-5.4$  km/h/century\* [-10.0 to -3.7]), July ( $-4.2$  km/h/century\* [-8.3 to 0.0]), September ( $-6.9$  km/h/century\* [-12.0 to -1.9]), November ( $-7.5$  km/h/century\* [-14.7 to -0.9]), and December ( $-5.2$  km/h/century\* [-9.5 to -0.5]), as are the wind speeds on an annual basis ( $-5.0$  km/h/century\*\*\* [-7.0 to -3.0]) and during spring ( $-6.4$  km/h/century\*\*\* [-10.8 to -2.4]), summer ( $-4.2$  km/h/century\* [-7.5 to -1.0]), and autumn ( $-5.0$  km/h/century\*\* [-9.0 to -1.4])

### Frequency Analyses

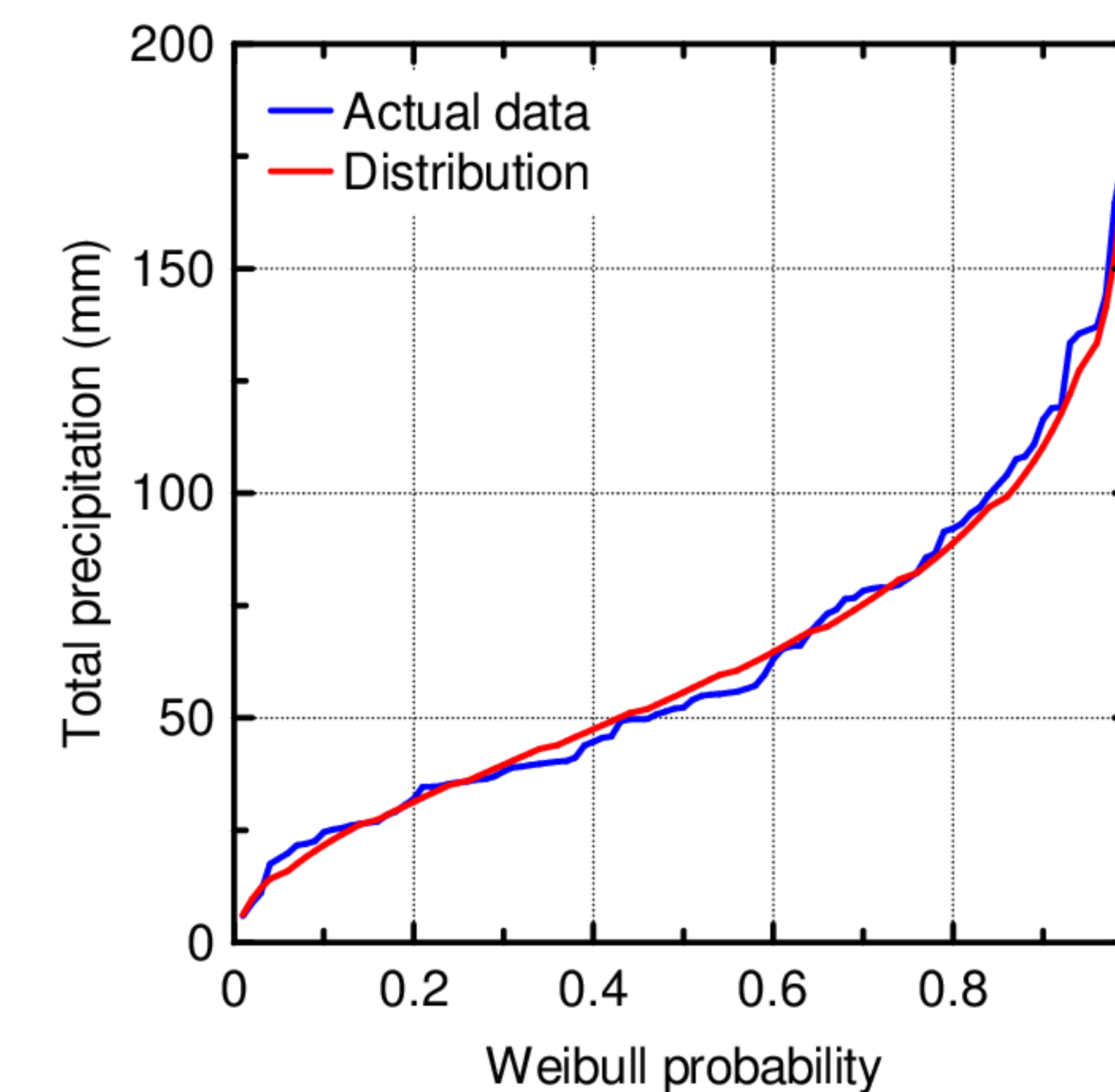
- unless otherwise stated, return periods estimated using a Pearson Type III distribution

**Table 2.** Estimated wet- and dry-year return periods for monthly, seasonal, and annual total precipitation at the Moose Jaw climate station (4015322). Values are in mm.

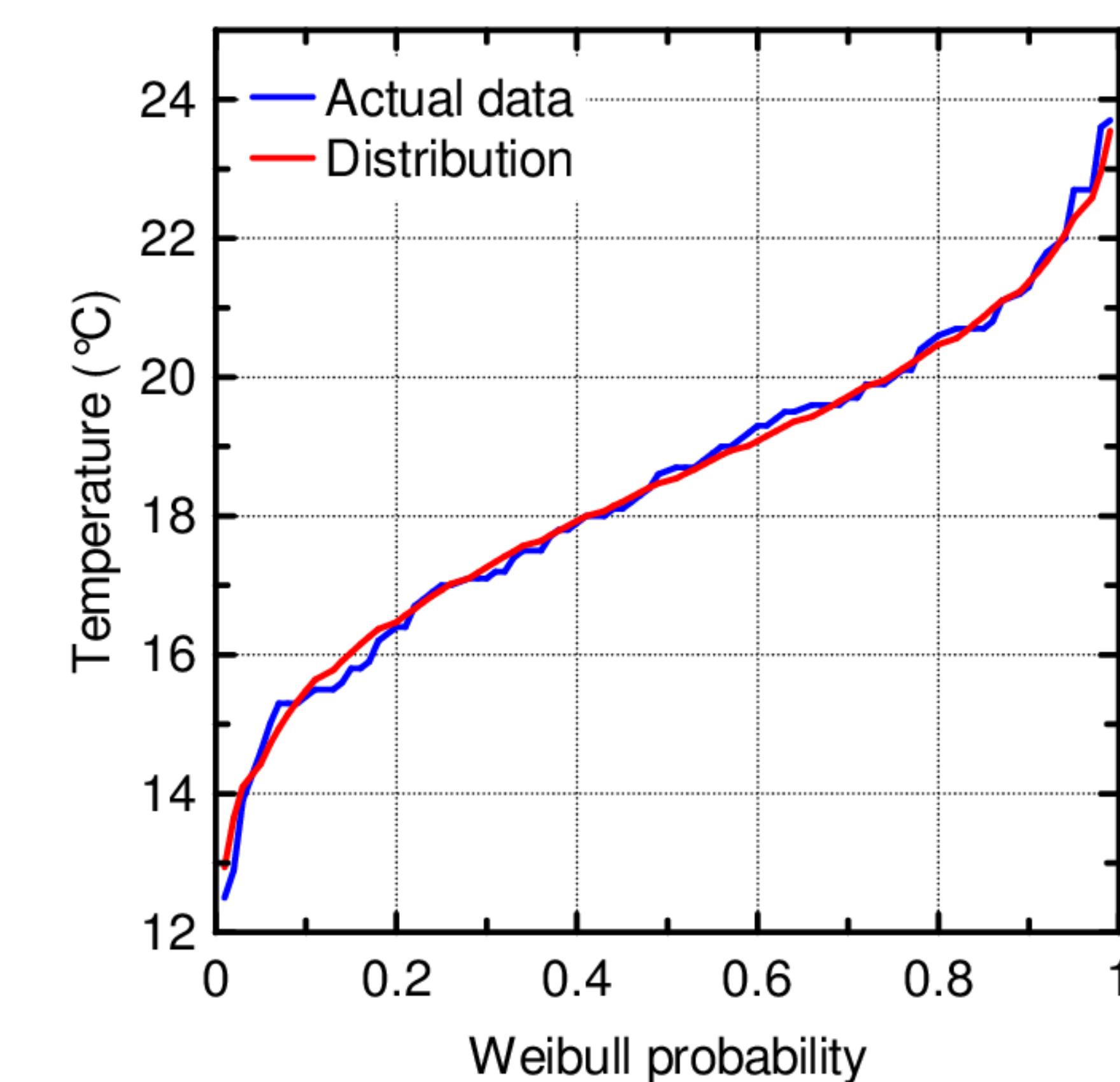
Return period (years)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Autumn	
Wet	200	60.4	54.7	57.2	91.7	162.2	244.2	191.3	180.3	155.2	86.6	76.1	61.4	740.6	124.7	219.2	496.3	217.6
	100	55.5	49.7	52.9	82.5	147.5	221.3	173.4	161.4	137.2	76.4	68.0	56.3	702.1	117.1	204.8	450.6	199.0
	50	50.4	44.5	48.5	73.2	132.4	198.1	155.2	142.3	119.2	66.2	59.8	50.9	661.9	109.2	189.7	404.6	180.0
	25	45.1	39.1	43.8	63.6	116.7	174.1	136.4	122.8	101.0	56.1	51.4	45.3	619.6	100.7	173.6	358.2	160.3
	10	37.4	31.7	36.9	50.3	94.5	141.0	110.3	96.1	76.8	42.6	40.0	37.3	558.8	88.3	150.2	295.4	132.7
	5	31.0	25.5	31.0	39.5	75.8	113.9	88.9	74.6	57.9	32.3	30.8	30.6	506.8	77.4	129.9	245.9	109.9
Dry	200	20.4	15.8	20.8	22.9	45.8	72.1	55.7	42.3	31.0	17.9	17.0	19.6	420.0	58.8	95.0	173.8	73.9
	100	15.7	11.8	16.3	16.3	33.0	55.3	42.2	29.7	21.3	12.9	11.7	14.9	381.6	50.3	79.2	146.9	59.0
	50	11.8	8.5	12.3	11.0	22.3	41.8	31.4	19.9	14.2	9.3	7.5	11.0	348.6	42.8	65.2	126.8	46.8
	25	8.1	5.6	8.3	6.4	12.4	29.9	21.7	11.5	8.6	6.6	4.0	7.3	316.9	35.3	51.5	110.3	35.7
	10	4.6	3.0	4.5	2.4	3.5	19.8	13.4	4.8	4.5	4.8	1.2	3.9	287.0	28.1	38.2	97.9	26.0
	5	2.7	1.6	2.3	0.4	0.0	14.6	9.1	1.4	2.8	4.1	0.0	2.0	269.8	23.7	30.3	92.2	20.8
200	0.0	0.0	0.0	0.0	0.0	7.6	3.2	0.0	1.1	3.5	0.0	0.0	243.6	16.9	17.9	85.9	13.5	

## Results and Discussion

**Figure 3.** Representative frequency distribution showing actual and estimated return periods for total precipitation during July at the Moose Jaw climate station (4015322).



**Figure 4.** Representative frequency distribution showing actual and estimated return periods for the monthly mean of daily maximum temperatures during May at the Moose Jaw climate station (4015322).



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## Results and Discussion

**Table 3.** Estimated wet- and dry-year return periods for monthly, seasonal, and annual total rainfall at the Moose Jaw climate station (4015322). Values are in mm.

Return period (years)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov <sup>a</sup>	Dec	Annual	Winter	Spring	Summer	Autumn		
wet	200	6.8	6.6	27.5	80.9	161.6	243.7	190.9	179.4	155.5	73.0	30.7	9.5	657.3	11.7	192.0	495.9	192.7	
	100	5.6	5.6	23.3	70.3	146.5	220.8	173.1	160.8	136.4	63.1	23.3	8.0	609.2	10.5	176.1	450.0	171.1	
	50	4.4	4.5	19.2	59.8	131.0	197.6	154.9	141.9	117.4	53.5	17.2	6.6	560.2	9.2	159.6	403.8	149.4	
	25	3.3	3.5	15.2	49.4	115.0	173.6	136.2	122.6	98.6	44.0	12.3	5.2	510.0	7.9	142.4	357.3	127.8	
	10	2.0	2.3	10.2	35.8	92.4	140.5	110.1	96.1	73.6	31.7	7.3	3.4	440.8	6.1	118.0	294.4	98.9	
	5	1.2	1.4	6.6	25.6	73.6	113.6	88.6	74.8	54.5	22.5	4.5	2.2	384.7	4.7	97.4	245.0	76.5	
	3	0.6	0.8	4.1	18.1	58.0	91.7	71.1	57.8	40.1	15.9	2.9	1.3	339.5	3.5	80.1	206.5	59.4	
	2	0.3	0.4	2.2	12.0	43.6	72.0	55.2	42.6	28.1	10.6	1.8	0.7	298.8	2.4	63.9	173.2	45.0	
	dry	3	0.1	0.1	0.9	7.5	31.0	55.2	41.5	30.0	18.9	6.7	1.1	0.3	264.7	1.5	49.4	146.5	33.7
		5	0.0	0.0	0.2	4.5	20.7	41.9	30.5	20.2	12.5	4.3	0.7	0.1	237.7	0.8	37.3	126.6	25.7
10		0.0	0.0	0.0	2.4	11.1	30.1	20.7	11.8	7.8	2.7	0.4	0.0	214.1	0.1	25.9	110.4	19.4	
25		0.0	0.0	0.0	1.1	2.7	20.2	12.2	4.9	4.7	1.8	0.3	0.0	194.5	0.0	15.5	98.2	15.0	
50		0.0	0.0	0.0	0.7	0.0	15.0	7.7	1.5	3.5	1.5	0.2	0.0	184.6	0.0	9.6	92.7	13.2	
100		0.0	0.0	0.0	0.6	0.0	11.2	4.3	0.0	2.8	1.5	0.1	0.0	177.2	0.0	4.9	89.1	12.2	
200		0.0	0.0	0.0	0.5	0.0	8.3	1.7	0.0	2.5	1.5	0.1	0.0	171.7	0.0	1.1	86.7	11.5	

<sup>a</sup> a two-parameter log normal distribution was employed, which likely underestimates extreme wet years.

- snowfall time series poorly modeled by available distributions
- only annual and winter periods achieved a reasonable fit (both with the Pearson Type III distribution)

**Table 4.** Estimated wet- and dry-year return periods for winter and annual total snowfall at the Moose Jaw climate station (4015322). Values are in mm.

Return period (years)	Annual	Winter		
wet	200	229.0	122.7	
	100	214.7	115.0	
	50	199.9	106.9	
	25	184.2	98.3	
	10	161.7	85.7	
	5	142.5	74.8	
	3	126.0	65.2	
	2	110.3	55.9	
	dry	3	96.0	47.3
		5	83.7	39.7
10		71.8	32.1	
25		60.7	24.8	
50		54.2	20.4	
100		48.9	16.8	
200		44.3	13.6	

## Results and Discussion

**Table 5.** Estimated warm- and cold-year return periods for monthly, seasonal, and annual mean of daily mean temperatures at the Moose Jaw climate station (4015322). Values are in °C.

Return period (years)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Autumn		
warm	200	-2.0	0.3	4.0	10.3	16.1	21.5	22.9	23.0	17.2	9.7	3.9	-0.3	6.7	-4.2	8.1	20.7	8.3	
	100	-3.1	-0.7	3.2	9.8	15.6	20.9	22.6	22.4	16.7	9.5	3.4	-1.3	6.3	-4.9	7.7	20.4	8.0	
	50	-4.4	-1.9	2.4	9.2	15.1	20.2	22.2	21.9	16.2	9.2	2.7	-2.3	6.0	-5.8	7.3	20.1	7.7	
	25	-5.8	-3.2	1.4	8.6	14.5	19.5	21.8	21.2	15.7	8.9	2.0	-3.5	5.6	-6.7	6.8	19.8	7.4	
	10	-8.0	-5.2	-0.1	7.5	13.7	18.5	21.2	20.3	14.8	8.2	0.7	-5.3	5.0	-8.1	6.0	19.3	6.8	
	5	-10.1	-7.1	-1.6	6.5	12.8	17.6	20.6	19.5	13.9	7.6	-0.5	-7.1	4.5	-9.5	5.3	18.8	6.2	
	3	-12.1	-9.0	-3.0	5.6	12.1	16.8	20.0	18.8	13.2	6.8	-1.8	-8.8	4.0	-10.7	4.6	18.4	5.6	
	2	-14.1	-11.0	-4.5	4.6	11.3	16.1	19.4	18.0	12.3	6.0	-3.2	-10.6	3.6	-12.0	3.8	17.9	4.9	
	cold	3	-16.2	-13.0	-6.0	3.6	10.5	15.4	18.7	17.3	11.5	5.0	-4.8	-12.5	3.1	-13.3	3.0	17.4	4.2
		5	-18.2	-14.9	-7.4	2.6	9.8	14.7	18.1	16.7	10.7	3.9	-6.3	-14.3	2.7	-14.5	2.3	16.9	3.5
10		-20.4	-17.1	-9.1	1.5	9.0	14.1	17.4	16.0	9.8	2.7	-8.1	-16.3	2.3	-15.8	1.4	16.4	2.7	
25		-22.7	-19.4	-10.8	0.3	8.2	13.4	16.7	15.3	8.9	1.2	-10.1	-18.5	1.9	-17.2	0.5	15.9	1.8	
50		-24.2	-21.0	-12.0	-0.5	7.7	13.1	16.2	14.9	8.3	0.1	-11.5	-20.0	1.6	-18.1	-0.1	15.5	1.2	
100		-25.6	-22.4	-13.0	-1.2	7.2	12.7	15.8	14.5	7.8	-0.9	-12.8	-21.3	1.4	-18.9	-0.6	15.2	0.7	
200		-26.8	-23.6	-14.0	-1.9	6.8	12.5	15.4	14.2	7.3	-1.9	-14.0	-22.5	1.2	-19.6	-1.1	14.9	0.1	

**Table 6.** Estimated warm- and cold-year return periods for annual growing degree days base 5.5°C (GDD<sub>5.5</sub>), base 8°C (GDD<sub>8</sub>), and base 10°C (GDD<sub>10</sub>) at the Moose Jaw climate station (4015322).

Return period (years)	GDD <sub>5.5</sub>	GDD <sub>8</sub>	GDD <sub>10</sub>		
warm	200	1936	1499	1181	
	100	1905	1468	1150	
	50	1869	1434	1116	
	25	1829	1395	1079	
	10	1764	1334	1019	
	5	1701	1274	963	
	3	1641	1216	909	
	2	1575	1154	851	
	cold	3	1508	1089	793
		5	1441	1026	737
10		1367	956	675	
25		1286	880	609	
50		1232	829	565	
100		1183	783	525	
200		1137	739	489	

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## Results and Discussion

**Table 7.** Estimated warm- and cold-year return periods for monthly, seasonal, and annual mean of daily minimum temperatures at the Moose Jaw climate station (4015322). Values are in °C.

Return period (years)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Autumn	
warm	200	-7.5	-4.2	-1.9	2.3	8.0	14.0	15.3	14.4	9.0	2.5	-2.4	-5.3	0.2	-9.2	0.9	13.2	1.6
	100	-8.6	-5.3	-2.6	1.9	7.7	13.5	15.0	14.0	8.6	2.4	-2.8	-6.3	-0.1	-10.0	0.6	13.0	1.4
	50	-9.9	-6.5	-3.4	1.5	7.3	12.9	14.7	13.6	8.3	2.1	-3.3	-7.3	-0.4	-10.8	0.3	12.7	1.1
	25	-11.2	-7.8	-4.2	1.0	6.9	12.3	14.3	13.1	7.8	1.9	-3.9	-8.5	-0.8	-11.8	-0.1	12.4	0.8
	10	-13.4	-10.0	-5.6	0.3	6.2	11.5	13.7	12.4	7.2	1.4	-4.9	-10.4	-1.3	-13.2	-0.7	12.0	0.3
	5	-15.5	-12.0	-7.0	-0.5	5.6	10.7	13.1	11.7	6.5	0.8	-5.9	-12.2	-1.8	-14.6	-1.3	11.5	-0.2
	3	-17.4	-13.9	-8.4	-1.2	4.9	10.0	12.6	11.1	5.9	0.3	-7.0	-13.9	-2.2	-15.8	-1.9	11.1	-0.7
cold	2	-19.5	-16.0	-9.8	-2.0	4.2	9.4	12.1	10.5	5.3	-0.5	-8.3	-15.7	-2.7	-17.1	-2.5	10.7	-1.3
	3	-21.5	-18.0	-11.3	-2.8	3.5	8.7	11.5	9.9	4.6	-1.3	-9.7	-17.6	-3.1	-18.4	-3.2	10.2	-1.9
	5	-23.5	-20.0	-12.8	-3.6	2.8	8.2	11.0	9.3	4.0	-2.2	-11.2	-19.4	-3.5	-19.6	-3.9	9.8	-2.5
	10	-25.7	-22.2	-14.5	-4.4	2.0	7.6	10.4	8.7	3.3	-3.2	-12.9	-21.3	-3.9	-21.0	-4.6	9.4	-3.2
	25	-28.1	-24.6	-16.4	-5.4	1.1	7.0	9.7	8.0	2.5	-4.5	-14.9	-23.5	-4.3	-22.3	-5.5	8.9	-4.0
	50	-29.6	-26.1	-17.6	-6.1	0.5	6.7	9.3	7.6	2.0	-5.4	-16.3	-24.9	-4.6	-23.2	-6.0	8.6	-4.6
	100	-31.0	-27.5	-18.7	-6.7	-0.1	6.4	8.9	7.2	1.5	-6.2	-17.6	-26.1	-4.8	-24.0	-6.5	8.3	-5.1
200	-32.3	-28.8	-19.8	-7.2	-0.6	6.2	8.6	6.9	1.1	-7.0	-18.9	-27.3	-5.0	-24.7	-7.0	8.0	-5.6	

**Table 8.** Estimated warm- and cold-year return periods for monthly, seasonal, and annual mean of daily maximum temperatures at the Moose Jaw climate station (4015322). Values are in °C.

Return period (years)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Autumn	
warm	200	3.8	5.3	10.4	19.0	24.2	29.2	31.1	31.9	25.7	17.2	10.8	4.7	13.4	1.4	15.7	28.6	15.2
	100	2.6	4.3	9.5	18.3	23.7	28.5	30.7	31.3	25.2	16.9	10.0	3.9	13.0	0.6	15.2	28.3	14.9
	50	1.3	3.2	8.5	17.4	23.1	27.8	30.2	30.6	24.5	16.5	9.2	2.9	12.6	-0.3	14.6	27.9	14.5
	25	-0.2	2.0	7.3	16.5	22.4	27.0	29.7	29.8	23.8	16.1	8.2	1.7	12.1	-1.2	14.0	27.5	14.1
	10	-2.5	0.1	5.6	15.1	21.4	25.8	28.9	28.6	22.7	15.3	6.6	-0.1	11.5	-2.7	13.0	26.8	13.4
	5	-4.7	-1.8	4.0	13.8	20.4	24.7	28.1	27.5	21.6	14.4	5.0	-1.9	10.9	-4.1	12.0	26.2	12.7
	3	-6.7	-3.6	2.5	12.5	19.5	23.8	27.4	26.6	20.6	13.5	3.5	-3.6	10.4	-5.4	11.1	25.7	12.0
cold	2	-8.8	-5.6	0.9	11.1	18.5	22.8	26.6	25.6	19.4	12.4	1.9	-5.4	9.8	-6.7	10.2	25.1	11.2
	3	-10.9	-7.6	-0.7	9.8	17.5	21.9	25.8	24.6	18.3	11.1	0.2	-7.3	9.3	-8.0	9.2	24.5	10.3
	5	-12.9	-9.6	-2.1	8.5	16.5	21.1	25.0	23.7	17.2	9.8	-1.5	-9.2	8.8	-9.3	8.3	23.9	9.5
	10	-15.0	-11.7	-3.7	7.0	15.4	20.2	24.2	22.8	16.0	8.3	-3.4	-11.3	8.4	-10.6	7.3	23.2	8.5
	25	-17.3	-14.2	-5.3	5.5	14.3	19.4	23.2	21.9	14.6	6.5	-5.4	-13.6	7.9	-12.0	6.2	22.6	7.4
	50	-18.8	-15.7	-6.4	4.5	13.5	18.9	22.6	21.3	13.8	5.2	-6.8	-15.2	7.5	-12.9	5.5	22.1	6.7
	100	-20.2	-17.2	-7.4	3.6	12.8	18.4	22.0	20.8	13.0	3.9	-8.1	-16.6	7.3	-13.7	4.9	21.7	6.0
200	-21.4	-18.6	-8.2	2.7	12.2	18.0	21.5	20.3	12.2	2.7	-9.3	-17.9	7.0	-14.4	4.3	21.4	5.3	

## Results and Discussion

**Table 9.** Estimated windy- and calm-year return periods for monthly, seasonal, and annual mean of homogeneous wind speeds at the Moose Jaw climate station (4015320). Values are in km/h.

Return period (years)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Autumn	
windy	200	25.6	27.0	24.0	24.6	26.1	23.1	20.1	20.2	23.4	23.5	24.4	23.8	21.0	23.0	23.5	20.0	23.1
	100	25.0	26.1	23.5	24.0	25.3	22.5	19.6	19.7	22.8	23.1	23.9	23.4	20.7	22.6	22.9	19.6	22.6
	50	24.3	25.3	22.9	23.4	24.4	21.9	19.0	19.2	22.2	22.6	23.3	23.0	20.4	22.2	22.4	19.2	21.9
	25	23.5	24.3	22.2	22.7	23.5	21.3	18.5	18.6	21.6	22.0	22.6	22.5	20.1	21.8	21.8	18.7	21.3
	10	22.4	22.9	21.2	21.7	22.1	20.3	17.6	17.8	20.5	21.2	21.5	21.7	19.5	21.1	20.9	18.0	20.3
	5	21.3	21.6	20.3	20.7	20.9	19.3	16.8	17.0	19.6	20.3	20.5	21.0	19.0	20.4	20.1	17.3	19.5
	3	20.3	20.4	19.5	19.8	19.8	18.4	16.1	16.2	18.7	19.6	19.5	20.2	18.6	19.9	19.4	16.8	18.8
calm	2	19.3	19.2	18.6	18.9	18.6	17.5	15.5	15.5	17.8	18.8	18.4	19.4	18.1	19.3	18.7	16.2	18.1
	3	18.2	18.0	17.7	18.0	17.6	16.6	14.8	14.7	16.8	17.9	17.3	18.6	17.7	18.7	18.0	15.6	17.5
	5	17.2	16.9	16.9	17.2	16.6	15.8	14.3	14.0	16.0	17.1	16.3	17.8	17.3	18.2	17.4	15.1	17.0
	10	16.1	15.7	16.1	16.3	15.6	14.9	13.7	13.3	15.0	16.3	15.2	16.9	16.8	17.6	16.8	14.5	16.5
	25	15.0	14.6	15.1	15.4	14.6	14.0	13.1	12.5	14.0	15.4	13.9	15.9	16.4	17.0	16.2	14.0	16.0
	50	14.3	13.8	14.6	14.8	14.0	13.4	12.7	12.0	13.4	14.8	13.1	15.3	16.1	16.6	15.8	13.6	15.7
	100	13.6	13.2	14.0	14.3	13.4	12.8	12.4	11.6	12.8	14.2	12.3	14.7	15.8	16.3	15.5	13.3	15.5
200	13.0	12.6	13.6	13.9	13.0	12.4	12.2	11.2	12.2	13.7	11.6	14.1	15.6	16.0	15.2	13.1	15.3	

## Conclusions

- a number of temporal trends in the Moose Jaw climate over the past century have been identified:
  - average annual and springtime temperatures are increasing, as are daily mean temperatures during March
  - mean daily maximum temperatures are increasing on an annual basis and during the spring period
  - mean daily minimum temperatures are increasing during February, March, August, and September, as well as on an annual basis and during spring and summer
  - growing degree days base 8°C (GDD<sub>8</sub>) and 10°C (GDD<sub>10</sub>) are increasing
  - rainfall has been increasing during March as well as during winter, and decreasing during October
  - significant declines in the mean of homogeneous wind speeds during April, May, June, July, September, November, and December, as well as on an annual basis and during spring, summer, and autumn
- frequency distributions of monthly, seasonal, and annual climate variables were generated to facilitate more reliable risk analyses for agricultural activities and hydrologic modeling efforts

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