



Supplement of

Recent hydrological response of glaciers in the Canadian Rockies to changing climate and glacier configuration

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Supplementary Tables

Table S1: Changes in precipitation for annual, seasonal, and monthly time periods [Comparison C1]. Highlighted bold numbers are significant at 95% confidence level.

Season/ month	AGRB					PGRB				
	p- value Wilcox test	p- value t-test	Past (mm)	Present (mm)	Difference (mm)	p- value Wilcox test	p- value t-test	Past (mm)	Present (mm)	Difference (mm)
Annual	0.912	0.683	611.4	626.6	15.2	0.143	0.121	697.0	768.7	71.7
Winter	0.043	0.037	254.5	205.0	-49.5	0.436	0.223	272.2	237.0	-35.2
Spring	0.089	0.191	115.0	128.1	13.1	0.064	0.057	152.4	182.1	29.7
Summer	0.052	0.020	132.9	171.4	38.5	0.009	0.006	146.2	196.4	50.2
Fall	0.481	0.468	109.0	122.1	13.1	0.218	0.260	126.2	153.2	27
January	0.123	0.056	92.9	58.2	-34.7	0.089	0.060	94.6	60.7	-33.9
February	0.821	0.882	32.5	31.5	-1	1.000	0.613	48.8	43.4	-5.4
March	0.436	0.313	40.1	45.1	5	0.165	0.069	61.2	77.2	16
April	0.496	0.356	34.6	39.6	5	0.280	0.259	40.7	48.3	7.6
May	0.436	0.571	40.4	43.5	3.1	0.393	0.420	50.6	56.5	5.9
June	0.043	0.095	47.1	61.0	13.9	0.029	0.076	61.9	80.0	18.1
July	0.054	0.055	39.0	55.0	16	0.089	0.064	45.1	63.6	18.5
August	0.353	0.319	46.7	55.4	8.7	0.123	0.103	39.2	52.8	13.6
September	0.280	0.227	48.0	63.6	-15.6	0.315	0.288	66.2	85.5	19.3
October	0.739	0.814	60.9	58.5	-2.4	0.529	0.497	60.0	67.7	7.7
November	0.579	0.462	53.9	58.8	4.9	0.063	0.067	73.7	93.7	20
December	0.082	0.086	75.3	56.5	-18.8	0.035	0.032	55.1	39.3	-15.8

Table S2: Changes in daily maximum temperature for annual, seasonal, and monthly periods [Comparison C1]. Highlighted bold numbers are significant at 95% confidence level.

Season/ month	AGRB					PGRB				
	p-value Wilcox test	p-value t-test	Past (°C)	Present (°C)	Difference (°C)	p-value Wilcox test	p-value t-test	Past (°C)	Present (°C)	Difference (°C)
Annual	0.002	0.002	2.1	3.1	1	0.000	0.000	1.3	2.8	1.5
Winter	0.009	0.009	-7.2	-5.3	1.9	0.001	0.001	-0.2	1.7	1.9
Spring	0.052	0.044	1.5	2.6	1.1	0.043	0.016	11	12.1	1.1
Summer	0.796	0.979	12.3	12.3	0	0.315	0.358	5.3	5.9	-0.6
Fall	0.436	0.529	5.9	6.3	0.4	0.007	0.005	-6.8	-5	1.8
January	0.000	0.001	-10.1	-5.0	5.1	0.000	0.000	-9.4	-4.6	4.8
February	0.579	0.668	-6.0	-5.4	0.6	0.579	0.740	-5.9	-5.5	-0.4
March	0.075	0.023	-3.9	-1.9	2	0.015	0.008	-5.0	-2.7	2.3
April	0.063	0.054	0.7	2.2	1.5	0.003	0.002	-1.1	1.2	2.3
May	0.684	0.878	7.5	7.4	-0.1	0.165	0.110	5.4	6.5	1.1
June	0.631	0.546	10.3	9.9	-0.4	0.393	0.405	8.7	9.2	0.5
July	0.739	0.723	13.3	13.5	0.2	0.015	0.012	12.0	13.4	1.4
August	0.631	0.771	13.1	13.3	0.2	0.123	0.070	12.2	13.4	1.2
September	0.912	0.986	8.9	8.9	0	0.853	0.809	8.5	8.8	0.3
October	0.218	0.230	3.0	3.7	0.7	0.105	0.157	2.2	3.1	0.9
November	0.105	0.081	-4.2	-2.6	1.6	0.029	0.032	-4.3	-2.5	1.8
December	1.000	0.870	-8.4	-8.2	0.2	0.912	0.980	-7.6	-7.6	0

Table S3: Changes daily minimum temperature for annual, seasonal, and monthly periods [Comparison C1]. Highlighted bold numbers are significant at 95% confidence level.

Season/ month	AGRB					PGRB				
	p-value Wilcox test	p-value t-test	Past (°C)	Present (°C)	Difference (°C)	p-value Wilcox test	p-value t-test	Past (°C)	Present (°C)	Difference (°C)
Annual	0.190	0.081	-4.5	-4.0	0.5	0.000	0.001	-4.9	-3.8	1.1
Winter	0.971	0.671	-12.3	-12	0.3	0.853	0.673	-11.2	-10.9	0.3
Spring	0.089	0.077	-5.7	-4.9	0.8	0.001	0.001	-7.0	-5.5	1.5
Summer	0.043	0.023	4.5	5.2	0.7	0.000	0.000	3.7	5.0	1.3
Fall	0.247	0.384	-1.1	-0.7	0.4	0.009	0.008	-2.0	-0.6	1.4
January	0.007	0.012	-15.0	-11.4	3.6	0.001	0.003	-13.3	-9.8	3.5
February	0.796	0.517	-12.1	-13.1	-1	0.739	0.382	-11.5	-12.8	-1.3
March	0.684	0.490	-9.8	-9.2	0.6	0.089	0.067	-10.8	-9.3	1.5
April	0.029	0.018	-6.9	-5.3	1.6	0.015	0.008	-7.9	-6.2	1.7
May	1.000	0.699	-0.5	-0.3	0.2	0.004	0.004	-2.4	-1.0	1.4
June	0.853	0.734	2.9	3.1	0.2	0.739	0.516	1.9	2.2	0.3
July	0.043	0.023	5.4	6.4	1	0.000	0.000	4.3	6.2	1.9
August	0.019	0.020	5.1	6.1	1	0.000	0.000	4.8	6.6	1.8
September	0.280	0.169	0.7	1.6	0.9	0.190	0.182	0.8	1.6	0.8
October	0.853	0.937	-2.9	-2.9	0	0.004	0.004	-4.7	-2.8	1.9
November	0.631	0.807	-9.2	-9.4	-0.2	0.739	0.985	-8.5	-8.5	0
December	0.280	0.393	-12.7	-13.9	-1.2	0.190	0.251	-11.4	-12.7	-1.3

Table S4: Changes daily mean temperature in annual, seasonal, and monthly periods [Comparison C1]. Highlighted bold numbers are significant at 95% confidence level.

Season	AGRB					PGRB				
	p-value Wilcox test	p- value t-test	Past (°C)	Present (°C)	Difference (°C)	p-value Wilcox test	p- value t-test	Past (°C)	Present (°C)	Difference (°C)
Annual	0.105	0.089	-1.1	-0.6	0.5	0.001	0.001	-1.6	-0.6	1
Winter	0.481	0.336	-9.7	-9	0.7	0.529	0.342	-8.9	-8.4	0.5
Spring	0.165	0.119	-2	-1.2	0.8	0.003	0.003	-3.4	-2	1.4
Summer	0.393	0.392	8.7	9	0.3	0.003	0.002	7.6	8.7	1.1
Fall	0.529	0.799	2.4	2.6	0.2	0.28	0.23	1.7	2.4	0.7
January	0.004	0.006	-12.5	-8.6	3.9	0.000	0.001	-11.3	-7.6	3.7
February	0.912	0.704	-9.1	-9.7	-0.6	0.796	0.537	-8.7	-9.6	-0.9
March	0.353	0.234	-6.8	-5.8	1	0.075	0.058	-7.9	-6.3	1.6
April	0.063	0.054	-2.9	-1.6	1.3	0.007	0.007	-4.3	-2.6	1.7
May	0.579	0.943	3.8	3.8	0	0.105	0.044	1.8	3.0	1.2
June	0.912	0.754	7.0	6.8	-0.2	0.436	0.507	5.7	6.0	0.3
July	0.190	0.214	9.7	10.3	0.6	0.002	0.001	8.4	10.1	1.7
August	0.631	0.373	9.3	9.8	0.5	0.019	0.010	8.6	10.1	1.5
September	0.739	0.727	4.8	5.1	0.3	0.631	0.727	4.7	5.0	0.3
October	0.853	0.991	0.1	0.1	0	0.052	0.089	-1.2	-0.2	1
November	0.853	0.870	-6.5	-6.4	0.1	0.971	0.632	-6.2	-5.8	0.4
December	0.436	0.499	-10.4	-11.2	-0.8	0.247	0.285	-9.4	-10.5	-1.1

Table S5: Results of Student's t-test for changes in annual mean values of water fluxes. Highlighted bold numbers are significant at the 95% confidence level. The comparisons are defined in Table 1.

Comparisons	Fluxes	AGRB				PGRB			
		p-value t-test	Mean 1 (mm)	Mean 2 (mm)	Difference (mm)	p-value t-test	Mean 1 (mm)	Mean 2 (mm)	Difference (mm)
C1	Snowfall	0.443	911	866	-45	0.121	1135	919	-216
	Rainfall	0.001	175	262	87	0.304	310	362	52
	Rainfall ratio	0.001	0.161	0.232	0.071	0.047	0.220	0.283	0.063
	Snowmelt	0.223	687	723	36	0.309	1105	974	-131
	Firn melt	0.652	275	307	32	0.806	163	146	-17
	Ice melt	0.537	532	501	-31	0.000	265	667	402
	Runoff	0.578	1320	1365	45	0.005	1581	1888	307
C2	Snowfall	0.892	911	901	-10	0.591	1135	1060	-75
	Rainfall	0.983	175	175	0	0.923	310	313	3
	Rainfall ratio	0.918	0.161	0.163	0.002	0.601	0.220	0.234	0.014
	Snowmelt	0.432	687	661	-26	0.683	1105	1056	-49
	Firn melt	0.930	275	267	-8	0.095	163	39	-124
	Ice melt	0.245	532	470	-62	0.225	265	364	99
	Runoff	0.279	1320	1236	-84	0.499	1581	1524	-57
C3	Snowfall	0.546	911	876	-35	0.292	1135	986	-149
	Rainfall	0.001	175	262	87	0.326	310	360	50
	Rainfall ratio	0.001	0.161	0.229	0.068	0.117	0.220	0.268	0.048
	Snowmelt	0.827	687	669	-18	0.613	1105	1041	-64
	Firn melt	0.587	275	314	39	0.015	163	414	251
	Ice melt	0.460	532	571	39	0.003	265	537	272
	Runoff	0.125	1320	1452	132	0.000	1581	2069	488
C4	Snowfall	0.545	901	866	-35	0.287	1060	919	-141
	Rainfall	0.001	175	262	87	0.340	313	362	49
	Rainfall ratio	0.001	0.163	0.232	0.069	0.118	0.234	0.283	0.049
	Snowmelt	0.035	661	723	62	0.527	1056	974	-82
	Firn melt	0.581	267	307	40	0.008	39	146	107
	Ice melt	0.454	470	501	31	0.006	364	667	303
	Runoff	0.101	1236	1365	129	0.001	1524	1888	364
C5	Snowfall	0.785	876	866	-10	0.606	986	919	-67
	Rainfall	0.986	262	262	0	0.974	360	362	2
	Rainfall ratio	0.895	0.163	0.232	0.069	0.645	0.268	0.283	0.015
	Snowmelt	0.504	669	723	54	0.621	1041	974	-67
	Firn melt	0.908	314	307	-7	0.003	414	146	-268
	Ice melt	0.111	571	501	-70	0.192	537	667	130
	Runoff	0.295	1452	1365	-87	0.124	2069	1888	-181

Table S6: Results of paired Student’s t-test and Wilcox test for changes in monthly values of water fluxes. Highlighted bold numbers are significant at the 95% confidence level. The comparisons are defined in Table 1.

Comparisons	Fluxes	AGRB		PGRB	
		p-value t-test	p-value Wilcox test	p-value t-test	p-value Wilcox test
C1	Snowfall	0.424	0.986	0.028	0.018
	Rainfall	0.000	0.000	0.141	0.000
	Snowmelt	0.525	0.109	0.303	0.922
	Firn melt	0.540	0.181	0.741	0.552
	Ice melt	0.437	0.859	0.000	0.000
	Runoff	0.500	0.059	0.000	0.000
C2	Snowfall	0.000	0.000	0.000	0.000
	Rainfall	0.003	0.000	0.100	0.000
	Snowmelt	0.000	0.000	0.028	0.262
	Firn melt	0.029	0.027	0.001	0.000
	Ice melt	0.000	0.000	0.000	0.000
	Runoff	0.000	0.000	0.023	0.057
C3	Snowfall	0.538	0.839	0.138	0.113
	Rainfall	0.000	0.000	0.162	0.001
	Snowmelt	0.312	0.097	0.604	0.897
	Firn melt	0.460	0.125	0.003	0.002
	Ice melt	0.336	0.072	0.000	0.000
	Runoff	0.061	0.003	0.000	0.000
C4	Snowfall	0.531	0.851	0.135	0.113
	Rainfall	0.000	0.000	0.170	0.001
	Snowmelt	0.265	0.013	0.496	0.613
	Firn melt	0.453	0.160	0.002	0.000
	Ice melt	0.346	0.078	0.000	0.000
	Runoff	0.048	0.004	0.000	0.000
C5	Snowfall	0.000	0.000	0.000	0.000
	Rainfall	0.234	0.000	0.511	0.000
	Snowmelt	0.000	0.003	0.006	0.288
	Firn melt	0.035	0.062	0.000	0.000
	Ice melt	0.000	0.000	0.000	0.000
	Runoff	0.000	0.000	0.000	0.018

Table S7: Results of Student's t-test and Wilcox test for changes in glacier mass balances. Highlighted bold numbers are significant at 95% confidence level. The comparisons were as per the Scenarios defined in Table 1.

Comparisons	Mass Balance	AGRB					PGRB				
		p-value Wilcox test	p-value t-test	Mean 1 (mm)	Mean 2 (mm)	Difference (mm)	p-value Wilcox test	p-value t-test	Mean 1 (mm)	Mean 2 (mm)	Difference (mm)
C1	Winter	0.029	0.019	474	417	-57	0.007	0.009	586	324	-262
	Summer	0.796	0.740	-1176	-1133	43	0.123	0.149	-857	-1056	-199
	Annual	0.579	0.910	-701	-716	-15	0.029	0.019	-271	-733	-462
C2	Winter	0.280	0.233	474	447	-27	0.043	0.059	586	401	-185
	Summer	0.247	0.522	-1176	-1083	93	0.123	0.249	-857	-709	148
	Annual	0.315	0.663	-701	-636	65	0.739	0.830	-271	-308	-37
C3	Winter	0.353	0.219	474	444	-30	0.315	0.278	586	474	-112
	Summer	0.481	0.686	-1176	-1229	-53	0.011	0.010	-857	-1306	-449
	Annual	0.529	0.534	-701	-785	-84	0.023	0.016	-271	-832	-561
C4	Winter	0.247	0.180	447	417	-30	0.315	0.266	401	324	-77
	Summer	0.481	0.683	-1083	-1133	-50	0.007	0.008	-709	-1056	-347
	Annual	0.529	0.519	-636	-716	-80	0.023	0.014	-308	-733	-425
C5	Winter	0.218	0.245	444	417	-27	0.089	0.075	474	324	-150
	Summer	0.218	0.374	-1229	-1133	96	0.105	0.114	-1306	-1056	250
	Annual	0.436	0.506	-785	-716	69	0.481	0.625	-832	-733	99