Government of
Northwest Territories

NWT Snow Survey Bulletin & Spring Water Level Outlook 2023 – Technical Report

Hydrology Group, Water Management and Monitoring Division
Environment and Climate Change (ECC)
April 18, 2023

Contents

Overview

This is an outlook for anticipated 2023 spring water levels in the Northwest Territories (NWT).

ECC reporting. Throughout the spring melt season, the Department of Environment and Climate Change (ECC) will provide regular reports on current water level and river ice conditions, and how break up is progressing. This situational awareness relies on information from various sources including winter snow data, over-winter temperatures, winter water level and flow data, near real-time water level and flow data (always provisional), near real-time photographs of water levels and ice from cameras at water level gauge sites, near real-time interpreted satellite imagery of ice conditions, forecasted weather conditions, and reports from community flood watch programs.

Current water levels. Overall, as the spring melt season begins, water levels across the territory as of April 18, 2023, are generally between average and below average, with some exceptions. The summer and fall of 2022 were warmer and drier than normal across the NWT. This has resulted in water levels decreasing from the historic high levels seen over the past couple of years to generally average water levels seen in fall 2022 at freeze-up.

Snowpack. Snowpack across the territory in the winter of 2022-23 was approximately average, with exceptions being higher than normal snowpacks in the Sahtu region and Peel River basin, and a much lower than normal snowpack in the Snare River basin in the North Slave region. These data are based on snow surveys conducted in late March/early April by ECC. These surveys measure the volume of water that is produced when a snowpack melts – this is termed the snow water equivalent (SWE). SWE varies based on the depth of snow and its density. Spring weather conditions will determine the timing of snowmelt, which is important because a quick, sudden snowmelt will cause a larger rise in water levels than would a prolonged snowmelt season

River ice. Winter air temperatures in 2022-23 in the NWT were slightly warmer than average, which, in part, impacts the thickness of river ice. Ice jams during break up typically form on north-flowing rivers, where warm weather and snowmelt cause ice to break up earlier on the southern reaches of a river. As this ice flows north (downstream), it may meet a more solid ice cover. When this happens, sheets of floating ice run into the solid ice and can form a dam (an 'ice jam'), which may cause water levels to rise rapidly behind it. The occurrence of ice jams is primarily dependent on weather conditions just prior to and during break up (e.g., how much and how quickly snowmelt water reaches river systems, and how the ice breaks up). Over-winter conditions, such as snowfall, winter air temperatures and ice thickness, can play a role in their occurrence as well.

Flood risk. As always, it is difficult to predict in advance how break up will occur – and if ice jams will form – as it is highly dependent on spring weather conditions. Although ice-jam flooding can happen in any year regardless of pre-existing water levels and snowpack SWE, the potential severity of flooding, if an ice jam occurs, can increase when water levels are already high and snowpacks are large. ECC recommends that residents in flood-prone communities follow the advice from Municipal and Community Affairs (MACA) to ensure that they are prepared for

possible flooding every year.

Outlook by region

North Slave Region

ECC snow surveys show that the snowpack in the Yellowknife River basin was average at 98% of normal (where 100% of normal = average), while the Snare River basin was well below average at 77% of normal as of early April 2023 (Table A1).

In general, water levels in the North Slave region have dropped substantially over the last year because of a very warm and dry summer in 2022. A below average snowpack will result in continued low levels into the spring. Provisional flows on rivers (Cameron and Yellowknife) and water levels on lakes (Prosperous and Prelude) close to Yellowknife are currently between below average and well below average. Flows on rivers draining into the East Arm of Great Slave Lake (Lockhart, Hoarfrost, Waldron) are well below average and have dropped substantially since the high flows of 2020 and 2021. Flows on rivers north of the Yellowknife River basin are extremely low.

The Snare River is currently at its third lowest level on record (40 years) and the Coppermine River (at its headwaters and through to Point Lake) is at its lowest level on record (60 years).

Great Slave Lake

Water levels on Great Slave Lake receded to average levels over the summer of 2022 after being extremely high since the summer of 2020. Low snowpack values in the North Slave region will likely result in lower flows and levels on local rivers and lakes but will not have a strong impact on water levels on Great Slave Lake as the vast majority (~75-80%) of the water in Great Slave Lake comes from the Slave River to the south. Therefore, water levels on Great Slave Lake during the summer of 2023 are heavily dependent on winter snowpack and summer precipitation in northern Alberta, British Columbia, and Saskatchewan.

Slave River Basin

The primary tributaries to the Slave River basin are the Peace River, Athabasca River and Lake Athabasca/Peace-Athabasca Delta region. As a result, ECC relies on snow survey data from other jurisdictions to assess the snowpack in the basin. SWE values in the Peace River basin were slightly below average at 93% of normal but shift to above average (124% of normal) further downstream towards the Peace-Athabasca Delta. SWE values in the upper Athabasca region are extremely high at 179% of normal.

Further north, ECC snow surveys in the South Slave region found that snowpack was average at 100% of normal. Alberta Environment and Protected Areas has declared that long lead indicators show an average potential for flooding along the Peace River and an above average potential for flooding on the Athabasca River at Fort McMurray. The weather experienced between the date of issue and break up will have a large impact on flood risk in the province.

Flow rates on the Slave River have fluctuated around average since the summer of 2022. Flow rates on the Peace River have also been about average, while flows on the Athabasca River are currently below average. Water levels on Lake Athabasca are about average and have dropped substantially since levels were at or near the highest on record in 2020 and 2021.

Taltson and Tazin River Basins

Poor weather conditions during late March and early April prevented safe access to remote snow survey sites.

Flows on the Taltson and Tazin rivers are currently below average and have dropped substantially since extreme record high flows in 2020 and 2021.

Water levels on Tazin Lake are about average. According to the Water Security Agency of Saskatchewan, average flows and water levels are expected across the Lake Athabasca basin this spring.

Hay River Basin

Snow surveys show that the snowpack in the Hay River basin is average this year at 100% of normal, as of late March 2023. This includes snow surveys conducted in Alberta and British Columbia, as 94% of the land that feeds into the Hay River is in those jurisdictions, although snow survey sites are sparse in these regions.

The Town of Hay River experienced severe flooding in the spring of 2022. The flooding was a result of high pre-existing moisture conditions in the basin (so there was limited room for the ground to hold snowmelt water), higher than average pre-existing water levels in the Hay River, higher than average snowpack, a later-than-normal spring, and an extreme precipitation event that fell on the basin during break up.

Water levels on the Hay River are currently below average and much lower than last year at this time. Warm weather in early April has helped to initiate early snowmelt in the basin, but as always, the weather experienced in the Hay River basin over the coming weeks will have a large impact on the flood risk at break up.

For the Hay River basin, the April 1st spring runoff outlook of Alberta Environment and Protected Areas estimates a normal range (85-115% of normal) for flow and water levels in parts of the upper Hay River basin, but also note that there are insufficient data to provide an outlook for most of the far northern section of Alberta.

Dehcho and Sahtu Regions

In the Liard River basin, Government of Yukon snowpack SWE data for April 1st indicate that the snowpack in the upper Liard basin is generally average at 102% of normal. Further downstream, snow surveys by the Government of British Columbia show that the snowpack is below average

(81% of normal), while ECC snow survey data in the lower Liard basin show average SWE values at 101% of normal. ECC snow surveys in the remainder of the Dehcho region (outside the Liard River basin) indicate that snowpack in the region is average at 104% of normal.
Flows on the Liard River over winter have been about average and have been that way since summer 2022. Recent increases in flows are due to the response of an early snowmelt event in early April.

Further north in the Sahtu region, ECC snow surveys found that snowpack SWE values are above average at 124% of normal.

Prior to the flooding events in Fort Simpson, Jean Marie River, and Fort Good Hope in 2021, water levels and flow rates on the Mackenzie River were the highest on record for that time of year, a contributing factor to the flooding experienced. Currently, water levels on the Mackenzie River at Fort Simpson and Norman Wells are below average. As with all years, the weather experienced during the coming weeks in the Liard and Upper Mackenzie River basins will have a large impact on the flood risk at break up.

Peel River Basin and Inuvik Region

ECC and Government of Yukon snow survey data for the Peel River basin show that snowpack SWE values are above average at 125% of normal. ECC snow surveys in the Inuvik region show that snowpack is slightly lower than average at 86% of normal.
Water levels on the Peel River are currently much higher than average. Water levels on the Mackenzie River at Tsiigehtchic and throughout the Mackenzie Delta are average for this time of year. The potential for flooding in the Mackenzie Delta will be dependent on spring weather conditions and the way the ice breaks up.

Factors to Watch

The potential and severity of freshet flooding will depend in large part on the weather over the upcoming weeks and how quickly the snow and ice melt. The following variables are the primary factors that influence water levels and if there will be flooding:

- Rate of snow melt
    - Slow and steady onset of warm weather allows a progressive snowmelt and slow delivery of meltwater to the river network
    - Sudden extreme warm weather can cause a rapid snowmelt which can cause rapid increases in water levels
    - Rain on snow events can cause rapid snowmelt and can lead to rapid increases in water levels
- Rate of ice melt/break up
    - Gradually warming weather across an entire basin allows ice to slowly degrade and melt (thermal break up)
    - Very warm weather in upstream areas can cause rapid snow melt and local ice break up. If this ice flows downstream into a solid ice cover, the force of the ice can cause downstream ice to break up and can lead to ice jams (mechanical break up)
- Current water levels in lakes and rivers, and moisture in wetlands and soil
- Snowpack volumes (snow water equivalent - SWE)
- Temperatures over the winter
- Whether ice jams form (primary cause of spring flooding in the NWT)
    - Can result in the back-up of large amounts of water and can cause flooding (even when water levels are low)
    - Combined with existing high water levels can produce severe flooding scenarios

Water level and flow data are part of the NWT Hydrometric Monitoring Network, funded by Environment and Climate Change Canada (ECCC) and ECC, and operated by the Water Survey of Canada. Data can be seen and/or downloaded at: https://wateroffice.ec.gc.ca/search/searchRealTime_e.html.

Please be reminded that all real time data are provisional.

Appendix A: Snow survey data for Spring 2023

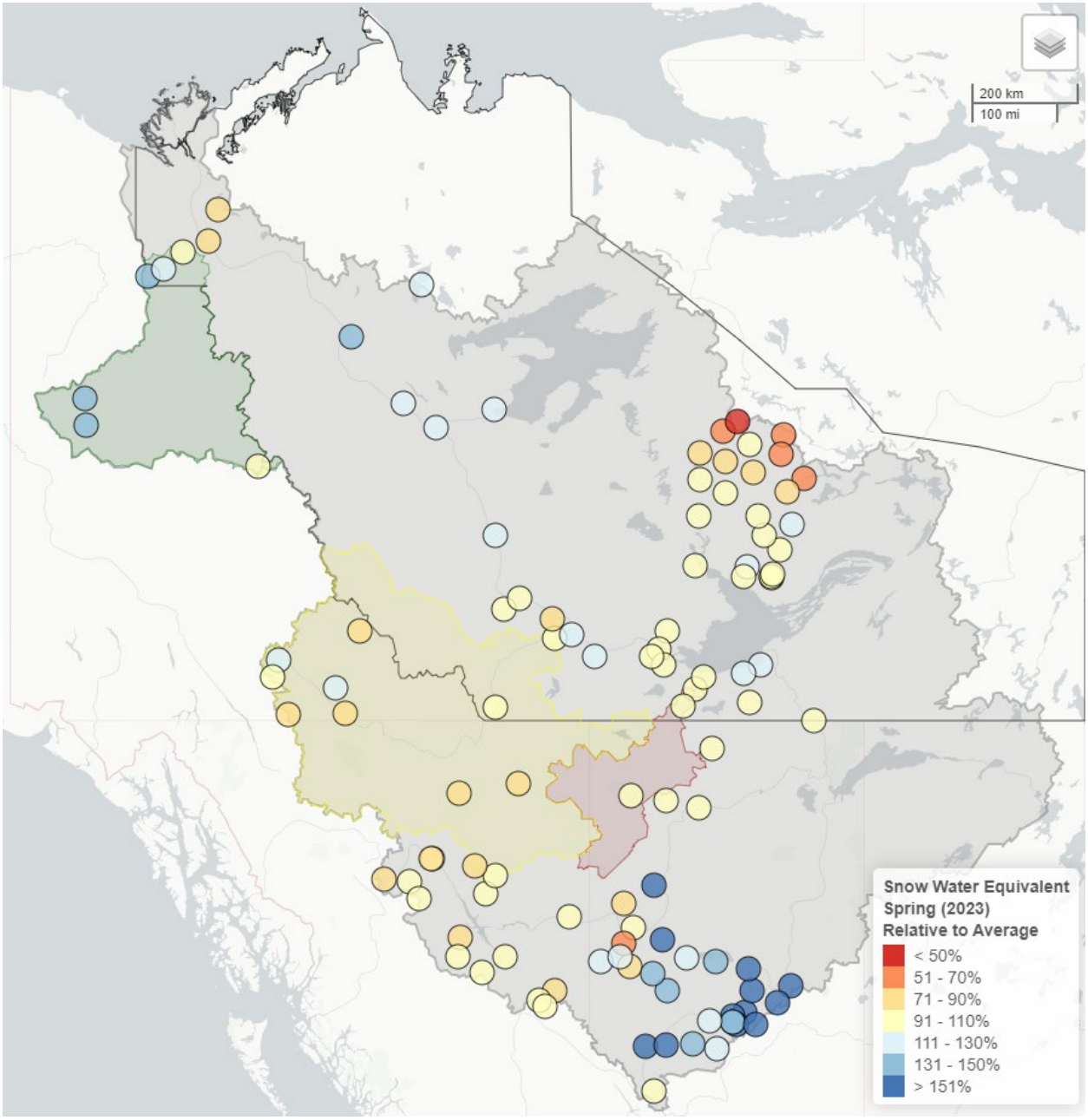

Figure A-1: Map of snow water equivalent (SWE) distribution in the Mackenzie River basin. Data from this map were compiled from ECC snow surveys (NWT) as well as snow survey data from neighbouring jurisdictions (Governments of Yukon, British Columbia, and Alberta). The large grey polygon is the Mackenzie River basin, the red polygon is the Hay River basin, the yellow polygon is Liard River basin, and the green polygon is the Peel River basin.

Table A-1: Detailed ECC snow survey data by location. Full dataset available upon request.
* Please note that at some locations, the mean SWE from 2001-2020 is based on very few years of data.
[$] Unable to access Taltson River Basin, Thubun Lake and Hook Lake in 2023.

Site	Long	Lat	Record length (years)	2001-2020 mean SWE (mm)* *italics: <20 years*	2023 mean depth (cm)	2023 mean SWE (mm)	2023 % of normal (relative to 2001-2020)
Yellowknife River Basin							
Allan Lake	-113.05	62.95	35	83.1	45.7	86.5	104.1
Bluefish Hydro	-114.25	62.68	28	*79.4*	55.0	102.5	129.0
Denis Lake	-112.62	63.37	36	103.0	57.4	118.1	114.6
Ingraham Trail km 64 NW	-113.38	62.50	41	81.2	47.6	77.0	94.8
Jolly Lake	-112.21	64.12	11	*132.4*	37.5	87.5	66.1
Little Latham Lake	-113.63	63.20	36	95.5	50.1	97.0	101.5
Nardin Lake	-113.85	63.51	36	100.0	50.8	96.5	96.5
Sharples Lake	-112.82	63.90	36	100.0	50.9	76.0	76.0
Means				**96.8**	**49.4**	**92.6**	**97.8**
Snare River Basin							
Big Lake	-112.93	64.80	26	*125.1*	34.4	71.0	56.7
Big Spruce Lake	-116.00	63.50	45	103.7	55.1	102.5	98.8
Castor Lake	-115.99	64.52	46	108.9	47.9	84.0	77.1
Christison Lake	-114.17	64.65	29	116.0	46.7	122.5	105.6
Ghost Lake	-115.07	63.88	46	102.5	56.1	100.0	97.5
Indin Lake	-115.03	64.38	45	107.5	51.7	83.0	77.2
Mattberry Lake	-115.96	64.09	46	94.8	53.0	86.0	90.7
Mesa Lake	-115.14	64.85	46	122.8	36.0	70.3	57.3
Snare Lake	-114.04	64.20	45	*101.7*	44.3	76.5	75.2
White Wolf Lake	-114.60	65.00	28	*139.3*	28.8	68.5	49.2
Winter Lake	-113.03	64.50	45	*79.5*	28.6	52.5	66.1
Means				**109.3**	**43.9**	**83.3**	**77.4**
Other North Slave Region							
Ingraham Trail km 64 SE	-113.39	62.51	25	87.1	49.8	87.0	99.9
Mosquito Creek	-116.16	62.70	25	*98.1*	58.6	92.5	94.3
Pocket Lake	-114.37	62.51	30	79.0	43.0	76.0	96.2
Tibbitt Lake Muskeg	-113.34	62.56	24	83.8	50.1	86.5	103.2
Means				**87.0**	**50.4**	**85.5**	**98.4**
South Slave Region							
Boundary Lake	-115.55	59.48	30	*163.4*	84.7	151.5	92.7
Crown Fire (Forestry)	-117.15	61.58	6	*85.0*	53.1	91.0	107.1
Enterprise (Forestry)	-116.15	60.56	6	*103.7*	51.2	93.5	90.2
Fort Providence (Forestry)	-117.46	61.26	9	*93.9*	57.7	97.5	103.8
Fort Smith	-111.86	60.00	40	*90.1*	52.1	94.0	104.3
Hay River (Forestry)	-115.84	60.77	9	*107.3*	61.7	105.0	97.8
Hook Lake[$]	-112.78	60.67	32	*96.5*			
Kakisa River	-117.27	61.00	42	110.1	52.5	99.5	90.4
Kimble Tower (Forestry)	-117.73	61.14	9	*108.6*	61.9	104.5	96.2
Little Buffalo Tower	-113.79	61.00	41	*122.1*	69.1	135.0	110.6
Nyarling River	-114.17	60.33	40	*107.7*	59.9	104.0	96.6
Pine Point	-114.38	60.85	41	*139.8*	76.0	155.5	111.2
Swede Creek	-116.57	60.27	42	98.4	54.0	101.0	102.6
Thubun Lake[$]	-111.75	61.50	37	*86.9*			

Means				**108.1**	**61.2**	**111.0**	**100.3**
Taltson River Basin[$]							
Alcantara Lake	-108.28	60.90	51	*113.2*			
Dunvegan Lake	-107.28	60.17	53	*122.6*			
Dymond Lake	-106.28	61.38	52	*130.1*			
Gray Lake	-108.35	61.85	55	*116.2*			
Halliday Lake	-109.03	61.38	53	*114.0*			
Hill Island Lake	-109.90	60.50	52	*104.5*			
Nonacho Lake	-109.67	61.72	53	*110.0*			
Piers Lake	-111.17	60.32	38	*100.7*			
Powder Lake (Forestry)	-109.41	61.04	8	*105.8*			
Thekulthili Lake	-110.23	60.97	51	*96.2*			
Tortuous Lake	-111.70	60.75	51	*91.7*			
Whirlwind Lake	-108.68	60.25	51	*105.8*			
Means				**109.2**			
Dehcho Region							
Checkpoint	-121.25	61.45	30	*107.0*	51.8	98.0	91.6
Fort Liard (Forestry)	-123.40	60.23	9	*79.3*	45.3	82.0	103.4
Fort Simpson	-121.33	61.80	28	*100.3*	50.0	87.0	86.7
Jean Marie River (Forestry)	-120.65	61.52	9	*89.7*	56.1	100.0	111.5
Nahanni Butte (Forestry)	-123.11	61.95	9	*104.2*	58.1	103.0	98.9
Ndulee Crossing (Forestry)	-122.53	62.15	9	*87.5*	54.2	94.0	107.4
Trout Lake (Forestry)	-119.81	61.14	9	*85.0*	57.9	105.0	123.5
Wrigley (Forestry)	-123.41	63.20	9	*77.1*	54.2	90.0	115.9
Means				**91.3**	**53.5**	**94.9**	**104.9**
Sahtu Region							
Colville Lake	-126.06	67.02	8	*85.2*	57.7	98.0	115.0
Deline	-123.43	65.19	7	*102.0*	65.5	123.0	120.6
Fort Good Hope	-128.61	66.27	7	*100.8*	70.5	142.0	140.9
Norman Wells	-126.76	65.28	8	*98.2*	62.3	126.0	128.3
Tulita	-125.53	64.90	7	*99.6*	56.7	114.0	114.4
Means				**97.2**	**62.5**	**120.6**	**123.9**
Inuvik/Gwich'in Regions							
Caribou Creek	-133.48	68.05	38	*122.4*	67.2	108.0	88.3
Fort McPherson	-134.74	67.47	12	*110.9*	60.6	105.0	94.7
James Creek	-136.00	67.14	8	*65.9*	50.5	94.0	142.6
Midway Lake	-135.44	67.23	8	*142.3*	78.9	158.0	111.0
Rengleng River	-133.83	67.63	38	*135.9*	68.8	114.0	83.9
Means				**115.5**	**65.2**	**115.8**	**104.1**

Appendix B: Provisional water level and flow plots (as of April 18th, 2023)

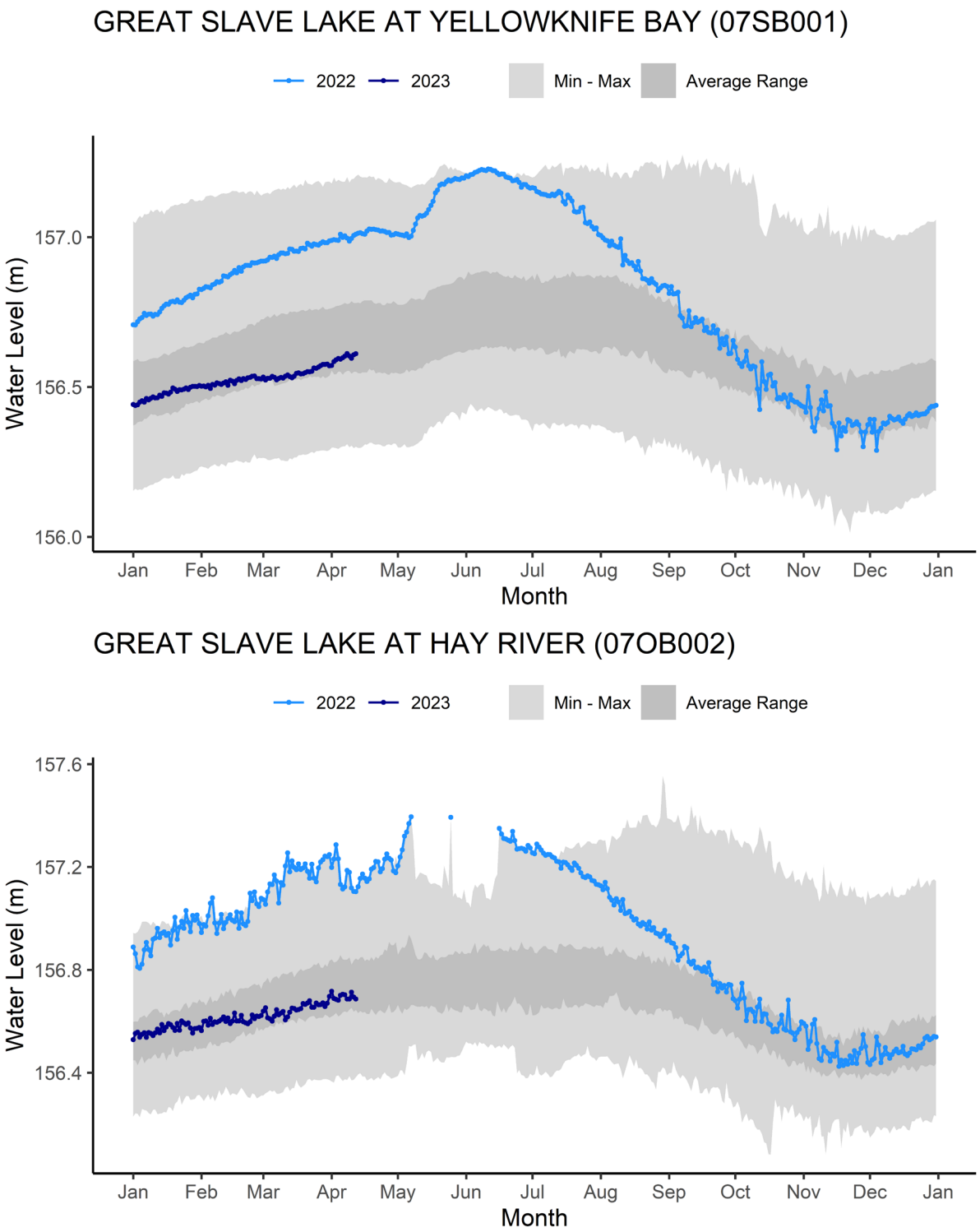

Figure B-1: Water levels (m) on Great Slave Lake for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums at: a) Yellowknife Bay; and b) Hay River.

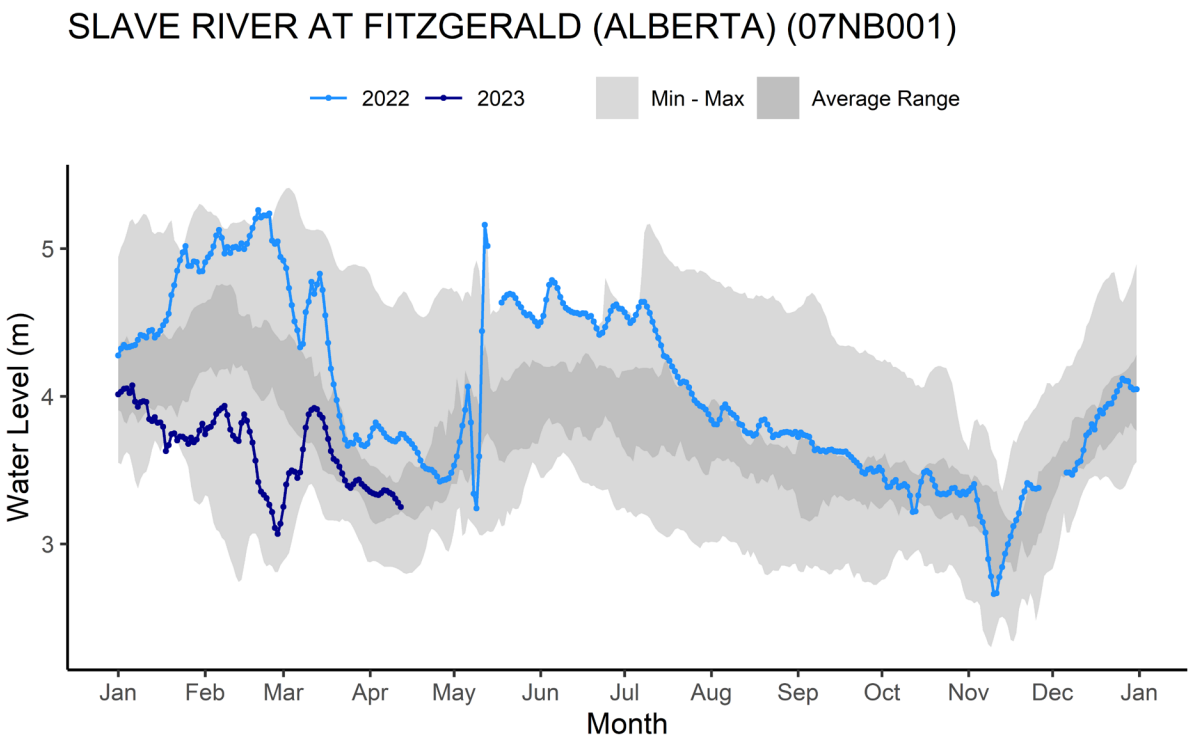

Figure B-2: Water levels (m) on the Slave River at Fitzgerald for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums

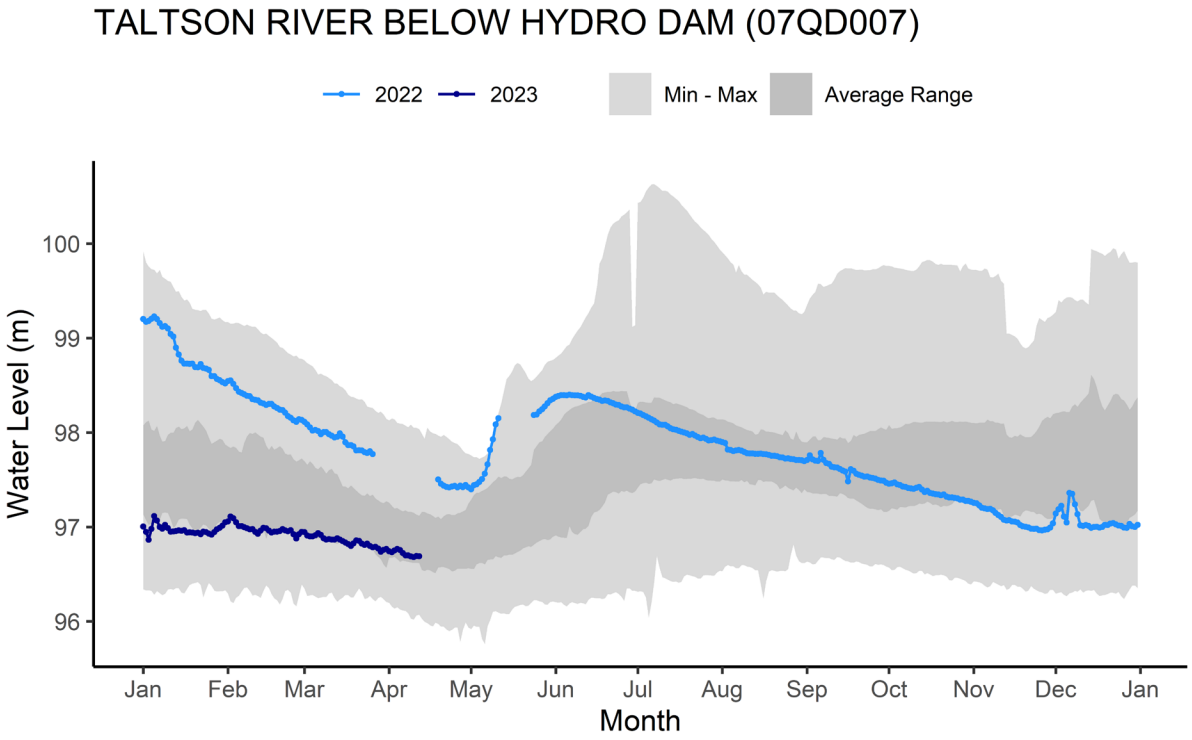

Figure B-3: Water levels (m) on the Taltson River for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums.

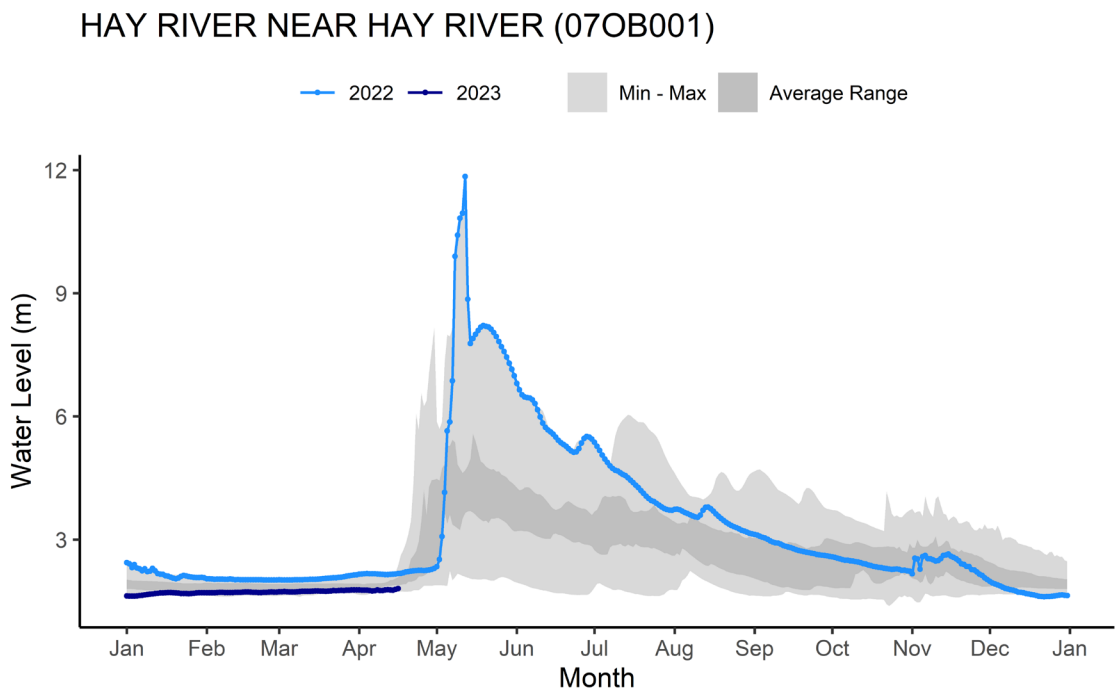

Figure B-4: Water levels (m) on the Hay River near Hay River for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums.

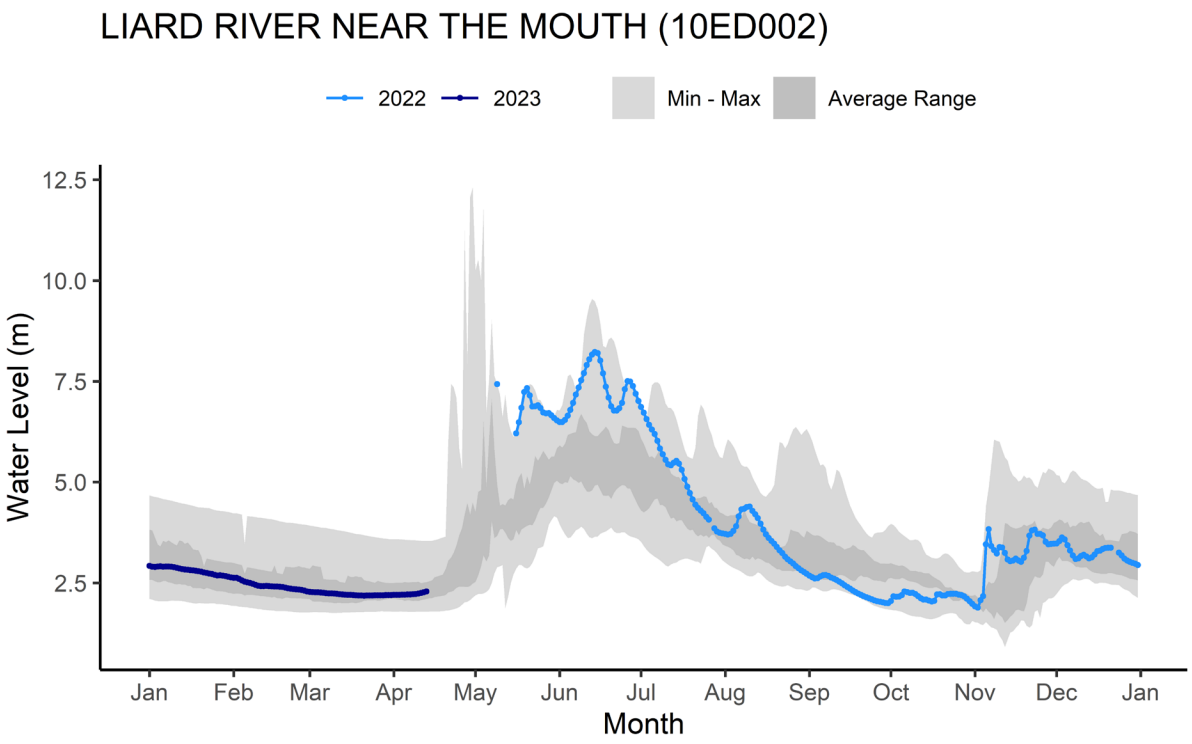

Figure B-5: Water levels (m) on the Liard River near the mouth for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums.

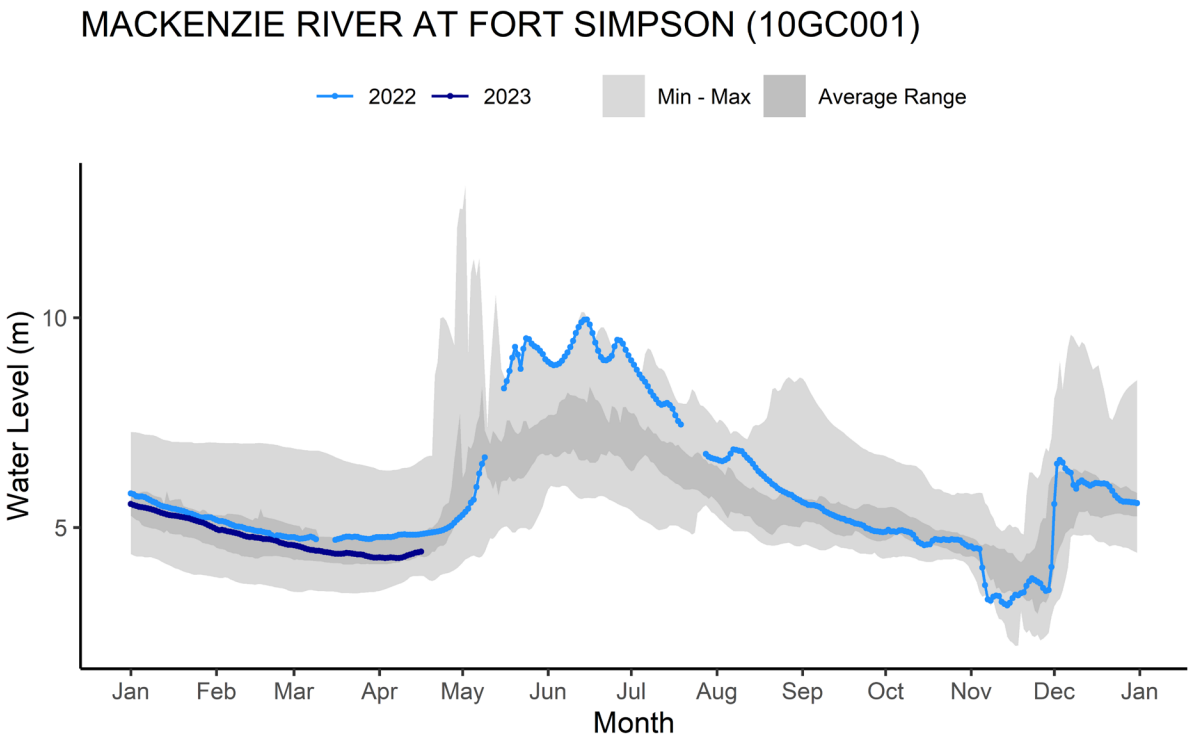

Figure B-6: Water levels (m) on the Mackenzie River at Fort Simpson for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums.

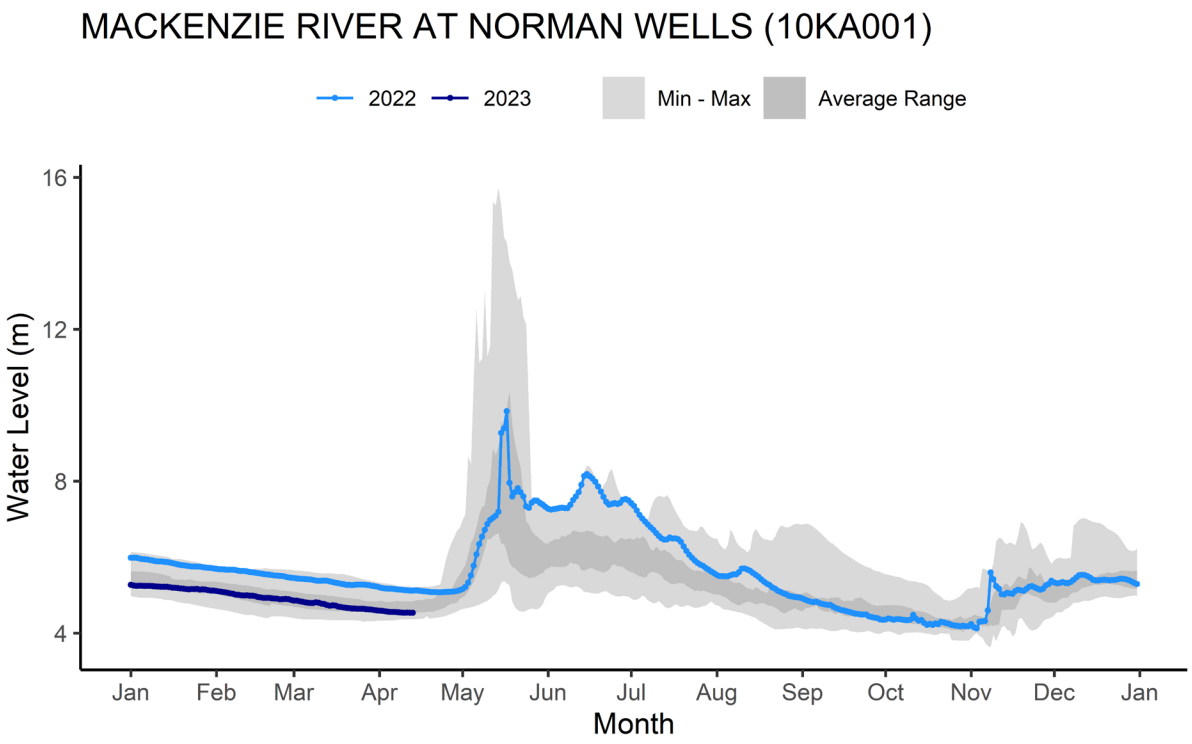

Figure B-7: Water levels (m) on the Mackenzie River at Norman Wells for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums.

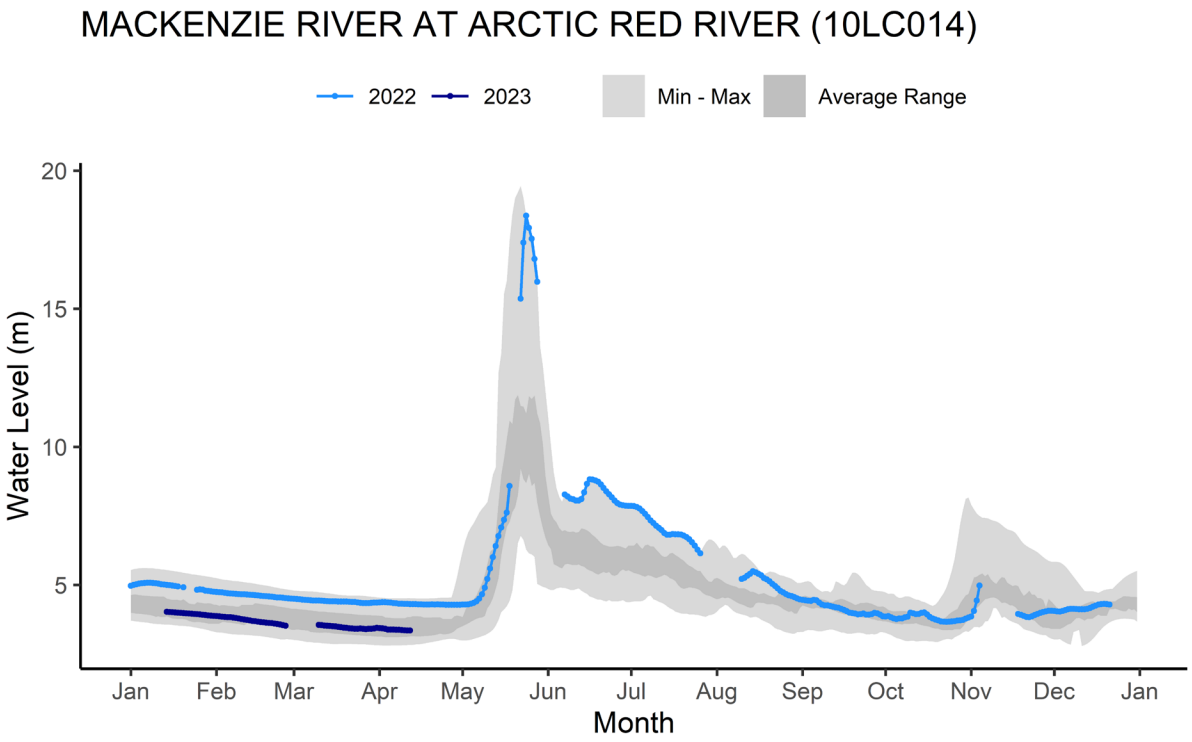

Figure B-8: Water levels (m) on the Mackenzie River at Tsiigehtchic (Arctic Red River) for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums.

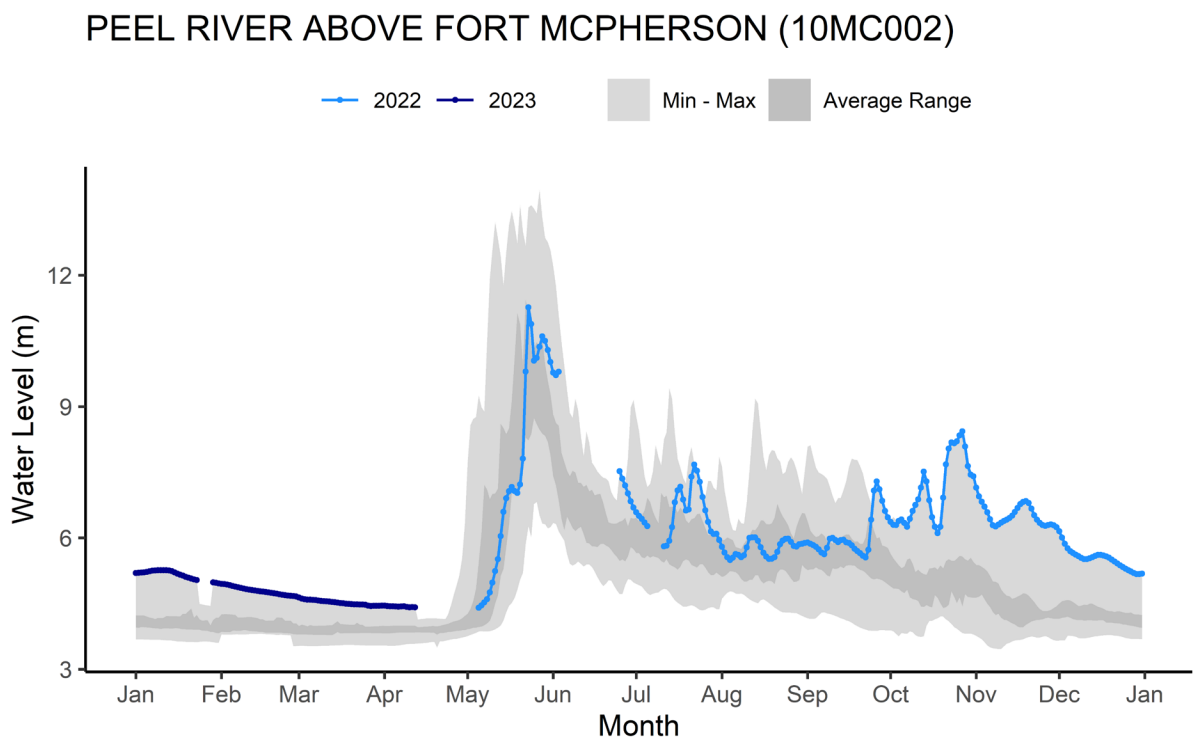

Figure B-9: Water levels (m) on the Peel River above Fort McPherson for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums.

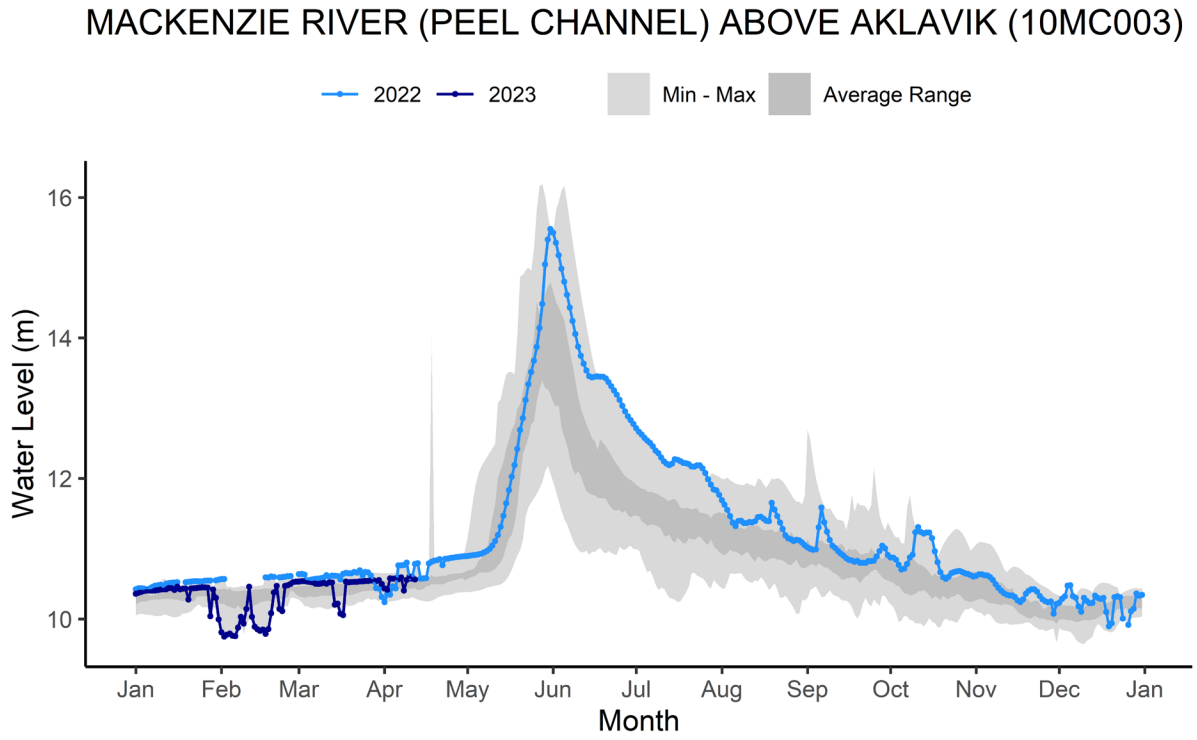

Figure B-10: Water levels (m) on the Mackenzie River (Peel Channel) above Aklavik for 2022 and 2023, relative to the historic average range (defined as the interquartile range) and historic maximum and minimums.

Appendix C: Climate data for the winter of 2022/23 for select NWT communities

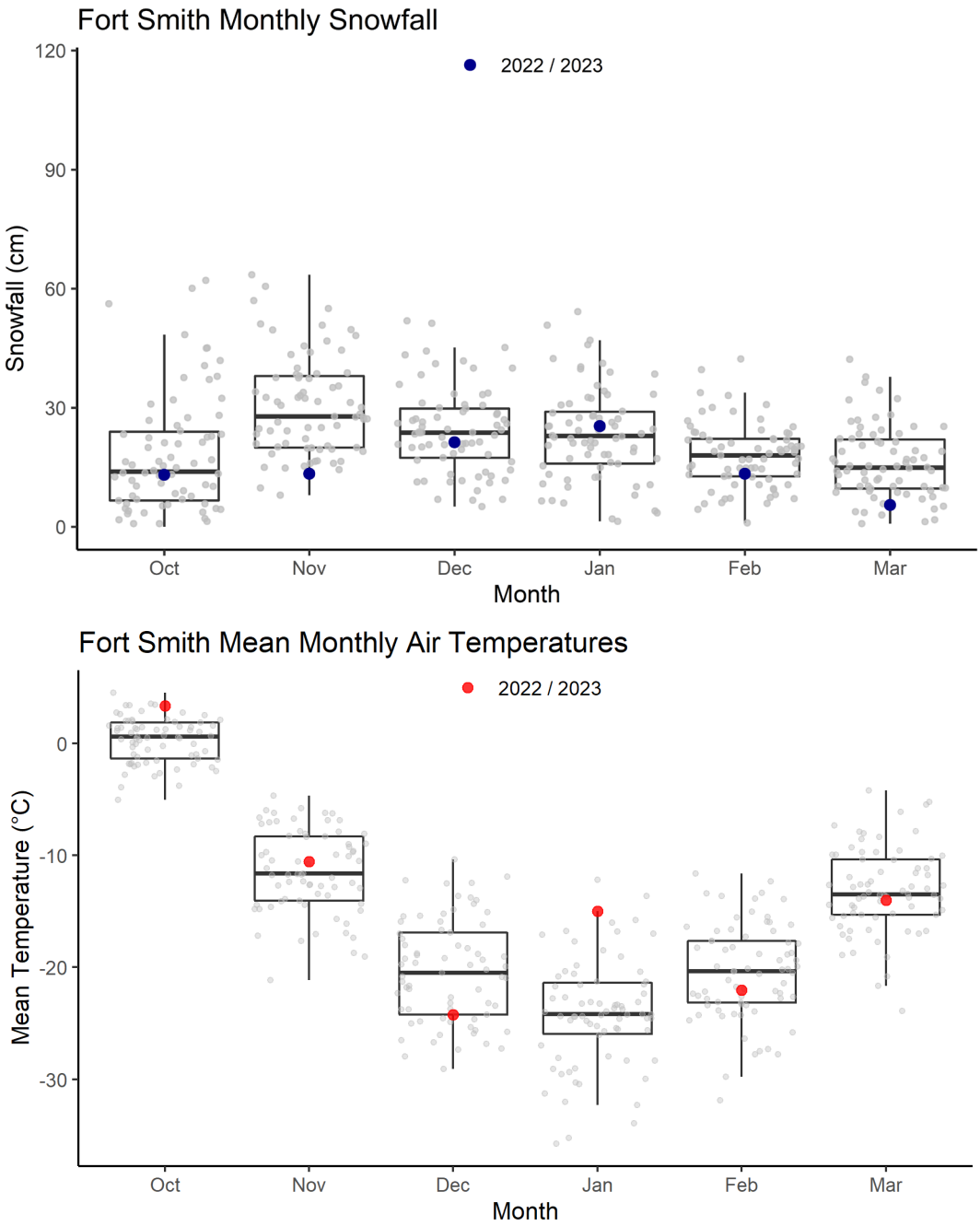

Figure C-1: Total monthly snowfall (cm) and mean monthly air temperatures (°C) for the winter of 2022/23 in Fort Smith. Data were collected at automatic climate stations operated by Environment and Climate Change Canada. Light grey dots represent values from previous years on record (1950 - 2023), when available. The thick horizontal black line is the median value, while the other horizontal lines represent the interquartile range.

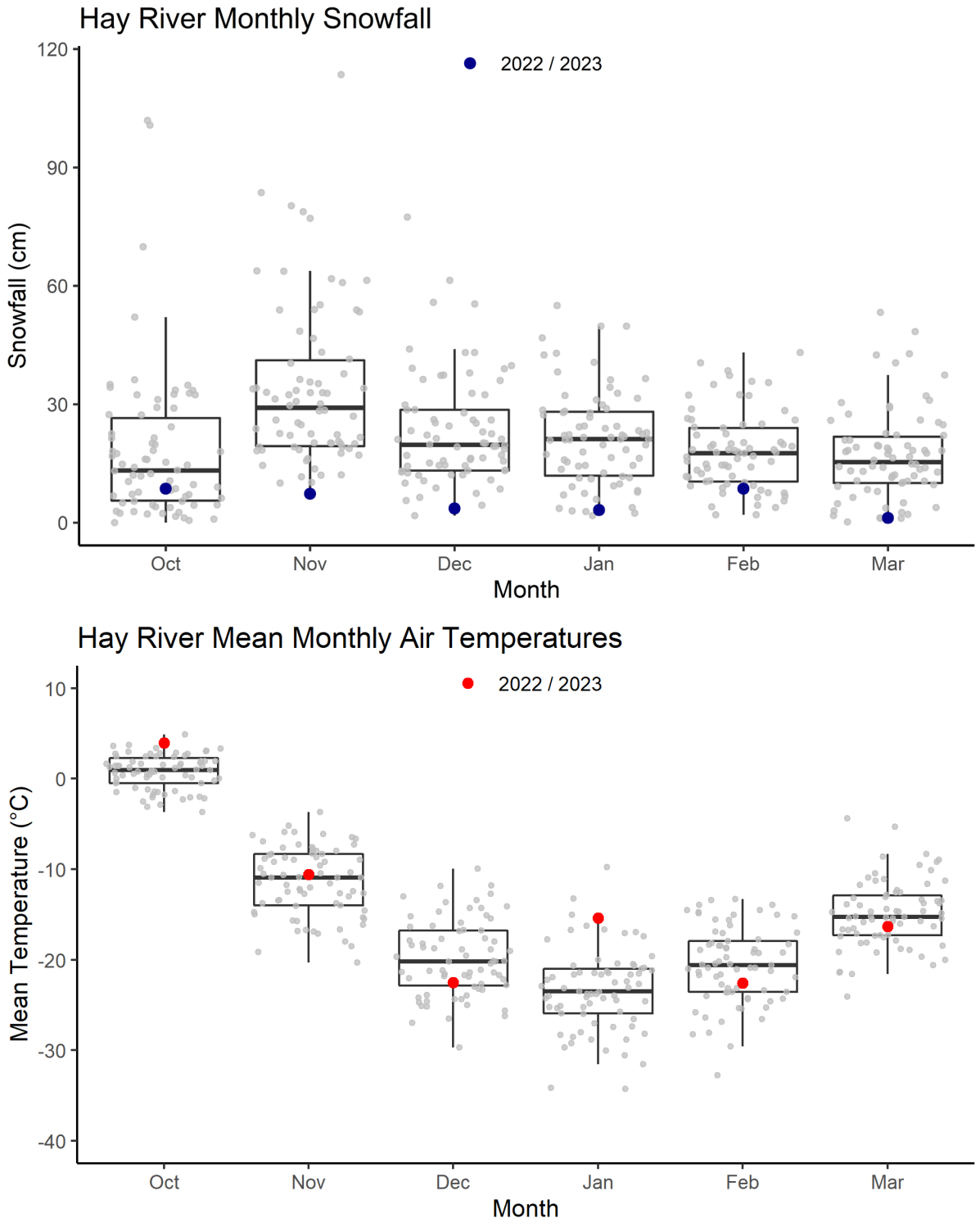

Figure C-2: Total monthly snowfall (cm) and mean monthly air temperatures (°C) for the winter of 2022/23 in Hay River. Data were collected at automatic climate stations operated by Environment and Climate Change Canada. Light grey dots represent values from previous years on record (1950 - 2023), when available. The thick horizontal black line is the median value, while the other horizontal lines represent the interquartile range.

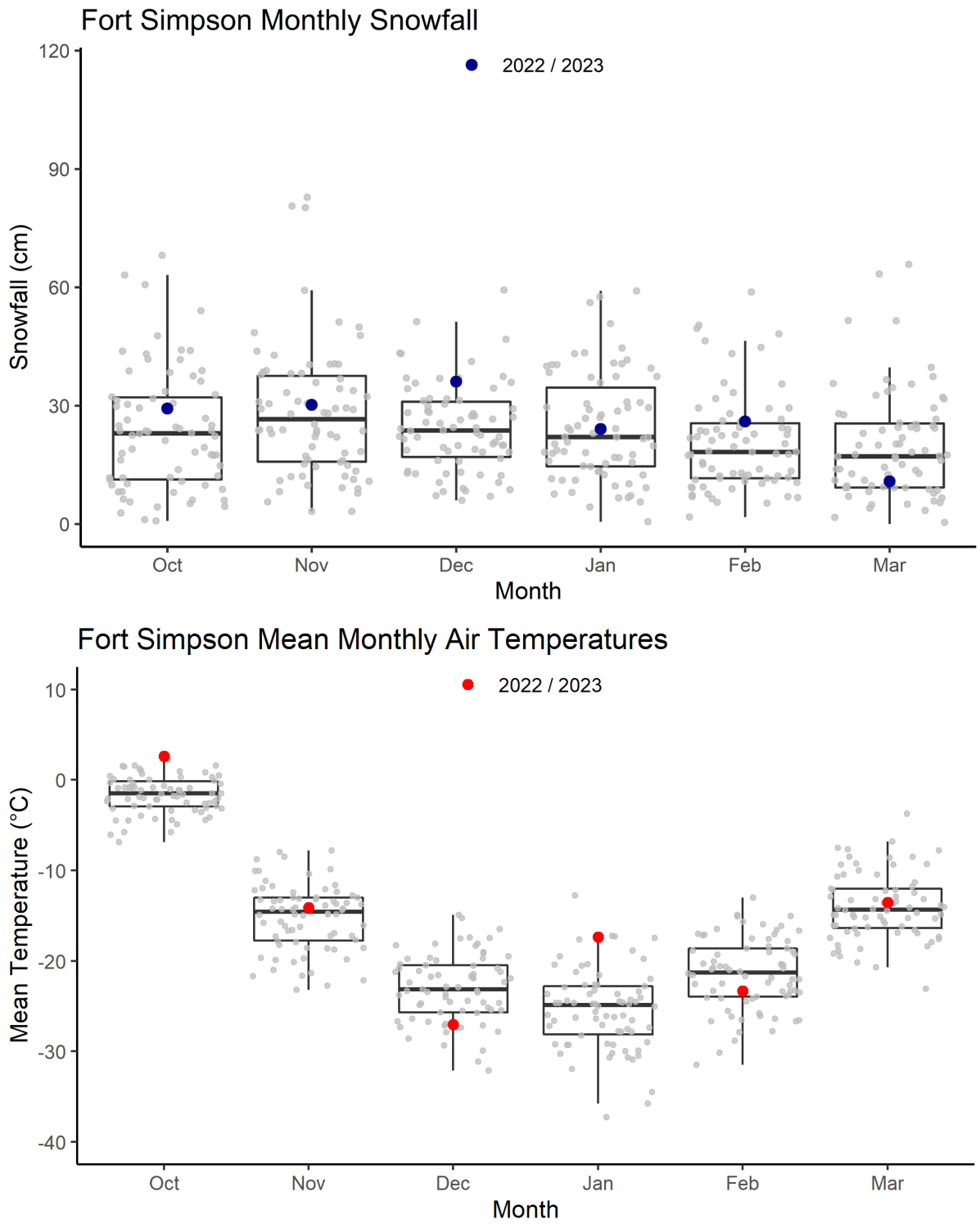

Figure C-3: Total monthly snowfall (cm) and mean monthly air temperatures (°C) for the winter of 2022/23 in Fort Simpson. Data were collected at automatic climate stations operated by Environment and Climate Change Canada. Light grey dots represent values from previous years on record (1950 - 2023), when available. The thick horizontal black line is the median value, while the other horizontal lines represent the interquartile range.

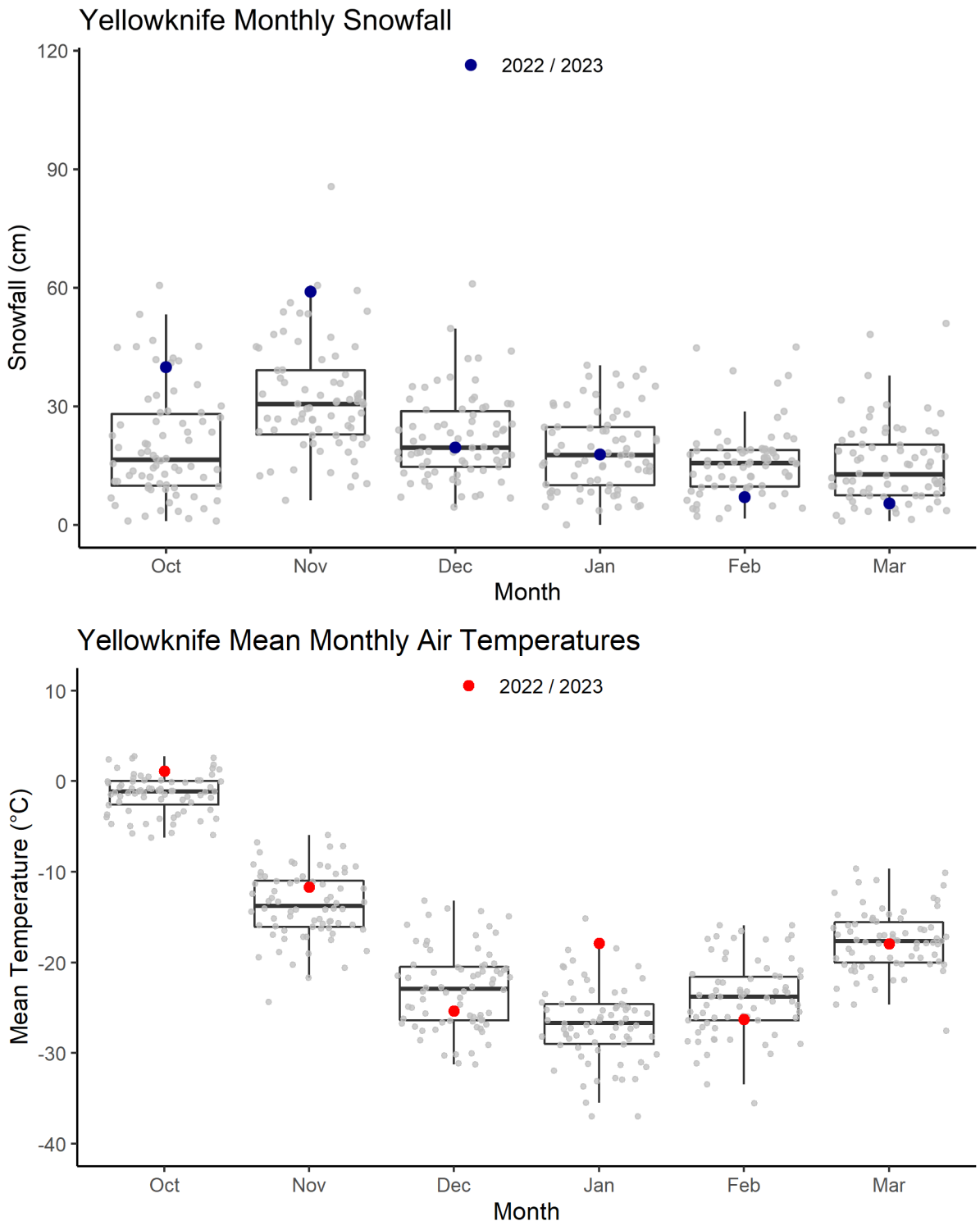

Figure C-4: Total monthly snowfall (cm) and mean monthly air temperatures (°C) for the winter of 2022/23 in Yellowknife. Data were collected at automatic climate stations operated by Environment and Climate Change Canada. Light grey dots represent values from previous years on record (1950 - 2023), when available. The thick horizontal black line is the median value, while the other horizontal lines represent the interquartile range.

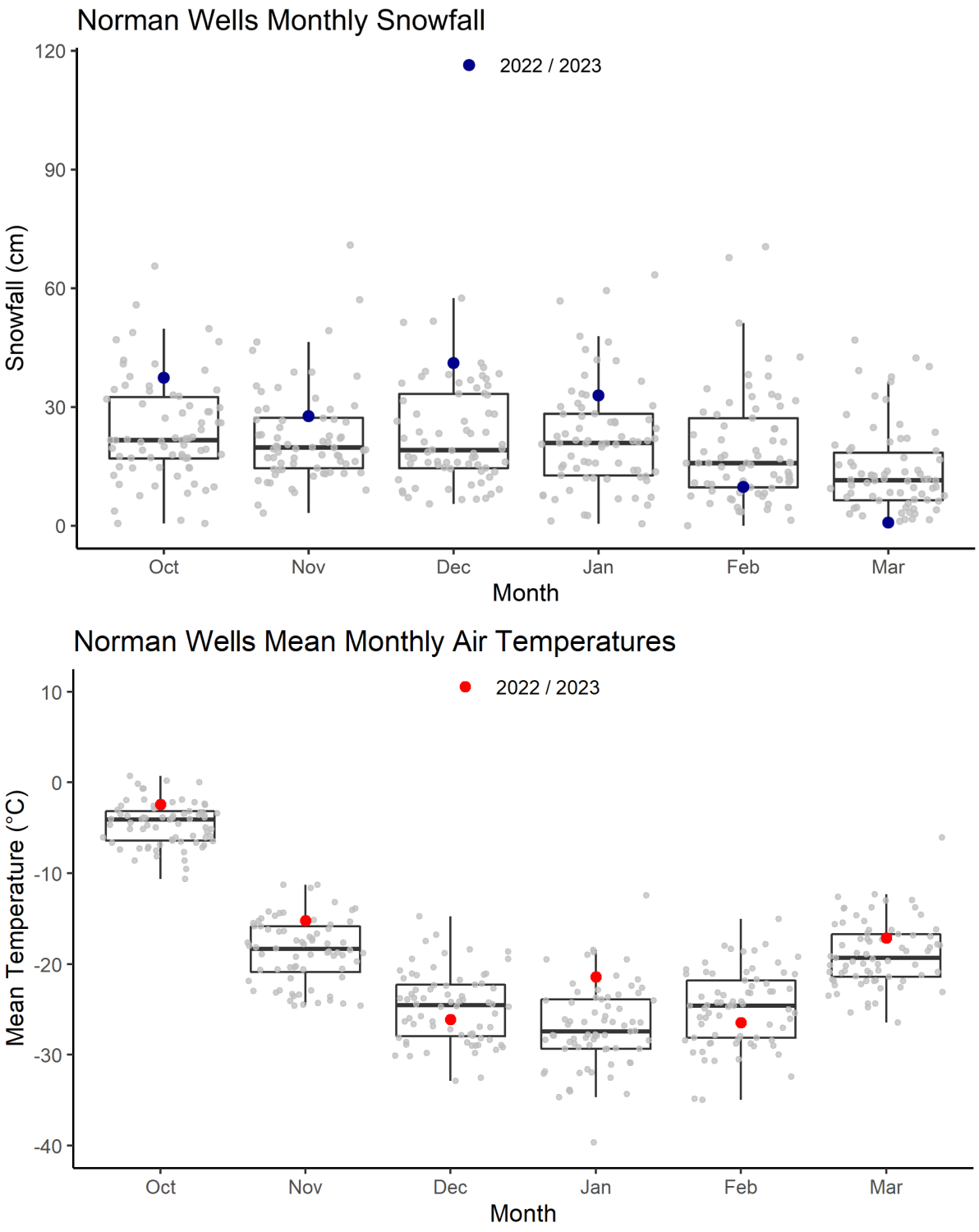

Figure C-5: Total monthly snowfall (cm) and mean monthly air temperatures (°C) for the winter of 2022/23 in Norman Wells. Data were collected at automatic climate stations operated by Environment and Climate Change Canada. Light grey dots represent values from previous years on record (1950 - 2023), when available. The thick horizontal black line is the median value, while the other horizontal lines represent the interquartile range.

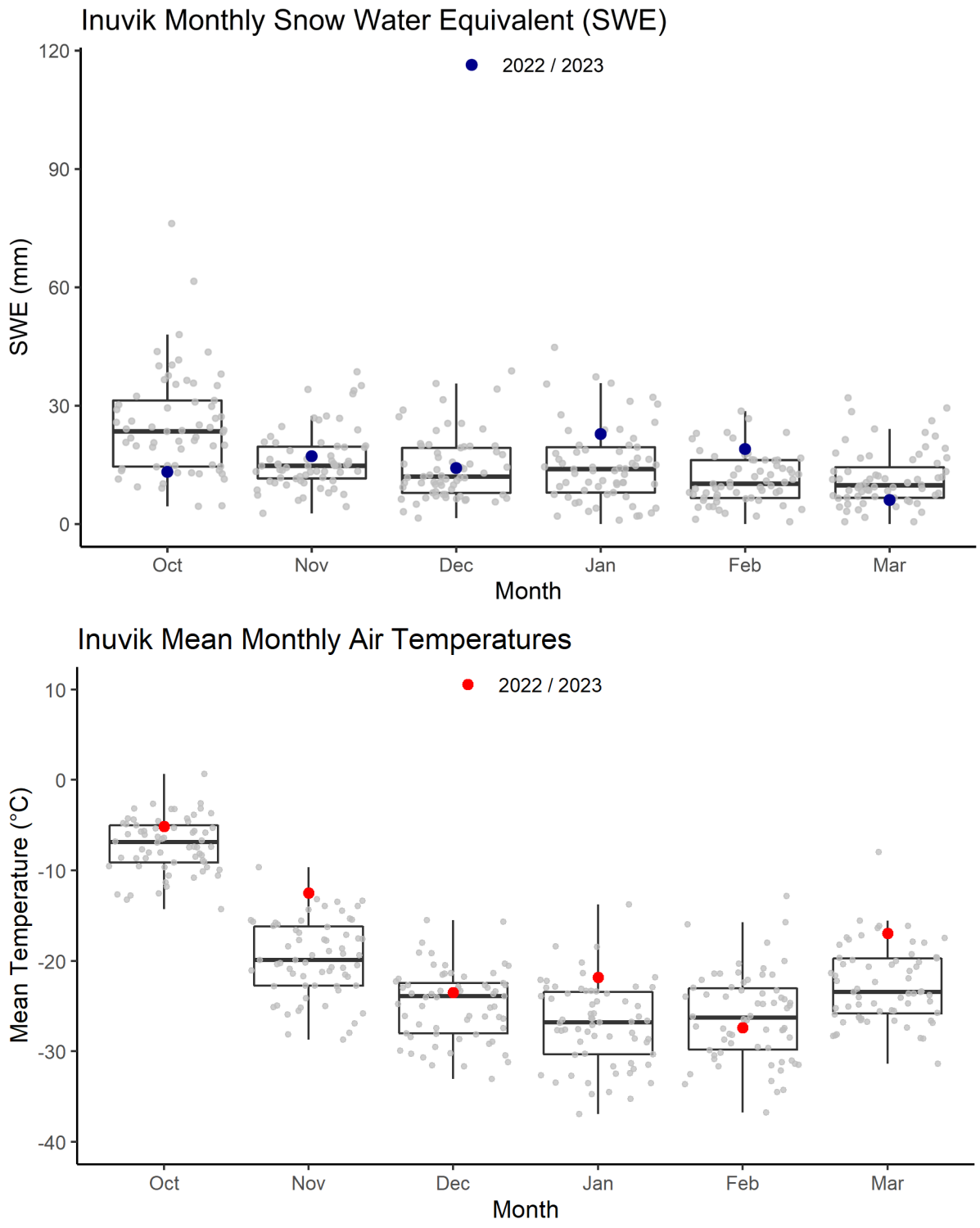

Figure C-6: Total monthly SWE (mm – this value is different than snowfall values at other communities as snowfall is not reported at the Inuvik climate station) and mean monthly air temperatures (°C) for the winter of 2022/23 in Inuvik. Data were collected at automatic climate stations operated by Environment and Climate Change Canada. Light grey dots represent values from previous years on record (1950 - 2023), when available. The thick horizontal black line is the median value, the other horizontal lines represent the interquartile range.

Appendix D: Other resources

Data from other jurisdictions can be found at the following links:

- **Yukon:** https://yukon.ca/en/snow-surveys-and-water-supply-forecasts
- **British Columbia:** https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/drought-flooding-dikes-dams/river-forecast-centre/snow-survey-water-supply-bulletin
- **Alberta:** https://rivers.alberta.ca/#
- **Saskatchewan:** https://www.wsask.ca/lakes-rivers/provincial/