

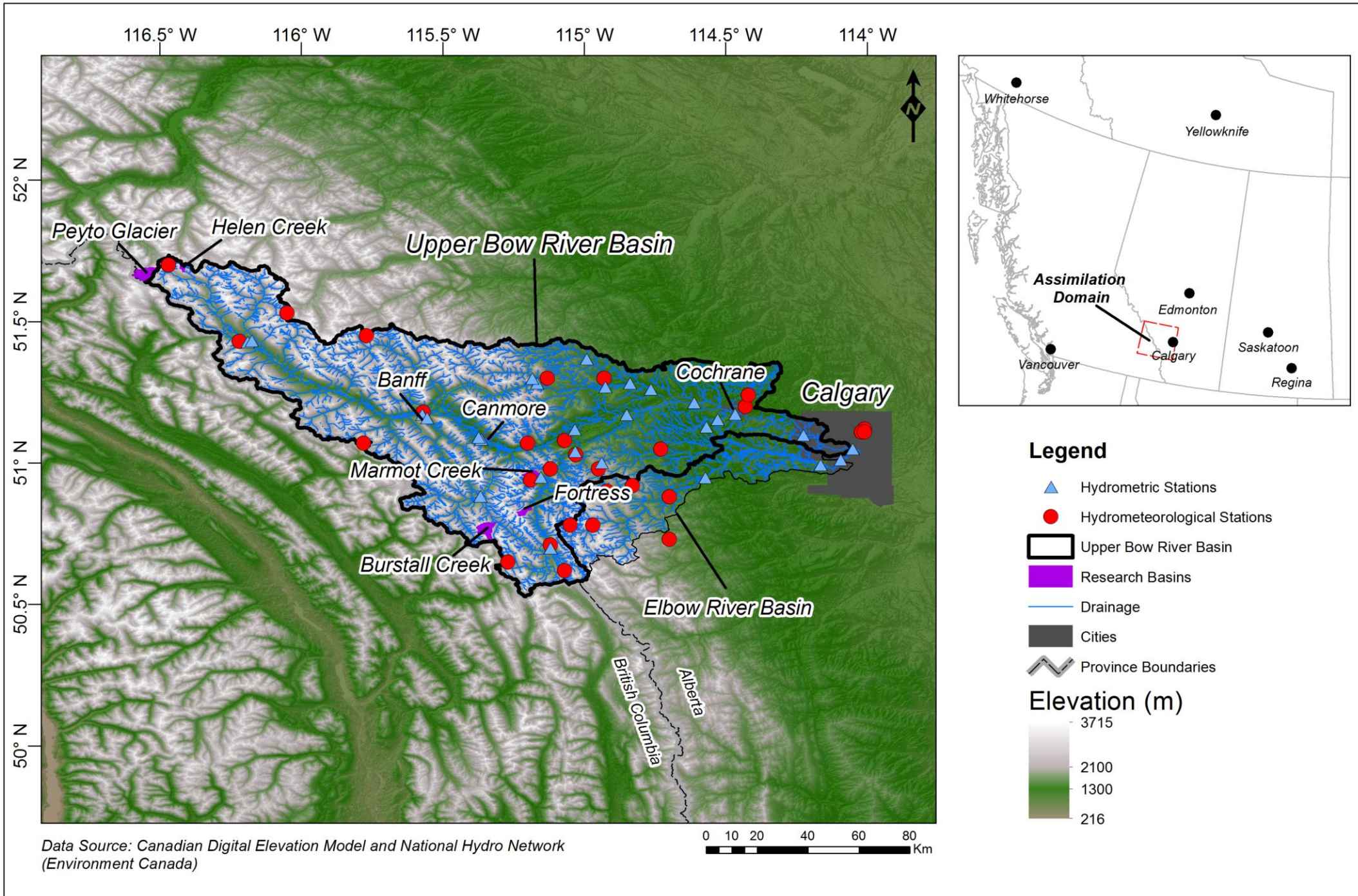
COPE Monitoring in the Canadian Rockies Hydrological Observatory

John Pomeroy, Andre Bertoncini,
Phillip Harder, Madison Harasyn,
Kieran Lehan, Lindsey Langs,
Hannah Koslowsky, Chris DeBeer

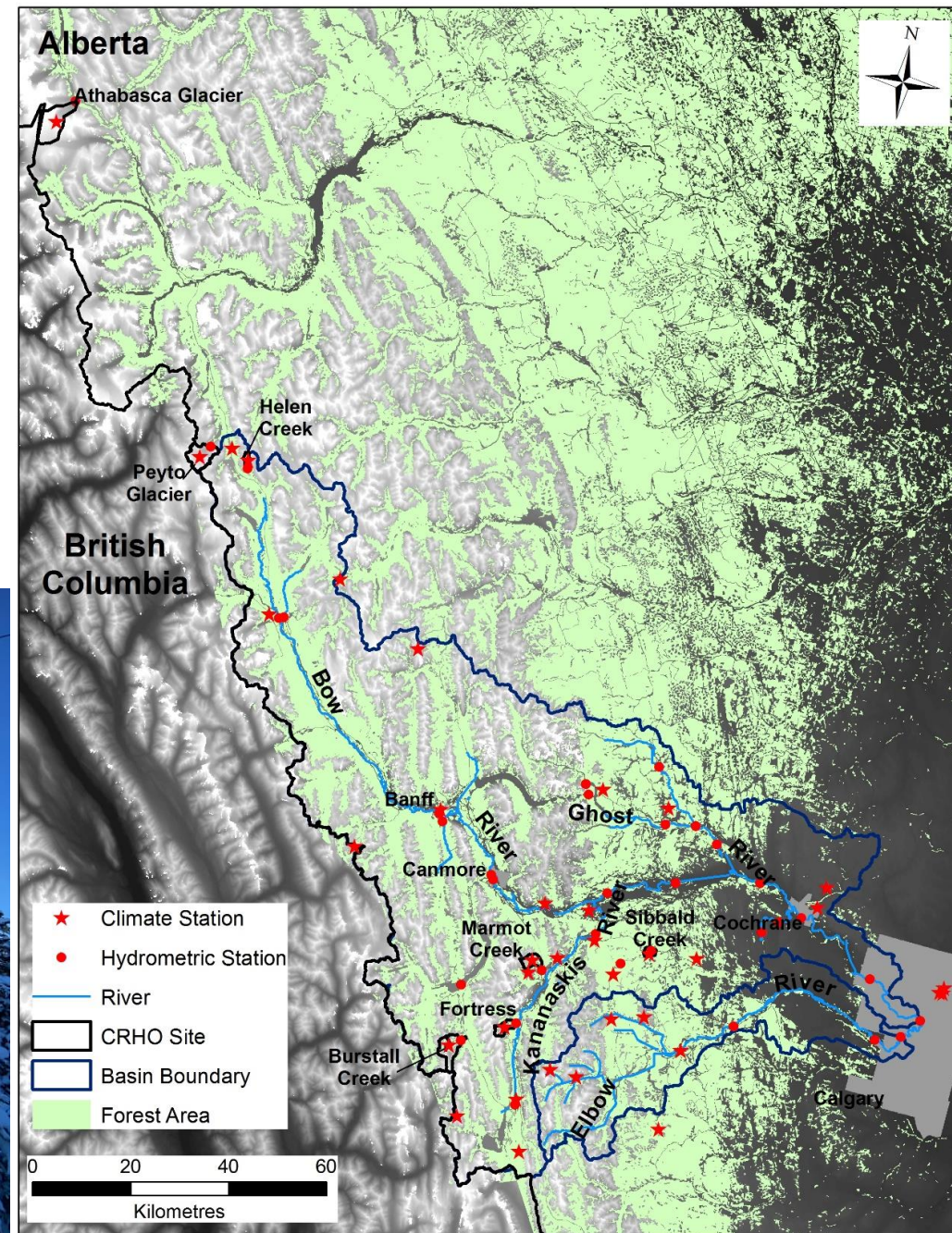
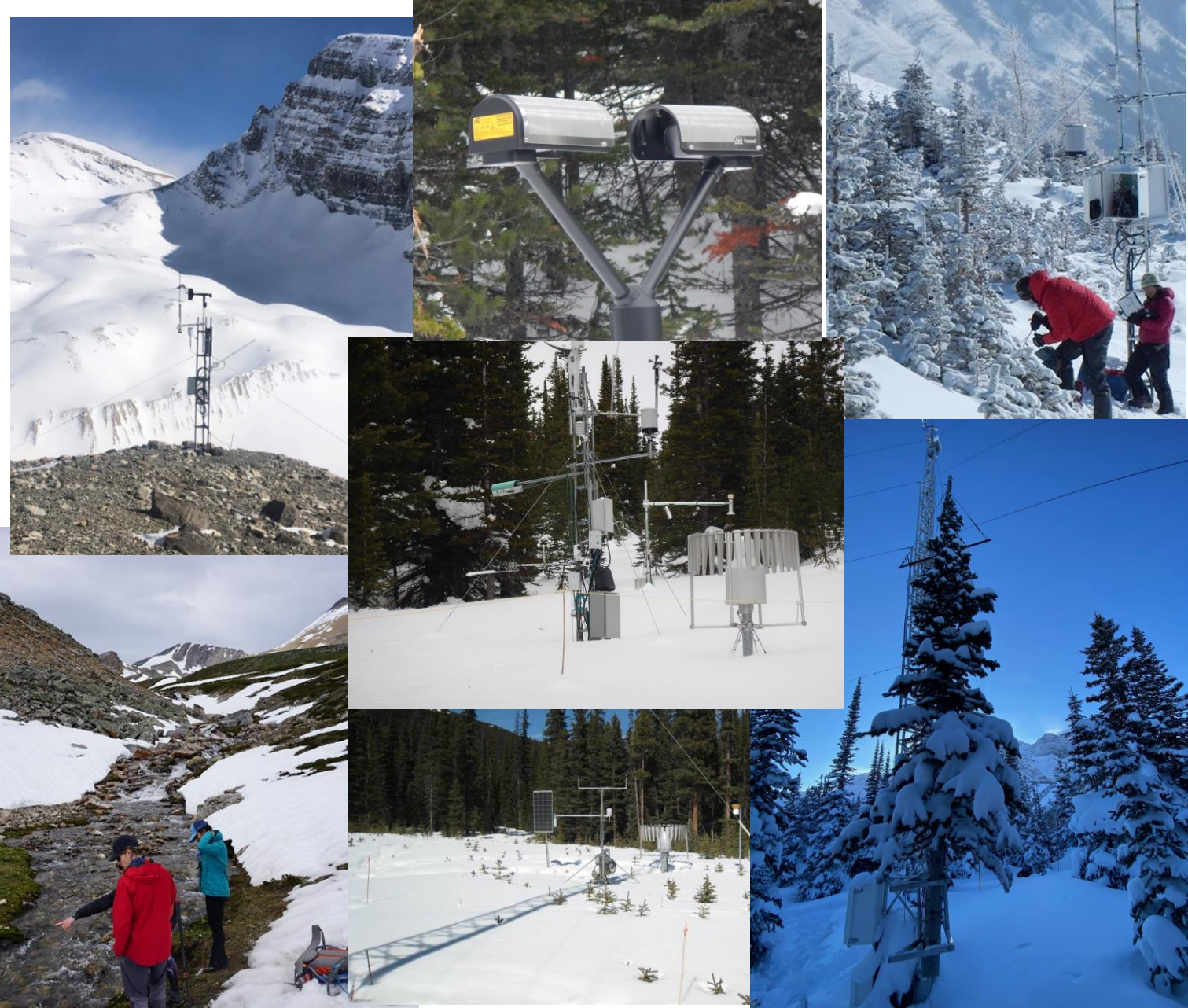
Centre for Hydrology,
University of Saskatchewan,
Canmore, Canada

Centre for Hydrology Coldwater Laboratory,
Canmore, Canada





CRHO Stations

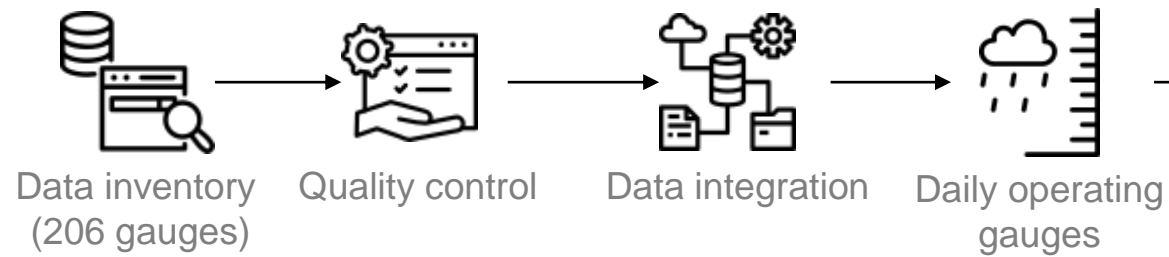


Precipitation Network Uncertainty

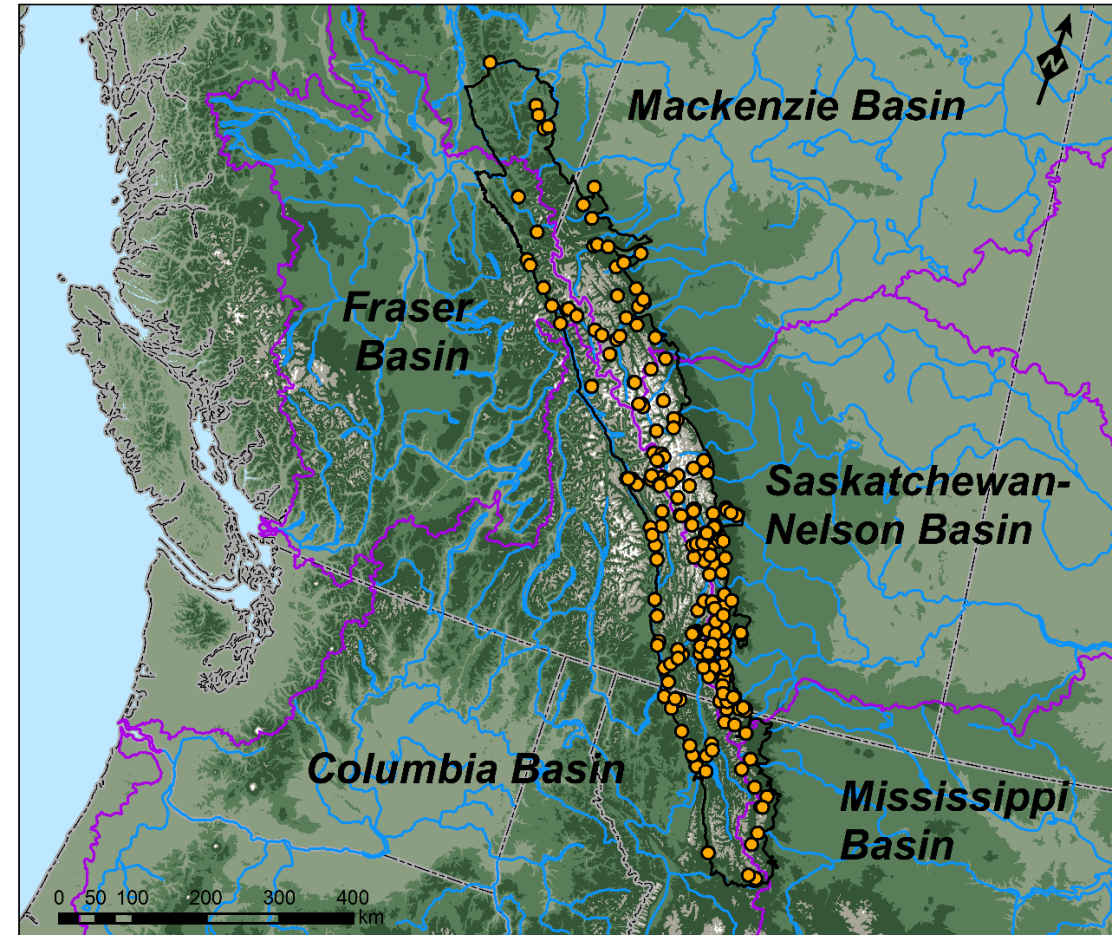
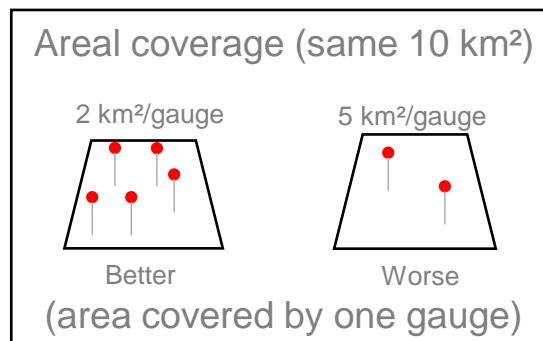
How many gauges are “enough”?

Kriging for horizontal extrapolation

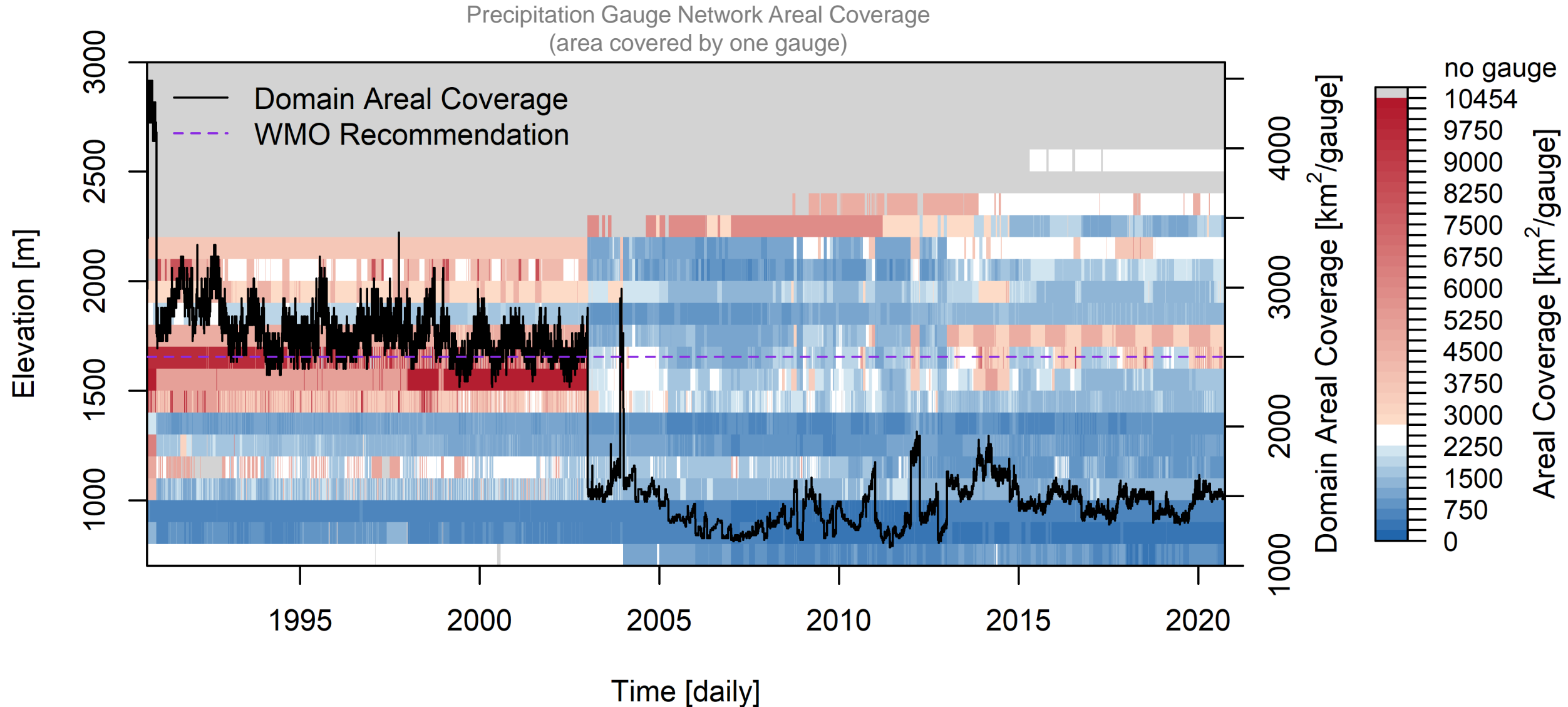
Lapse rates for vertical extrapolation



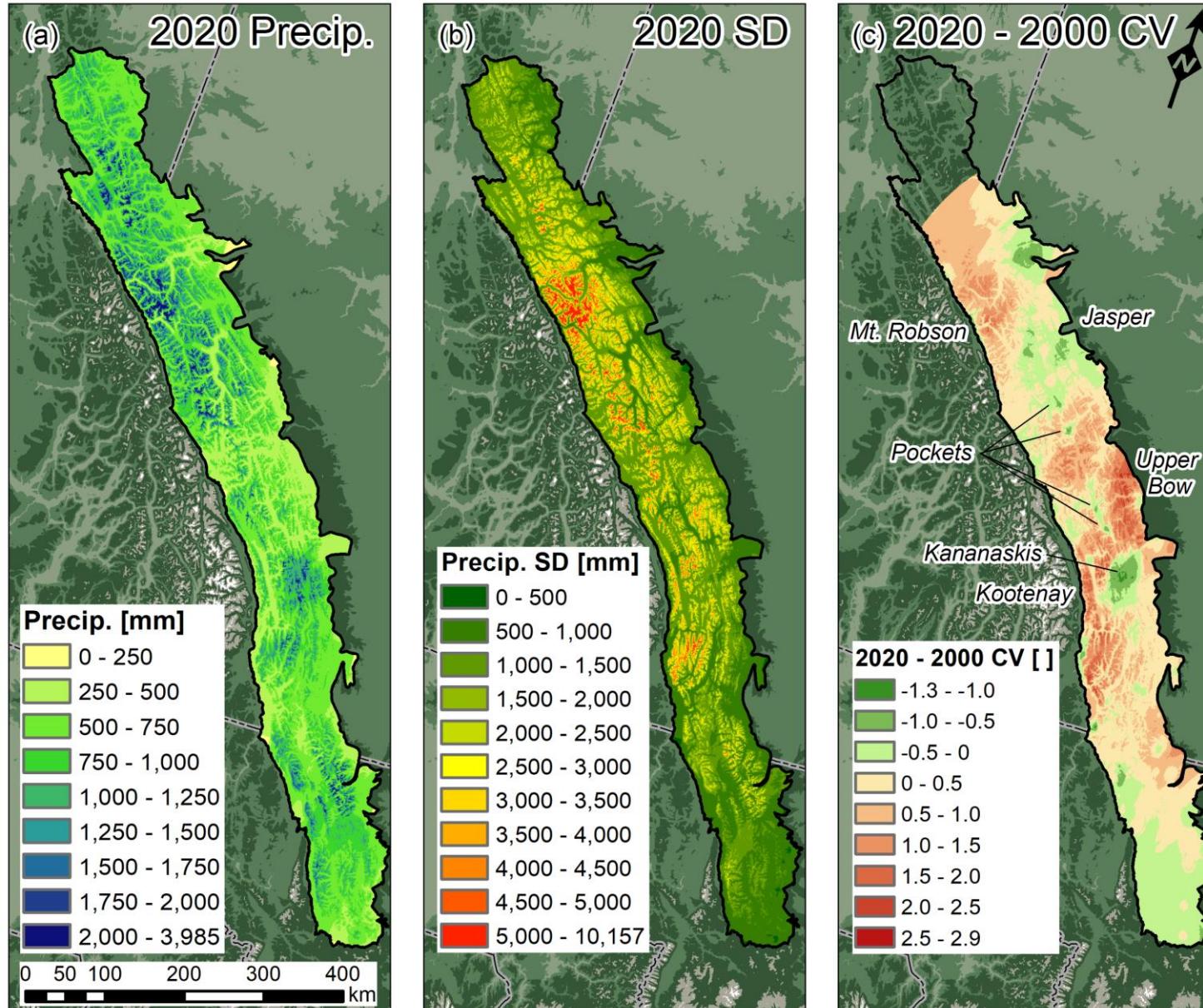
Example



Areal Coverage of Precipitation Gauges



Spatio-temporal and Elevational Precipitation Uncertainty



Uncertainty expressed as standard deviation and coefficient of variation of precipitation

CRHO establishment and increased gauge density in provincial networks has reduced uncertainty.

More high elevation gauges needed.

Andre Bertoncini

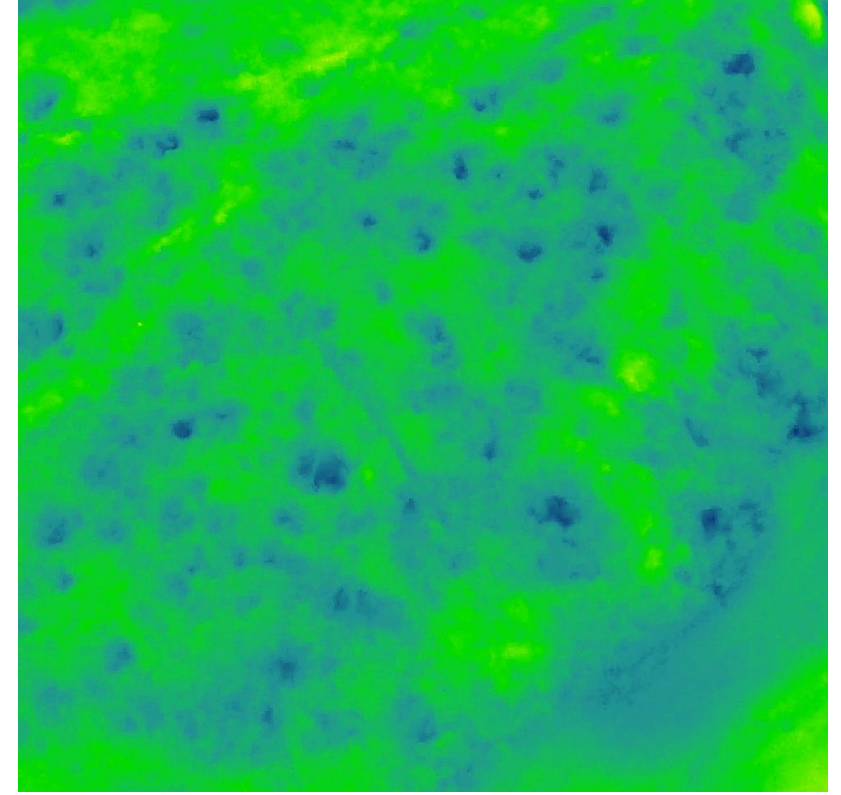
UAV-Lidar Snow Surveys in Marmot Creek



Alta-X mounted Reigl miniVUX-2 lidar used to collect surface elevation data over whole basin area



Raw lidar point cloud around Forest Ridge Tower and Hanging Tree

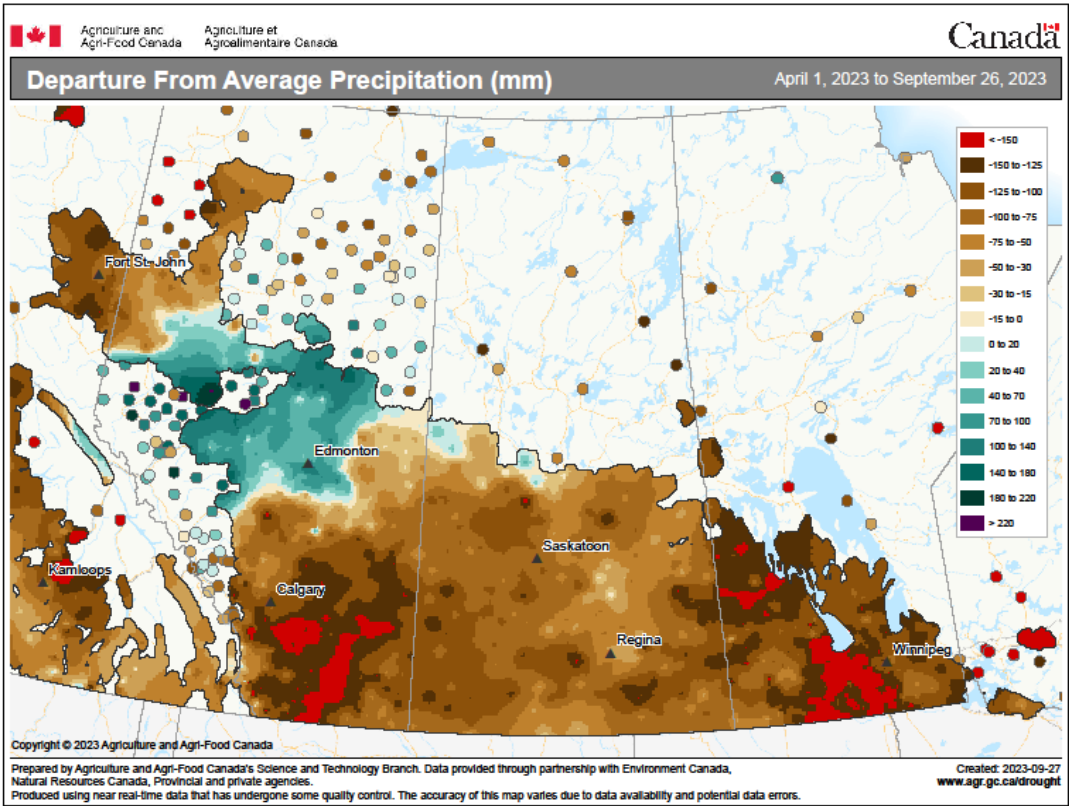


Surface model created from ground lidar returns, bare ground subtracted for snow depth mapping. Holes are tree wells.

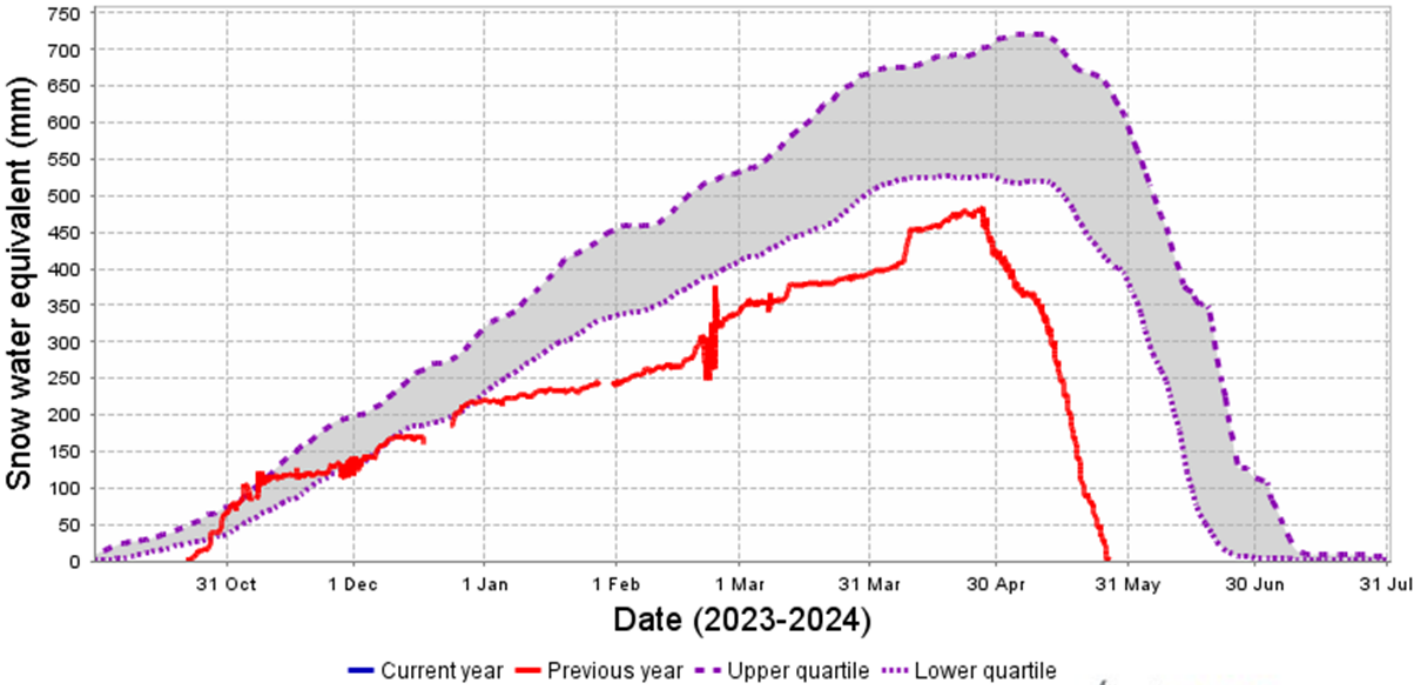
Bow River Basin – Drought of 2023

Snowpacks 150 mm below normal
Melt one month earlier than normal

Spring, summer precipitation ~100 mm below normal



Snow water equivalent for the current year (blue),
the previous year (red), and the normal range (grey)
for station 05BB803
Sunshine Village

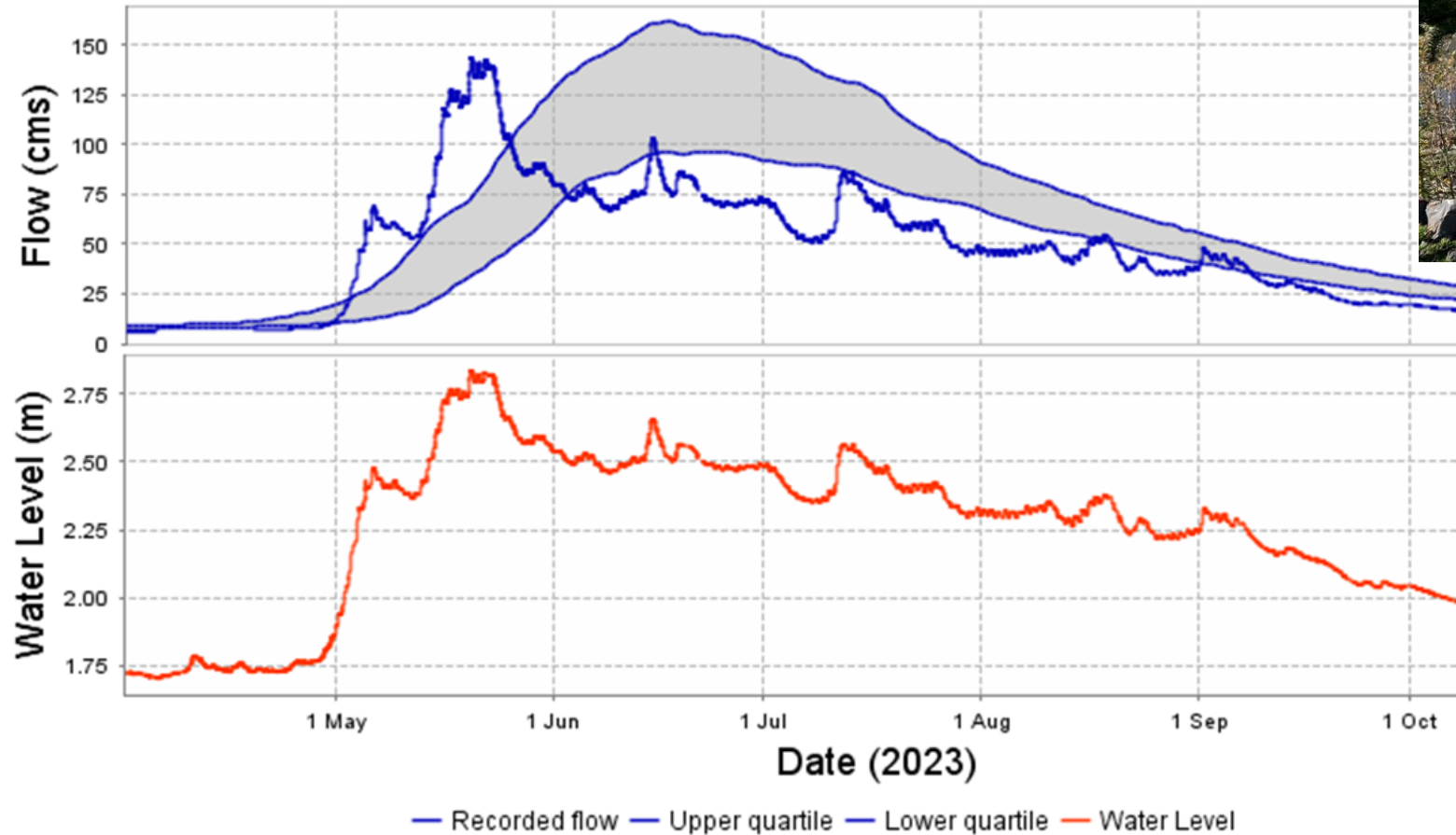


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Snowpacks depleted in research basins in mid May
Glacier melt started in early May at low elevations.

Hydrological Drought

Calculated flow (blue), normal flow range (grey),
and water level (red) for 05BB001
Bow River at Banff

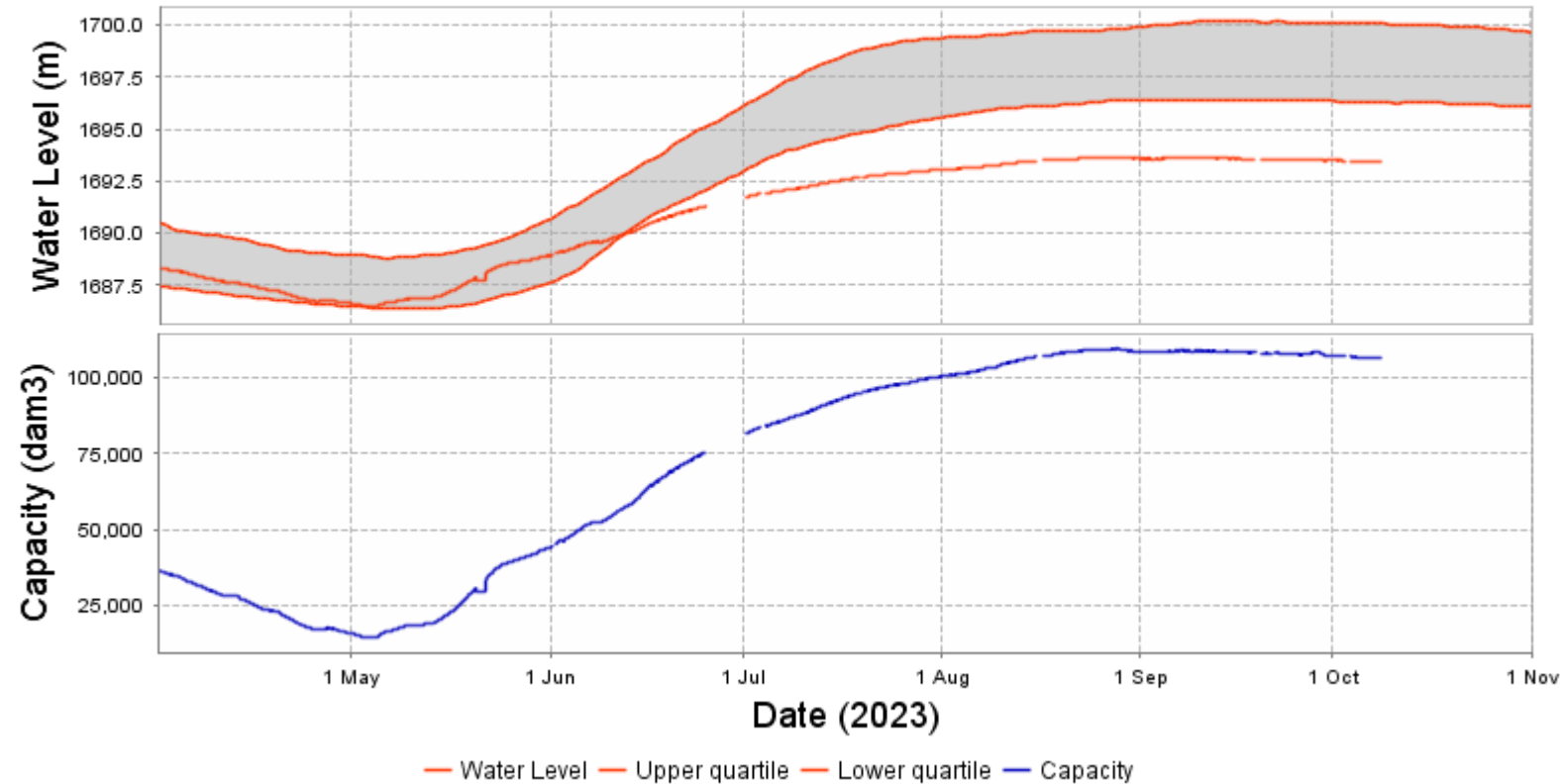


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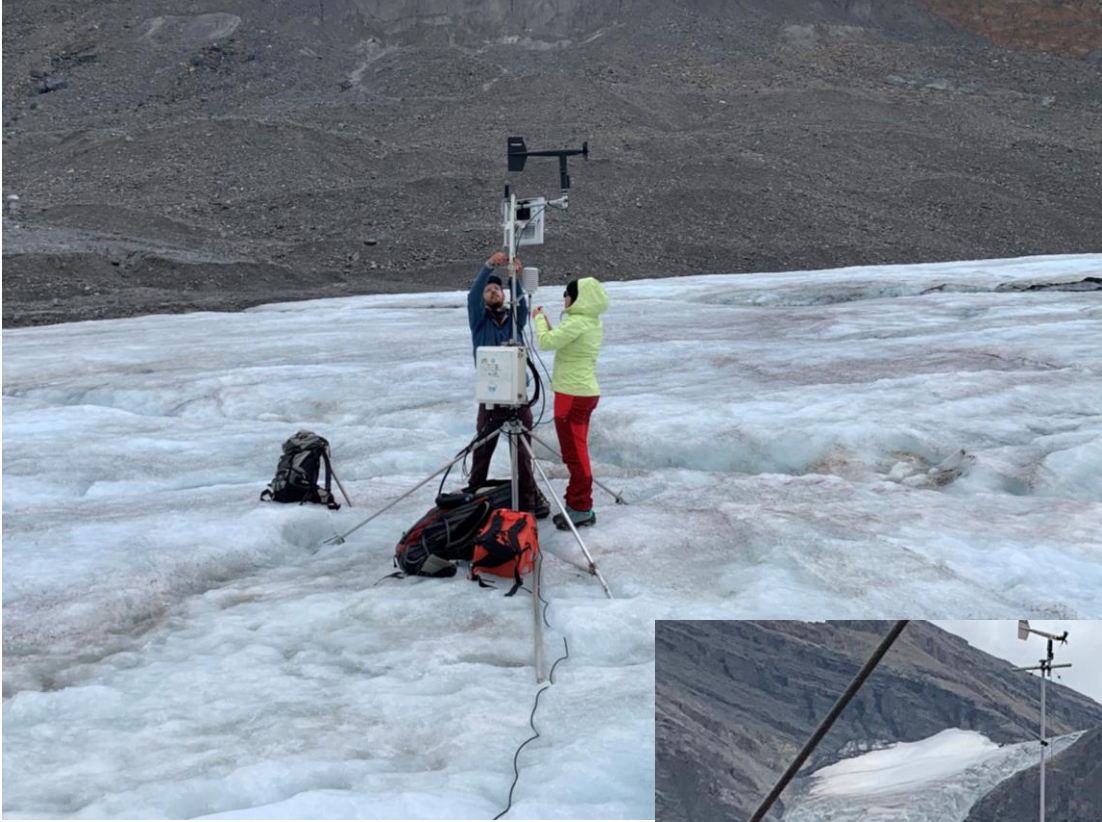
Hydrological Storage Drought

Water level (red), normal level range (grey)
and reservoir capacity (blue) for 05BC006
Spray Reservoir at Three Sisters Dam TAU

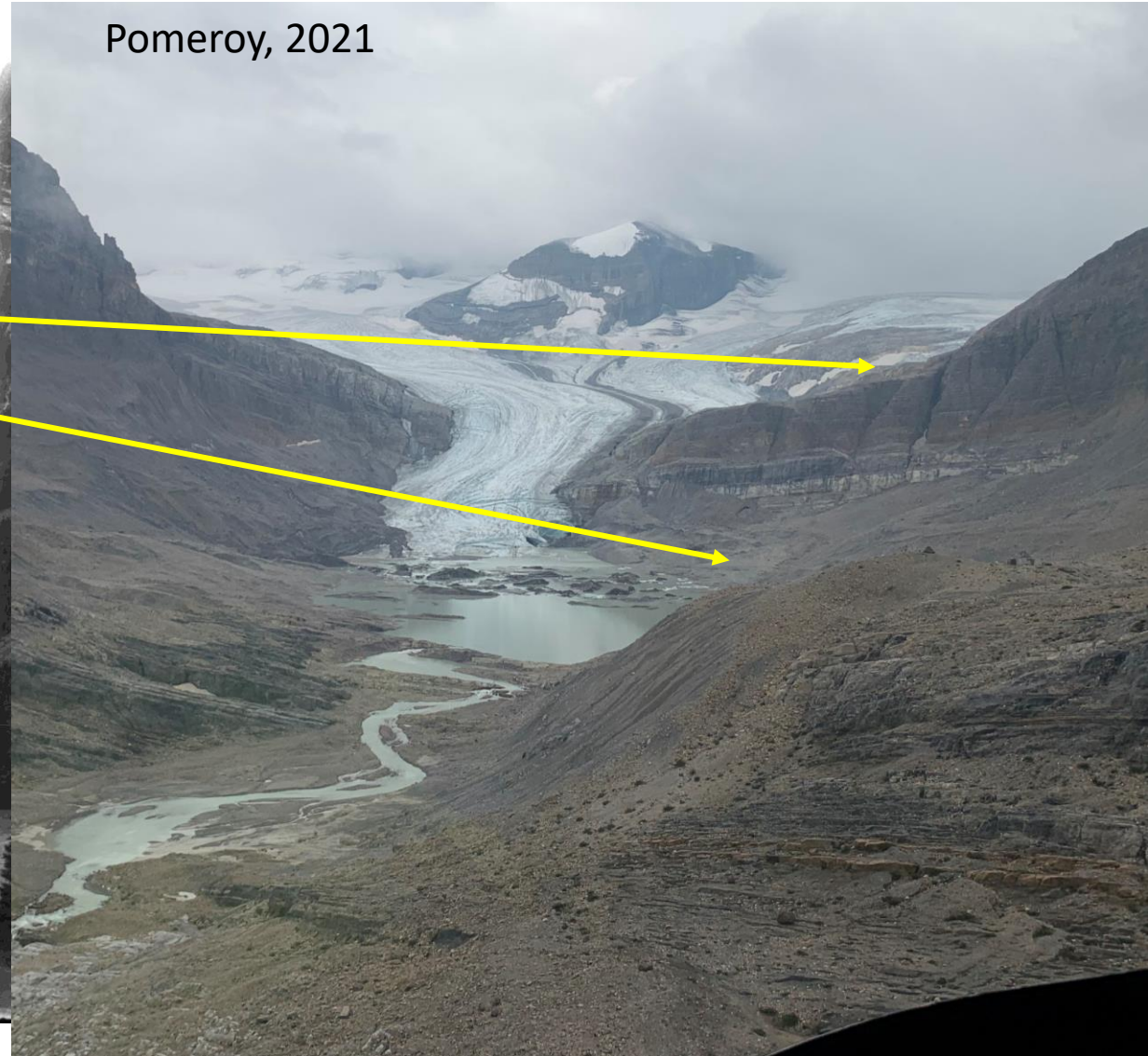
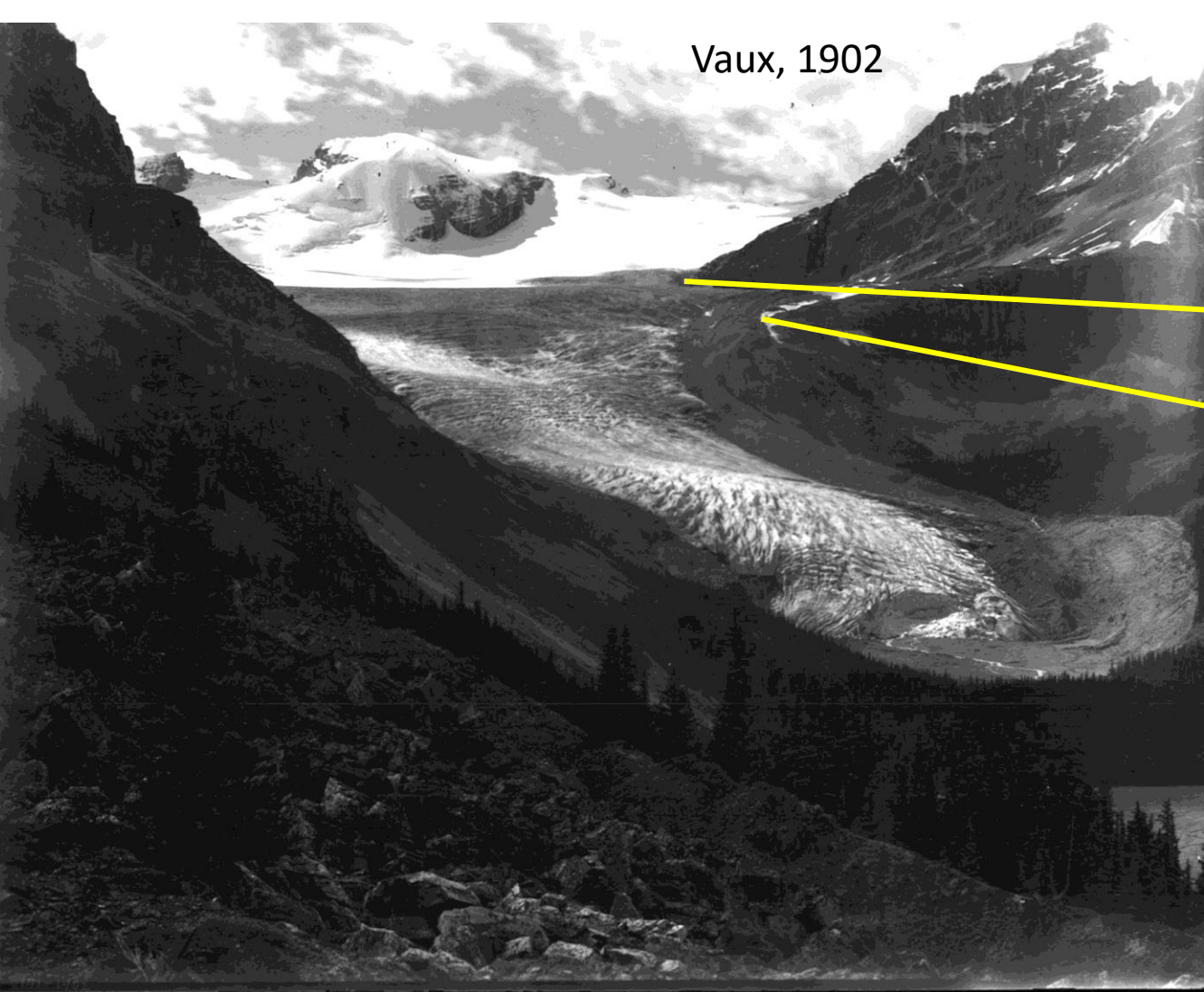


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Peyto Glacier Retreat to 2021



Peyto Glacier 2008 to 2023



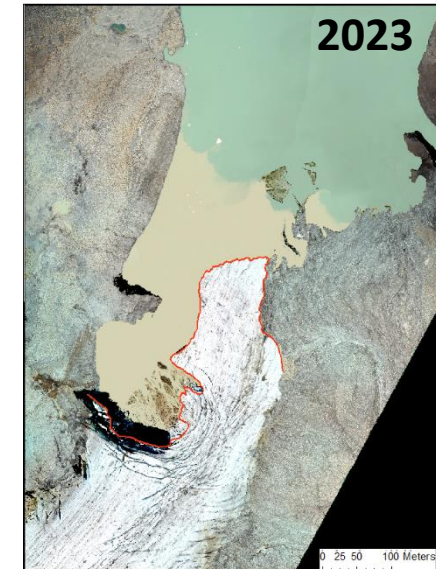
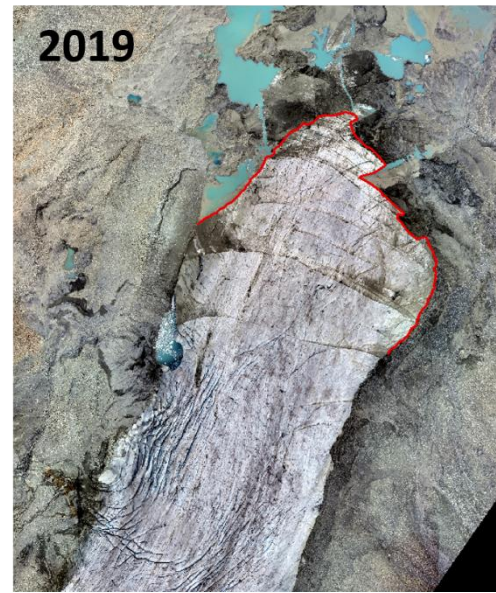
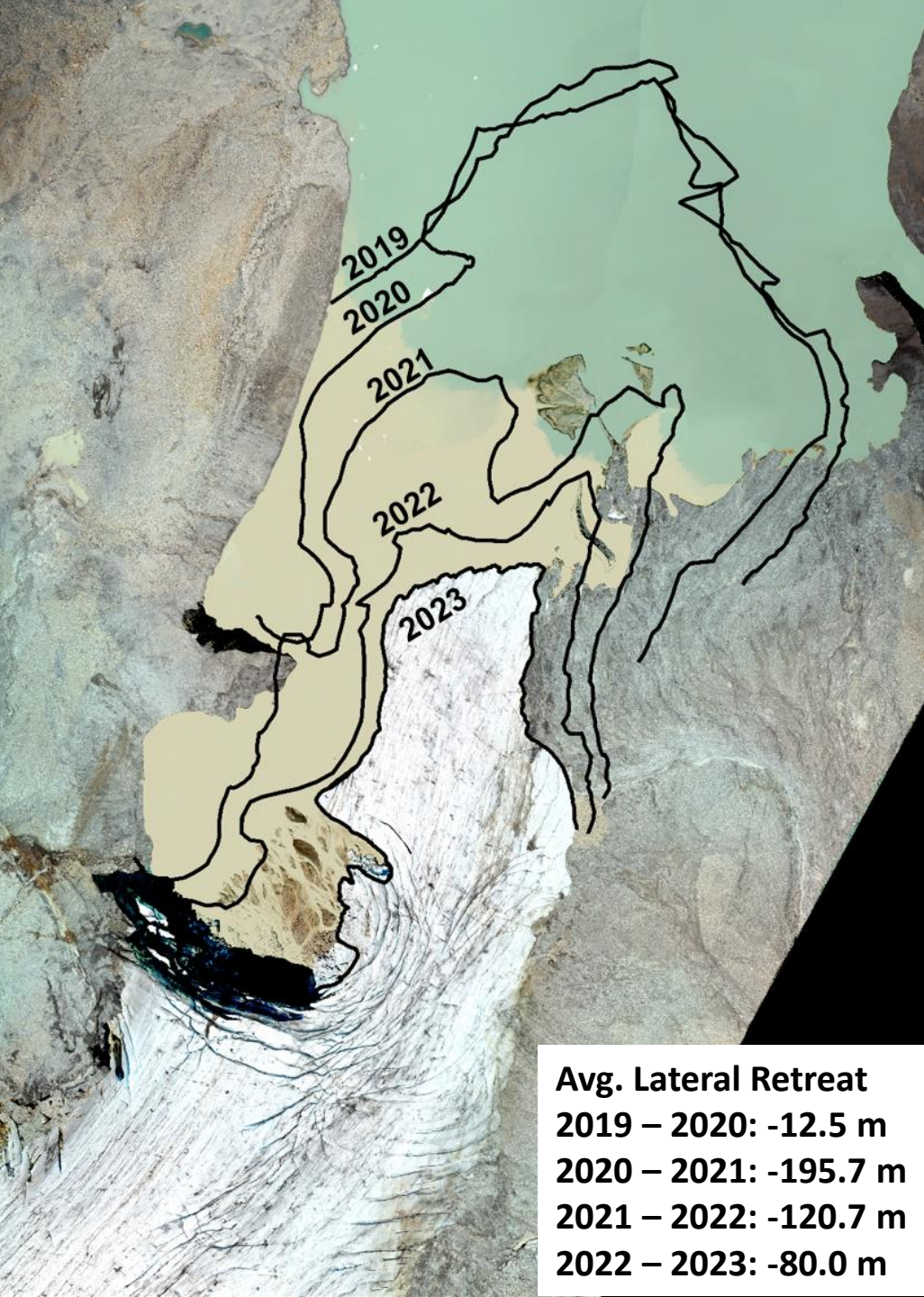
August 2008



August 2023

UAV LiDAR Glacier Surveys

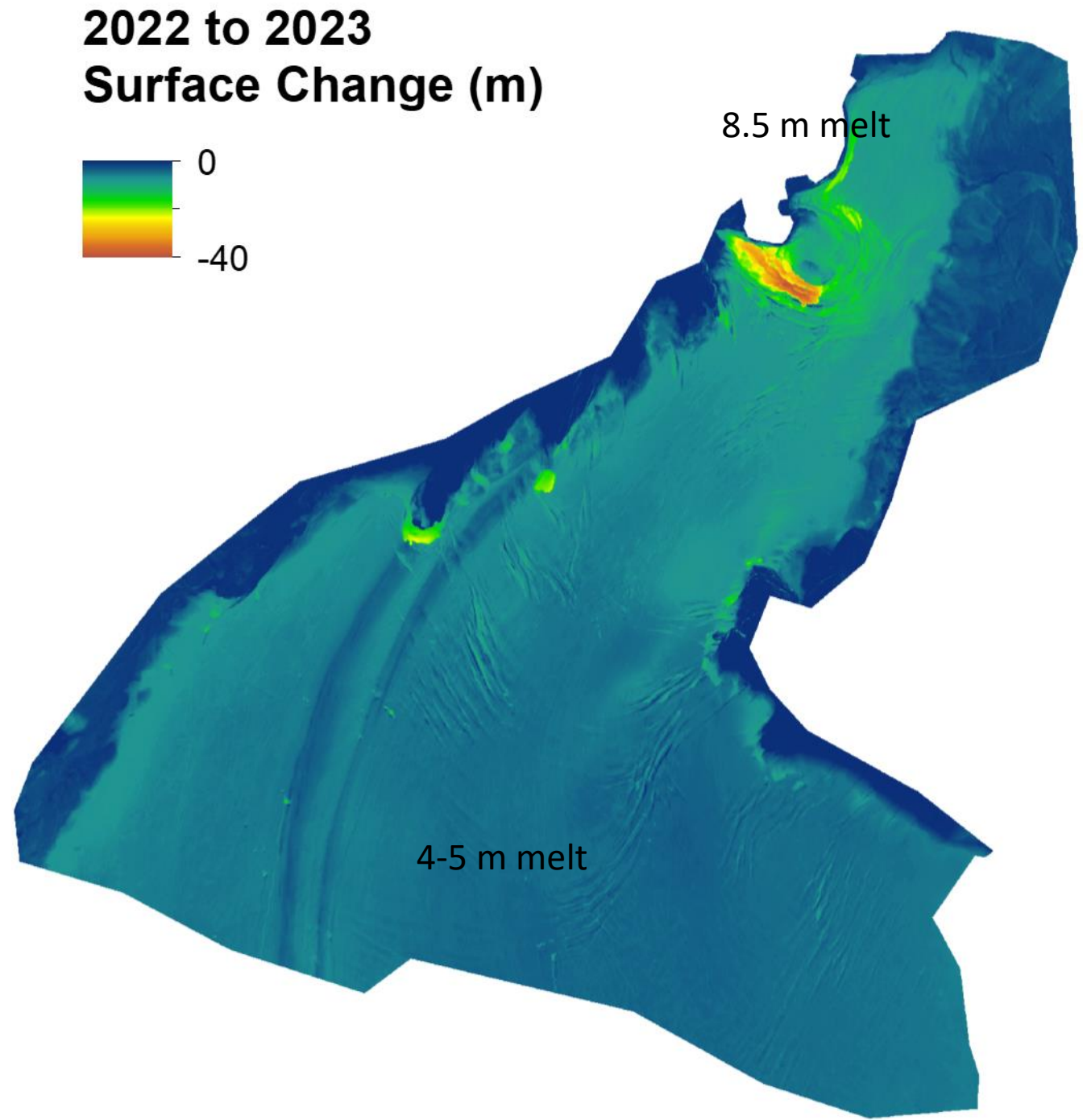
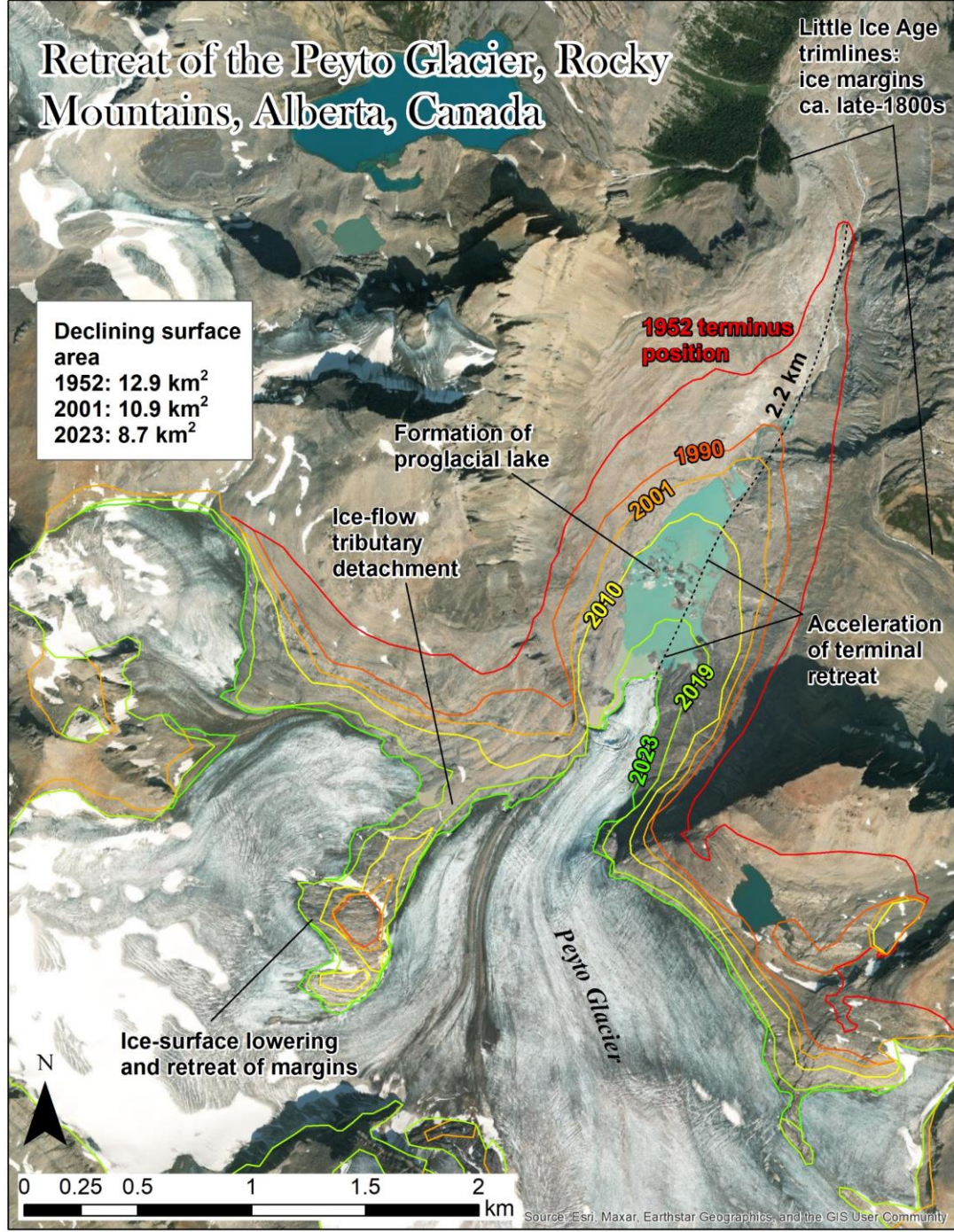




Extent of Peyto glacier toe from
 2019 – 2023, overlain over aerial
 photography of Peyto taken in 2023

Definition of Peyto glacier toe
 for each year from 2019 - 2023

Harasyn and Harder



Athabasca Glacier 1980 to 2023



October 1980

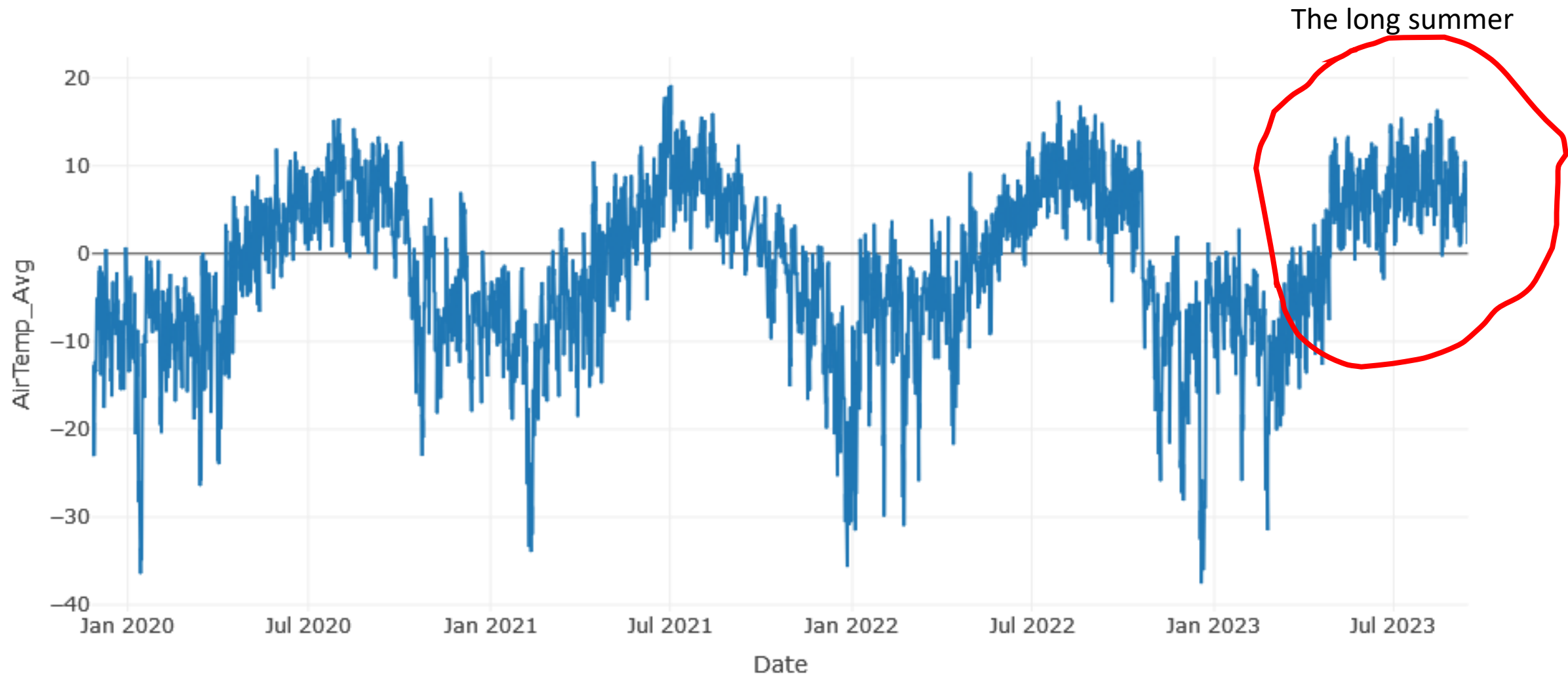


August 2023

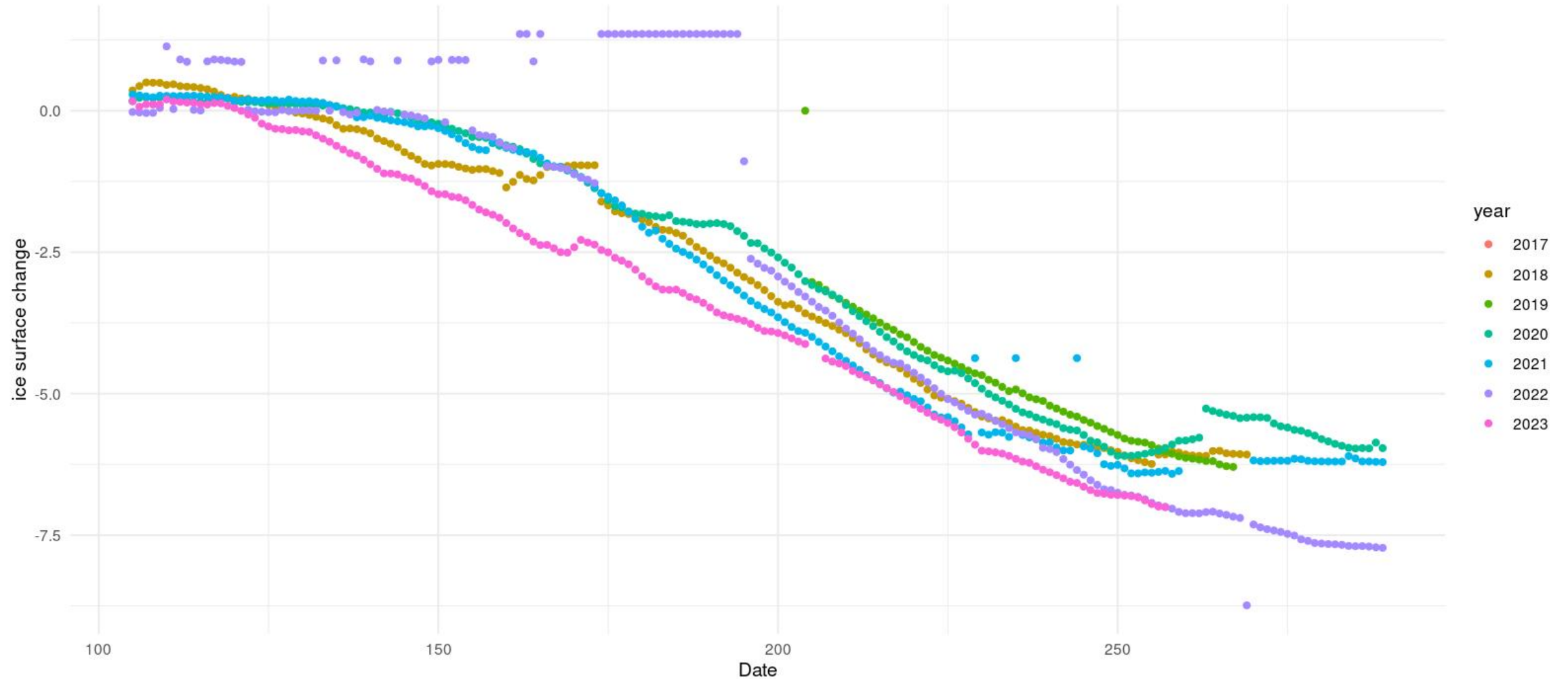
Athabasca Glacier – recent changes



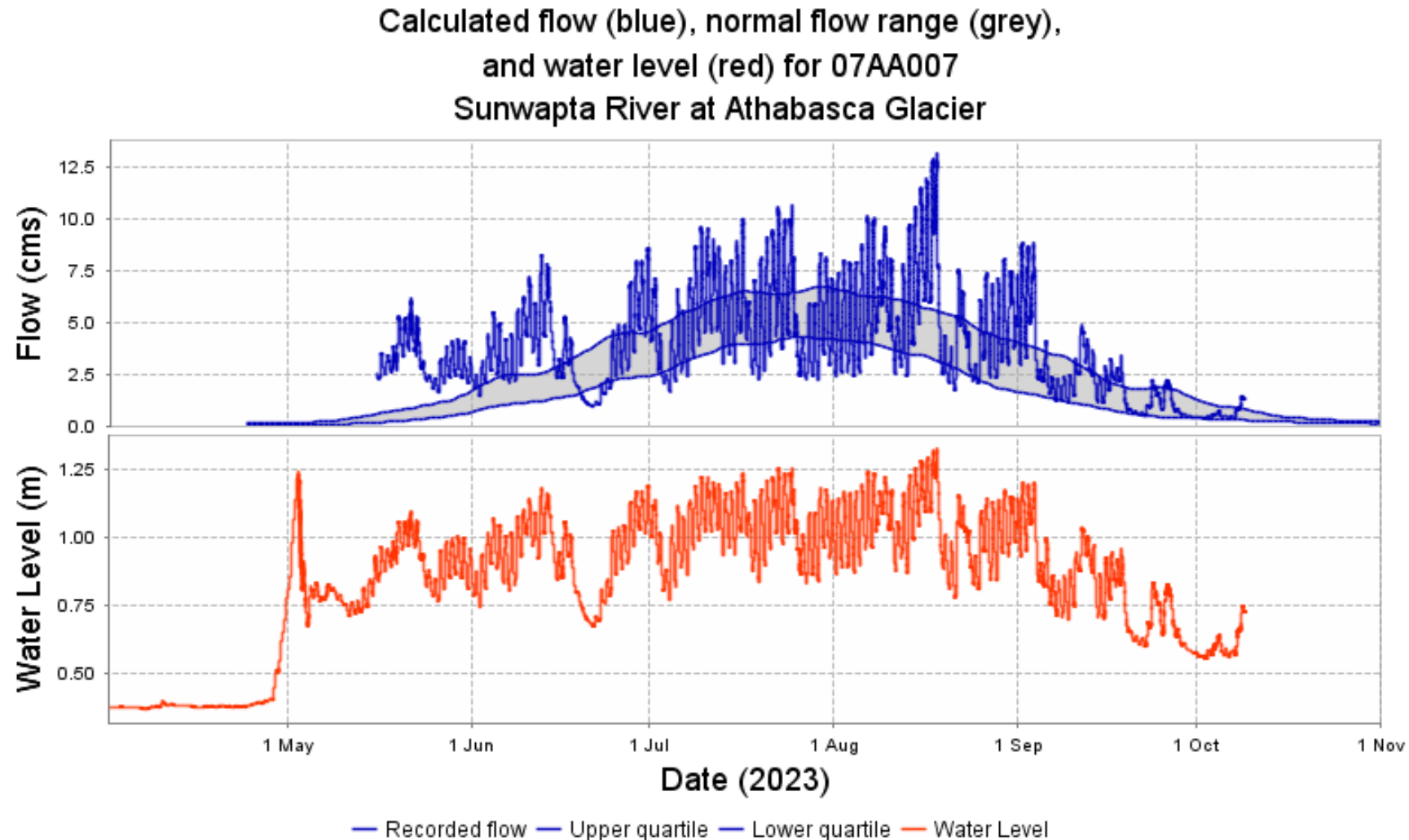
Recent Athabasca on-ice Air Temperatures



Athabasca Glacier Ice Melt

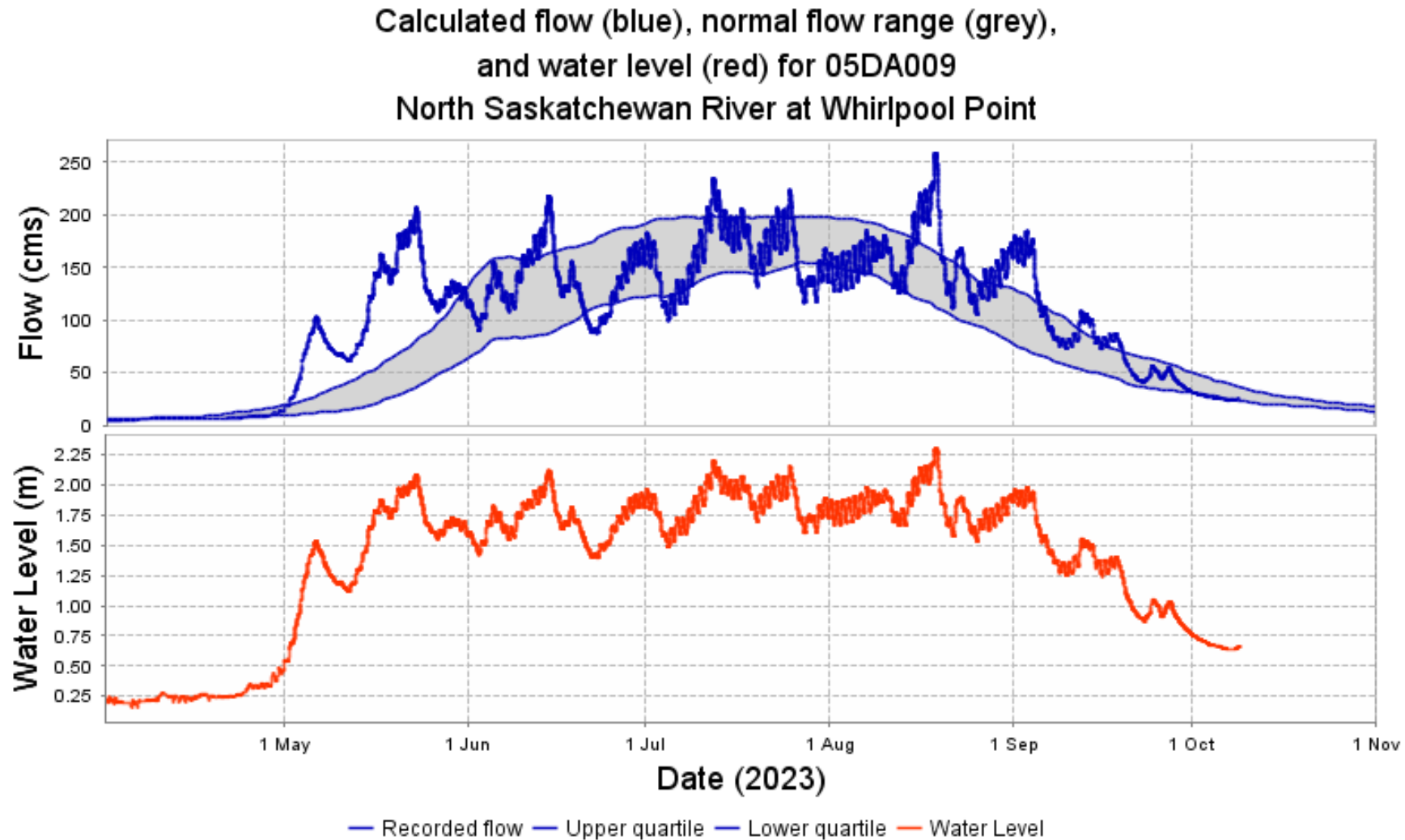


Glacier Streamflow Regime in Drought



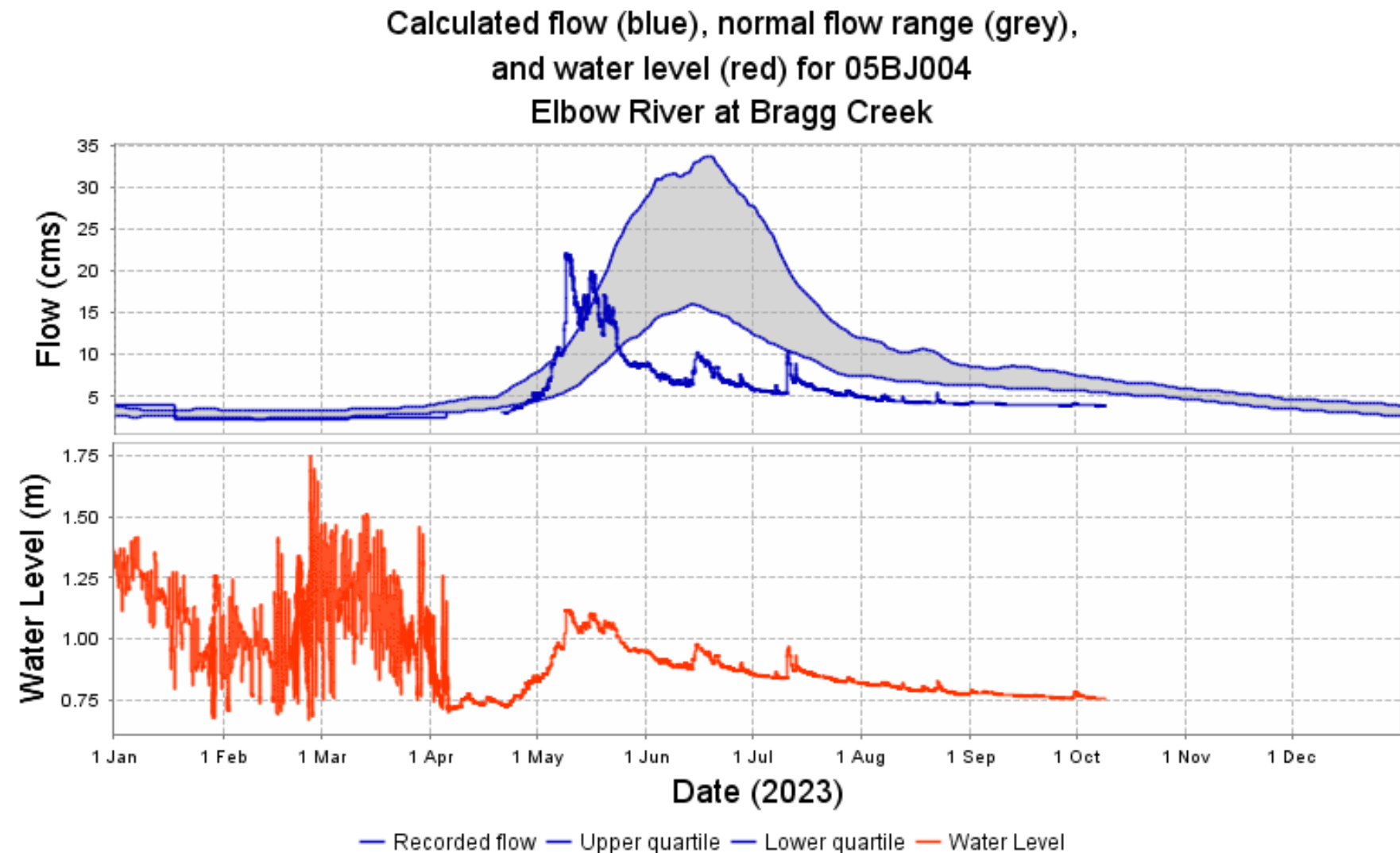
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Glacier Influenced Streamflow Regime in Drought

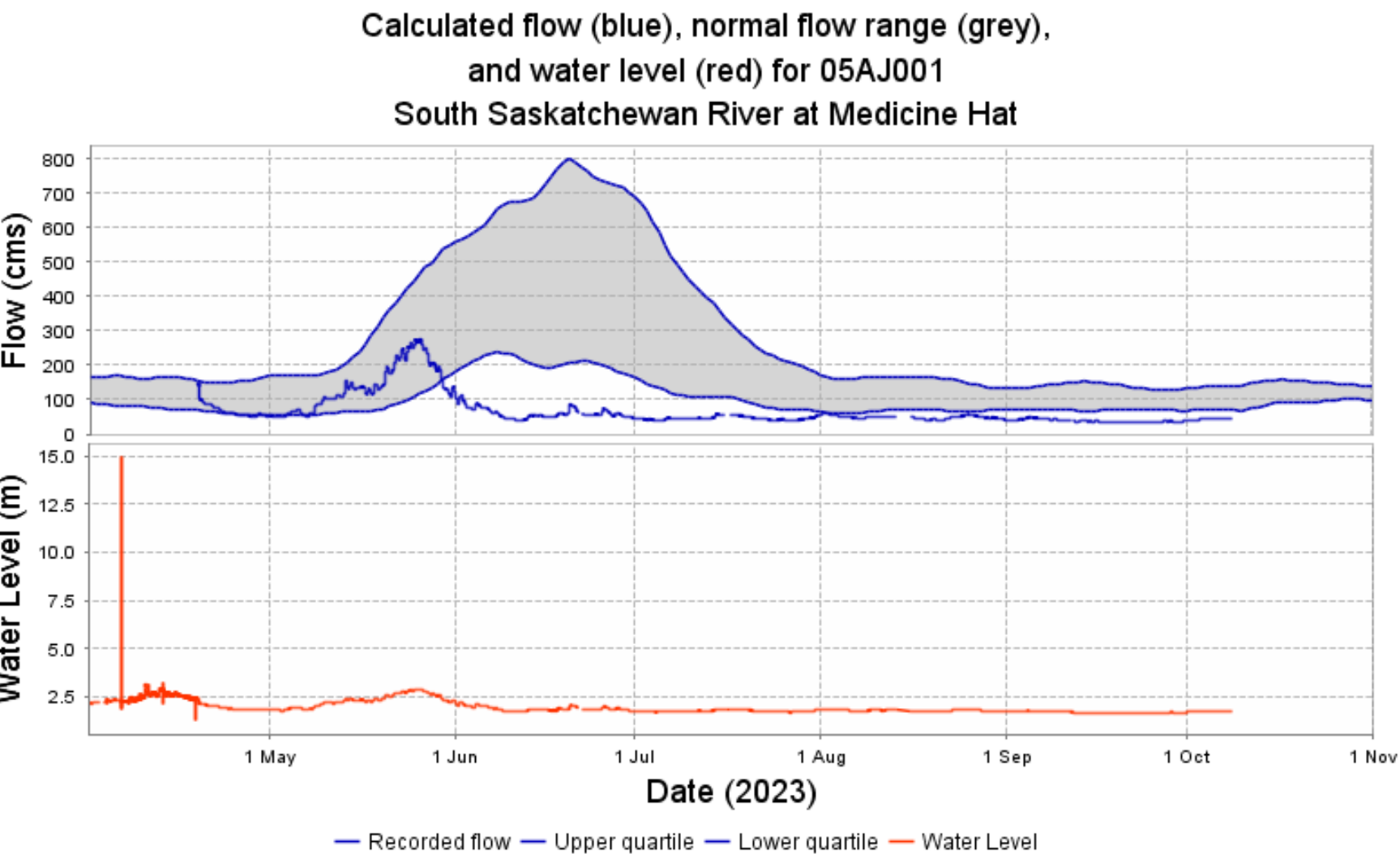


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Nival Streamflow Regime in Drought



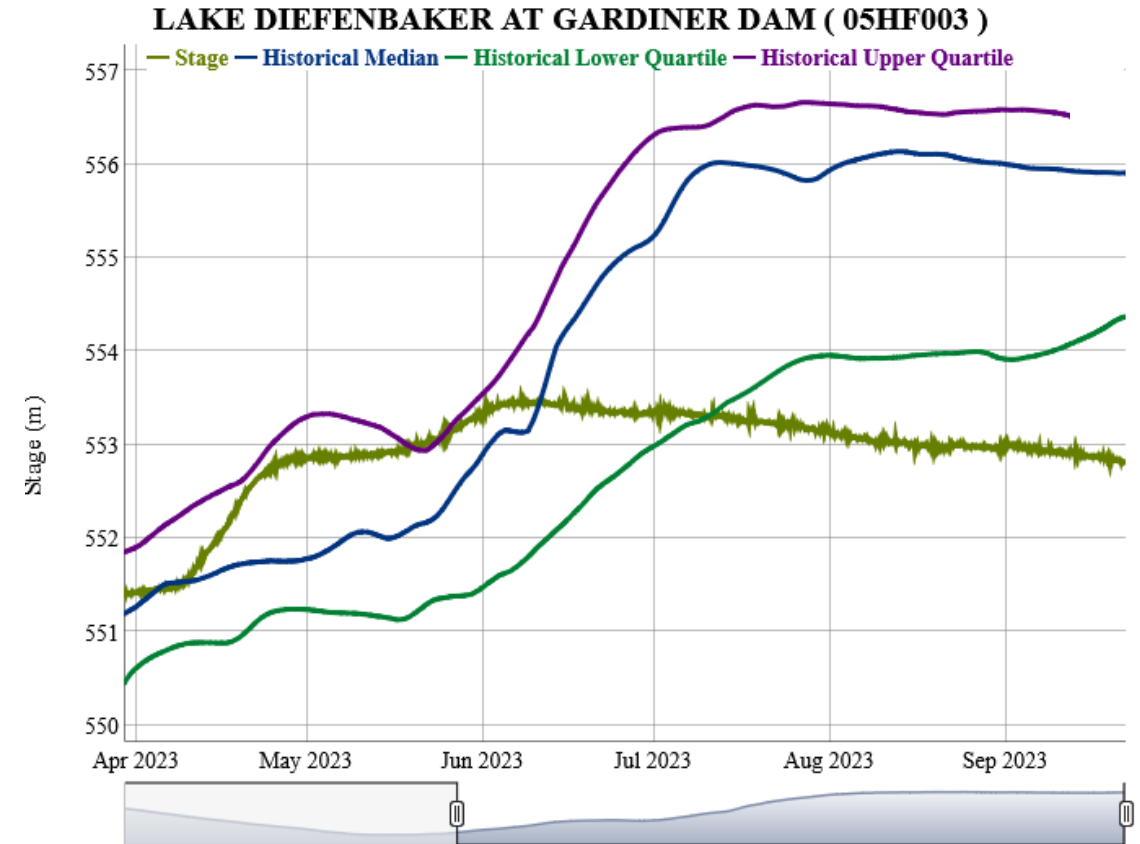
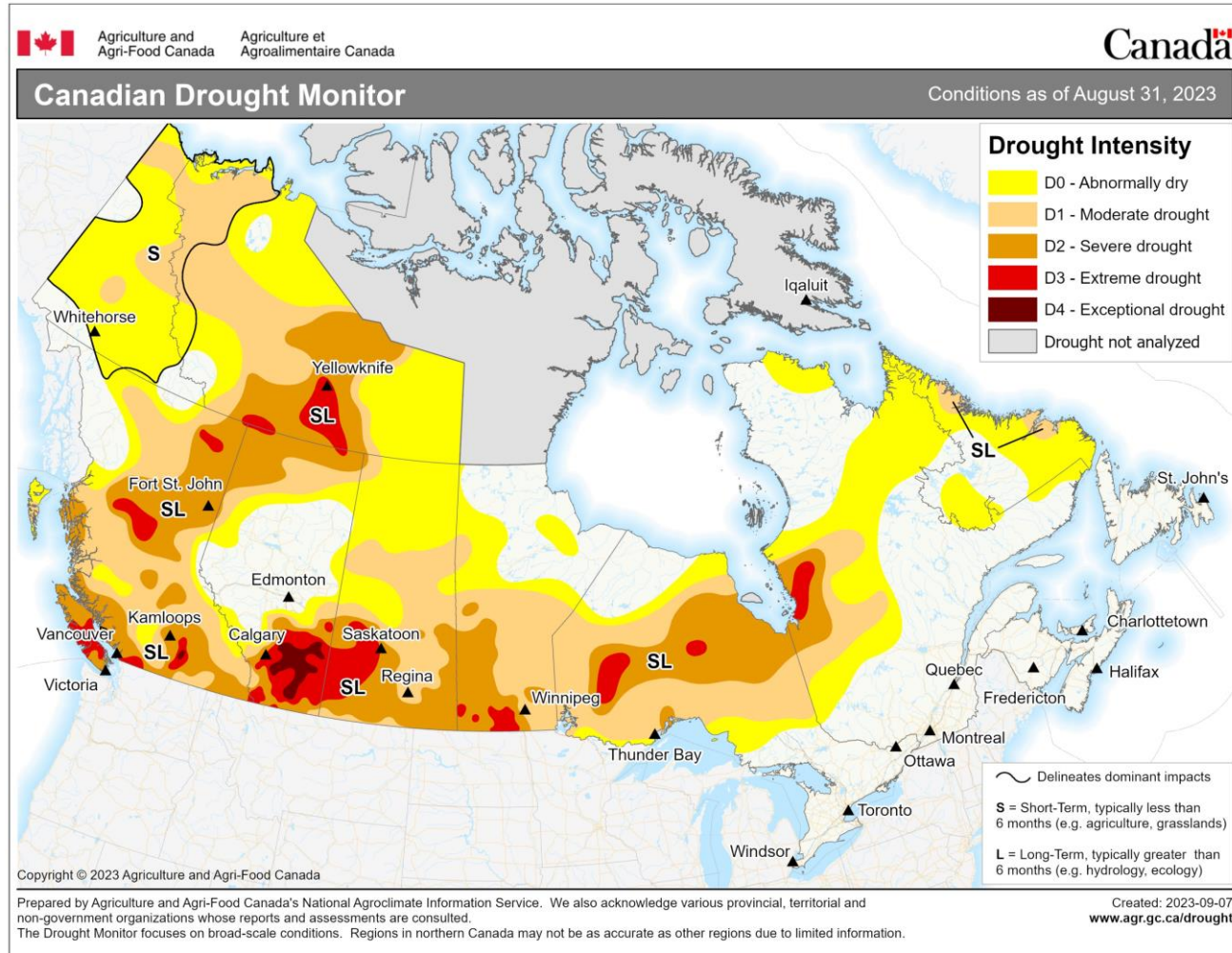
Hydrological and Agricultural Drought Downstream



Downstream Impacts

LAKE DIEFENBAKER AT GARDINER DAM

Close x



Fish death, irrigation closures and restrictions, municipal use restrictions, reduced hydroelectricity, reduced effluent dilution

Data Publications

- Fang X., Pomeroy J.W., DeBeer C.M., Harder P. and Siemens E., (2019), Hydrometeorological data from Marmot Creek Research Basin, Canadian Rockies., Earth System Science Data, 11 , 455:471, doi: 10.5194/essd-11-455-2019
- Pradhananga D., Pomeroy J.W., Aubry-Wake C., Munro S., Shea J., Demuth M.N., Kirat N.H., Menounos B. and Mukherjee K., (2021), Hydrometeorological, glaciological and geospatial research data from the Peyto Glacier Research Basin in the Canadian Rockies., Earth System Science Data, 13 , 2875:2894, doi: 10.5194/essd-13-2875-202
- Rasouli K., Pomeroy J.W., Janowicz J.R., Williams, T.J. and Carey S.K. , (2019), A long-term hydrometeorological dataset (1993-2014) of a northern mountain basin: Wolf Creek Research Basin, Yukon Territory, Canada., Earth System Science Data, 11 , 89:100, doi: 10.5194/essd-11-89-2019

<https://research-groups.usask.ca/hydrology/data.php>