

Centre for Hydrology Coldwater Laboratory,
Canmore, Canada



GWFO's Canadian Rockies Hydrological Observatory: Status, Observations and Findings

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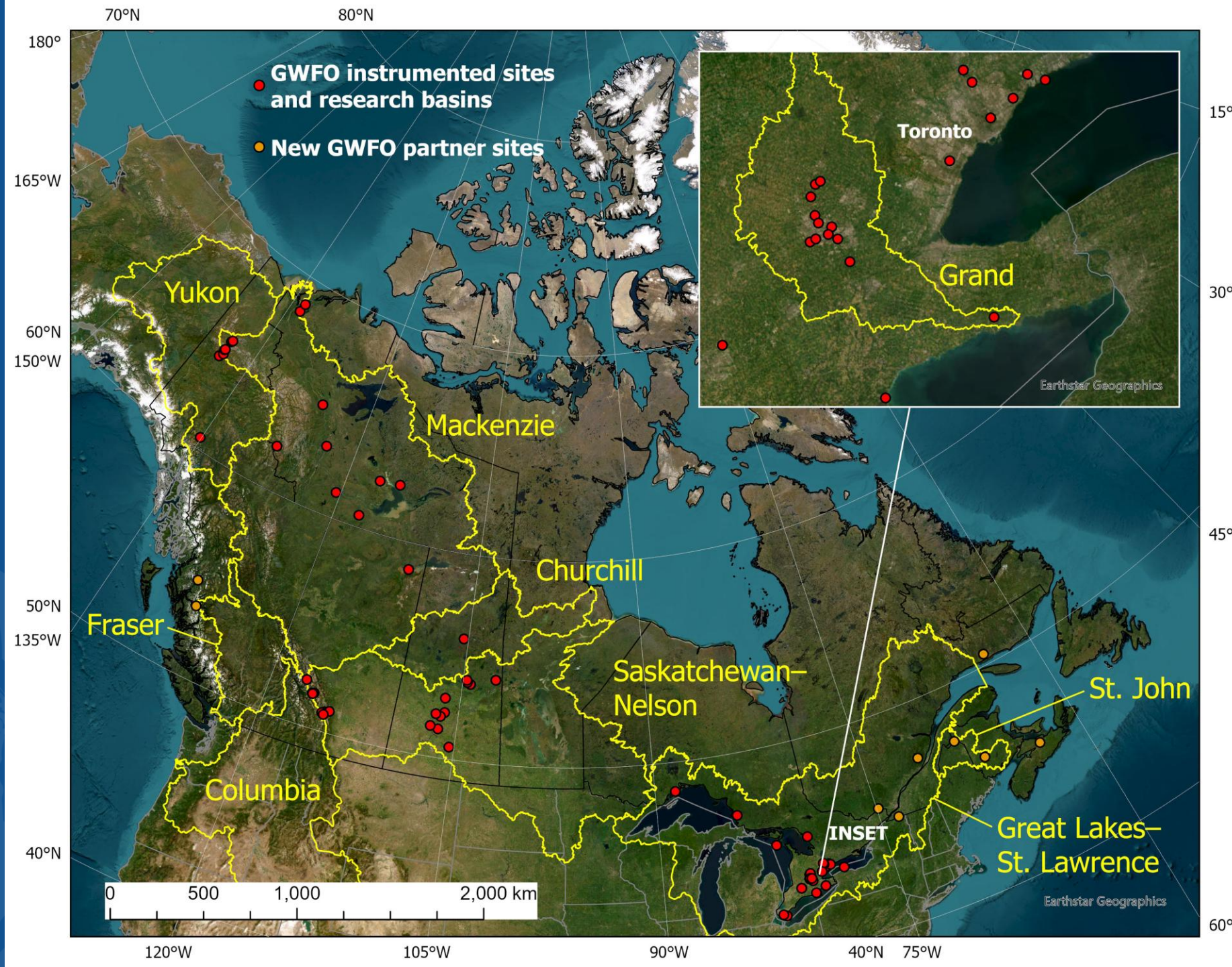


Global Water Futures Observatories

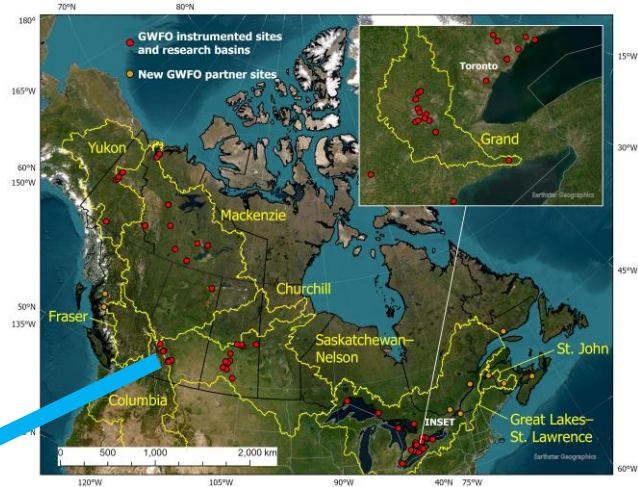
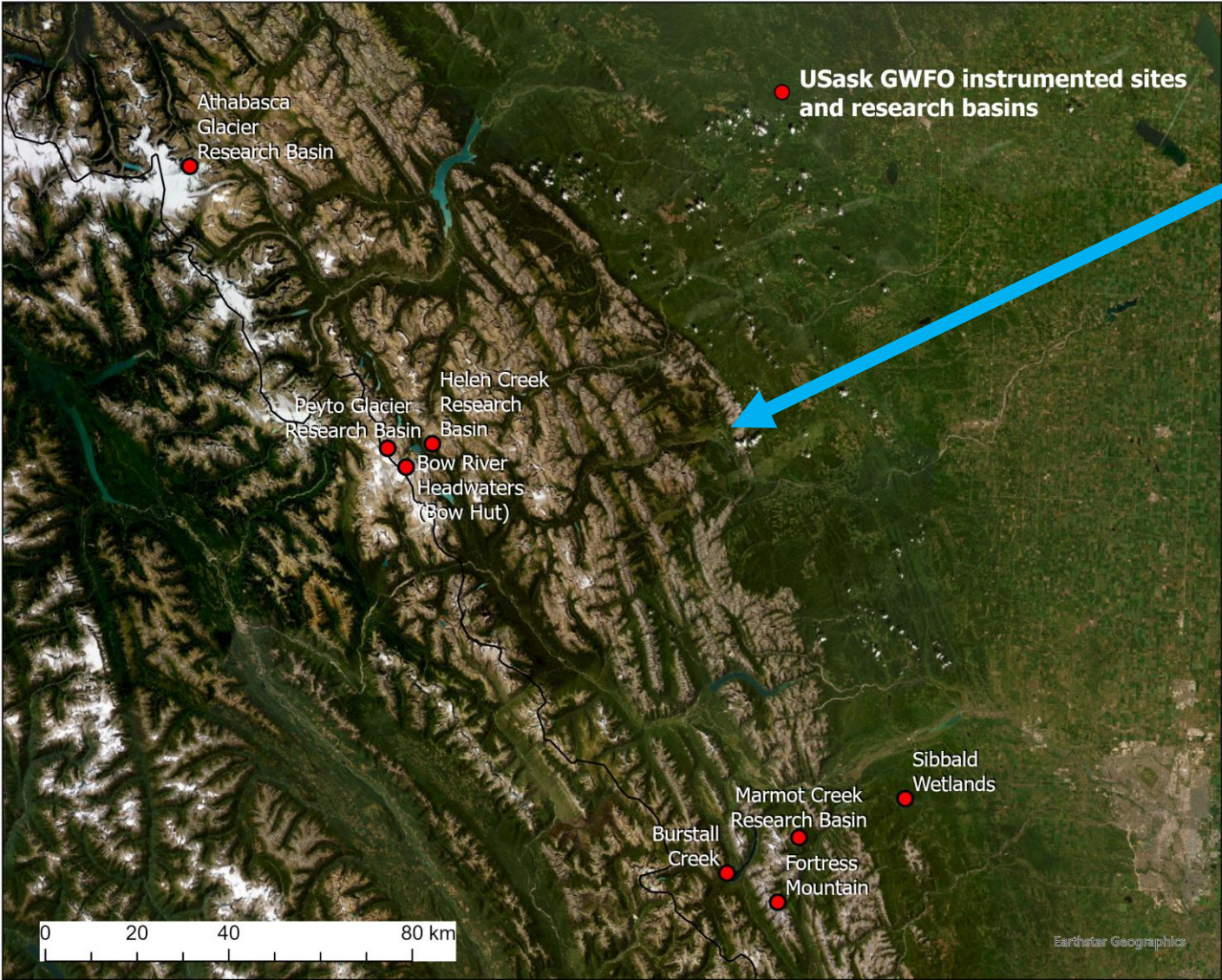
<https://gwfo.ca/>

Great Lakes
Saint Lawrence
Maritimes
Prairies
Western Cordillera
North

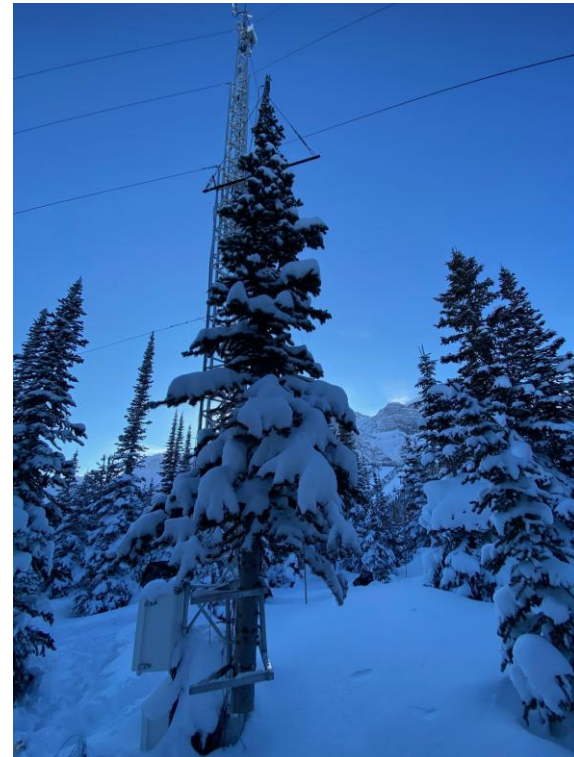
\$75 M Infrastructure
8 major river basins
49.25 HQP



GWFO's Canadian Rockies Hydrological Observatory



Canadian Rockies Hydrological Observatory



Fortress Ridge 2025



State of the Observatory – Fortress Ridge

Nov 2025



Dec 2025



August 2026



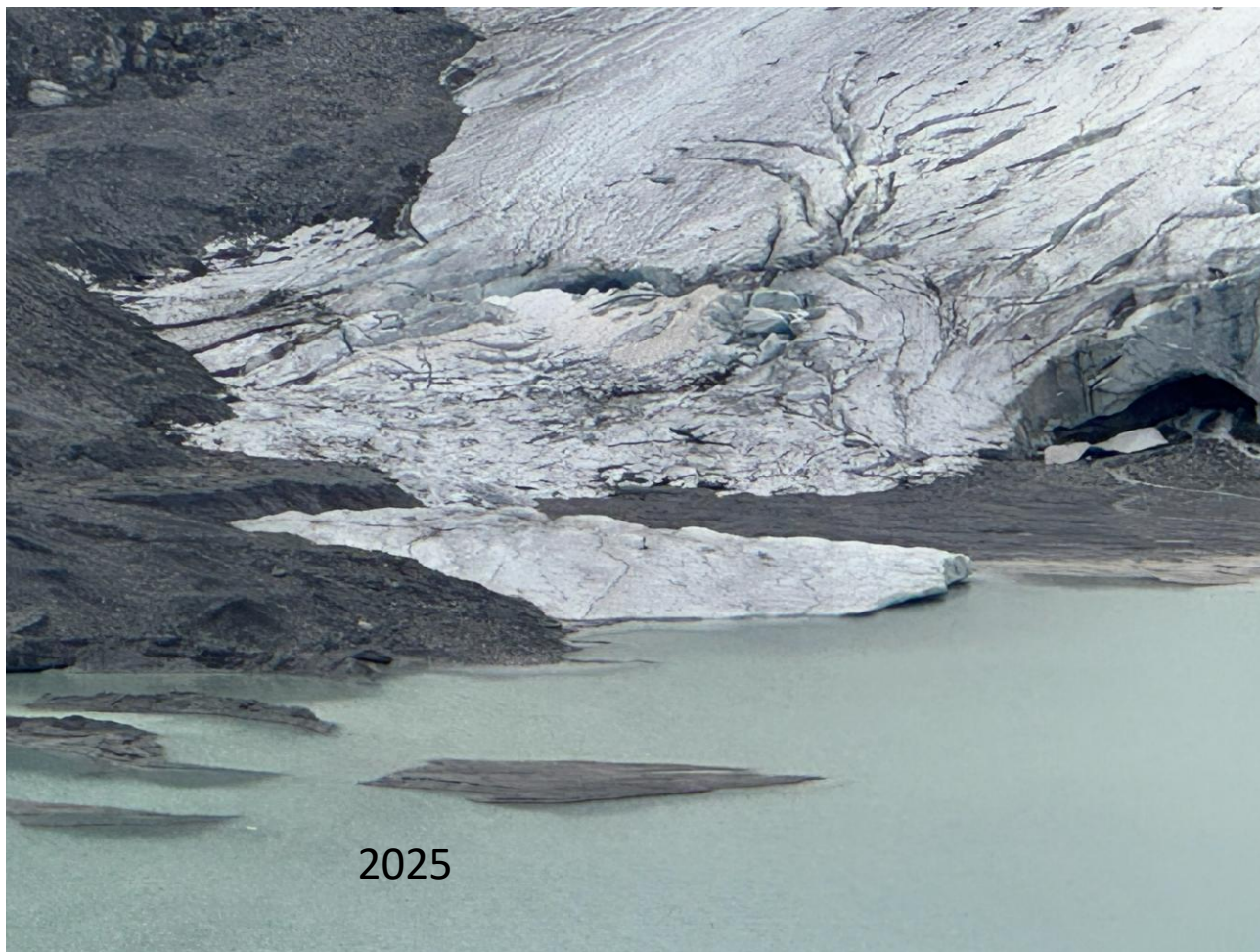
Dec 2025



May 2026

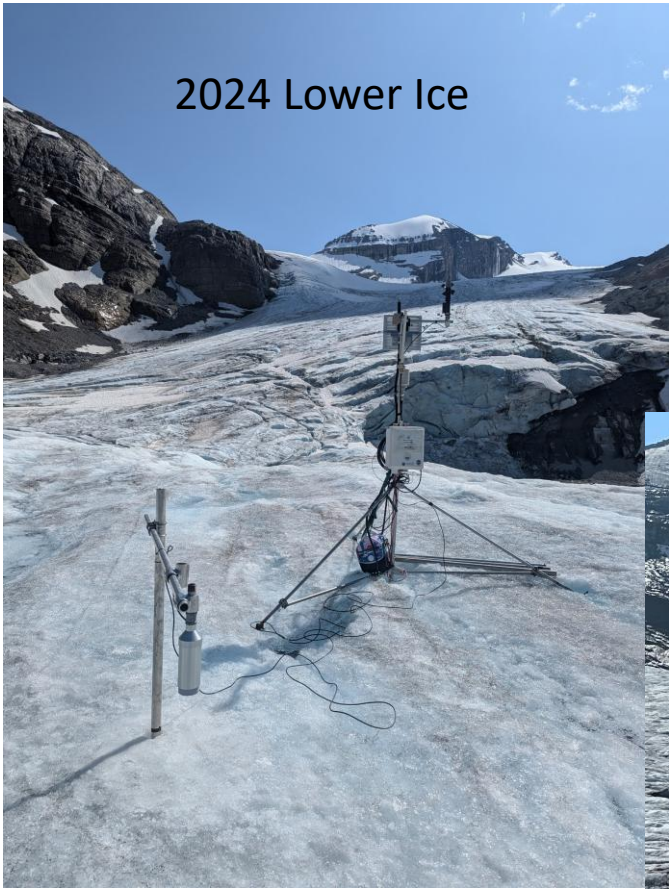


State of the Observatory – Peyto Glacier



Peyto Glacier Stations

2024 Lower Ice



2025 Lower Ice



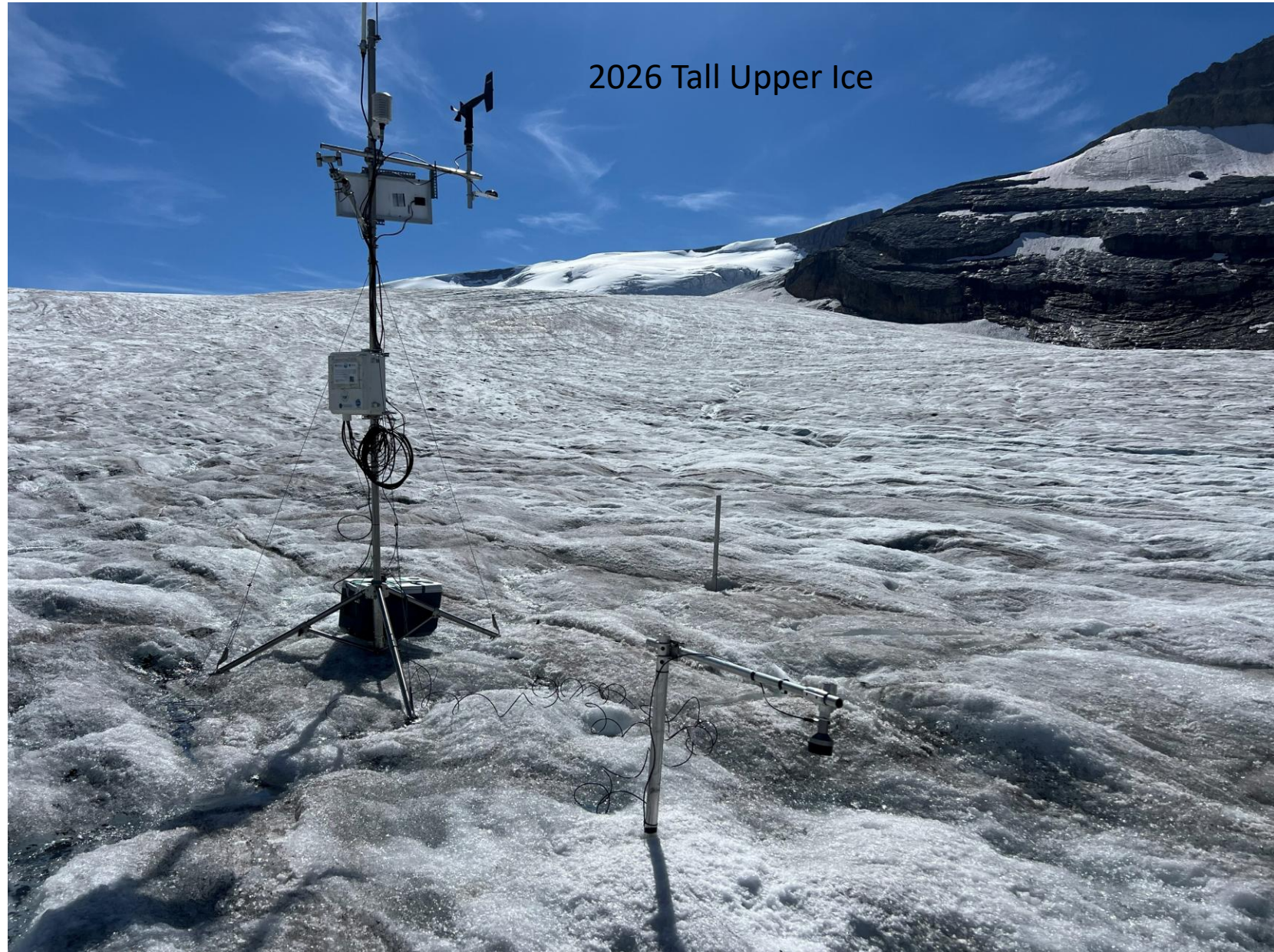
2026 Winter Upper Ice



2025
Upper Ice



Peyto Glacier Stations



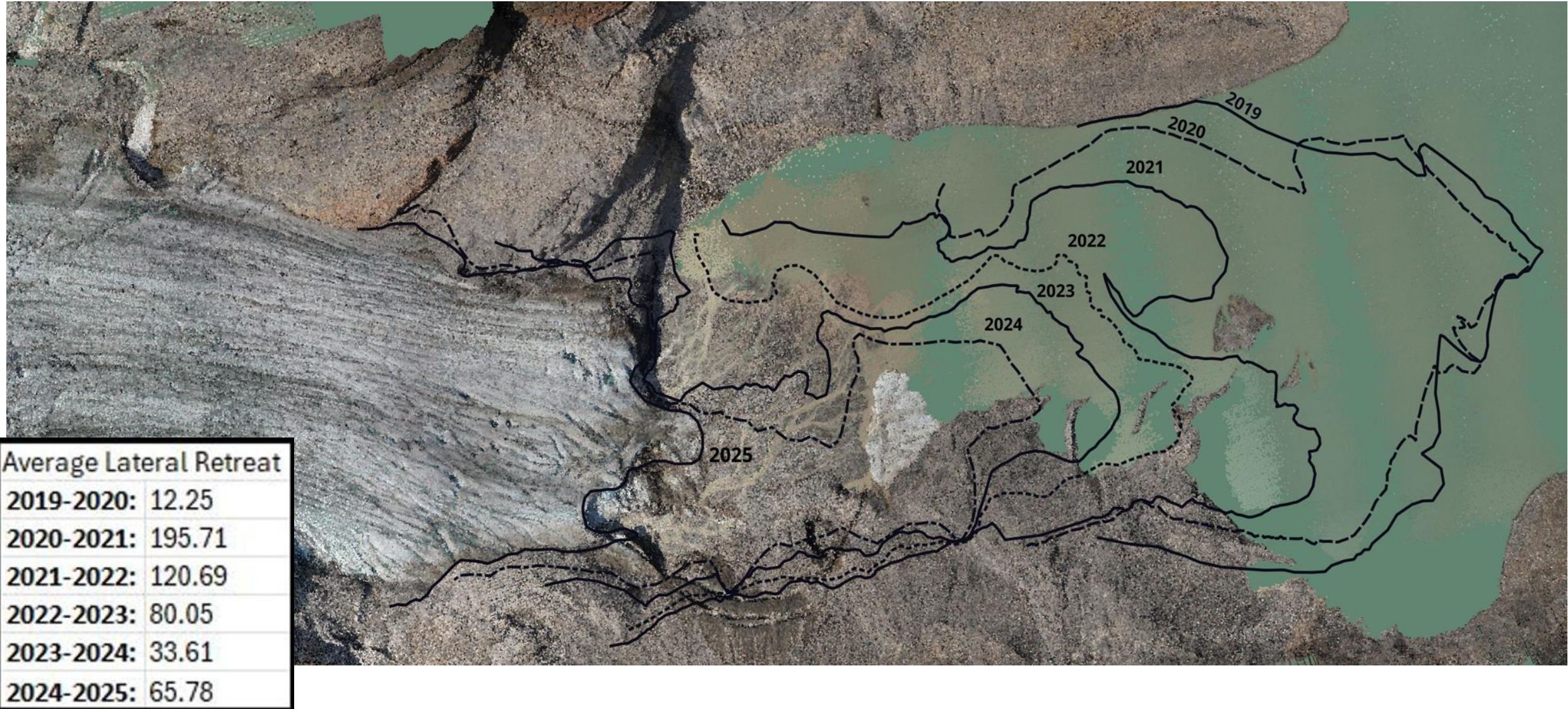
Glacier Volume Monitoring at Peyto Glacier



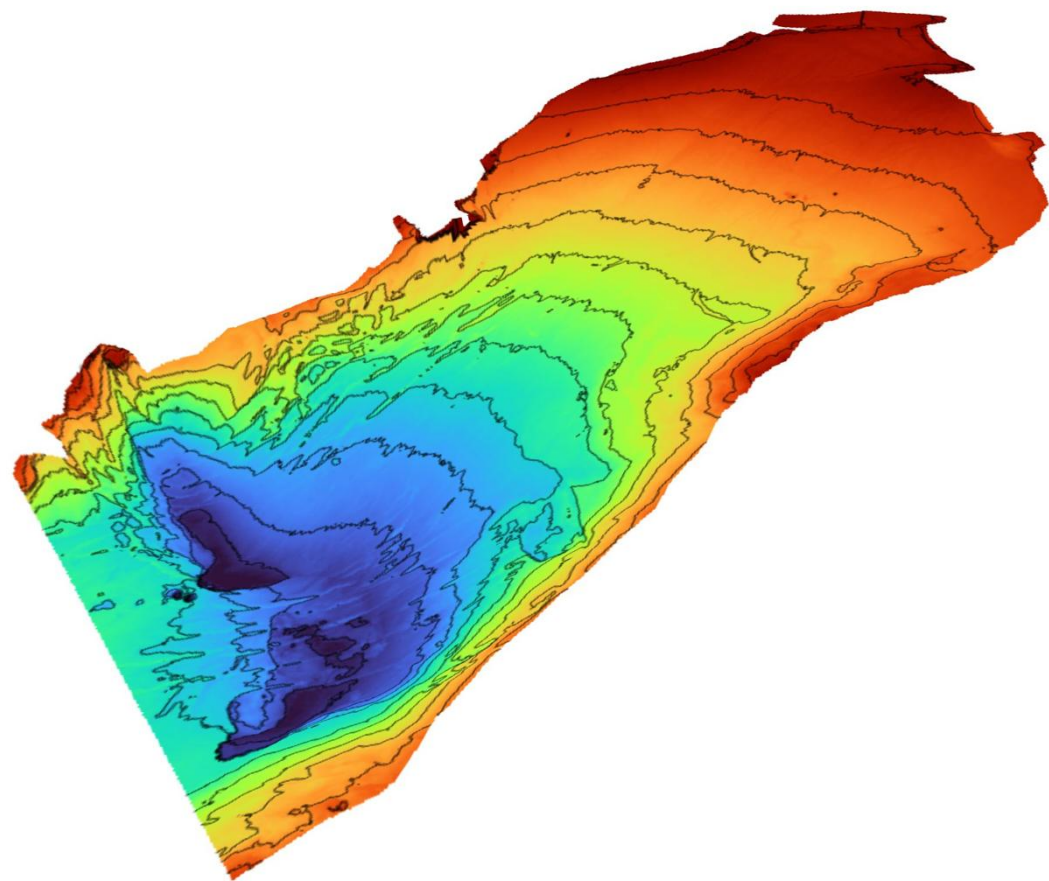
Peyto Glacier -



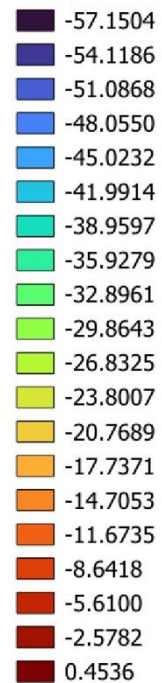
Peyto Retreat ~ 0.5 km over 6 years



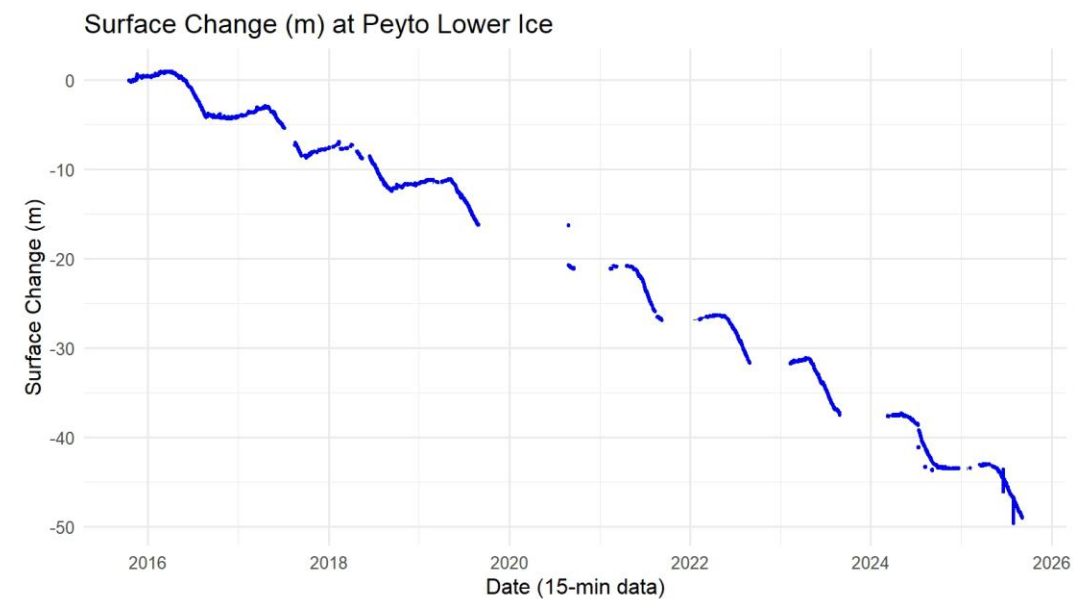
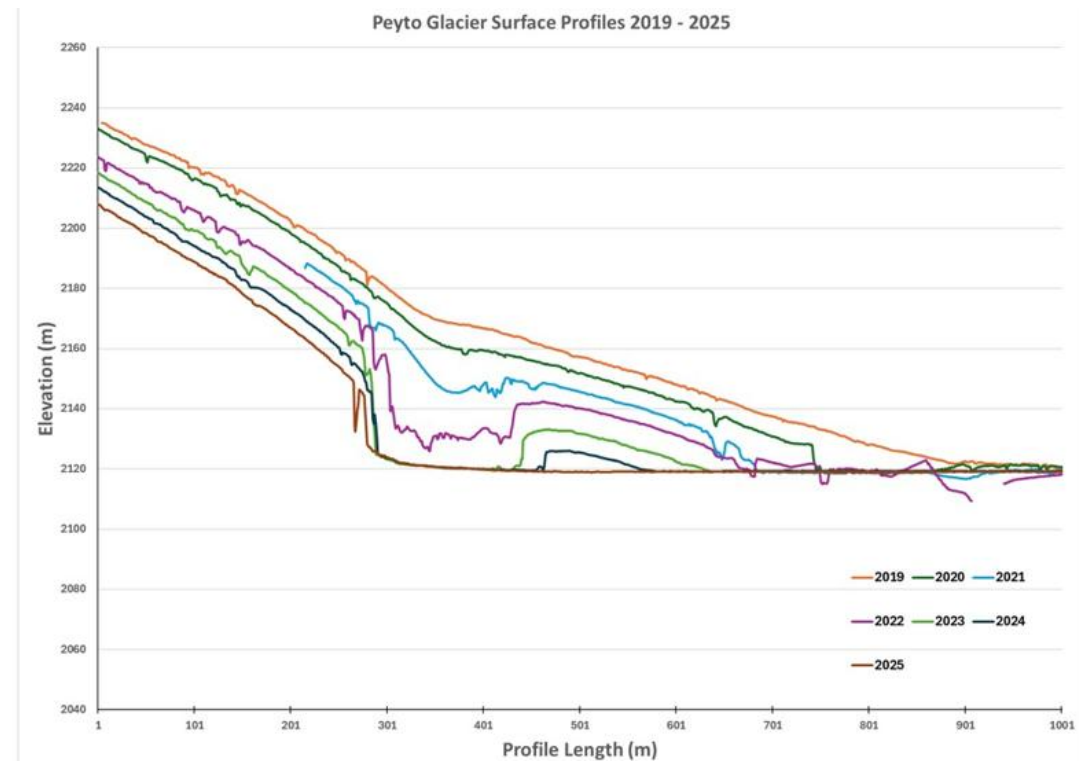
Peyto Ablation



Loss (m)



Surface elevation change 2019-2025



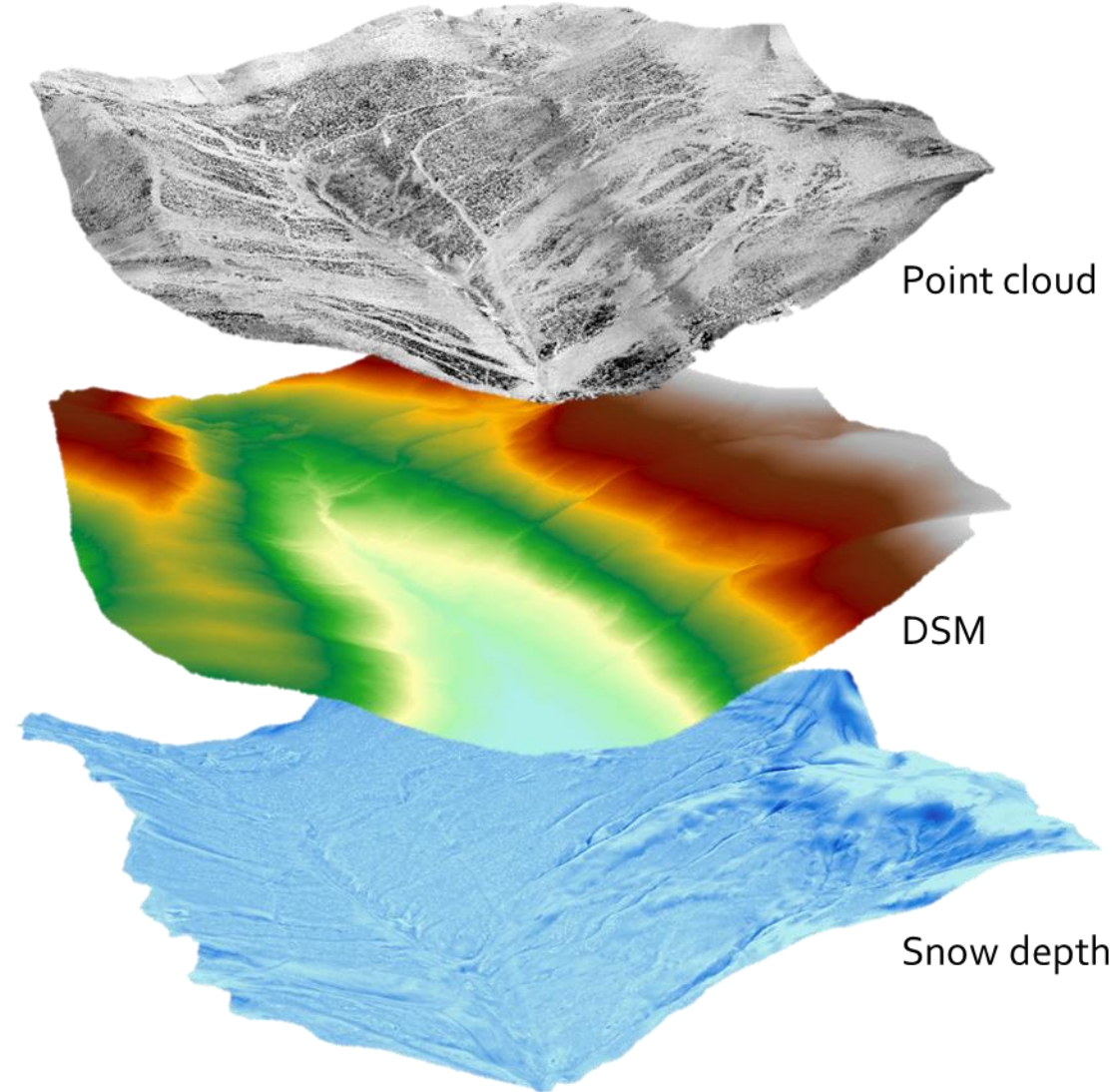
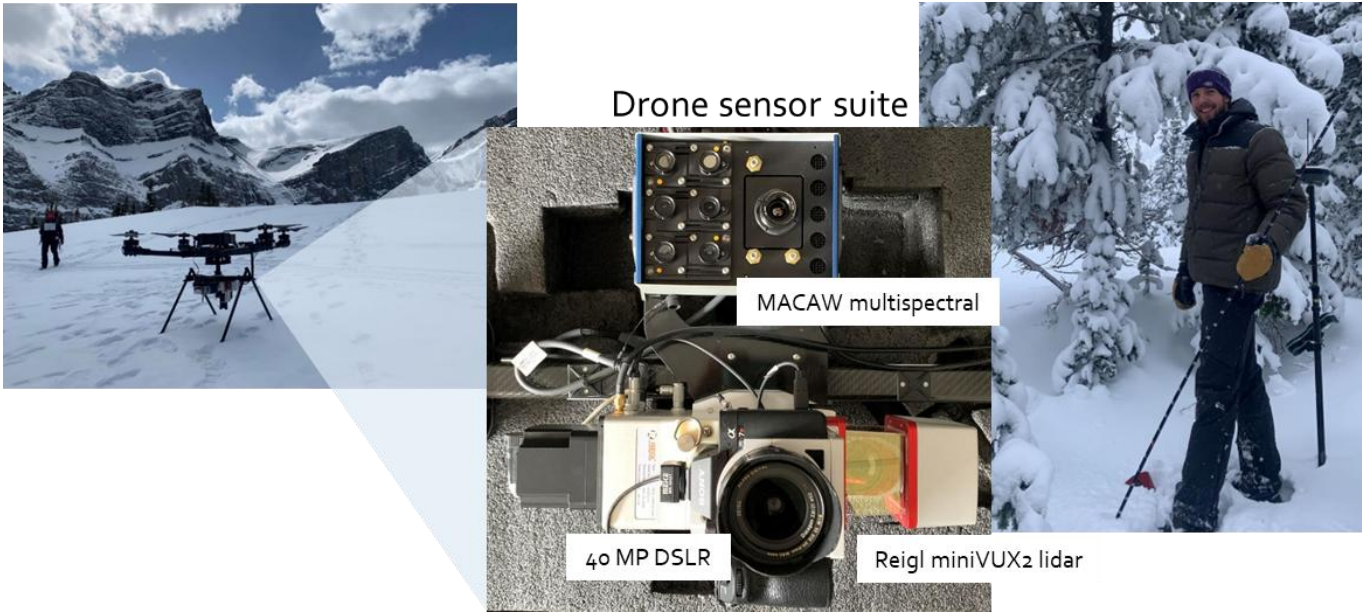
New Station – Athabasca Rock Glacier



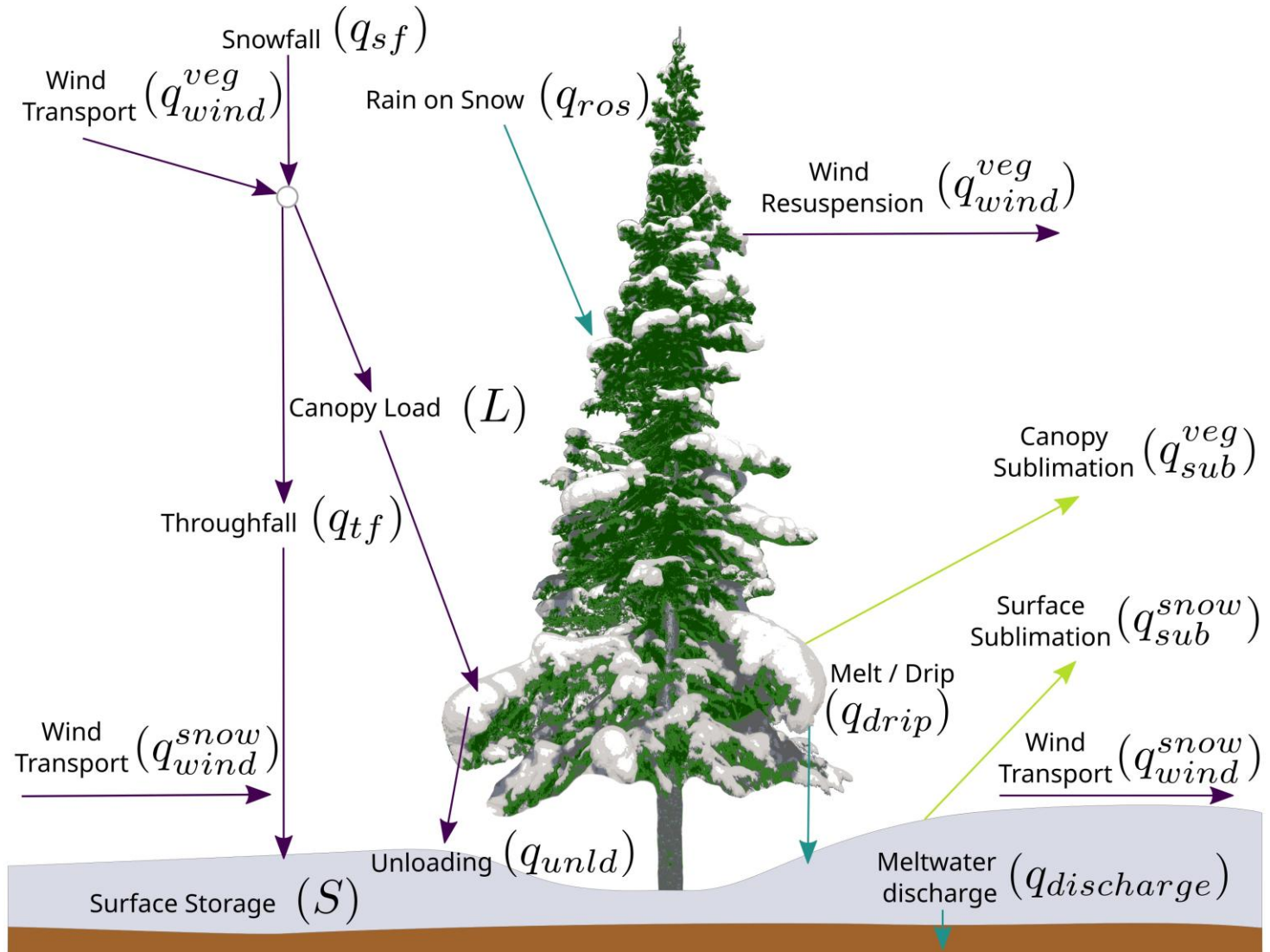
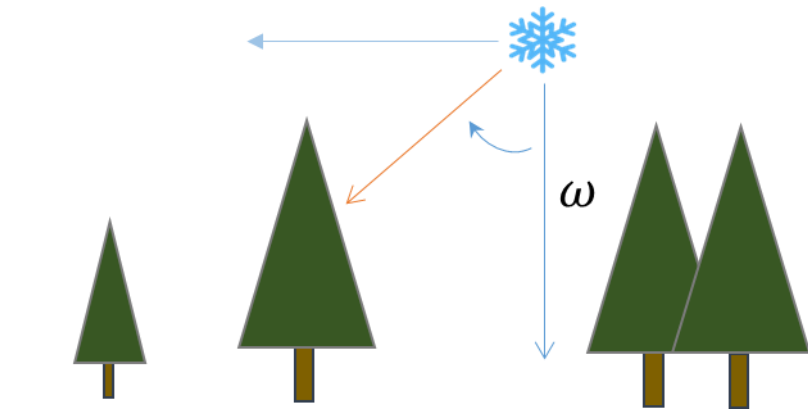
Matthew McLaughlin, MSc

$$\text{SWE (kg/m}^2\text{)} = \text{snow density (kg/m}^3\text{)} \times \text{snow depth (m)}$$

LiDAR provides snow depth, but snow density needed to calculate SWE

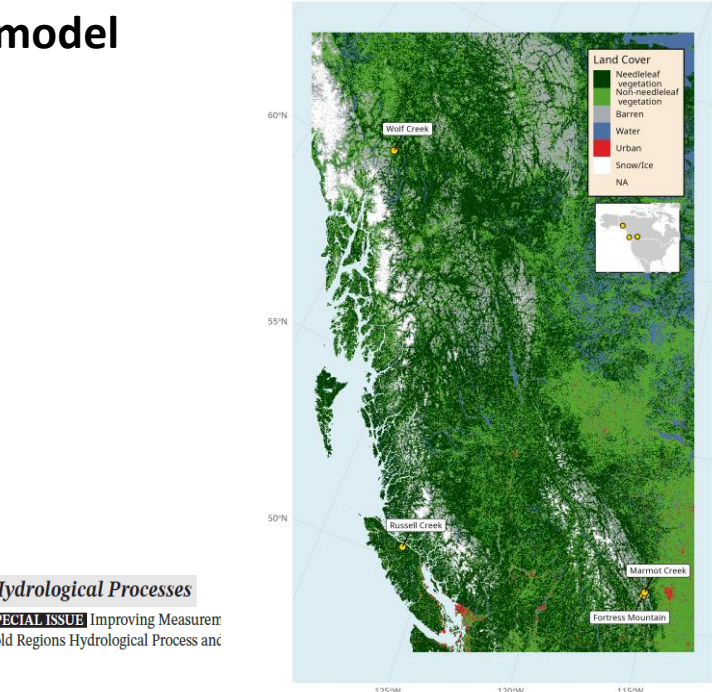


New Snow Interception Model



Snowfall Partitioning and Disposition in Needleleaf Forests

CanSnow: New snow interception model



Hydrological Processes

SPECIAL ISSUE Improving Measurement of Cold Regions Hydrological Processes and

RESEARCH ARTICLE OPEN ACCESS

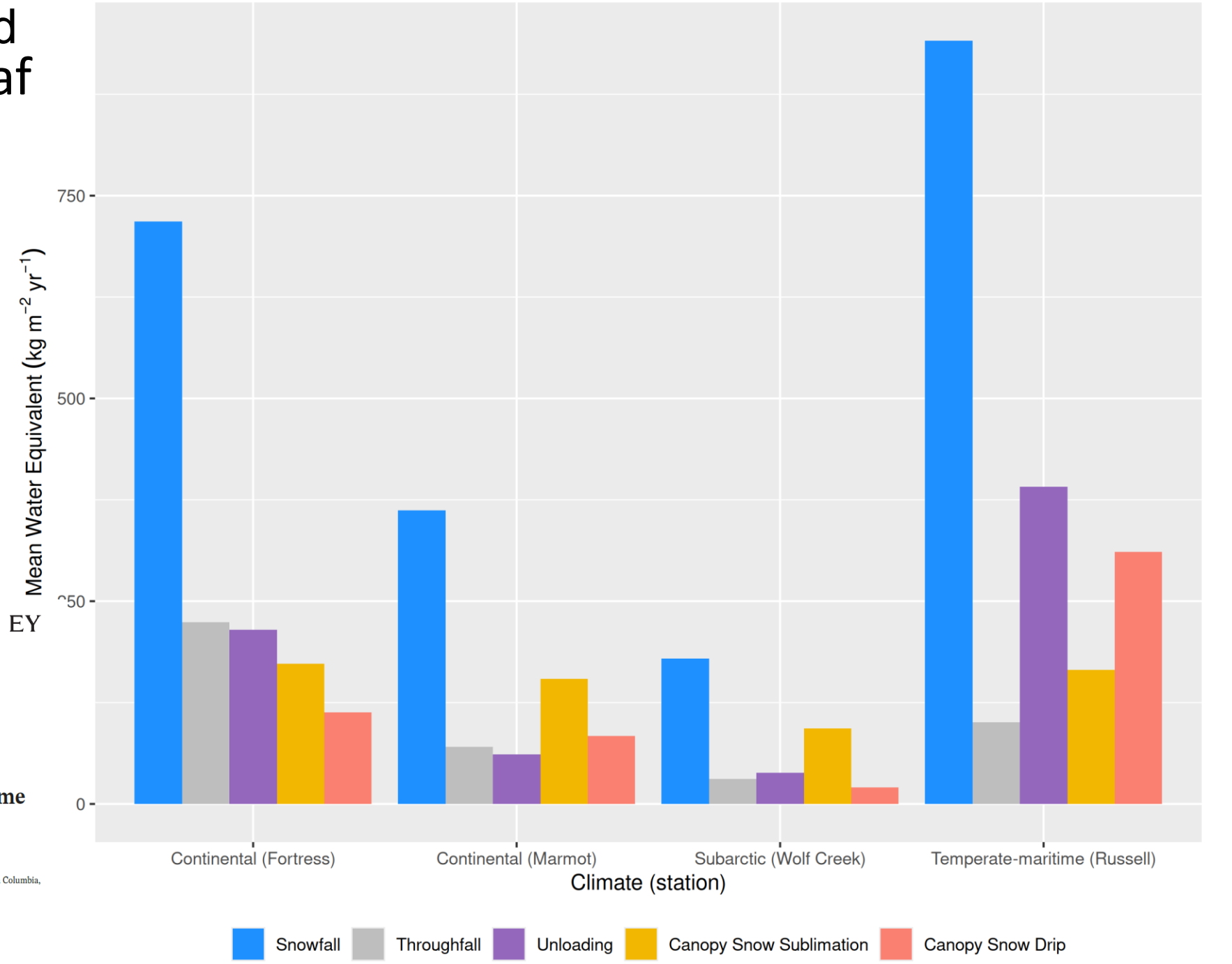
An Evaluation of New Snow Interception and Ablation Parameterisations in Continental, Subarctic and Maritime Needleleaf Forests

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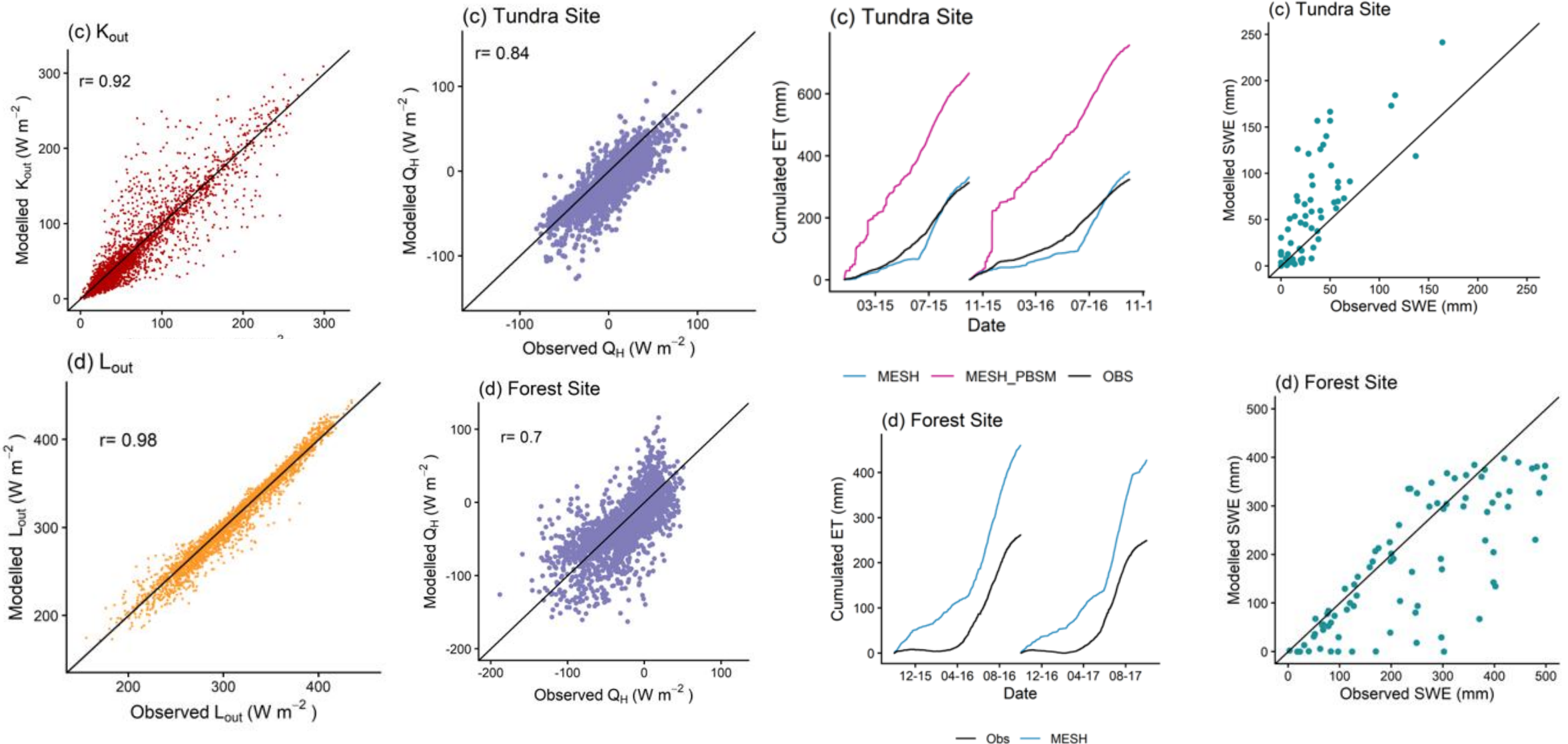
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MESH Testing at Fortress Mountain Research Basin

Tundra Site



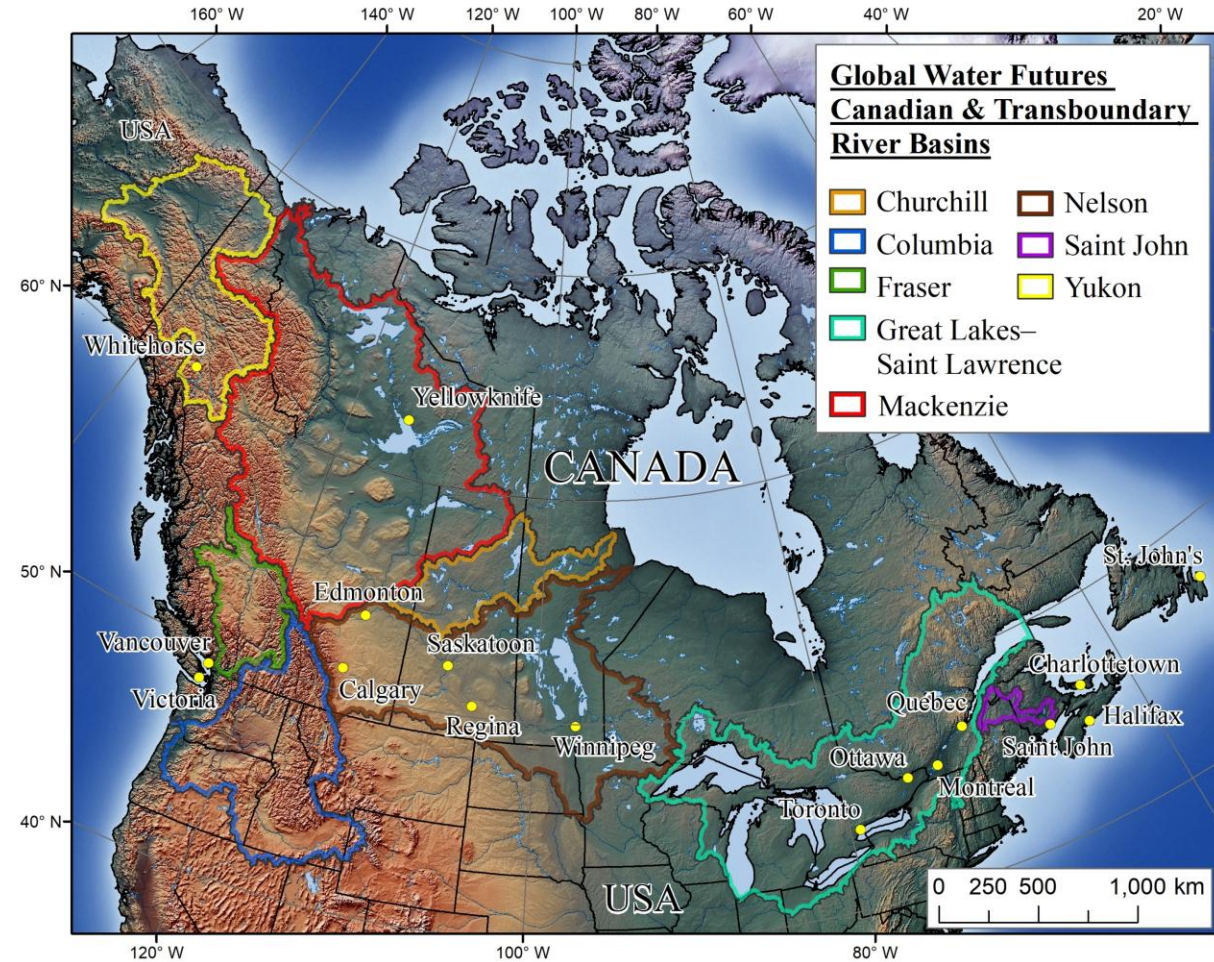
Upscaling from INARCH Headwaters to Continents - Modelling Considerations

- Need for robust climate change adaptation strategies.
- Future climate impacts on hydrology of over 5 M km²
- Glacier loss, permafrost thaw, and shifting river flows
- Changing land cover – forest shift, agricultural expansion
- Need for adaptive water resource management and resilience building.

Future Landscape Changes

Glaciers will largely vanish in mountains,

Widespread vegetation shifts:
shrubification of in tundra, tree line advance, and Boreal Forest retreat

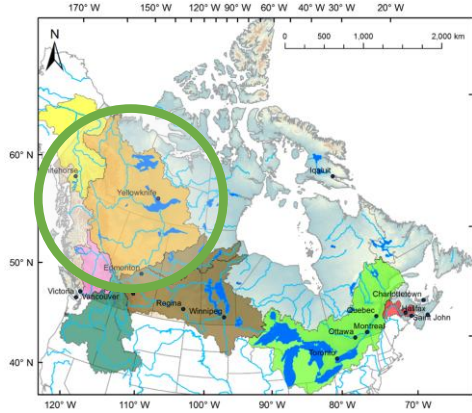


Continental-Scale Modelling with MESH

- Designed around the Canadian Land Surface Scheme – strong physical basis
- Simplified parameterization around grouped response units suitable for ungauged basins
- ‘Open-source’ community model
- Integrated with Environment Canada operational prediction system and provincial operational forecasts
- Repeatable workflows and model setup
- Model agnostic framework for forcing and parameterisation



Mackenzie River Basin Hydrology

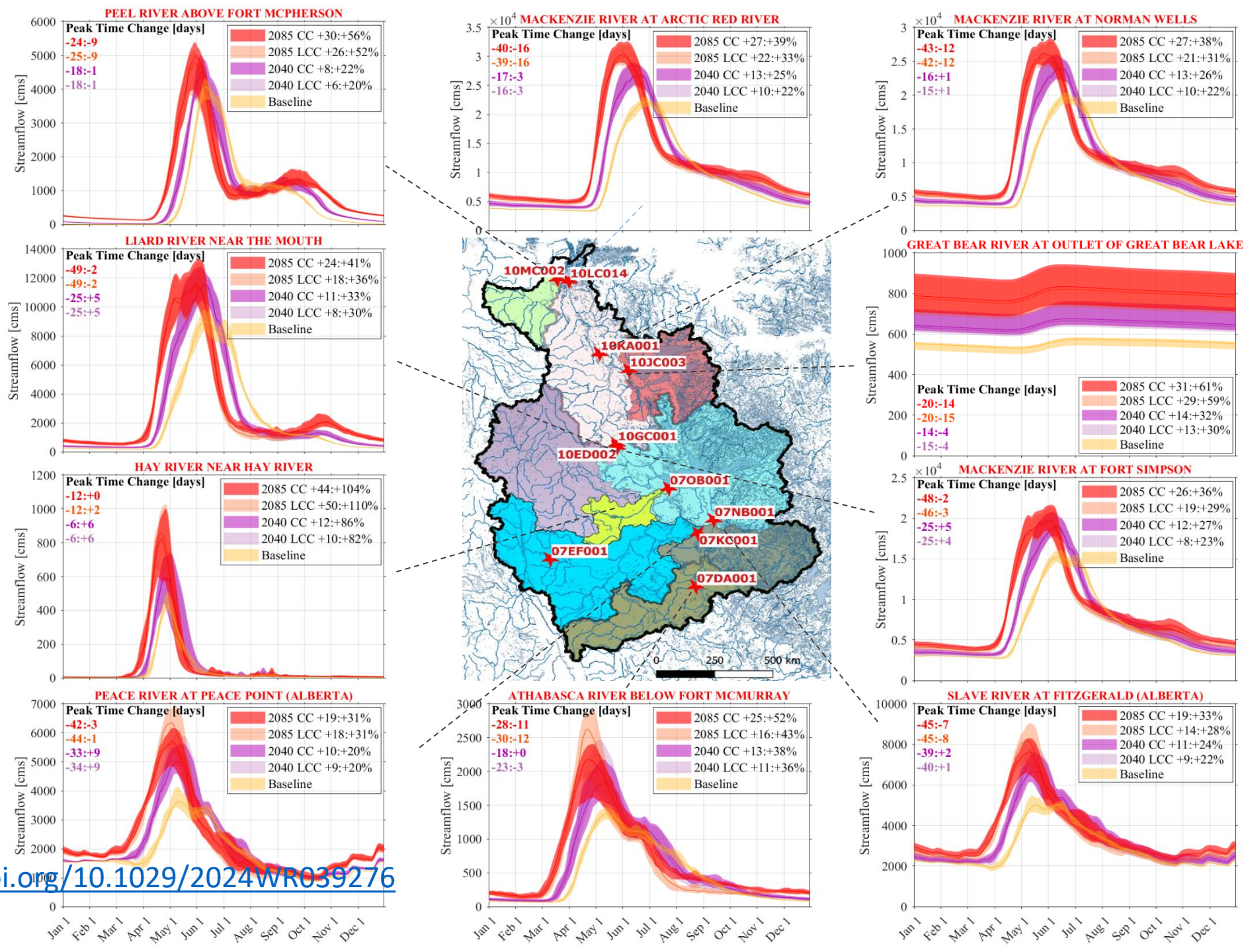


Volume change shown in legend boxes

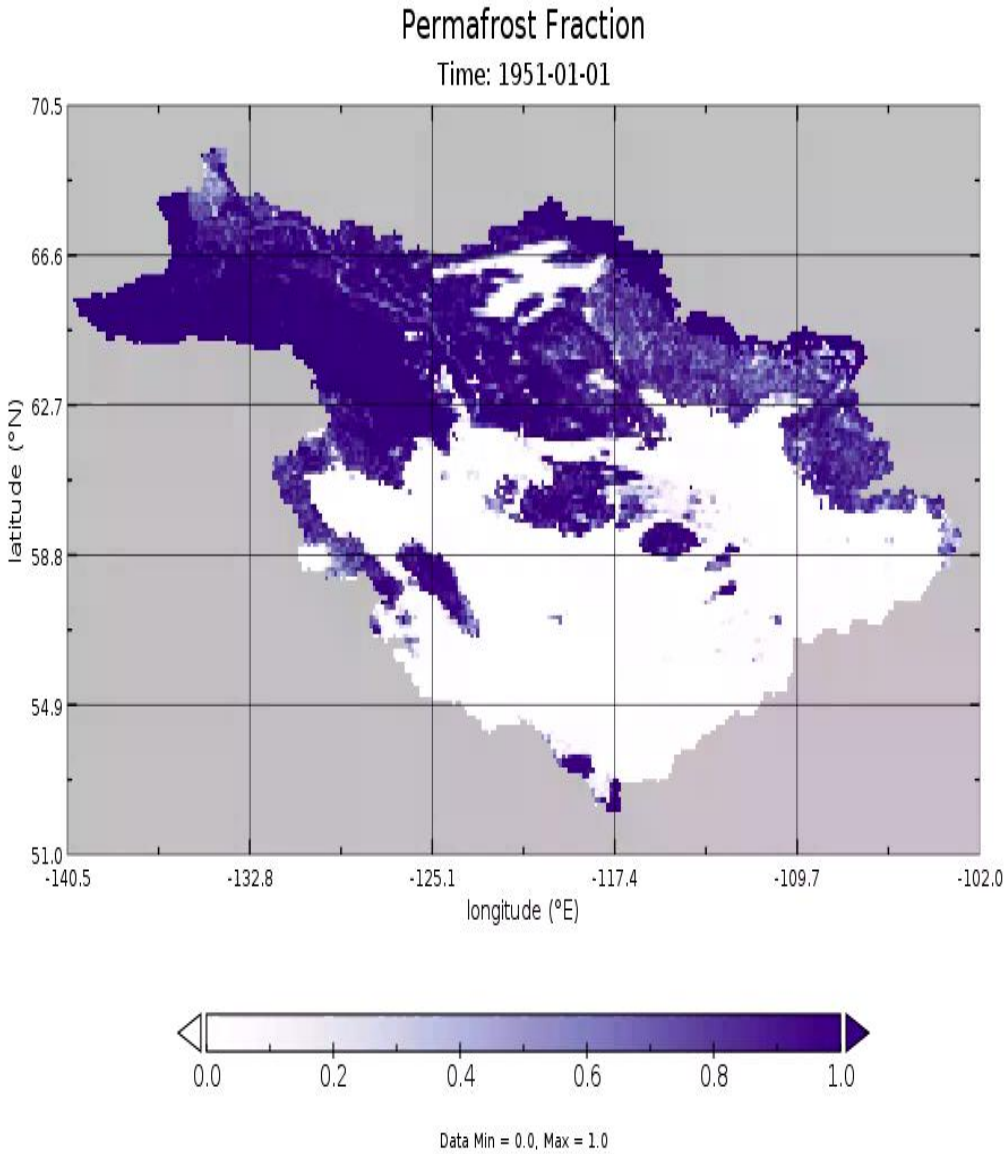
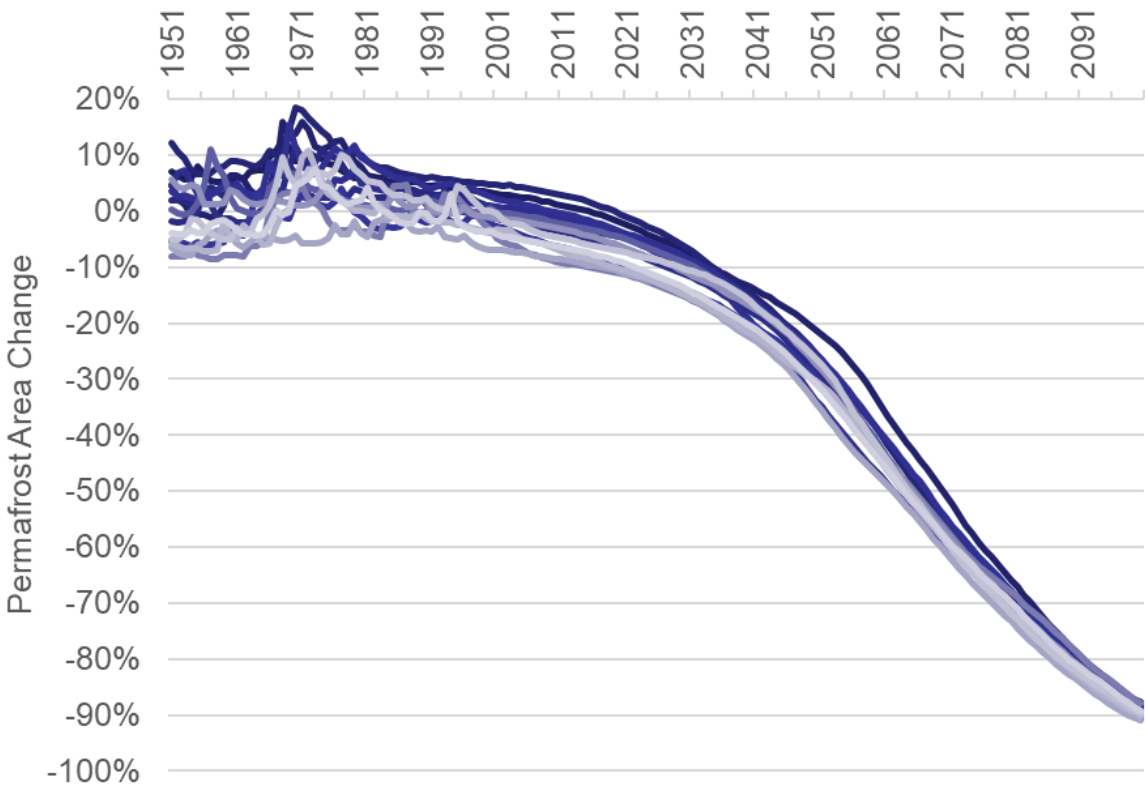
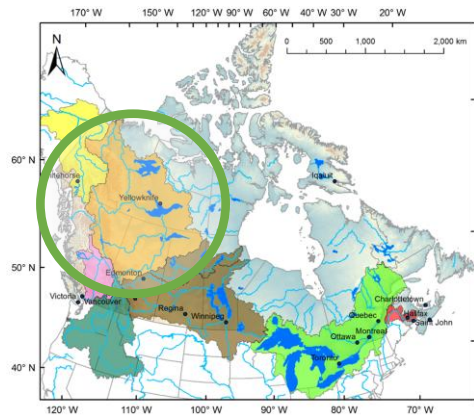
Peak Time Changes shown in Top Corner

Both are shown as range min:max across the ensemble

Elshamy et al. (2025): <https://doi.org/10.1029/2024WR039276>



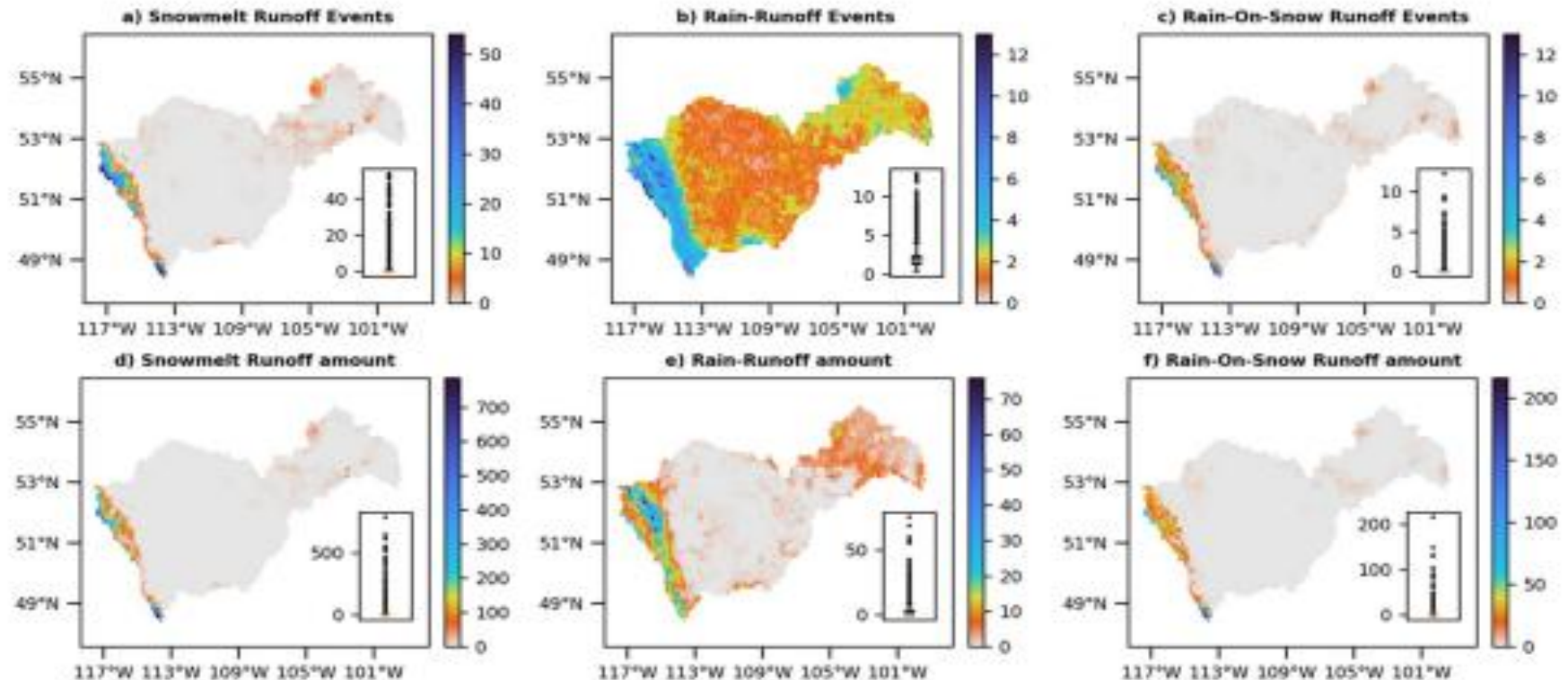
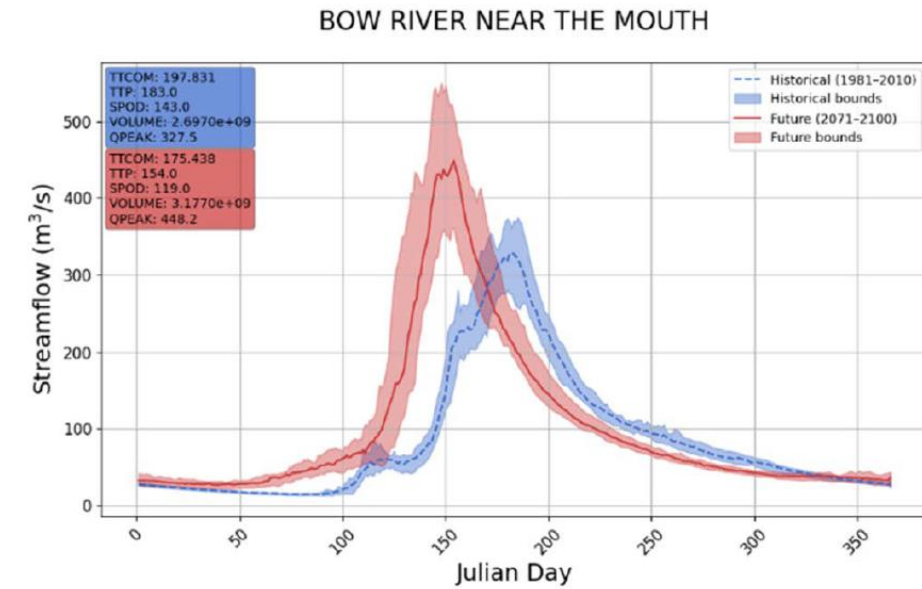
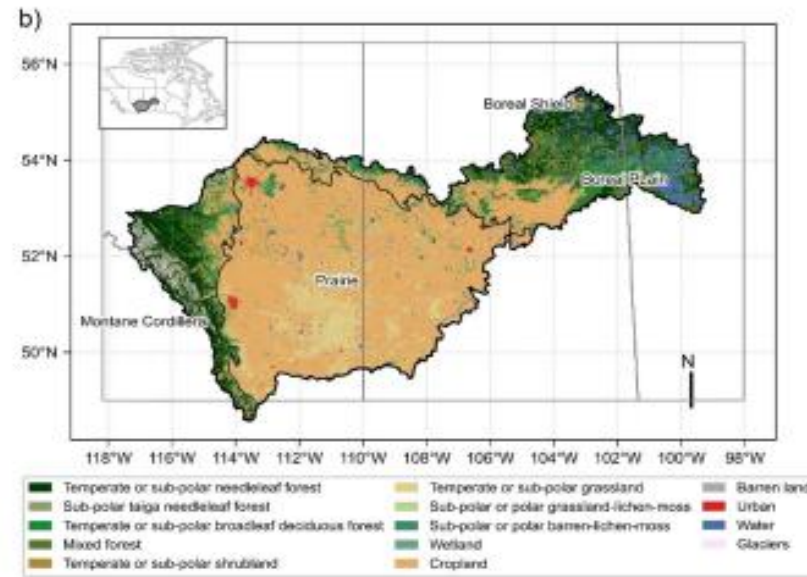
Mackenzie River Basin Permafrost



Saskatchewan River Basin Hydrology

- Precipitation phase partitioning strongly affects hydrological simulations and future climate-impact projections.
- Simple temperature-threshold approaches introduce substantial uncertainty, especially in higher-elevations.
- Psychrometric energy-balance method gives more physically consistent snow/rain partitioning and reduces predictive uncertainty.

Yassin et al. (2025; 2026):
<https://doi.org/10.1002/hyp.70320>
<https://doi.org/10.1002/hyp.70608>



Conclusions

- The Canadian Rockies Hydrological Observatory carries on a 64-year record of intensive hydrometeorological and cryospheric research observations.
- Climate warming and extremes are causing floods, droughts and cryospheric retreat throughout the area with substantial impacts downstream
- Further exploration – snow redistribution, snowmelt, icemelt, debris-covered icemelt,
- Further model development and benchmarking: CHM, CRHM, MESH, Tethys-Chloris, SUMMA.....



James P Bruce
1928-2026

founder of

- Marmot Creek
- Hydrometeorology in Canada
- Canada Centre for Inland Waters
- IPCC
- Nobel Prize winner

