

Water Futures for Alberta



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GLOBAL WATER FUTURES
SOLUTIONS TO WATER THREATS
IN AN ERA OF GLOBAL CHANGE



UNIVERSITY OF
SASKATCHEWAN



GLOBAL WATER FUTURES
OBSERVATORIES





www.globalwaterfutures.ca



2016-2025
65 projects and teams
23 universities funded



University of Guelph

University of British Columbia

University of Northern British Columbia

University of Calgary

Université Laval

McGill University

Université du Québec à Montréal

University of Alberta

University de Montreal

University of Manitoba

University of Victoria

Brock University

Canadian Rivers Institute (University of New Brunswick & University of Prince Edward Island)

Yukon University



Global Water Futures Aims:

- a) to place **Canada as a global leader in water science for cold regions,**
- b) to address the **strategic needs of the Canadian economy in adapting to change and managing the risks of uncertain water futures and extreme events.**

A Project Driven by User Questions

"What information and forecasting tools are available to help us anticipate extreme events under climate change?"



Objective 1

Improve Disaster Warning

"How will our water resources and reliant ecosystems change in the near-term and long-term under climate change?"



Objective 2

Harness Big Data to predict water futures with numerical models

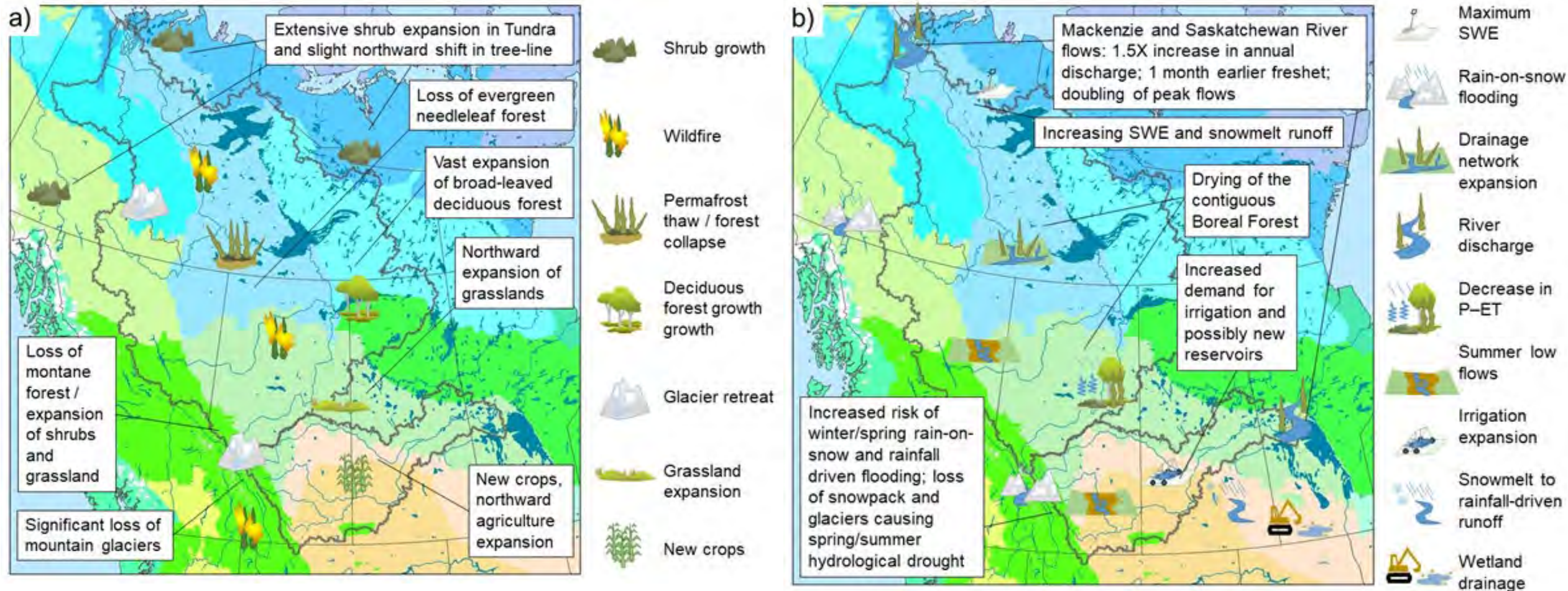
"What information and tools could help people, sectors, and orders of government manage water resources?"



Objective 3

Inform adaptation to change and risk management

Western Canada's Water Future – late 21st C



Global Water Future's coupled water observation, data management, water prediction, and knowledge mobilization strategy



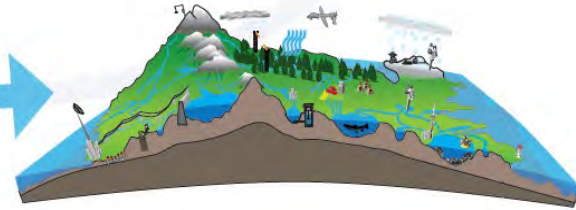
User Engagement & Information Sharing



Cloud Computing
Data Modelling



Data Sensing



7 major river basins

64 water observatories
Global Water Futures Observatories

5 Million km²



Global Water Futures Observatories 2023-2029

INNOVATION

Canada Foundation
for Innovation

Fondation canadienne
pour l'innovation



CANADA
FIRST
RESEARCH
EXCELLENCE
FUND

APOGÉE
CANADA
FONDS
D'EXCELLENCE
EN RECHERCHE



UNIVERSITY OF
SASKATCHEWAN



UNIVERSITY OF
WATERLOO



McMaster
University



LAURIER
Inspiring Lives.



Carleton
UNIVERSITY



UNIVERSITY OF
TORONTO
SCARBOROUGH



TRENT
UNIVERSITY

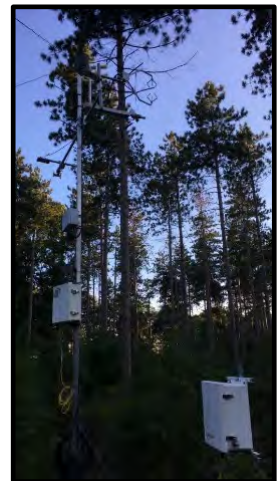
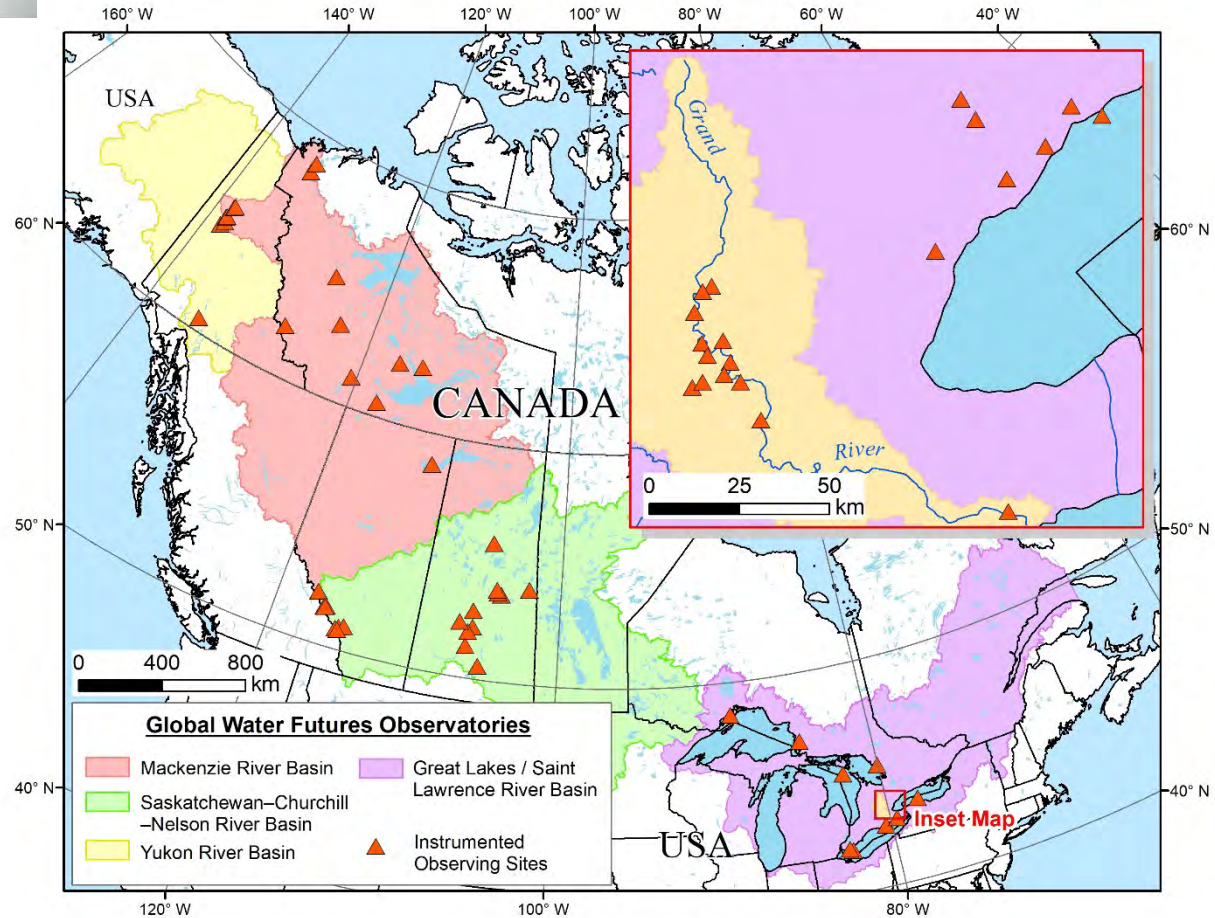
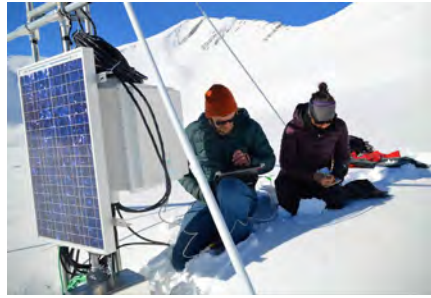
Western
UNIVERSITY · CANADA



University
of Windsor

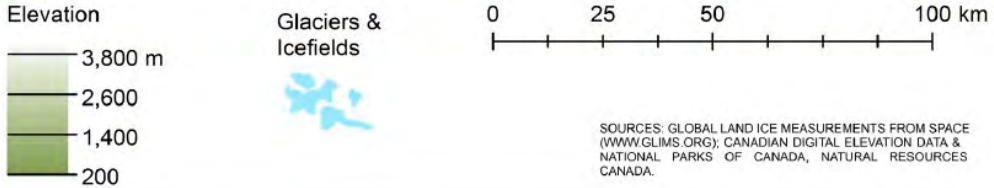


Canada's freshwater early warning system





Canadian Rockies Hydrological Observatory

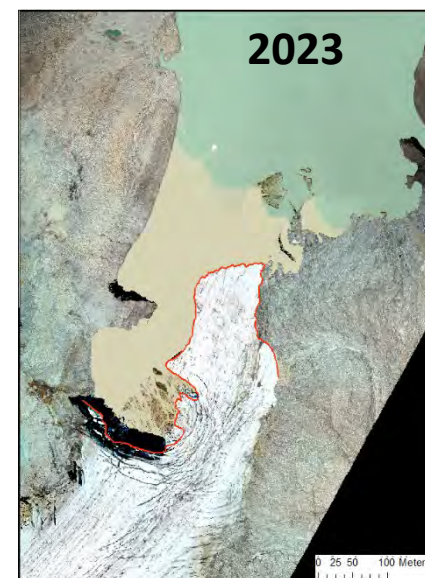


Glacier Monitoring – Global Water Futures Observatories





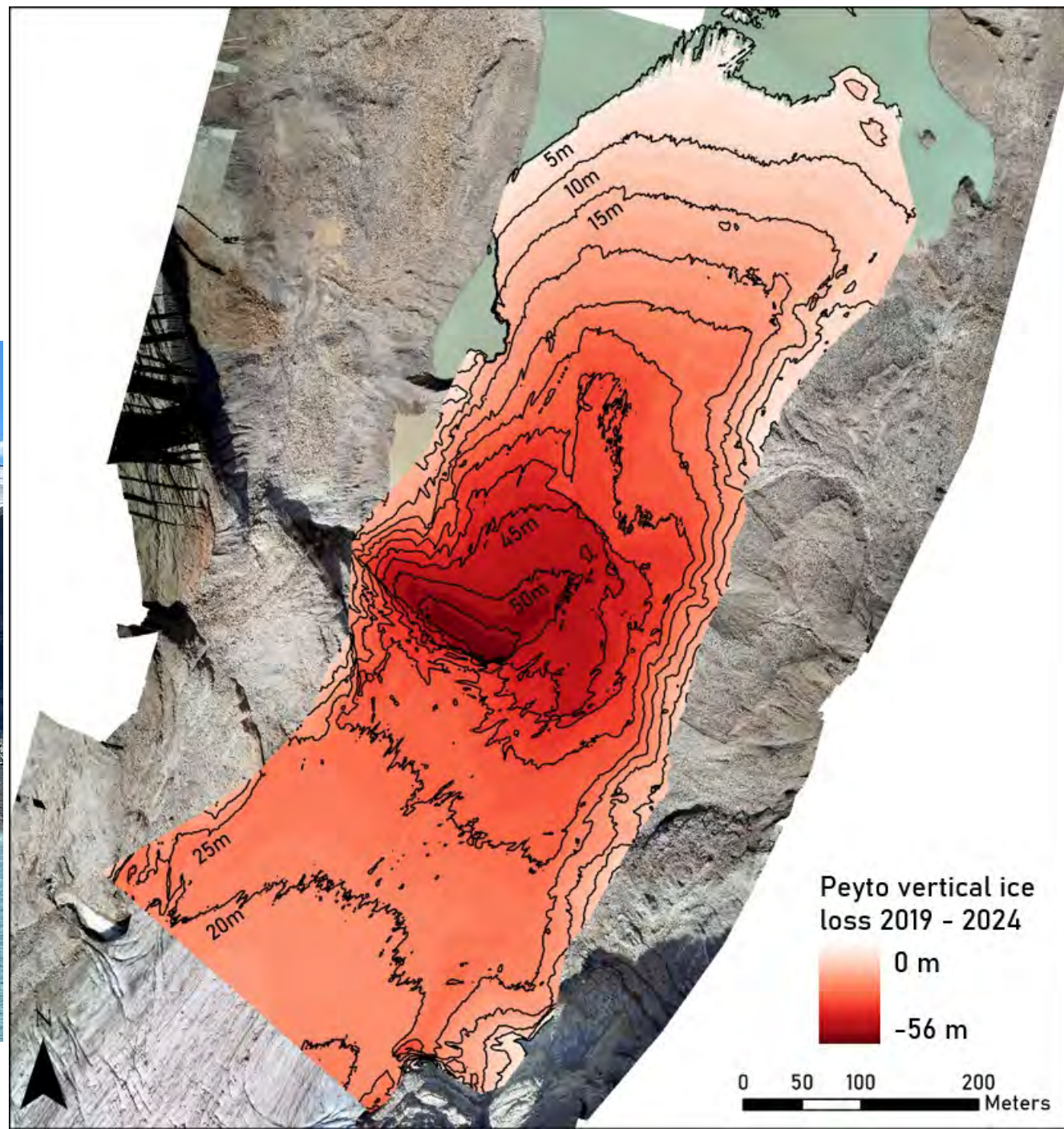
Avg. Lateral Retreat	
2019 – 2020:	-12.5 m
2020 – 2021:	-195.7 m
2021 – 2022:	-120.7 m
2022 – 2023:	-80.0 m
2023 – 2024:	-34.37 m



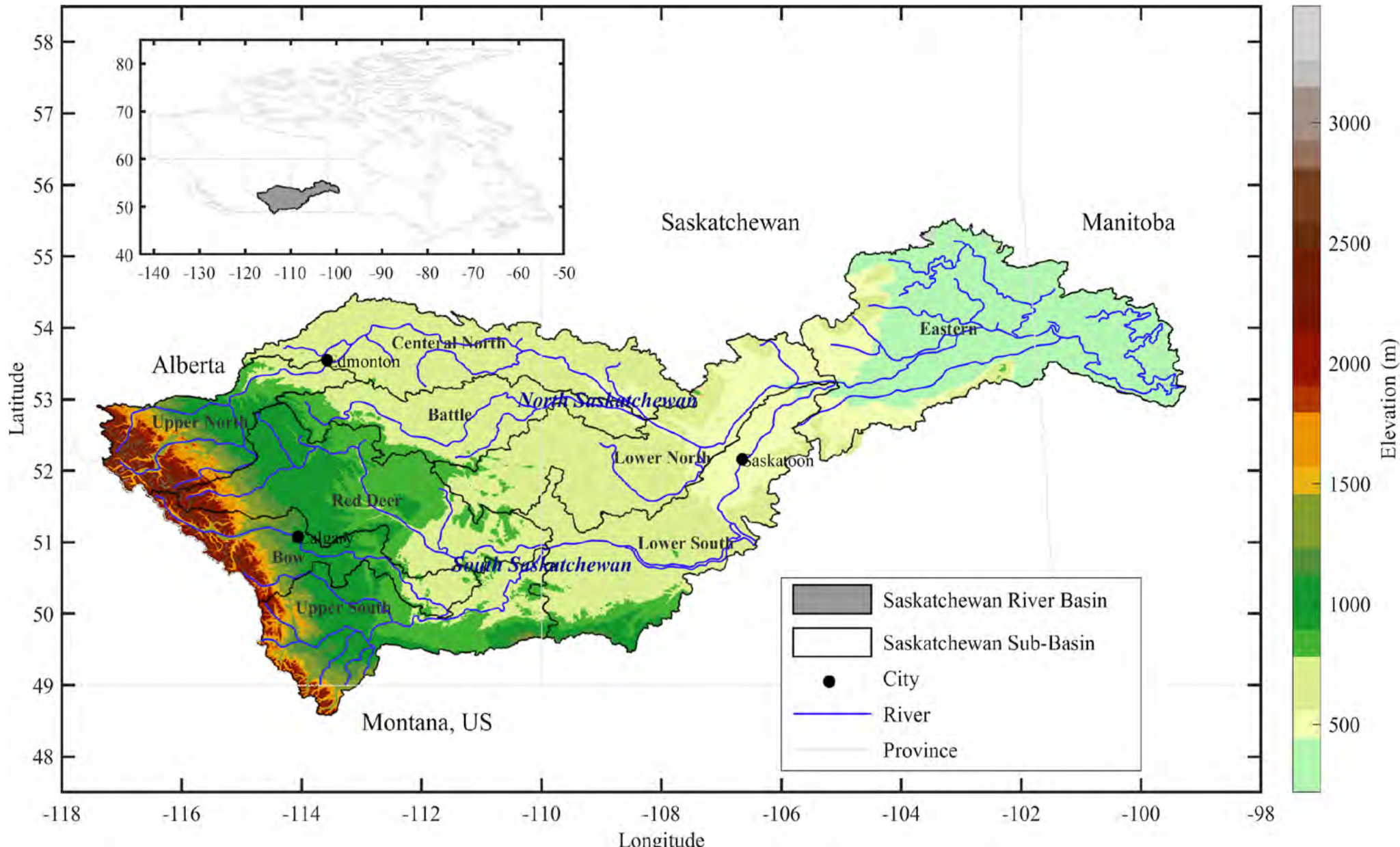
Extent of Peyto glacier toe from 2019 – 2024, overlain over aerial photography of Peyto taken in 2024

Definition of Peyto glacier toe for each year from 2019 - 2024

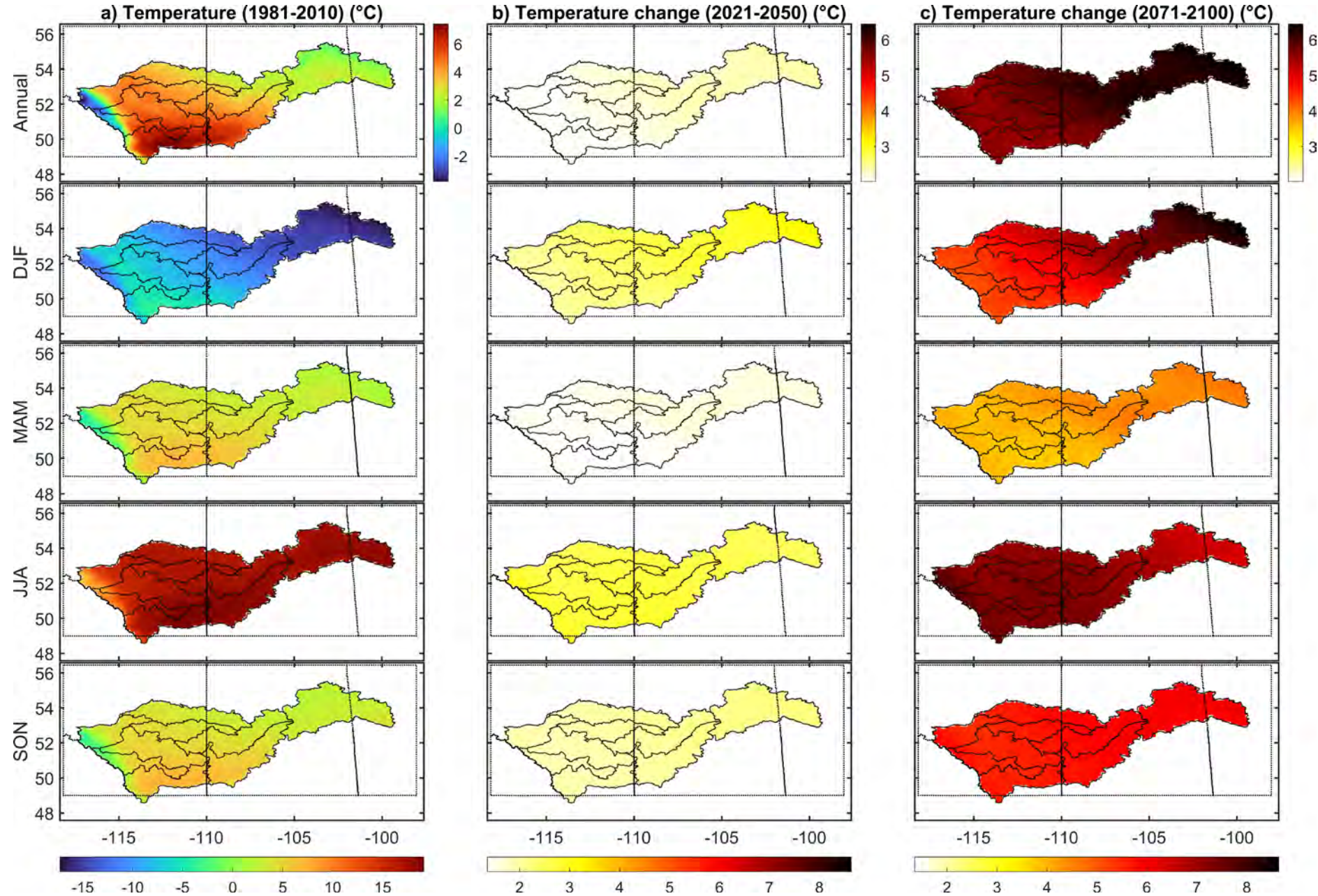
Peyto Glacier 5-year Vertical Loss



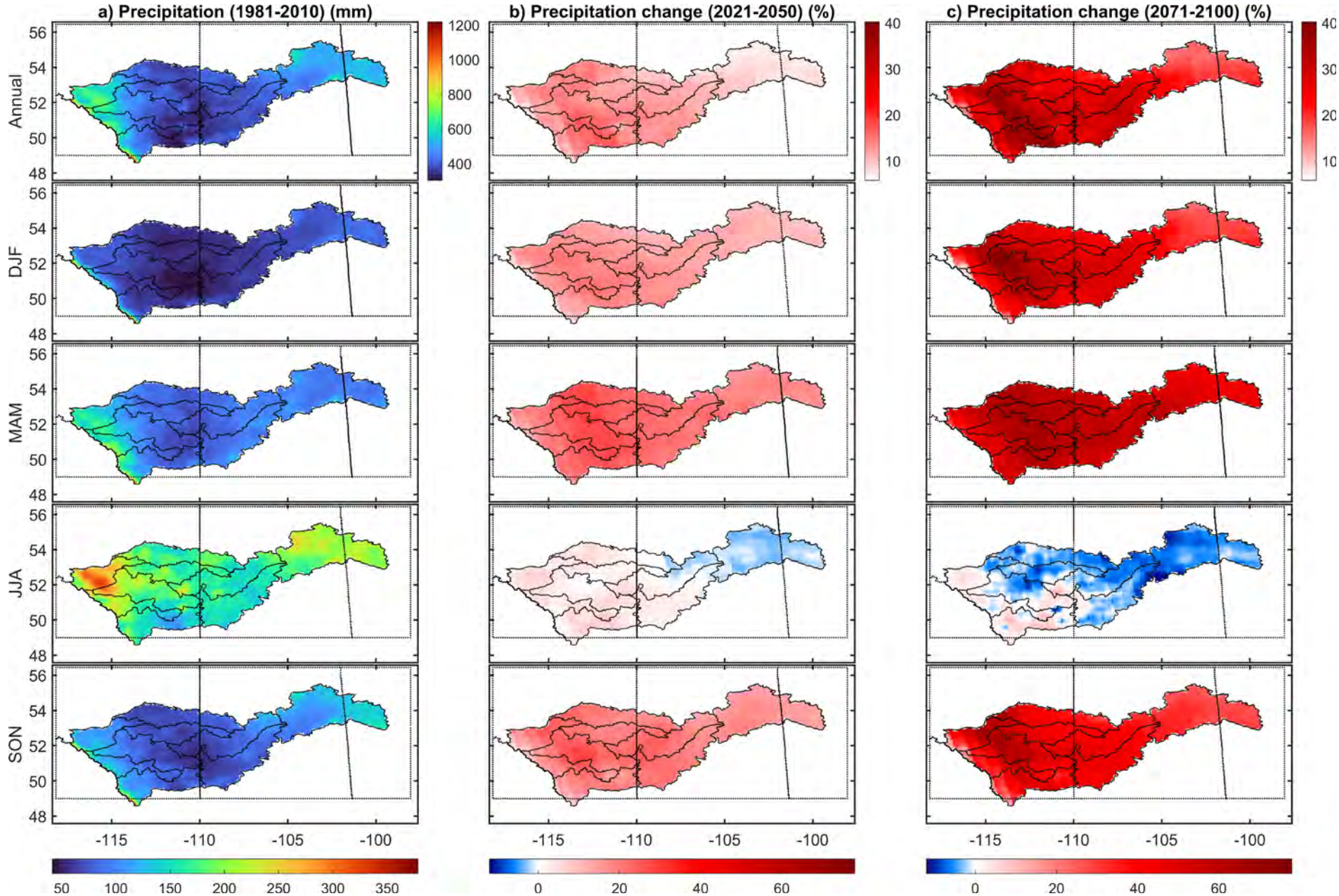
Saskatchewan River Basin (SRB)



Temperature Change to Late Century



Precipitation Change to Late Century

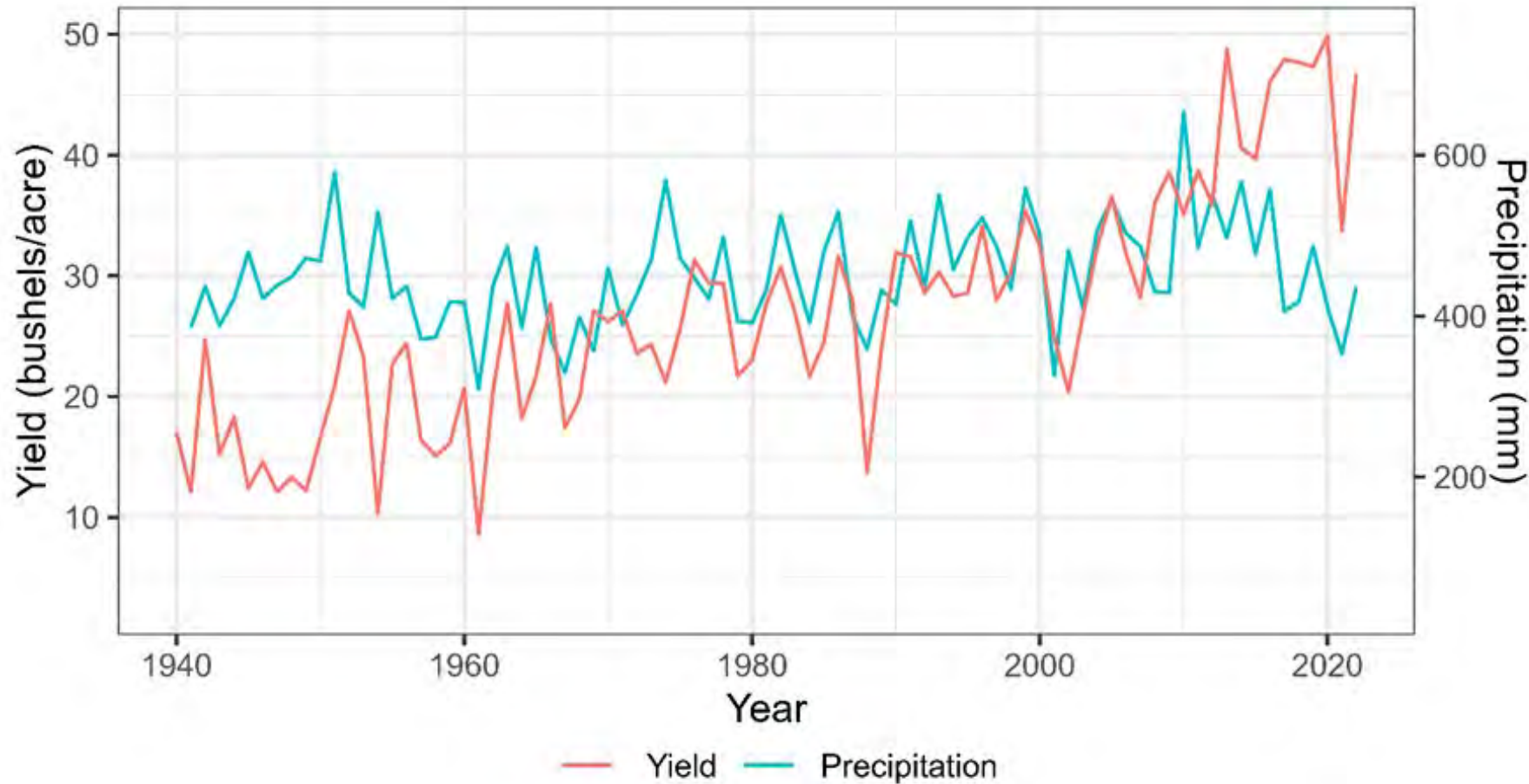


Future Extremes in the Canadian Prairies

Under a high emission climate scenario

- Summer precipitation declines whilst temperature rises – more annual rainfall, less snowfall
- Frequency of drought doubles by 2100
- Duration of drought increases by 6 months by mid-century
 - More rapid development, longer persistence, rapid end
- Severity of drought increases
- Number of large, multiple day rainstorms will increase
- Extreme one-day rainfall totals are increasing and may increase 35% by 2100

Decoupling of Precipitation and Wheat Yields



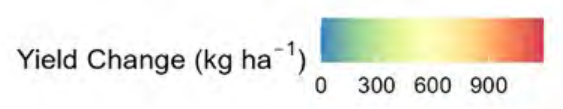
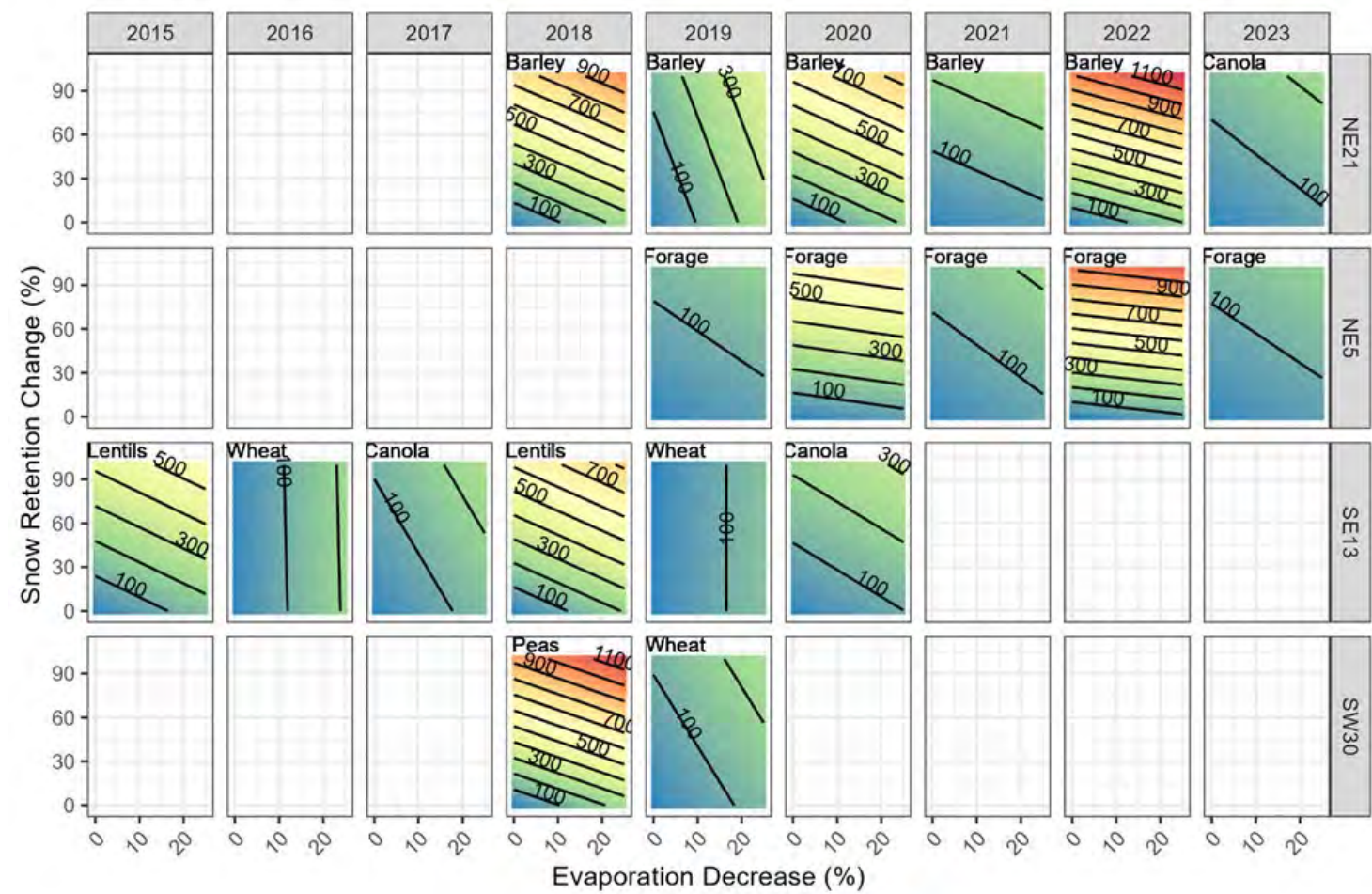
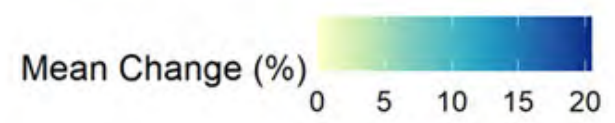
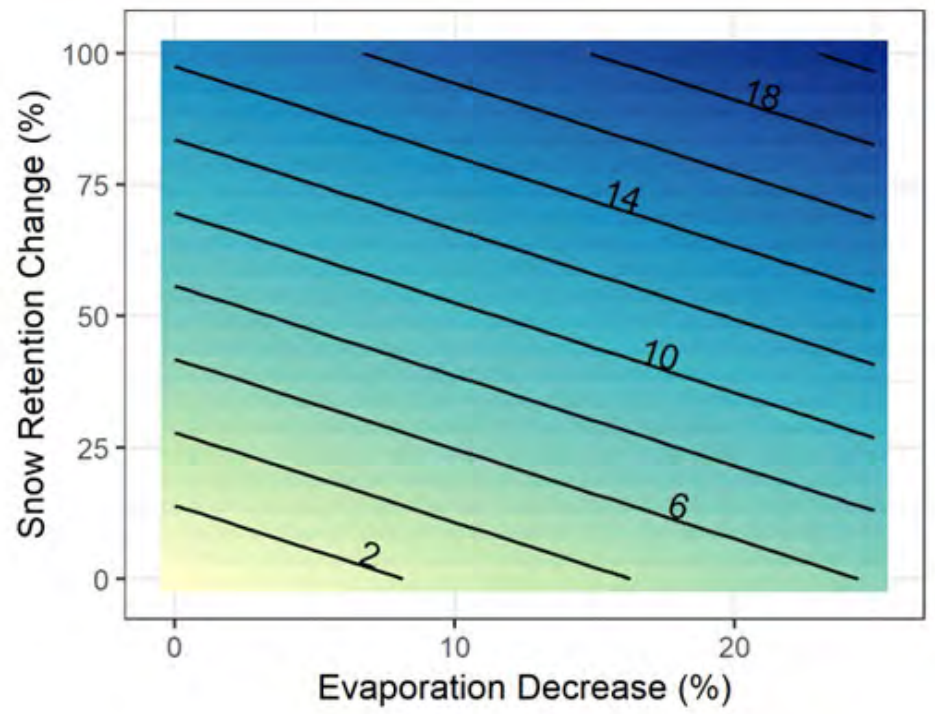
Saskatchewan Spring Wheat Yield and Water Year Precipitation (ERA5-Land)

Crop Growth from Snowmelt or Rainfall?

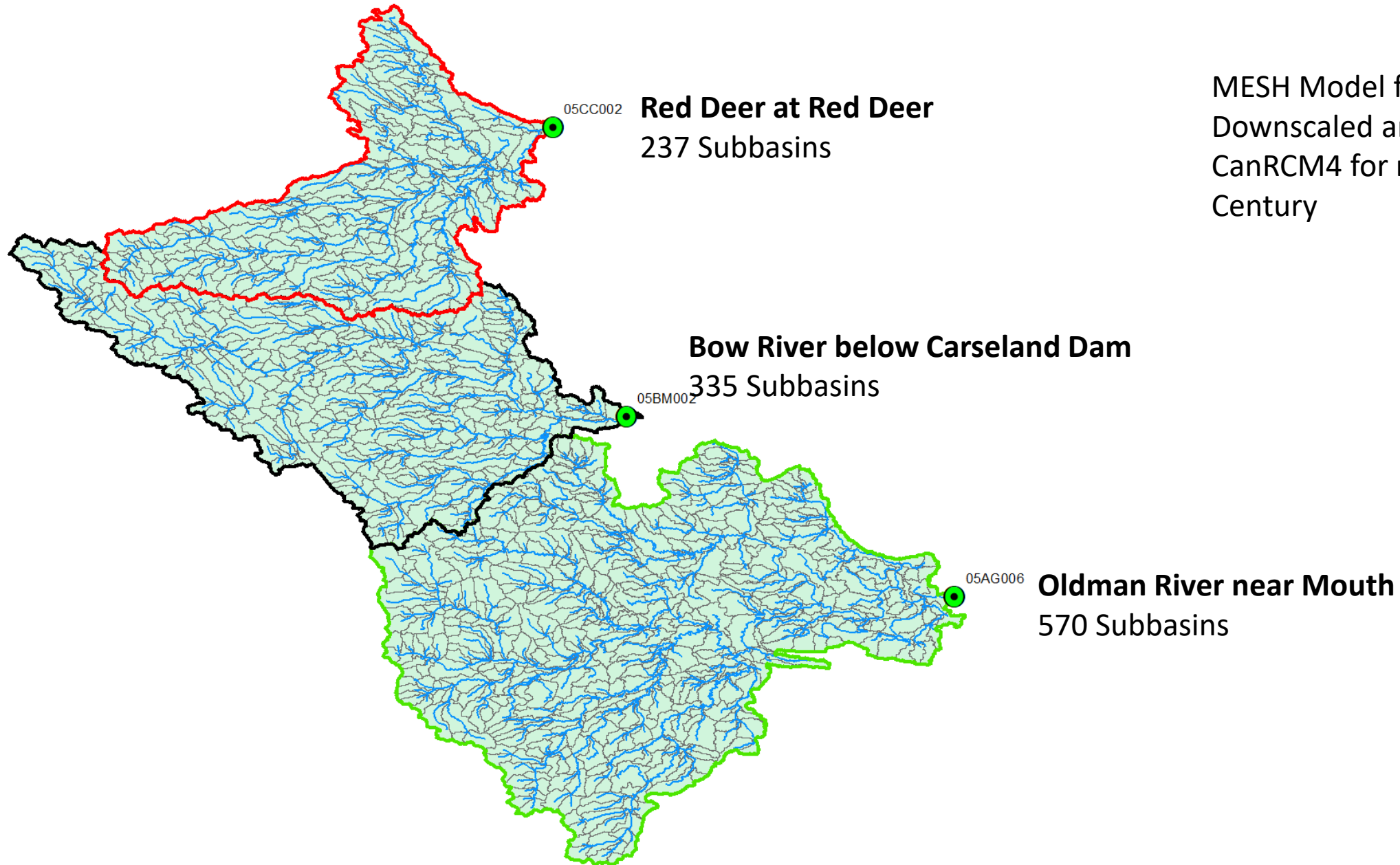


Maximise Crop Available Water and Crop Yields Through Blowing Snow Retention and Residue to Reduce Soil Evaporation

Crop Available Water Change = % of Crop Water Use



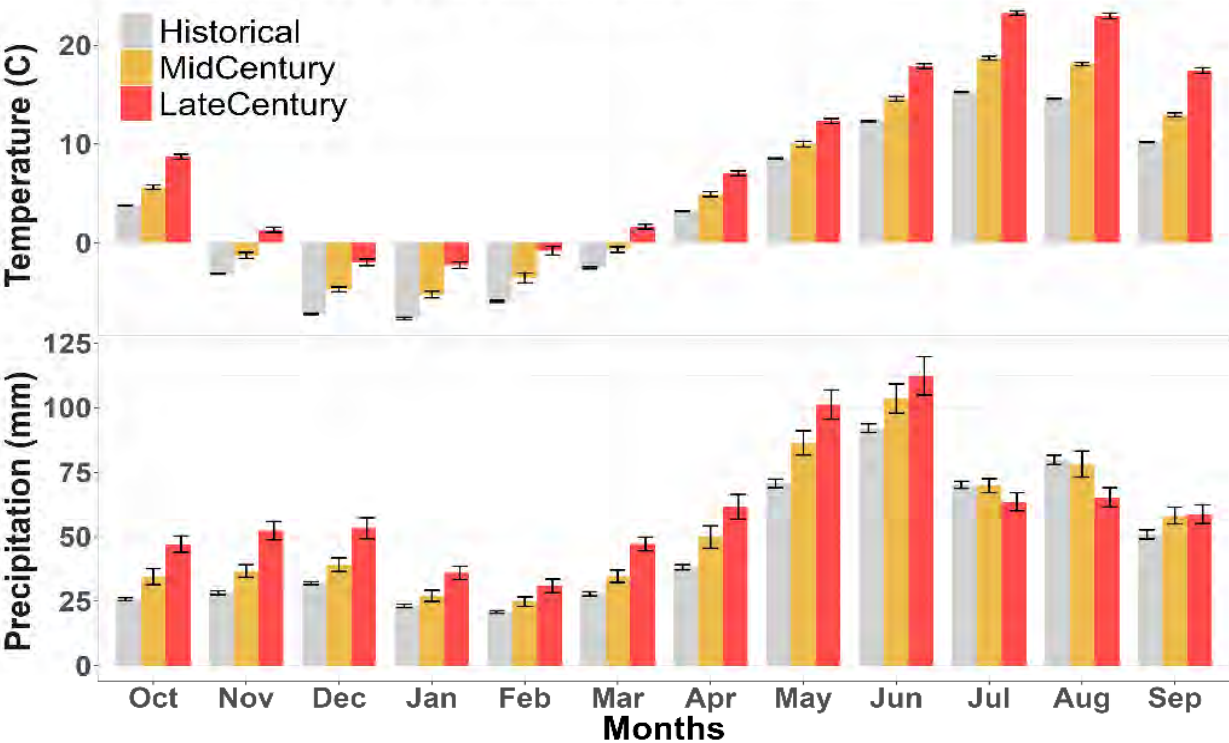
South Saskatchewan Headwater River Basins



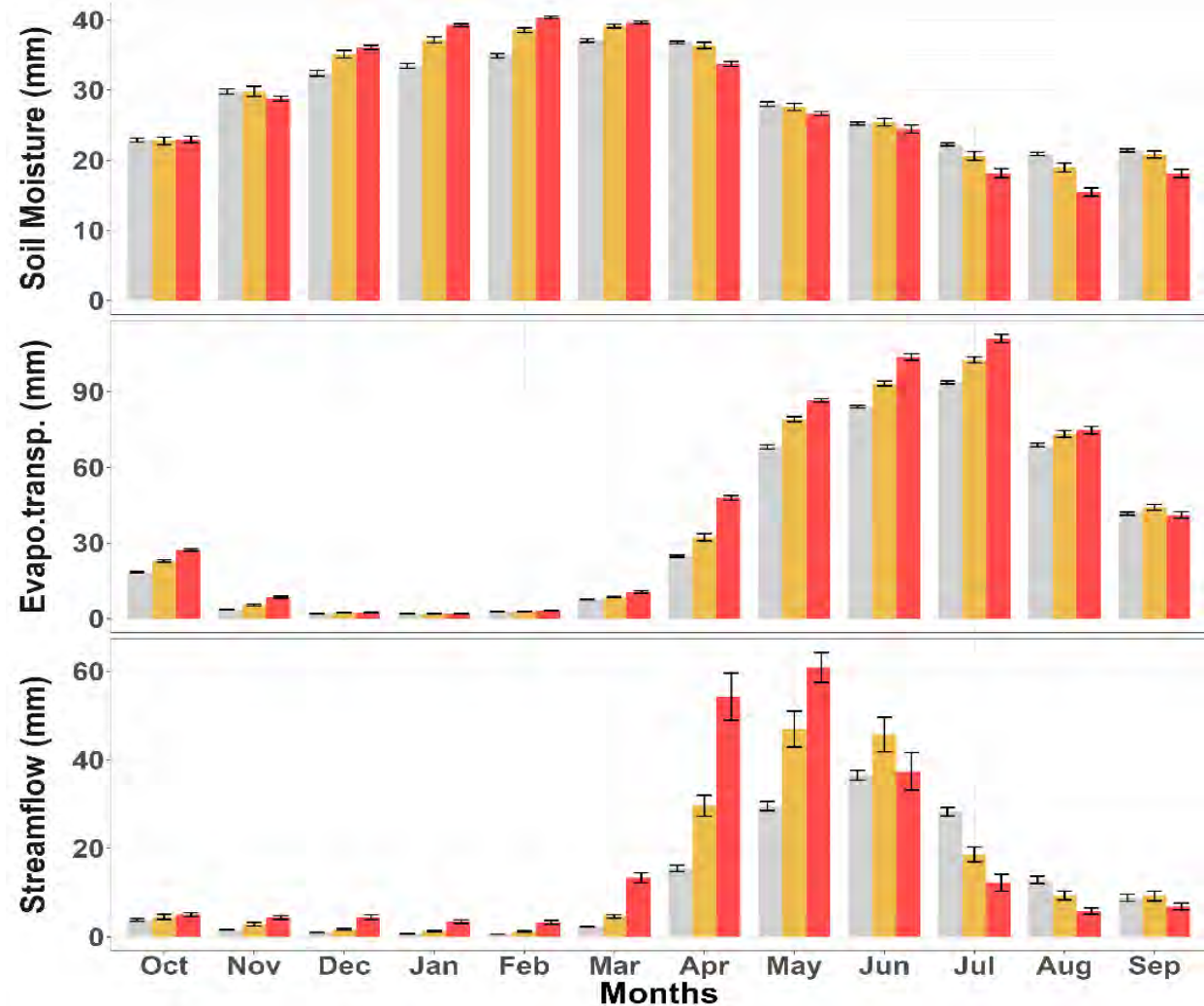
MESH Model forced with
Downscaled and bias corrected
CanRCM4 for mid and late 21st
Century

Climate and Hydrological Change in the Red Deer River Basin

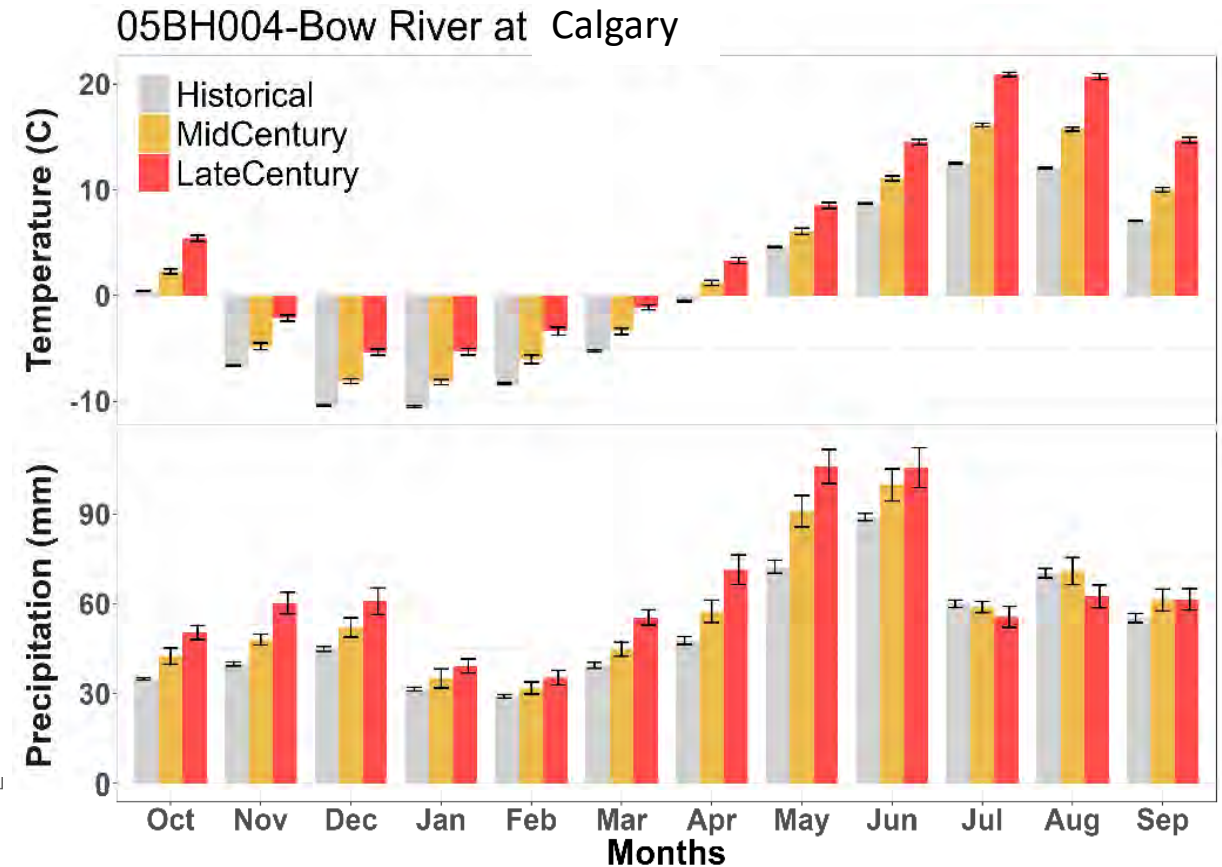
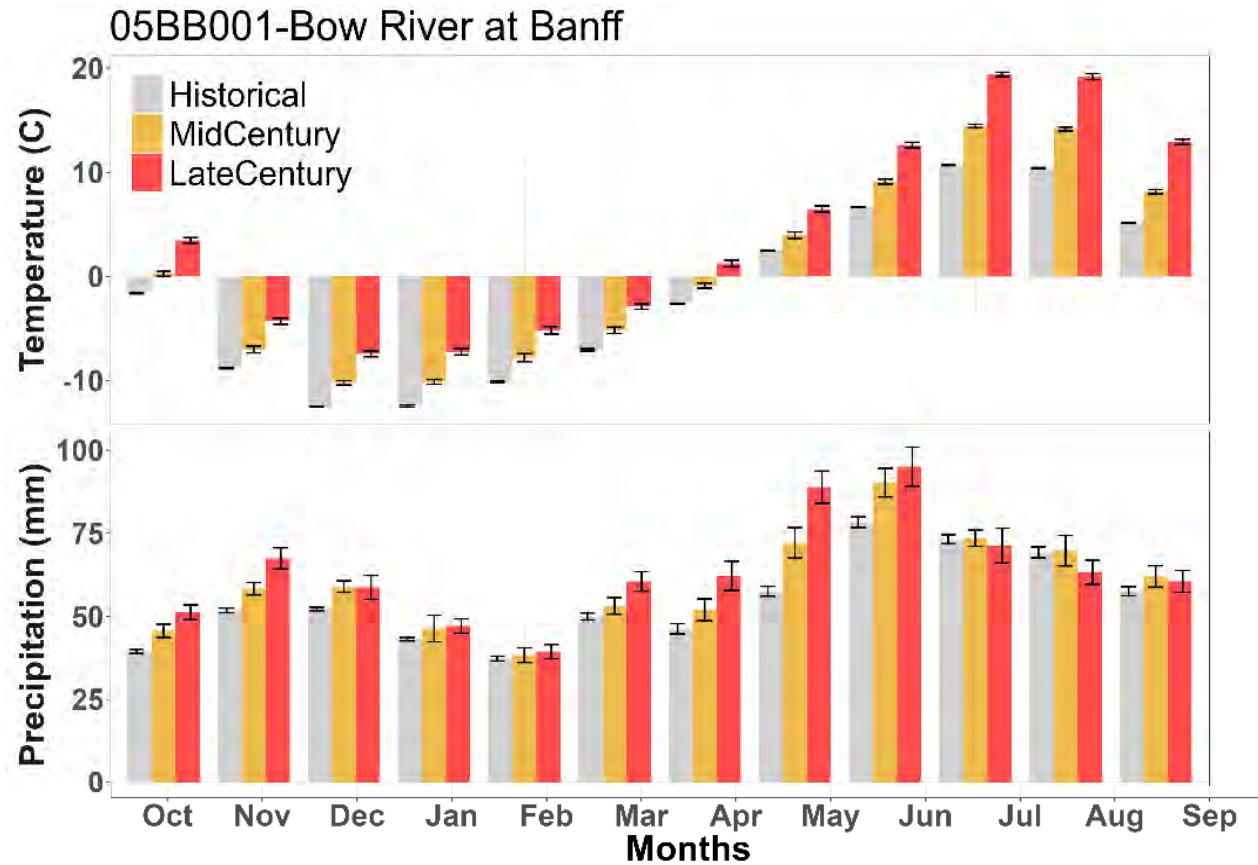
05CC002-Red Deer at Red Deer



Historical is 1980-2010



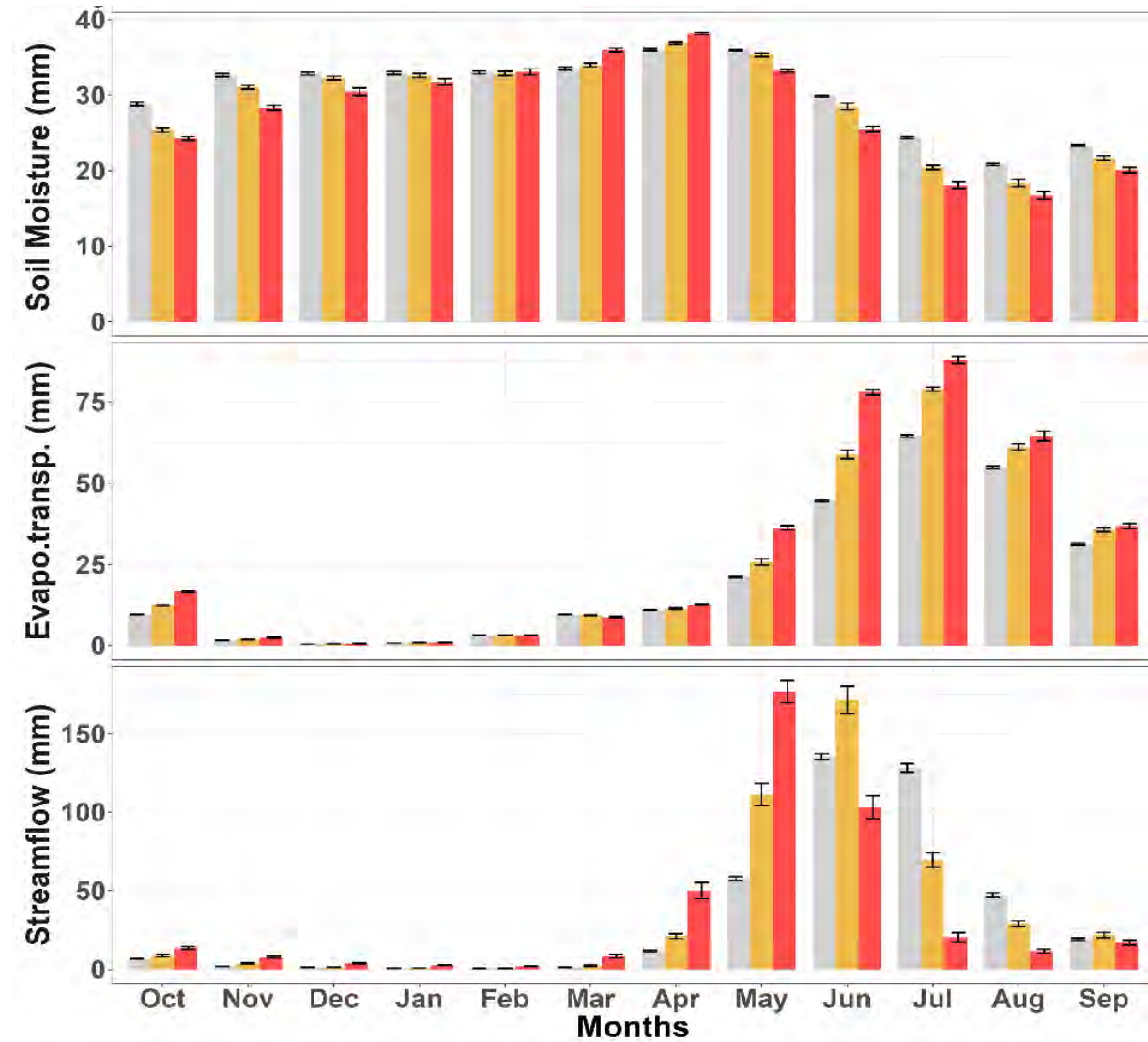
Climate Change in Bow River Basin



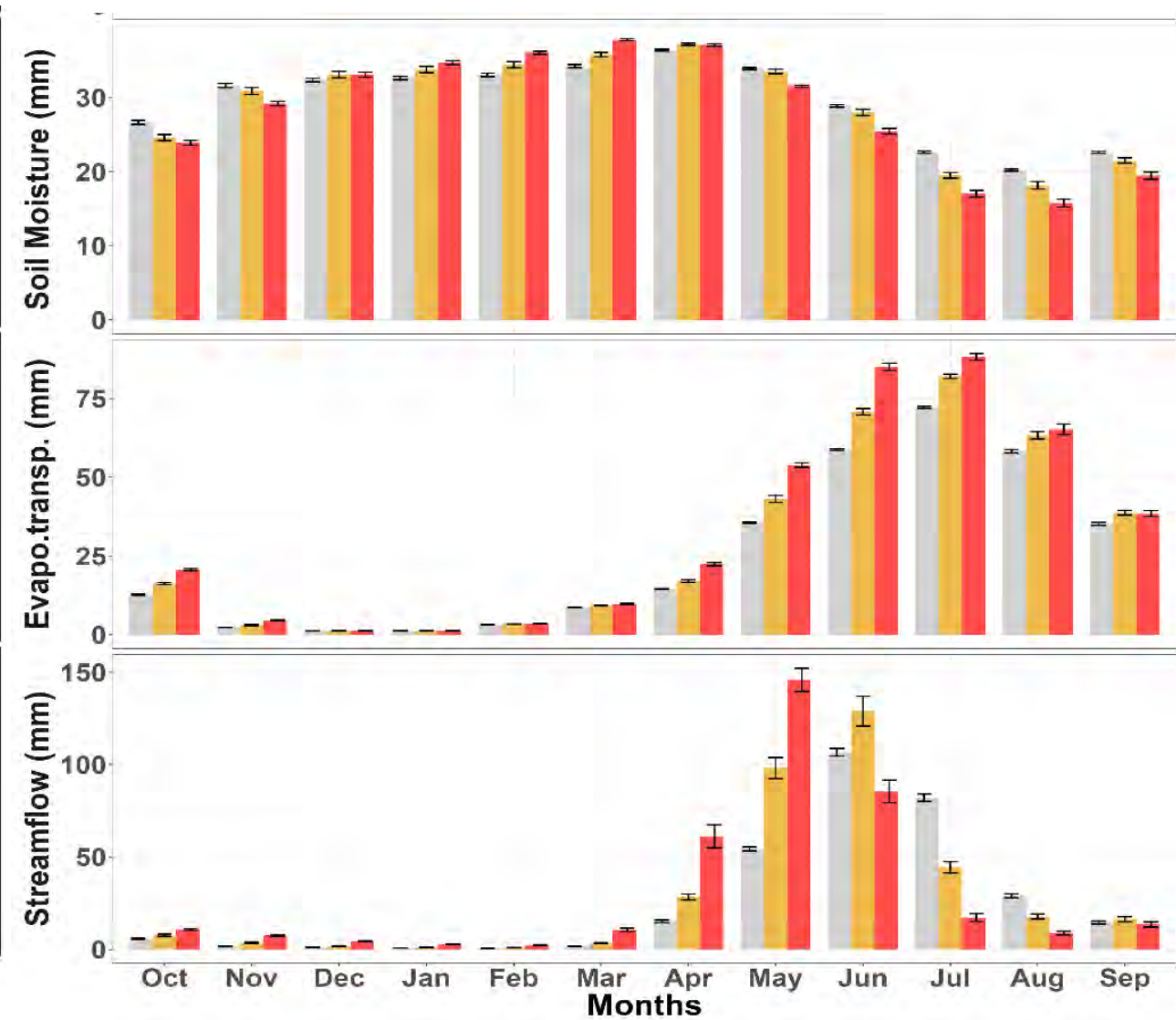
Historical is 1980-2010

Hydrological Change in Bow River Basin

Bow River Basin at Banff

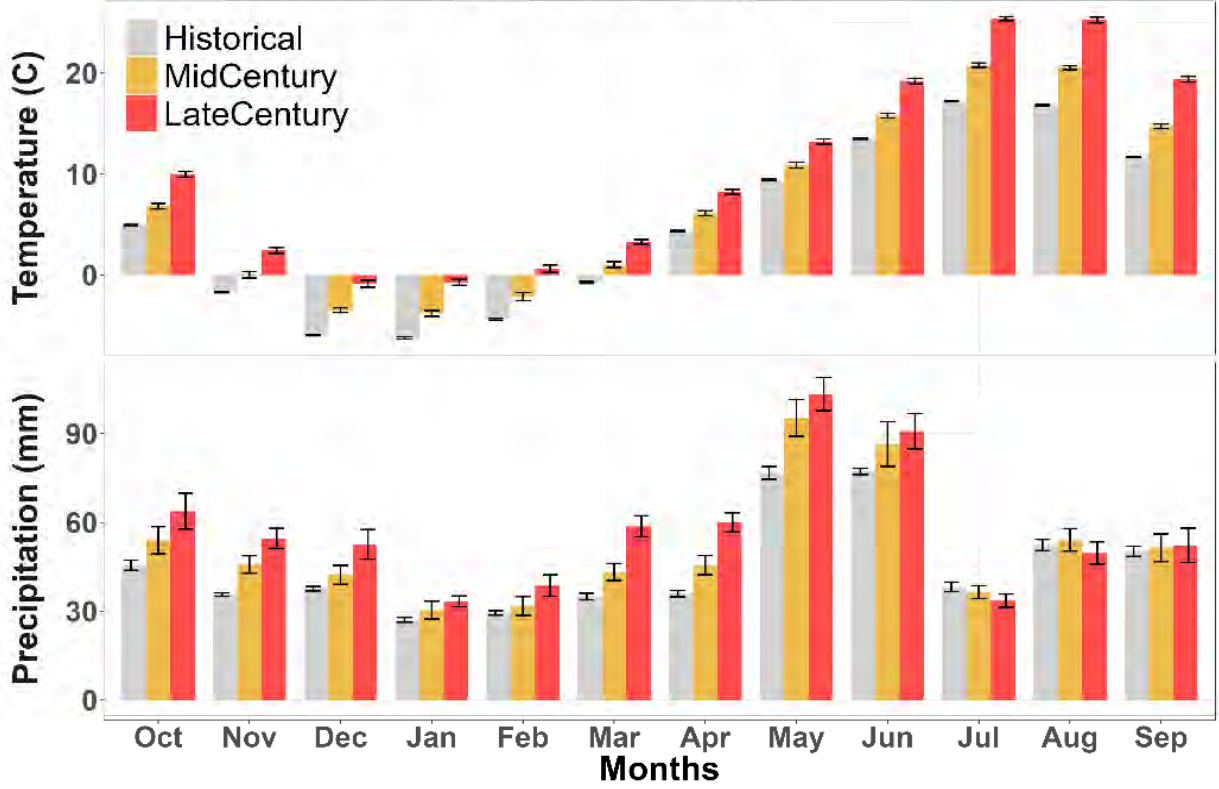


Bow River Basin at Calgary

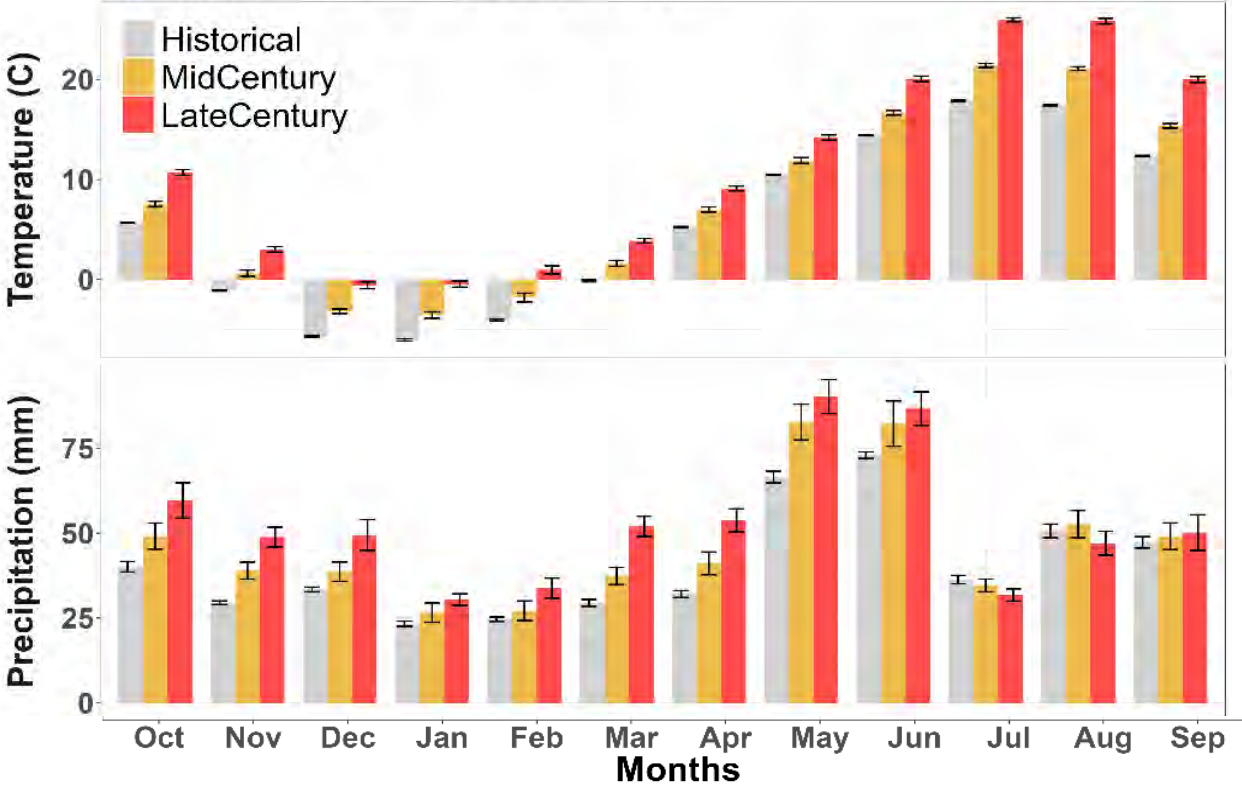


Climate Change in the Oldman River Basin

05AD007-Oldman River at Lethbridge

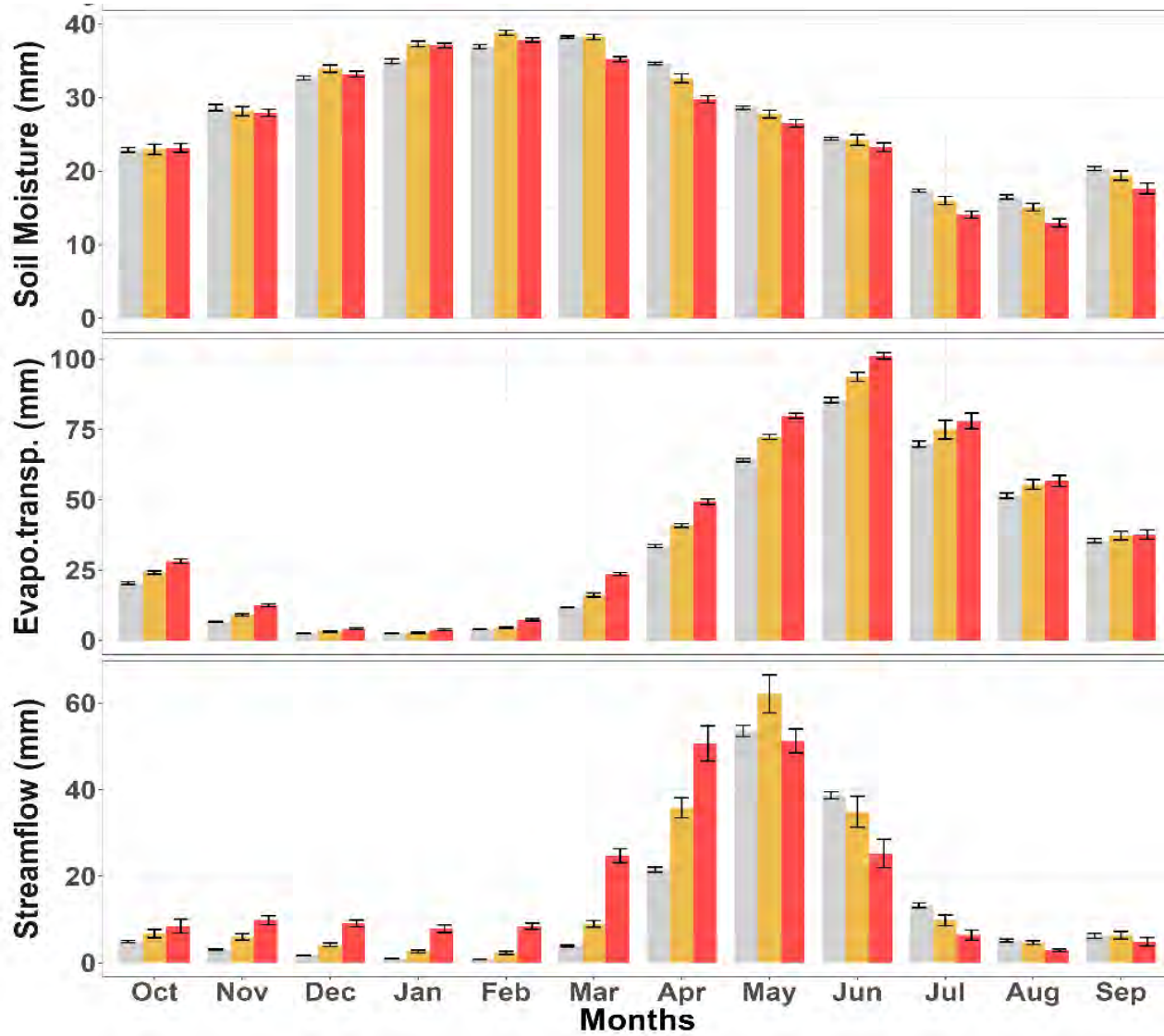


05AG006-Oldman River at Mouth

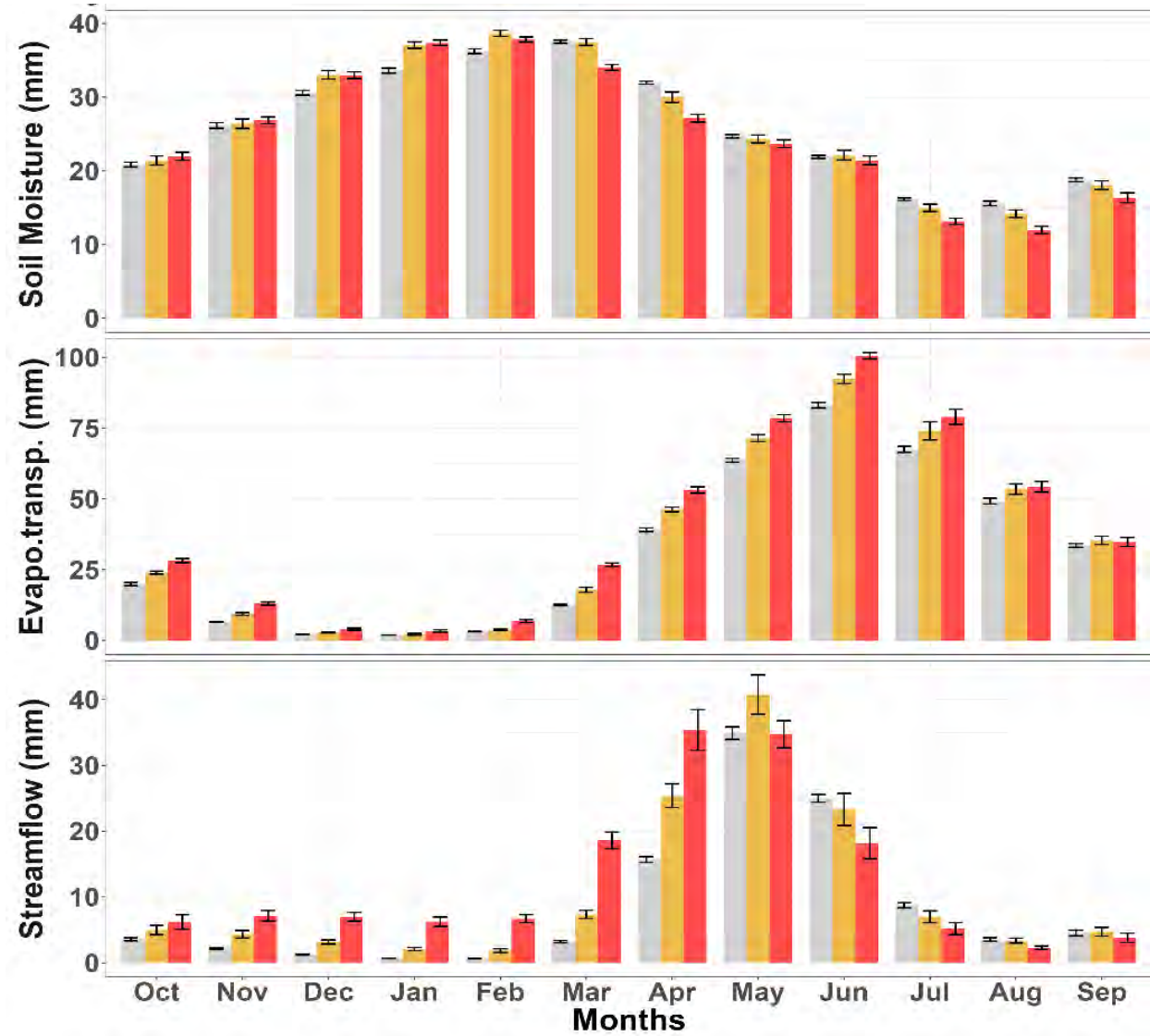


Hydrological Change in the Oldman River Basin

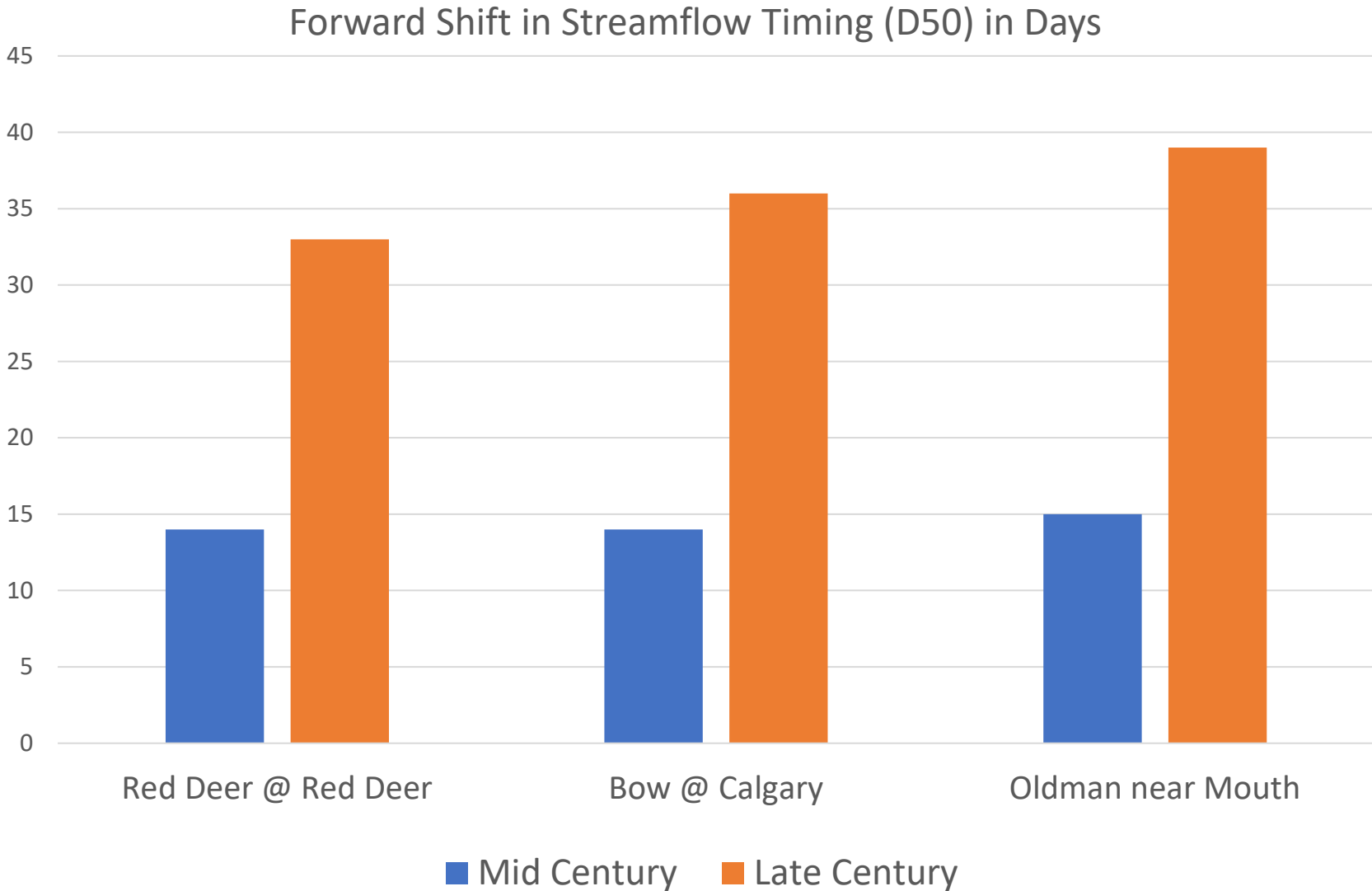
Oldman River @ Lethbridge



Oldman River @ The Mouth

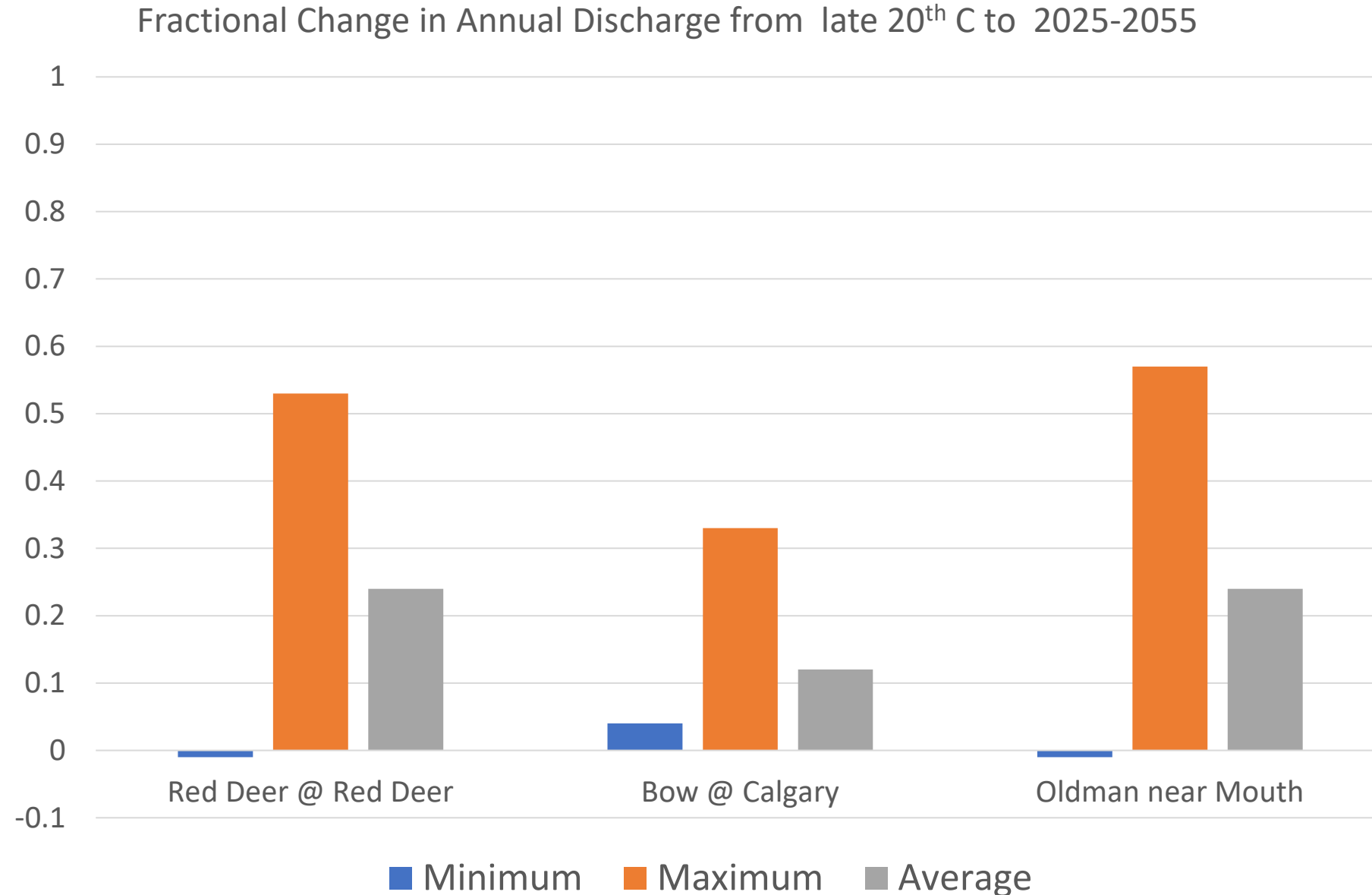


Changing in River Flow Timing

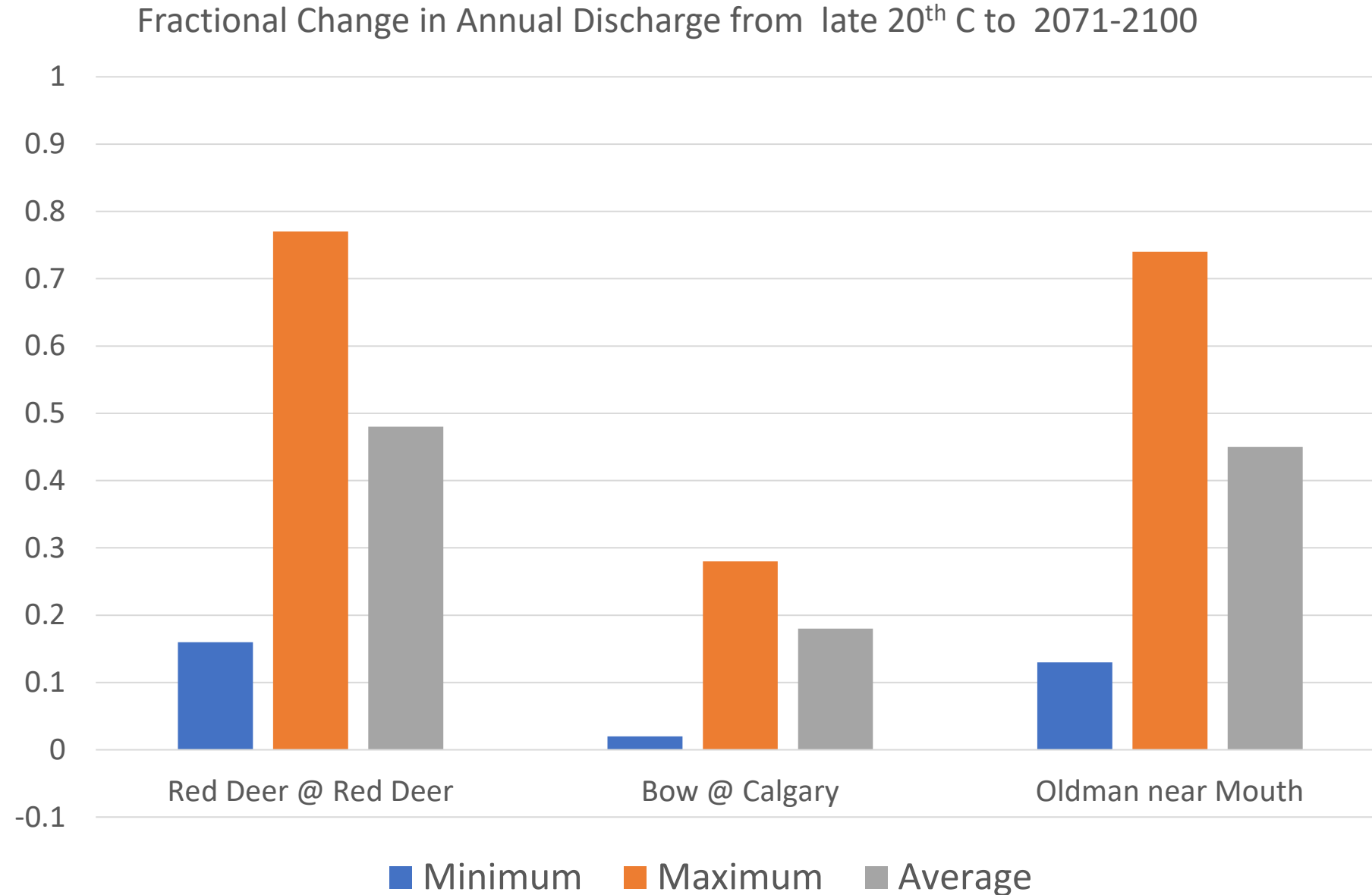


D50 is the Centre of Mass of Streamflow, the timing is the day of the year in which this occurs

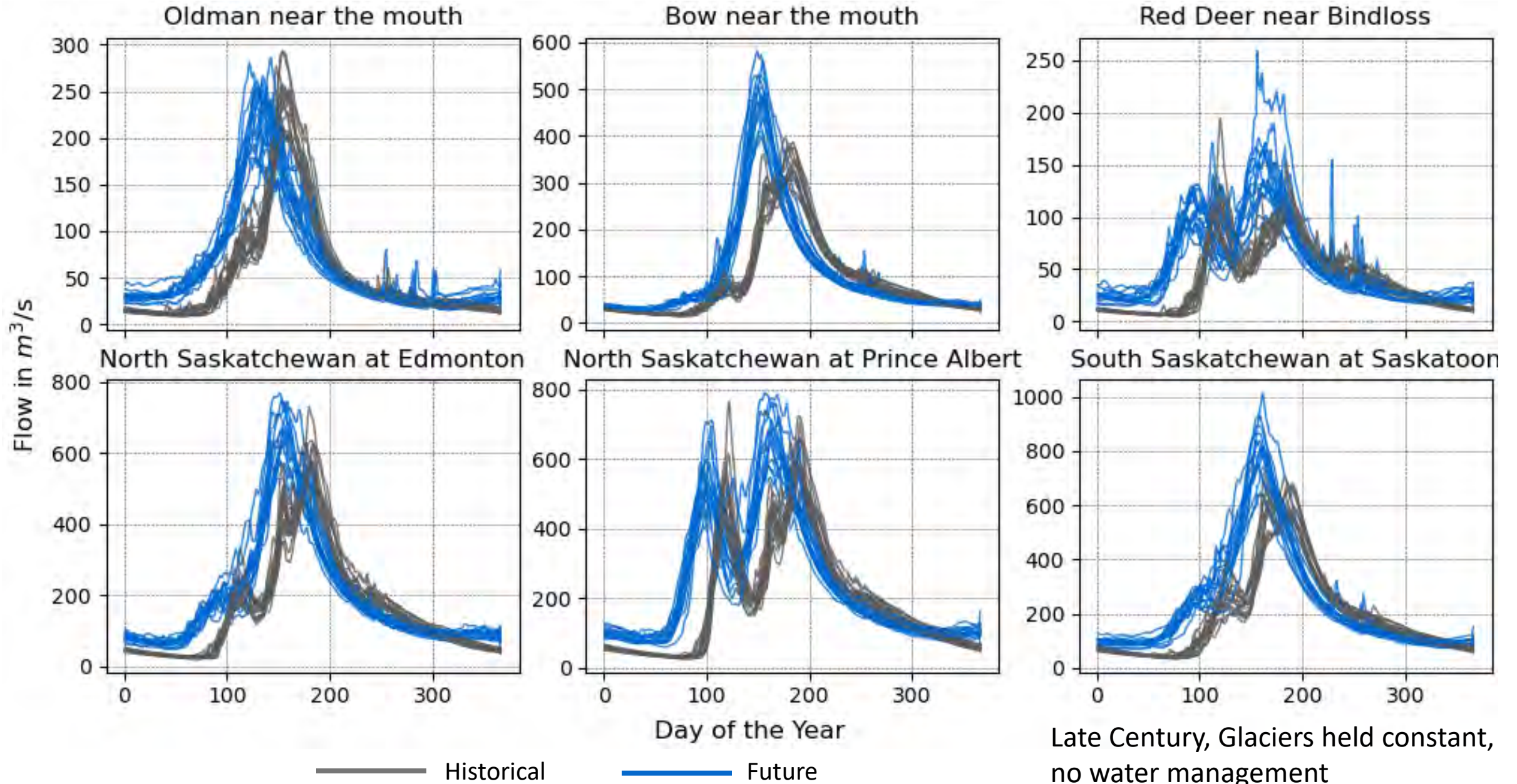
Changes in Annual Water Supply by early Mid Century



Changes in Annual Water Supply by Late Century



Saskatchewan River Basin – Natural Streamflow Change



Conclusions

- 5 °C or more of warming is possible by the end of the century with increased rainfall likely, except in summer which may be drier.
- Glacier retreat and melt is accelerating – glacier contributions to water in the irrigated districts of Alberta are declining and will be negligible in a few decades.
- Droughts to become more common, longer and severe – intervened by very wet periods.
- Snow management and residue retention can increase yields by more than 20% in years with dry summers.
- Detailed hydrological model coupled to a future climate model provides possible future impacts of climate change on Alberta's water supplies –
 - rising temperatures
 - rising winter/spring rainfall
 - declining summer rainfall.
- Timing of major mountain river discharges will be accelerated by **15 days in mid-century** and by **one month by late century**
- Major mountain river annual discharges might **decrease slightly or increase by up to half** of current flows by **mid-century**
- Major mountain river annual discharges might **not change or increase by up to ¾** of current flows by **late century**
- **Drop in June-July-August river flows** in most scenarios, sometimes to 50% of current flows.

Future Considerations

- Much warmer temperatures, wetter winters, earlier springs, drier summers are likely
- Variability of water supply and soil moisture conditions will increase – more floods and droughts of greater severity and duration
- Mountain streamflow will come earlier and fluctuate more due to declining snow and glaciers
- Irrigation demand is likely to increase in warmer, drier summers
- Crop growth potential and crop variety range may increase in warmer summers
- More efficient irrigation application, adapted crops and increased water storage (on farm, wetland, reservoir, groundwater?) will be needed to maintain or increase irrigated agriculture in the Prairies
- Irrigation expansion? Need to carefully assess demand vs supply and ecosystem/human needs in light of increased variability and changes to storage over the whole Saskatchewan-Nelson Basin
- Need to observe, predict and preserve the mountain headwaters supply and quality will become even greater.



Global Water Futures

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