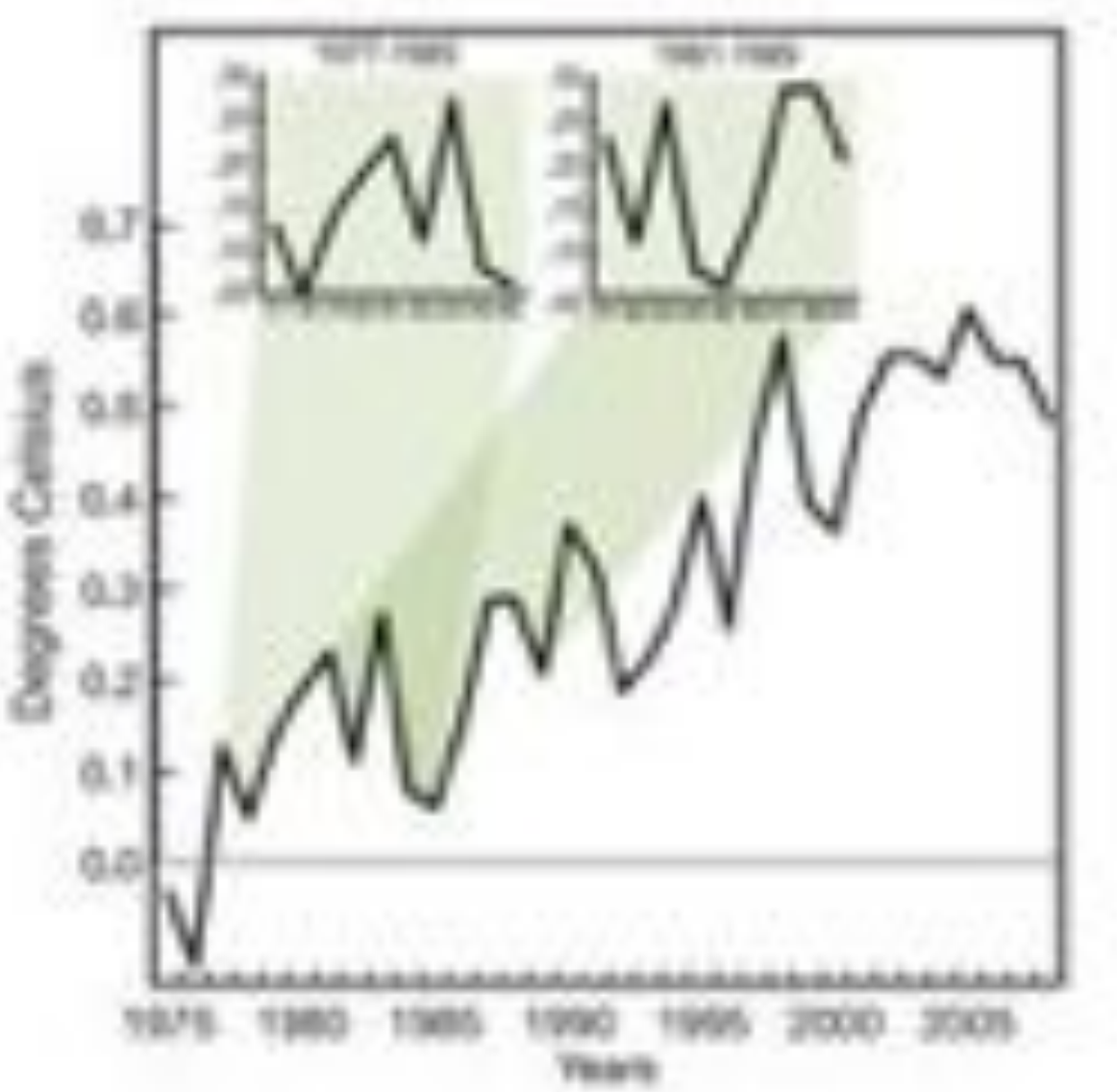
Regional Climate Change and Variability Projections

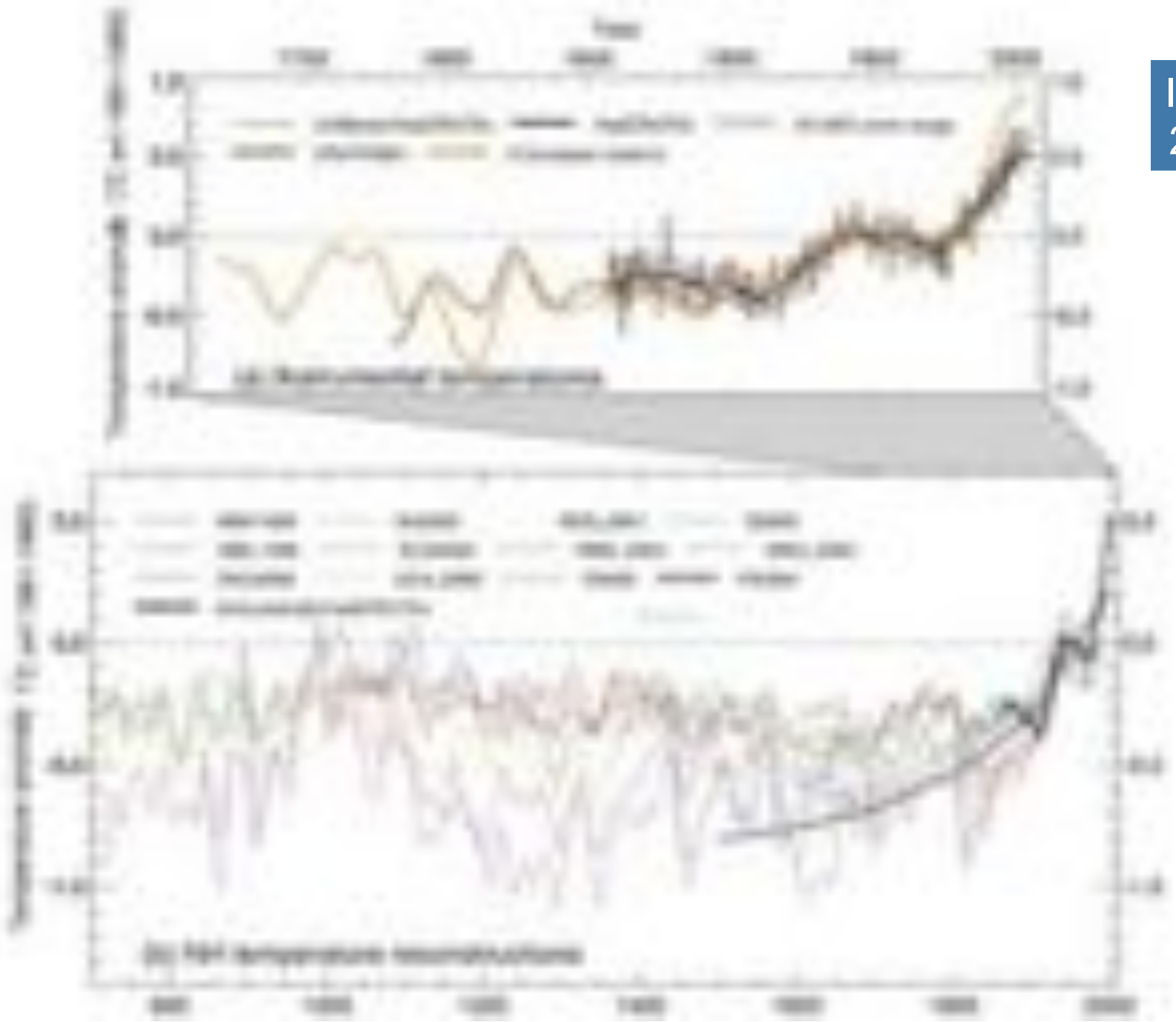
Dave Sauchyn, Prairie Adaptation Research Collaborative, U of R

***Crown Managers Forum,* Fernie, BC, April 14, 2010**

Is the climate warming or cooling?

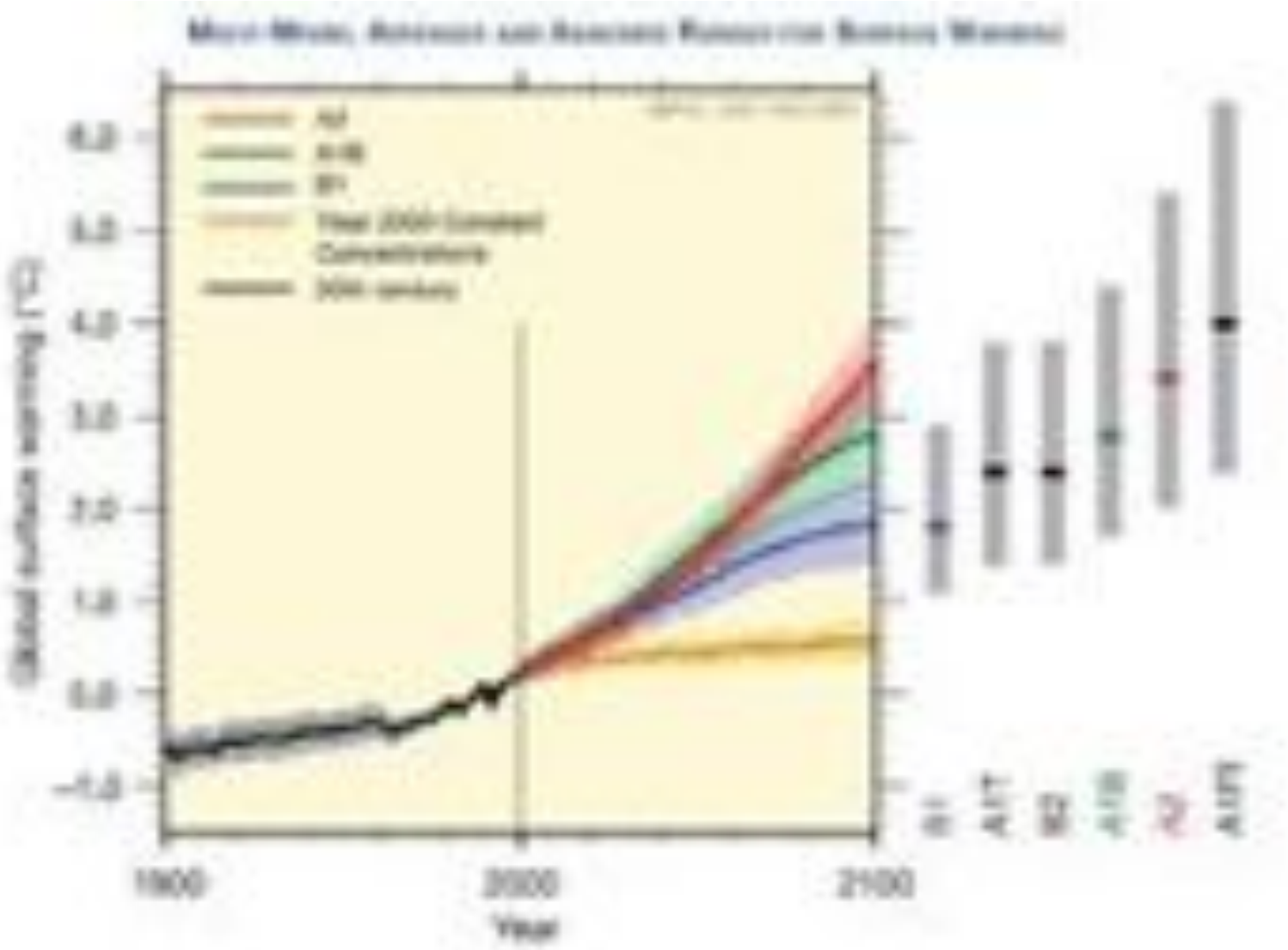


Easterling and Wehner, 2009

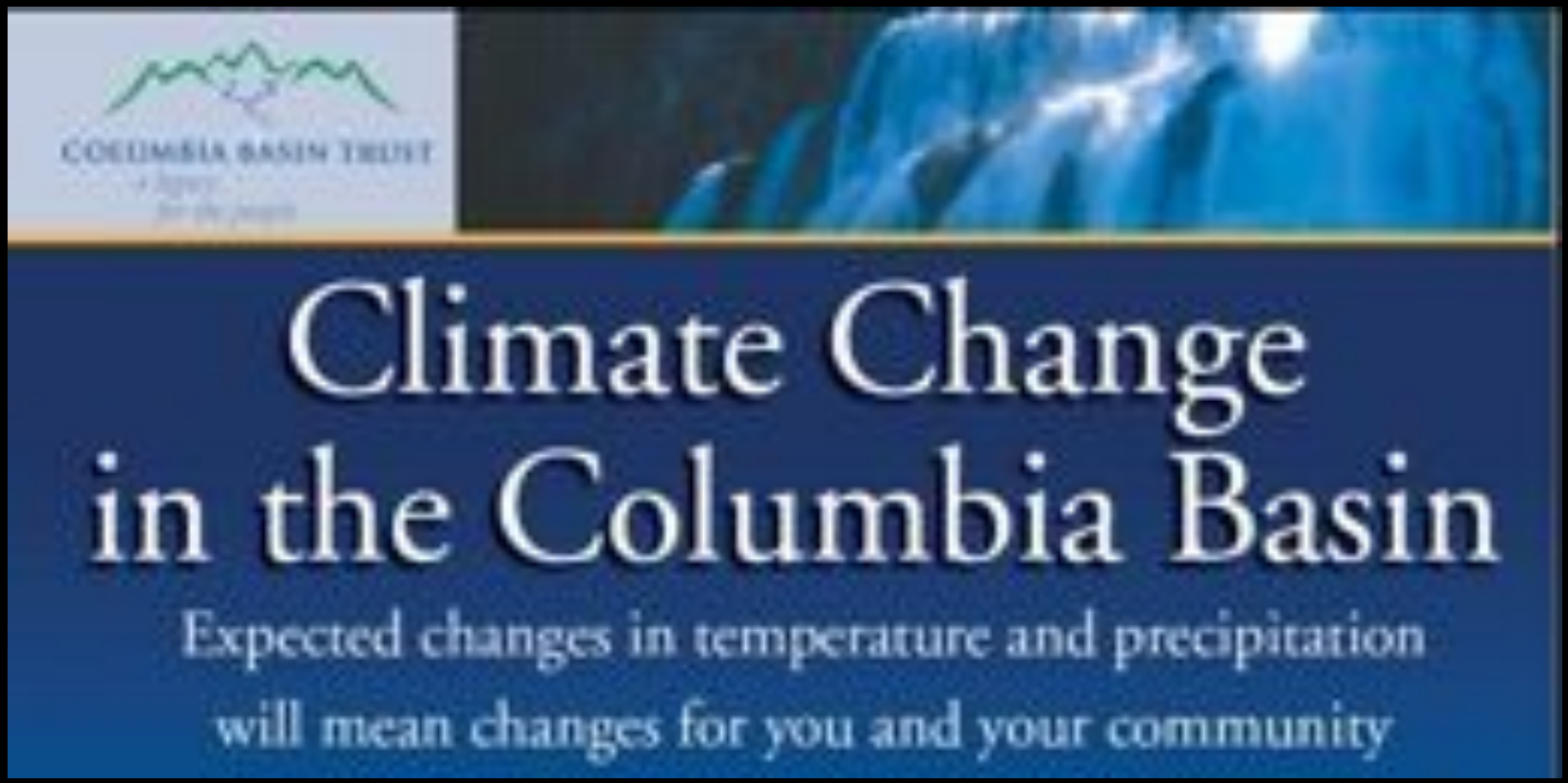


IPCC
2007

Climate Projections (IPCC 2007)



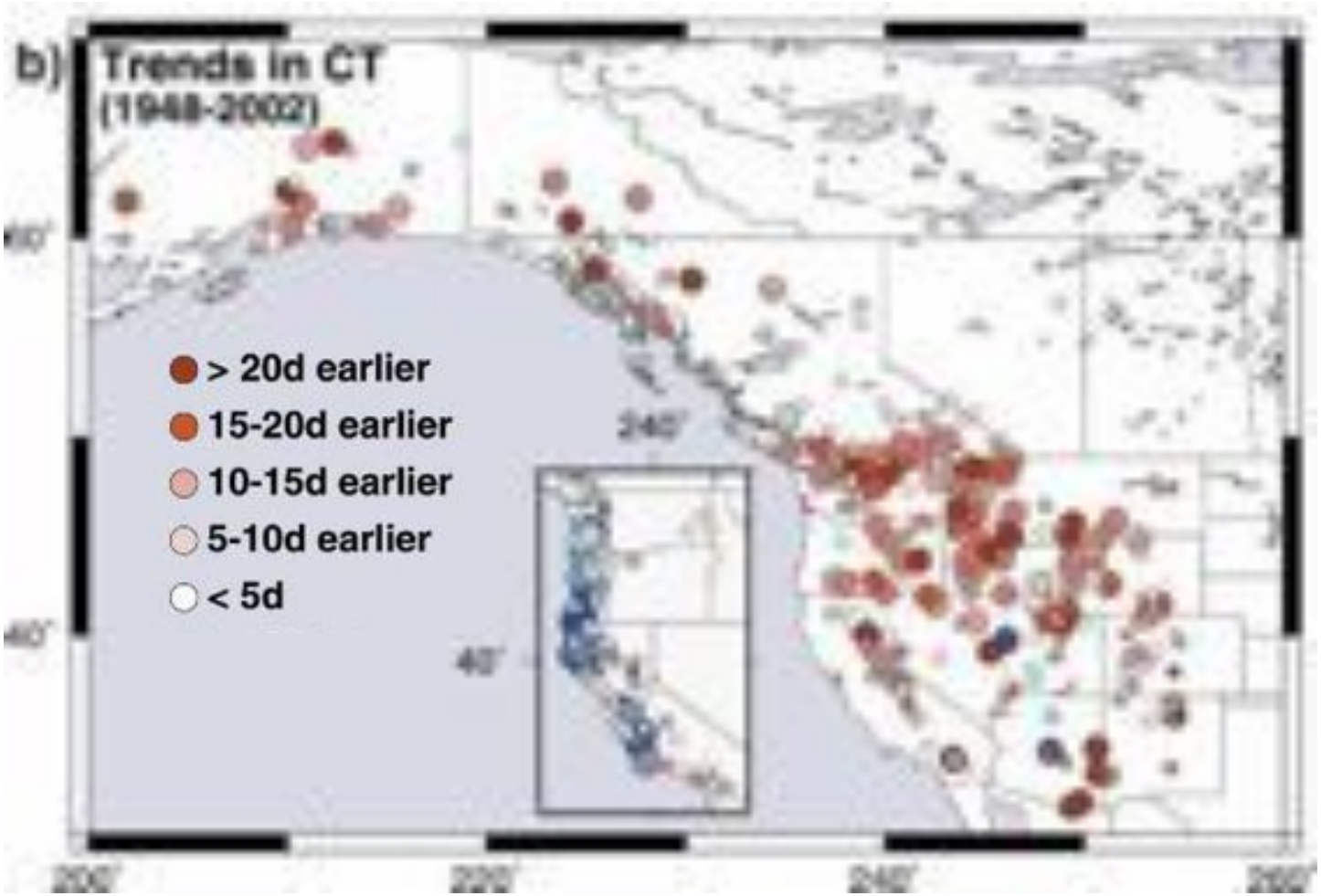
Anthropogenic warming and sea level rise would continue for centuries, even if greenhouse gas concentrations were to be stabilized.



PACIFIC CLIMATE IMPACTS CONSORTIUM

Canada contributes about
40% of the total runoff
in Columbia River,
with only 15% of the area.

Trends in date of center of mass of annual flow

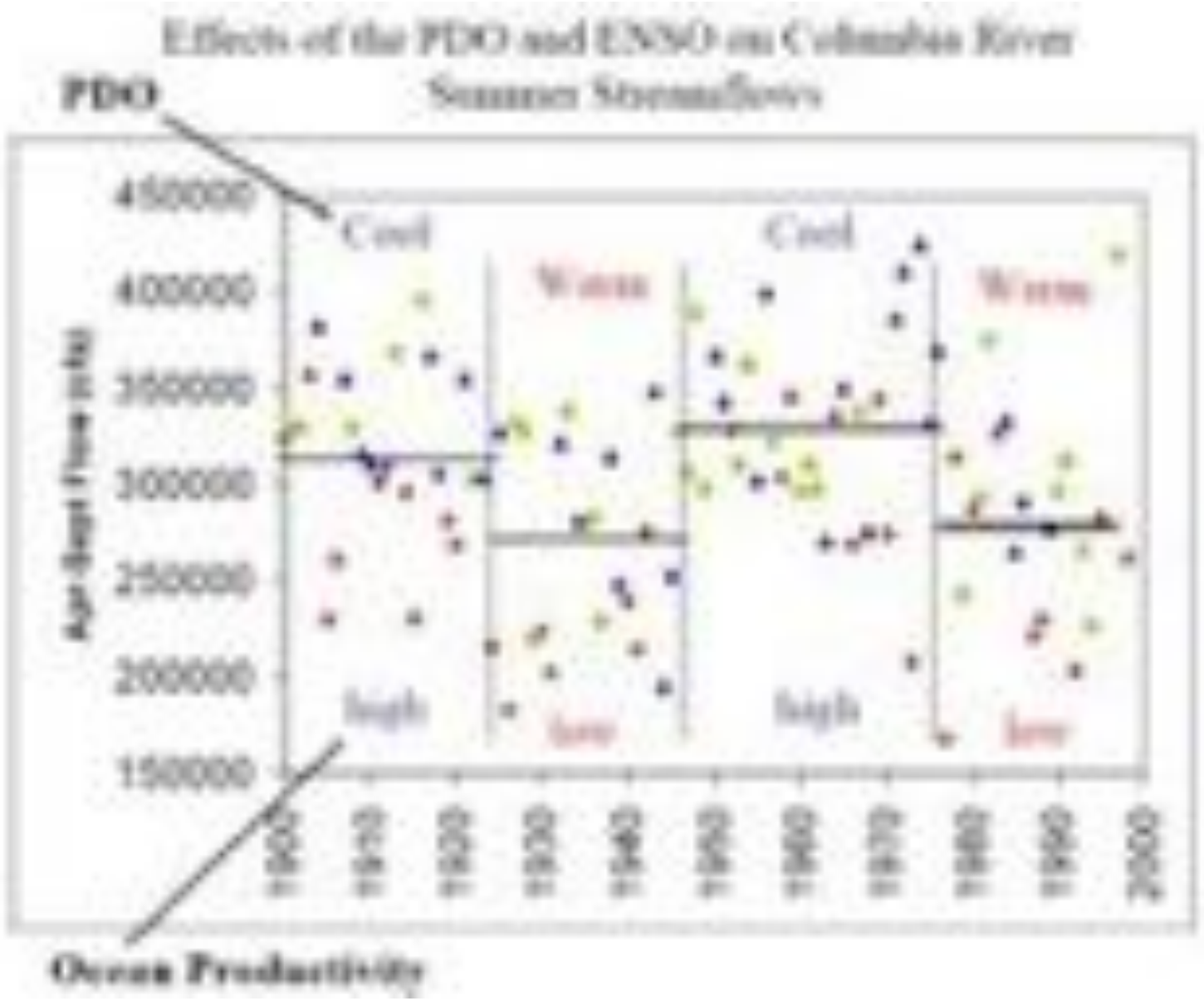


Stewart et al. 2005

Trends in April 1 SWE, 1960–2002

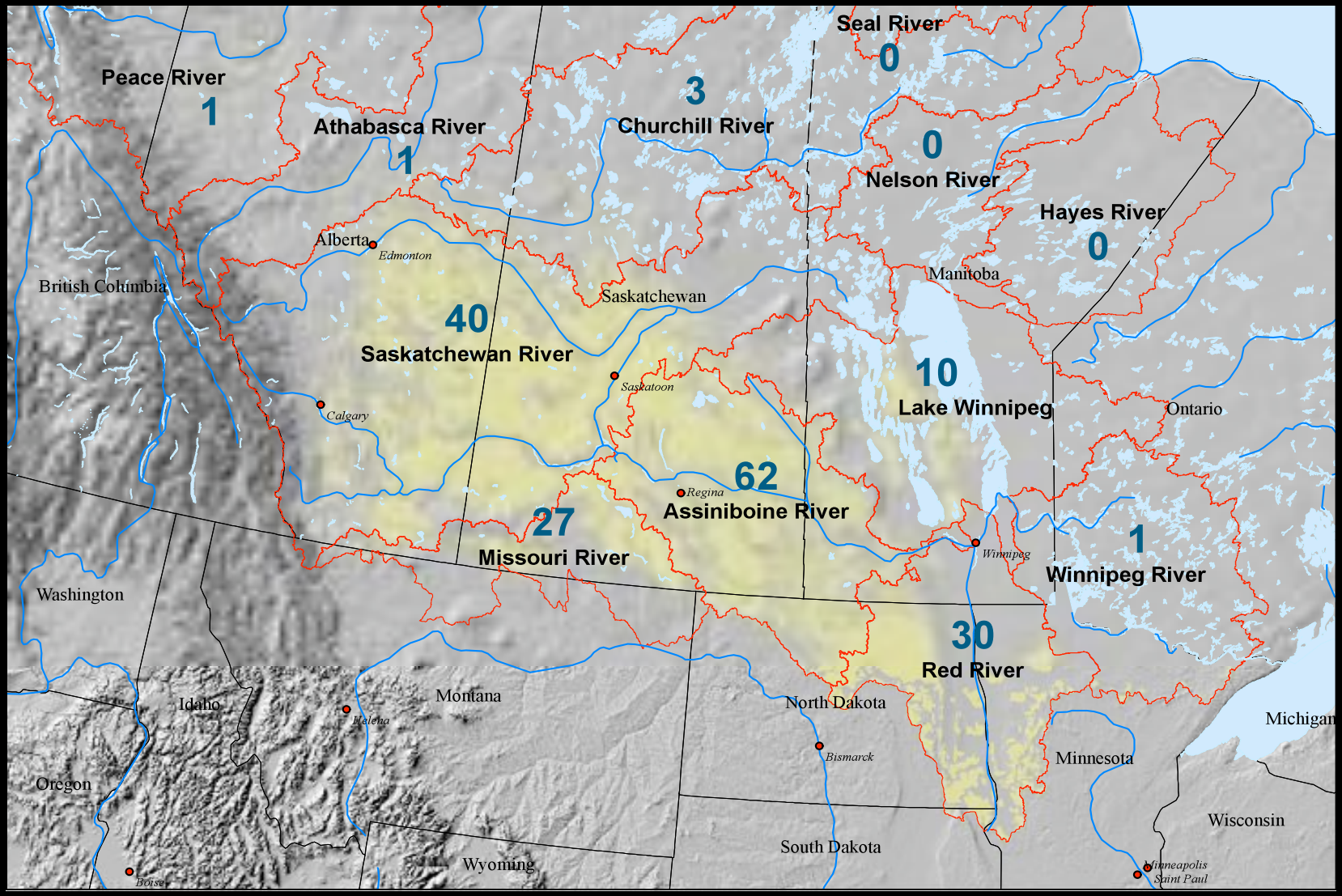
…even after accounting for the role of known patterns of climate variability, there is a substantial downward trend in overall snowpack in the West that is consistent with the observed warming.

Mote, 2006



Hamlet et al. 2005

Prairie Drainage Basins (source: PFRA)



Prairie Adaptation Research Collaborative

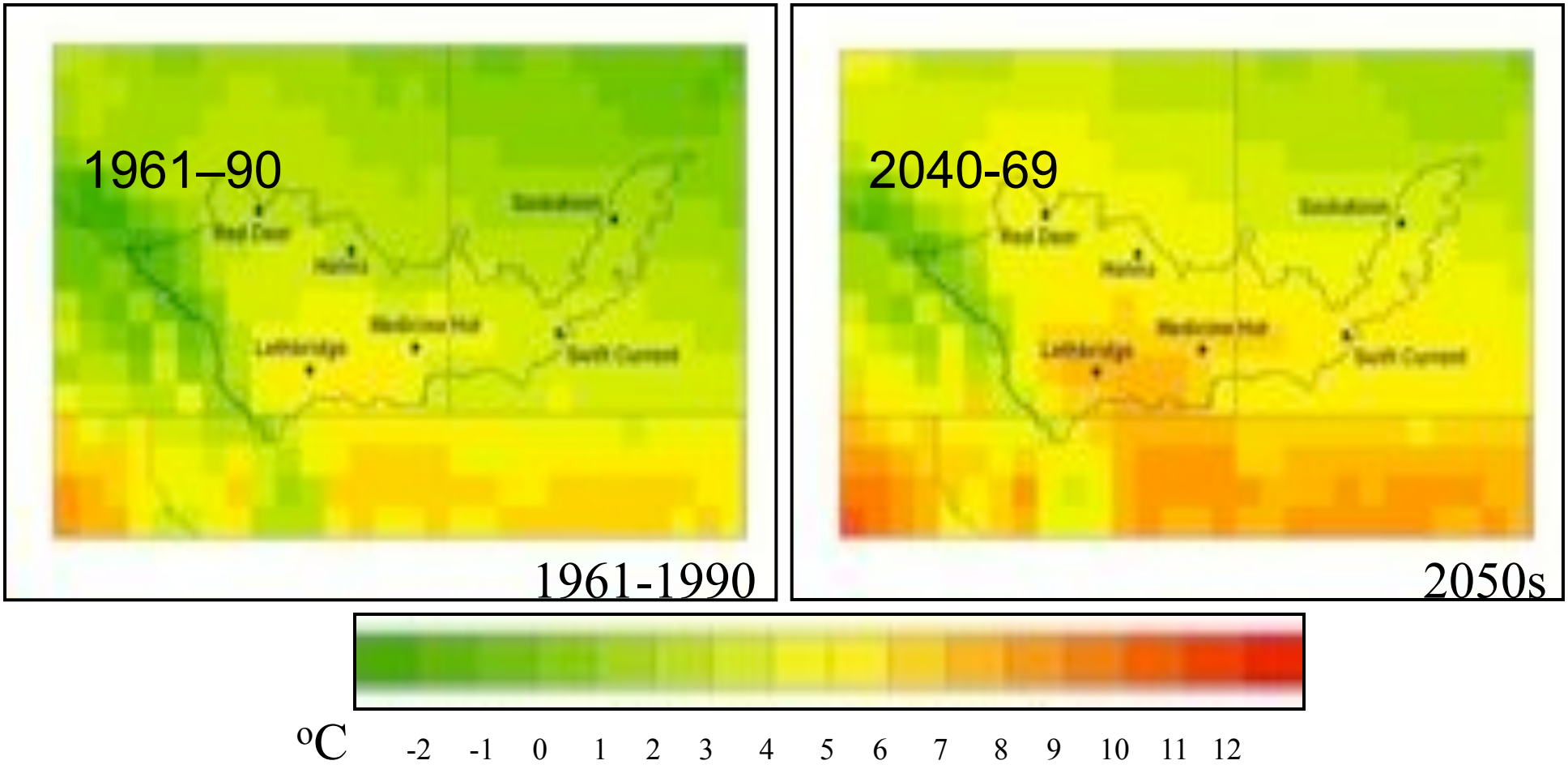
PARC is a partnership of the governments of Canada, Alberta, Saskatchewan and Manitoba mandated to pursue climate change impacts and adaptation research in the Prairie Provinces.

- Alberta Vulnerability Assessment Project, Alberta Environment
  - Climate Change Scenarios
  - Biophysical Impact Assessment
  - Integrated Vulnerability Assessment

- Prairies Chapter, National Assessment of Climate Change Impacts and Adaptation

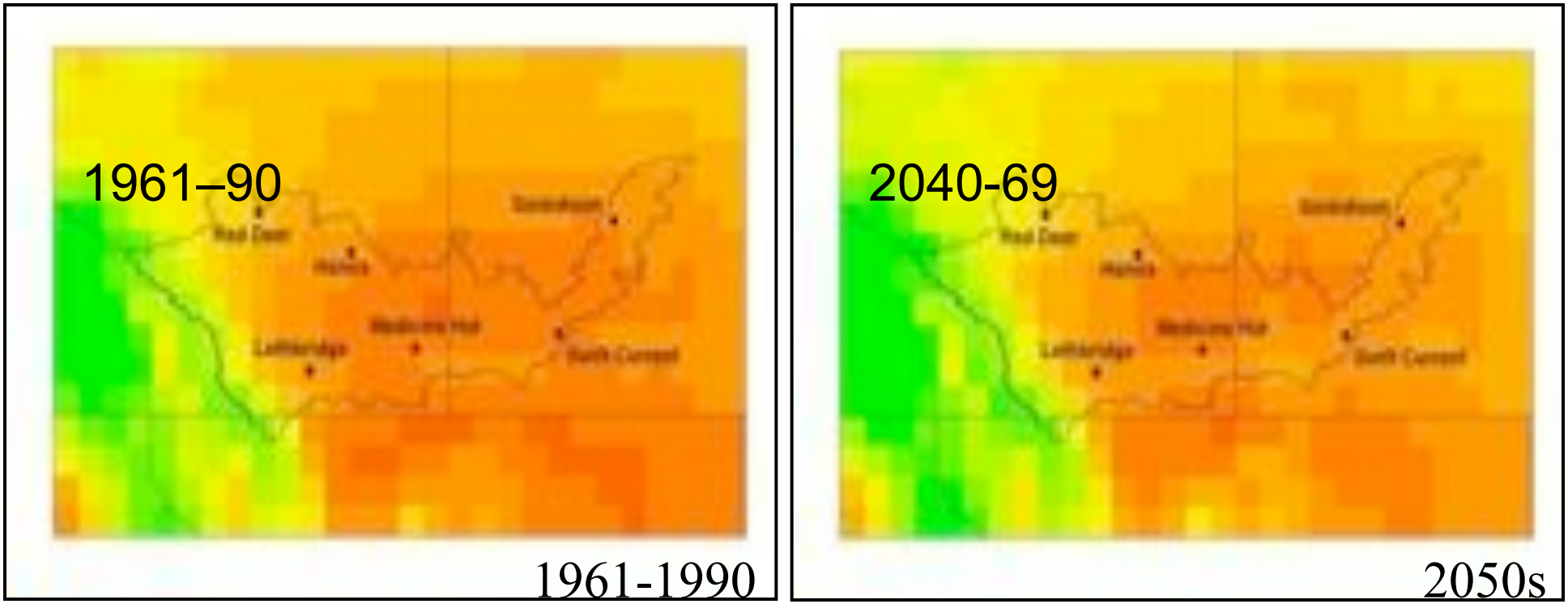
- Institutional Adaptation to Climate Change, Elqui (Chile) and South Saskatchewan (Canada) River Basins

Annual Temperature



These median scenarios were derived from the Canadian Global Climate Model (CGCM) version 3.1/T47 and greenhouse gas emission scenario B1(2).

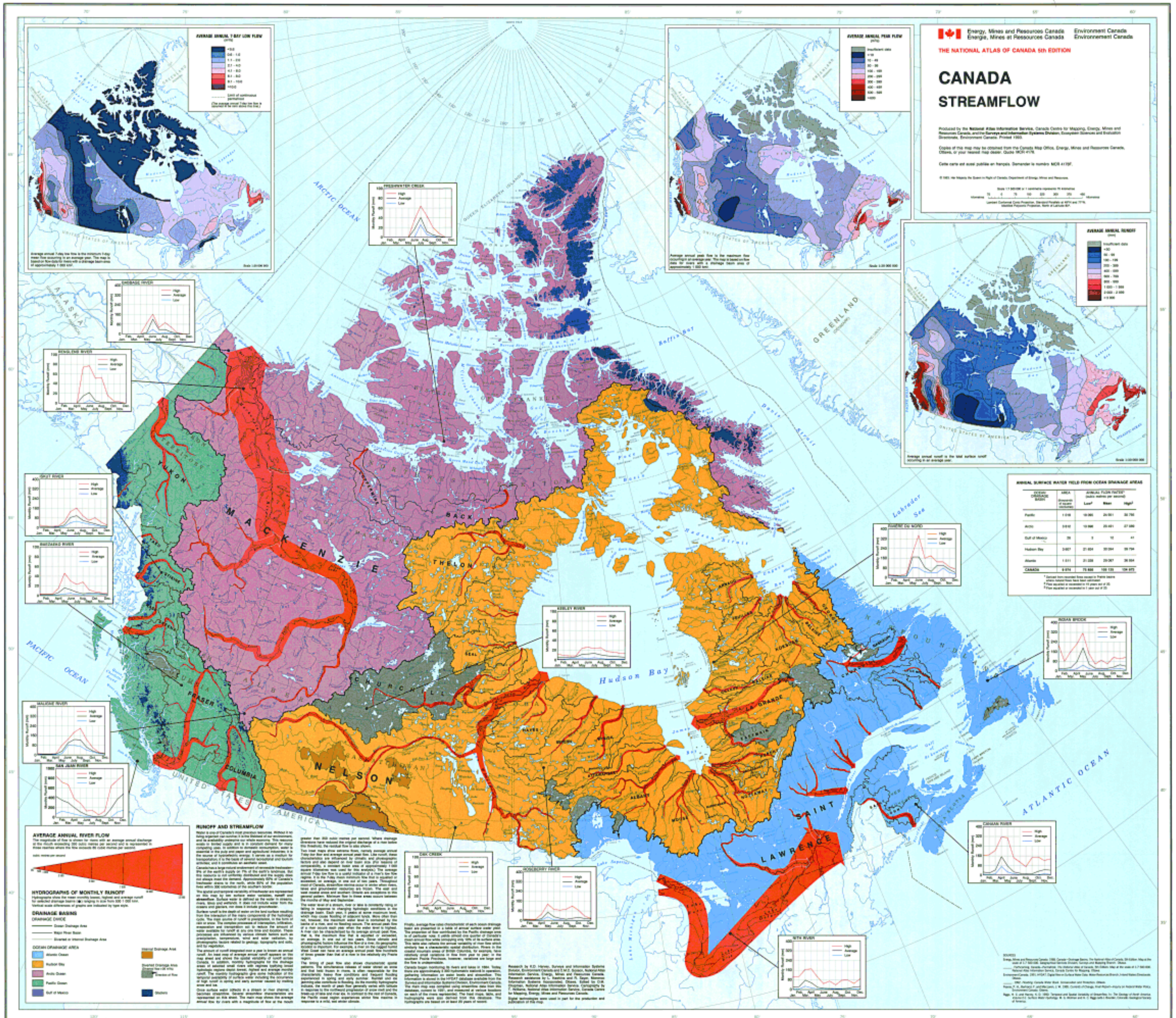
Annual Precipitation



These median scenarios were derived from the Canadian Global Climate Model (CGCM) version 3.1/T47 and greenhouse gas emission scenario B1(2).

The recent warming exceeds the global average

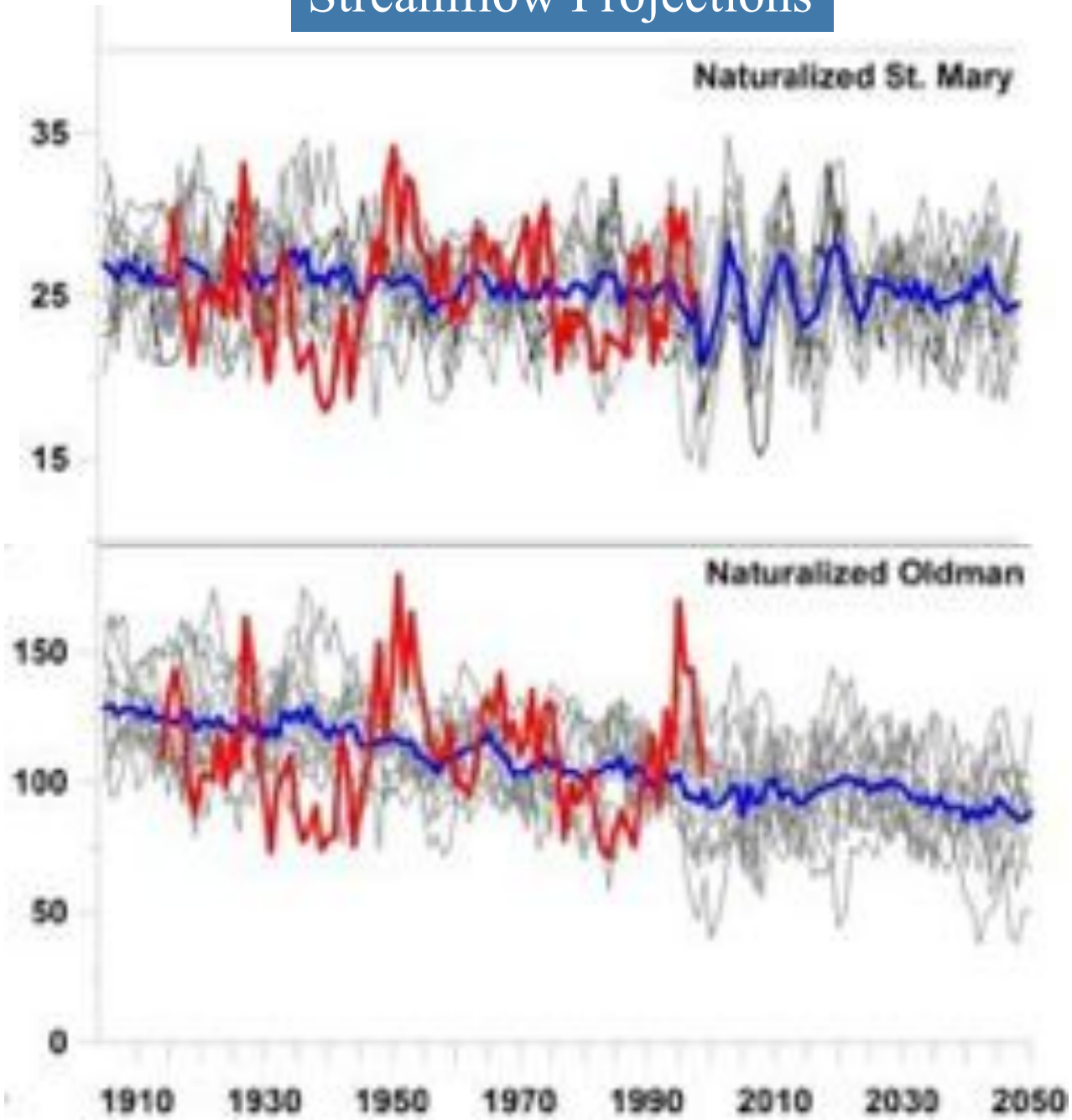
Future climates are outside the range of natural variability


Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada
Environment Canada
Environnement Canada
THE NATIONAL ATLAS OF CANADA 5th EDITION
CANADA
STREAMFLOW
AVERAGE ANNUAL 7 DAY LOW FLOW
AVERAGE ANNUAL PEAK FLOW
AVERAGE ANNUAL RUNOFF
ANNUAL SURFACE WATER YIELD FROM OCEAN DRAINAGE AREAS
AVERAGE ANNUAL RIVER FLOW
HYDROGRAPHS OF MONTHLY RUNOFF
DRAINAGE BASINS
RUNOFF AND STREAMFLOW
ARCTIC OCEAN
PACIFIC OCEAN
ATLANTIC OCEAN
Hudson Bay
GREENLAND
ALASKA
UNITED STATES OF AMERICA
MACKENZIE
NELSON
SAINT LAWRENCE
YUKON
FRASER
COLUMBIA
CHURCHILL
BACK
THELON
LA GRANDE
Labrador Sea
Baffin Bay
Davis Strait

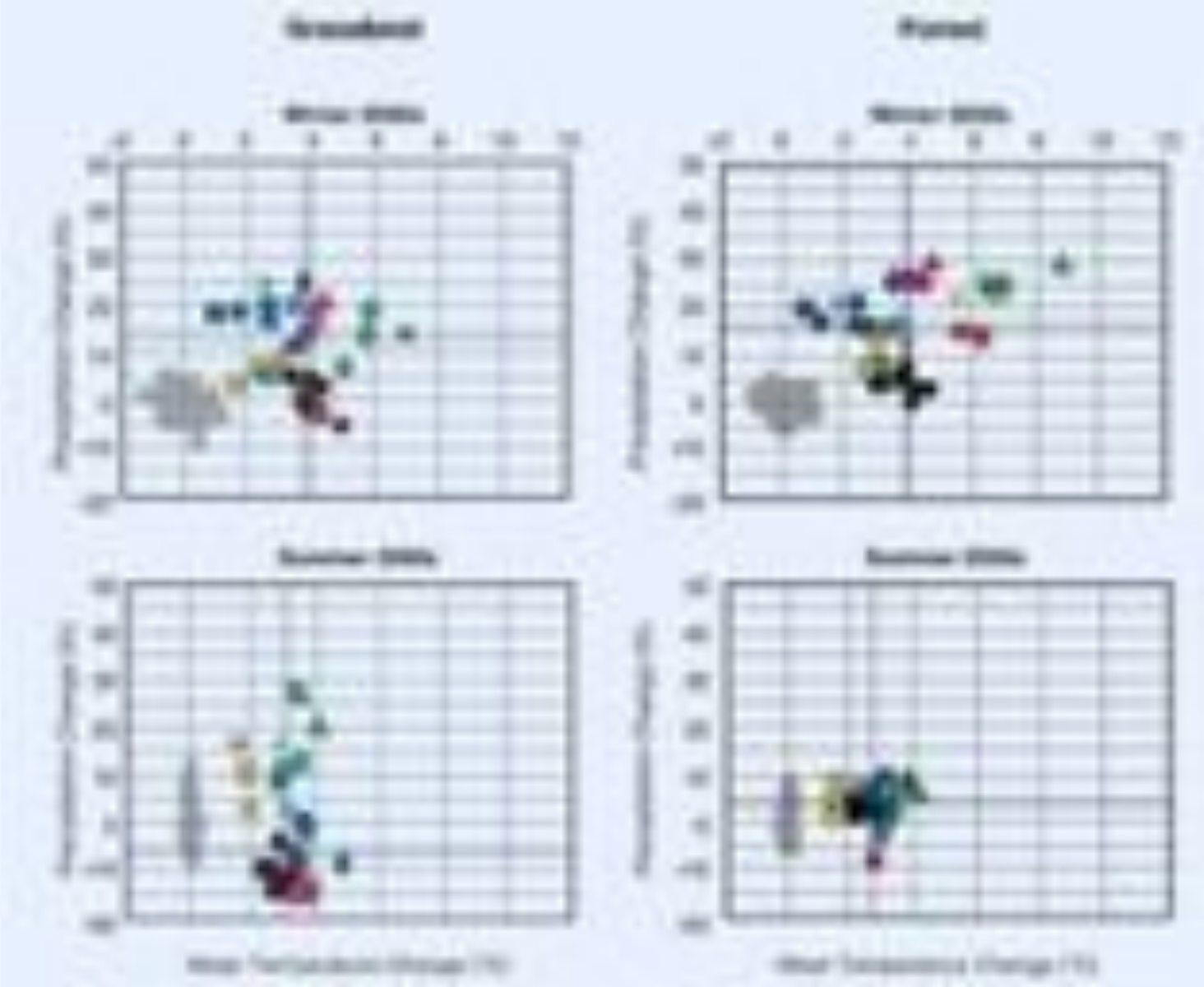
Canada

Global Warming Amplifies Hydro-Climatic Variability

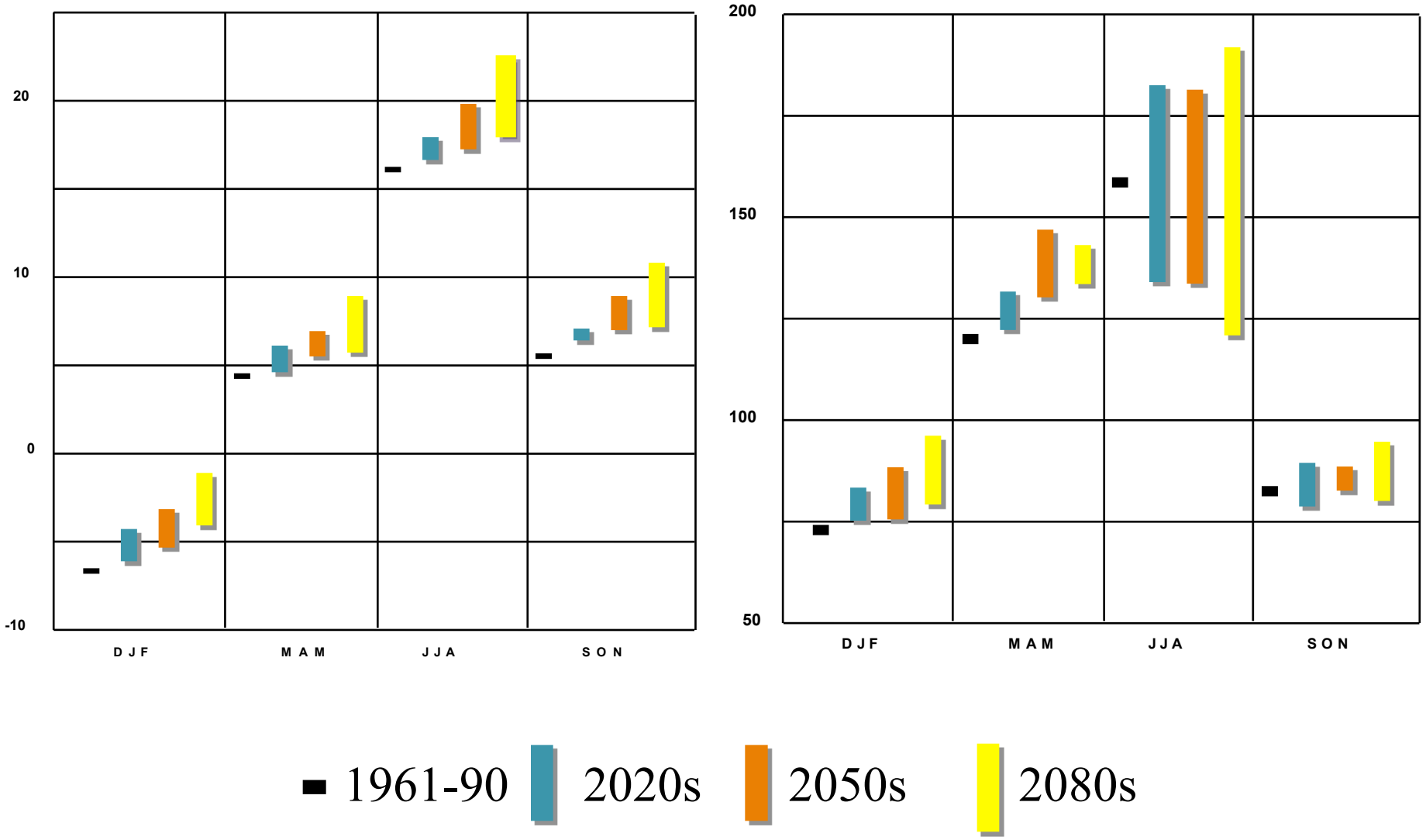
Streamflow Projections



Seasonal Scenarios



Temperature – Lethbridge - Precipitation

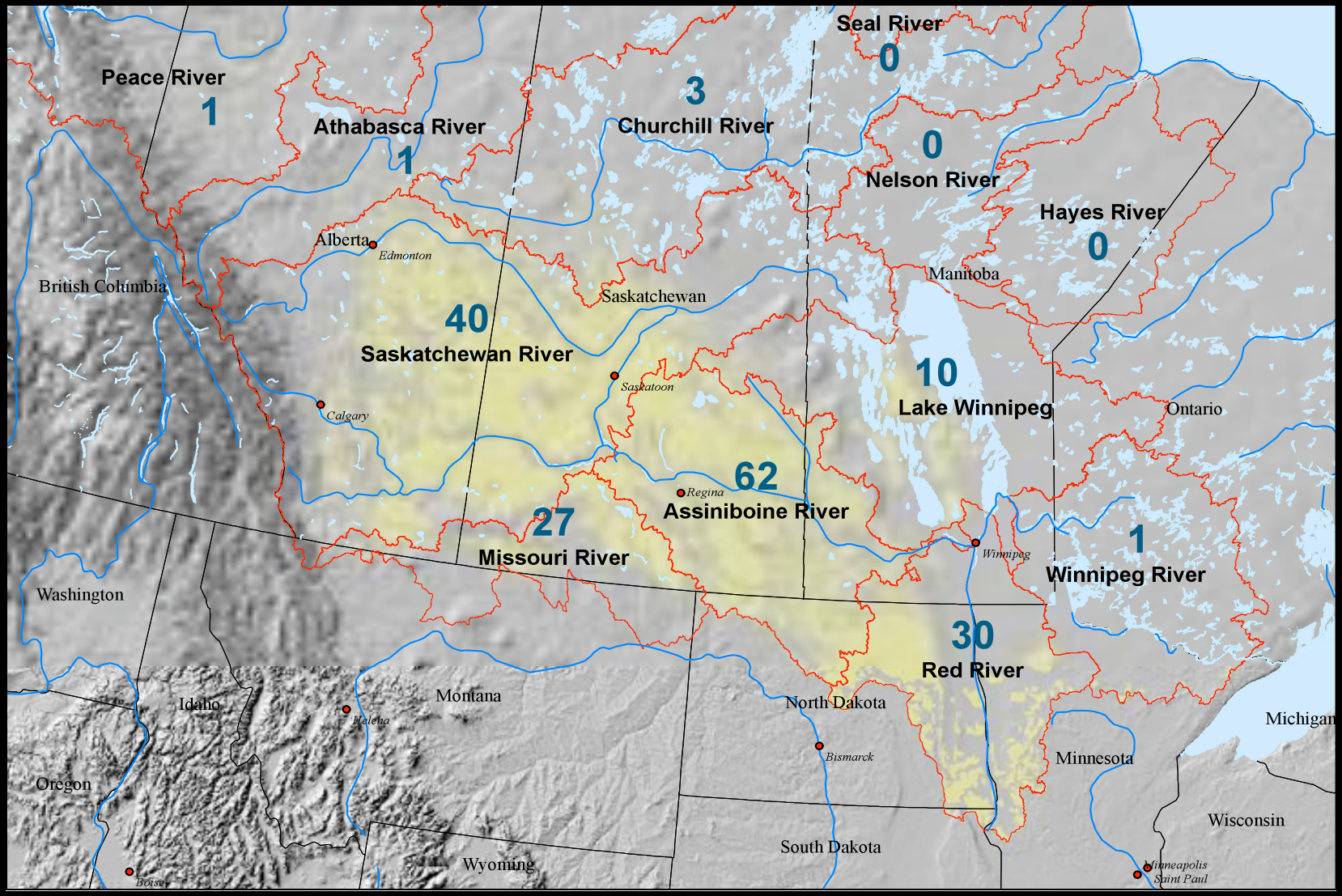


One of the most certain projections is that extra water will be available in winter and spring, while summers generally will be drier

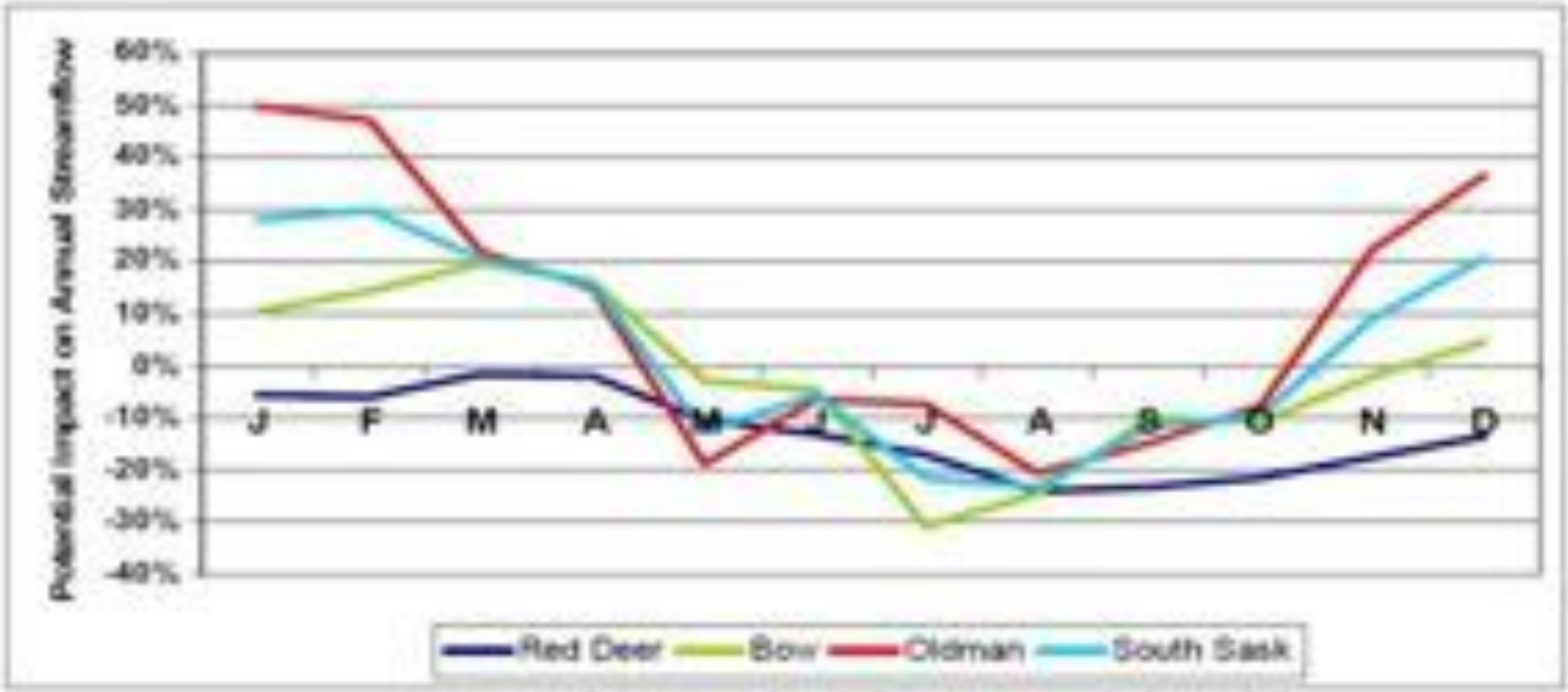
On average, there will be slightly to significantly less surface and soil water

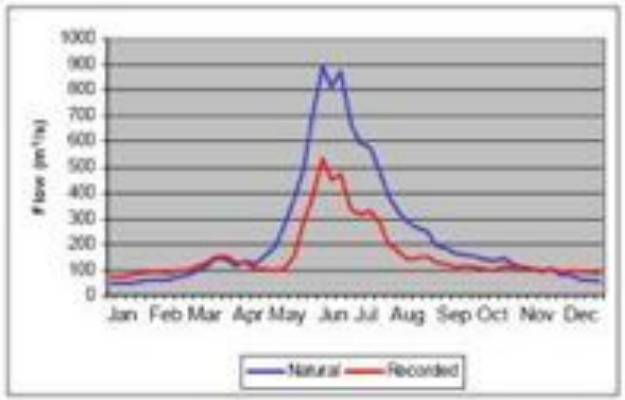
We are losing the advantage of a cold winter

Prairie Drainage Basins (source: PFRA)



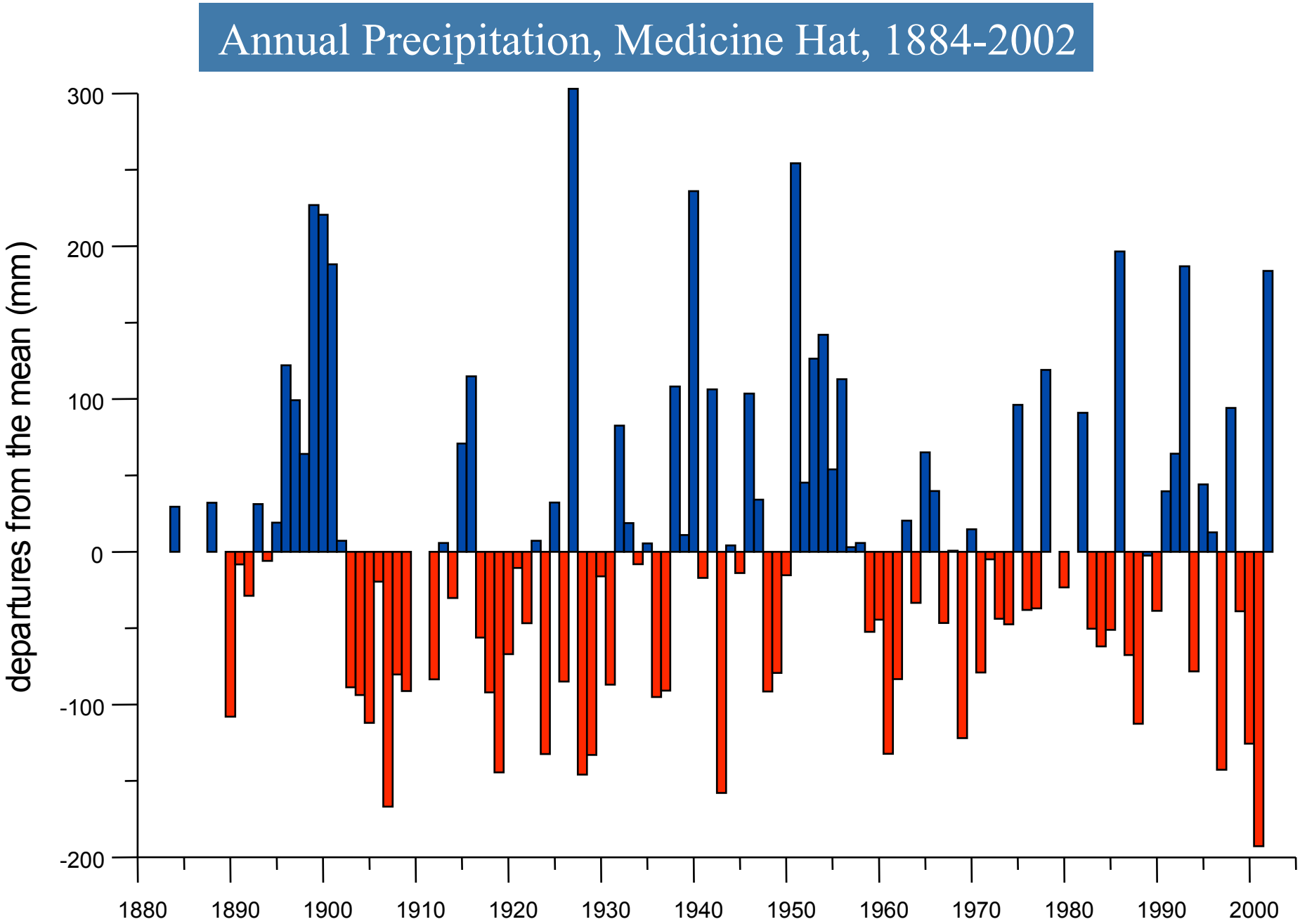
Potential Climate Change (%) Impacts on Natural Flows in the SSRB





AMEC. 2009. South Saskatchewan River Basin in Alberta: Water Supply Study. Alberta Agriculture and Rural Development.

Martz et al. (2007)


Annual Precipitation, Medicine Hat, 1884-2002
departures from the mean (mm)
300
200
100
0
-100
-200
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000

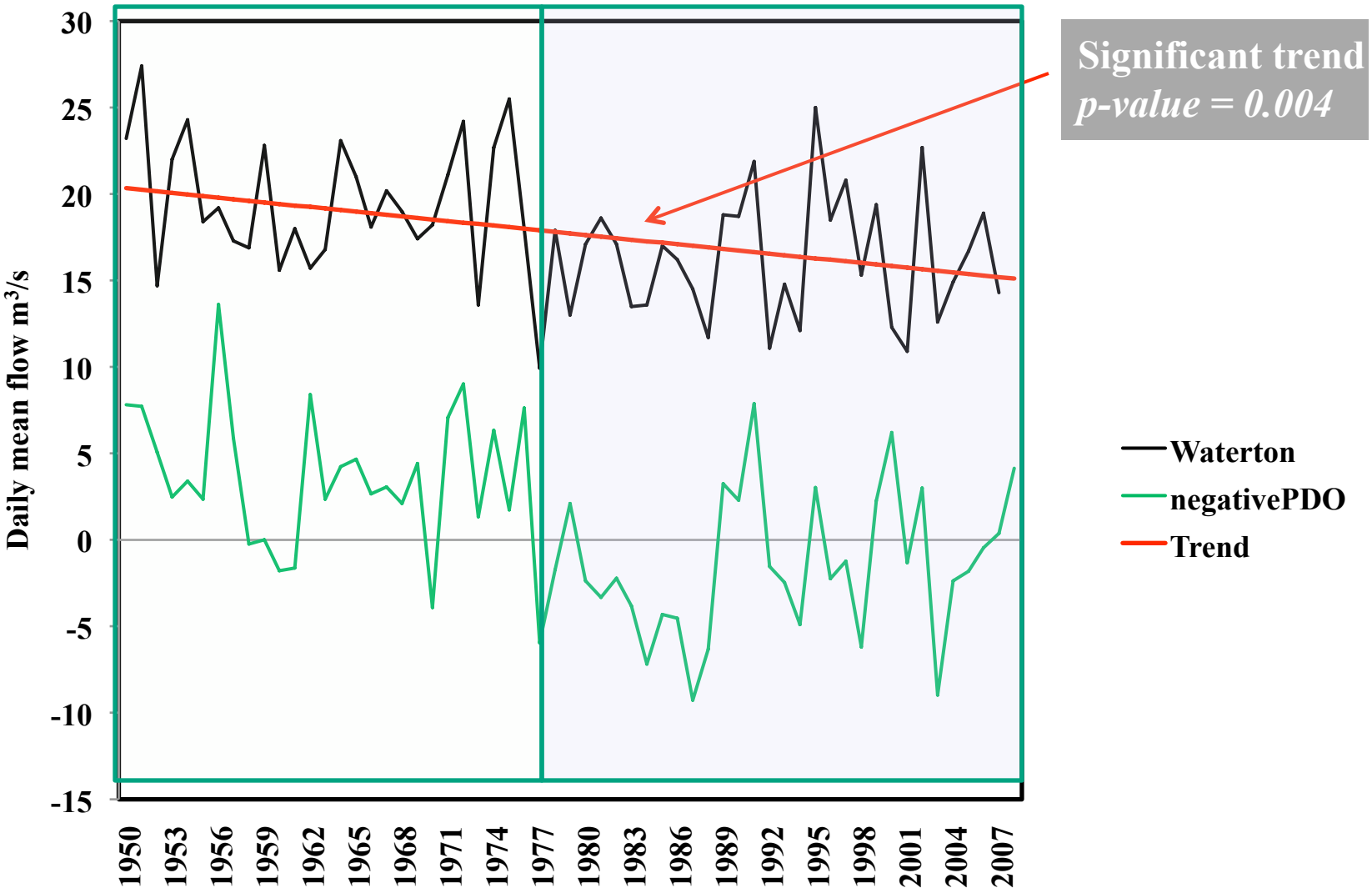
Climate Variability

many regional climate changes can be described in terms of **preferred patterns of climate variability**

changes in the strength and phase of these patterns can lead to **larger-amplitude regional responses to forcing** than would otherwise be expected

it is therefore important to consider the extent to which **observed changes are** linked to **internal variability or to anthropogenic climate change**

Waterton River near Waterton 1950-2007



Important Climate Feedback Mechanisms

Carbon cycle: the capacity oceans and ecosystems to sequester carbon changes in warmer world; in general, it declines

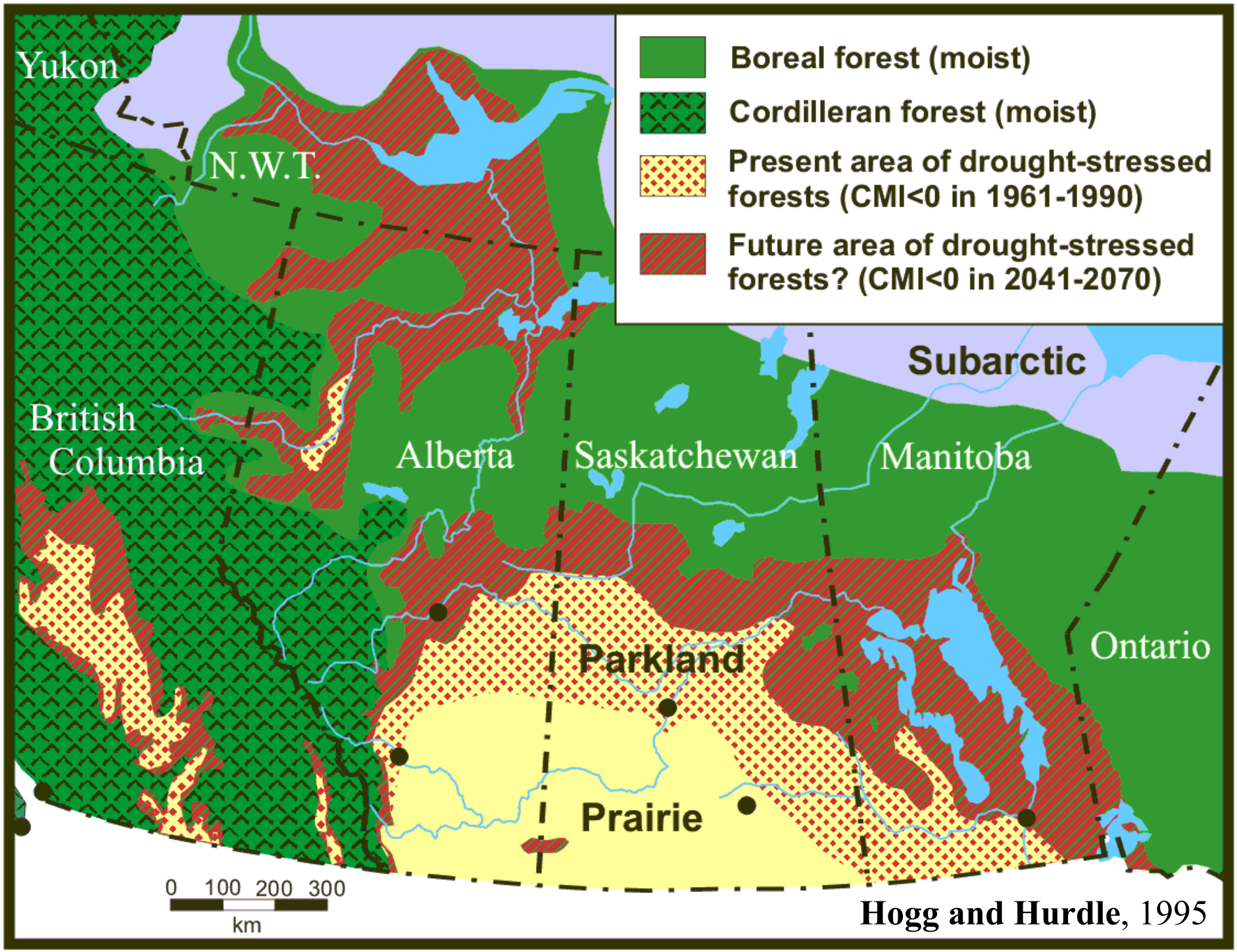
Changes in snow and ice cover: over 90% of the incident solar radiation is reflected by snow and ice surfaces

Specific humidity: increasing in a warming world; with rising amounts of water vapour in the atmosphere, there are **widespread increases in the numbers of heavy precipitation events**; BUT d**rought duration and intensity has also increased**

There will be greater variation in hydroclimate

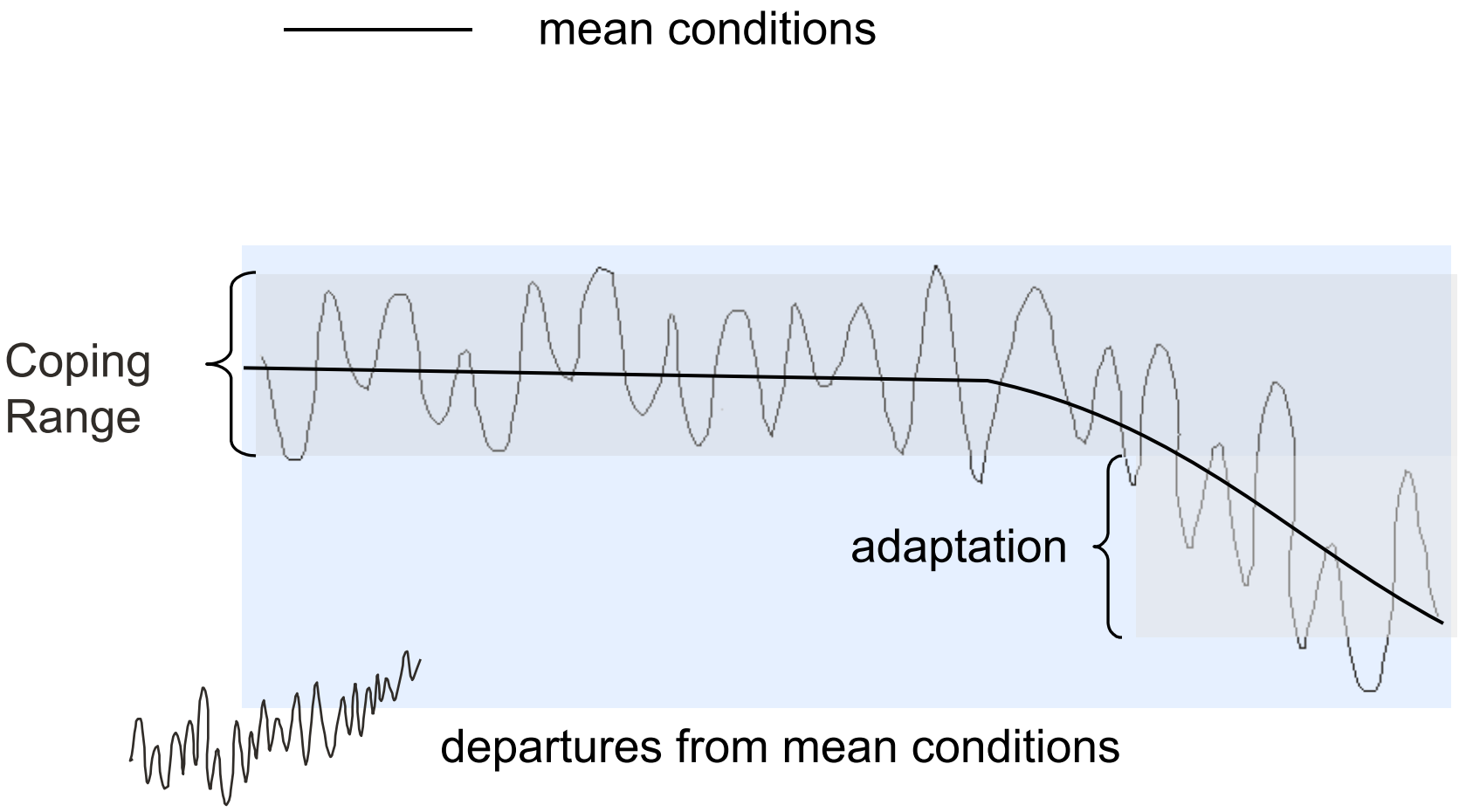
Both drought and unusually wet years could occur with greater frequency and severity

Major ecological changes are expected.


Boreal forest (moist)
Cordilleran forest (moist)
Present area of drought-stressed forests (CMI<0 in 1961-1990)
Future area of drought-stressed forests? (CMI<0 in 2041-2070)
Yukon
N.W.T.
British Columbia
Alberta
Saskatchewan
Manitoba
Subarctic
Ontario
Parkland
Prairie
0 100 200 300
km
Hogg and Hurdle, 1995

Extreme weather and climate are “wild cards” because the effects of increasing frequency and severity are generally not considered well or at all in climate change impact assessments.

Climate Trends and Variability



The net impacts of climate change are not clear

The impacts of climate change will depend on how well we adapt and how much adaptation is required


CLIMATE
SUMMIT
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.