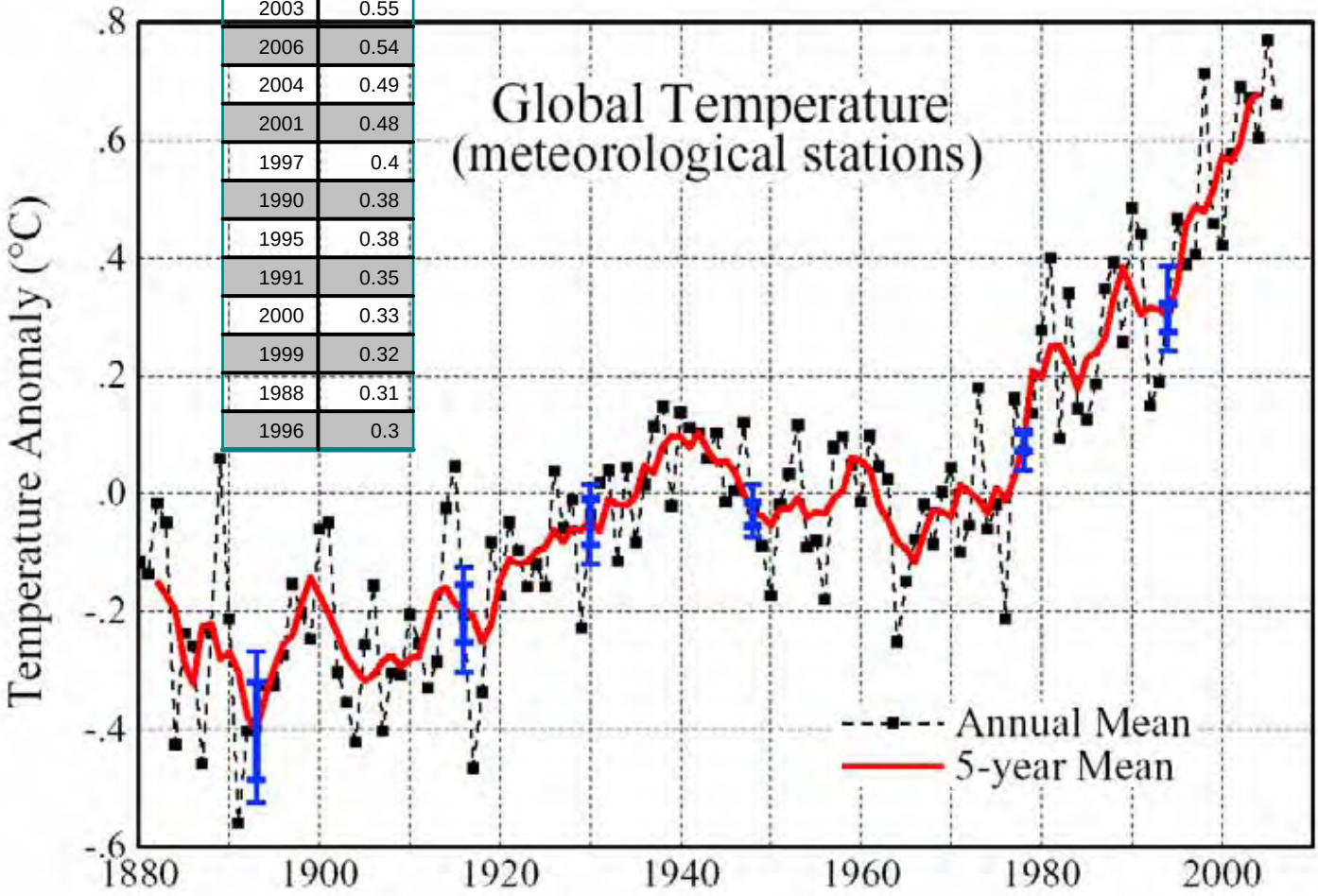
Climate Change on the Prairies

Dave Sauchyn
Prairie Adaptation Research Collaborative, University of Regina

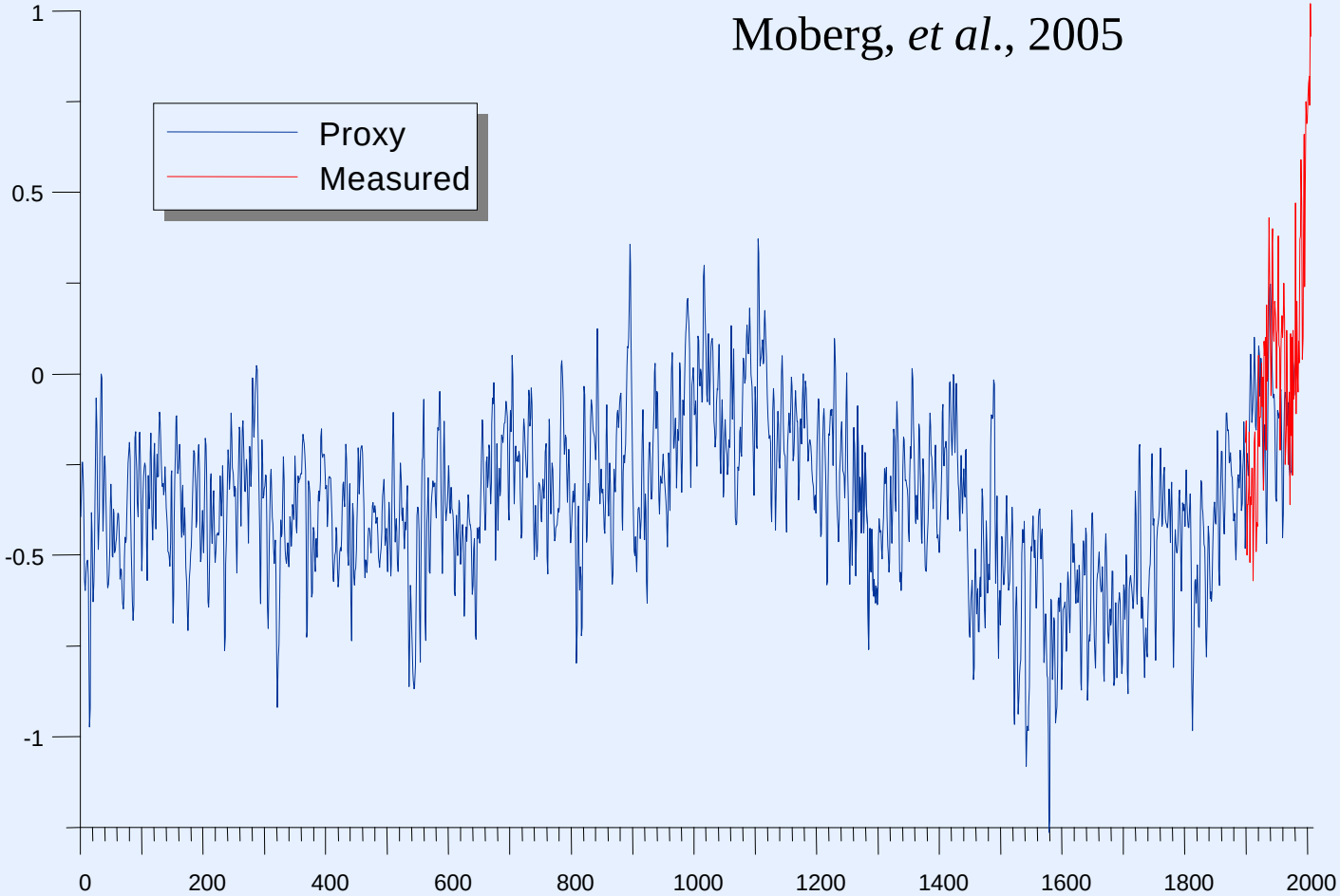
Saskatchewan Irrigation Projects Association Inc., 2007 Annual Conference, Moose Jaw, Saskatchewan, December 3, 2007

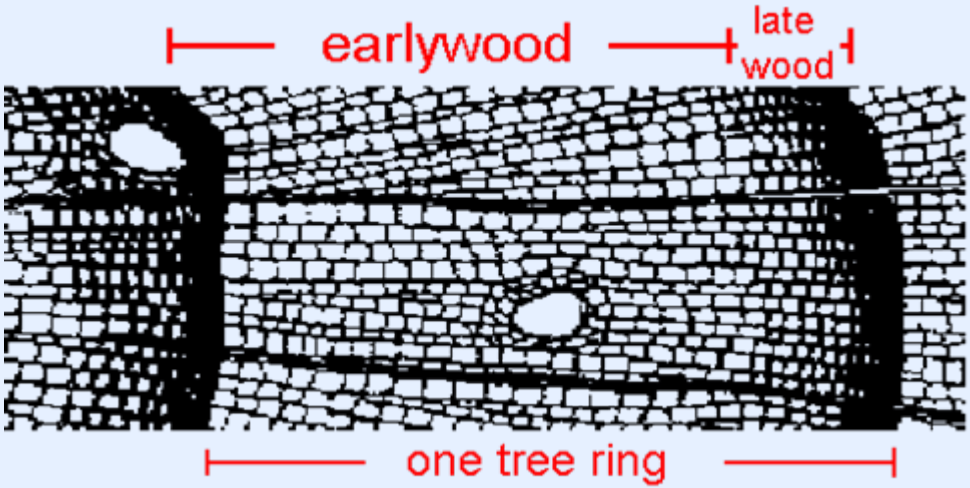
2005	0.63
1998	0.57
2002	0.56
2003	0.55
2006	0.54
2004	0.49
2001	0.48
1997	0.4
1990	0.38
1995	0.38
1991	0.35
2000	0.33
1999	0.32
1988	0.31
1996	0.3

http://data.giss.nasa.gov/gistemp/

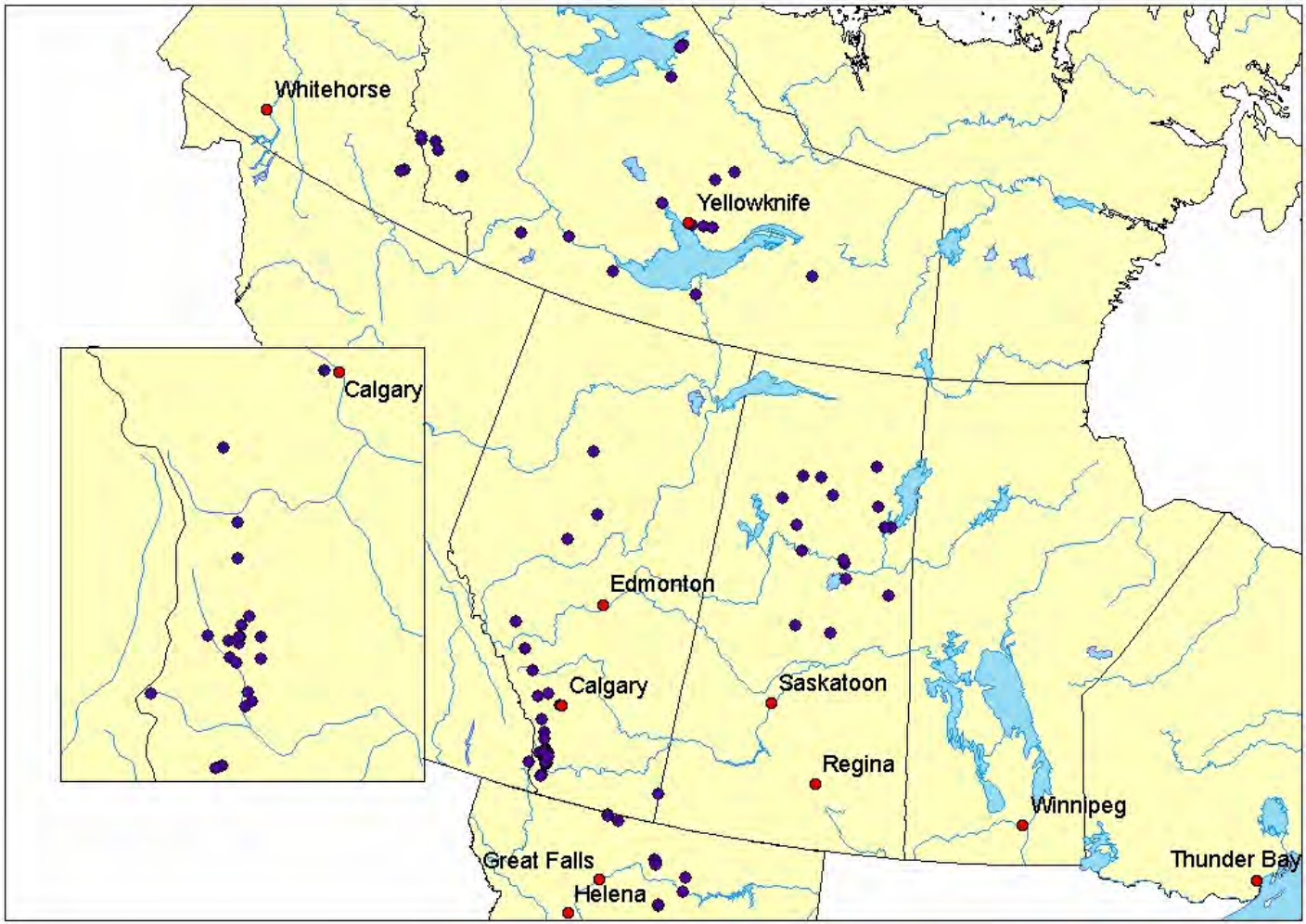


Northern Hemisphere temperature, past 1000 years



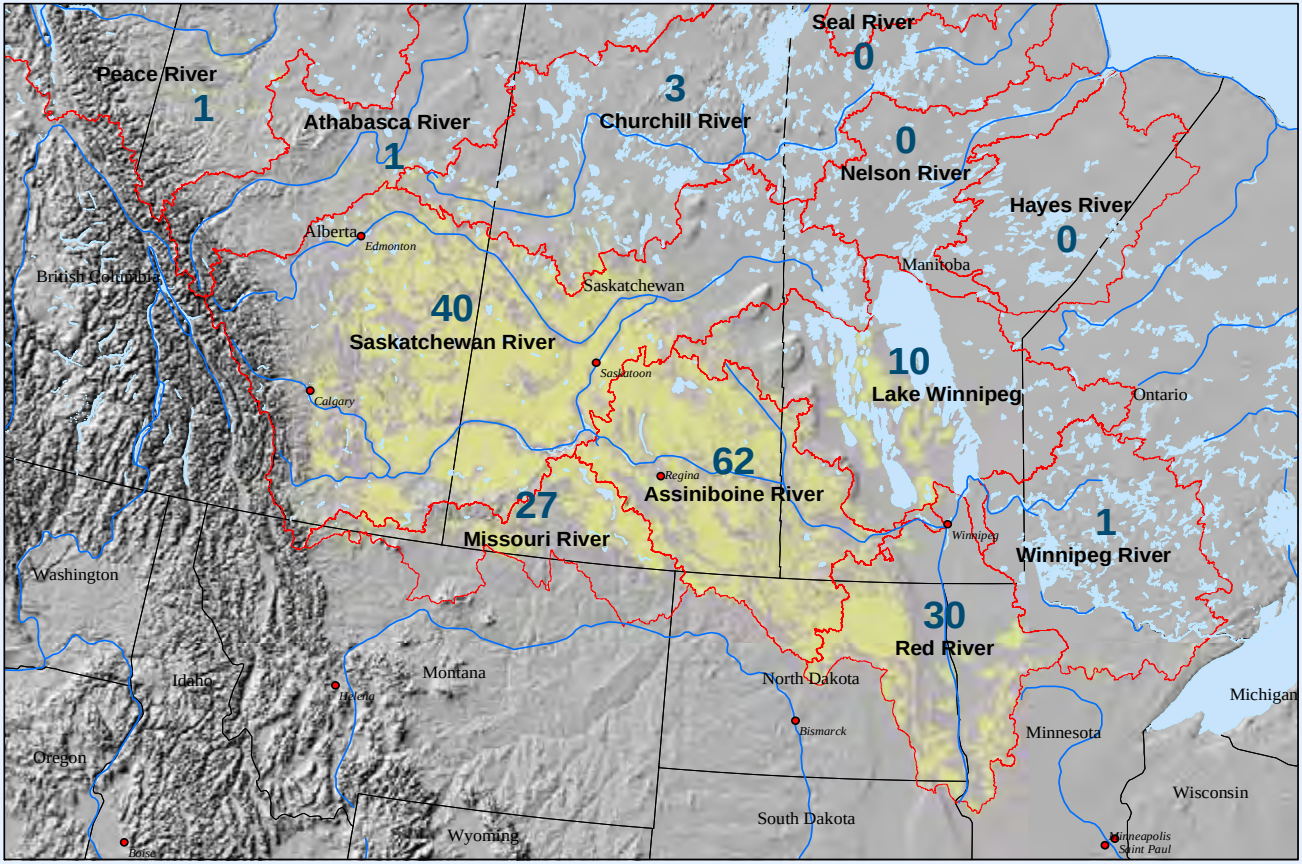

earlywood
late wood
one tree ring

Tree-Ring Sampling Sites



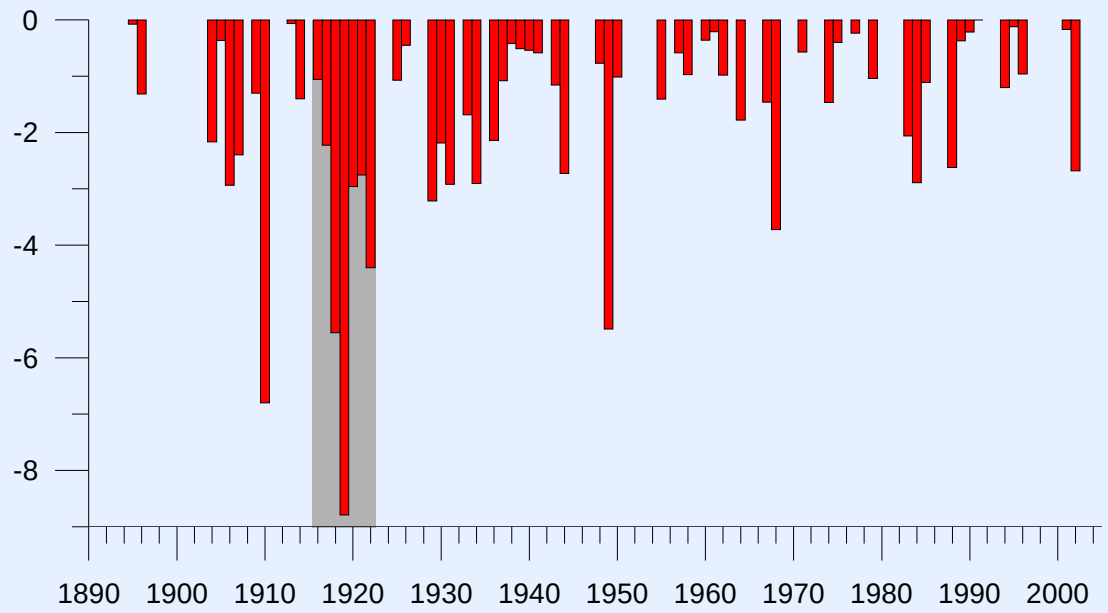
Prairie Drainage Basins

Non-contributing drainage area (percent of total basin area) for prairie drainage basins
-median annual runoff-

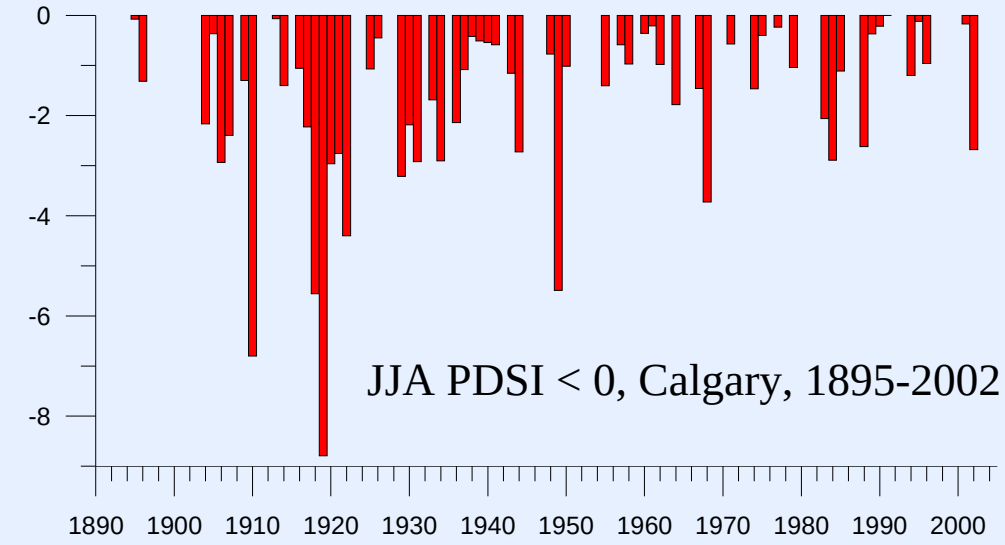


Source: Non-contributing area - Agriculture and Agri-Food Canada, P.F.R.A.
Elevation data - Environmental Systems Research Institute

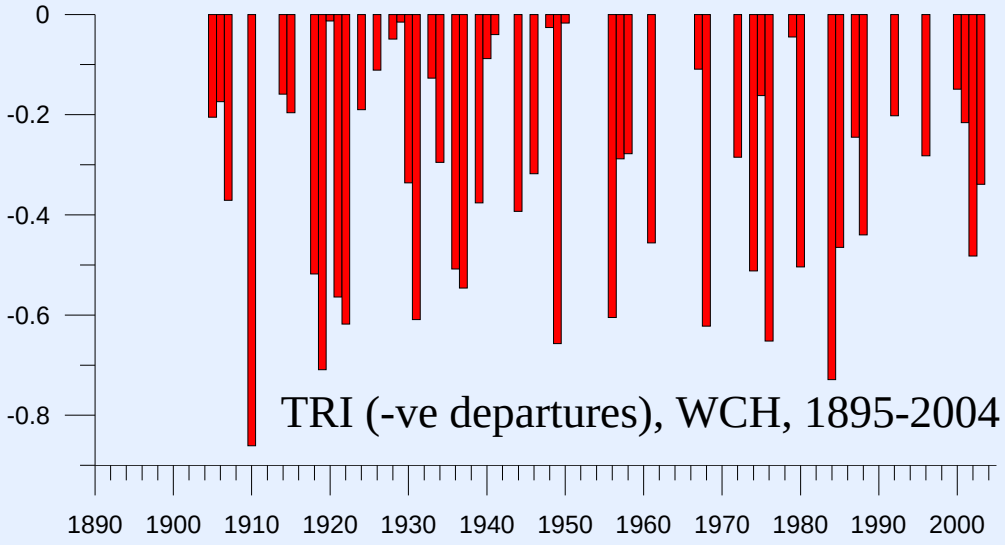
Summer (JJA) PDSI* < 0, Calgary, 1895-2002

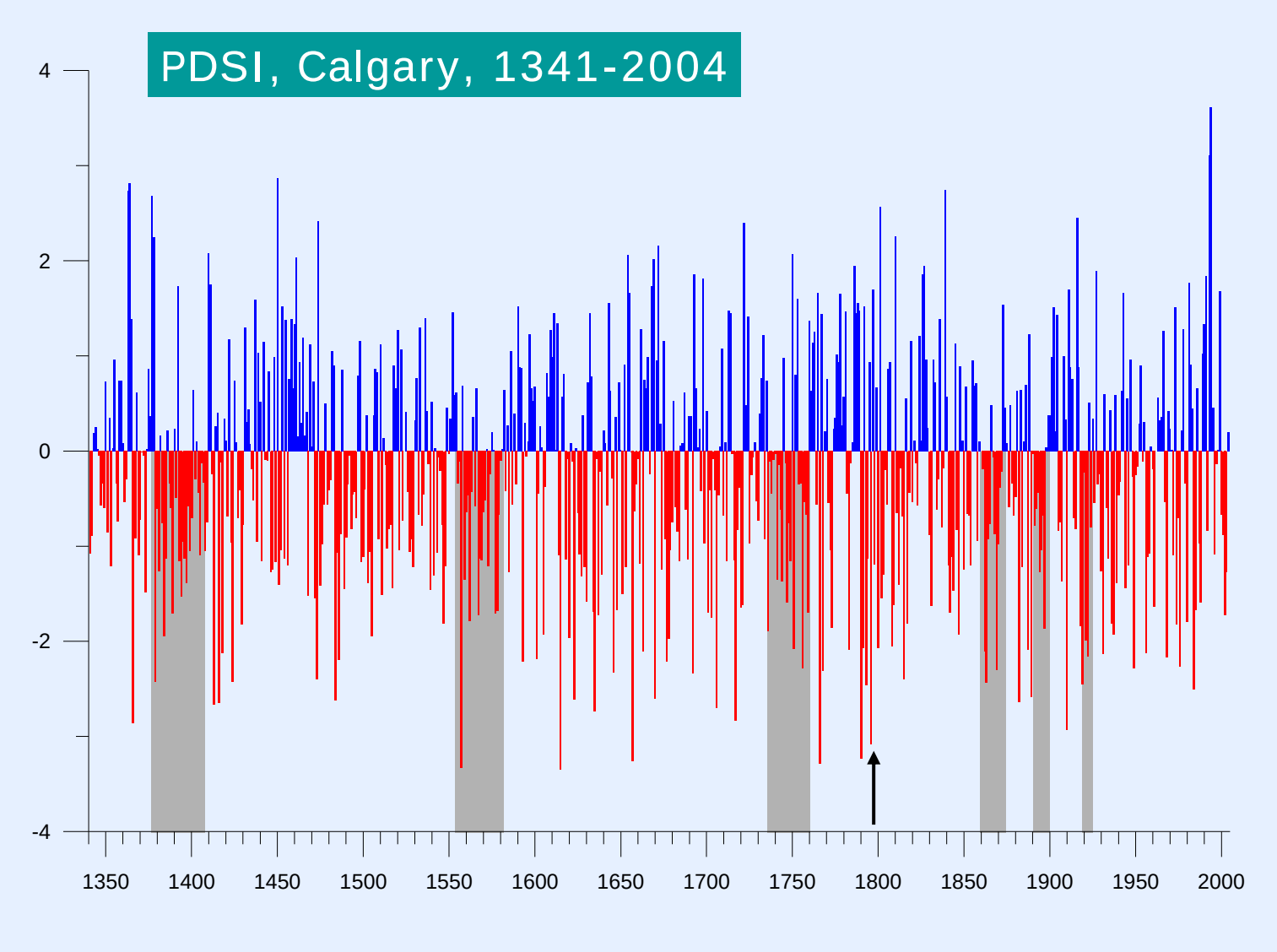


* Palmer Drought Severity Index


0
-2
-4
-6
-8
JJA PDSI < 0, Calgary, 1895-2002
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000

r = 0.628


0
-0.2
-0.4
-0.6
-0.8
TRI (-ve departures), WCH, 1895-2004
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000

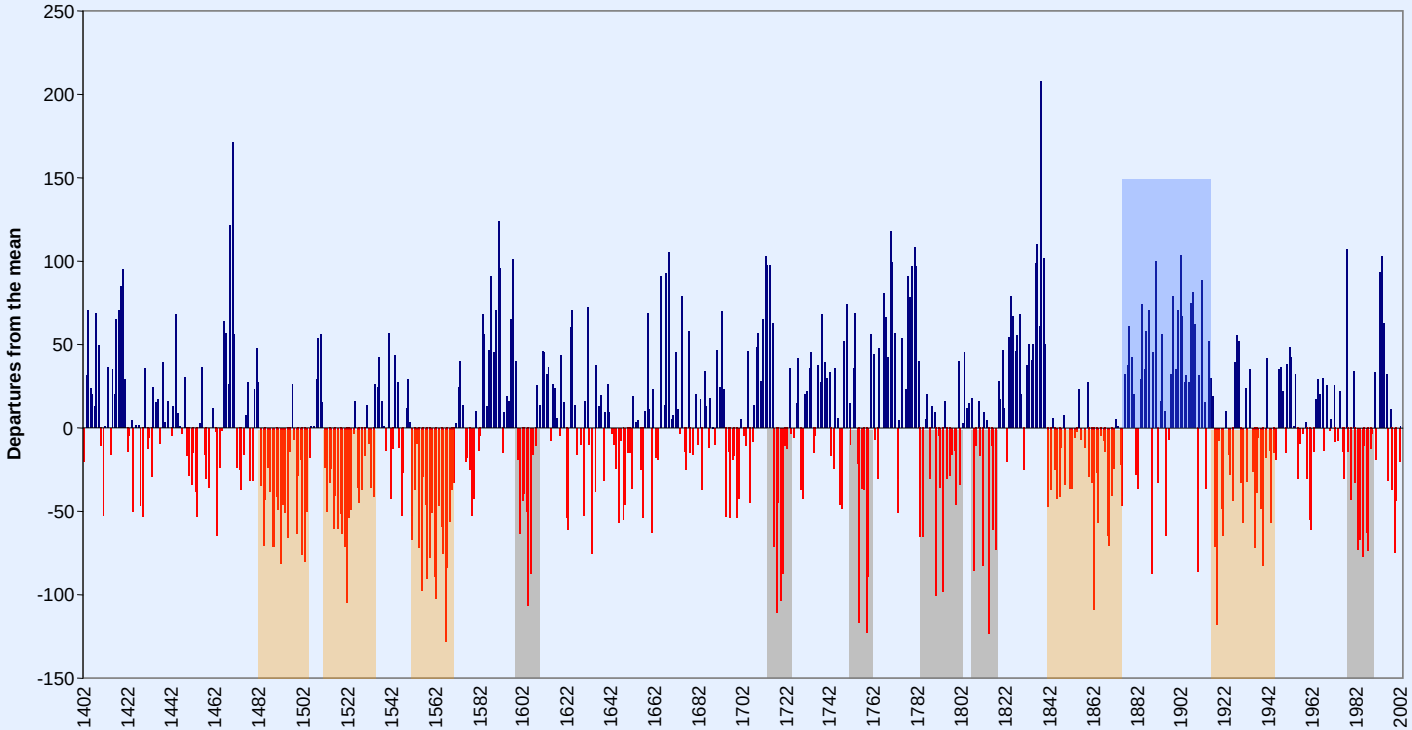

PDSI, Calgary, 1341-2004
4
2
0
-2
-4
1350
1400
1450
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000

Spring 1796, Edmonton House

At Edmonton House, a large fire burned “all around us” on April 27th (1796) and burned on both sides of the river. On May 7th, light canoes arrived at from Buckingham House damaged from the shallow water.

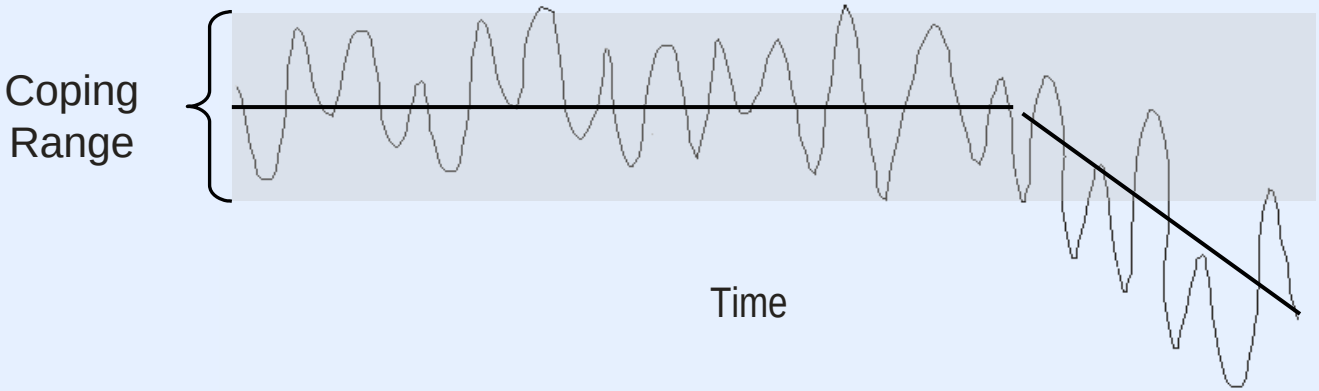
Timber intended to be used at Edmonton House could not be sent to the post “for want of water” in the North Saskatchewan River. On May 2nd, William Tomison wrote to James Swain that furs could not be moved as, “there being no water in the river.” (Johnson 1967: 33-39, 57)

South Saskatchewan River at Medicine Hat, 1402-2004

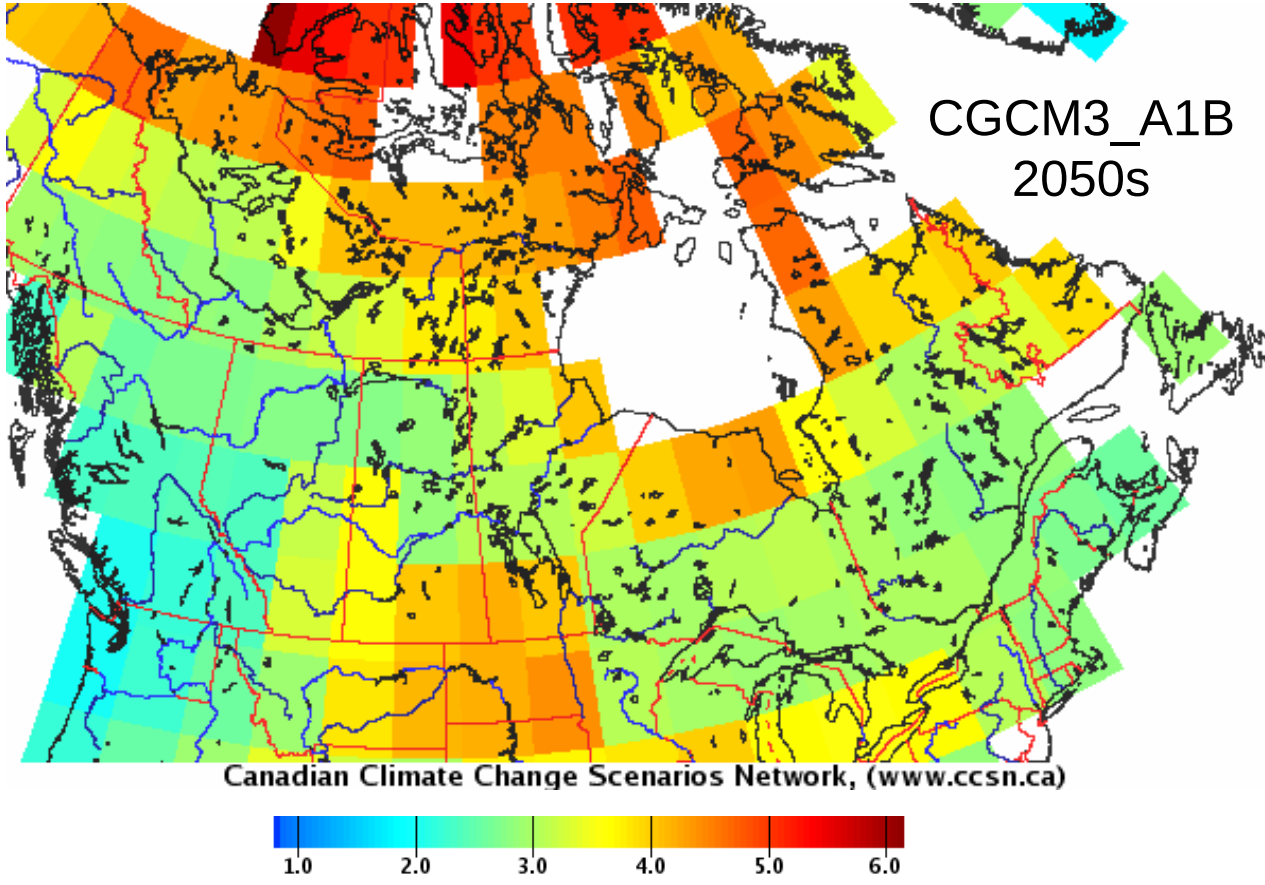


Climatic variability

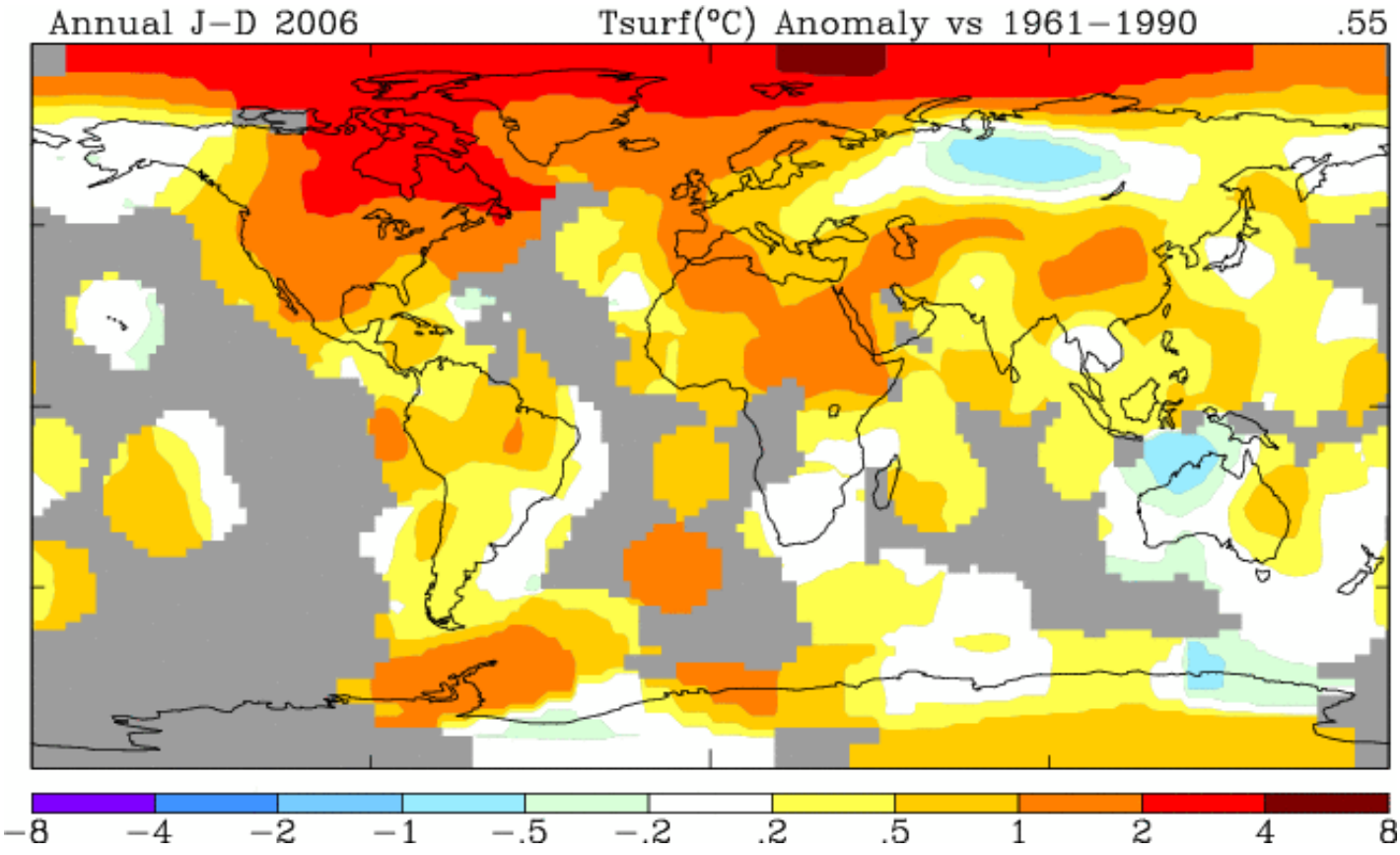
Climatic change



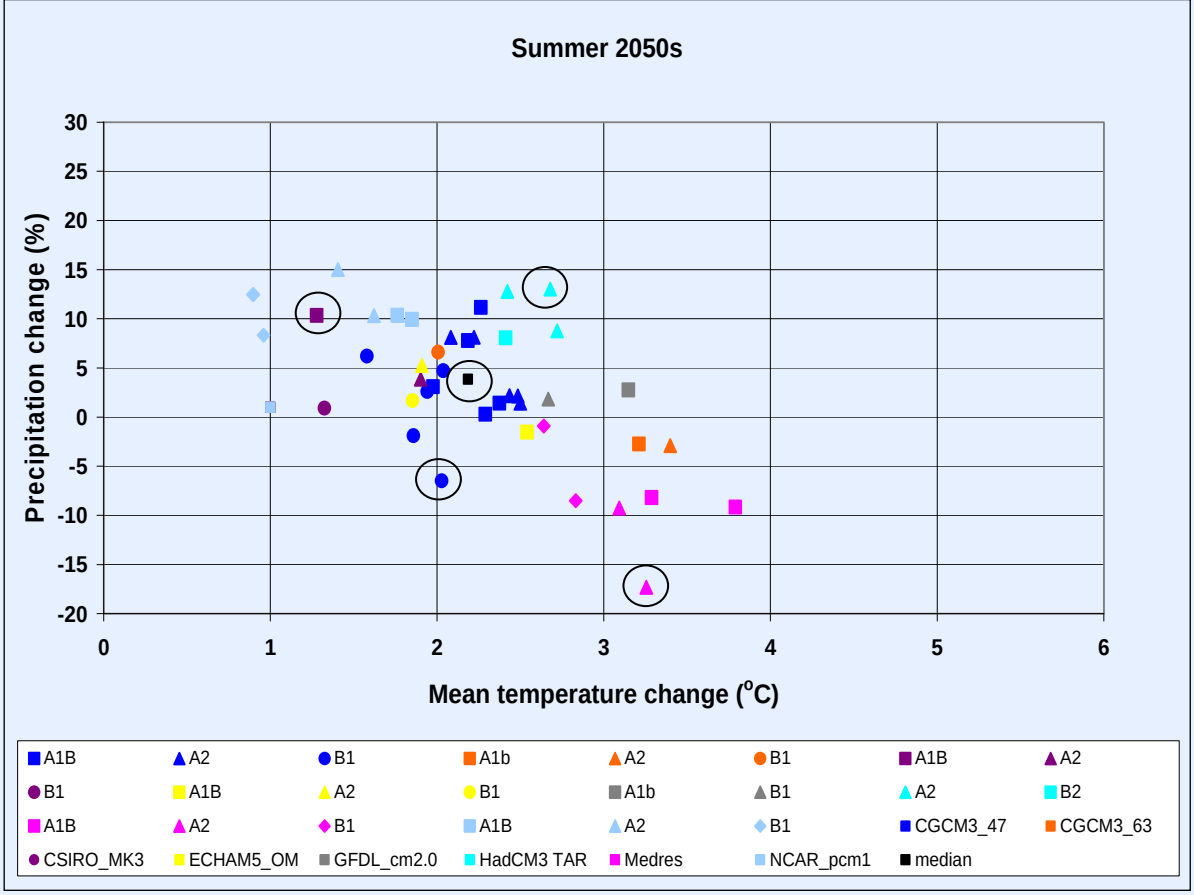
Change in temperature (C) from baseline (1961-90)



2006 Temperatures: Departures from Normal (1961-90)

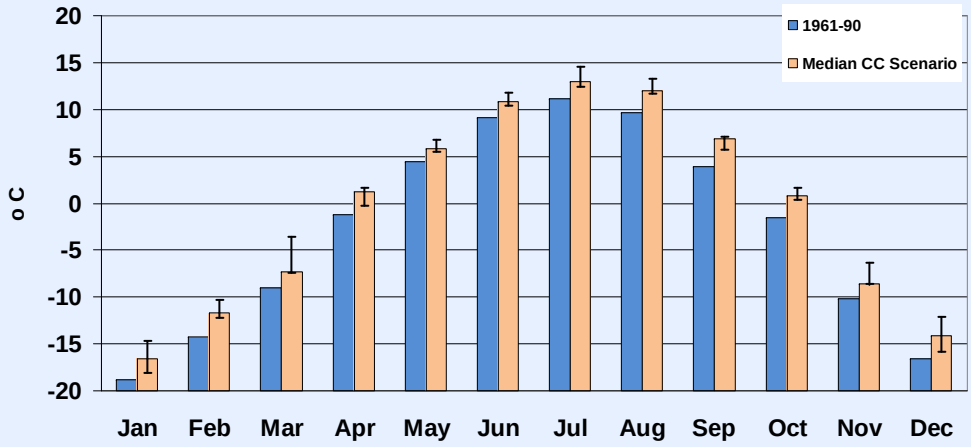


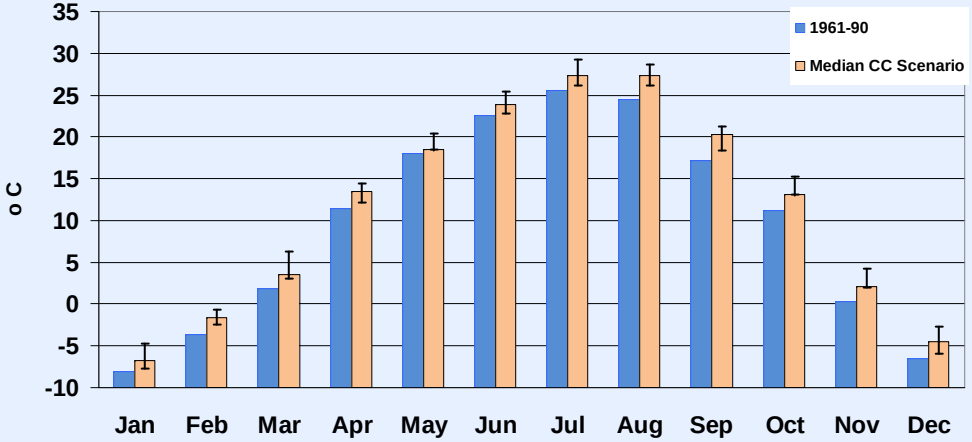
http://data.giss.nasa.gov/gistemp/



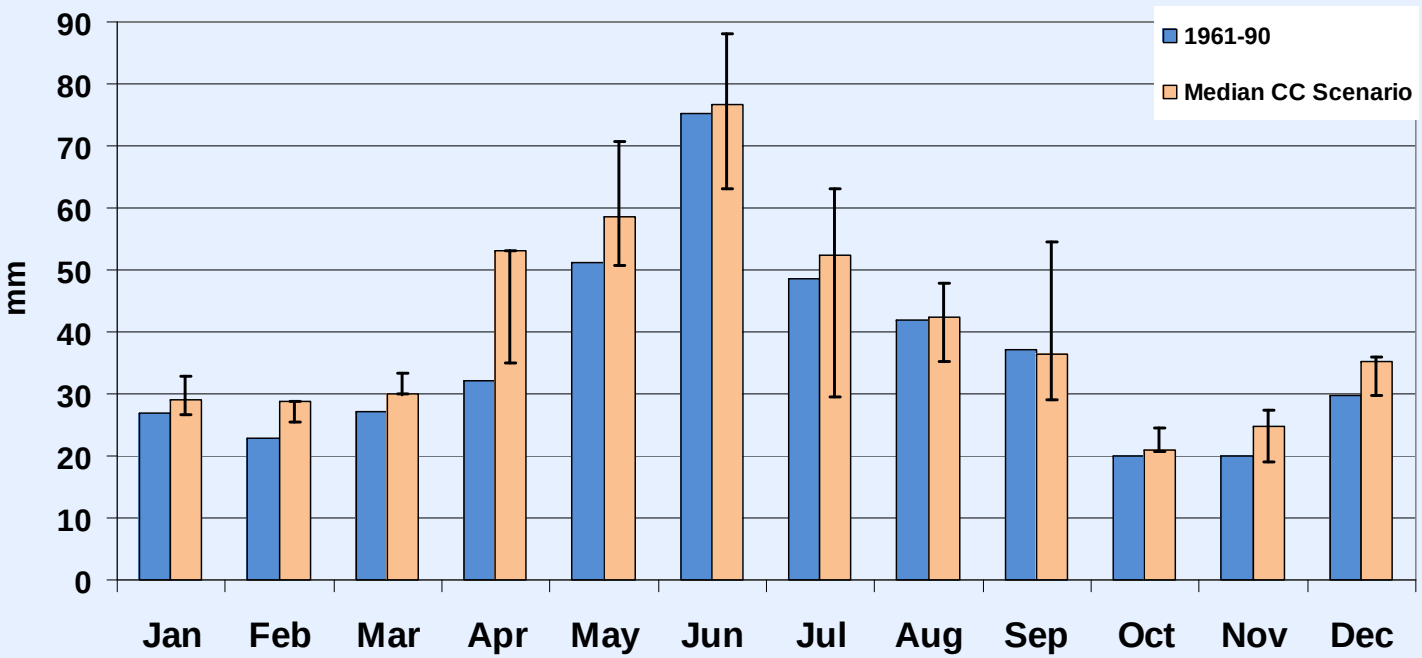
Scatter plots indicating mean temperature (ºC) and precipitation (%) change for SSRB for the 2050s summer. The models were chosen based on the availability of the required climate variables: daily minimum and maximum temperature and daily precipitation. Miroc Medres A2(1) (warm/dry), HadCM3 TAR A2(a) (warm/wet), CGCM3.1/T47 B1(1) (cool/dry), CSIRO MK3.0 A1B(1) (cool/wet), CGCM3.1 T47 B1(2) (median). (Value in brackets identifies the run number).

Minimum and maxiumum temperature, Swift Current, 2050s



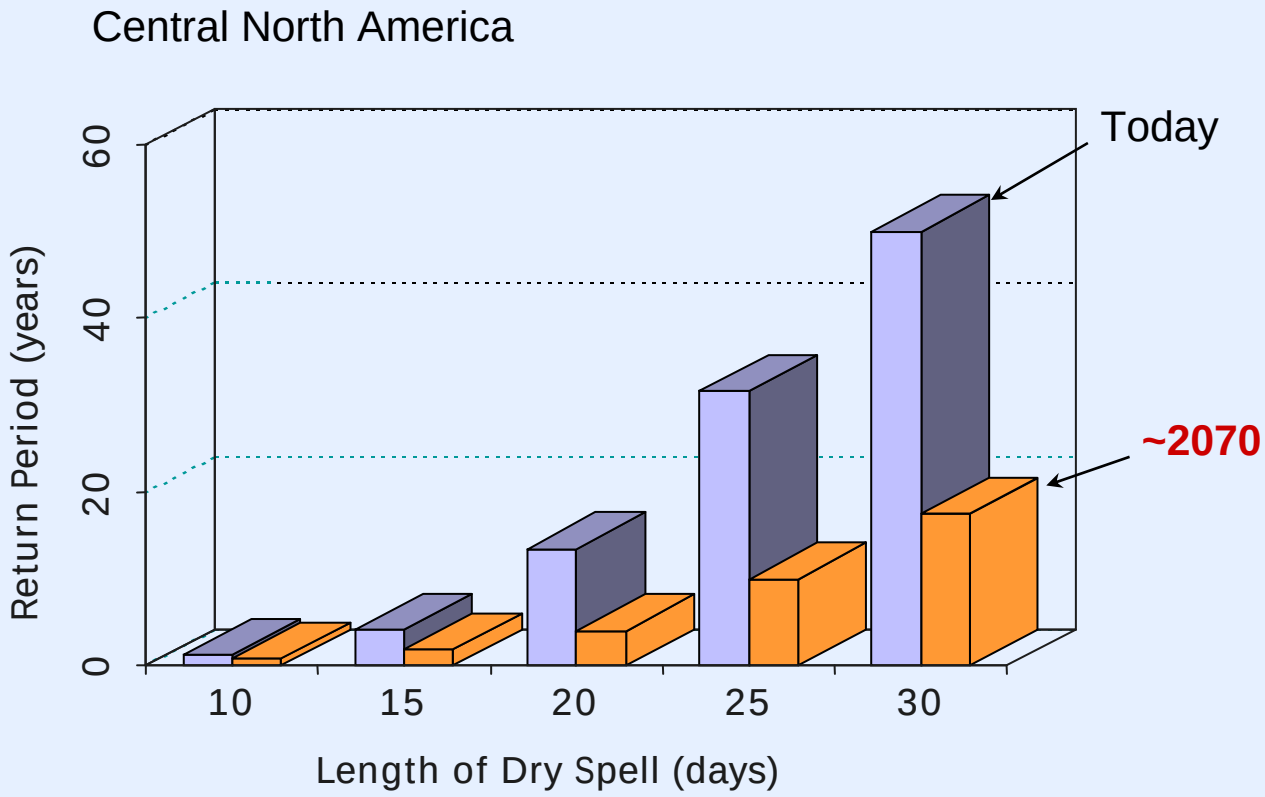


Monthly precipitation, Swift Current, 2050s

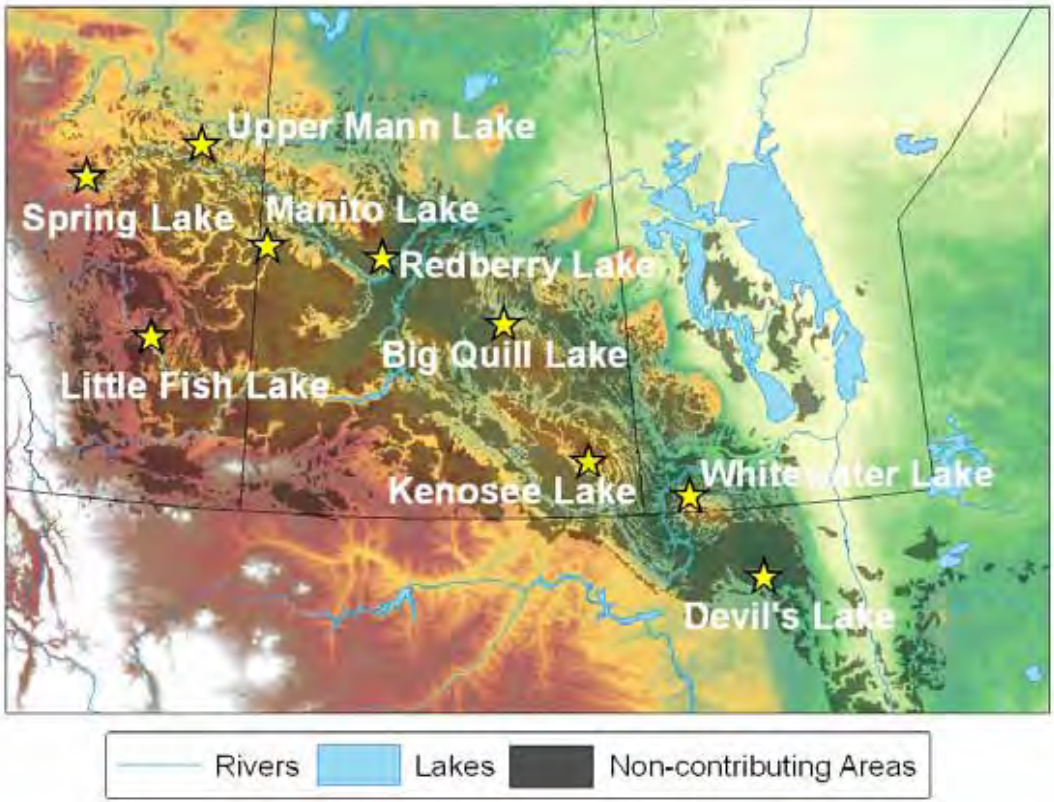


Increasing Drought Frequency

Kharin and Zwiers, 2000

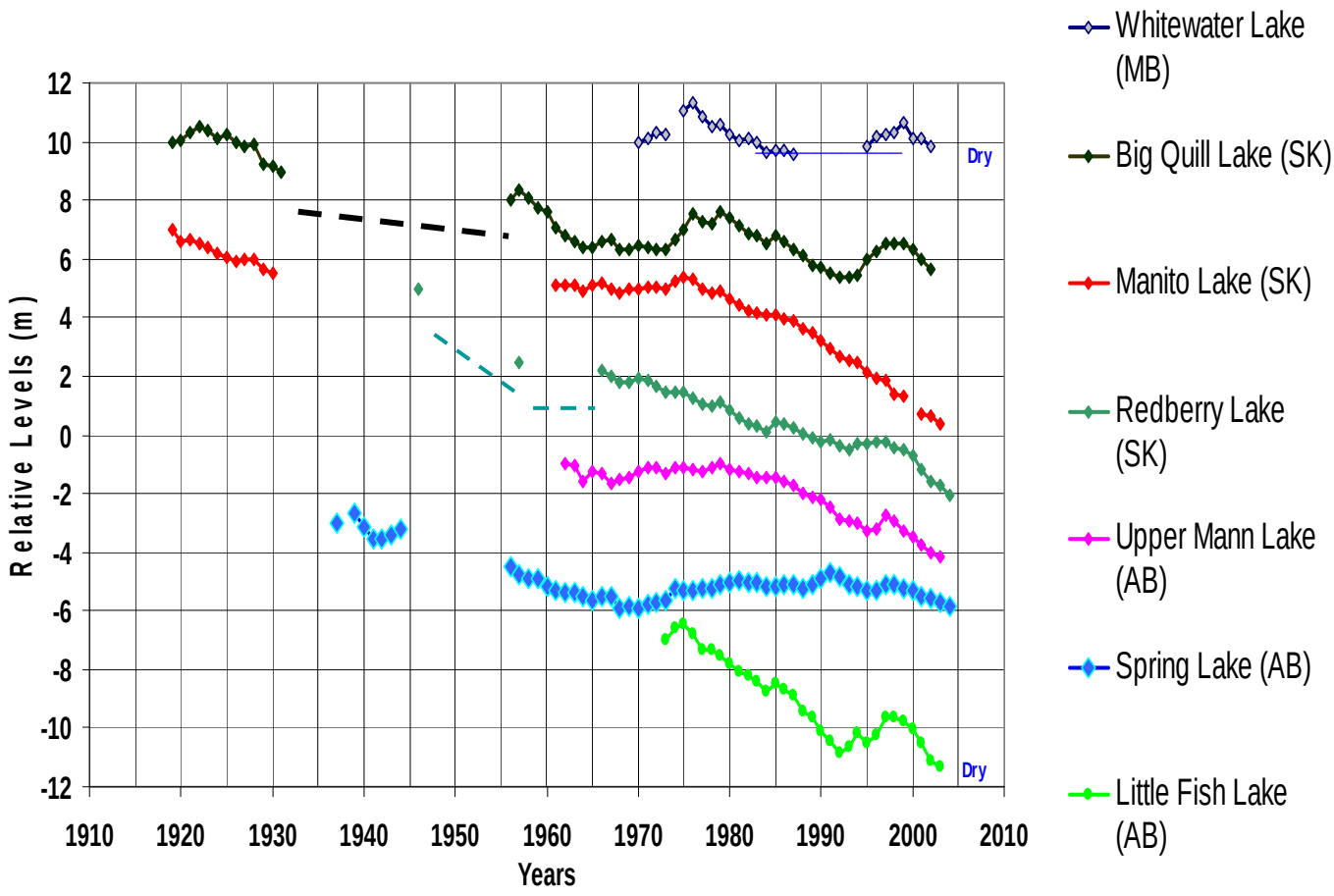


Closed-basin Prairie Lakes



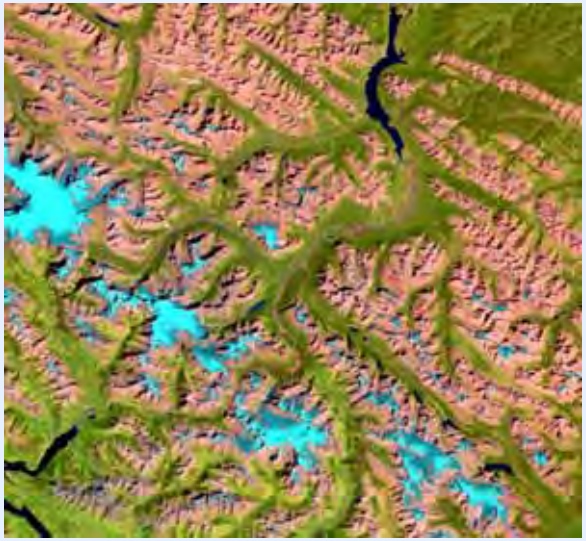
(van der Kamp *et al*.)

Closed-basin lake level changes, 1918-2004 (van der Kamp *et al.*)



Climate Change Impacts on Rocky Mountain glaciers

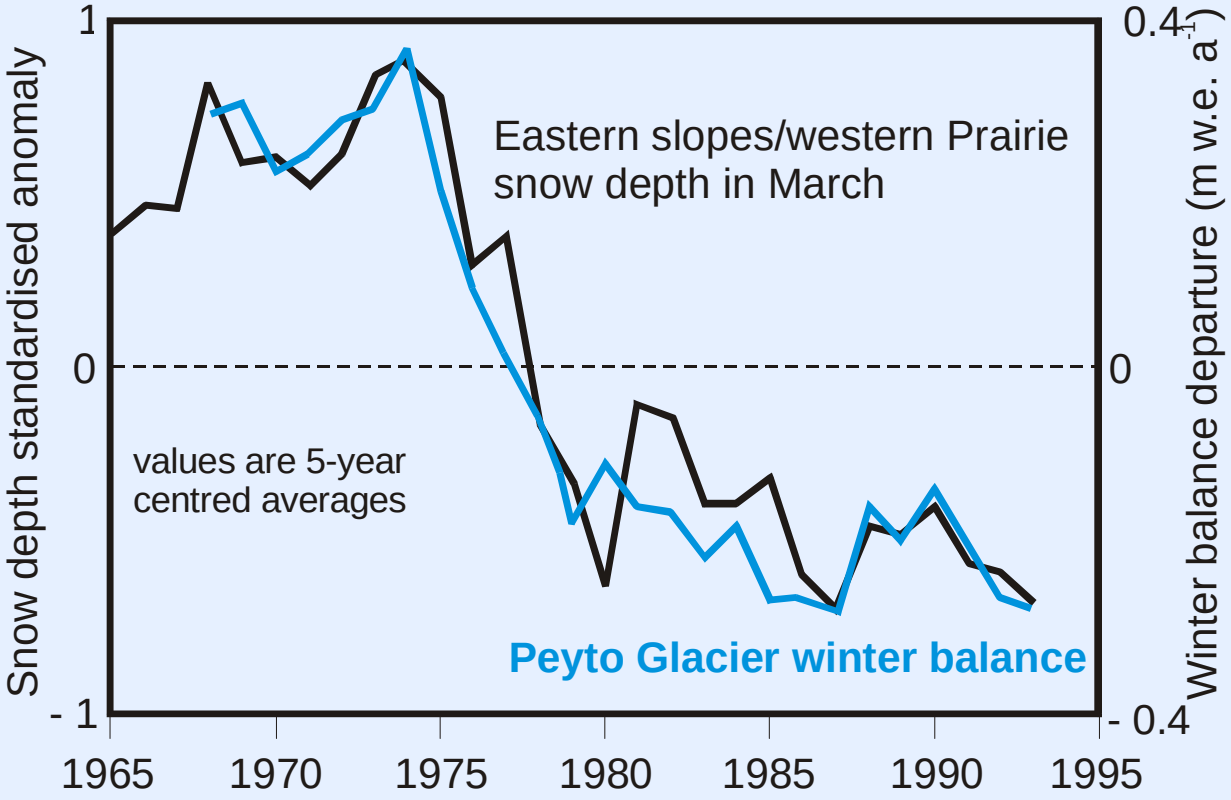
Demuth and Pietroniro, 2001



Glacier cover has decreased rapidly in recent years; it now approaches the least extent in the past 10,000 years

A phase of increased stream flow from global warming has past; basins have entered a potentially long-term trend of declining flows

Declining supplies of glacier runoff have serious implications for the adaptive capacity of downstream surface water systems and for trans-boundary water allocation



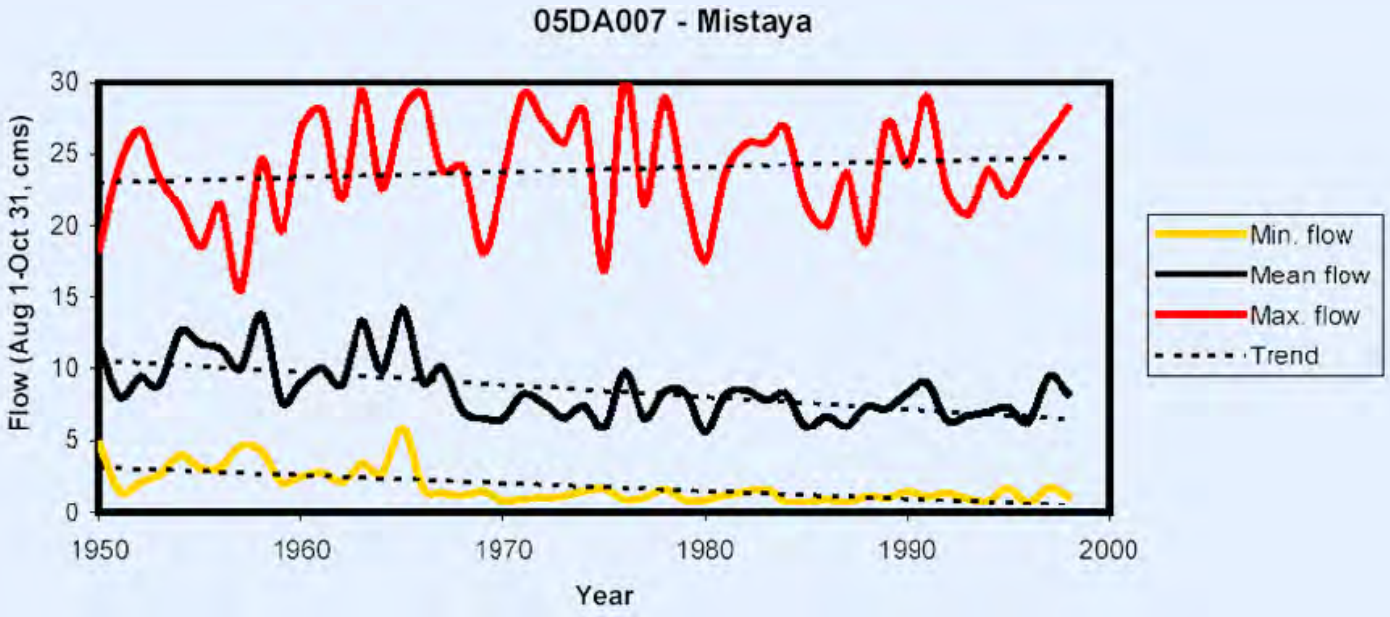
Demuth and Pietroniro, 2001

Peyto Glacier

2006

M.N. Demuth

Declining Mean and Minimum Streamflow

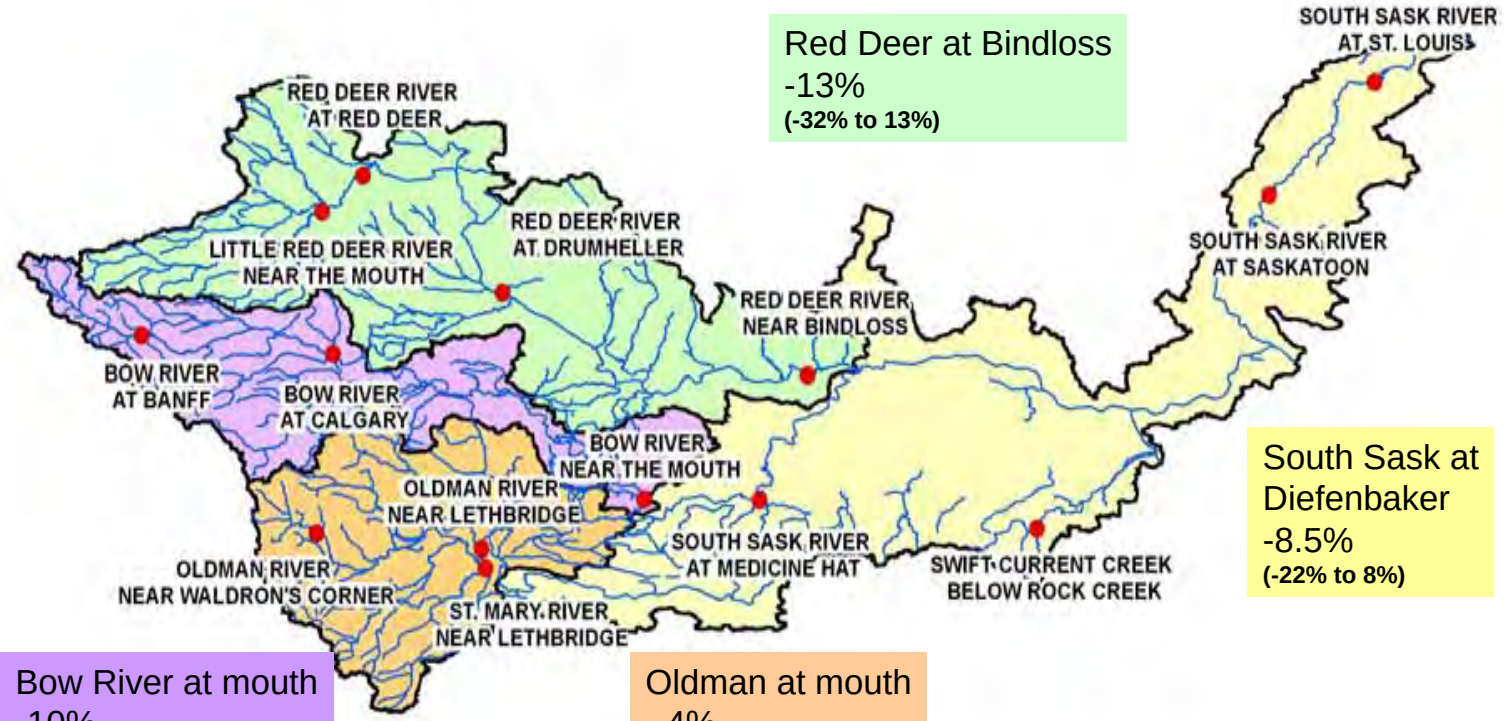


Demuth and Pietroniro 2001

Estimated Glacier Melt Contribution

	TBF %	Annual %
Edmonton	**7.4**	**1.8**
Calgary	**2.4**	**0.6**

GCM scenario results, 2039 – 2070, cumulative flows



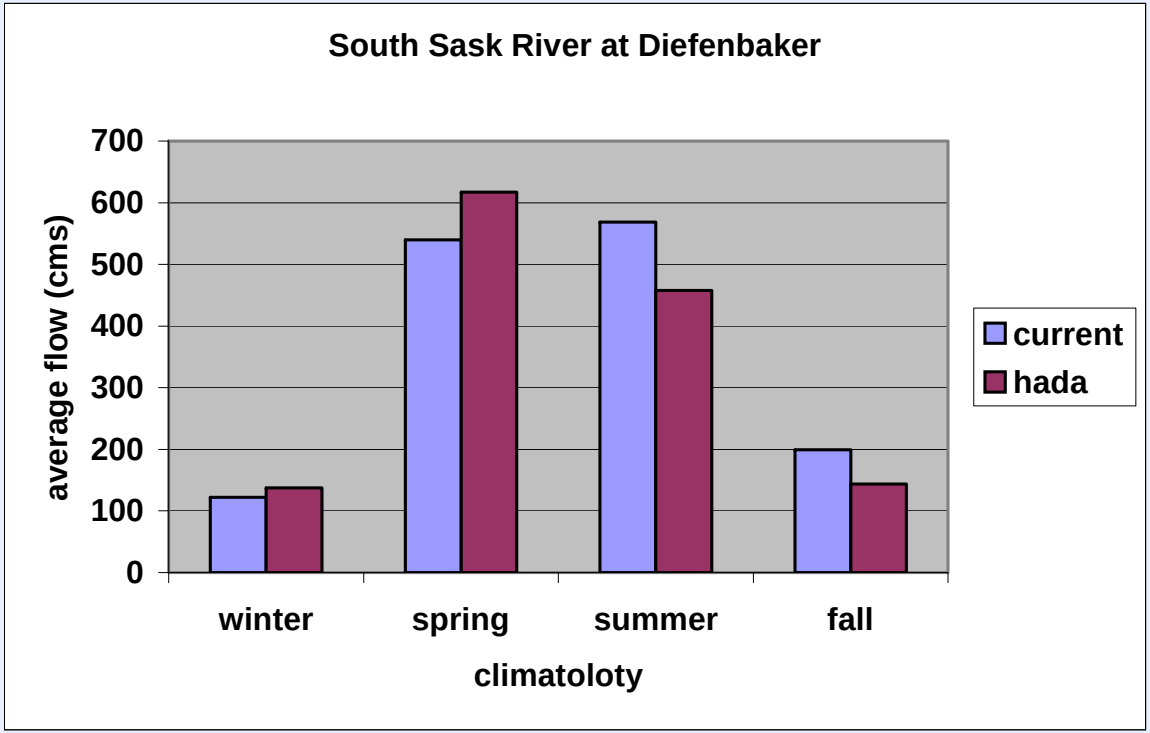
Red Deer at Bindloss
-13%
(-32% to 13%)

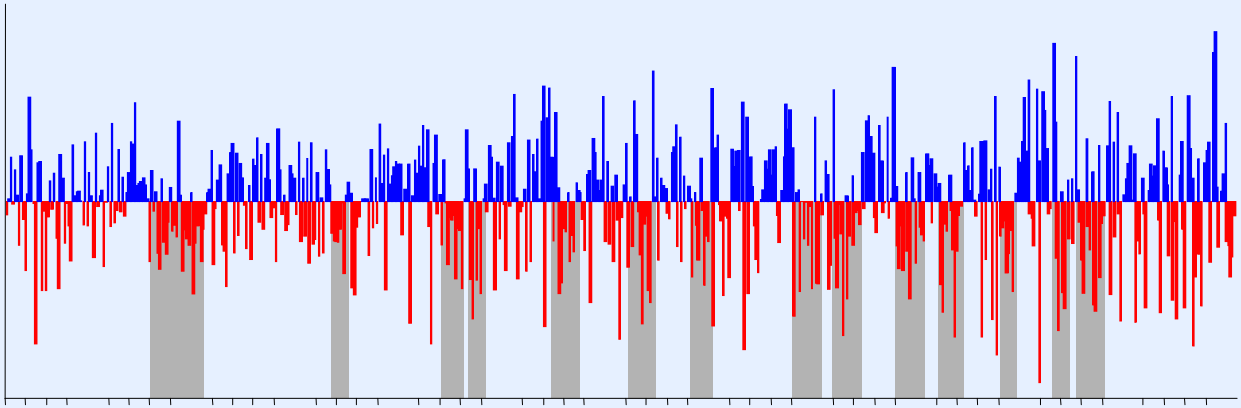
South Sask at Diefenbaker
-8.5%
(-22% to 8%)

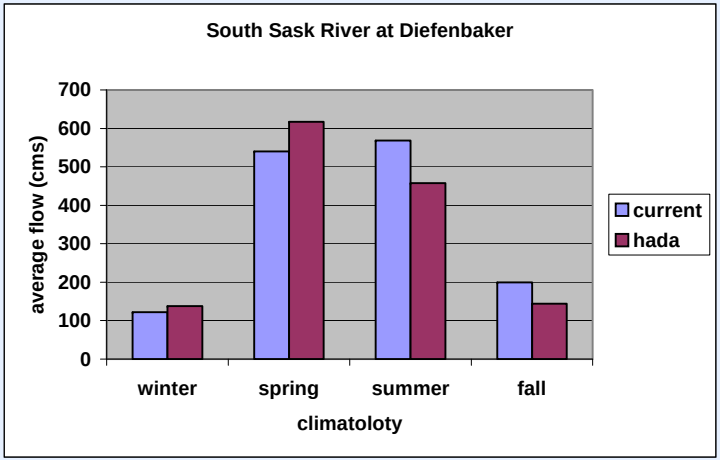
Bow River at mouth
-10%
(-19% to 1%)

Oldman at mouth
- 4%
(-13% to 8%)

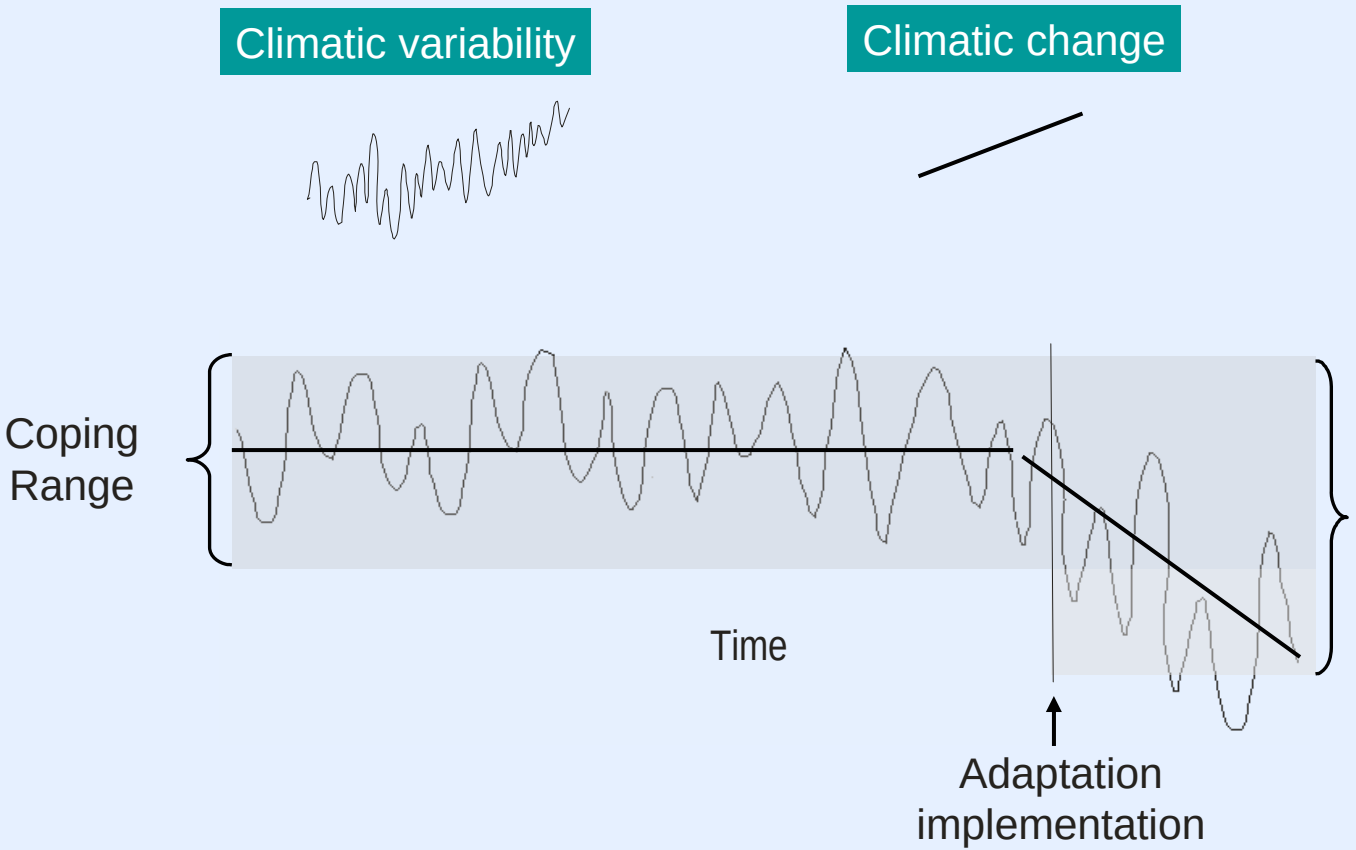
GCM scenario results, 2039 – 2070, seasonal flows







A “myth of abundance” and an explicit assumption that “the hydrological regime is stationary and will continue to be stationary in the future”.


Climatic variability
Climatic change
Coping
Range
Time
Adaptation
implementation

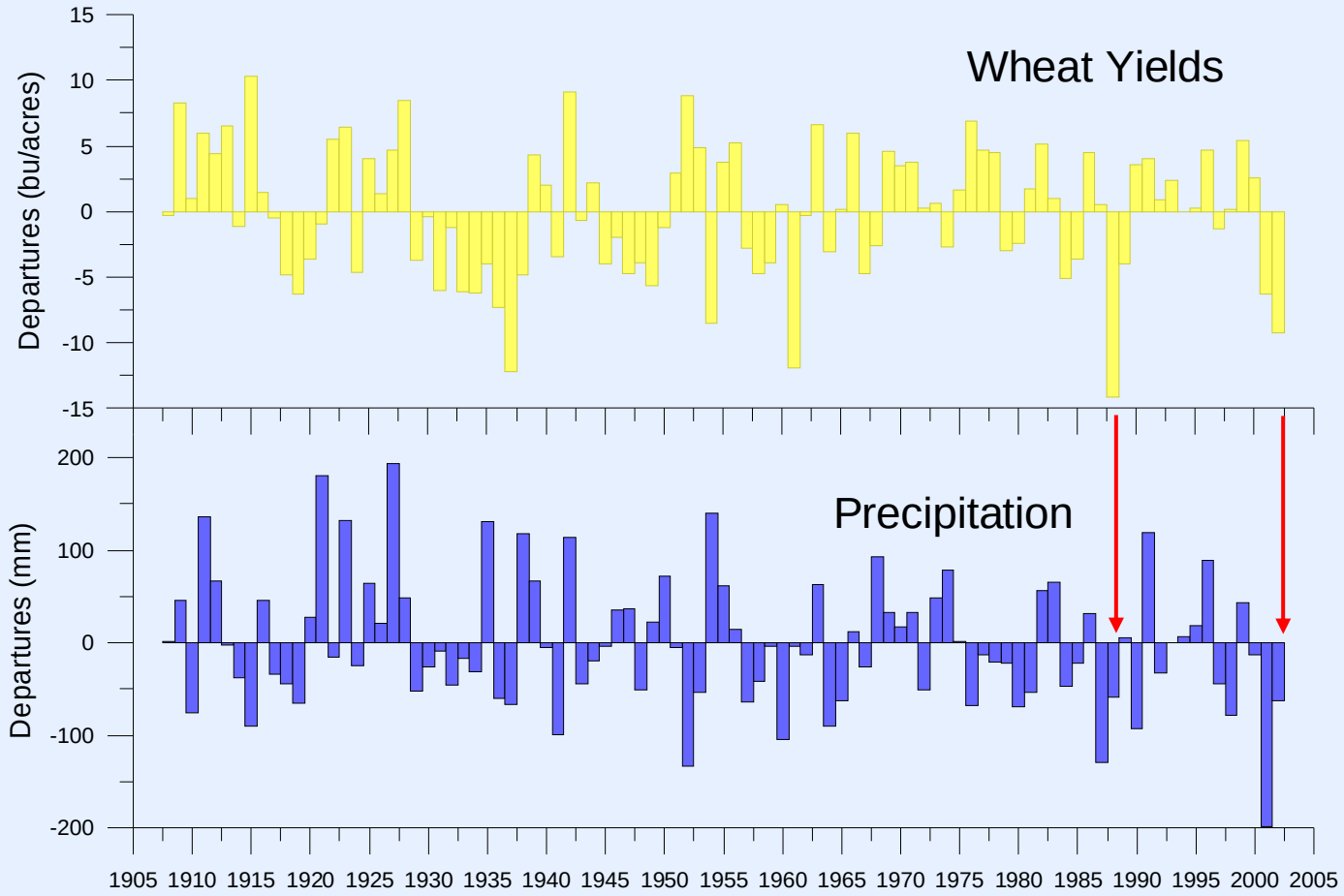
Adaptive Capacity

Determinant	Explanation
Economic resources	Greater economic resources increase adaptive capacity Lack of financial resources limits adaptation options
Technology	Lack of technology limits range of potential adaptation options Less technologically advanced regions are less likely to develop and/or implement technological adaptations
Information and skills	Lack of informed, skilled and trained personnel reduces adaptive capacity Greater access to information increases likelihood of timely and appropriate adaptation
Infrastructure	Greater variety of infrastructure can enhance adaptive capacity, since it provides more options Characteristics and location of infrastructure also affect adaptive capacity
Institutions	Well-developed social institutions help to reduce impacts of climate-related risks, and therefore increase adaptive capacity
Equity	Equitable distribution of resources increases adaptive capacity Both availability of, and access to, resources is important

Adaptation

The degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate (IPCC, 2001).

Wheat Yields, Saskatchewan / Precipitation, Saskatoon, 1906-2002



Irrigation: the primary adaptive strategy in dry environments

- mitigates the impacts of drought, reduces farm risks, support higher crop diversity, increases profit margins, and improves the long-term sustainability of smaller farm units
- Southern Alberta: 7796 km of conveyance works (canals and pipelines) and 49 reservoirs.
- from surface (flood or gravity) irrigation to wheel-move and centre pivot sprinkler irrigation to irrigationation of field corners and low pressure application devices
- on-farm application efficiency increased from approximately 60% in 1990 to about 71% by 1999
- decrease in evaporation losses has occurred with installation of pipelines

From: *Irrigation in the 21st Century*

Future improvements in crop water management

- Further transformation of irrigation methods and improved design of on-farm systems
- A shift in irrigated crop types from cereals to higher value specialty crops. Training and education of irrigation farmers on techniques and benefits of higher levels of crop water management will increase
- Improvements in irrigation scheduling technology and widespread use of scheduling techniques will continue

From: *Irrigation in the 21st Century*

Centre for Young Farmers and Sustainable Agriculture

Sustainable Agriculture

Sustainable agriculture refers to an agricultural production and distribution system that:

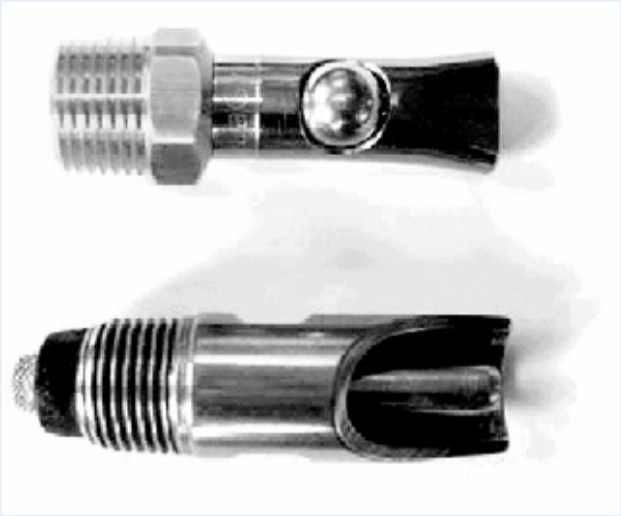
- Achieves the **integration** of natural biological cycles and controls,
- Protects and renews **soil** fertility and the natural resource base,
- Optimizes the management and use of **on-farm** resources,
- **Reduces** the use of nonrenewable resources and purchased production inputs,
- Provides an adequate and dependable farm **income**,
- Promotes **opportunity** in family farming and farm communities, and
- **Minimizes** adverse impacts on health, safety, wildlife, water quality and the environment

To achieve sustainable agriculture we must deal both with issues involving environmental impacts as well as productivity of the land. Any program to successfully develop a system of sustainable agriculture must have farmer involvement at all stages of its development, and must look at a farming system as a whole, not just at individual elements.

JV Farms, High River, Alberta

ball-bite drinker

standard drinker



- one-year trial, from August 2004 to July 2005, the ball-bite drinker sections of the barn used 35 per cent less water that the standard drinker sections
- no detrimental effects on the animals or facility management
- decrease in water usage led to many secondary benefits

Resolution - 2005 PC AGM

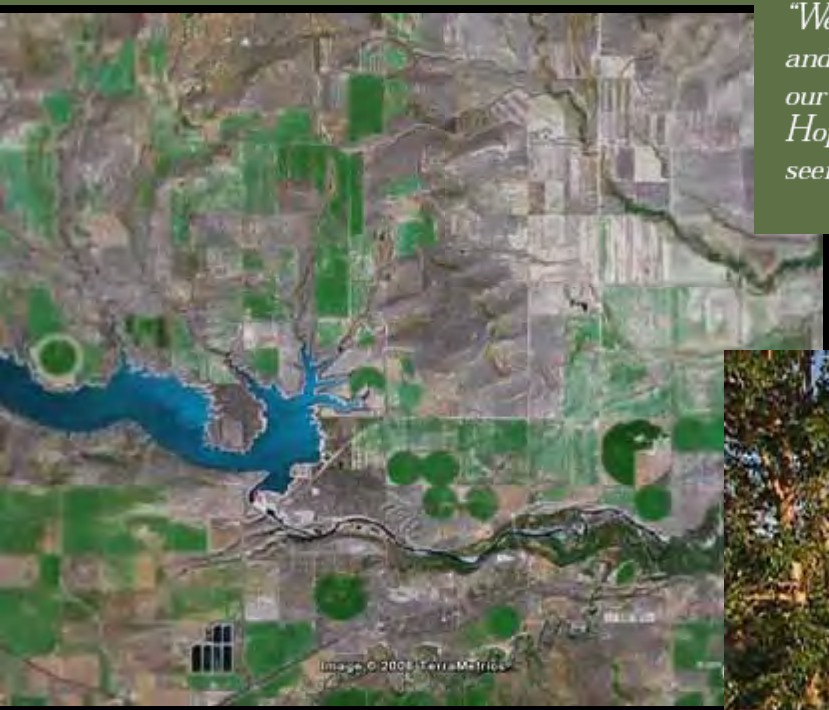
Progressive Conservative Party of Alberta 2005 AGM

Resolution submitted by the Cardston-Taber-Warner PC Association

Resolved: The Government of Alberta recognizes and acknowledges that water is a very important commodity and valuable resource. The Government also recognizes the need for more storage of this valuable resource.

We will look at alternatives to costly and environmentally sensitive dams, by encouraging a study to look at the possibility of on farm storage, particularly on the corners of pivot irrigation land. This storage would help producers have water for agriculture in the early and late season if required.

Beaver Creek Watershed Group



"We are really the ones who manage the land every day and the positive actions we take today will ensure that our children have healthy riparian areas and clean water. Hopefully they will grow up understanding what it seemed to take us forever to learn."

Dixon Hammond

COMMITTEES

HOUSE OF COMMONS

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Standing Committee on Environment and Sustainable Development (ENVI)

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- Preparing a Submission to a House of Commons Committee

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Committee Environment and Sustainable Development (ENVI)

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Example: John Smith

Organization

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1020

Mr. Nathan Cullen
Dr. David Sauchyn
Mr. Nathan Cullen
Dr. David Sauchyn
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The Chair
Dr. David Sauchyn
The Chair
Mr. Mark Warawa
Mr. Michael Cleland

1025

Mr. Mark Warawa
Mr. Kory Teneycke
Dr. David Sauchyn

IPCC 4th Assessment Report

WMO INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE UNEP

800+ contributing authors
450+ lead authors from 130+ countries
2500+ scientitic expert reviewers
6 years of work
4 volumes

IPCC 4th Assessment Report

WMO INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE UNEP

- Most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations

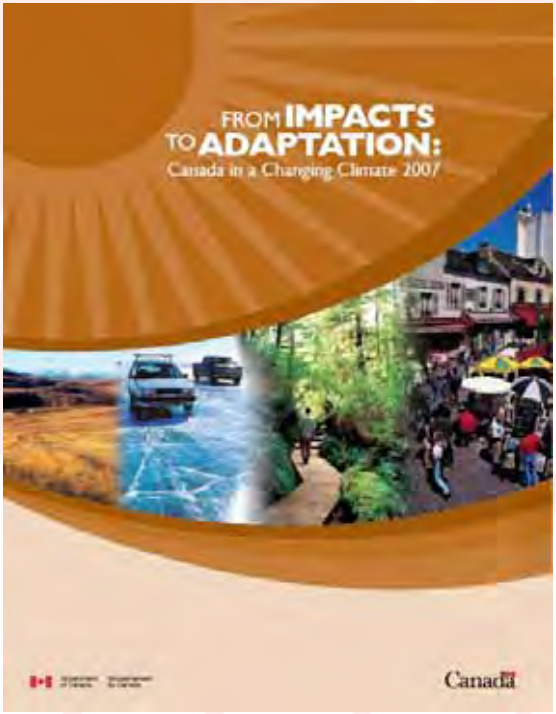
- Warming would continue for centuries, even if greenhouse gas concentrations were to be stabilized

From Impacts to Adaptation: Canada in a Changing Climate 2007
Publication Date: Fall 2007

Edited by: Donald Lemmen, Natural Resources Canada
Fiona Warren, Natural Resources Canada
Elizabeth Bush, Environment Canada
Jacinthe Lacroix, Environment Canada

http://www.adaptation.nrcan.gc.ca/assess_e.php

Synthesis Report and Highlights



http://www.adaptation2007.nrcan.gc.ca

- Regionally-focused analysis (North, Atlantic, Québec, Ontario, Prairies, BC, International), not policy prescriptive
- 145 authors, 110 reviewers, over 3000 references cited
- Documents recent impacts, current and future vulnerabilities
- Includes examples of ongoing adaptation initiatives
- Key products - science report (500 pages – english and french), Synthesis Report and Highlights (each 40 page bilingual documents)

Synthesis Report
Chapter 1: Introduction
Chapter 2: Background
Chapter 3: Northern Canada
Chapter 4: Atlantic Canada
Chapter 5: Québec
Chapter 6: Ontario
Chapter 7: The Prairies
Chapter 8: British Columbia
Chapter 9: Canada in an International Context
Chapter 10: Future Directions

http://www.adaptation.nrcan.gc.ca/assess_e.php

http://www.parc.ca

PARC

The **Prairie Adaptation Research Collaborative** 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. Our objective is to generate practical options to adapt to current and future climate change. We are also charged with fostering the development of new professionals in the emerging science of climate change impacts and adaptation.

PARC also hosts:

- C-CIARN Prairies, part of the national Canadian Climate Impacts and Adaptation Network.
- National Assessment on Climate Change - Prairies Chapter

Climate models generally forecast drier and warmer conditions and increased climate variability for the Prairie Provinces. This implies stress on agriculture, reduced river and stream flows, increased fires and pathogen stress in our forests, and impacts on biodiversity, to highlight a few challenges. Since its inception in 2000, PARC has been involved in dozens of interdisciplinary projects to address climate change impacts and adaptation issues. Explore our site to view our research projects and reports and learn about our support for graduate researchers and interns. Climate change affects all of us in some way - how does it affect you?

NEW! Feature: > Climate Scenarios for Alberta

The warming in the Praries exceeds the global average.

Projected future climates are outside the range of natural variability observed in the 20th century

Paleoclimate records include droughts of longer duration than experienced by EuroCanadians

Longer warmer summers and shorter summers will be provide opportunites for reducing costs and for new economic acitivies

But most impacts are adverse because most economies and activities are not well adapted to change

There will be greater variation from season to season and year to year

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

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

Major ecological changes are expected.

There are advantages and disadvantages to a shorter winter

The net impacts of climate change are not clear because they depend on rates of climate change and adaptation strategies

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

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University of British Columbia Press

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