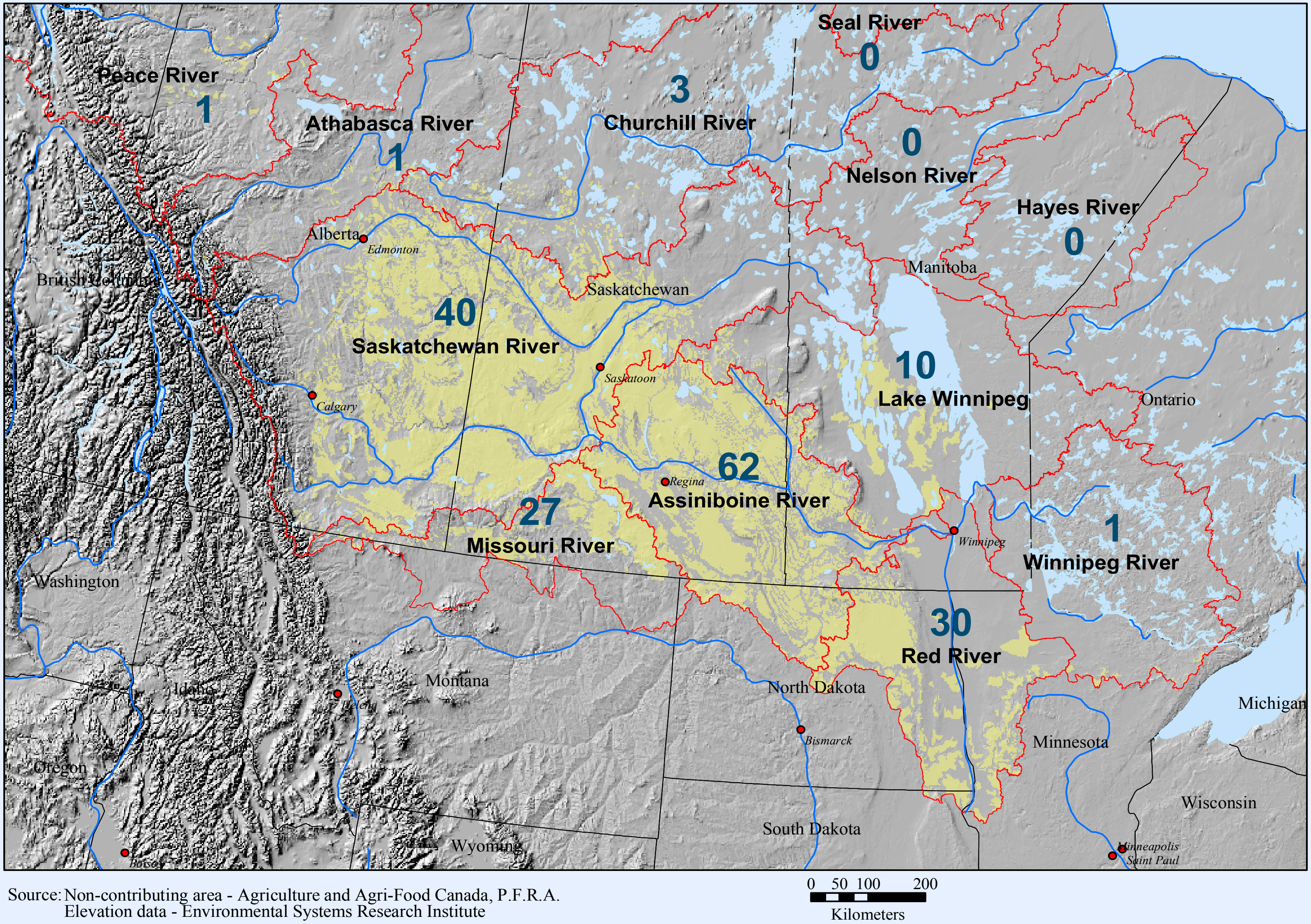
Water and Climate scenarios for the SSRB

Dave Sauchyn, Jodi Axelson and Suzan Lapp
Prairie Adaptation Research Collaborative,
University of Regina

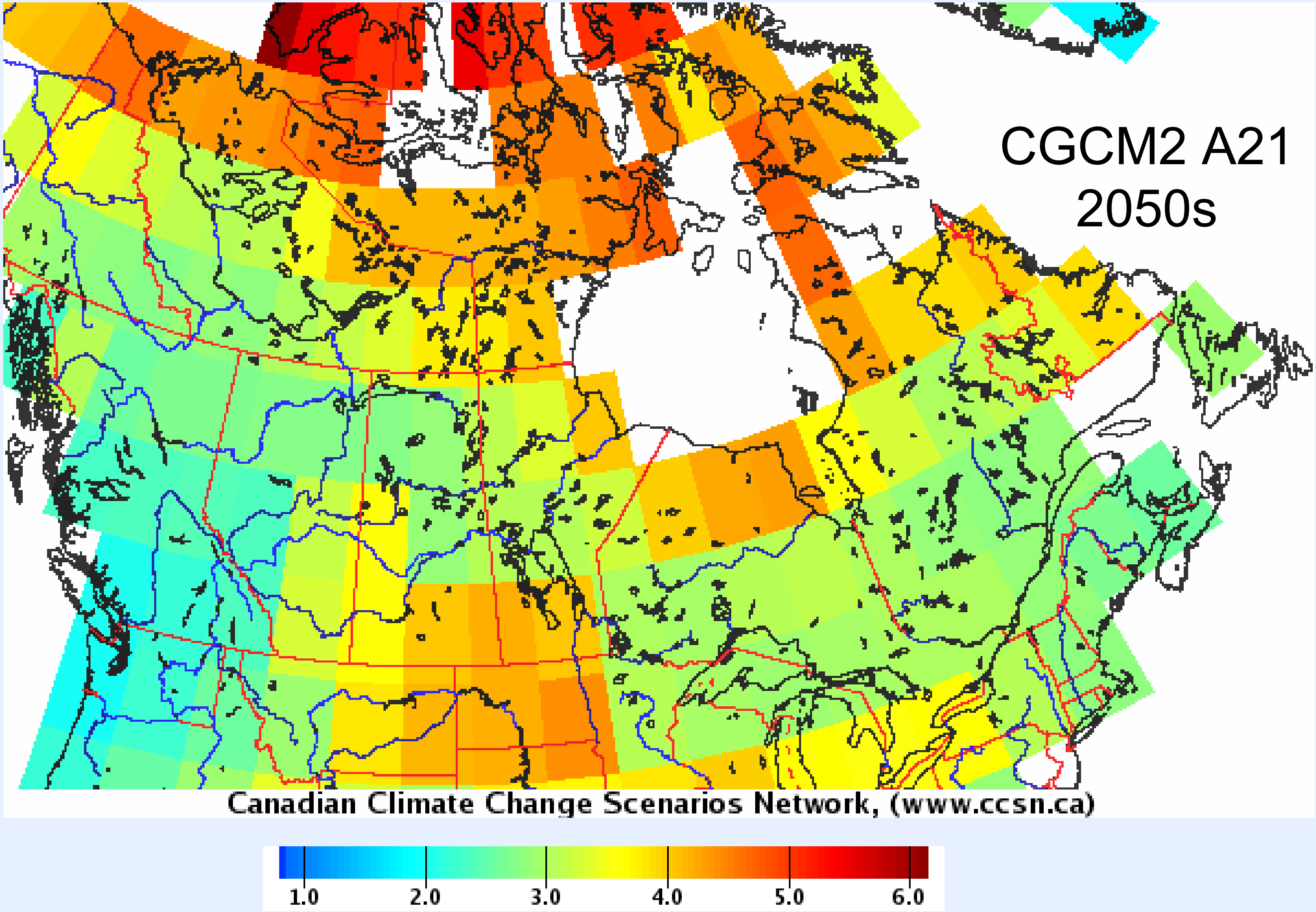
IACC Project Stakeholders Meeting
Outlook, SK, 25 January 2007

Prairie Drainage Basins

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

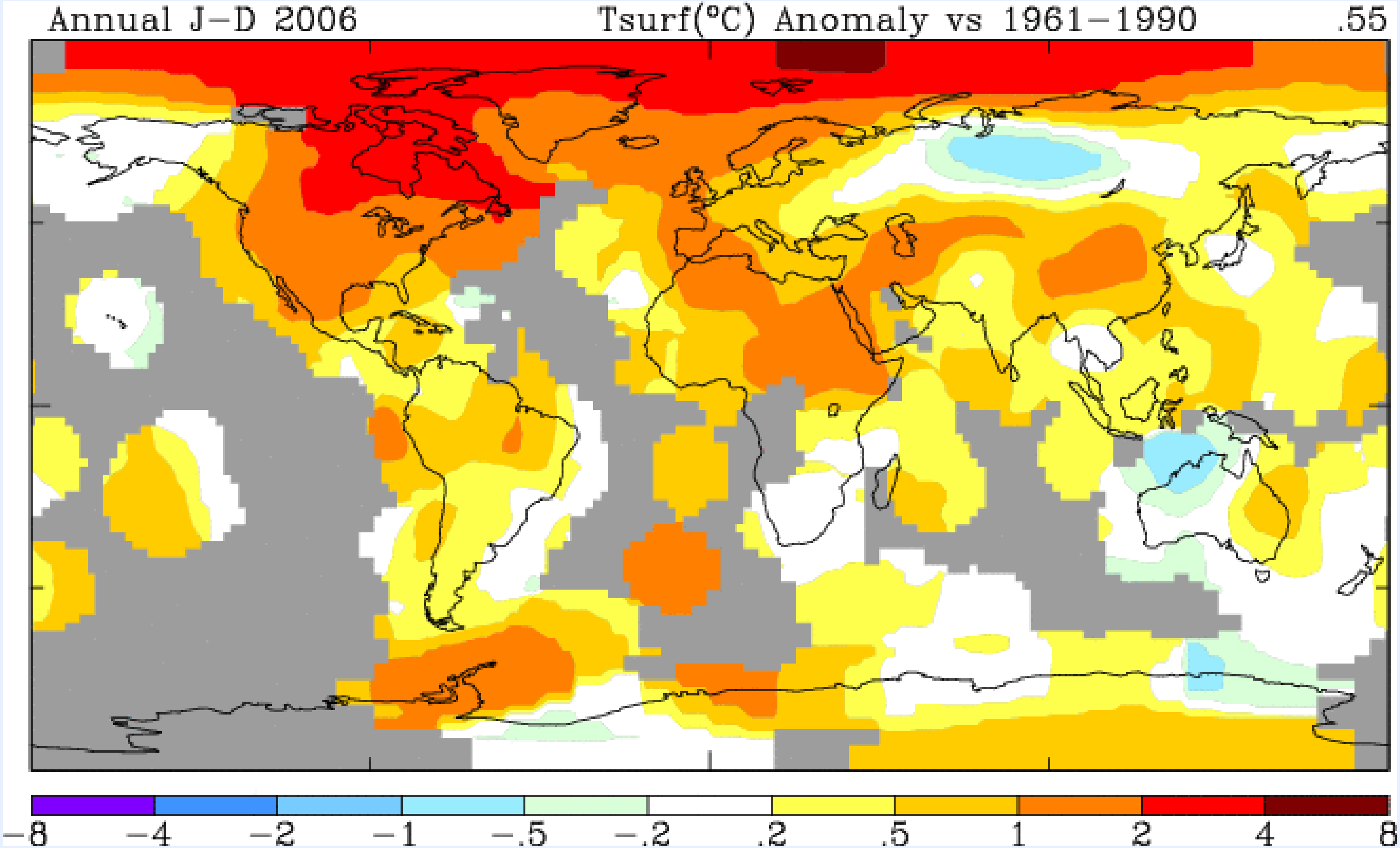


Source: Non-contributing area - Agriculture and Agri-Food Canada, P.F.R.A.
Elevation data - Environmental Systems Research Institute



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

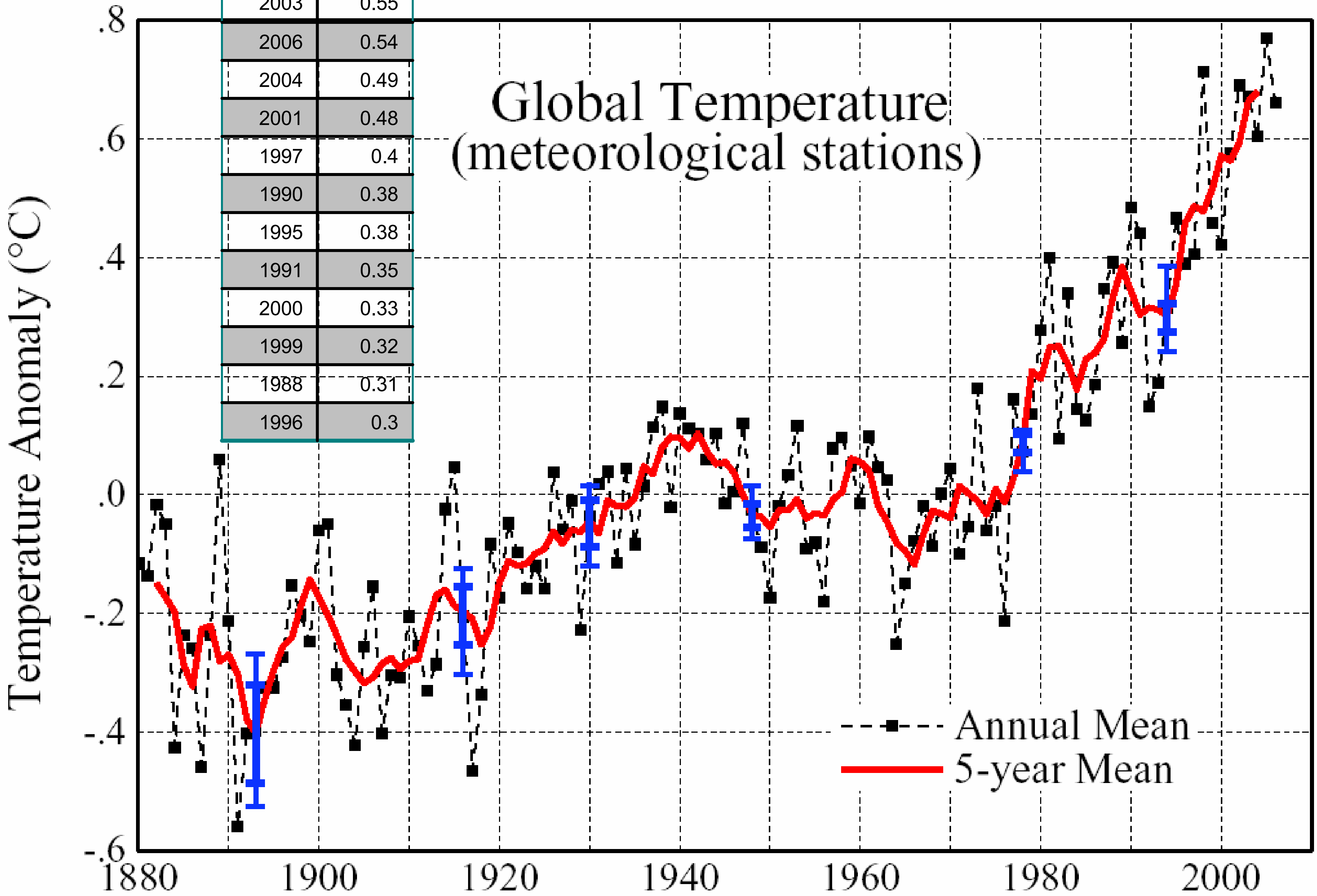
2006 Temperatures: Departures from Normal (1961-90)



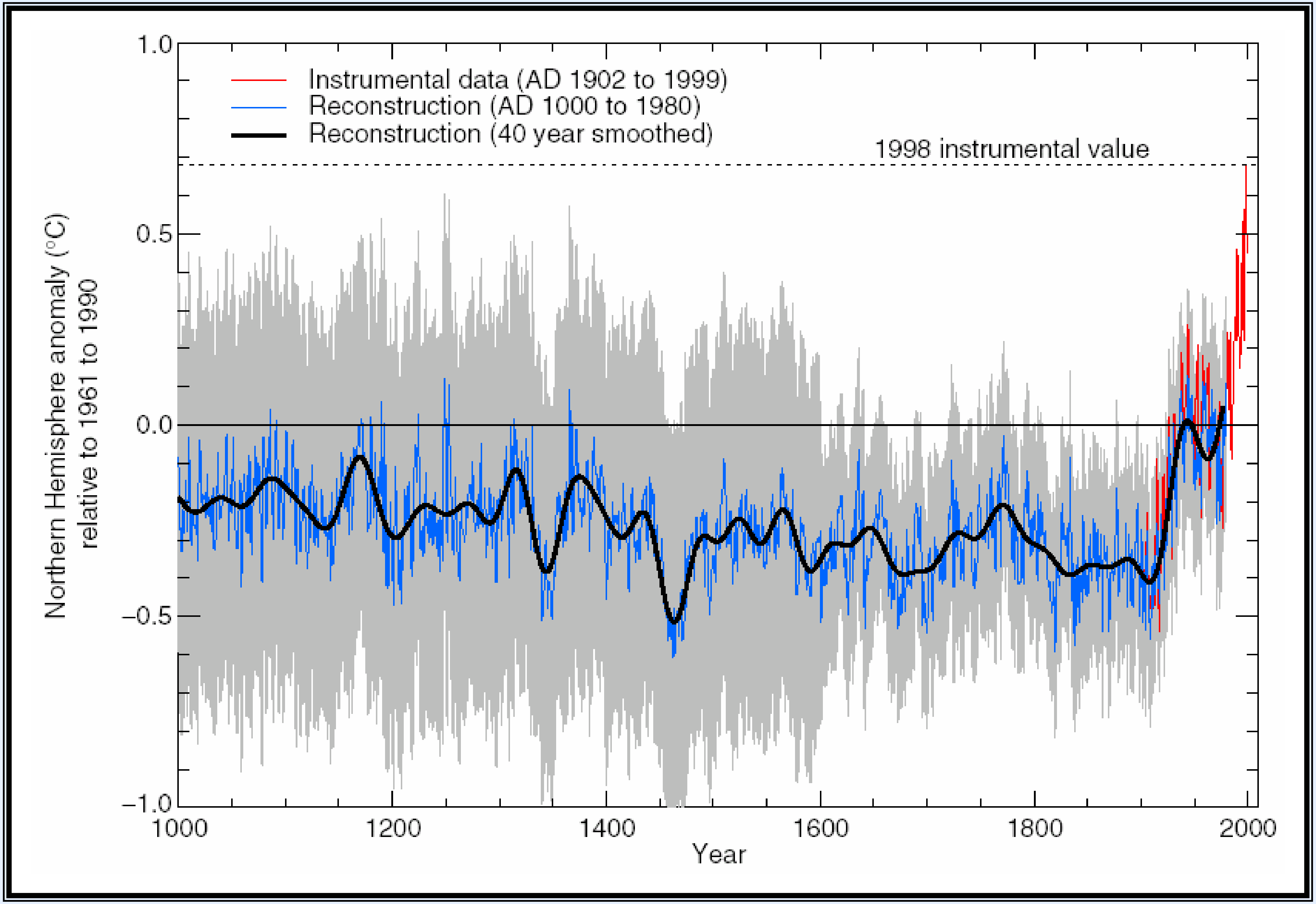
http://data.giss.nasa.gov/gistemp/

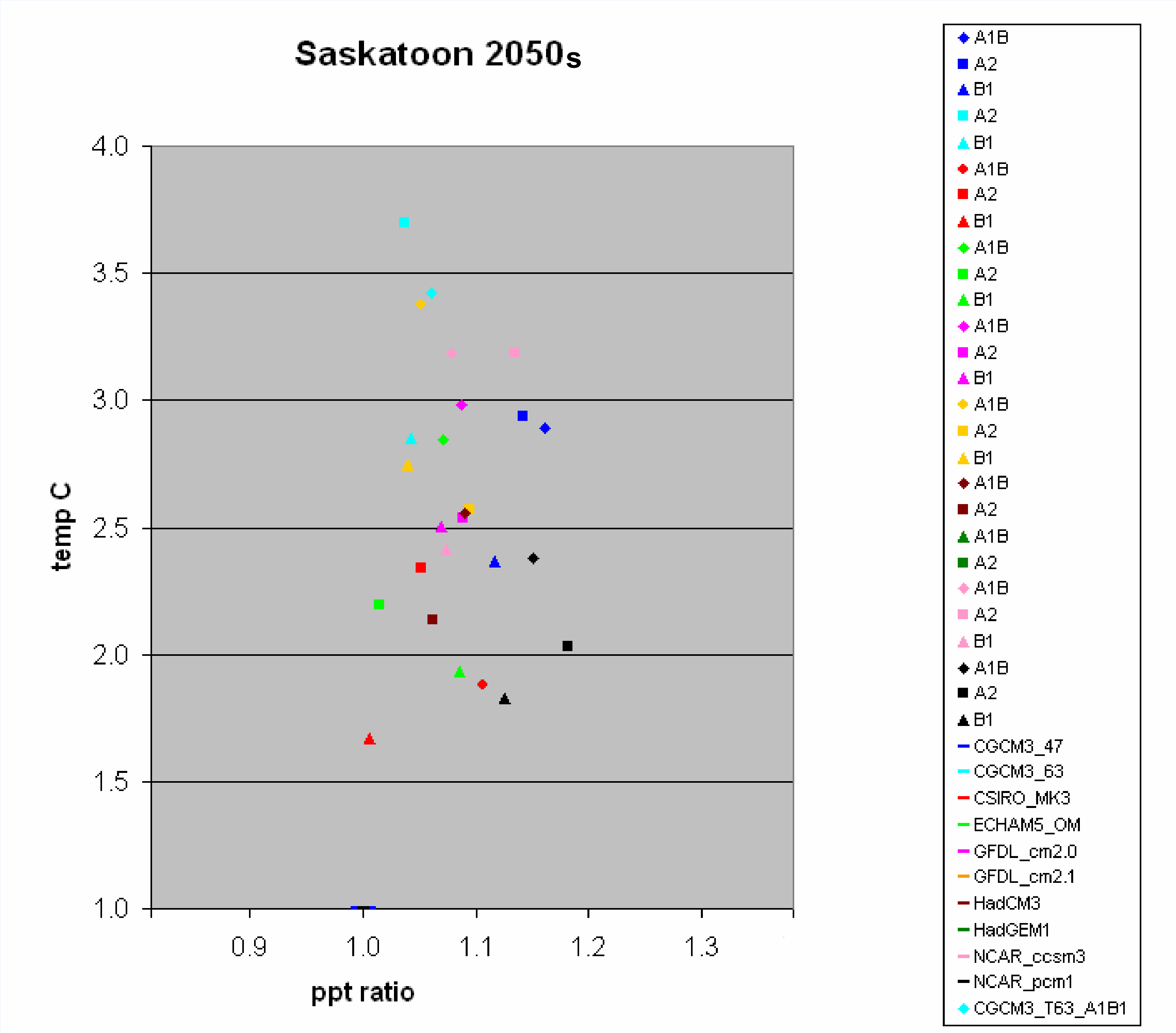
2005	0.63
1998	0.57
2002	0.56
2003	0.55
2006	0.54
2004	0.49
2001	0.48
1997	0.4
1990	0.38
1995	0.38
1991	0.35
2000	0.33
1999	0.32
1988	0.31
1996	0.3

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



Northern Hemisphere temperature, past 1000 years



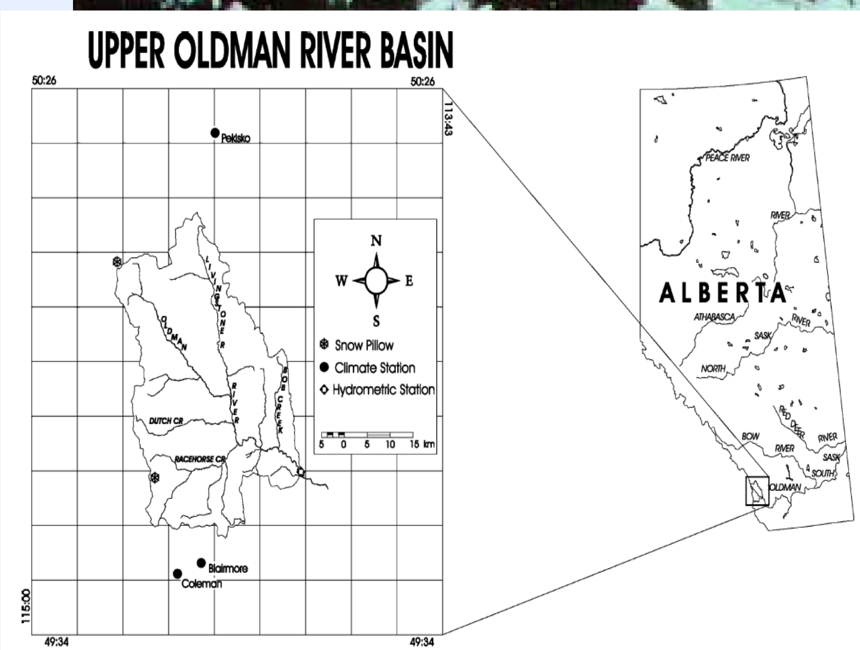


Saskatoon 2050s
4.0
3.5
3.0
2.5
2.0
1.5
1.0
temp C
0.9
1.0
1.1
1.2
1.3
ppt ratio
A1B
A2
B1
A2
B1
A1B
A2
B1
A1B
A2
B1
A1B
A2
B1
A1B
A2
B1
A1B
A2
A1B
A2
A1B
A2
B1
A1B
A2
B1
CGCM3_47
CGCM3_63
CSIRO_MK3
ECHAM5_OM
GFDL_cm2.0
GFDL_cm2.1
HadCM3
HadGEM1
NCAR_ccsm3
NCAR_pcm1
CGCM3_T63_A1B1

Climate Warming Impacts on Snowpack Accumulation in an Alpine Watershed

Suzan Lapp, M.Sc. thesis, U of L

Lapp *et al*. 2005, Int. J. Climatology



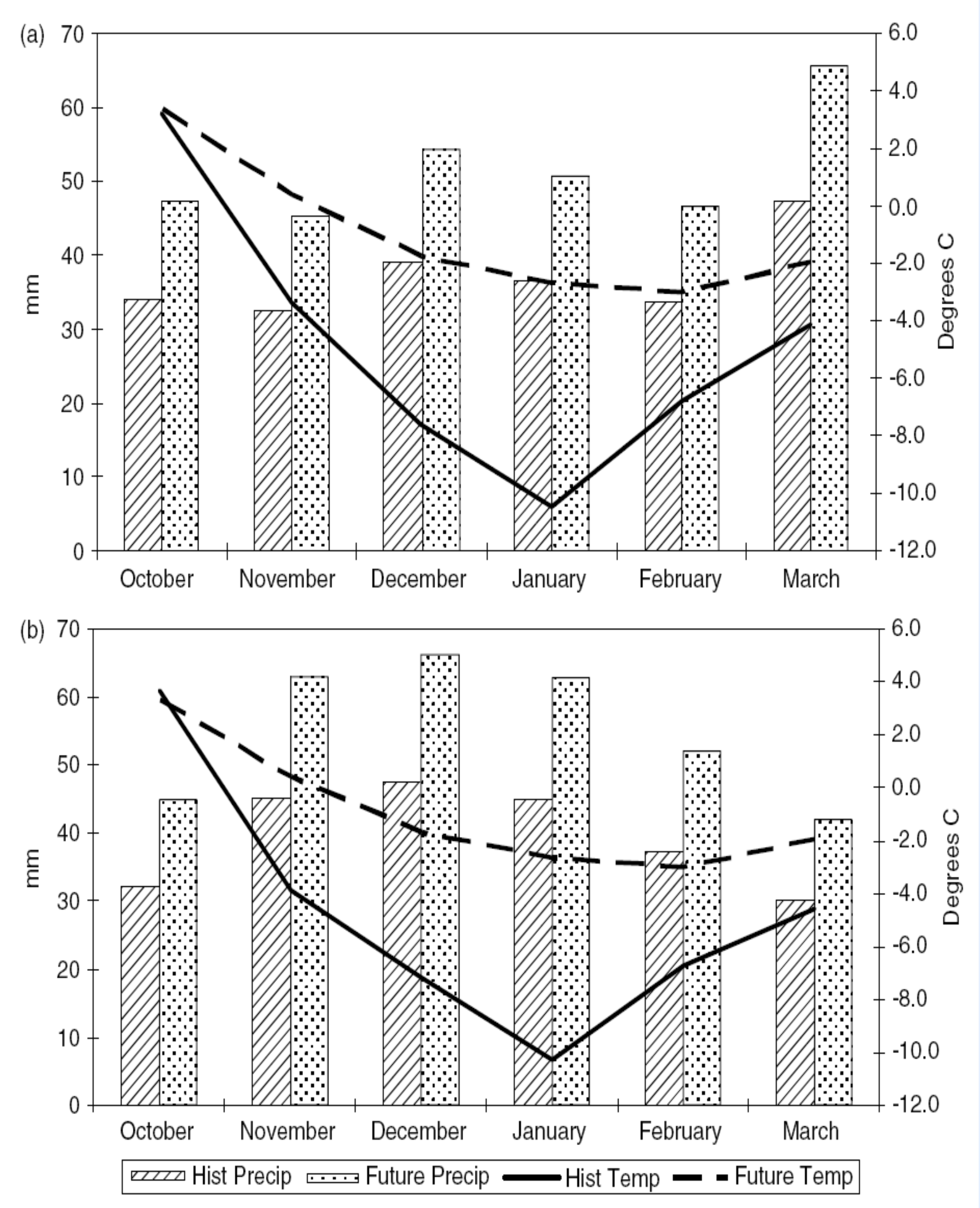
Historical and Future (CGCM1) Climate

October - March

(a) Pekisko

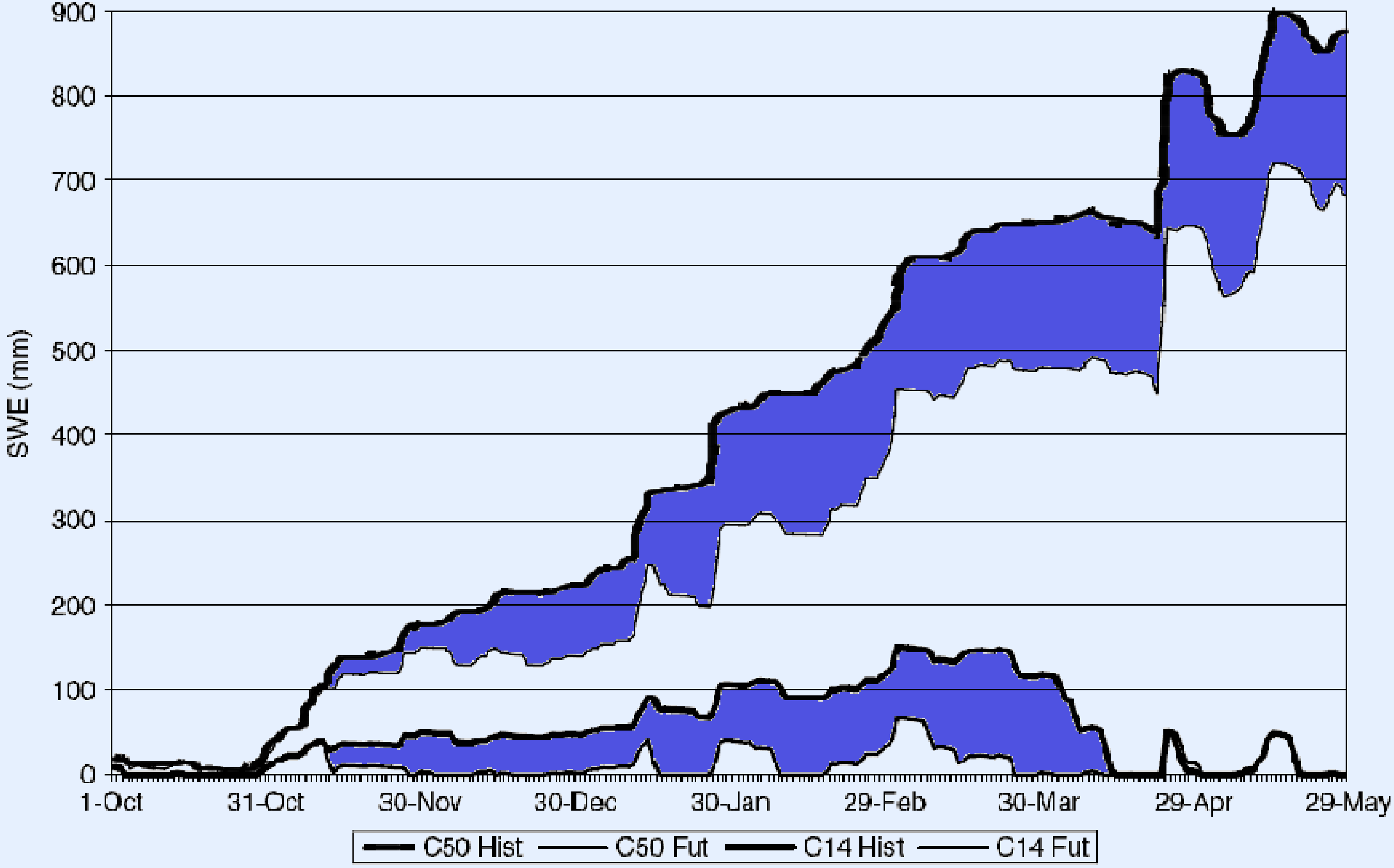
(b) Coleman

Lapp *et al*. 2005

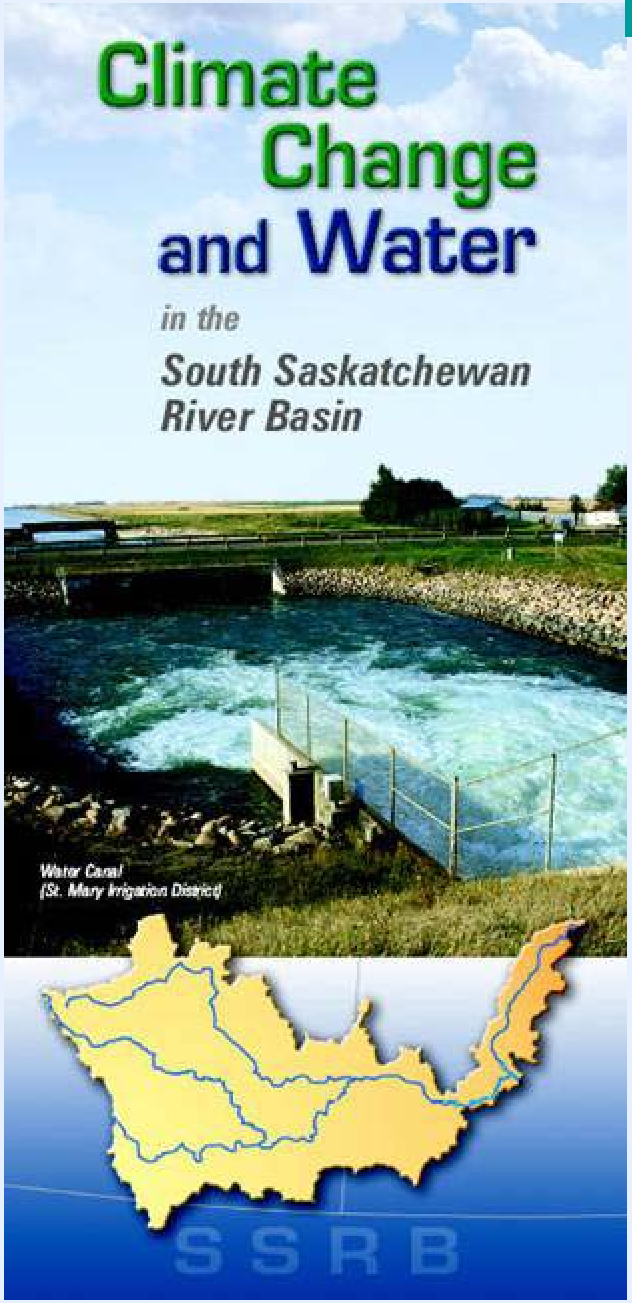


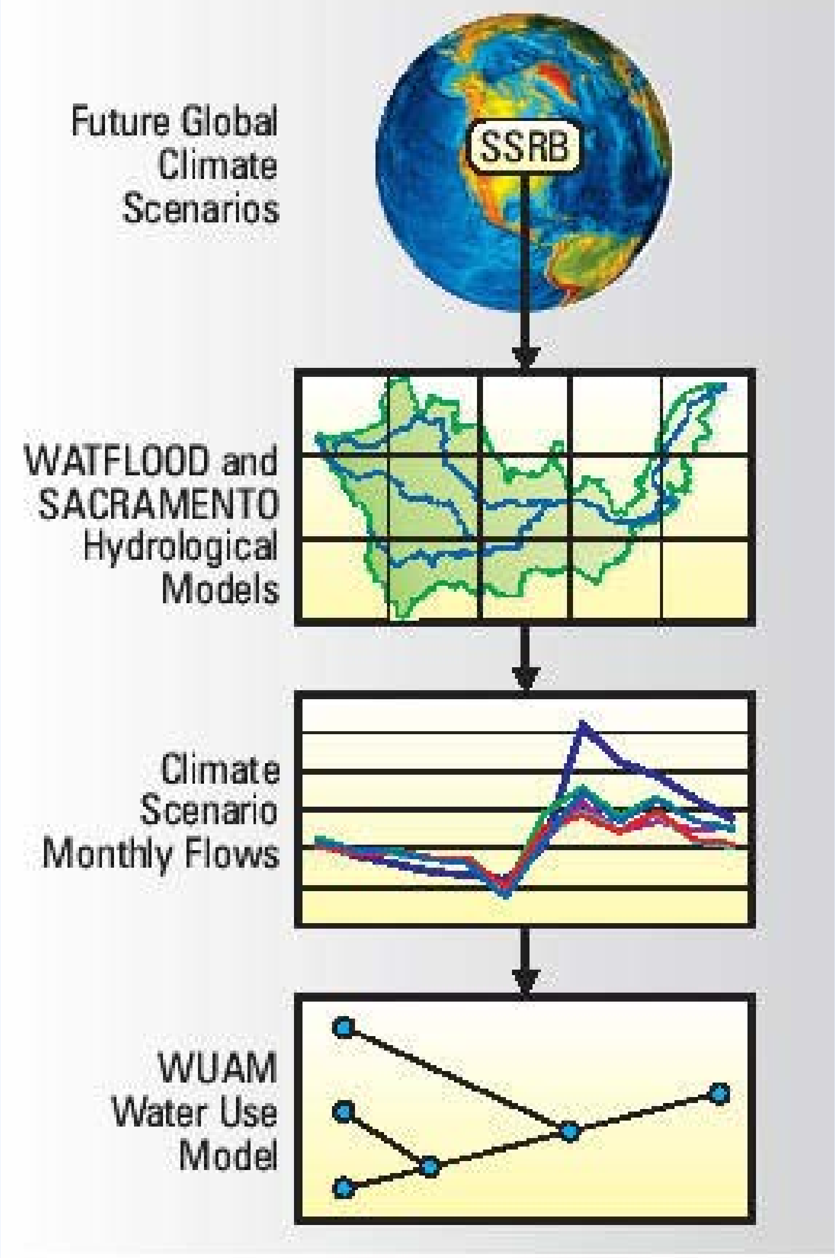
Cumulative Snowpack

Lapp *et al*. 2005



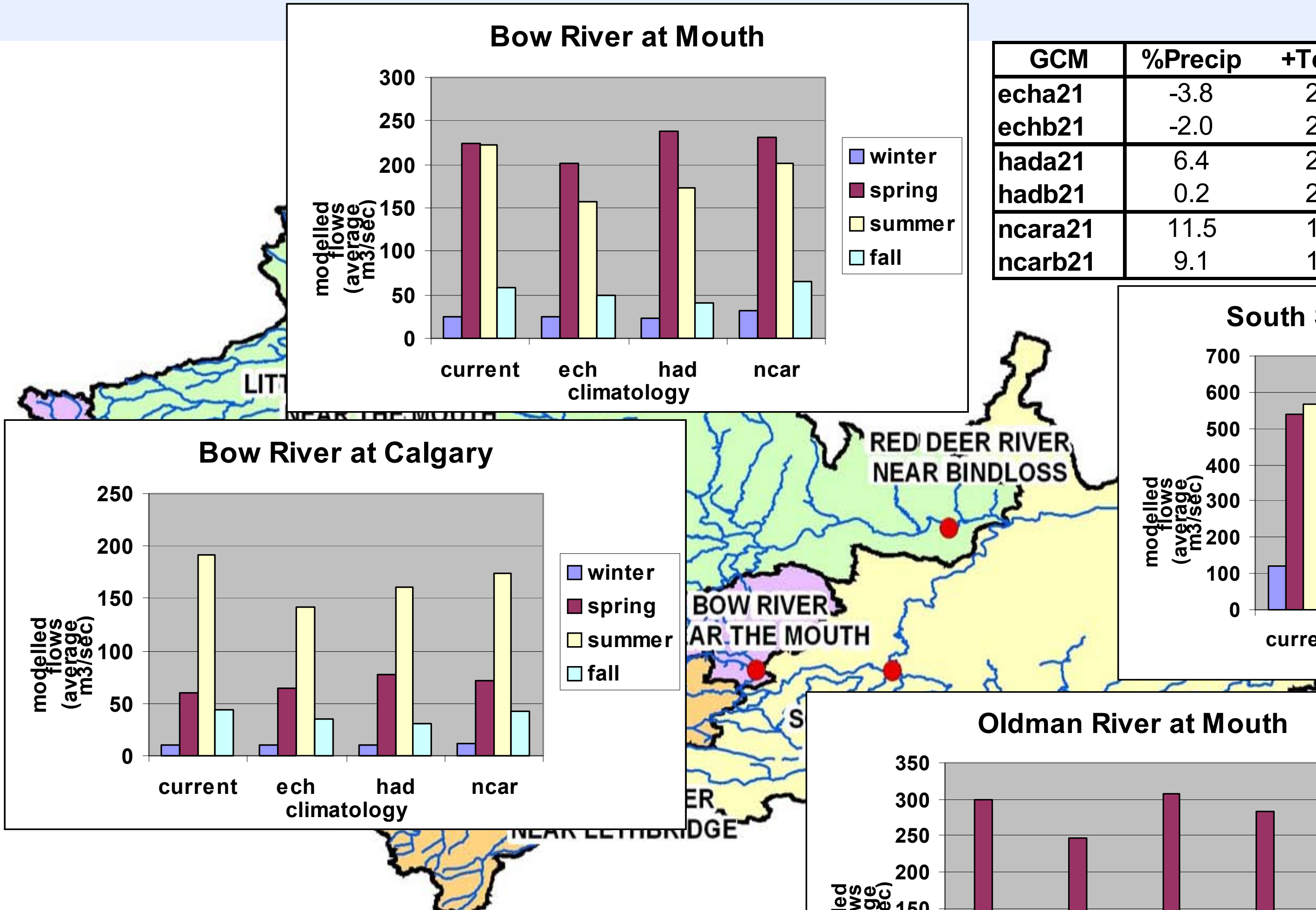
http://www.parc.ca/ssrb/index.html



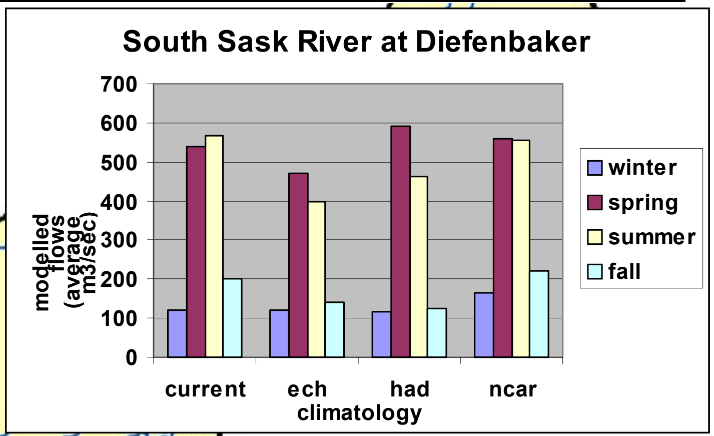


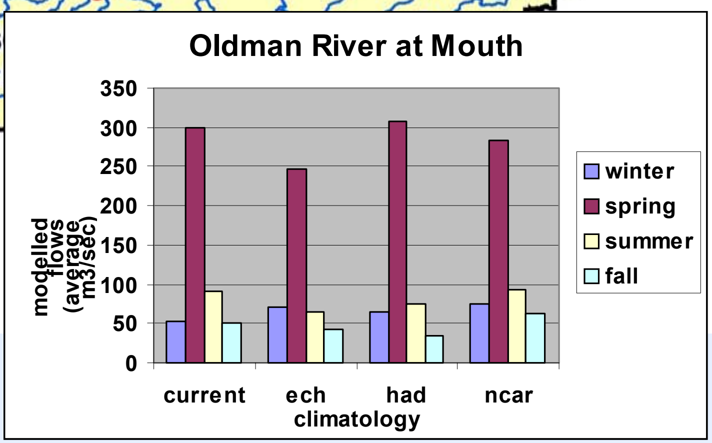
Seasonal flows, SSRB, 2039-2070

Pietroniro *et al.*, 2006



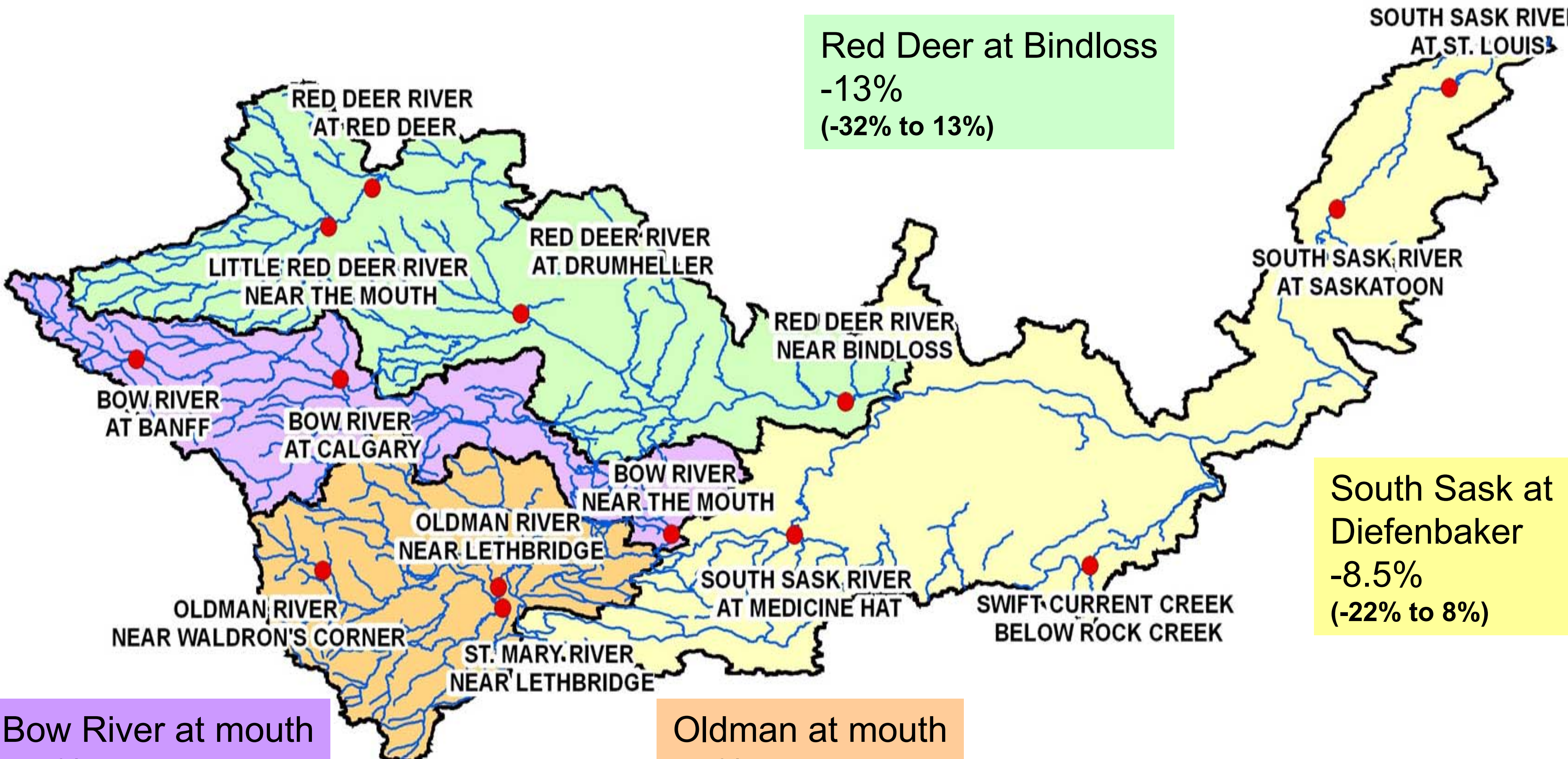
GCM	%Precip	+Temp	Description
echa21	-3.8	2.8	driest, warmest
echb21	-2.0	2.8	
hada21	6.4	2.3	moderately wet and warm
hadb21	0.2	2.1	
ncara21	11.5	1.7	wettest and least warm
ncarb21	9.1	1.5	





Projected annual flow, 2039 – 2070

Pietroniro *et al*., 2006



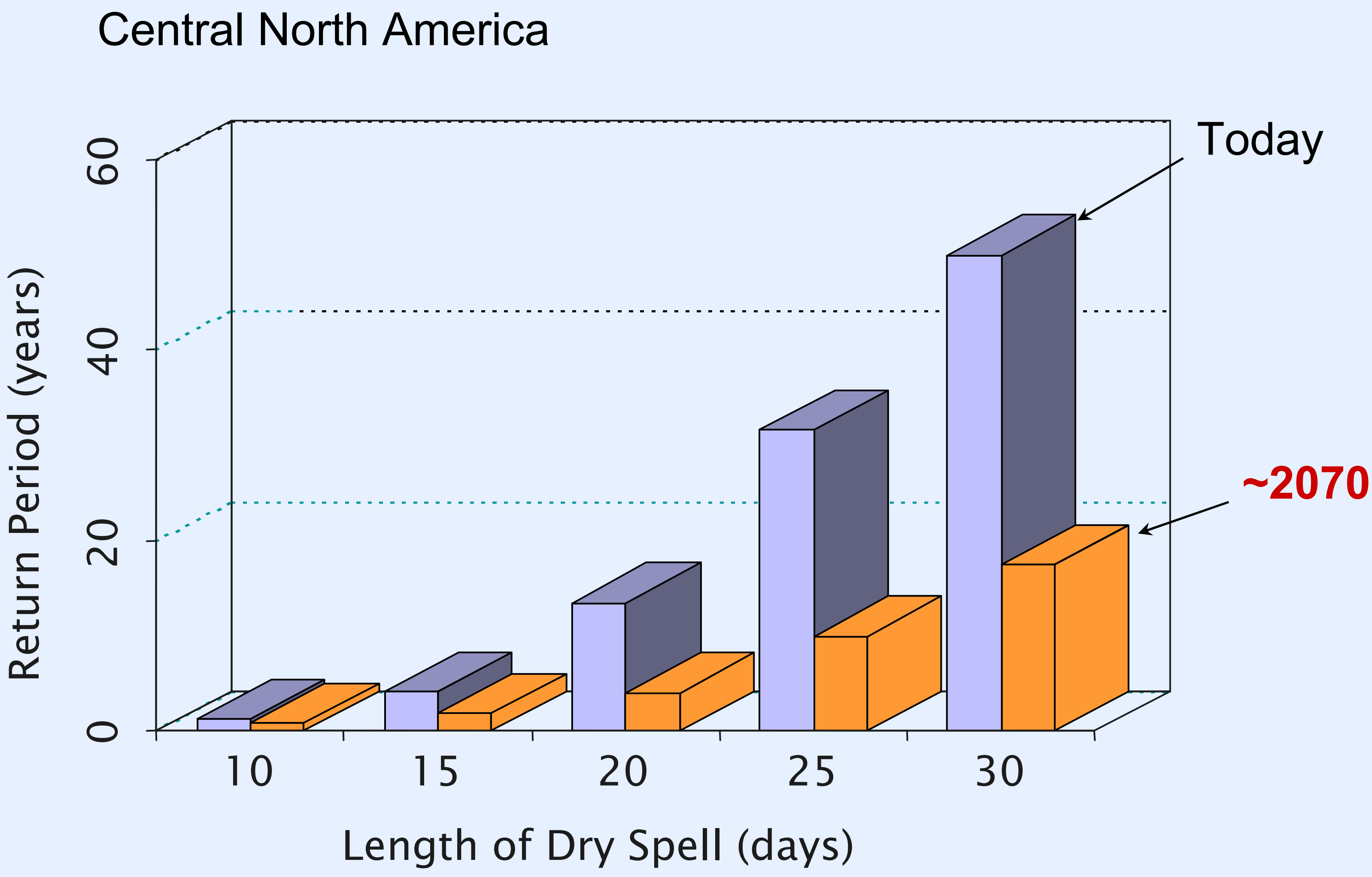
Red Deer at Bindloss
-13%
(-32% to 13%)

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

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

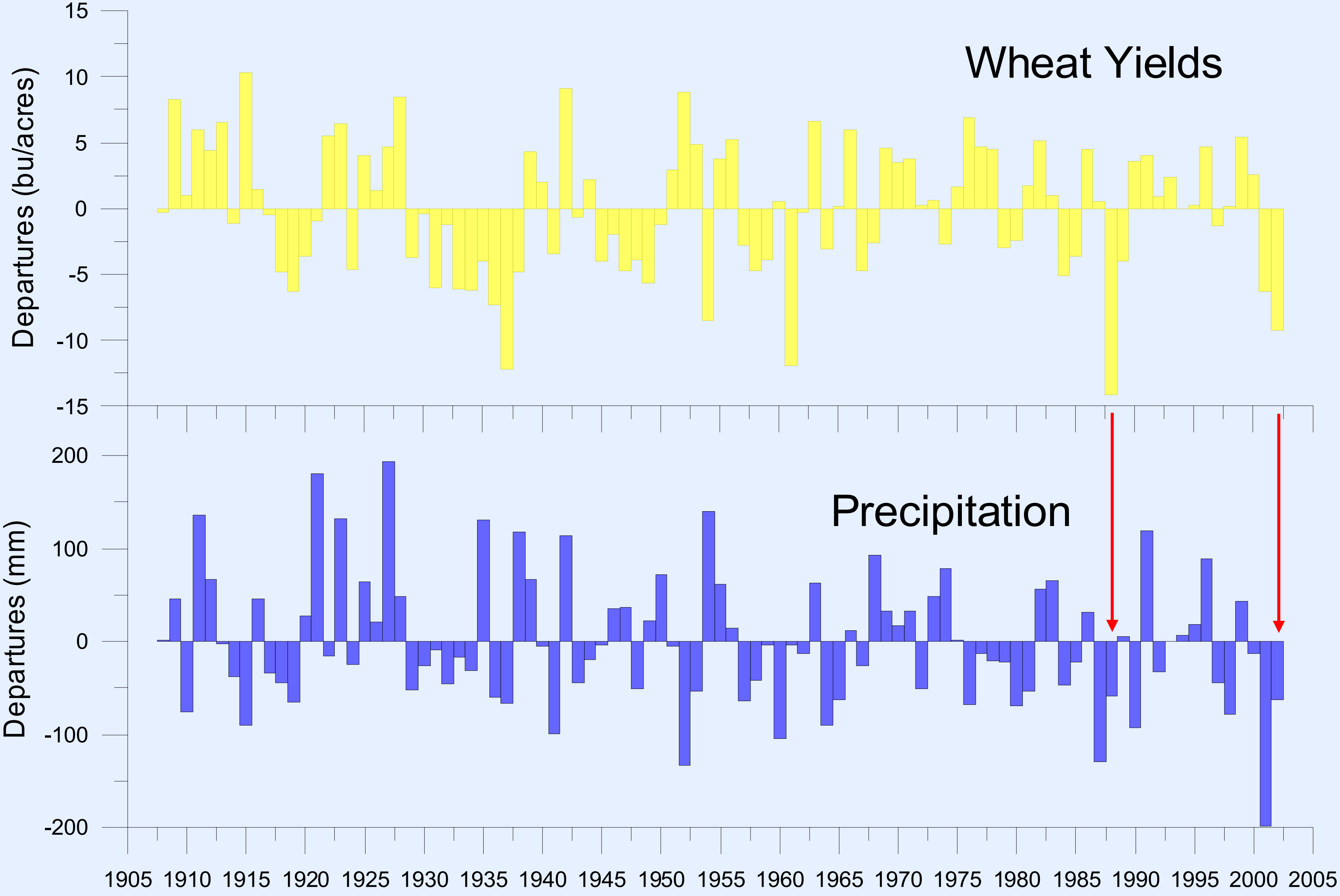
Oldman at mouth
- 4%
(-13% to 8%)

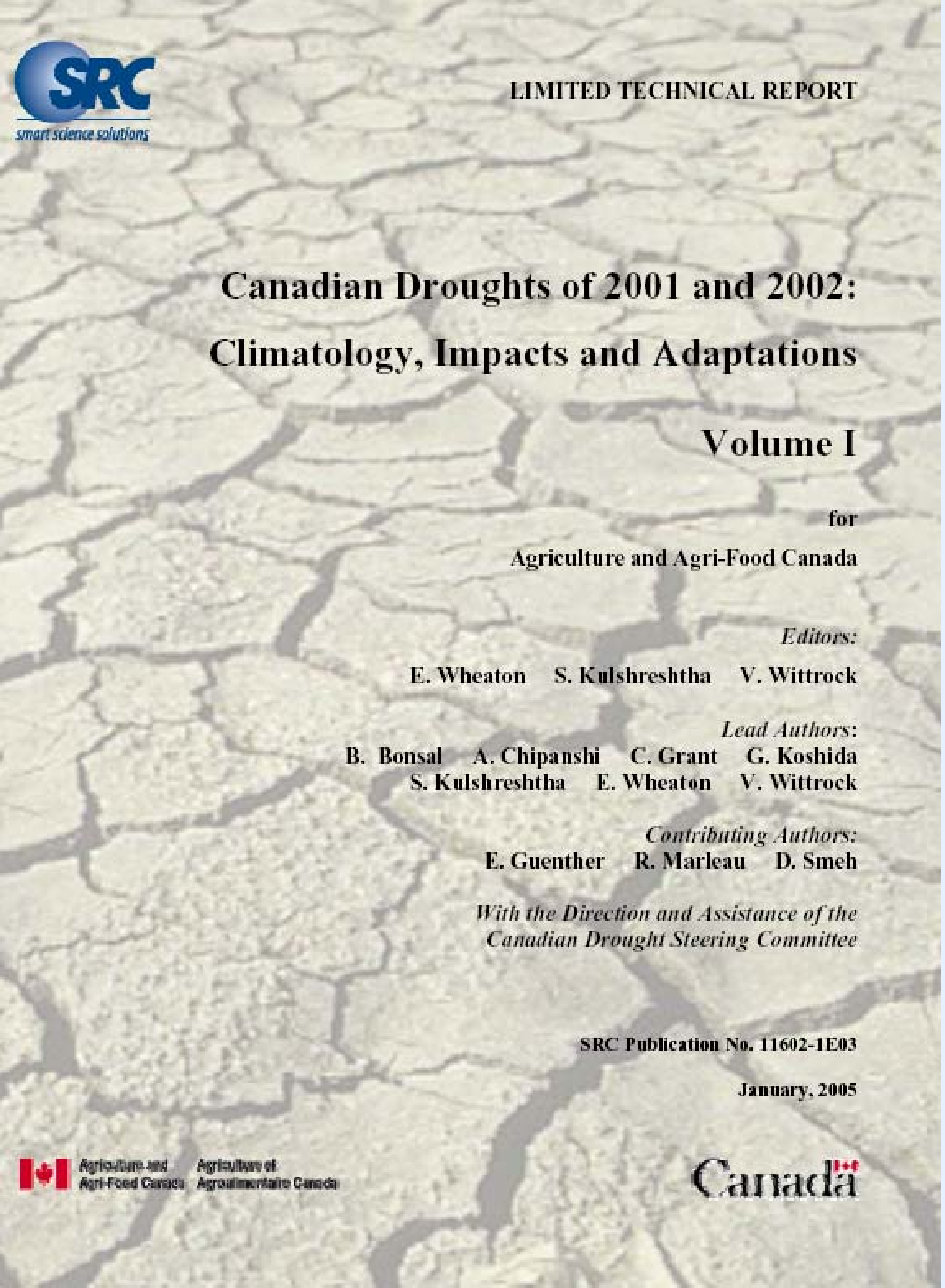
Increasing Drought Frequency



Kharin and Zwiers, 2000

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




SRC
smart science solutions

LIMITED TECHNICAL REPORT

Canadian Droughts of 2001 and 2002:
Climatology, Impacts and Adaptations

Volume I

for

Agriculture and Agri-Food Canada

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With the Direction and Assistance of the Canadian Drought Steering Committee

SRC Publication No. 11602-1E03

January, 2005

Agriculture and Agri-Food Canada Agriculture et Agroalimentaire Canada

Canada

- **Agricultural production** dropped an estimated $3.6 billion for the 2001 and 2002 drought years, with the largest loss in 2002 at more than $2 billion.
- The **Gross Domestic Product** fell some $5.8 billion for 2001 and 2002, again with the larger loss in 2002 at more than $3.6 billion.
- **Employment** losses exceeded 41,000 jobs, including nearly 24,000 jobs in 2002.
- **Net farm income** was negative or zero for several provinces for the first time in 25 years. A negative net farm income occurred in Saskatchewan for 2002, and a zero netfarm income was reported for Alberta in 2002.

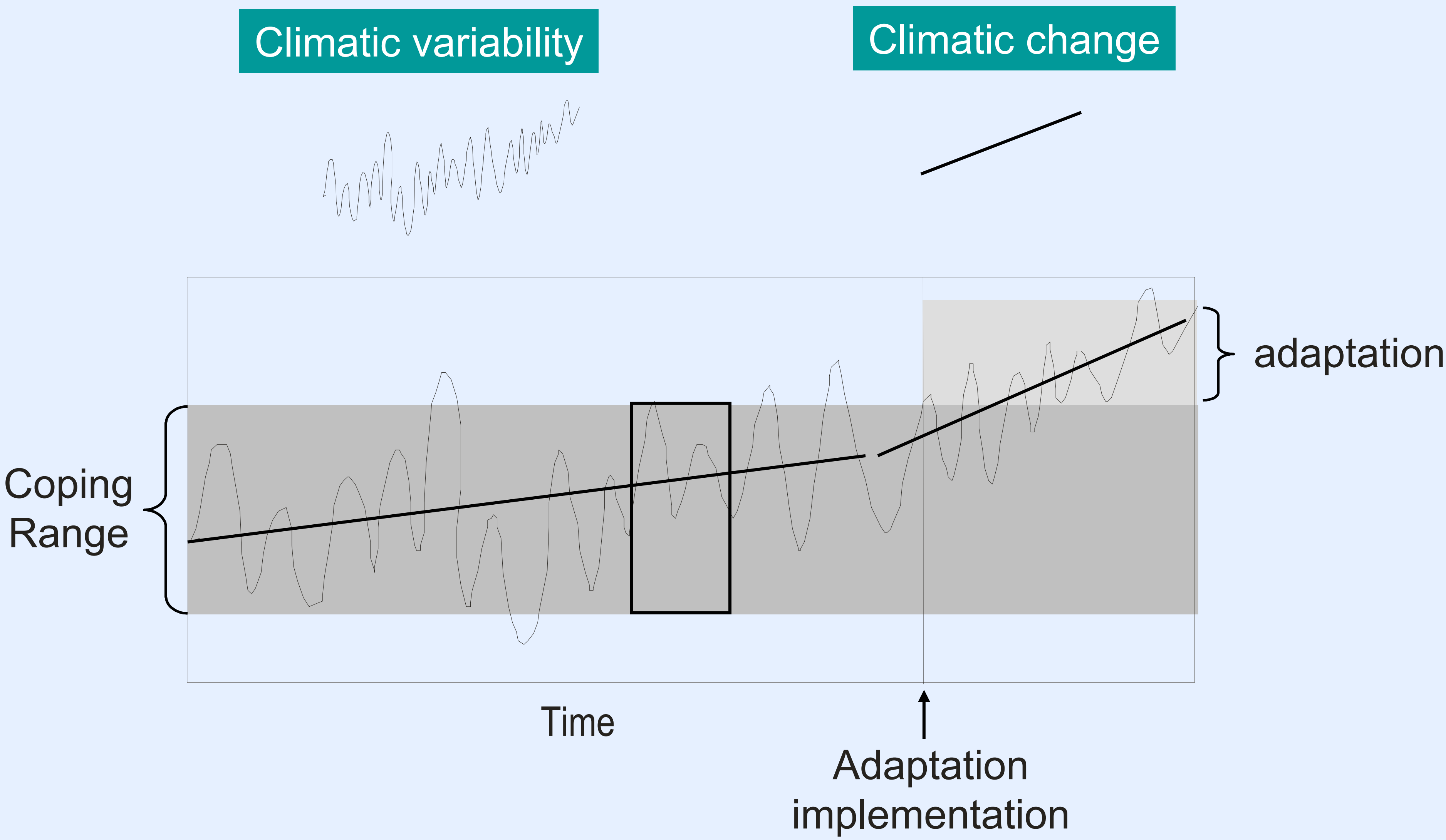
Drought Research Initiative (DRI)

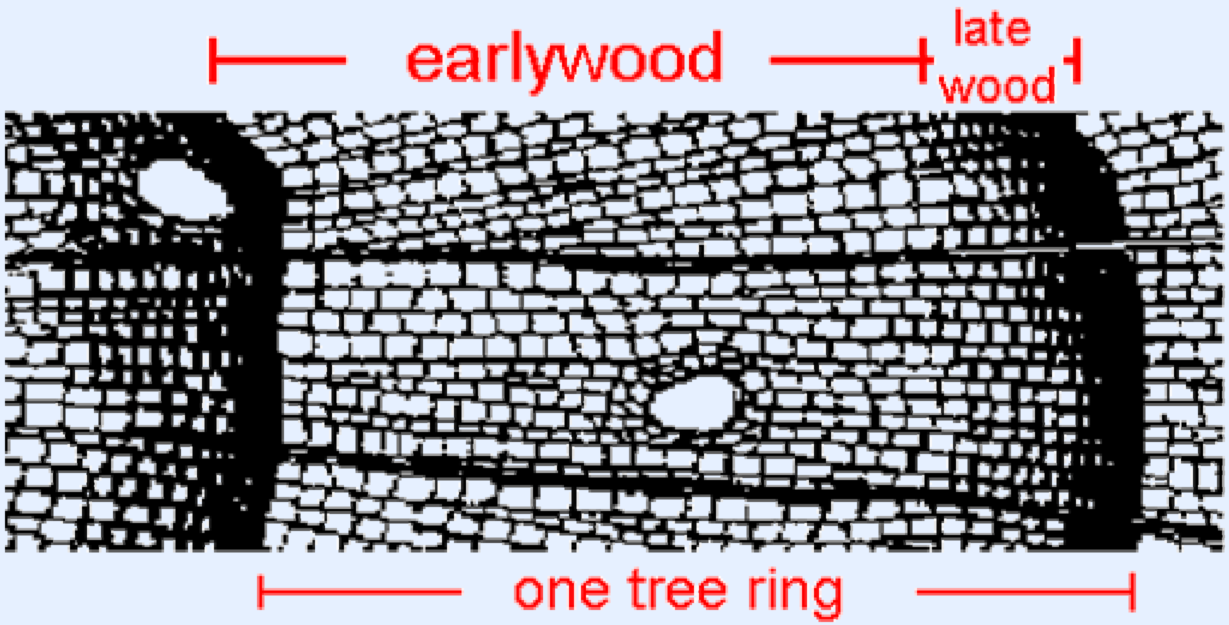
To better understand the physical characteristics of and processes influencing Canadian Prairie droughts, and to contribute to their better prediction, through a focus on the recent severe drought of 1999 - 2004/05.

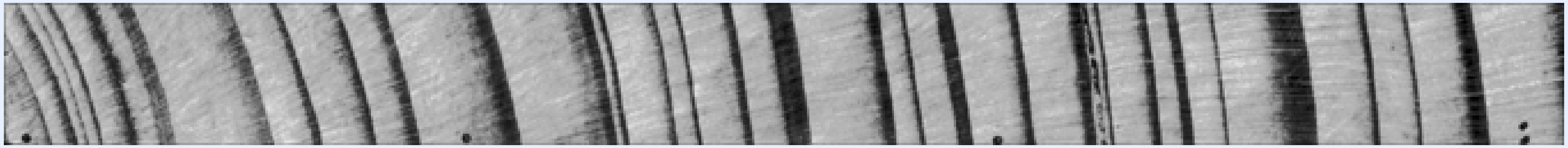
DRI

DROUGHT RESEARCH INITIATIVE

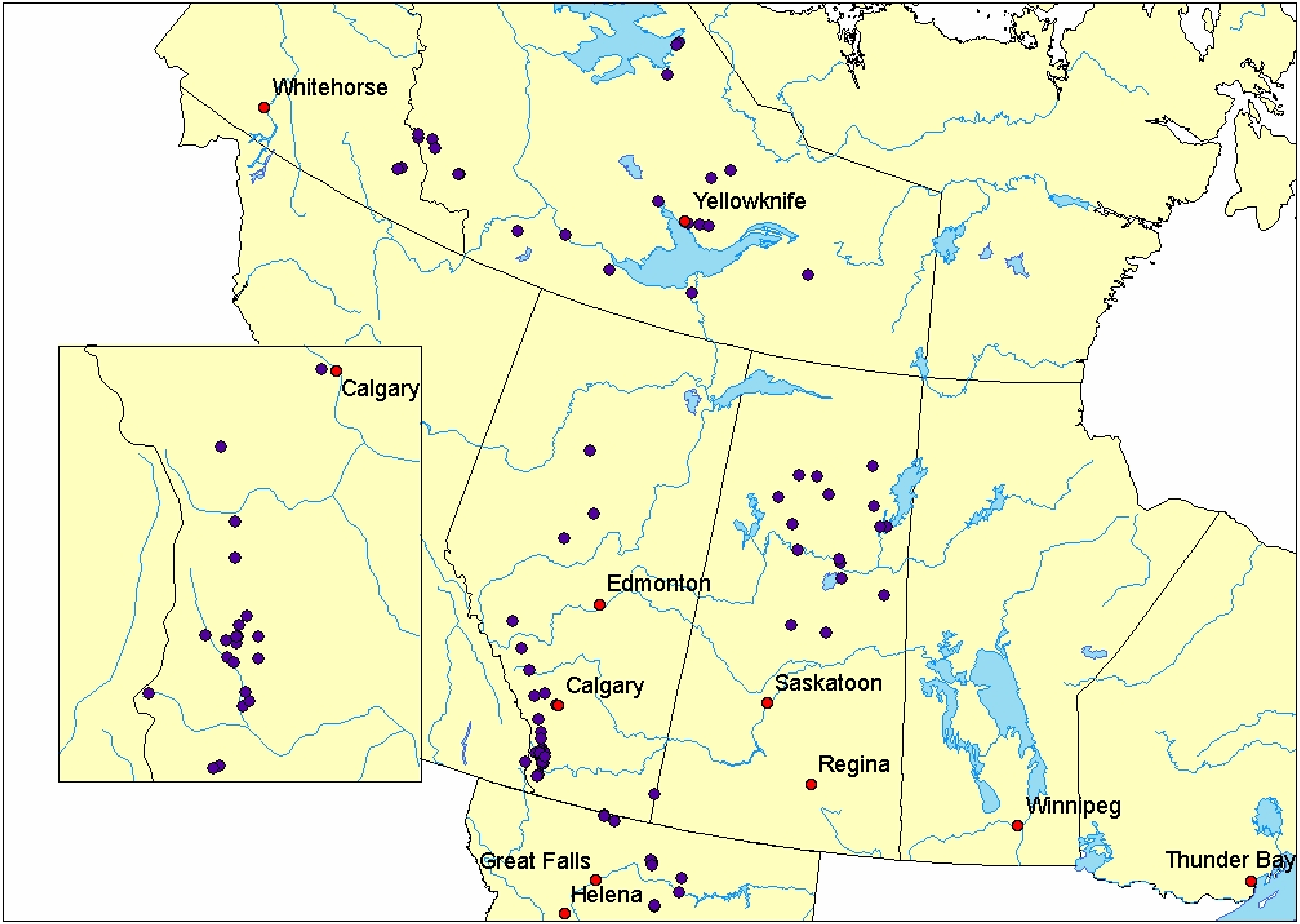
RÉSEAU DE RECHERCHE SUR LA SÉCHERESSE


Climatic variability
Climatic change
adaptation
Coping Range
Time
Adaptation implementation

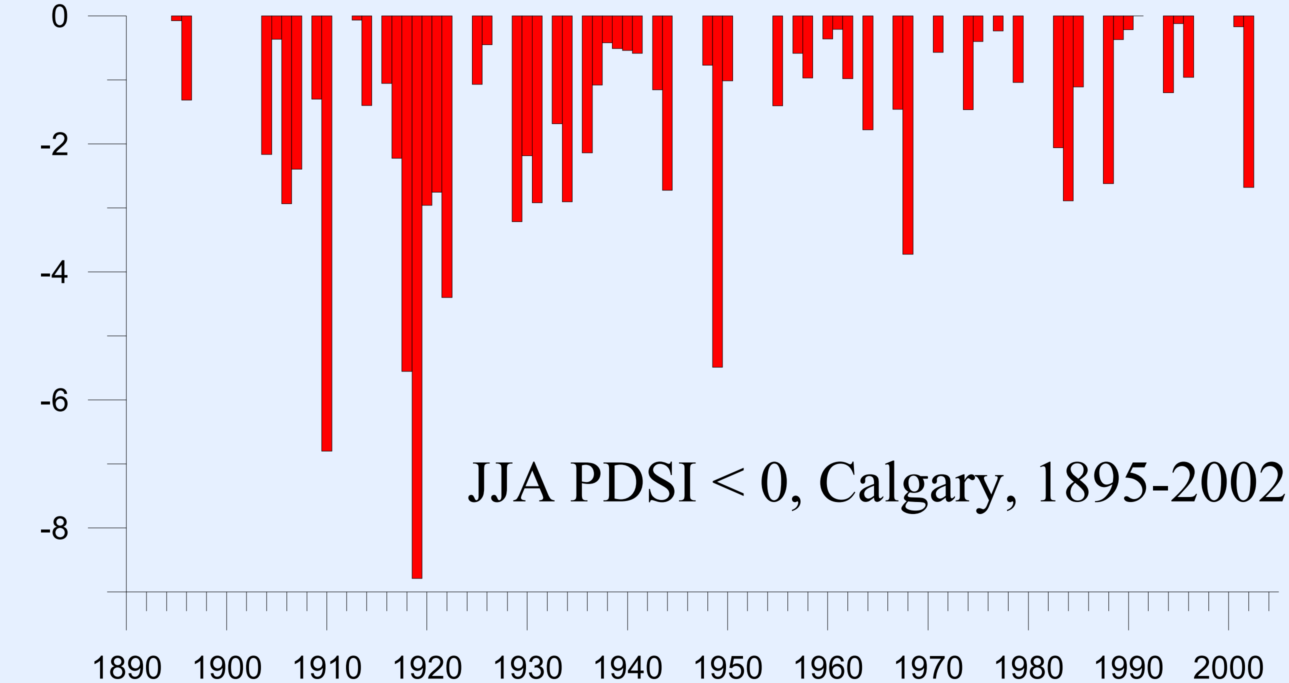

earlywood
late
wood
one tree ring



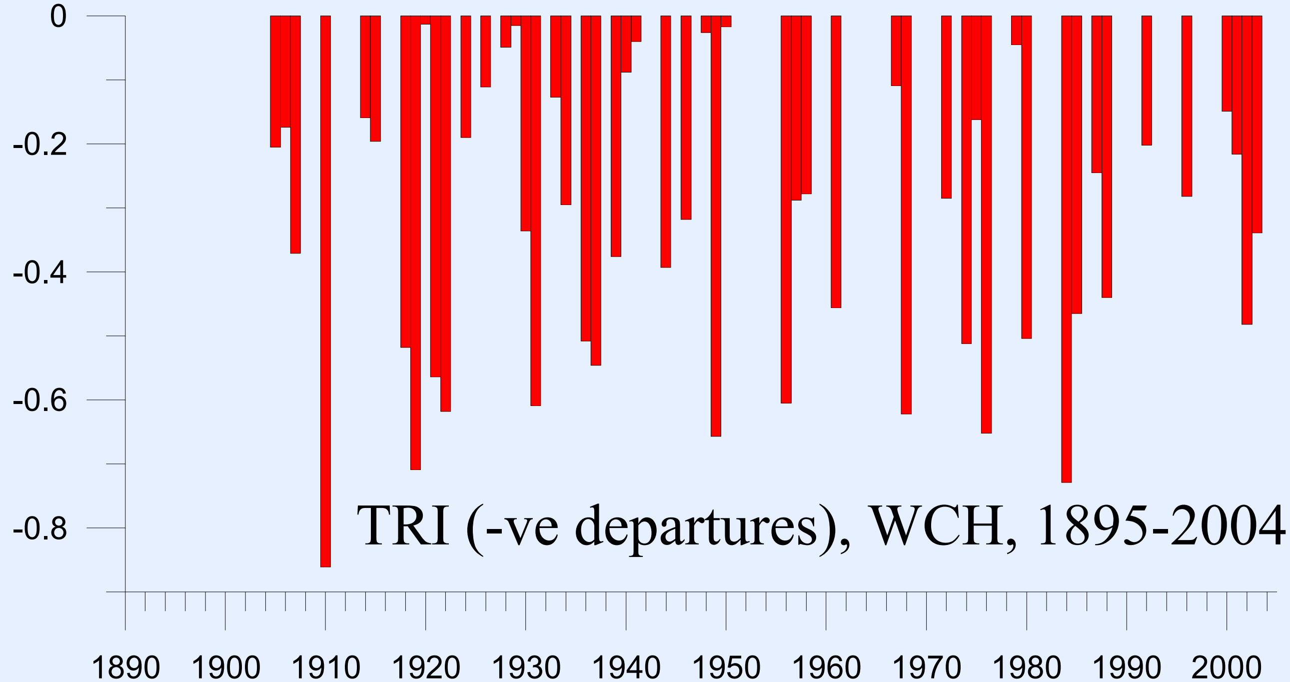
Tree-Ring Sampling Sites



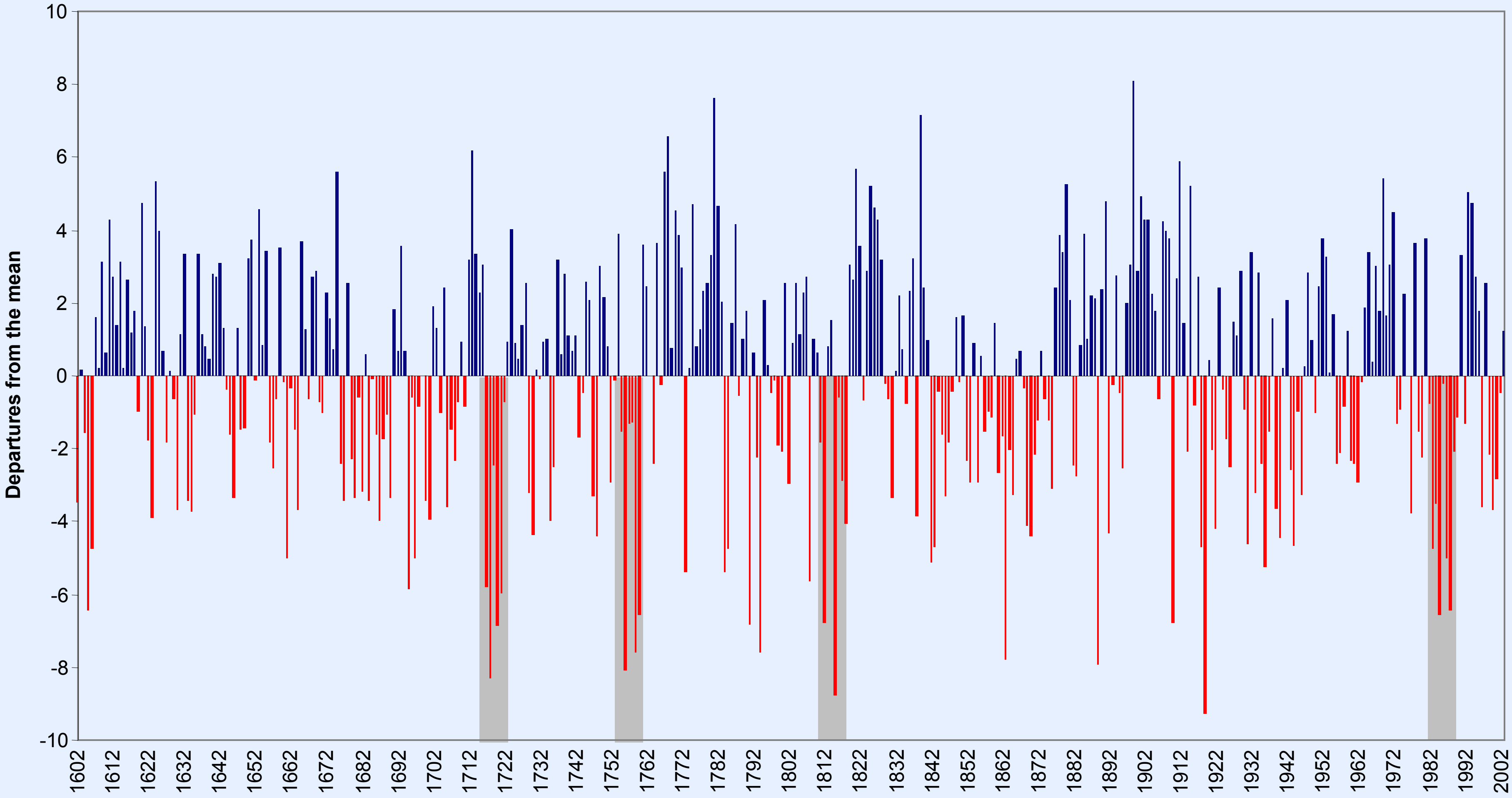



JJA PDSI < 0, Calgary, 1895-2002
0
-2
-4
-6
-8
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000

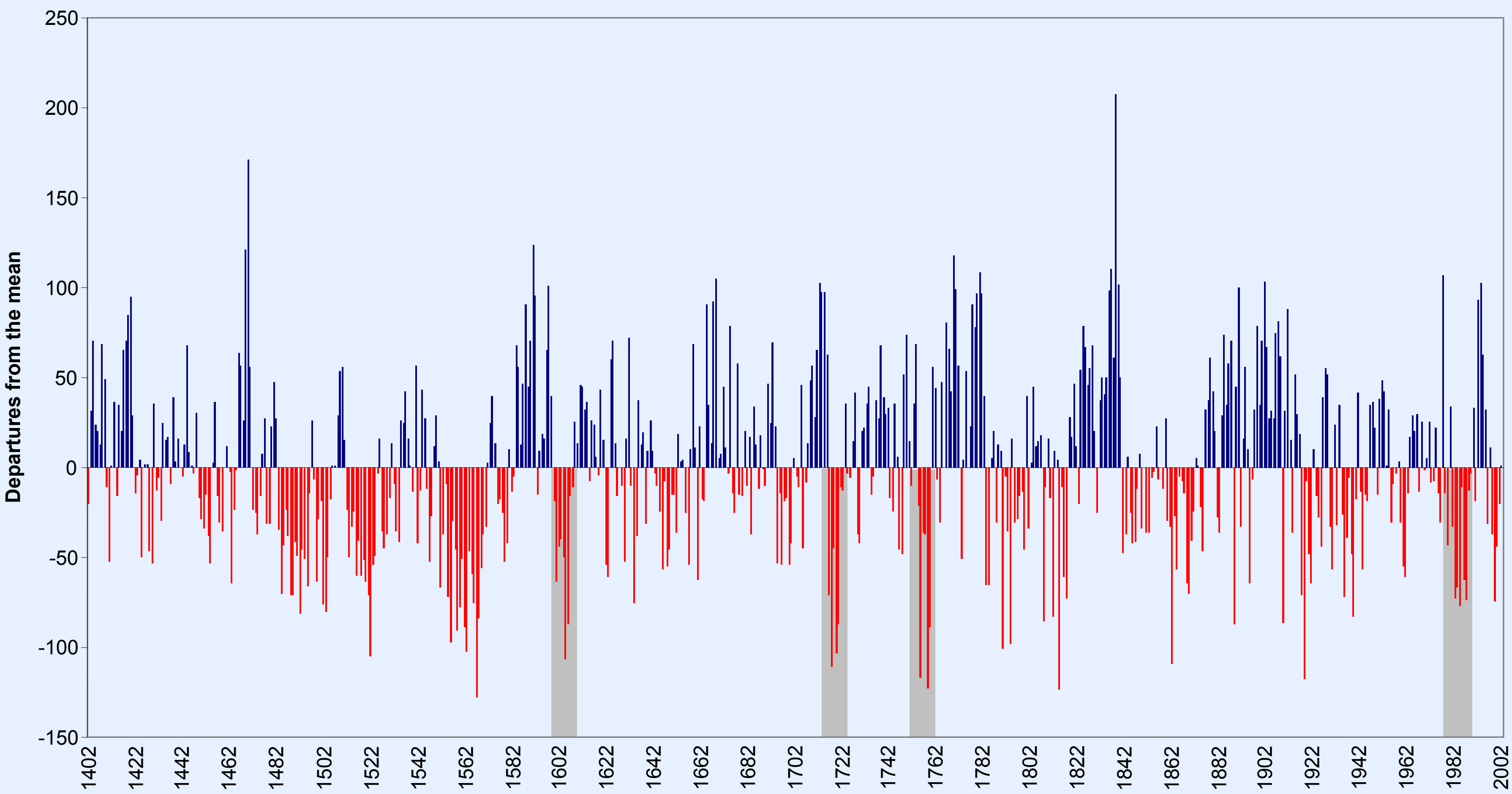
r = 0.628

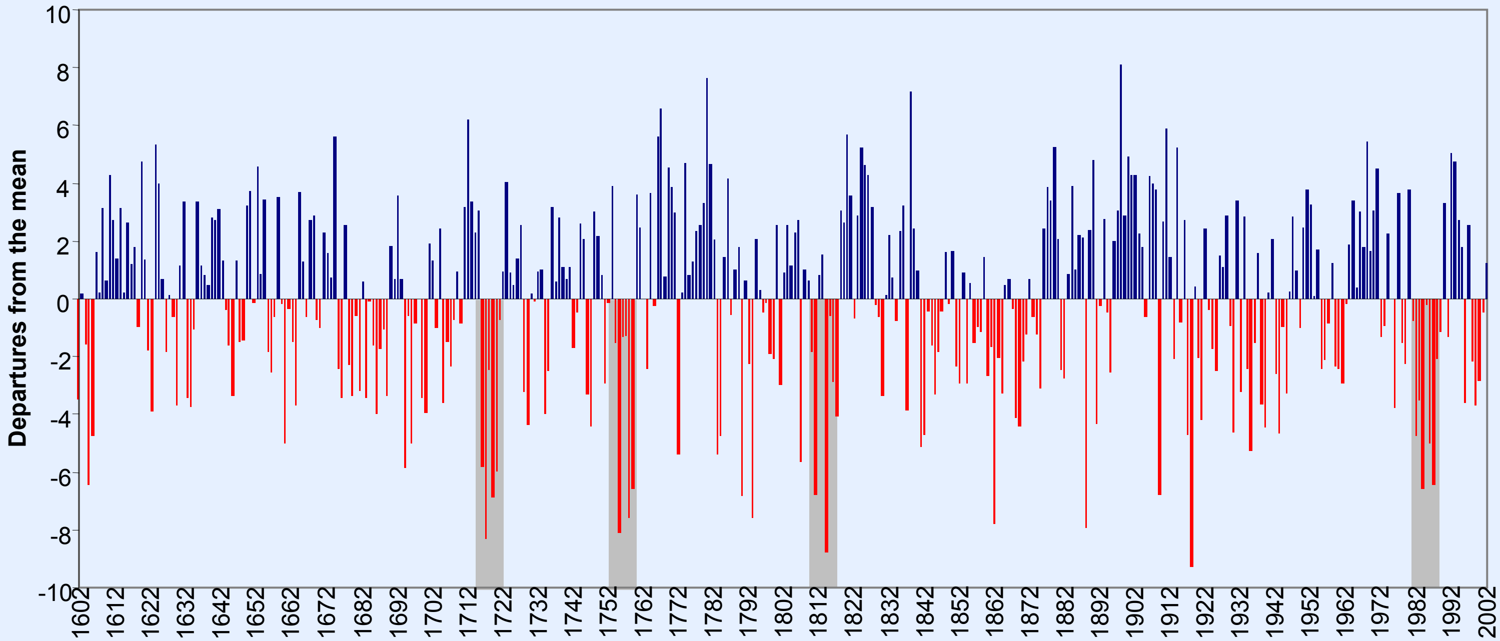

TRI (-ve departures), WCH, 1895-2004
0
-0.2
-0.4
-0.6
-0.8
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000

Oldman River at Waldron's Corner (1602-2004)

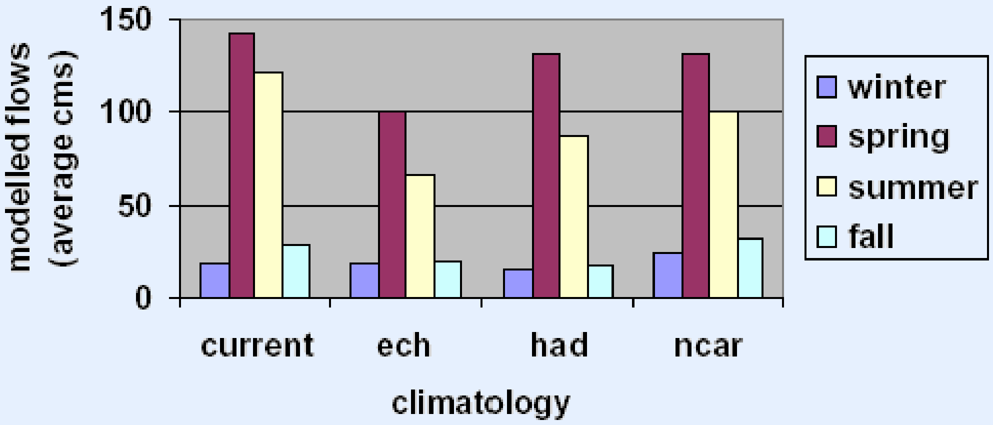


South Saskatchewan River at Medicine Hat, 1402-2004





Old Man River at Lethbridge

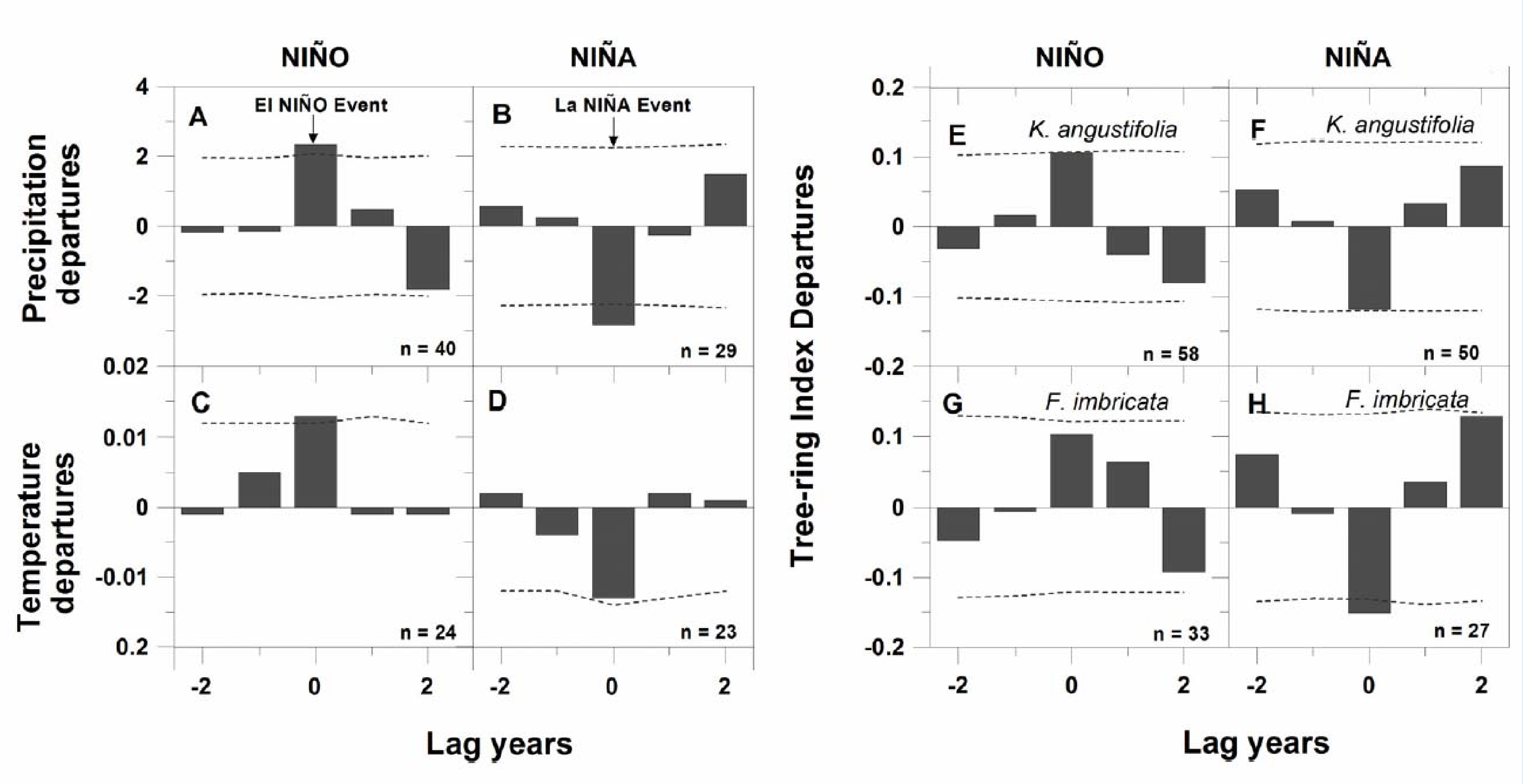


A "myth of abundance" and an assumption that "the hydrological regime is stationary and will continue to be stationary in the future".

Paleohydroclimate, northern Chile

Jonathan Barichivich, Laboratorio de Dendrocronología
Universidad Austral de Chile,Valdivia

Hydroclimatic forcing, northern Chile



Interannual to Multidecadal Climate Forcing

Climate index description	Period	Data source	Reference
Atlantic Multidecadal Oscillation (AMO) Mean monthly Atlantic SST anomalies north of the equator.	1856-2006	CDC, NOAA-CIRES http://www.cdc.noaa.gov/Timeseries/AMO/	Enfield *et al.* 2001
Pacific Decadal Oscillation (PDO) Leading Principal Component of monthly SST anomalies in the north Pacific Ocean, poleward of 20°N.	1900-2004	JISAO http://jisao.washington.edu/pdo/PDO.latest	Mantua *et al.* 1997
Niño 3.4 Index Mean monthly SST anomalies for the Niño 3.4 Region, east central Tropical Pacific (5N-5S, 170-120W).	1871-1999	CPC, NOAA-NCEP http://www.cpc.ncep.noaa.gov/data/indices/	Trenberth 1997

Growth Response to Climate Forcing

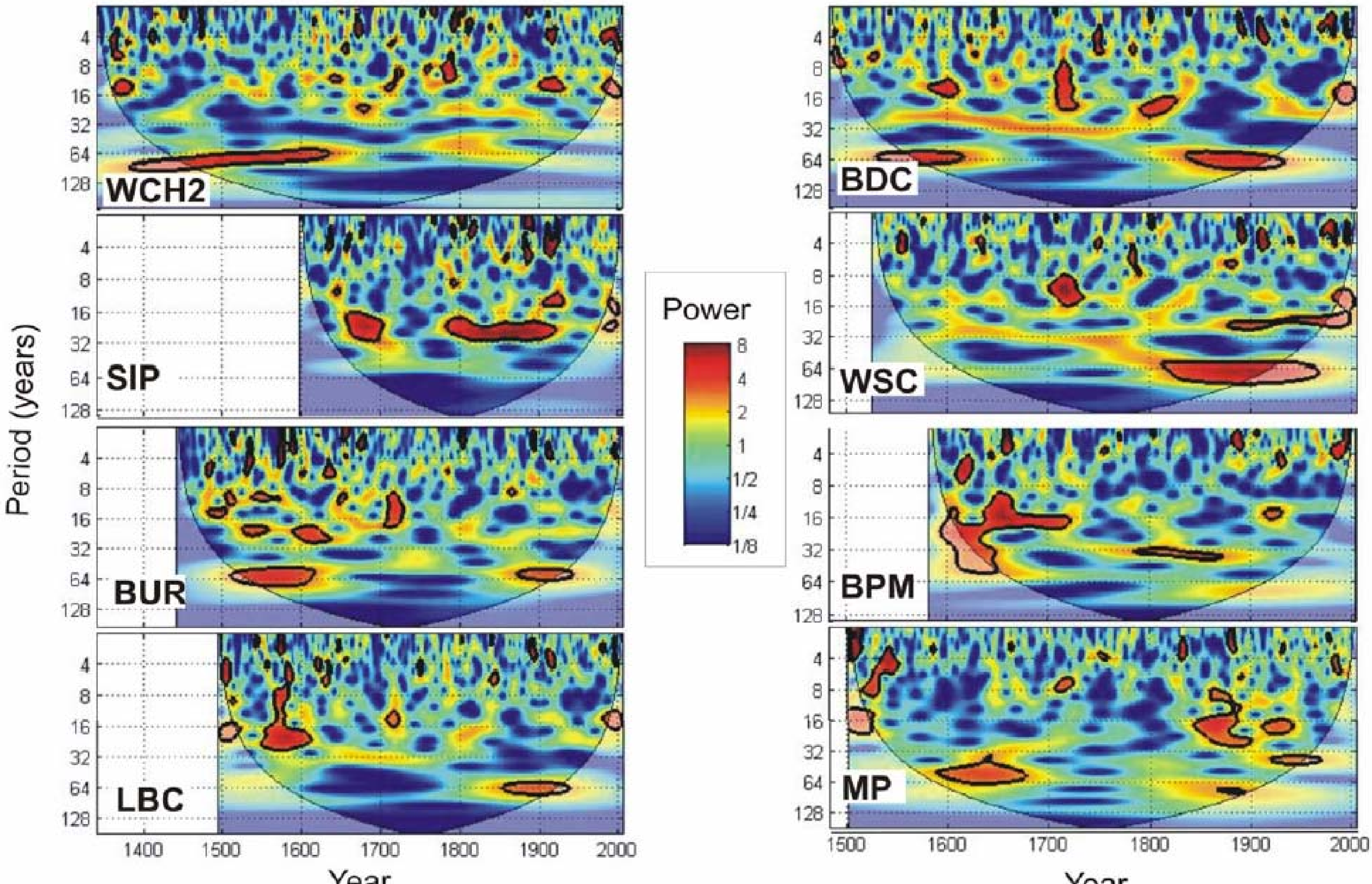
Table 4. Influences of climate forcings based on the spatial correlation patterns between the tree-growth PCs and global SST and SLP (Figs. 17-22).

Species	Region associated to each PC	Climate forcing	Season
PC1			
Picea glauca	North	AMO (−)	Spring-summer
Pinus banksiana	East	PDO (−)	Winter
Pseudotsuga menziesii	South	ENSO (+)#	Winter-spring
Pinus contorta	North	AMO (−)	Spring-summer
Picea mariana	North	ENSO (−)	Winter-spring
PC2			
Picea glauca	East	PDO (−)	Winter-spring
Pinus banksiana	South	AMO (+)#	Winter
Pseudotsuga menziesii	South	AMO (−)	Winter-spring
Pinus contorta	South	No clear pattern	
Picea mariana	East	PDO (−) and AMO (−)	Winter-summer
Pinus flexilis	South	ENSO (+)	Winter-spring

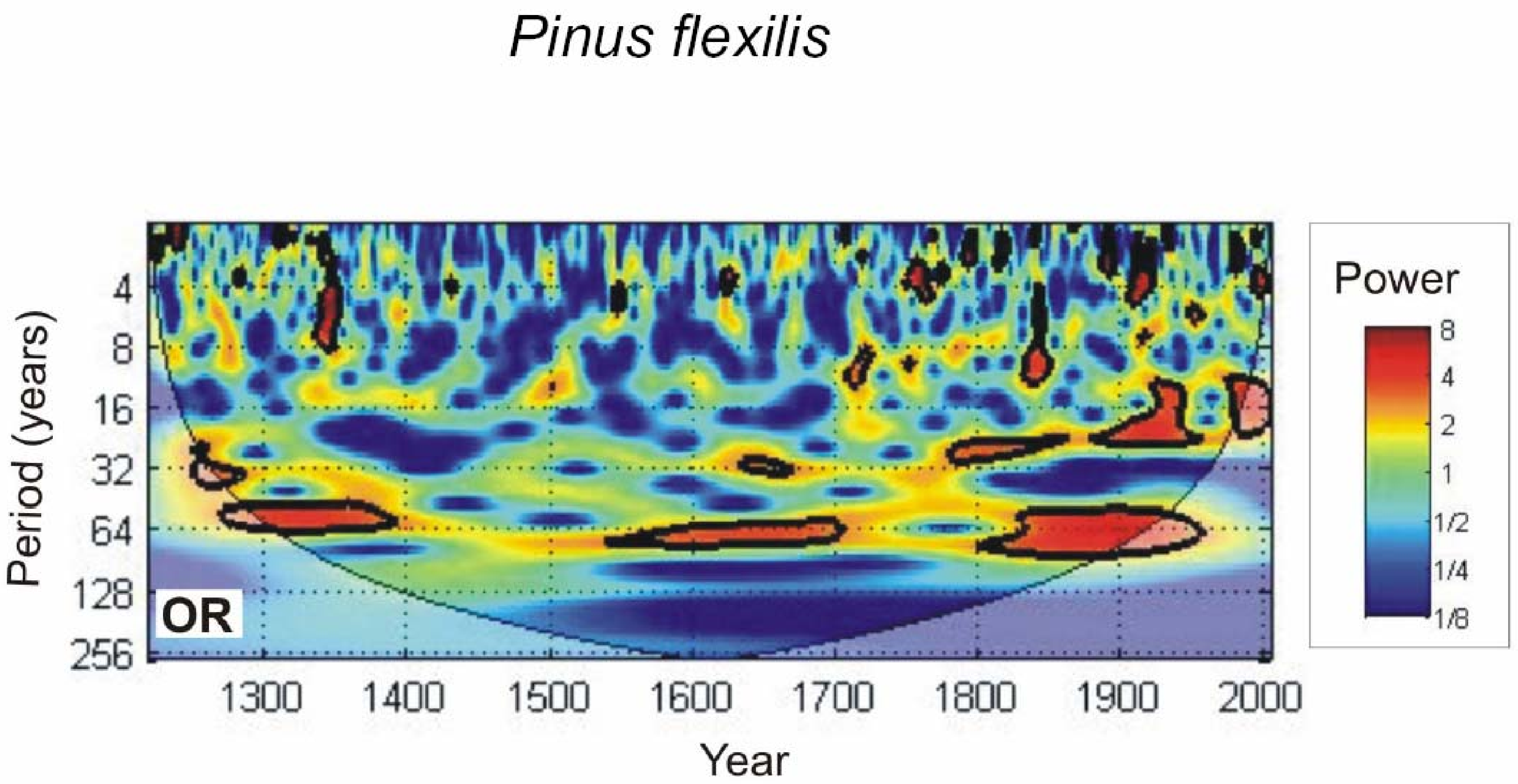
#: not coherent with the correlation results between PCs and the forcing indices.

Wavelet power spectra

Pseudotsuga menziesii



Wavelet power spectrum



Adaptation

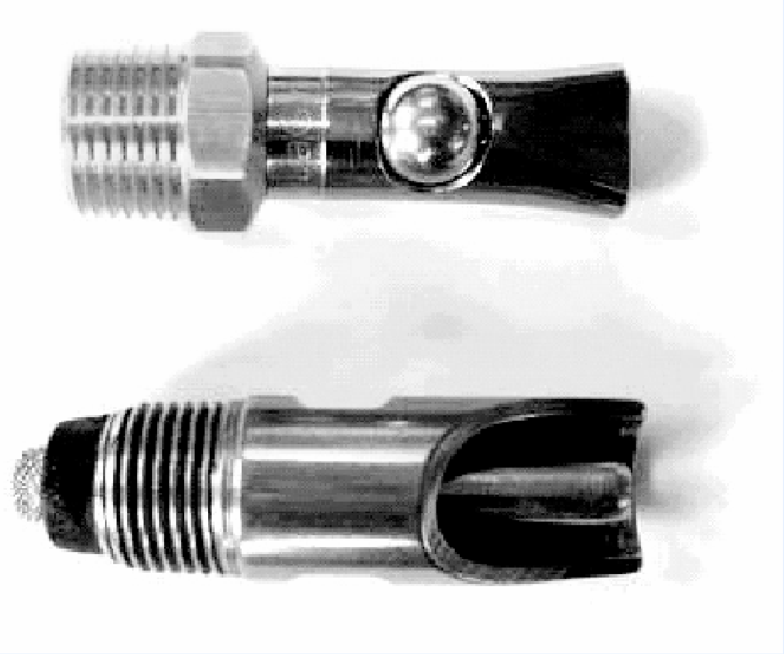
The degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate (IPCC, 2001).

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

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. the
- significant decrease in water usage led to many secondary benefits

Dennis McKerracher
JV Farms, High River, AB

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.

National Assessment - **Prairies Chapter**

Dave Sauchyn, PARC, Lead
Suren Kulshreshtha, U of S, Co-Lead
Danny Blair, U of W
Jim Byrne, U of L
Debra Davidson, U of A
Polo Diaz, U of R
Norm Henderson, PARC
Dan Johnson, U of L
Mark Johnston, SRC
Justine Klaver, U of A
Stephan Keinzle, U of L
Elaine Wheaton, SRC

NACC Prairies Chapter - Key Findings

- there is large adaptive capacity but little evidence that it is being mobilized by fromal (government) and informal (stakeholder groups) institutions
- adaptations will include adaptive technologies for improved water use efficiency and water policy to ensure that an increasingly scarce resource is properly allocated
- cost of drought ($3.6 billion in 2000-01) indicates sensitivity to climate variability even in the absence of climate change
- avoiding risk and possibly disasters requires a serious effort to control greenhouse gas emissions and to develop polices and programs to enable adaptation to a warmer and drier climate
- policy must enable individuals and businesses to manage financial and natural resources to build resilience to climate change and variability