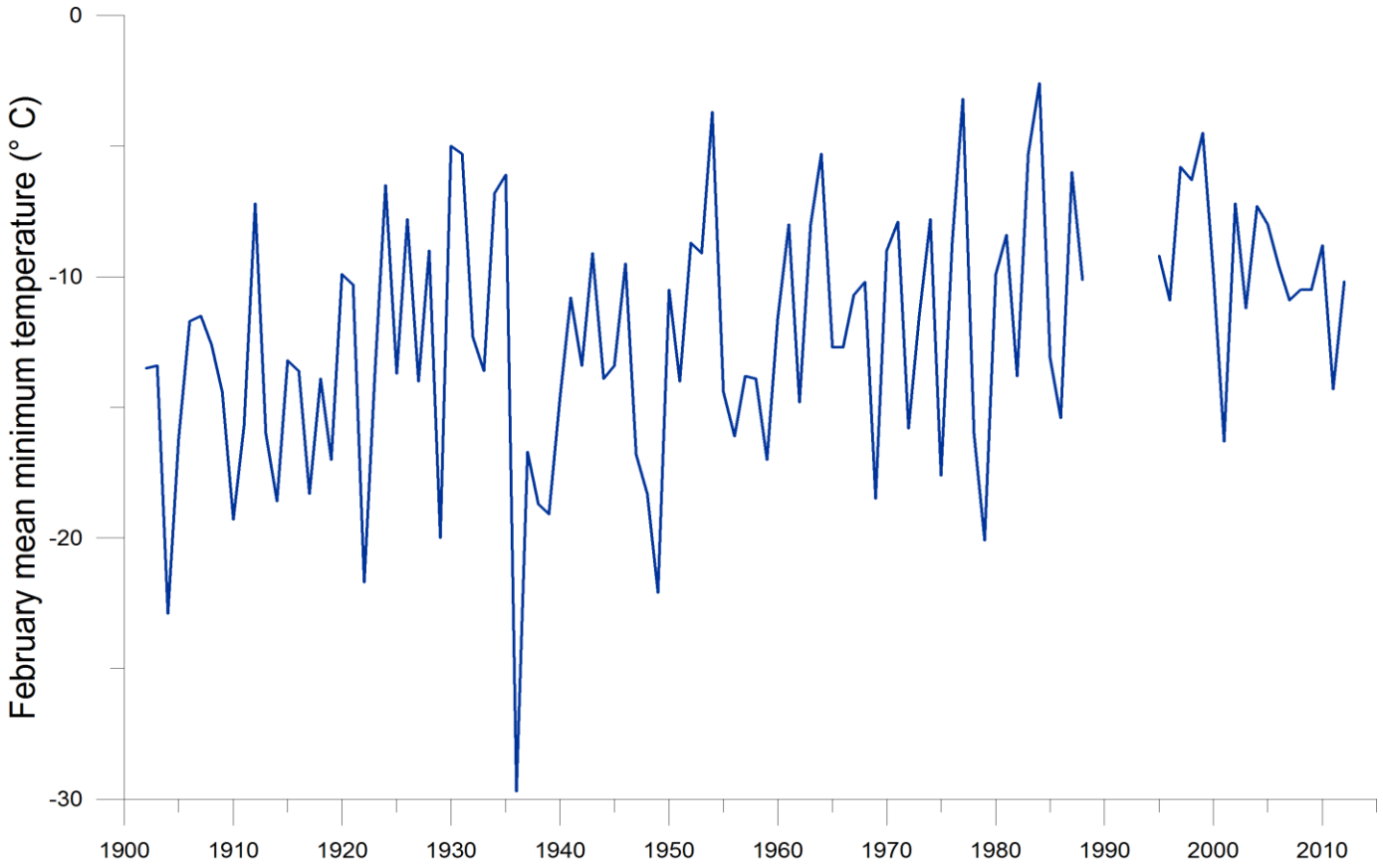
Historical Climate Variability

Dave Sauchyn and Jessica Vanstone
Prairie Adaptation Research Collaborative, University of Regina



Strengthening Economic Security of Irrigated Agriculture in the Oldman Basin, Lethbridge, 06 November 2013

Vulnerability and Adaptation to Climate Extremes in the Americas (VACEA)

Vulnerabilidad y Adaptación a los Extremos Climáticos en las Américas

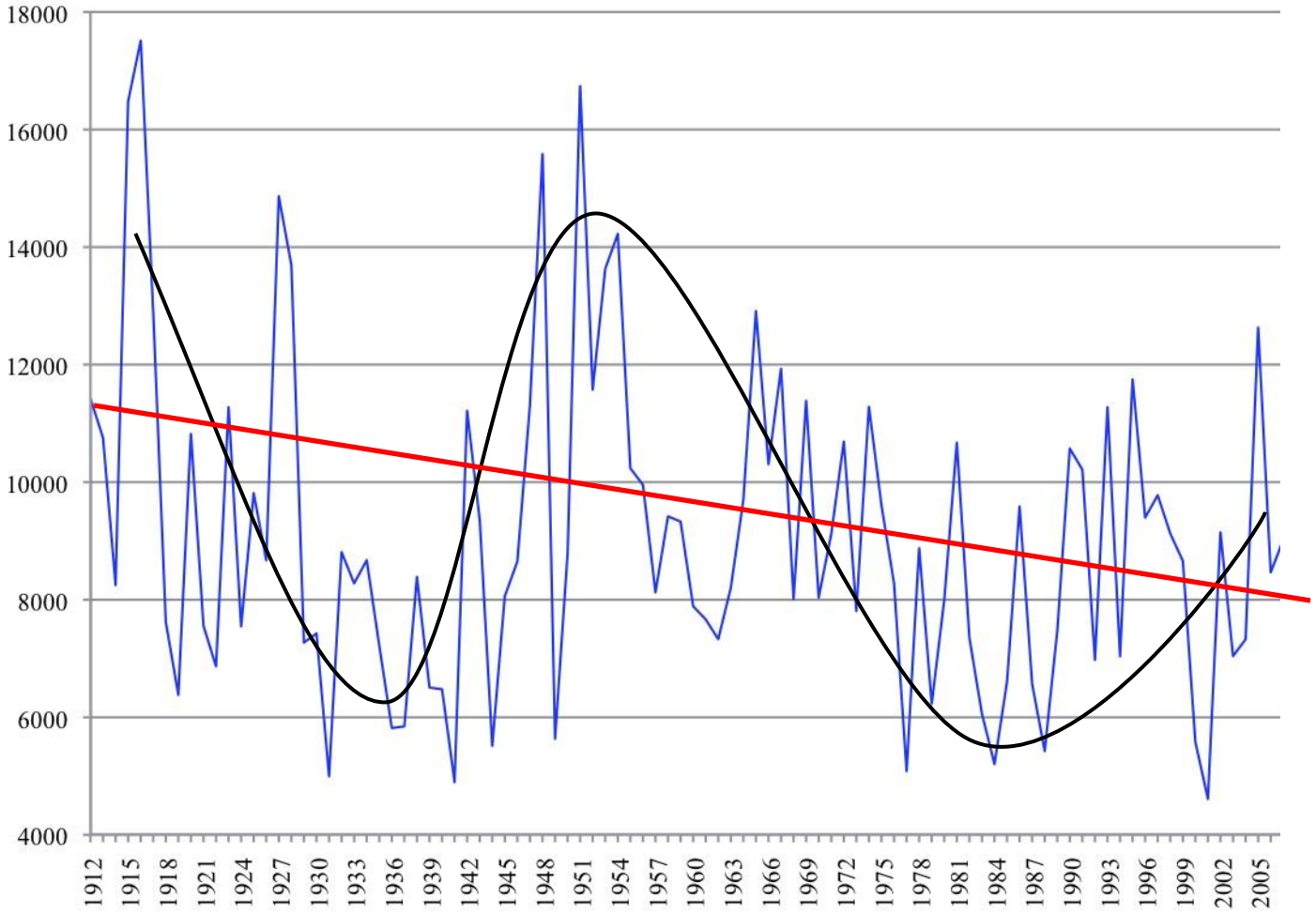
Principal Investigators:

Los investigadores

Dr. Dave Sauchyn, University of Regina, Canada
Dr. Fernando Santibañez, Universidad de Chile, Santiago

www.parc.ca/vacea/

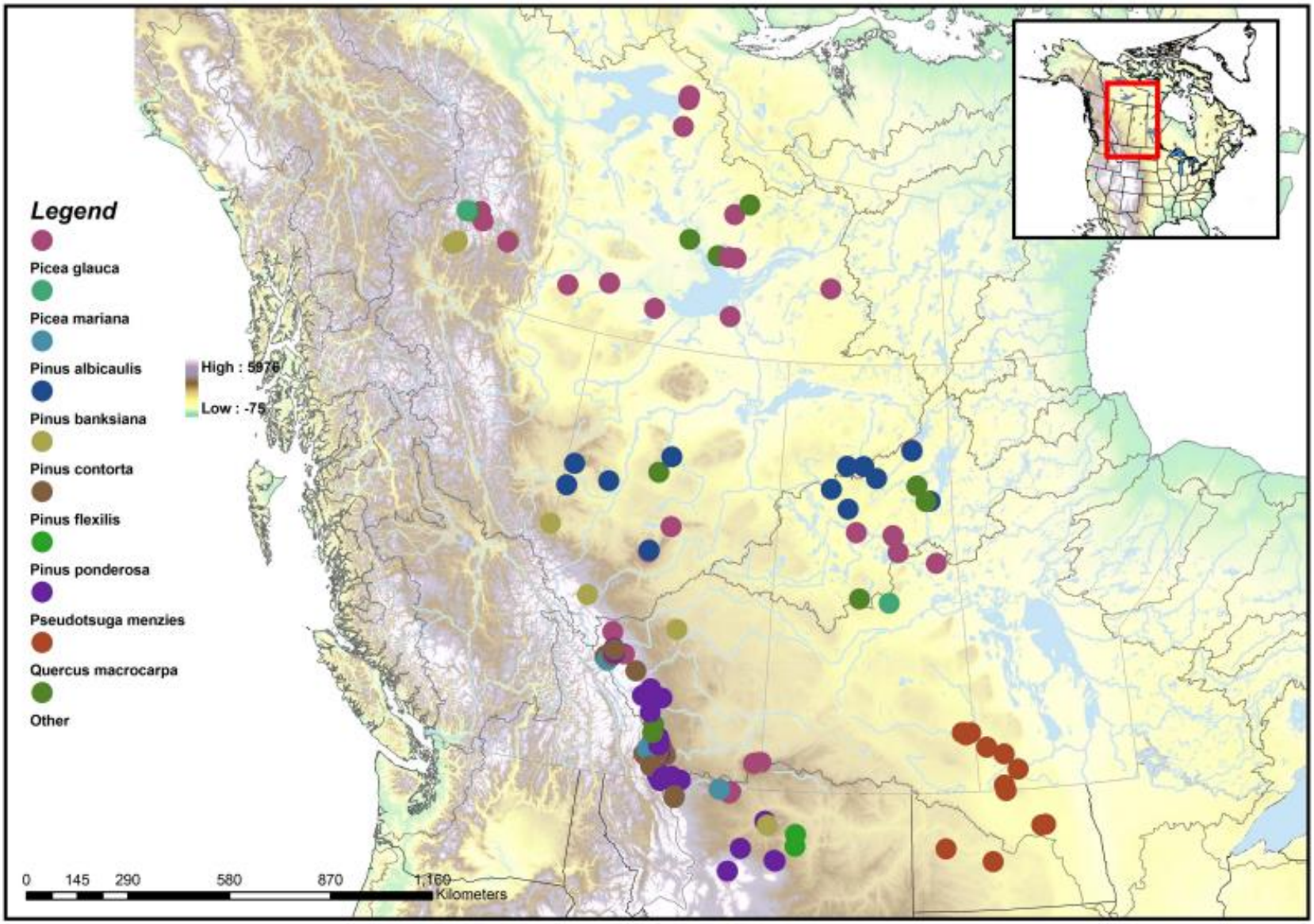
Annual natural flow, South Saskatchewan River at Medicine Hat



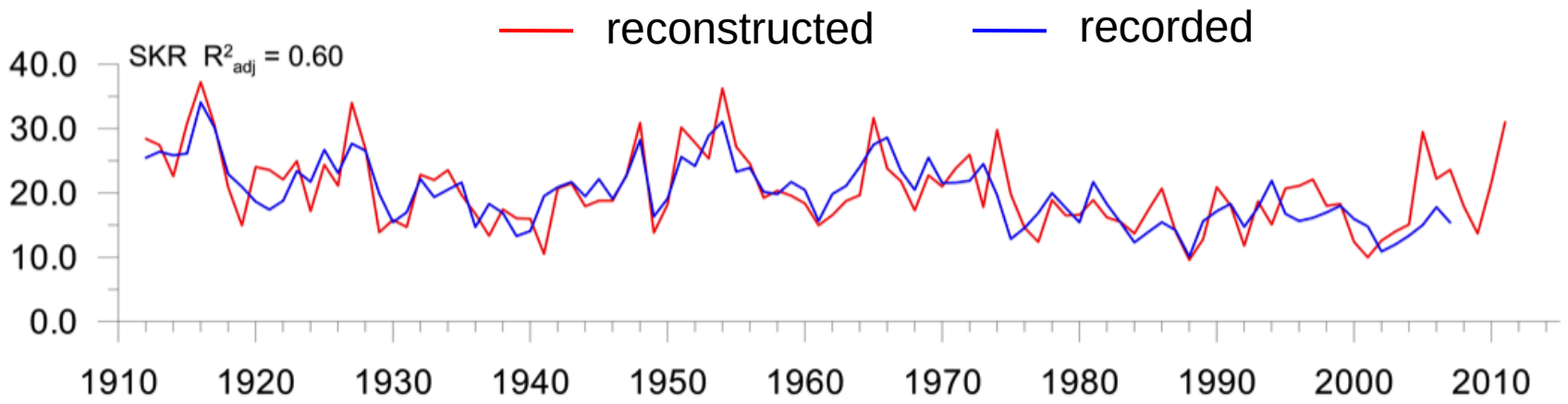
source: PPWB

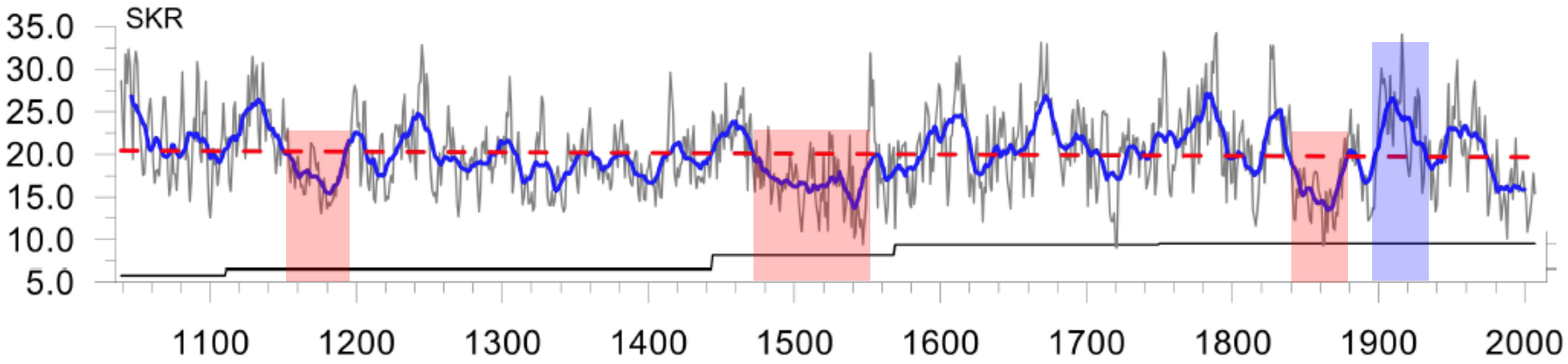

UNITED
DEWALT
UNITED

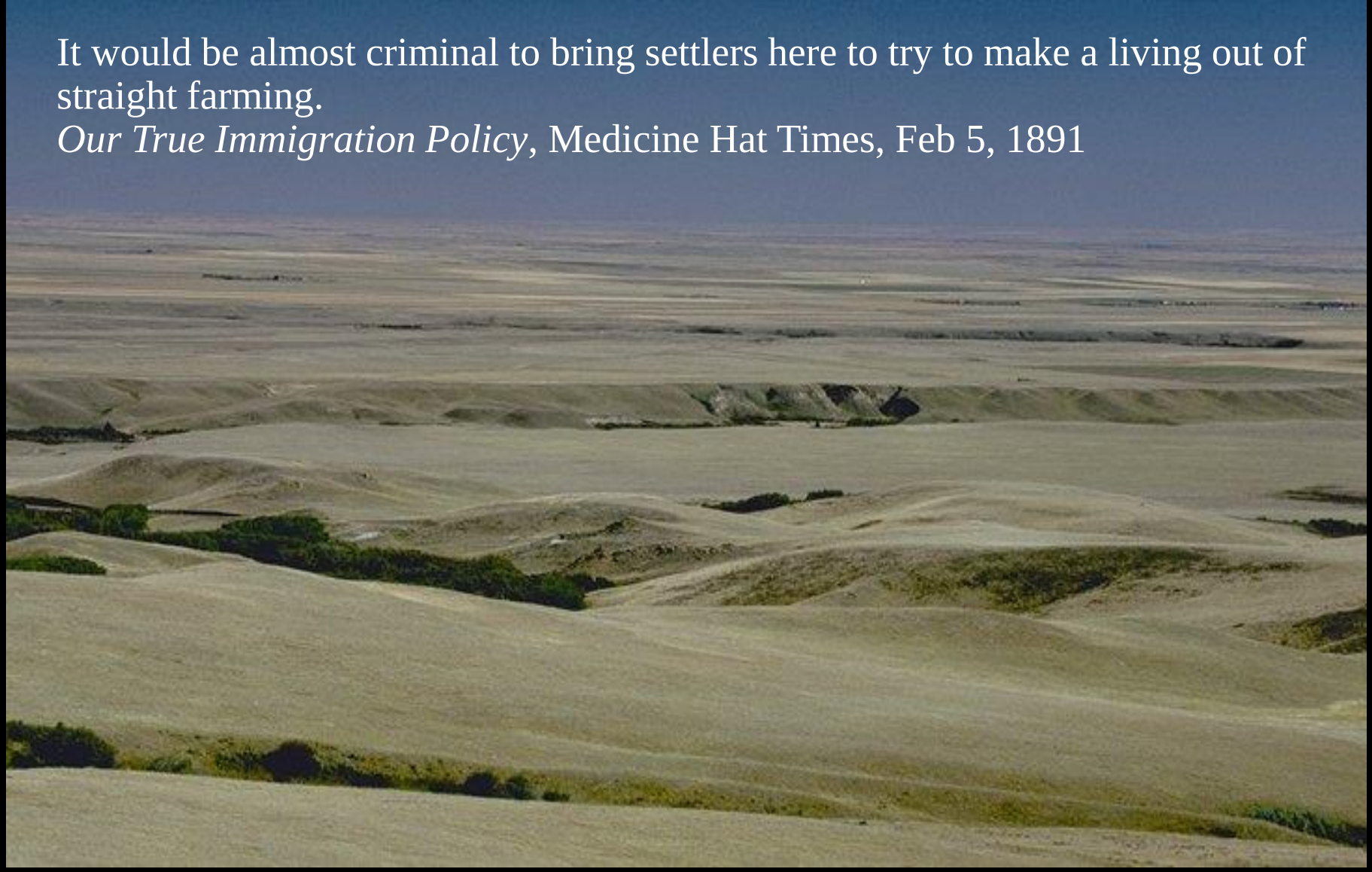
University of Regina Tree-Ring Lab Network



Annual Flow, South Saskatchewan River at Medicine Hat







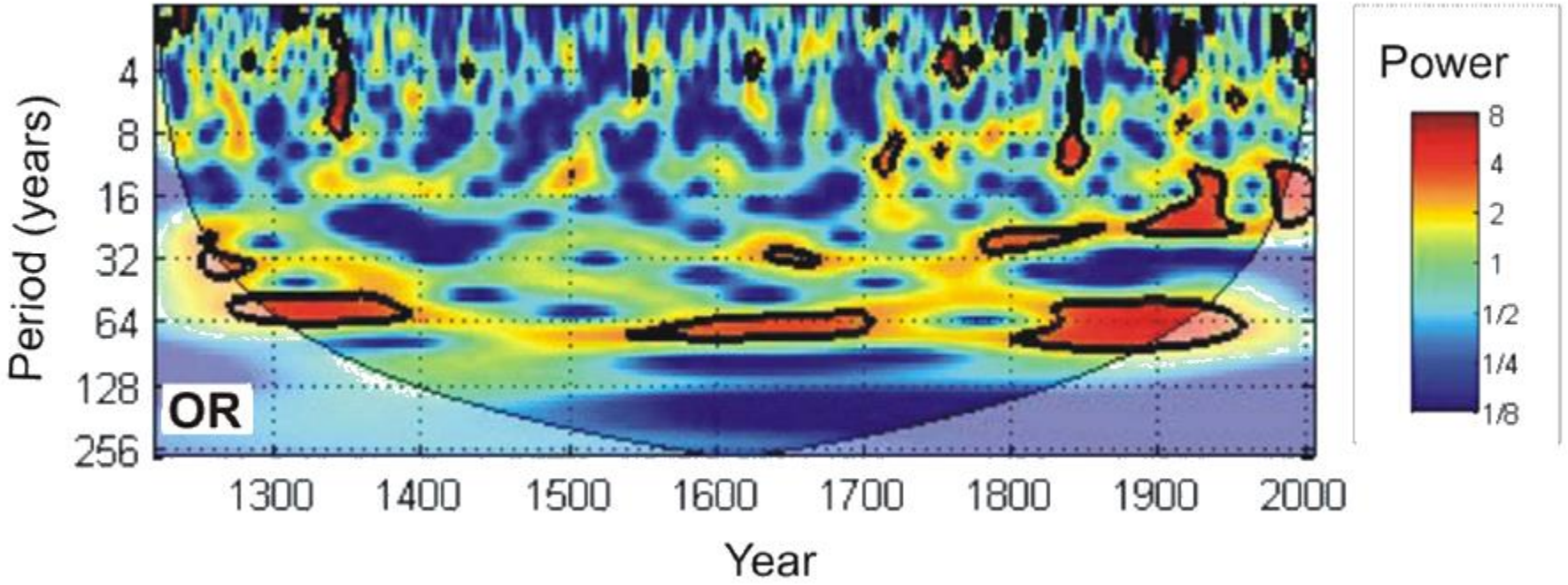
This large belt of country embraces districts, some of which are valuable for the purposes of the agriculturalist, while others **will forever be comparatively useless**. ... The least valuable portion of the prairie country has an extent of about 80,000 square miles… John Palliser, London, July 8, 1860

1900-1910s: wet decades

SE 6-33-11-W4, May 1914

1901	73,022	
1911	374,295	413%
1921	588,454	57%

Cycles in the tree rings

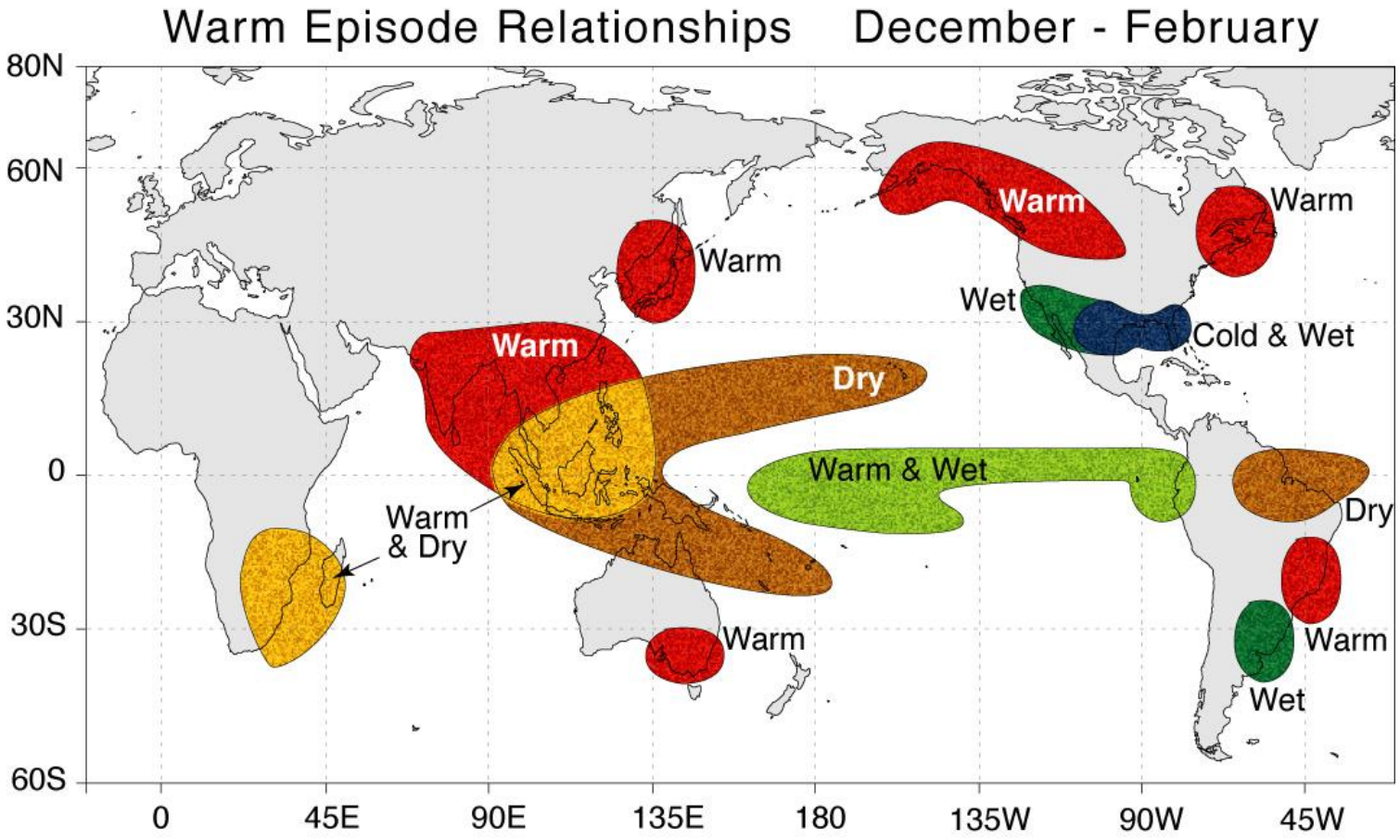


“I found looking at the **tree-ring growth**, that there’s **an approximate 60-year weather cycle** in this country, but 60 years isn’t definite, it could be 70 years and it could be even less, with weather **there’s nothing written in stone.**”

Reno Welsch, Upper Tennessee Creek, Alberta, 04/09/2012

El Niño remote impacts: Teleconnections

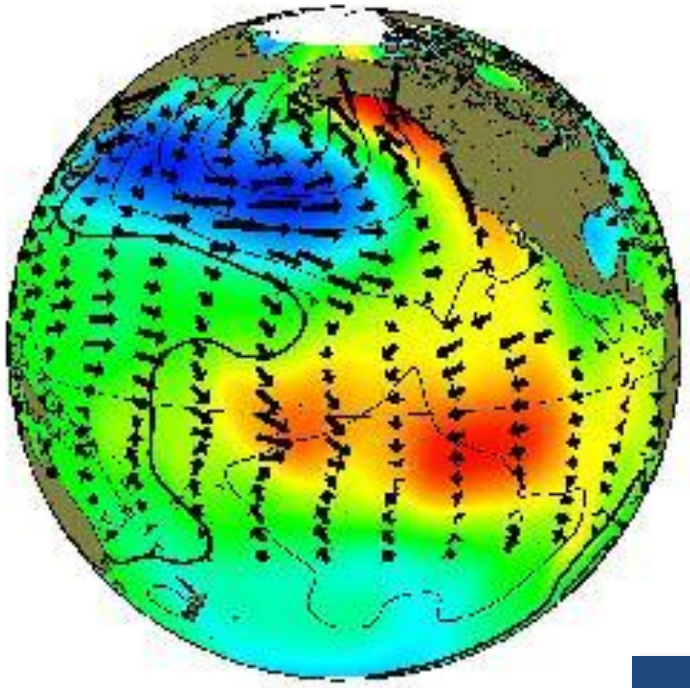
La Niña teleconnections have the opposite effect



Neelin, 2011. *Climate Change and Climate Modeling*, Cambridge UP

The Pacific Decadal Oscillation (PDO)

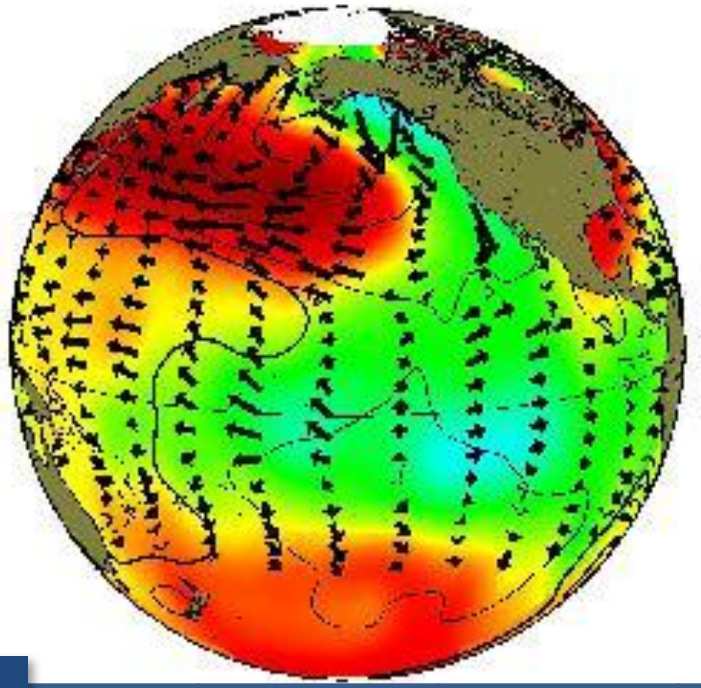
warm phase



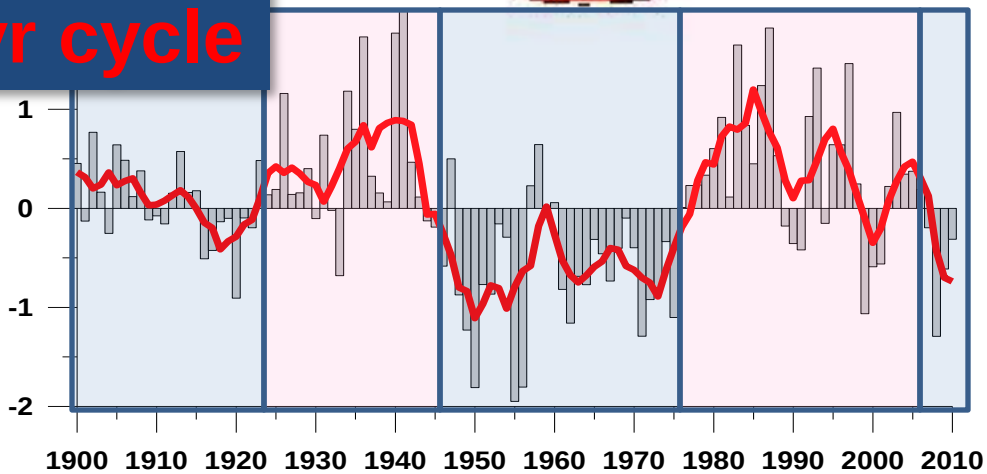
Co

0.8
0.4
0.2
0.0
-0.2
-0.6

cold phase

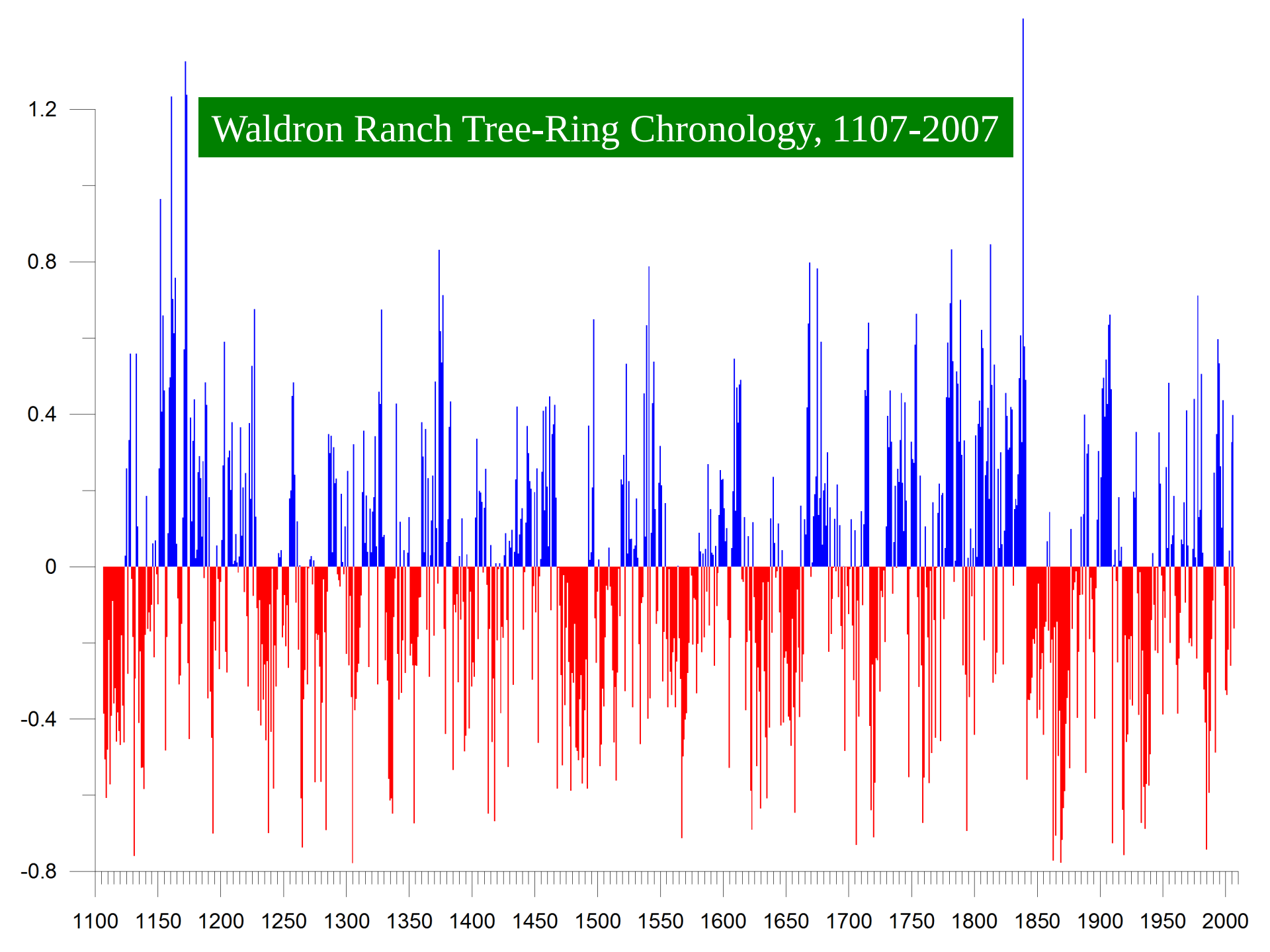


~60 yr cycle



http://jisao.washington.edu/pdo/

Typical wintertime Sea Surface Temperature Anomalies (colors), Sea Level Pressure (contours) and surface wind (arrows) anomaly patterns during warm and cool phases of the PDO


Waldron Ranch Tree-Ring Chronology, 1107-2007
1.2
0.8
0.4
0
-0.4
-0.8
1100
1150
1200
1250
1300
1350
1400
1450
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000

Stationarity and Ergodicity

Milly, et al., 2008. Climate change: stationarity is dead: whither water management: "**Stationarity**— the idea that natural systems fluctuate within an unchanging envelope of variability — is **a foundational concept that permeates training and practice in water-resource engineering**."

Klemeš, 1989. The improbably probabilities of extreme floods and droughts: "**Stationarity** … diverges from reality with **the length of the period** considered… despite the preaching about the importance of long records, hydrologists are in fact more comfortable with short one."

"**Ergodicity** implies that the historic record of a hydrological phenomenon can be regarded as one of an infinite number of realizations … this is **a fundamental assumption**"

"**Both of these assumptions** are not only arbitrary and unrealistic, they deliberately **make a mockery of reality** …"

Developing **adaptive strategies** [involves] scenarios of future hydroclimatic variability and proxy (pre-instrumental) sources of hydroclimate data. This provides a much broader perspective on the variability of water levels ... It requires, however, that water resource managers and agencies accept and accommodate **a lesser degree of determinacy, certainty and stationarity**.

- *Sauchyn, Demuth, and Pietroniro, 2008. Canada's Rocky Mountains and western plains. In Upland Watershed Management and Global Change*

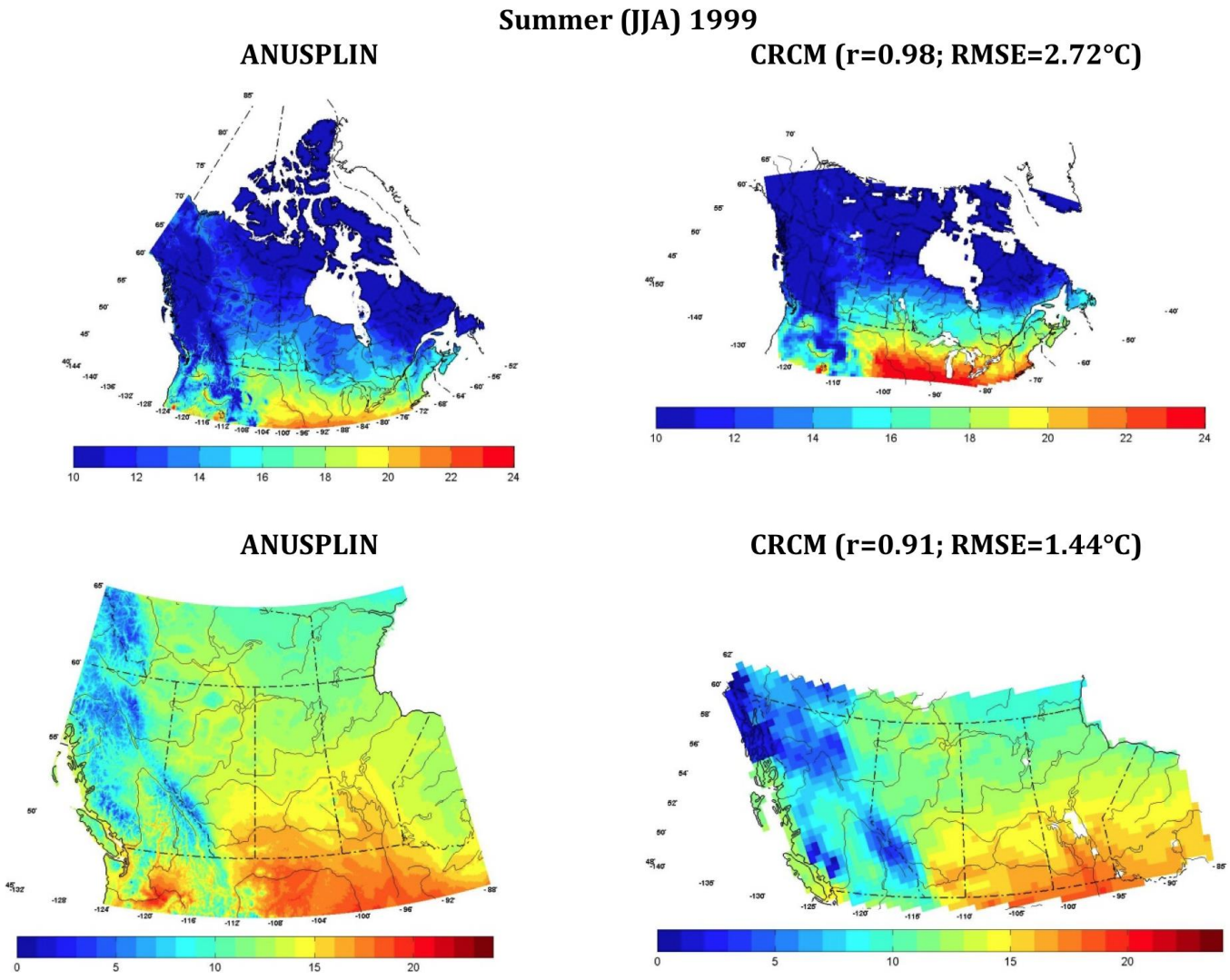


Figure 2: Comparison of mean temperature (°C) fields for observed (ANUSPLIN; left) and from CRCM (right), across Canada (top) and Western Canada (bottom).

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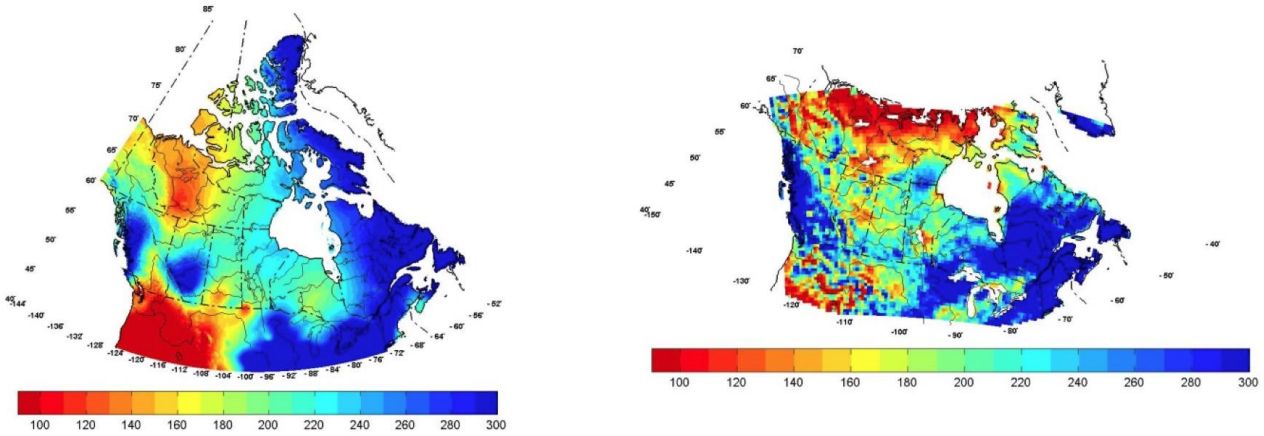
Summer (JJA) 1999

ANUSPLIN **CRCM (r=0.41; RMSE=93.02mm)**



ANUSPLIN **CRCM (r=-0.10; RMSE=57.3mm)**

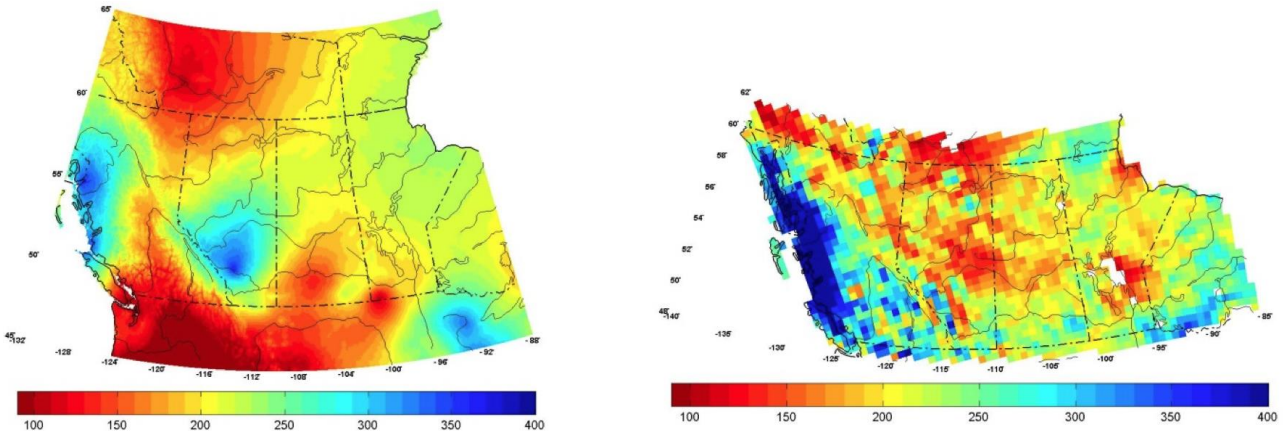


Figure 3: Comparison of total precipitation (mm) fields for observed (ANUSPLIN; left) and from CRCM (right), across Canada (top) and Western Canada (bottom).

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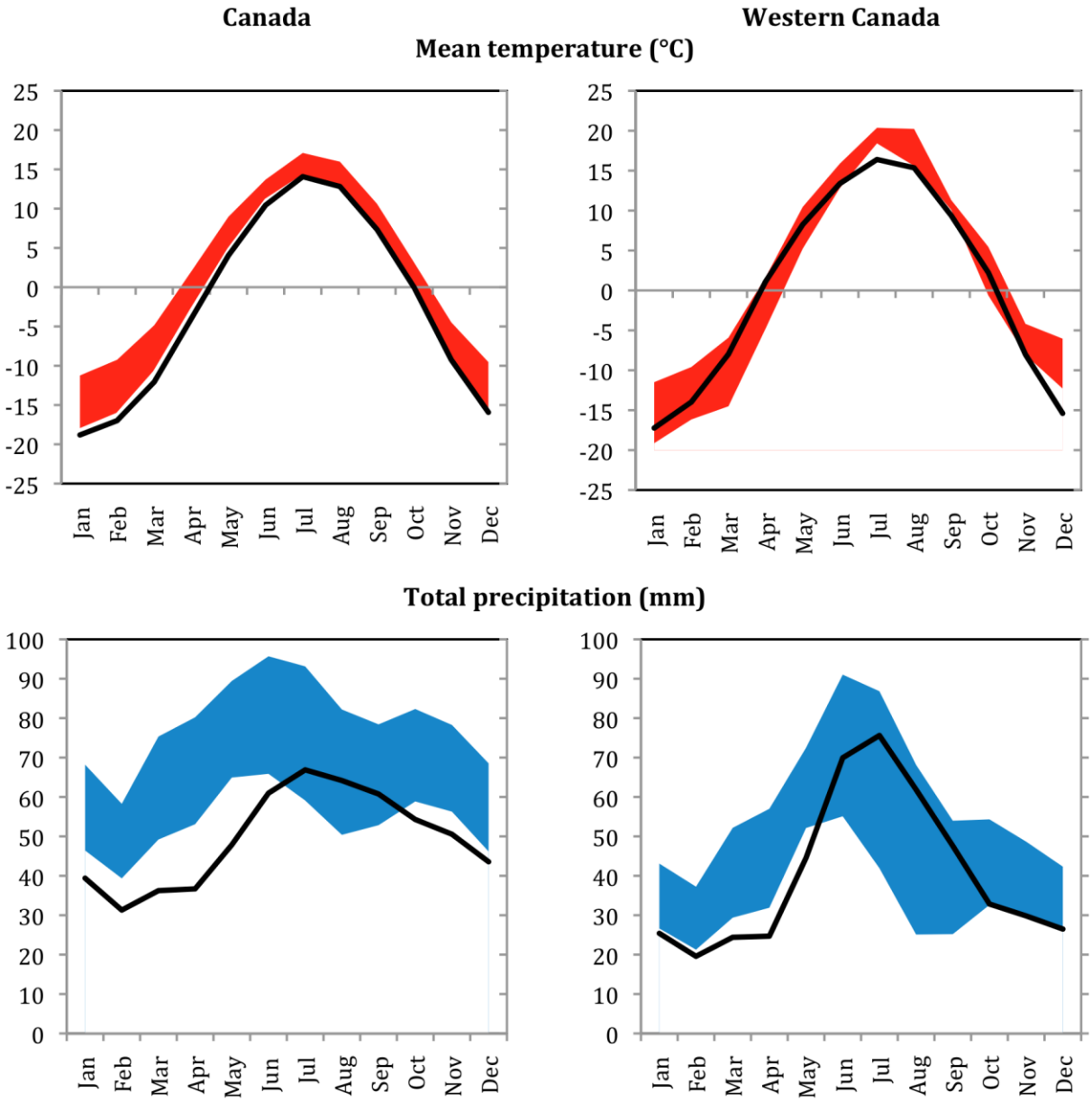

Figure 1: Average annual cycle of mean temperature (°C) and total precipitation (mm) for Canada (left) and Western Canada (right) for 1980-2004. The coloured bands represent the extent of the results from six RCMs and the black line is the ANUSPLIN observed data.

Barrow 2013