Modeling for Climate Variability

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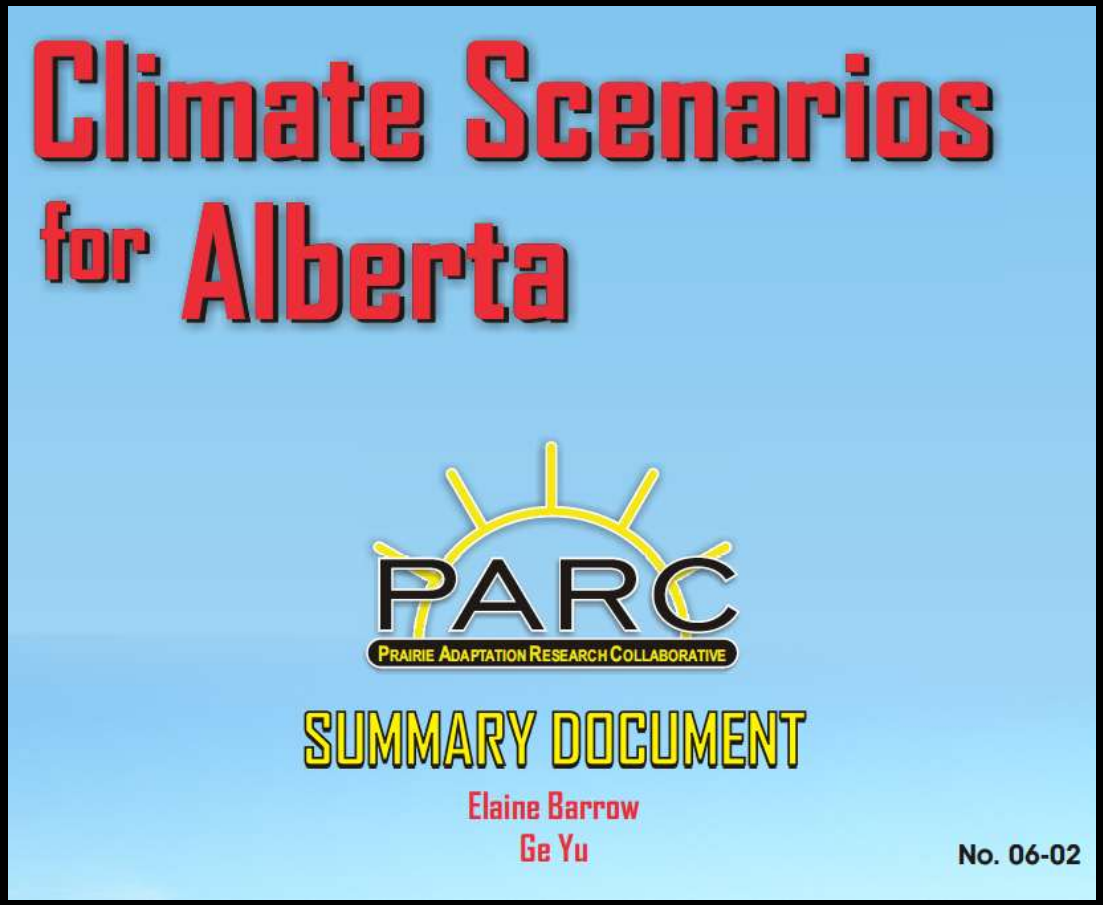


AESRD Environmental Modeling Workshop, Edmonton, 13-14 March 2013

The **Prairie Adaptation Research Collaborative** (PARC) is a Research Institute based at the University of Regina. It was created as partnership of the governments of Canada, **Alberta**, Saskatchewan and Manitoba mandated to pursue climate change impacts and adaptation research in the Prairie Provinces.

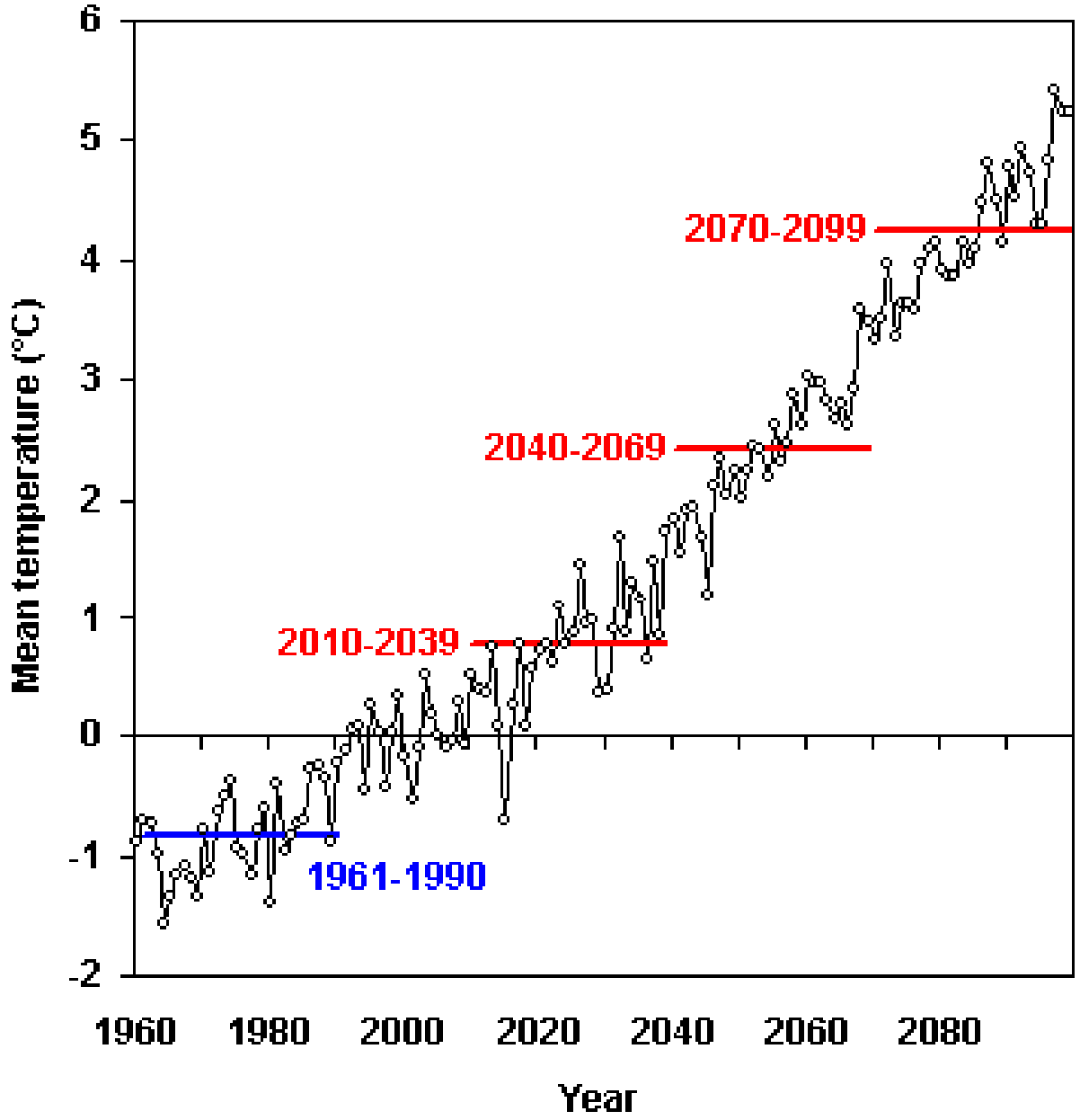
UNIVERSITY OF REGINA

PARC

Major Initiatives ($Ms)

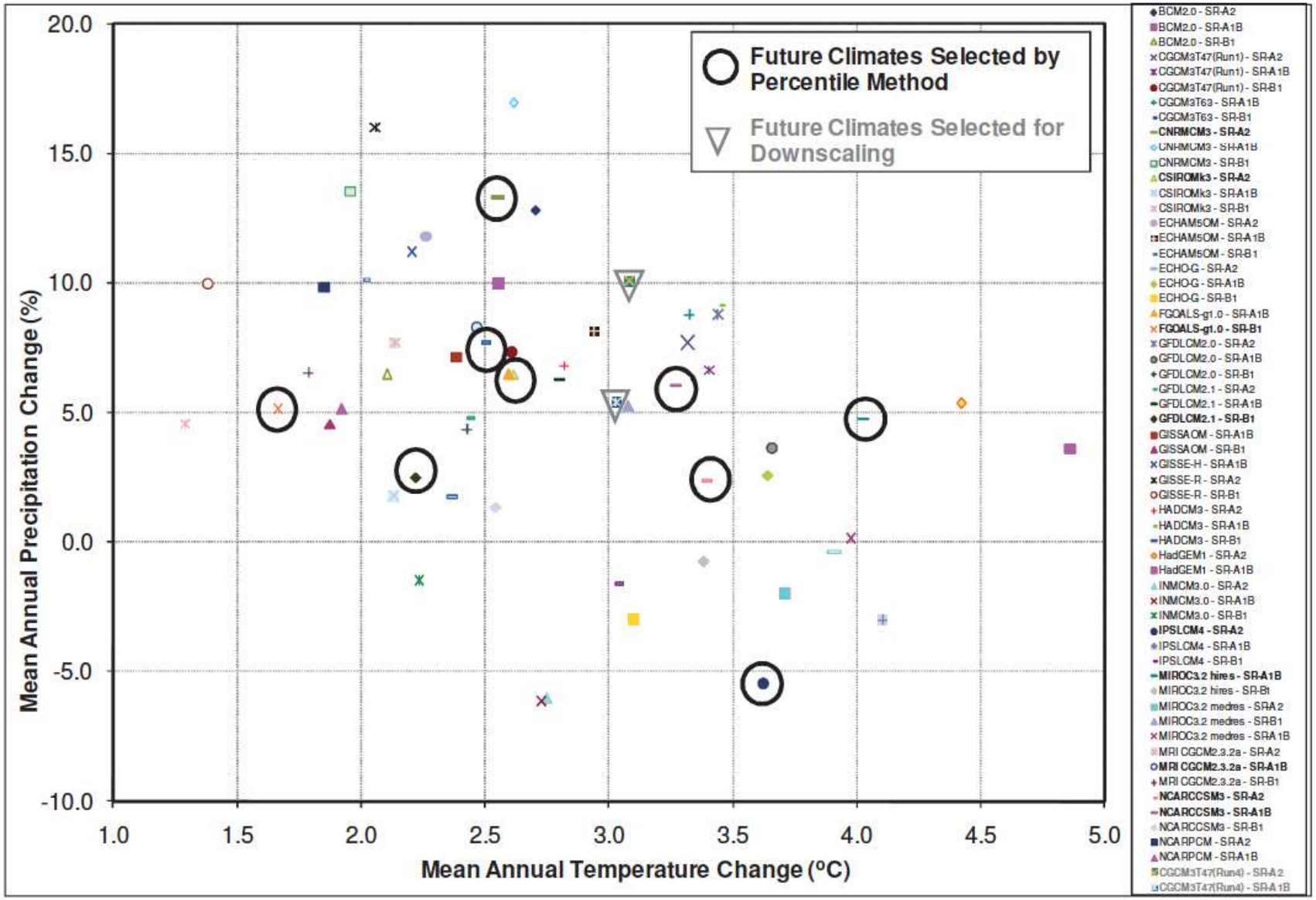
- 2000-2006: C-CIARN Prairies
- 2004-2008: Alberta Vulnerability Assessment Project, **AESRD**
- 2006-2010: Saskatchewan Climate Impact Assessment
- 2006-2008: Prairies Chapter, From Impacts to Adaptation
- 2008- 2011: Prairies RAC - **AESRD**
- 2011-2016: VACEA project – **Oldman River Basin**

Constructing Climate Change Scenarios



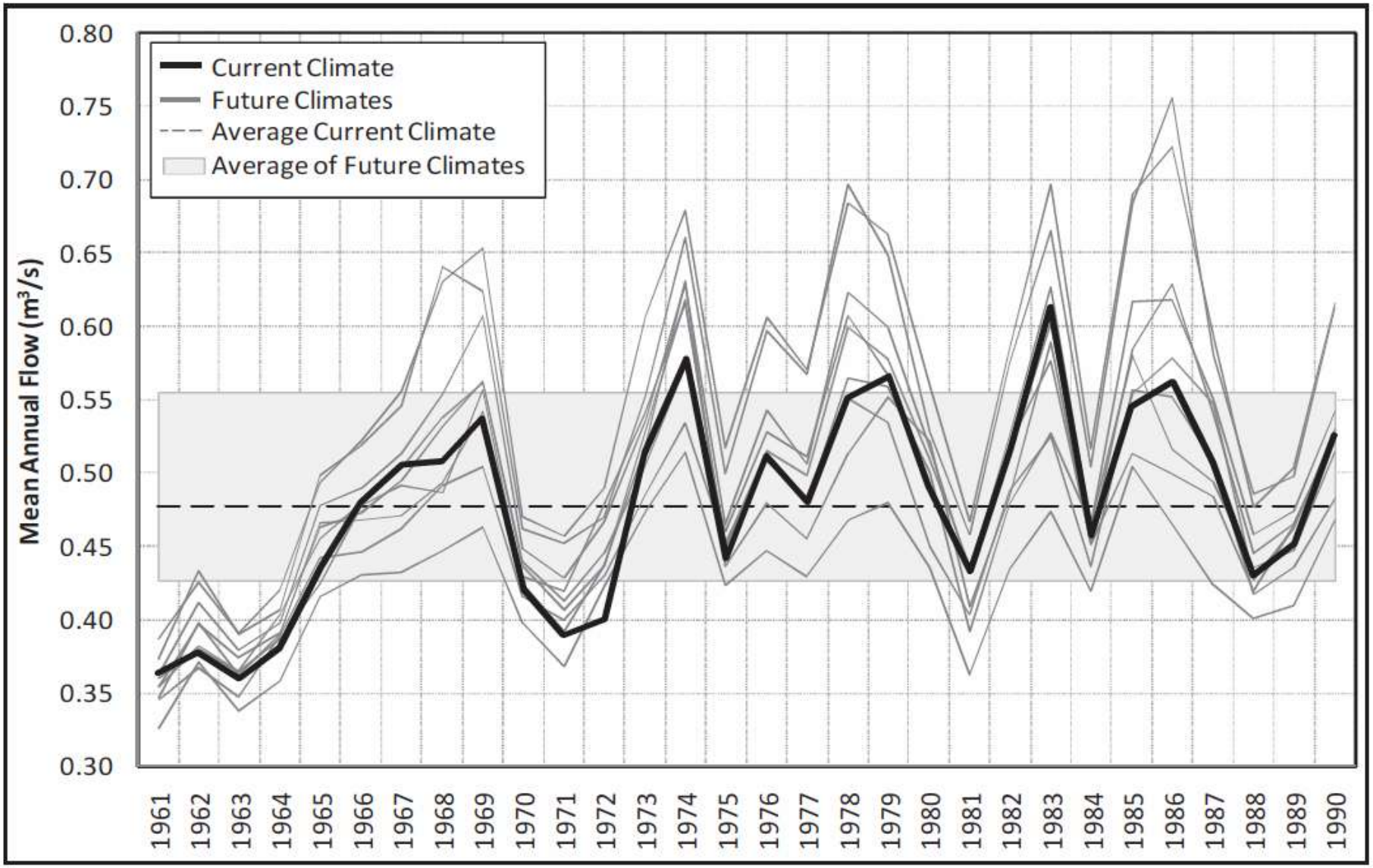
Source: Dr. Elaine Barrow

Selecting Future Climates



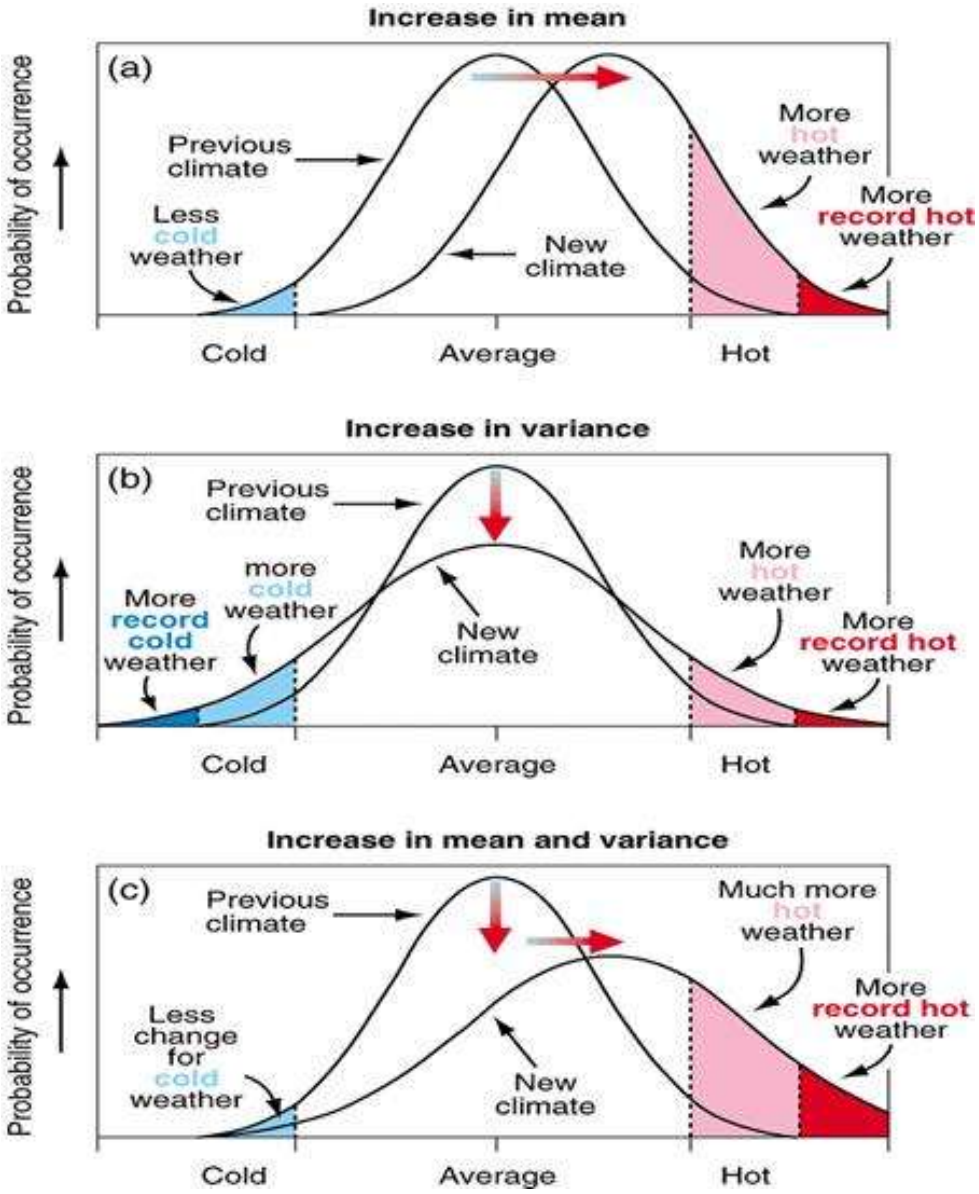
From: Guide for Assessment of Hydrologic Effects of Climate Change in Ontario

Annual streamflow with current (1961-90) and future (2041-2070) climate



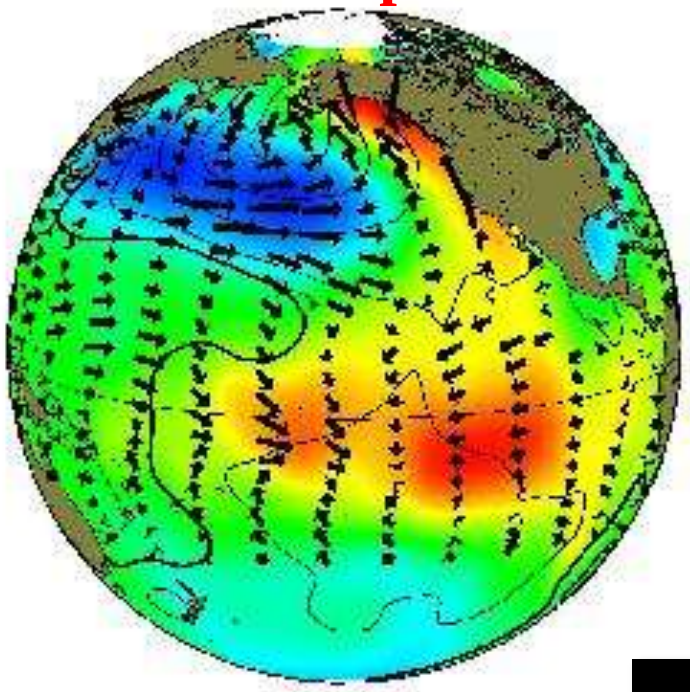
From: Guide for Assessment of Hydrologic Effects of Climate Change in Ontario

Climate Change



The Pacific Decadal Oscillation (PDO) is a major factor controlling Canadian Prairie precipitation and streamflow

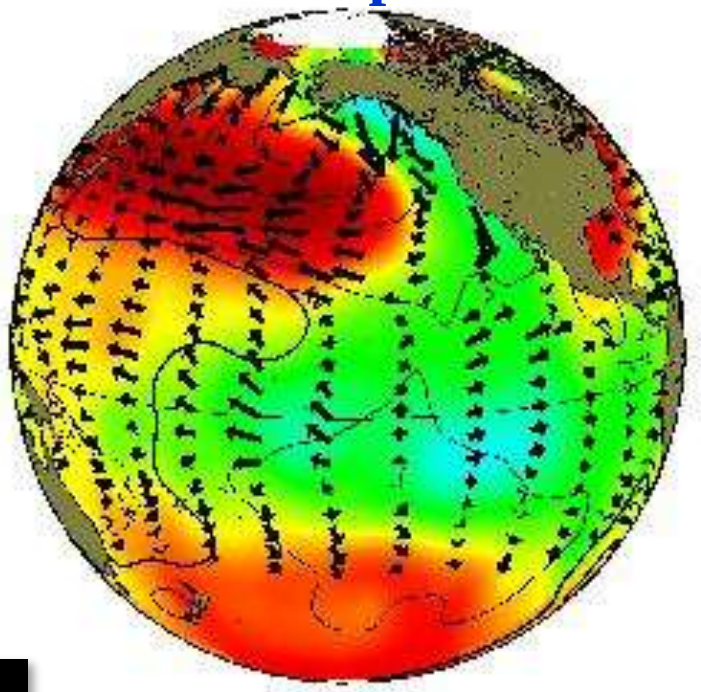
warm phase



Co

0.8
0.4
0.2
0.0
-0.2
-0.6

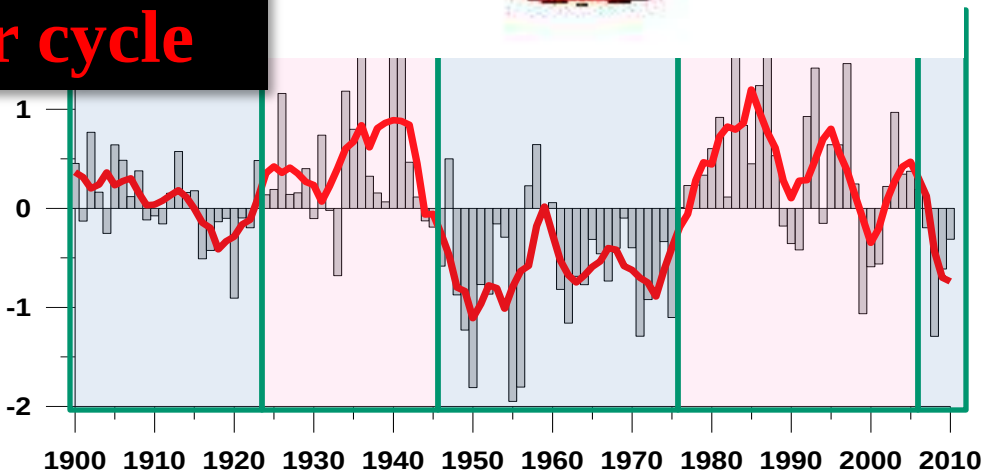
cold phase



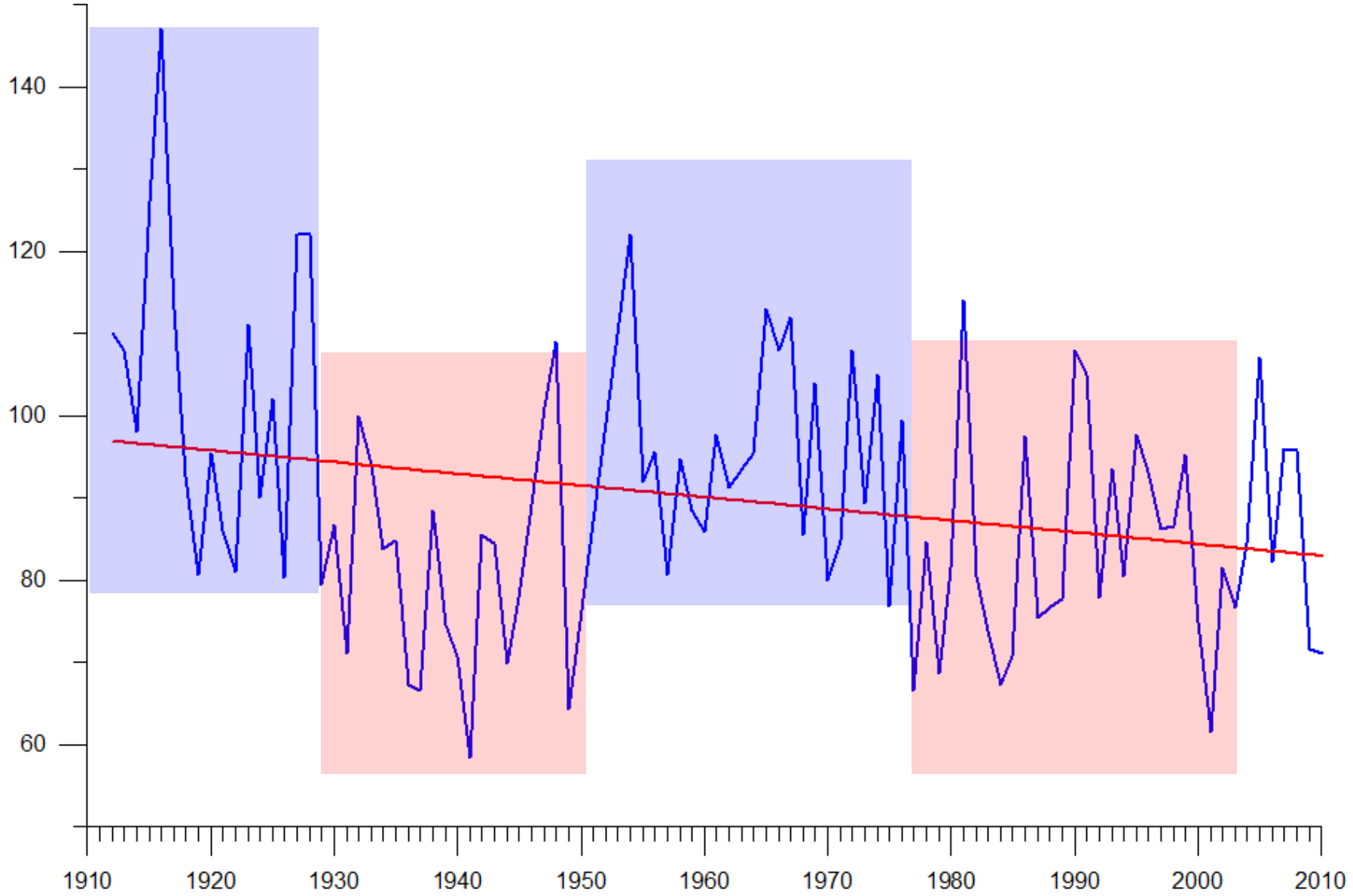
~60 yr cycle

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



Mean annual flow (m^3/sec), Bow River at Banff, 1911-2010



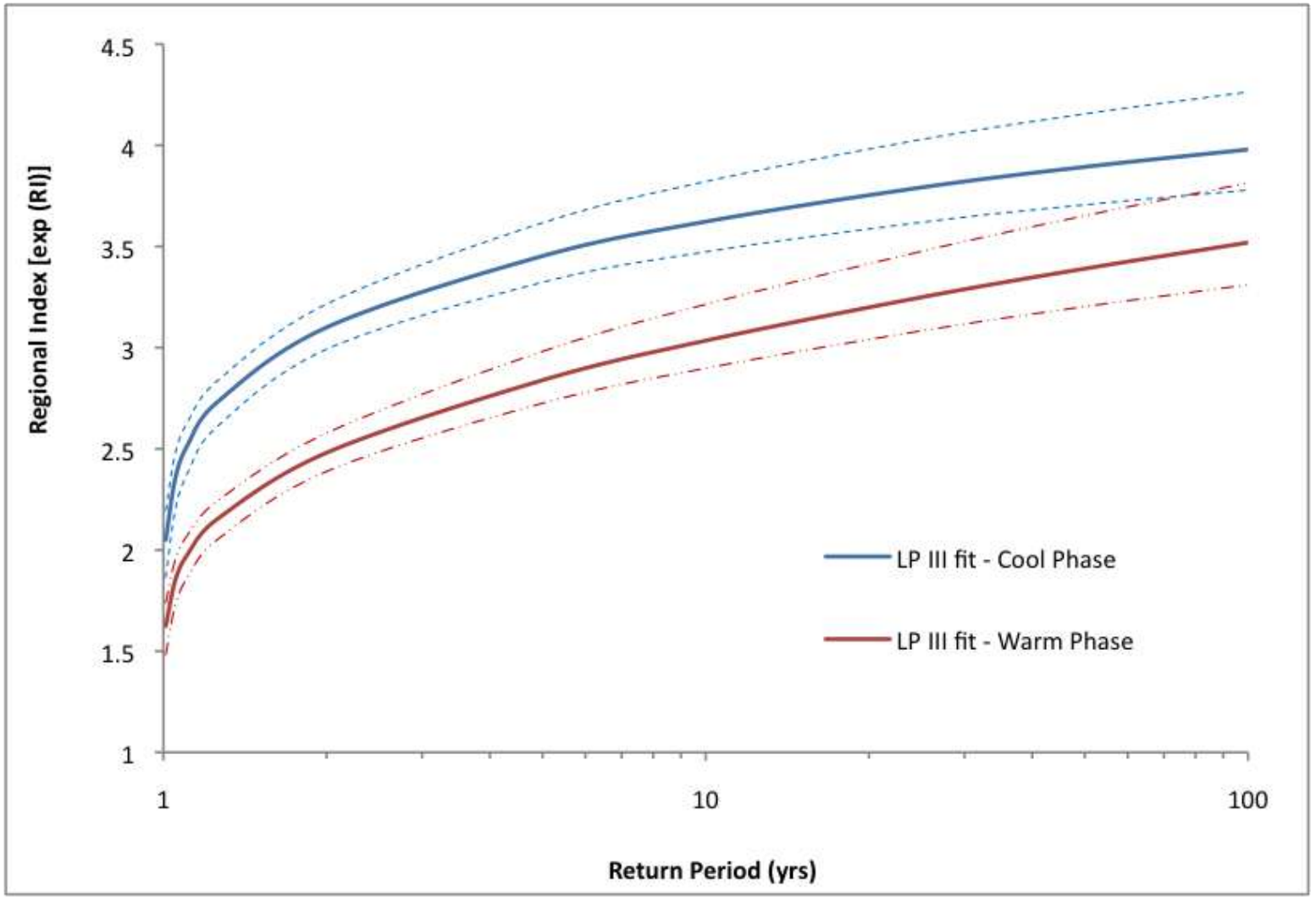
Cooking Lake, Alberta, 19 Sept 2008


Rosetown
Towing Inc.
CAA
ROAD
CLOSED

Probabilities of two consecutive years of 25th and 75th quartile flows by PDO phase - Saskatchewan River

Streamflow record	25th + PDO	25th – PDO	75th + PDO	75th – PDO
Actual Oldman R. near Lethbridge [05AD007]	0.196	0.000	0.020	0.146
Naturalized S. Saskatchewan R. at Medicine Hat	0.200	0.000	0.022	0.171
Actual S. Saskatchewan R. at Medicine Hat [05AJ001]	0.196	0.000	0.020	0.171
Naturalized Elbow R. below Glenmore Dam	0.200	0.000	0.044	0.146
Actual Elbow R. below Glenmore Dam [05BJ001]	0.176	0.048	0.059	0.190
Naturalized Bow R. at Calgary	0.178	0.000	0.044	0.195
Actual Bow R. at Calgary [05BH004]	0.176	0.024	0.039	0.195
Naturalized Spray R. at Banff	0.133	0.000	0.067	0.122
Naturalized N. Saskatchewan R. at Edmonton	0.118	0.024	0.098	0.119
Actual N. Saskatchewan R. at Edmonton [05DF001]	0.118	0.024	0.078	0.122
Actual N. Saskatchewan R. at Prince Albert, SK [05GG001]	0.137	0.049	0.039	0.122
Actual Saskatchewan R. at the Pas, MB [05KJ001]	0.137	0.025	0.059	0.175
Mean	0.149	0.015	0.043	0.135

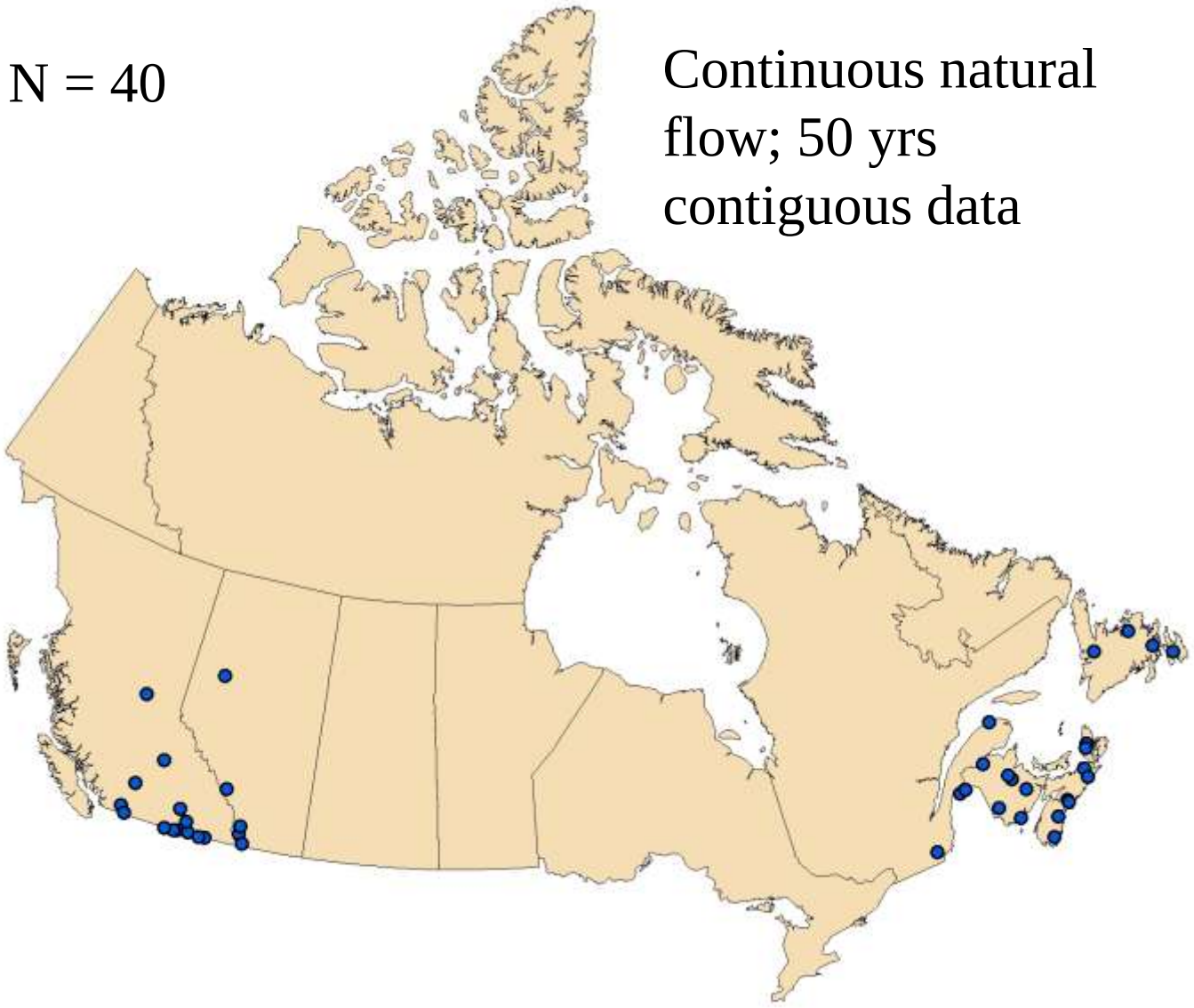
Expected annual peak flow by PDO phase for 25 gauging stations



Gurrapu et al. 2012

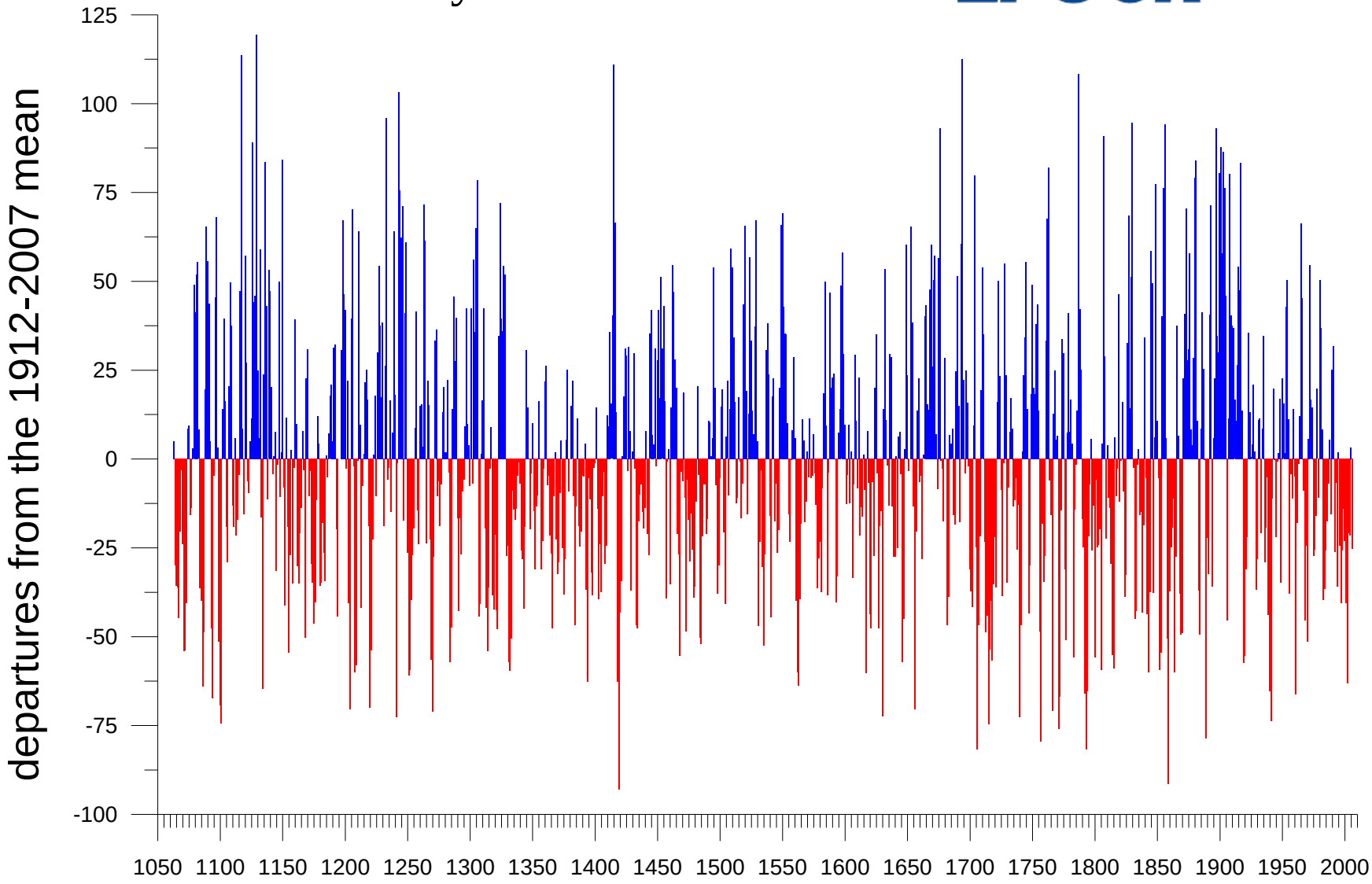
N = 40

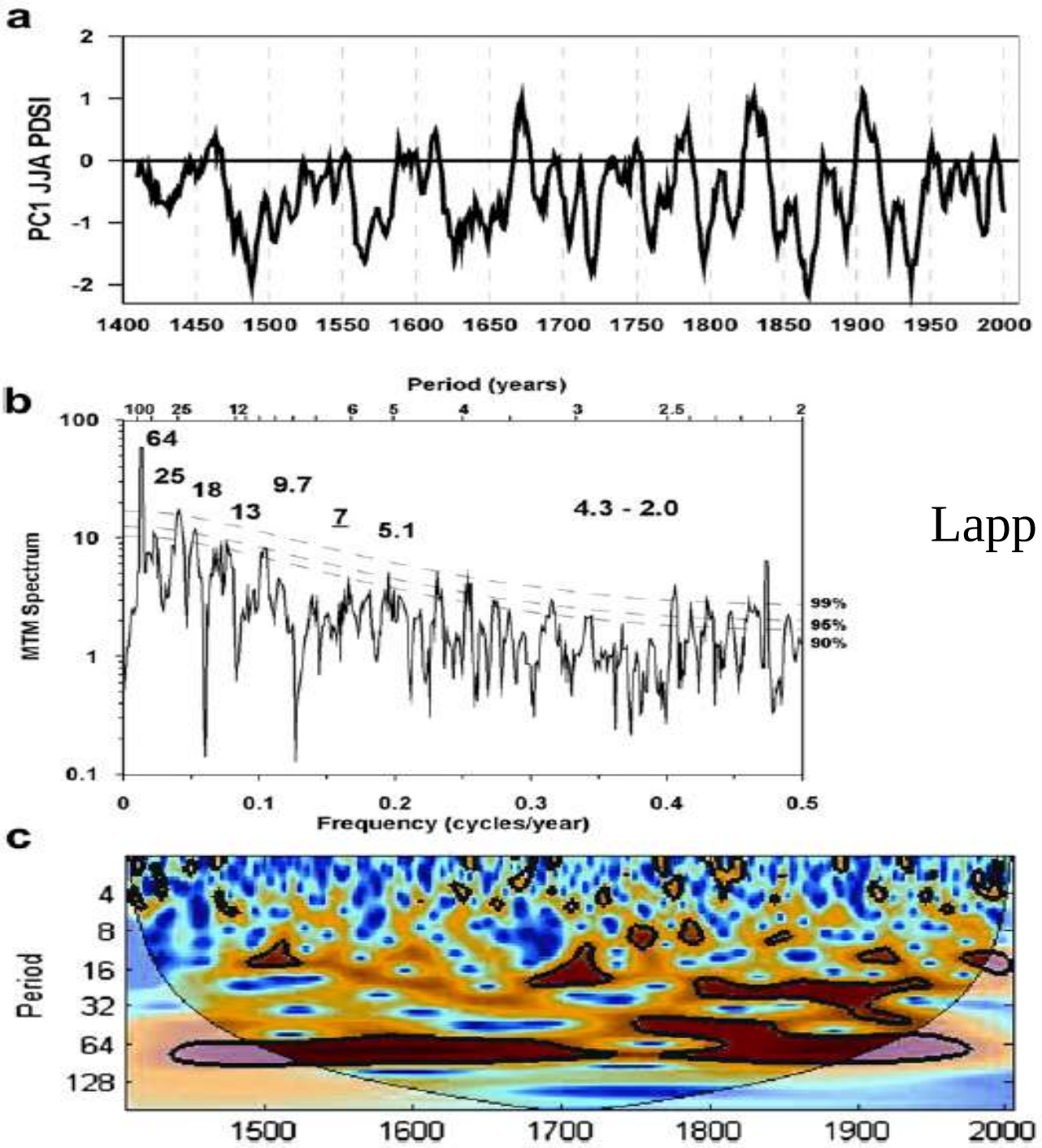
Continuous natural flow; 50 yrs contiguous data



Mean Annual Flow (m^3sec^{-1}) North Saskatchewan River, 1063-2006

Sauchyn *et al*. 2011

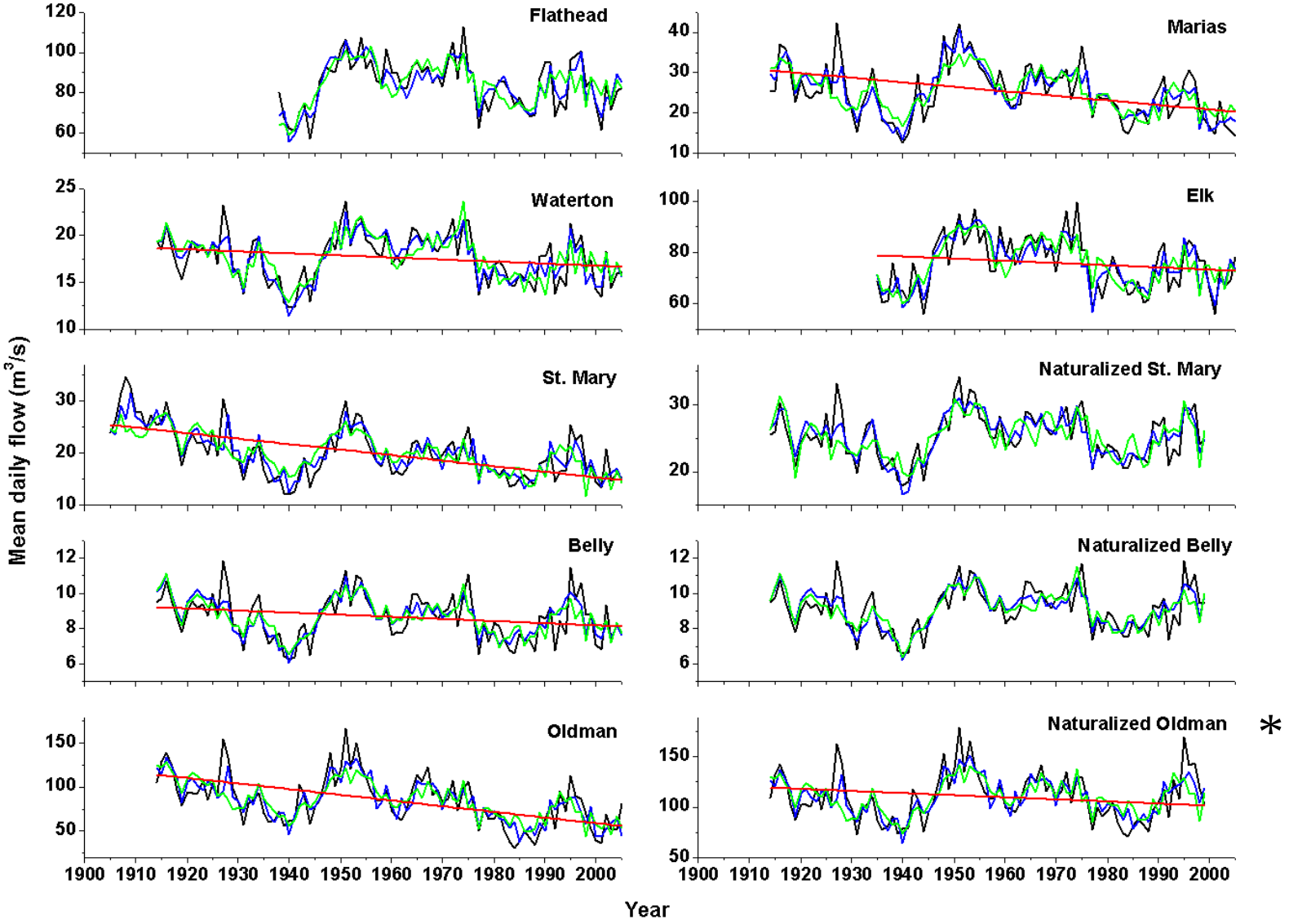




Lapp et al. 2012

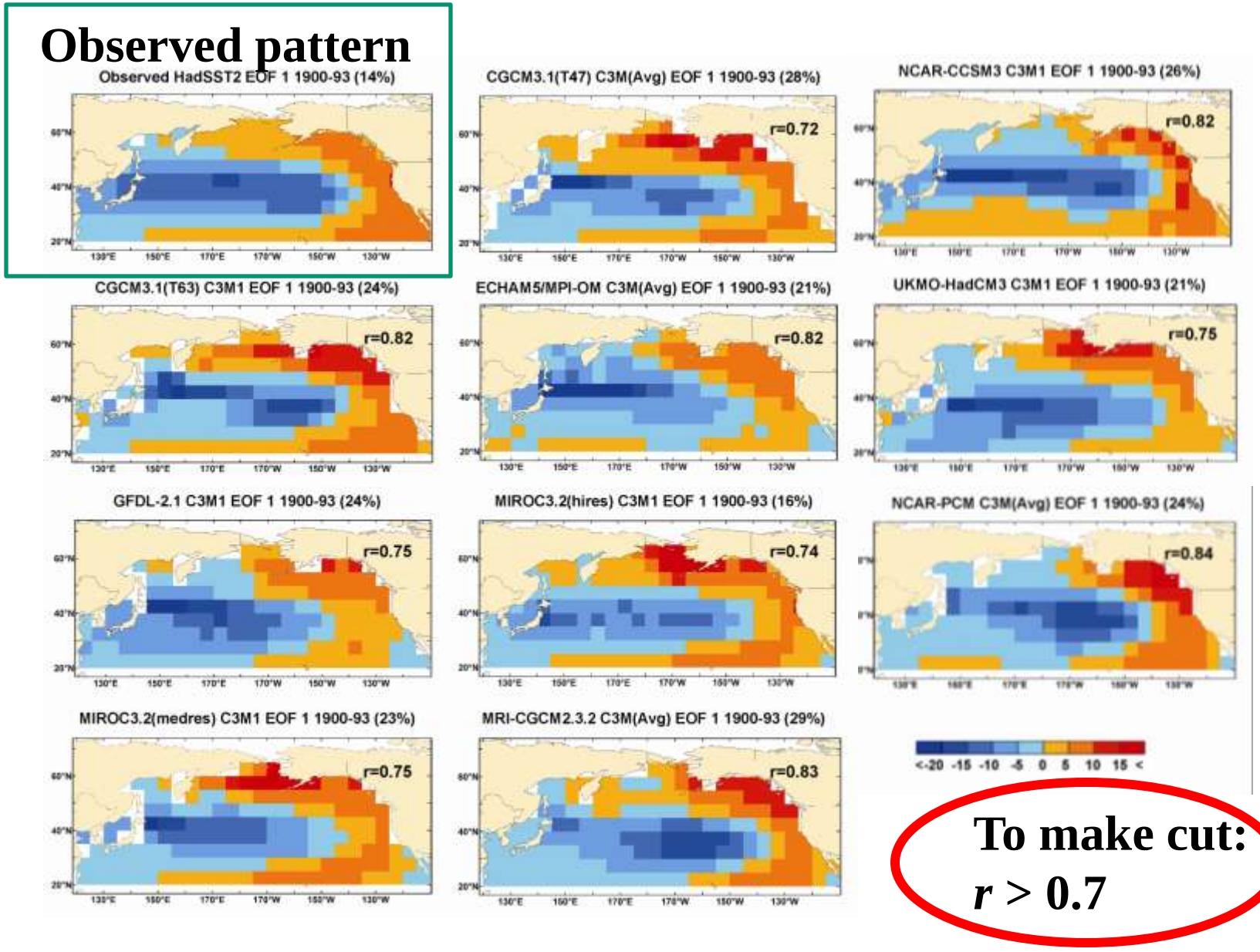
St. Jacques et al. 2012

GLS Streamflow Models by Gauge



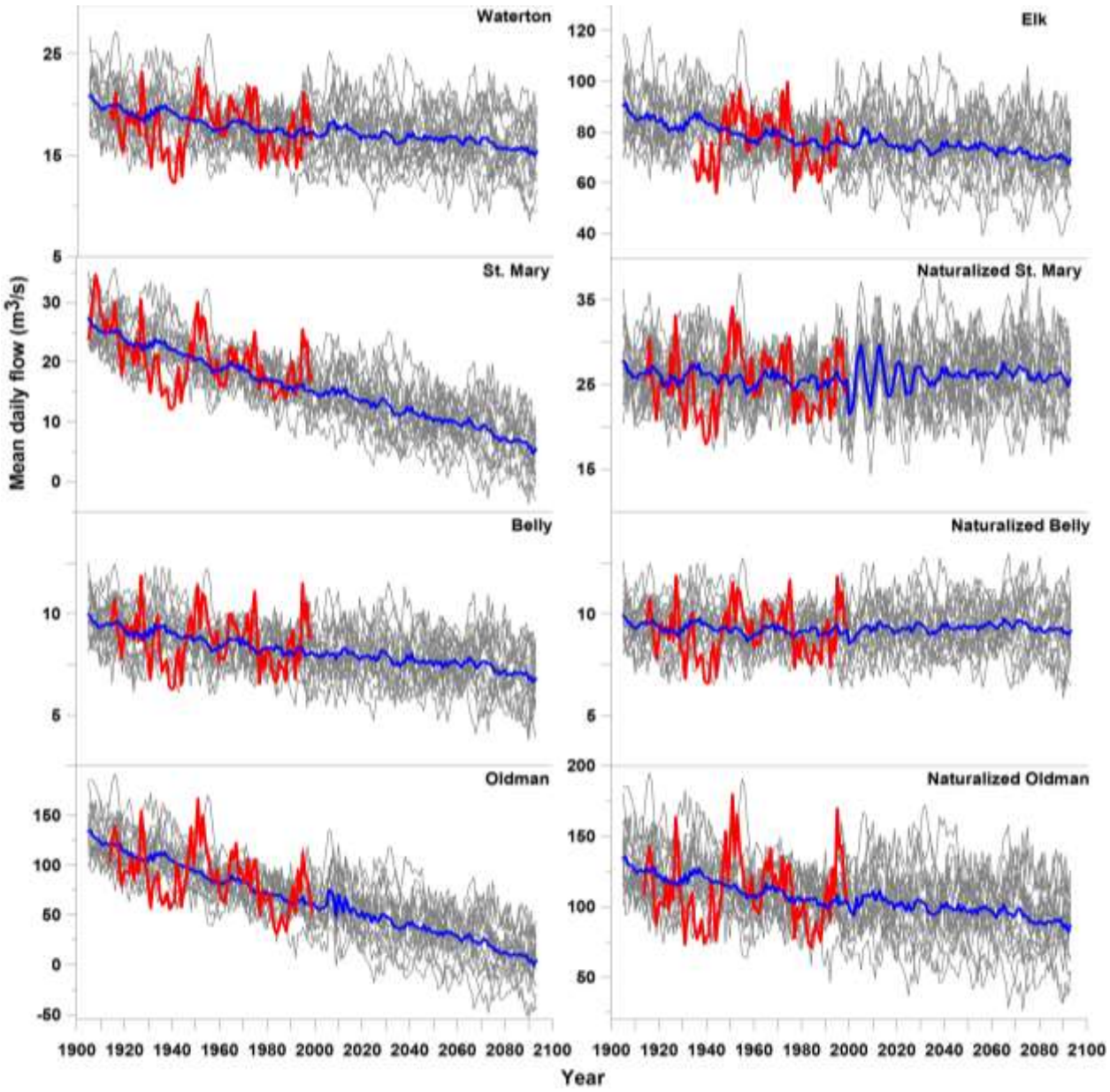
* e.g., $Qt = -0.24 - 5.16*trend - 8.38*PDO - 10.02*PDO_{P2} - 10.19*SOI_{P2}$

PDO: Observed versus 20th century simulations



To make cut:
***r* > 0.7**

Streamflow Simulations, 1900-2100



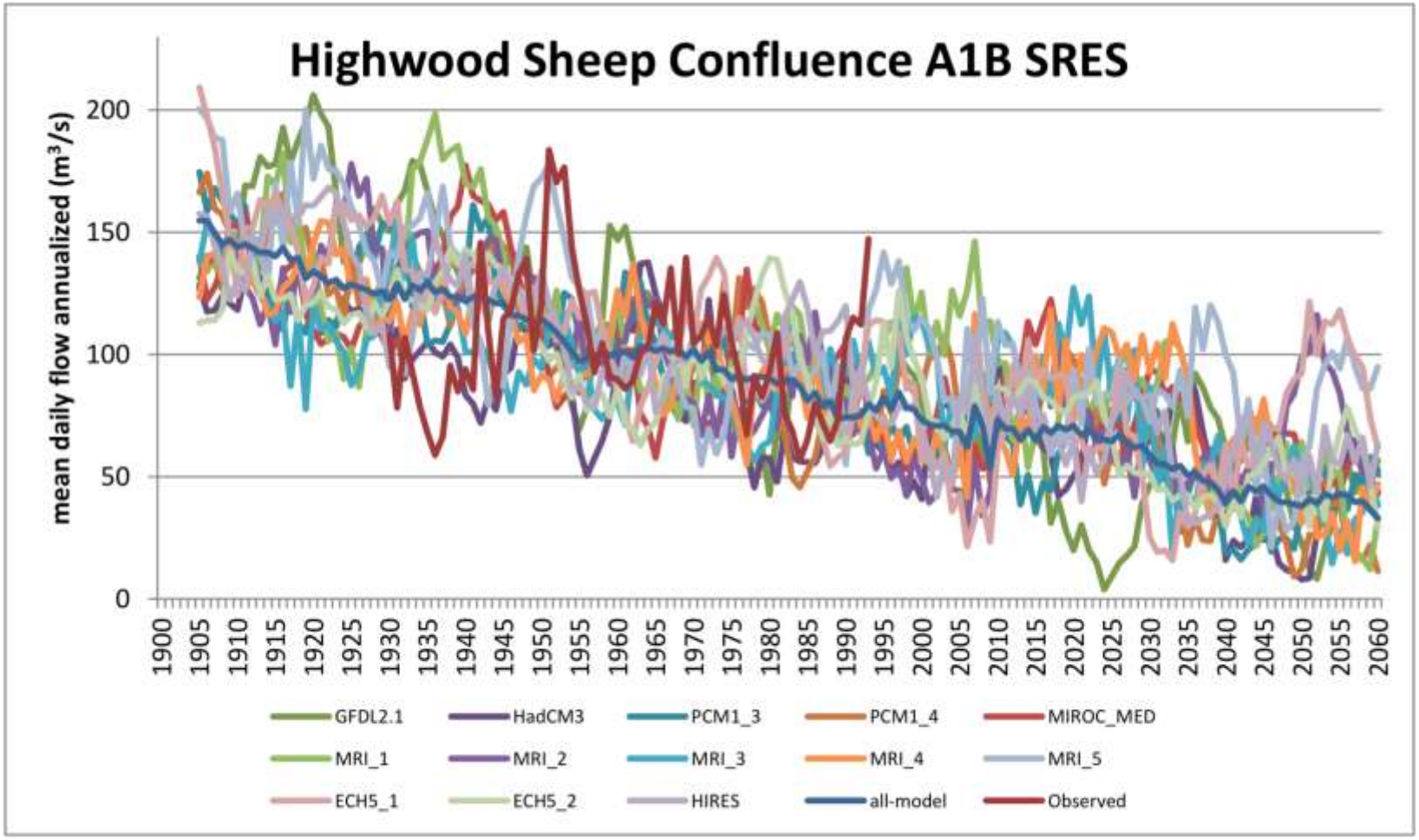
simulation

gauge record

mean simulation

St. Jacques et al. 2012

Ensemble Projection of Annual Flows



Conclusion

- The **standard practice** of running hydrological models with projected climate means is the best approach for assessing impacts of changes on land use and mean climate conditions on **water balances and basin yield**.

- However this approach **fails provide information on shifts in hydrologic extremes** because the variability is inherited from the model calibration; the forcing of interannual to decadal variability is not modeled.

- Considerable time and effort is given to the calibration and validation of environmental models but not to the **selection and validation of climate models**.

- Why are **climate models** not considered **environmental models**?