

# Hydrologically Related Disasters and Impacts and Adaptation

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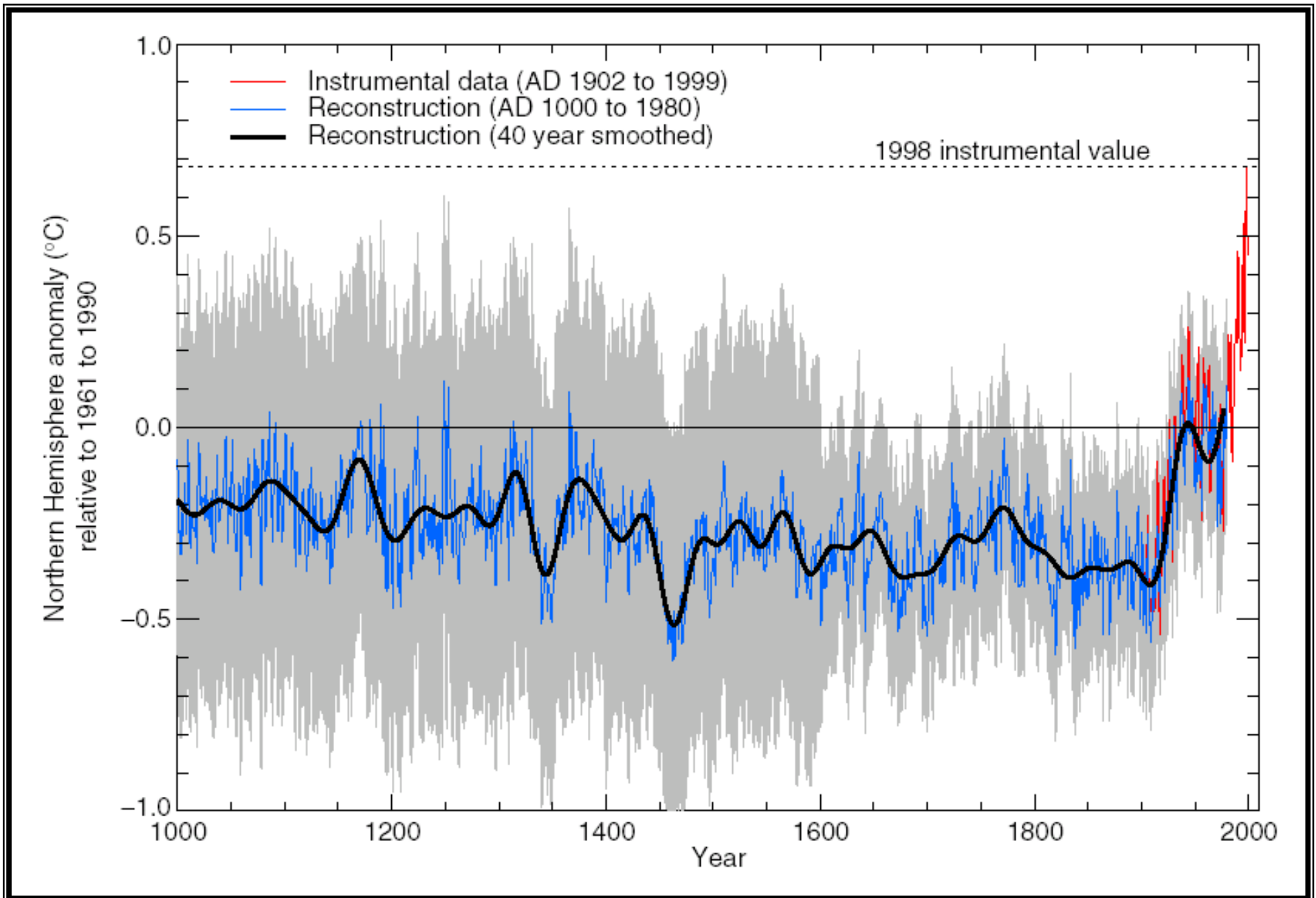
April 2, 2002

# Historical Adaptation to Climatic Variability

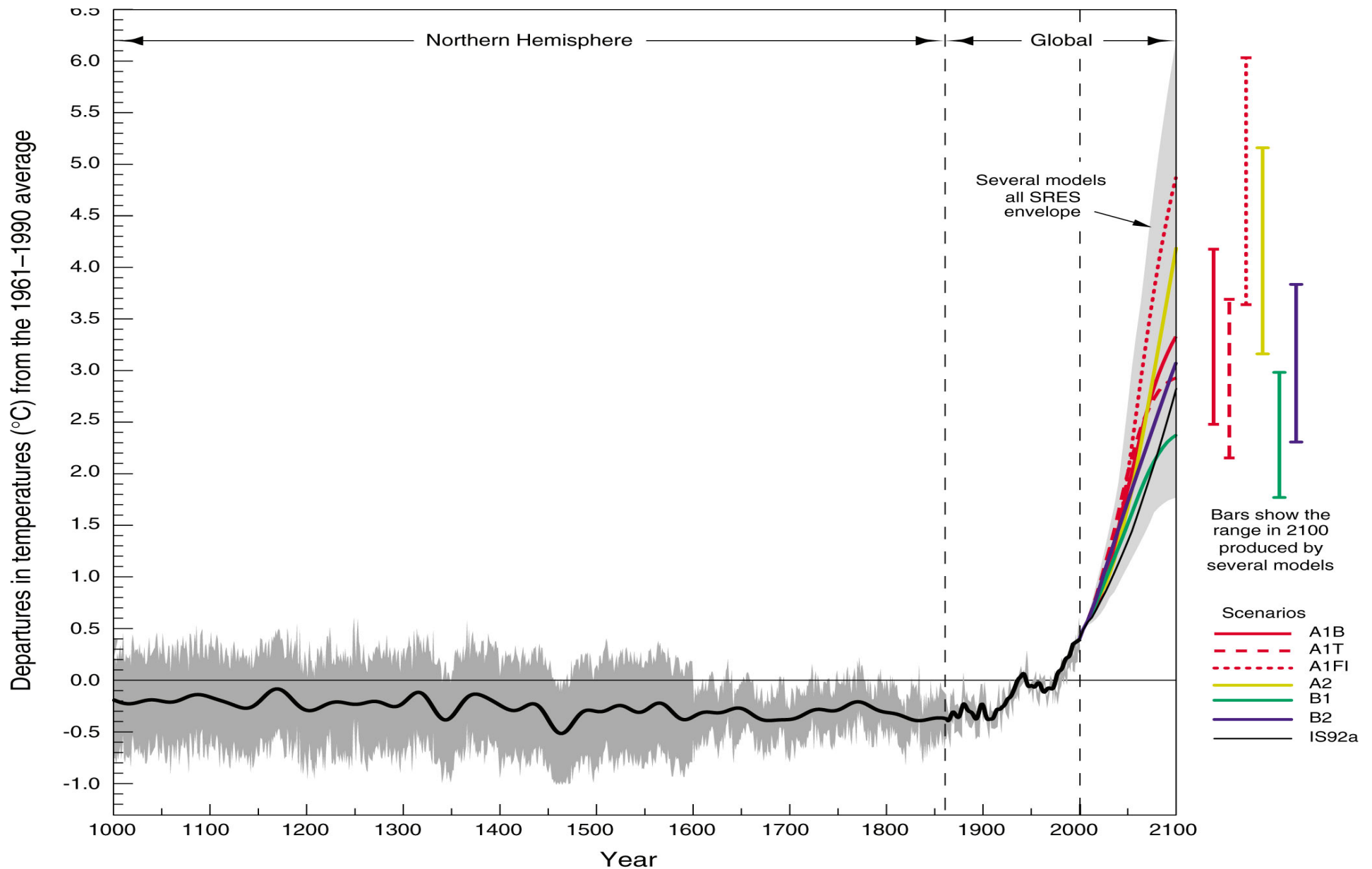
... it is likely that region-specific **changes in the hydrologic cycle produced the greatest societal and economic challenges.** ... When record keeping became routine, those cultures with some level of awareness of at least the natural variability in rainfall and perhaps even an understanding of the characteristic timescales of drought/flood cycles would be at some advantage in managing their agricultural and commercial resources. **Few examples of such awareness and coping strategies** exists (even for the present day)

Dunbar, 2000: 78

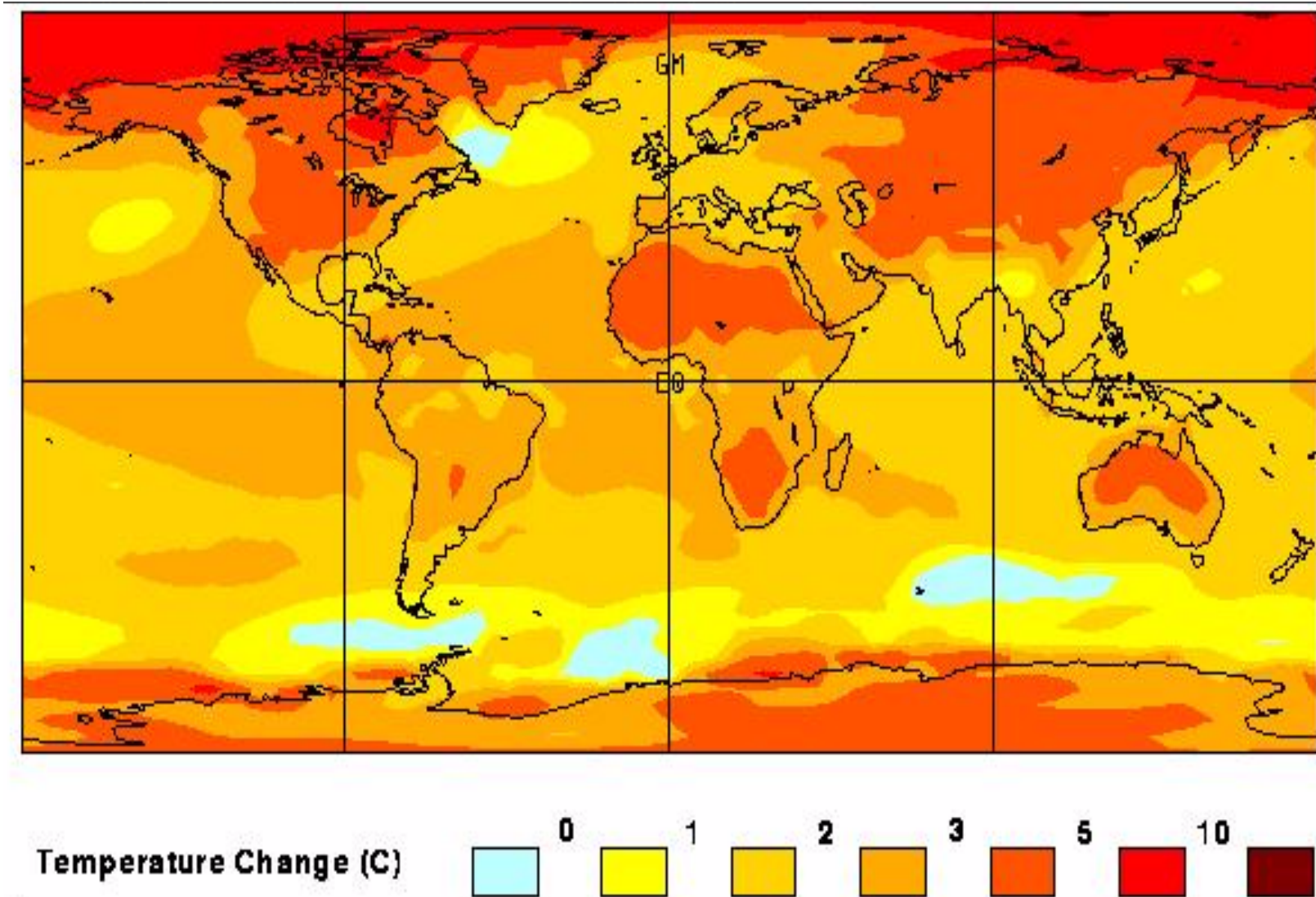
# Northern Hemisphere (1000 years) temperature records



# Temperature Projections for 21st Century

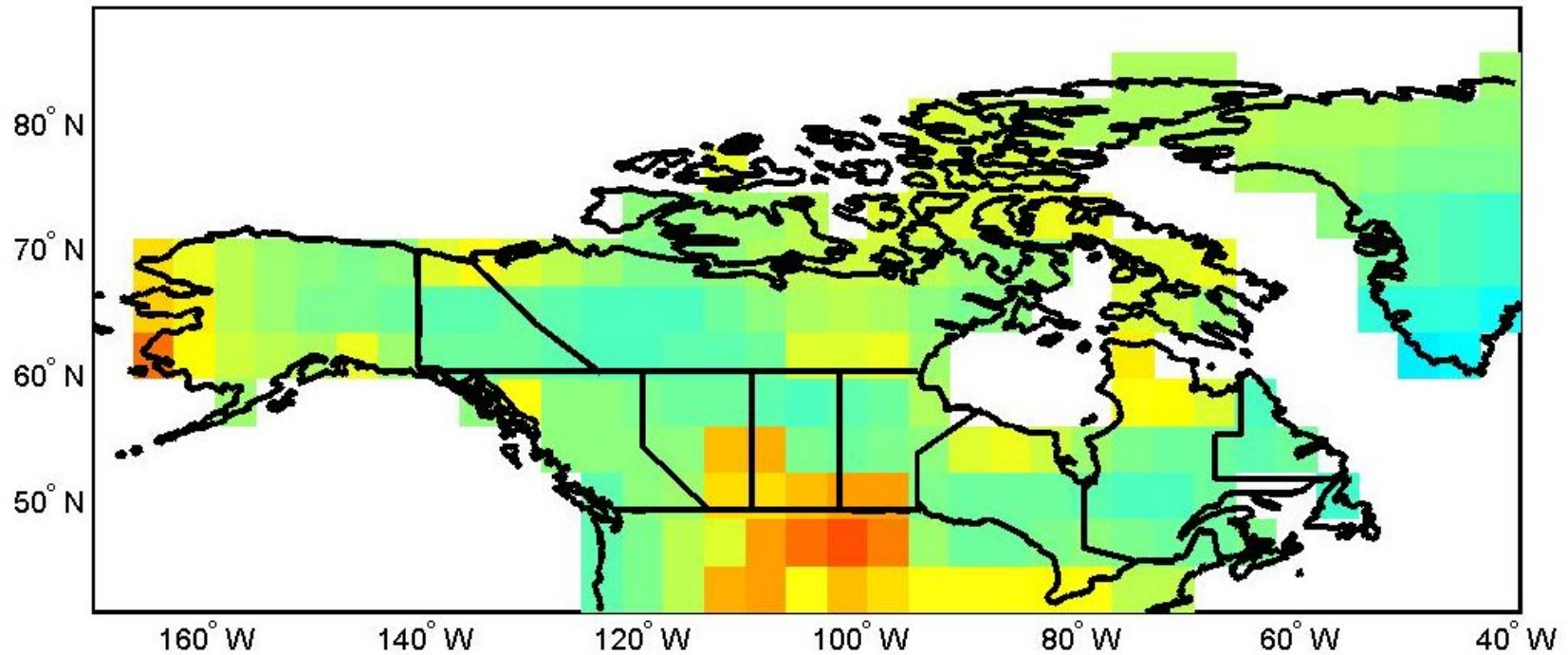


# Projected Temperature Change, 1910 - 2040

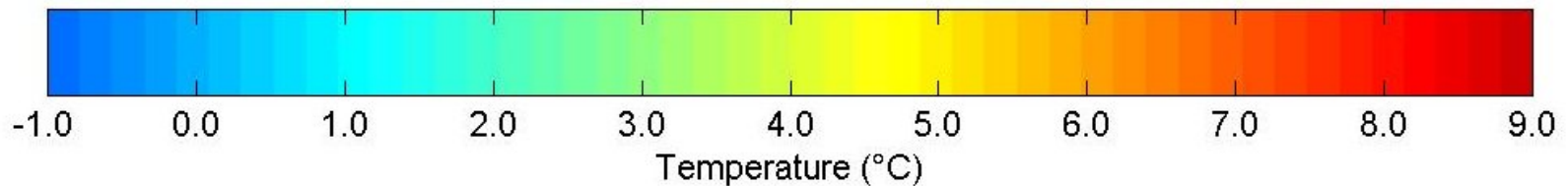


*Combined Effect of Projected Greenhouse Gas and Sulphate Aerosol Increases.- Canadian Model*

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## CGCM1, Mean Spring Temperature Change 2050

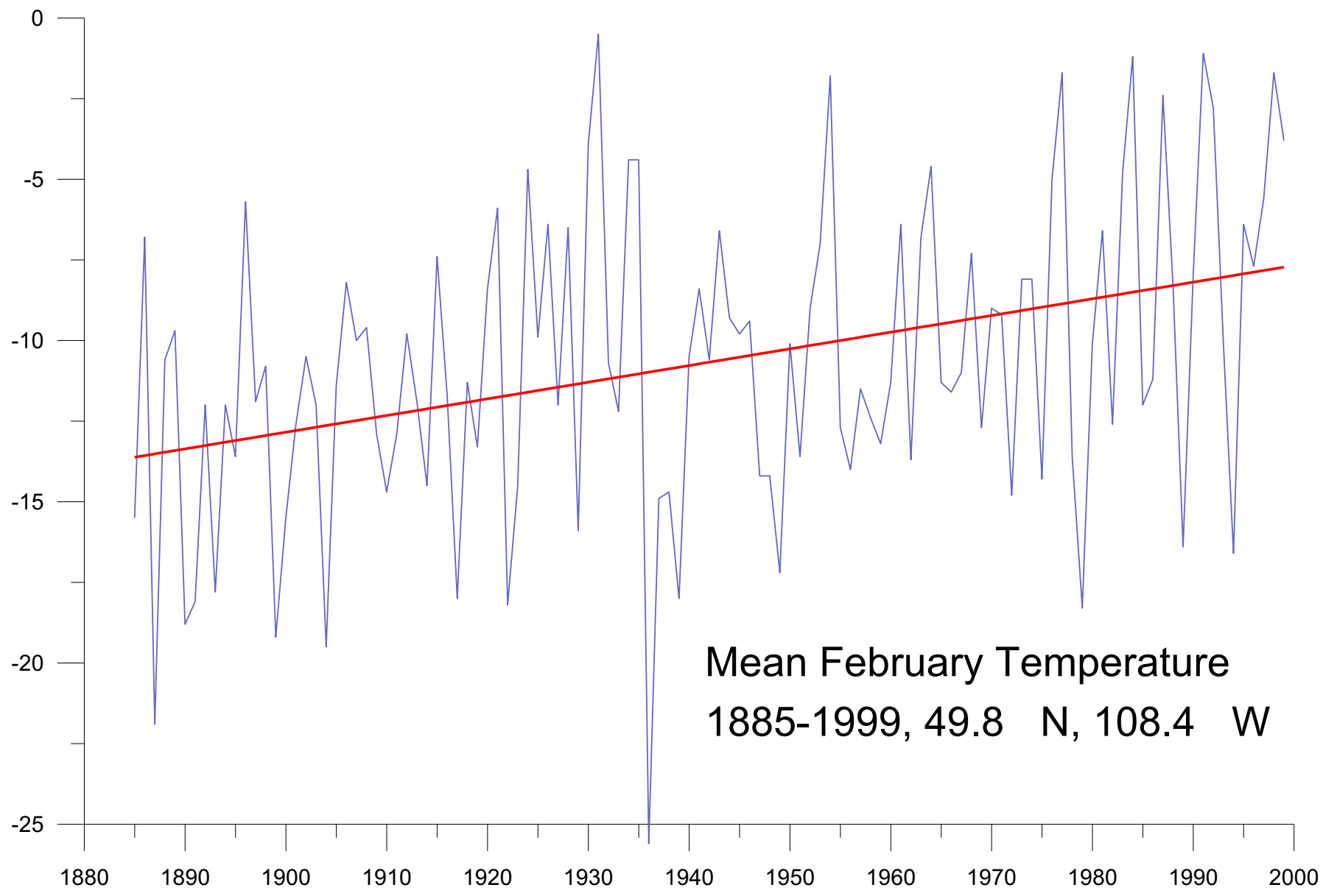


<http://www.cics.uvic.ca/scenarios/index.cgi>

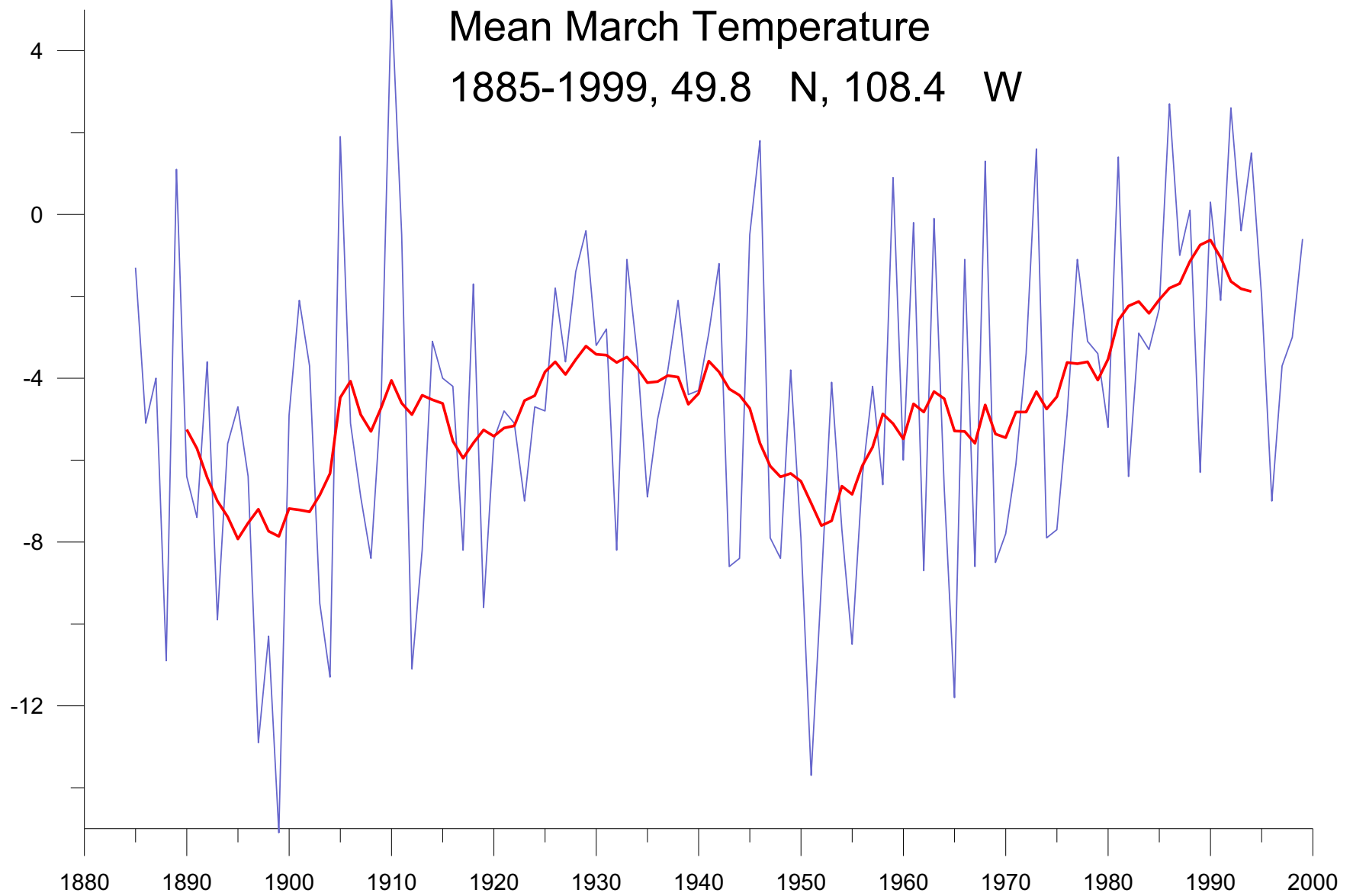
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# Projections for the future climate of the Prairie Provinces

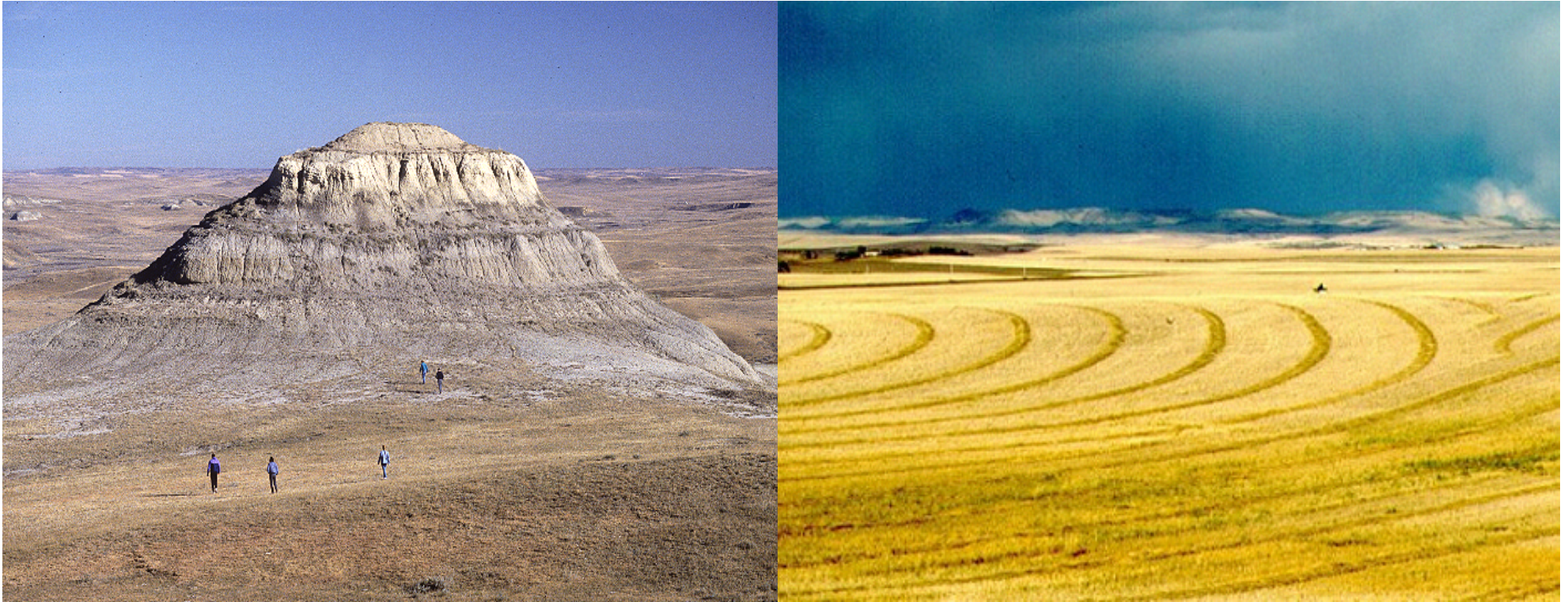
<b>Temperature</b>	increasing, greater in winter than summer, greater at night than during day
<b>Precipitation</b>	great uncertainty, annually small increase to significant decrease
<b>Evaporation</b>	increased
<b>Soil moisture</b>	decreased
<b>Growing season</b>	increased
<b>Water Resources</b>	increased variability, earlier peak flows
<b>Extreme events</b>	increased frequency and magnitude





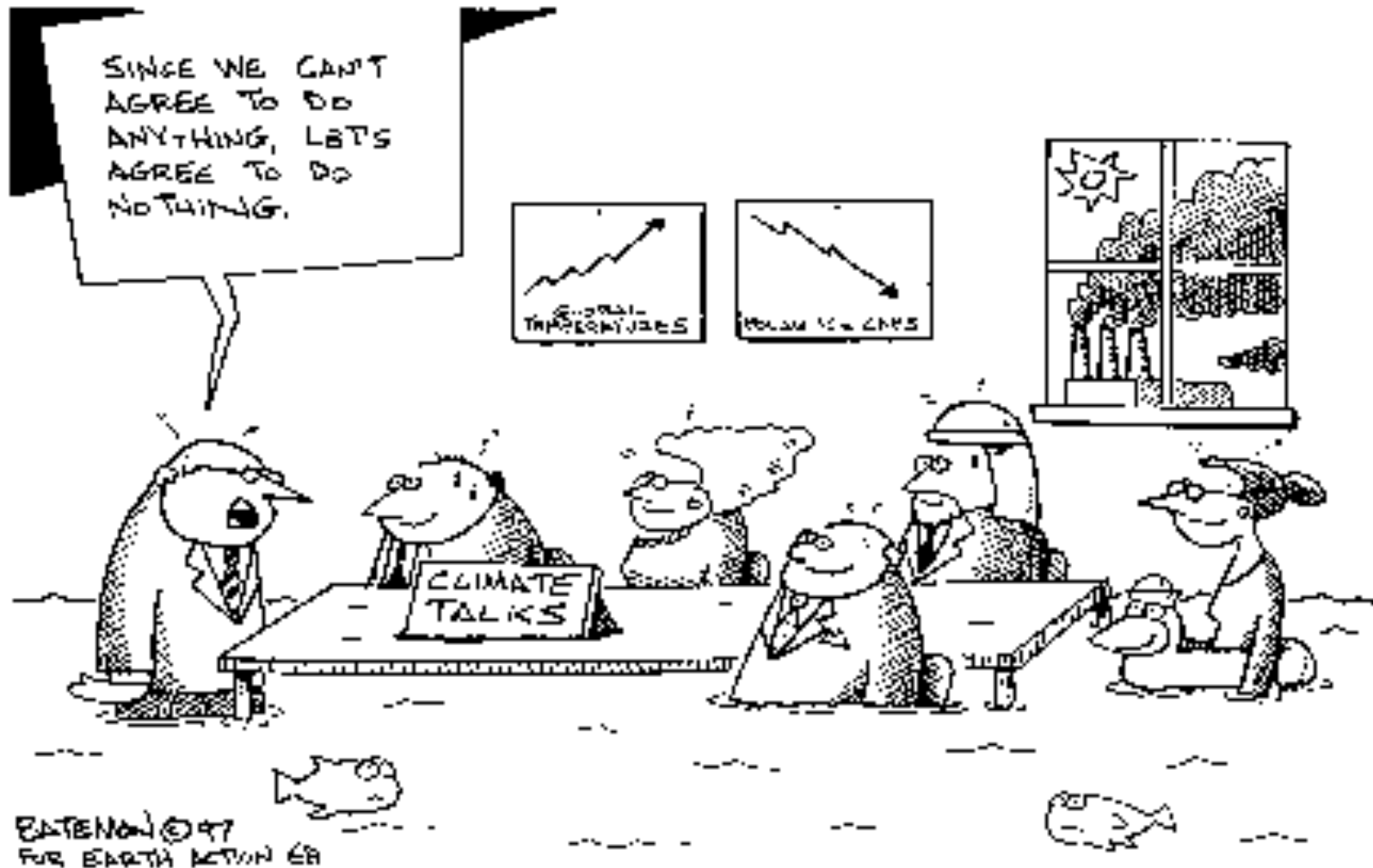


# The Canadian Plains

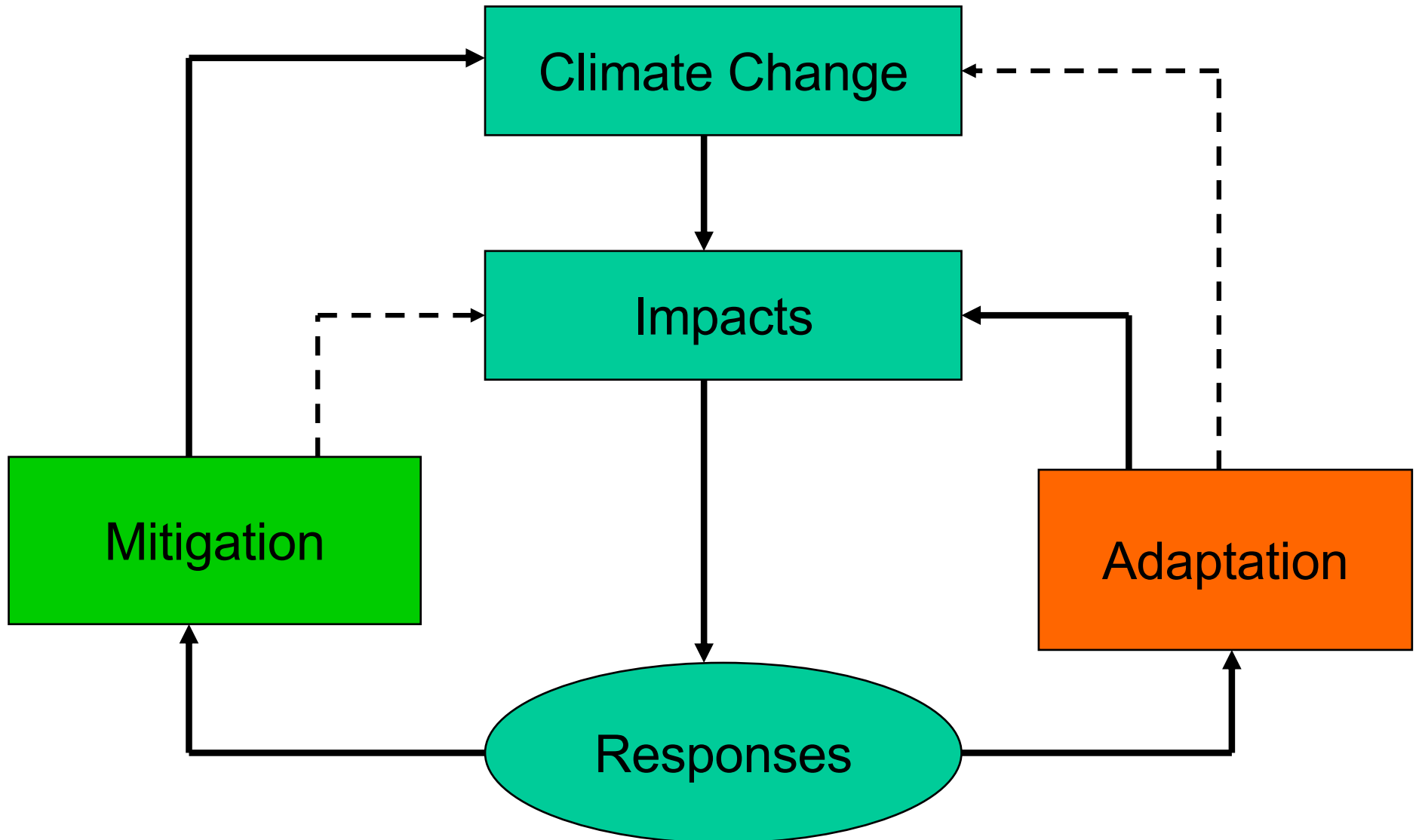


Natural and socio-economic systems are sensitive to climatic variability, climatic change and extreme hydroclimatic events

# What can we do?

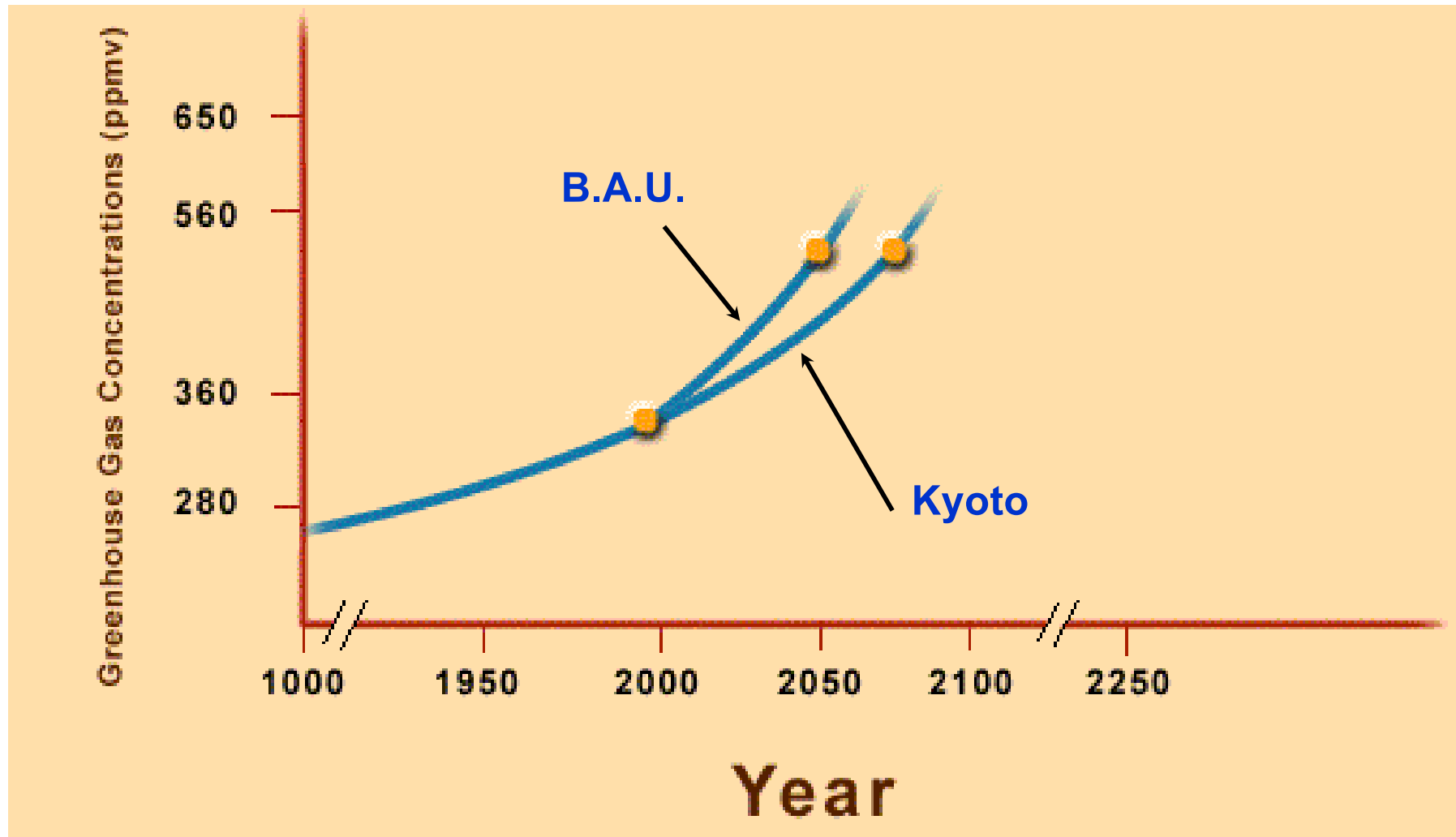


# Addressing Climate Change: Mitigation and Adaptation



# Kyoto Is An Important First Step

(delays doubling by about 20 years)



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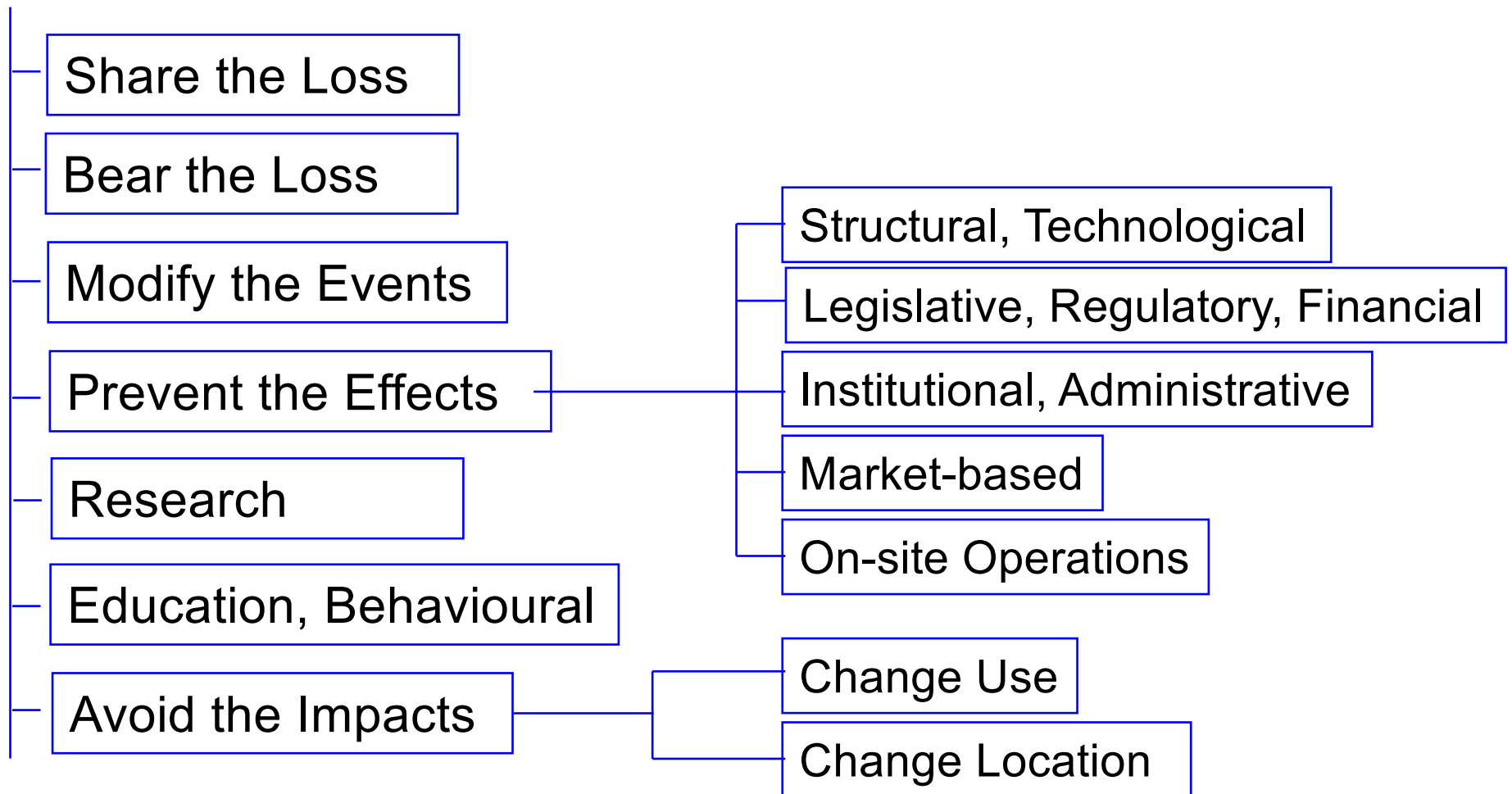
[www.parc.ca](http://www.parc.ca)

The **Prairie Adaptation Research Collaborative** is a facilitative, interdisciplinary research network established to **understand the potential impacts of climate change** on the Canadian Prairie Provinces and conduct research necessary to **develop appropriate adaptation strategies**.

# ADAPTATION:

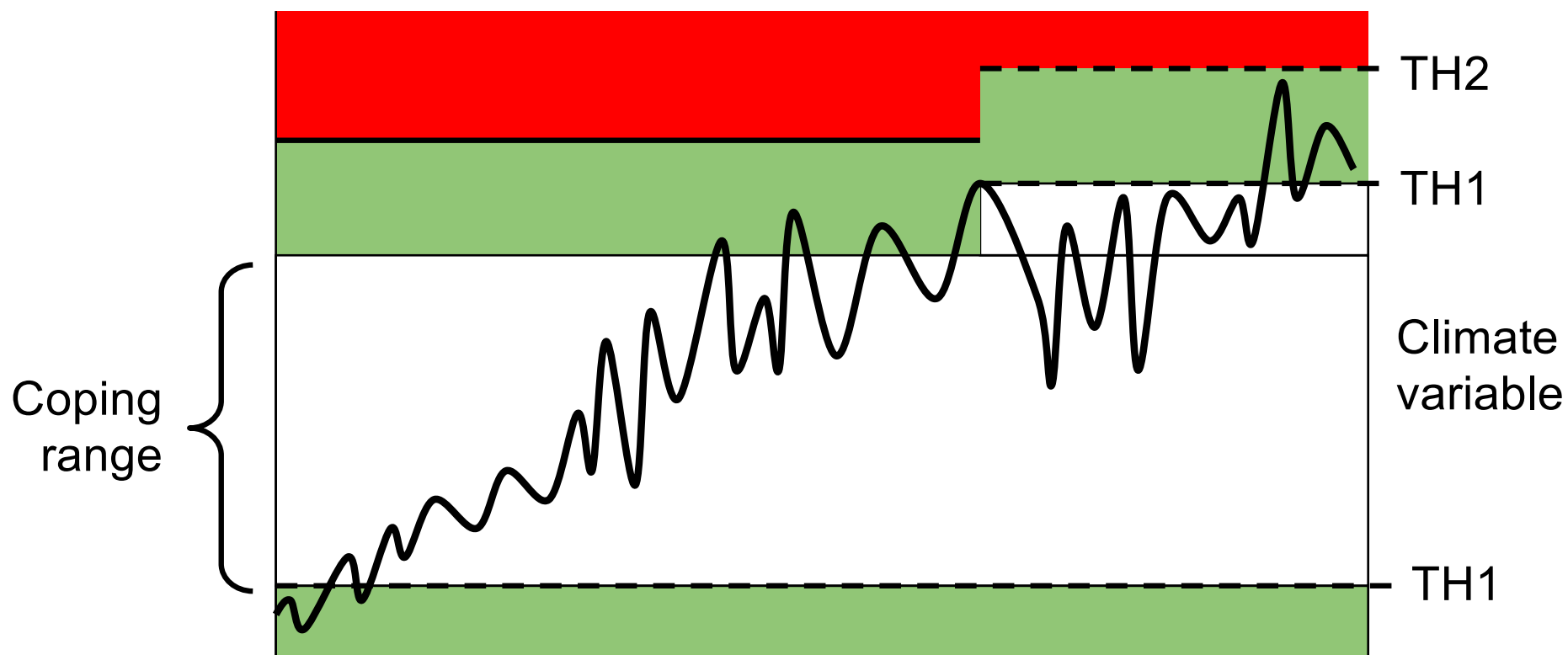
- Degree to which **adjustments** are possible in practices, processes, or structures of systems to projected or actual changes of climate
- Adaptation can be **spontaneous or planned** and can be carried out in response to, or in anticipation of changes in conditions
- Represents a practical means of accommodating **current climatic variability** and extreme events, as well as adjusting to longer term climatic change
- Estimated that Canada spends \$11 billion responding to current climatic variability

# Adaptation Options





# Impact (Risk) Assessment & Adaptation



Realistic climate change impact assessments must take adaptation into account (Pittock and Jones, 2000)

# Adaptation - Water

- Integrated management of surface and groundwater supplies
- Investment in water wells, since groundwater is the alternative to surface water under drier conditions
- Restricting the drainage of wetlands where groundwater is recharged
- Declining supplies of glacier runoff have serious implications for the adaptive capacity of downstream surface water systems and for trans-boundary water allocation

# Water Projects

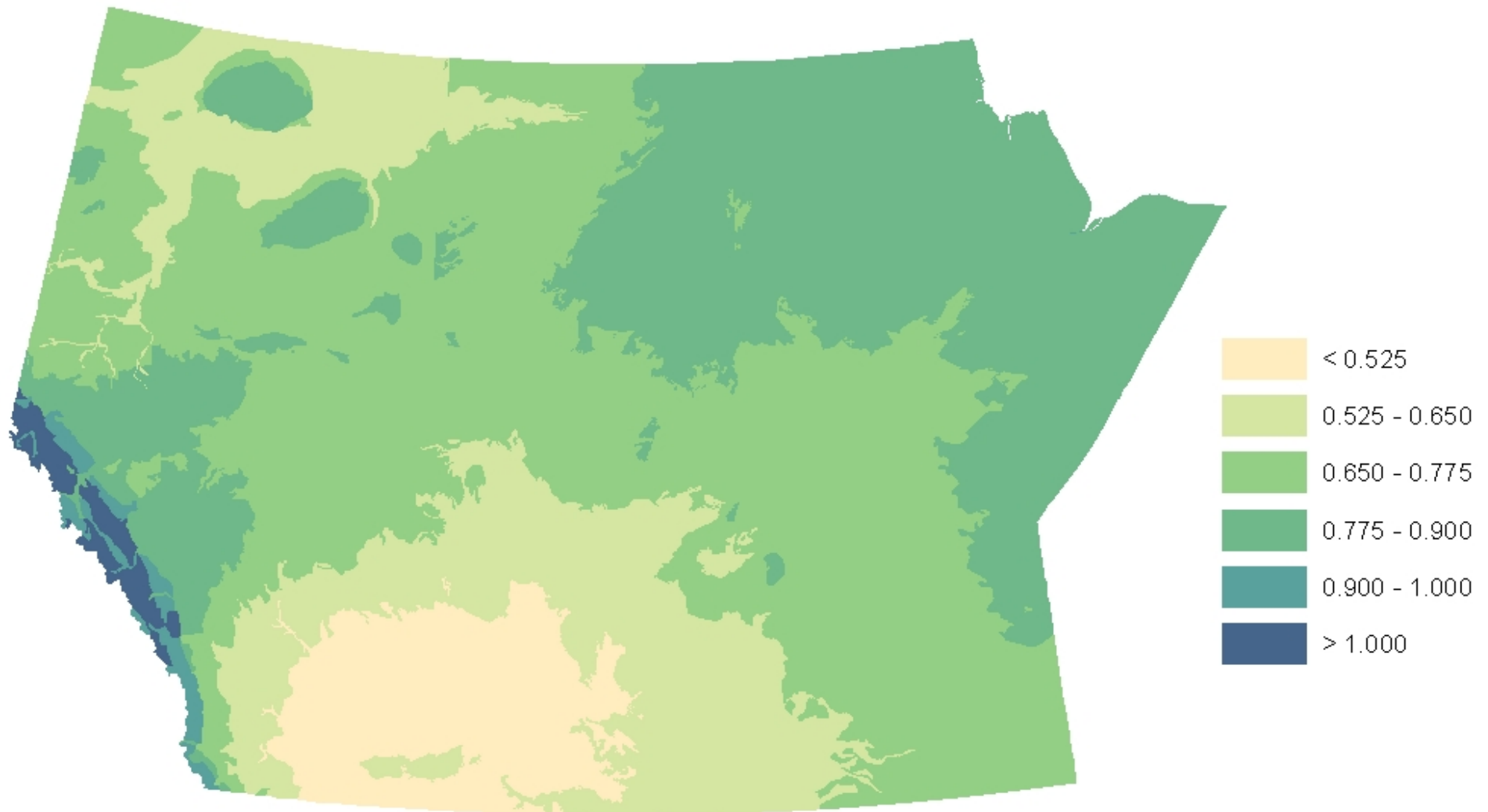
- Potential Impact of Climatic Change on Prairie Groundwater Supplies: Review of Current Knowledge
  - Thorleifson, Maathuis & Lebedin
- The impact of climate change on the glaciers of the Canadian Rocky Mountain eastern slopes and implications for water resource-related adaptation in the Canadian prairies
  - Demuth & Pietroniro

# Impacts on Water Resources

- 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
- Shallow aquifers are vulnerable to reduced recharge
- Reduced groundwater recharge with loss of wetlands
- Water tables were several to 20 meters lower during the altithermal period – a possible analogue of future climate

# Ratio of Precipitation to Potential Evapotranspiration for the Prairie Provinces

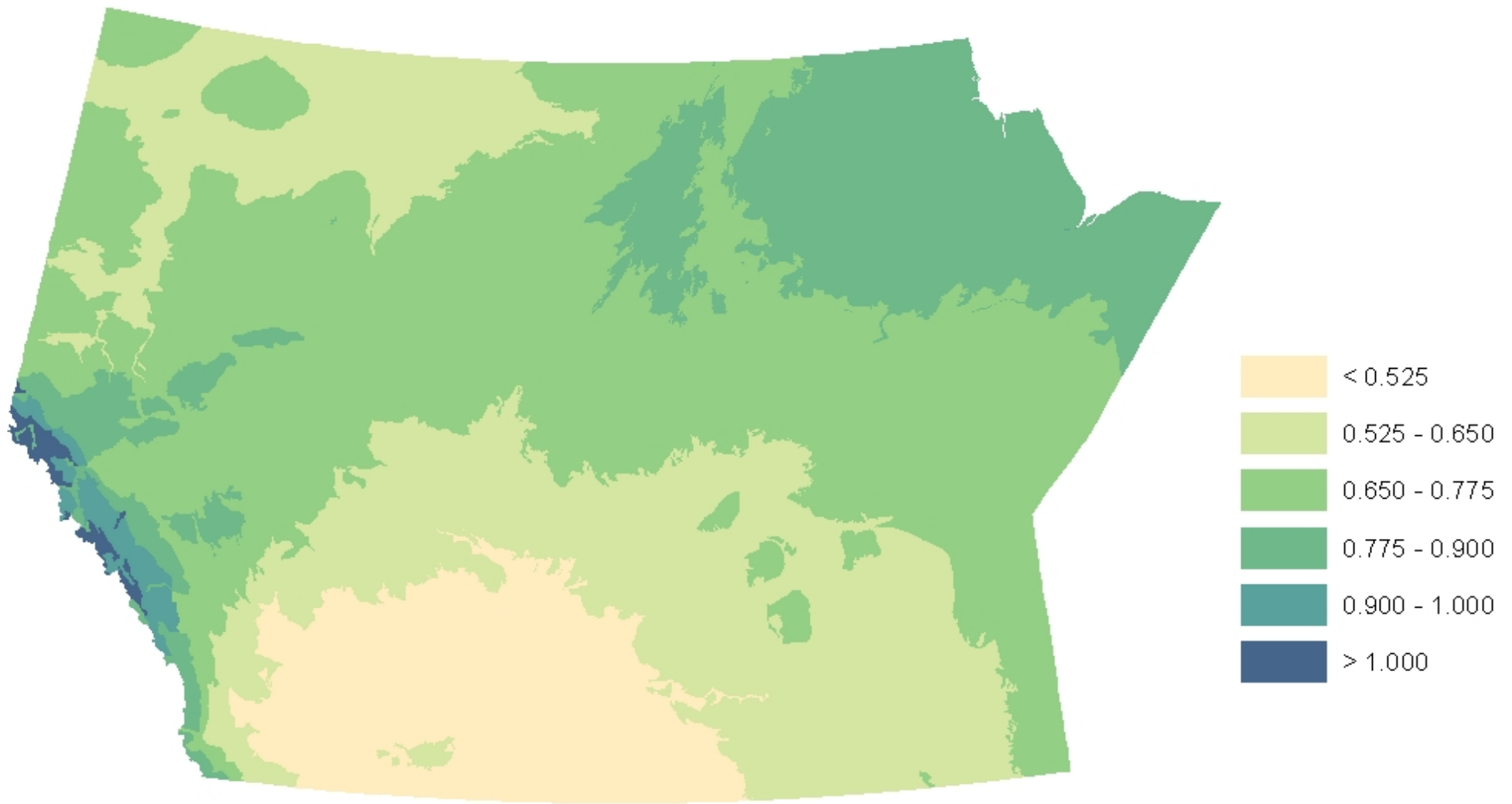
1961-1990



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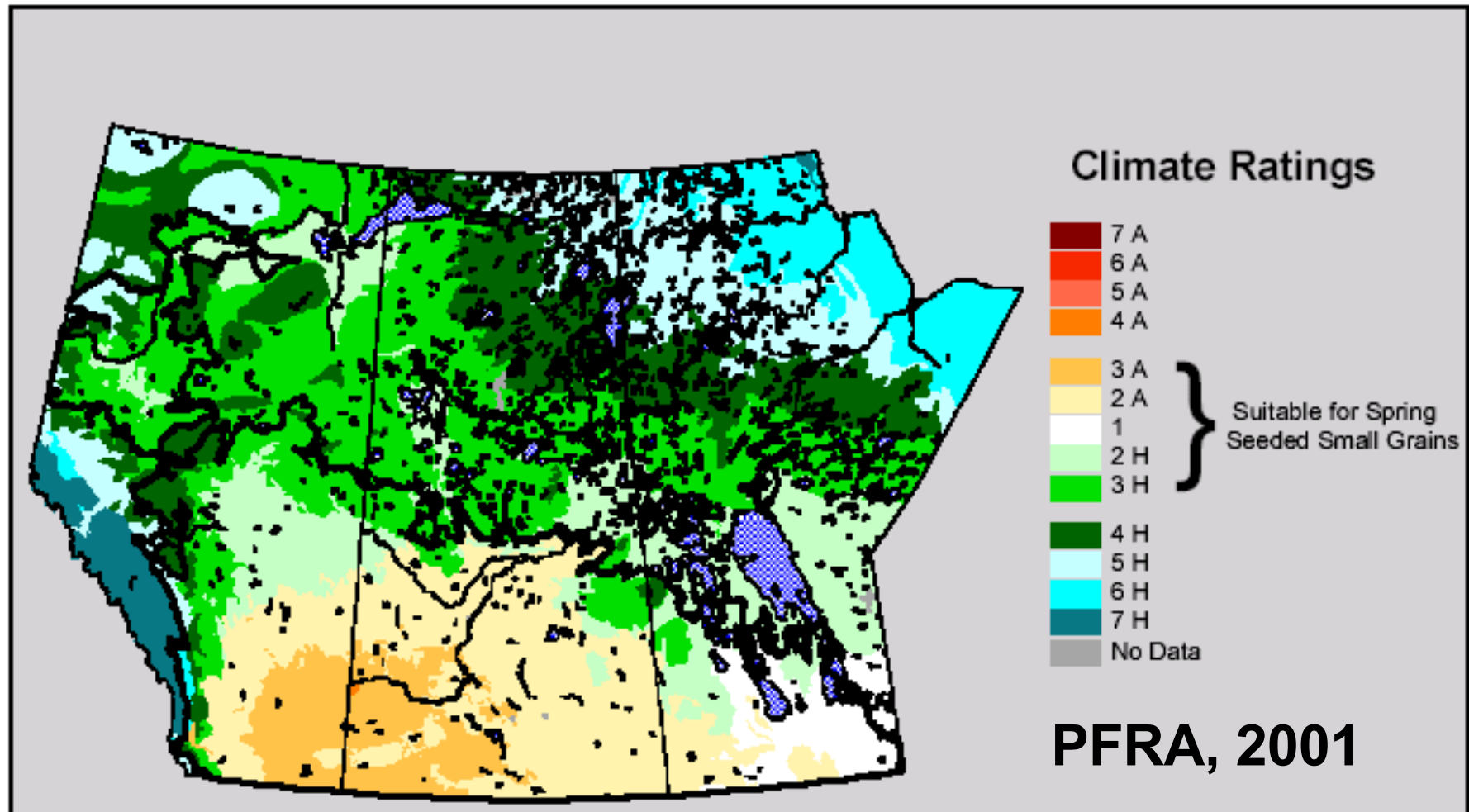
# Ratio of Precipitation to Potential Evapotranspiration for the Prairie Provinces

2040-2069

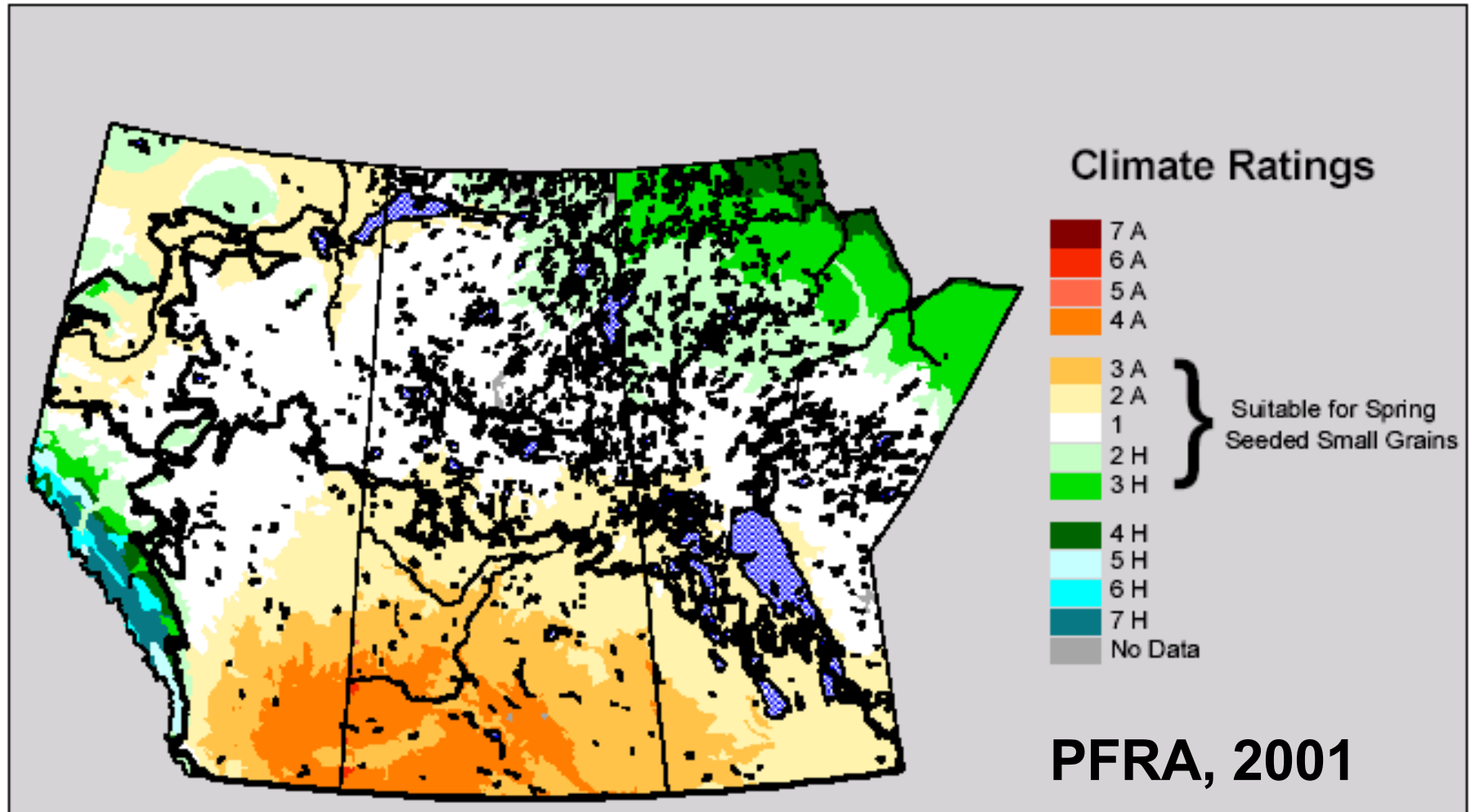


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# Land Suitability Rating System (LSRS) Climate Classification (1961-90)



# Land Suitability Rating System (LSRS) Climate Classification (2040-69)

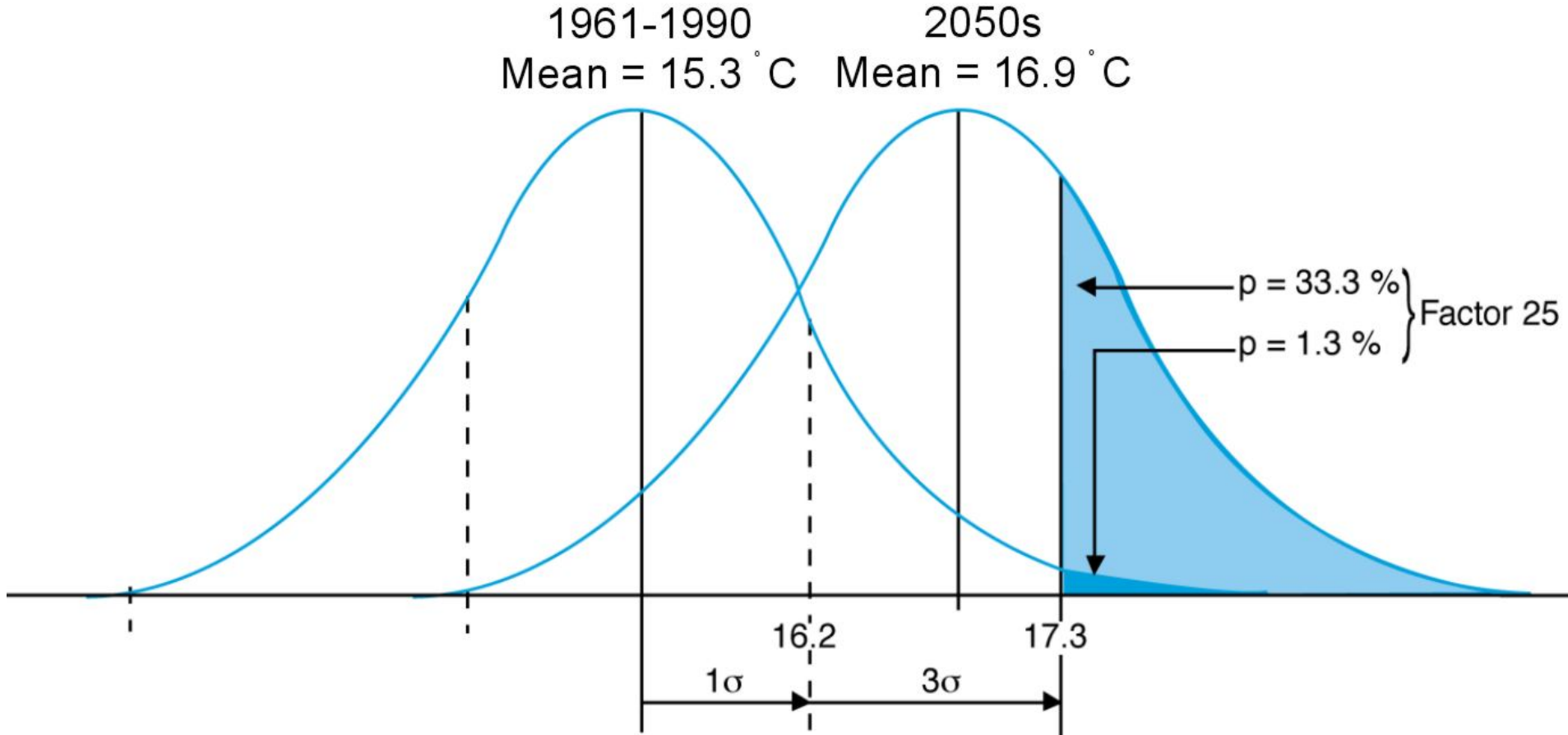




# Adaptation to Climatic Variability

A projected **increase in climate variability**, including more frequent drought and major hydroclimatic events, **is the most ominous climate change scenario**. It is a more formidable and complex challenge than the adaptation of practices, processes and infrastructure to long-term climate trends. More extreme **climate anomalies** are more likely to exceed natural and engineering thresholds beyond which the impacts of climate are much more severe.

# Climate change and extreme climatic events



# Extreme rainfalls in southern Saskatchewan

Buffalo Gap, May 30, 1961

- one-hour: 258 mm

Parkmanm, August 3-4, 1985

- six-hour: 267 mm
- 12-hour: 362 mm
- 24-hour: 381 mm

Vanguard, July 3, 2000

- eight-hour: 334-387 mm

Note: all data from bucket surveys

# Vanguard Storm, July 3, 2000

Duration: eight hours (1600-2400)

Bucket estimates of total rainfall:

- Near Vanguard: 334 mm
- In Vanguard: 343 mm
- North of Vanguard: 356 mm
- Four miles east of Vanguard: **387 mm**

Mean annual precipitation / rainfall (1961-90): 345 / **245 mm**

Previous one-day rainfall in the Vanguard area: 114 mm

Probable Maximum Precipitation for the Vanguard area for July 3 (Hopkinson, 1999): 24-hour: 569 mm, **6-hour: 404 mm**, 1-hour: 403 mm



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## Instantaneous Discharge ( $\text{m}^3/\text{s}$ ), Notukeu Creek near Vangaurd (05JB001)

April 26	0.504	
May 29	0.016	
July 4	162	
July 5	256	10 km downstream of gauge site
July 5	91.6	
July 6	90.3	
July 12	34.0	
July 19	3.82	

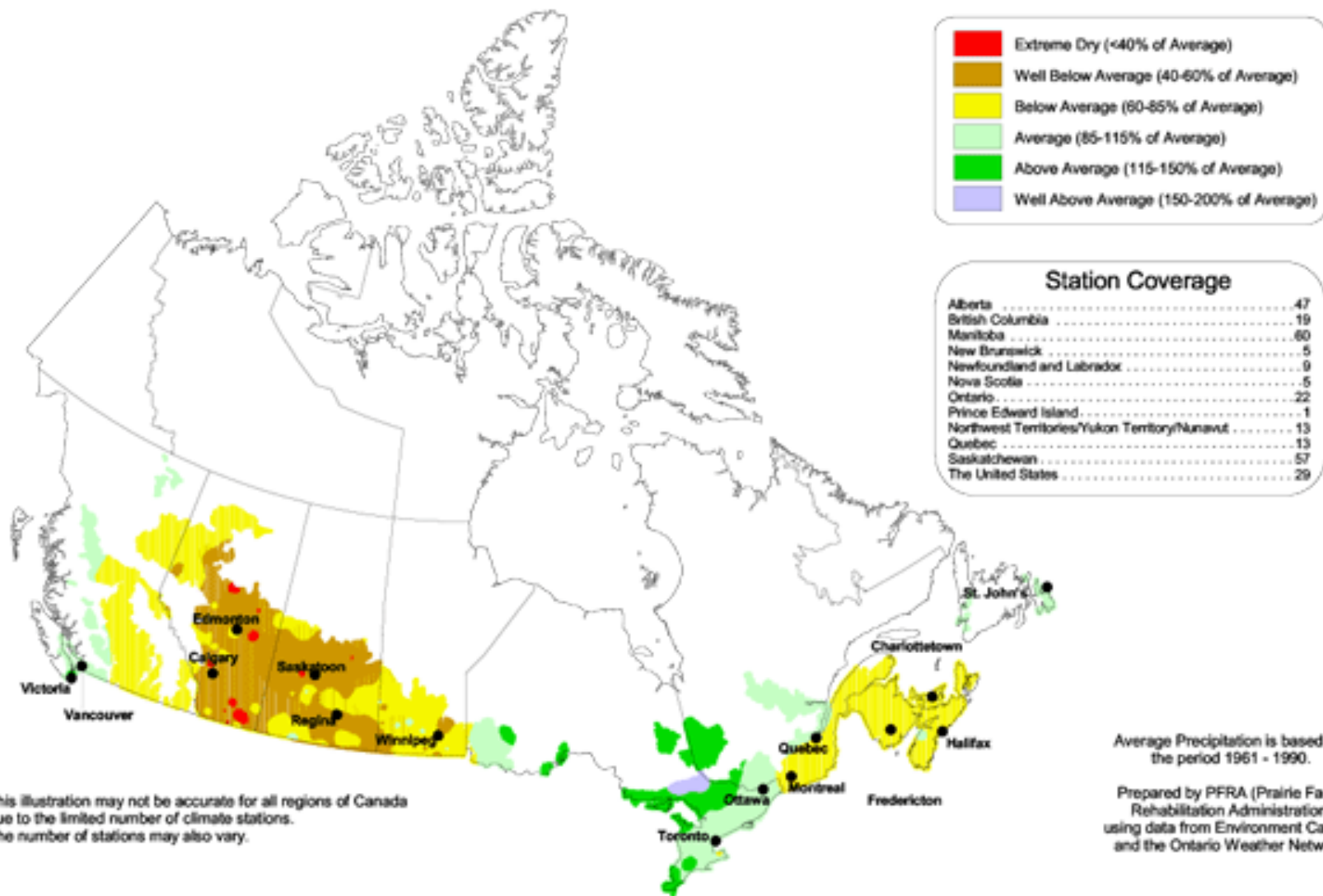
### Historical maximums (since 1915)

snowmelt peak flow: **227  $\text{m}^3/\text{s}$** , April 7, 1952

rainstorm flood peak flow: **74.5  $\text{m}^3/\text{s}$** , July 2, 1991

# Percent of Average Precipitation in Agricultural Areas

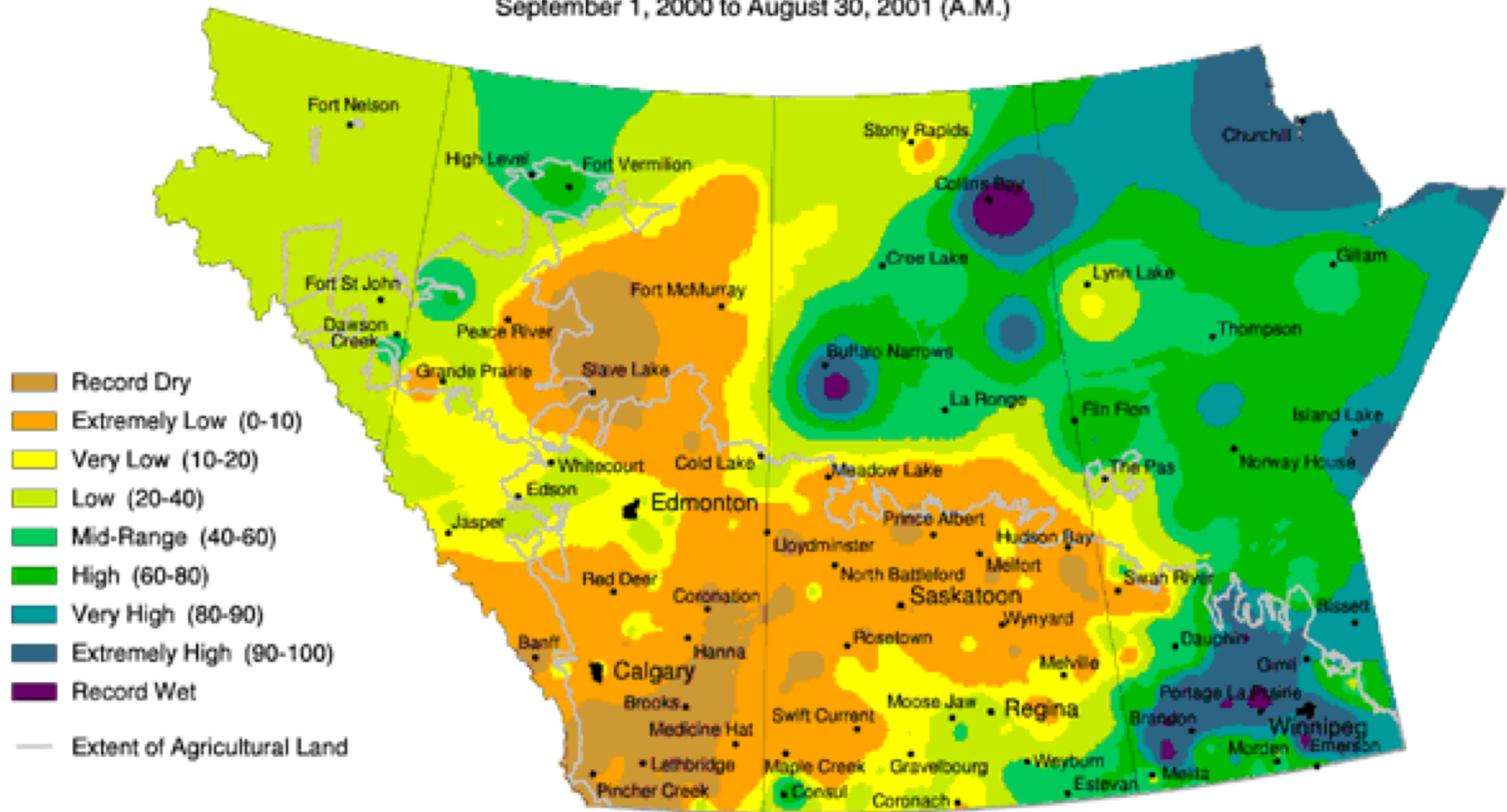
September 1, 2001 to March 12, 2002



<http://www.agr.gc.ca/pfra/drought.htm>

# Precipitation Percentiles

September 1, 2000 to August 30, 2001 (A.M.)

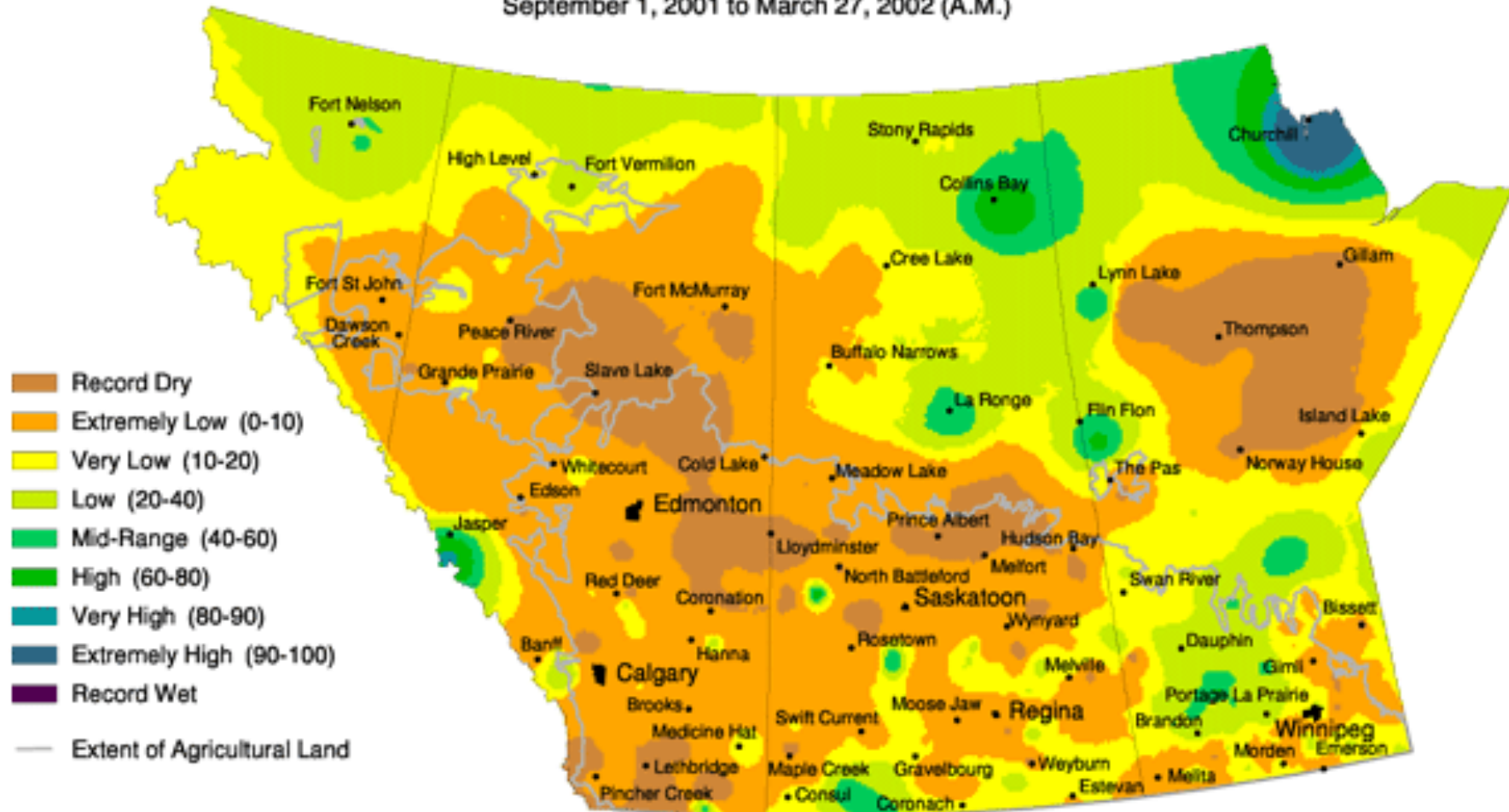


Prepared by PFRA (Prairie Farm Rehabilitation Administration) using data from the Timely Monitoring Network and the many federal and provincial agencies and volunteers that support it.

<http://www.agr.gc.ca/pfra/drought.htm>

# Precipitation Percentiles

September 1, 2001 to March 27, 2002 (A.M.)



Prepared by PFRA (Prairie Farm Rehabilitation Administration) using data from the Timely Monitoring Network and the many federal and provincial agencies and volunteers that support it.

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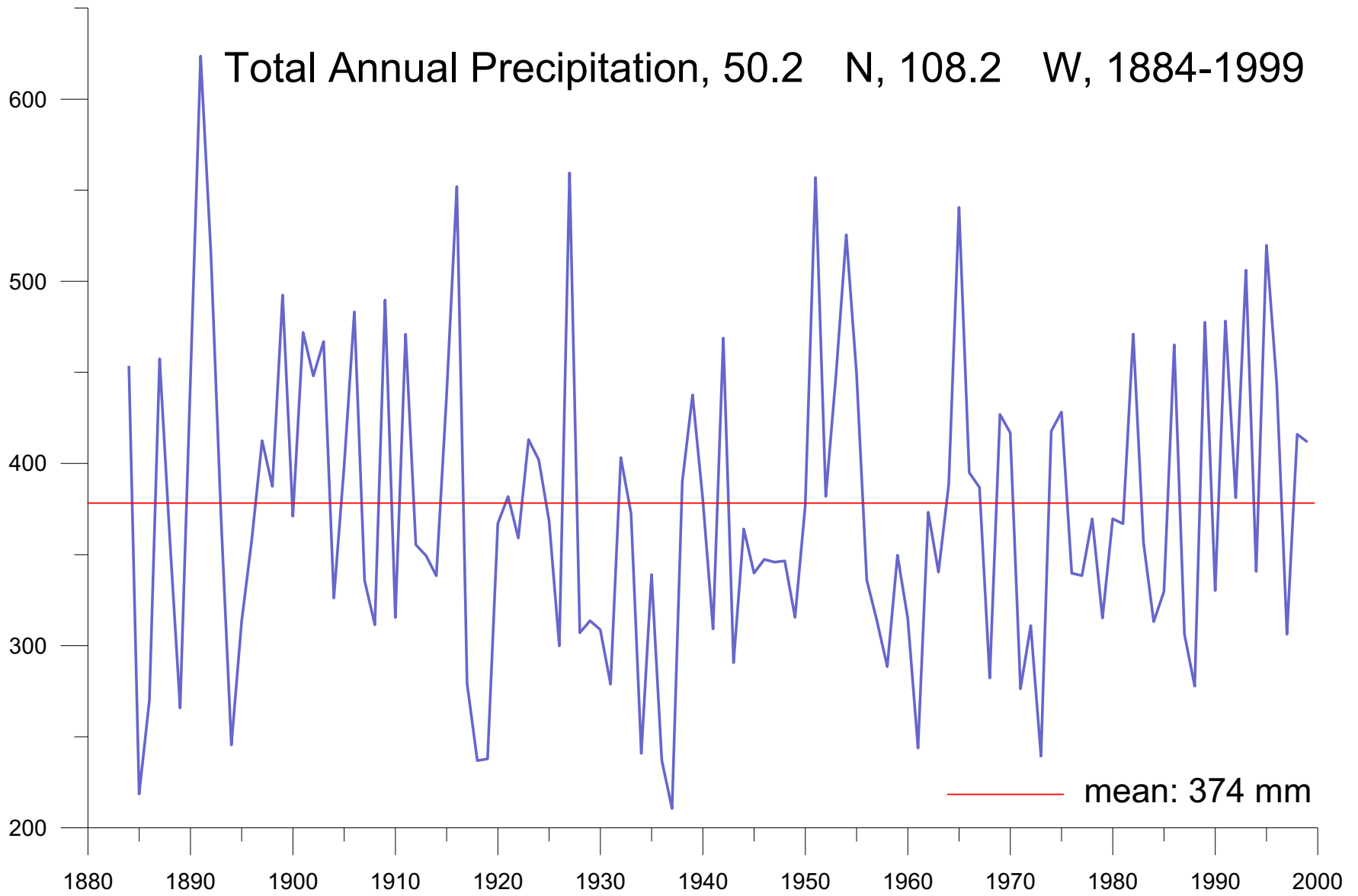
Near Seven Persons, Alberta, January 1, 2002

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Red Deer River, September 30, 2001

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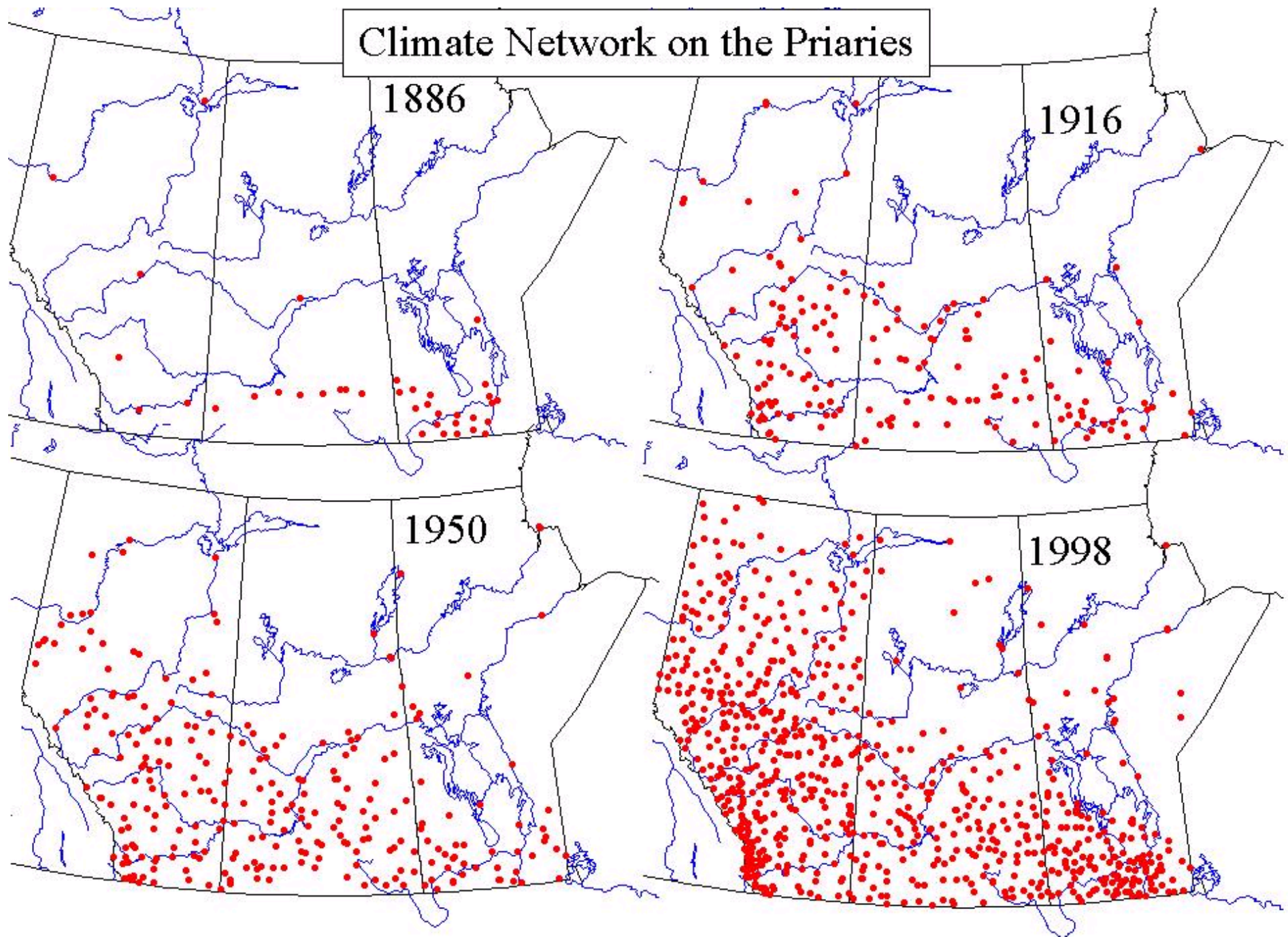


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## Historical Precipitation (mm) Medicine Hat, Alberta

1999	289	1928	194
2000	198	1929	207
2001	148	1930	324
	635		725
1987	272	1935	346
1988	227	1936	245
1989	337	1937	249
	836		840

# Climate Network on the Priaries



Ron Hopkinson, MSC



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# Battle Creek valley, West Block, Cypress Hills



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# Bears Paw Mountains, North-central Montana

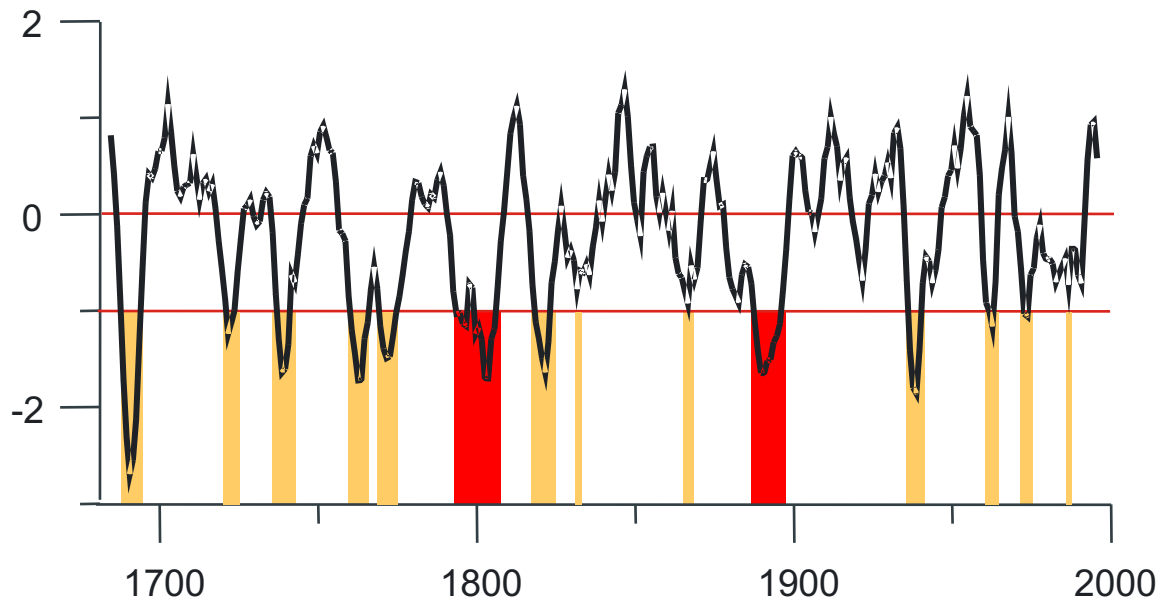


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# Reconstructed Regional July PDSI

(Sauchyn and Skinner, 2001)

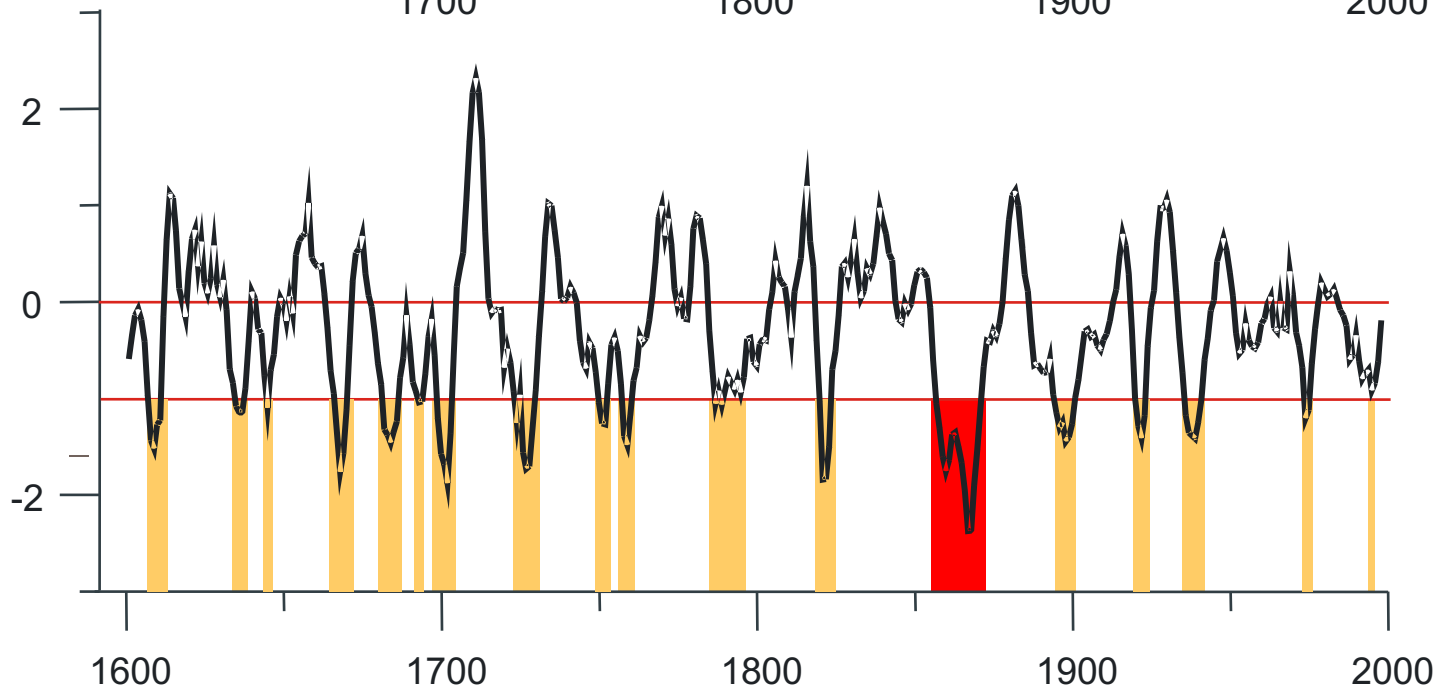
SW Sask.  
and  
SE Alberta



drought

decadal  
drought

North-central  
Montana



Sand dune formed in the 1790s, Great Sand Hills, SK



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*This large belt of country embraces districts, some of which are valuable for the purposes of the agriculturalist, while others **will for ever be comparatively useless**. ... The least valuable portion of the prairie country has an extent of about 80,000 square miles, and is that lying along the southern branch of the Saskatchewan, and southward from thence to the boundary line, ...*

CAPT<sup>N</sup>. JOHN PALLISER,  
London, July 8, **1860**

Historians have often wondered why the **growth of the Northwest between 1887 and 1896 languished** so. ... the king of explanations for the stunted growth was that of farming, limited as it was, was a failure. ... with the nemesis, **drought**, loose on the land summer upon summer. ... The government knew of the desert; why did it stand by silently, sending sacrifices to the wilderness.

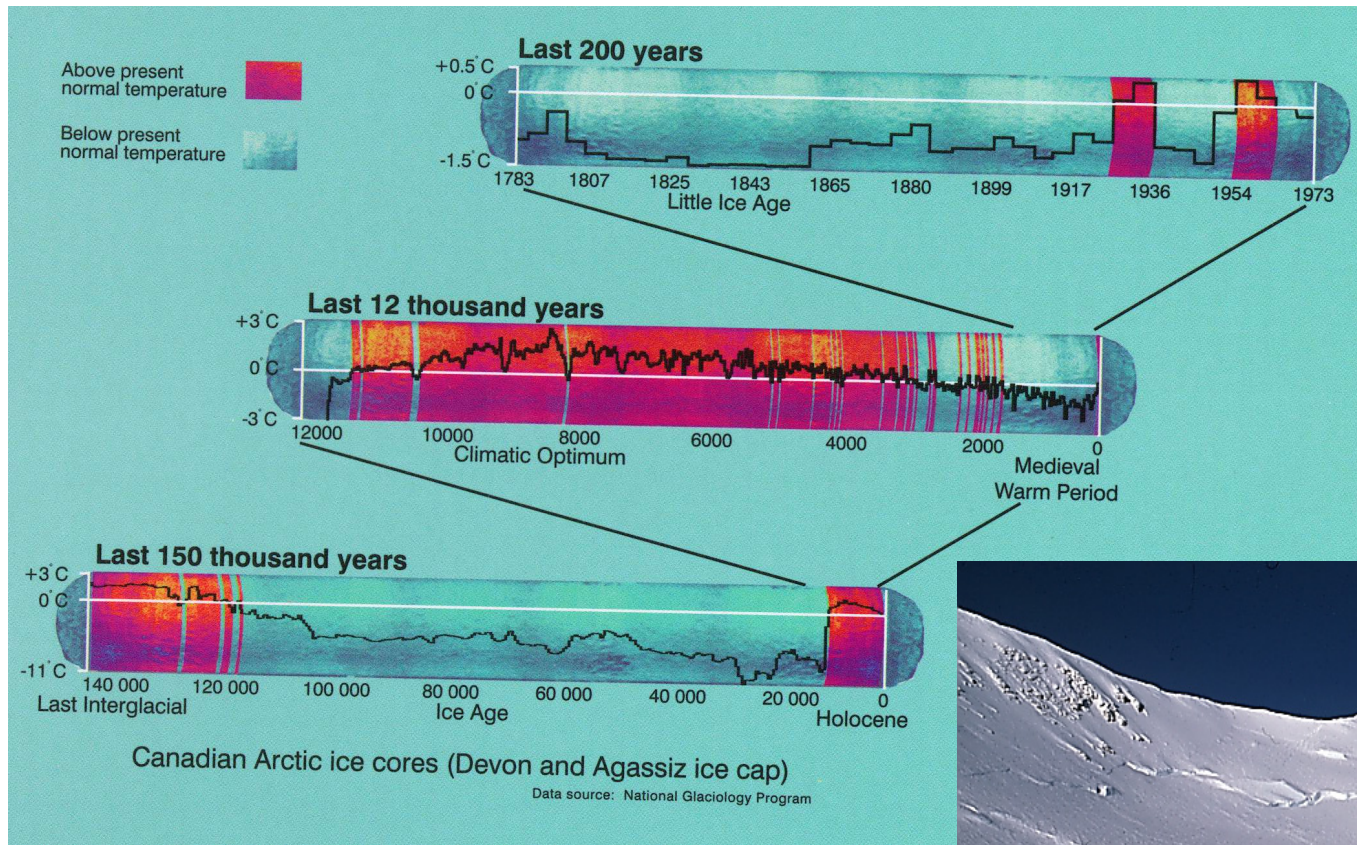
David C. Jones (1987: 16-17), *Empire of Dust*

It would be **almost criminal to bring settlers here** to try to make a living out of straight farming.

The Medicine Hat Times, February 5, 1891

*Our True Immigration Policy*

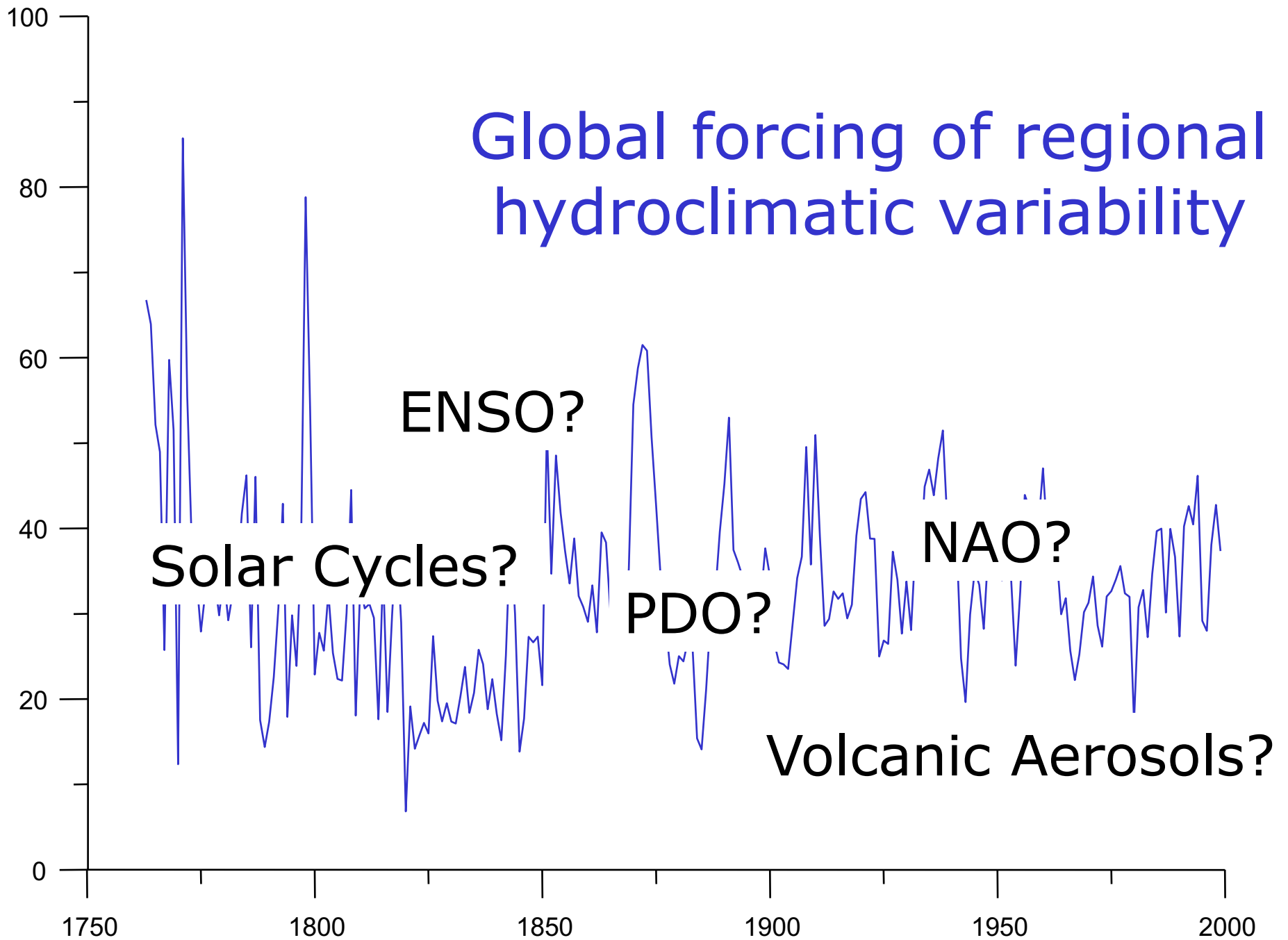
# Climate is Always Changing



From GSC Misc. Report 71 (2001)

Ice cores, tree rings,  
lakes and oceans sediments:  
**windows on the past**

# Global forcing of regional hydroclimatic variability





North American Drought Reconstruction Project  
Lamont Doherty Earth Observatory, Columbia University





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