Tree-ring reconstructions in southwestern Alberta

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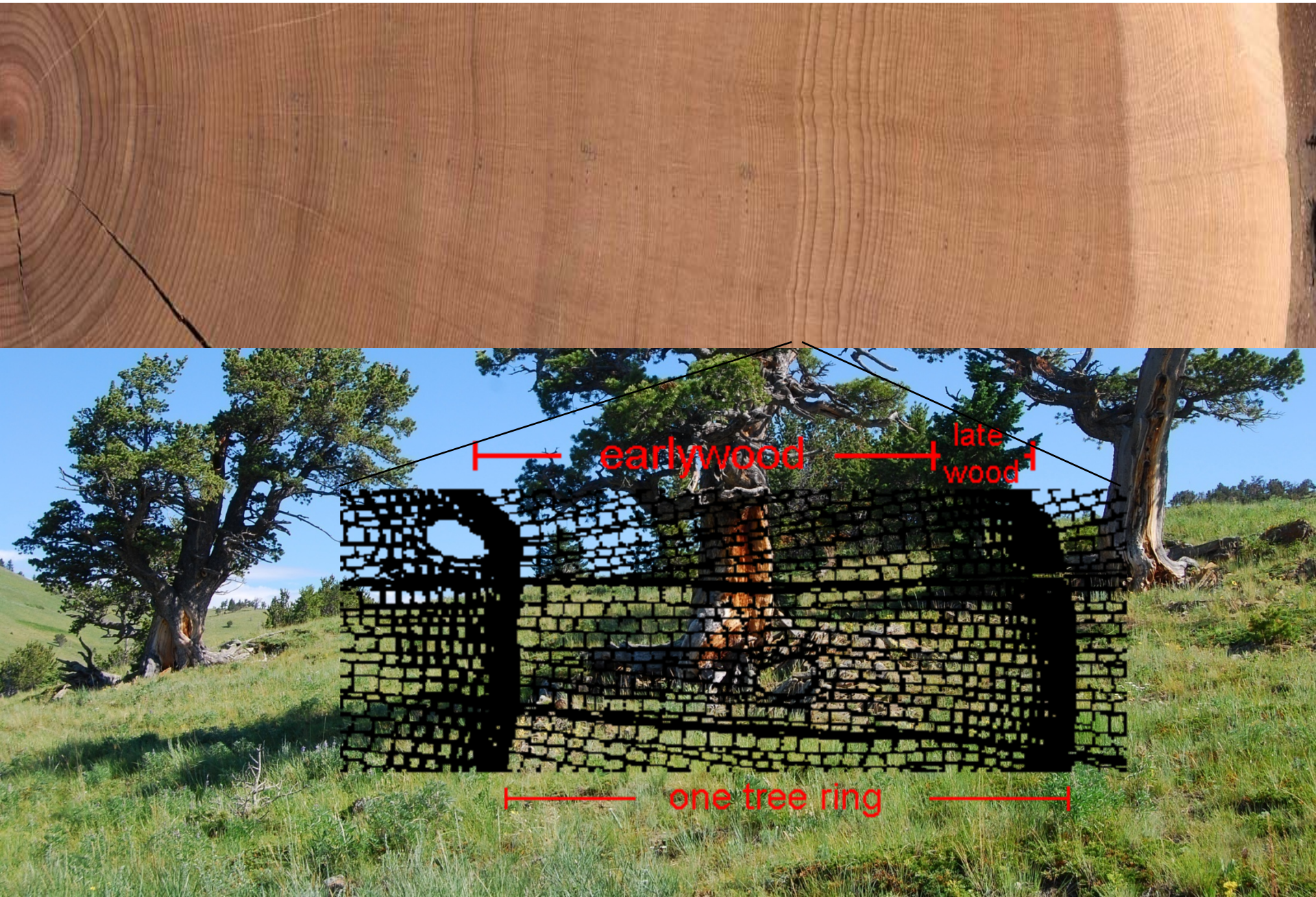
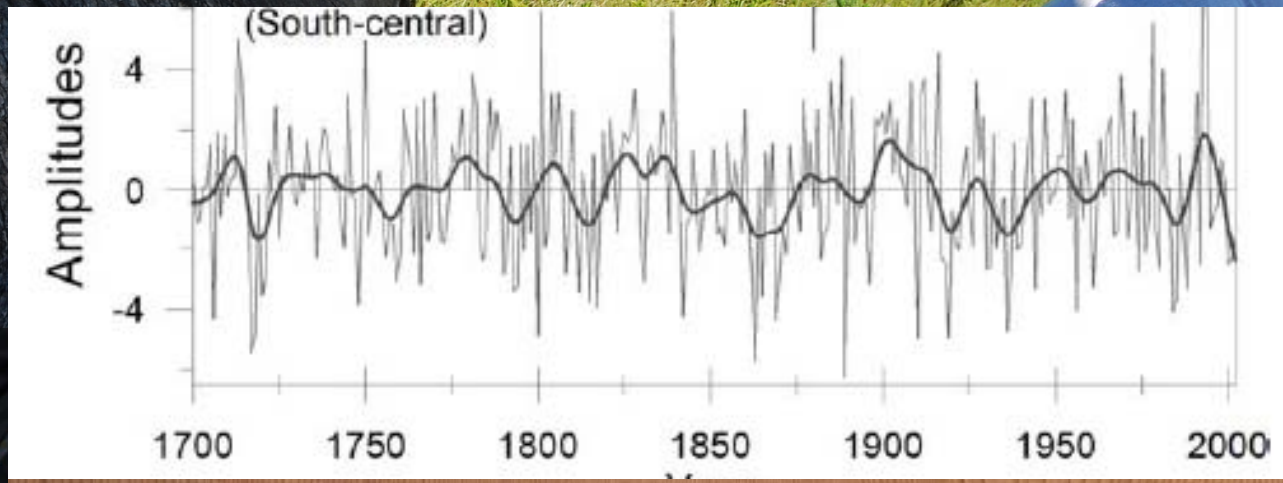
5th Annual Waterton-Glacier Science & History Day
Waterton Lakes National Park
July 22, 2008

Tree-rings



Sampling


(South-central)
Amplitudes
4
0
-4
1700
1750
1800
1850
1900
1950
2000

Why study in the Cordillera?

Mountains as “Water Towers” for adjacent lowlands

Headwaters of major rivers

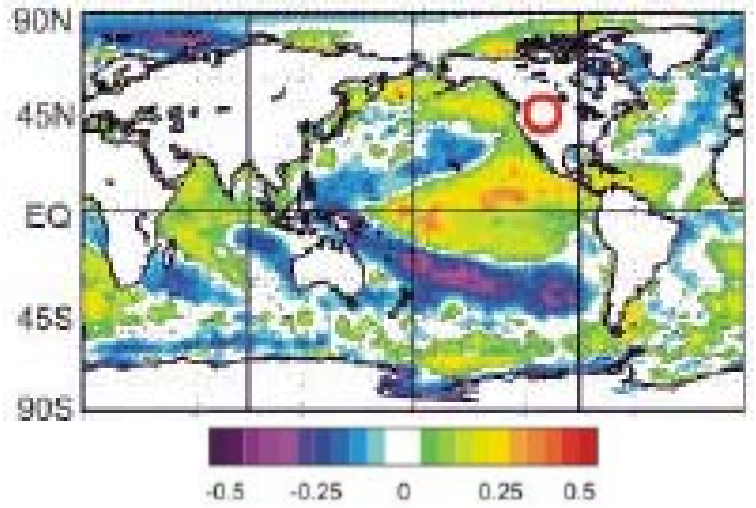
Snow cover is the critical source for summer streamflow

Why Tree-rings?

Annually resolved records
Diversity of species
Trees are long lived
2-300 years are common
exceptionally much longer series found

DOMINANT WEATHER COMES FROM THE WEST

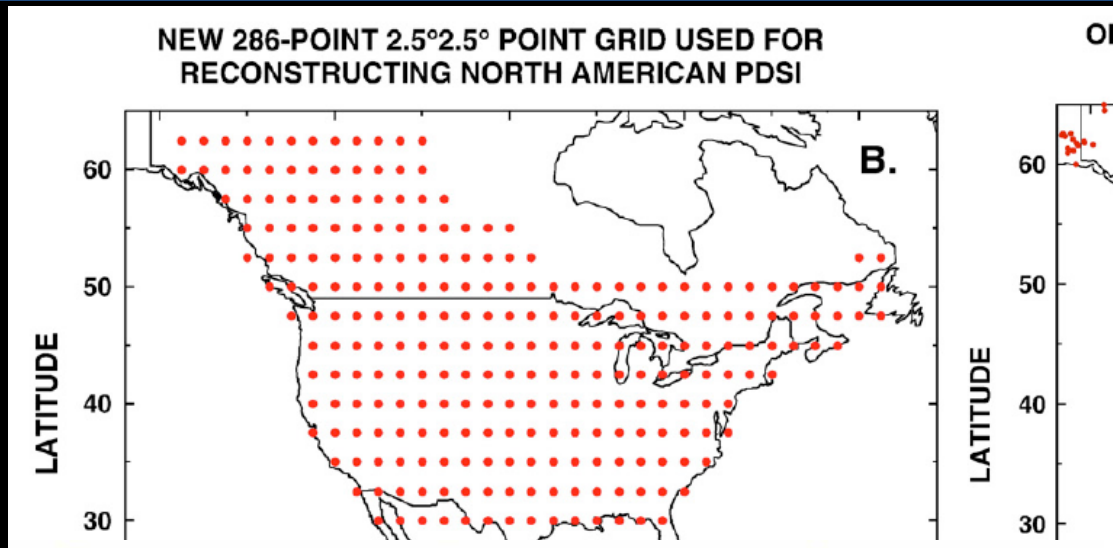
Dominated by atmospheric circulation from Pacific

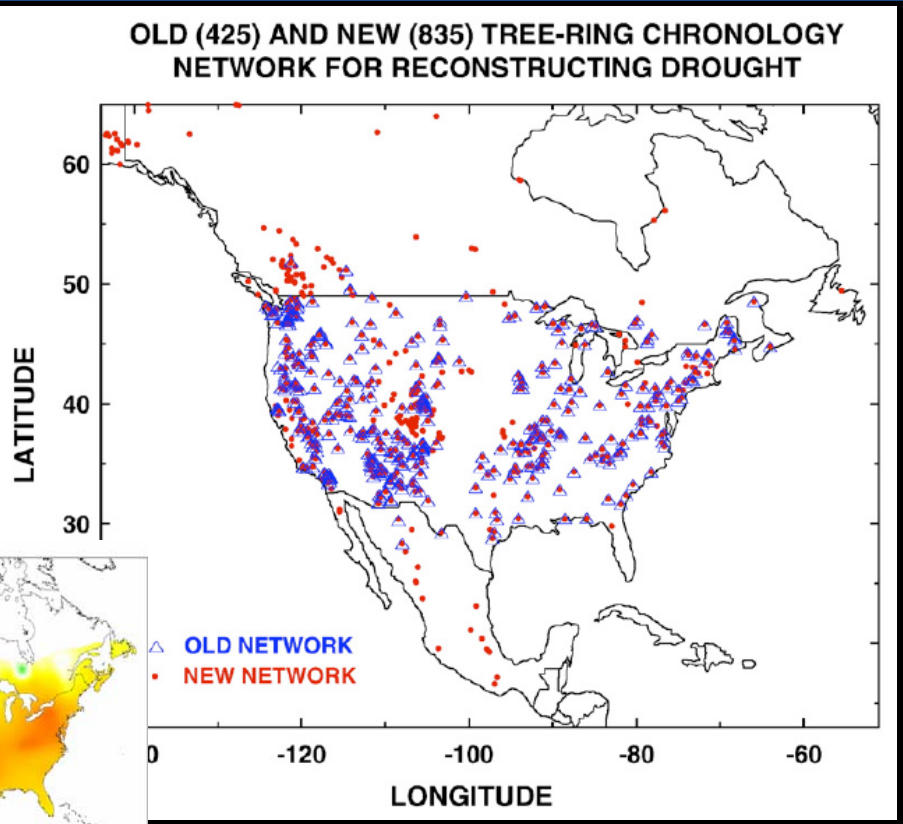


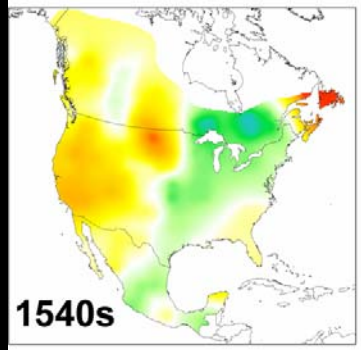
Correlation ring-widths of Douglas fir in southwestern AB with spring Pacific Sea Surface temperatures

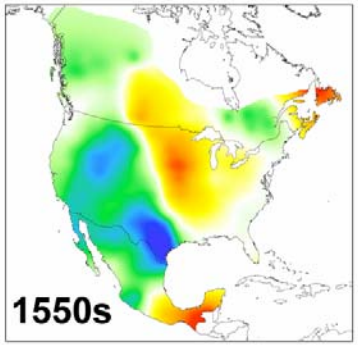
Adapted from Luckman 2008

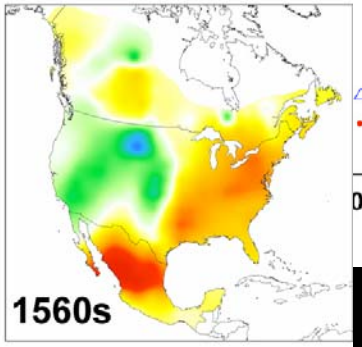
North American Drought Atlas (PDSI Grids) and Tree-Ring Networks (Cook et al, 2006)

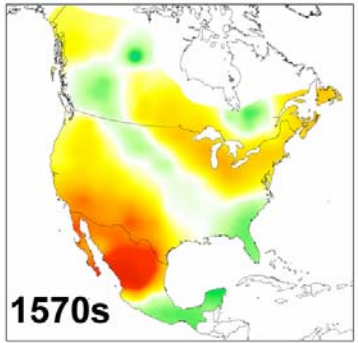


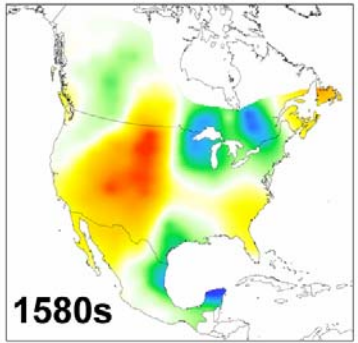






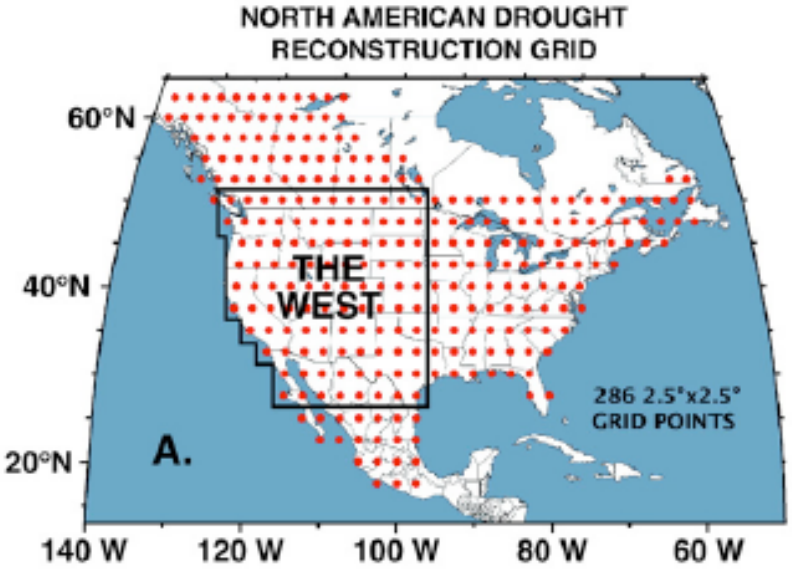


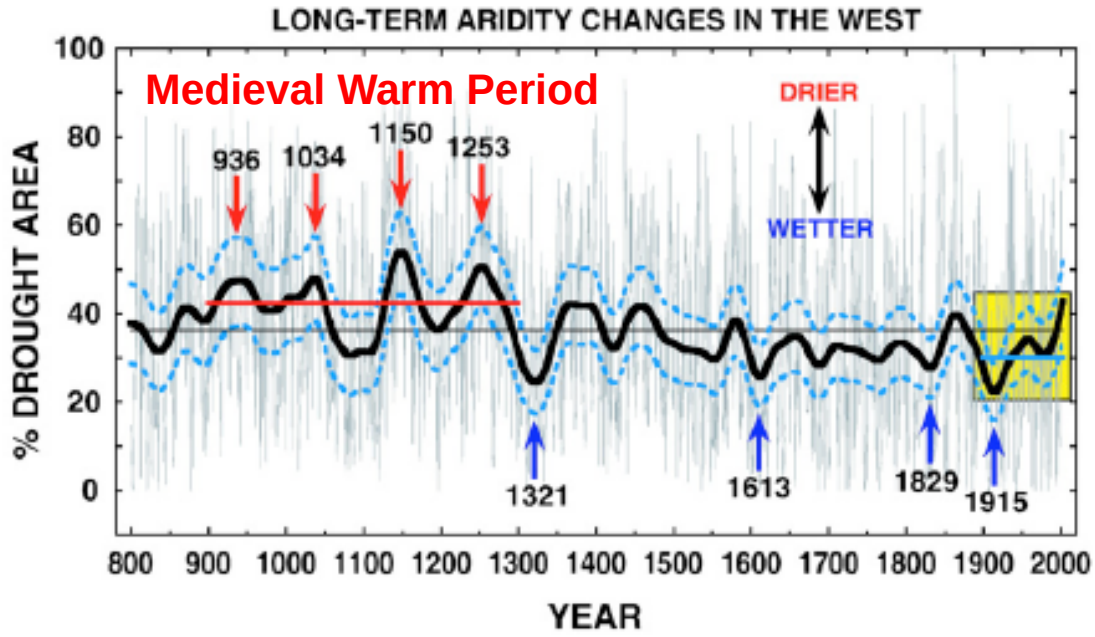




Mid 16th century "Megadrought"

The big picture – long-term context for aridity changes

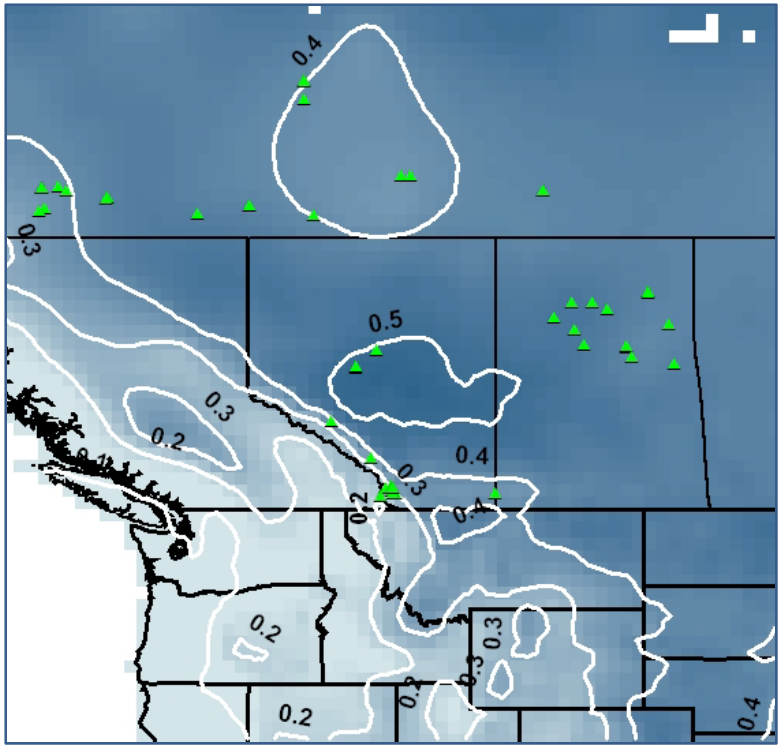


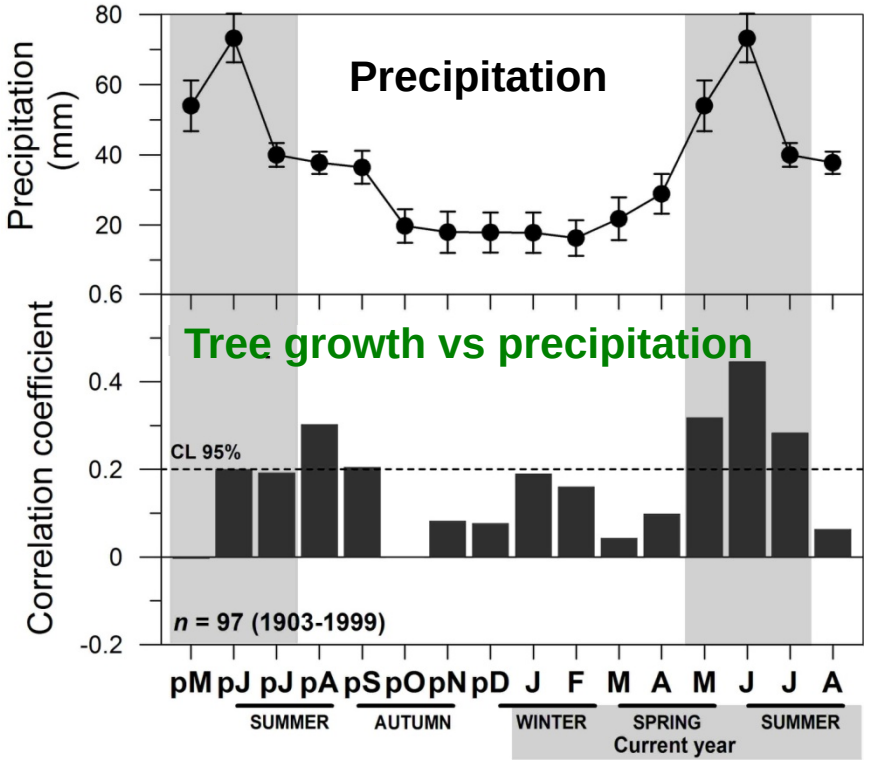


Cook et al. 2007

Now SW Alberta – precipitation seasonality and tree response

Ratio: Summer/Annual Precipitation

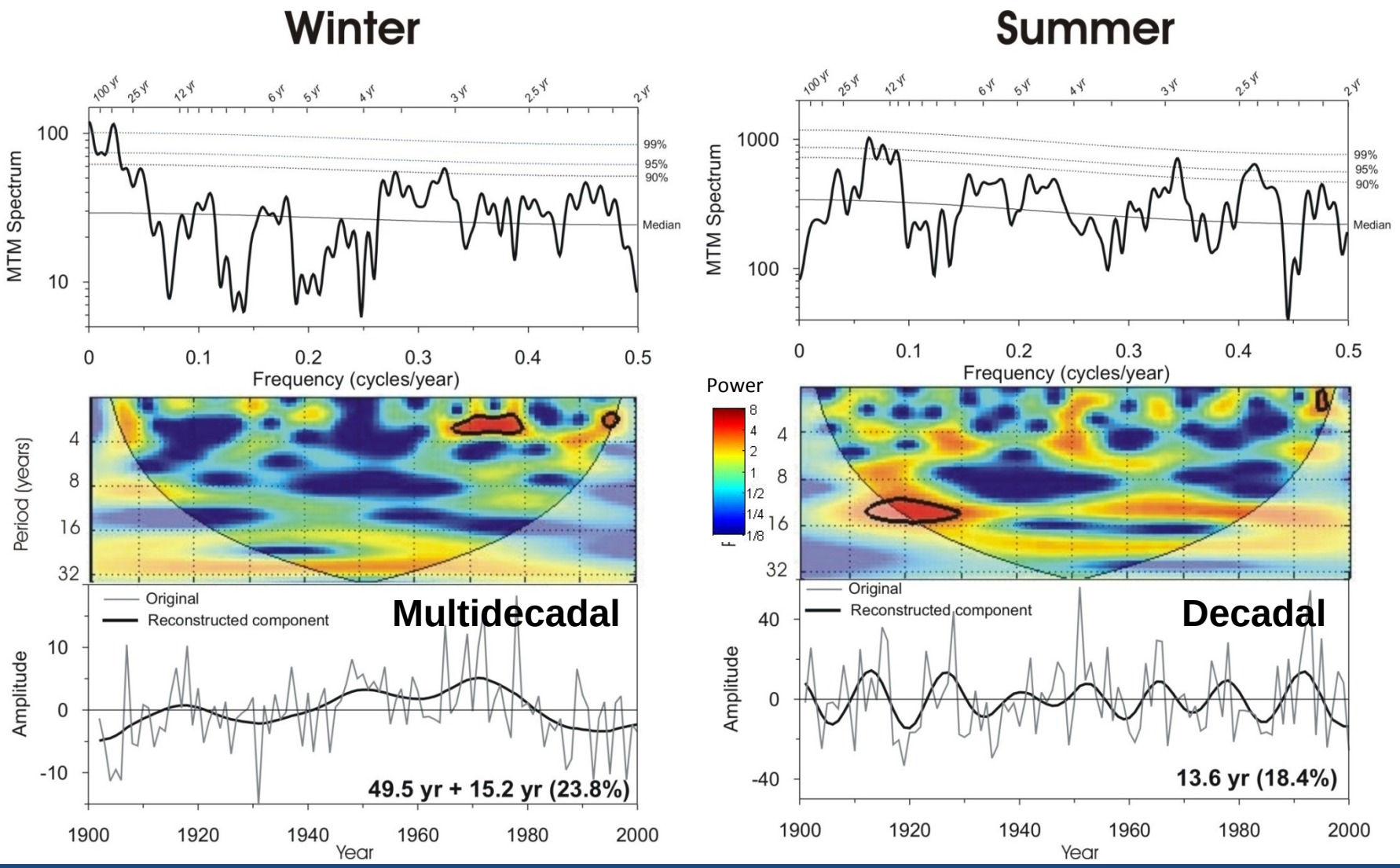




Summer precipitation > 30% annual

Tree growth responds to previous and current SUMMER precipitation

Different signals in winter and summer observed precipitation



Different behaviour reflects seasonally varying circulation controls

SW Alberta reconstructions- Precipitation and drought

Emma Watson and Brian Luckman
University of Western Ontario (UWO)

David Sauchyn et al.
PARC, University of Regina

SW Alberta reconstructions- Tree-ring network

Importance of a paleo perspective

Droughts on the Canadian Prairies reconstructed using tree-rings

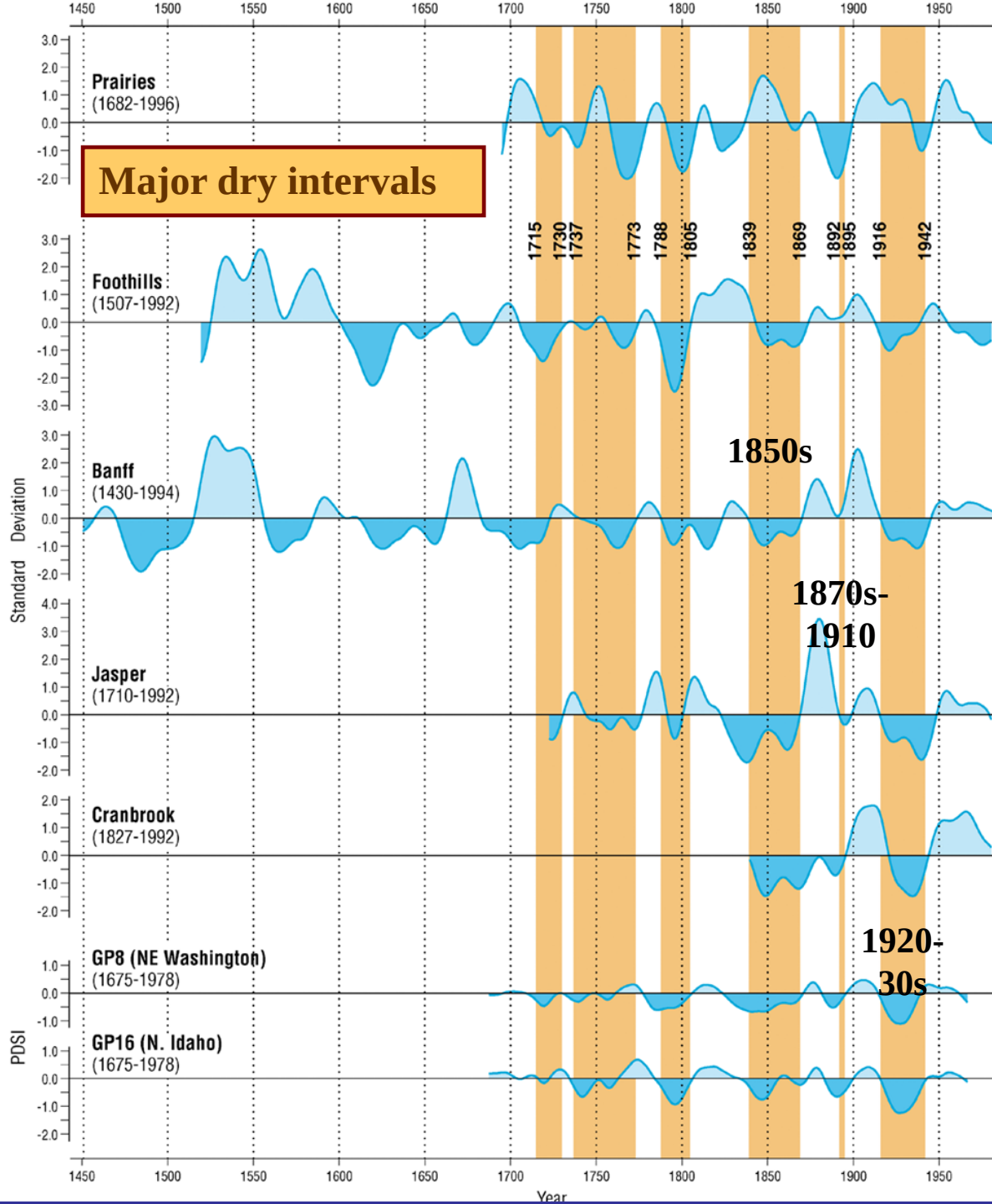
Palliser Expedition 1857-60 reported unfavourable drought conditions

Macoun Expedition 1876 reported area suitable for settlement

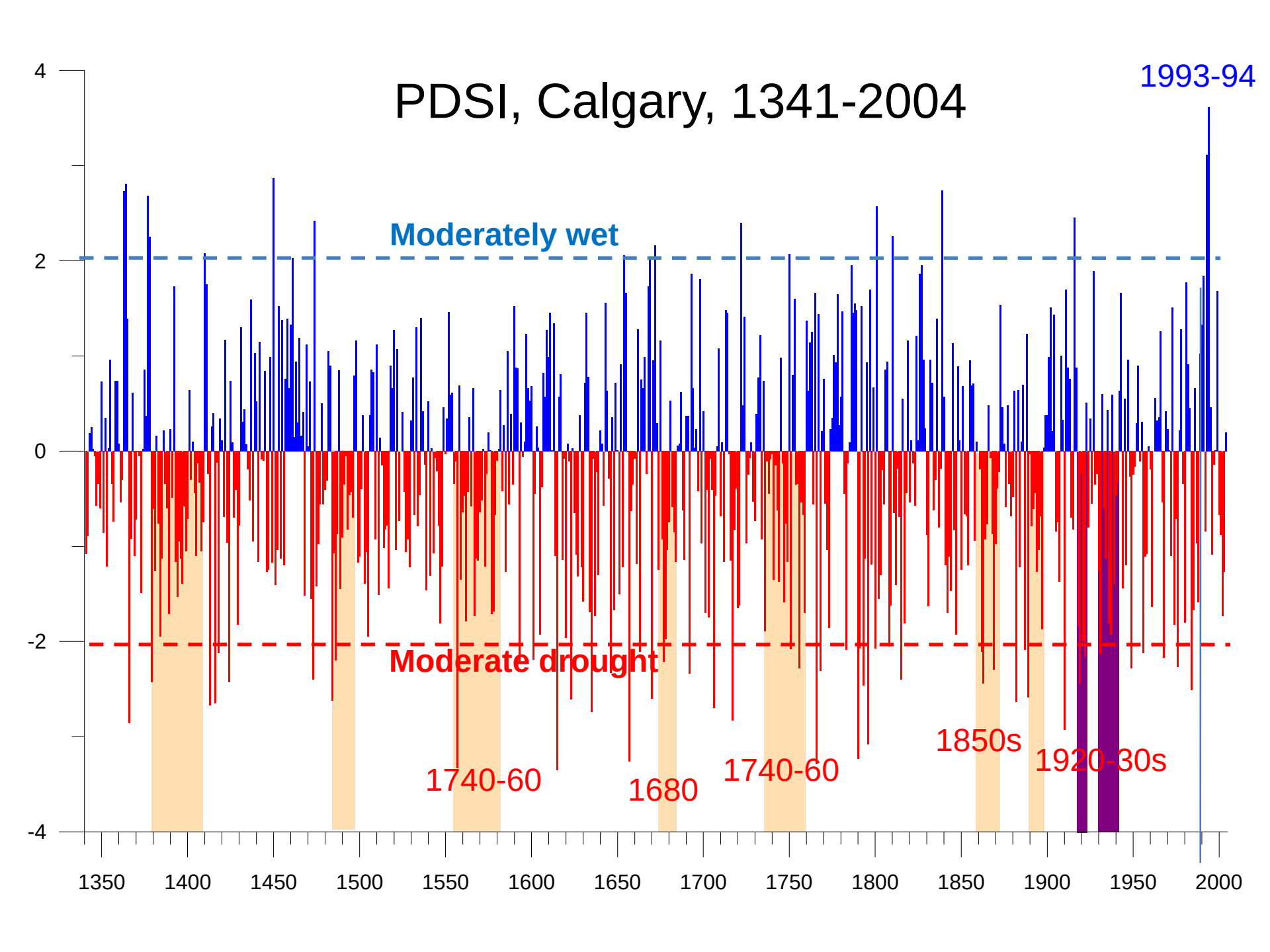
Main colonization ca. 1890-1920

Dustbowl 1920s and 1930s
(Watson and Luckman 2001)

Importance of networks



from Luckman 2007


PDSI, Calgary, 1341-2004
1993-94
Moderately wet
Moderate drought
1740-60
1680
1740-60
1850s
1920-30s
4
2
0
-2
-4
1350
1400
1450
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000

SW Alberta reconstructions- streamflow

Emma Watson and Brian Luckman
University of Western Ontario (UWO)

David Sauchyn et al.
PARC, University of Regina

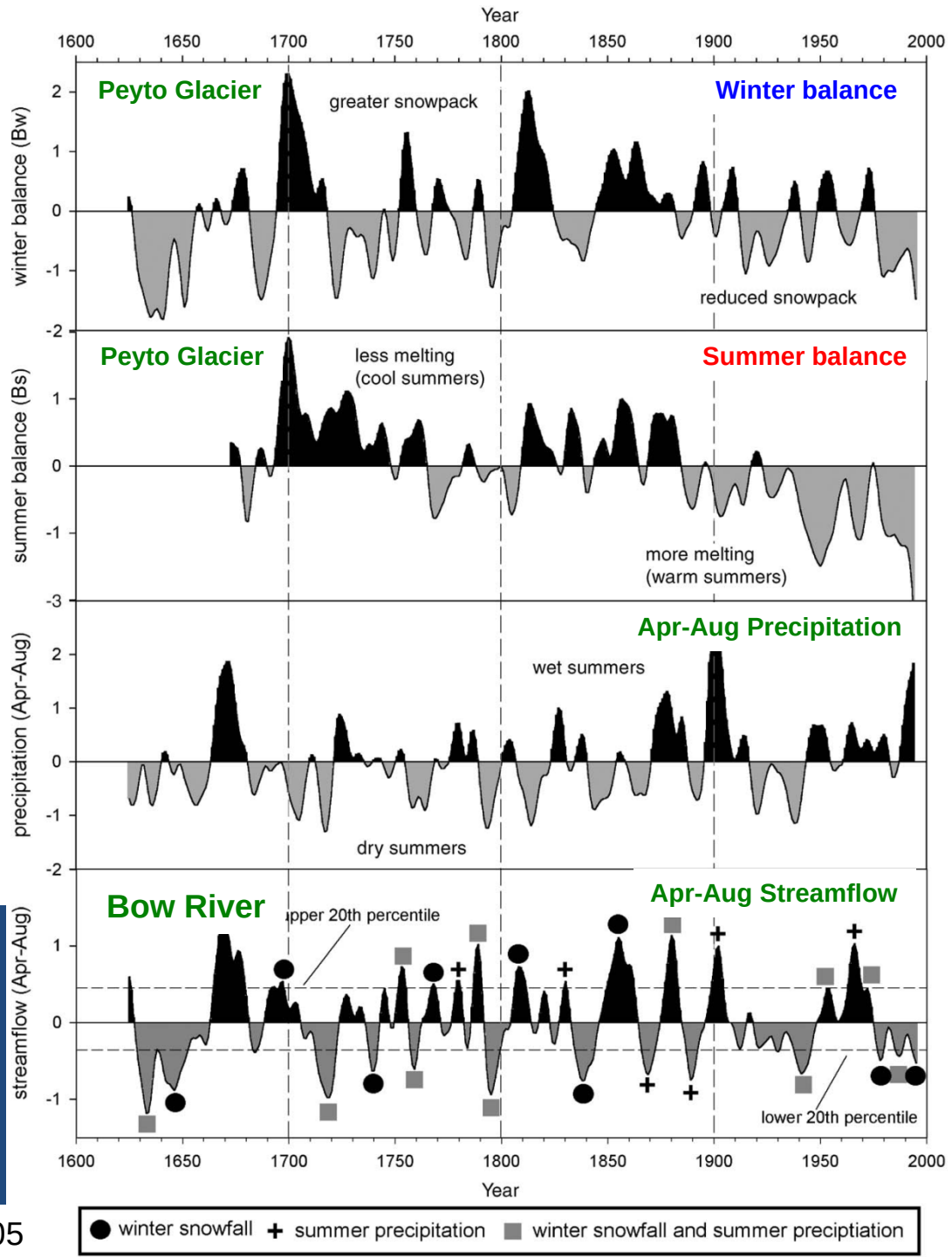
Bow River at Banff

Contributors to streamflow

- **Winter precipitation**
- **Glacier melt**
- **Summer precipitation**

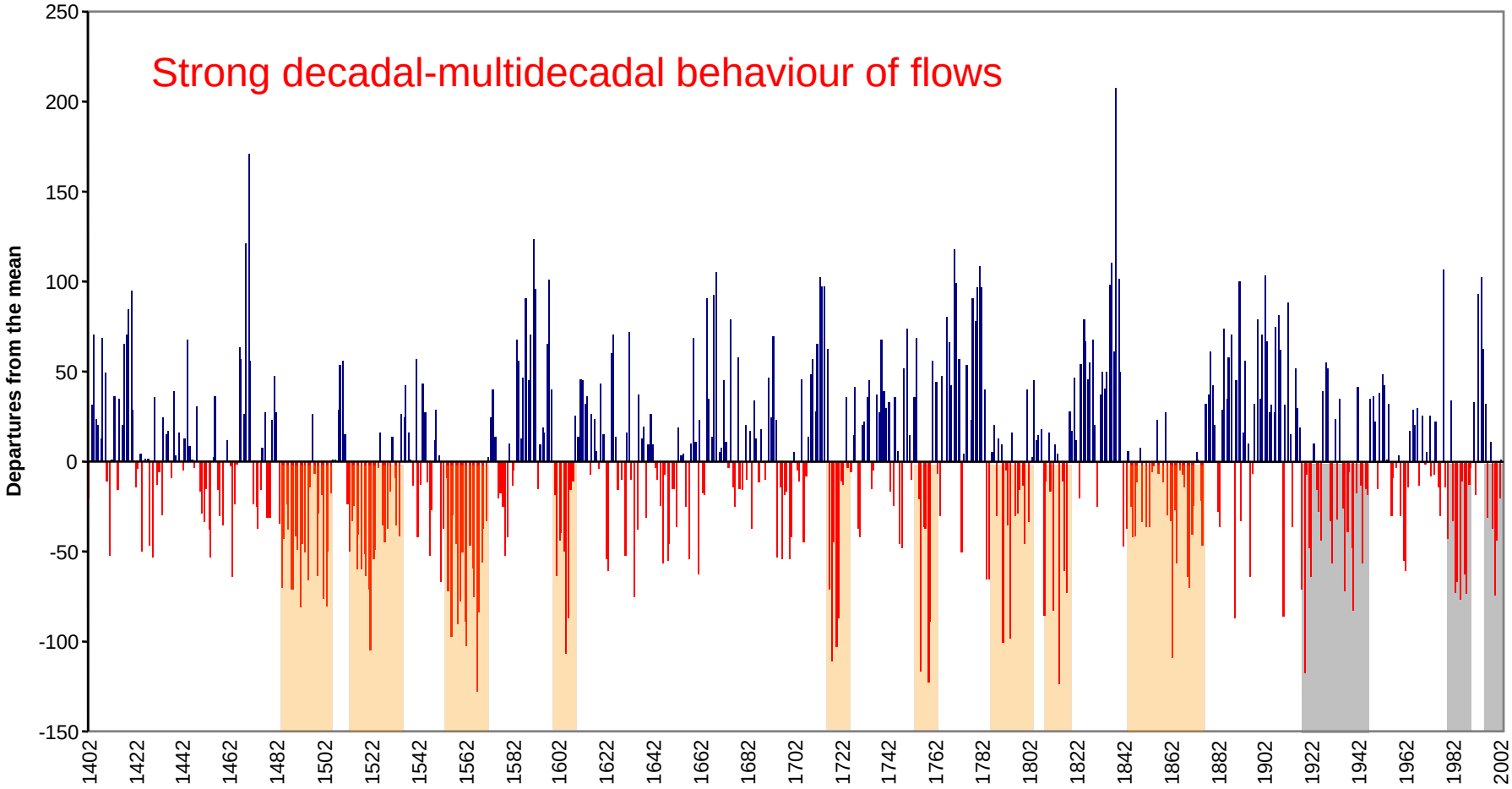
IMPORTANT
Streamflow recons require both summer and winter sensitive proxies

Pronounced departures in **spring-summer streamflow** can be the result of increased/decreased winter snowfall, summer precipitation or both



Watson and Luckman 2005

South Saskatchewan River at Medicine Hat, 1402-2004



Axelson 2007, MSc. Dissertation

Remarks

- High quality hydroclimatic reconstructions can be developed in SW Alberta using tree-ring networks

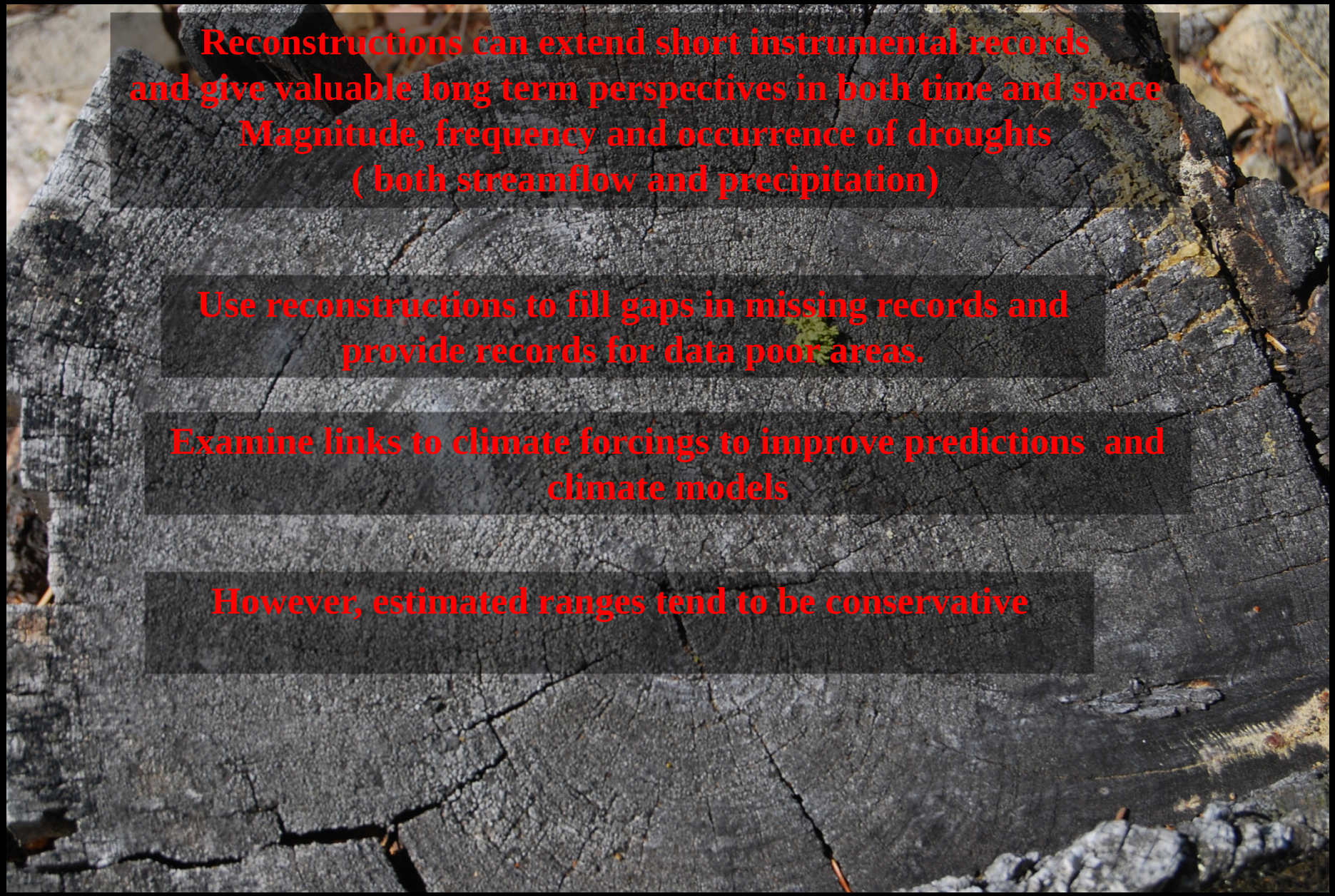
- The drought history of the region is well-known for the last 4-5 centuries and there is potential to extend it back to the Medieval Warm Period (800-1200) by using relict wood (e.g., Limber pine)

- Problems developing physically realistic flow reconstructions for snowmelt dominated rivers from summer sensitive tree-ring chronologies – need of winter proxies in the tree-ring networks

- Strong decadal-multidecadal variability in the reconstructions

- Complex relationships between hydroclimate and large-scale Pacific and Atlantic climate drivers – low frequency modulation and interaction between forcings

Potential uses of tree ring data



from Luckman 2007

Thank you for your attention