Tree-Ring Based Reconstructions of Hydroclimate in Northern Utah

WaDR Team

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Presentation to the Great Salt Lake Tech Team, DNR Building, SLC, August 18, 2015

UtahState University
PLANTS, SOILS & CLIMATE

WAsatch Dendroclimatology Research (WADR) Group

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BRIGHAM YOUNG UNIVERSITY FOUNDED BYU 1875 PROVO, UTAH

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Rocky Mountain Research Station

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

Eric Allen

STATE

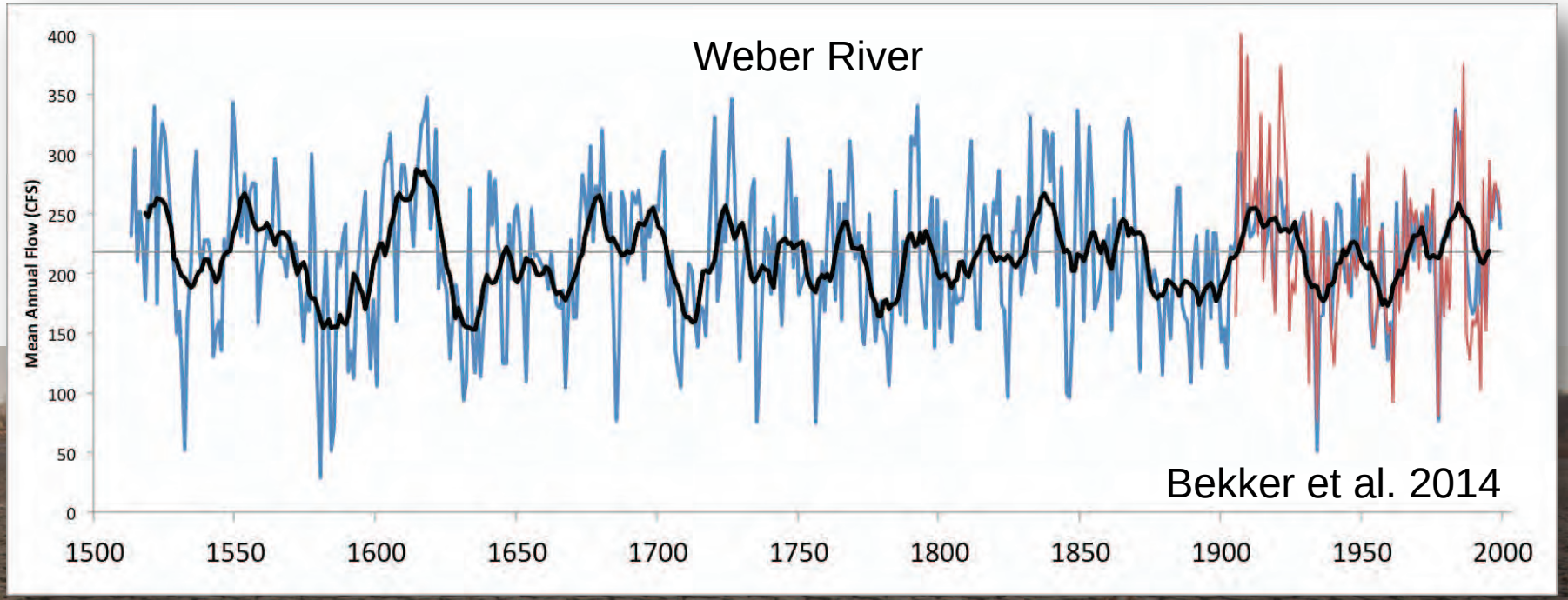
Tim Bardsley

Western Water Assessment

University of Colorado Boulder

CIRES
Cooperative Institute for Research in Environmental Sciences

Tree rings = a longer view of past (natural) hydroclimatic variability



http://www2.ucar.edu/

Dendrochronology

Across much of the western US, annual growth is limited by moisture availability

So:

– a dry year leads to a *narrow* growth ring

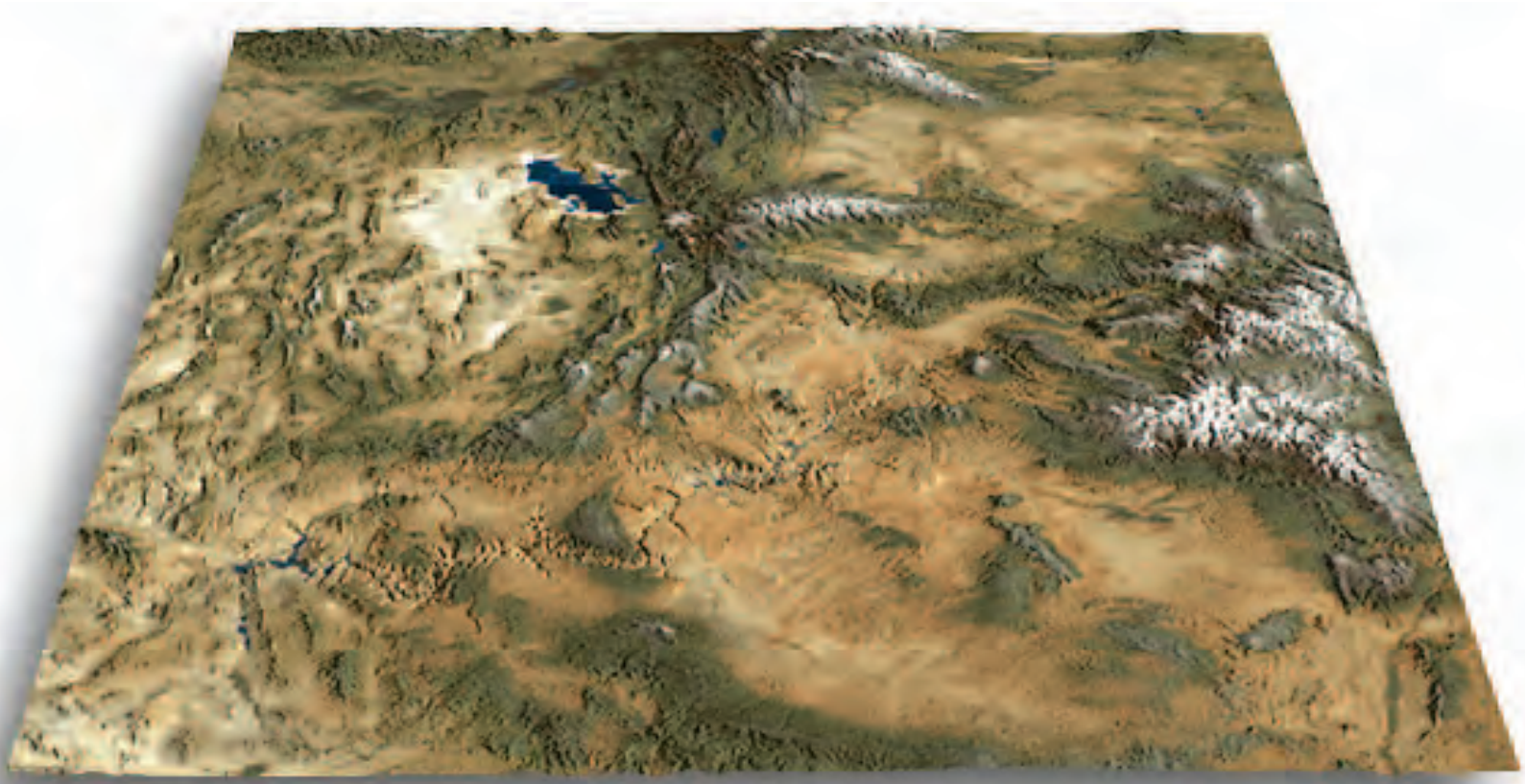
– a wet year leads to a *wide* growth ring

Choice of site where trees will be sensitive to moisture

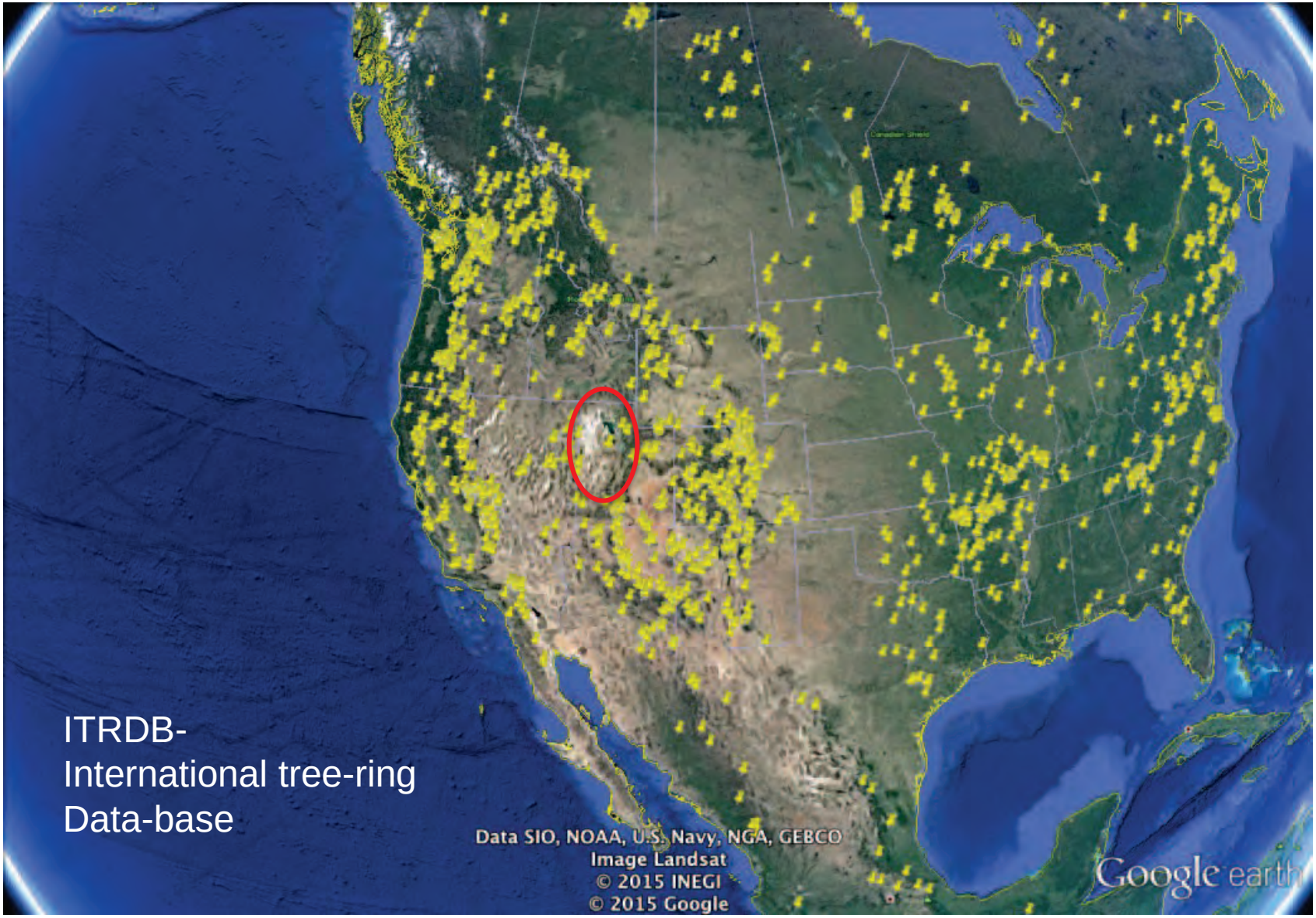
On low-elevation, steep, rocky, south-facing slopes, growth is typically limited by *moisture* availability (snowpack, rainfall, evaporation)

WaDR Results

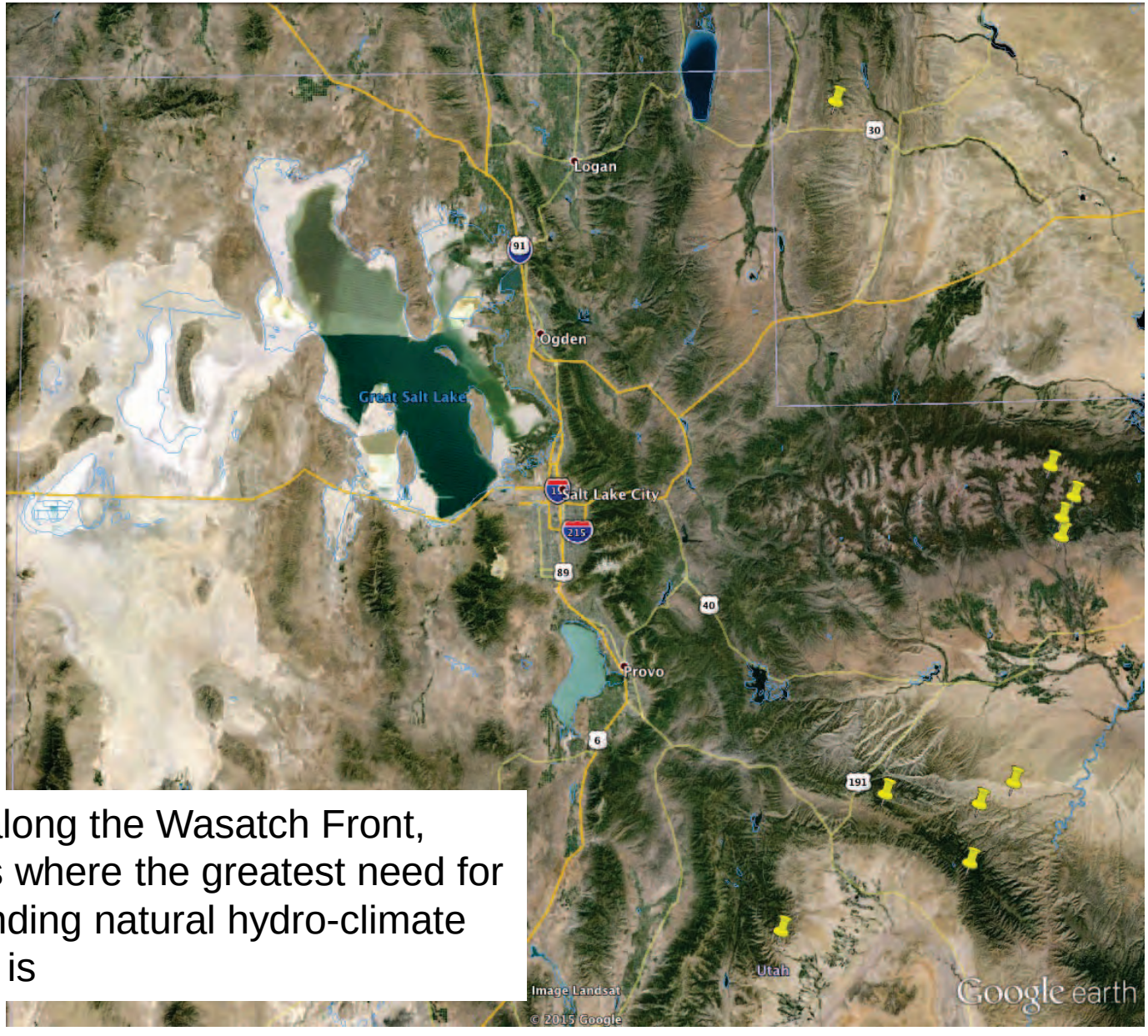
- Need for NEW Tree Ring series in the region.
- Where we have gone.
- Current Published reconstructions.



Tree-ring Chronologies prior to 2010



Tree ring data bases – quite sparse in this region

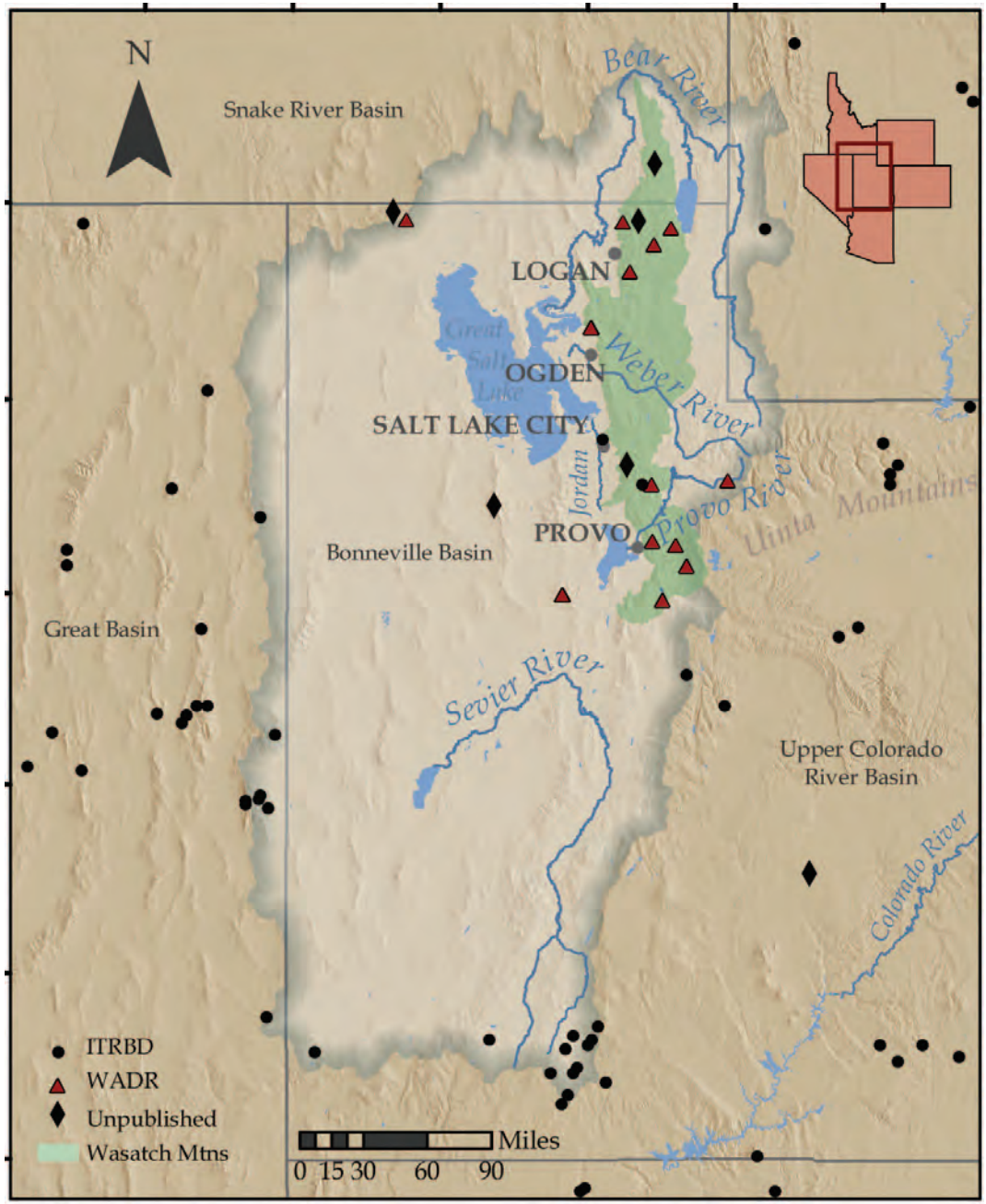


No data along the Wasatch Front,
Yet that is where the greatest need for understanding natural hydro-climate variability is

We have added several new chronologies - allowing us to produce a number of reconstructions in the region

Logan River
Weber River
Great Salt Lake
Bear River

Several more on the way



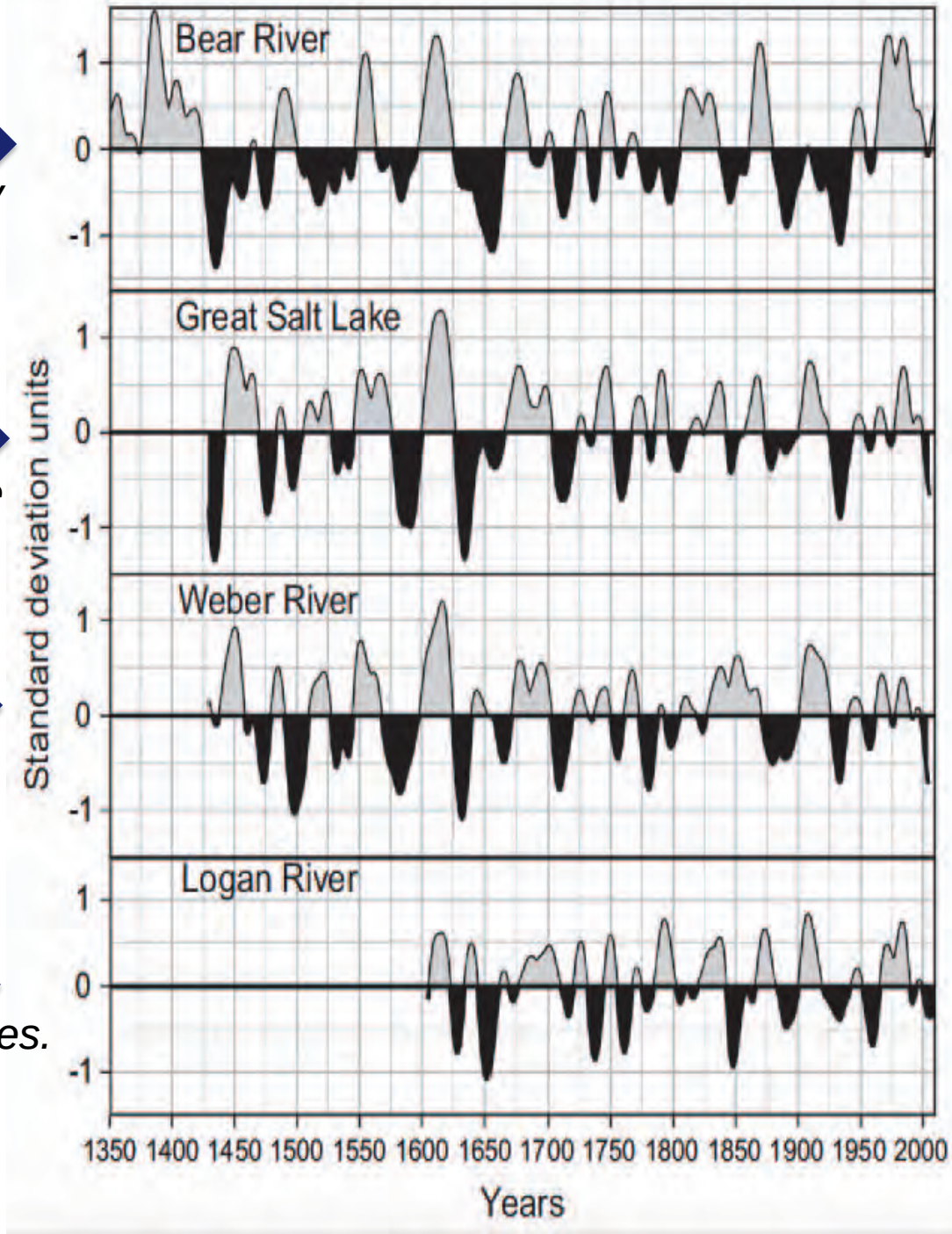
WaDR published reconstructions

1200 years
DeRose et al. 2015. *J of Hydrology*

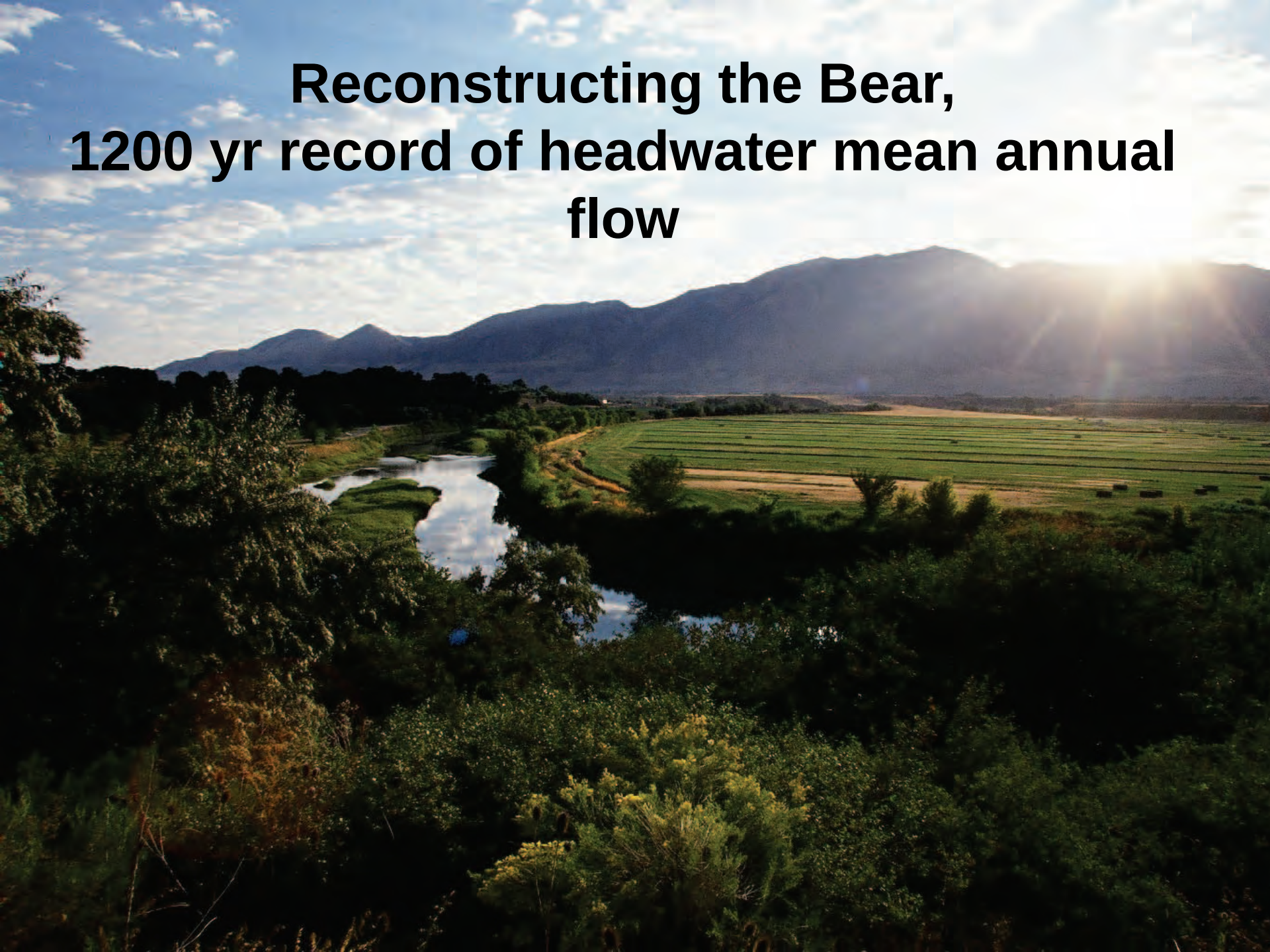
600 years
DeRose et al. 2014. *The Holocene*

600 years
Bekker et al. 2014. *J Am. Resources Assoc*.

400 years
Allen et al. 2013. *Water Resources Res.*



Reconstructing the Bear, 1200 yr record of headwater mean annual flow



Development of the 1200 yr chronology

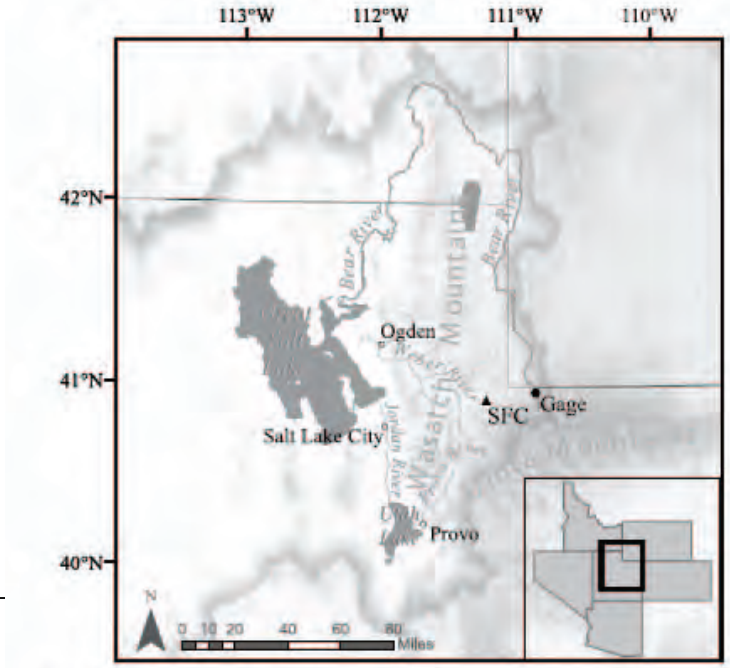
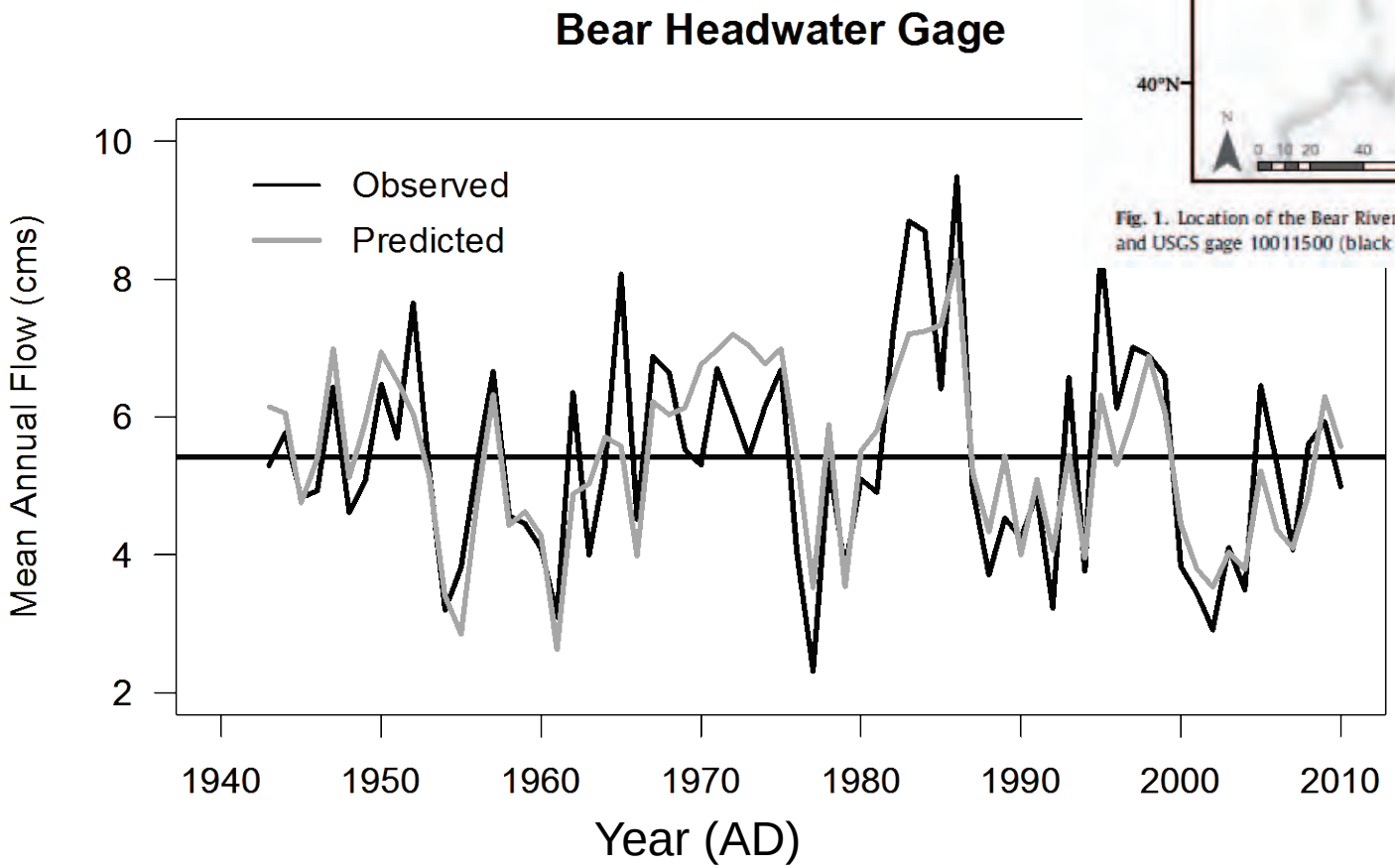
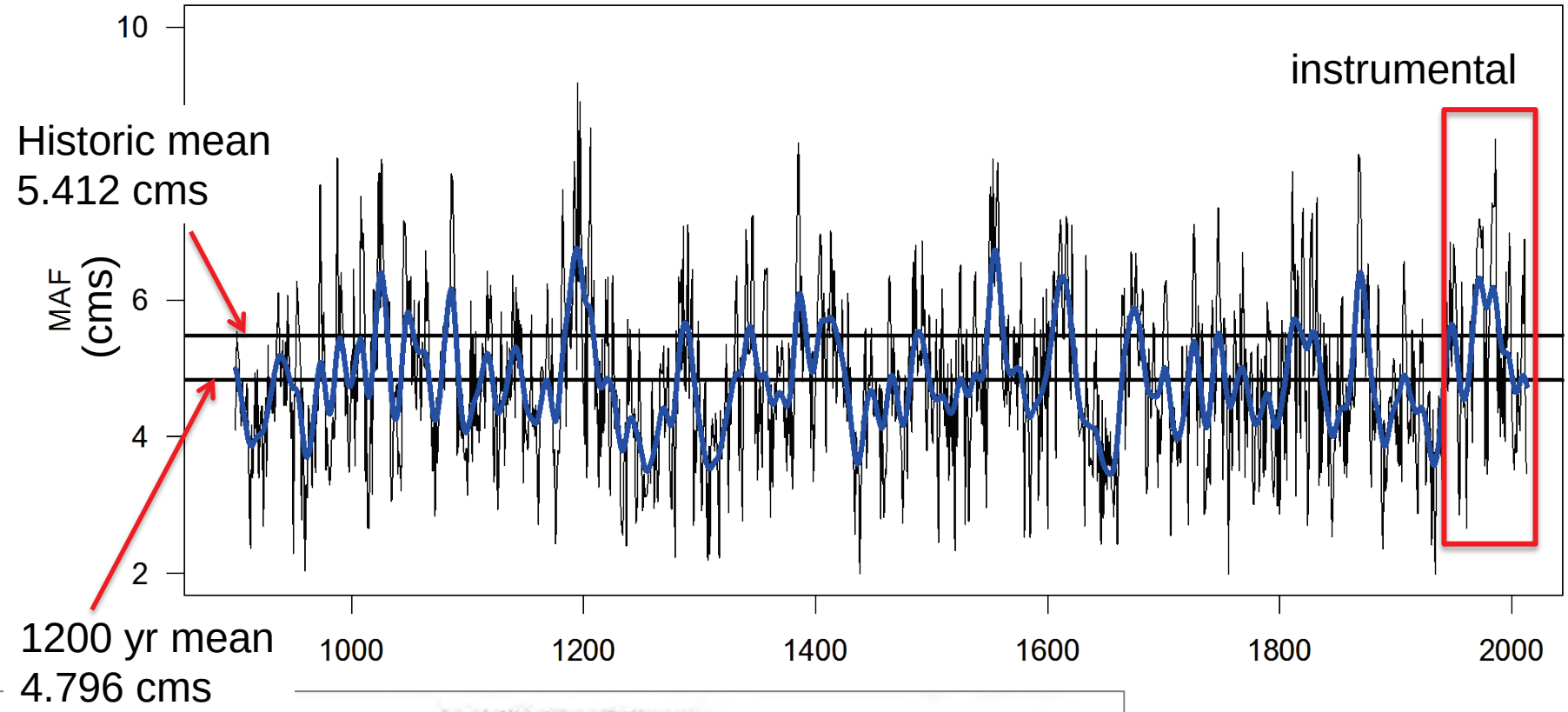


Fig. 1. Location of the Bear River, South Fork of Chalk Creek chronology (triangle) and USGS gage 10011500 (black circle).



DeRose et al. 2015. *J of Hydrology*

Reconstructed flow for the Bear River, AD 800 – AD 2000



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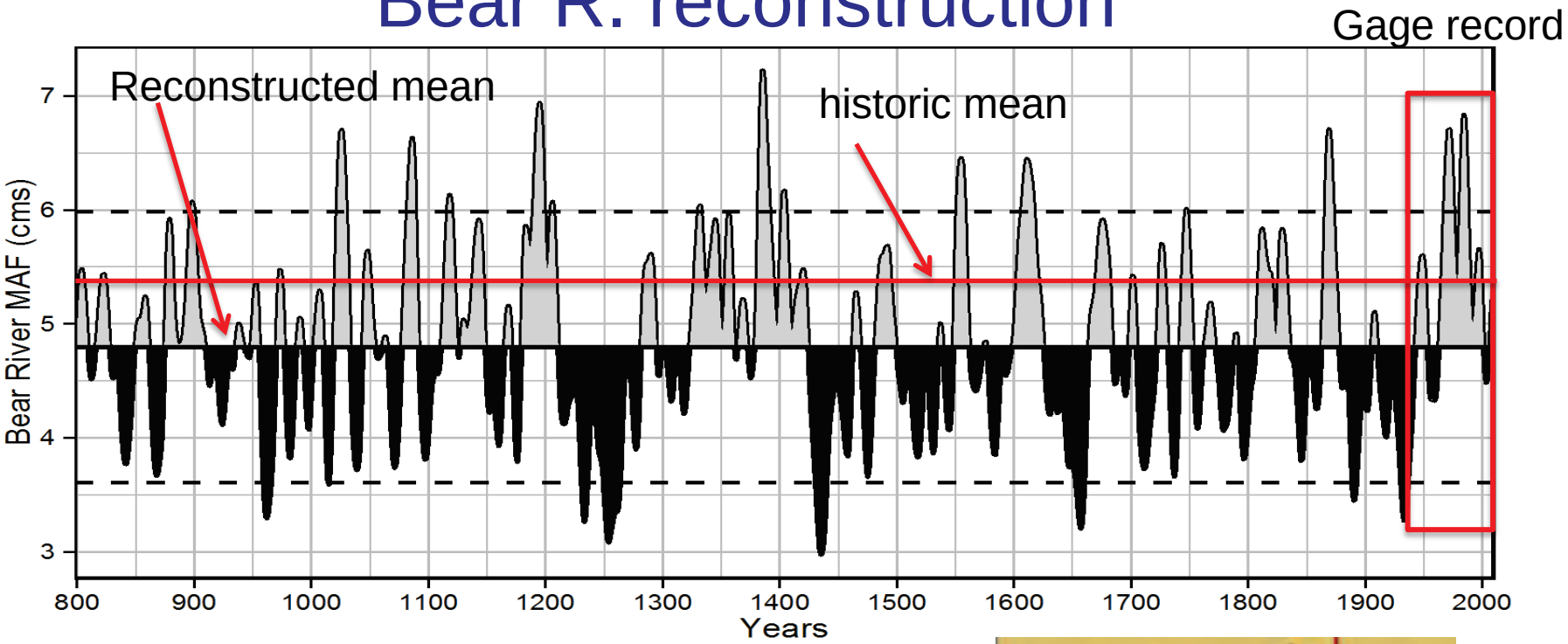
A millennium-length reconstruction of Bear River stream flow, Utah

R.J. DeRose [a,*], M.F. Bekker [b], S.-Y. Wang [c], B.M. Buckley [d], R.K. Kjelgren [c], T. Bardsley [e], T.M. Rittenour [f], E.B. Allen [g]

Bear R. reconstruction



10-yr spline
1-sigma shown

The future of N. Utah's water resources

DeRose et al. 2015. *J of Hydrology*

Spectral analysis of the Bear River flow reconstruction

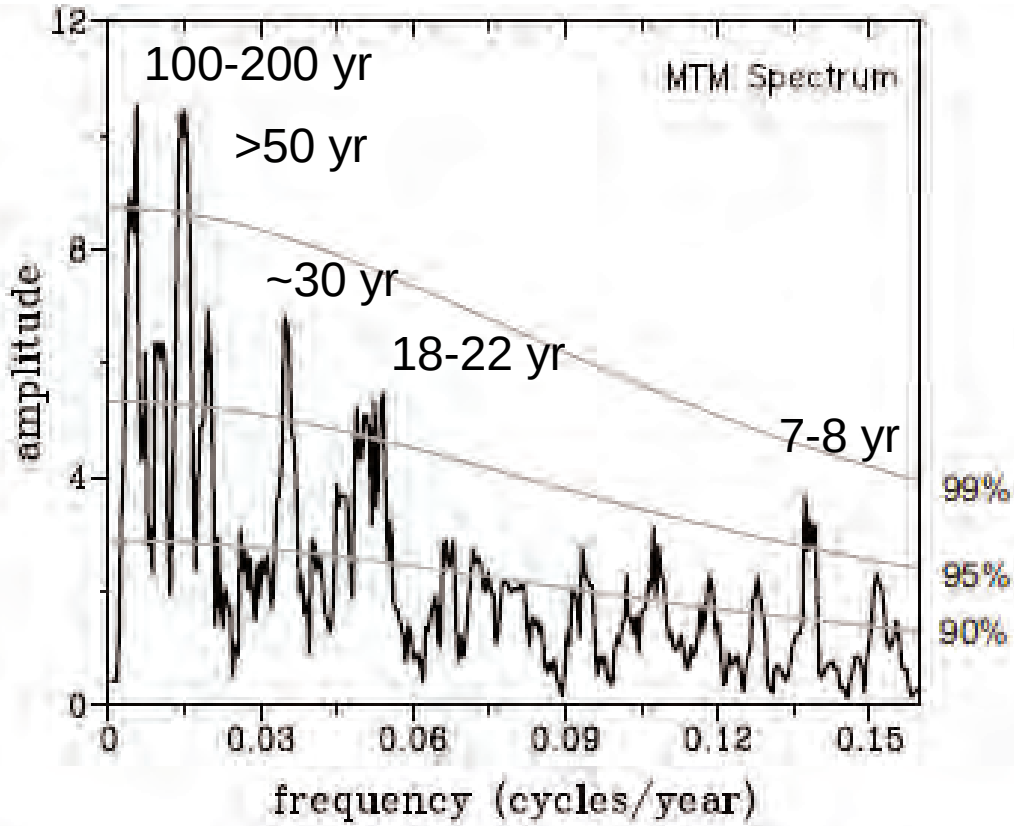
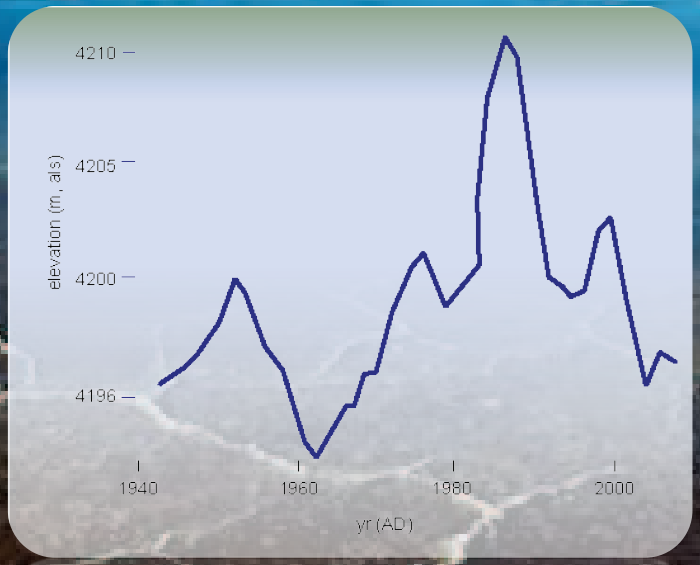


Fig. 4. Spectrum produced by adaptive multi-taper method of spectral analysis for the 800–2010 Bear River reconstructed stream flow. Gray contour lines indicated 99%, 95%, and 90% confidence levels against a red noise background.

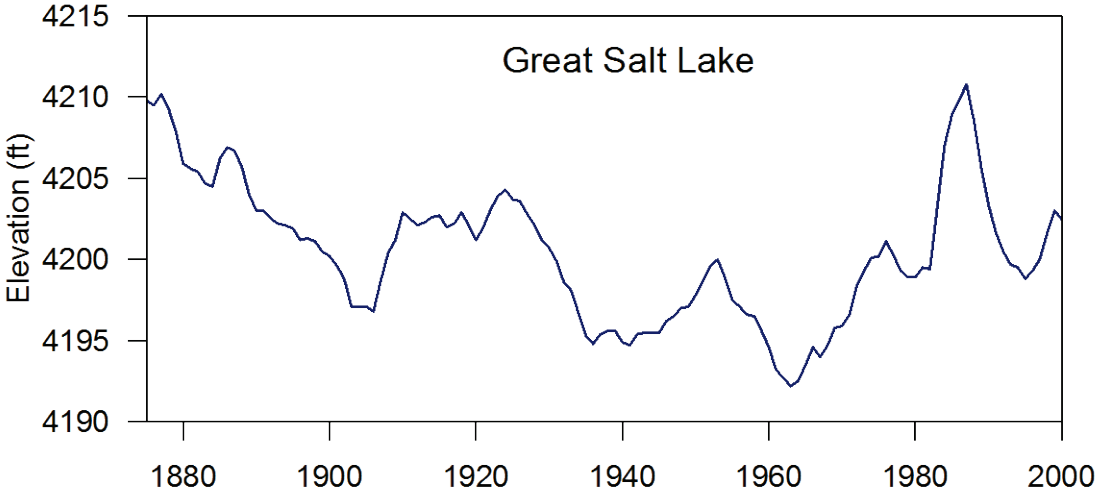
DeRose et al. 2015

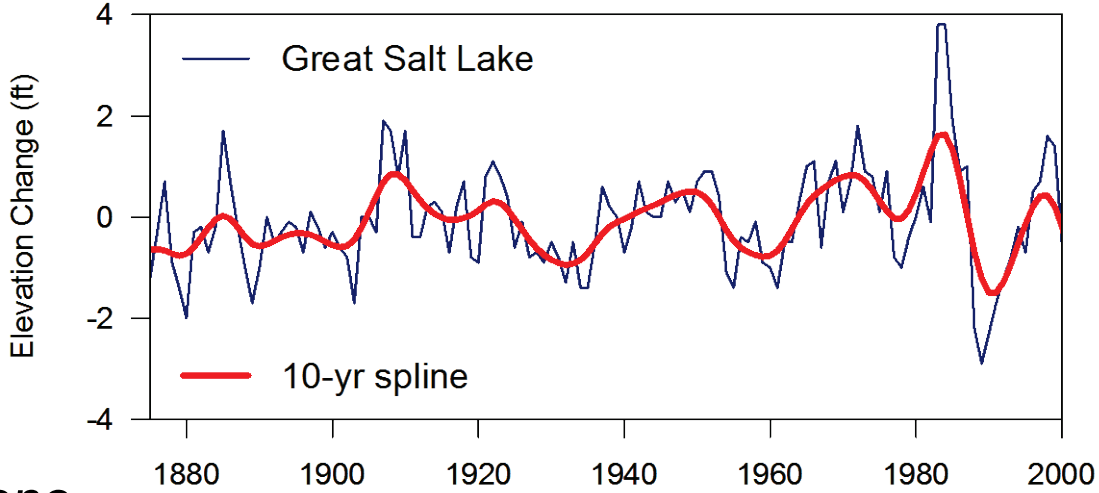
Reconstructing lake level change, Great Salt Lake



DeRose et al. 2014. *The Holocene*

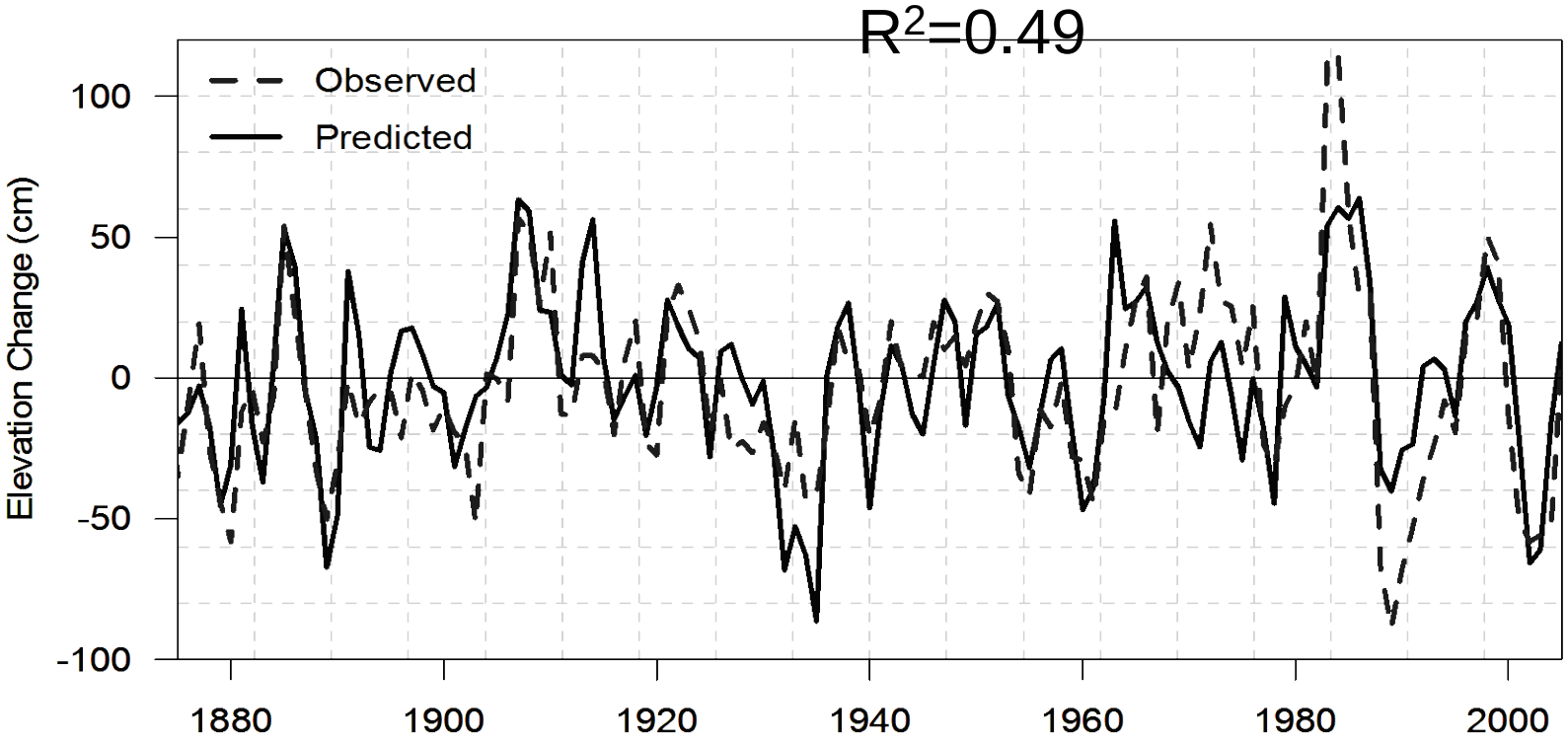
Great Salt Lake elevation tendency t-(t-1)





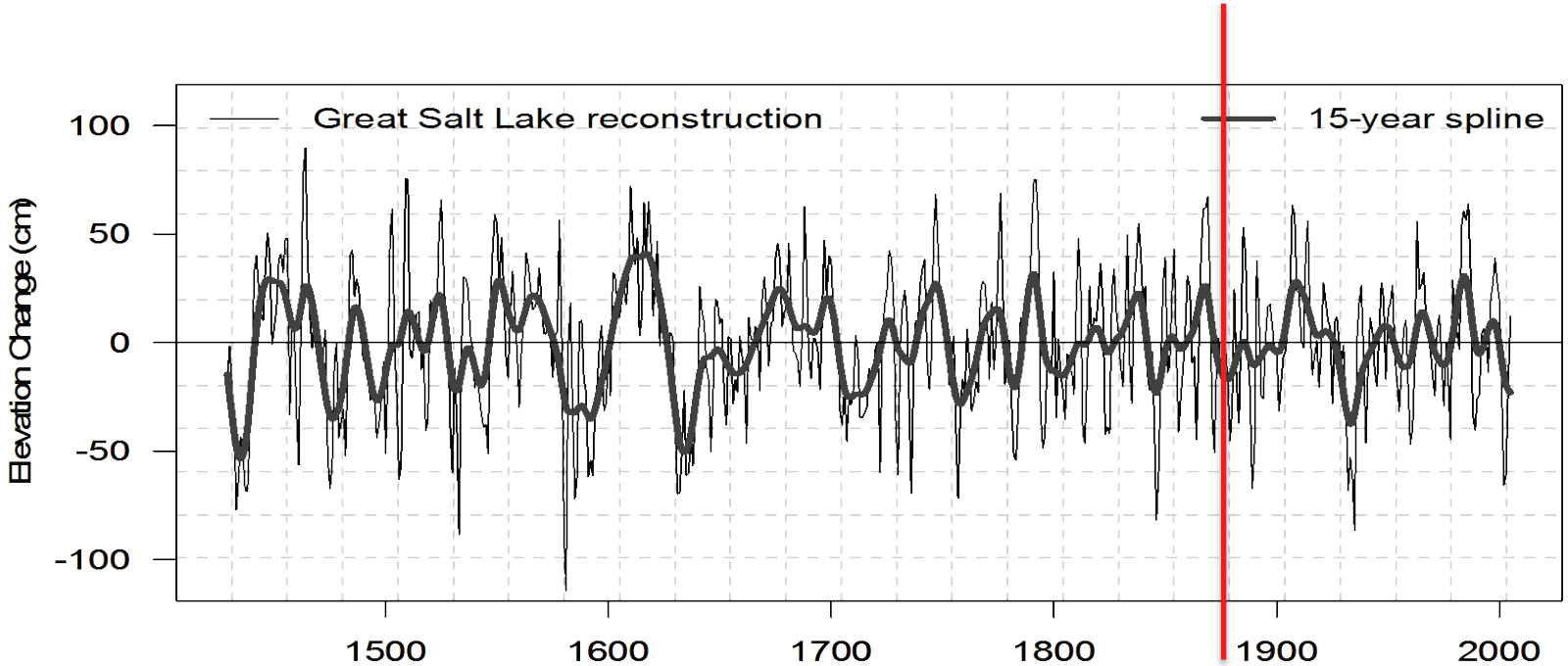
DeRose et al. 2014. *The Holocene*

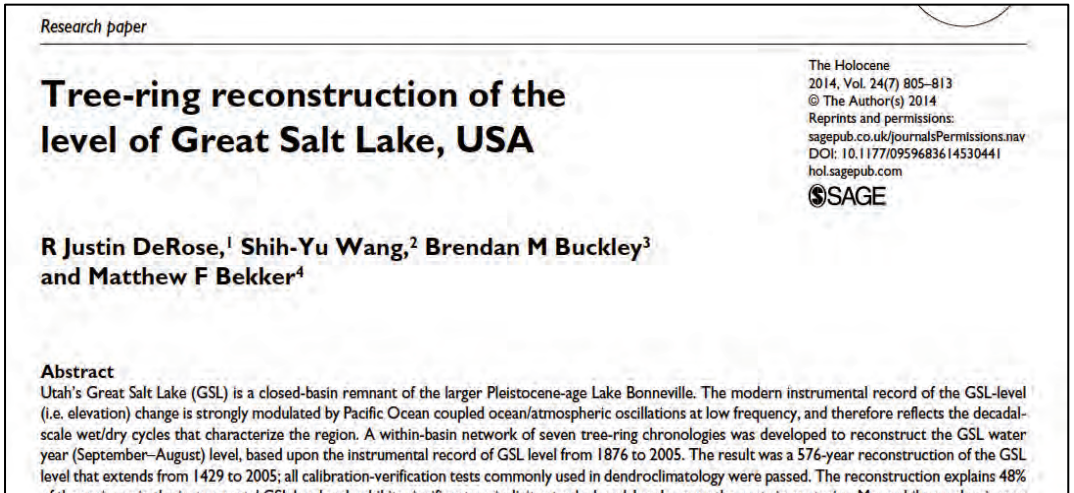
GSL Model



DeRose et al. 2014. *The Holocene*

The Great Salt Lake – a regional integrator





Research paper

Tree-ring reconstruction of the level of Great Salt Lake, USA

The Holocene
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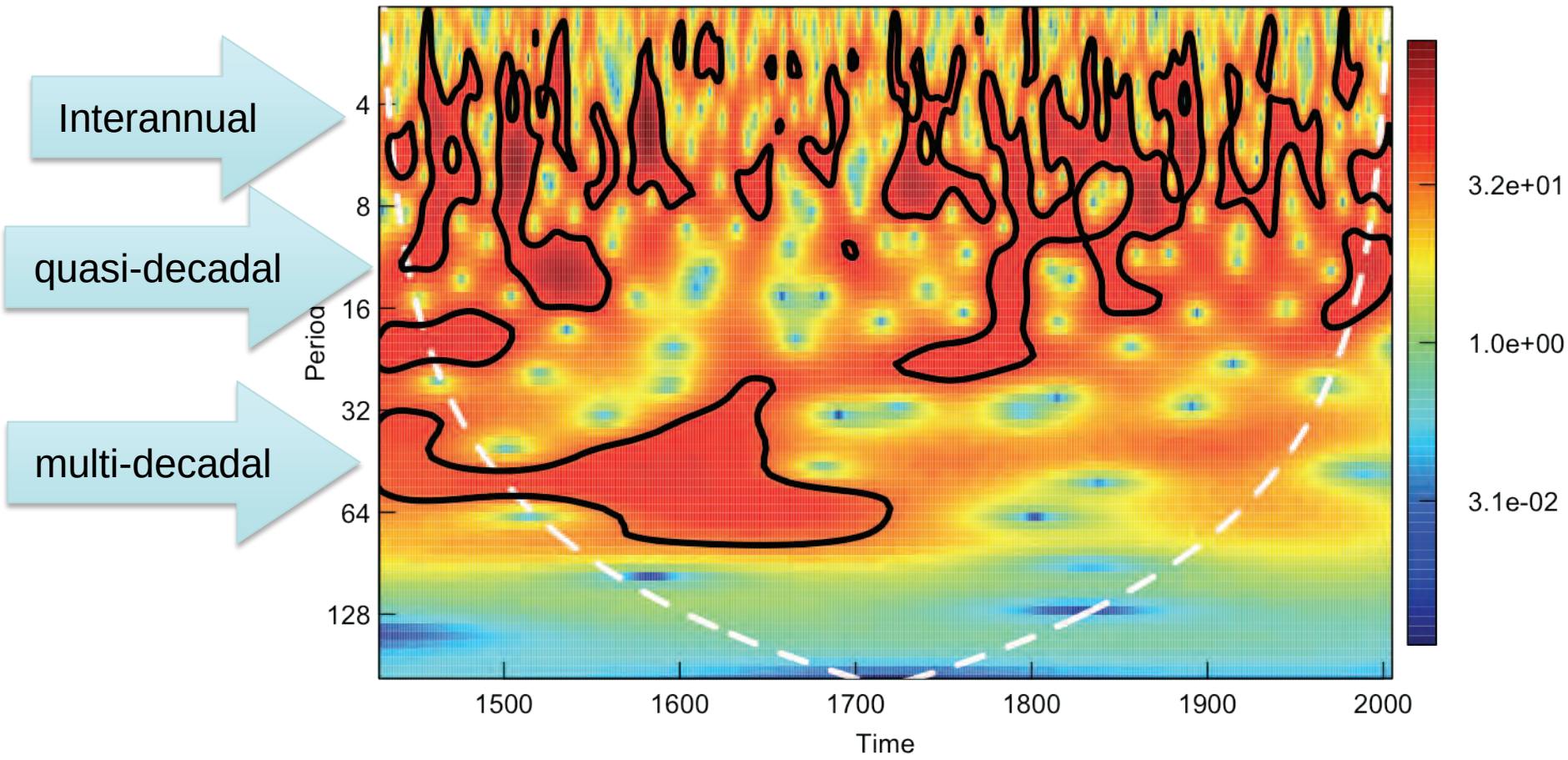
DOI: 10.1177/0959683614530441
hol.sagepub.com
SAGE

R Justin DeRose,[1] Shih-Yu Wang,[2] Brendan M Buckley[3] and Matthew F Bekker[4]

Abstract
Utah's Great Salt Lake (GSL) is a closed-basin remnant of the larger Pleistocene-age Lake Bonneville. The modern instrumental record of the GSL-level (i.e. elevation) change is strongly modulated by Pacific Ocean coupled ocean/atmospheric oscillations at low frequency, and therefore reflects the decadal-scale wet/dry cycles that characterize the region. A within-basin network of seven tree-ring chronologies was developed to reconstruct the GSL water year (September–August) level, based upon the instrumental record of GSL level from 1876 to 2005. The result was a 576-year reconstruction of the GSL level that extends from 1429 to 2005; all calibration-verification tests commonly used in dendroclimatology were passed. The reconstruction explains 48%

GSL Periodicity

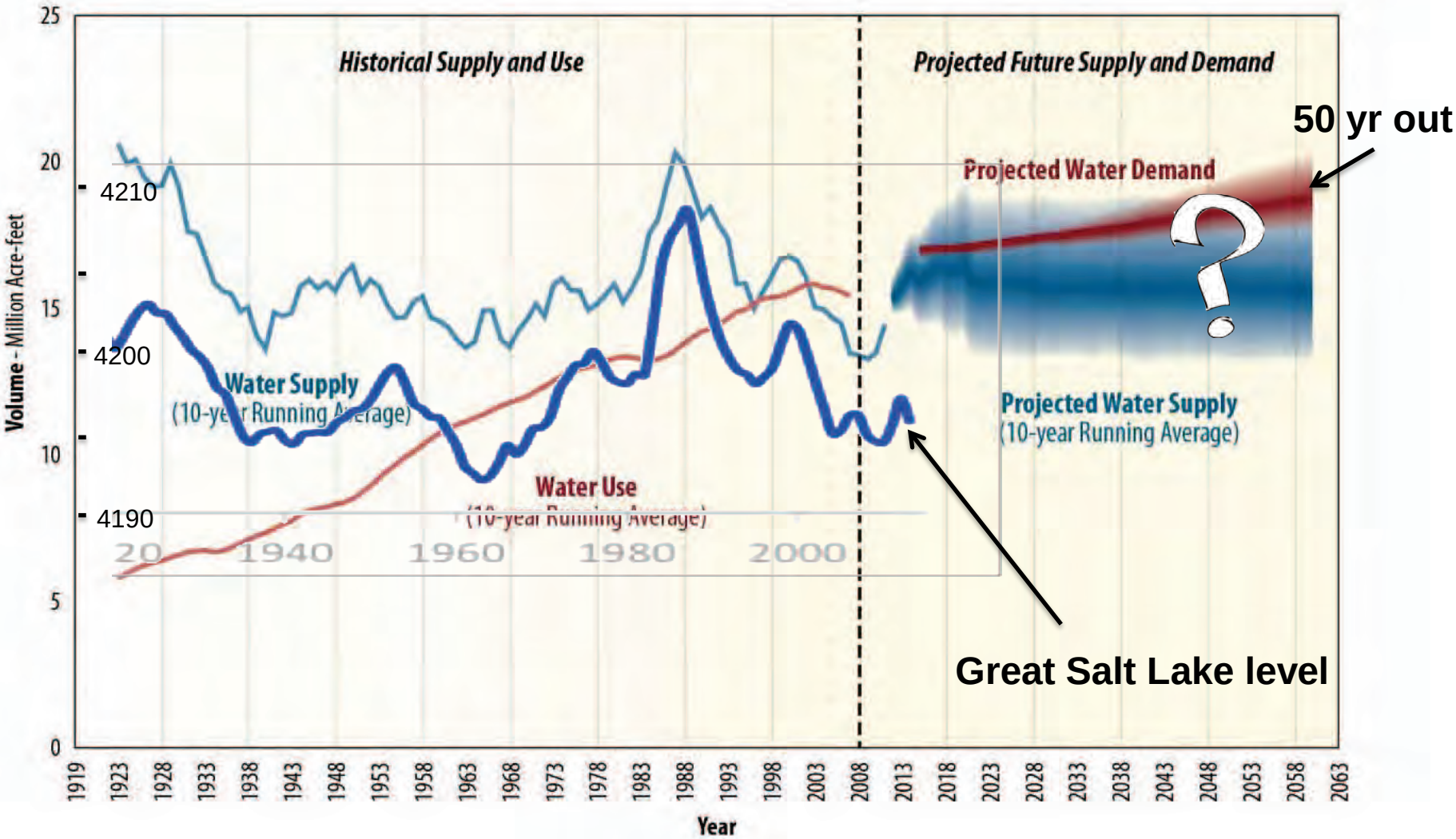


Linked to Pacific variability

The next step:

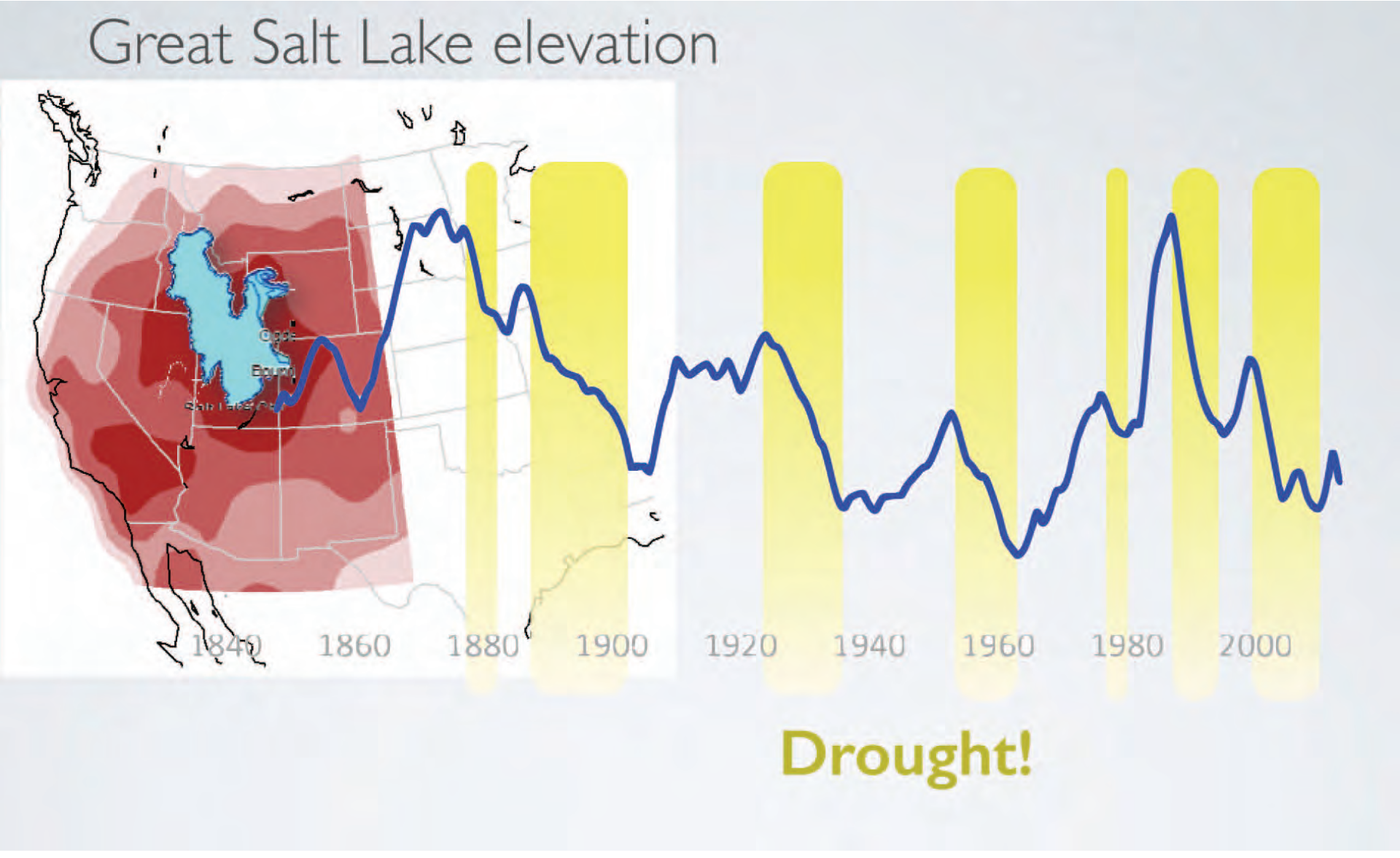
Use of tree-ring chronologies for predictive models

Colorado River Water Supply and Demand – last century



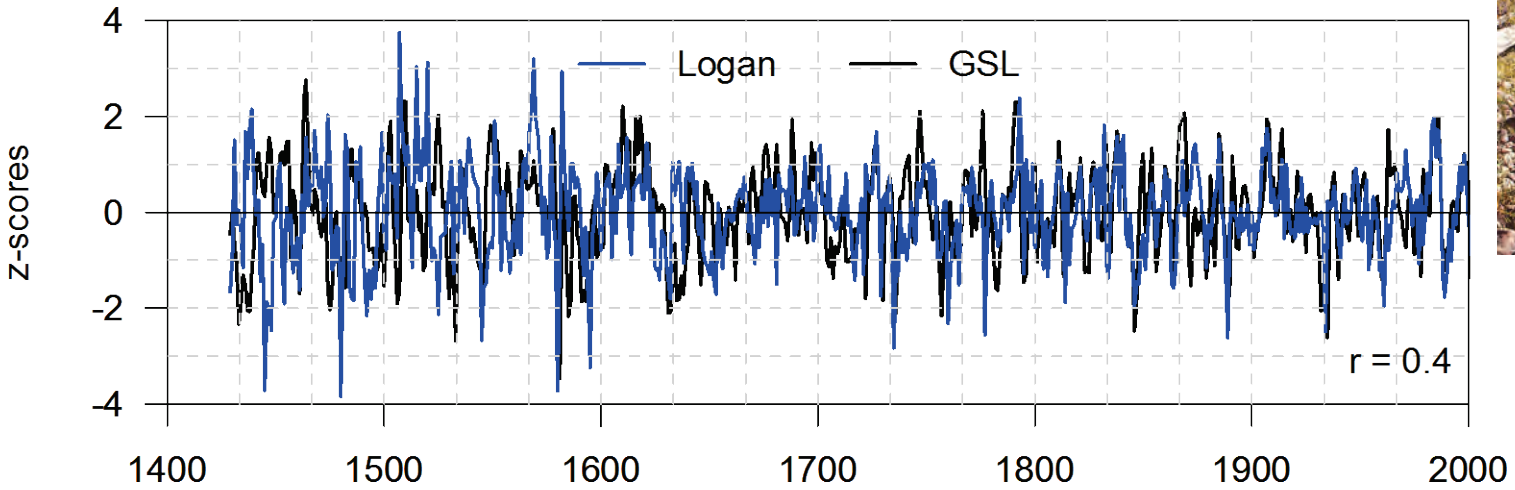
What is controlling variability in the region ?

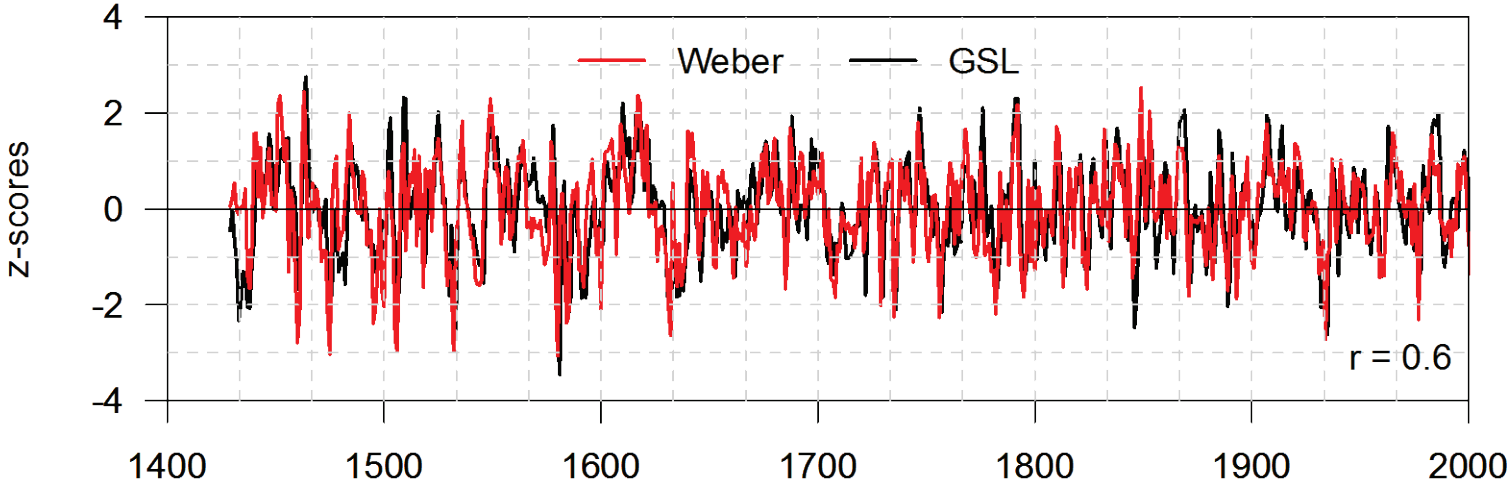
GSL records hydroclimatic conditions

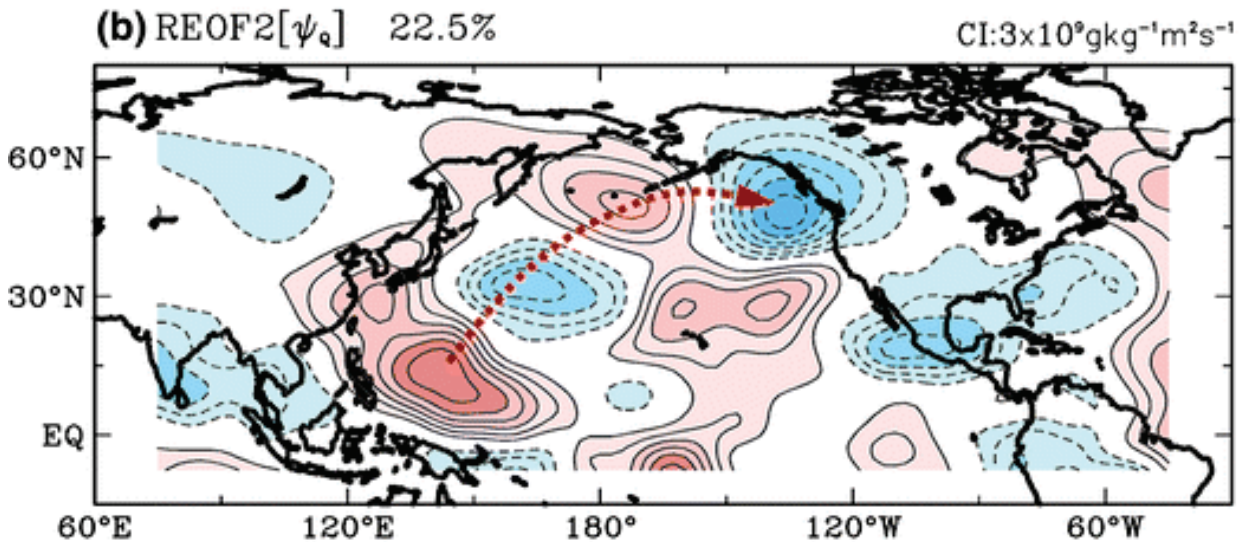


GSL vs streamflow

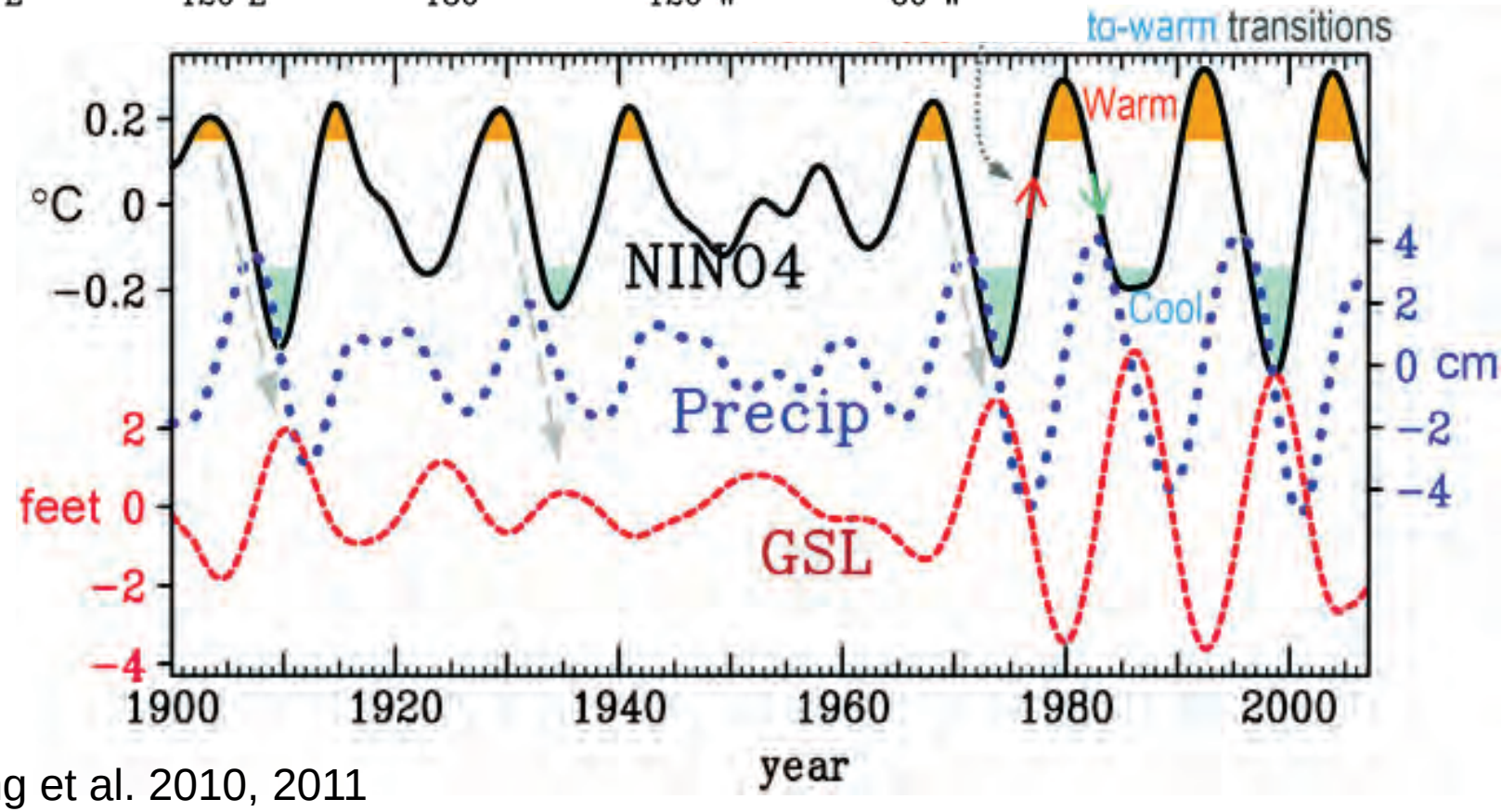
à Hydrologic integrator!





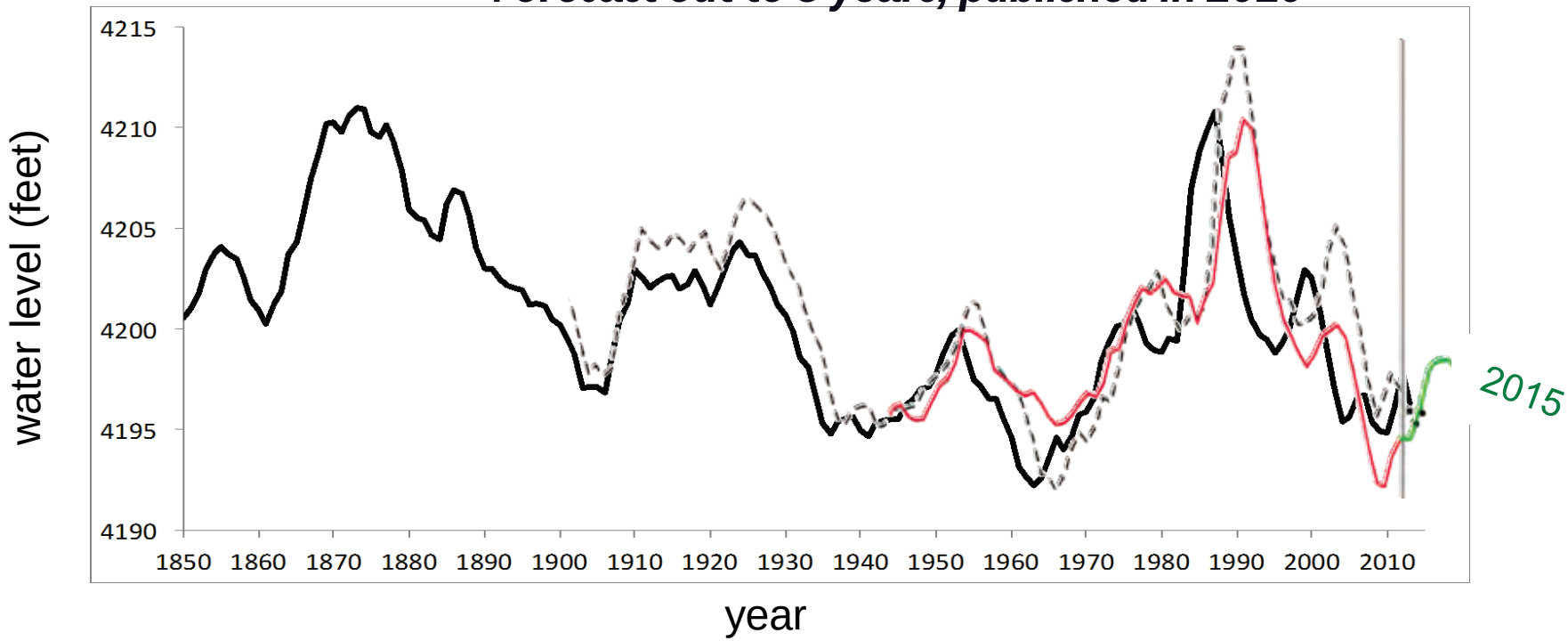


IS



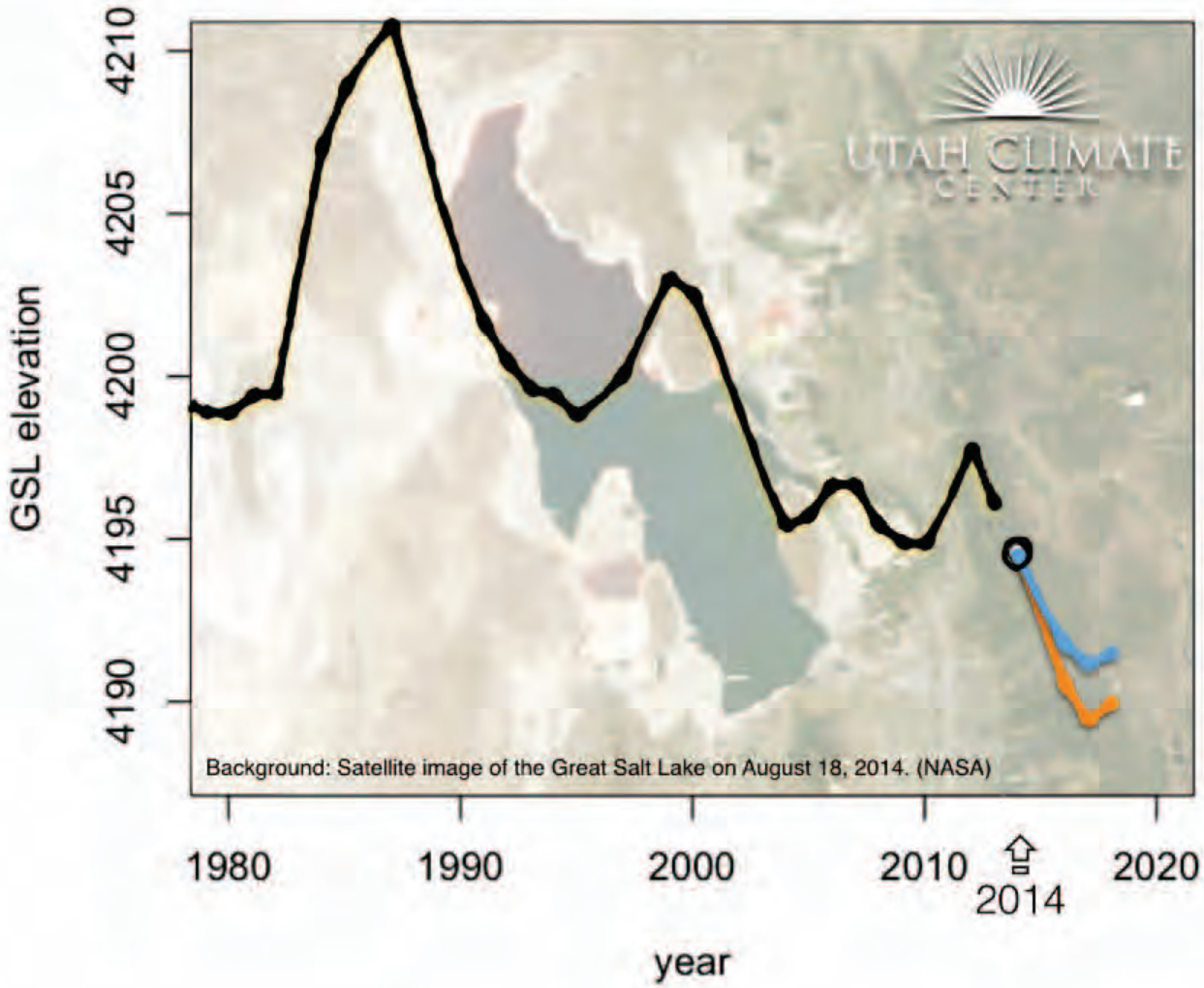
Wang et al. 2010, 2011

Forecast out to 8 years, published in 2010



Gillies et al. 2010

GSL – The latest forecast, now live at https://climate.usurf.usu.edu/



Based upon previous research conducted at USU and Utah Climate Center (1,2), the level of the Great Salt Lake (GSL) is predicted to continue a decline towards 2017, at which point the lake level will begin to rise.

Blue prediction is derived from GSL and tropical Pacific sea surface temperature (1);

orange prediction is produced with a 700+ year long tree-ring reconstruction of GSL level (2).

Implications

and

Applications

Western Water Assessment

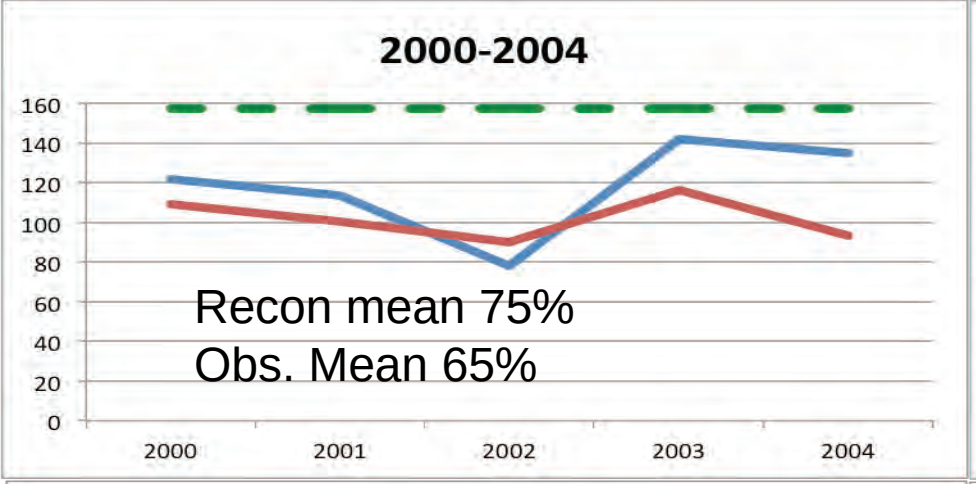
CIRES

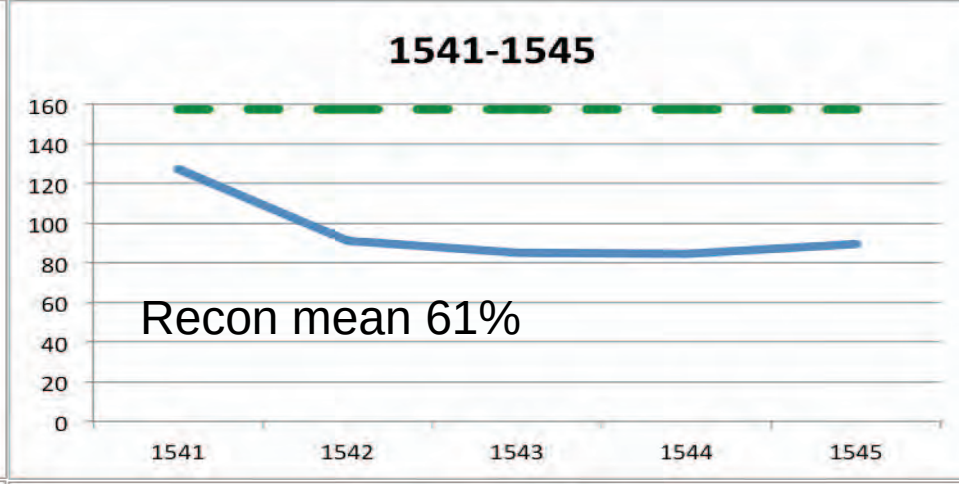
University of Colorado Boulder

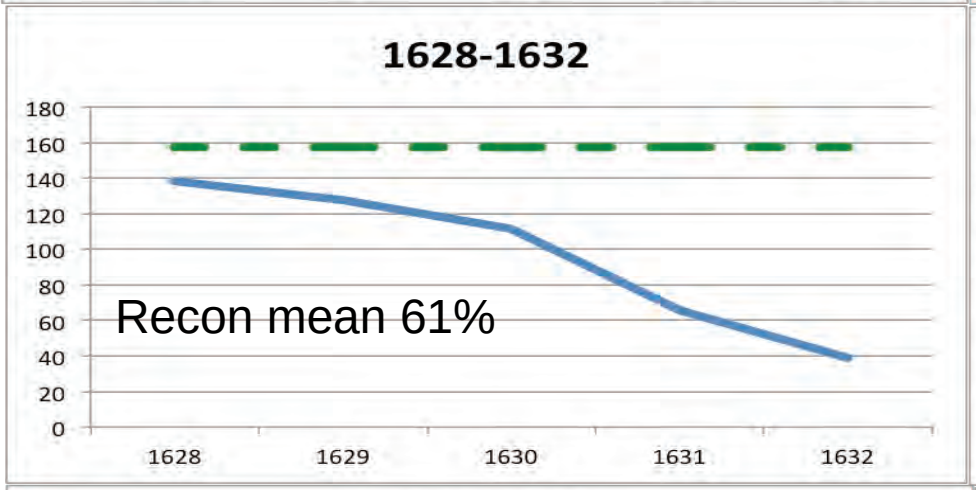
Weber Basin Water Conservancy District

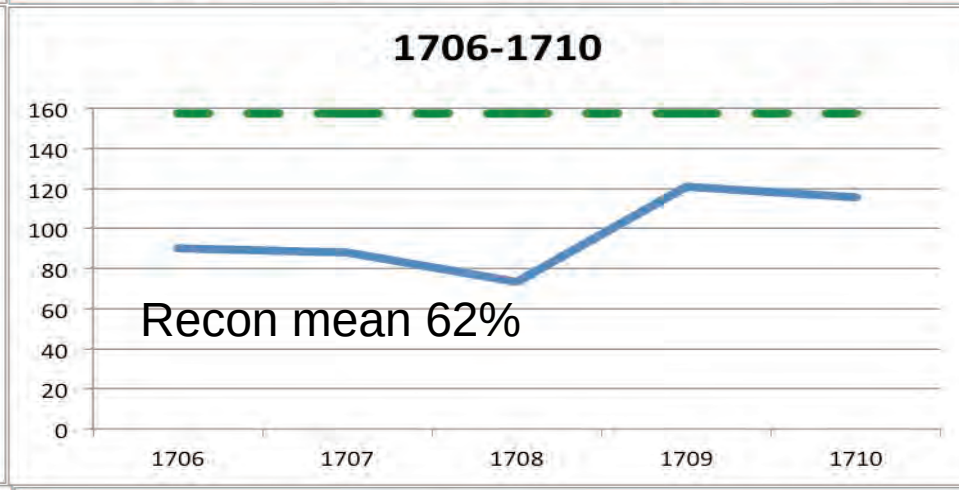
Utah State University

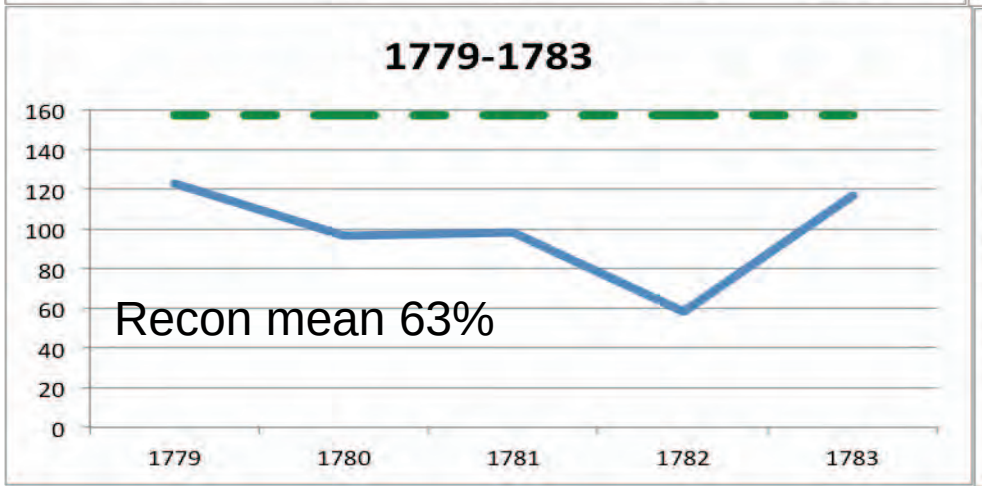
Utah Division of Water Resources

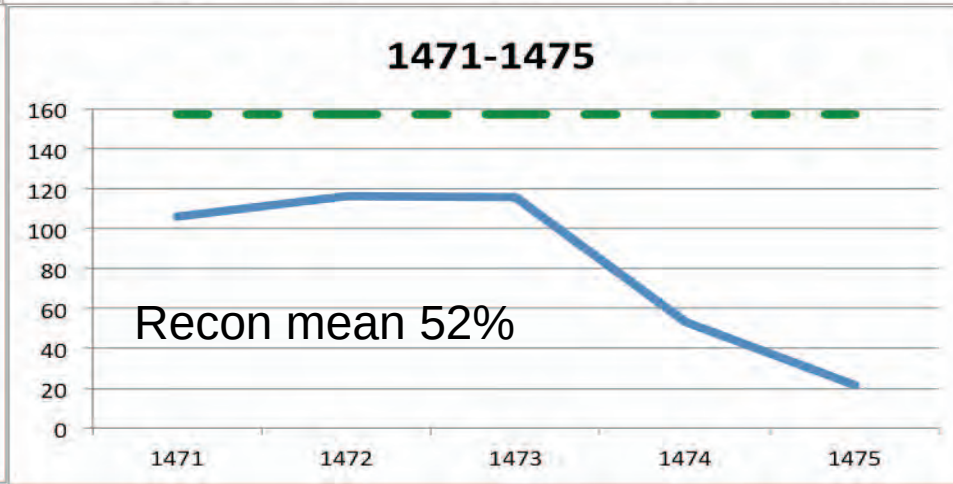

2000-2004
160
140
120
100
80
60
40
20
0
2000
2001
2002
2003
2004
Recon mean 75%
Obs. Mean 65%


1541-1545
160
140
120
100
80
60
40
20
0
1541
1542
1543
1544
1545
Recon mean 61%


1628-1632
180
160
140
120
100
80
60
40
20
0
1628
1629
1630
1631
1632
Recon mean 61%

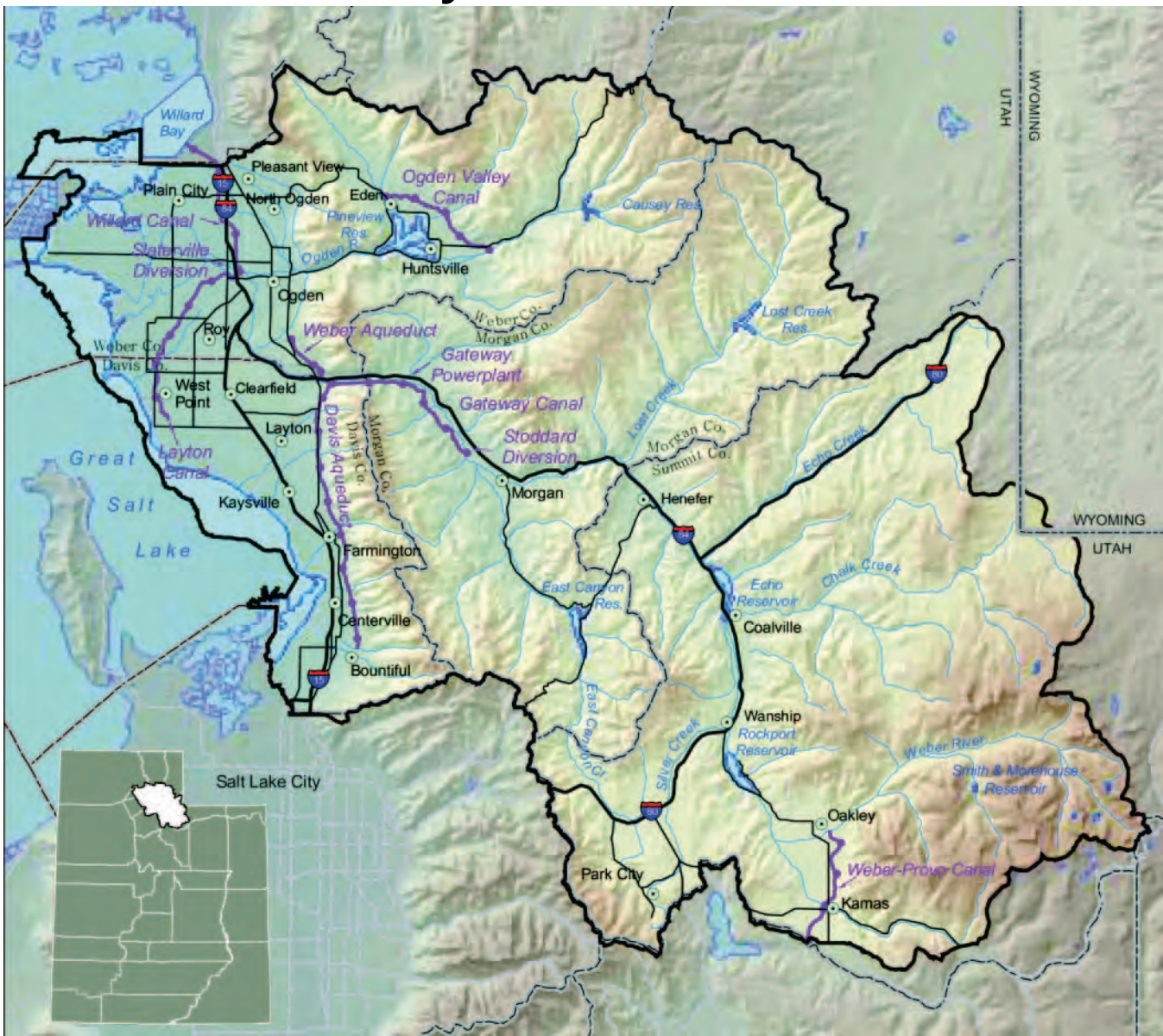

1706-1710
160
140
120
100
80
60
40
20
0
1706
1707
1708
1709
1710
Recon mean 62%


1779-1783
160
140
120
100
80
60
40
20
0
1779
1780
1781
1782
1783
Recon mean 63%


1471-1475
160
140
120
100
80
60
40
20
0
1471
1472
1473
1474
1475
Recon mean 52%

Weber Basin Water Conservancy District

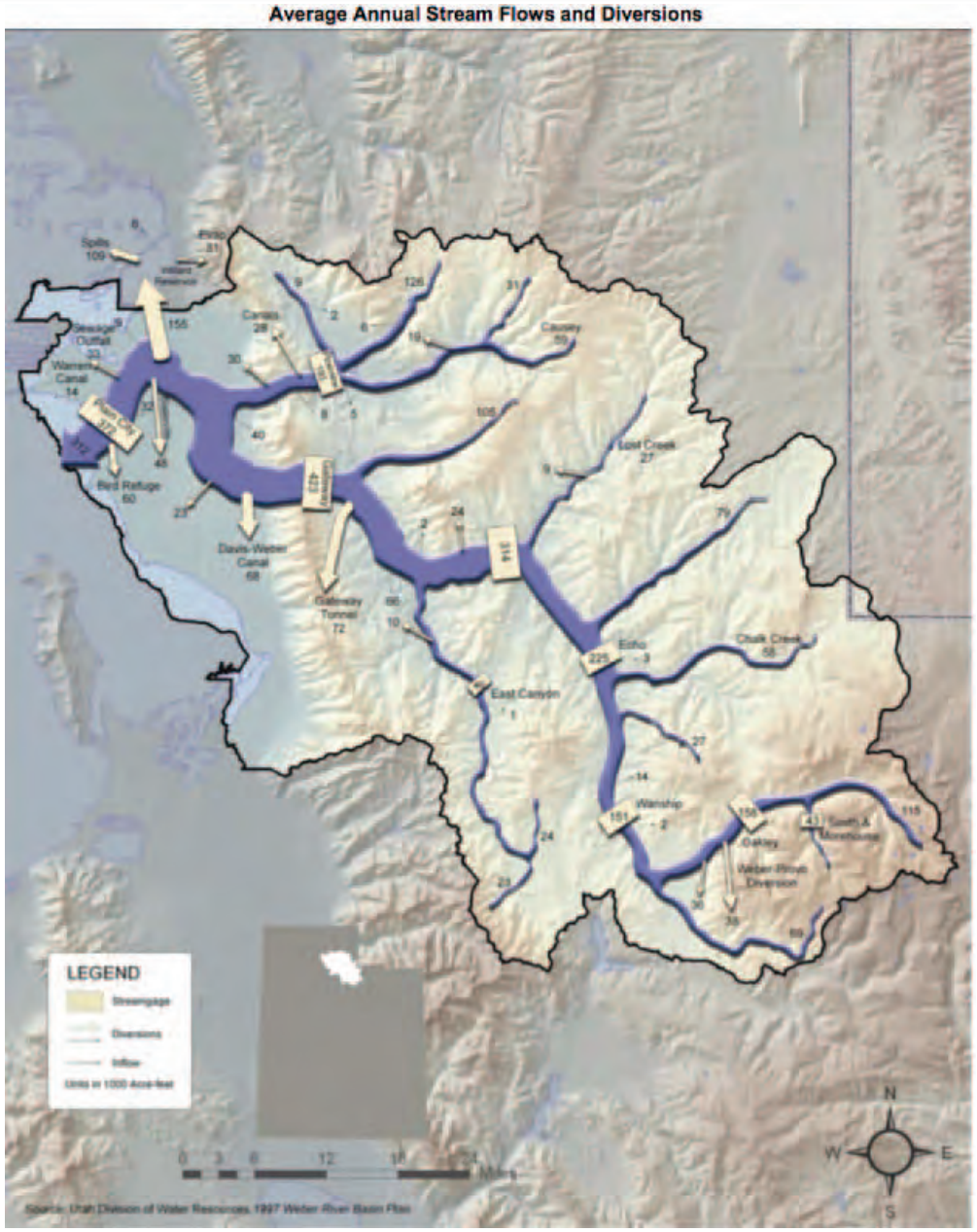
- Wholesaler of municipal/industrial and irrigation water to 5 counties
- 7 reservoirs
- Large pressurized secondary system



Weber Basin Project

- Process
  UT DWRes, USU,WWA
  Similarities/differences vs. SLC

- Purpose
  Evaluate the resilience of the system to paleo droughts and climate change



Western Water Assessment

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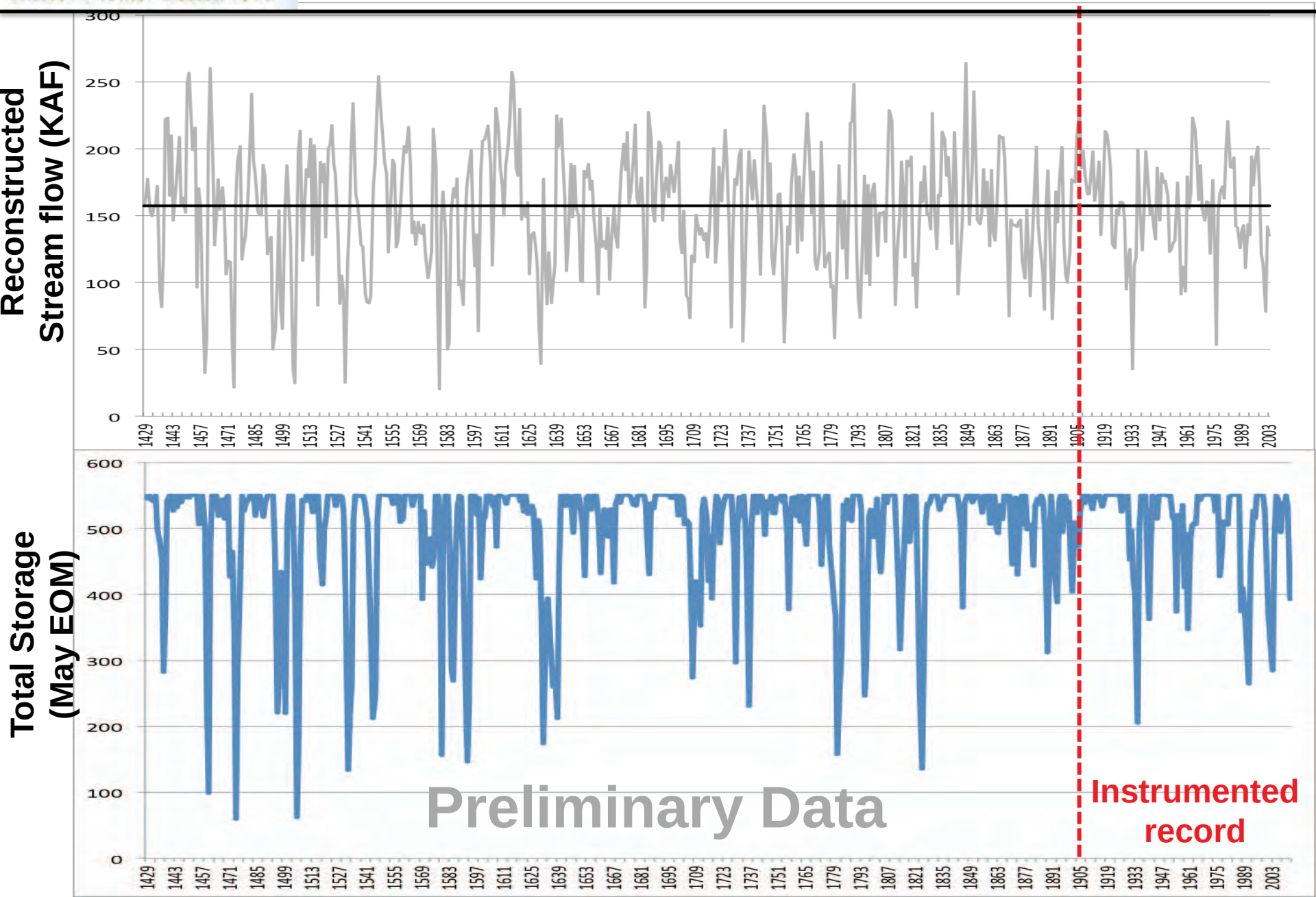

Thank you,
Questions
WAsatch Dendroclimatology