

Insights from Arizona's Past Climate: A 2000 Year Perspective

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Planning for Local Government Climate
Challenges:
Connecting Research and Practice Workshop

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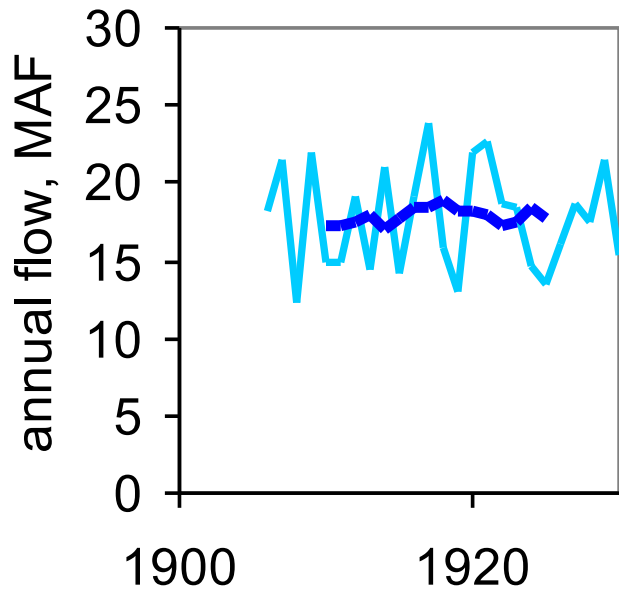


Insights from Arizona's Past Climate: A 2000 Year Perspective

- Why look back?
- Why 2000 years?
- What information does this history provide?
- How can this information be applied to decision making?

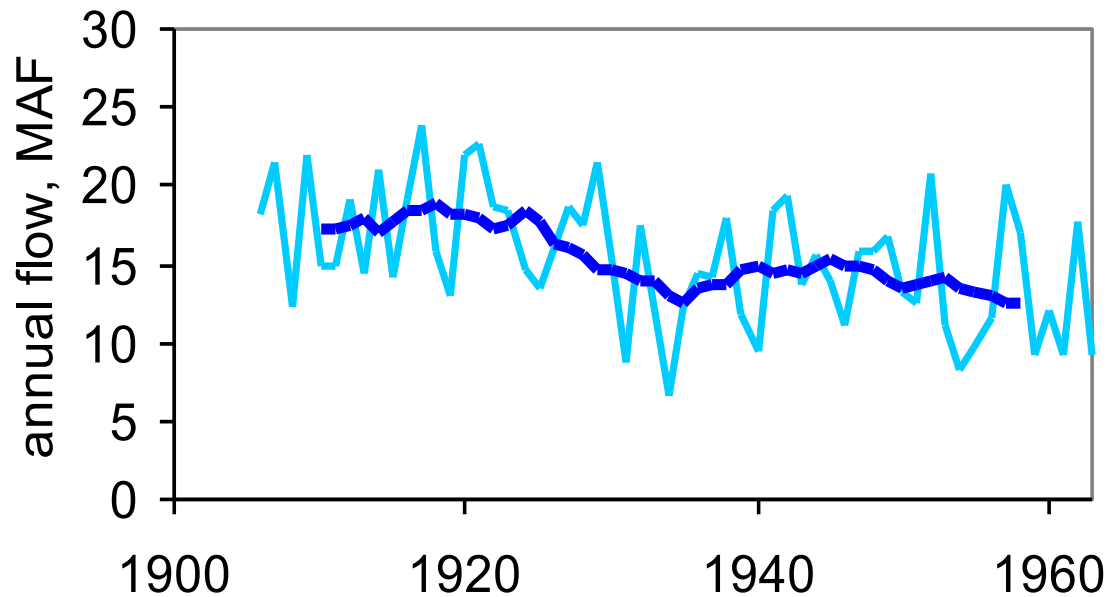
Why look back?

Historically, compacts, water policy and management have been based on the available climate and gage records



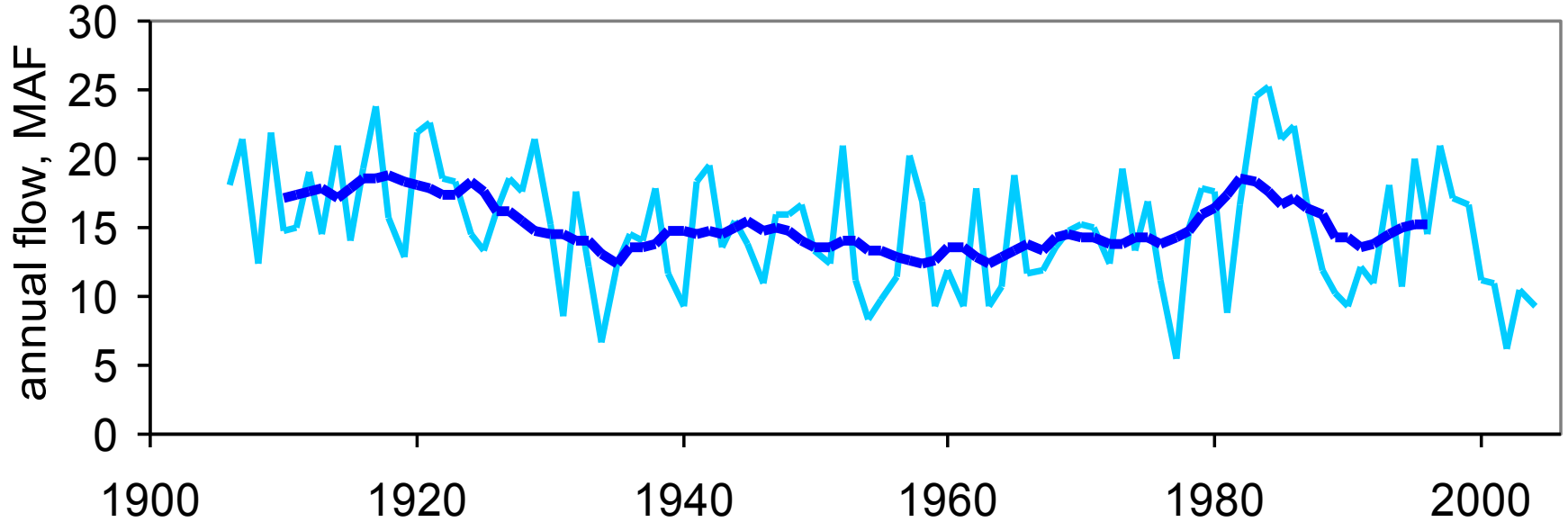
Colorado River at Lees Ferry, 1906-1930

Historically, compacts, water policy and management have been based on the available gage records



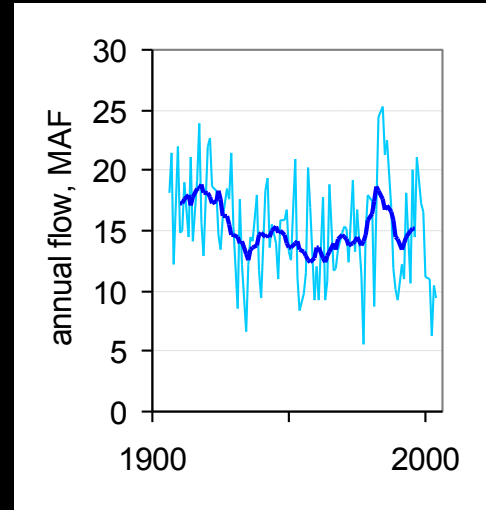
Colorado River at Lees Ferry, 1906-1960

Historically, compacts, water policy and management have been based on the available gage records



Colorado River at Lees Ferry, 1906-2004

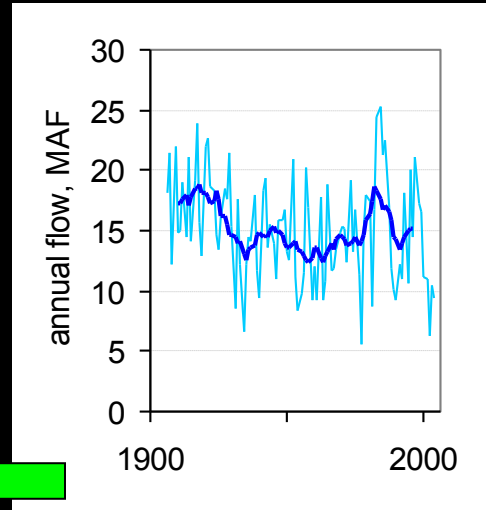
How representative is the gage record over a longer time frame?



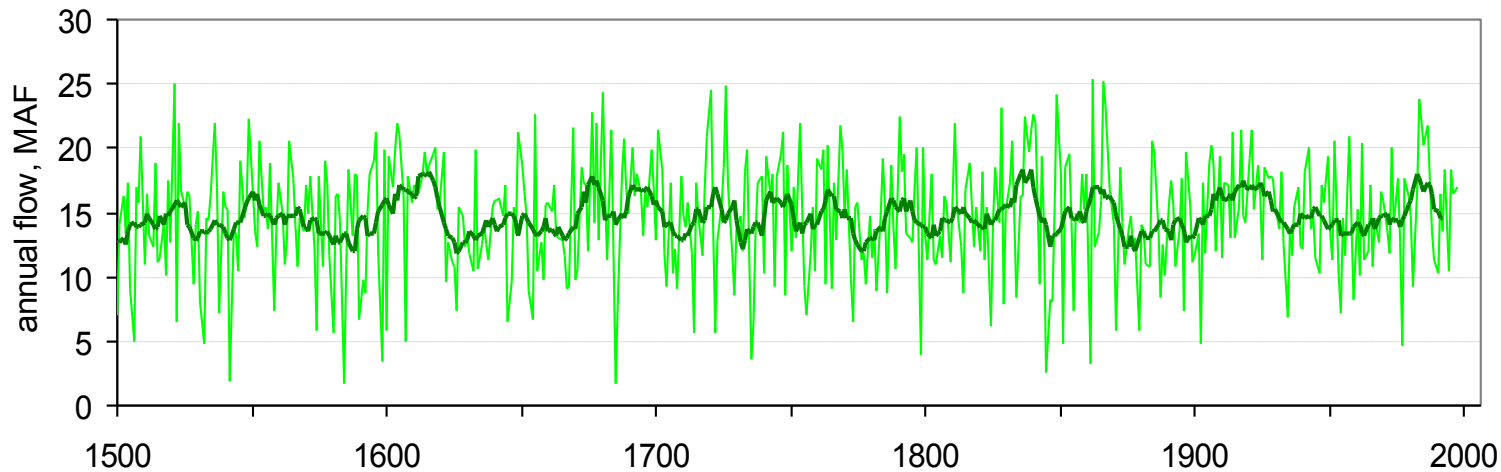
Colorado River
at Lees Ferry,
1906-2004

How representative is the gage record over a longer time frame?

By extending the gaged hydrology by hundreds of years into the past, the reconstructions provide a more complete picture of hydrologic variability



Colorado River at Lees Ferry, 1906-2004



Tree-ring reconstruction of Colorado River, Lees Ferry, 1490-1997

Why 2000 years?

Why 2000 years?

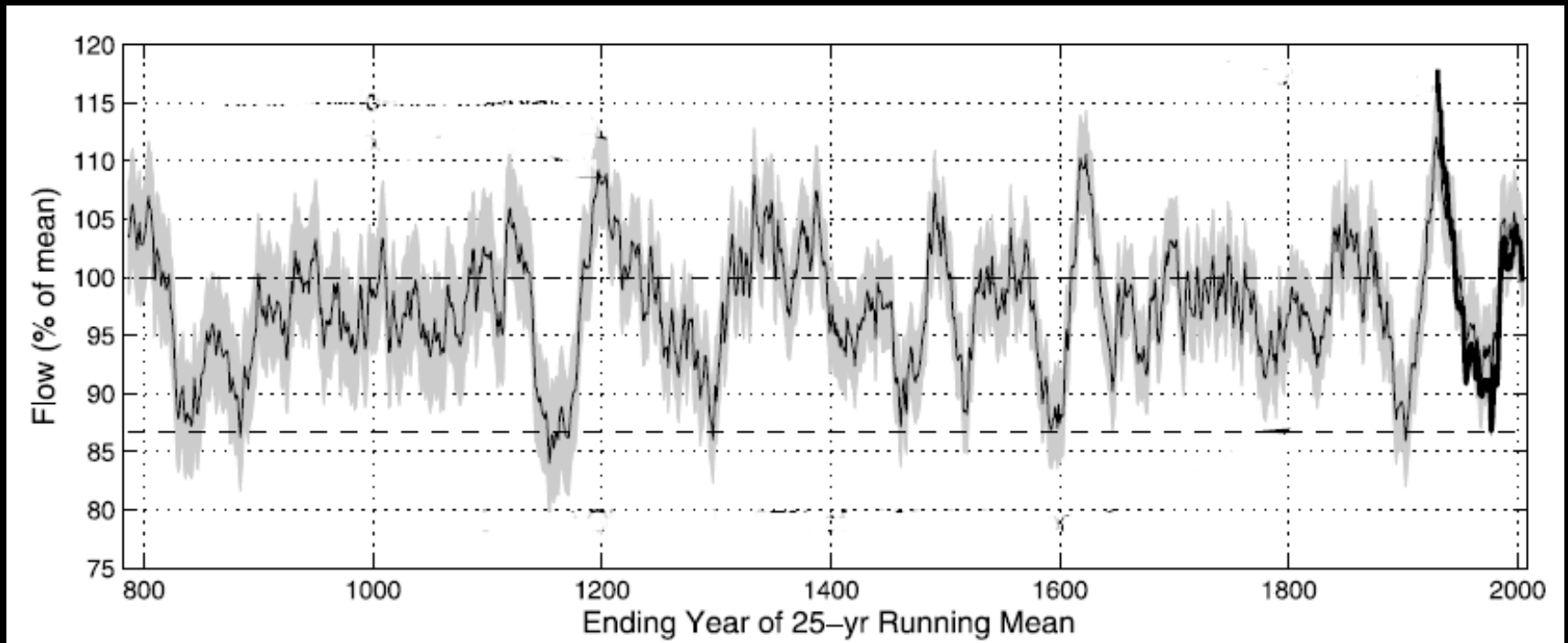
- The major controls on climate ---at the largest scale-- have been essentially about the same over this period of time
- Paleoclimatic data --in the form of annually resolved and precisely dated tree rings-- are available for much of the Southwestern US



What information does this history provide?

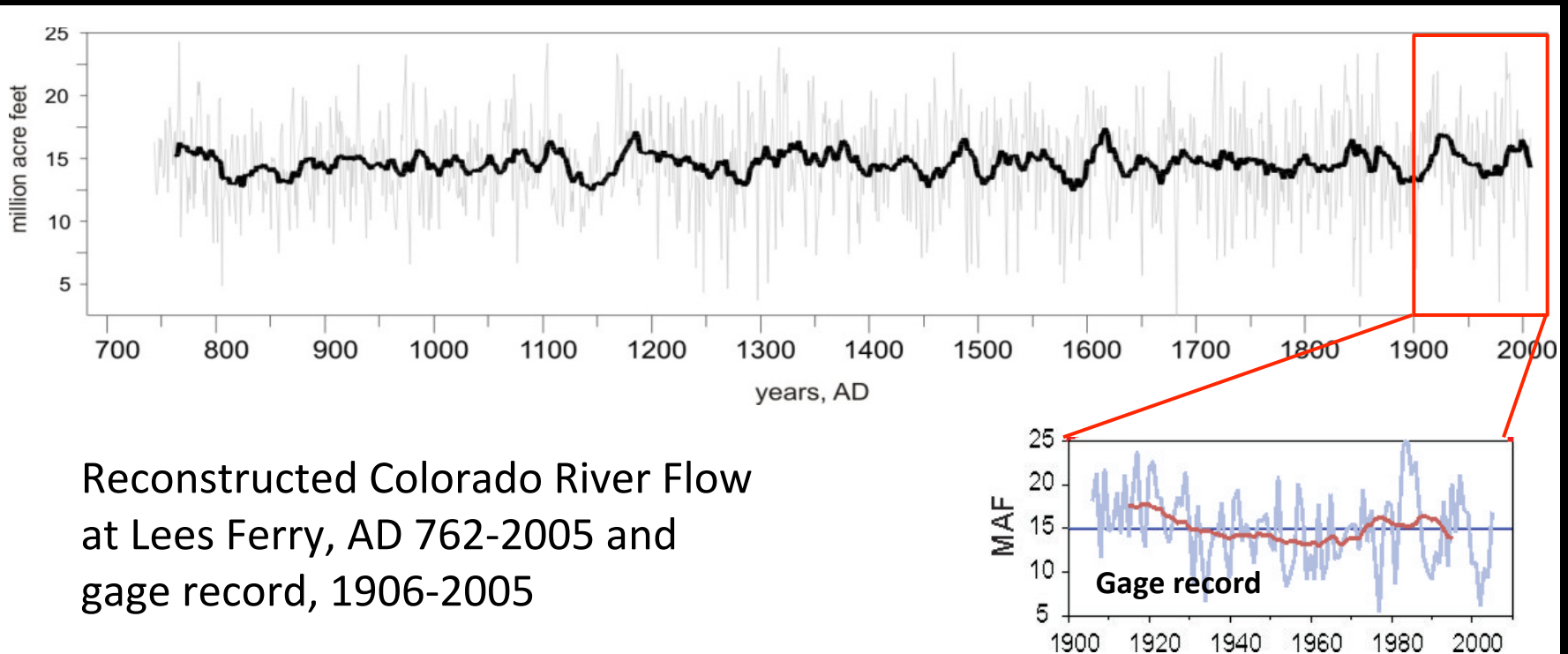


Colorado River at Lees Ferry, AD 762-2005



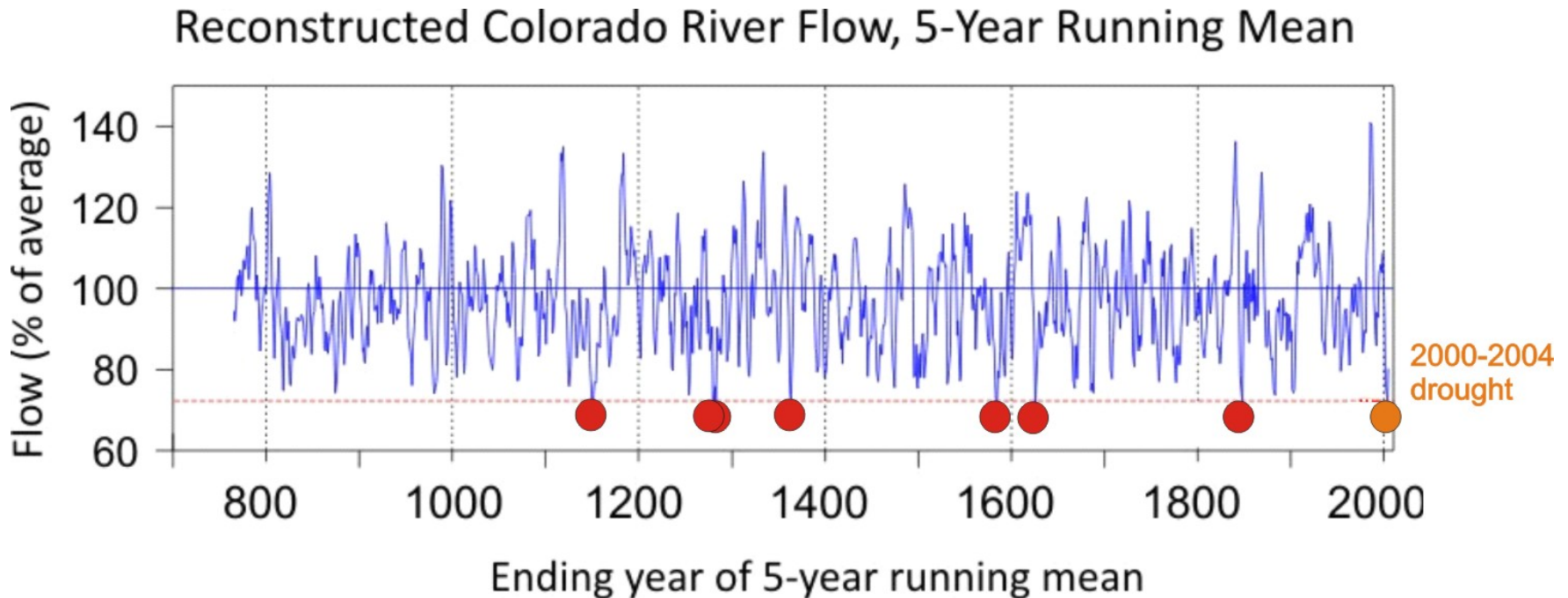
Context:

How representative is the gage record over a longer time frame?



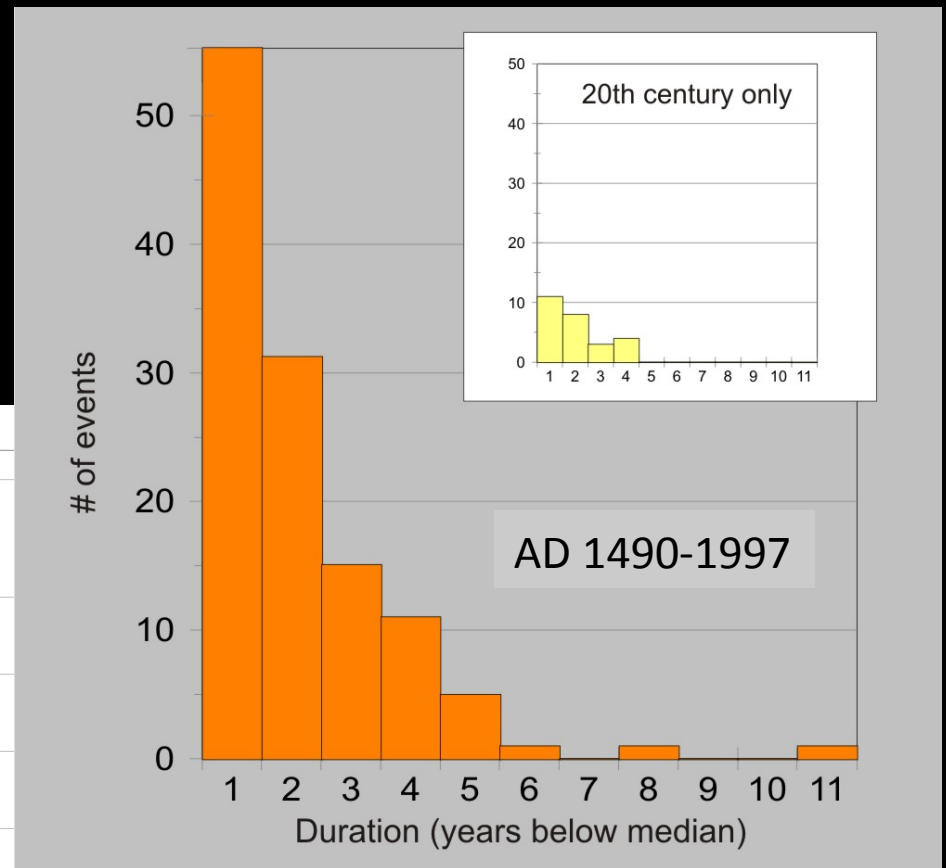
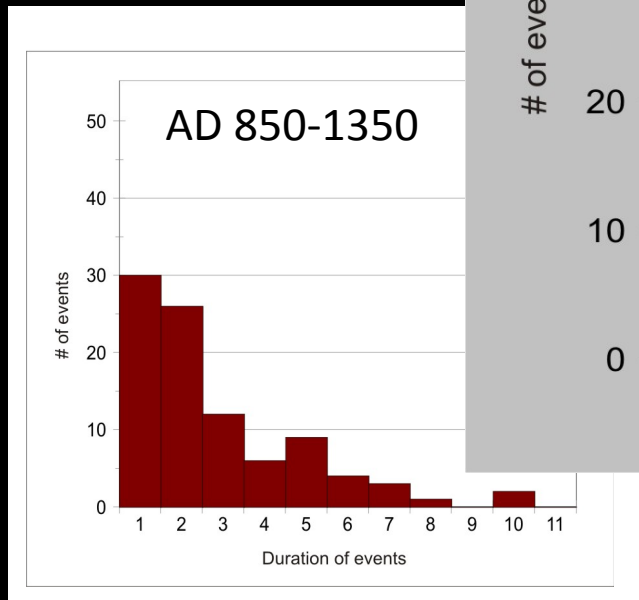
Assessment of extreme events:

The 2000-2004 drought in a millennial context



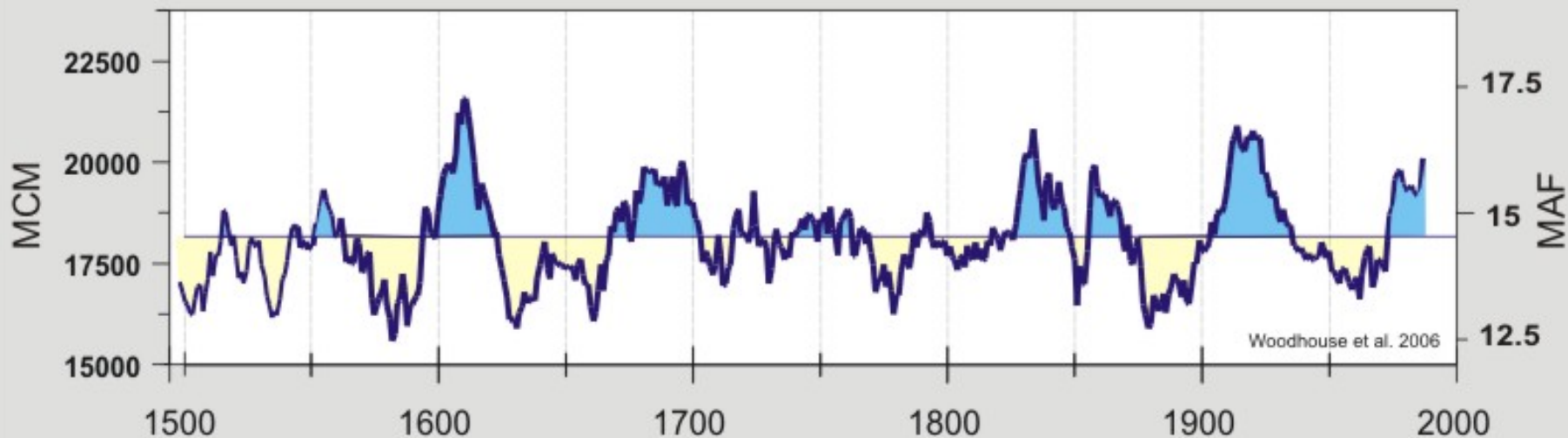
Awareness of a broader range of drought variability:

Colorado River drought duration and frequency, 762-2005, compared to the 20th century



Insights on low-frequency (scale of decades) variability

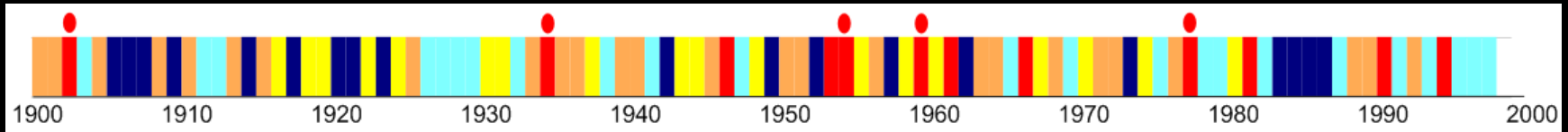
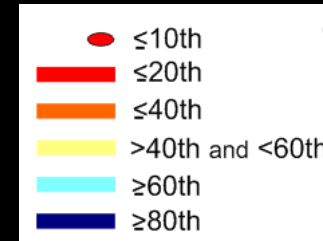
Lees Ferry Streamflow Reconstruction (20-yr moving average), 1490-1997



Pluvials	Droughts
Wettest non-overlapping 20-yr average	Driest non-overlapping 20-yr average
1602-1621	1573-1592
1905-1924	1622-1641
1825-1844	1870-1889
1978-1997	1652-1671
1687-1706	1526-1545
	1953-1972 (8th)

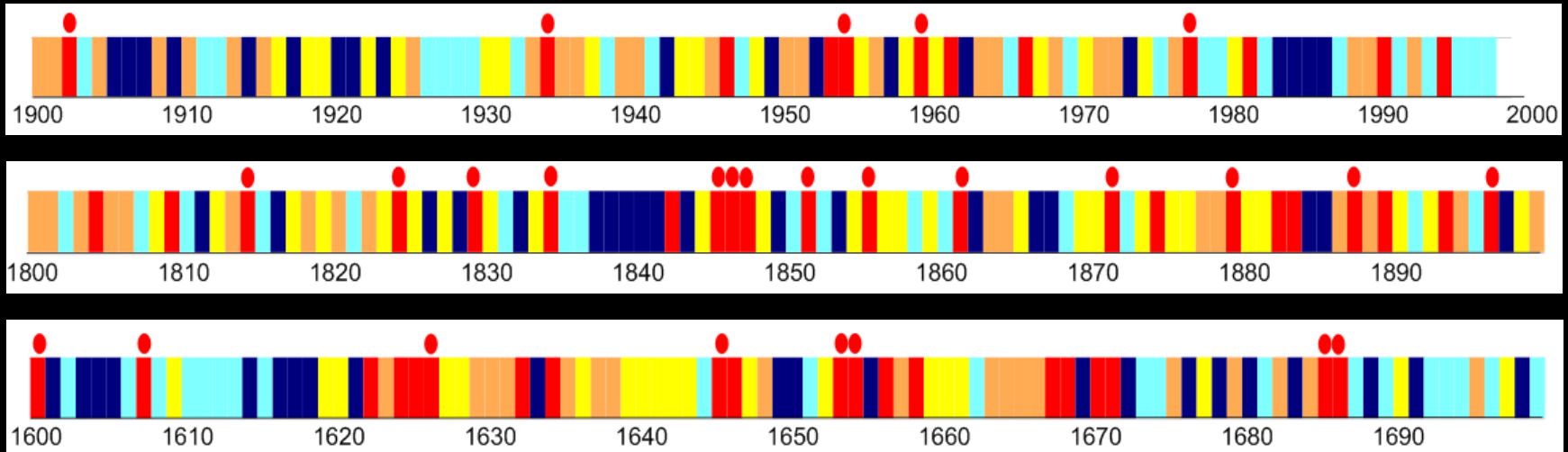
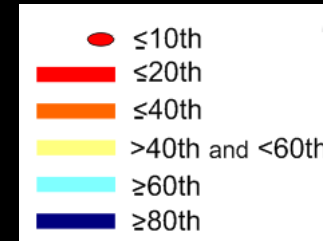
A Richer Sequence of Flows:

Lees Ferry Reconstructed Streamflow
values categorized by percentile



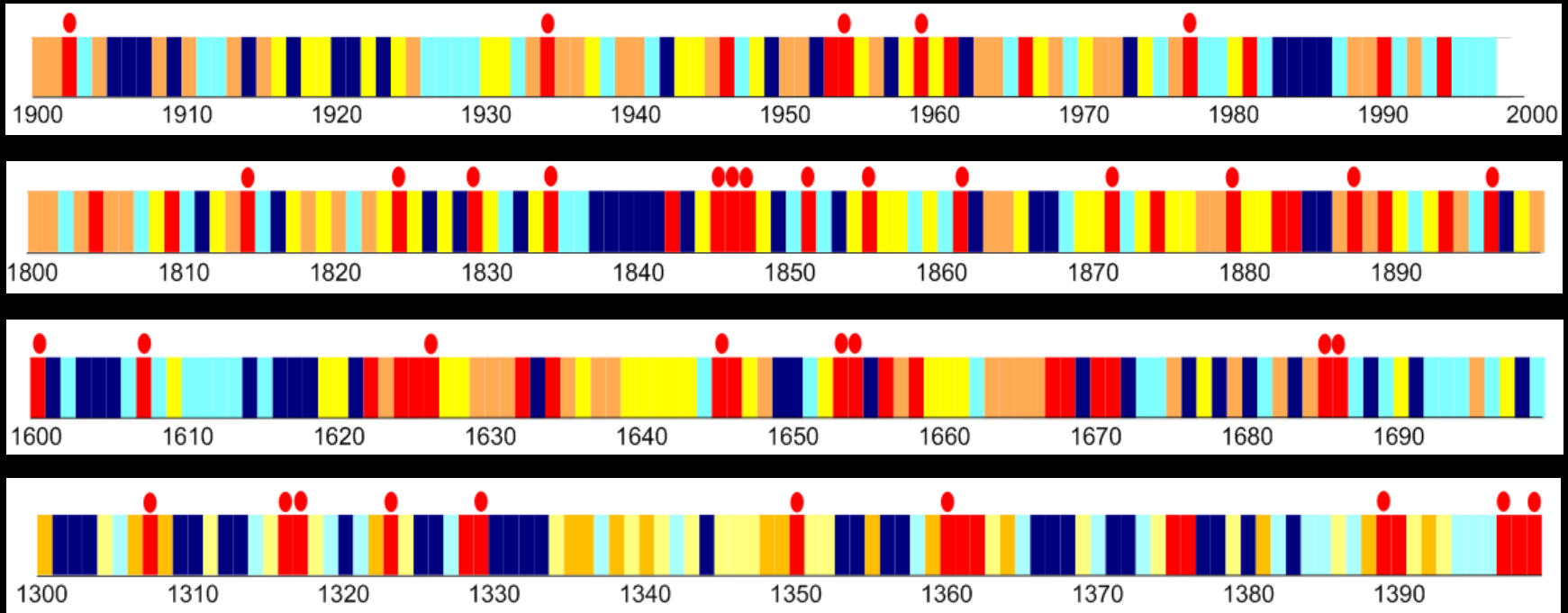
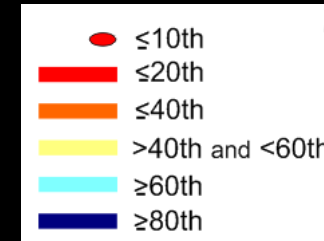
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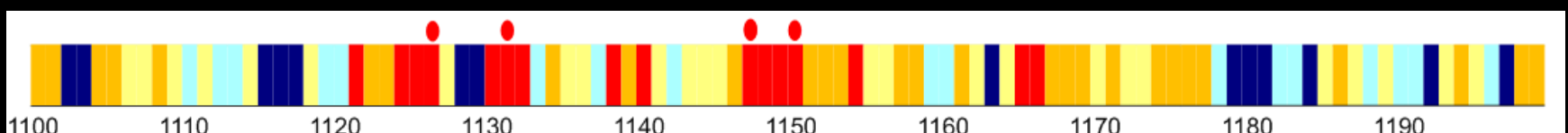
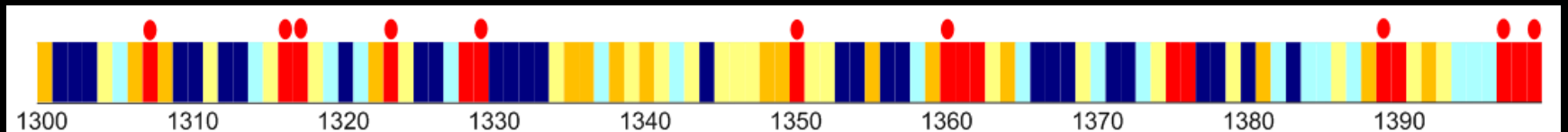
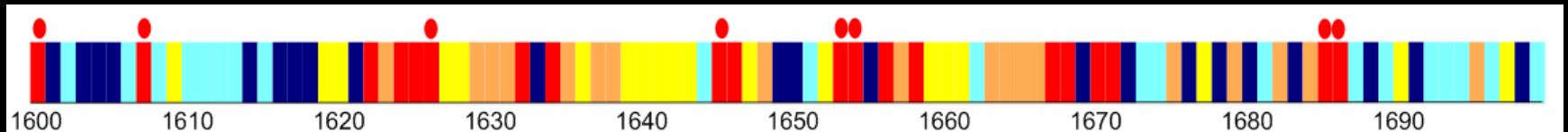
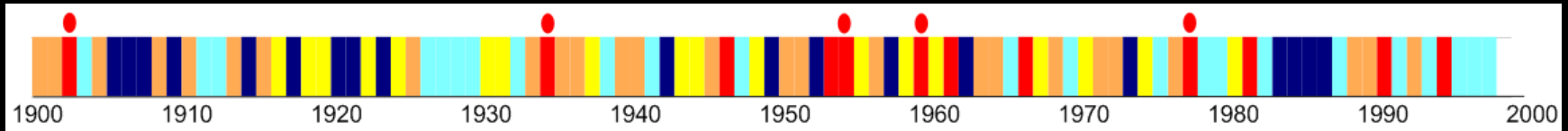
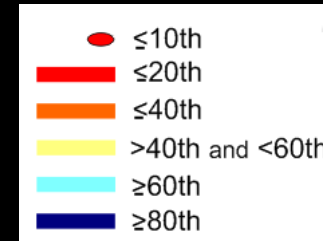
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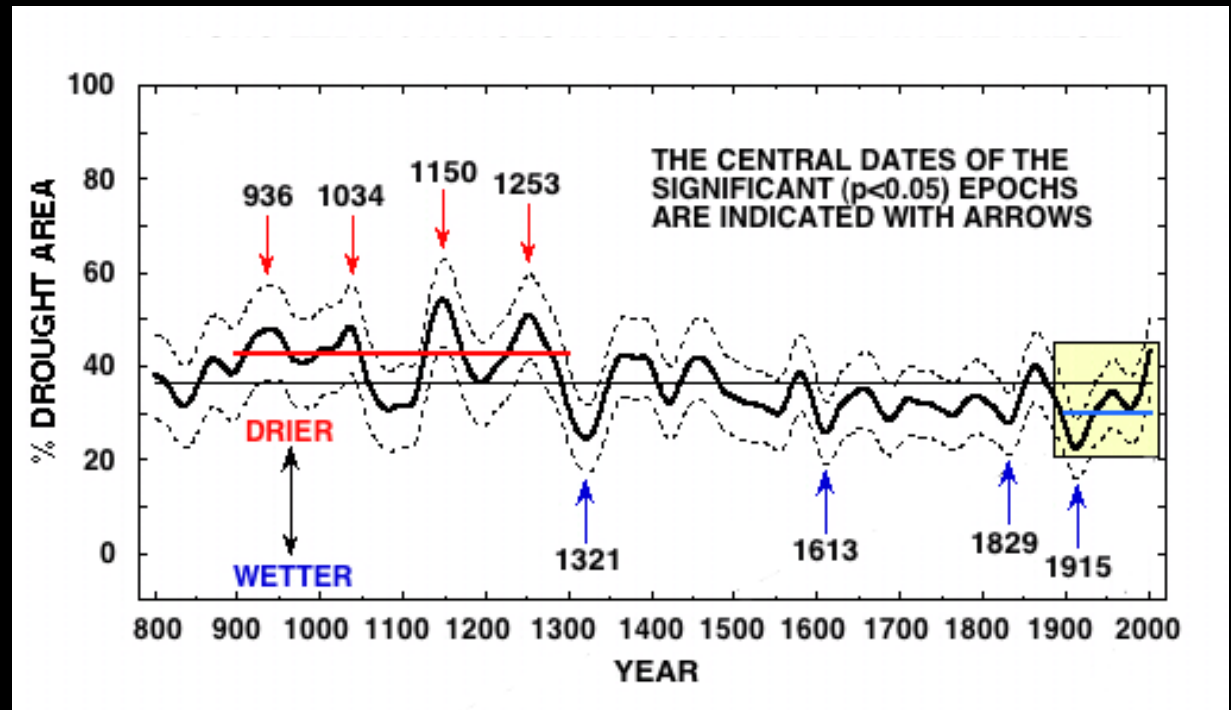
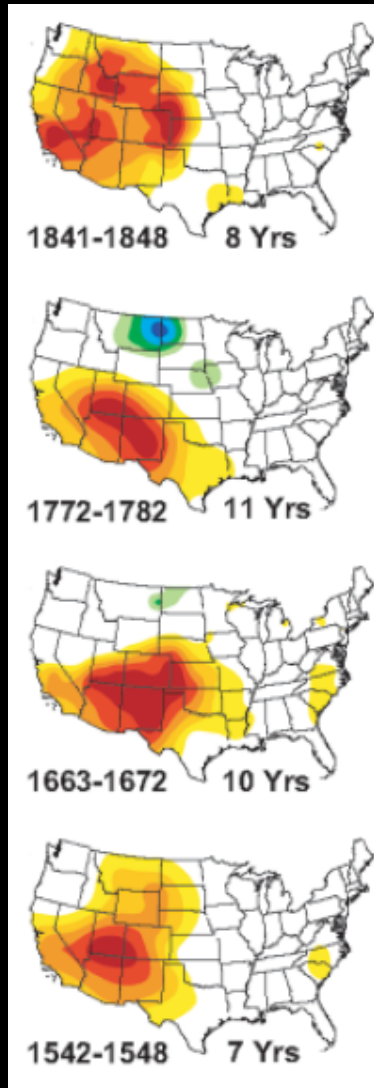
A Richer Sequence of Flows:

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Droughts also have a spatial dimension

Long-term Change in Drought Area in the Western US



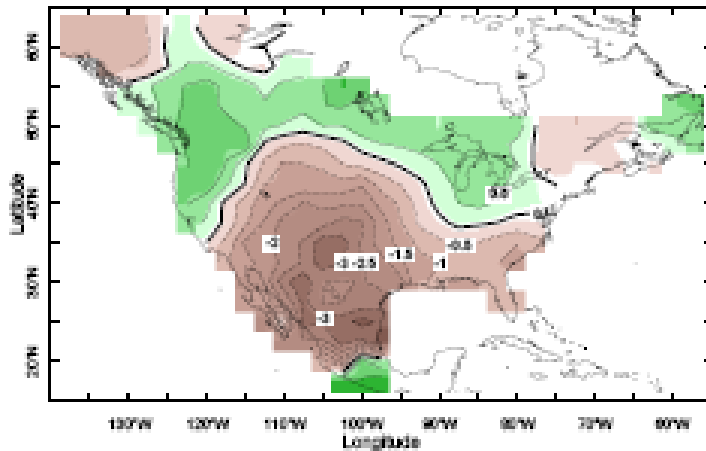
Cook et al. 2004

1950s-like Droughts in the Past

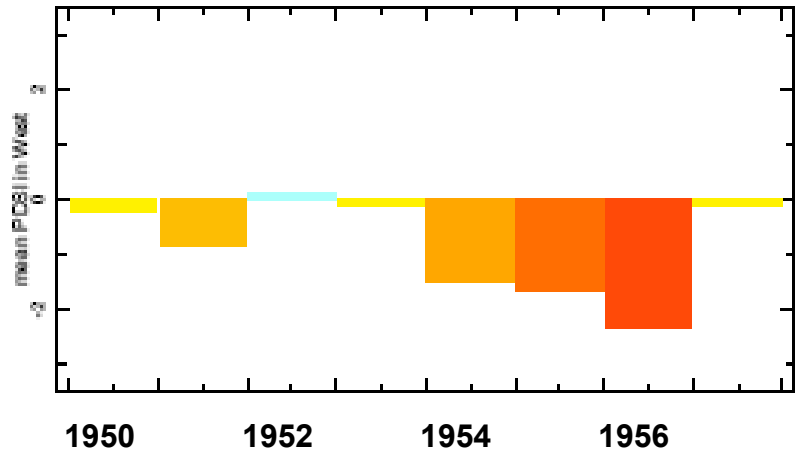
Fye et al. 2003

Perspectives on Spatial Extent, Duration, and Severity of Drought: 1950s drought compared to Medieval Period drought

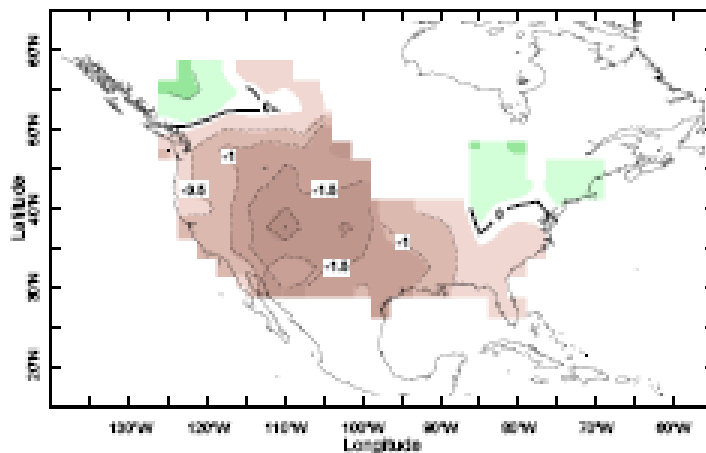
AD 1950-1957



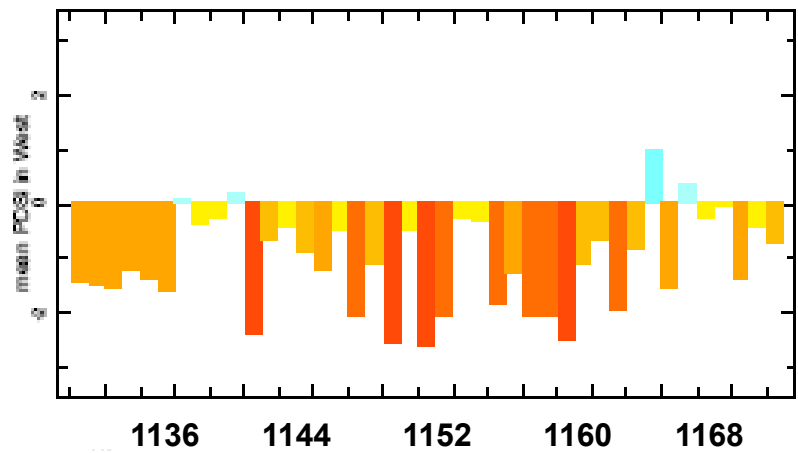
Mean Summer PDSI in West, 1950-1957



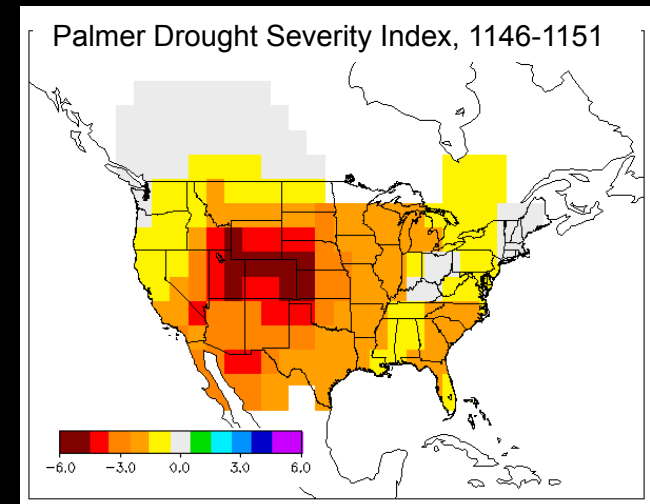
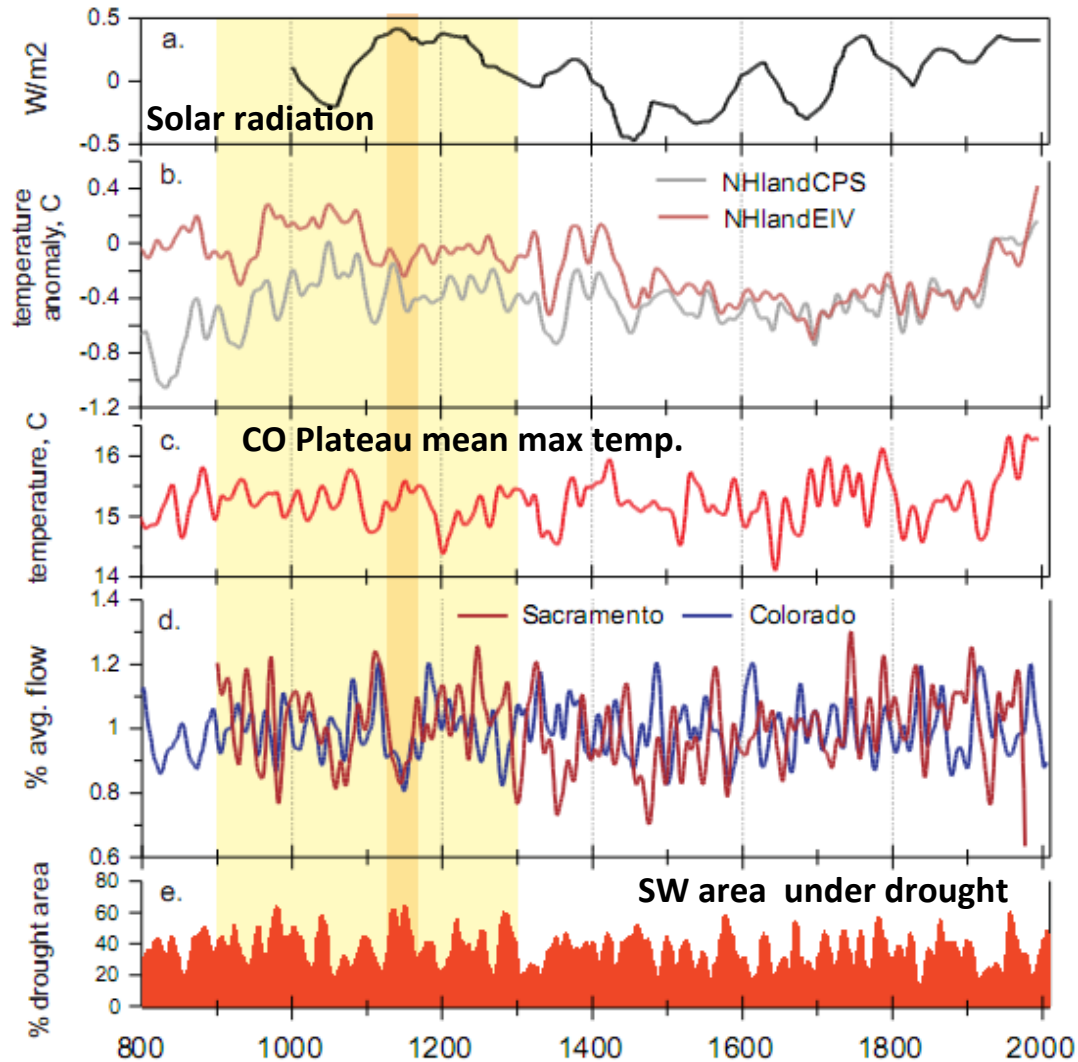
AD 1130-1170



Mean Summer PDSI in West, 1130-70



Worst case drought scenario: 12th century medieval drought



What about the summer monsoon?



In the southwestern US, the width of the first part of the growth ring provides information on winter rainfall, while the width of the part that grows later in the season provide information on summer rain.

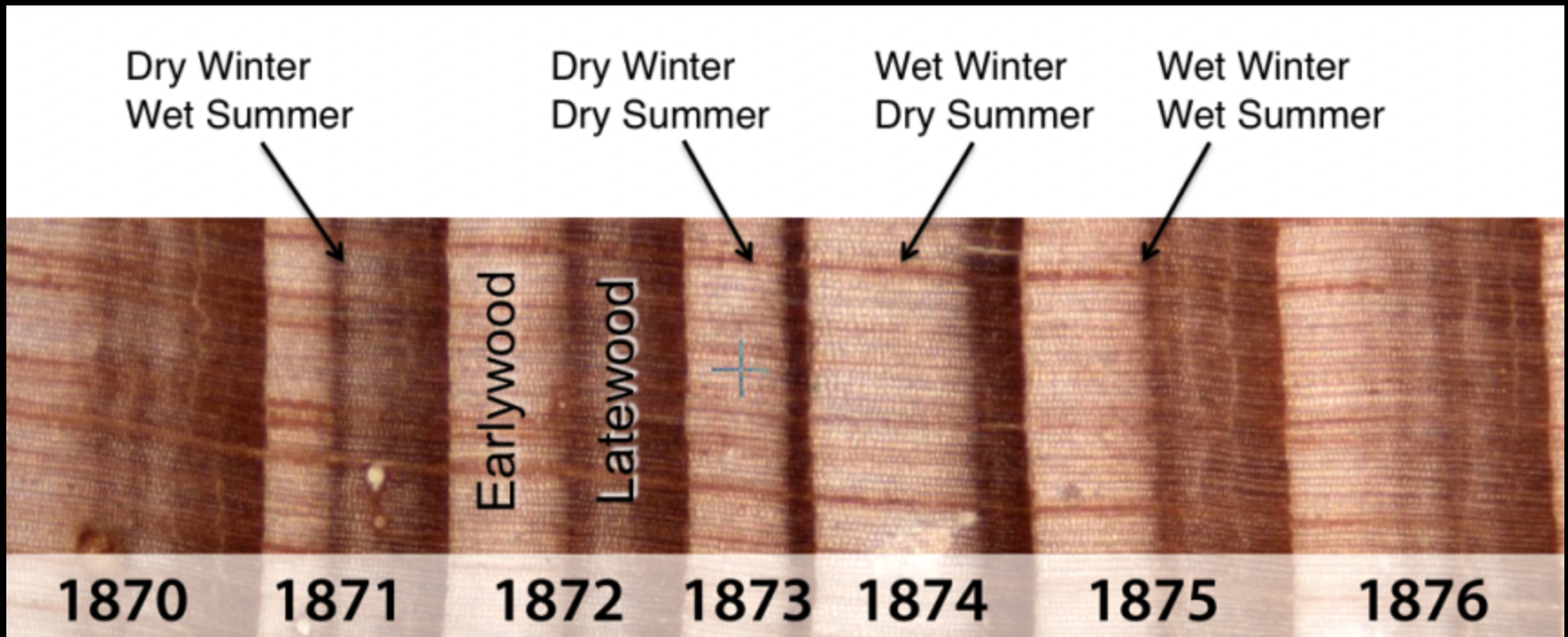
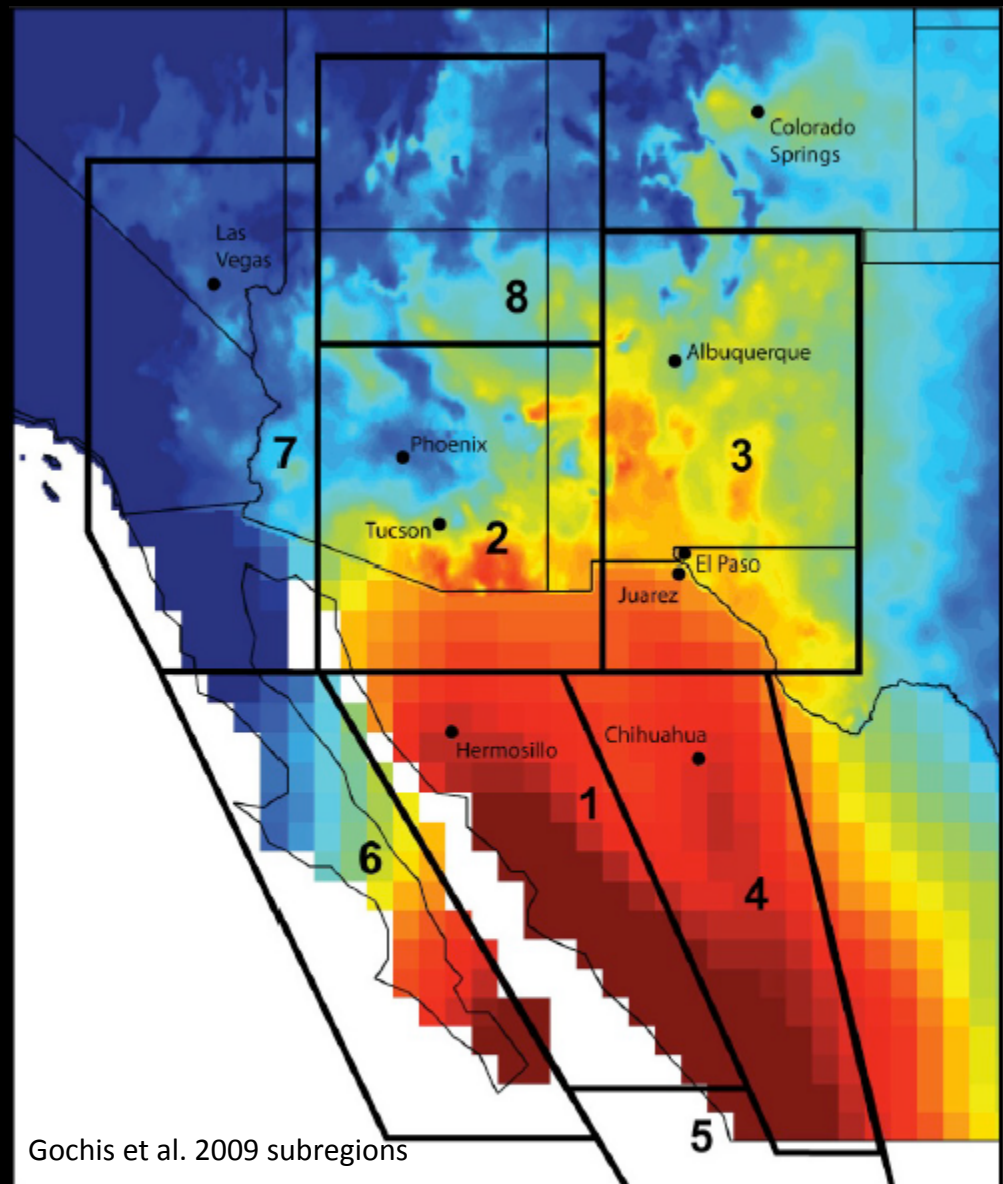


Image: Dan Griffin

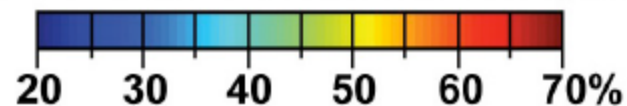
North American Monsoon Domain with Subregions

Fraction of annual precipitation that falls in July-September



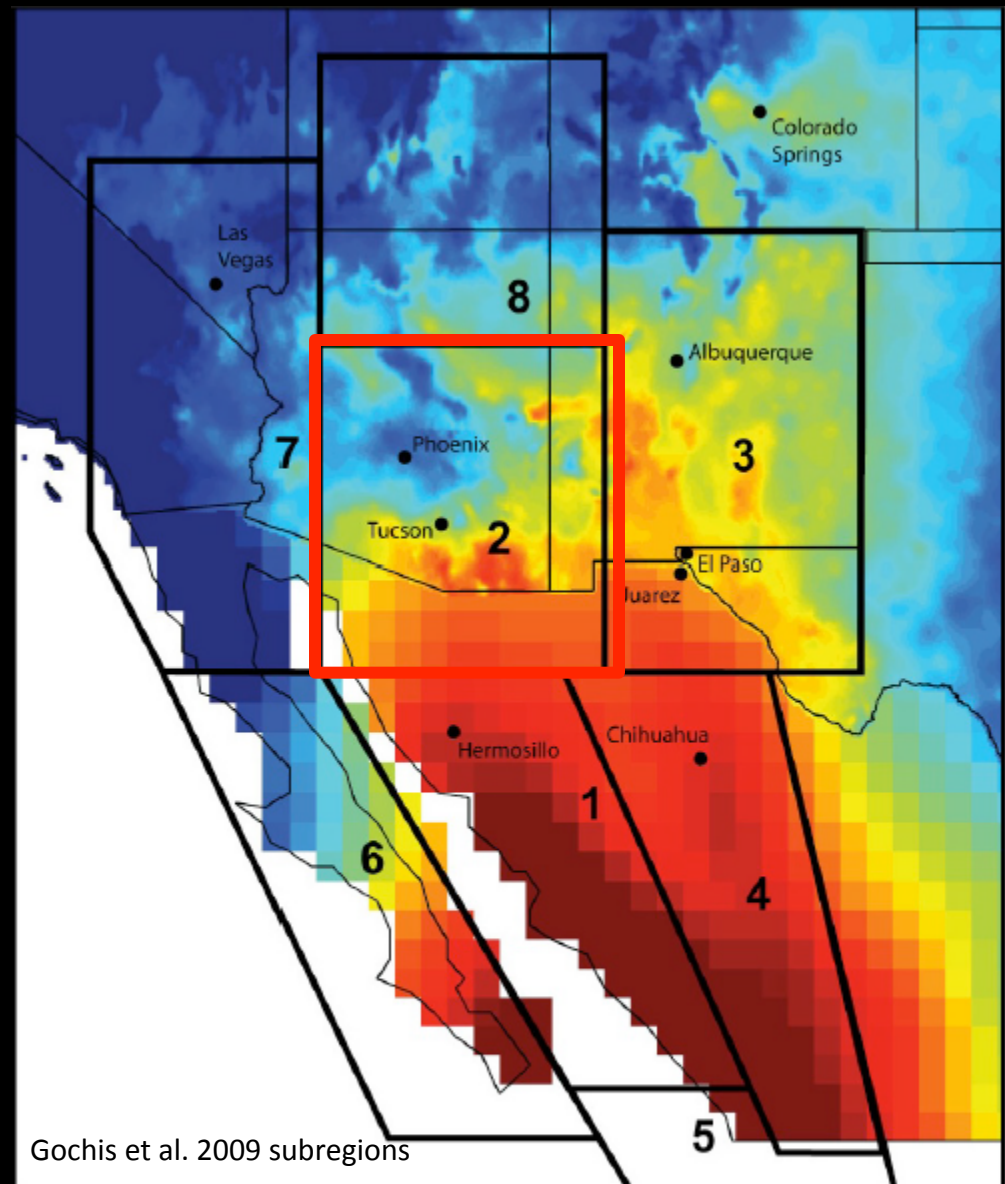
Gochis et al. 2009 subregions

JAS Fraction of Annual Precipitation



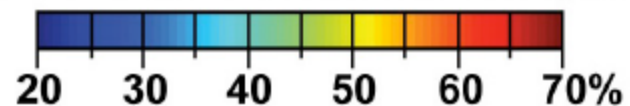
North American Monsoon Domain with Subregions

Focus on Region 2

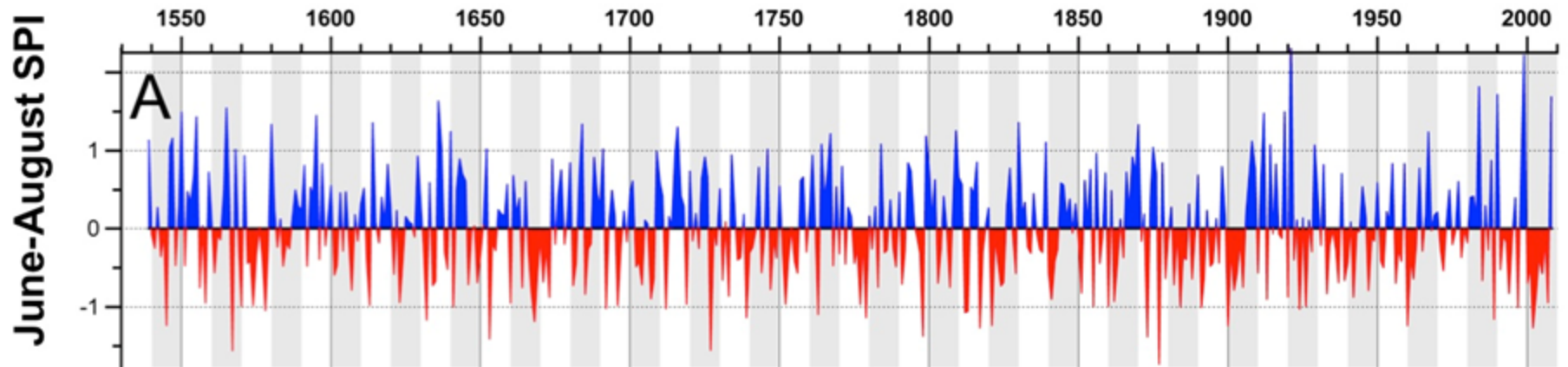


Gochis et al. 2009 subregions

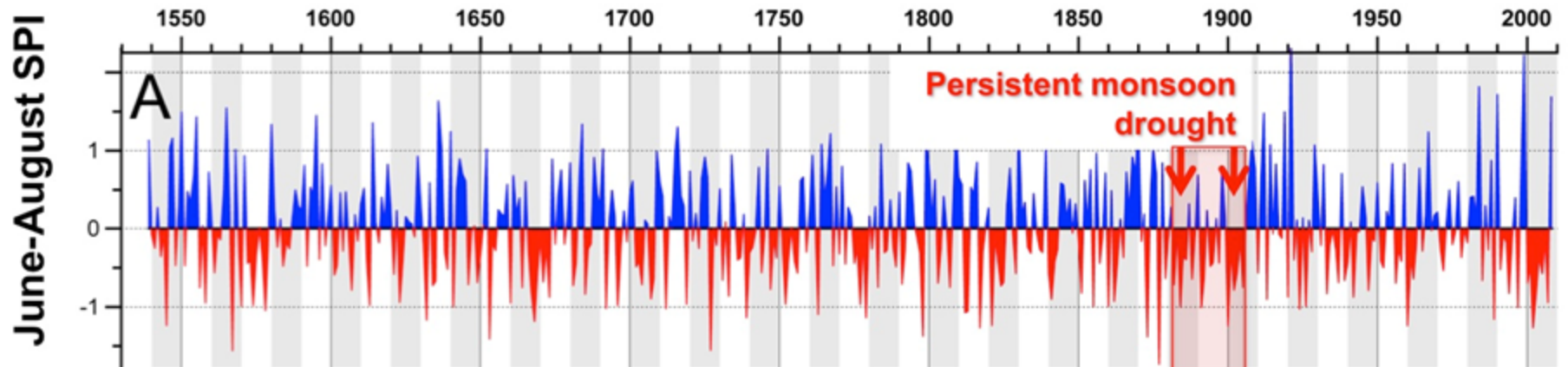
JAS Fraction of Annual Precipitation



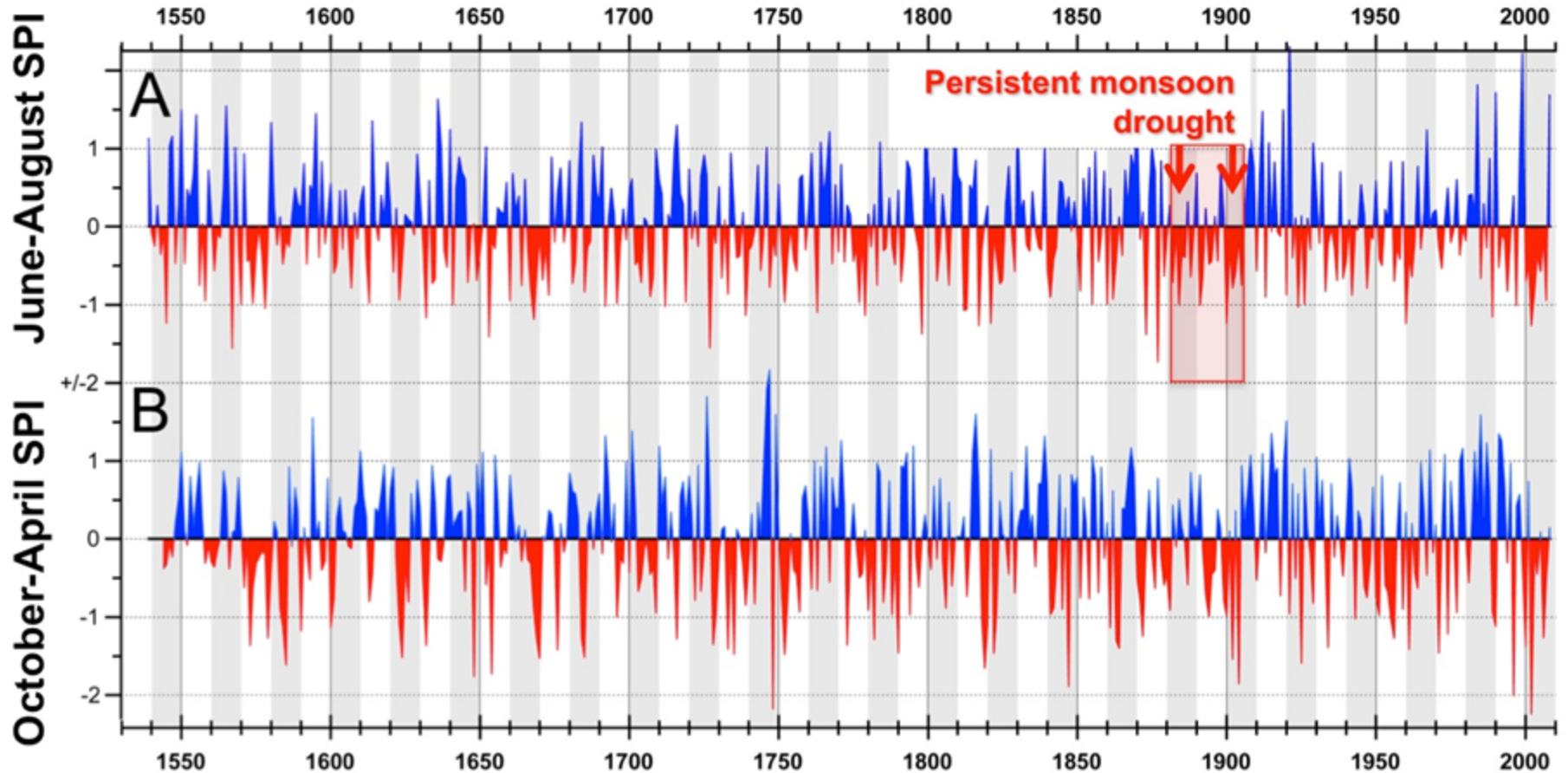
Reconstruction of Arizona June-August precipitation, 1539-2008



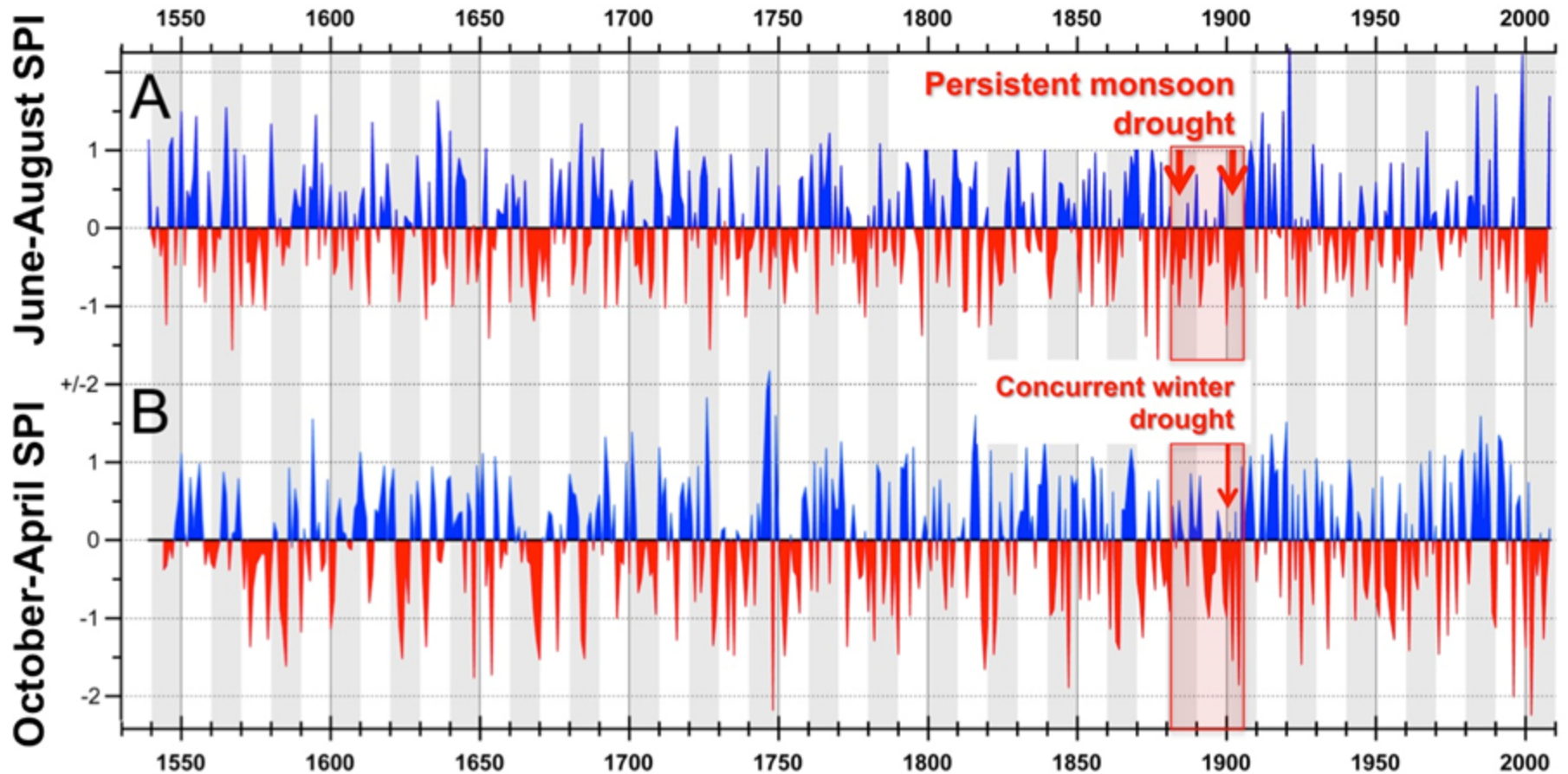
Reconstruction of Arizona June-August precipitation, 1539-2008



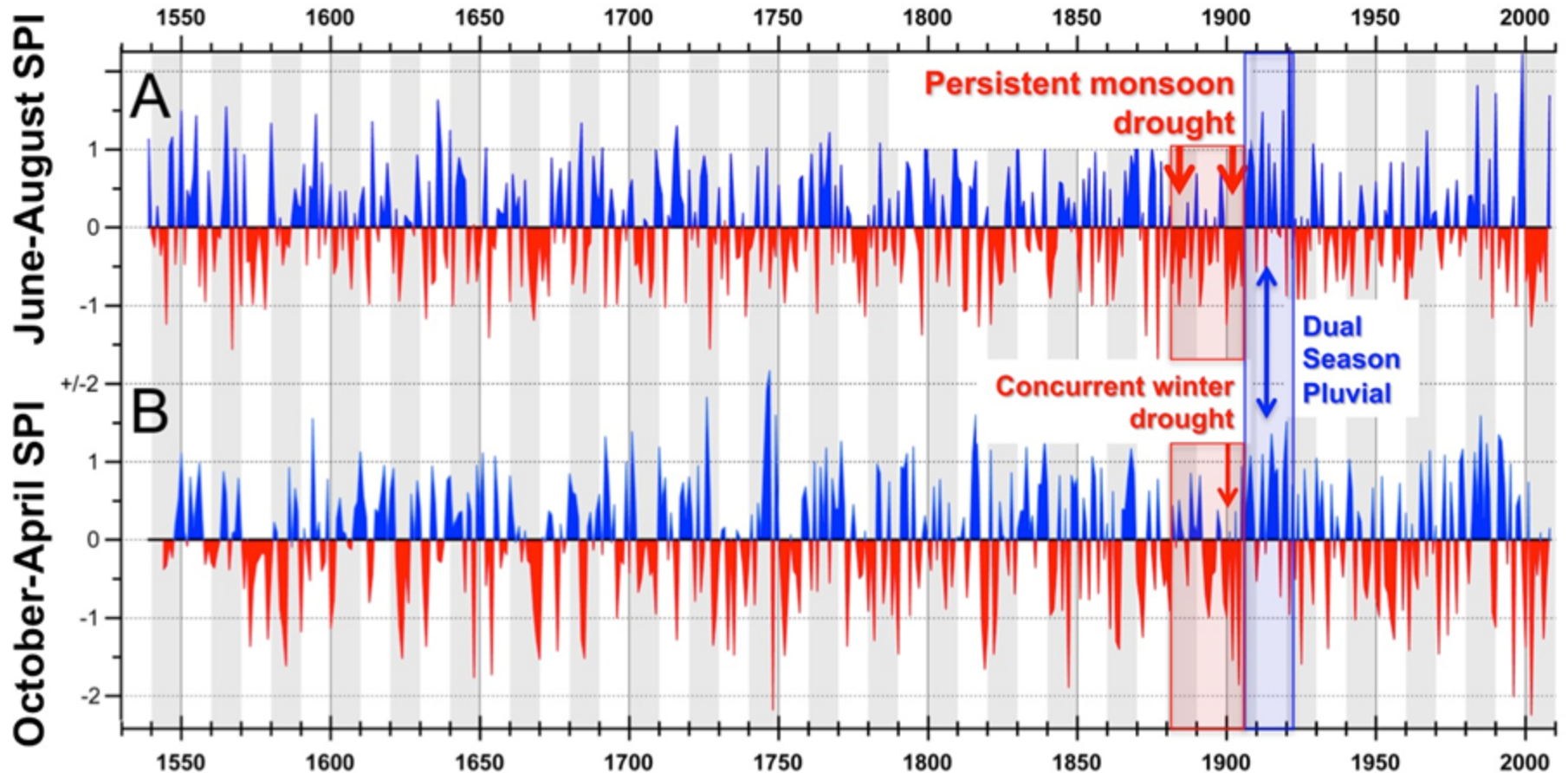
Reconstruction of Arizona June-August and October-April precipitation, 1539-2008



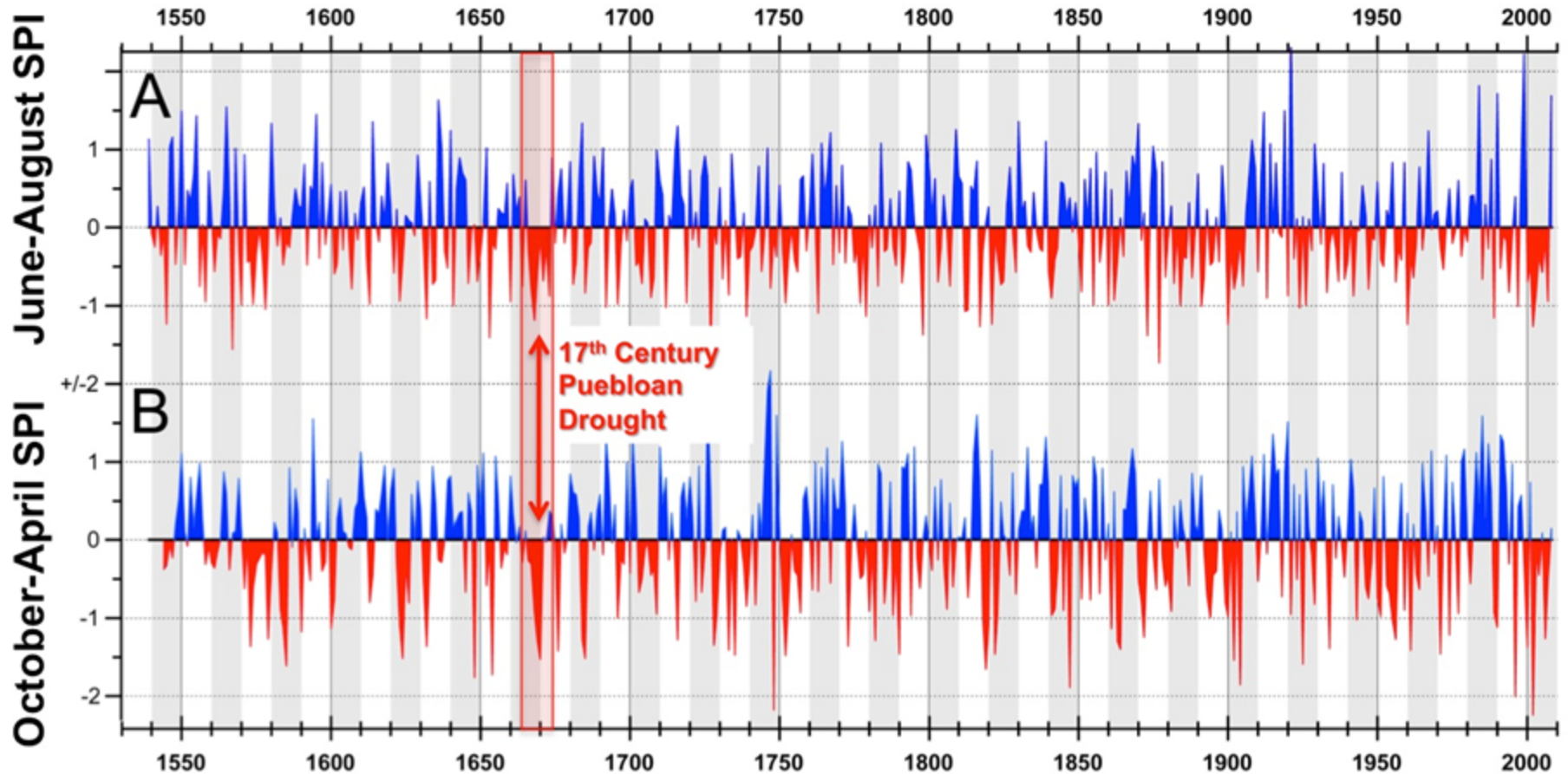
Reconstruction of Arizona June-August and October-April precipitation, 1539-2008



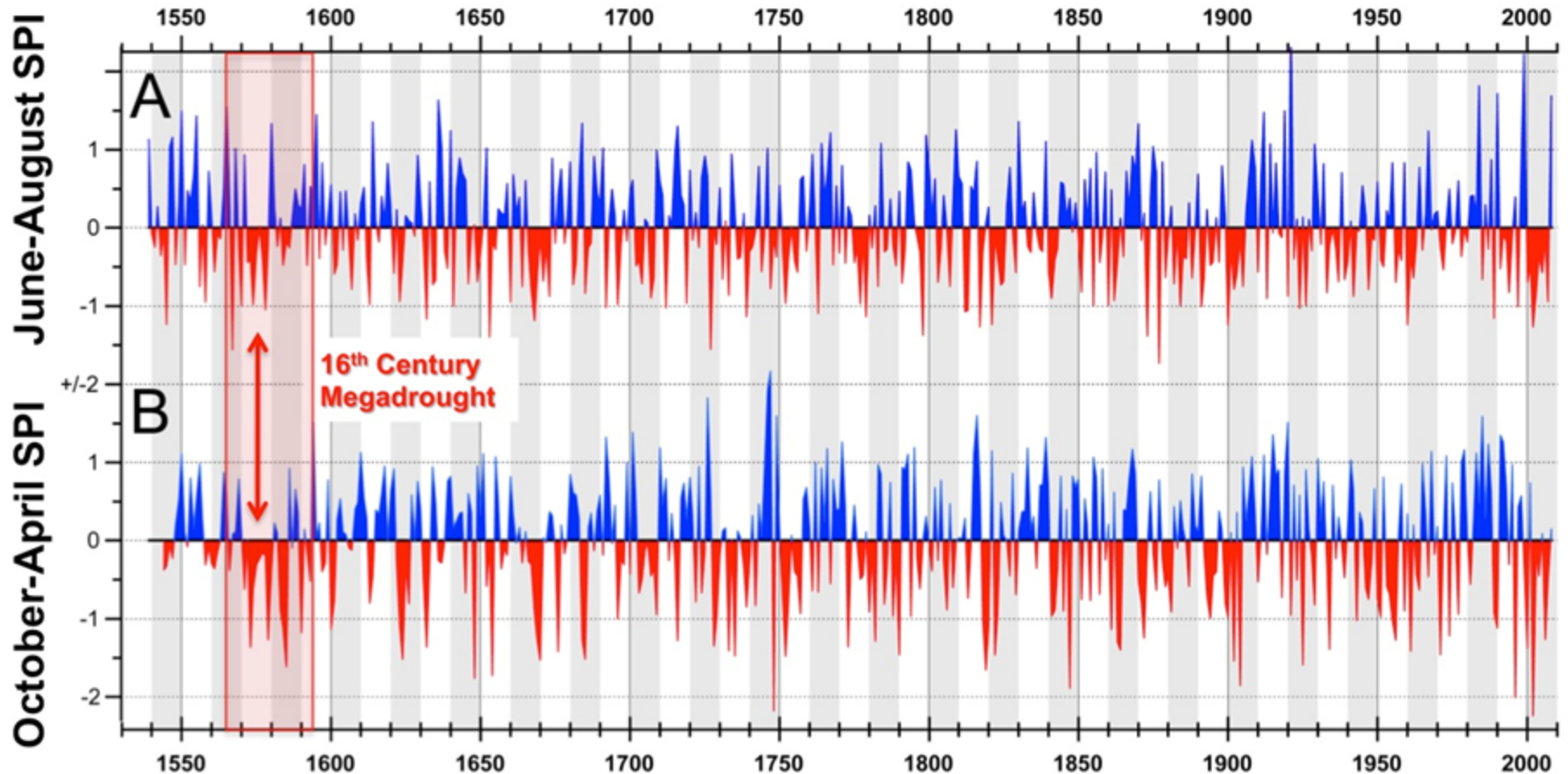
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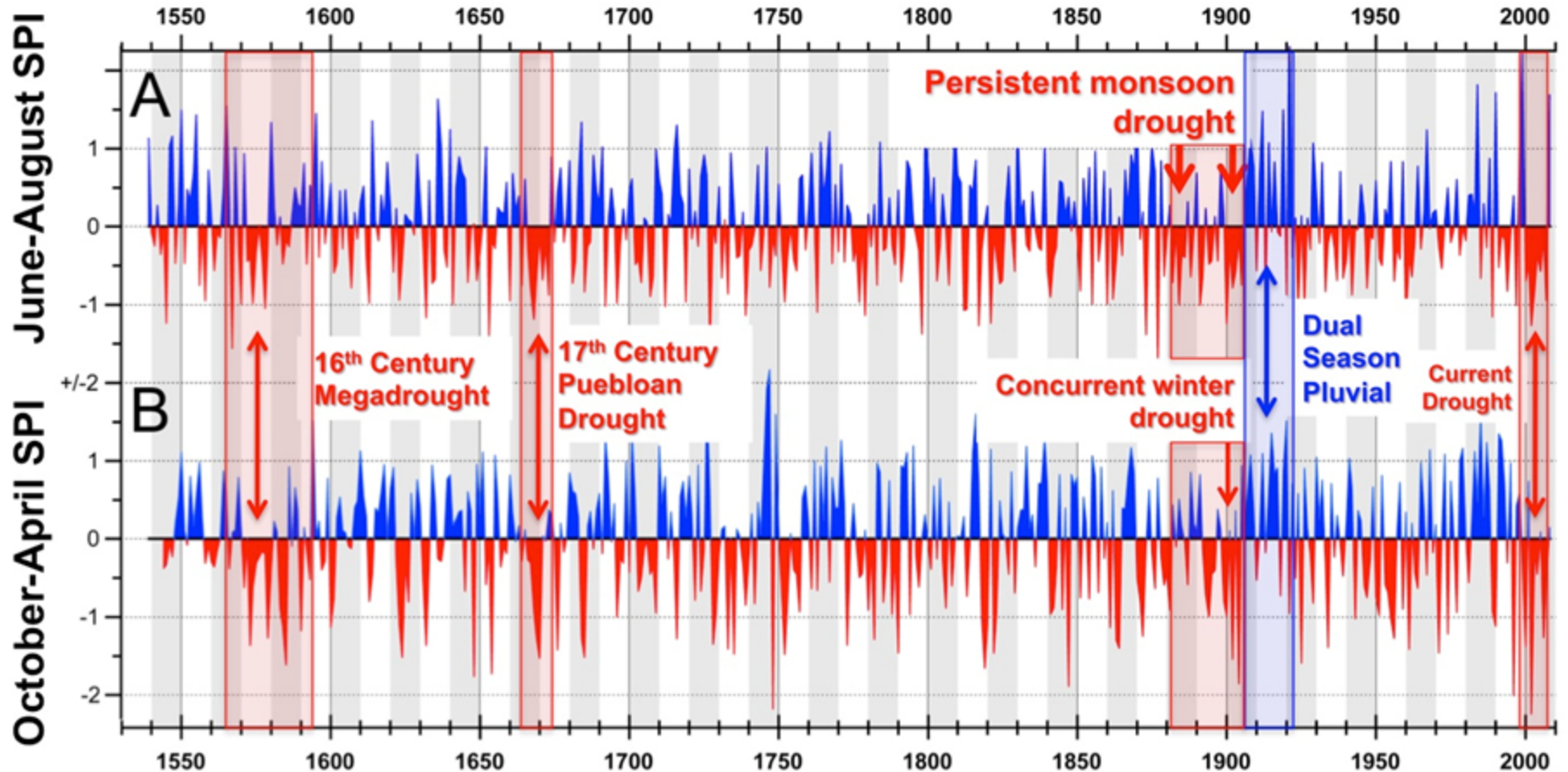
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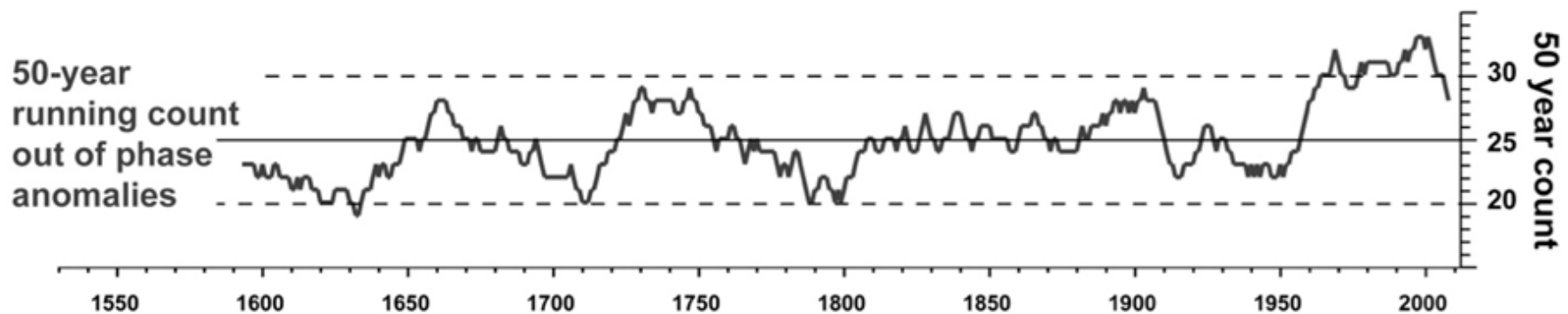
Reconstruction of Arizona June-August and October-April precipitation, 1539-2008



Reconstruction of Arizona June-August and October-April precipitation, 1539-2008



How often has a wet winter been followed by a dry summer (or a dry winter followed by a wet summer)?



A history of fire frequency from fire scars in trees + seasonal precipitation reconstructions

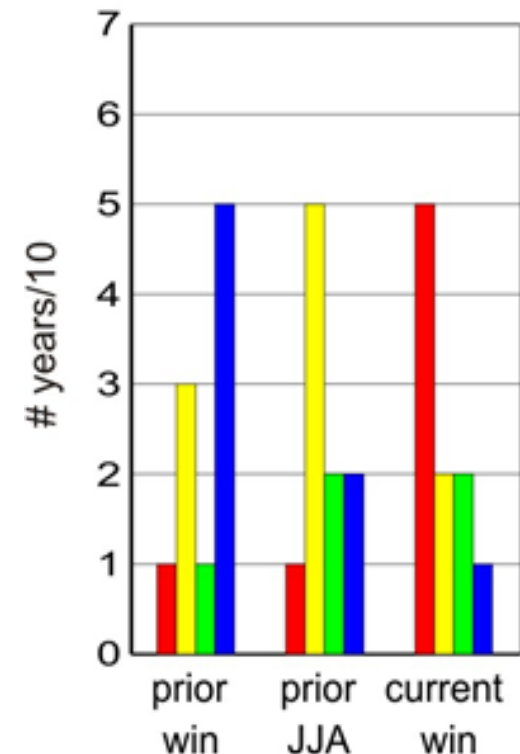


Top 10 Years for Pre-monsoon Season Fires

Big fire years = wet previous winter, dry previous summer, very dry current winter

- driest20pctl
- dry50pctl
- notdry
- wettest20pctl

NAM2 (Arizona)



How are climate and streamflow reconstructions being used by water providers and other decision makers?

- To provide an awareness of a broader range of climatic & hydrologic variability than contained in the gage record
- As the basis for determining a drought “worst-case scenarios”
- To test system reliability under a broader range of conditions by incorporating reconstruction data into water supply models
- When used in combination with climate change projections, to assess a range of plausible future scenarios
- To communicate risk or to aid in making recommendations

Questions, comments?

URLs that may be useful:

TreeFlow: Streamflow Reconstructions from
Tree Rings: treeflow.info

Investigating North American Monsoon
Variability in the Southwestern USA using
Instrumental and Tree-Ring Data:

<http://monsoon.ltrr.arizona.edu/>

