Kansas Droughts: a long-term perspective

KANSAS GEOLOGICAL SURVEY
The University of Kansas

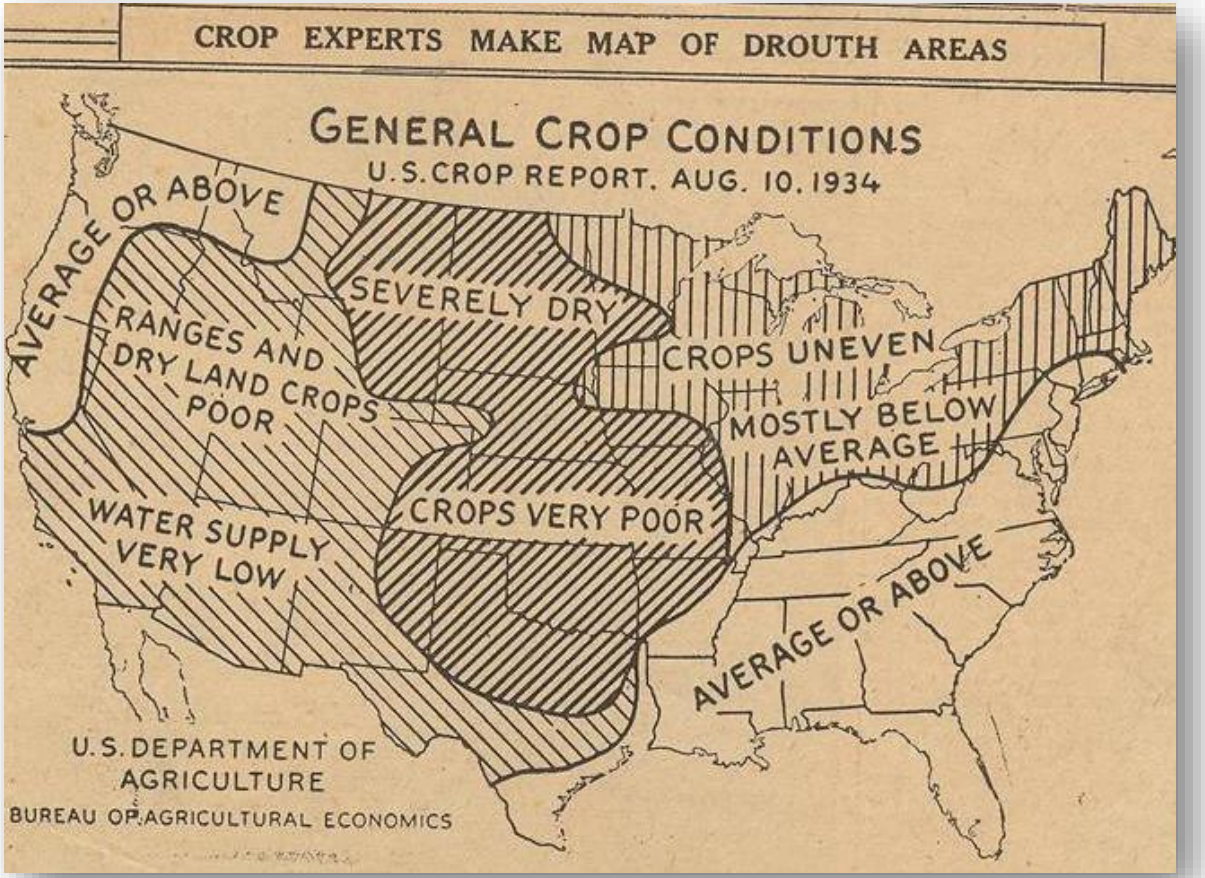
Tony Layzell, Kansas Geological Survey

Drought is one of the greatest recurring natural disasters in North America

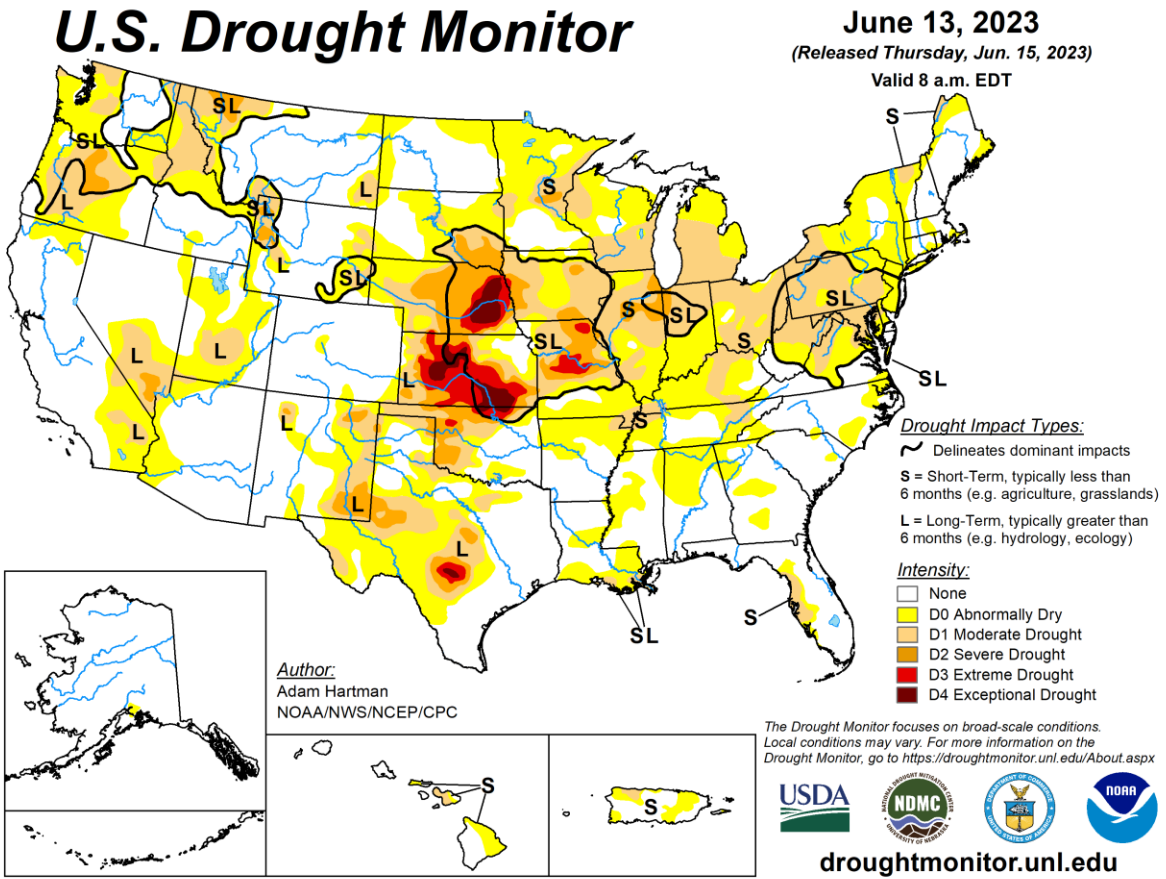
Since 1980, drought events in US have cost almost **$215 billion**

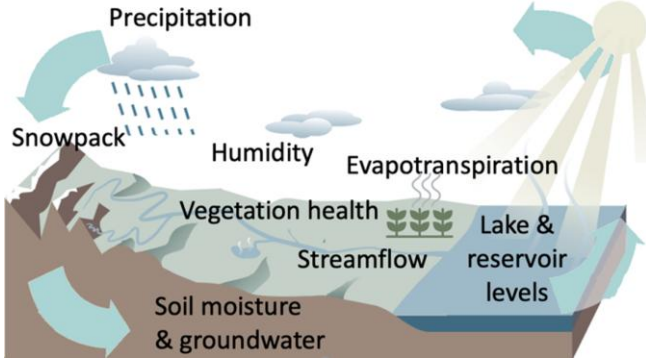
A period of **abnormally** dry weather that **persists long enough** to produce serious economic, environmental or social impacts”

Measuring drought



Measuring drought





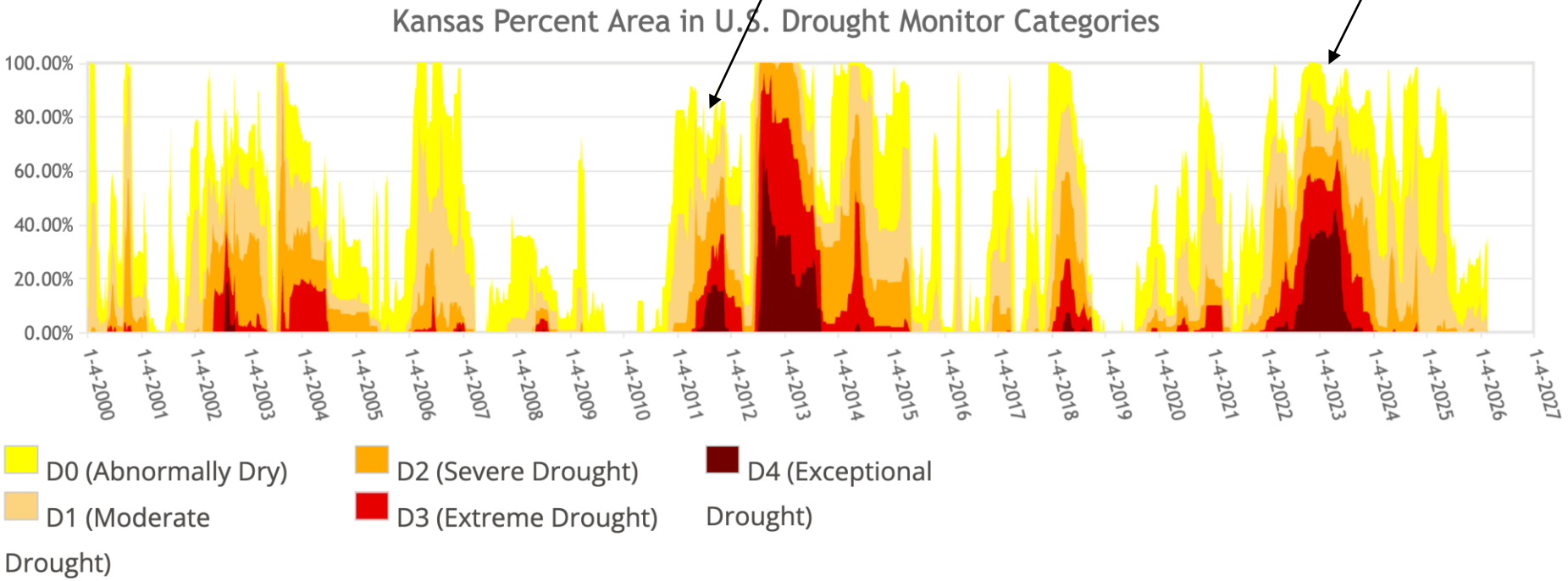
Standardized Precipitation Index

Short term 1-3 months
Long term 6-60 months

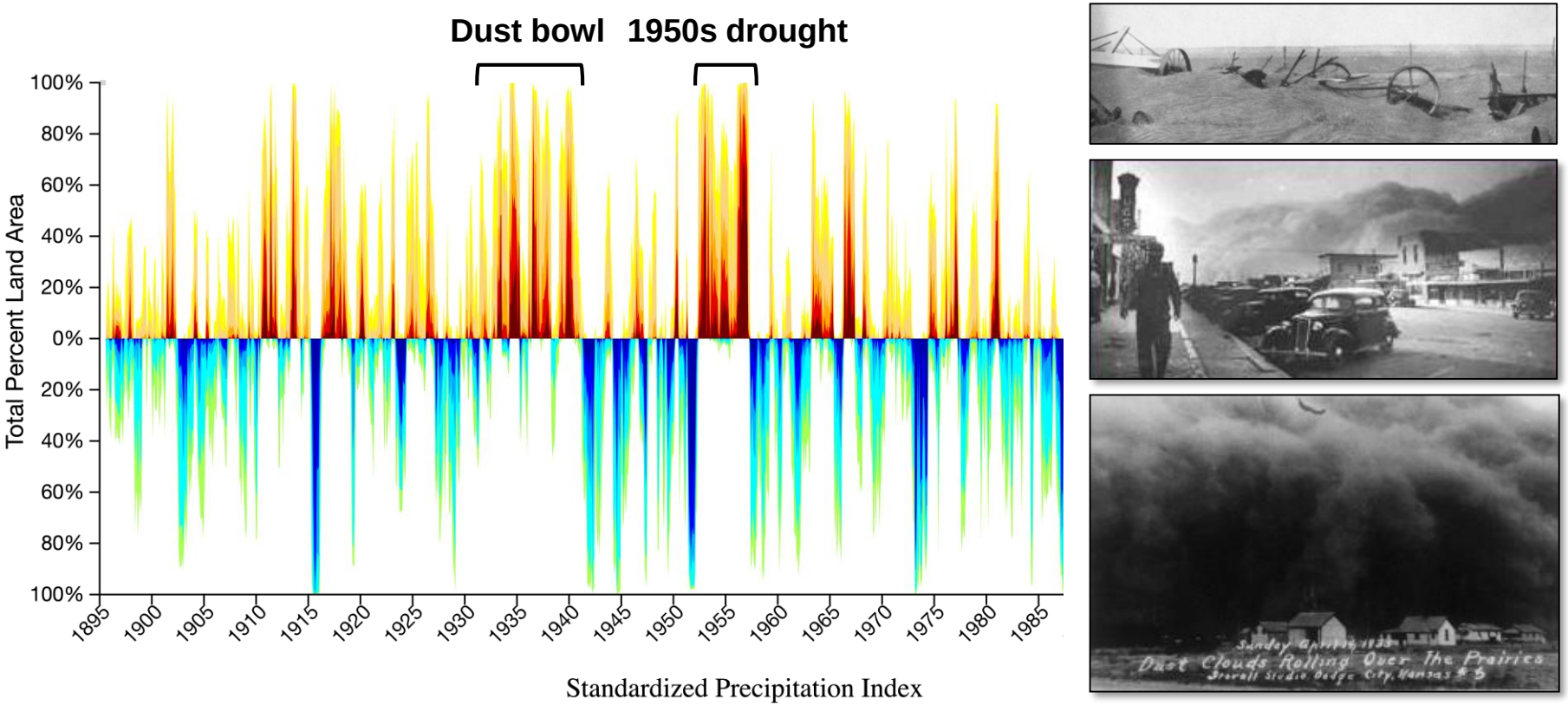
$30+ billion US

$1.7 billion KS

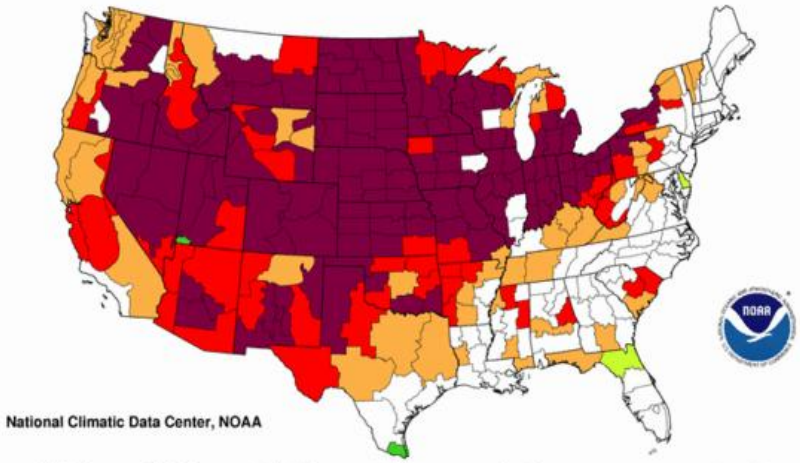
$3 billion KS



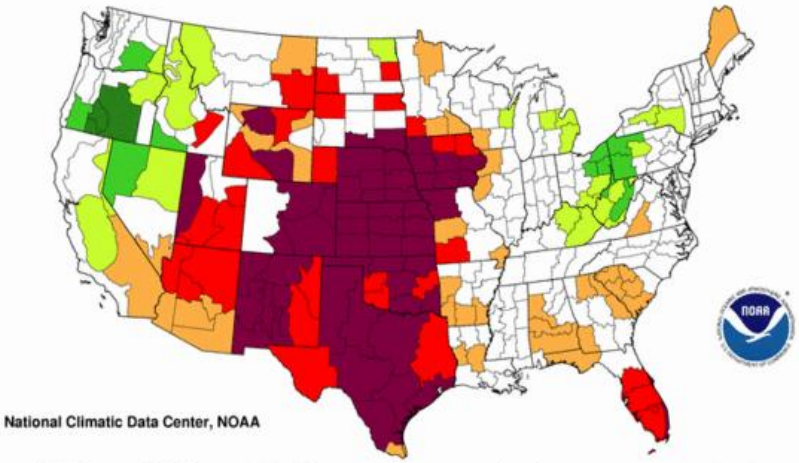
From the U.S. Drought Monitor website, https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx, 3-2-2026


Dust bowl
1950s drought
Total Percent Land Area
100%
80%
60%
40%
20%
0%
20%
40%
60%
80%
100%
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Standardized Precipitation Index
Kansas
D4
D3
D2
D1
D0
W0
W1
W2
W3
W4
Dust Clouds Rolling Over The Prairies

Palmer Drought Severity Index
July, 1934



Palmer Drought Severity Index
July, 1956



Sea surface temperatures

PDO = Pacific Decadal Oscillation
AMO = Atlantic Multi-decadal Oscillation

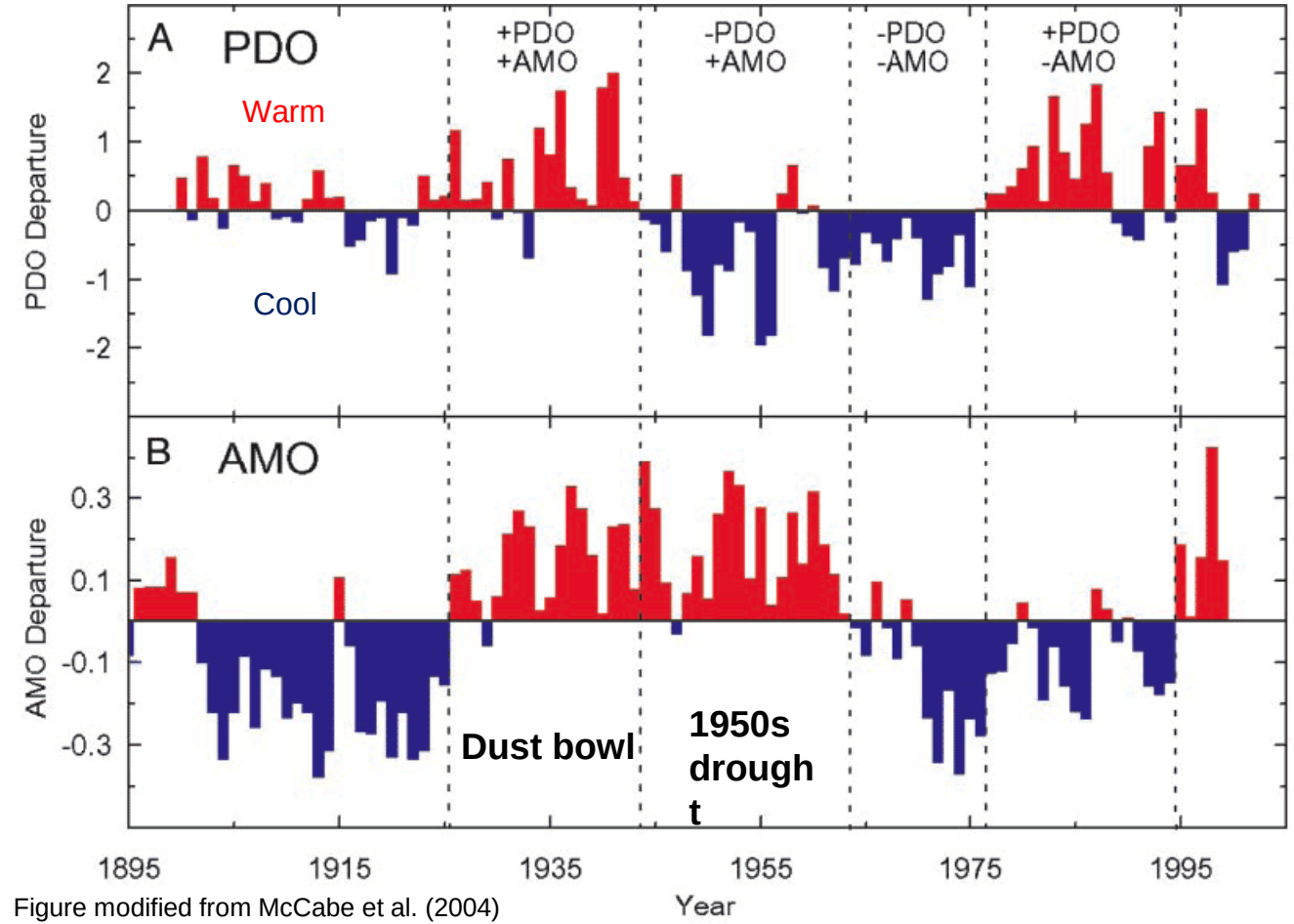
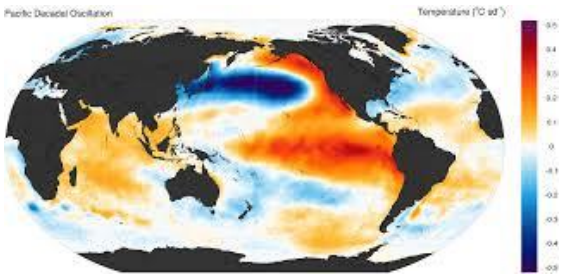
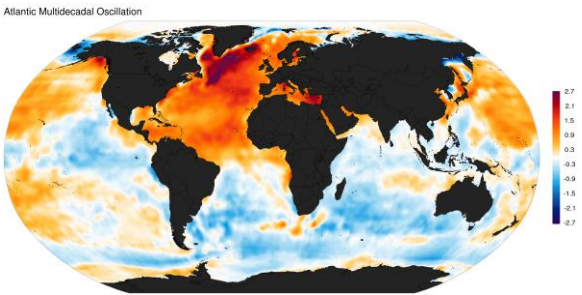


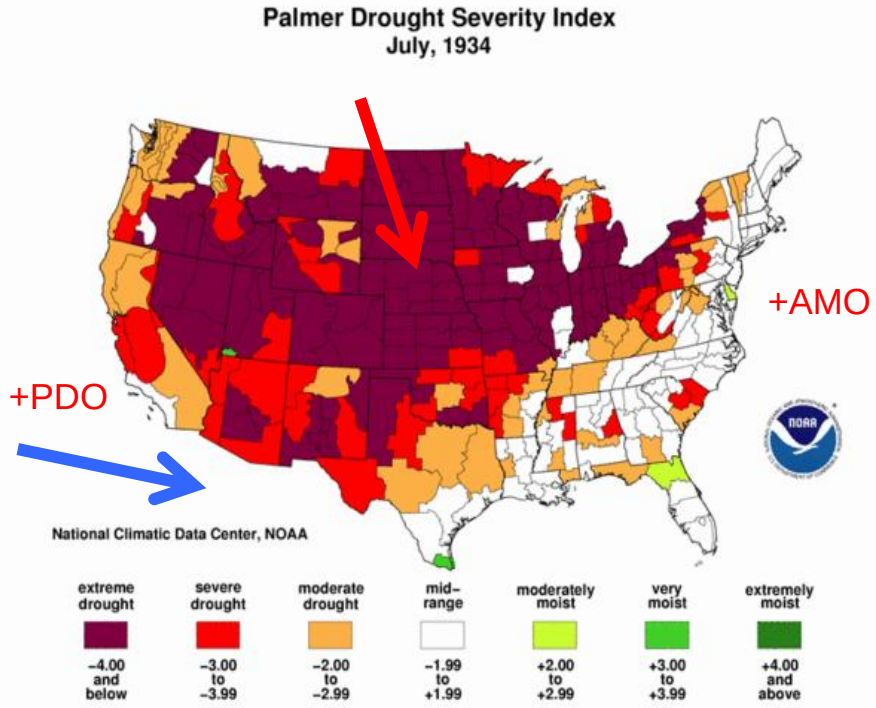
Figure modified from McCabe et al. (2004)

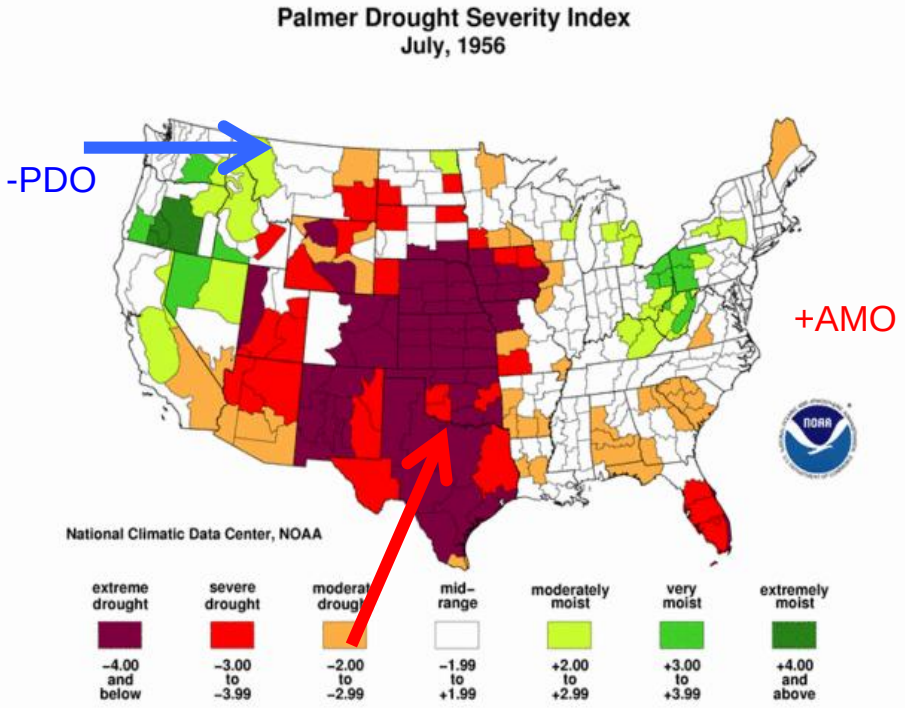


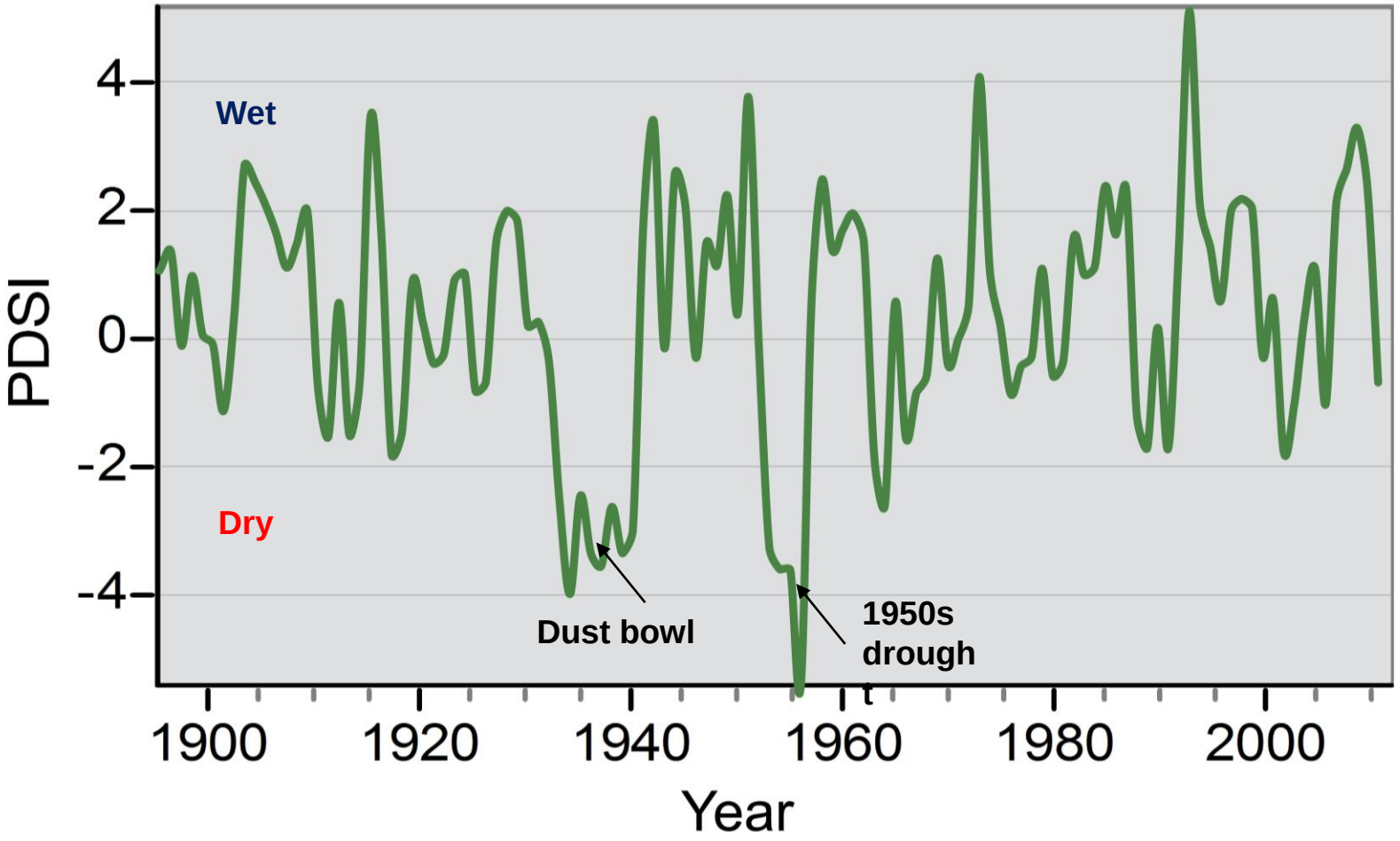
~10-20 years



~30-40 years


Palmer Drought Severity Index
July, 1934
+AMO
+PDO
National Climatic Data Center, NOAA
extreme drought
severe drought
moderate drought
mid-range
moderately moist
very moist
extremely moist
-4.00 and below
-3.00 to -3.99
-2.00 to -2.99
-1.99 to +1.99
+2.00 to +2.99
+3.00 to +3.99
+4.00 and above


Palmer Drought Severity Index
July, 1956
-PDO
+AMO
National Climatic Data Center, NOAA
extreme drought
severe drought
mid-range
moderately moist
very moist
extremely moist
-4.00 and below
-3.00 to -3.99
-2.00 to -2.99
-1.99 to +1.99
+2.00 to +2.99
+3.00 to +3.99
+4.00 and above


PDSI
4
2
0
-2
-4
Wet
Dry
Dust bowl
1950s
drough
t
1900
1920
1940
1960
1980
2000
Year

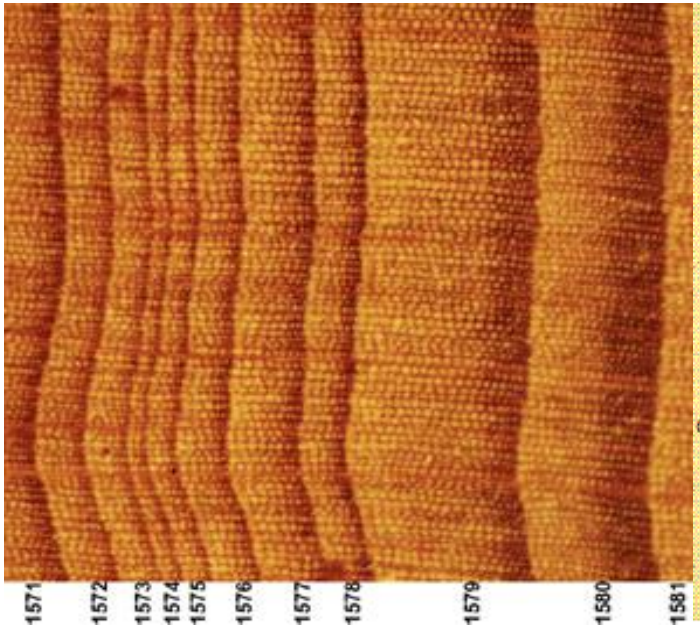
Tree-rings

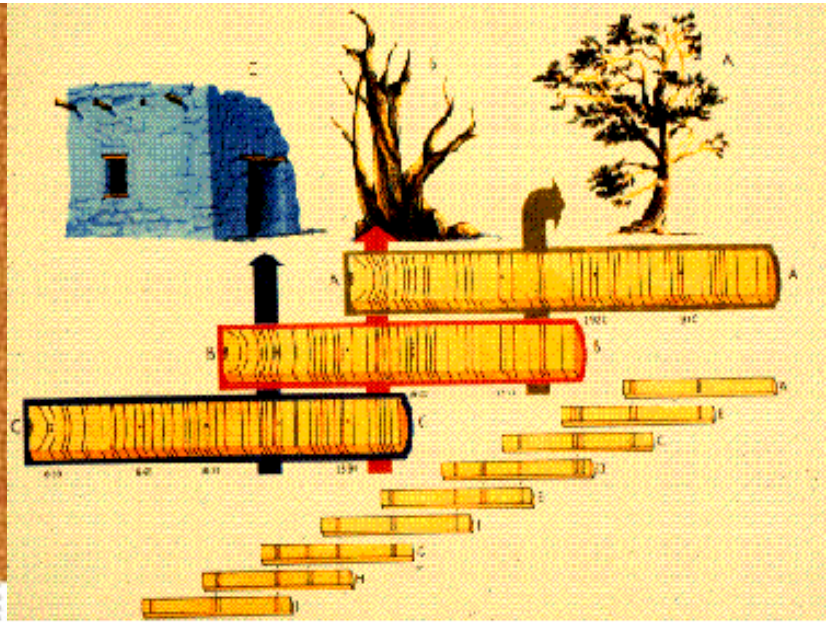
- Plant processes are constrained by environmental variables
  - Precipitation, temperature, soil moisture etc.

Favorable conditions = wide tree-ring
Unfavorable conditions = narrow ring

Tree-rings

- Individual tree-rings can be dated to an exact calendar year
- Cross-matching
  - Match ring-growth across multiple samples in a given area (similar environmental conditions)



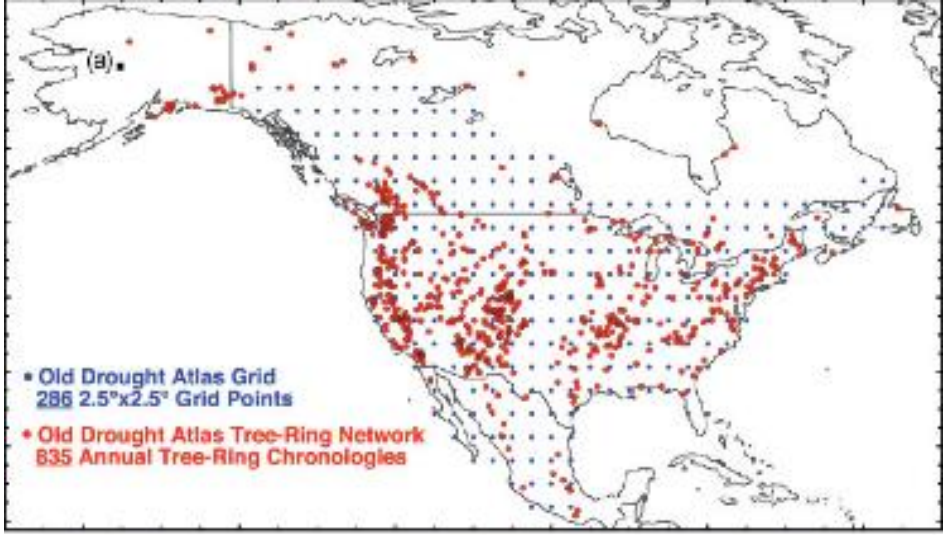


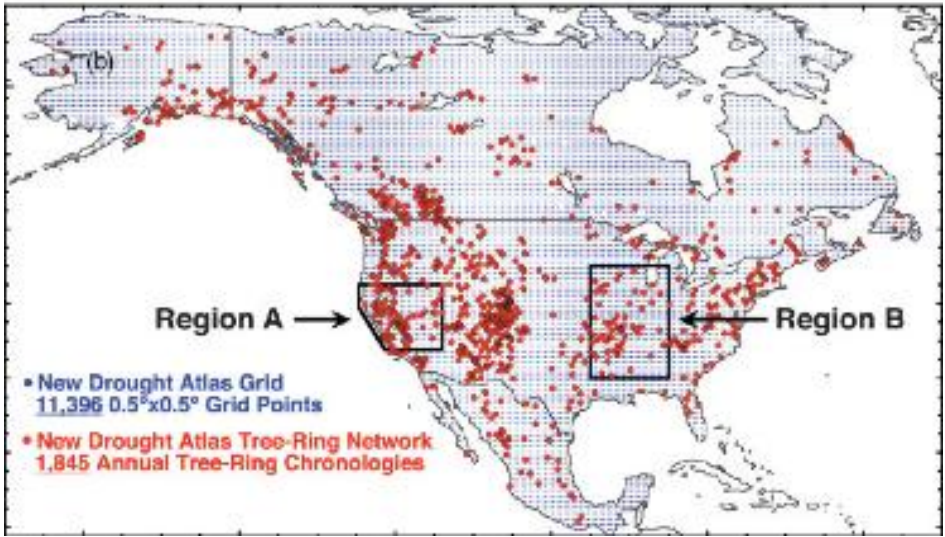
North American Drought Atlas

- Extensive network of annual tree-ring chronologies (International Tree-Ring Data Bank)

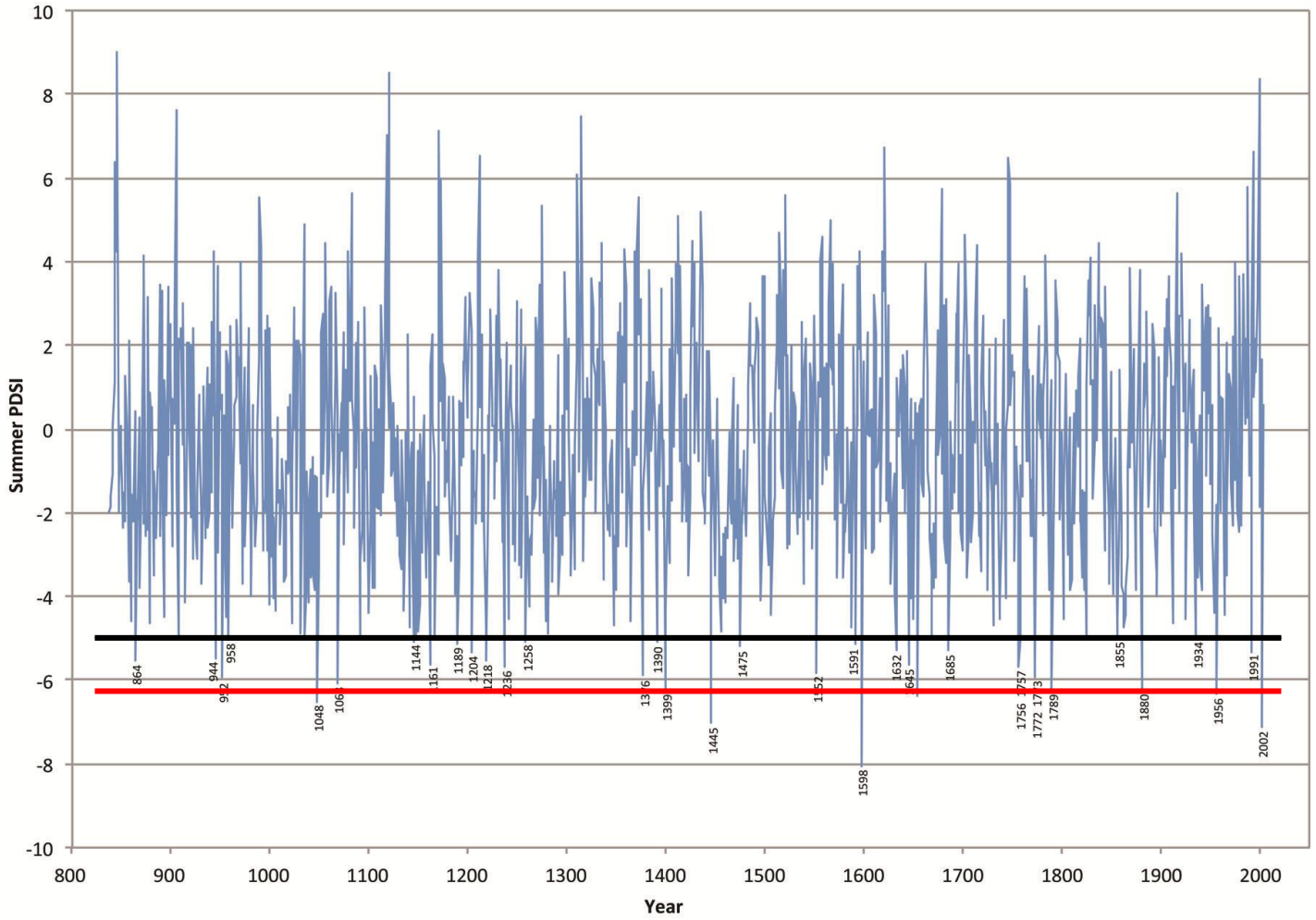
- Cook and Krusic (2004) and Cook et al. (2010) developed annual PDSI reconstructions

- Calibration period (1928-1978)
- Verification period (1900-1927)
- 4 different statistical tests

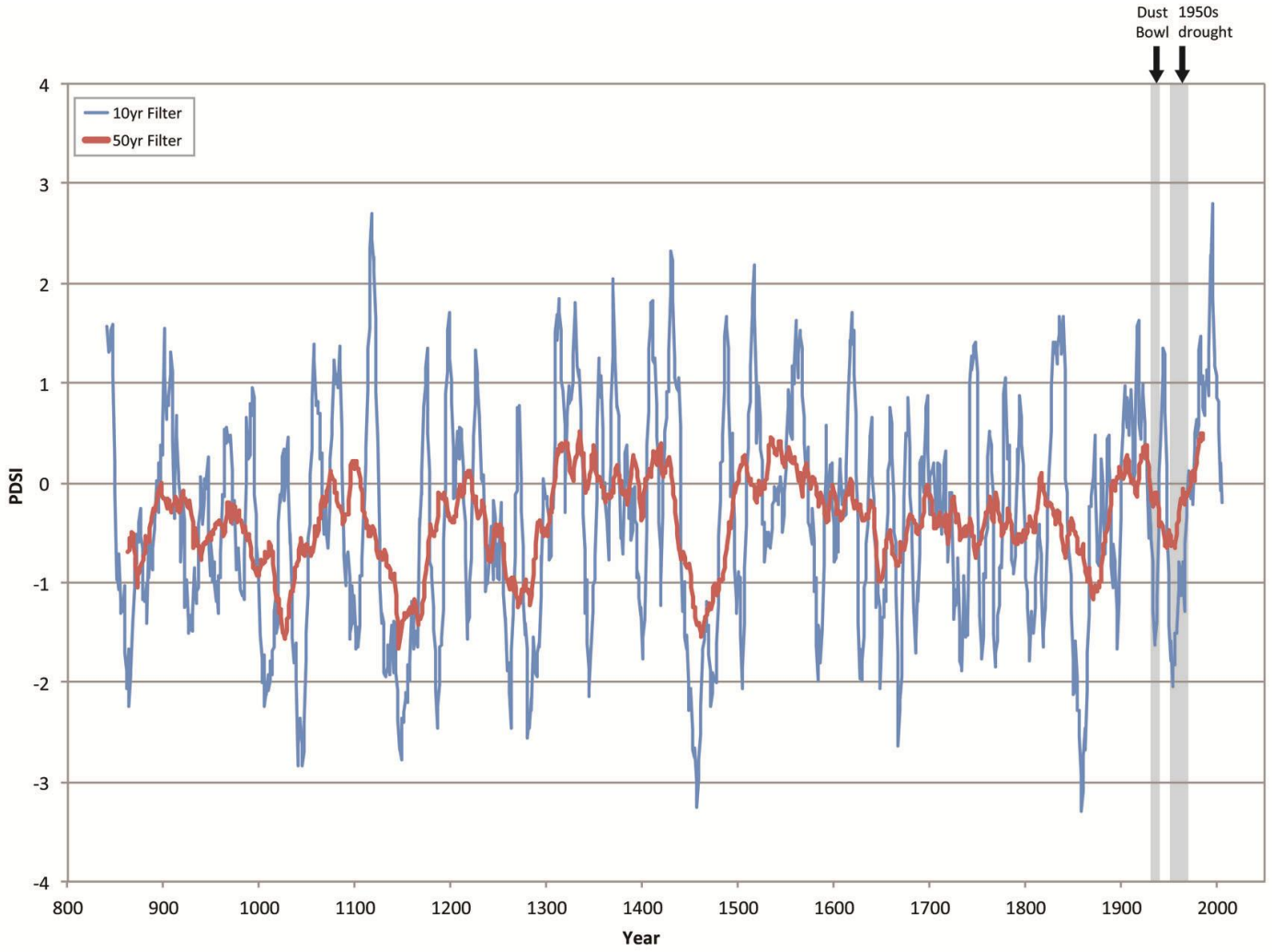




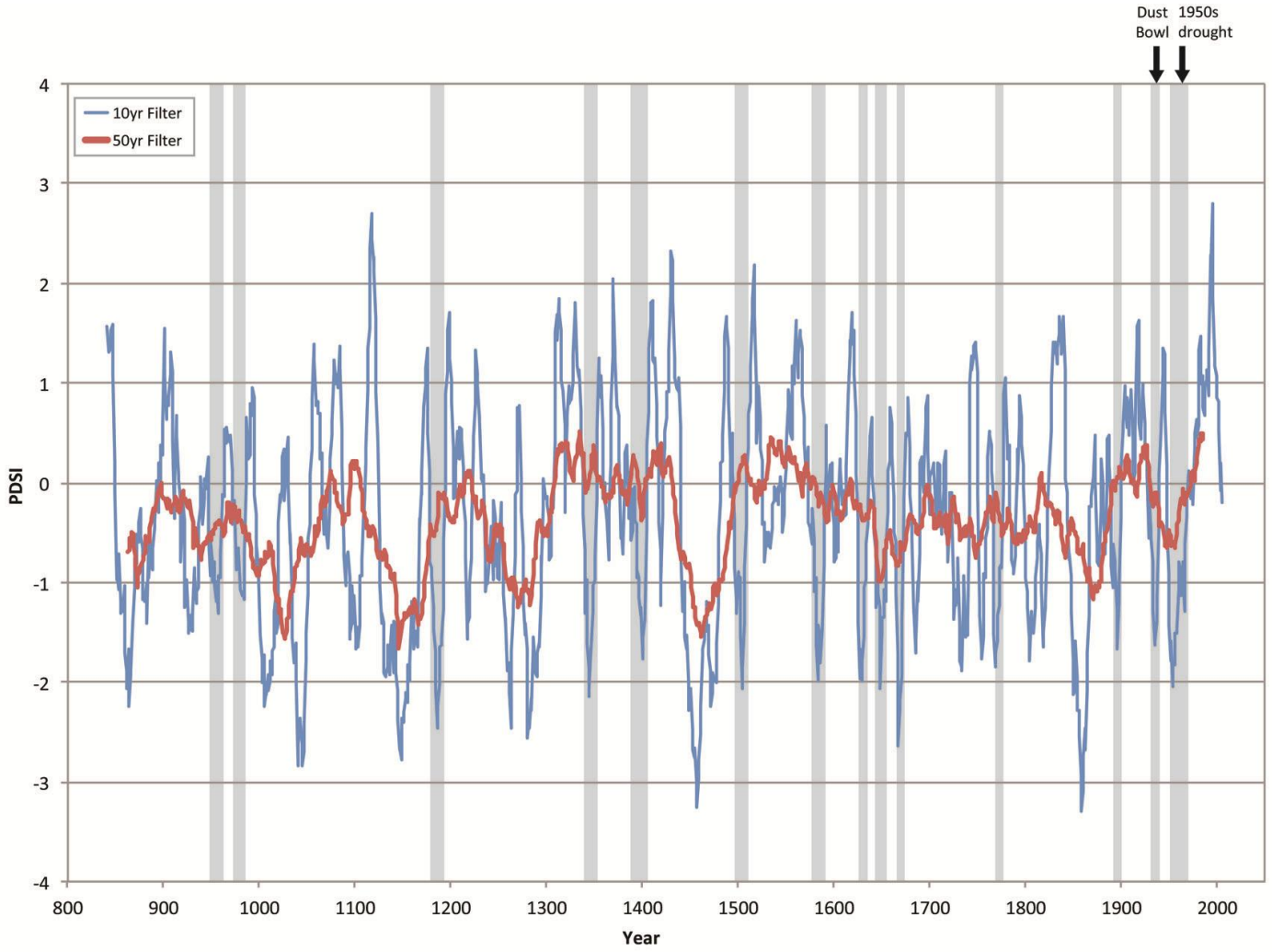
SW Kansas


Summer PDSI
Year
10
8
6
4
2
0
-2
-4
-6
-8
-10
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
864
944
958
1048
1144
1161
1189
1204
1218
1236
1258
1390
1399
1445
1475
1591
1598
1632
1685
1855
1880
1934
1956
1991
2002

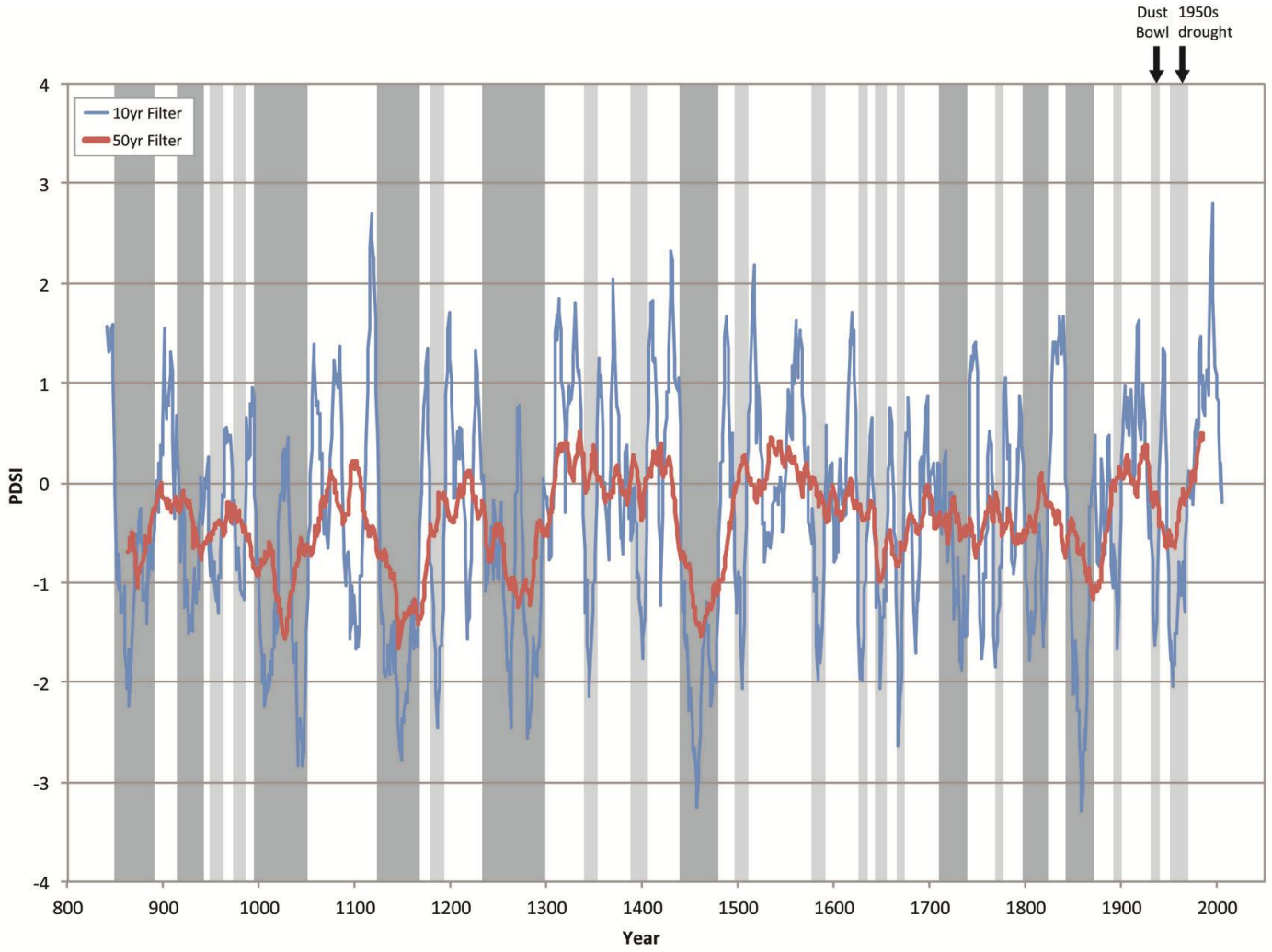
SW Kansas


Dust Bowl
1950s drought
10yr Filter
50yr Filter
PDSI
4
3
2
1
0
-1
-2
-3
-4
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Year

SW Kansas


Dust Bowl
1950s drought
10yr Filter
50yr Filter
PDSI
4
3
2
1
0
-1
-2
-3
-4
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Year

SW Kansas

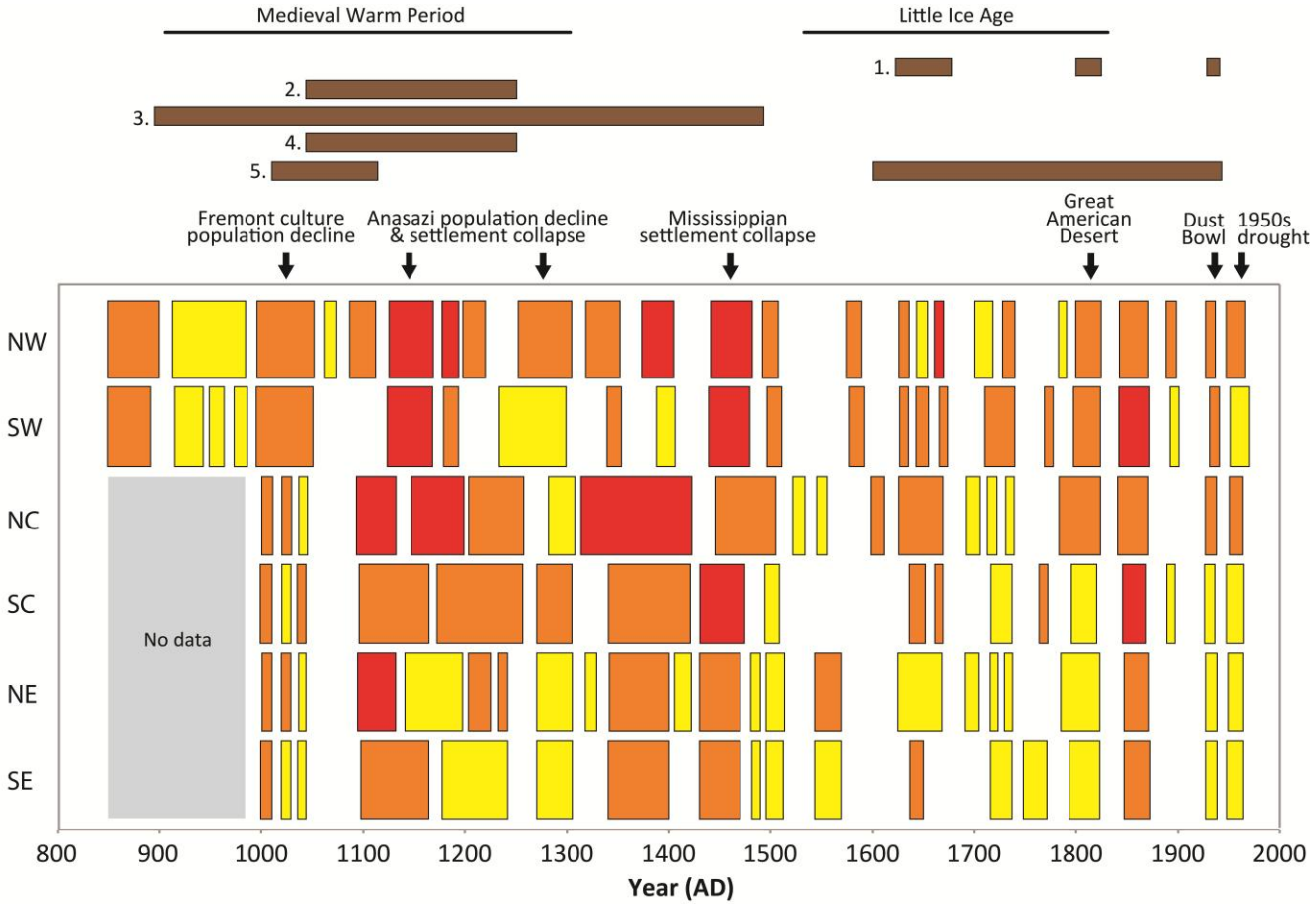

Dust Bowl
1950s drought
10yr Filter
50yr Filter
PDSI
4
3
2
1
0
-1
-2
-3
-4
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Year

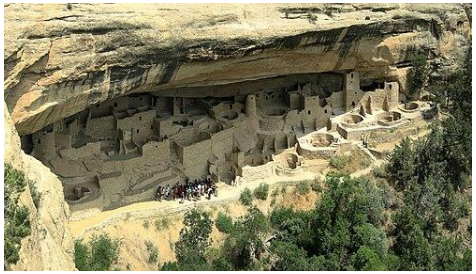
“Great American Desert” – Stephen Long expedition 1819-1820

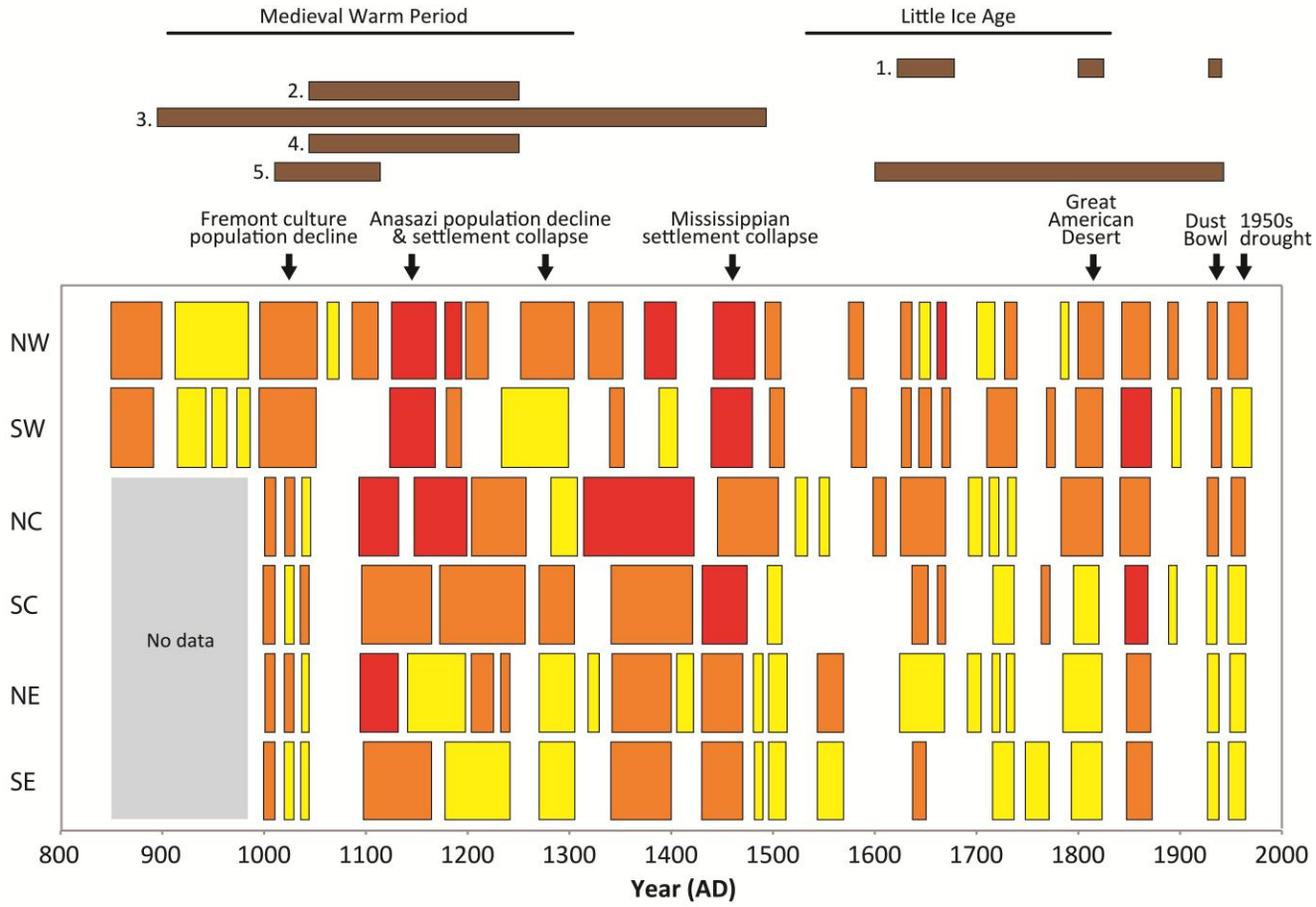
“distetute of vigetation as they are Bald” – Jacob Fowler 1821

“sitting summer” – Set-tan (Little Bear) 1855

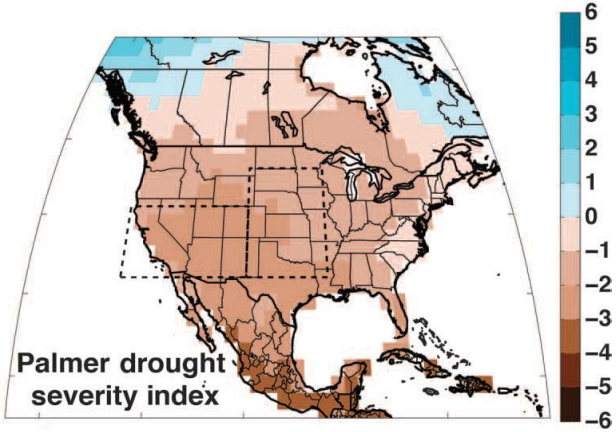
Newspaper reports of dust storms, crop failures, “scorching, withering, blighting” winds – 1854-1860s





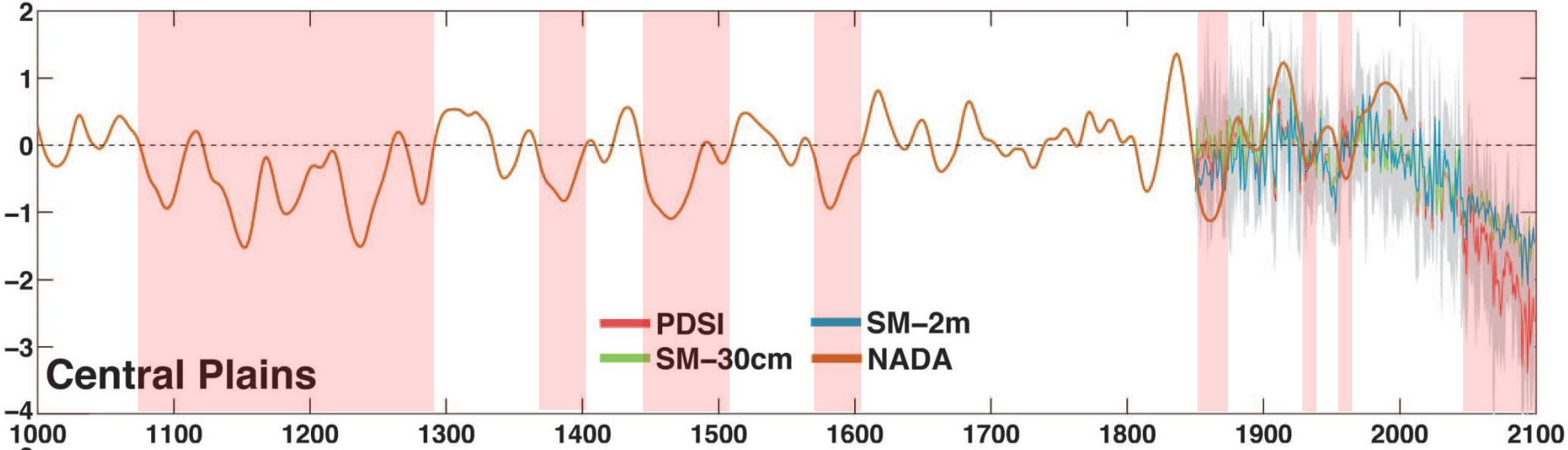

Medieval Warm Period
Little Ice Age
1.
2.
3.
4.
5.
Fremont culture population decline
Anasazi population decline & settlement collapse
Mississippian settlement collapse
Great American Desert
Dust Bowl
1950s drought
NW
SW
NC
SC
NE
SE
No data
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Year (AD)

CMIP5 Drought projections, 2050-2099



Cook et al., 2015

How representative are these historic droughts?



Southwestern Megadrought – began in 2000 (26 years and counting…)

Largest reservoir in US

TEXAS Geosciences
The University of Texas at Austin
Jackson School of Geosciences

ABOUT RESEARCH ACADEMIC

HOME / NEWS / RELIEF FROM DROUGHT IN SOUTHWEST...

Relief From Drought in Southwest U.S. Likely Isn't Coming, According to New Research

JULY 15, 2025

Hoover Dam, Lake Mead, 2021

Lake Oroville, CA - 24% capacity, 2021