California's Climate in Perspective

Paleoclimate records of past droughts and floods

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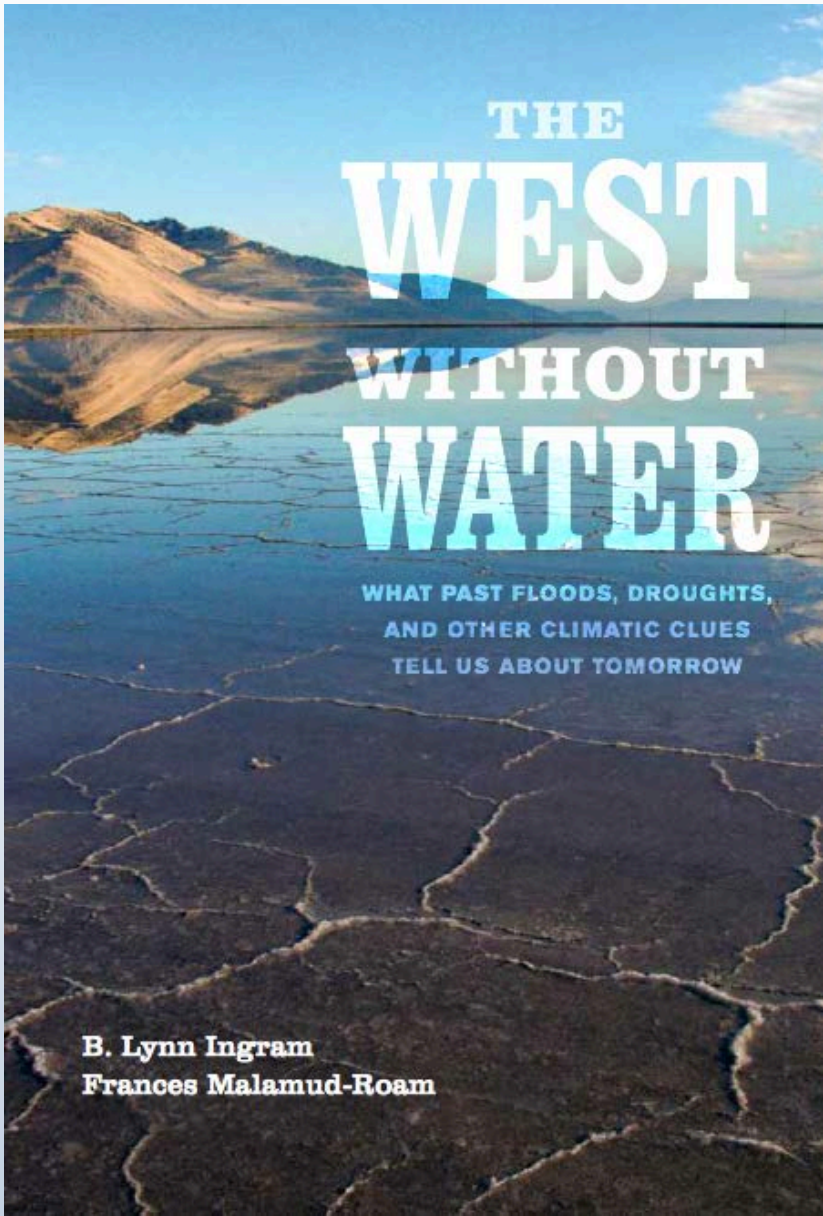


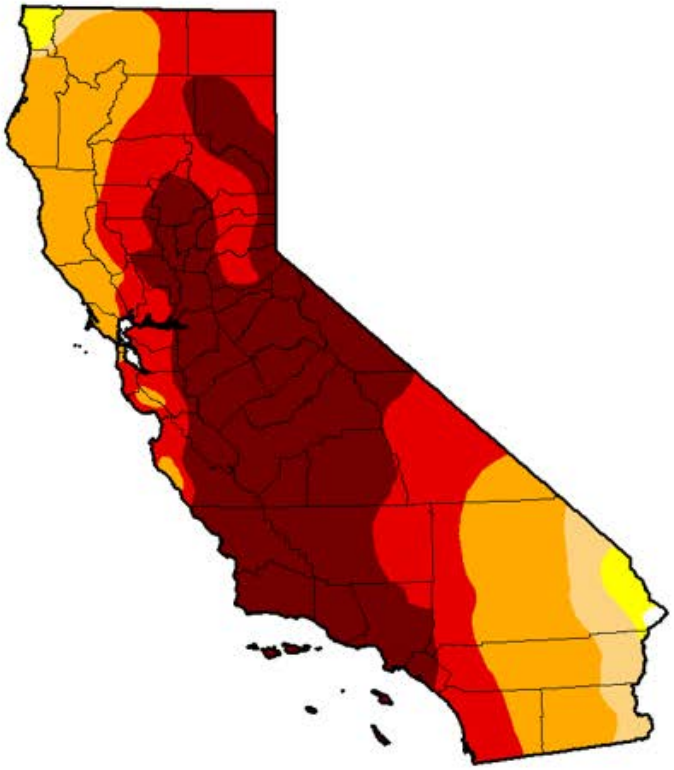
Questions

- How much does climate vary naturally?
- How frequent and severe were past droughts, fires, and floods?
- How did they impact past human societies?
- How did warming impact water resources in the past?

Home 〉 State Drought Monitor

U.S. Drought Monitor

California



February 24, 2015

(Released Thursday February 26, 2015)

Valid 7 a.m. EST

Statistics type: (•) Traditional (D0-D4, D1-D4, etc.) ( ) Categorical (D0, D1, etc.)

Drought Condition (Percent Area):

Week	Date	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	2015-02-24	0.16	99.84	98.10	93.44	67.46	39.92
Last Week	2015-02-17	0.16	99.84	98.10	93.44	67.46	41.20
3 Months Ago	2014-11-25	0.00	100.00	99.72	94.42	79.69	55.08
Start of Calendar Year	2014-12-30	0.00	100.00	98.12	94.34	77.94	32.21
Start of Water Year	2014-09-30	0.00	100.00	100.00	95.04	81.92	58.41
One Year Ago	2014-02-25	0.00	100.00	94.56	90.82	73.83	26.21

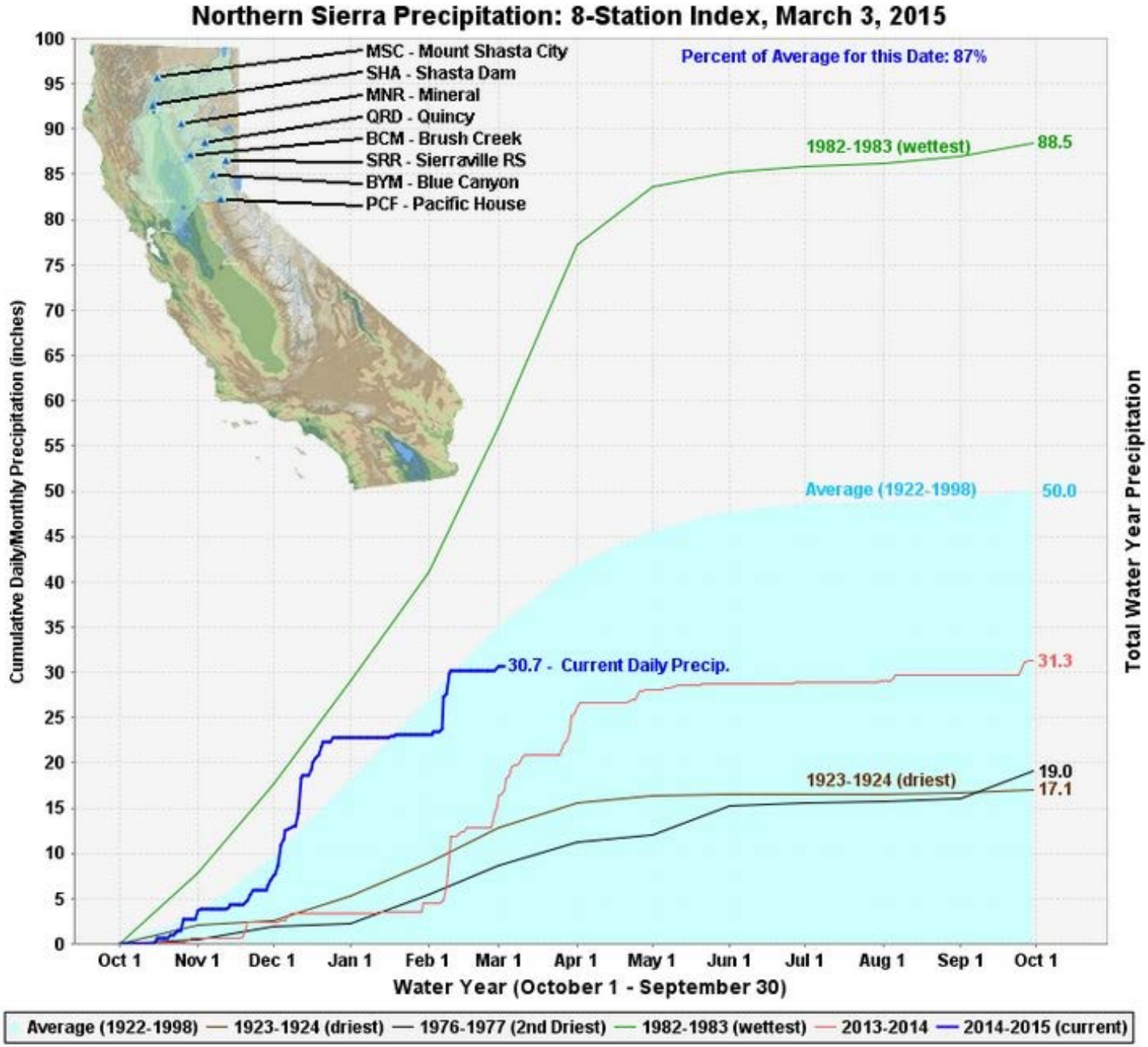
Population Affected by Drought: **37,003,598**

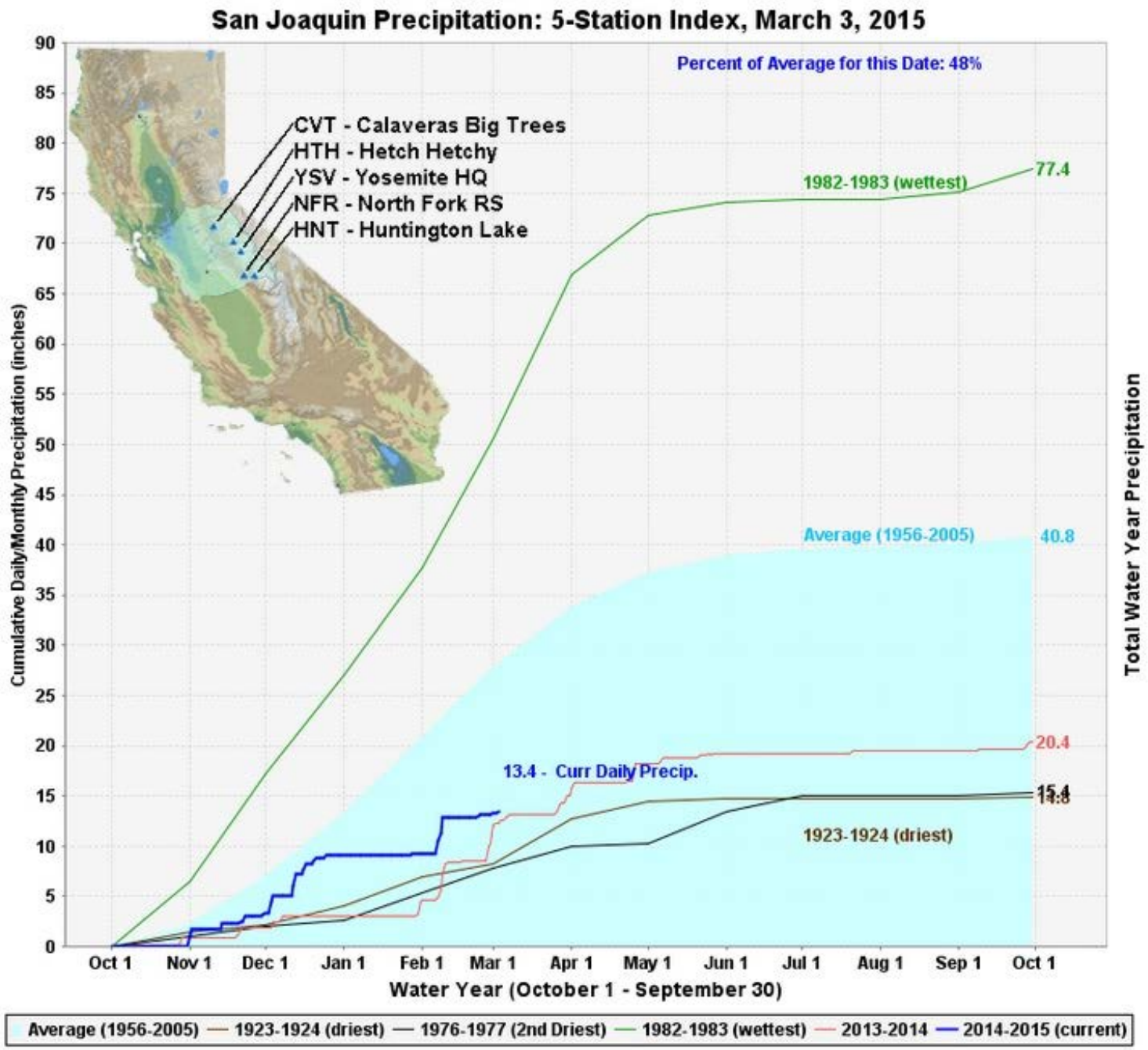
View More Statistics

Intensity:

- D0 - Abnormally Dry
- D1 - Moderate Drought
- D2 - Severe Drought
- D3 - Extreme Drought
- D4 - Exceptional Drought

We've entered the 4th year of drought


Northern Sierra Precipitation: 8-Station Index, March 3, 2015
MSC - Mount Shasta City
SHA - Shasta Dam
MNR - Mineral
QRD - Quincy
BCM - Brush Creek
SRR - Sierraville RS
BYM - Blue Canyon
PCF - Pacific House
Percent of Average for this Date: 87%
1982-1983 (wettest)
88.5
Average (1922-1998)
50.0
30.7 - Current Daily Precip.
31.3
1923-1924 (driest)
19.0
17.1
Cumulative Daily/Monthly Precipitation (inches)
Total Water Year Precipitation
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Water Year (October 1 - September 30)
Average (1922-1998)
1923-1924 (driest)
1976-1977 (2nd Driest)
1982-1983 (wettest)
2013-2014
2014-2015 (current)

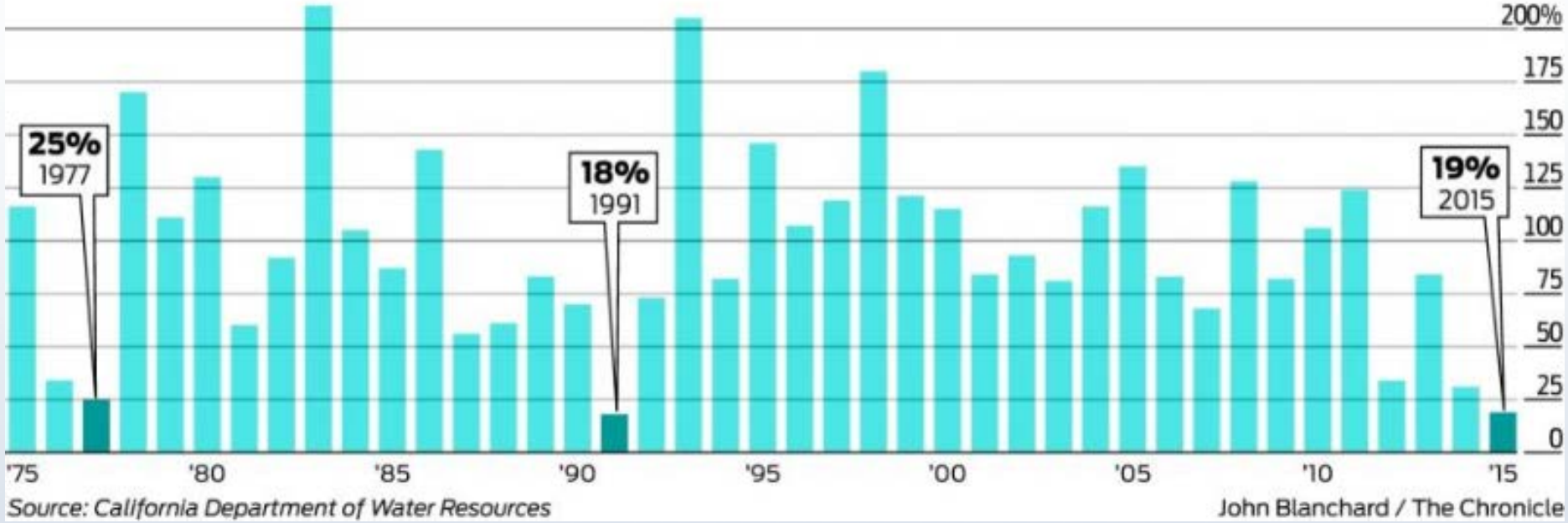

San Joaquin Precipitation: 5-Station Index, March 3, 2015
Percent of Average for this Date: 48%
CVT - Calaveras Big Trees
HTH - Hetch Hetchy
YSV - Yosemite HQ
NFR - North Fork RS
HNT - Huntington Lake
1982-1983 (wettest)
77.4
Average (1956-2005)
40.8
20.4
13.4 - Curr Daily Precip.
15.4
14.8
1923-1924 (driest)
Cumulative Daily/Monthly Precipitation (inches)
Total Water Year Precipitation
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Water Year (October 1 - September 30)
Average (1956-2005)
1923-1924 (driest)
1976-1977 (2nd Driest)
1982-1983 (wettest)
2013-2014
2014-2015 (current)

Reservoirs low (~ 45% average statewide)

Shasta Reservoir

California statewide average snowpack for March 1

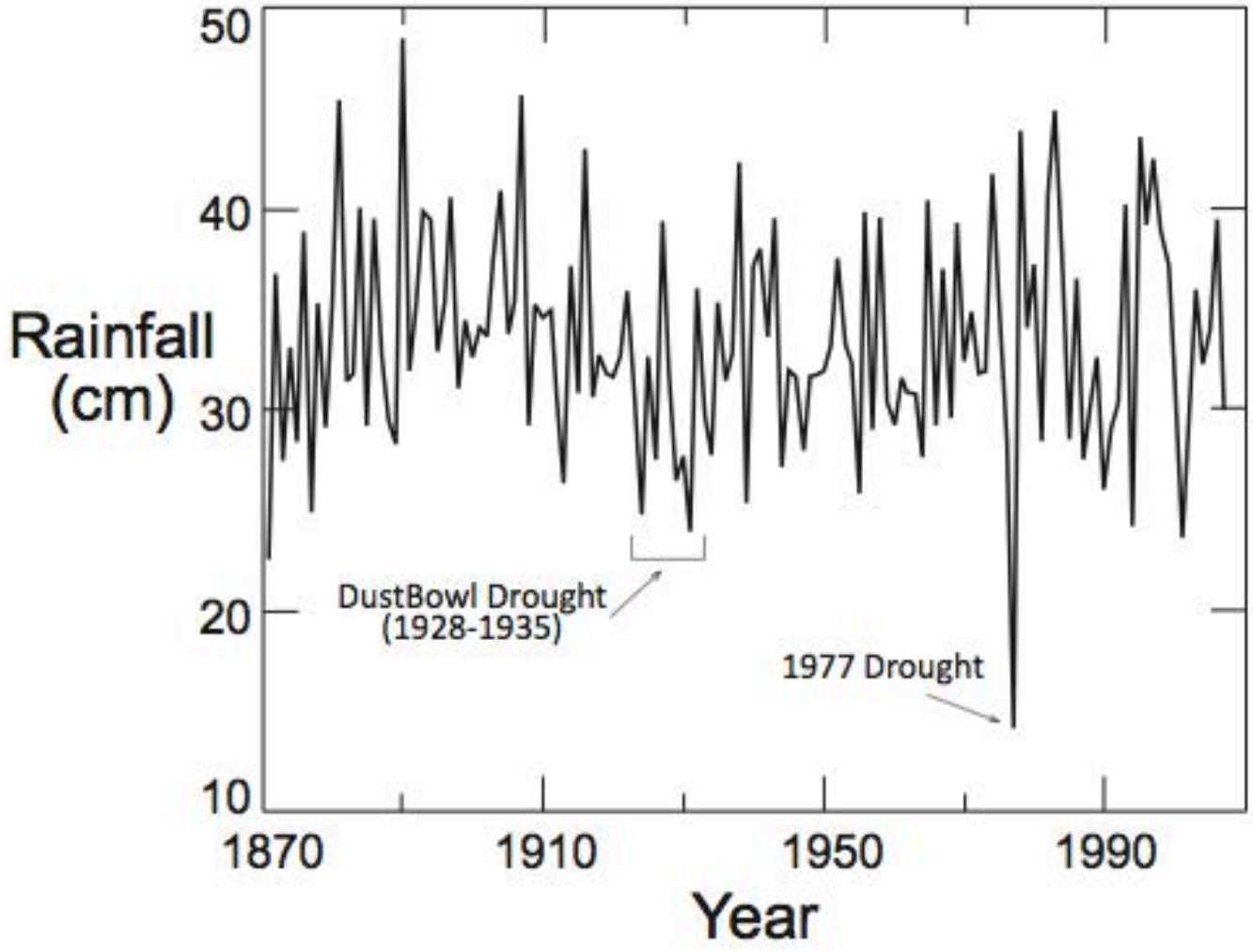
Percent of historical average of water content in snow.



Source: California Department of Water Resources

John Blanchard / The Chronicle

Precipitation highly variable in CA over the past 150 years



The Dust Bowl Drought in CA: 1928-1935

Similar drought: 1987-1992

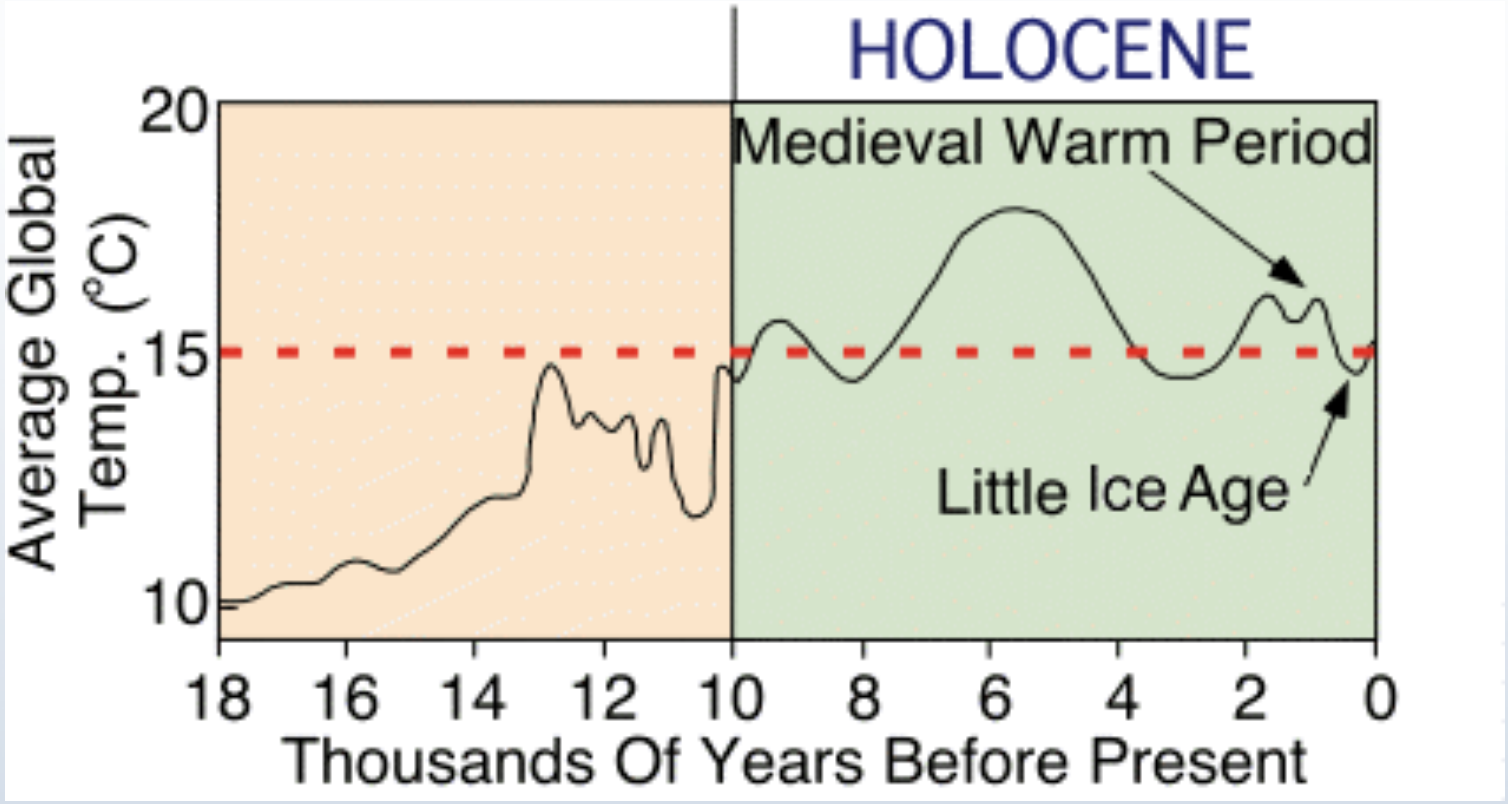
20th century floods

1938 Orange County
(Santa Ana River)

1955 Santa Cruz
(San Lorenzo River)

And others: 1969, 1983, 1997, 2006…

Previous ice age interglacial



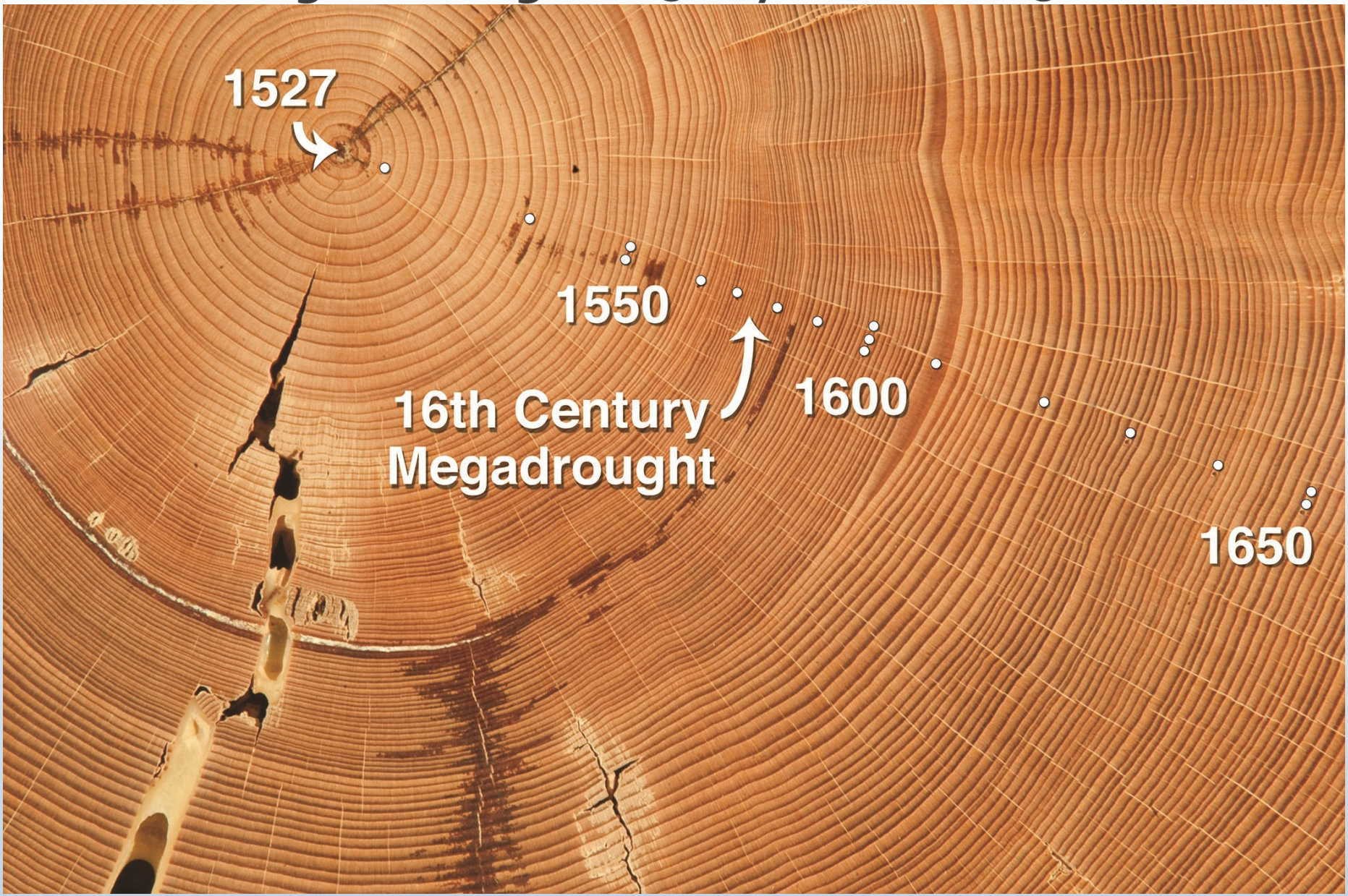
Understanding past climate

- Deciphering long-term climate changes before humans were keeping records
- Indirect (proxy) evidence for past climate change contained in the natural environment
  - sediments, fossils, trees, lakes, glaciers
  - Temperature, precipitation, sea level, wildfire frequency, vegetation type

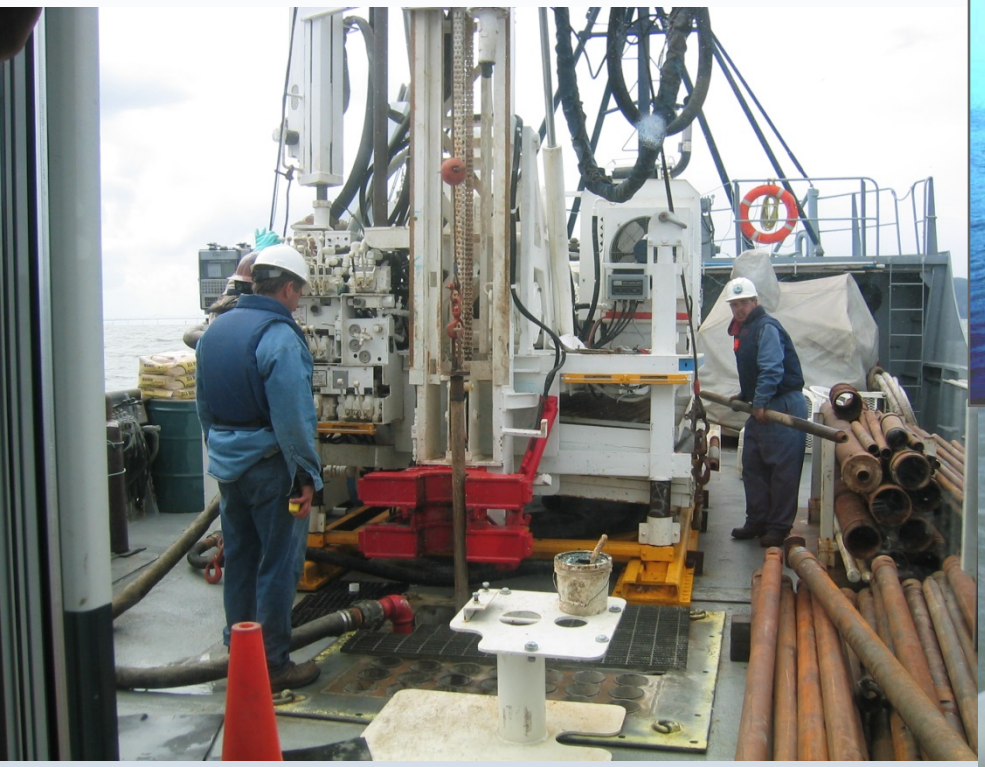
Coring tree-trunks – pencil thin cores

- annual growth rings reflect precipitation and temperature

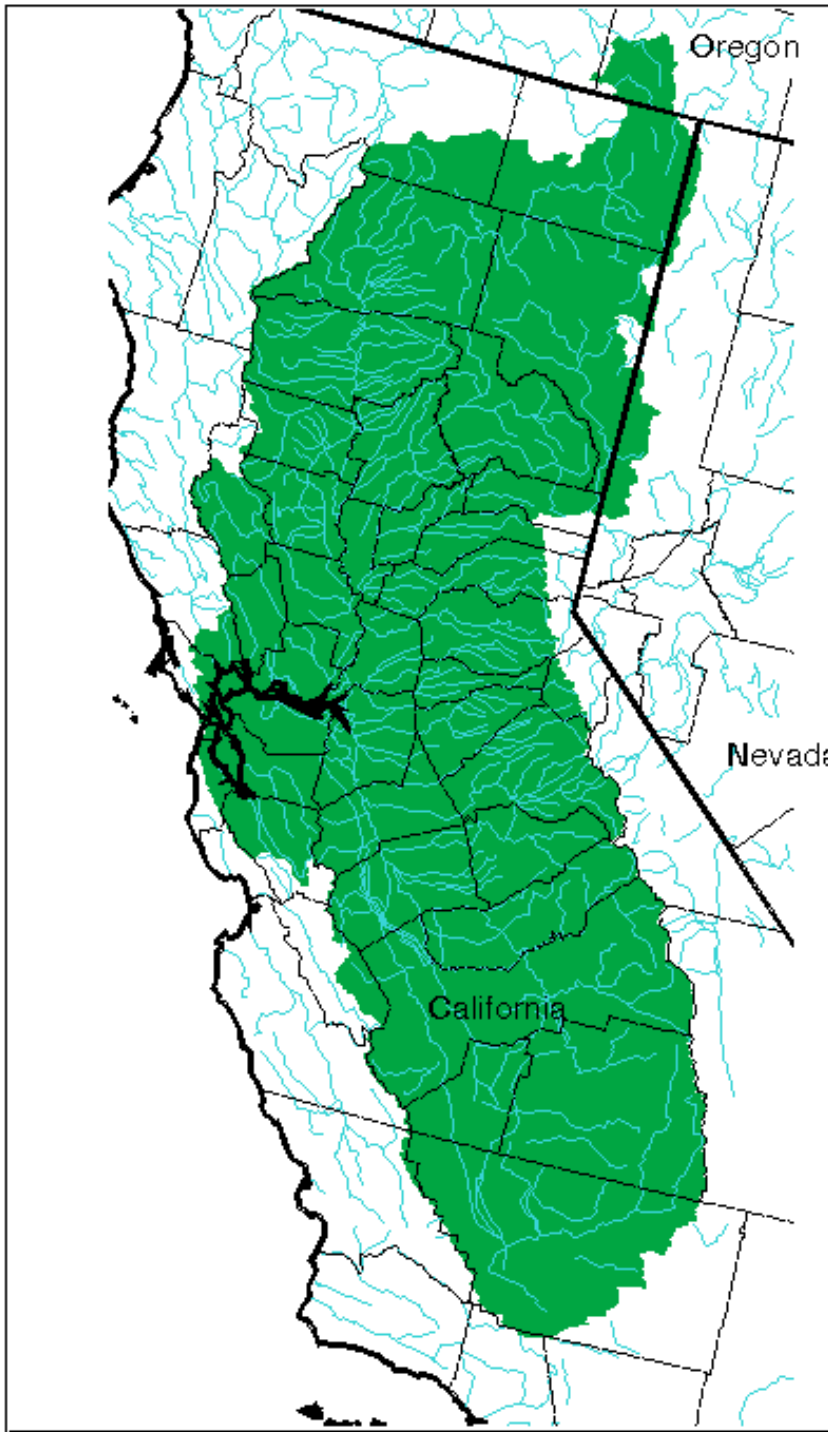
Longest drought in 500 years: late 1560s



Sediment cores - San Francisco Bay



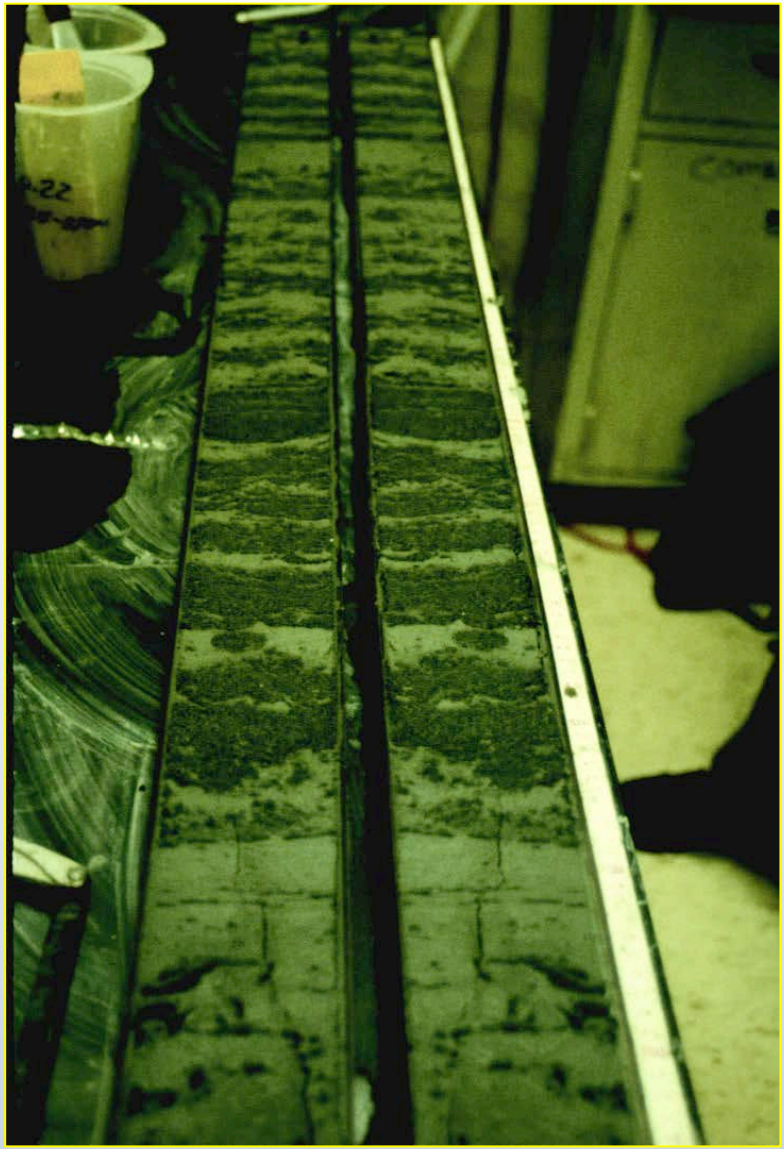
- San Francisco Bay watershed
- 40% area of California
- Precipitation and runoff drain through San Francisco Bay

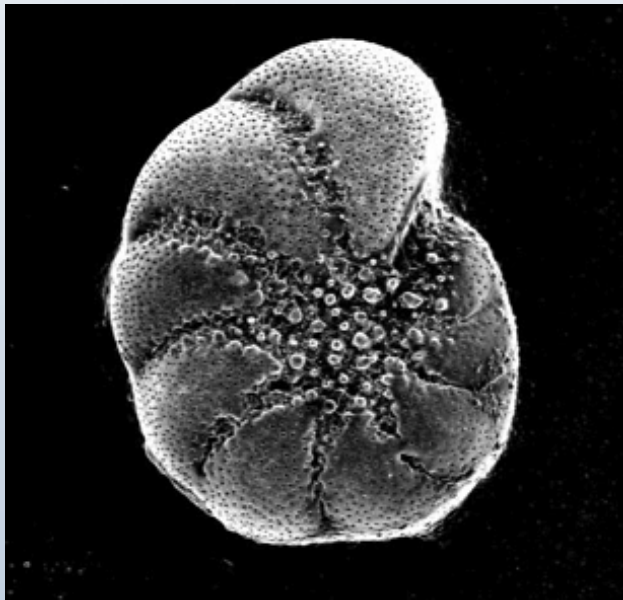


Salinity in SF Bay reflects precipitation and runoff over the drainage basin

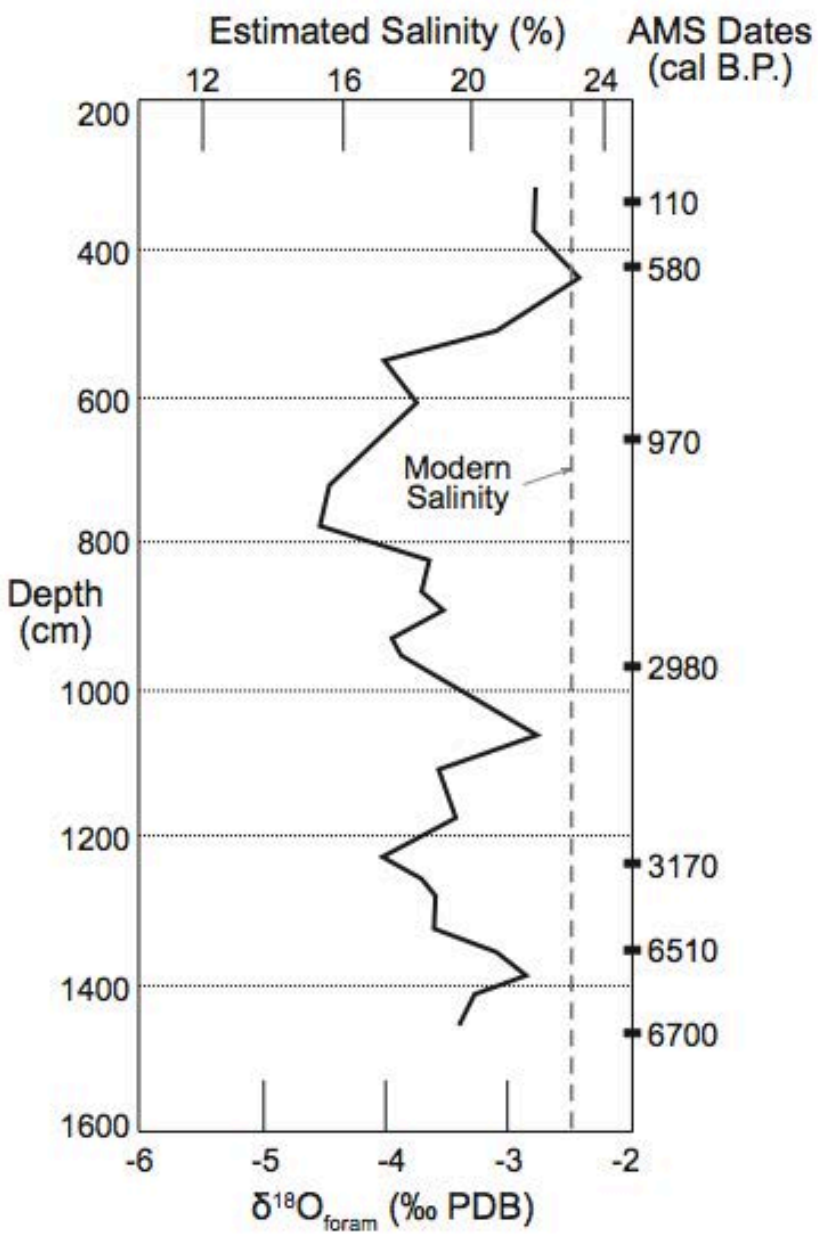
SF Bay sediment core

- date with 14C
- Separate fossil shells
- Chemistry reflects salinity





Changes in salinity reflected in marsh vegetation

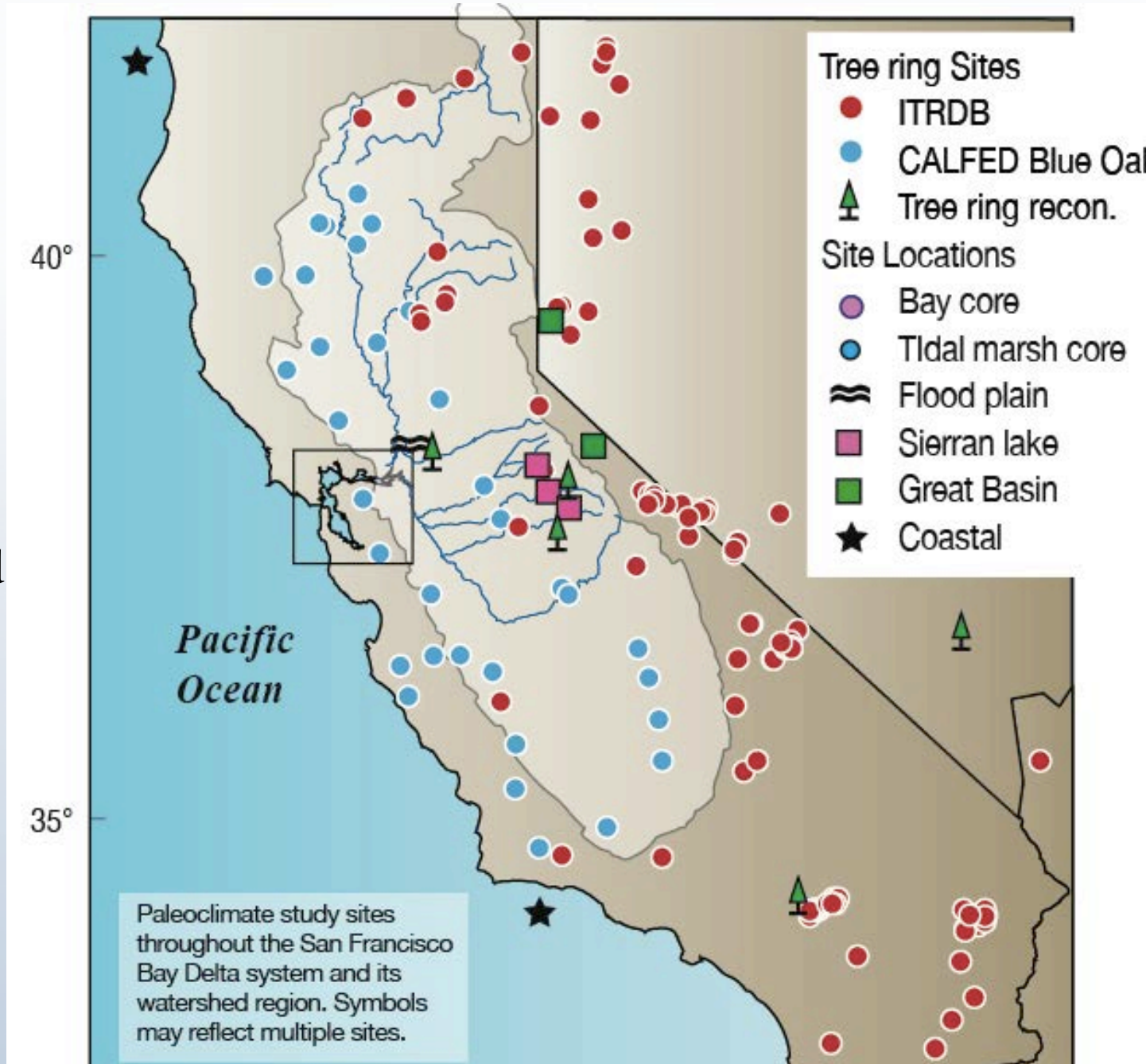


Medieval Warm Period (dry)

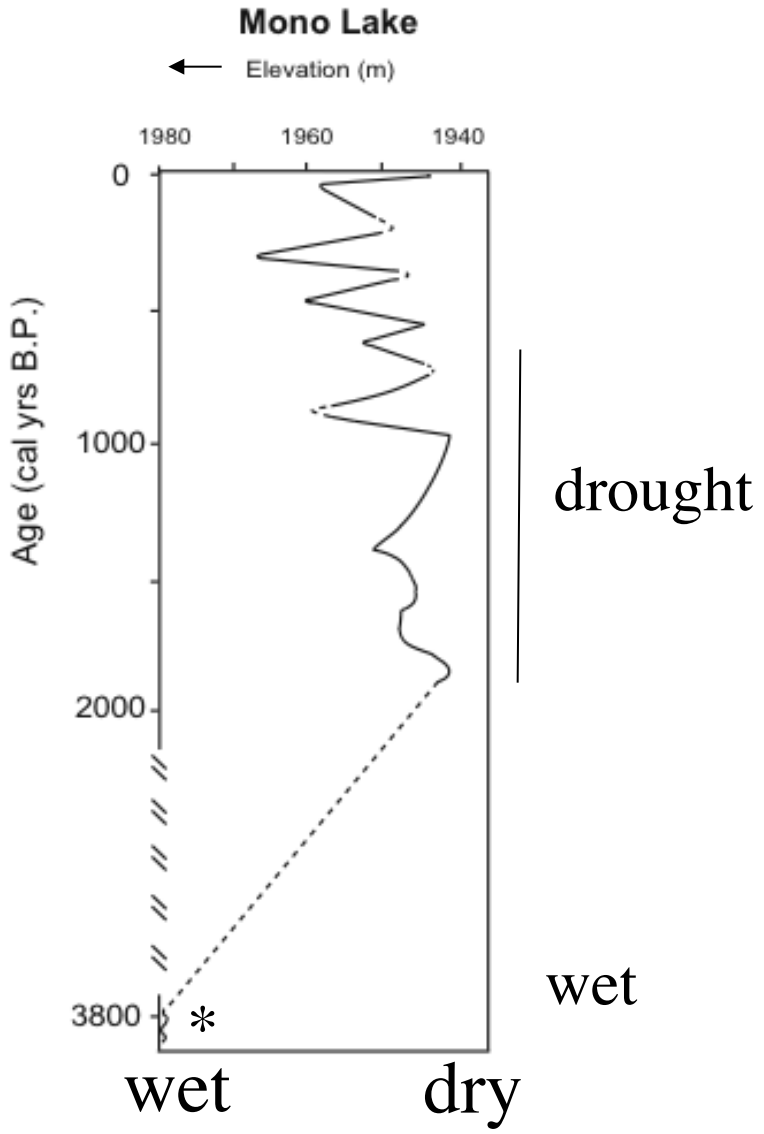
Tree rings
Lake sediments
Floodplain cores

SF Bay/marsh
Sediment cores

SF Bay watershed



1800-600 years ago, Mono Lake levels low (dry)



(Stine, 1990)

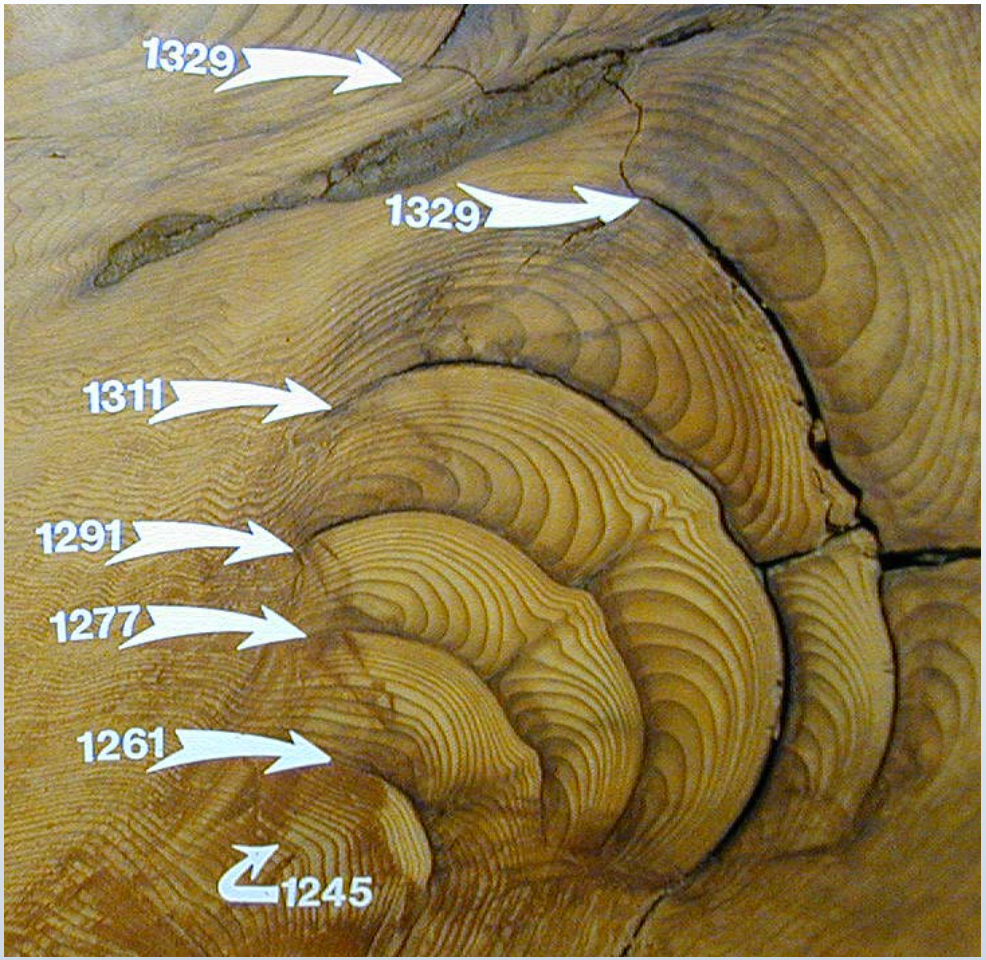
Submerged tree-stumps

-A.D. 900-1100
-A.D. 1200-1350

“Medieval megadroughts”

Stine (Nature, 1994)

Giant Sequoia fire scars – increased fires during Medieval megadroughts



(from Swetnam et al., 2008)

Anasazi collapse in 4 corners during Medieval drought

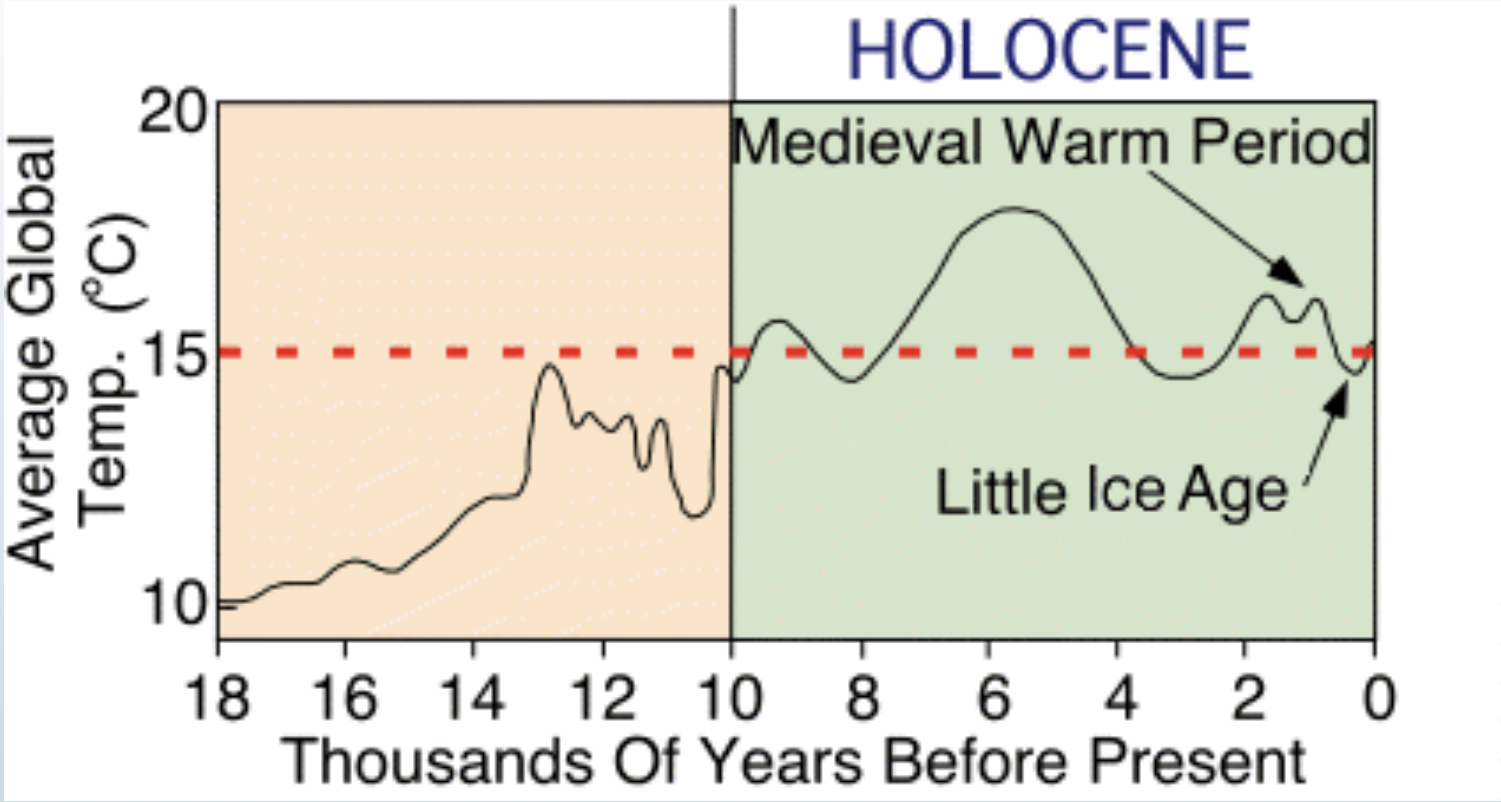
Mesa Verde, SW Colorado

Montezuma Castle, central Arizona

California coastal shellmound sites abandoned

(Evidence of conflict/violence, infant mortality, starvation)

Earlier megadrought 6000-4700 years ago



Mid-Holocene drought (6000-4700 years ago)

Lake Tahoe level was much lower

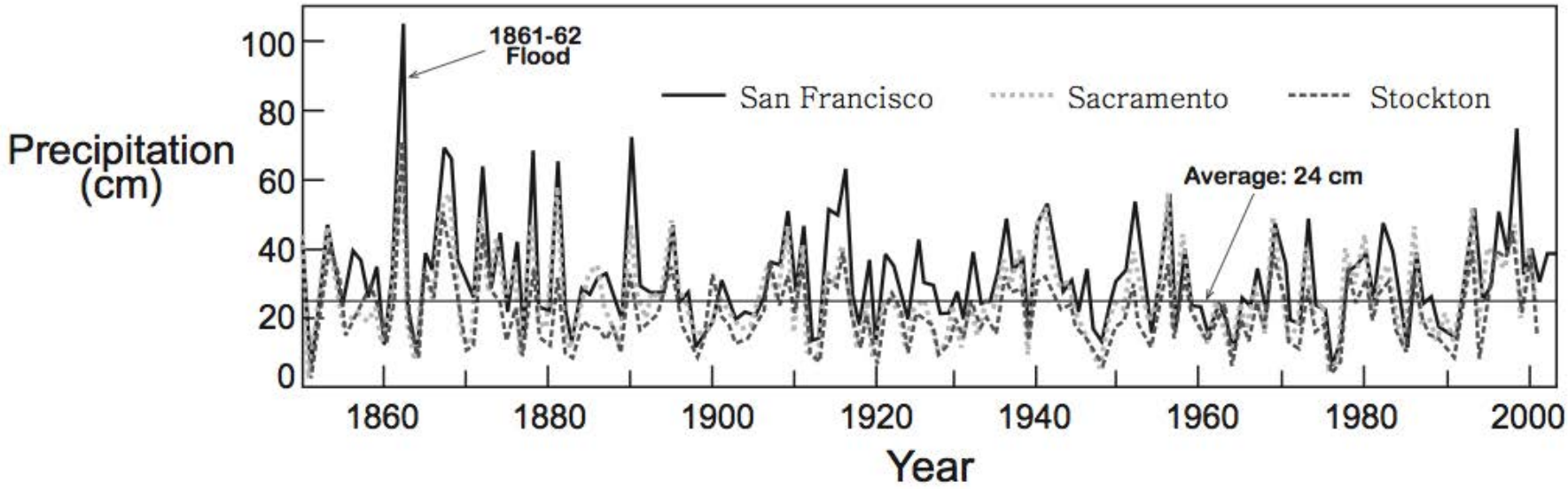
Tulare Lake dry during mid-Holocene:

- Buried mud cracks
- Fossils of land plants

California megafloods

Largest historical flood: 1861-62

Precipitation was 3 to 4 times normal



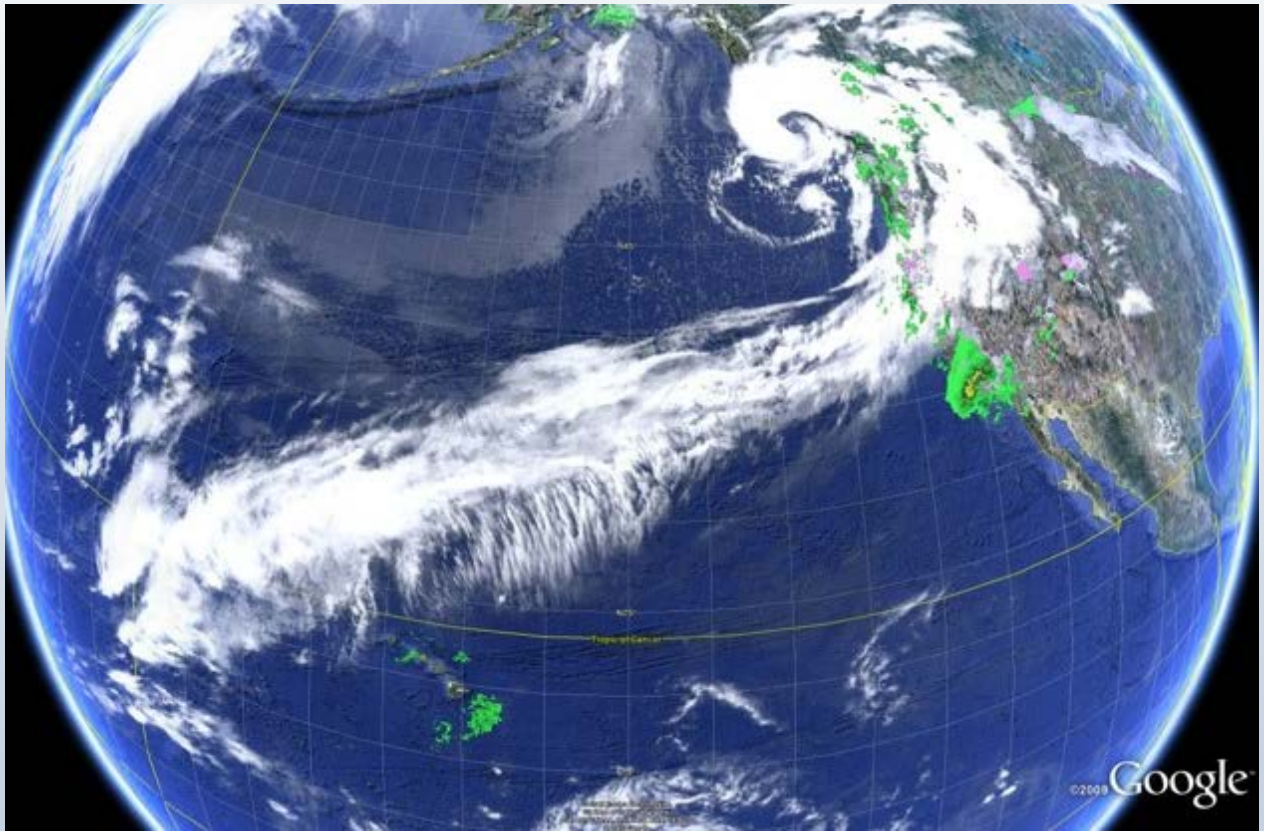
(historical reconstructions from Mock, 2006)

1861-62 Flood

- Rained for 43 days (late December to early February)
- Filled Central Valley, flooded Sacramento
- Flooded LA to San Diego

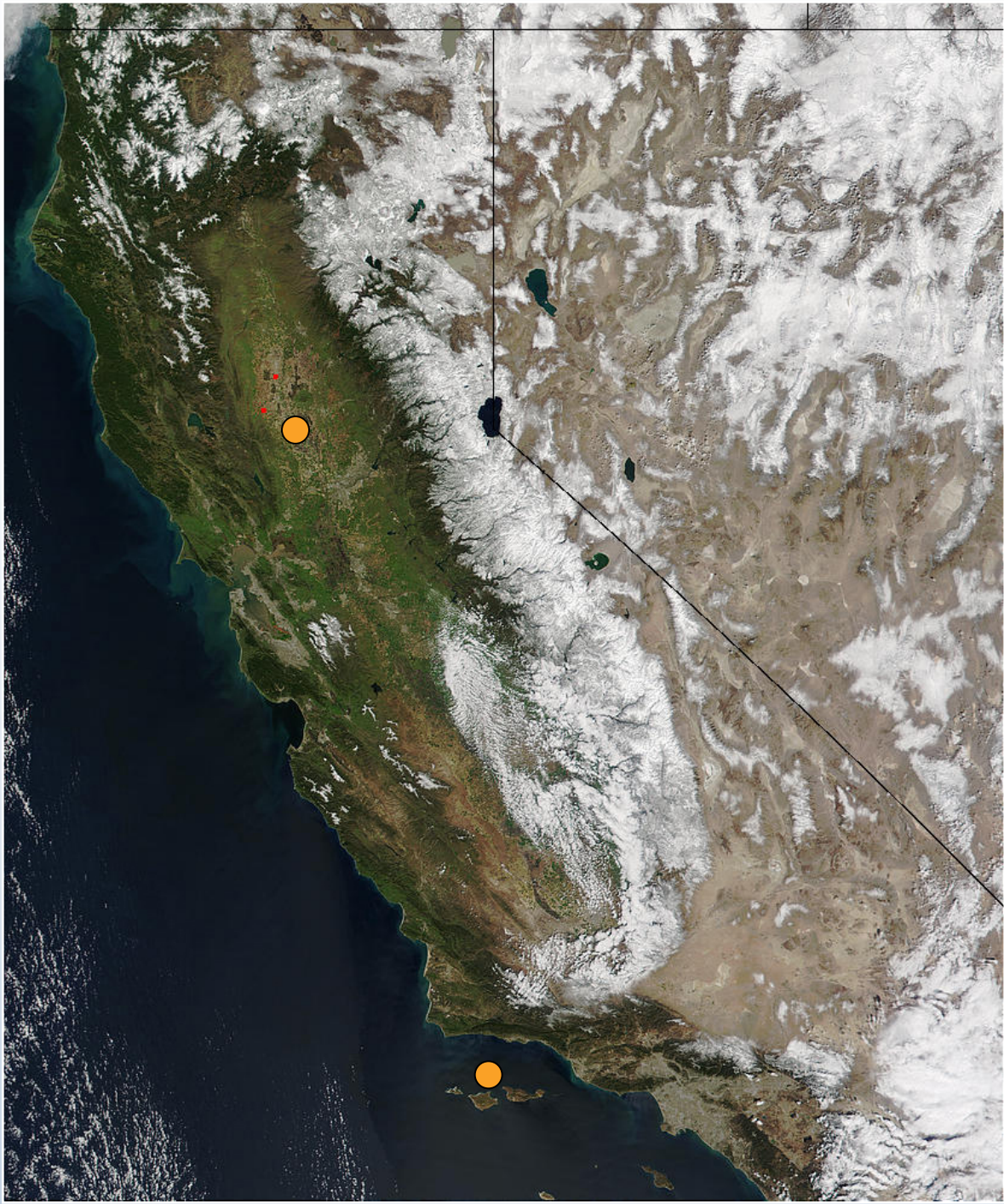
Cause of flooding: Atmospheric Rivers

- 1000s of km long (across ocean basins), 100s of km wide
- Carry warm water vapor from tropics to mid-latitudes
- equivalent of up to 10 Mississippi Rivers



Sacramento Valley
floodplain sediments

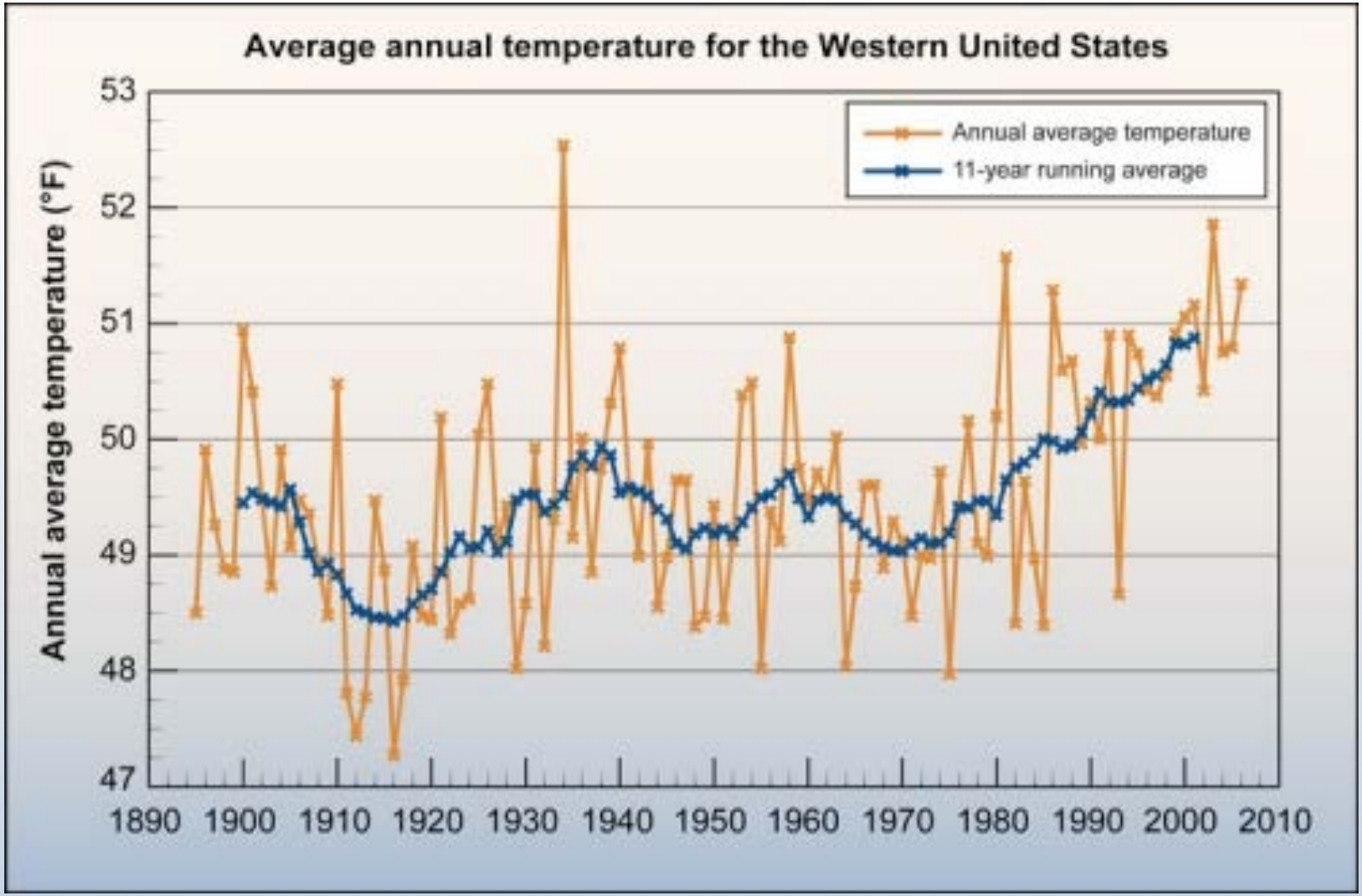
CA Coast:
Santa Barbara Basin



Sediment cores:

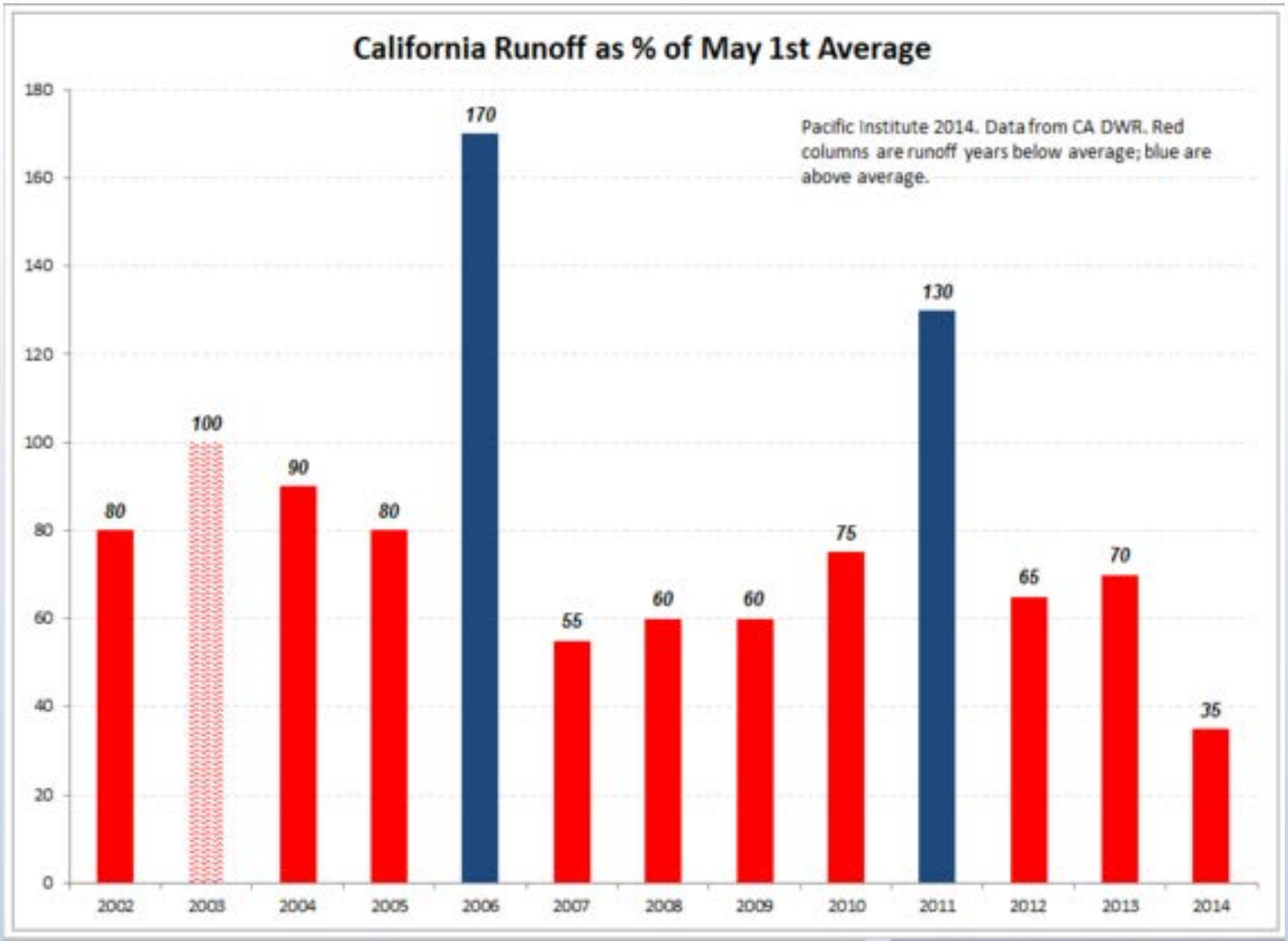
- Annual layers
- Unusually thick sediment layers from megafloods
- Thickness of layer proportional to size of flood
- "megafloods" occurred every 100-200 years

Future warming predicted will cause more drying…



10 years since 2002 have been drier than average.

Are we in the first 10 years of a megadrought?



We need to begin preparing now

- for a warmer and drier future
- for more frequent intense flood events
- Longer, more intense dry seasons