DROUGHT IN THE WEST: QUESTIONS OF HISTORY AND SCALE

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Presented to: Groundwater Management District Association, Meeting in San Diego Jan. 8, 2009

A History of Drought in the West

based on data compiled by E. Cook, C. Woodhouse, and co-workers

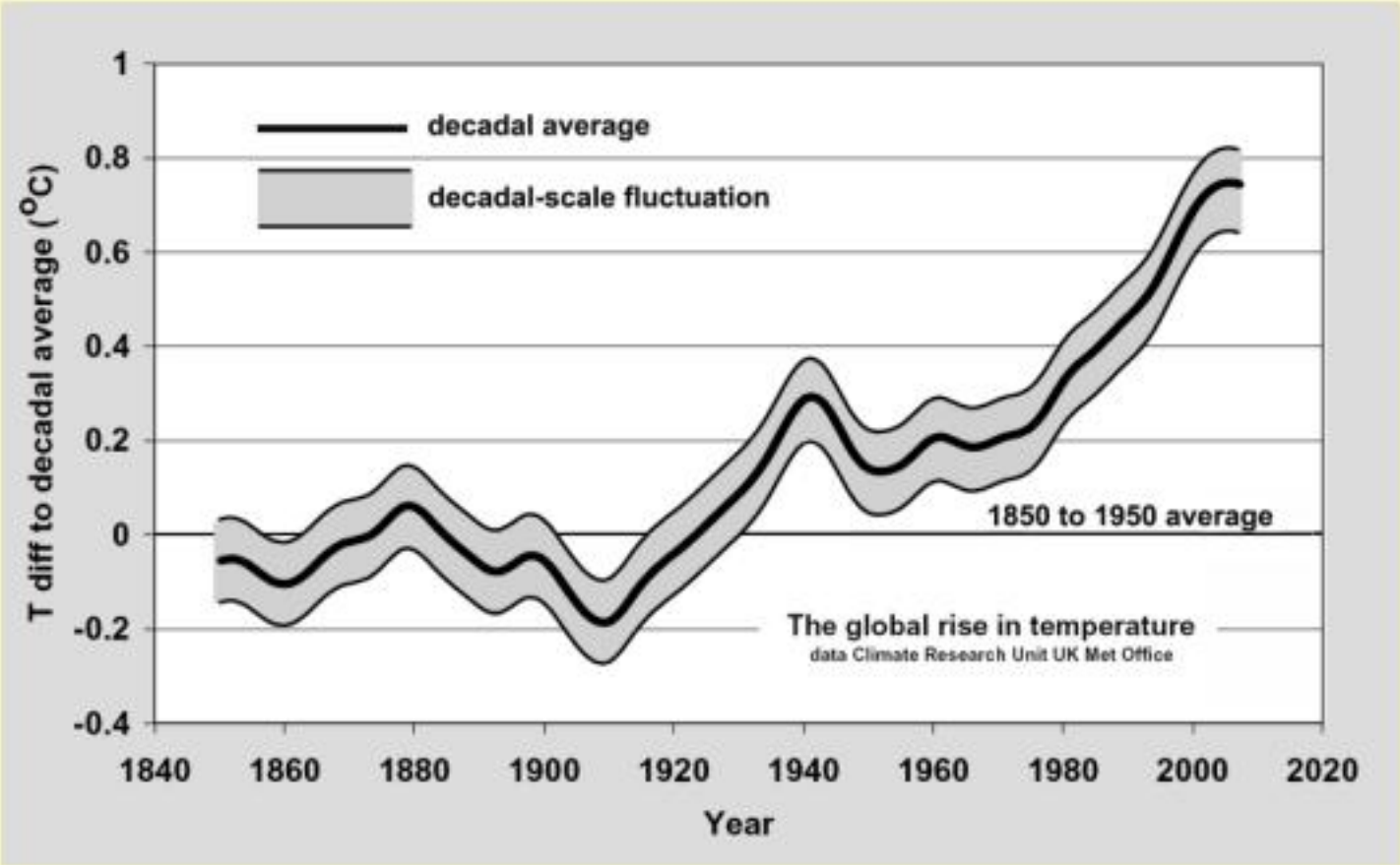
data available from the NOAA web site

Points to be made:

- There are a number of reasons to worry about the prospect of severe drought
- Drought emerged as an important driver of ancient history in the Southwest
- The discovery resulted from developing the tree-ring method for dating
- The definition of drought is a matter of scale both in space and time
- In the West, in the Great Basin and Southwest, there are three great regimes
- There is evidence for large-scale similarities between the Mountain West and the Midwest, on the scale of centuries
- When the northern North Atlantic was warm (Middle Ages) the West had an increased occurrence of large and long drought spells.

- There are reasons to worry about the prospect of severe drought.

Concern n. 1: It is getting warmer. Since the 1930s.



In part, this is a natural trend.

But since 1980 it seems largely man-made.

Can this trend increase drought in the West? Models say yes.

Conern n. 2: The snow of the Sierra Nevada that feeds the rivers of northern California in summer is melting early - leaving summers dry

Concern n. 3: The ice glaciers in the Rocky Mountains are turning into ghost glaciers, the streams they feed dry up. (Note the freshness of newly exposed moraines below the remnant ice bodies.)

Stanley Glacier near Banff, B.C.

Beetles are killing pine trees throughout the Rocky Mountain West

•Drought emerged as an important driver of ancient history in the Southwest

The 11th century saw heavy building activity in many parts of the Southwest. By A.D. 1300 most of these sites were abandoned.

Inaccessible location for many of the buildings suggests defensive strategies played a role in chosing sites

Some structures (such as these towers) suggest motivations included a need for storage units (to cope with episodic drought events)

Fotunately, the ruins have the information necessary to determine the time of building of these structures. This makes it possible, in principle, to compare times of building with environmental conditions.

The study of the abandoned ruins and cliff houses of the Southwest brought forth a new science: dendrochronology. First it was about dating and then the reconstruction of climate change from tree-ring sequences.

A.E.Douglass, tree-ring pioneer

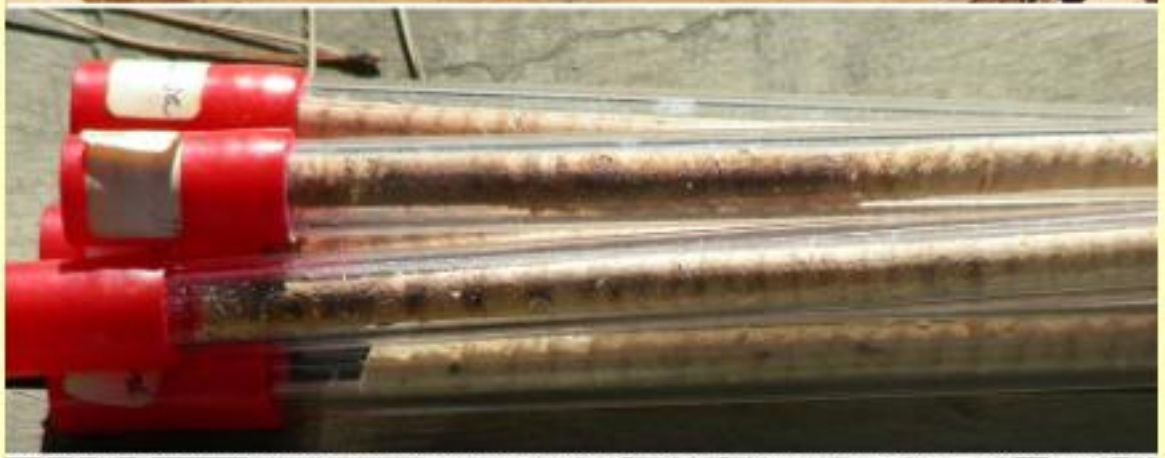
A.E. Douglass, an astronomer, became the founder-director of Tucson's Tree Ring Laboratory. Thanks to tree-ring studies since Douglass, we can get an idea about what drought history looked like in the West, through the last several centuries.

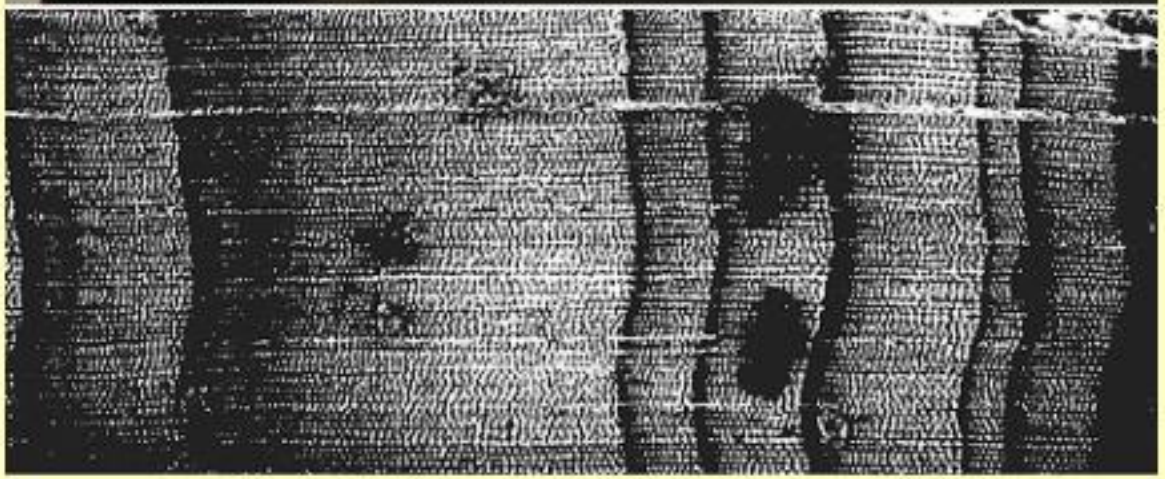
The mechanics of tree-ring analysis are rather simple.

One takes a core, then records the thickness of the rings in sequence. A happy tree makes thick rings, an unhappy one thin ones.

Depending on local circumstances, happiness indicates precipitation or warmth (in the growth season) or both.

Statistics is used to relate tree growth to the parameter sought.





Douglass also pioneered the study of the ancient bristlecone pines, finding that they are thousands of years old

The trees are highly drought resistant. They grow on very poor soil, on dolomitic rocks.

The trees are commonly well-spaced, and show deeply eroded core wood, several feet thick

Tree rings provide a reasonably good record of drought history.

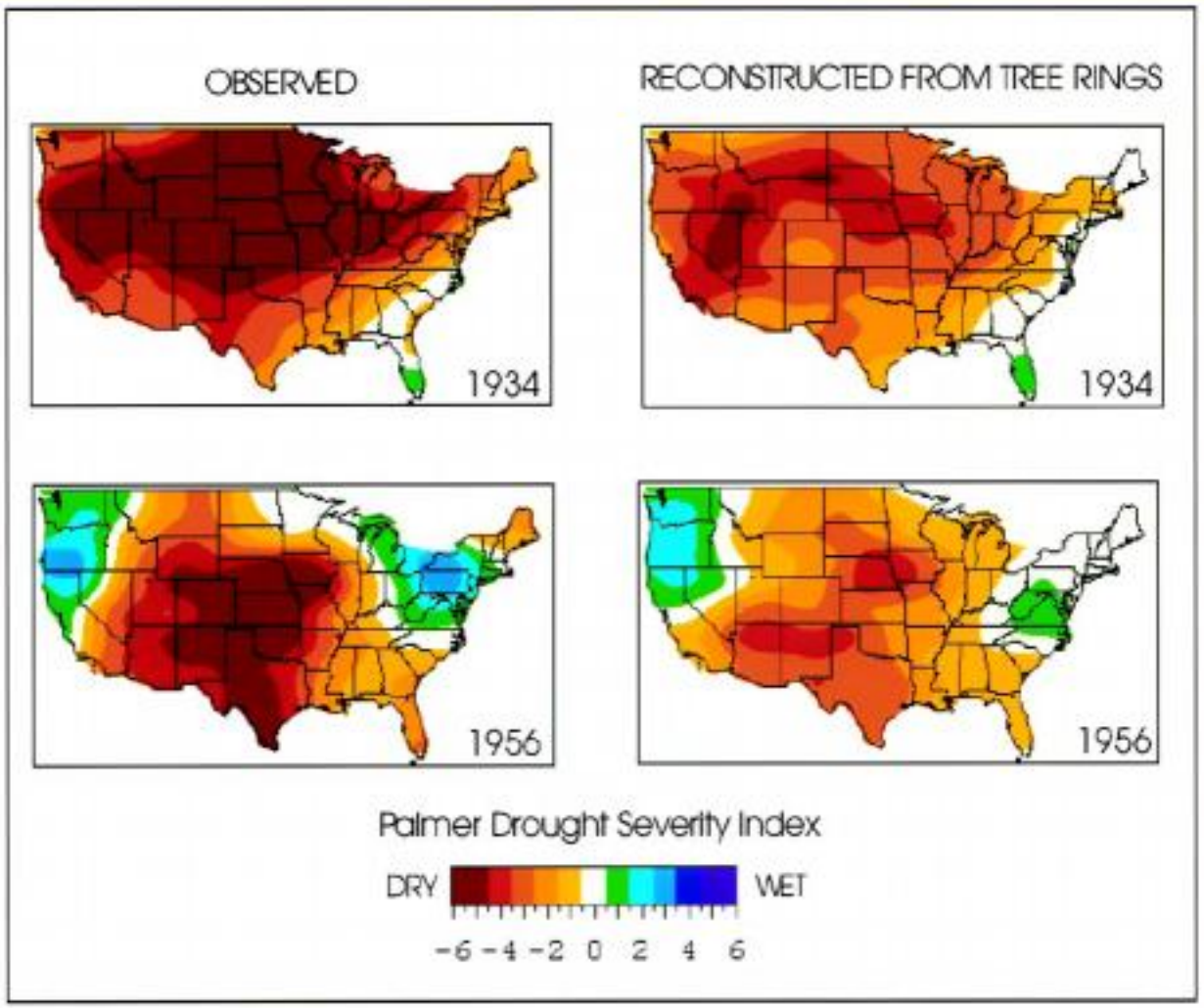


Fig. 5. Comparison of observed and tree-ring reconstructed PDSI values for two of the most extreme drought years in the twentieth century, 1934 and 1956. Although the severity of these droughts is not fully captured by the tree-ring reconstructions, the reconstructions duplicate the spatial extent and duration (see Fig. 6) of these droughts. Images are from the NOAA/NESDIS Web site (see text) (Karl et al. 1990; Guttman 1991; Cook et al. 1996).

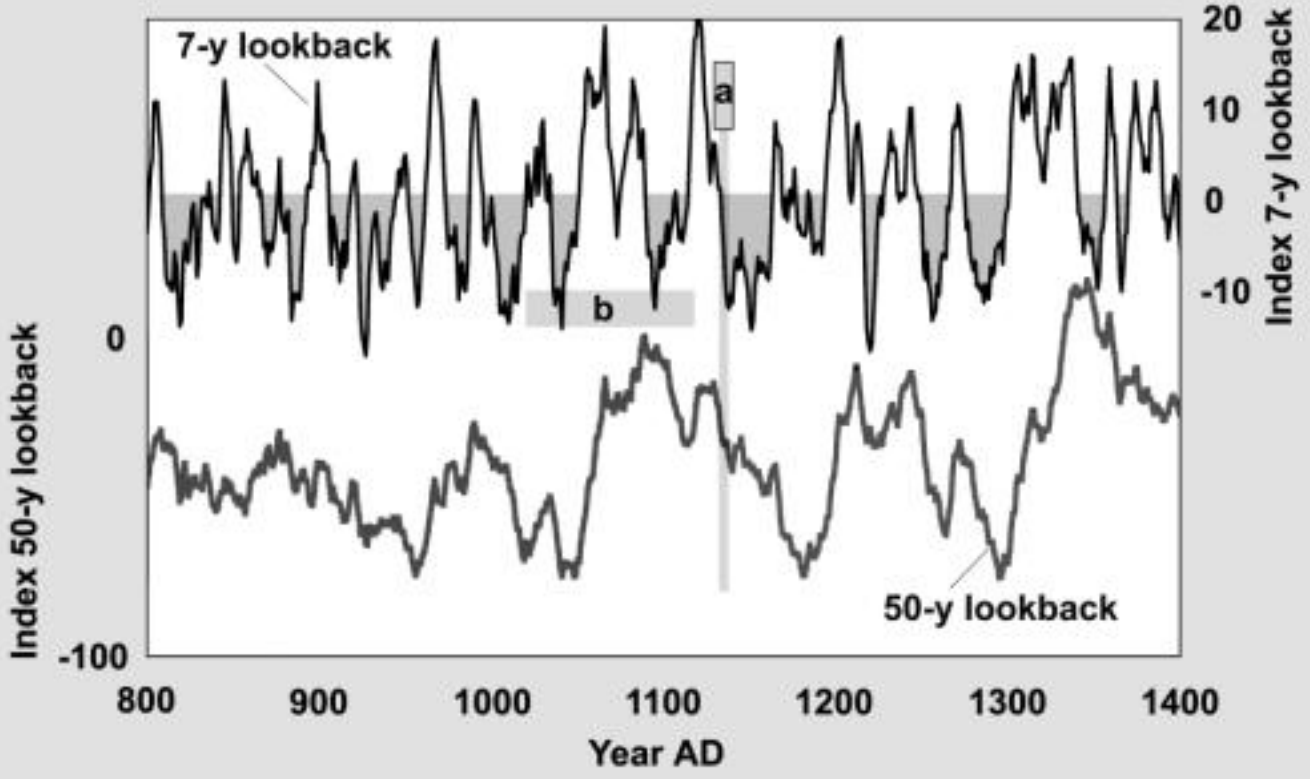
Woodhouse and Overpeck 1998

The definition of drought would seem to depend on the time scale considered (the "look-back" time). Short-term drought events can be bridged using storage, and getting water from springs and rivers. Long-term drought means springs and rivers dry up. In the Southwest, there is disruption of "normal" activities first within the 12th century and then late in the 13th. The big dispersion is in the 13th close to 1300 (referred to major drought by A.E. Douglass, in 1929).

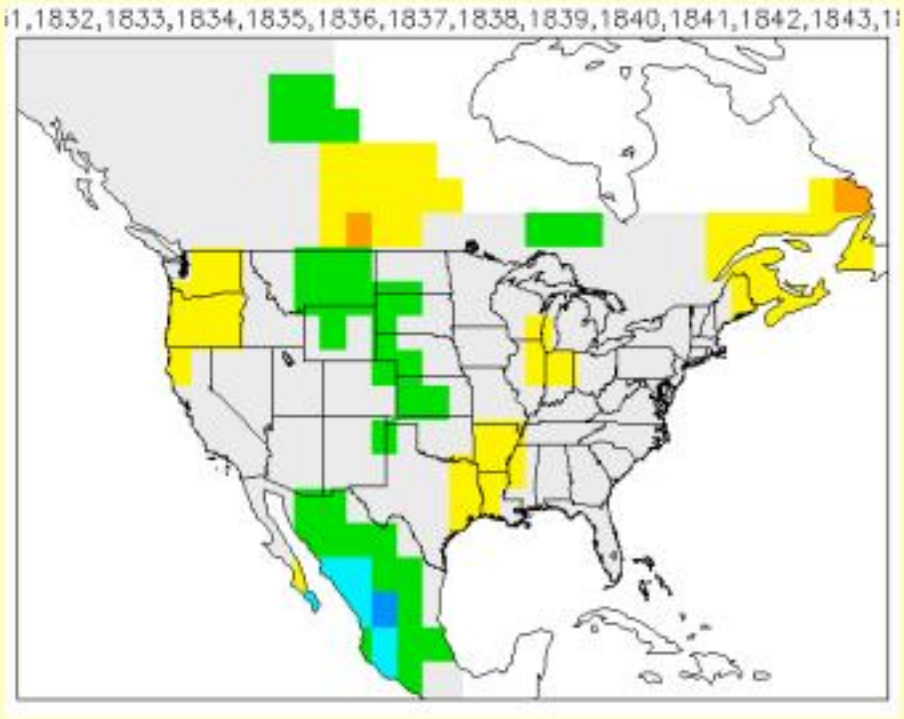
The lookback curves show cumulated drought indeces (PDSI) within the lookback window.

b, Chaco building time, "Classic Bonito";

a, decline of population begins, "late Bonito."

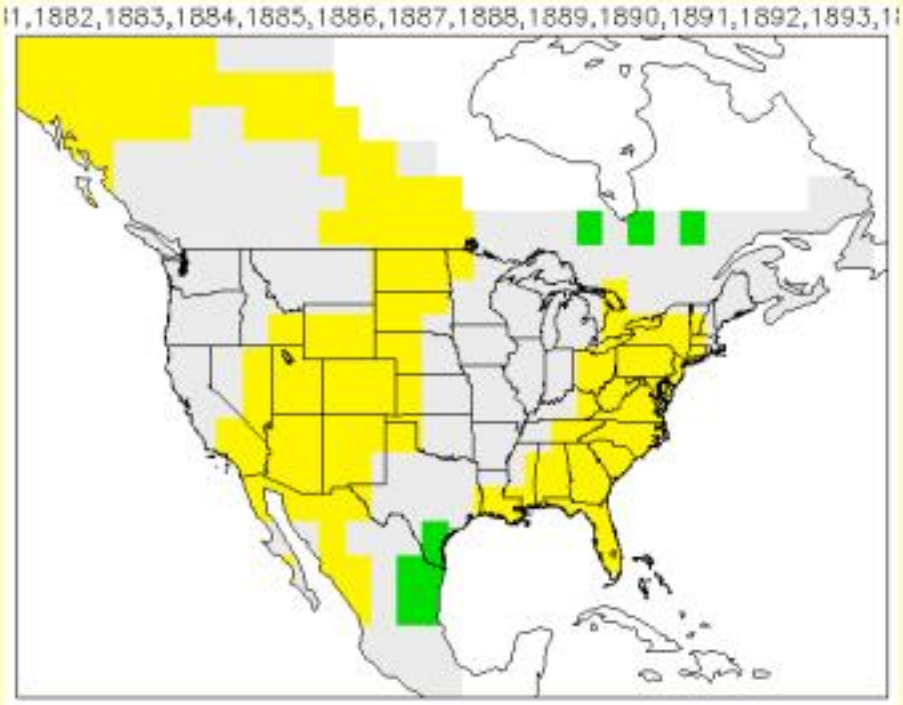


The scale of drought in a 25-year time frame



1825-1850

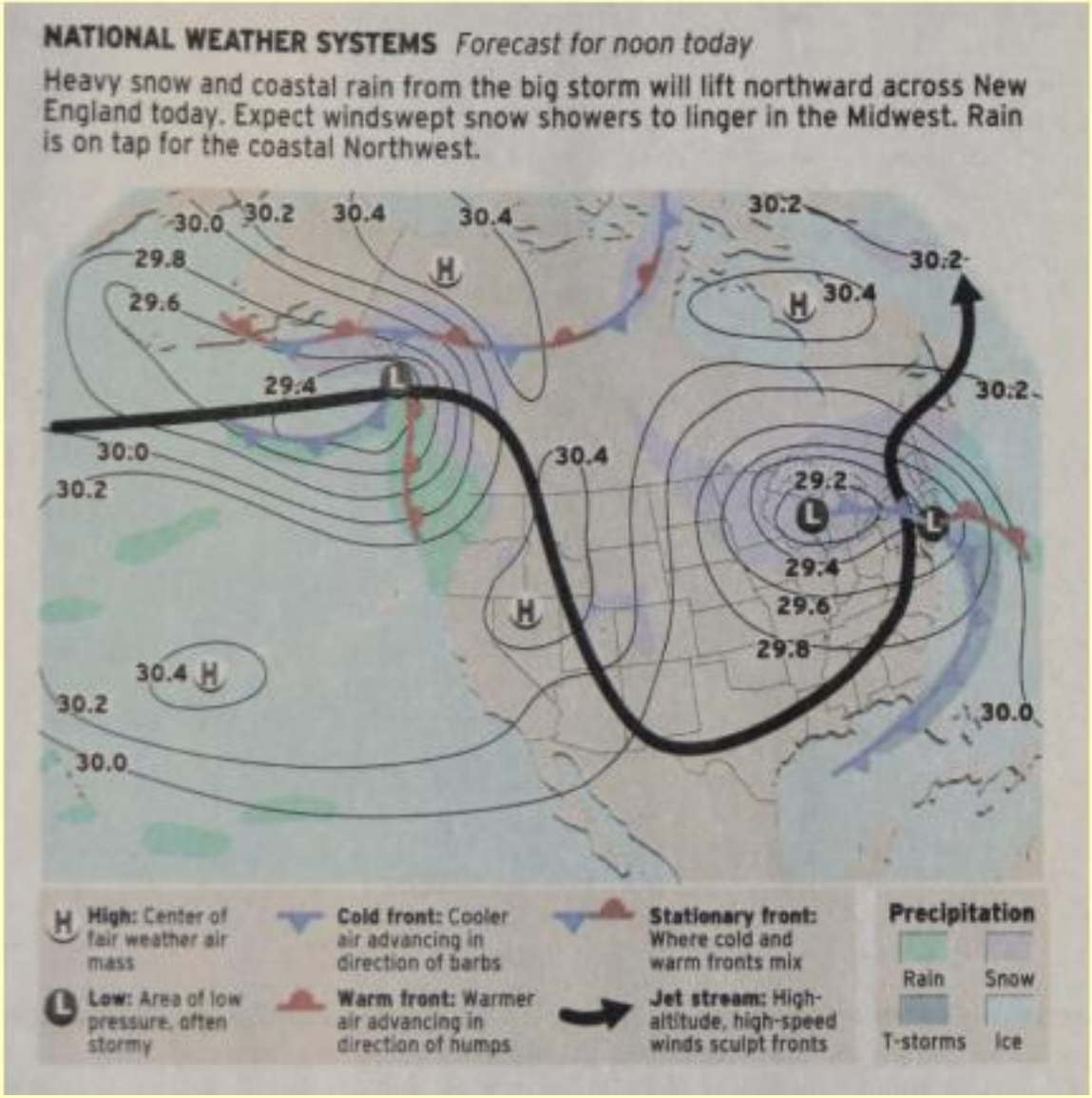
The scale of drought typically comprises many states, but not normally most of the states.



1850-1875

NOAA web site

The scale is given by the connections provided by large-scale patterns of upper air circulation, here illustrated for a day in March 2007 (in the San Diego Union).

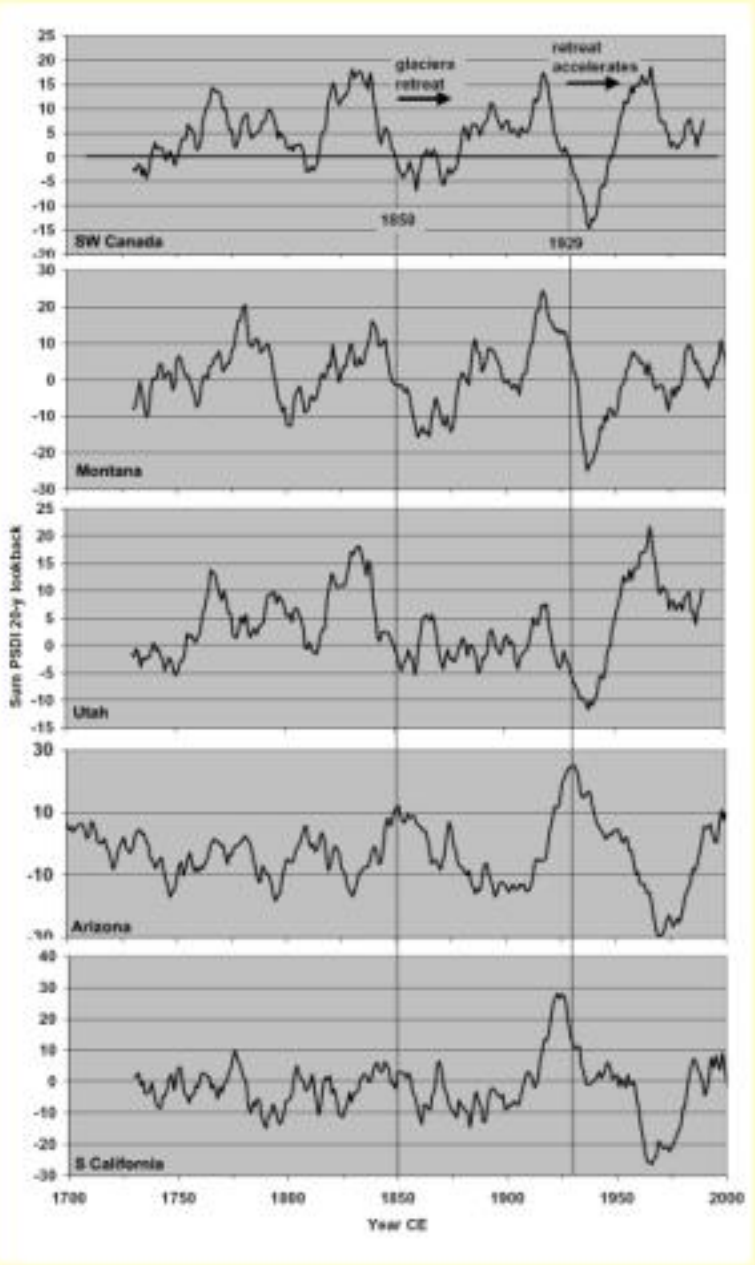


Note the scale of jet stream and highs and lows. Note the contrast between the West and the region east of the Mississippi.

The West has a number of different climate regions:

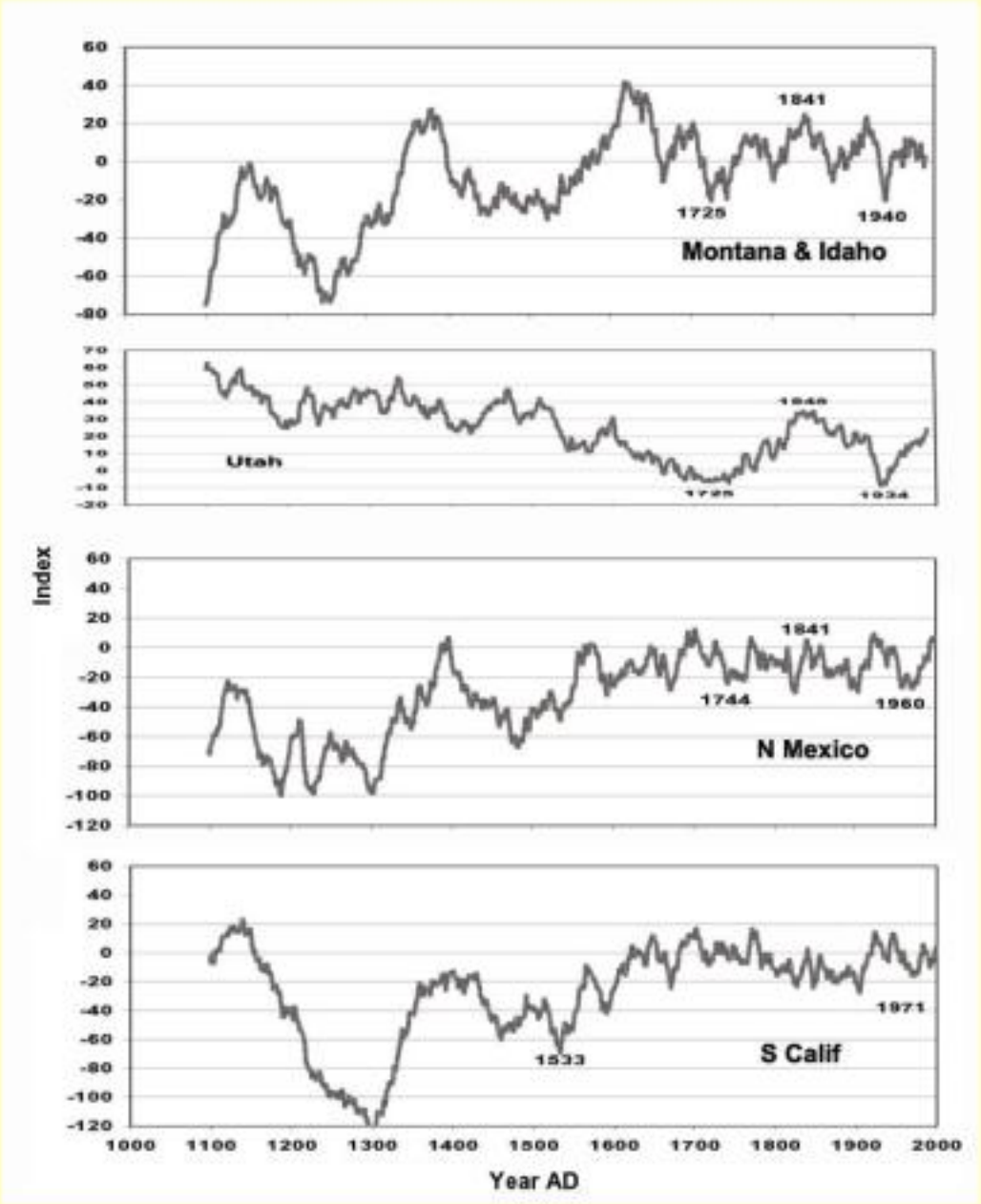
SW Canada and Montana have similar history, as do Southern California and Arizona.

Utah does its own thing -- more influenced by the climate change in the north than in the south.



The similarity in climate history of the southwestern states holds up for the last 1000 years, in this comparison of 100-year lookback series.

Before 1500, large climate cycles dominate the narrative both in Montana/Idaho and in the Southwest. After 1500, there is a shift to shorter cycles and less variability.



The drought history of the Midwest and the West has much in common, on long time scales. Severe drought periods were common and widespread from the 8th to the 13th century.

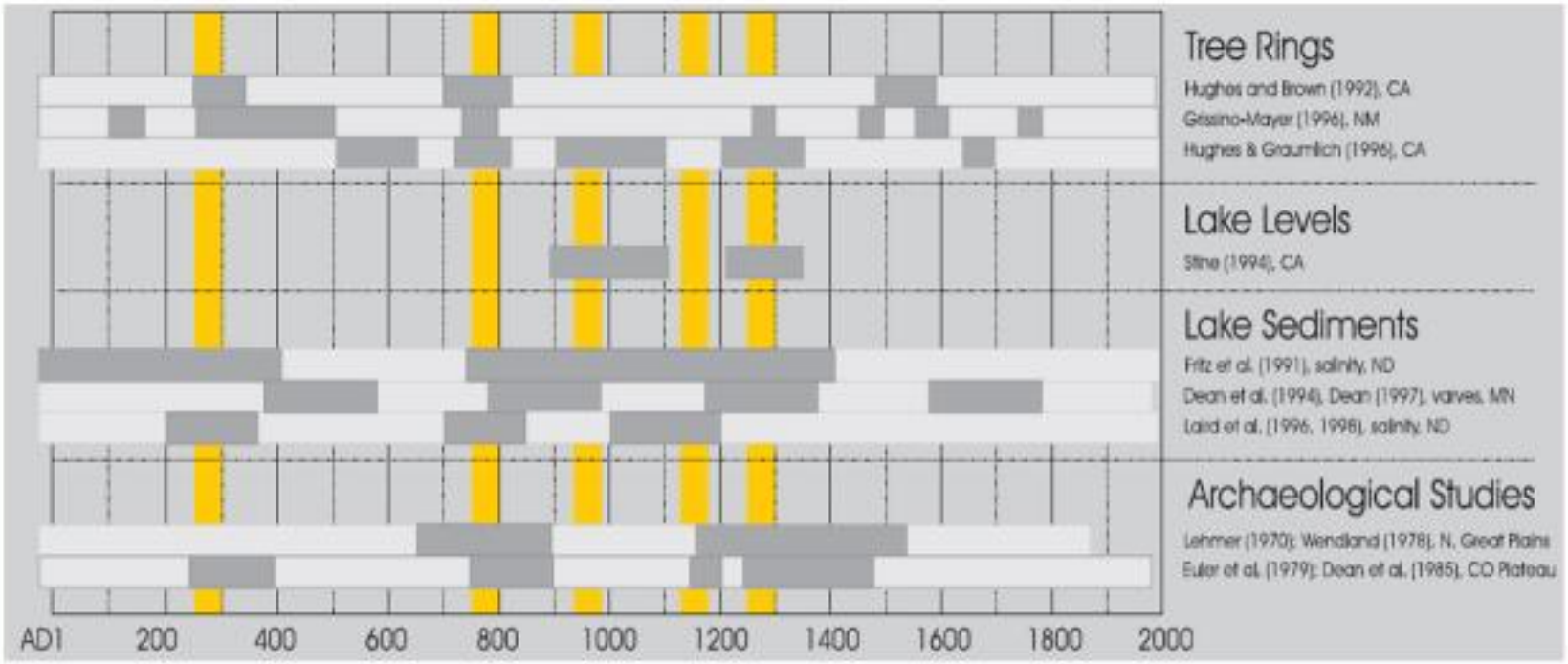
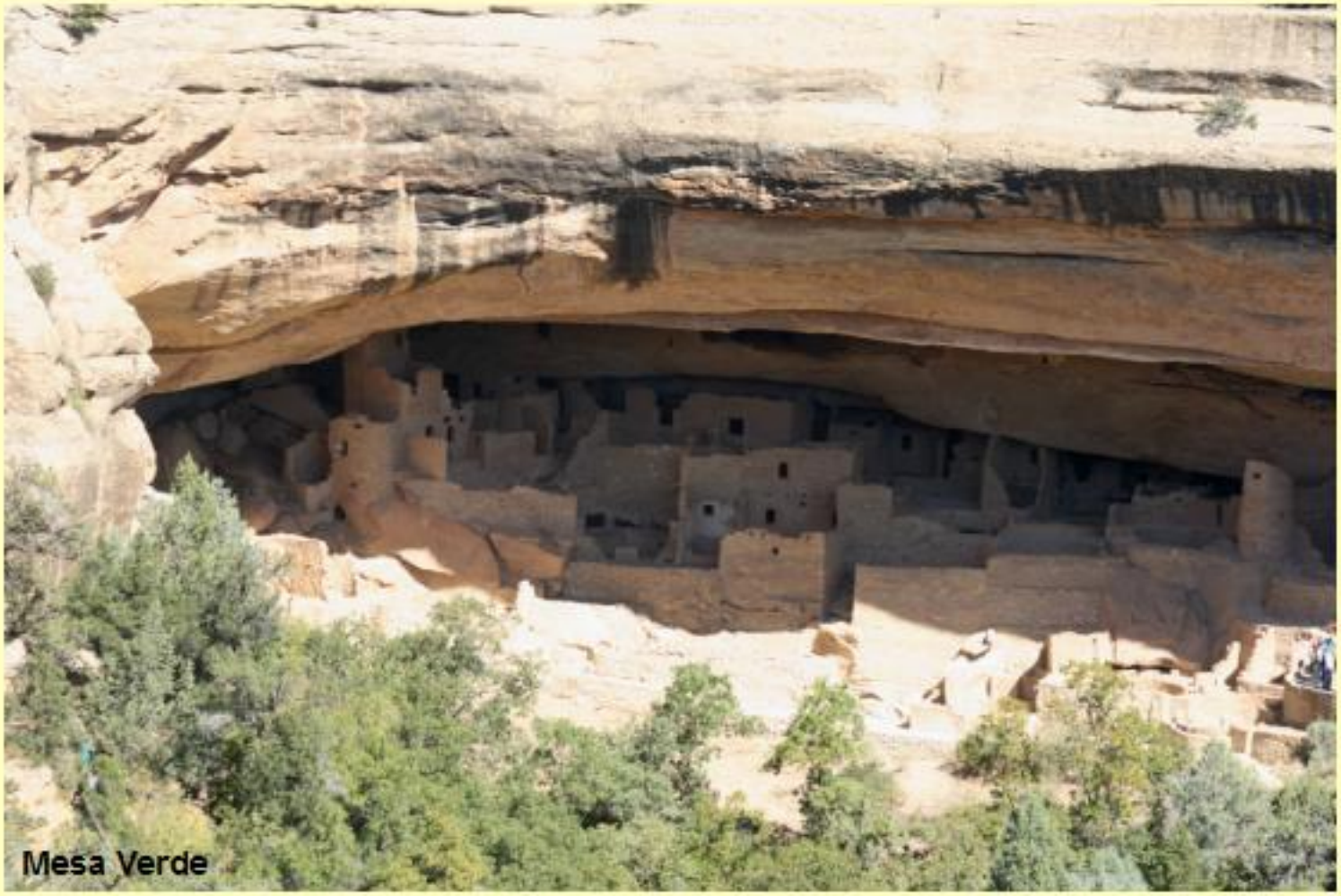


FIG. 10. Paleoclimatic records of Great Plains and western U.S. century-scale drought, A.D. 1–present, as recorded in a variety of paleoclimatic data. The pale gray horizontal bars reflect the length of the series, and the dark gray indicate periods of drought. Orange vertical bars represent multidecadal droughts that appear to have been widespread.

Woodhouse and Overpeck 1998

To what degree the history of drought of the West is a guide for future developments is not known -- we are entering climate conditions that are informed by greenhouse gas concentrations without precedent. Thus, when projecting developments, our experience is being applied to a shifting framework.



References

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Website: http://www.ncdc.noaa.gov/paleo