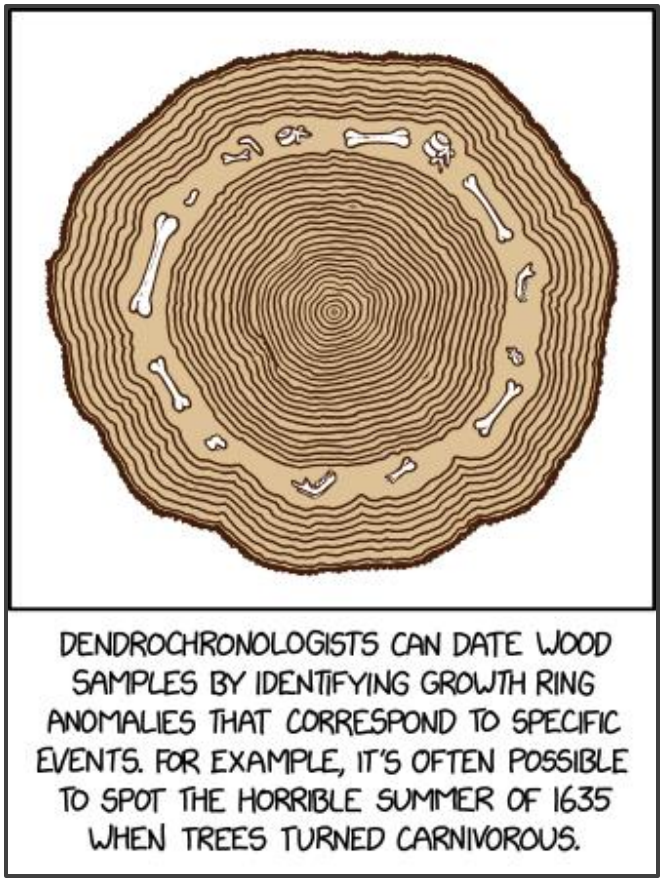
Tree Rings as Paleoclimate Proxies

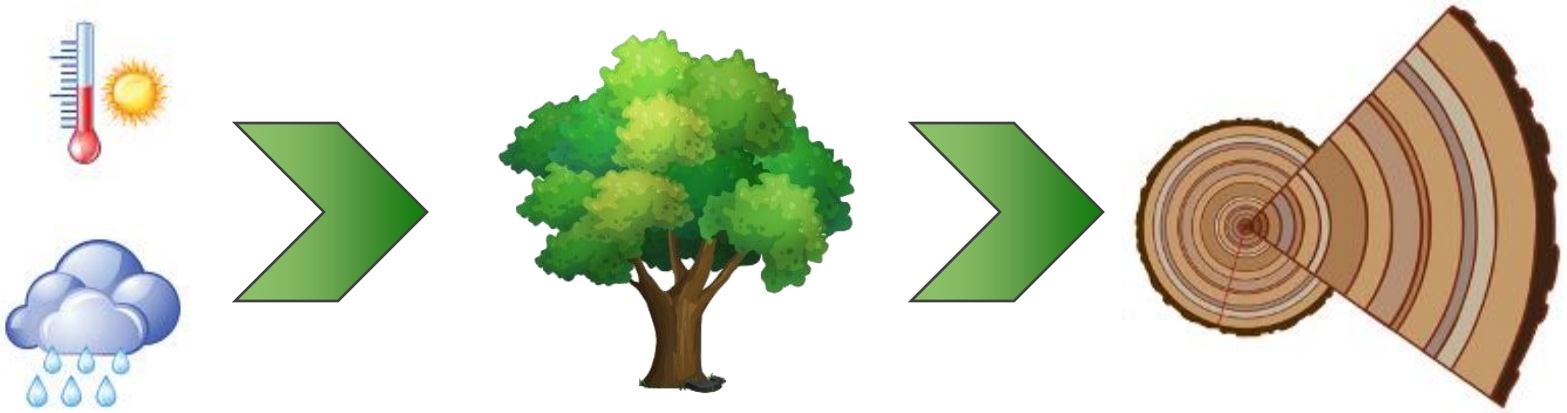
Today's Agenda

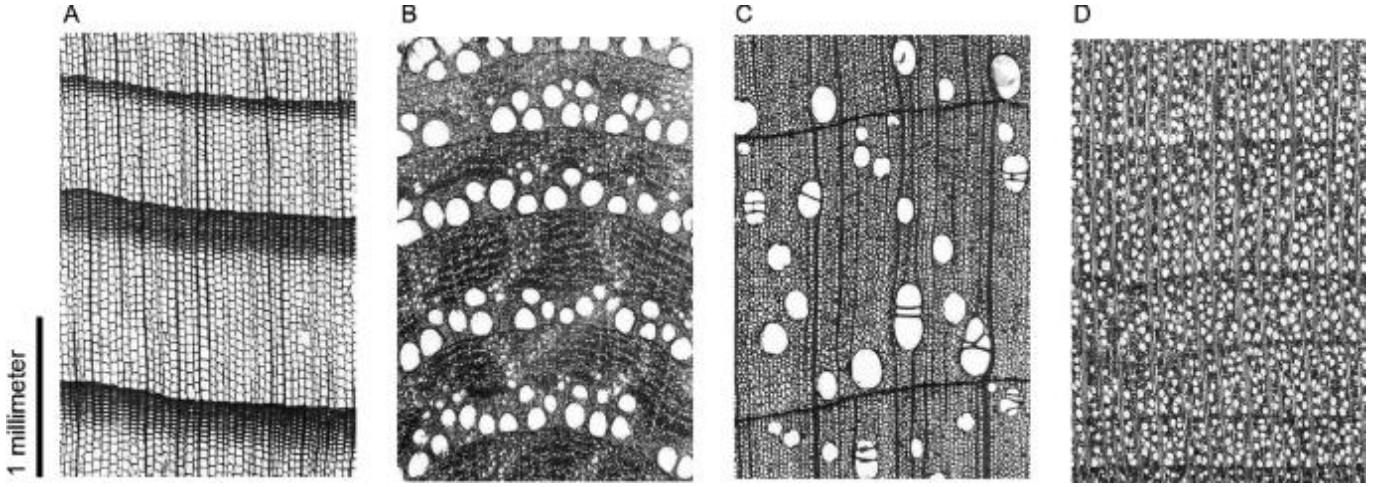
- What are Tree Rings?
- History of Dendrochronology
- Dendrochronology as a Science
- Paleoclimate Reconstructions



xkcd.com

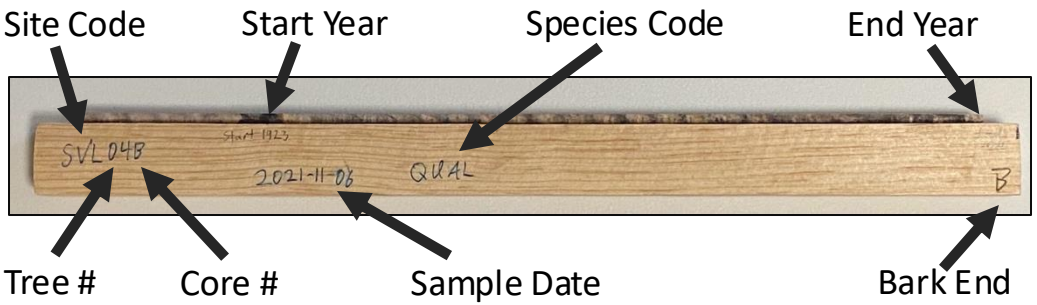
Tree Rings





Tree Cores


ELMER'S
School Glue


Site Code
Start Year
Species Code
End Year
SVL048
Start 1923
2021-11-08
QUAL
B
Tree #
Core #
Sample Date
Bark End

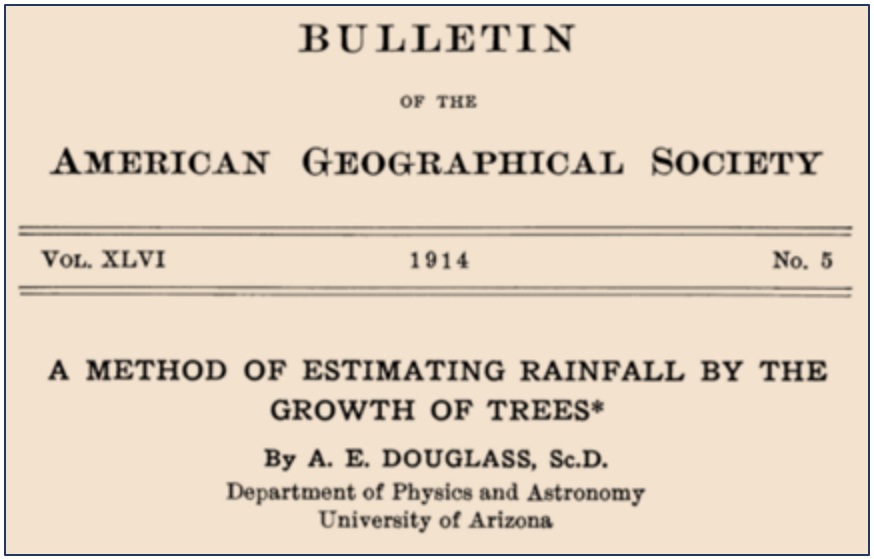
History of Dendrochronology

- Theophrastus (Greece 322 BCE)
- Leonardo Da Vinci (Italy ca. 1500)
- Duhamel & Buffon (France 1737)
- A.C. Twinning (Connecticut 1827)
- Theodor Hartig (Germany 1837)
- Charles Babbage (England 1838)
- Jacob Kuechler (Texas 1859)
- Robert Hartig (Germany 1867)
- A.E. Douglass (Arizona 1904)

Andrew Ellicott Douglass

"Father of dendrochronology"

- 1867-1962
- American astronomer
- Formalized the science



BULLETIN

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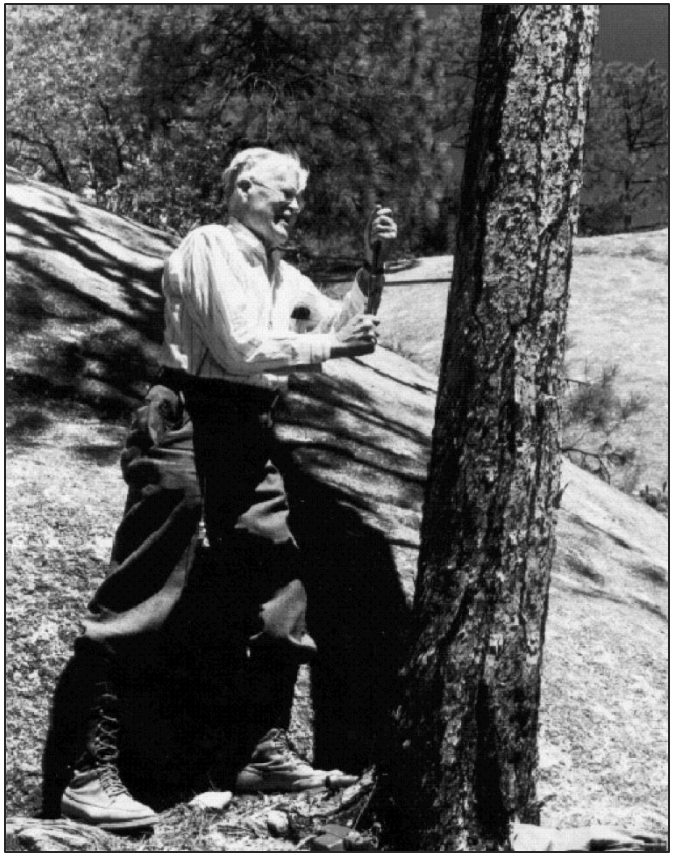
A METHOD OF ESTIMATING RAINFALL BY THE GROWTH OF TREES*

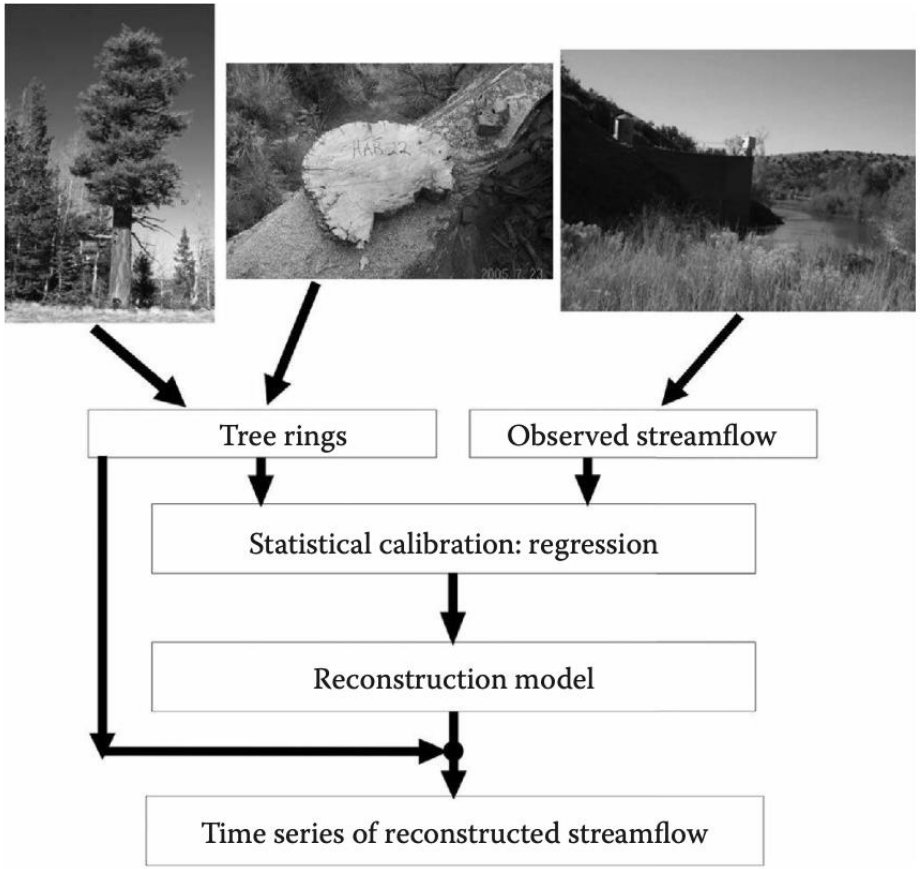
By A. E. DOUGLASS, Sc.D.

Department of Physics and Astronomy
University of Arizona



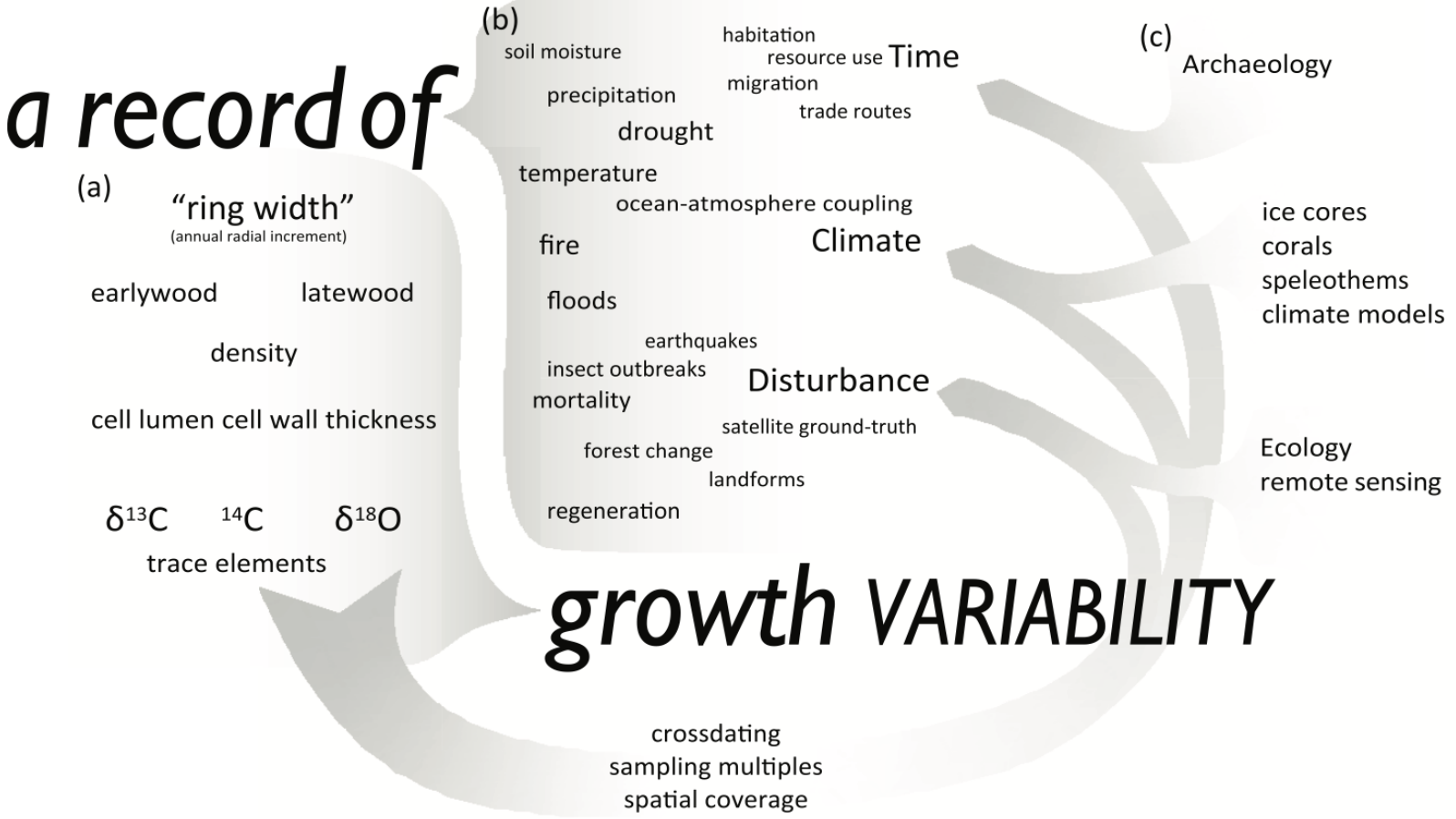
Dendrochronology as a Science

- Quantitative
- Statistical methods
  - Detrending
  - Linear regressions
  - Principle component analysis
- Observed instrumental and historical records



Woodhouse et al. (2016)

Tree Rings



Pearl et al. (2019)

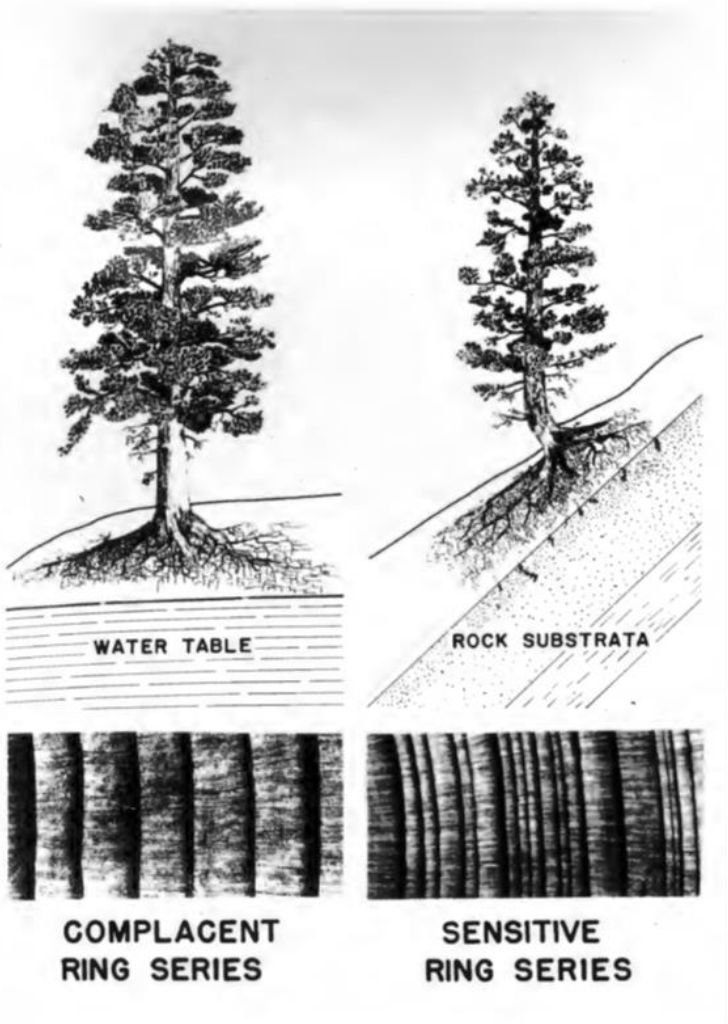
Principle of Aggregate Tree Growth

$$R_t = A_t + C_t + \delta D1_t + \delta D2_t + E_t$$

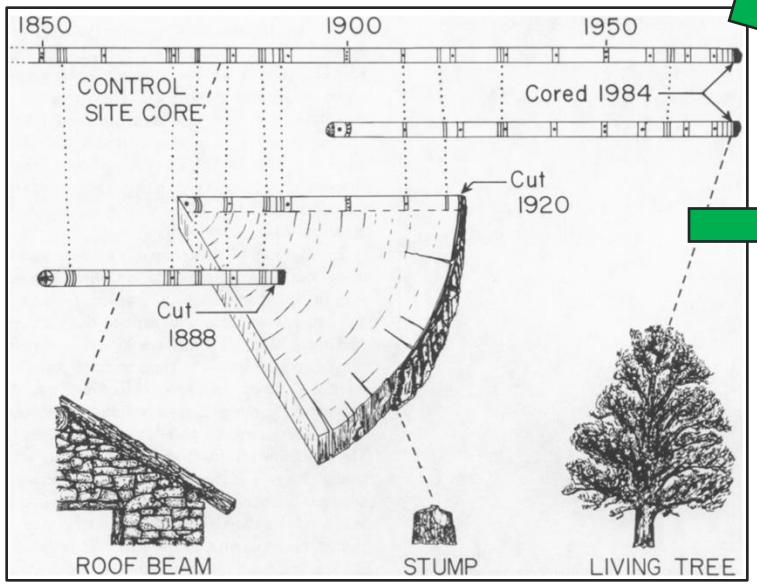
- R_t: tree-ring growth
- A_t: age-related growth trend
- C_t: climate during a particular year
- $\delta D1_t$: disturbances within the forest stand
- $\delta D2_t$: disturbances external to forest stand
- E_t: random processes that aren't accounted for
- t: year

Climate-Sensitive Trees

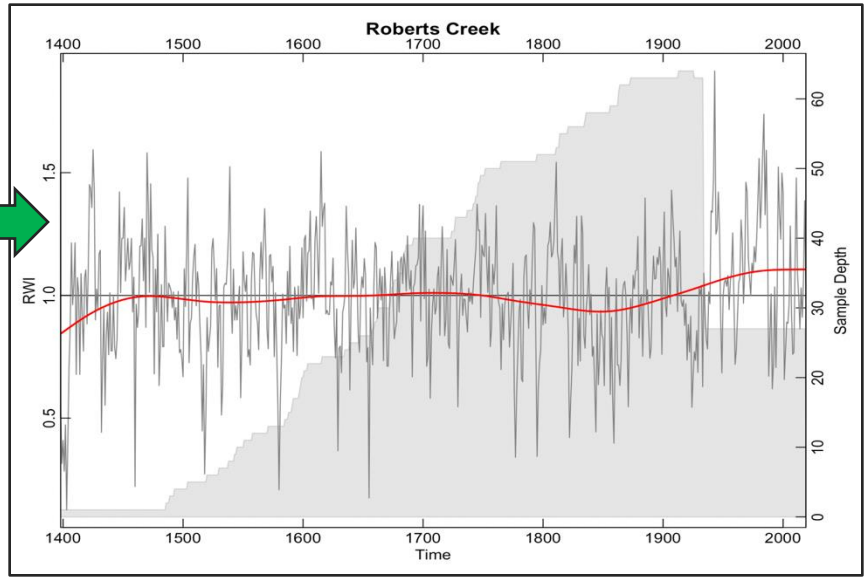
- Site Characteristics:
  - Aspect and Slope
  - Elevation
  - Soil Type
  - Topography
- Minimal competition from other plants
- Sample size:
  - ~15-50 trees



Basics of Dendrochronology



Hattori and Thompson (1987)



Harris and Csank (2023)

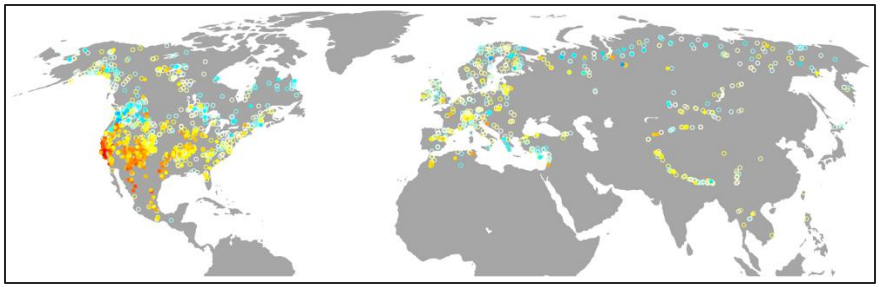
Advantages

- Absolute dating
- Annual to sub-annual resolution
- Versatile
- Long-lived

Csank (2009)

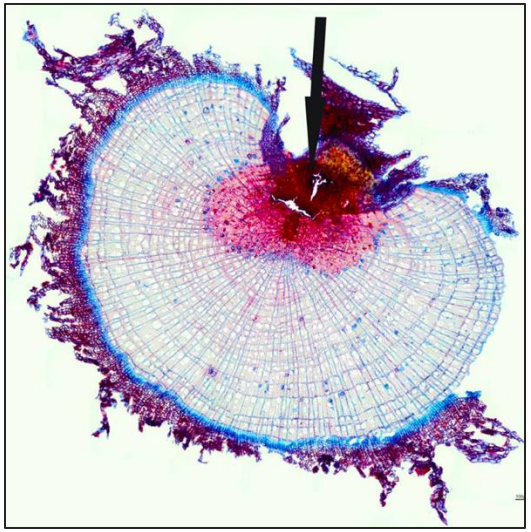
Disadvantages

- Limited temporal coverage
- Limited spatial extent
- Short calibration data
- Not all species put on annual rings

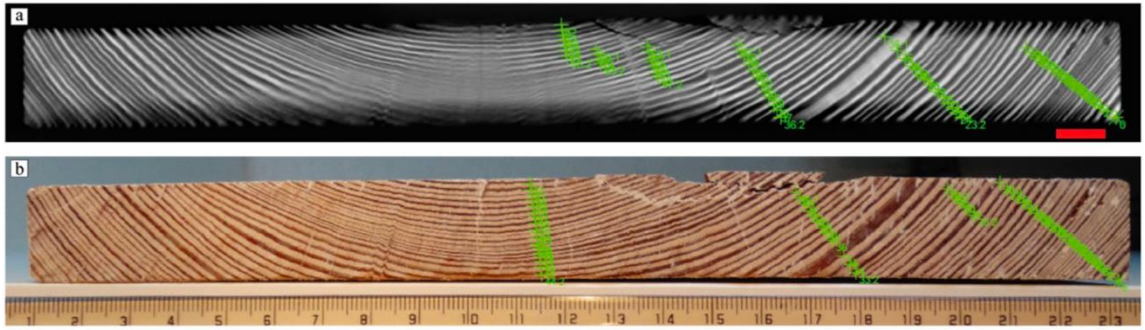


St. George (2014) – site sensitivity to winter precipitation

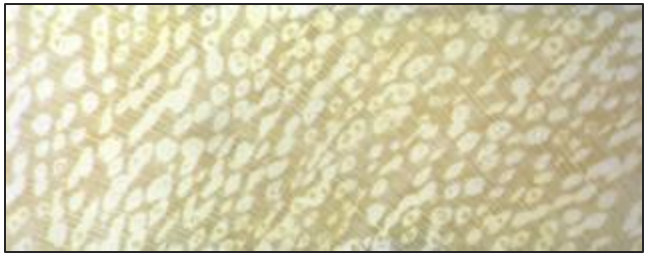
Frontiers in Dendroclimatology



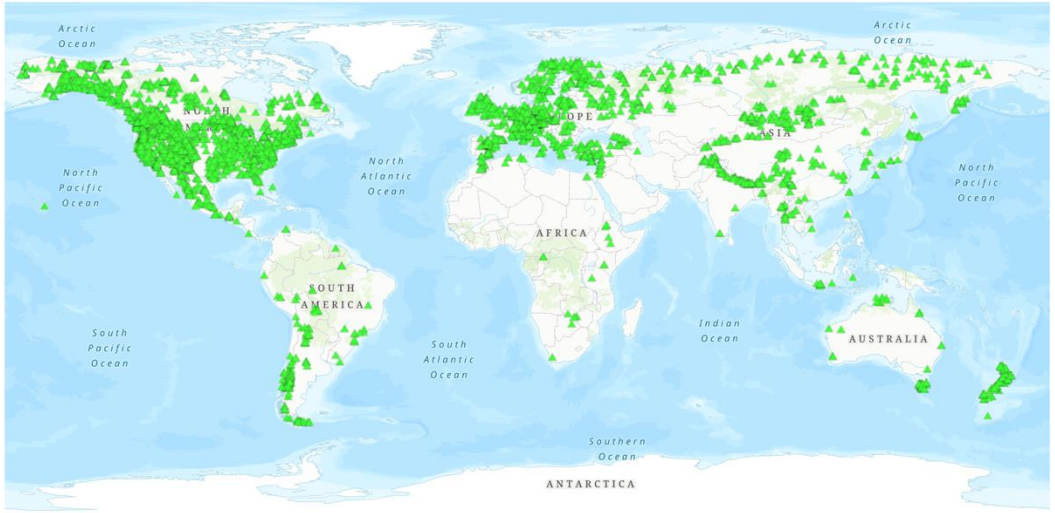
Pearl et al. (2019)



Bossema et al. (2021)

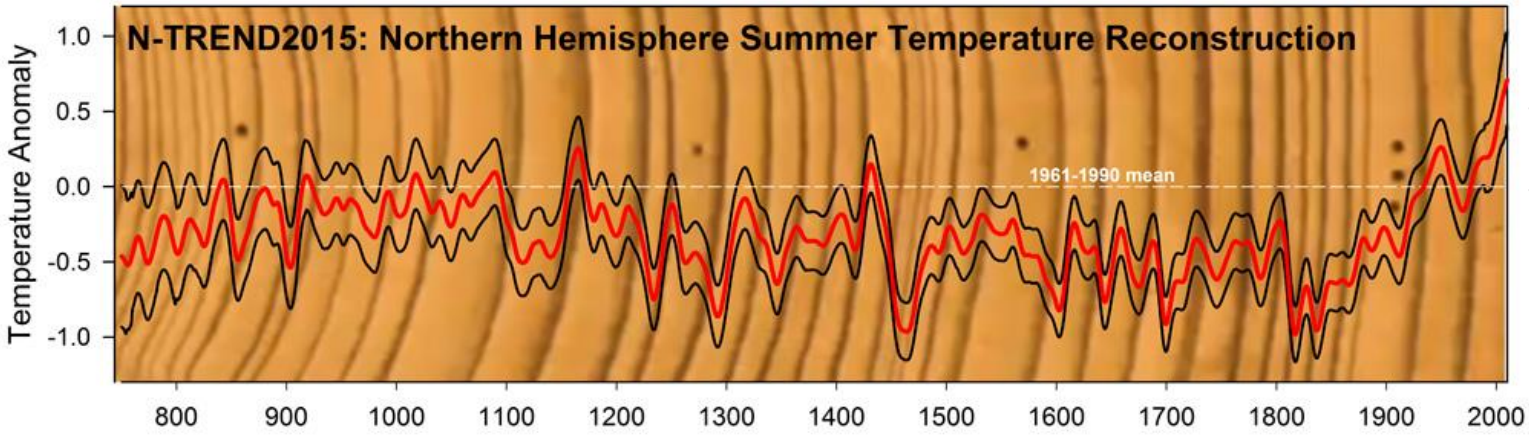


Speer et al. (2022)

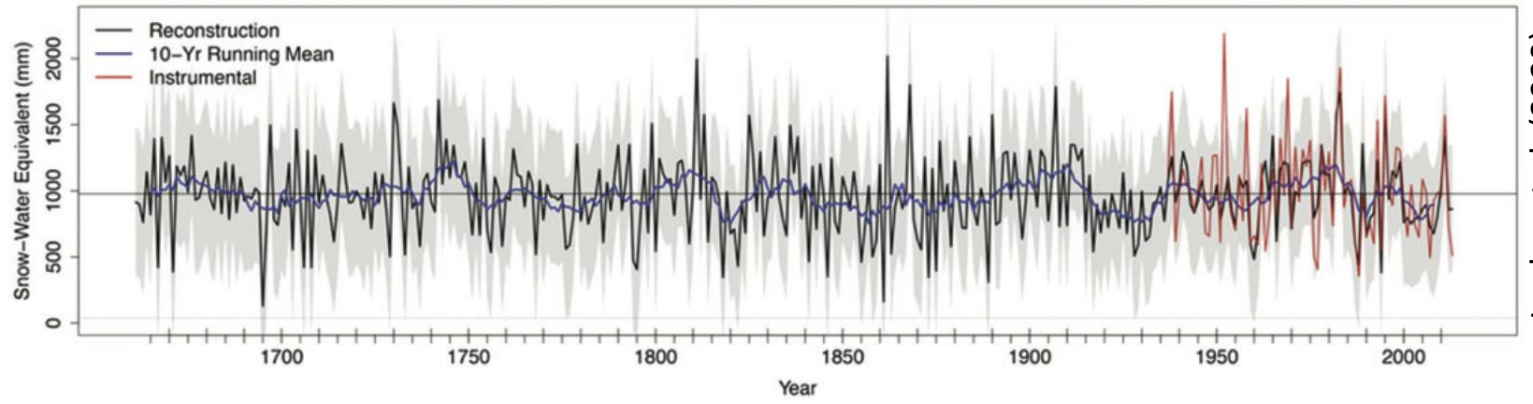


International Tree Ring Data Bank

Paleoclimate Reconstructions



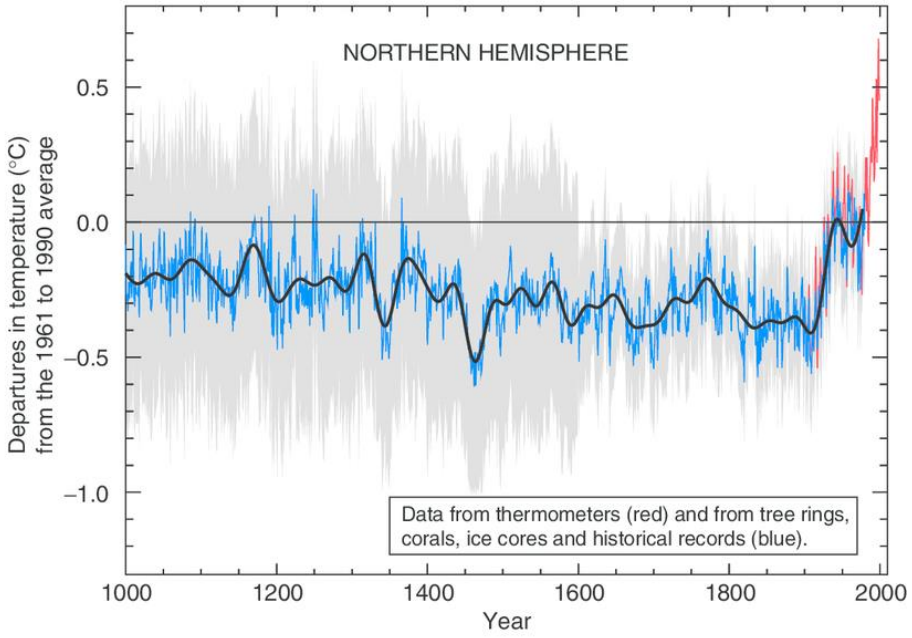
Wilson (2016)



Lepley et al. (2020)

Bristlecone Pine and Temperature

LaMarche, V.C., Jr. (1969), Environment in Relation to Age of Bristlecone Pines. *Ecology*, 50: 53-59.

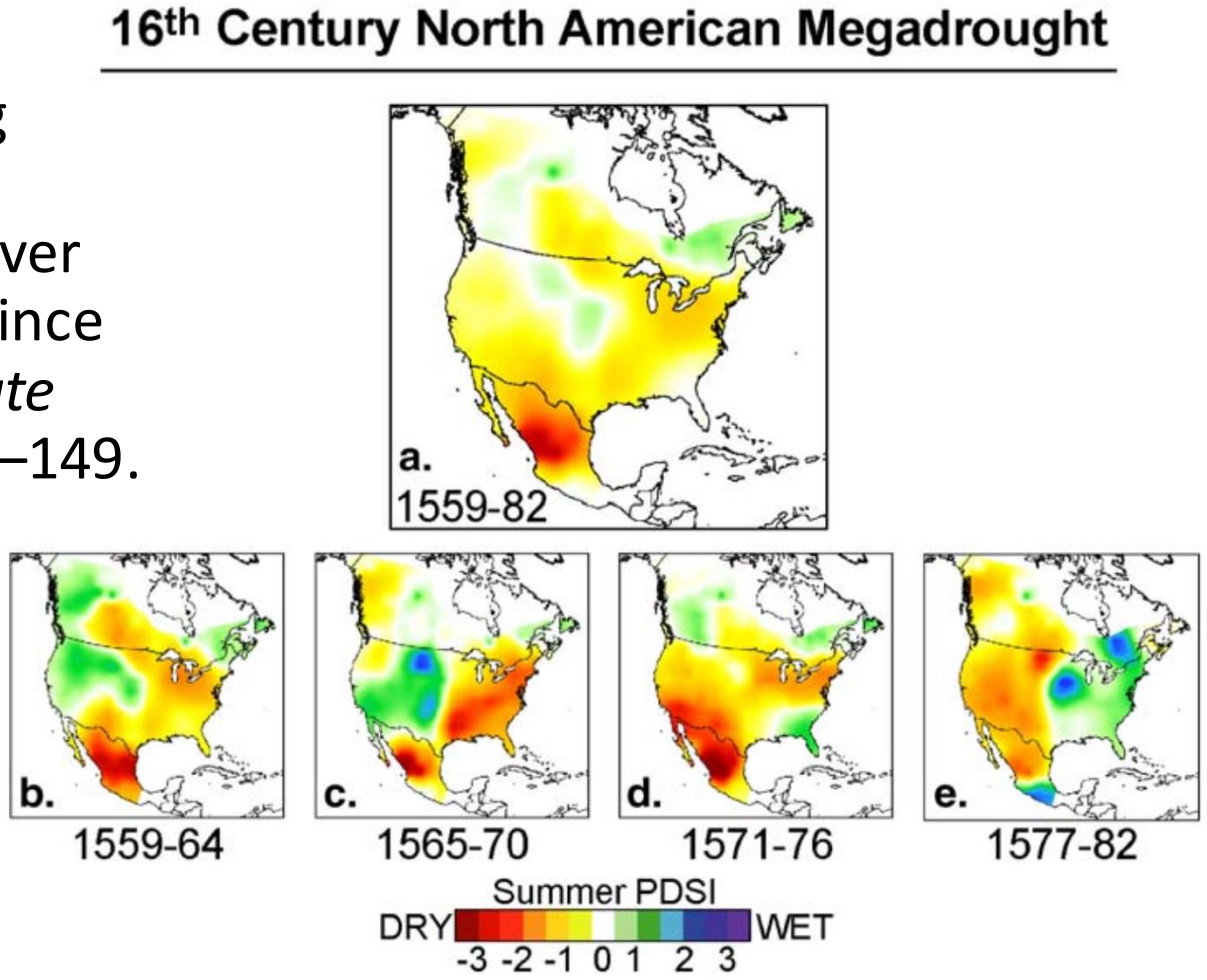


Mann et al. (1999)

Methuselah: 4,853 years old
White Mountains

Palmer Drought Severity Indices

Stahle, D. W. et al. (2007). Tree-ring reconstructed megadroughts over North America since A.D. 1300. *Climate Change*, *83*, 133–149.



Colorado River Streamflow

Meko, D., et al. (2007). Medieval drought in the Upper Colorado River Basin. *Geophysical Research Letters*, 34.

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