

Climate Change: Experimental Techniques of Paleoclimatology

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Motivation

- Thermometer, satellite, and weather balloon measured temperatures show global warming trend since ~1950
- Understand if current temperature changes are natural or unnatural
- Reconstruct history of Earth's climate through the experimental techniques of paleoclimatology

Historical Records

- When little instrumental data available, turn to historical records
- Records of harvest dates, freezing/thawing events, blossoming of plants, sea ice occurrence, etc. around the world
 - Overlapping instrumental data crosschecked with historical records, build quantitative results

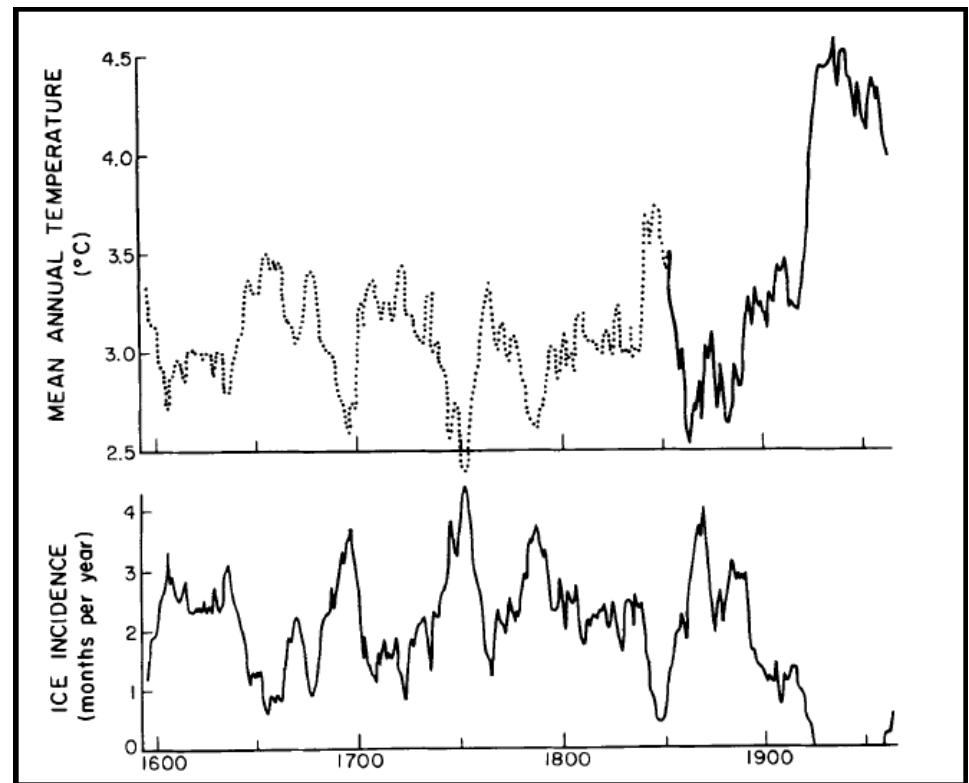


Figure 5b from Bradley 1991a:
Paleotemperatures shown by dashed line

Ice Cores

- Form annual layers much like trees and corals
 - Many dating techniques: isotopes, volcanic ash, radioactive dating of gases
- $\delta^{18}\text{O}$ and δD greatly dependent on temperature
- Reconstruct past temperatures provided correct dating of core

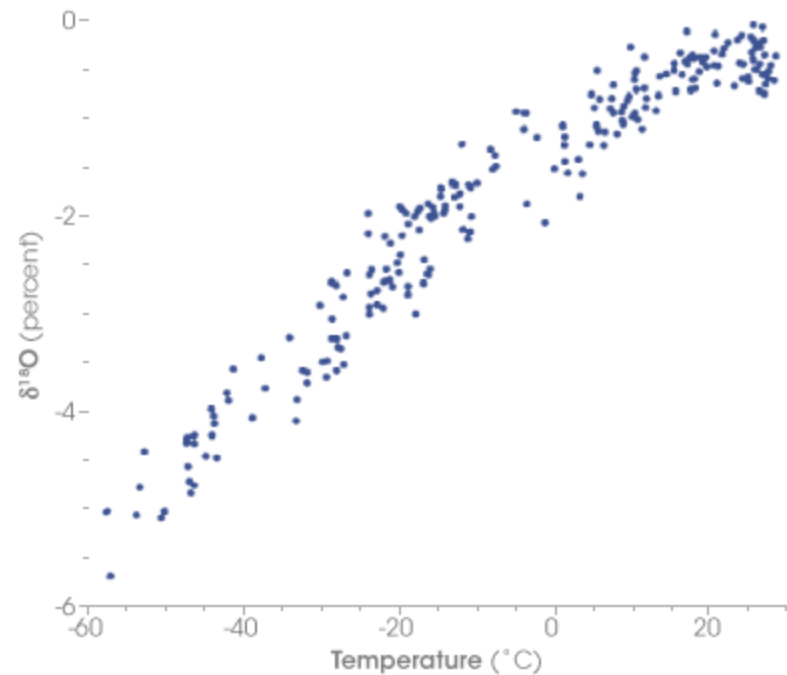
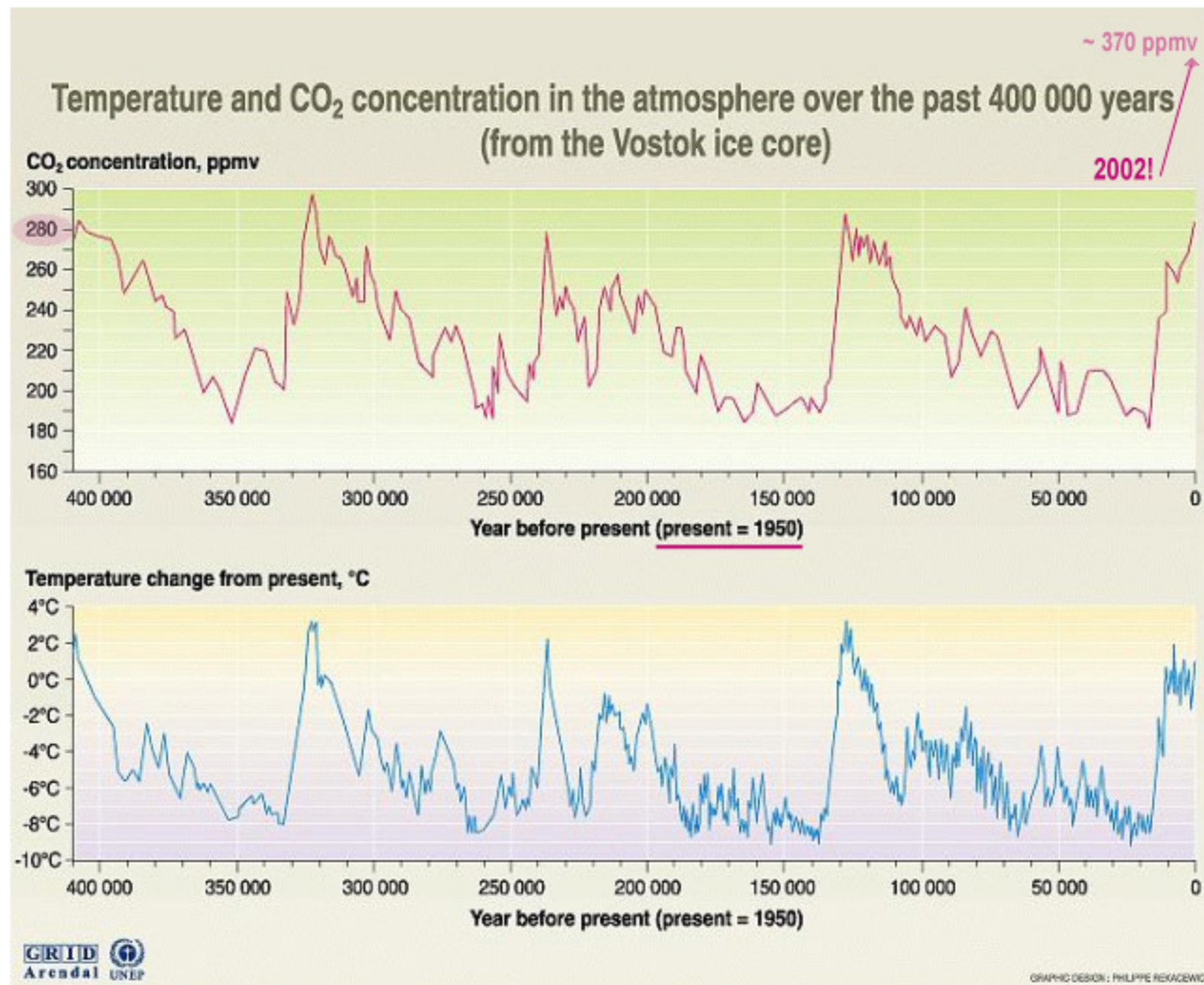


Figure from NASA's Earth Observatory
Paleoclimatology website



Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, *Nature* 399 (3 June), pp 429-436, 1999.

(Note: 2002 information added to diagram)

Figure from Climate Action Network Canada, adapted from
Petit & Jouzel et al. 1999

Corals

- Certain long-lived corals form distinct annual bands
- Temperature data from isotope ratios of oxygen and carbon
 - Coral skeletal $\delta^{18}\text{O}$ influenced by surface temperature and salinity
- Usually track instrumental temperature measurements
 - Must average several cores from same location for good S/N
 - Uncertainties in salinity -> overestimates of temperature rise

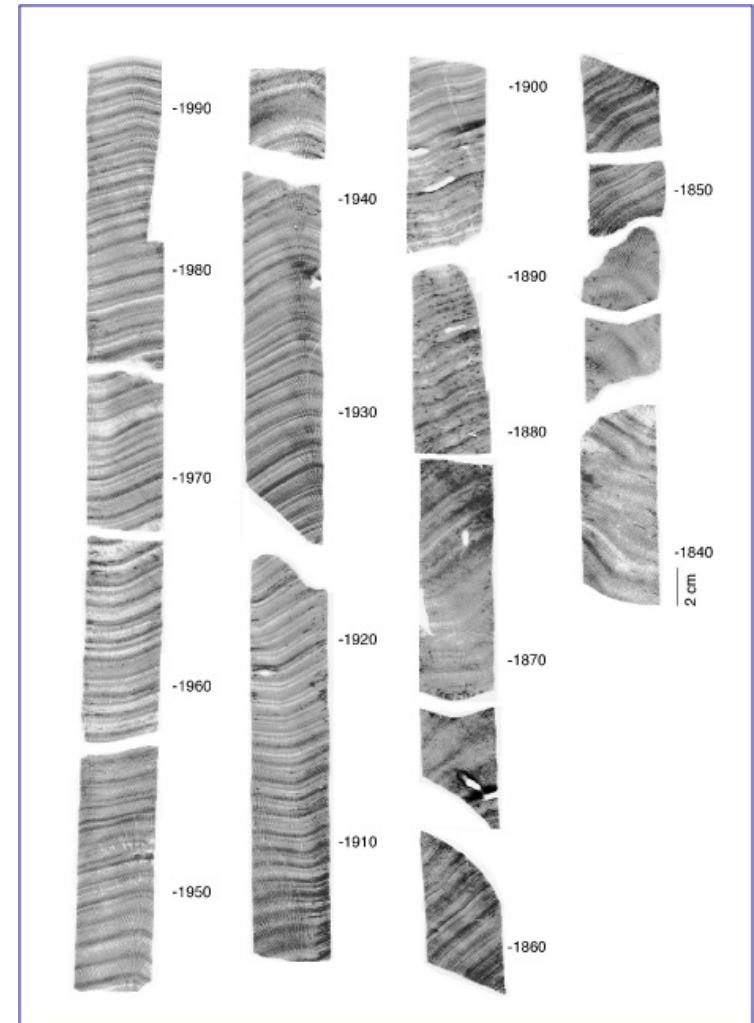


Photo from European Consortium for
Ocean Research Drilling

Tree Rings

- Environmental factors strongly effect annual ring growth
- Can calibrate ring width with most limiting climatic variable: temperature, precipitation, etc.
- Reconstruct past temperatures assuming conditions similar in past

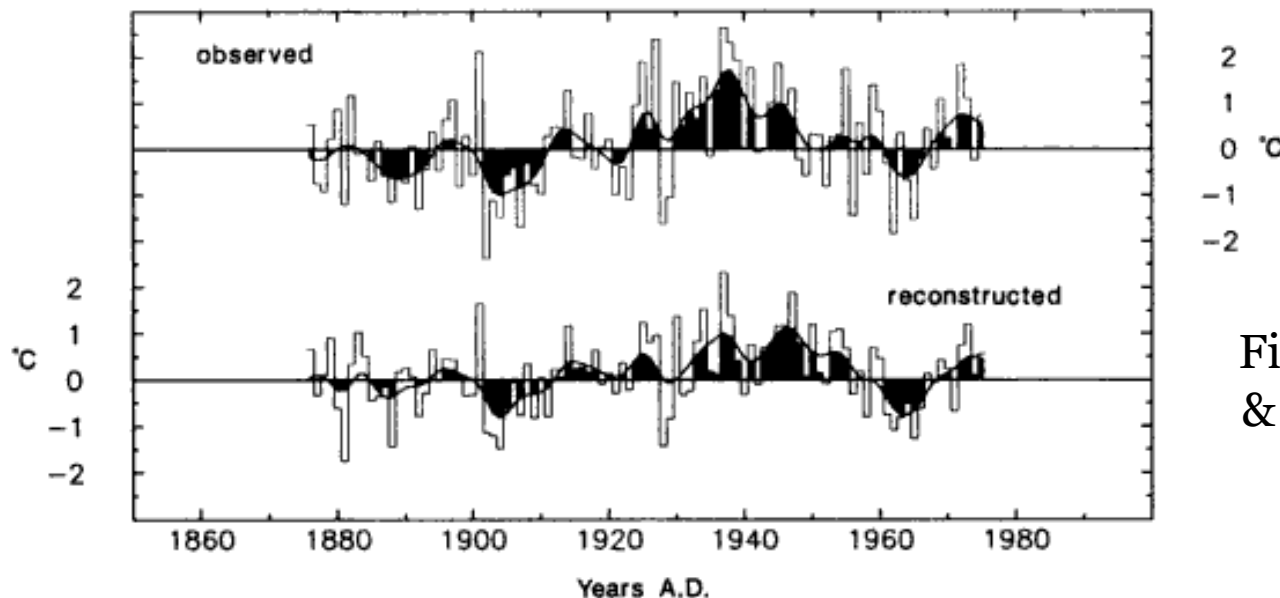


Figure 19.4 from Briffa & Schweingruber 1992

The New Hockey Stick!

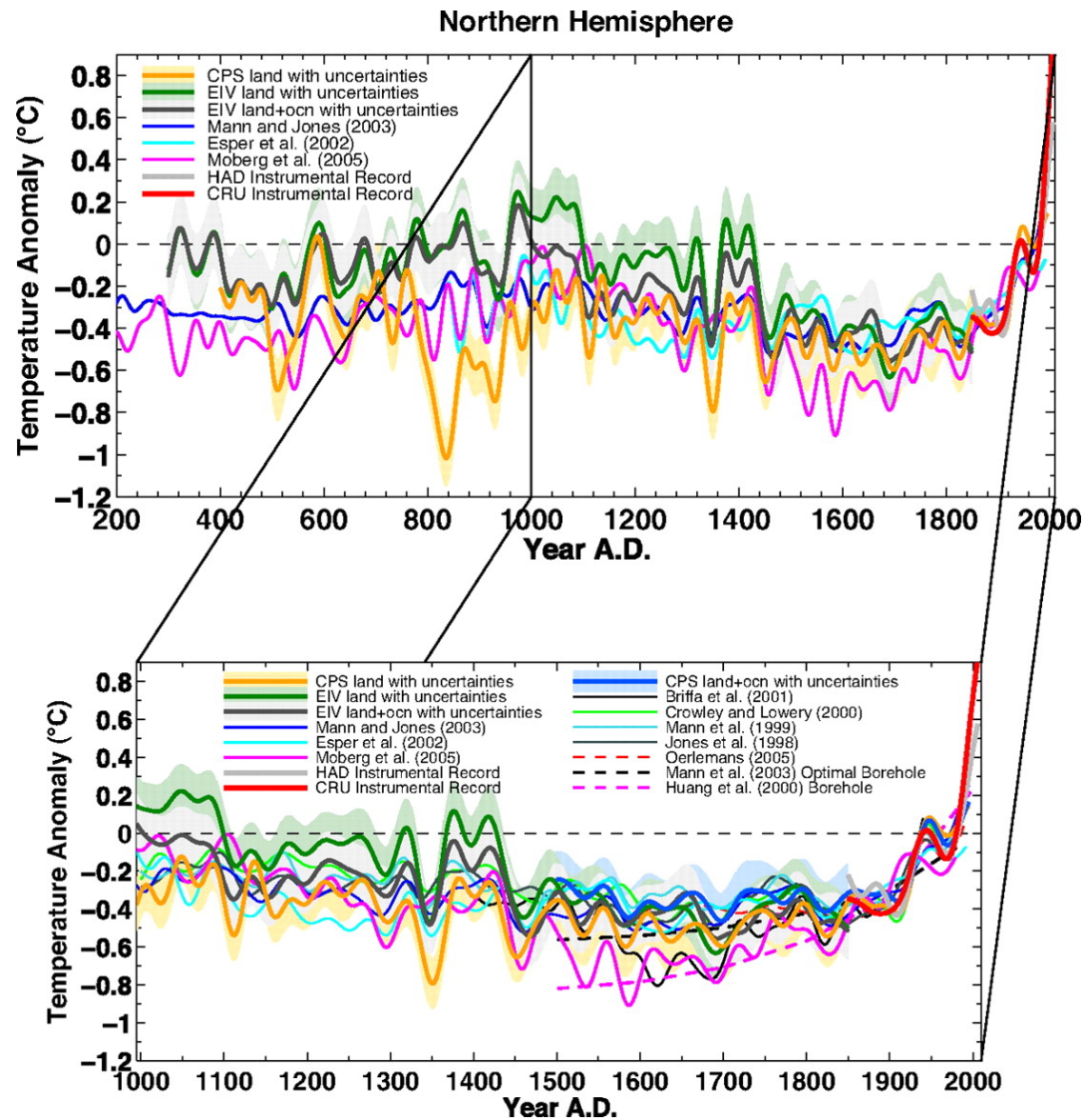


Figure 3
from Mann
et al. 2009



References

- Bradley, R. S. 1991. Amsterdam: Elsevier.
- Grottoli A, Eakin CM. 2007. *Earth-Science Reviews* 81: 67–91.
- Mann ME, et al. (2008) *Proc Natl Acad Sci USA* 105:13252–13257
- Petit, J.R., Jouzel, J., Raynaud, D., Barkov, N.I., Barnola, J.M., Basile, I., et al. (1999) *Nature* 399: 429-436.
- *Climate Since AD 1500*. Edited by R.S. Bradley and P.D. Jones. London and New York: Routledge, 1992
- NASA's Earth Observatory Paleoclimatology website:
http://earthobservatory.nasa.gov/Features/Paleoclimatology/paleoclimatology_intro.php
- NOAA Paleoclimatology website:
<http://www.ncdc.noaa.gov/paleo/paleo.html>