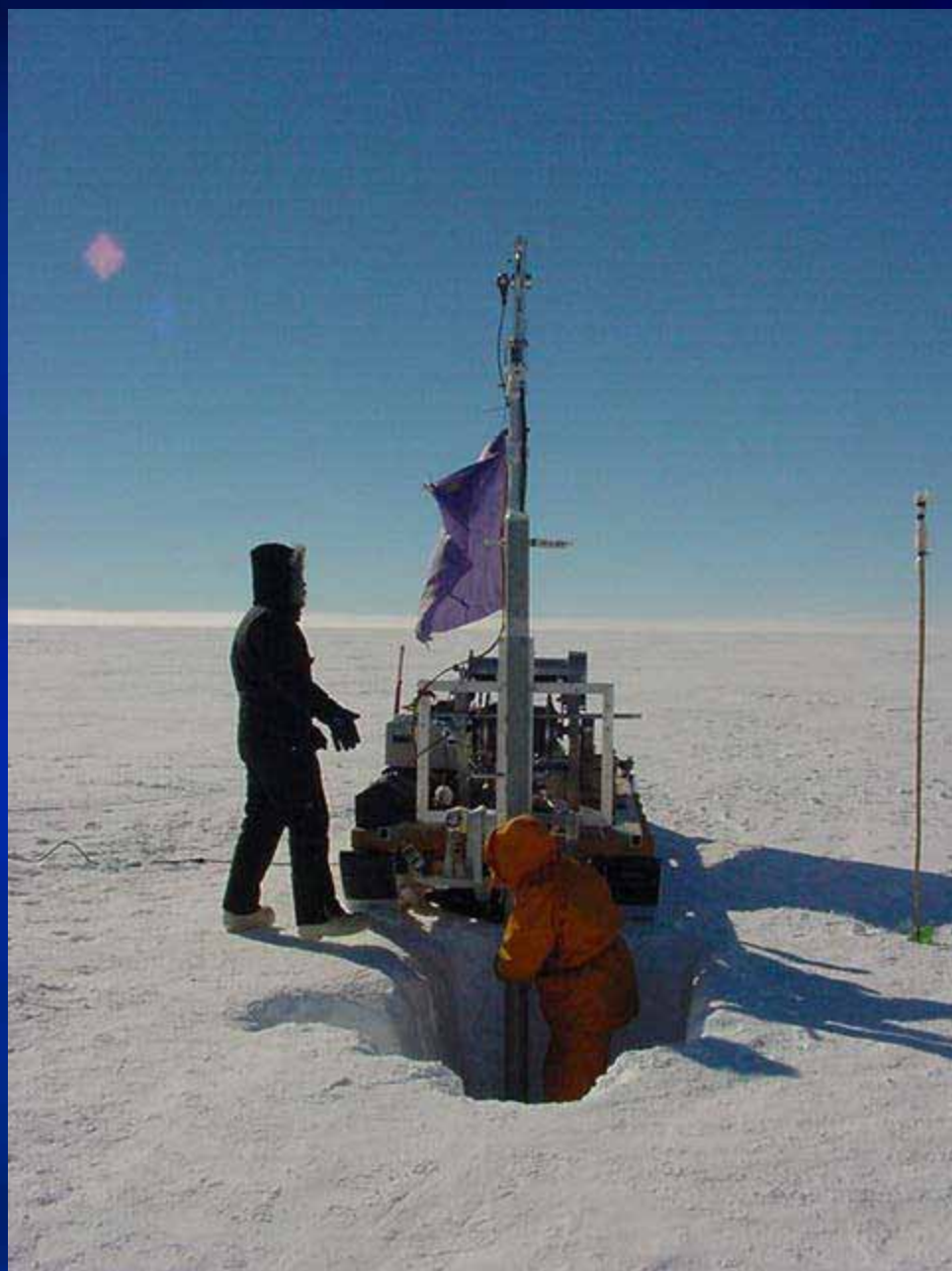


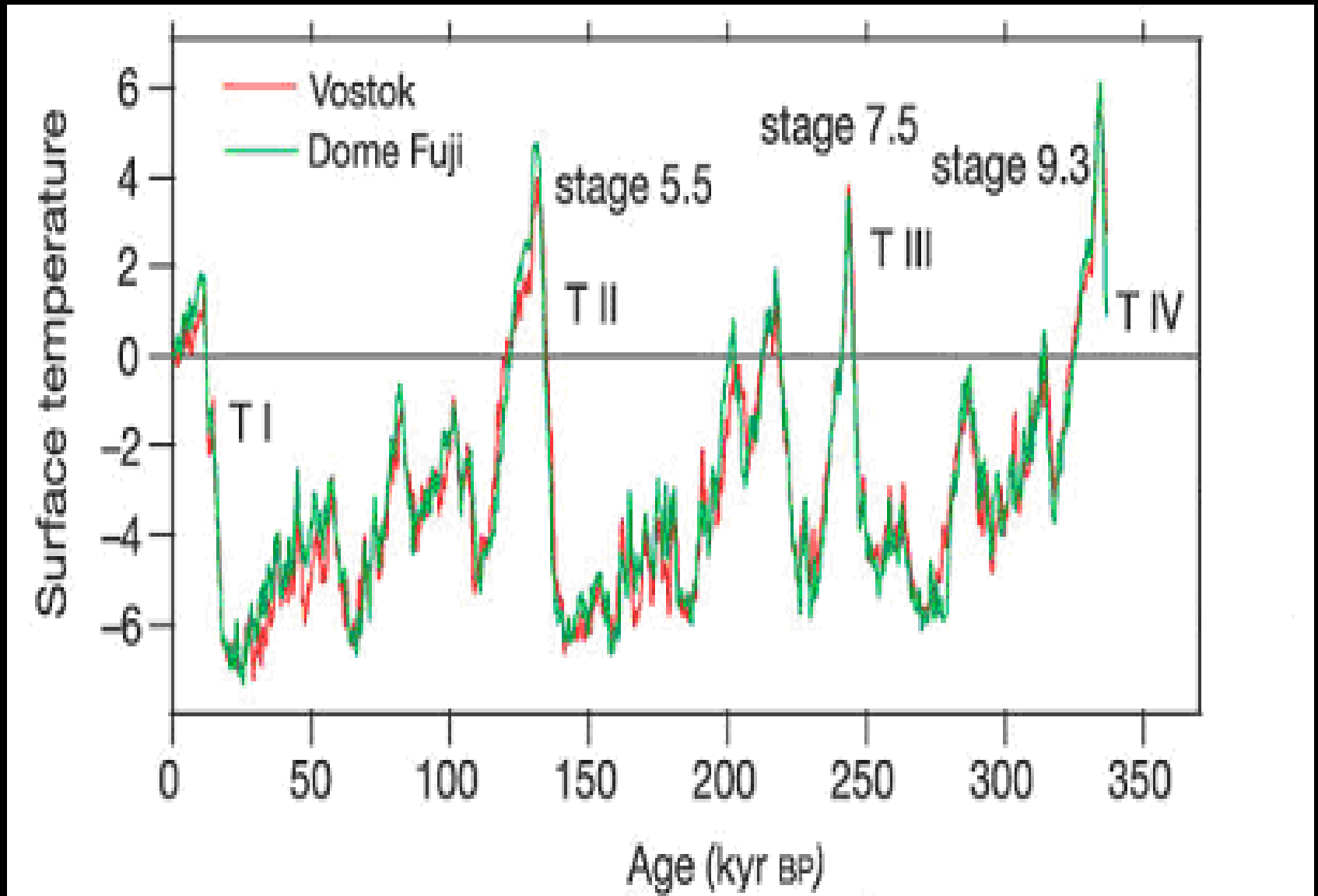
Ice age begins anew, ca. 2 million years ago

Last Glacial Maximum 18,000 years ago





300,000 years of temperature information



1,000+ years of local climate from proxies

Ice cores

Boreholes

Pollen

Insects (esp. beetles)

Sea floor, lake bed sediments

Tree growth

Tree-line limits

Glaciers

Bogs (mummies)

Speleothems

Shoreline drifts

Coral

Documentary records

Cultural changes

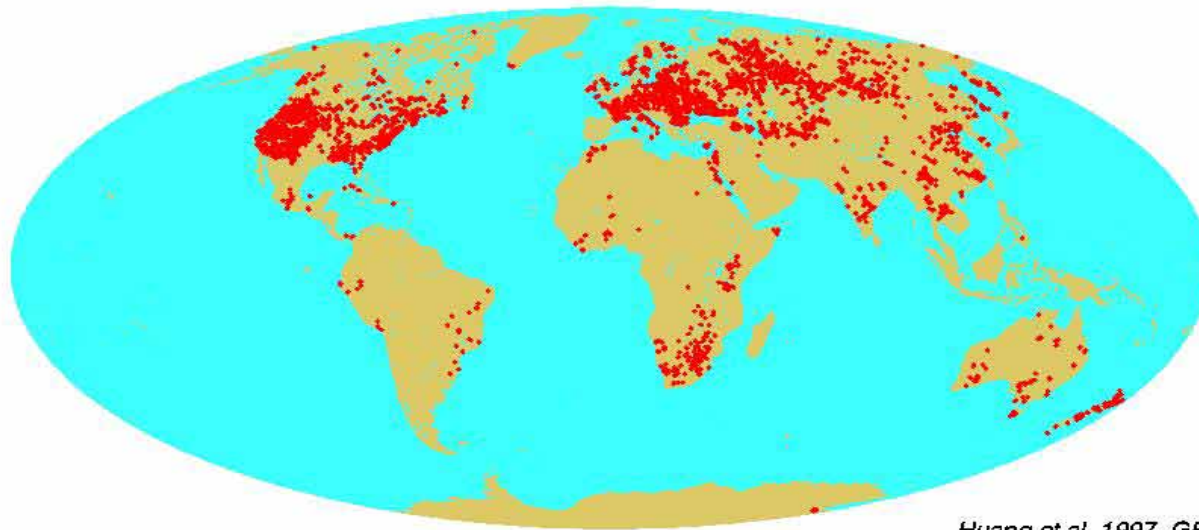
Worldwide, where evidence is available:

- Medieval Warm Period, ca. 800 to 1300 CE
- Little Ice Age, ca. 1300 to 1900 CE
- 20th century climate is generally not the most extreme in most regions

Note: MWP and LIA anomalies are local events across the globe; averaging over broad spatial scales blurs important information on patterns of environmental change.

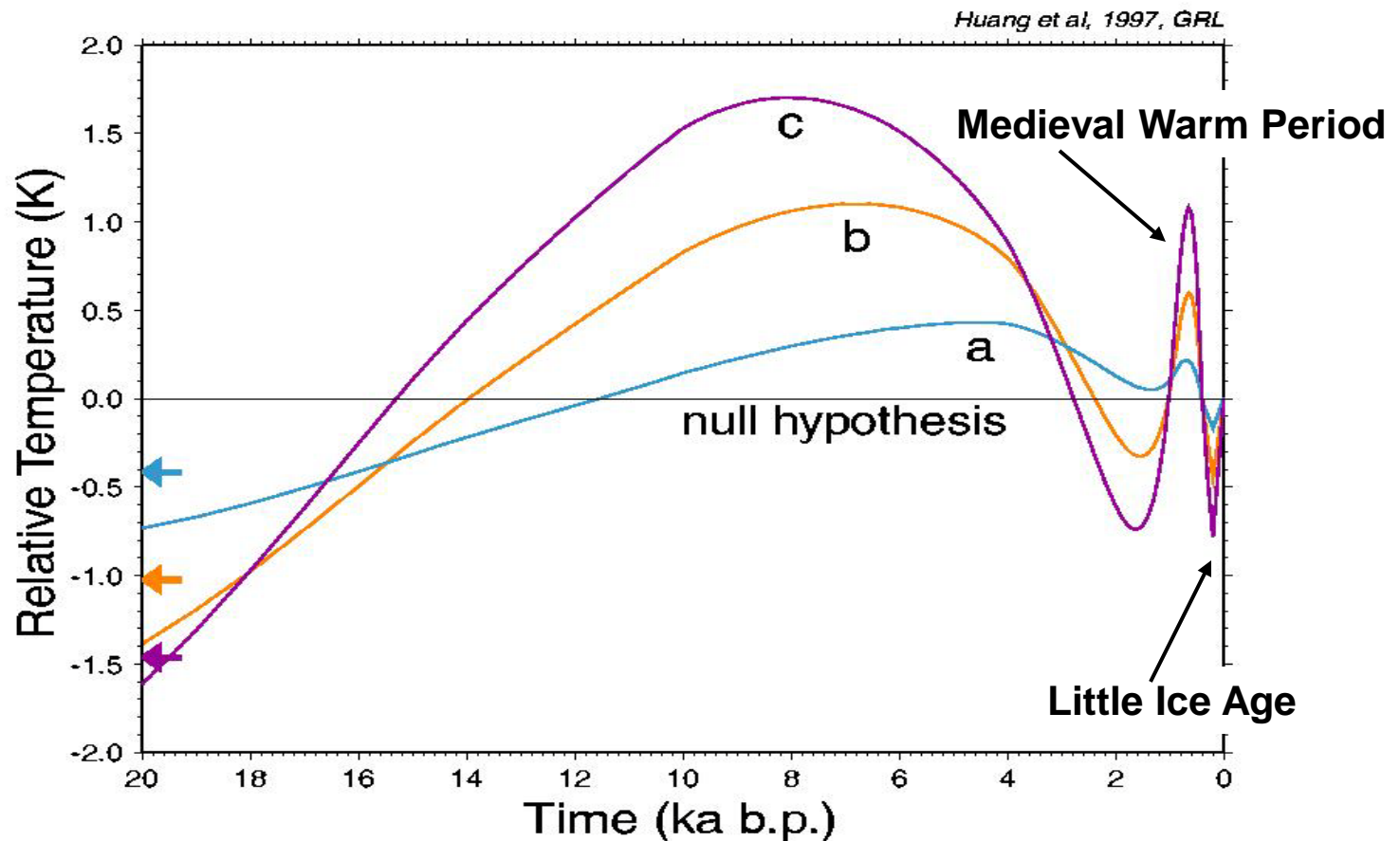
Over 6,000 boreholes contain past climate information

Selected Heat Flow Sites

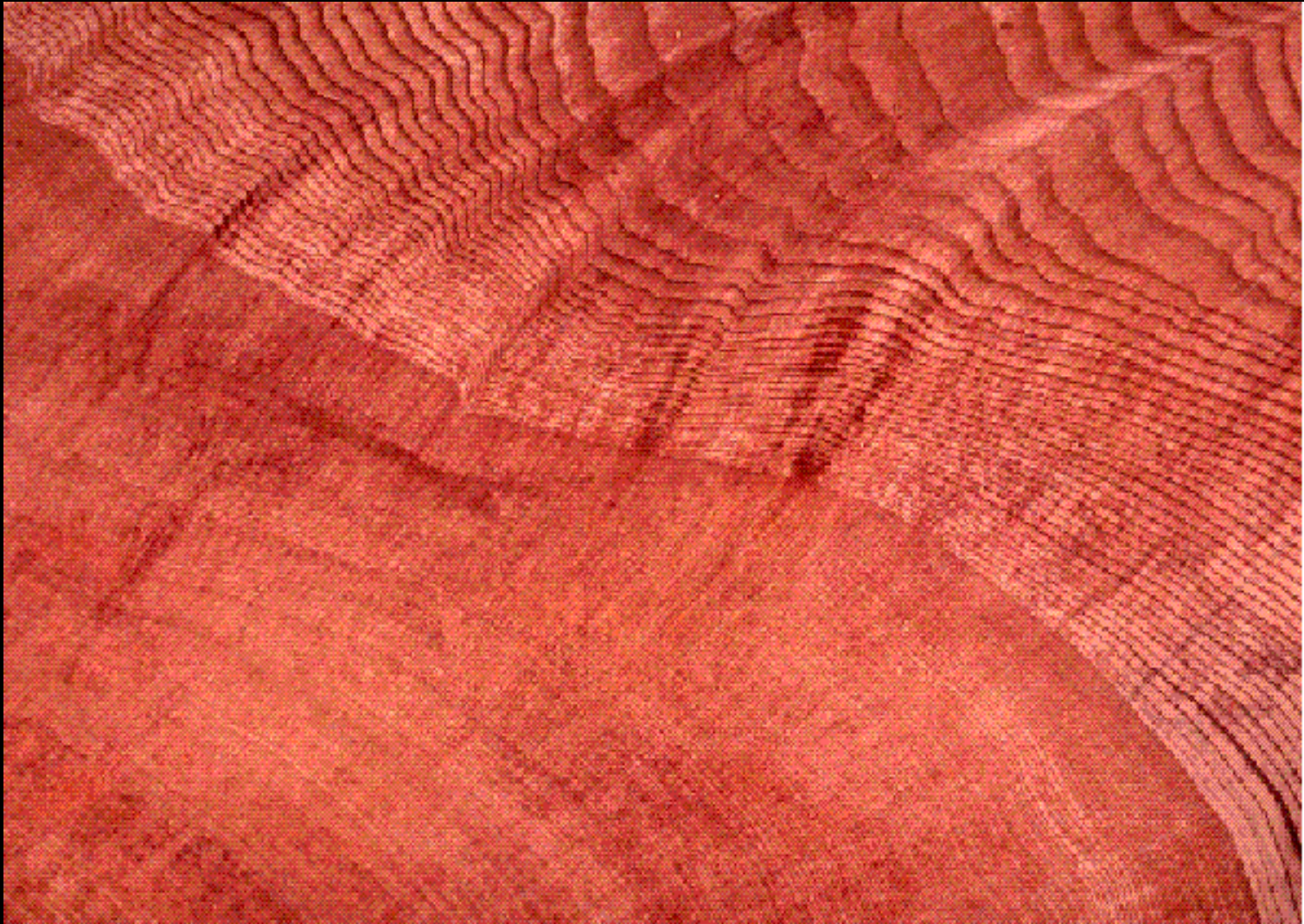


Huang et al, 1997, GRL

Results of 6,000 boreholes show Medieval Warm Period and Little Ice Age



Wildfire in 1297 C.E.



Tree growth, Tasmania

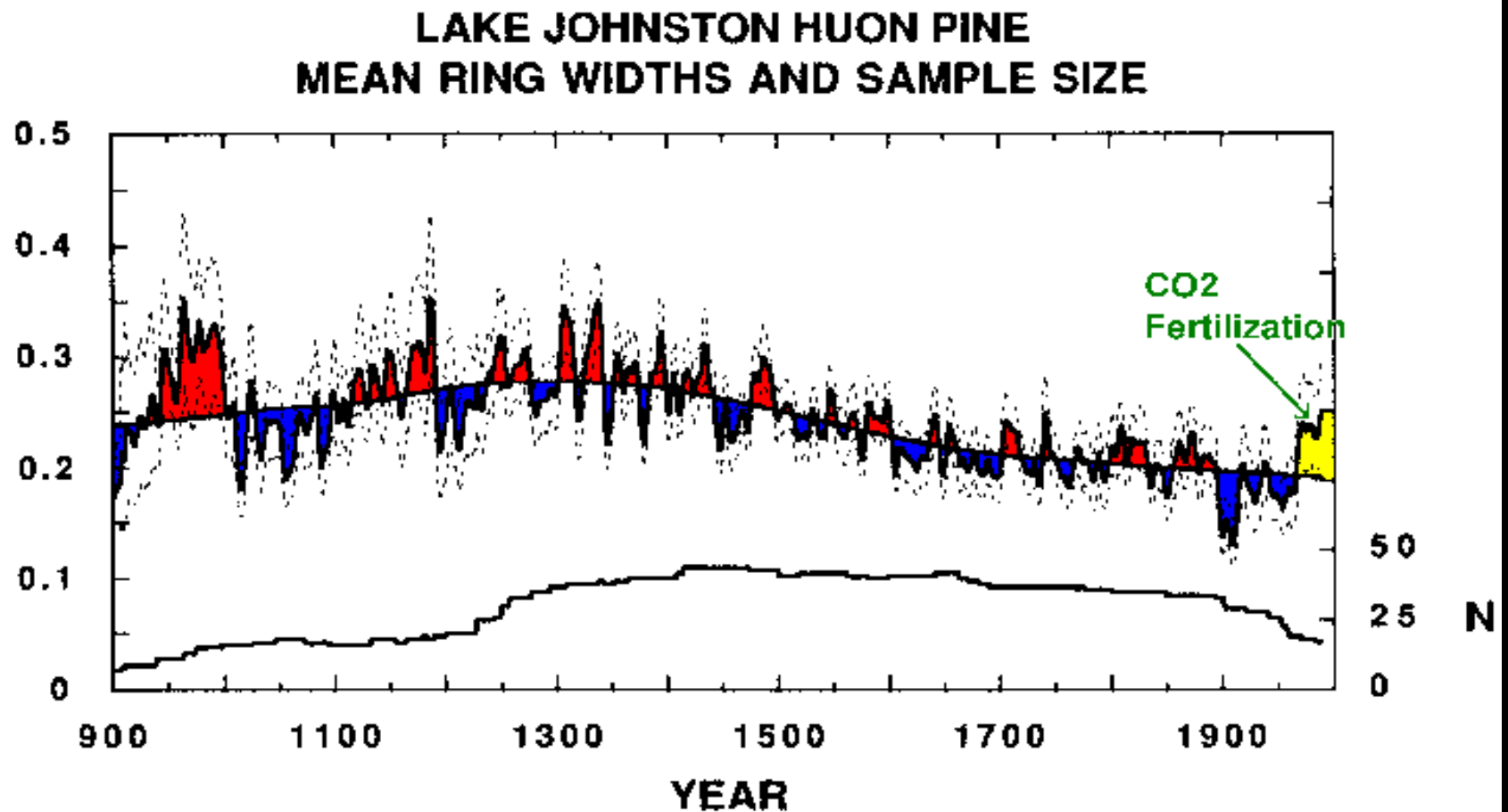
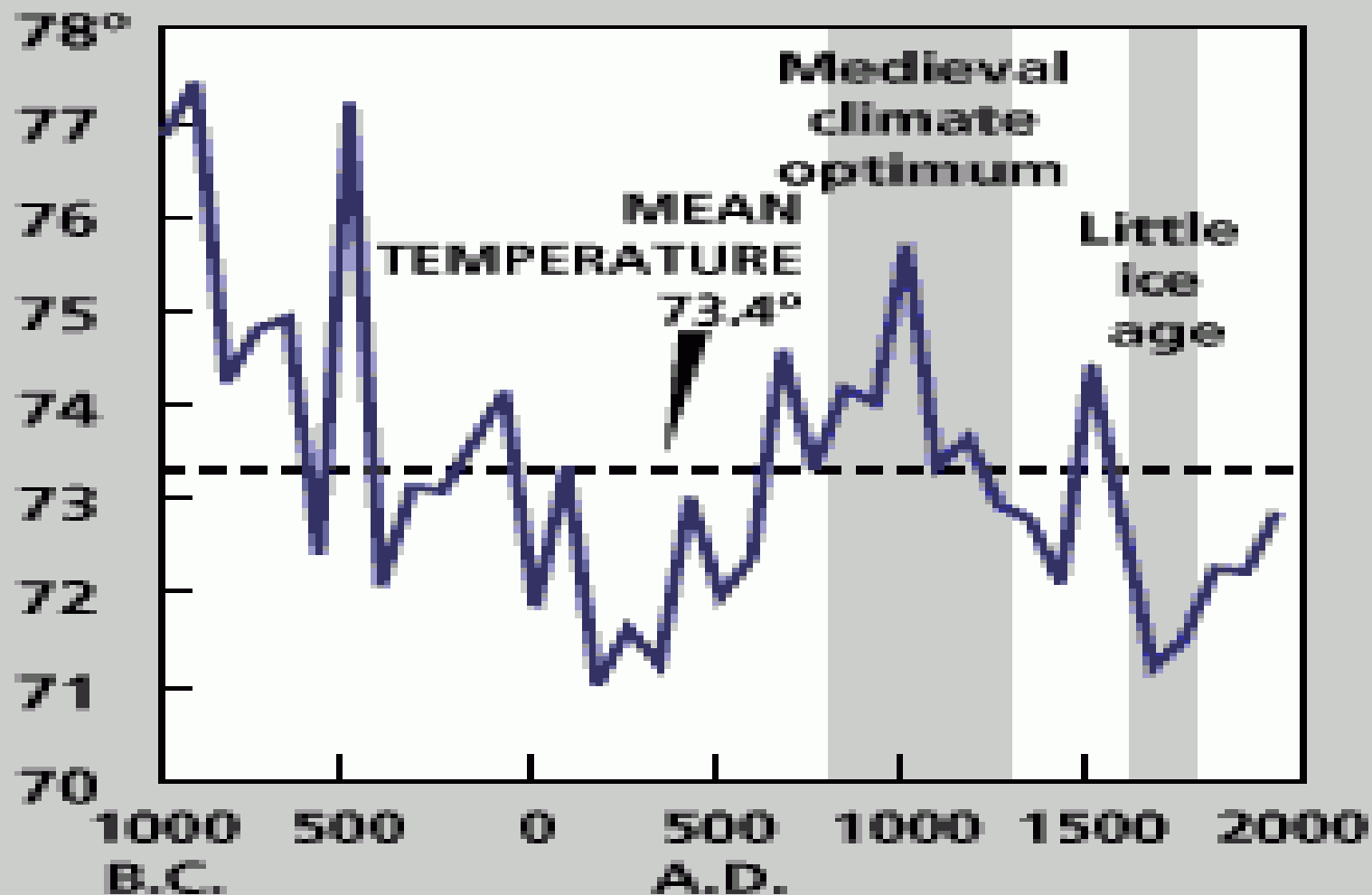


Figure 2 Lake Johnston Huon pine mean ring-width series in millimetres and sample size (N). The annual data have been smoothed with a 10-year smoothing spline to highlight the multiyear fluctuations. The dashed lines are 95% confidence limits estimated using the bootstrap method. The heavy solid line describes the general shape of the growth trend believed to be largely nonclimatic in origin.

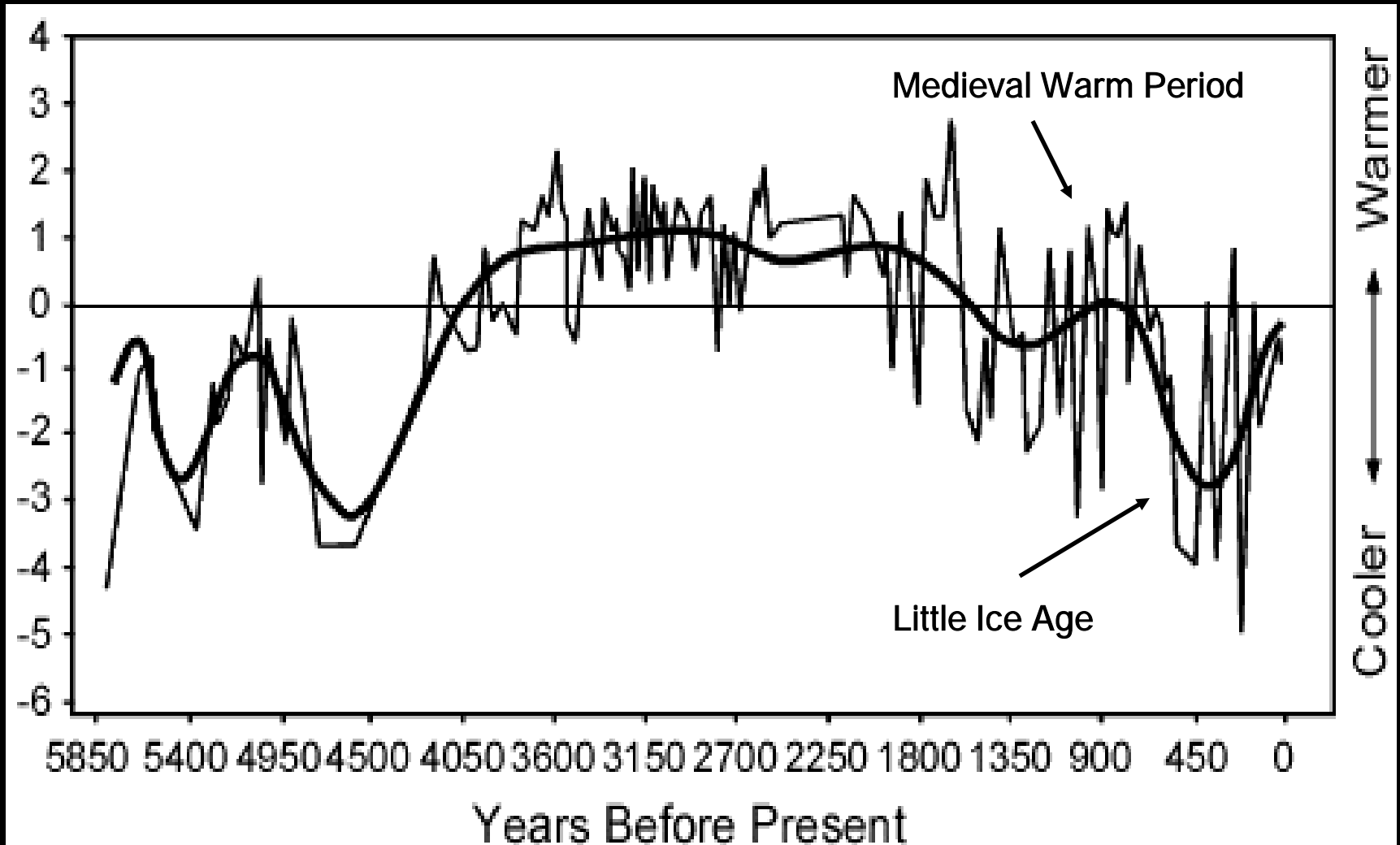
CLIMATE IN PERSPECTIVE

Temperature of the Sargasso Sea from 1000 B.C. to 1975 A.D., in Fahrenheit



Source: Science (1996)

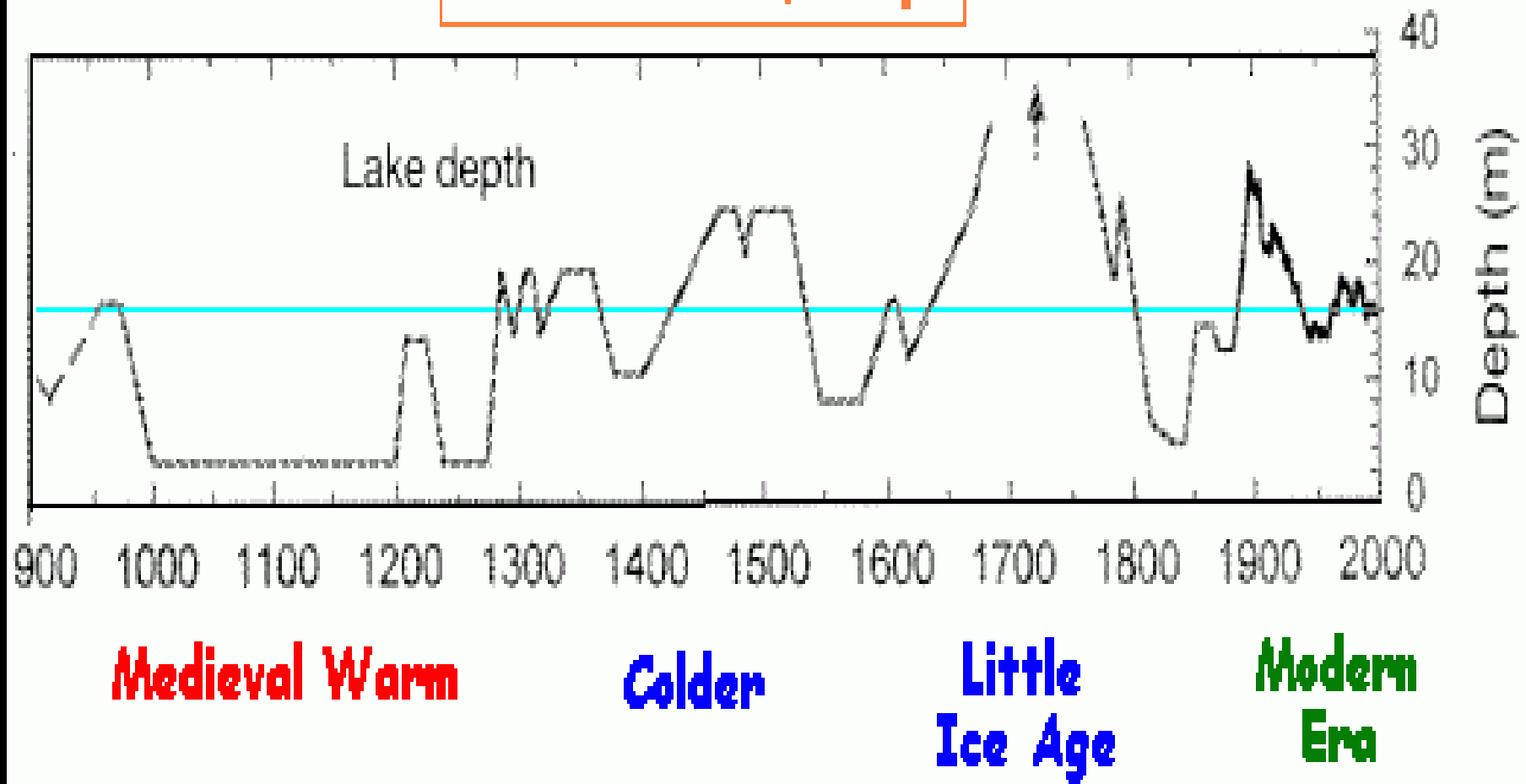
China: Peat cellulose $\delta^{18}\text{O}$



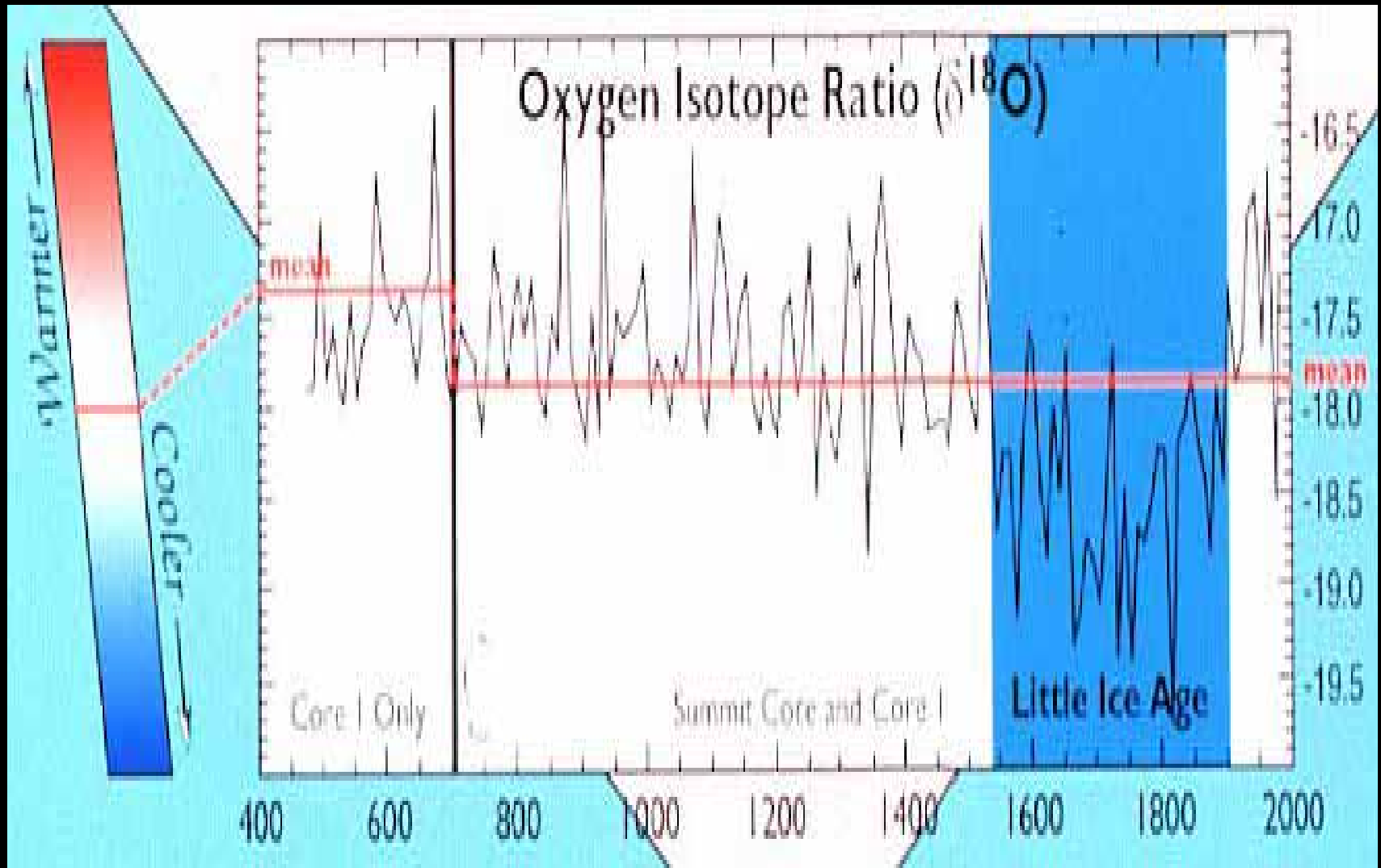
Hong et al. 2000

Lake Level and Salinity, East Africa

Lake Naivasha, Kenya

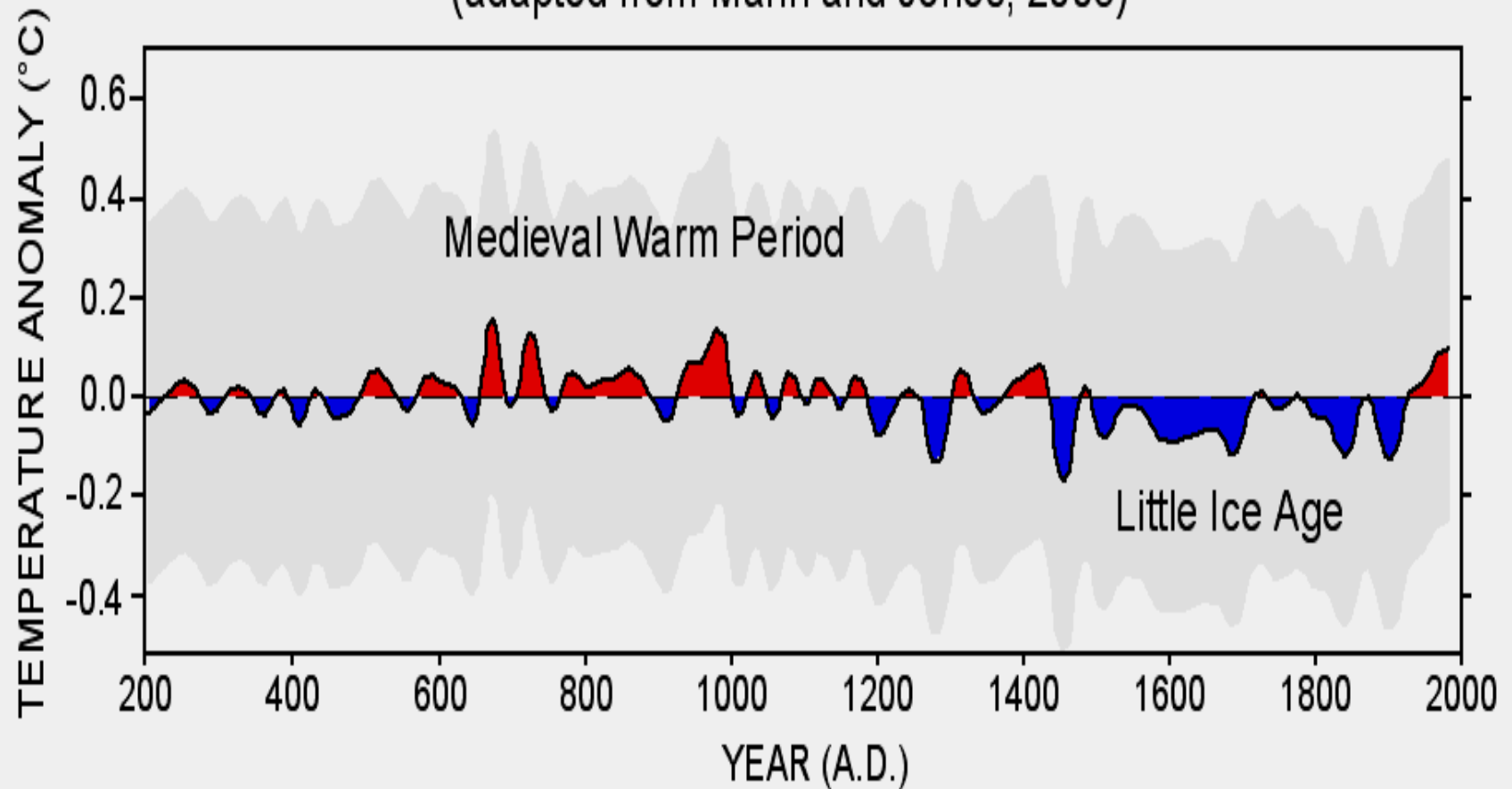


Quelccaya Glacier, Peru



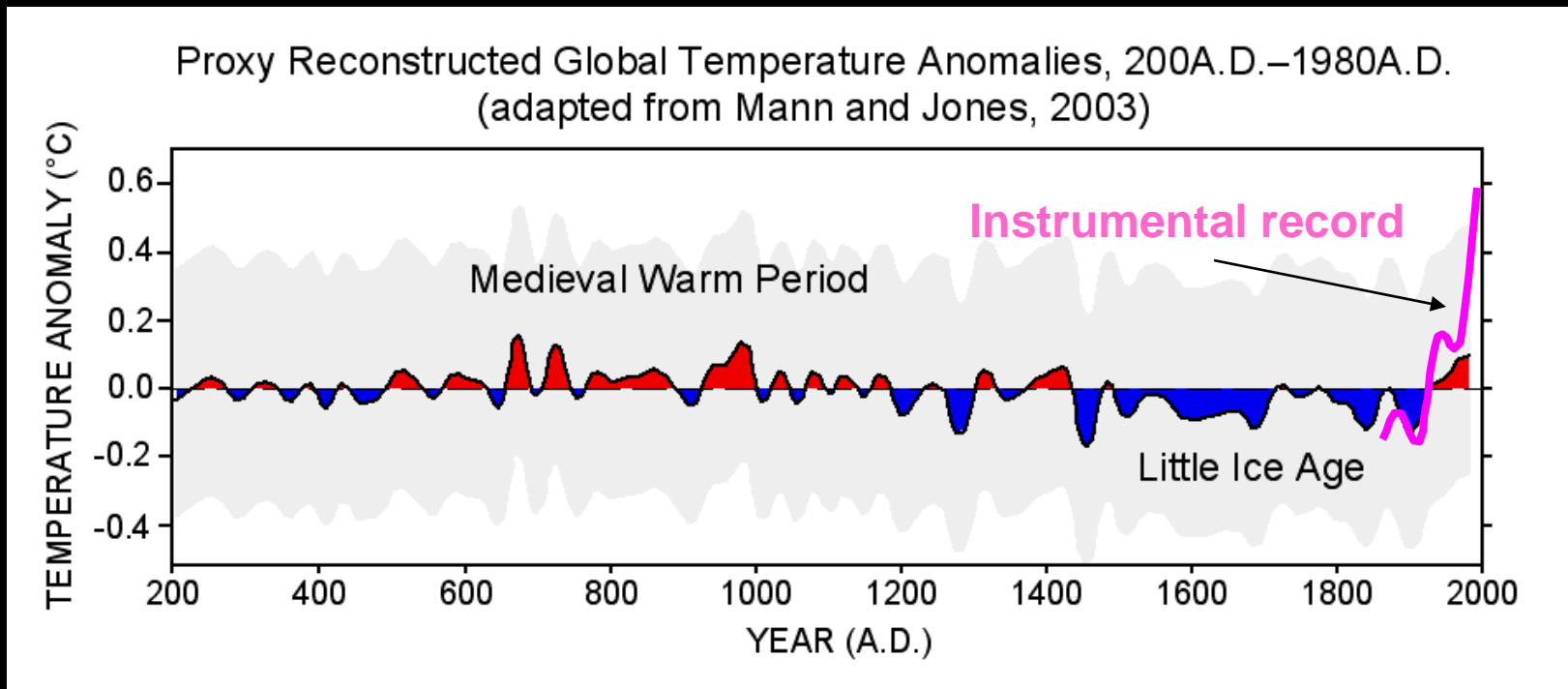
Global temperature from proxies?

Proxy Reconstructed Global Temperature Anomalies, 200A.D.–1980A.D.
(adapted from Mann and Jones, 2003)



Mann and Jones, 2003

When the instrumental global temperature record is overlaid on the proxy reconstructed global temperature record it becomes evident that these two sources of temperature information are not of the same character.



Life expectancy for H. sapiens

Early	50,000 years ago	<30 years
Rome	2,000 years ago	25-30 years*
England	1200 C.E.	35 years†
	1370 C.E.	18 years†
	1600 C.E.	38 years
	1740 C.E.	33 years
	2000 C.E.	78 years

Notes:

* Males only

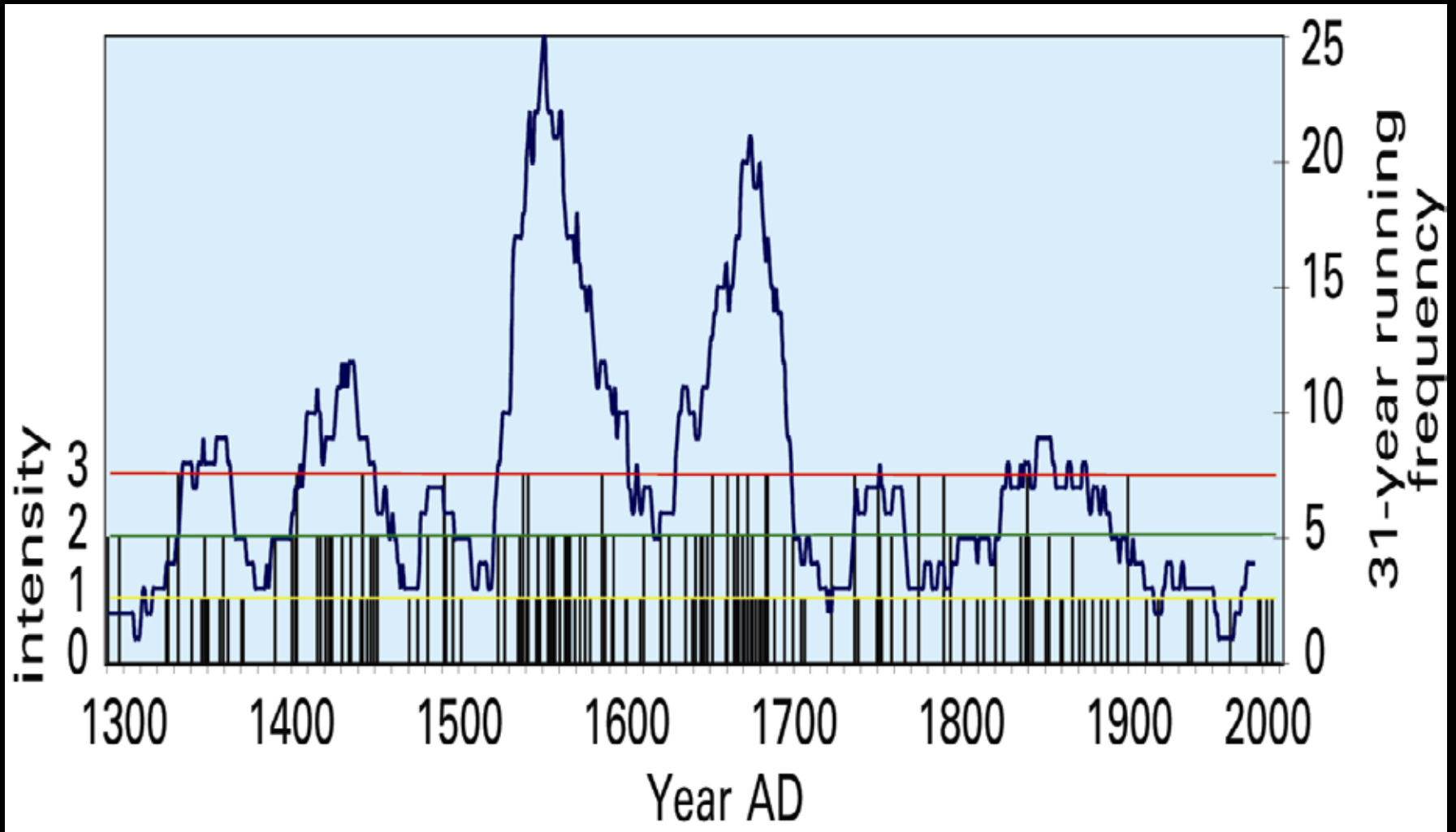
† Male landowners only

Black death and Chinese flooding 1332



Citizens of Tournai bury plague victims. These are fortunate to have coffins. Most victims were interned in mass graves. 1349

Pegnitz River – flooding peaks in Little Ice Age



Little Ice Age: Resurgence of witch burnings

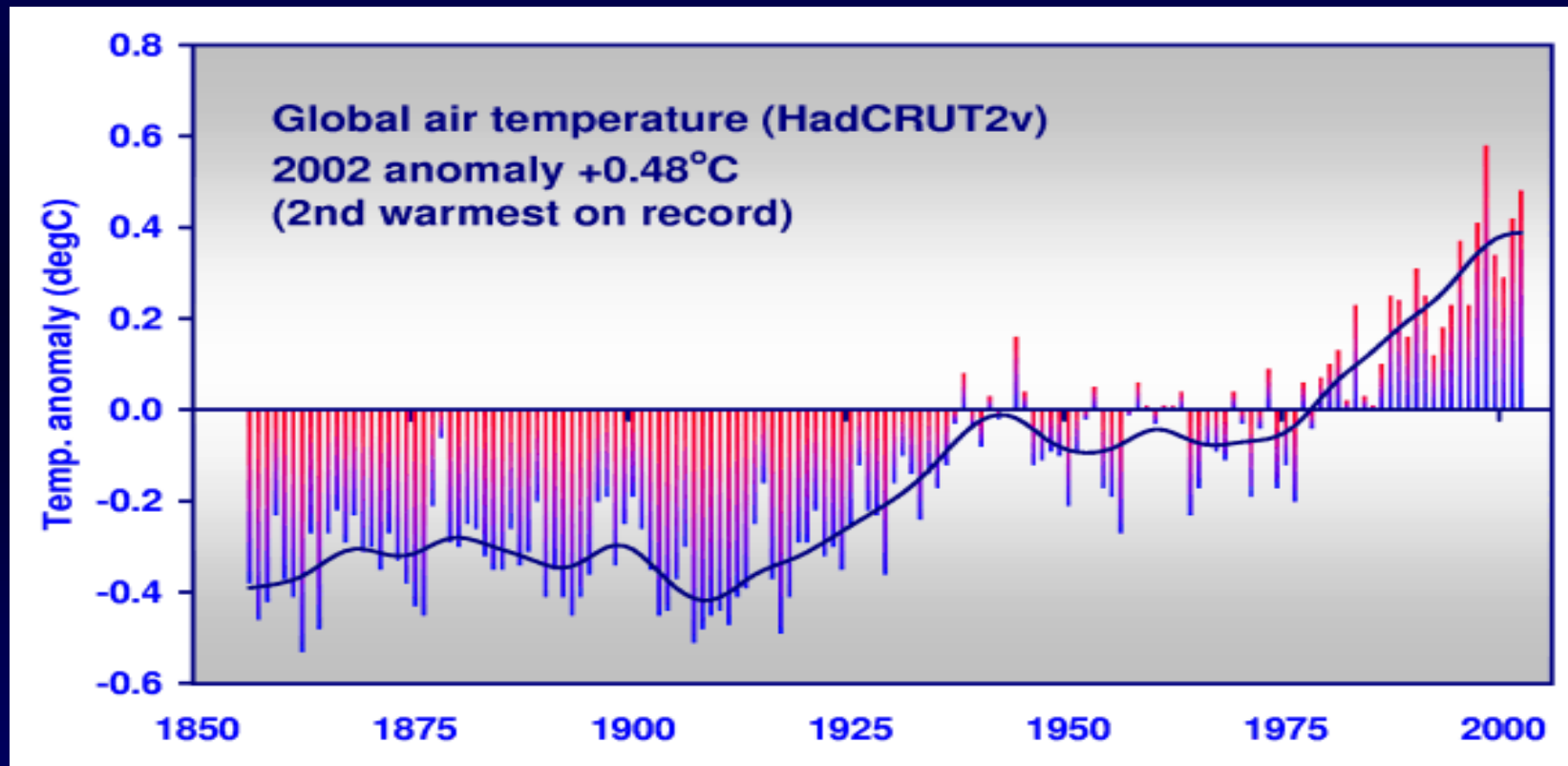
Period	Locale	Number of women burned
1580 - 1620	Pays de Vaud	1000
1580 - 1595	Lorraine	800
1581 - 1595	Treves	350
1626	Bamburg	600
	Würzburg	900
	Electorate Mainz	900
	Westphalia	2000

"Since everybody thought that the continuous crop failure was caused by witches from devilish hate, the whole country stood up for their eradication."

Johann Linden, Treves, ca. 1590)

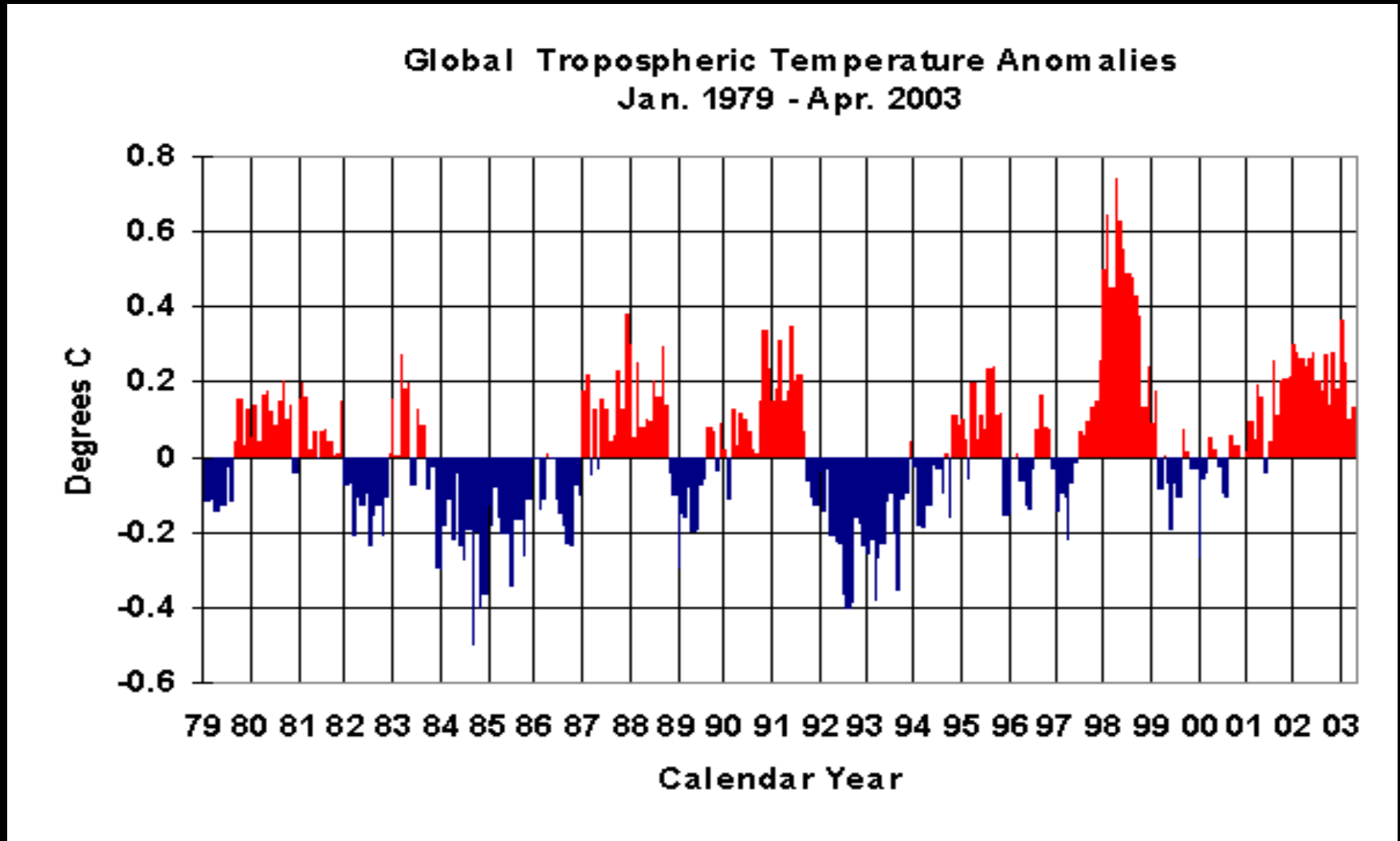
Source: W. Behringer 1987, 1995

20TH C SURFACE TEMPERATURE TRENDS NOT CLOSELY LINKED TO THE AIR'S CONTENT OF HUMAN-MADE GREENHOUSE GASES

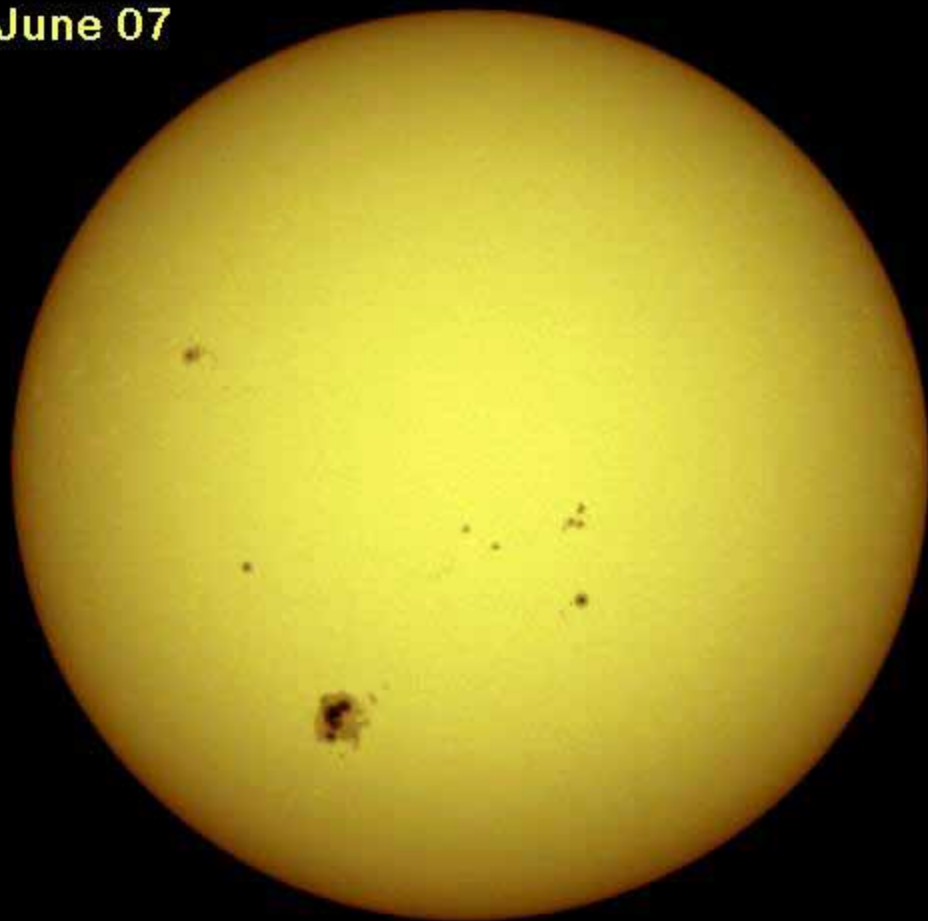


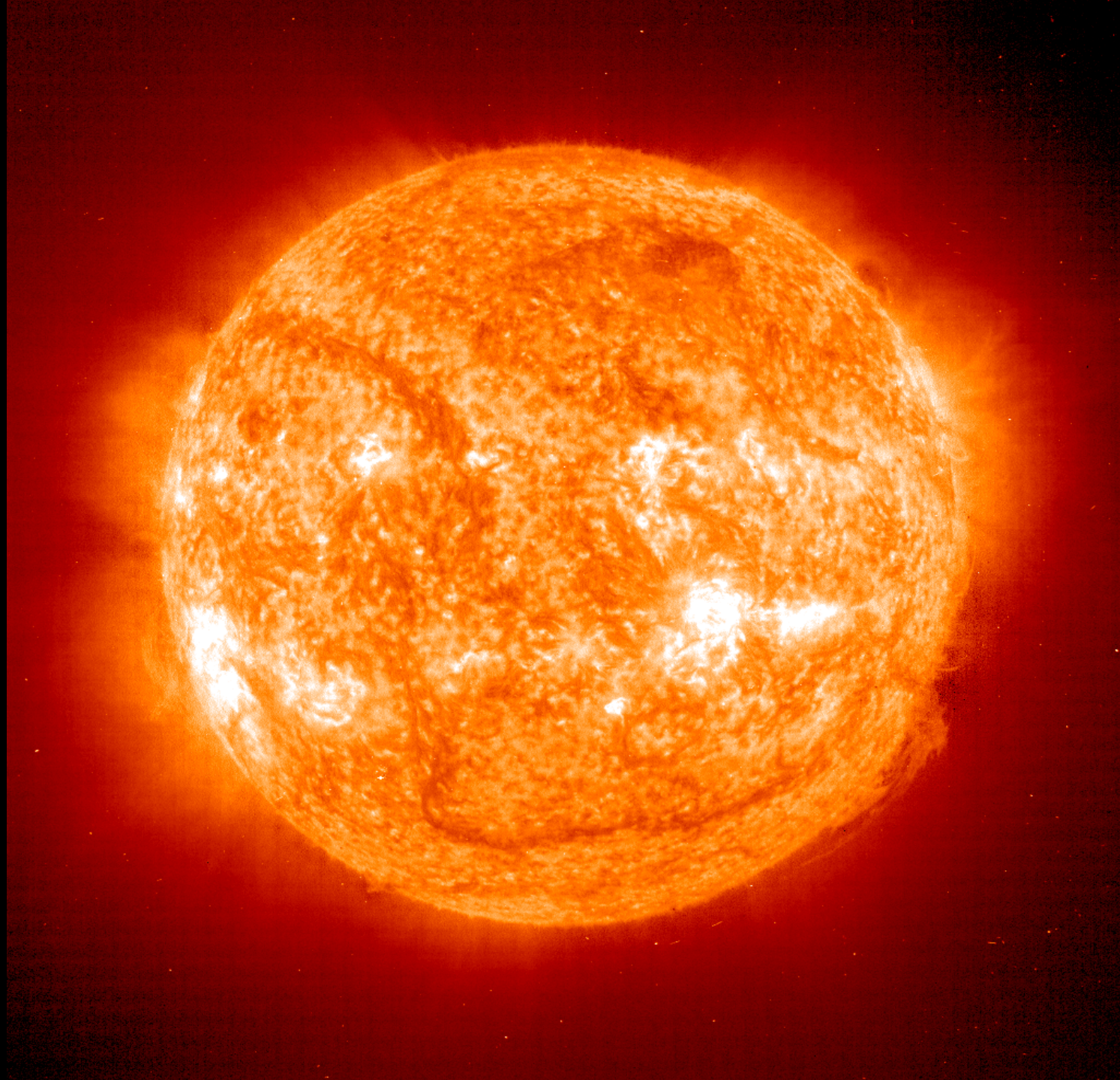
<http://www.cru.uea.ac.uk/cru/info/warming/>

Key measurements: Low troposphere shows no meaningful warming trend with more carbon dioxide in the air

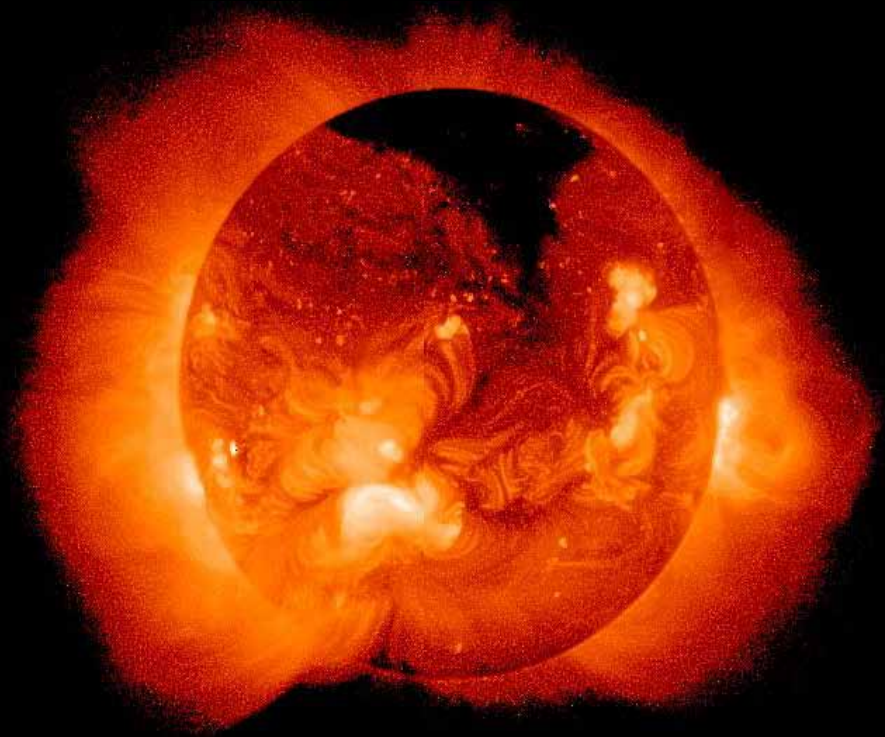
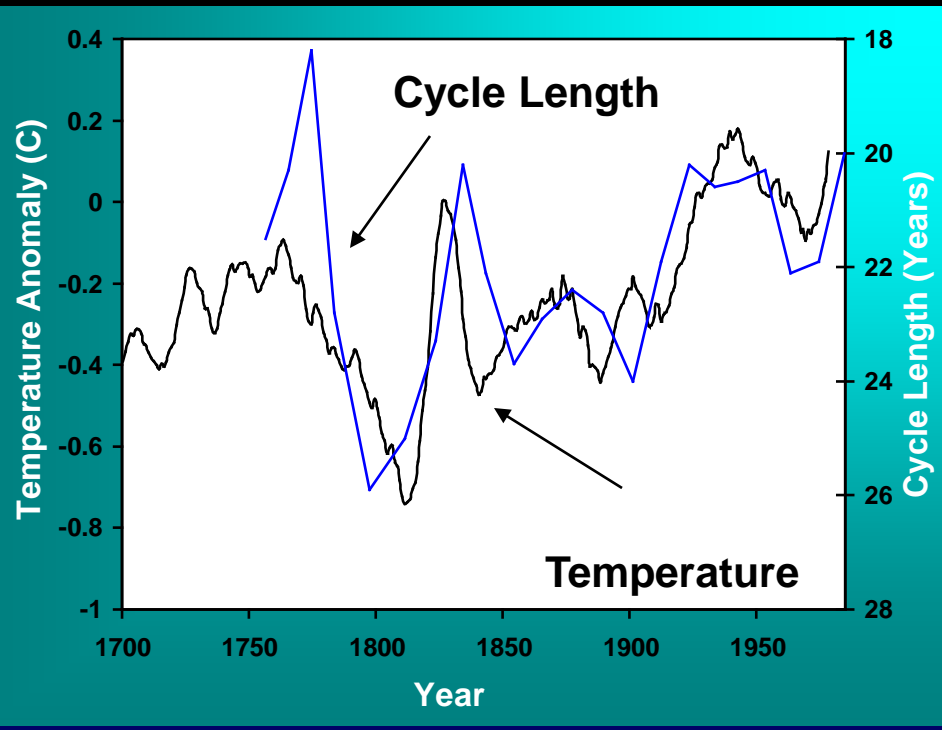


1992 June 07





A SUN – CLIMATE LINK? NORTHERN HEMISPHERE LAND TEMPERATURE AND SOLAR CYCLE

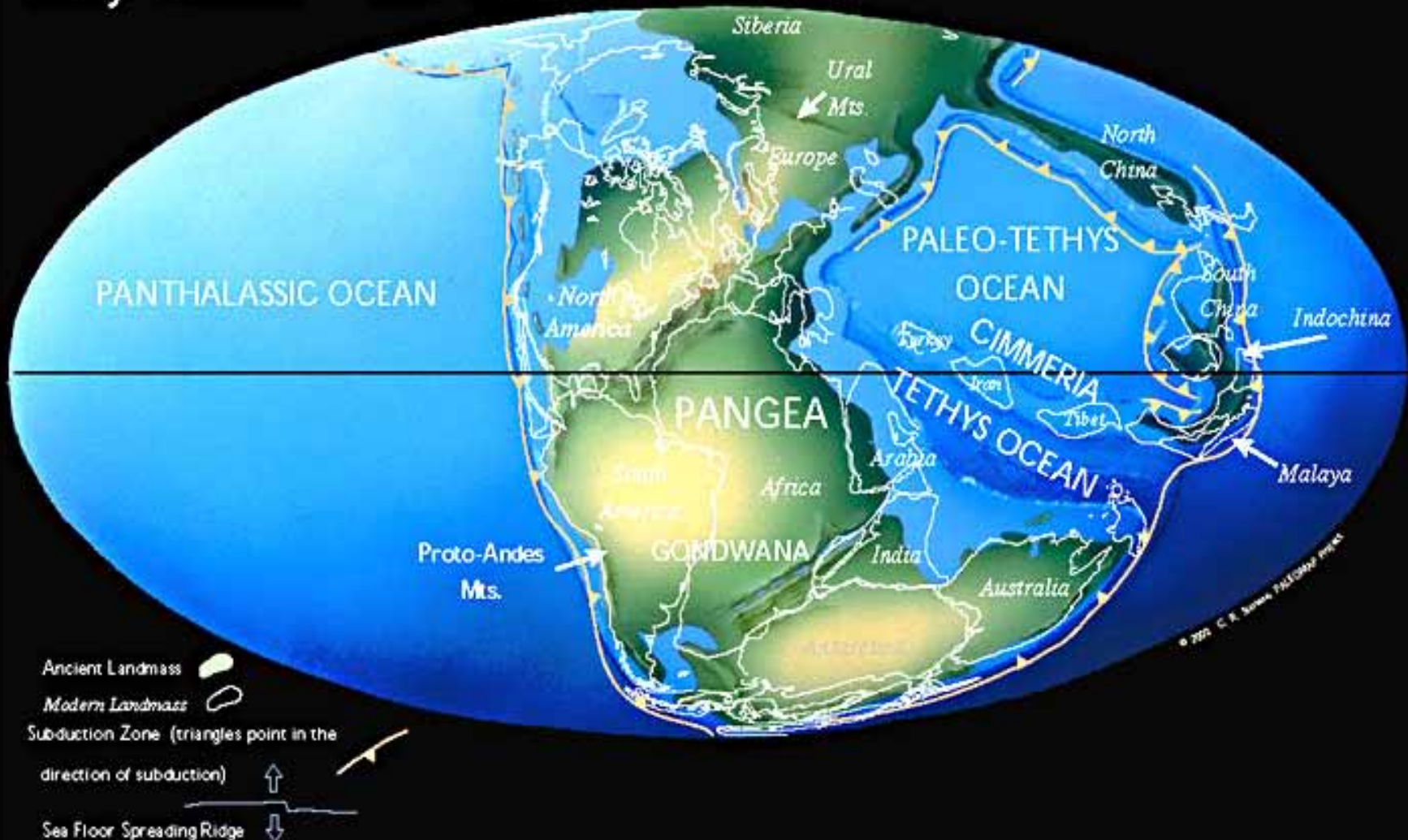


Left – Changes in the sun's output are strongly correlated with terrestrial temperatures where records are available. Data are from S. Baliunas and W. Soon 1995.

Right – YOKOH satellite image of one million C plasma in the sun's outer atmosphere. The plasma is shaped and heated by magnetic fields.

The last ice age ends

Early Triassic 237 Ma



The Mesozoic -- a climate high!



Early mammal ancestor: Morganucodon



70 million years ago, the Pleiades is born



© Anglo-Australian Obs./Royal Obs. Edinburgh

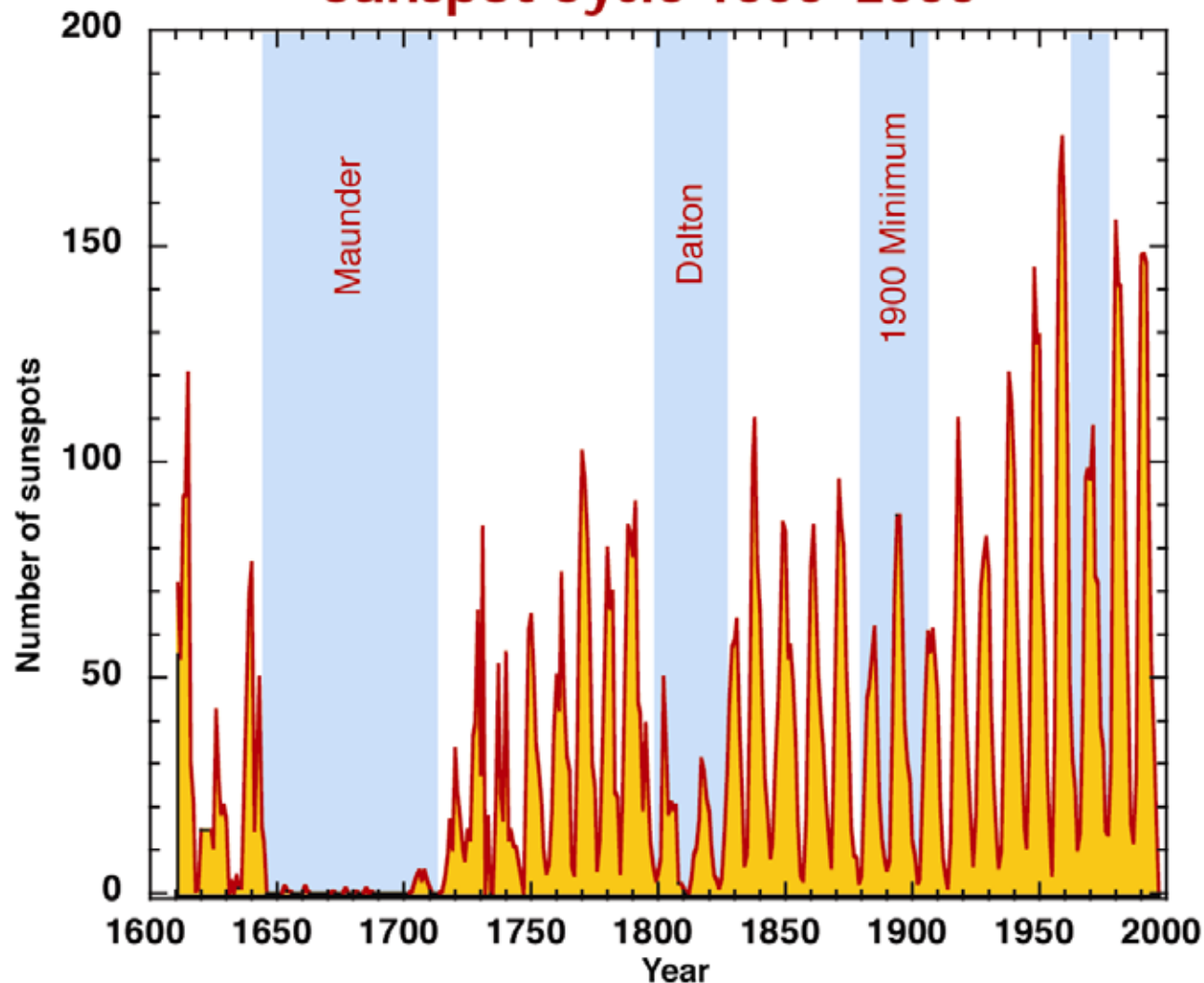
15 million year old ice sheet



Coral contains climate information



Sunspot Cycle 1600–2000



Past Global Changes and Their Significance for the Future

Alverson, Oldfield and Bradley eds.

Beer *et al.* (2000) QSR, 19 403–15.

After Hoyt and Schatten (1998) Solar Physics, 179, 189–219.

Climate and weather are always changing; the 20th century was not exceptional.

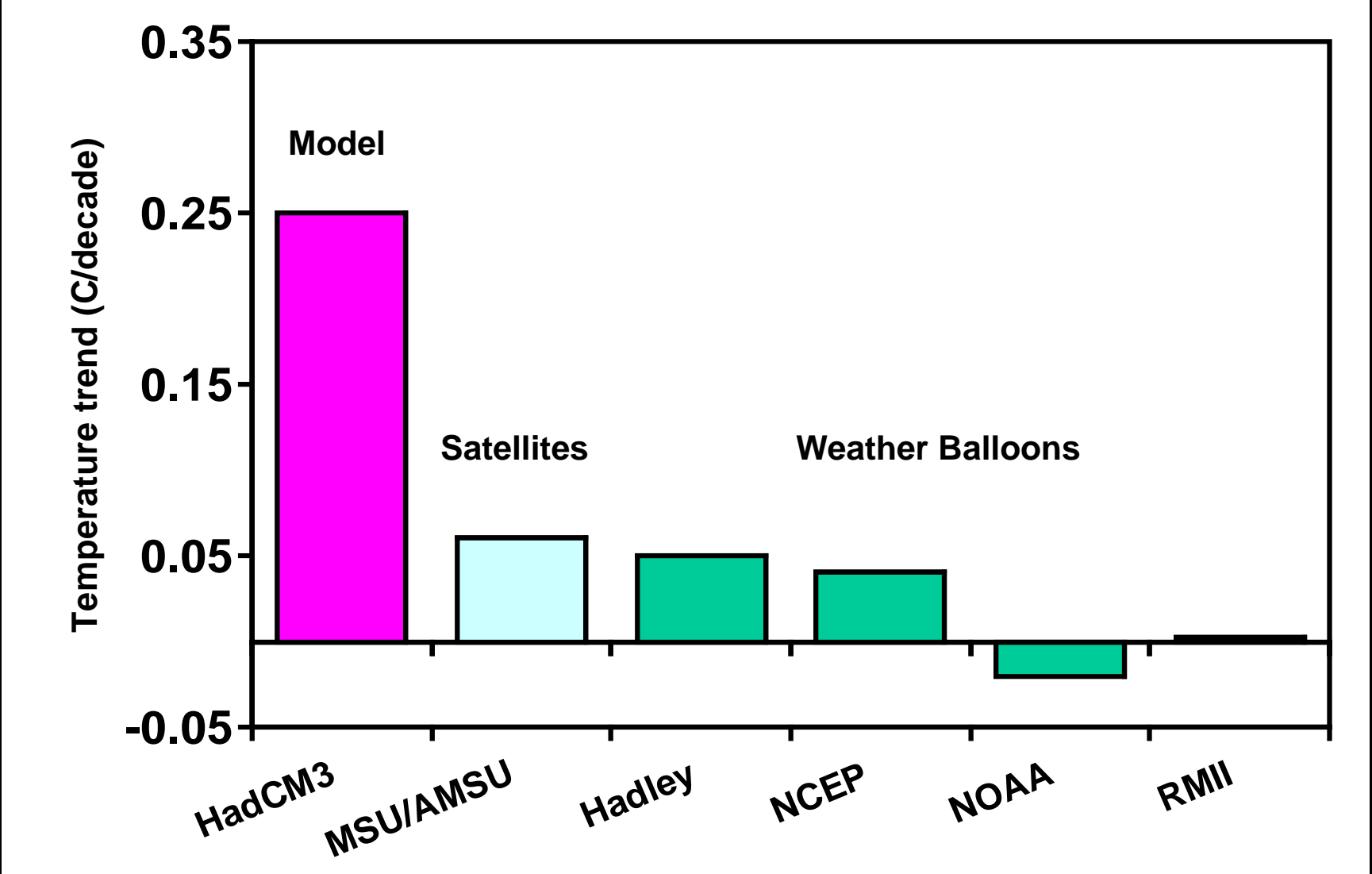
The most sensitive and globally comprehensive measurements (satellite and balloon readings of low troposphere) find no meaningful enhanced greenhouse warming, in contradiction to computer simulations.

The Kyoto Protocol would be ineffective (averts ~0.06 C warming by 2050) and expensive (~2T lost U.S. GDP over ten years).

Earliest writing from Sumer, ca. 3300 BCE?



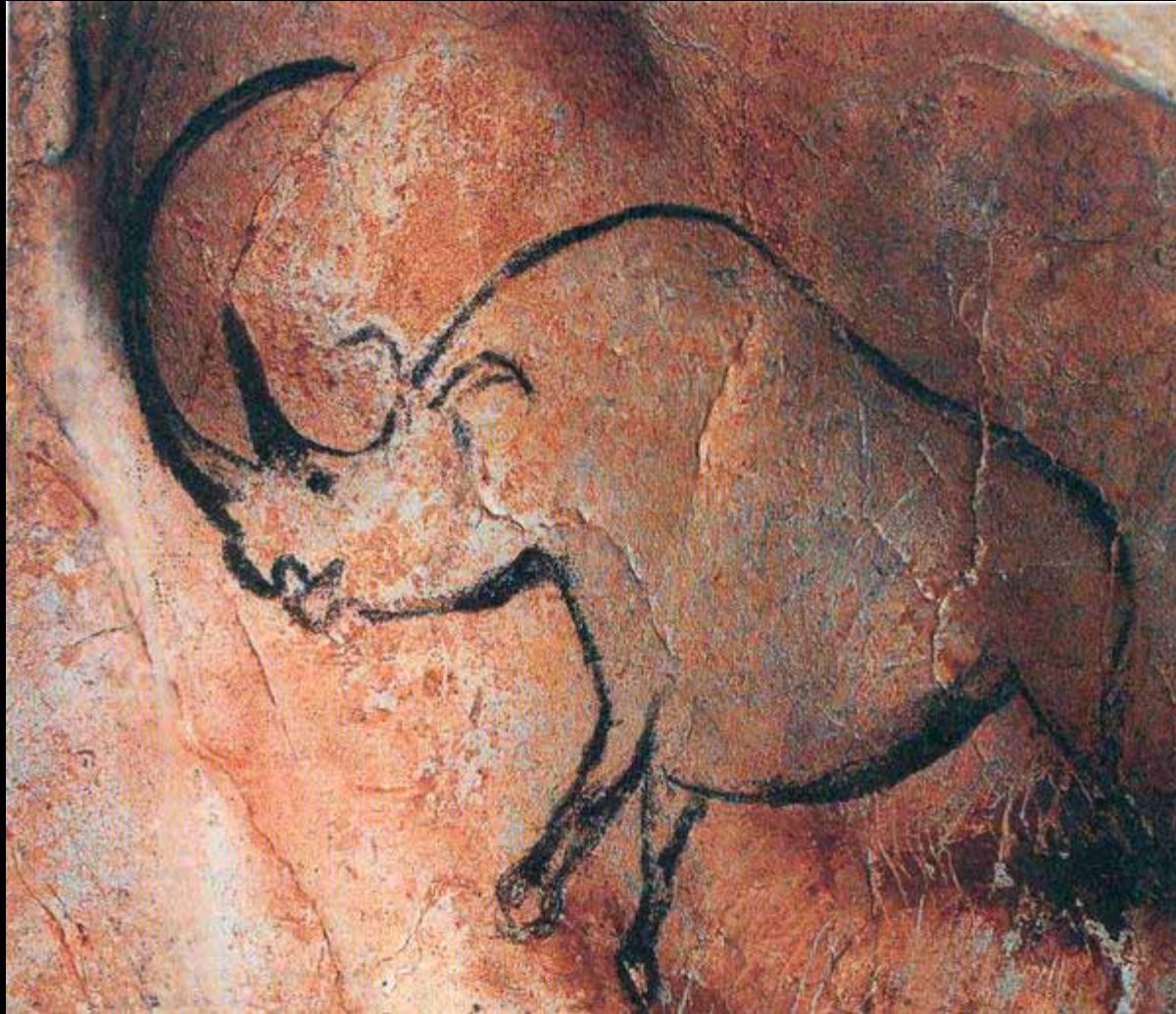
Key measurements: Low troposphere shows no meaningful global warming trend with more carbon dioxide in the air



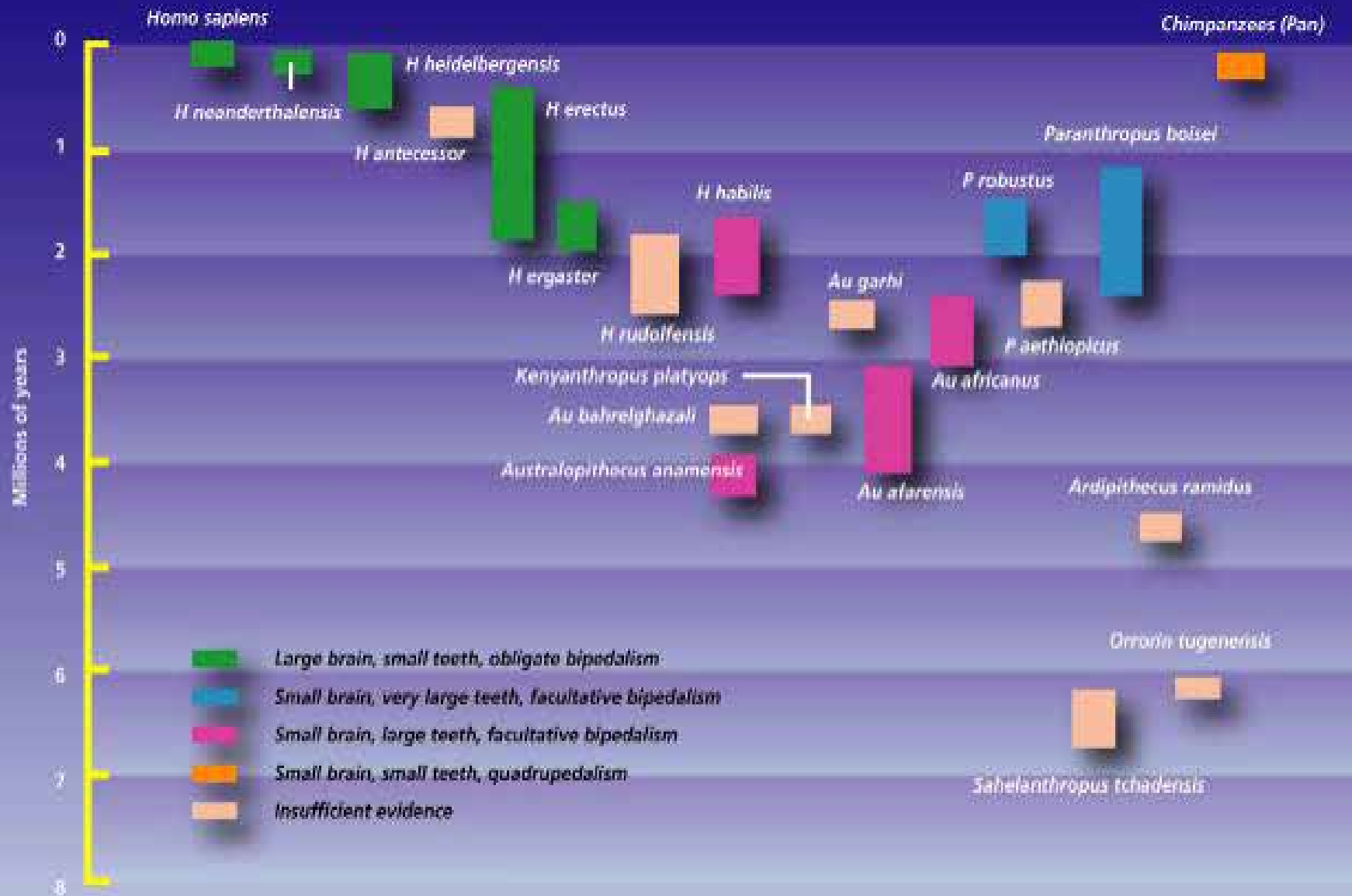
Cro Magnon cave artists were fully human



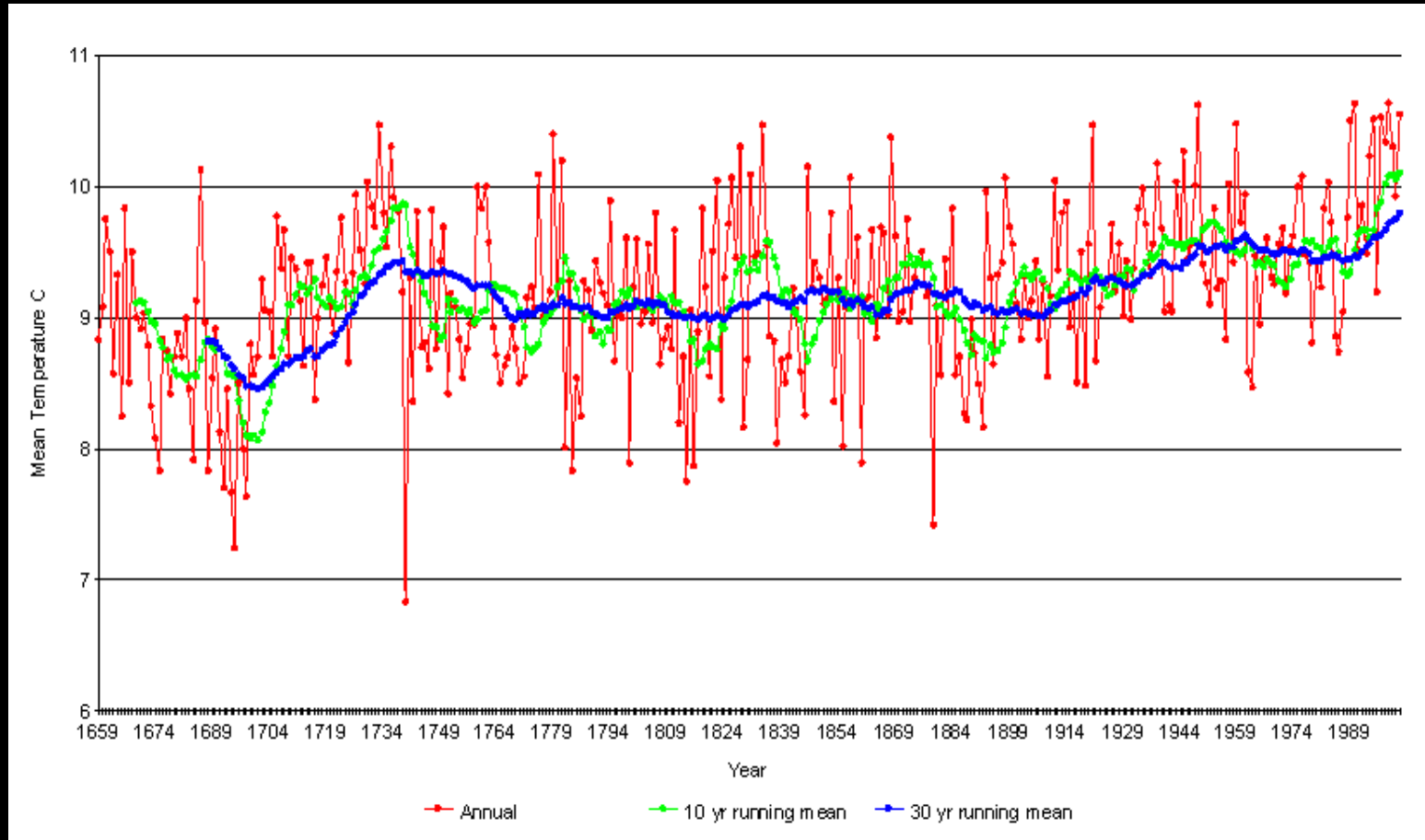
Woolly Rhinoceros drawn in Chauvet Cave over 20,000 years ago



Hominid line may be 6 million years old



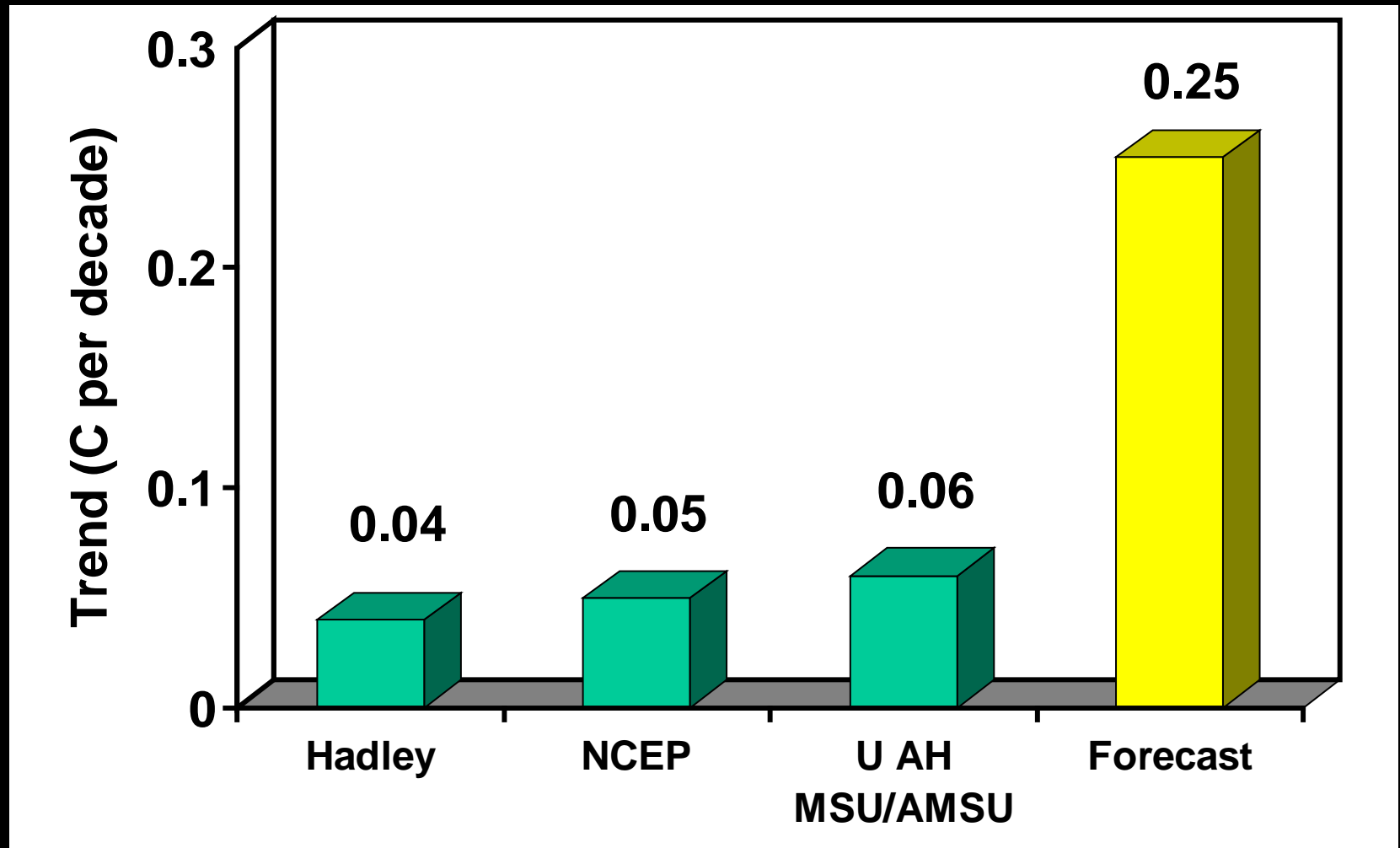
Central England Temperature 1659-2002



Instrumental measurements show a long-term warming trend and the greatest rate of warming ca. 1690s – 1730s.

http://www.usefulinfo.co.uk/globalclimate/figure_1.htm

Low troposphere is where human-made warming trend must appear



J. Christy et al. 2003 *J. Atmospheric & Oceanic Tech.*



Enhanced greenhouse must warm low troposphere (1- 5 km height) *faster* than surface

Forecast (low tropos.) +0.25 C/decade

Surface +0.15 C/decade

Hadley (Balloon) +0.04 C/decade

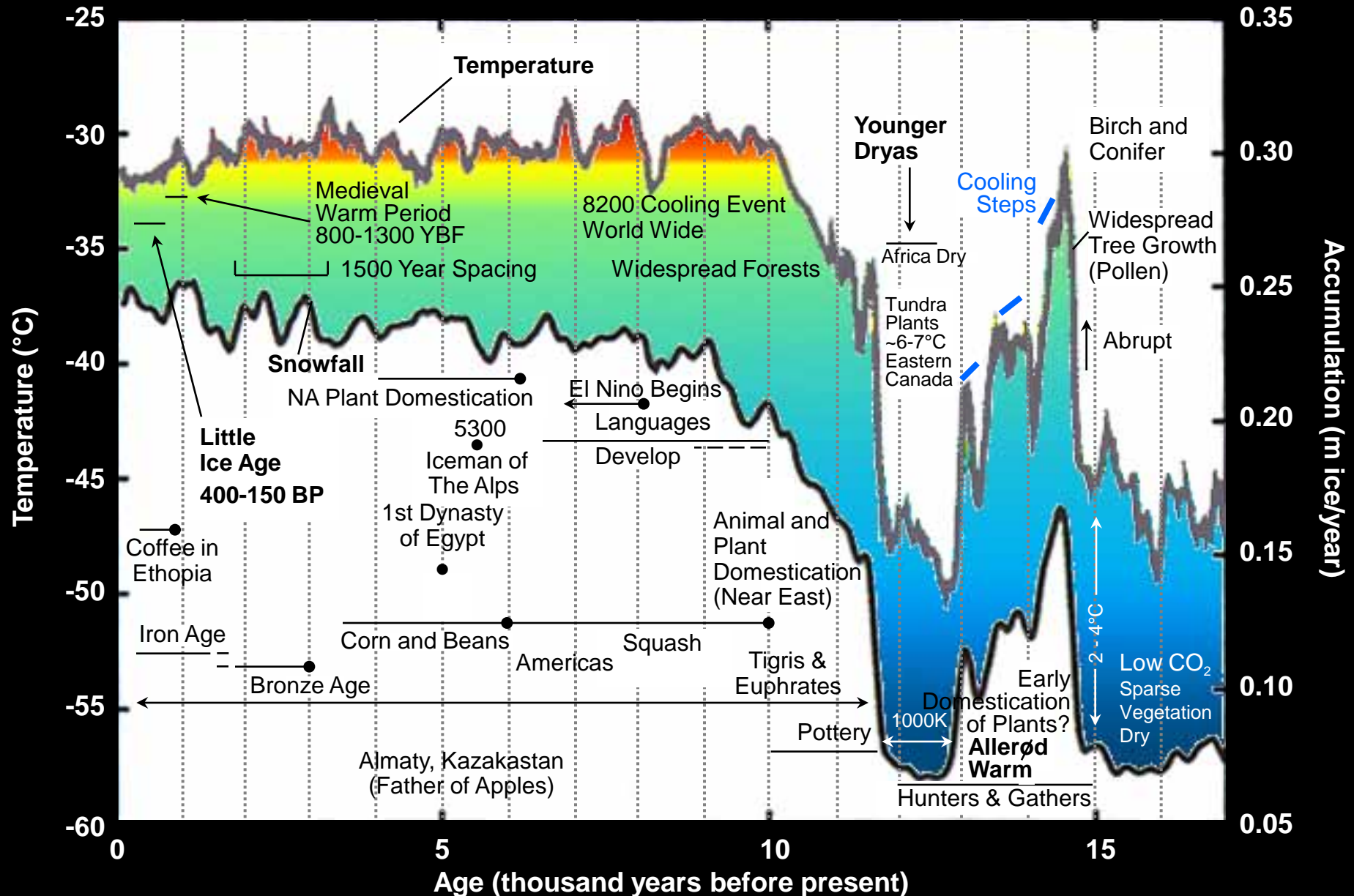
NCEP (Balloon) +0.05 C/decade

U AH MSU/AMSU
(Satellite) +0.06 C/decade

Abrupt Changes in the Earth's Climate

Measured in Central Greenland Over the Last 17,000 Years

Paleo Temperatures & Snowfall - After Cuffey and Clow 1997 / Alley 2000



Speleothems contain climate information



© Dave Bunnell