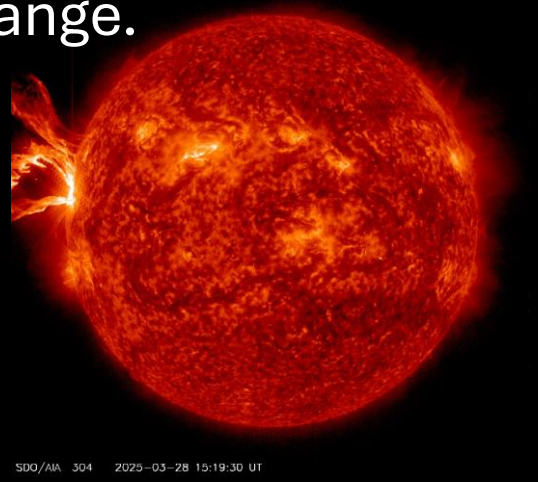
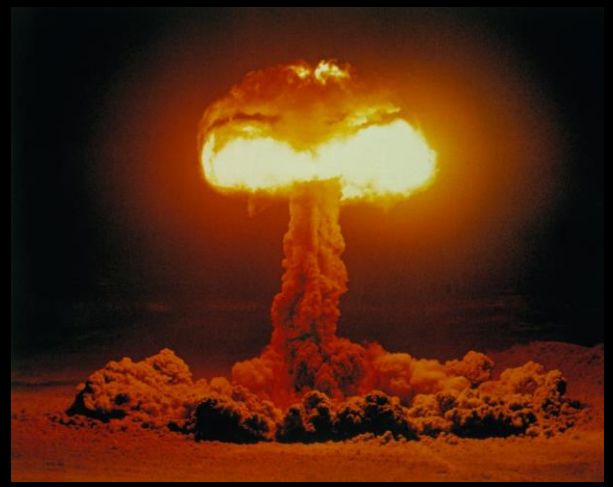
University of Exeter

Marine Science, Environmental Science, and Physical Geography

Dr David Reynolds
Lecturer in Physical Geography
Centre for Geography and Environmental Science

My research and teaching focuses on understanding the mechanisms and drivers of environmental variability. Ultimately, my research aims to constrain uncertainties associated with predictions of likely future environmental change.





Geography & Environmental Science

Top 40 in the world for Geography

QS World University Subject Rankings 2025

Top 15 in the UK for Geography and Environmental Science

11th in the Complete University Guide 2025

Opportunities to learn from experts on field courses

82% of our Geography graduates in employment or further study within 15 months of graduating

Based on full-time, first degree, UK domiciled graduates, HESA Graduate Outcomes survey 2020/21

University of Exeter

This lecture is a taster for the types of content you might find across CGES degree programmes. In particular, within these modules:

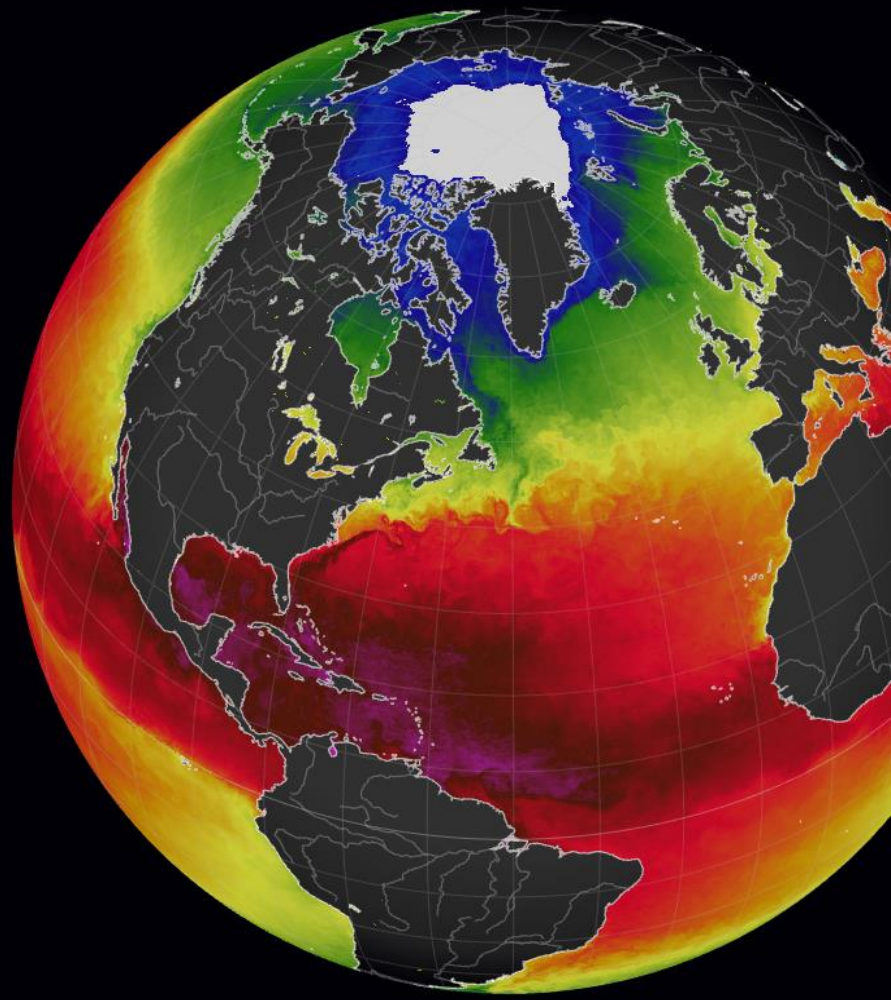
GEO1408B – Global Issues

GEO2467 – Climate Change – The Physical Basis of the IPCC

GEO2462 – Research Methods and Design

GEO3455 – Marine Climate and Environmental Change

GEO3438 – Research Dissertation




ipcc
INTERGOVERNMENTAL PANEL ON
climate change
WMO
UNEP

The IPCC was founded in 1988

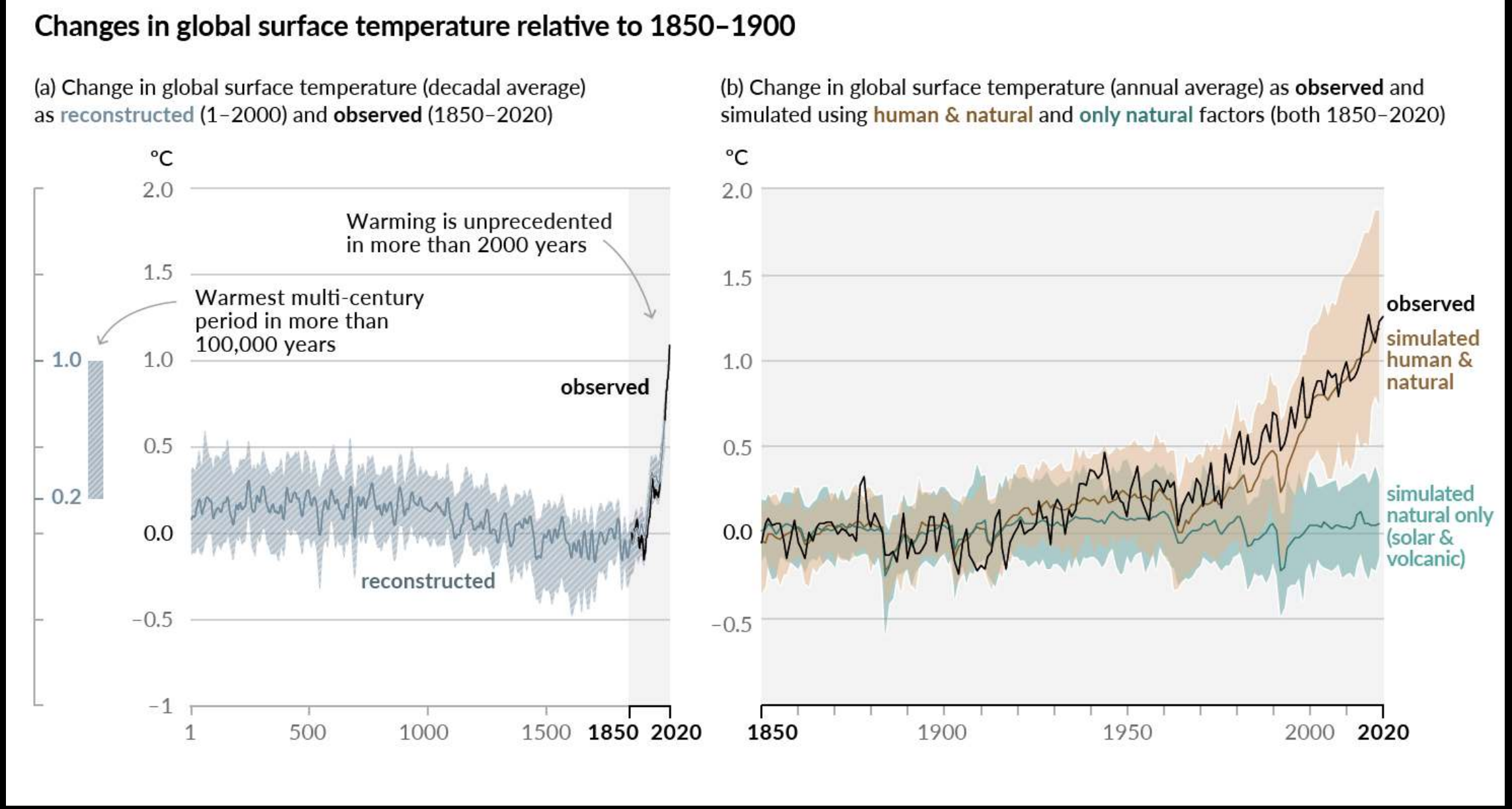


Figure SPM.1 | History of global temperature change and causes of recent warming Panel (a) Changes in global surface temperature reconstructed from paleoclimate archives. Panel (b) Changes in global surface temperature over the past 170 years.

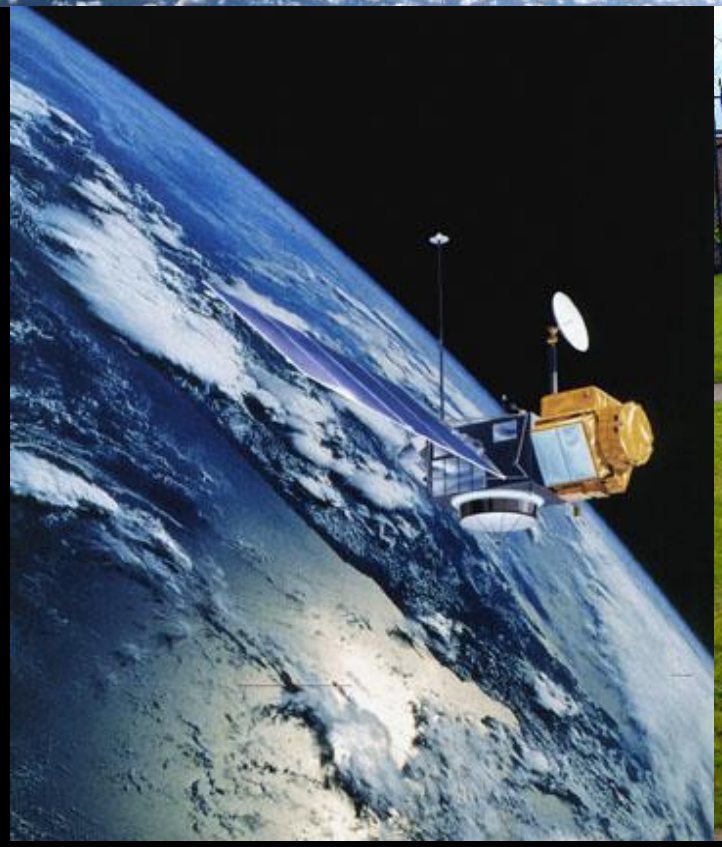
How do can the IPCC make these statements?

Observations

Proxy based reconstructions

Observations of surface air temperature

- Satellites – since 1970’s
- Ground observations
  - Weather stations
    - Thermometers
    - Rain gauges
    - Barometer
  - Ocean buoys
    - Temperature
    - Salinity
    - Turbidity



Timeline of the invention of thermometers

1593 – First water thermometer (Galileo Galilei)

1654 – First sealed liquid (alcohol) thermometer invented.

1659 – Central England Temperature series started.

1714 – First mercury thermometer (Gabriel Fahrenheit)

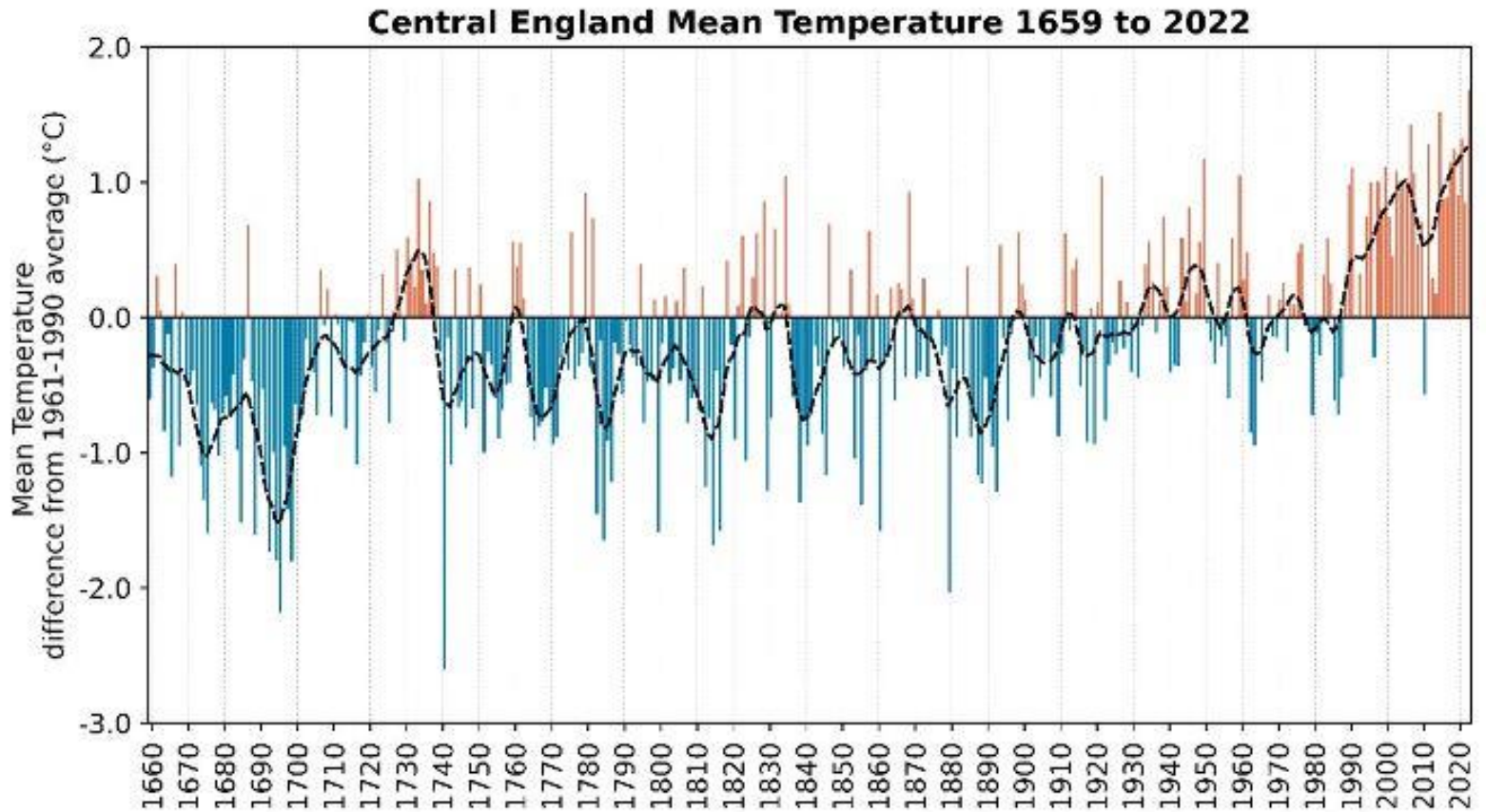
1742 – Celsius scale devised (Anders Celsius)

1848 – The Kelvin scale of absolute temperature proposed

1979 – First Satellite observations

1990’s – Digital thermometers

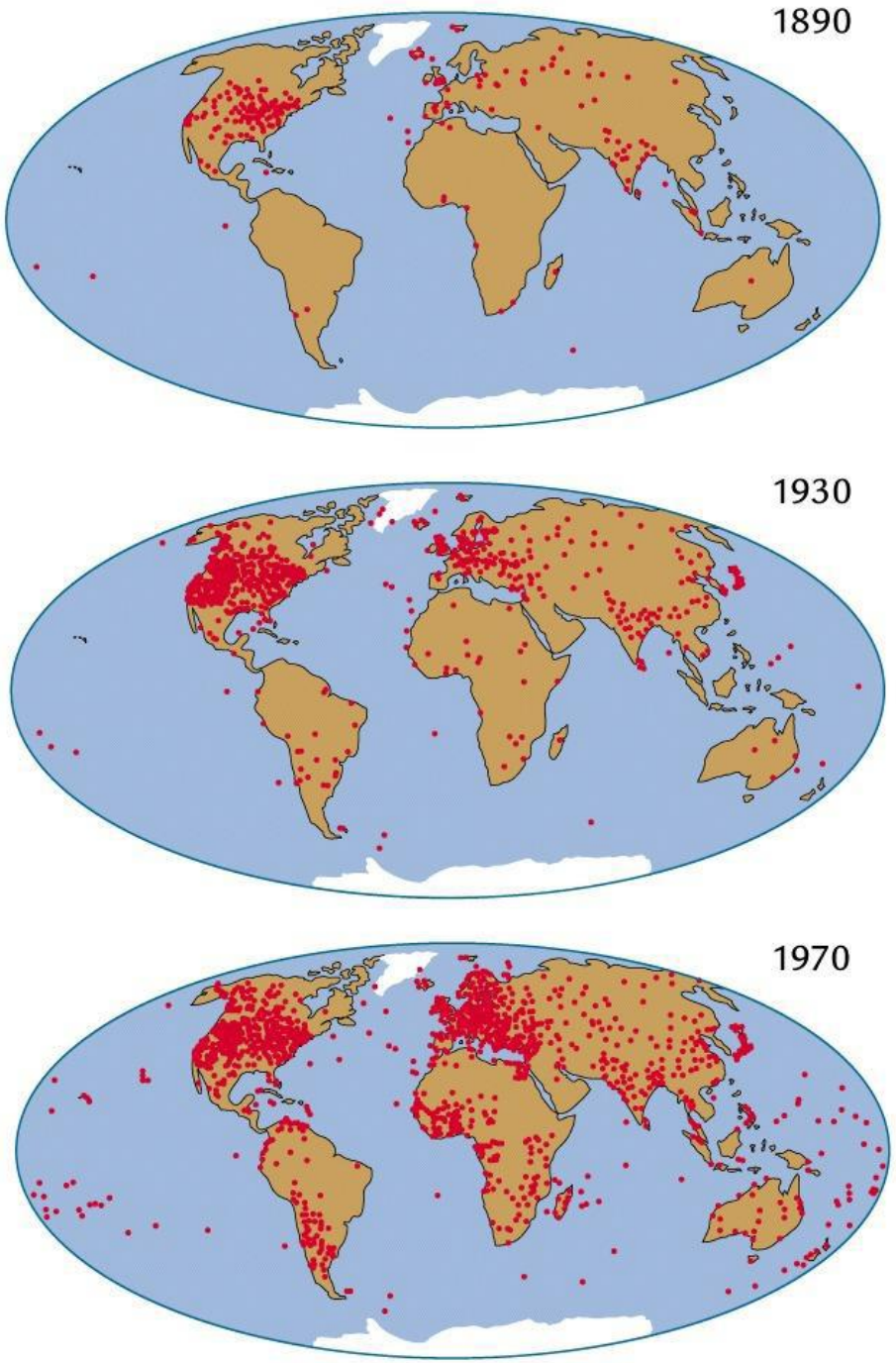
The Central England Temperature series



Estimating global air temperature

Thermometers invented in Europe. It took time for the technology to propagate around the world

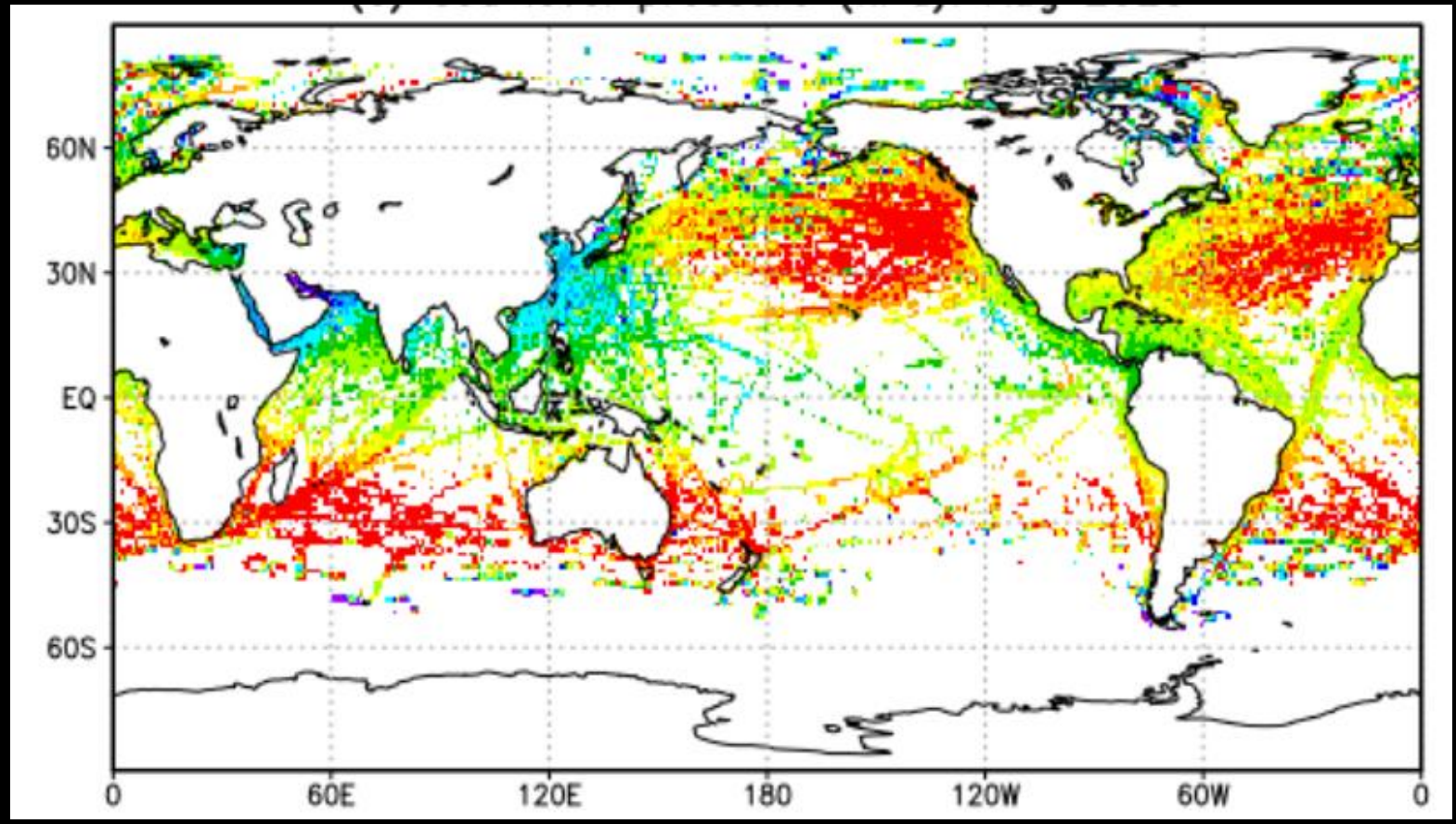
Global Historical Climatology Network >7000 stations



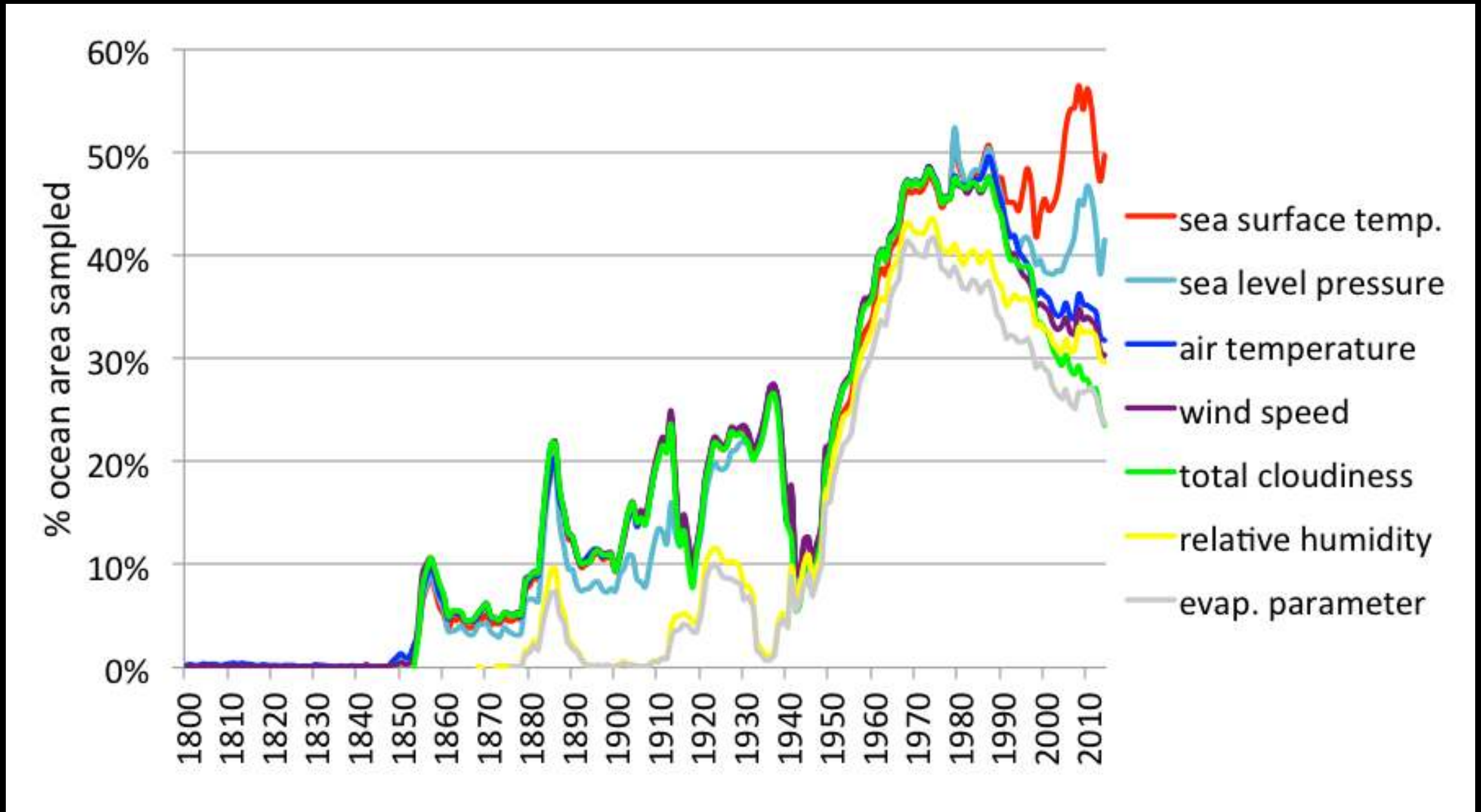
Measuring air temperature over the ocean

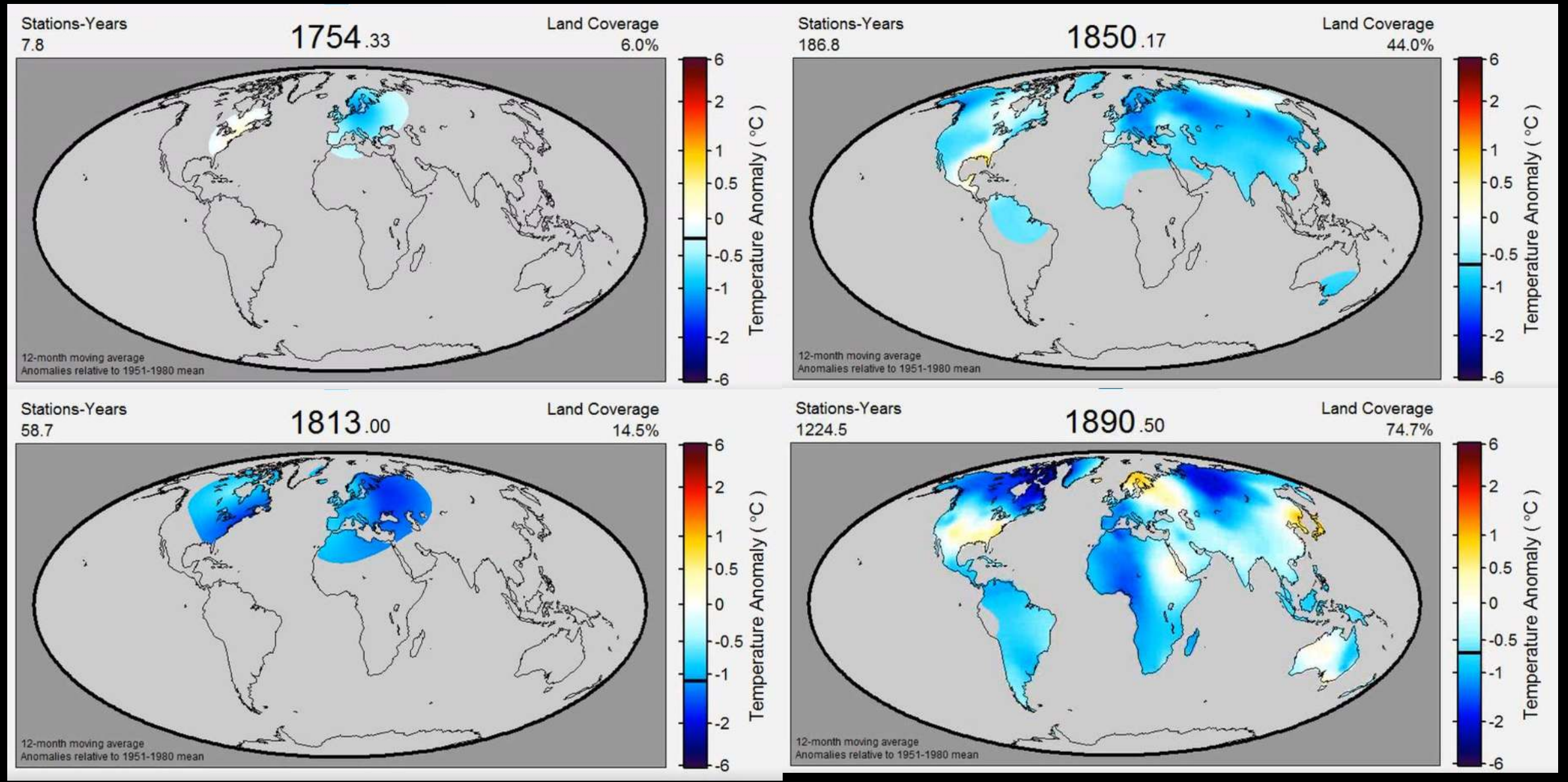
International Comprehensive Ocean-Atmosphere Data Set

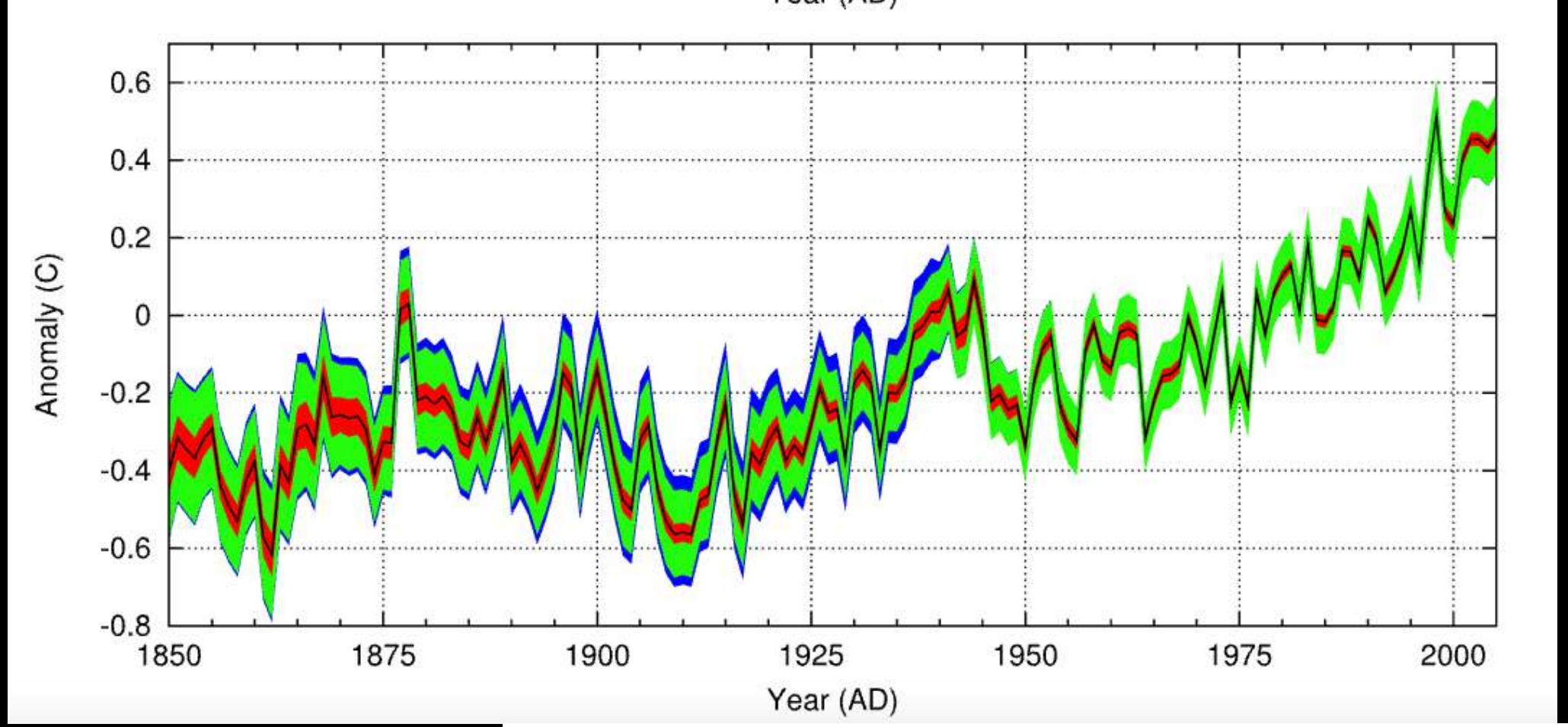
ICOADS



Proportion of the ocean covered by ICOADS




Stations-Years
7.8
1754.33
Land Coverage
6.0%
12-month moving average
Anomalies relative to 1951-1980 mean
Temperature Anomaly (°C)
6
2
1
0.5
0
-0.5
-1
-2
-6
Stations-Years
186.8
1850.17
Land Coverage
44.0%
12-month moving average
Anomalies relative to 1951-1980 mean
Temperature Anomaly (°C)
Stations-Years
58.7
1813.00
Land Coverage
14.5%
12-month moving average
Anomalies relative to 1951-1980 mean
Temperature Anomaly (°C)
Stations-Years
1224.5
1890.50
Land Coverage
74.7%
12-month moving average
Anomalies relative to 1951-1980 mean
Temperature Anomaly (°C)



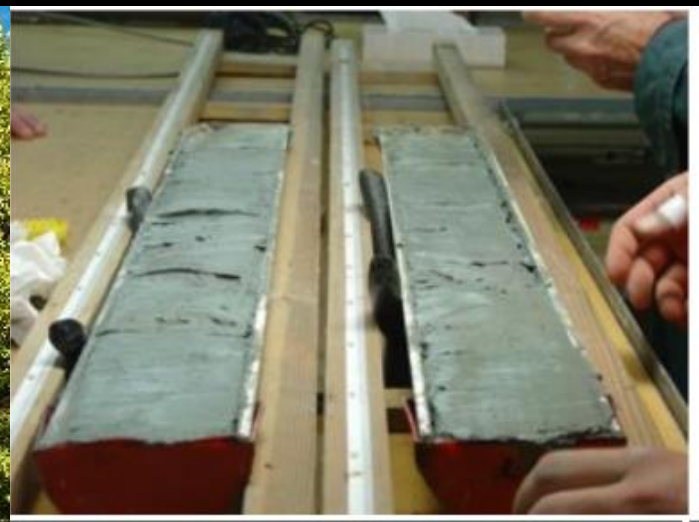
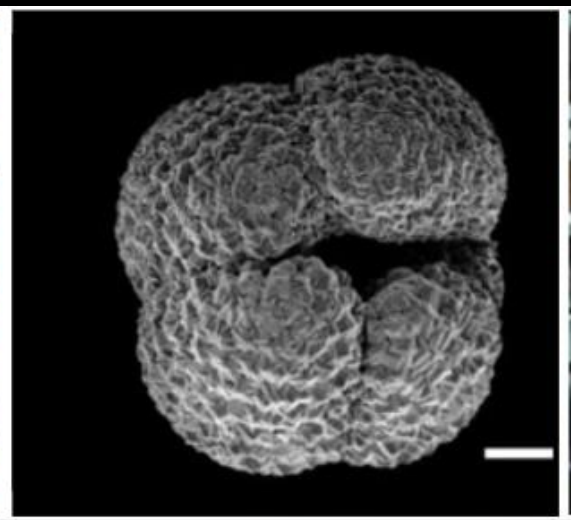
JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 111, D12106, doi:10.1029/2005JD006548, 2006

Uncertainty estimates in regional and global observed temperature changes: A new data set from 1850

P. Brohan,[1] J. J. Kennedy,[1] I. Harris,[2] S. F. B. Tett,[3] and P. D. Jones[2]

How do we know that what is captured by the observations is unprecedented and not just natural variability?

Reconstructions of past climate

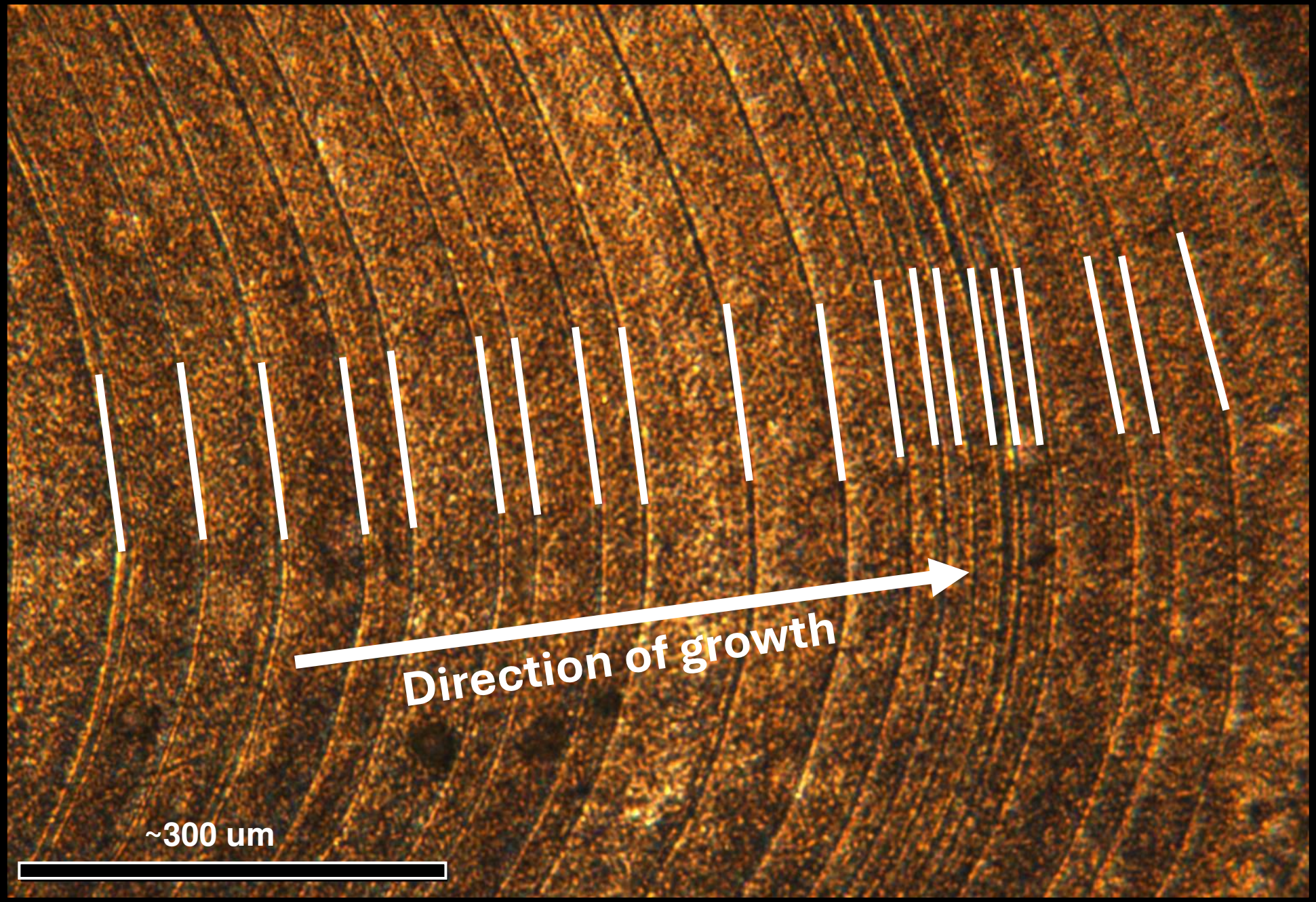






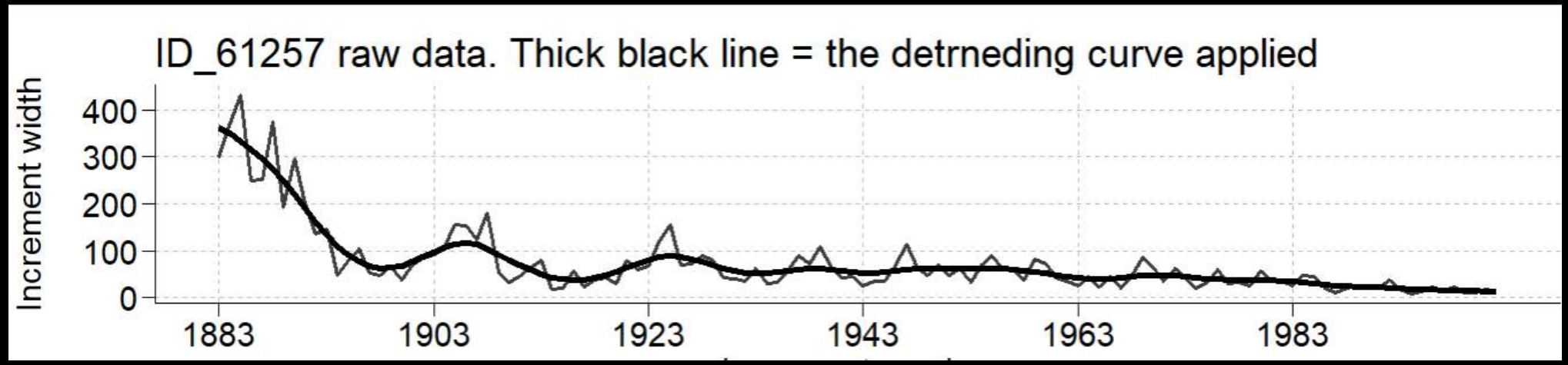
Dendrochronology

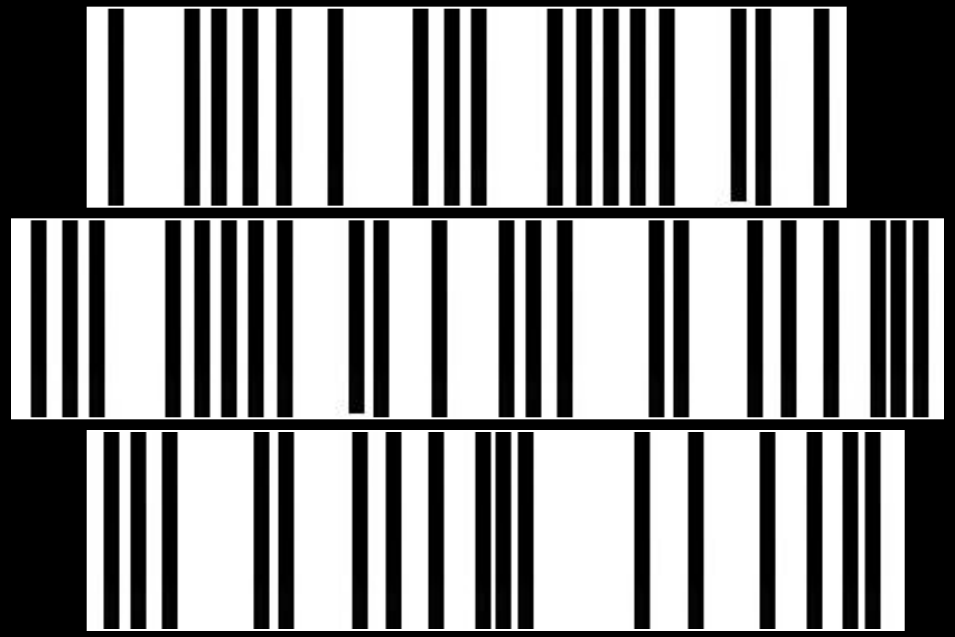
Crossdating

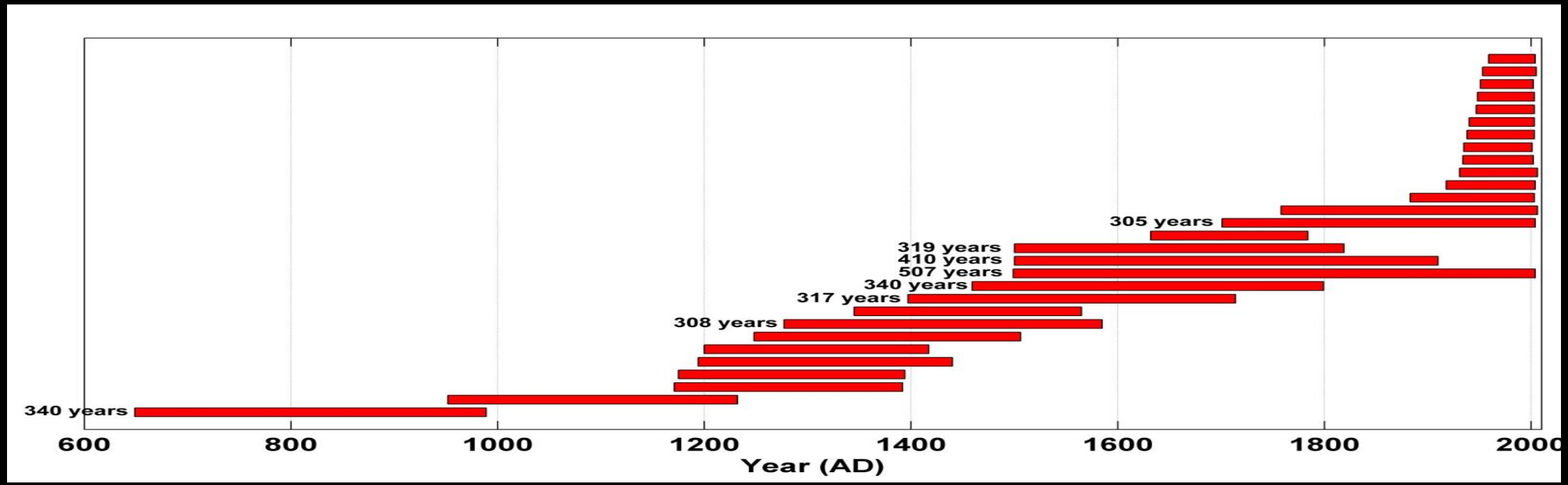
Developed by dendrochronology

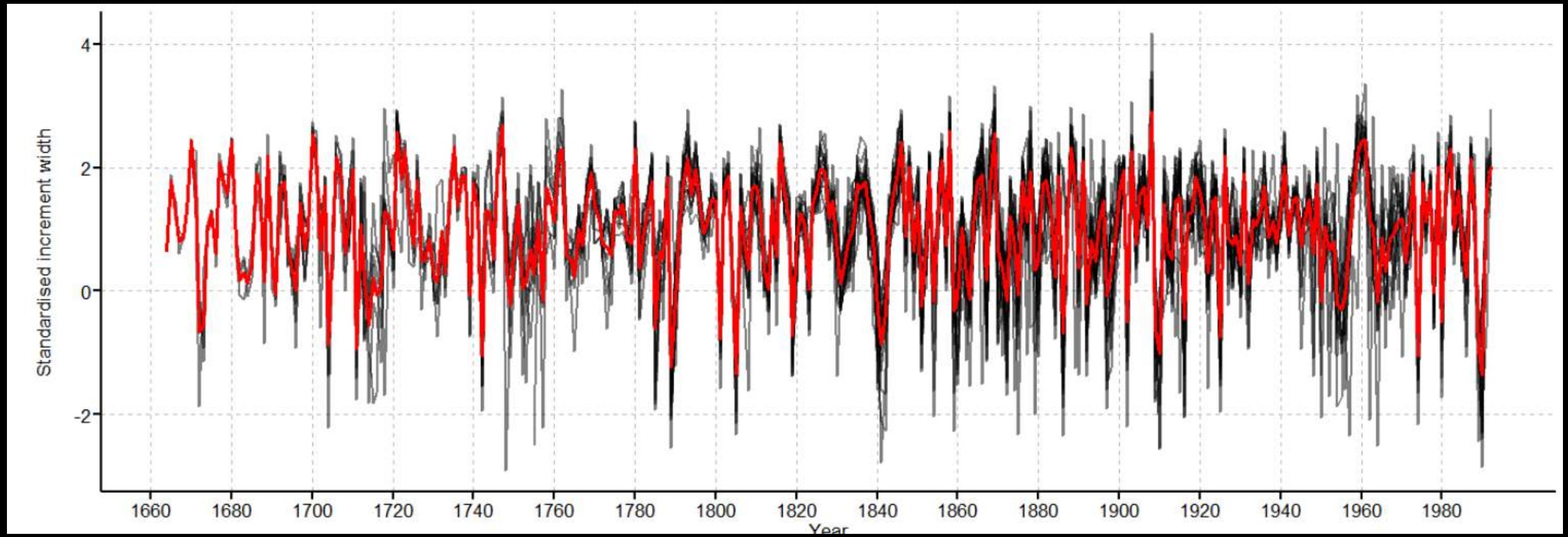


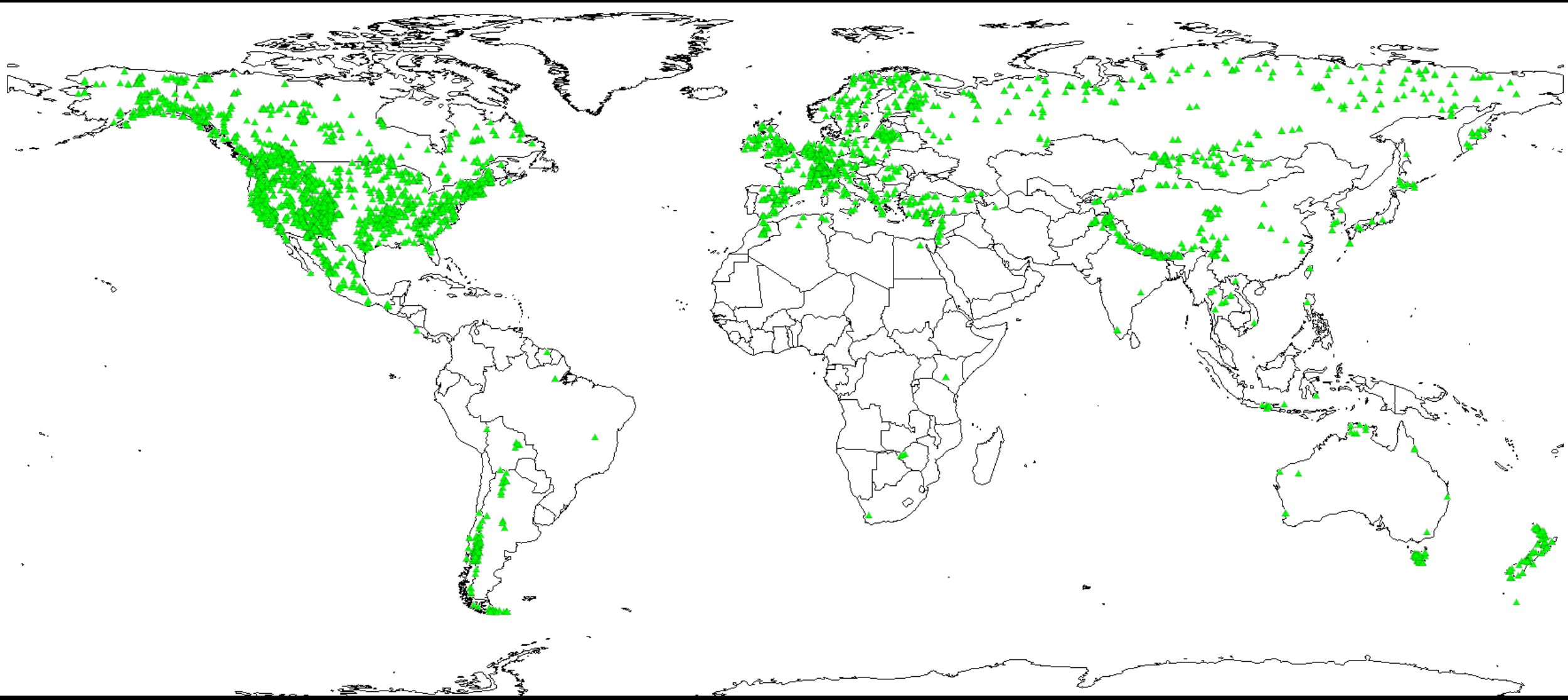
Crossdating – The core principle to absolute dating

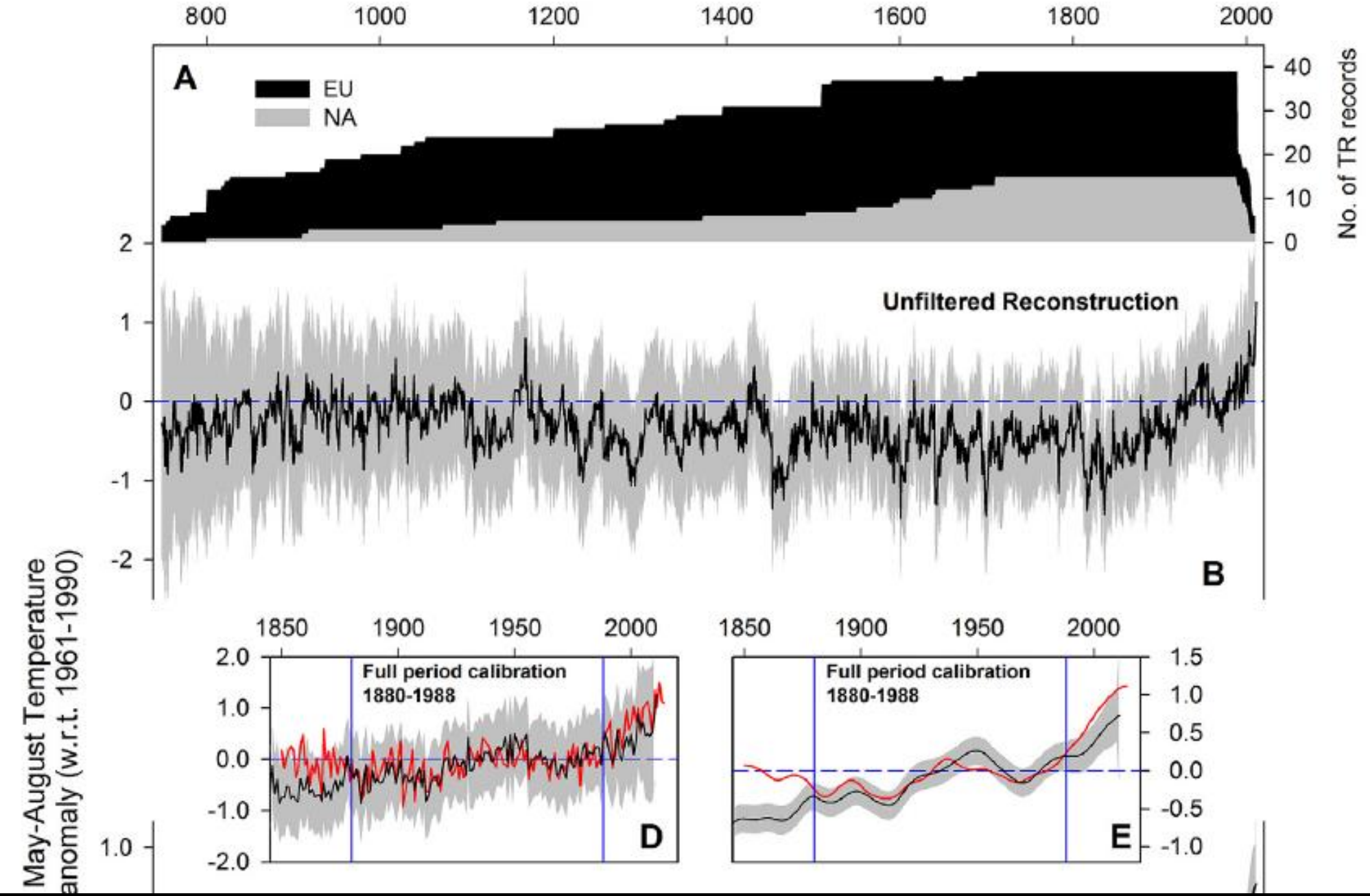


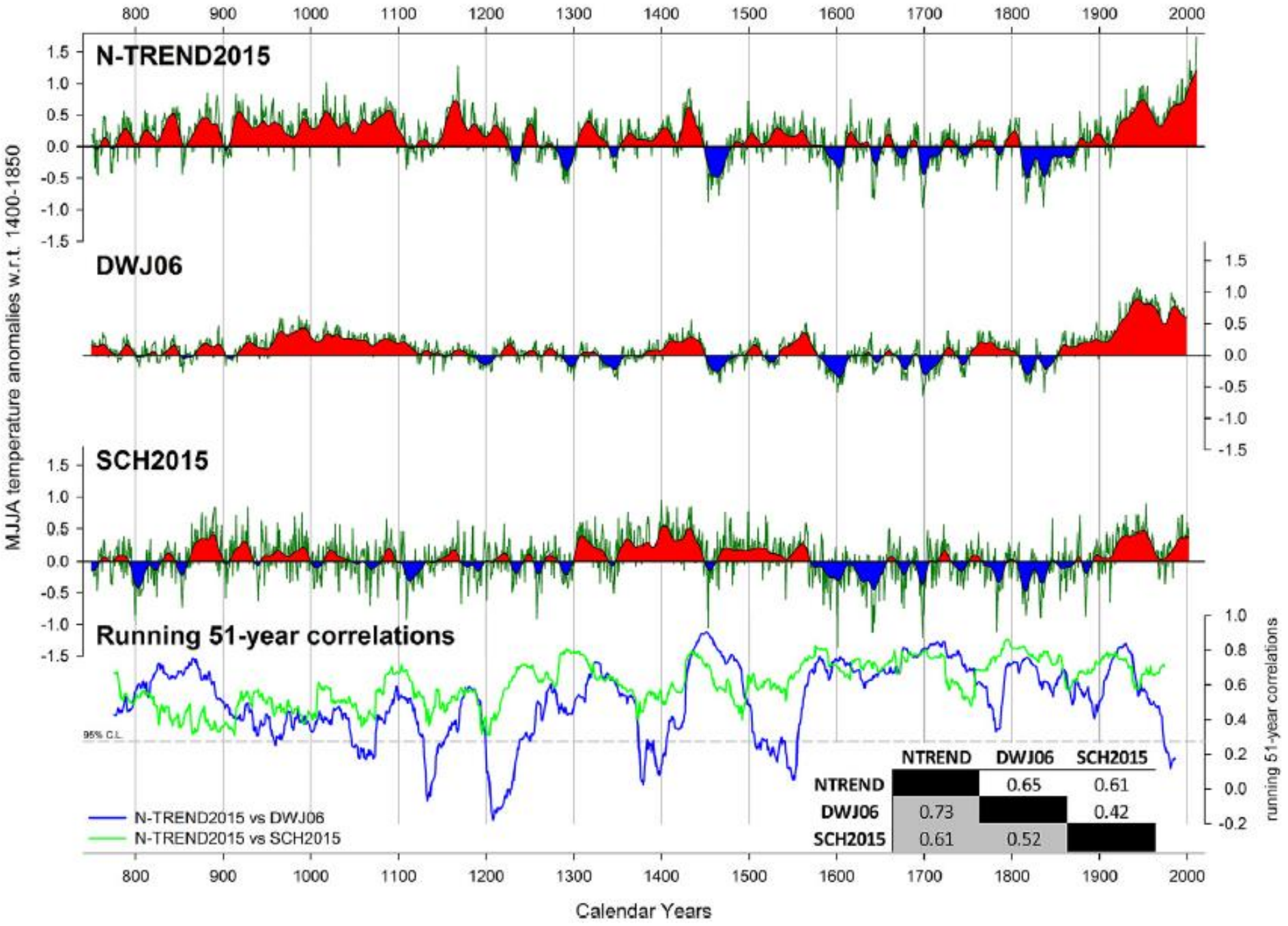



305 years
319 years
410 years
507 years
340 years
317 years
308 years
340 years
600
800
1000
1200
1400
1600
1800
2000
Year (AD)

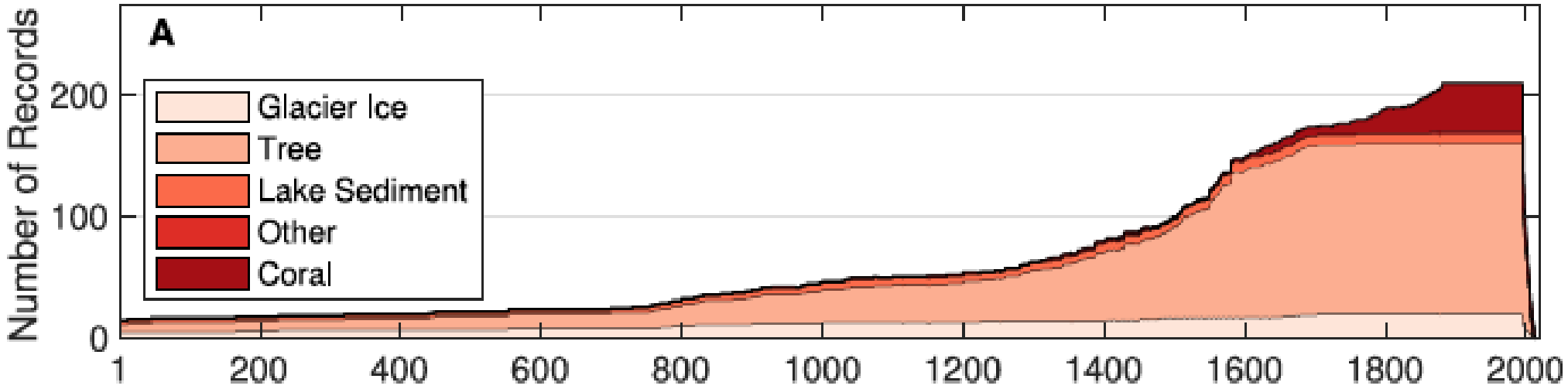

Standardised increment width
4
2
0
-2
1660
1680
1700
1720
1740
1760
1780
1800
1820
1840
1860
1880
1900
1920
1940
1960
1980
Year




800
1000
1200
1400
1600
1800
2000
A
EU
NA
40
30
20
10
0
No. of TR records
2
1
0
-1
-2
Unfiltered Reconstruction
B
May-August Temperature
anomaly (w.r.t. 1961-1990)
1850
1900
1950
2000
2.0
1.0
0.0
-1.0
-2.0
Full period calibration
1880-1988
D
1850
1900
1950
2000
1.5
1.0
0.5
0.0
-0.5
-1.0
Full period calibration
1880-1988
E
1.0


N-TREND2015
DWJ06
SCH2015
Running 51-year correlations
MJJA temperature anomalies w.r.t. 1400-1850
running 51-year correlations
Calendar Years
95% C.L.
N-TREND2015 vs DWJ06
N-TREND2015 vs SCH2015
NTREND DWJ06 SCH2015
NTREND 0.65 0.61
DWJ06 0.73 0.42
SCH2015 0.61 0.52

Multi proxy based approach



Quaternary Science Reviews 286 (2022) 107537

Contents lists available at ScienceDirect

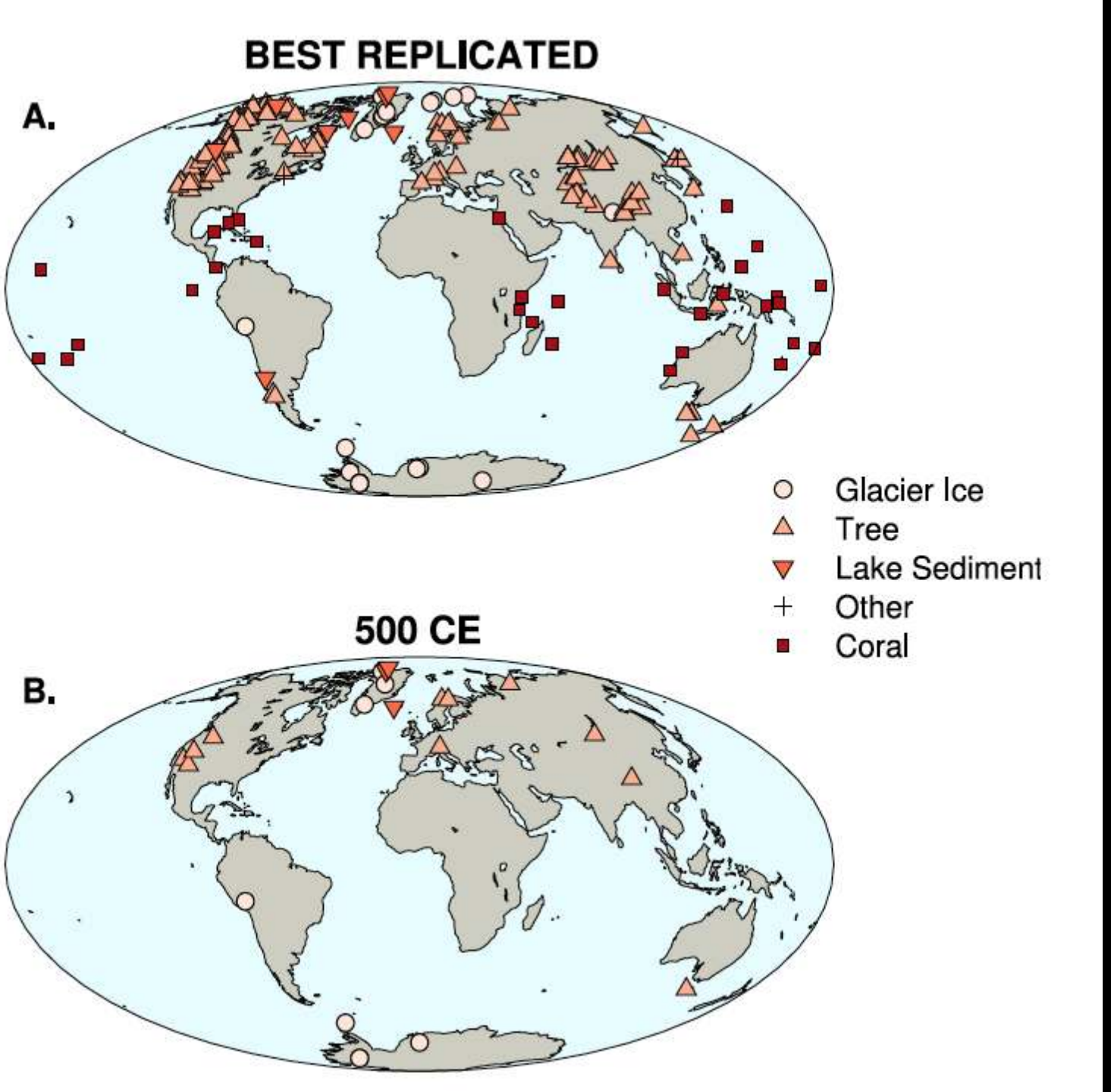
Quaternary Science Reviews

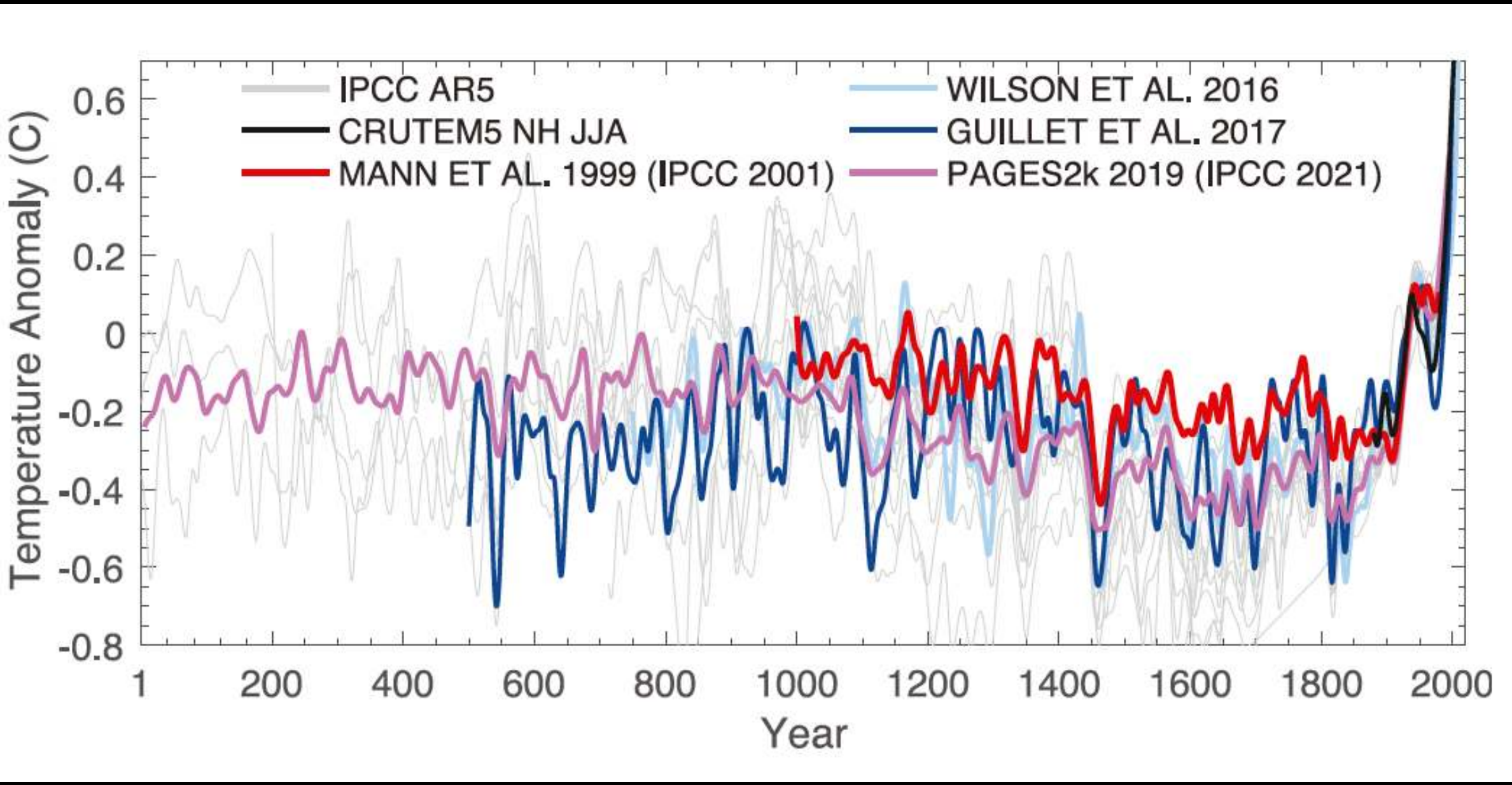
journal homepage: www.elsevier.com/locate/quascirev

Progress and uncertainties in global and hemispheric temperature reconstructions of the Common Era

Kevin J. Anchukaitis [a, b, c, *], Jason E. Smerdon [c]

[a] School of Geography, Development, and Environment, University of Arizona, Tucson, 85721, AZ, USA
[b] Laboratory of Tree-Ring Research, University of Arizona, Tucson, 85721, AZ, USA
[c] Lamont-Doherty Earth Observatory of Columbia University, Palisades, 10964, NY, USA


BEST REPLICATED
A.
Glacier Ice
Tree
Lake Sediment
Other
Coral
500 CE
B.


IPCC AR5
CRUTEM5 NH JJA
MANN ET AL. 1999 (IPCC 2001)
WILSON ET AL. 2016
GUILLET ET AL. 2017
PAGES2k 2019 (IPCC 2021)
Temperature Anomaly (C)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
1
200
400
600
800
1000
1200
1400
1600
1800
2000
Year

Summary

- Modern observations of air temperature typically only span the last 100 or so years.

- The Central England data provides the longest record, but still mostly captures anthropogenically influenced climate.

- We therefore need proxy data to provide long term context and provide information on the natural rhythms of the climate system

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Thank You