

CLIMATE SKEPTICS AND THE STATE OF CLIMATE SCIENCE

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About me...

- Professor of Statistics and Biostatistics at the University of North Carolina
- Incoming Director of the Statistical and Applied Mathematical Sciences Institute, supported by the NSF. SAMSI organizes research programs covering many applications of mathematics and statistics, including climate change
- Numerous published papers on statistics of climate
- Regular visitor to National Center for Atmospheric Research
- Member of Climate Change Policy Advisory Committee for the American Statistical Association
- Member of International Detection and Attribution Group (supported by DOE)
- One of about 50 lead authors of the Climate Change Science Program report on extremes
- Not affiliated with IPCC

All opinions expressed here represent my own personal views and not those of my employers, research sponsors or the American Statistical Association

What is the role of statisticians in a debate about climate change?

- Many of the questions about climate science are closely connected with the collection and analysis of data
 - Raw data, e.g. weather stations
 - Proxy data — tree rings, ice cores, etc.
 - Data generated by climate models
- Many of the judgments involved are inherently statistical, e.g. looking for trends, dealing with missing data, correcting for possible errors
- There are also many instances in climate science where highly sophisticated data analysis techniques are involved (e.g. paleoclimate)
- Statisticians are naturally placed to advise and perform their own research on these issues!

“We cannot help remarking that it is very surprising that research in an area that depends so heavily on statistical methods has not been carried out in close collaboration with professional statisticians”

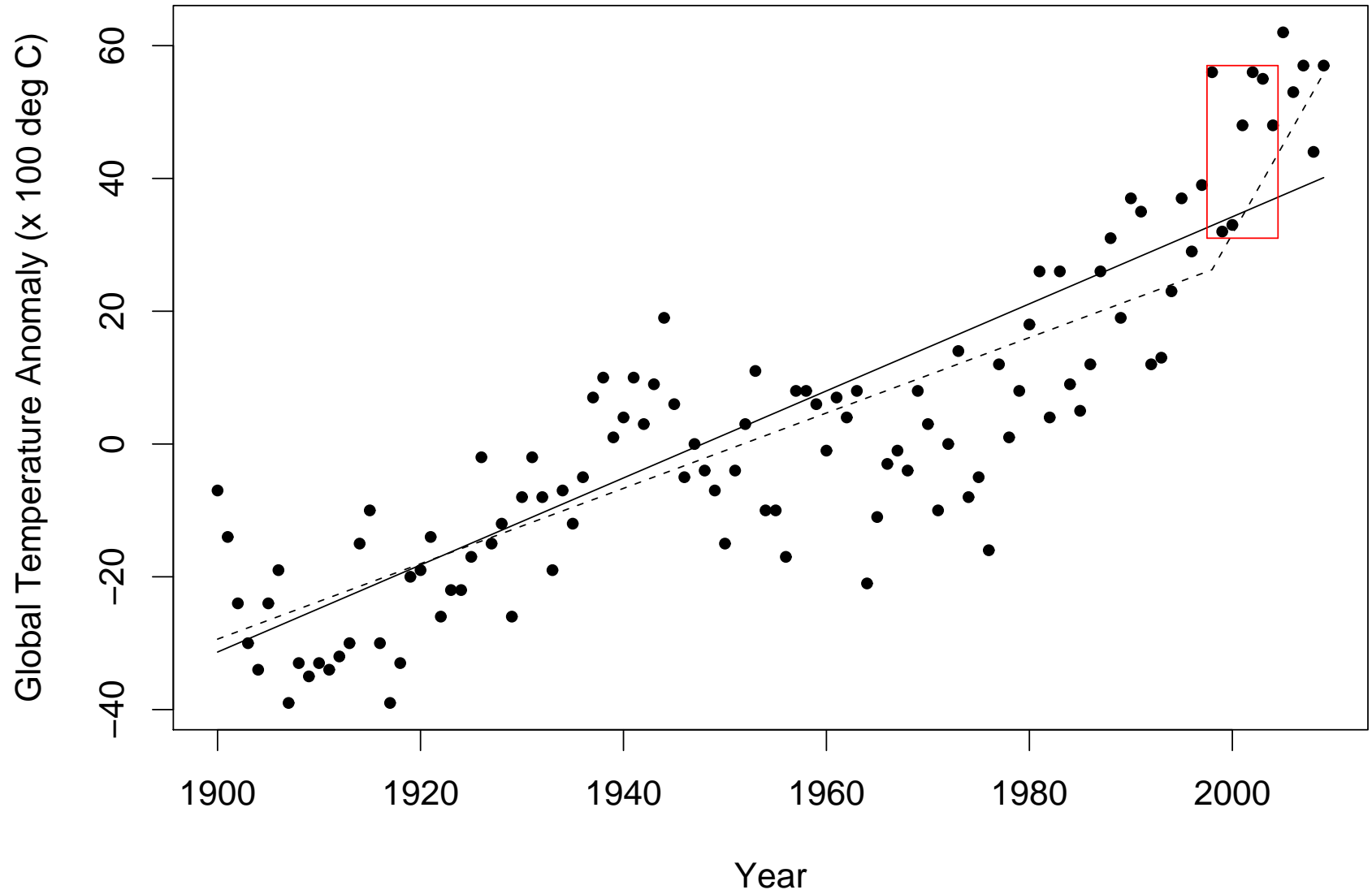
— from the Report of the International Panel set up by the University of East Anglia to examine the research of the Climatic Research Unit

Criticisms of Climate Science

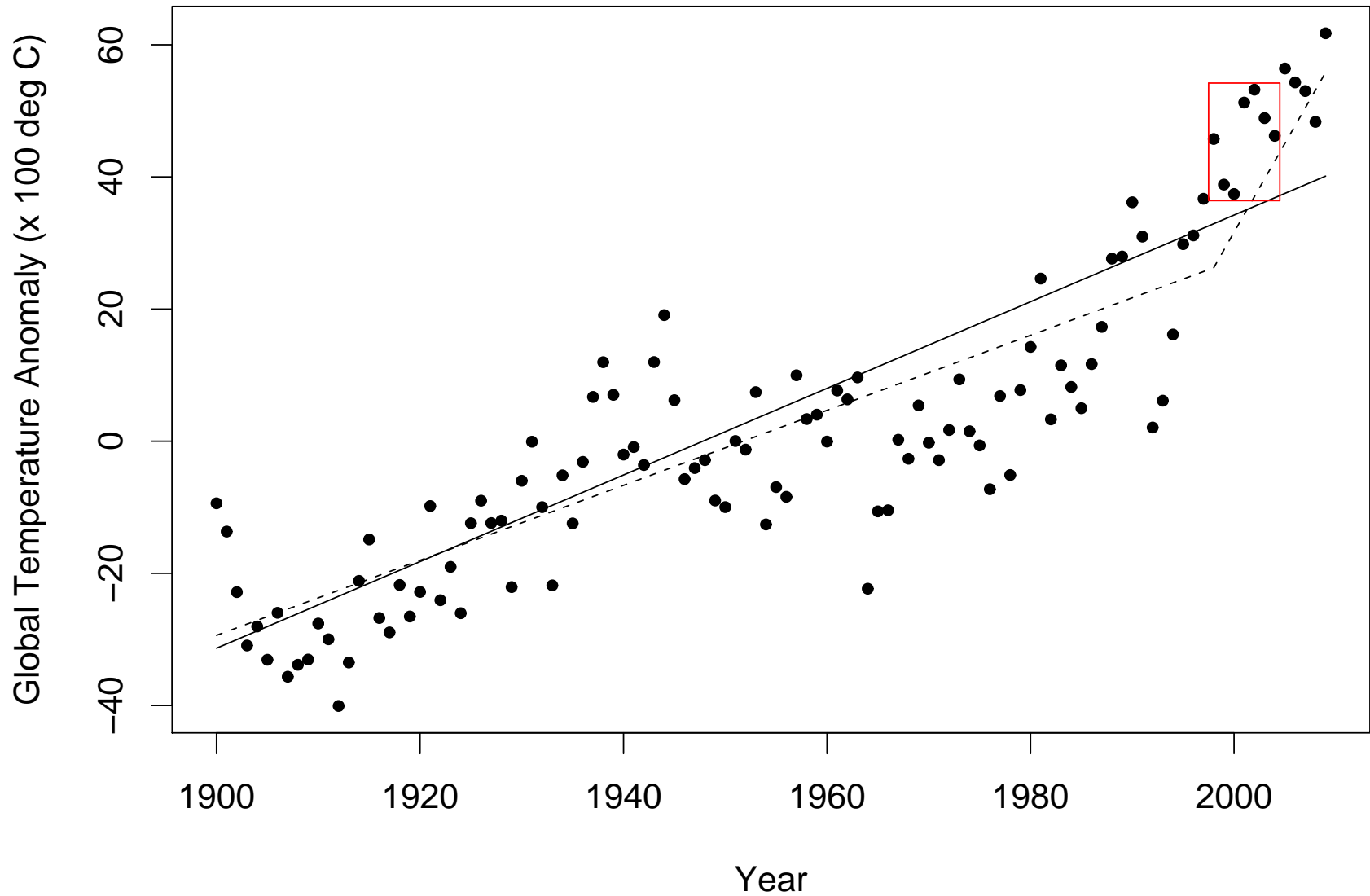
- Recent events have shaken the public confidence in climate science
- However, most of the criticisms of the science itself are not new (it's just that they weren't previously known to the general public)
- Robust criticism is a natural (and necessary) part of the scientific process. It would be amazing if all the world's scientists truly agreed on every detail
- In my view, climate science would benefit from a fuller and more open discussion of where there are differences of scientific viewpoint, and how these differences are addressed as part of an ongoing scientific process
- I illustrate these points with two examples
 - The claimed decrease in temperatures since 1998
 - The “hockey stick curve”

Have Temperatures Really Decreased Since 1998?

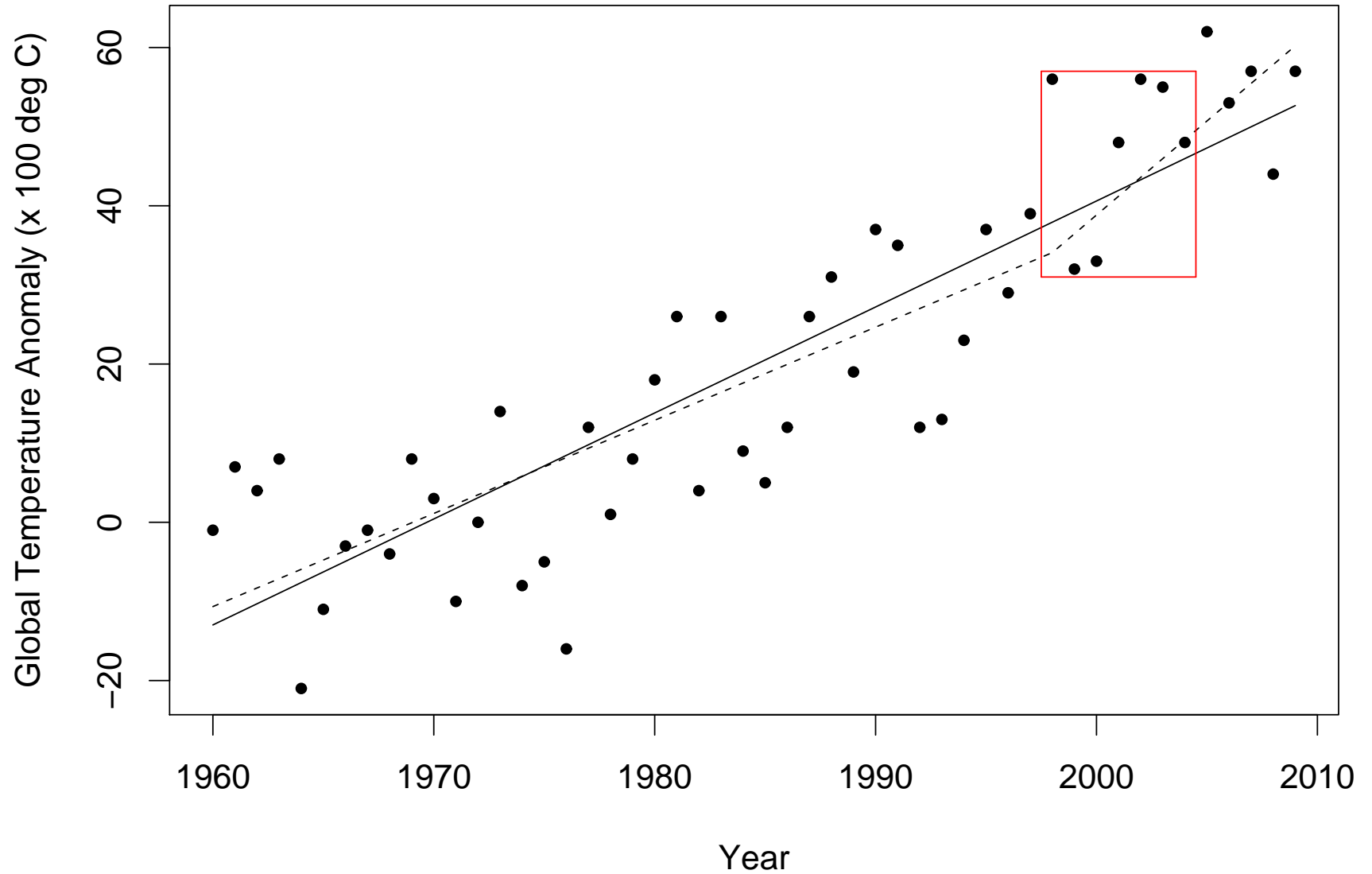
- Data from GISTEMP — global temperature anomalies, 1900–2009
- Fitted linear trends by regression analysis, adjusted for auto-correlation
- Considered possibility of a change of slope in 1998
- Also adjusted for the Southern Oscillation Index, used as a proxy for El Niño
- Repeated analysis for 1960–2009 as trend is more nearly linear over this period



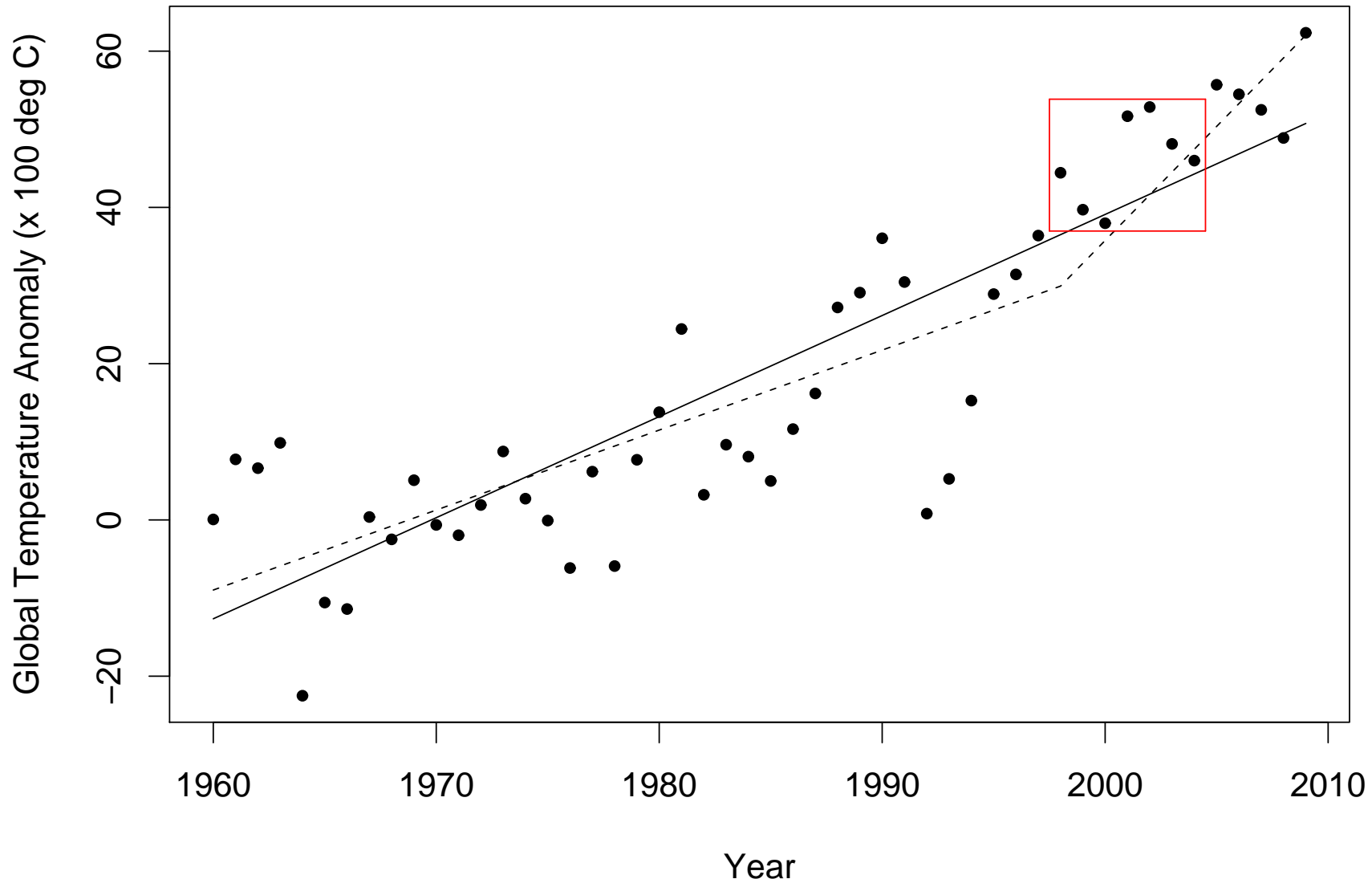
Global temperature anomaly data 1900–2009, with linear trends



Global temperature anomaly data 1900–2009, adjusted for SOI



Global temperature anomaly data 1960–2009, with linear trends



Global temperature anomaly data 1960–2009, adjusted for SOI

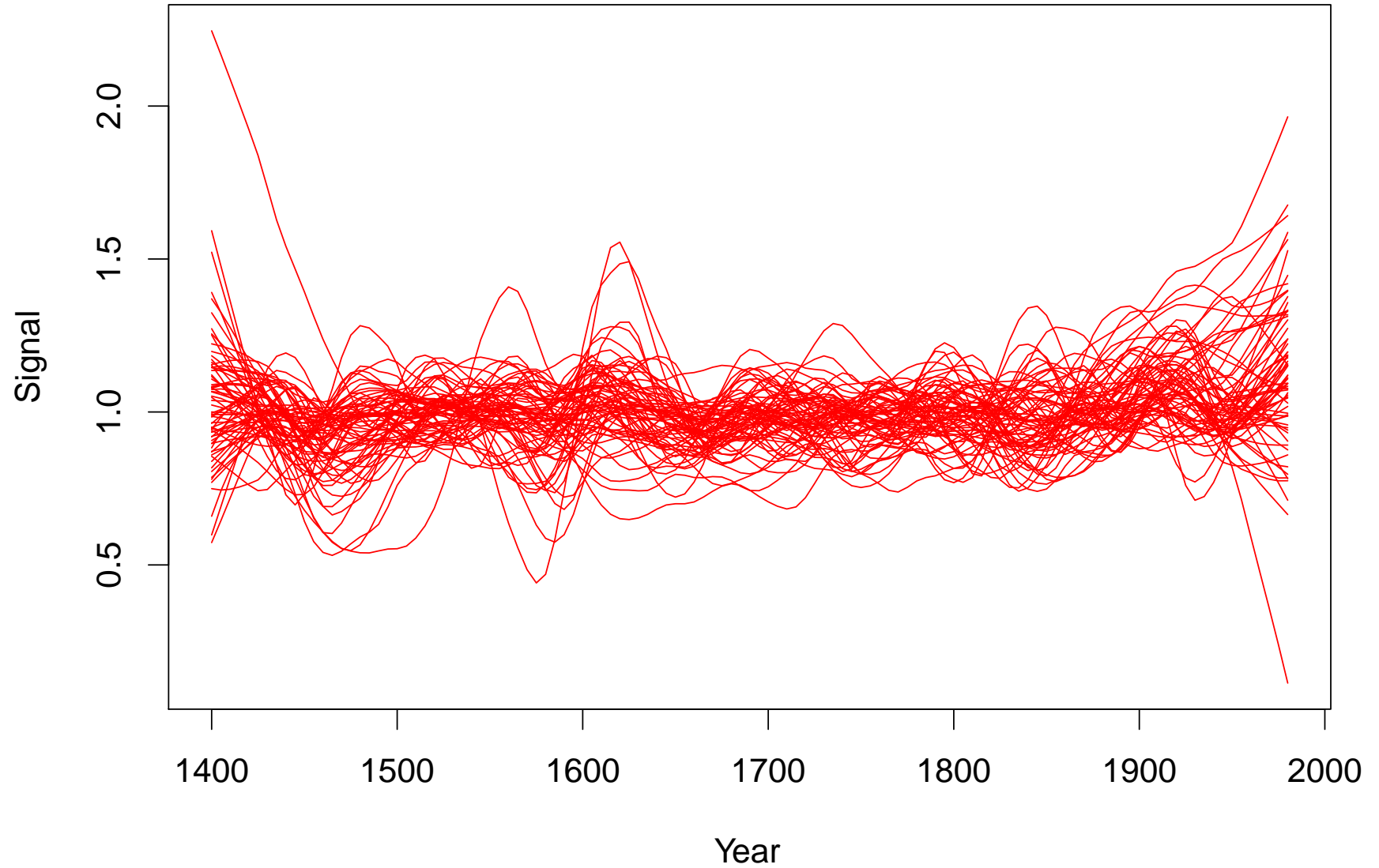
Conclusion from Temperature Trend Analysis

- No evidence of decrease post-1998 — if anything, the trend increases after this time
- After adjusting for El Niño, even stronger evidence for a continuously increasing trend

The “Hockey Stick” Controversy

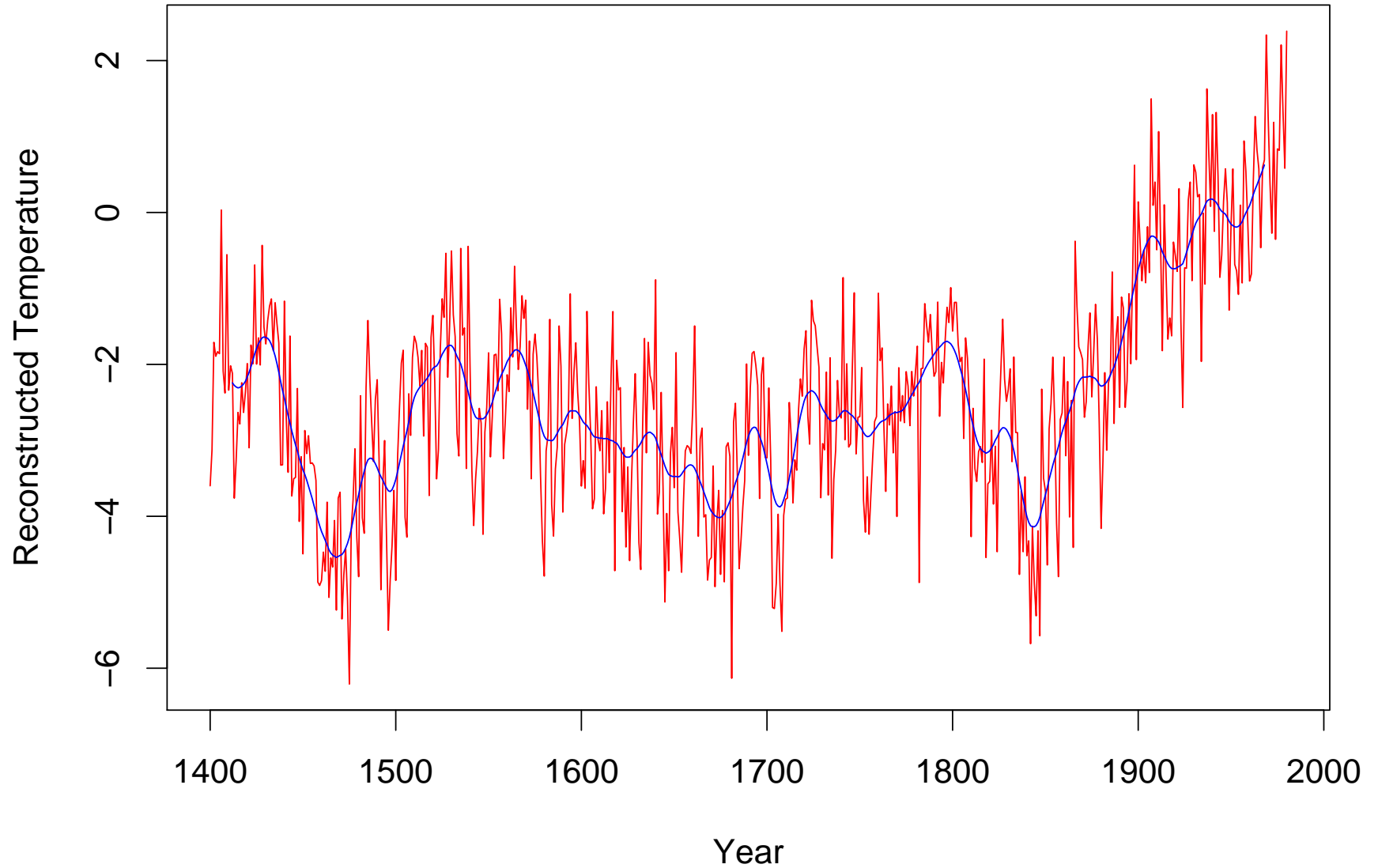
- Originally constructed in 1998/1999 by Mann, Bradley and Hughes (MBH)
- McIntyre and McKittrick (2003, 2005) criticized the statistical analysis in MBH. Their criticism was later expanded in a 2006 report to the House Energy Committee by statistics professor Edward Wegman
- A key point of the criticism was MBH’s inappropriate use of a statistical technique known as Principal Components Analysis
- Other authors have acknowledged these points but argued that the basic “hockey stick” shape is still valid (NRC report from 2006; Li, Nychka and Ammann, *Tellus* 2007)
- I illustrate these points here with some analyses of the main tree ring data (thanks to Doug Nychka and Caspar Ammann for data and programs)

Raw Tree Ring Data



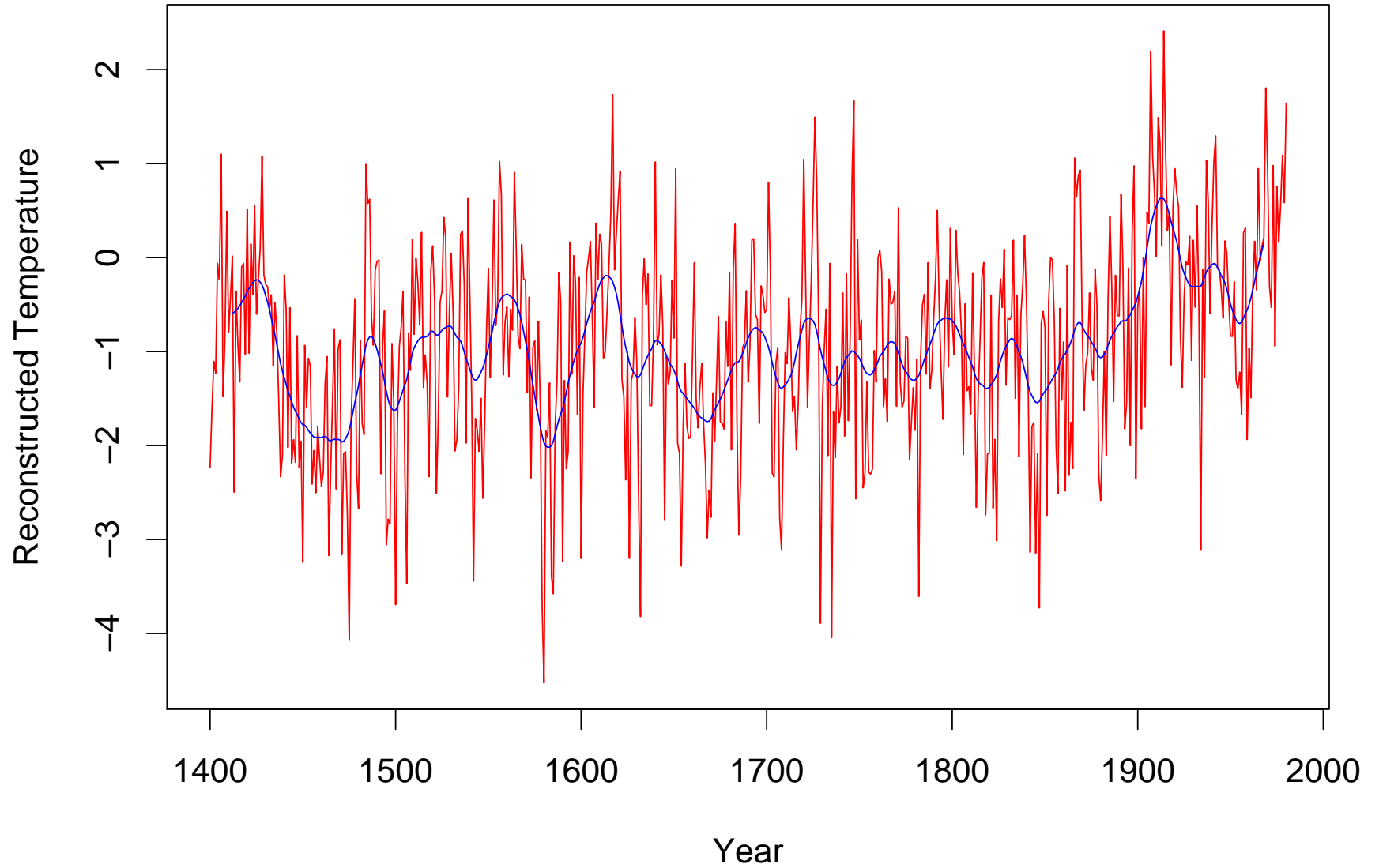
Tree ring data (1400-1980) from 70 trees

Original MBH Method



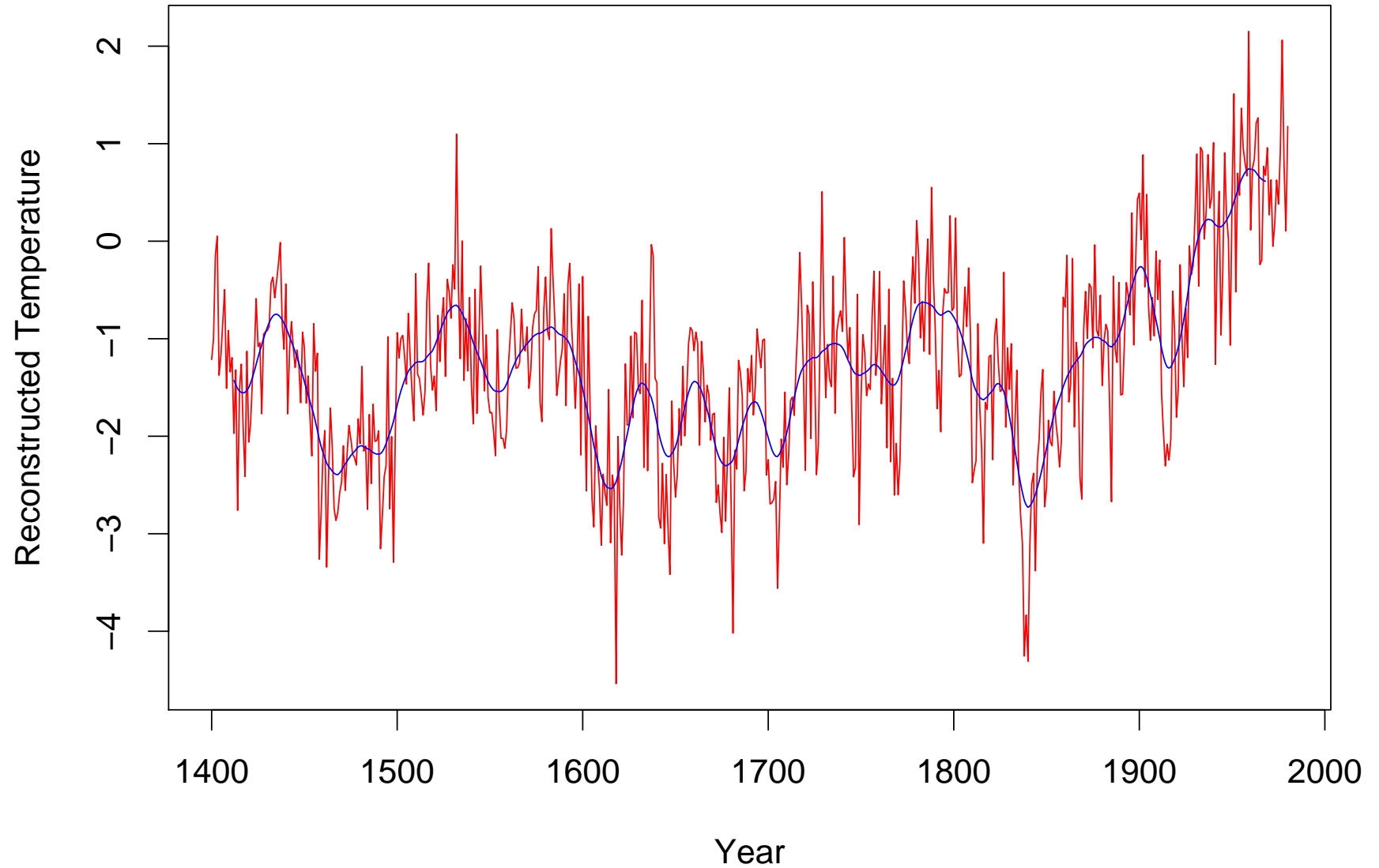
Original MBH plot, reconstructed for this presentation
(red curve is raw data; blue curve is smoothed to show overall trend)

First Principal Component, Centered to 1902–1980

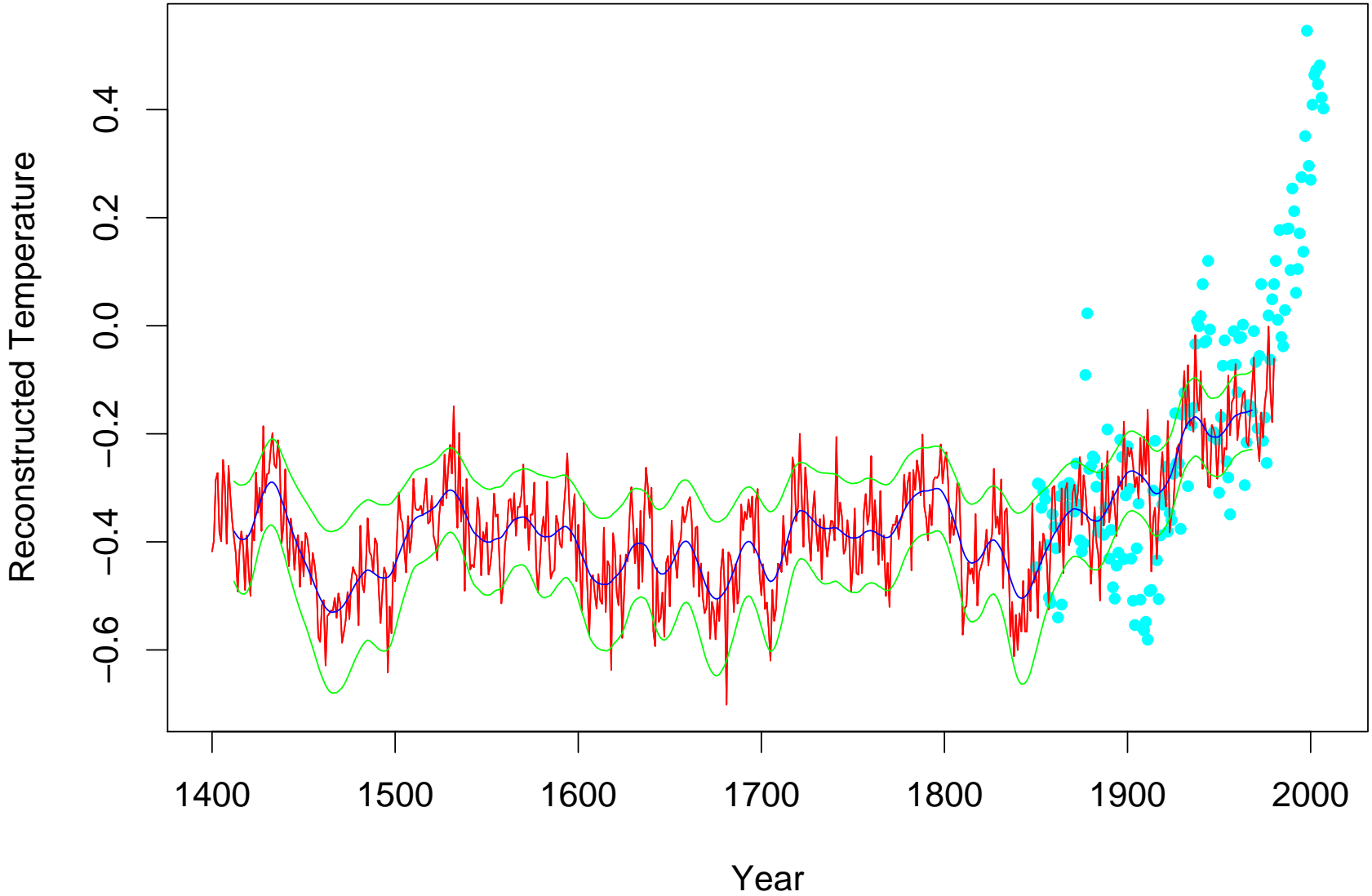


First principal component (McIntyre and McKittrick)

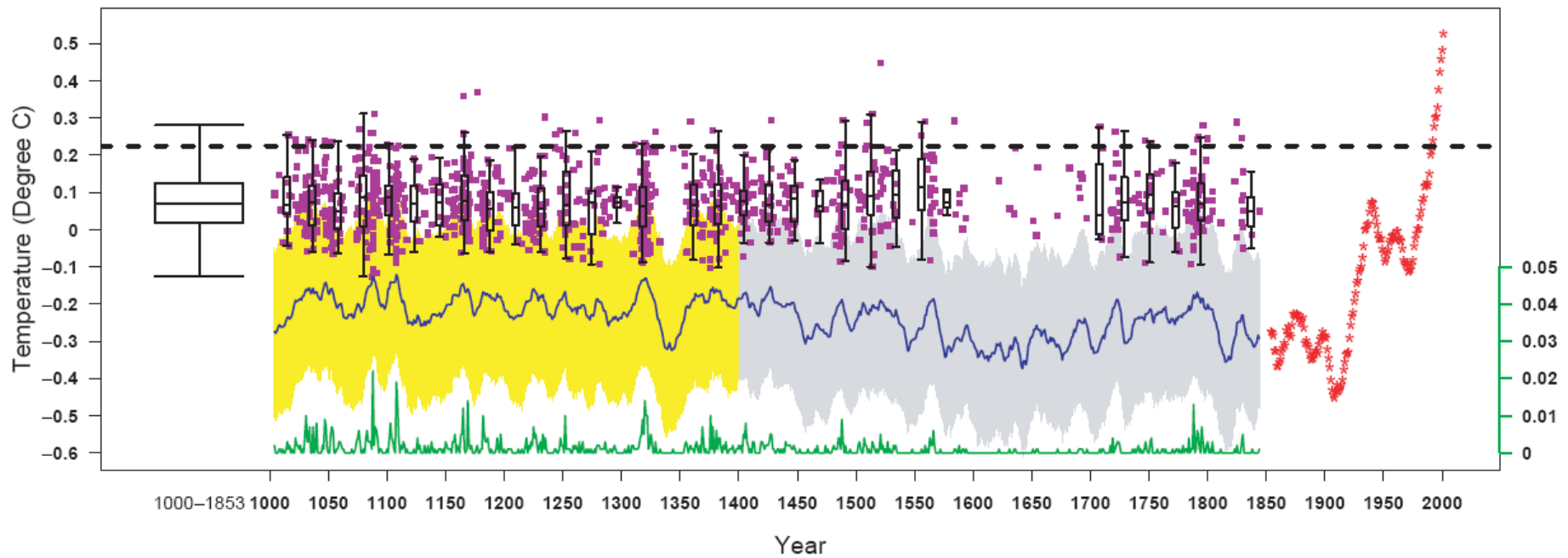
Second Principal Component, Centered to 1902–1980



Second principal component



Reconstruction with 5 principal components, adding directly measured temperatures



A more detailed reconstruction of the temperature signal and uncertainty bands, including the distribution of decadal maxima (purple dots). From Li, Nychka and Ammann (2007).

Conclusion from Tree Rings Analysis

- It's true that the first principal component (correctly calculated) does not show any "hockey stick" shape
- However, when additional principal components are included, the result is similar to MBH
- More refined questions, e.g. whether the 1990s were indeed the warmest decade of the millenium, can be addressed by more sophisticated statistical analyses

Addressing Criticisms of the Scientific Process

- **DATA!:** I believe that the climate science community is already one of the most open about making data available to the rest of the scientific community and the general public.
- However, recent events should lead to some reassessment of whether current data processing and data sharing processes are adequate

Data Policy of the Journal of the American Statistical Association

“Data - Whenever a dataset is used, its source should be fully documented. When it is not practical to include the whole of a dataset in the paper, the paper should state how the complete dataset can be obtained. Unless conditions of security or confidentiality intervene, availability of the data on which the paper is based is a requirement for publication.”

- Many other societies and journals have similar policies
- It is unclear just how rigorously these policies (including ASA's) are enforced in practice
- I believe the scientific community is moving toward greater acceptance of policies of this nature, but there are still many issues associated with doing this on a routine basis

Make Research Data Public?—Not Always So Simple

A Dialogue for Statisticians and Science Editors

Abstract

Putting data into the public domain is not the same thing as making those data accessible for intelligent analysis. A distinguished group of editors and experts who were already engaged in one way or another with the issues inherent in making research data public came together with statisticians to initiate a dialogue about policies and practicalities of requiring published research to be accompanied by publication of the research data. This dialogue carried beyond the broad issues of the advisability, the intellectual integrity, the scientific exigencies to the relevance of these issues to statistics as a discipline and the relevance of statistics, from inference to modeling to data exploration, to science and social science policies on these issues.

Statistical Science, to appear

Peer Review in Scientific Journals and the IPCC

- Peer review is an essential part of the scientific process. it ensures that all results are “quality checked” before appearing in print. It is not a guarantee that all published results are correct, but it is better than any known alternative.
- Climate skeptics should publish their results in scientific journals, not in blogs and other unofficial outlets.
- However, journal editors and reviewers also have their part to play in this. It is important that papers not be rejected simply because they present an unpopular scientific viewpoint.
- I don't believe dissenting scientists are intentionally excluded from IPCC, but there is some perception to that effect

**Thank you for the opportunity to make
these remarks!**