

# Communicating Uncertainty: The phantom hockey stick

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- Surface temperature reconstructions
- The Mann et al reconstruction
- Ensembles
- Independent lines of evidence



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# Paleoclimate temperature reconstructions

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*How do we know temperatures before thermometers?*

Surface temperatures are related to other proxy variables: e.g. tree ring width, lake and marine sediments, corals, ice cores, historical records.

- *Calibrate* the relationship among temperature and proxies when both are measured.
- *Predict* temperature from proxies that are dated from earlier years

# The Hockey Stick

## Northern Hemisphere temperatures 1000AD - 2000AD

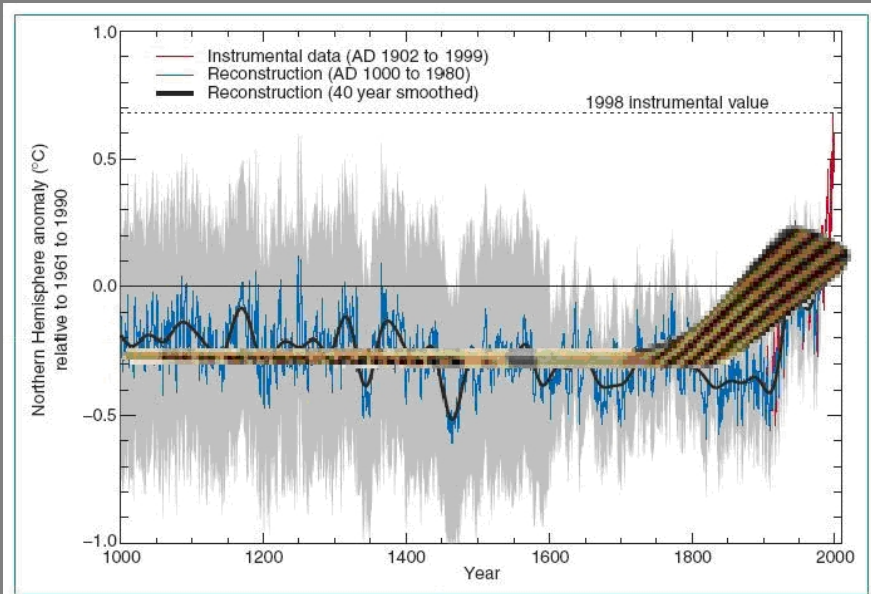
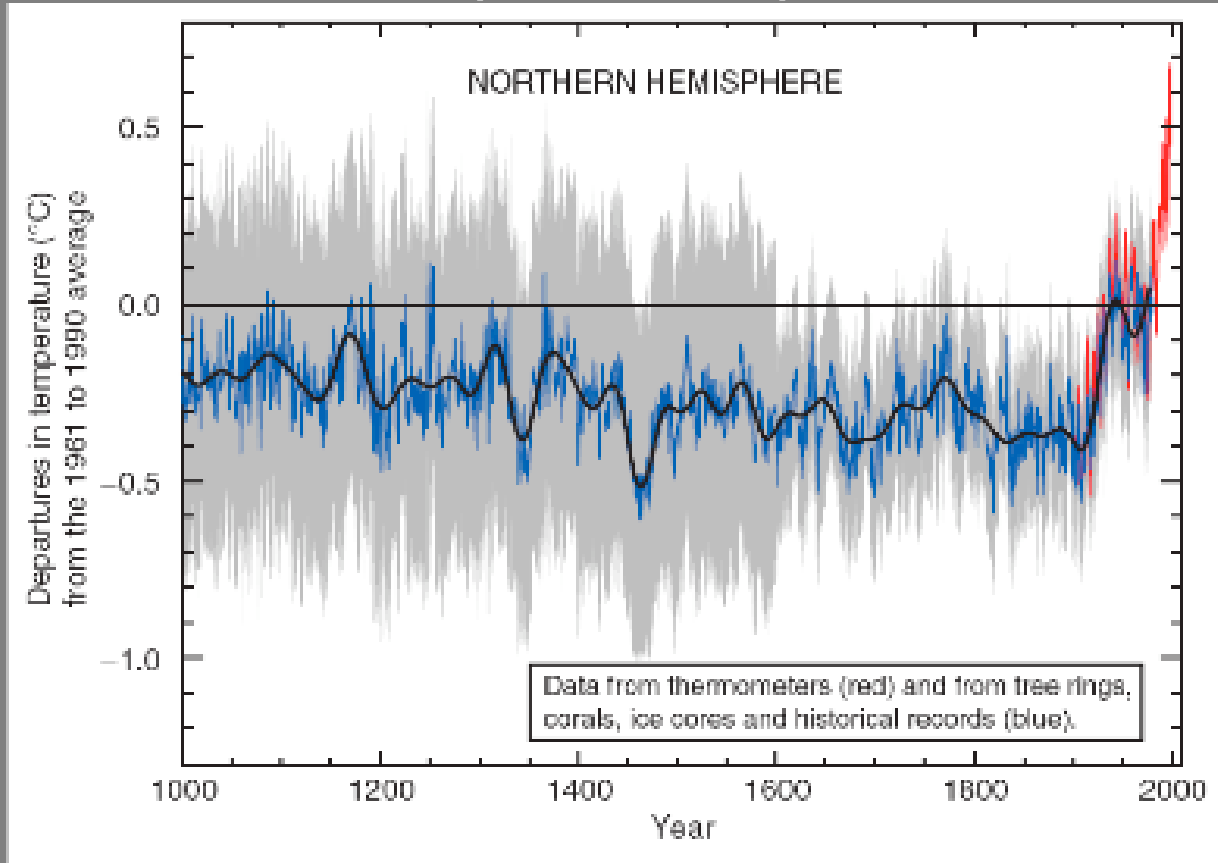


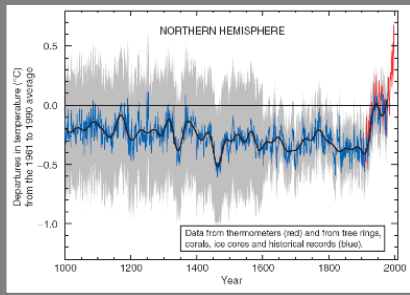
Figure 5: Millennial Northern Hemisphere (NH) temperature reconstruction (blue – tree rings, corals, ice cores, and historical records) and instrumental data (red) from AD 1000 to 1999. Smoother version of NH series (black), and two standard error limits (gray shaded) are shown. [Based on Figure 2.20]

# The Mann et al reconstruction

Northern Hemisphere temperatures 1000AD - 2000AD



Mann, Bradley and Hughes 1998 *Nature*.



Mann et al. (1999)

“... the 1990s are likely the warmest decade, and 1998 the warmest year, in at least a millennium”

- This work became central to the Intergovernmental Panel on Climate Change (IPCC) 2001 report.
- Used informally to argue human influence on climate
- Recently the subject of debate ...
  - Nearly all the contention has centered around the mean curve and not considered the uncertainty in this estimate.*

## Definitions of certainty

The IPCC defines likely as having an estimated confidence of 66 - 90 percent, or better than two-to-one odds.

## *Quantifying uncertainty*

- **The grey area around the hockey stick does not give an idea about shape.**

*At what point are the wiggles due to the proxies not variations in temperature?*

- **Uncertainties are only the statistical ones from a fixed method.**

*What if tree rings respond differently in 1200AD?*

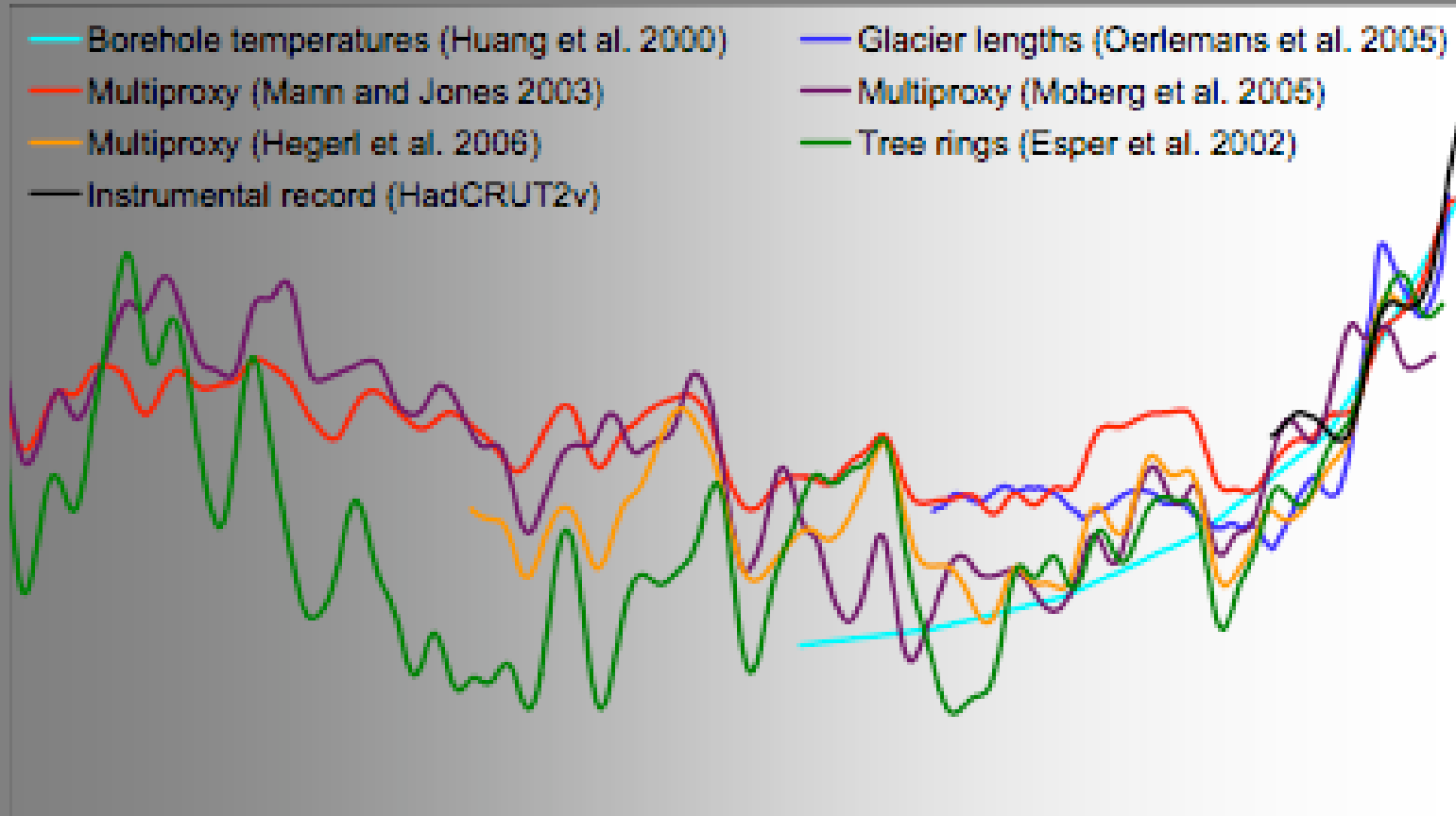
- **Maxima are always tricky ...**

*Little analysis of maximum statistic in Mann work*

# The current state of knowledge?

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## An ensemble of reconstructions

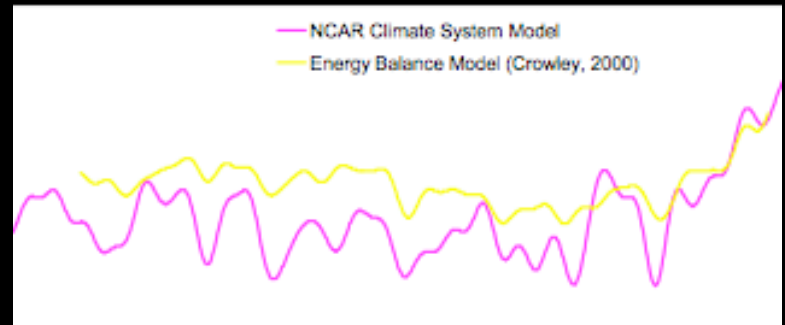
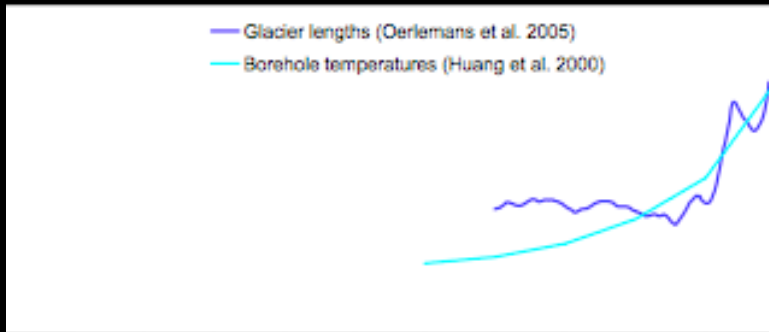
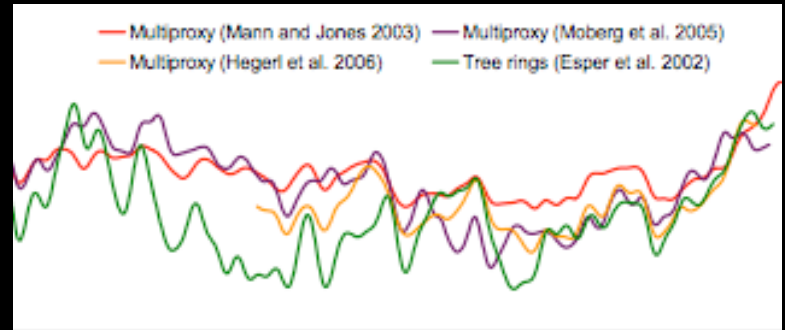
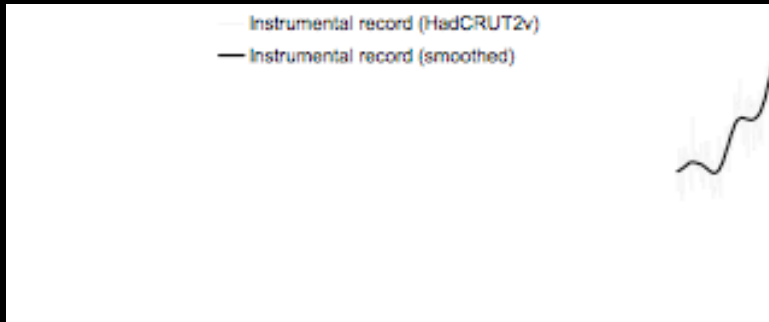




# Separate lines of evidence

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Reducing uncertainty depends on the convergence from distinct sources of information



**Instruments, proxies and numerical models.**

# Summary

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- Uncertainty analysis should be a companion to the estimate
- Uncertainties should address the features of interest — ensembles are often useful for this.
- Uncertainties can be reduced by multiple sources of information.