

The Hockey Stick

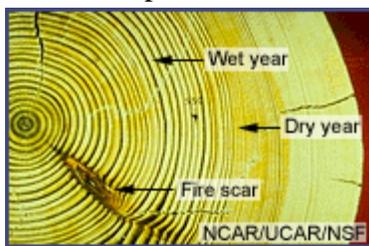
In the world of climate change, considerable attention has been paid to world temperatures in the last 1,000 years. In the past 150 years or so, this has been measured with thermometers. I already mentioned to you the problems in this regard:

1. Are all thermometers accurate?
2. How can we determine accuracy of thermometers no longer available for comparison?
3. Where were the thermometers placed: in a hot, black asphalt covered parking lot or in the shade of a big willow tree, or where a cool breeze blew on them.
4. Do we have enough comparable thermometers in enough places around the Earth to arrive at an accurate world temperature?

Between 1,000 A.D. and 1850 or so A.D., accurate thermometers were not available. Temperatures then are estimated now by using indirect methods such as measuring the growth of trees. In the trunks of trees, a growth ring is produced for each year of life. In the warm, moist spring, big fat cells are produced. By the cool, dry fall, slender, thin cells are produced. Between the cells of fall and those of the next spring a demarcation or growth ring can be observed. The study of tree rings to date trees is known as “dendrochronology” from the Greek word “dendron or δένδρον” for tree and “chronos or χρόνος” for time.

Note that in recent times tree ring data can be checked against data from thermometers to test the accuracy by which tree ring data is converted to actual temperature.

Counting the growth rings can tell us the age of the tree, or at least the age when it died. The thickness of a growth ring tells us whether it was a good or poor year for tree growth. So thicker rings mean more suitable temperatures and more water. By comparing living trees and dead trees of the same species and by studying the characteristics of growth rings for years of which we know growing conditions enables us to estimate temperatures and rainfall for years in the distant past.



Between 1000 and 1850 A.D., tree ring data are often used to estimate global temperatures.

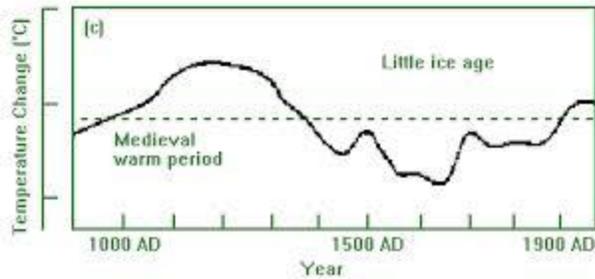
The “hockey stick” is a plot of temperature change against time. Such plots were popularized by climate researcher Michael Mann. They frequently show more or less of a straight line from 1000 A.D. to 1950 or so and then a precipitous rise. Thus the graph looks something like a hockey stick laid on the floor with the short, puck-pushing end rotated up (see graph with hockey stick below).

No one denies that world temperatures have been increasing rapidly for the past half century or so, and the measurements are reasonably accurate since they were made with

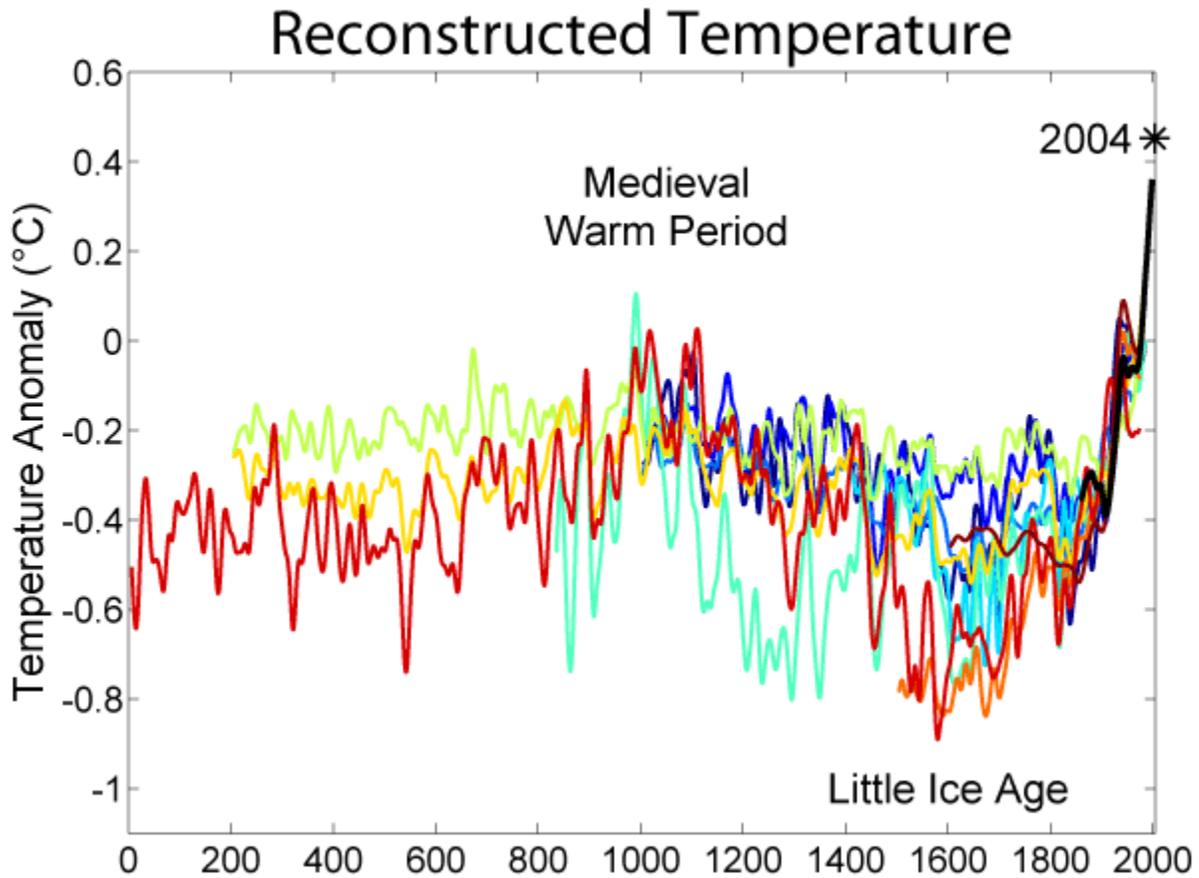
thermometers. However, between 1000 A.D. and around 1850, temperatures are estimated from dendrochronology, growth of coral, percent of heavy oxygen in ice cores, and other direct measurements. To convert these measurements into a graph, various assumptions are made and these are entered into a computer as a formula to convert, say, tree ring data into a graph. This is where problems arise because various formulas can be used.

Historical records and references from literature as well as tree ring and other indirect data all indicate a medieval warm period between 1000 A.D. and 1400 A.D. They also indicate a distinctly cooler period, known as the “Little Ice Age” from between 1400 and 1700 A.D.

Some reconstructions of temperature show these two contrasting periods clearly or not so clearly (see two figures below)

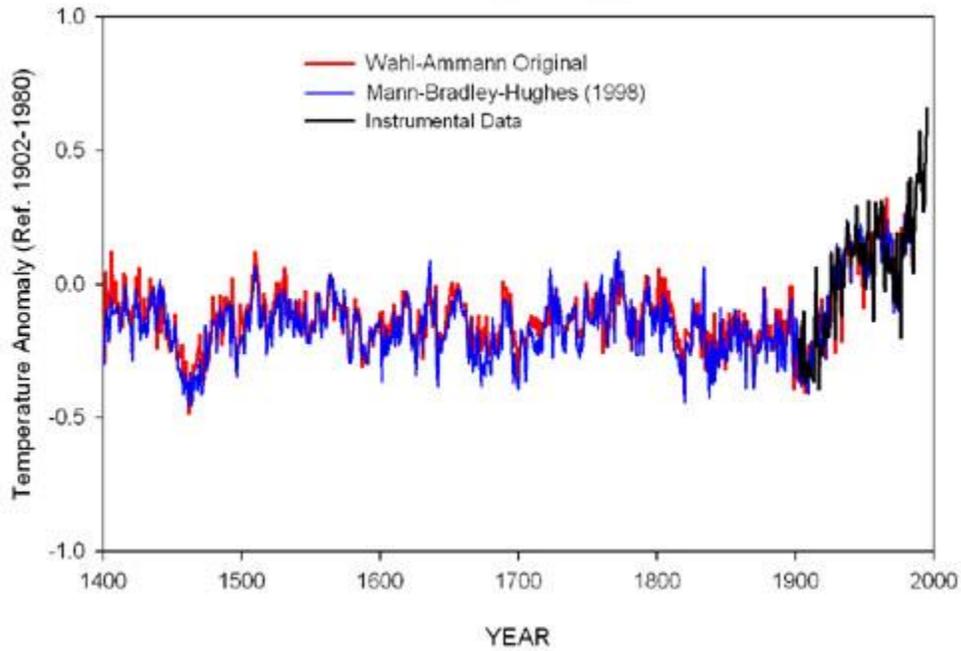


(www.atmos.washington.edu)



(From Wikipedia “Medieval Warm Period”)

Other reconstructions, including Mann’s don’t show the Medieval Warm Period or the Little Ice Age at all although the recent warming trend of the past 50 years is clear (see three figures below).



(From University Corporation for Atmospheric Research.
<http://www.ucar.edu/news/releases/2005>)

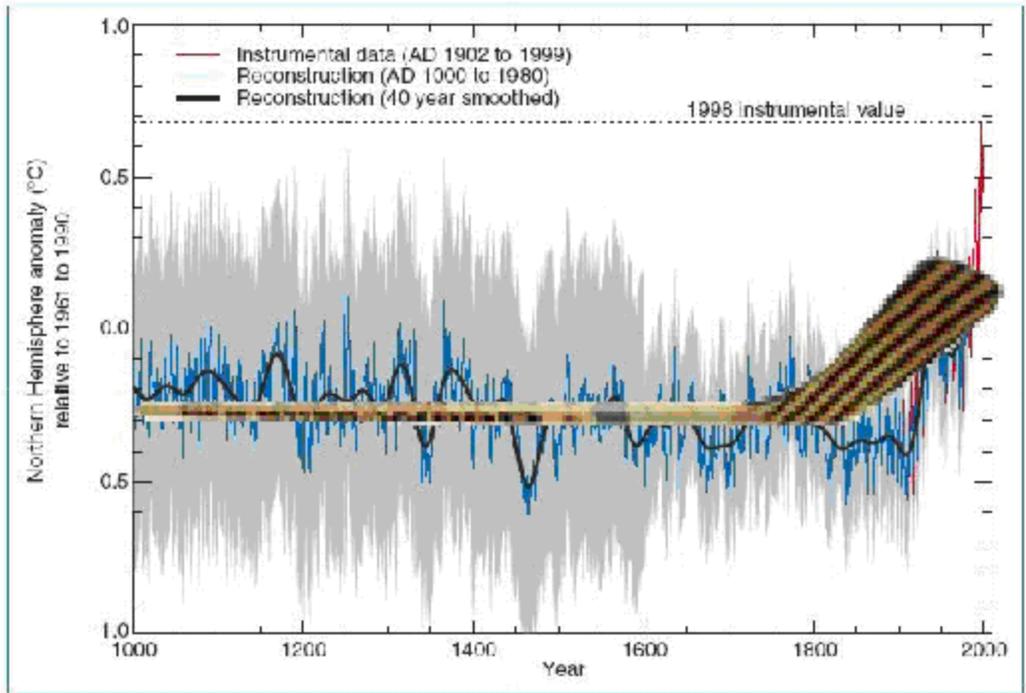
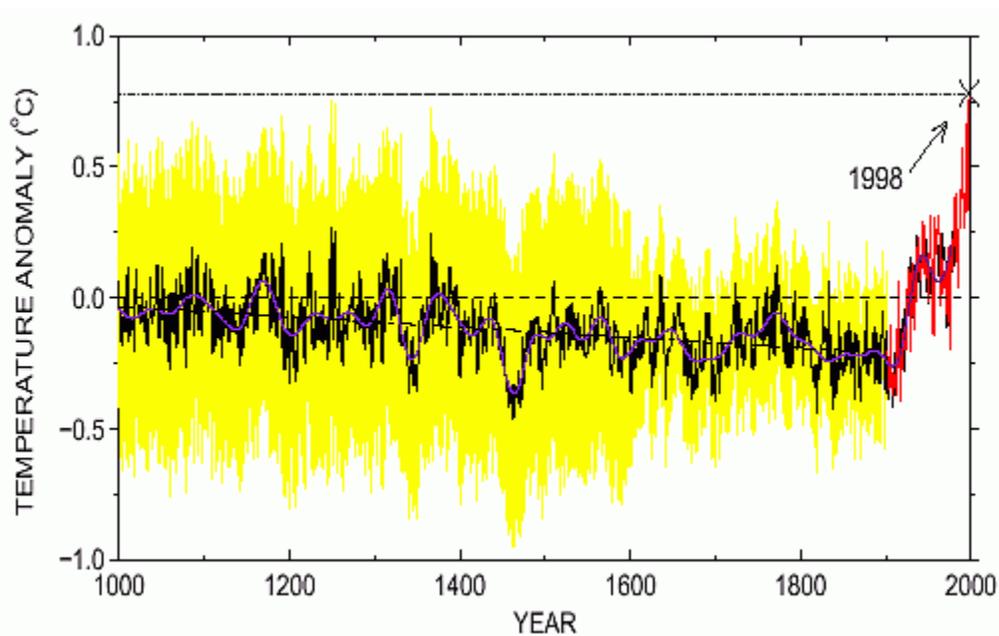


Figure 5. Millennial Northern Hemisphere (NH) temperature reconstruction (blue – tree rings, corals, ice cores, and historical records) and instrumental data (red) from AD 1000 to 1999. Smoother version of NH series (black), and two standard error limits (gray shaded) are shown. [Based on Figure 2.20]

Gray area is the area of 95% probability for the black line.

(From Marlo Lews, Real Climate Spin. Competitive enterprise Institute <http://cei.org>)



(From John L. Daly. The 'Hockey Stick': A new Low in Climate Science. <http://www.john-daly.com>)

Yellow area represents 95% probability for the purple line. You can see that possible variability is quite large.

Part of the controversy swirling around Mann's work is why his reconstructions don't show the Medieval Warm Period and the Little Ice Age even though lots of data of various sorts indicates that they did occur. One answer is that Mann's data and the data of some other investigators indicate that these two anomalies were much more noticeable in Europe than in the world as a whole.

The Hockey Stick has been included in IPCC (Intergovernmental Panel on Climate Change) reports. The latest report (Fifth Assessment Report) was released in 2014. These reports represent the combined efforts of many scientists whose data indicate that world temperature is increasing as a result of human activity that releases CO₂ into the air. They are characterized by climate change deniers as excessively alarmist and as lacking a complete and accurate examination of the facts.

Time, of course, will tell. And that's a problem because before all the skeptics are convinced it will be too late, if they are wrong, to change the results. If IPCC scientists *are* excessively on the side of agreeing that humans are causing dangerous temperature increases as the CO₂ increases then the climate deniers are excessively on the side of denying that humans are causing climate change problems. The disagreement between climate change promoters and deniers have left the range of pure science and become political and personal.

You are encouraged to read Michael Mann's 2012/14 book *The Hockey Stick and the Climate Wars*, in which he covers in detail how the hockey stick graph was determined and in which he discusses and refutes many of the criticisms—including personal attacks and death threats--directed at it. This book should be available from public libraries as well as the usual sources.

Recall that the hockey stick consists of two parts: the rapidly rising part from around 1900 to the present and the long relatively level part from 1000 A.D. to 1900. These, again, correspond to data taken with thermometers and data computed from studies of tree rings and other related sources. All the arguments and discussion of the 1000 to 1900 data are largely irrelevant if the 1950 to present data are correct in showing major increases in temperature. Of course, some climate change deniers claim that Mann's data level out major increases in temperature, *not* due to human activity, that occurred prior to 1950.

Also, please visit Michael Mann's web page for all sorts of articles, diagrams, interviews and recorded talks. http://www.meteo.psu.edu/holocene/public_html/Mann/index.php In April, 2014, he published an article in *Scientific American* entitled "Earth Will Cross the Climate Danger Threshold by 2036."

<http://www.scientificamerican.com/article/earth-will-cross-the-climate-danger-threshold-by-2036/>

In this article he predicts that when CO₂ concentrations in the atmosphere reach 560 parts per million, which is twice the preindustrial level of 280 parts per million, we will have reached the level at which considerable irreparable damage to Earth will inevitably occur. This damage,

for example, will include that caused by melting of the polar ice caps and subsequent catastrophic rises in the levels of oceans. When the CO₂ concentration will reach 560 parts per million depends on which assumptions you make, but he believes it will be around 2036.