

Greenhouse - The Sceptics Strike Back

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The effect of human activities and in particular the burning of fossil fuels on the global climate is one of the most contentious environmental issues being debated at present. There are two sides to this debate. One side, a collection of scientists, environmentalists, politicians and members of the general public believe that we are influencing the global climate in a way that will have serious impacts on ecosystems. These will be referred to as the "greenhouse lobby", for want of a better term. The other side, the "greenhouse sceptics", is a collection of scientists, environmentalists, politicians and members of the general public do not believe that human activities are having such an impact, or that the cost of prevention is greater than the cost of adaptation. The greenhouse debate should resolve this difference, and allow humanity to determine the best course of action for the future, confident that both sides of the argument have been assessed in a rational, scientific manner.

Alas, this is not the case - the debate is not going well. This paper focuses on two recent examples that will illustrate this. The first is the Castles-Henderson critique of the predictions of the Inter-governmental Panel on Climate Change. IPCC is the United Nations body that deals with climate change. It is the father of the Kyoto Protocol. The second is the broken Hockey Stick, which is at the heart of the scientific debate.

The Castles-Henderson critique

Ian Castles is a former head of Australia's Department of Finance and Australian statistician. David Henderson is a former director of the OECD's economic research department. Both have international reputations in their field. They have been highly critical of the projections of global temperatures that underpin the IPCC's policy documents. Now to understand why the comments of a pair of economists have any credibility in the prediction of climate you need to appreciate the elements of the models that are used to predict future temperatures. Figure 1 shows how it is all done.

There are three parts to these models. The ones that we hear the most about are the "General Circulation Models". These attempt to predict temperature using a variety of inputs including the concentration of CO₂ in the atmosphere. There is considerable debate about the value of these GCM's¹ for prediction as they make extensive use of fitted parameters to match past climate data.

The second element of the IPCC model is the bit that predicts the concentration of CO₂. This is done using a dynamic model of the carbon cycle. Figure 2 shows the carbon cycle. Around 750 gigatonnes of carbon (GtC) is stored in the atmosphere. The annual interchange of carbon between oceans and atmosphere is estimated at 90 GtC while the annual interchange between the atmosphere and plant life is about 60 gigatonnes. Annual anthropogenic emissions from the burning of fossil fuels are about 5.5 gigatonnes. The concentration of CO₂ in the atmosphere is rising, and the rate of rise suggests that around 3.3 Gt more CO₂ is entering the atmosphere as leaving. Where the concentration will end up depends upon the net generation of CO₂ by man and the response of the atmosphere via natural negative feedback loops. One is known about already. Higher CO₂ concentrations lead to more rapid plant growth². But the extent of the negative feedback is still uncertain so just knowing the magnitude of the imbalance between CO₂ entering and leaving the atmosphere at any time will not aid in predicting the future concentration of CO₂ in the atmosphere. But the global carbon cycle remains a difficult beast to deal with.

Ian Castles and David Henderson concerned themselves with the last part of the model - the bit that predicts emissions over the forecast period. Emissions are strongly related to economic activity so prediction of emissions becomes a question of predicting the change in global economic activity. Castles and Henderson believed that the IPCC modellers made two key errors. It is all highly technical, but in brief:

- They incorrectly measured the starting point. The problem arises when comparisons between countries are made using foreign exchange rates rather than the generally accepted practice that uses "purchasing power parity". The difference between the two methods is demonstrated every year when The Economist magazine produces its "Big Mac Index" which compares market exchange rates and purchasing power parity using a Big Mac as global yardstick. The IPCC elected to use foreign exchange rates to define the starting point for global growth predictions over the forecast period and as a result may have understated the economic activity in the developing world by a factor of 3.
- The IPCC was optimistic in predicting the rise in output from the developing world. The IPCC modellers assumed that the GDP per person in the developed world will rise by a factor of 5 from 1990 to 2100 - a reasonable annual growth rate of around 1.5%. They then assumed that the GDP per person in the developing world would rise to be within 45% of the GDP per person of the developed world.

Together, these two factors mean that the GDP of the entire developing world must rise by a factor of 65 in the 110 years up to 2100. Whilst this equates to a seemingly modest 3.9% per year, growth at this rate for an extended period and for so much of the world has never been seen before. For instance the rapid growth in Japan during the 20th century only saw a twenty-fold increase in GDP. The bottom line of the Castles-Henderson critique was that the IPCC's low-case scenarios are not low-case scenarios, and that the panel has failed to give a true account of the range of potential outcomes.

The Castles-Henderson critique was published in the journal *Energy and Environment*³. The same issue contained a response by 15 authors associated with the IPCC that sought to defend the panel's projections. This response accused the two critics of bias, bad faith, peddling "deplorable misinformation" and neglecting what the 15 regard as proper procedure. This sort of response from the IPCC and its supporters is seen all the time; they are always written by a large number of co-authors to add strength in numbers, and they always attack the credibility of the critics. And sadly, as is the case here, they fail to answer the case that the critics had argued

Here is an example of an IPCC attack, found in an IPCC press release of December 8 last year.

*"Criticism of IPCC's work has been mounted by so called "two independent commentators" Ian Castles and David Henderson... . Mr Ian Castles is a member of the Lavoisier Group, a group founded in Australia, whose sole mission is to oppose anything that aims to protect the environment."*⁴

The term "*two independent commentators*" in quotes is clearly designed to undermine the credibility of Ian Castles and David Henderson, as is the reference to the Lavoisier Group. The aims of the Lavoisier Group include promoting debate within Australia on greenhouse science and greenhouse policy; and ensuring that the full extent of the economic consequences of the Kyoto Protocol are fully understood by the Australian community. Being associated with such an organisation does not preclude one from raising valid criticisms of IPCC methods. In fact, the senior climate negotiator and special representative of the US State Department, Harlan Watson, described the IPCC press release as "*intemperate and inappropriate*".⁵

The Economist magazine took up the case on behalf of Castles and Henderson. In its edition of Nov 6th 2003⁶, The Economist reviewed the debate about the emissions scenarios and pointed to the IPCC's "*dangerous economic incompetence*". The Economist went further and questioned the peer review process adopted by the IPCC – one that uses a large number of authors and reviewers but ones that are drawn from a narrow professional domain. Economic and statistical expertise is not among their strengths.

How has the IPCC responded to all of this? Regrettably, the IPCC has ignored this criticism and decided in November 2003 that the current scenarios provided "*a credible and sound set of projections, suitable for use in the next assessment report*". It has said that the Castles-Henderson critique is "*totally unfounded*"⁷. This assertion was based largely on modelling work done by Alan Manne of Stanford University and Richard Richels of the Electric Power Research Institute⁸. The paper by Manne and Richels concluded that it makes little difference whether market exchange rates or purchasing power parity is used. In February this year there was a workshop at Stanford University that gave economic modellers a chance to debate the issue. One of the participants, Alan Heston of the University of Pennsylvania, is a leading world expert on international economic comparisons and purchasing power parity. He tore the Manne and Richels paper to pieces, concluding that the only plausible case for using market exchange rates was "*political, not economic*"⁹.

The debate over the economics underpinning the IPCC's temperature predictions continues.

The Broken Hockey Stick

Now for the Hockey Stick. Is it broken or not?

The Hockey Stick first appeared in a paper published 1999¹⁰. The lead author was Michael Mann, a prominent climate scientist. The Hockey Stick is a representation of global temperatures for the past 1000 years. It appeared again in the Third Assessment Report of the Inter-governmental Panel on Climate Change. Michael Mann was a major contributor to this assessment report. Figure 3 shows the Hockey Stick. It combines a record of temperatures for the past thousand years derived primarily from an analysis of tree rings with recent surface temperature records. Tree rings are one of many temperature proxies - geological or biological deposits that have characteristics that can depend upon earlier temperatures. For instance, the thickness of tree rings depends in part on the temperature during the growing season, particularly in colder climates.

The Hockey Stick first appeared in 1999. Yet by 2001, and with little real debate, it had become the generally accepted measure of global temperatures for the past thousand years. This slow but steady decline in temperatures for

the past 1000 years was a dramatic revision of the previously held view of the Earth's recent climate. This prior view looks something like Figure 4 and contained two dominant features:

- There was the Medieval Warm Period (MWP) - that's when the Vikings successfully colonised Greenland.
- There was the Little Ice Age (LIA) - that's when the Thames could freeze over.

With the publishing of the Hockey Stick in the IPCC report, the greenhouse lobby disavowed the Medieval Warm Period and Little Ice Age as global events. It was impossible to say that they did not occur because written history – principally from Northern Europe refers to them. But the argument of the IPCC and others is that these events were limited to northern Europe.

Since it first appeared, some researchers have questioned the Hockey Stick. Some questions relate to the blade – the surface temperature record. Here are some examples.

- The surface temperature record does not match one interpretation of measurements of lower atmospheric temperatures made by satellites. Figure 5 compares the University of Alabama-Huntsville¹¹ dataset with the surface temperature record available from the Hadley Centre for Climate Prediction and Research¹². Note that an alternative interpretation - one by Remote Sensing Systems yields a closer agreement with the surface temperatures.
- However, independent measurements of temperatures in the lower atmosphere derived from weather balloons tend to support the UAH analysis of satellite temperatures¹³.

This discrepancy between the surface and satellite temperature records is particularly problematic because many of the general circulation models explain the surface temperature record but not the satellite record.

The sceptics have fought back, in other areas as well.

The first was to publish alternate records of recent temperatures that paint a different picture. Figure 6 shows one. Jan Esper of the Swiss Federal Research Institute¹⁴ examined tree-ring chronologies from 14 sites in the Northern Hemisphere and showed that the average of these chronologies supports the large-scale occurrence of the MWP over the Northern Hemisphere. There are a couple of interesting things here. First, late 20th century temperatures are not unprecedented. Secondly, the rates of temperature rise we are currently experiencing appear not to be abnormal. Figure 7 presents some data from China¹⁵. It covers the entire “Christian period” as the Chinese authors so eloquently put it. The temperatures were inferred from phenological events such as plant budding or flowering dates from historical and documentary records plus winter snow day records from historical documents. The trend lends weight to the global extent of both the LIA and MWP. It also points to earlier, similar warm and cool periods. The authors of this study also point to the relatively rapid transitions between hot and cold periods.

The second was to examine the literature for other evidence of the LIA and MWP. The key issue here is to demonstrate that the LIA and MWP were global in extent. That they occurred in Europe is not disputed as written history refers to them. Perhaps the most extensive of these reviews was written by Harvard astrophysicist Willie Soon and colleagues¹⁶. The authors reviewed roughly 250 studies and concluded that a large number of local events all happening around the same time suggested that the LIA and MWP were global events, albeit with significant regional variations.

The third approach was a re-appraisal of the analysis carried out by Mann et al. Two Canadians, Stephen McIntyre and Ross McKittrick (M&M)¹⁷ published their results in 2003. The authors found what they felt were a number of faults in the analysis carried out by Mann and associates. These faults related to the inclusion, truncation and omission of data sets in the statistical analysis needed to link different tree ring data sets into a single series. The results were dramatic, as can be seen in Figure 8. The MWP is restored.

But this paper is not about climate science as such; it is about the greenhouse debate. The nature of the debate is well summarised by a comment by Roger Pielke, Jr. from the Center for Science and Technology Policy Research, University of Colorado. The comment related to the paper by Willie Soon et al.

"You'd be challenged, I'd bet, to find someone who supports the Kyoto Protocol and also thinks that this paper is good science, or someone who thinks that the paper is bad science and is opposed to Kyoto"¹⁸

There were responses and rebuttals from both sides, starting with paper written by Michael Mann and 11 other authors¹⁹. This led to a response by Soon et al, and then a rebuttal by Mann and co, and so on. The paper was included in several testimonies to the US Congress including one given by Michael Mann²⁰, who naturally was critical of the paper and also one given by John Christy²¹ in support of the paper. John Christy was Alabama's State Climatologist and had also served as a Lead Author on the IPCC. And finally, the editor who was responsible for

publication was attacked²². One theme that does consistently appear in the criticisms of the Willie Soon paper is this notion that it stands apart from the consensus of scientific opinion. Mann's testimony to the Senate included the statement:

*"Modeling and statistical studies indicate that such anomalous warmth cannot be explained by natural factors but, instead, requires significant anthropogenic (that is, 'human') influences during the 20th century. Such a conclusion is the indisputable **consensus of the community of scientists** actively involved in the research of climate variability and its causes."*

This conveniently ignores the Oregon Petition²³, which urges the US government not to ratify the Kyoto Protocol, and states that:

"There is no convincing scientific evidence that human release of carbon dioxide, methane, or other greenhouse gasses is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate."

To date, more than 17,100 basic and applied American scientists have signed the Petition. The list includes 2,660 physicists, geophysicists, climatologists, meteorologists, oceanographers, and environmental scientists. A further 5,000 are scientists whose fields of specialization in chemistry, biochemistry, biology, and other life sciences make them well qualified to evaluate the effects of carbon dioxide upon the Earth's plant and animal life. There is a debate going on about the validity of the Oregon Petition but it does not alter the fact that a large number of American scientists have added their names to it. There are a few other similar documents:

1. the 1992 "Statement by Atmospheric Scientists on Greenhouse Warming," with more than 100 signatures;
2. the 1992 "Heidelberg Appeal," with more than 4,000 signatures; Although not specifically about climate change, it did call for rational scientific debate about the problems facing humanity.
3. the 1996 "Leipzig Declaration," signed by some 130 prominent U.S. climate scientists, including several who participated in the IPCC.

The response to the publication of M&M's paper was similar in many respects to the response to Willie Soon's paper, in terms of responses and rebuttals from either side. A good record of the communications from either side of the debate can be found at <http://www.uoguelph.ca/~rmckitri/research/trc.html>. Two points are worth particular attention:

- The difficulties that M&M had in obtaining the original dataset used by Mann and co-authors suggested that no other reviewer had asked for this data. So whilst Mann's paper was subjected to peer review, the analysis that led to the key conclusions regarding 20th warming was not. That by itself raises questions about IPCC's scientific process. In an interview, McKittrick said,

"If a study is going to be the basis for a major policy decision, then the original data must be disseminated and the results have to be reproducible. That's why in our case we have posted everything online and invite outside scrutiny."²⁴

- In the correspondence between M&M and Michael Mann, the role of 3 (out of 22) key indicators available in the 15th century portion of the database is discussed. Mann showed that without these series his results would match those of M&M. The discovery that the Hockey Stick is so sensitive to just 3 sets of data suggests that the famous graph lacks robustness.

These are not trivial questions.

History is riddled with cases where the "consensus" view amongst scientists was proved to be wrong. It is the application of the scientific method that protects us against these incorrect views from becoming dogma. However, the scientific method and politics often do not mix. I suggest that this is the problem with climate science.

The climate change and greenhouse debate is highly polarised - this paper focused on two examples. This makes it very difficult for an outsider to assess the true state of temperature changes in recent times. And yet these assessments must be made, as Governments worldwide are now making some of their most expensive policy decisions ever based on uncritical acceptance of a theory that may be decidedly unsound in itself.

¹ "Taken by Storm", has a good discussion of these models. Also see "Modeling climatic effects of anthropogenic carbon dioxide emissions: unknowns and uncertainties" Soon et al, *Climate Research*, V18 (2001) p259

² "Biosphere's Response to Higher CO2", www.greeningearthsociety.org, April 20, 2002

³ "The IPCC Emission Scenarios: An Economic-Statistical Critique", Ian Castles and David Henderson, Energy and Environment, V14, n2&3

⁴ IPCC Press Statement of December 8, 2003

⁵ Reported in "Report from COP-9" at www.globalwarming.org

⁶ "Hot potato revisited", The Economist, November 6, 2003

⁷ IPCC Press Statement of 8 December 2003

⁸ "Market Exchange Rates or Purchasing Power Parity: Does the Choice Make a Difference to the Climate Debate?", Alan S. Manne & Richard G. Richels, AEI-Brookings Joint Center for Regulatory Studies, Working Paper 03-11, September 2003

⁹ Reported in "No future in Kyoto Protocol", The Australian, March 2, 2004

¹⁰ "Northern Hemisphere Temperatures During the Past Millennium: Inferences, Uncertainties, and Limitations", Mann M.E. et al, AGU GRL, V3.1, 1999

¹¹ John Christy and Roy Spencer at the University of Alabama-Huntsville (UAH) maintain a record of satellite-based temperature measurements that begins in January 1979 and is updated monthly. The data set is available at http://www.nsstc.uah.edu/data/msu/t2lt/tltglhmam_5.1 and the trend to date (July 2003) is 0.074 C / decade.

¹² This is available at http://www.met-office.gov.uk/research/hadleycentre/CR_data/Annual/land+sst_web.txt.

¹³ "Global Atmospheric Temperatures: Error Estimates of AMSU/MSU", John Christy, Roy Spencer and Daniel Braswell, 14th Symposium On Global Change And Climate Variations. Also see "Temporal Homogenization of Monthly Radiosonde Temperature Data. Part II: Trends, Sensitivities, and MSU Comparison", John Lanzante, Stephen Klein and Dian Seidel, J. Climate, V16, (2003) p241-262.

¹⁴ "Low-Frequency Signals in Long Tree-Ring Chronologies for Reconstructing Past Temperature Variability", Jan Esper, Edward Cook and Fritz Schweingruber, Science, V295, Issue 5563 (2002) 2250-2253

¹⁵ "Winter half-year temperature reconstruction for the middle and lower reaches of the Yellow River and Yangtze River, China, during the past 2000 years", Ge, Q., J. Zheng, X. Fang, Z. Man, X. Zhang, P. Zhang, and W.-C. Wang. The Holocene, V13, n6 (2003), pp933-940.

¹⁶ "Reconstructing Climatic and Environmental Changes of the Past 1000 Years: A Reappraisal", Willie Soon and Sallie Baliunas, Energy & Environment, March 2003

¹⁷ "Corrections to the Mann et. al. (1998) Proxy Data Base and Northern Hemispheric Average Temperature Series", Stephen McIntyre and Ross McKittrick, Energy & Environment, V14, n6 (2003)

¹⁸ Reported in "Hot Words" by David Appell published in the June 24, 2003 edition of Scientific American.

¹⁹ "On Past Temperatures and Anomalous Late-20th Century Warmth," Mann et al, Eos, V84, n27, (2003), p256.

²⁰ Testimony of Professor Michael E. Mann, University of Virginia, Charlottesville before the U. S. Senate Committee on Environment and Public Works, July 29, 2003

²¹ Testimony of Dr John Christy before the U.S. House of Representatives' Committee on Resources, May 13, 2003.

²² See "Climate study just hot air say critics", New Zealand Herald, August 7, 2003

²³ The Petition Project can be found at <http://www.oism.org/pproject/>

²⁴ Reported in "Researchers question key global-warming study", by Nick Schulz, www.usatoday.com/news/opinion/editorials/2003-10-28-schulz_x.htm.

Figure 1: Predicting temperatures

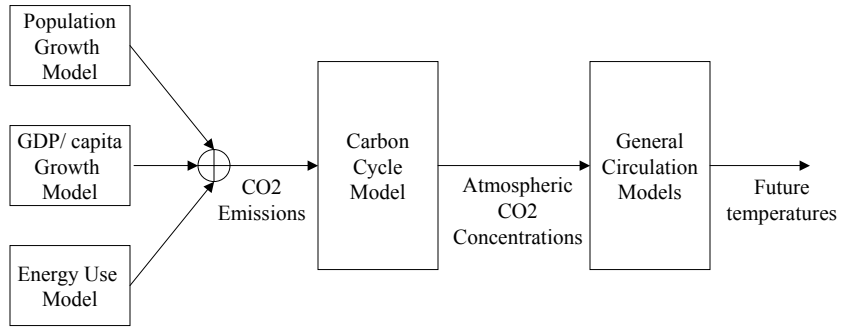
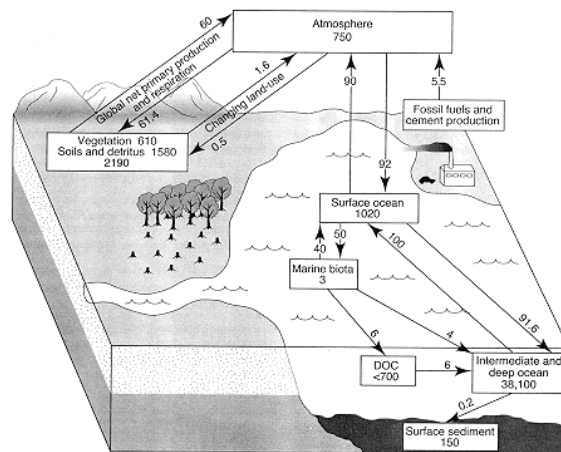


Figure 2: The Global Carbon Cycle



from Schimel, et al. 1995. CO₂ and the carbon cycle.
 In: Climate Change 1994. Cambridge University Press: Cambridge, UK.

Figure 3: The Hockey Stick

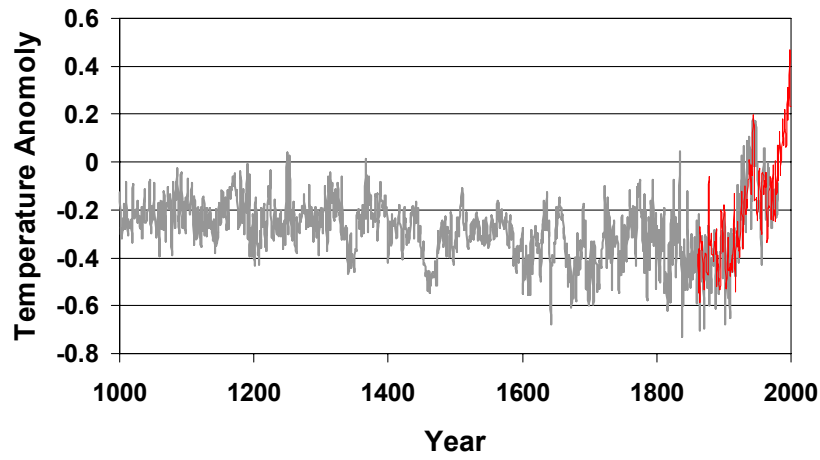


Figure 4: The earlier record

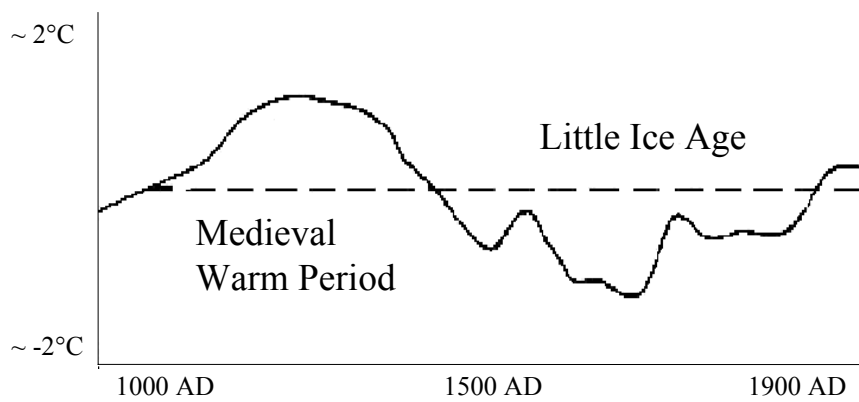
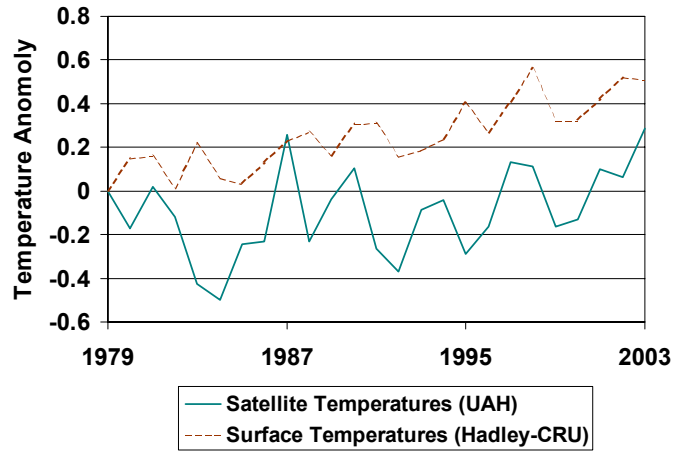


Figure 5: Satellite and surface temperatures compared



Note: Records have been offset to match at 1979

Figure 6: An alternate tree-ring record

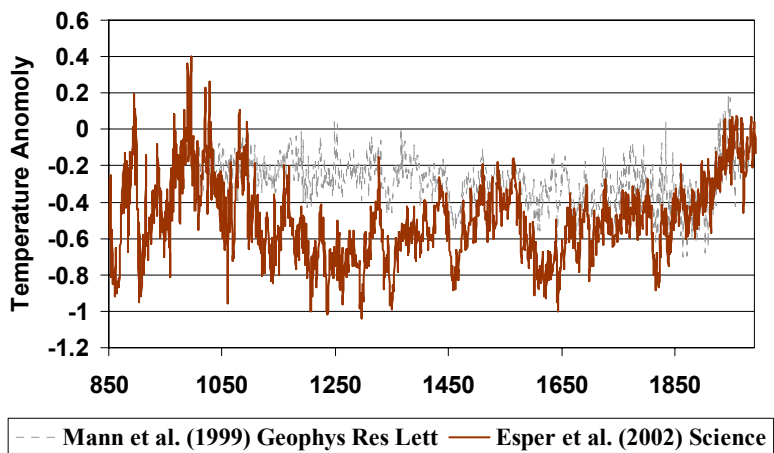
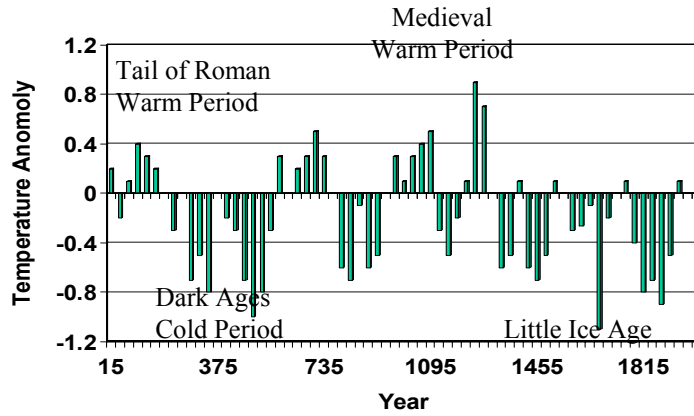
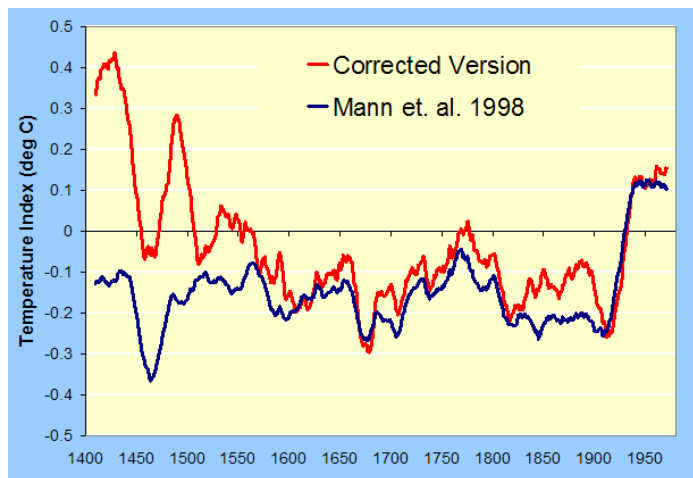


Figure 7: Evidence from China



From: Ge, Q., et al., 2003, East-Central China Winter Half-year Temperature Reconstruction, IGBP PAGES/World Data Center for Paleoclimatology, Data Contribution Series # 2003-090., NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

Figure 8: The broken Hockey Stick



Taken from McIntyre and McKittrick, Energy & Environment, V14, n6 (2003)