

Is the Climate Really Changing Abnormally?

M by Ross McKitrick

any Canadians have heard the striking claim that the 1990s were “very likely” the warmest decade of the millennium, and 1998 was likely the warmest year. This claim was based on a “hockey stick” curve (see figure 1) from the 2001 Report of the UN’s Intergovernmental Panel on Climate Change (IPCC, 2001). The chart used temperature proxies, such as tree ring widths and ice core layering, to create a temperature index that appeared to slowly trail down for 900 years, then suddenly bend upwards around 1900. The graph was originally introduced by researcher Michael Mann and colleagues in 1998, and was extended in a subsequent paper (Mann *et al.*, 1999).

The hockey stick figure featured prominently in reports by the IPCC, appearing not only in figures 2.20 and 2.21 of the 2001 Working Group 1 *Assessment Report*, but also in figure 1 of the *Summary for Policymakers*, figure 5 of the *Technical Summary*, and twice (in figures 2-3 and 91b) in the *Synthesis Report*. Each time the figure is used it is large (sometimes more than half a page) and in bright colour. It is no exaggeration to say that the hockey-stick figure

was the poster-child in the popular case against global warming. The Canadian government also made heavy use of this graph in its arguments for adopting the Kyoto Protocol.

But is it true? That was the question that occurred to Stephen McIntyre, a Canadian businessman involved in financing mineral exploration. In that business, eye-catching graphics are an important tool in raising money, so he knew to be wary of them—things are not always as they seem. McIntyre’s impression of the hockey-stick chart was that it was just another promotional trick of the type that he was used to analyzing in business. Curiosity aroused, McIntyre decided to see how it was put together. It wouldn’t be easy.

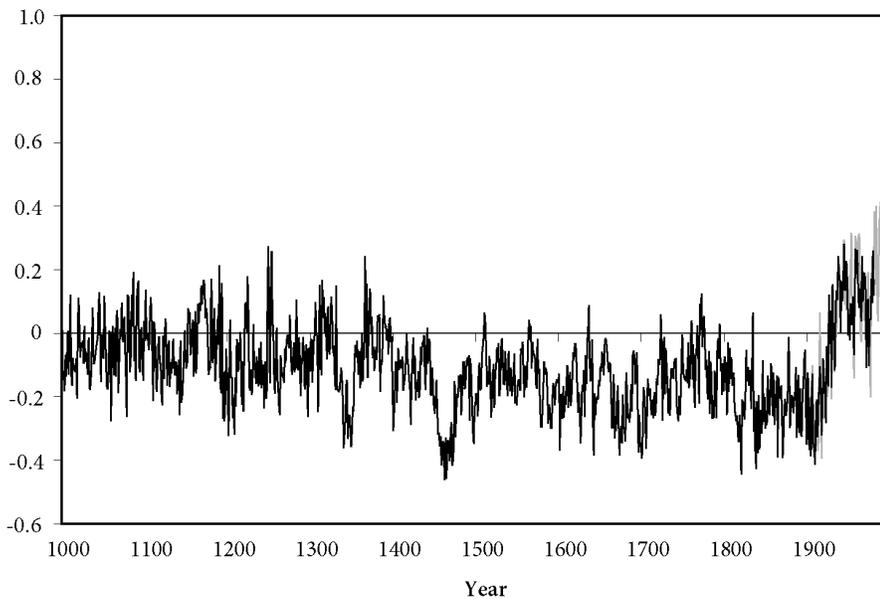
Sorry, wrong numbers

In early 2003, McIntyre contacted Professor Mann and asked him for the data used to produce the hockey stick chart. It took a while for a usable file to be produced, which struck McIntyre as odd. In the finance sector, “due dili-

Ross McKitrick is Associate Professor, Department of Economics, University of Guelph and Senior Fellow at The Fraser Institute.



Figure 1: The Hockey Stick



Temperature index, averaged over the Northern Hemisphere, in °C.
 The black line (1000-1980) is derived from proxy records.
 The grey line (1902-1998) is derived from weather records.

gence packages,” including raw data, are kept at hand to permit independent replication of calculations. So the data should have been available, if, as McIntyre had heard, the IPCC had thousands of the world’s top scientists involved in a rigorous peer review process. But obviously the IPCC never checked the data since they weren’t available, nor were the programs that generated the hockey stick available (and as of this writing most still aren’t).

The hockey stick data are all annual (one observation per year) and consist of temperature proxies of various lengths. All the series begin between 1400 and 1820 and end around 1980. Only 90 series (out of just over 400) go back to 1400. The data used for the final hockey-stick calculations consists of two types. Some are proxy records from individual sites, while some are weighted averages that group multiple sites together. These averages are called “principal compo-

nents (PCs).” The weights are chosen so that the resulting PCs can be ranked in order of importance as to how they explain patterns in the underlying data. The first PC is, by definition, the “dominant” pattern, the second PC is a lesser pattern, and so on through the third, fourth, etc. McIntyre set out to rebuild the graph from scratch, by collecting all the series used as inputs to Mann’s PCs (according to the list in the original article), and using standard statistical software to reproduce the PCs. But the results weren’t even close. Nor could he get any guidance from Mann about what was going wrong.

My collaboration with Stephen McIntyre began in the late summer of 2003. After we published some criticisms of Mann’s data set and results, new details emerged, including an internet archive that contained a small portion of the computer code used to make the hockey stick. In these files

McIntyre discovered why the PCs couldn’t be replicated. Rather than using a standard method for calculating PCs, Mann had applied an unusual data manipulation that distorted the results. The method involved several unreported steps, but the most important one subtracts the average of the final 79 years of the series. Recall that some series go back as far as the year 1400. If you subtract the average of the entire series you create a “centered” series, which has a mean of zero. If you subtract the mean of the ending subsegment you get a “decentered” series, which does not have a mean of zero. But most of the series will still be pretty close to centered, since they don’t trend up or down over their length.

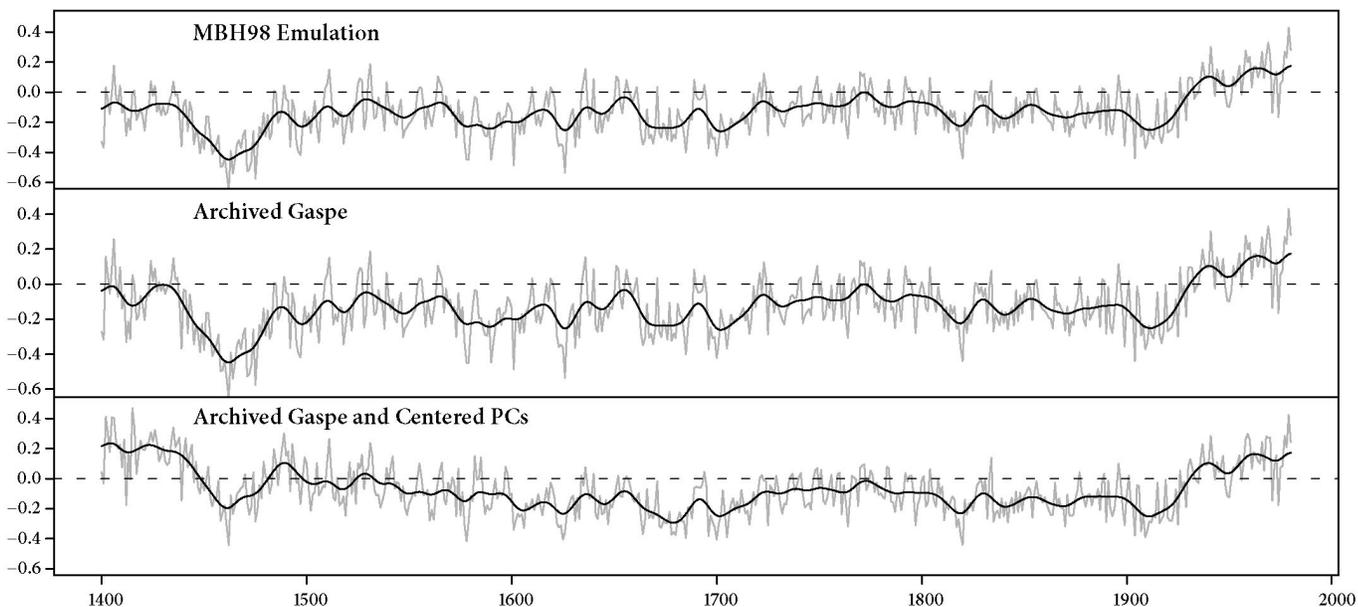
However, there were a handful of proxy series in the data set whose mean does shift in the twentieth century. They were collected in the 1980s by a US tree ring researcher named Donald Graybill, who, with his colleague Sherwood Idso, published a study about them in 1993. The trees they looked at were the long-lived bristlecone pines (all going back to before 1400) from mountainsides in the western USA. They were able to show that a growth spurt

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occurred in the twentieth century that was not due to temperature changes, and they speculated it was due to rising CO₂ levels in the air. While the cause of



Figure 2: “The Bottom Line”



Top Panel: Emulation of proxy portion of hockey stick graph as promoted by IPCC. Middle Panel: after removing extrapolated segment of Gaspé series. Bottom Panel: after using conventional, centered PC methods.

the growth spurt remains debated, no one believes it represents a temperature trend since the local temperature data show no such pattern.

Breaking the hockey stick

Because the Graybill series trend up in the twentieth century, the post-1901 mean is higher than the mean of the entire 1400-1980 length, so they were decentered. Then, Mann’s PC algorithm chose weights that heavily favoured decentered series. The vast majority of data in the analysis does not look like a hockey stick. But the peculiar method Mann used searched out the handful of hockey stick records and put all the weight in the first PC on these. That is, it labeled the

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Graybill hockey stick-shaped series the “dominant pattern,” even though they are not temperature proxies at all, and should not even have been used in the analysis. We have been able to show (McIntyre and McKittrick, 2005b) that a

corrected PC algorithm demotes the hockey stick shape to the status of a minor, local effect, which of course it is. The “dominant pattern” is not a hockey stick at all. Rather, it shows the late twentieth century to be pretty much in the middle of natural climate fluctuations.

There was another odd feature of Mann’s data. One data series, a cedar tree ring record from the Gaspé peninsula, was used twice in the same dataset. The Gaspé cedar record only goes back to 1404 and the data prior to 1447 were known to be unreliable because there were too few trees in the sample. In one usage, the Gaspé series was used back to 1400, with the earliest portion filled by extrapolation. In the other usage, no extrapolation was made and the data weren’t used until 1450. When McIntyre checked he found the extrapolation had a large impact on the final results.

Conclusion

So what's the bottom line? Figure 2 (taken from McIntyre and McKittrick, 2005a) shows three versions of the hockey stick chart. The top panel is our replication of the pre-1980 portion of the IPCC hockey stick graph. The second panel shows the effect of removing the Gaspé extrapolation. Finally, the third panel additionally fixes the PC programming flaw.

By simply correcting two gross errors in the way the IPCC's poster-child chart was created, the original conclusions are overturned. The late twentieth century is no longer climatically unique in comparison to recent history—a finding that refutes a fundamental claim of Kyoto supporters.

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