

Yet another hockey stick scandal

Ross McKittrick

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On March 8, a paper appeared in the prestigious journal *Science* under the title “A reconstruction of regional and global temperature for the past 11,300 years.” Temperature reconstructions are nothing new, but papers claiming to be able to go back so far in time are rare, especially ones that promise global and regional coverage.

Interest in such work is motivated by the need to understand how modern climate changes compare to historical (and presumably natural) variability. This helps identify how much of the recent changes might be attributable to greenhouse gas emissions, and how nature responds to warming and cooling episodes.

The new study, by Shaun Marcott, Jeremy Shakun, Peter Clark and Alan Mix, was based on an analysis of 73 long term proxies, and offered a few interesting results: one familiar (and unremarkable), one odd but probably unimportant, and one new and stunning. The latter was an apparent discovery that 20th century warming was a wild departure from anything seen in over 11,000 years. News of this finding flew around the world (see survey of media coverage elsewhere on this page) and the authors suddenly became the latest in a long line of celebrity climate scientists.

The trouble is, as they quietly admitted over the weekend, their new and stunning claim is groundless. The real story is only just emerging, and it isn't pretty.

The unremarkable finding of the Marcott et al. paper was that the earth's climate history since the end of the last ice age looks roughly like an upside down-U shape, starting cold, warming up for a few thousand years, staying warm through the mid-Holocene (six to nine thousand years ago), then cooling steadily over the past five millennia to the present. This pattern has previously been found in studies using ground boreholes, ice cores and other very long term records, and was shown in the first IPCC report back in 1990. Some studies suggest it was, on average, half a degree warmer than the present, while others have put it at one or even two degrees warmer. A lot of assumptions have to be made to calibrate long term proxy measures to degrees Celsius, so it is not surprising that the scale of the temperature axis is uncertain.

Another familiar feature of long term reconstructions is that the downward-sloping portion has a few large deviations on it. Many show a long, intense warm interval during Roman times 2,000 years ago, and another warm interval during the medieval era, a thousand years ago. They also show a cold episode called the Little Ice Age ending in the early 1800s, followed by the modern warming. But the Marcott et al. graph didn't have these wiggles, instead it showed only a modest mid-Holocene warming and a smooth decline to the late 1800s. This was odd, but probably unimportant, since they also acknowledged using so-called “low frequency” proxies that do not pick up fluctuations on time scales shorter than 300 years. The differences between the scale of their graph and that of others could probably be chalked up to different methods.

The new, and startling, feature of the Marcott graph was at the very end: their data showed a remarkable uptick that implied that, during the 20th century, our climate swung from nearly the coldest conditions over the past 11,500 years to nearly the warmest. Specifically, their analysis

showed that in under 100 years we've had more warming than previously took thousands of years to occur, in the process undoing 5,000 years' worth of cooling.

This uptick became the focus of considerable excitement, as well as scrutiny. One of the first questions was how it was derived. Marcott had finished his Ph.D. thesis at Oregon State University in 2011 and his dissertation is online. The *Science* paper is derived from the fourth chapter, which uses the same 73 proxy records and seemingly identical methods. But there is no uptick in that chart, nor does the abstract to his thesis mention such a finding.

Stephen McIntyre of climateaudit.org began examining the details of the Marcott et al. work, and by March 16 he had made a remarkable discovery. The 73 proxies were all collected by previous researchers, of which 31 are derived from alkenones, an organic compound produced by phytoplankton that settles in layers on ocean floors, and has chemical properties that correlate to temperature. When a core is drilled out, the layers need to be dated. If done accurately, the researcher could then interpret the alkenone layer at, say, 50 cm below the surface, to imply (for example) the ocean temperature averaged 0.1 degrees above normal over several centuries about 1200 years ago. The tops of cores represent the data closest in time to the present, but this layer is often disturbed by the drilling process. So the original researchers take care to date the core-top to where the information begins to become useful.

According to the scientists who originally published the alkenone series, the core tops varied in age from nearly the present to over a thousand years ago. Fewer than 10 of the original proxies had values for the 20th century. Had Marcott et al. used the end dates as calculated by the specialists who compiled the original data, there would have been no 20th century uptick in their graph, as indeed was the case in Marcott's PhD thesis. But Marcott et al. redated a number of core tops, changing the mix of proxies that contribute to the closing value, and this created the uptick at the end of their graph. Far from being a feature of the proxy data, it was an artifact of arbitrarily redating the underlying cores.

Worse, the article did not disclose this step. In their online supplementary information the authors said they had assumed the core tops were dated to the present "unless otherwise noted in the original publication." In other words, they claimed to be relying on the original dating, even while they had redated the cores in a way that strongly influenced their results.

Meanwhile, in a private email to McIntyre, Marcott made a surprising statement. In the paper, they had reported doing an alternate analysis of their proxy data that yielded a much smaller 20th century uptick, but they said the difference was "probably not robust", which implied that the uptick was insensitive to changes in methodology, and was therefore reliable. But in his email to McIntyre, Marcott said the reconstruction *itself* is not robust in the 20th century: a very different thing. When this became public, the Marcott team promised to clear matters up with an online FAQ.

It finally appeared over the weekend, and contains a remarkable admission: "[The] 20th century portion of our paleotemperature stack is not statistically robust, cannot be considered representative of global temperature changes, and therefore is not the basis of any of our conclusions."

Now you tell us. The 20th century uptick was the focus of worldwide media attention, during which the authors made very strong claims about the implications of their findings regarding 20th century warming. Yet at no point did they mention the fact that the 20th century portion of their proxy reconstruction is garbage.

The authors now defend their original claims by saying that if you graft a 20th century thermometer record onto the end of their proxy chart, it exhibits an upward trend much larger in scale than that observed in any 100-year interval in their graph, supporting their original claims. But you can't just graft two completely different temperature series together and draw a conclusion from the fact that they look different.

The modern record is sampled continuously and as a result is able to register short term trends and variability. The proxy model, by the authors' own admission, is heavily smoothed and does not pick up fluctuations below a time scale of several centuries. So the relative smoothness in earlier portions of their graph is not proof that variability never occurred before. If it had, their method would likely not have spotted it.

What made their original conclusion about the exceptional nature of 20th century warming plausible was precisely the fact that it appeared to be picked up both by modern thermometers and by their proxy data. But that was an illusion. It was introduced into their proxy reconstruction as an artifact of arbitrarily redating the end points of a few proxy records.

In recent years there have been a number of cases in which high profile papers from climate scientists turn out, on close inspection, to rely on unseemly tricks, fudges and/or misleading analyses. After they get uncovered in the blogosphere, the academic community rushes to circle the wagons and denounce any criticism as "denialism." There's denialism going on alright--on the part of scientists who don't see that their continuing defence of these kinds of practices exacts a toll on the public credibility of their field.