Validity of "*A Reconstruction of Regional and Global Temperature for the Past 11,300 Years*"
by Marcott, Shakun, Clark, and Mix

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(Note: Because of the far-reaching implications of the conclusions in this paper and the nature of the data, this review will be broken into several segments. This is Part I).

The news media has exploded with extraordinary claims of '*unprecedented* global warming' asserted in a paper "***A Reconstruction of Regional and Global Temperature for the Past 11,300 Years***" by Marcott, Shakun, Clark, and Mix in Science. A NY Times headline reads "*Global Temperatures Highest in 4,000 Years*," and proclaims that global warming will "surpass levels not seen on the planet since before the last ice age."

Here are some of the truly extraordinary assertions in the paper:

1. ***"Current global temperatures of the past decade … are warmer than during ~75% of the Holocene temperature history."***
2. ***"Global mean temperature for the decade 2000–2009 …. are, however, warmer than 82% of the Holocene"***
3. *~0.6°Cof warming from the early Holocene (11,300 yr B.P.) to a temperature plateau extending from 9500 to 5500 yr B.P.. This warm interval is followed by a long-term 0.7°C cooling from 5500 to~100 yr B.P. (Fig. 1B).*
4. *Early Holocene (10,000 to 5000 years ago) warmth is followed by ~0.7°C cooling through the middle to late Holocene (<5000 years ago), culminating in the coolest temperatures of the Holocene during the Little Ice Age, about 200 years ago.*
5. *"Global temperatures are warmer than at any time in at least 4,000 years."*
6. *"Over the coming decades are likely to surpass levels not seen on the planet since before the last ice age."*
7. *"Surface temperature reconstructions of the past 1500 years suggest that recent warming is unprecedented in that time."*
8. *Our global temperature reconstruction for the past 1500 years is indistinguishable within uncertainty from the Mann et al. (2) reconstruction*
9. *A cooling trend from a warm interval (~1500 to 1000 yr B.P.) to a cold interval (~500 to 100 yr B.P.), which is approximately equivalent to the Little Ice Age (Fig.1A). This similarity confirms that published temperature reconstructions of the past two millennia capture long-term variability, despite their short time span (3, 12, 13).*
10. *"Global temperature of the early20th century (1900–1909) was cooler than>95% of the Holocene."*
11. *"Global temperature….. has risen from near the coldest to the warmest levels of the Holocene within the past century*."
12. A heat spike like this has never happened before, at least not in the last 11,300 years. *"If any period in time had a sustained temperature change similar to what we have today we would have certainly seen that in our record. "* It is a good indicator of just how fast made-climate change has progressed. (Marcott quoted on CNN)

They arrived at these conclusions by "*reconstructing regional and global temperature anomalies for the past 11,300 years from 73 globally distributed records*" "*largely derived from marine archives (~80%),"* including paleoclimate temperature proxies such as alkenone, planktonic foraminifera Mg/Ca 23, fossil pollen,

ice-core stable isotopes, and Mann et al. (2008) tree ring reconstructions. Although a list of sources of the data from the 73 sites is provided in an appendix, nowhere is any real data presented, so assessing the validity or accuracy of the original data is not possible without digging out all of the source papers. Just how accurate are these marine temperature reconstructions? We really can't tell without any original data for specific sites. There are two issues here: (1) How accurately can the paleotemperatures be measured, and (2) how accurate is the dating of the material? The accuracy of the paleotemperature measurement depends on the method used and since multiple methods were used, the results are a mixture of varying accuracies. Dating marine fossils (80% of the samples used in the study) depends on radiocarbon measurements, and the marine lag effect. Radiocarbon in marine organisms is generally 400-800 years older than land organisms, so correction factors must be used, and this affects the accuracy of dates.

Eighty percent of the source data sites were marine, so temperatures from 80% of the data set used in this paper record ocean water temperatures, not atmospheric temperatures. Thus, they may reflect temperature changes from ocean upwelling, changes in ocean currents, or any one of a number of ocean variations not related to atmospheric climates. This in itself means that the Marcott et al. temperatures are not a reliable measure of changing atmospheric climate.

The paper consists entirely of complicated computer manipulations of data (definitely not light reading for anyone but computer modelers) and conclusions. As Andy Revkin (Dot Earth) points out, **"*This work is complicated, involving lots of statistical methods in extrapolating from scattered sites to a global picture, which means that there's abundant uncertainty*."**

Without any original data to assess, how can we evaluate the validity of the conclusions? The only way is to check the conclusions against well-established data from other sources. As Richard Feynman eloquently described the scientific method, once hypotheses (conclusions) are set out, their consequences can be checked against experiments or observations. **If a hypothesis (conclusion) disagrees with observations or experiments, it is wrong. It doesn't make any difference how beautiful the hypothesis (conclusion) is, how smart the author is, or what the author's name is, if it disagrees with data, experiments, or observations, it is wrong**. Period. So let us apply this method to the conclusions of this paper and test them to see if they are right or wrong.

First, let's test the Marcott et al. 11,300 year temperature curve against the GISP2 Greenland ice core oxygen isotope record (Alley, 2000) (Figure 1 below). The Greenland ice core data is widely considered to be the 'gold standard' of quantitative paleo-temperature measurements with thousands of accurately dated analyses covering many thousands of years. **From the Alley (2000) curve, it is readily apparent that temperatures during virtually all of the period from 10,000 to 1,500 years ago were warmer than at present and 85% of the past 10,000 years were warmer than present.** The curve extends to 95 years ago, but even if we add 0.7°C for warming over the past century (dashed line), temperatures were still dominantly warmer than present.

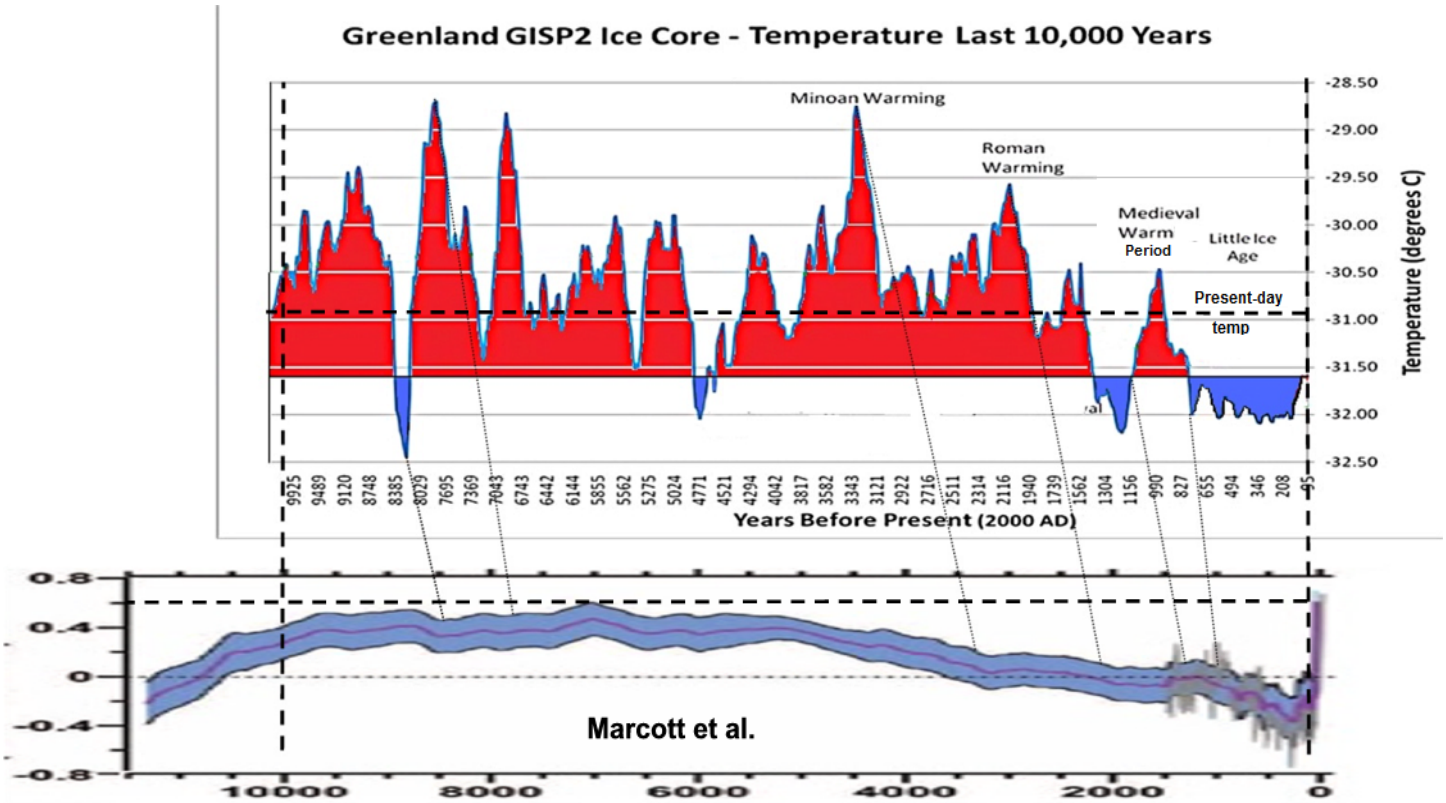

Figure 1. Comparison of Greenland ice core temperatures and Marcott et al. temperatures for the past 10,000 years. (Top curve modified from Alley, 2000 based on data from Cuffy and Clow; bottom curve modified from Marcott et al., 2013)

Let's compare this to the Marcott et al. conclusion *"Current global temperatures of the past decade ... are warmer than during ~75% of the Holocene temperature history"* and *"Global mean temperature for the decade 2000-2009 ....are warmer than 82% of the Holocene"*(lower curve, Figure 1). The Marcott et al. conclusion is totally at odds with the Greenland ice core data. But why should we believe the ice core data rather than the Marcott et al. computer generated curve? Well, the ice core curve is based on thousands of isotope measurements that reflect paleotemperatures and the chronology is accurate to within about 1-3 years, whereas the Marcott et al. curve is essentially based on computer-manipulated data with multiple data types using different technologies with varying accuracy and chronology accurate only within hundreds of years. Marcott et al. assert that this doesn't matter over a period as long as 10,000 years. But, of course, the accuracy of a body of data depends on the sum of the accuracies of its individual components, e.g. you can't claim microscopic accuracy from a bulldozer, no matter how you manipulate the data.

What about the global implications of the Greenland ice core data? The cores come from specific sites on the Greenland ice sheet, so doesn't the data pertain just to those particular places? That's true, but the real question is does it mirror the global climate? The answer to that is definitely yes—correlation of temperatures from the ice cores with global glacial fluctuations is clear and unequivocal. Even small fluctuations of ice core paleo-temperatues can be accurately correlated with advance and retreat of glaciers globally (this topic will be expanded later). In addition, modern Greenland temperatures mimic global temperatures—comparison of temperature records from weather stations in Greenland with global temperatures confirm that Greenland marches in lock step with global climate (Figure 2). Thus, we can conclude that paleo-temperatures in Greenland ice cores are representative of global temperatures.

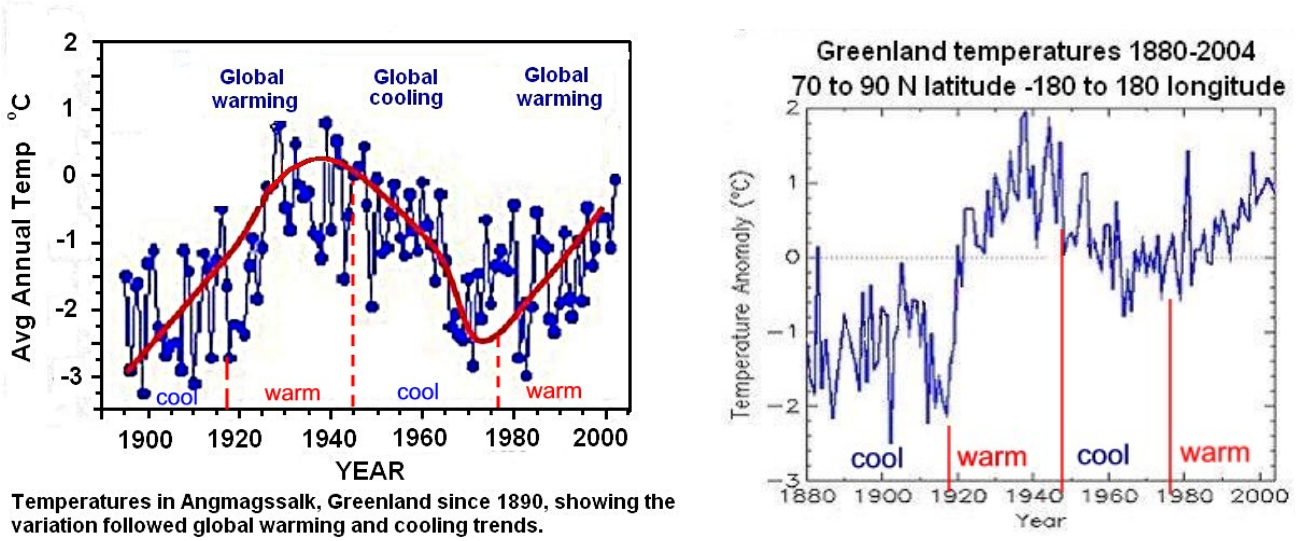

Figure 2. Comparison of Greenland temperatures

Let's look at some specific features of the Marcott et al. curve. As shown in more than 3,000 publications, the Medieval Warm Period (MWP) is widely recognized to have been somewhat warmer than present Figure 1). **In the past 10,000 years, at least six other warm periods of magnitude equal to the MWP occurred; nine other warm periods that were 0.5°C warmer than the MWP occurred; two warm periods that were 1°C warmer than the MWP occurred; and three warm periods that were 1.5°C warmer than the MWP occurred. All of these periods warmer than the MWP clearly contradict the Marcott et al. conclusions.**

The Marcott et al. conclusions that *"Current global temperatures of the past decade … are warmer than during ~75% of the Holocene temperature history"* and *"Global mean temperature for the decade 2000-2009 ….are warmer than 82% of the Holocene"* are clearly contrary to measured, accurate, real-time data and thus fail the Feynman test, i.e., they are wrong.

This rebuttal addresses only part of the Marcott et al. paper. To include analyses of all the issues would take a much longer response, so this is just Part 1. The next part will consider some or all of the remaining conclusions listed at the beginning.

References

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