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Oppositely Directed

Errors and omissions cast doubt on Royal Society's solar study

In their paper, "Recent oppositely directed trends in solar climate forcings and the global mean surface air temperature," authors Mike Lockwood and Claus Fröhlich contend that solar variations have played no part in the observed rise of global surface temperatures during the past 20 years. Indeed, they argue that their measurements of solar variability during the past two decades exhibit trends that are directly opposite to those that would produce warming.

In making this claim, Lockwood and Fröhlich oversimplify, dismiss, and ignore scientific findings that suggest the opposite—that solar changes over the course of the 20th century have contributed to global warming by as much as 25-35 percent. In doing so, Lockwood and Fröhlich's article in *The Proceedings of the Royal Society A* seems to bear more of a dictatorial tone than one of a full and inclusive scientific investigation.

For instance, in characterizing the solar influence of the earth's climate at different timescales, they state, "The Earth's surface air temperature does not respond to the solar cycle. Even a large amplitude modulation would be heavily damped in the global mean temperature record by the long thermal time constants associated with parts of the climate system, in particular the oceans (Wigley & Raper 1990)."

There are, however, a number of papers in the scientific literature that show that the 11-year solar cycle is evident in the earth's surface temperatures. Lockwood and Fröhlich cite none of these papers. For example, a 2005 paper by a research team headed by noted solar researcher Dr. Judith Lean (and sometime co-author of Fröhlich) found:

> Increasingly sophisticated statistical studies of high-fidelity climate, atmospheric, and solar variability time series in recent decades are contributing new knowledge of the Sun's influence on global change. Empirical evidence indicates surface and lower tropospheric temperature changes of order 0.1K (peak-to-peak) associated with the solar activity cycle. The solar signal strength grows with altitude, to 1K at 50 km. Changes in rainfall patterns in tropical regions also exhibit solar cycle periodicities, as do atmospheric ozone concentrations. Multiple regression analysis suggests that the solar influence on global

> change from solar minimum to maximum is comparable to anthropogenic effects over the same 5-year interval.

Lean et al. (2005) also pointed out how the empirical evidence stands in contrast to the modeled results of Wigley and Raper (1990), the very same results that Lockwood and Fröhlich use to dismiss the possibility of the 11-year solar cycle on the earth's temperatures.

> The empirical evidence suggesting a significant (0.1 K) surface temperature response to solar forcing, approximately in-phase with the solar cycle, is inconsistent with current understanding that oceanic thermal inertia strongly dampens (by a factor of 5) forcing at a period of the decadal solar cycle (Wigley and Raper, 1990).

These conclusions by Lean and colleagues are similar to those reported a few years earlier by Douglass and Clader (2002) who found a clear response in surface temperatures to the solar cycle. They, too, report that their findings are at odds with those of Wigley and Raper (1990).

> Our measured value for the response time of a few months is at variance with tens of years estimated in some energy-balance models involving the mixed-layer of the ocean. For example, Wigley and Raper [1990] predict that the sunspot cycle signal would be attenuated to values of 0.02–0.03ºK which is about 30% of what we observe.

Further, research by Scafetta and West confirmed the findings of Lean et al. (2005) and Douglass and Clader (2002) that decadal variations in solar output were imprinted upon global surface temperatures to a measurable degree and that was greater than then that projected by climate models.

> In fact, the 11-year climate sensitivity…is equal to the 11-year climate sensitivity estimated by Douglass and Clader [2002]. Douglass and Clader also estimated that the 11-year solar cycle is associated with a 0.10K temperature cycle and this value is equal to our estimate…see also Lean [2005]. …[O]ur estimate of the 11-year temperature cycle…is approximately 1.5–3 times larger than what these models predict. Douglass and Clader [2002] arrived at a similar conclusion about the Wigley model.

And most recently, Camp and Tung (2007) report that previous efforts, such as those by Douglas and Clader (2002), Lean et al. (2005) and Scafetta and West (2005) actually *under*estimate that impact of the 11-year solar cycle on the earth's surface temperatures. Camp and Tung (2007) conclude:

> We obtained a globally averaged warming of almost 0.2ºK during solar max as compared to solar min, somewhat larger than previously reported. More importantly, we have established that the global-temperature response to the solar cycle is statistically significant at over 95% confidence level.

Figure 1 is taken from Camp and Tung (2007) and illustrates the strong similarity between (detrended) surface temperatures and solar irradiance variations since the late 1950s.

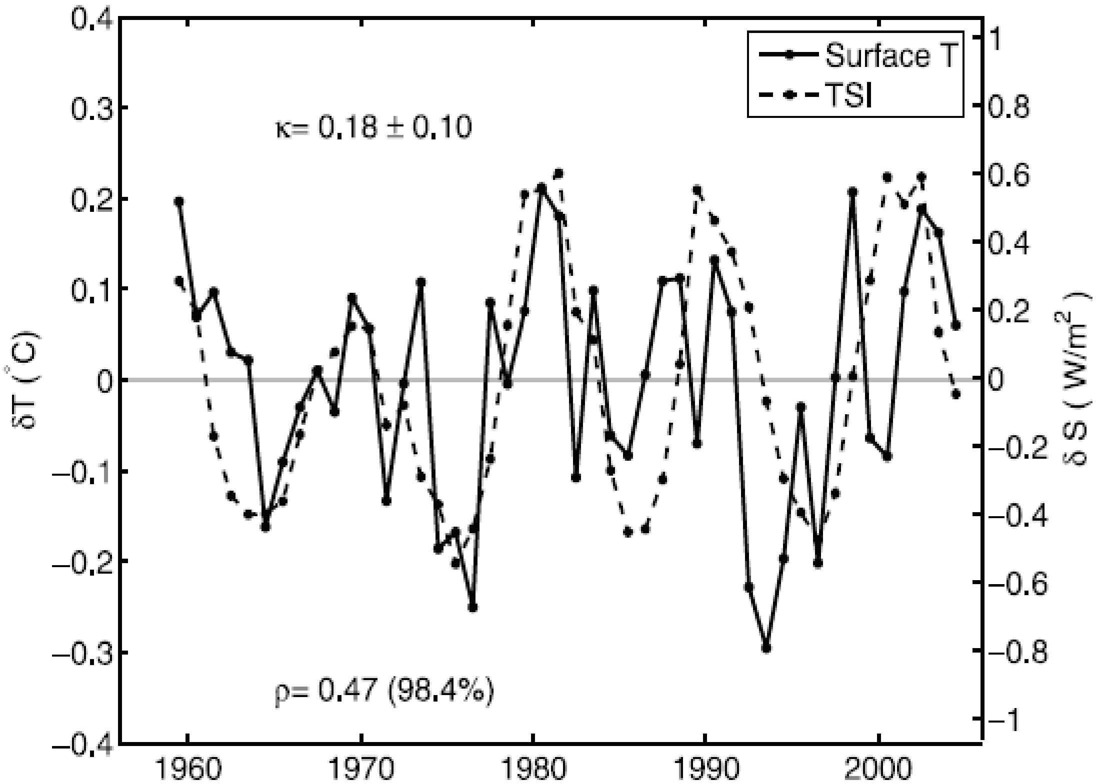

Figure 1. Detrended global surface temperature history (solid line, left-hand scale) and the history of solar irradiance (dashed line, right-hand scale), from 1959-2004 (source: Camp and Tung, 2007).

Thus, the scientific literature is full of papers that have reported a relationship between the 11-yr solar cycle and the earth's temperature. Yet none were cited by Lockwood and Fröhlich. Worse is the fact that with the citation of a lone model result (Wigley and Raper, 1990)—a model result that was specifically shown to be at odds with the observations in each of the works described above—Lockwood and Fröhlich flatly deny that the solar variations over the course of the 11-year solar cycle can influence the temperature of the earth's surface. Such denial, in face of a large body of scientific results to the contrary suggests that Lockwood and Fröhlich ignore evidence when it is inconvenient to their (apparently preconceived) ideas. Such behavior calls into question the overall veracity of their conclusions, as the reader is left to wonder whether or not Lockwood and Fröhlich fairly considered contrasting evidence that may exist.

There are further examples that indicate they did not.

In Scafetta and West (2005), Duke University researchers Nicola Scafetta and Bruce West went beyond calculating the effect of the 11-year solar cycle on the earth's temperatures and investigated whether changes from one solar cycle to the next induces a trend in the earth's temperature. They estimated that from 1980-2002, secular changes in the solar variability (apart from the 11-year cycle) were responsible for somewhere between 10 to 30 percent of the observed rise in the earth's temperature during the same period. In a second study, Scafetta and

West (2006) refined their estimate and found that between 25 and 35 percent of the observed surface warming from 1980 to 2000 could be from solar variability.

Nowhere do Lockwood and Fröhlich refer to these findings—findings from a study designed to test the very concept that Lockwood and Fröhlich examine but whose results run directly contrary to Lockwood and Fröhlich conclusions. Instead, they act as if they don't exist.

Failing to cite other research on the very same problem described in one's own research is simply bad form—not recognizing the effort of those who have come before implies that you are taking all the credit for the scientific idea. It is made worse when omitting research results that are nearly diametrically opposed to your own. In this case, you mislead the reader into thinking that you are telling the only story.

When writing up research results to appear in the scientific literature, you must place those results within the current scientific knowledge base. You do this by citing research work that has come before your own—and describe how your research has taken existing results further, or stands in contrast to earlier work. By ignoring and failing to cite previous work, you provide an unfair and biased picture of the current state of scientific knowledge—and deprive the reader of the tools necessary to accurately assess your contribution to the field.

A reader of Lockwood and Fröhlich would be misled on several accounts. In fact, the omission of key references that tell a different story than the one told by Lockwood and Fröhlich is so obvious and widespread, that one must wonder how the paper got through the review process without a reviewer insisting on the inclusion of previous research results along with a discussion of how and why the new results differ from the existing literature. That this request was either not made or not followed, leaves the informed reader with the distinct impression that it was the purpose of the paper (both of the authors and the editor) to push forward a preset conclusion rather than a fair and honest assessment of how the results of Lockwood and Fröhlich fit in with the existing scientific understanding.

Perhaps Lockwood and Fröhlich results trump all others. Perhaps they have covered all their bases and examined all the angles, but it is impossible to tell. From our review above, we know that there are errors in some of their statements and omissions in their literature citations. Do these oversights invalidate their conclusions? At the very least, they dissuade us from unreserved acceptance.

References

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