FORUM

Pattern of Strange Errors Plagues Solar Activity and Terrestrial Climate Data

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The last decade has seen a revival of various hypotheses claiming a strong correlation between solar activity and a number of terrestrial climate parameters. Links have been made between cosmic rays and cloud cover, first total cloud cover and then only low clouds, and between solar cycle lengths and northern hemisphere land temperatures. These hypotheses play an important role in the scientific debate as well as in the public debate about the possibility or reality of a man-made global climate change.

Analysis of a number of published graphs that have played a major role in these debates and that have been claimed to support solar hypotheses [*Laut*, 2003; *Damon and Peristykh*, 1999, 2004] shows that the apparent strong correlations displayed on these graphs have been obtained by incorrect handling of the physical data. The graphs are still widely referred to in the literature, and their misleading character has not yet been generally recognized. Readers are cautioned against drawing any conclusions, based upon these graphs, concerning the possible wisdom or futility of reducing the emissions of man-made greenhouse gases.

These findings do not by any means rule out the existence of important links between solar activity and terrestrial climate. Such links have been demonstrated by many authors over the years. The sole objective of the present analysis is to draw attention to the fact that some of the widely publicized, apparent correlations do not properly reflect the underlying physical data.

A Pattern of Strange Errors

In 1991, Eigil Friis-Christensen and Knud Lassen published an article in *Science* claiming a "strikingly good agreement" between solar cycle lengths (that is, the fluctuating lengths of the cycles undergone by the number of sunspots) and northern hemisphere land temperatures over the period 1860–1990. The article attracted worldwide attention and is still frequently referred to in the scientific literature; it still plays an important role in the public debate on the possible causes of global climate change. These results were later extended and updated by the same authors in 1995 and 2000, respectively.

However, close analysis of the central graphs in all of these articles reveals questionable handling of the underlying physical data. In the 1991 article, the impressive agreement of the solar curve with terrestrial temperatures during the global warming of the recent decennia had been a major factor in the article's strong impact. But this agreement was actually an artifact: it had simply been obtained by adding, to a heavily smoothed ("filtered") curve, four additional points covering the period of global warming, which were only partially filtered or not filtered at all.

Figure 1a shows northern hemisphere land temperatures (red asterisks) and filtered and nonfiltered solar cycle lengths (blue plus signs). The added four points are marked 1–4. The rationale for adding them without proper filtering was that the proper filtering of these points could not be performed because the observational data necessary for the filtering were not yet available in 1991. So instead of restricting the curve to the proper data that were available at the time, a curve was presented that consisted of different types of data where the agreement with global warming was due to the non-filtered data alone. Today, in the year 2004, more data have become available, and the four points can be plotted more correctly (see Figure 1c, which shows properly filtered solar cycle lengths). Now the sensational agreement with the recent global warming, which drew worldwide attention, has totally disappeared. Nevertheless, the authors and other researchers keep presenting the old misleading graph.

The authors, too, have published an update of Figure 1a [*Lassen and Friis-Christensen*, 2000] using precisely the same data as are used in Figure 1c. However, because of some trivial arithmetic errors, they arrive at a different curve (Figure 1b), a curve that still exhibits some of the originally claimed agreement with the recent global warming. They draw special attention to this agreement, but actually the upward bend of their solar curve is only a consequence of their arithmetic errors. A correct calculation based upon their data leads to Figure 1c.

Also, the article published in 1995 by Lassen and Friis-Christensen, investigating the possible correlation of solar activity and terrestrial temperatures over the extended period of four centuries, contains unacceptable data procedures [*Laut*, 2003].

Damon and Peristykh [1999, 2004] applied the correctly filtered solar cycle lengths. Their

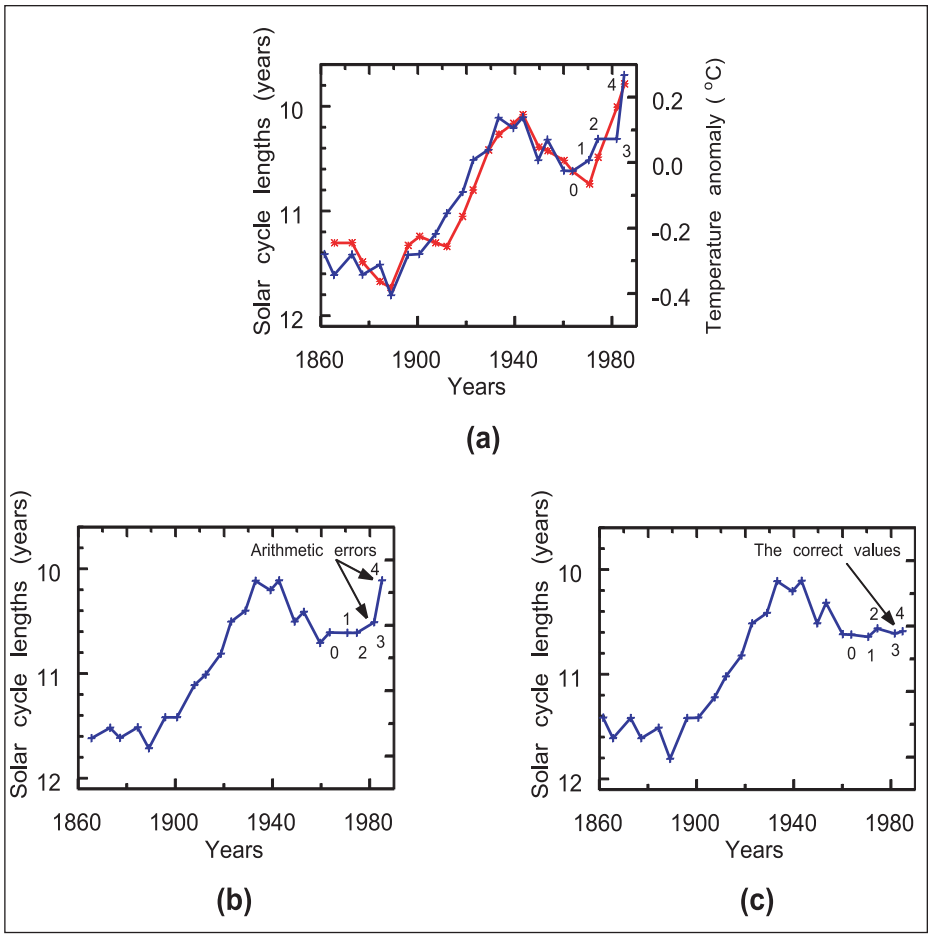

Fig. 1. (a) Solar cycle lengths (blue plus signs) and terrestrial temperatures (red asterisks) as presented by Friis-Christensen and Lassen [1991]. *All points on the solar curve up to the point marked zero represent 1,2,2,2,1-filtered values, the points marked 1 and 2 represent values that are only partially filtered; and the points marked 3 and 4 represent values that are not filtered at all. (b) An update as presented by* Lassen and Friis-Christensen [2000]. *The upward bend of points 3 and 4, corresponding to the recent global warming, is the result of some trivial arithmetic error. (c) The correct update.*

recent update is presented in Figure 2. It shows that the Gleissberg cycle has three maxima within the period covered. The first is slightly higher than the third. The third is the cycle that Friis-Christensen and Lassen correlated with 20th century warming. However, they normalized a single Gleissberg cycle to 20th century temperatures without using paleoclimate as a boundary condition. As pointed out by Damon and Peristykh, this provided them an unwarranted degree of freedom in choosing the solar cycle length (SCL) scale such as to raise the third cycle by approximately 0.2°C. Furthermore, their famous Figure 2 (Figure 1a of this Forum article), which helped them provide the illusion of 95% correlation with the instrumental data, was—as also mentioned above—provided by the use of unfiltered data. Our present Figure 2, which includes filtered data to 1990, does not exhibit any precipitous rise in smoothed SCL after the minimum of the instrumental data at circa. 1970. The results of Damon and Peristykh suggest that the SCL (Gleissberg) contribution to northern hemisphere warming could at most be 25% to 1980 and 15% to 1997.

Other examples of unacceptable handling of observational data are presented by *Svensmark and Friis-Christensen* [1997] and *Svensmark* [1998]. They, too, show a strikingly good agreement of solar and terrestrial data, in this case of the intensity of galactic cosmic radiation (representing solar activity) and total global cloud cover. Again, a close examination reveals a strange data selection. The agreement over a substantial part of the period investigated, i.e. over the last several years, has been obtained by employing data from the U.S. Defense Meteorological Satellite Program that actually do not represent total global cloud cover and therefore do not belong in the context of their analysis. An update with the correct data (from the International Satellite Cloud Climatology Program, ISCCP) shows that the development of total global cloud cover since 1992 has been in clear contradiction to the hypothesis proposed by the authors; that is, it is quite different from the development of the intensity of galactic cosmic radiation [*Laut*, 2003]. A strange detail that becomes apparent when comparing the original 1997 presentation by Svensmark and Friis-Christensen with the 1998 update by Svensmark is that the more recent part of the ISCCP data, which actually conflicted with the hypothesis and which were still shown in the 1997 article, were omitted from the 1998 article.

In 2000, Marsh and Svensmark presented a new hypothesis claiming that it actually is "low cloud cover" rather than "total cloud cover" that exhibits the strong correlation with galactic cosmic ray intensity. They did not mention that the original hypothesis involving total cloud cover in the meantime had been invalidated by observations. When it turned out that the agreement with low cloud cover became poor after 1989, the authors explained the discrepancy by again putting forward a new hypothesis [*Laut*, 2003]. It shall not be discussed here because the question of whether the new claim is right or wrong has no implications for the examples presented here.

Public Impact of Misleading Information

Several of the figures discussed here have attracted worldwide attention. One example of the exploitation of the graphs in the public debate is a 2001 TV documentary, "The Climate Conflict," produced for Danish state television by Lars Mortensen. It featured Henrik Svensmark and Eigil Friis-Christensen as the ingenious mavericks of today's climatology, who discovered the dominant influence of solar activity upon our climate and now fight a stubborn scientific establishment—represented by the United Nations Intergovernmental Panel on Climate Change—and the ruthless proponents of the "so-called greenhouse theory." The film has made a tremendous impact upon public opinion in Denmark and several other countries and is now part of the curriculum in many Danish high schools. It won an impressive series of international awards: Special Prize of H.M. The Prince Rainier III in 2001 at the 41e Festival de Télévision de Monte-Carlo; Best Environmental Film at Téléscience in Montreal 2001; Best Science Film at Telecencia, Portugal; and the Silverserpent at Filmobidos 2001 in Obidos, Portugal. The suggestive basis for the solar claims—as presented personally by Svensmark and Friis-Christensen on the screen—are the misleading graphs from the above mentioned 1991 and 1998 articles.

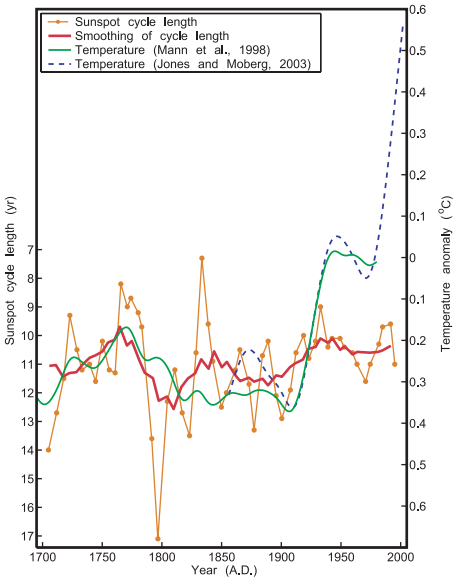

Fig. 2. Comparison of the variation of multiproxy paleotemperature reconstructions and instrumental data with variations of solar cycle length (SCL) is shown. The basic SCL data (orange dots connected by thin orange line) are calculated from epochs of maxima and minima of the sunspot cycle. Note the large variations from ca. 7 to17 yr. These variations are smoothed by Gleissberg's use of a trapezoidal filter with weights of 1,2,2,2,1 (thick red line). The results produce three maxima of what has been referred to as the Gleissberg cycle. Fourier analysis of the INTCAL98 data demonstrates that the 88-year Gleissberg cycle continues for at least 12,000 year [Peristykh and Damon, *2003]*. Mann et al. *[1999] have extended northern hemisphere temperature estimates over the past millennium. If* Friis-Christensen and Lassen *[1991] had been correct, there should have been 11 global warming events during that time equivalent to the contemporaneous event. However, the current event is unique and obviously of anthropogenic origin.*

Acknowledgments

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