

April 27, 2007

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Regarding: “The Great Global Warming Swindle”, broadcast in the UK on Channel 4 on March 8, 2007

We have concerns regarding the use of a graph featured in the documentary titled ‘Temp & Solar Activity 400 Years’. Firstly, we have reason to believe that parts of the graph were made up of fabricated data that were presented as genuine. The inclusion of the artificial data is both misleading and pointless. Secondly, although the narrator commentary during the presentation of the graph is consistent with the conclusions of the paper from which the figure originates, it incorrectly rules out a contribution by anthropogenic greenhouse gases to 20th century global warming. These concerns are detailed below.

1. Fabricated data

The graph is correctly attributed to Svensmark and Christensen, although it originally appeared in a 1995 paper by Lassen and FriisChristensen (L+FC) [*J. Atmos. Terr. Phys.* 57 (8): 835-845(11)]. The graph compares sunspot cycle length to a northern hemisphere land air temperature reconstruction. Figure 1 below is a screenshot from the documentary, alongside the original L+FC graph.

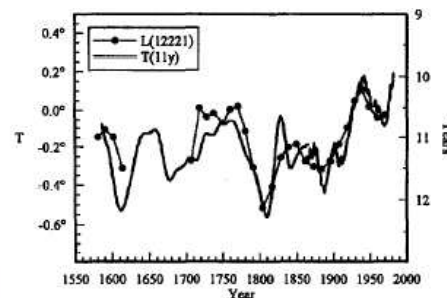
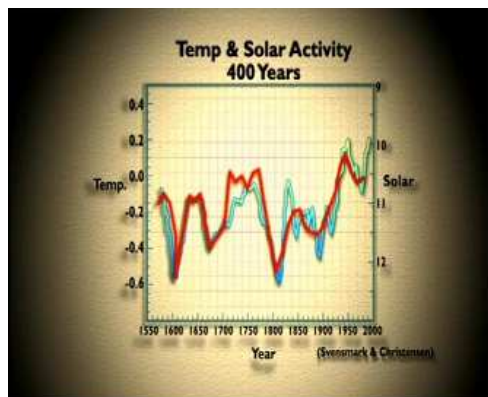


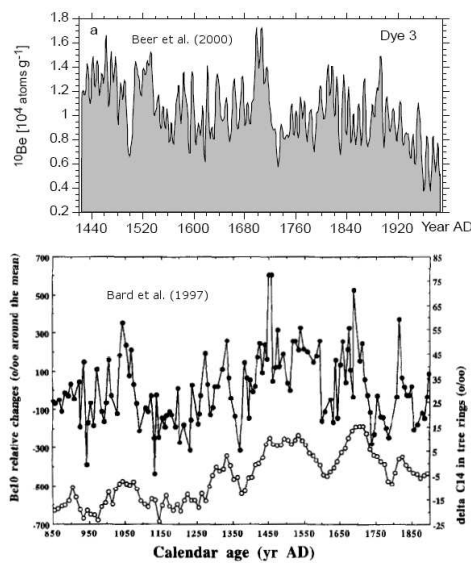
Fig. 6. Eleven-year running average of annual mean values of the northern hemisphere land air temperature 1579–1860 relative to the average temperature 1881–1975, reconstructed by Grovman and Landsberg (1979) together with corresponding values for 1851–1987 relative to 1951–1980 from Jones *et al.* (1986) and Jones (1988). Also plotted is the filtered value (1-2-2-2-1 filter) of the sunspot cycle length.

[Figure 1: Click to enlarge](#)

In the L+FC graph, there exists a gap in the sunspot cycle length curve for the period 1610-1710. This is associated with the Maunder minimum period, which featured few sunspots, and from which obtaining a solar cycle length from sunspots is not possible. However, in the documentary graph, this gap is notably absent. During that period, the solar activity and temperature curves appear to be exactly correlated.

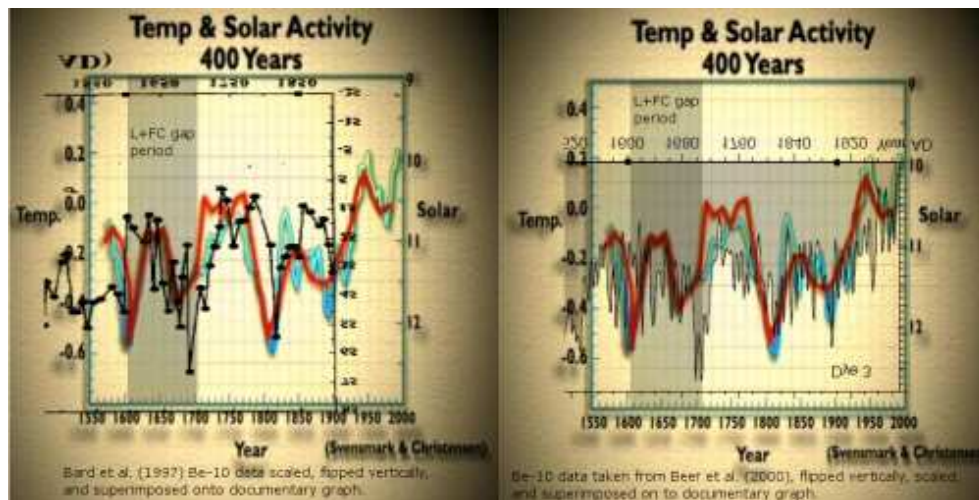
This raises the question of how the gap was filled in. Since Beryllium-10 (Be-10) concentration measurements do in fact show solar activity variations during the Maunder minimum, it is possible that the filmmakers used Be-10 concentration measurements from

ice cores as an indicator of solar cycles. Possible data is found in papers by Beer et al. (2000) [*Space Sci. Rev.* 94: 53–66] and Bard et al. (1997) [*Earth Plan. Sci. Lett.* 150: 453–462] (Figure 2 below).



[Figure 2: Click to enlarge](#)

To examine whether these curves could have been used to fill the L+FC graph we superimpose each Be-10 graph onto the documentary graph (Figure 3 below). However, comparing the Be-10 and filled-in curves, we believe that neither of the Be-10 studies could have been the data source.



[Figure 3: Click to enlarge](#)

Furthermore, the remarkable closeness to which the documentary's 'Solar Activity' trend matches the temperature record for the gap period would be highly fortuitous and unexpected – regardless of the data source. Such a tight correlation is unprecedented elsewhere in the graph and inconsistent with the natural uncertainty of the data. We thus have reason to believe that the gap was simply filled in with artificial data for the program.

If this is the case, the documentary graph artificially overstates the correlation between solar cycle length and this particular northern hemisphere temperature reconstruction over the period 1580-1775.

2. Narrator commentary

While the graph is presented on screen, the narrator makes the following statement:

So Professor Friis-Christensen and his colleagues examined 400 years of astronomical records to compare sun-spot activity against temperature variation. Once again, they found that variations in solar activity were intimately linked to temperature variation on earth. It was the sun, it seemed, not carbon dioxide or anything else that was driving changes in the climate.

Here, the audience is told that the L+FC results demonstrate (a) the sun drove temperature changes over the past 400 years, and (b) no other agents were involved in changing the climate in that time. This is an overstatement that is not supported by the graph, interview statements by Friis-Christensen in the program, nor any related scientific literature. Although solar variations seem to be a major cause of climate variations on centennial and millennial time scales in the pre-industrial era (see for example Bond et al., 2001 [*Science*, 294: 2130-6]), there are certainly other natural sources of climate change. For the industrialised period, the L+FC (and other) results do not exclude an effect from man-made greenhouse gases.

The sunspot cycle length data in the L+FC graph shown on the screen stops in 1975. To demonstrate that both solar activity and temperature increased simultaneously from 1975 to 1985, Friis-Christensen and Lassen in their original 1991 paper included partially filtered and even unfiltered data for the last points in the graph. Updated calculations by Lassen and Friis-Christensen (2000) [*JGR*, 105(A12): 27493-27495] confirmed this trend between 1975 and 1985. However, they also explicitly concluded that after 1985 the temperature continued to rise while the sunspot cycle length flattened out, and thus no longer correlated with surface temperature. This point was not included in the narrator's statement.

In conclusion, the results presented in L+FC graph used by the documentary does not exclude the impact of other climate forcing agents on the climate at any period in the last 400 years, including anthropogenic greenhouse gases. To suggest as much is incorrect. Indeed, the lack of correlation demonstrated by Lassen and Friis-Christensen beyond 1985 (omitted in the program) highlights that there must be other climate forcing agents at work. Alternatively, this could indicate that solar cycle length is not (as is the case for the sunspot number) a perfect descriptor of solar activity associated with climate.

Addendum by Eigil Friis-Christensen:

The last sentence above illustrates the dilemma for the physicist and the limitations of correlation analyses. For a physicist a break down of a correlation where you would expect one is just as – or sometimes even more - informative as a good correlation when it comes to the ultimate goal, which is to understand the physics. Climatologists are more concerned whether the observations fit their preconceived model and prefer to describe solar activity by one single parameter. But solar activity can not be described by a single number. There are many different manifestations of the turbulent and 3-dimensional distribution of energy release from the Sun, and for a physicist the real challenge is to find those parameters of solar activity that best correlate with climate in order to provide a clue regarding the exact physical mechanism that could be responsible for a cause and effect relationship. The present case illustrates how science works. In 1997 the results of a parallel line of research indicated a more direct physical link between solar activity and climate (Svensmark and Friis-Christensen, 1997 [*Journ. Atm. Sol. Terr. Phys.*, 59:1225-32]). This result was later refined with more and better observations and documented that during the last two solar cycles there is a very good correlation between the solar modulation of the cosmic rays and the low altitude cloud cover (Marsh and Svensmark, 2000 [*Space Science Review*, 94: 215-30]). So therefore, and in spite of the fact that the solar cycle length seemed not to explain the most recent temperature increase after 1985, solar variations still do have direct effect on important climate parameters. How large this effect may be on the global temperature is currently being investigated, and is outside the scope of this comment. But there is no reason

to neglect a contribution from man made greenhouse gases. The question is how much. Only increased understanding of the physical processes can give us the answer.