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Scientists Take Issue With Solar Innocence

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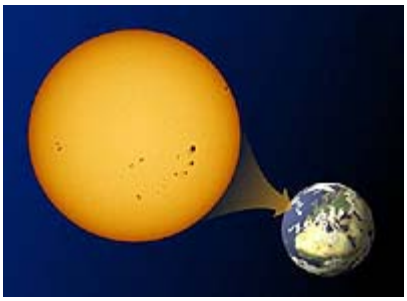

illustration only

Following an article published in the UK science magazine *New Scientist*, a group of solar physicists have taken issue with the article's slant that the Sun is not to blame for global warming.

The scientists further argue that the original article was misinterupted as suggesting the sun does not play a key role in our recent detection of global warming.

Paal Brekke a solar physicist with the SOHO project told SpaceDaily that there is growing evidence that the sun and its relationship with the ebb and flow of cosmic rays is responsible for a substantial portion of the increase in global tempurates.

In an article published on the University of Oslo website Paal Brekke and Nigel Marsh provide details on the growing evidence that Cosmic Rays have a significant influence on the Earth's cloud cover and reprinted with the permission of the authors.

In a scientific report from the Danish Meteorological Institute (Report 99-9) Thejll and Lassen revisit the correlation between the sunspot cycle and Northern Hemisphere temperature trends.

They conclude that the solar forcing that is described by the solar cycle length model no longer dominates the long-term variation of the land air temperature.

Their result was presented in New Scientist on 6 May 2000 with the title "Don't blame the Sun" and the opening words: "Greenhouse effect sceptics may have lost their final excuse". This short article will try to clarify a few facts about these statements.

First of all, it is striking that the journalist uses the forceful language mentioned, when one compares it with the more cautious last quote from Thejll: "We're now seeing that the Sun plays a role, and something in addition to the Sun". We interpret this to mean that the Sun is still an important contributor to the temperature trends.

The results referred to in the New Scientist article have not yet been published in the peer-reviewed literature. Nevertheless they were presented in a press release and they made news in the media.

The central proposition, that the temperature no longer follows the cycle length, is not new. Henrik Svensmark published a similar figure as in New Scientist more than a year ago (see Figure 3 in his paper, Physical Review Letters, 81, p. 5027, 1998.).

Svensmark stated that the long-term trend of cosmic-ray variation follows the warming trend better that either the sunspot number or the solar cycle length (the latter deviates in the last few years).

The results from Thejll and Lassen cannot be used to conclude anything about the relationship between the Sun and the climate. Obviously the Sun's behaviour is much more complex than sunspots alone can show.

We now know that the Sun's interplanetary magnetic field and the solar wind have increased by a factor 2 the last 100 years, and this variation does not follow the variation in sunspots.

Recently it was found that the Earth's cloud cover, observed by satellites, is strongly correlated with galactic cosmic-ray flux. One interpretation is that the cosmic rays are the dominant source of ions in the free troposphere and stratosphere. These ions may grow via clustering to form aerosol particles, which may ultimately become cloud condensation nuclei and thereby seed clouds.

Clouds influence vertically integrated radiative properties of the atmosphere, both by cooling through reflection of incoming short-wave radiation (sunlight), and heating through trapping of outgoing long-wave radiation (thermal radiation).

The net radiative impact of a particular cloud mainly depends upon its height above the surface and its optical thickness. High optically thin clouds tend to warm, while low optically thick clouds tend to cool it. With a current estimate for the net climatic forcing of the global cloud cover as a cooling of 17- 35 W/m2, clouds play an important role in the Earth's radiation budget. Any significant solar influence on global cloud properties can potentially be very important for Earth's climate.

To summarize, the pattern of systematic change in the global climate over recorded history seems to follow the observed changes in cosmic-ray flux, and it is consistent with the explanation that a low cosmic-ray flux corresponds to fewer clouds and a warmer climate, and vice versa. There was a systematic decrease in the cosmic-ray flux by about 15% over the course of the last century, caused by a doubling of the solar coronal-source magnetic flux.

By reconstructing cloud cover from the cosmic ray flux and using the estimates for cloud radiative forcing, one can infer form Svensmark 1998 a warming of approximately 1.5 W/m2, over the past century (1901-1995).

This is potentially important, considering that over the same period the estimated heating from increased CO2 emission is 1.5 W/m2, while changes in the solar irradiance at Earth

are said to be 0.4 W/m2 (Lockwood and Stamper, Nature, 399, p. 437, 1999).

Whether the global warming trend recently measured is dominated by anthropogenic effects or has a significant or even dominant solar component is not yet understood.

The climate of the future will be the sum of man-made and natural variations, but the man-made part cannot be estimated reliably until the contributions of natural agents (Sun, volcanoes, El Nino) have been defined, and subtracted from the observed changes of the past 100 years. This figure shows the IPCC estimates from the global annual averaged radiative forcing due to changes in anthropogenic greenhouse gases and areosols from 1850-1992 (first seven columns of the figure).

Positive forcings leads to a warming and negative forcings cause a cooling. Natural changes due to the Sun are indicated by the final two columns; the first is the IPCC estimate of changes in solar output over the same period and the second is an additional column (taken from the CLOUD proposal at CERN - which includes the influence of galactic cosmic rays on cloud formation.

A small systematic rise or fall in the global temperature is caused by a net imbalance ("forcing") in the Earth's energy radiation budget. The radiative forcing caused by the increase in CO2 fraction since 1750 is estimated to be 1.5 W/m2, compared to the global average incoming ratiation of 342 W/m2, i.e. an imbalance of only 0.4%.

After including the effects of all greenhouse gases (+2.45 W/m2), areosols (-0.5 W/m2) and their indirect influence on clouds (-0.75 W/m2, but poorly known), the present net radiative forcing from mankind is estimated to be about 1.2 W/m2.