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Past Solar Irradiance Variations



Sun, Earth and Sky, Springer-Verlag)

Hunters in the Snow, 1565. During the prolonged period between 1500 and 1850, average temperatures in Northern Europe were much colder than they are today. This chilly spell, known as the little Ice Age, lives on in this painting by Pieter Bruegel the Elder. The coldest part of this period coincides with a conspicuous absence of sunspots and other signs of solar activity, called the Maunder Minimum. (from Kenneth R. Lang, 1995,

There is an urgent need for detailed studies of the effect of man-made greenhouse gases on the Earth's atmosphere and climate. One of the unknown boundary conditions for models of the evolution of the Earth's climate is the magnitude of the variation of the solar irradiance (i.e. the total solar brightness measured at mean Sun-Earth distance).

From spacecraft-based measurements (Fig.1) of the total solar irradiance it has been established that this quantity is closely related to the Sun's magnetic activity. In addition, a good correlation is found between indirect indicators of solar magnetic activity and various terrestrial temperature indicators over timescales of thousands of years (Fig.2), and an excellent correlation is seen between certain parameters of solar activity and the air temperature over land masses in the northern hemisphere on solar cycle timescales in this century (Fig.3).

The magnitude of the contribution of solar luminosity variations to global change, however, has been the subject of considerable debate. The measured irradiance variability of 0.1% during the recent Schwabe (11-year) cycle (Fig.1) is too small to account for the observed global warming during the past century (of about 0.6°) alone, provided that current models do not underestimate the sensitivity of Earth's climat system to solar radiative forcing.

Several proxies of solar irradiance suggest that the sun has undergone periods of extraordinary low activity (Fig.2). Most popular is the so-called Maunder Minimum which coincides with a period of unusually low average temperatures in Northern Europe, know as the little Ice Age (see picture on top of page). Measurements of

stellar Ca emission (a proxy for magnetic activity) of sun-like stars ([Fig.4](#)) led to the conclusion that solar irradiance may have been reduced by up to 0.24% relative to the present day mean, during these periods. Such an extension of the range of solar irradiance variations puts the hypothesis of a direct connection to terrestrial climate on a much firmer footing.

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Further readings:

[M. Fligge, S.K. Solanki, 1997, *Solar Physics*, 173\(2\), 427](#)



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