ON THE FLUCTUATIONS OF THE TOTAL SOLAR IRRADIANCE

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The fundamental quantity for the total solar irradiance is the solar constant J which is determined by the mean Sun-Earth distance and by the energy budget in the interior of the sun. The mean distance is the major semi-axis of the earth orbit and therefore a constant of celestial mechanics. The energy production and transport in the interior of the sun must be constant at least during a Helmholtz-Kelvin period. Actually, the heat budget of the sun is constant during some billion years.

These theoretical expectations are in good correspondence to the measurements of the absolute solar constant J during the last 12 years. The observed variations of the total solar constant have relative magnitudes $\frac{\Delta J}{J}$ of some point of one promill only (Fröhlich 1977, 1987). These variations involve statistical fluctuations over time scales of minutes and long terms with periods of the solar activity $T \approx 11$ years (Reid 1991).

The long-term variations are caused by the periodical increase and reduction of vorticity and magnetic fields in the solar convection zone. The dynamical and magnetical energies of these fields come from the energy of the heat current from the interior to the solar's atmosphere. The reduction of the solar activity means an additional transfer of dynamical and magnetical energy in heat and therefore an additional contribution to the energy of the heat radiation.

The formation of the coupled magnetic and vorticity fields during the time of increasing solar activity is a negative source and the breakdown of these fields during the times of decrease is a positive source of heat energy. At the extreme of the periodical activity these transfer processes are not likely and the actual value of J is its mean value $J = J_o$.

A solar cycle starts with a minimum of activity at which all heat transported from the interior to solar's atmosphere becomes radiation energy (phase$\varphi = 0$, with $J = J_o$). For $0 < \varphi < \pi$ a small part of the heat energy converts into the magnetical and dynamical energy of sunspots and the radiation energy is smaller than the mean value ($J < J_o$). At the activity maximum ($\varphi = \pi$) this energy conversion is stopped ($J = J_o$) and will be turned. In the phase $\pi < \varphi < 2\pi$ the magnetical and dynamical energy of the activity centres convert into heat and the solar radiation becomes larger than the mean value ($J > J_o$). An approximation formula is $J = J_o - \Delta J \sin\varphi$ (with maximal variation ΔJ). The mean (total) solar irradiance is a constant given by J_o and independing on the solar activity.

References

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