CLIMATE, SECULAR CHANGES IN ORBIT AND IRRADIATION OF THE EARTH

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The total solar irradiation (TSI) is $\mathcal{F}d^{-2}$ at the distance d to the Sun (in astronomical units) where $\mathcal{F}$ is the averaged solar surface flux in units $\mathrm{kW/m^2}$ ($\mathcal{F}$ is some $63\,\mathrm{MW/m^2}$.) The available power to drive the climatic processes for the planet of radius R is

$$W = \pi R^2 \mathcal{F} d^{-2}. \tag{1}$$

The variation of d, $\mathcal{F}$ and the areal distribution of W on the surface of the Earth are the components for climatic processes and their temporal change

- The temporal variation of $\mathcal{F}$ of accuracy $\mathrm{O}(10^{-3}, 10^{-4})$ are available from surface or satellite observations over some 150 years. The solar cycle is clearly present in these time series, especially in the satellite observations, however, for eventual secular changes exist observational upper limits only and theoretical results from stellar evolution theory. During the life time of Milankovich a constant $\mathcal{F}$ was assumed, especially on the $\mathrm{O}(10^5)$ years time scale of his considerations.

- The variation of d has strictly periodic and quasi periodic components. The full exploration of the latter was not available during the life of Milankovich. It can be expected that the enormous development of numerical celestial mechanics will produce considerable step forward in this field in the XXIth century.

- The areal distribution of W is the most problematic point because of the number of components to have influence on it, merely a few to mention here. Distribution of continents, oceans, mountain chains, chemical composition of the atmosphere, water in condensed form or vapour, aerosols, atmospheric and ocean circular systems, the parameters from celestial mechanics like orbit eccentricity, axis obliquity and perihelion precession of the Earth. Harmonic and quasi random changes can originate from these, and the other, not fully known factors.

The horizon of Milankovich's work, elaborated partly by G. Bacsák was the glacial and interglacial intervals of the terrestrial climate in the Pliocene, Pleistocene. They had found evidences of correlation of terrestrial climate and parameters from celestial mechanics which were available in the pre-computer era.