An Idea for a New Modeling Approach of Climatic Changes. A Correlation Study for Cyprus.

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Abstract: Mathematical Modeling in climatic changes prediction has been based on more or less simple energy balances considering the Earth along with its atmosphere, with the so-called solar "constant" taken as an invariant. However evidence has been supplied in previous WSEAS Conferences that this constant, *S*, does not remain a constant but it does fluctuate, following the cycles of the solar activity. Furthermore the transmission parameters concerning the input and the output energy, τ_V and τ_{IR} from/to the system Earth-Atmosphere also vary and this reflects the human activity leading to increased greenhouse gas quantities, being blamed for a dramatic climatic change the last decades. Thus, considering those fluctuating properties, the following equation for Earth's mean temperature, *T*, has been developed (*A* being albedo equal to 0.3 and σ is the Stefan – Boltzmann constant)

$$T^4 = \frac{S(1-A)(1+\tau_V)}{4\sigma(1+\tau_{IR})}$$

with the following multivariate treatment:

$$dT = \left(\frac{\partial T}{\partial S}\right)_{\tau_{IR},\tau_V} dS + \left(\frac{\partial T}{\partial \tau_{IR}}\right)_{S,\tau_V} d\tau_{IR} + \left(\frac{\partial T}{\partial \tau_V}\right)_{S,\tau_{IR}} d\tau_V$$

We need to obtain the derivatives: $\frac{\partial T}{\partial S}, \frac{\partial T}{\partial \tau_{IR}}, \frac{\partial T}{\partial \tau_V}$ because all S, τ_{IR}, τ_V change.

Key-words: Climatic change, environment, mathematical modeling, heat balance, transmission coefficient in the ultraviolet, transmission coefficient in the infrared, solar constant, microclimatic considerations

1 Introduction

Mathematical modeling of Climate change or global warming has followed two principal lines. One of those is the single layer atmosphere model as it has been described previously [1]. Multilayered energy balances have also been applied [2]. Another distinction is whether the models are one dimensional or two dimensional [3]. As noticed in the WSEAS Conference at Cambridge, 2008 [4] most of the models focus on the anthropogenic CO_2 and other gas emissions and the greenhouse effects and the solar constant is taken as an invariant.

2 The Modeling Idea

Evidence has been supplied in previous WSEAS Conferences that the solar "constant", S, does not remain a constant but it does fluctuate [4], following the cycles of the solar activity. Furthermore the transmission parameters concerning the input and the output energy, τ_V and τ_{IR} from/to the system Earth-Atmosphere also vary and this reflects the human activity leading to increased greenhouse gas quantities, being blamed for a dramatic climatic change the last decades. Thus, considering those fluctuating properties the following equation for Earth's mean temperature, T, has been developed (A being albedo equal to 0.3 and σ the Stefan – Boltzmann)constant

$$T^4 = \frac{S(1-A)(1+\tau_V)}{4\sigma(1+\tau_{IR})} \qquad (1)$$

with the following multivariate treatment:

$$dT = \left(\frac{\partial T}{\partial S}\right)_{\tau_{IR},\tau_V} dS + \left(\frac{\partial T}{\partial \tau_{IR}}\right)_{S,\tau_V} d\tau_{IR} + \left(\frac{\partial T}{\partial \tau_V}\right)_{S,\tau_{IR}} d\tau_V \qquad (2)$$

We need to obtain the partial derivatives: $\frac{\partial T}{\partial S}, \frac{\partial T}{\partial \tau_{IR}}, \frac{\partial T}{\partial \tau_V}$ because all S, τ_{IR}, τ_V change. Then the total differential of the temperature becomes:

$$dT = \frac{(1-A)(1+\tau_V)}{16T^3\sigma(1+\tau_{IR})} dS + \frac{-S(1-A)(1+\tau_V)}{16T^3\sigma(1+\tau_{IR})^2} d\tau_{IR} + \frac{S(1-A)}{16T^3\sigma(1+\tau_{IR})} d\tau_V \qquad (3)$$

Knowing the range of change of the solar constant as well as of the transmission coefficients, over a certain time period, the differential equation could be solved (integrated) over that time period.
Thus we need the functions:

dS=f(dt), $d\tau_{IR}$=f(dt) and $d\tau_V$=f(dt)

t, being the time. The functions could be obtained from databases. Then the partial differential equation is converted to an ordinary one and could be easily solved.

3 Sunspots

Sunspots on the Sun's surface are "cold" areas (characterized by a temperature of 3000 K, compared to the 6000 K Sun's surface bulk temperature) caused by solar activity and the eruption of solar masses towards the planet system, including Earth. The energy losses then, associated to this kind of activity, are manifested in surface areas of lower temperature that the mean temperature of Sun's atmosphere. Therefore the sunspot number can be taken as a measure of the solar activity and also for the variation of the solar "constant". In Fig.1 below the monthly averaged sunspot numbers is given over the period 1750-2011.

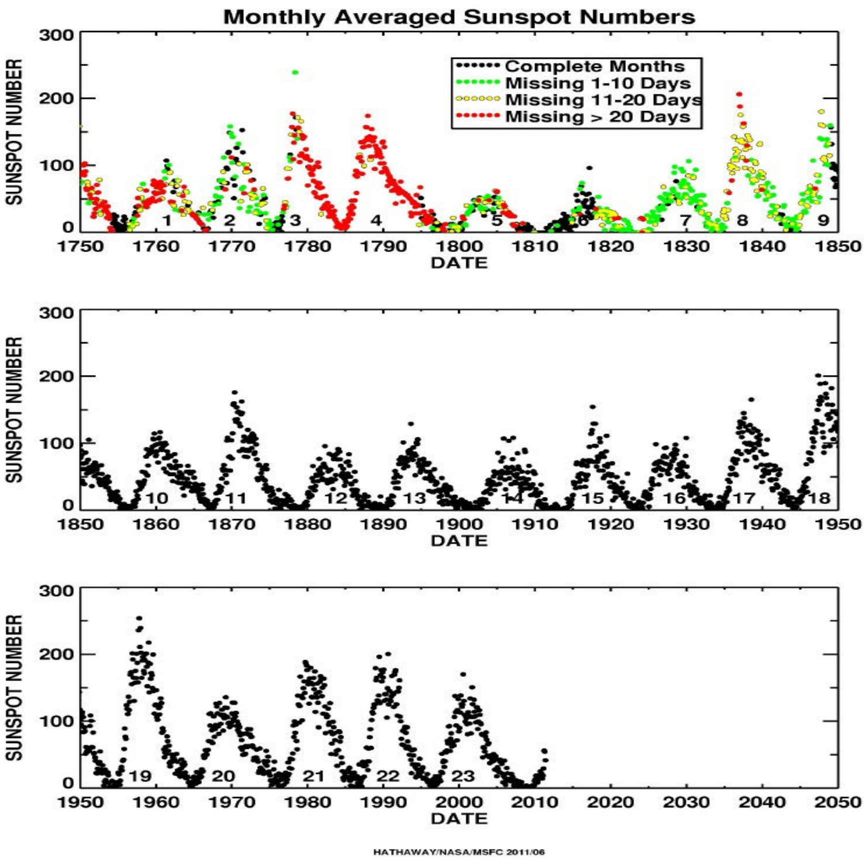

Figure 1. The sunspot number variation given as a monthly averaged number since 1750 [5].

It is quite obvious that the solar activity follows a cyclic variation with the well known period of approximately 10-11 years [5]. As it will be evidenced below, also the drought and rainy seasons in sensitive subtropical areas follow a 10-11 year fluctuation. Are those two variations inter-correlated?

4 Precipitation Data of Cyprus and Correlation with the Sunspot Number

In the following Fig.2 the precipitation data of Cyprus during the years 1901-2000 is presented

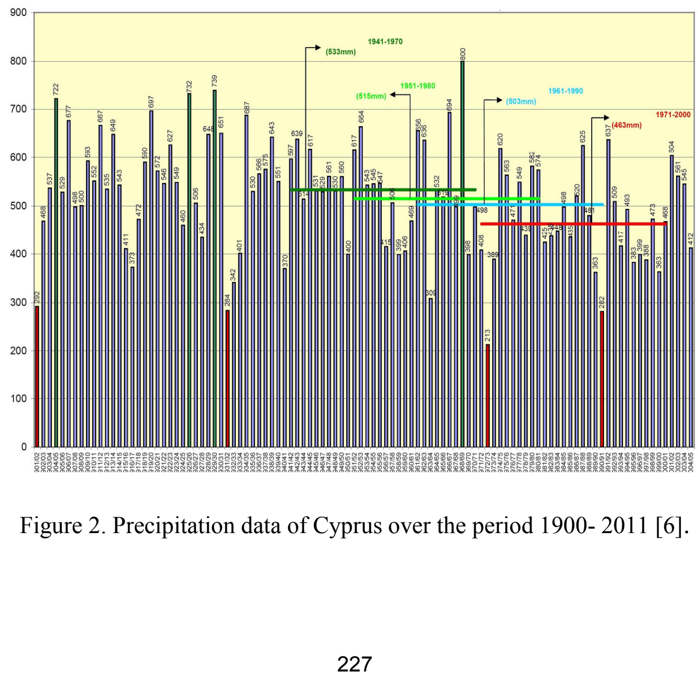

Figure 2. Precipitation data of Cyprus over the period 1900- 2011 [6].

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It can be seen that as it was the case with corresponding data of Greece [4], the drought and rainy periods follow also a cycle of the same more or less duration of the cycle of the sunspots. The precipitation data as well as the data of the sunspot numbers for the same time period are given in Fig.3 below

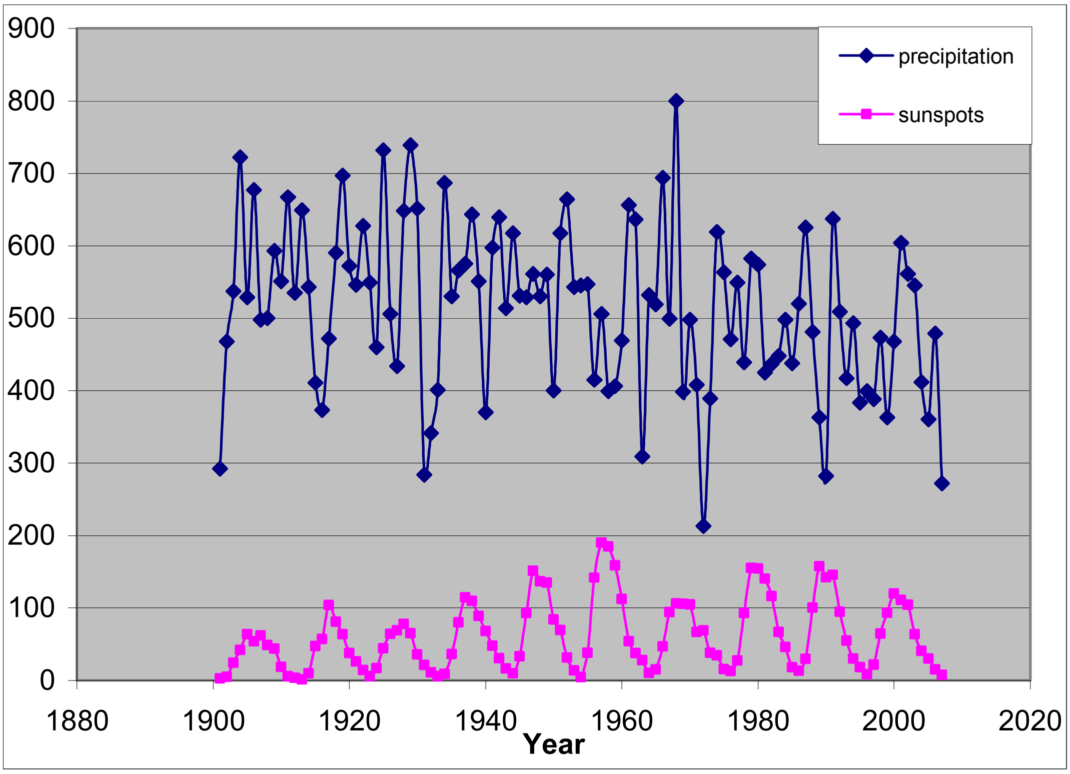

Figure 3. Correlation between precipitation in Cyprus and the sunspot number

From Fig. 3 it is clear the tendency for the precipitation minima to follow with a hysteresis the maxima of the solar activity. In Fig. 4, the maxima of the sunspot numbers and the precipitation data (with one year hysteresis) are shown. The correlation coefficient of the solar cycle peaks and the precipitation minima is approximately -0.5 giving a clear evidence of a tendency the lower precipitation values to occur around the years of high solar activity (sunspot maxima)

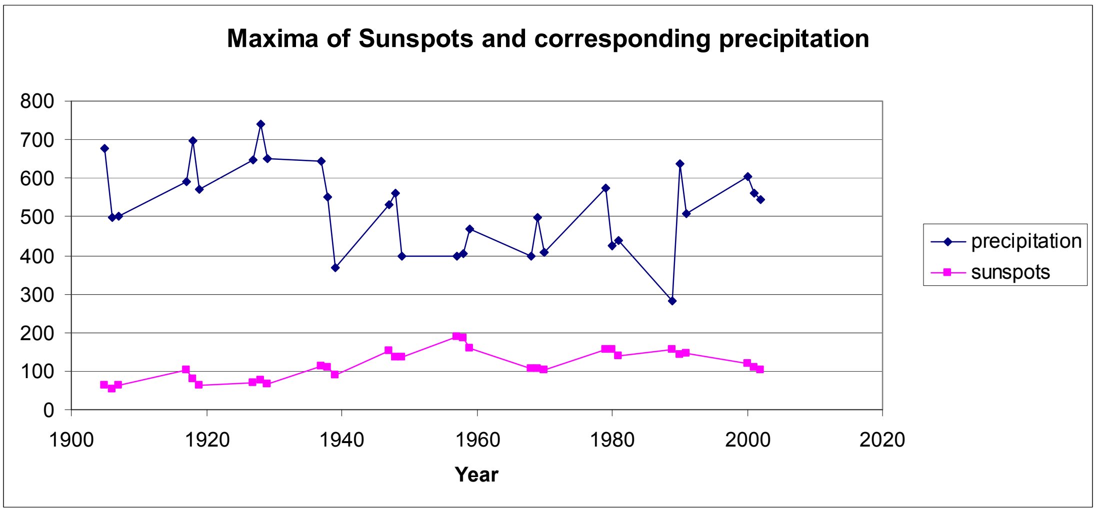

Figure 4: Correlation between sunspot maxima and corresponding precipitation

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5 Concluding Remarks

A new model idea has been presented in this paper, which takes into account both the natural and the anthropogenic causes of the climatic change phenomenon. Furthermore, precipitation data of Cyprus has been correlated with solar activity as it is manifestated by the sunspot number as well as a demonstration of the tendency of lower precipitation values in the year following the maxima.

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