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Galactic Cosmic Rays and the Environment

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Recently Svensmark and Friis-Christensen (1997) reported an indication that the Galactic Cosmic Rays (GCR) modulated by the solar wind may contribute to the variations in the formation of clouds, which in turn should follow the 11 y solar cycle.

On the other hand experiments, conducted in vitro, on the variations of $\delta^{13}C$ in symbiont bearing foraminifera have shown that the carbon isotope fractionation from sea water, of the calcite of their shells, depends mainly on the photosynthetic activity (primary productivity) of the symbionts and therefore from the illumination level of their habitat.

We have measured and analyzed (Cini Castagnoli et al., 1999) the $\delta^{13}C$ profile of G. ruber in an Ionian sea shallow water core very precisely dated.

This allows us to acquire information on the ambient light level (connected to the solar irradiance modulation and to the cloud coverage) of the Gallipoli terrace in the past Millenium. The record (1205-1975 AD) of 200 points with time resolution 3.87 years shows a highly significant 11 y cyclicity covariant with Sunspots of amplitude 0.04 ‰. A test for determining the $\delta^{13}C$-irradiance relation has been performed by studying variations of $\delta^{13}C$ and the percentage annual number of rainy days during the last century in this region. Our results agree with the expectations on the basis of experiments performed in vitro on G. sacculifer (on G. ruber is not available).

The amplitude of the 11 y $\delta^{13}C$ signal turns out to be of the order of 1.5 W/m^2. This value seems to be quite high (although of the same order) to be directly induced solely by changes in the solar constant, if in past times they were similar to those measured in space during solar cycles 22-23. The effect could be mediated by changes in clouds formation by GCR. We estimate that the cloudiness variations (from rainy days in our site) necessary to produce our $\delta^{13}C$ 11 y signal is of ~ 3 % (peak to through) this value is in agreement with the variations of the global cloud coverage between 1980 and 1995 connected to the climax neutron monitor GCR intensity modulation by the above mentioned authors.

References

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