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Lunar signal in cloudiness is stronger than in precipitation

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Before 1970 certain influence of the Moon on weather was repeatedly affirmed. In important papers it was demonstrated that extreme precipitation events occur more frequently on the third to fifth day after syzygies. The effect is sometimes called Bowen's signal and similar lunar or semilunar modulation was later found also in ozone concentrations, sunshine, thunderstorm frequencies and in global temperatures observed by polar orbiting satellites. The explanation suggested by Bowen was the variation of ice nuclei of meteoric origin, leading to variation of precipitation. Alternative mechanisms have been proposed, like rotation of the Earth around Earth-Moon barycentre or light reflected by the Moon (both effects small in magnitude), tidal influence on heat redistribution on the Earth or on the waves in the atmosphere. Possible source of variation of cloud condensations nuclei (CCN) in troposphere are also galactic cosmic rays (GCR) affected by solar activity and by lunar influence on the Earth's magnetosphere. The question whether GCR may directly affect the climate, providing an effective indirect solar forcing mechanism, was recently raised in IPCC Third Assessment Report and is investigated in the CLOUD experiment at the Proton Synchrotron at CERN.

In our previous papers we tried to study the presence of Bowen's signal in daily precipitation series at Prague-Klementinum in period 1804-2008 and in 14 century-long daily precipitation series across Europe by method of superposition of epochs (MSE) with synodic month as epoch and the date of new moon as the null day. The temporal occurrence of lunar variation of precipitation was identified by means of correlation coefficient ψ between semilunar cosine function (period $4\pi/29{,}53$) and the vectors of means from the MSE matrix. The correlation coefficients were not statistically important in most cases but they had characteristic quasi-periodic course, persisting at all stations and related probably to solar magnetic Hale cycle. We also tried to analyse dependence of the effect on climatic seasons and on orbital position of the Earth.

Data and Method: Recently we retrieved from the archives of the Czech Hydrometeorological Institute the data about mean daily cloudiness at Prague-Klementinum in period 1775-2010. The assumption was that CCN produced in troposphere by GCR should play role also in this instance. The average daily cloud cover has been probably determined by the same method all the time and thus the accuracy of the data is higher than in case of precipitation. The statistical analysis was done by the same way as in previous section.

Results: The graphs of ψ*(cloudiness)* were drawn against data of ψ*(precipitation)* and of *solar variation* represented by sunspot numbers. The presence of semilunar variation in cloudiness series is far more distinctive on much longer time span than in precipitation ones. It also exhibits expressive parallel courses with the other series, but we register number of slight shifts in timing between the series and several cases of obscure phase reversals.

Discussion: Even though only faint statistical signals were found, the results are convincing. From quasi-persistency of the signals and from ocular relationship to solar cycle it can be concluded that there *is* physical connection. If specific derived characteristic exhibits such close relationship to solar activity it can be regarded as another proof of solar forcing. It should be further studied if it is really per lunar influence or via similar solar rotational period and sector structure of interplanetary magnetic field.