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Quasi-persistency of lunar synodic signal of precipitation in different parts of year

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In the 1960's 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 of meteorological parameters was later found also in ozone concentrations, sunshine, thunderstorm frequencies and in global temperatures observed by polar orbiting satellites. The original explanation suggested by Bowen was the variation of ice nuclei of meteoric origin, leading to variation of precipitation. Since that time 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 condensations nuclei in troposphere are also galactic cosmic rays affected by solar activity and the variability of their capture efficiency as a result of lunar distortion of the Earth's magnetosphere.

In our previous papers we tried to study the presence of Bowen's signal in an extremely long daily data series at Prague-Klementinum and alternatively 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 Pearson´s correlation coefficient between semilunar cosine function (period 4/29,53) 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 related probably to solar magnetic Hale cycle.

Method: Recently we divided the original series from Klementinum in period 1804-2008 (2532 synodic epochs) into sub-files according to seasons of year: spring (MAM), summer (JJA), autumn (SON), winter (DJF), summer half-year (AMJJAS), winter half-year (ONDJFM) and full year. Division by position of the Earth on the orbit led to sub-files spring equinox (FMA), summer solstice (MJJ), autumnal equinox (ASO) and winter solstice (NDJ). The assumption was that changes in meteorological conditions and position of the Sun on the sky during the seasons may give hint of physical explanation of the long-term manifestation of Bowen's signal. The analysis was done by the same way as in previous section.

Results: The graphs of were drawn against data of solar variation represented by year to year differences of sunspot numbers, marked in a different way for opposite orientations of solar dipole (in cycles 20 to 23 according to measurements at Mount Wilson Solar Observatory, during cycles 6-19 in a "symbolic" way). The overall picture in all sub-series exhibits expressive parallel courses of precipitation and solar data with many slight shifts in timing across the whole set of sub-series and several cases of obscure phase reversals.

Discussion: Taking into account the quantity of calculations (MSE in a moving window, correlation analysis) on precipitation data with very bad distribution properties which yield faint statistical signal, the results are convincing. From the quasi-persistency of the signal and from ocular relationship to solar cycle it can be concluded that there is physical connection. It should be further studied if it is really per lunar influence or more straightforwardly via similar solar rotational period and sector structure of IMF.