



Upcoming modern grand minimum and solar activity prediction backwards five millennia

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In this study using a summary curve of two eigen vectors of solar magnetic field oscillations derived with Principal Components Analysis (PCA) from synoptic maps for solar cycles 21-24 we extrapolate solar activity backwards five millennia showing the occurrence grand cycles of 350-400 years. The summary curve shows a remarkable resemblance to the past sunspot and terrestrial activity: grand minima - Maunder Minimum (1645-1715AD), Wolf minimum (1280-1350 AD), Oort minimum (1010-1050 AD) and Homer minimum (800-900 BC) and grand maxima - modern warm period (1990-2015), medieval warm period (900-1200 AD), Roman warm period (400-10 BC) and others. We verify the extrapolated activity curve by pre-telescope observations of large sunspots, by maximum of the terrestrial temperature and extremely intense terrestrial auroras seen in 14-16 centuries and observed and simulated butterfly diagram for the Maunder Minimum (MM). We confirm the occurrence of upcoming Modern grand minimum in 2020-2055 and show it will have higher solar activity and shorter duration compared to MM. The results are probed with the terrestrial features and the two-layer solar dynamo model with different meridional circulation velocities. We argue that Sporer minimum (1450-1550) derived from the increased abundances of isotopes C14 and Be10 are likely produced by a strong increase of the terrestrial background radiation caused by galactic cosmic rays of powerful supernovae.