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Hindcast and forecast of grand solar minina and maxima using a three-frequency dynamo model based on Jupiter–Saturn tidal frequencies modulating the 11-year sunspot cycle

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The Schwabe frequency band of the Zurich sunspot record since 1749 is found to be made of three major cycles with periods of about 9.98, 10.9 and 11.86 years. The two side frequencies appear to be closely related to the spring tidal period of Jupiter and Saturn (range between 9.5 and 10.5 years, and median 9.93 years) and to the tidal sidereal period of Jupiter (about 11.86 years). The central cycle can be associated to a quasi-11-year sunspot solar dynamo cycle that appears to be approximately synchronized to the average of the two planetary frequencies. A simplified harmonic constituent model based on the above two planetary tidal frequencies and on the exact dates of Jupiter and Saturn planetary tidal phases, plus a theoretically deduced 10.87-year central cycle reveals complex quasi-periodic interference/beat patterns. The major beat periods occur at about 115, 61 and 130 years, plus a quasi-millennial large beat cycle around 983 years. These frequencies and other oscillations appear once the model is non-linearly processed. We show that equivalent synchronized cycles are found in cosmogenic records used to reconstruct solar activity and in proxy climate records throughout the Holocene (last 12,000 years) up to now. The quasi-secular beat oscillations hindcast reasonably well the known prolonged periods of low solar activity during the last millennium such as the Oort, Wolf, Sporer, Maunder and Dalton minima, as well as the 17 115-year long oscillations found in a detailed temperature reconstruction of the Northern Hemisphere covering the last 2000 years. The millennial cycle hindcasts equivalent solar and climate cycles for 12,000 years. Finally, the harmonic model herein proposed reconstructs the prolonged solar minima that occurred during 1900– 1920 and 1960–1980 and the secular solar maxima around 1870–1890, 1940–1950 and 1995–2005 and a secular upward trending during the 20th century: this modulated trending agrees well with some solar proxy model, with the ACRIM TSI satellite composite and with the global surface temperature modulation since 1850. The model forecasts a new prolonged solar minimum during 2020–2045, which would be produced mostly by the minima of both the 61 and 115-year reconstructed cycles. Finally, the model predicts that during low solar activity periods, the solar cycle length tends to be longer, as some researchers have claimed. These results clearly indicate that both solar and climate oscillations are linked to planetary motion and, furthermore, their timing can be reasonably hindcast and forecast for decades, centuries and millennia.

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