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Abrupt climate change: correlations of astronomical forcing with the ∼1470-yr quasi-periodicity

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Associated with Dansgaard-Oeschger and Bond IRD events, and millennial-scale variability and intensity of ENSO at millennial scales, the 1470-yr quasi-periodicity of abrupt climate change has been extensively debated, both as to cause and existence. Although the quasi-periodic nature of this cycle suggests external forcing, arguments of stochastic resonance within the climate system and mathematical averaging have been used to dismiss it. Individually, solar and lunar forcing have been dismissed as being too weak to cause it. However, coherence with cosmogenic nuclide records at centennial and millennial scales suggests a link with solar forcing, although no known solar cycle of that length exists. The longest known solar cycle is the 11.4-yr cycle of solar variability. Rahmstorf's (2003) investigation of this quasi-periodicity in Greenland ice cores concluded that Dansgaard-Oeschger events were paced by an external, regular, orbital cycle or solar forcing. The modelled superposition of the 88±11yr Gleissberg and ∼209-yr Suess de Vries (SdV) cycles (inferred solar cycles) by Braun et al. (2005) was shown to produce a 1470-yr cycle, but did not show a direct link between these solar frequencies and forced hydrological cycles.

However, the superposition of 133-yr and 209-yr cycles also emulates a 1474-yr periodicity. Here I show statistically-significant correlations between independent, total solar irradiance (TSI) reconstructions from 10Be Antarctic ice-core data during the late Holocene and a normalised, chronologically-anchored model of superimposed 209-yr and 133-yr cycles. These two constituent cycles are evident in astronomical data of solar and lunar declinations, Earth-Sun and Earth-Moon distances, and consequently top-of-the-atmosphere (TOA) TSI, insolation, and gravitational data. The associated physical models of insolation, TSI, and gravitation covering the last 5.5 ky also show pronounced centennial- and millennial-scale oscillations. Apart from the known influence of the Moon on tidal sedimentation patterns, this evidence suggests that lunar gravitation also modulates the cosmogenic nuclide record through these 133-yr and 209-yr cyclical patterns. Because the 133-yr cycle is strongly featured in solar declination data, modelling of insolation shows patterns of sudden and extreme insolation change, especially at high latitudes. Multiple lines of evidence suggest that the Sun and Moon produce tidally-forced climate signals of Earth's ocean and atmosphere at multiple time scales, where precession, perihelion, perigee, lunation, and nutation are key components. Consequently, the ∼1500-yr quasi-periodicity can be seen as a high-frequency expression of the same physical forces that produce the Milankovitch precessional and obliquity cycles.