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Climate cyclicity during the Holocene and Mid-Holocene transition

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Since the first suggestion of 1,500-year cycles in the advance and retreat of glaciers (Denton and Karlen, 1973), many studies have uncovered evidence of repeated climate oscillations of 2,500, 1,500, and 1,000 years. During last glacial period, natural climate cycles of 1,500 years appear to be persistent (Bond and Lotti, 1995) and remarkably regular (Mayewski et al, 1997; Rahmstorf, 2003), yet the origin of this pacing during the Holocene remains a mystery (Rahmstorf, 2003), making it one of the outstanding puzzles of climate variability. Solar variability is often considered likely to be responsible for such cyclicities, but the evidence for solar forcing is difficult to evaluate within available data series due to the shortcomings of conventional time-series analyses. However, the wavelets analysis method is appropriate when considering non-stationary variability.

Here we show by the use of wavelets analysis that it is possible to distinguish solar forcing of 1,000- and 2,500- year oscillations from oceanic forcing of 1,500-year cycles. Using this method, the relative contribution of solar-related and ocean-related climate influences can be distinguished throughout the 10,000 Holocene intervals since

the last ice age. These results reveal that the mysteriously regular 1,500-year climate cycles are linked with the oceanic circulation and not with variations in solar output as previously argued (Bond et al, 2001). In this light, previously studied marine sediment (Bianchi and McCave, 1999; Giraudeau et al, 2000), ice core (O'Brien et al, 1995) and dust records (Jackson et al, 2005) can be seen to contain the evidence of combined forcing mechanisms, whose relative influences varied during the course of the Holocene. The mid-Holocene appears to play a key role because is a transition period between two forcing. The first part of the Holocene undergoes a solar forcing whereas the 5000-0 period seems to be under the influence of the oceanic activity. Circum-Atlantic climate records cannot be explained by solar forcing, but require changes in ocean circulation, as suggested previously (Broecker et al, 2001; McManus et al, 1999). These periodicities and mid-Holocene transition can be seen in the southern hemisphere (Arz et al, 2001, Nielsen et al, 2004,...) too and give good arguments for Ganopolski model (Ganopolski et al, 1998) whose describes the first part of the Holocene as unstable due to fresh water input and a second part driven by oceanic activity.