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Clim. Past, 3, 569-575, 2007
www.clim-past.net/3/569/2007/

The origin of the 1500-year climate cycles in Holocene North-Atlantic records

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Abstract. Since the first suggestion of 1500-year cycles in the advance and retreat of glaciers (Denton and Karlen, 1973), many studies have uncovered evidence of repeated climate oscillations of 2500, 1500, and 1000 years. During last glacial period, natural climate cycles of 1500 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 1000- and 2500- year oscillations from oceanic forcing of 1500-year cycles. Using this method, the relative contribution of solar-related and ocean-related climate influences can be distinguished throughout the 10 000 yr Holocene intervals since the last ice age. These results reveal that the 1500-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; Chapman and Shackleton, 2000; Giraudeau et al., 2000), ice core (O'Brien et al., 1995; Vonmoos et al., 2006) 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. Circum-Atlantic climate records cannot be explained exclusively by solar forcing, but require changes in ocean circulation, as suggested previously (Broecker et al., 2001; McManus et al., 1999).

Final Revised Paper (PDF, 3690 KB) Discussion Paper (CPD)

Citation: Debret, M., Bout-Roumazeilles, V., Grousset, F., Desmet, M., McManus, J. F., Massei, N., Sebag, D., Petit, J.-R., Copard, Y., and Trentesaux, A.: The origin of the 1500-year climate cycles in Holocene North-Atlantic records, Clim. Past, 3, 569-575, 2007. Bibtex EndNote Reference Manager