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Extraction of orbital frequencies from noisy insolation and paleomagnetic intensity using complex wavelet transform and influence of eccentricity in paleoclimatology

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Intensive discussions exist on the presence or not of orbital frequencies in the geomagnetic field through the study of paleointensity field of sedimentary sequences. If some climatic variations, alternation of glacial and interglacial periods, are governed by insolation variations, it means by orbital frequencies (eccentricity, obliquity, precession,..)(Berger 1976, Berger and Loutre 1991), no real theory links these frequencies to the maintenance or generation process of magnetic field (convection and rotation).

Extraction algorithms of frequencies modulation laws were developed from the phase of the complex continuous wavelet transform in acoustic area (Saracco et al 1991, Delprat et al 1992). Under asymptotic conditions of the signal or of the analyzing wavelet with respect to the signal, we can extract ridges from the phase of the CCWT, corresponding to the frequency and amplitude modulation laws of the signal. We first apply this method on synthetic insolation signal and extract the main three orbital frequencies (precession, obliquity and eccentricity). Secondly, we show the robutness of this method in presence of a high level of noise (Gaussian white noise added). We then apply this algorithm on two real records obtained from long sedimentary sequences of 800ka BP and 1.3ka BP respectively, the 'delta O18' record from MD900963 core (Maldive area, tropical Indian ocean, Bassinot et al 1994), and the relative paleointensity record from MD972140. The ridges extracted correspond to the magnetic signature of eccentricity around 100 ka (oscillations between 98,2ka and 102ka) and to the obliquity (around 41ka). Obliquity is partially present. These ridge extractions without 'a priori' information of the signal confirm the real influence of orbital frequencies.

In particular, this confirms the role played by the eccentricity at the end of glacial and interglacial episodes corresponding to excursions and inversions of geomagnetic field as Thouveny et al 2004, and Carcaillet et al 2003 suggested.