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Paleo-productivity changes revealed by spectral analysis performed on coccoliths assemblages

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Several climate changes occurred over geological time at different time-scales. Spectral analyses performed on paleo-climate data suggested that these cyclicities verify irregularly into time-space domain. Paleo-climate oscillations occur with high or low frequencies dues to the oscillation of the major orbital parameters (characterized by low frequencies and high period) and some minor high-frequencies events.
During last years, analyses on frequencies domain have been performed also on coccoliths assemblages. Coccolithophores are a special phytoplankton group living today at all latitude regions within the photic zone (0-200 m of depth) (Winter & Siesser, 1994). They are sensitive indicators of environmental conditions because they directly depend on temperature, salinity and nutrients as well as the availability of sunlight (McIntyre and Bé, 1967; Giradeau et al., 1993; Winter & Siesser, 1994; Baumann & Freitag, 2004). Therefore coccolithophores quickly respond to fluctuations in climate as well as changes in surface-water conditions (Baumann & Freitag, 2004). Thus coccoliths can be clearly used as paleo-climate data because of their power of recordering and amplifying climatic change signals.
In addition, primary productivity depends on the amount of insolation received by Earth surface. In this study Sun insolation has been calculated in terms of intensity and energy, in order to compare them with maximum productivity activity. Precession controls sun intensity insolation, while the energy is controlled by obliquity. Thus, the intensity depends on the duration of the insolation,while the energy is connected to the amount of insolation (Berger, 1978; Loutre et al., 2004; Huybers, 2006).
In this study, spectral analyses have been performed on coccoliths data with the result of individuating high and low frequencies content in productivity signals. Auto-spectral and cross-spectral analyses have been performed through Matlab software using several available functions plus a new function created in order to evaluate cross-wavelet power spectra. Auto-spectral analysis aims to describe the distribution of variance contained in each single signal over frequency or wavelength, while cross-spectral analysis correlates two time series in the frequency domain (Trauth, 2009).
We have performed spectral analyses using the complex Fourier transform and the Short time Fourier transform. Both the transforms lose any kind of time information in transforming the signal from time to frequency domain (Jenkins and Watt, 1968). These transforms don't allow us to individuate when an event occurred in the past. In order to overcome this limit we have also applied Wavelet analysis which represents frequency content of a signal over the time thus it allows us to visualize when an event occurred into time domain (Torrence and Compo, 1998; Prokoph and El Bilali, 2008; Grinsted et al., 2004). Moreover we have performed a simple cross and a cross-spectral analysis between different proxy groups to discover their possible correlations into time and frequency domains.

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