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Vegetation response to obliquity and precession forcing during the Mid Pleistocene Transition in Western Mediterranean region (ODP Site 976)

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About 1 Ma ago, the response of the global climatic system shifted and showed the progressive dominance of an eccentricity and precession combination, resulting in the appearance of 100 kyr-long cycles. This shift from the earlier “41 kyr world” to the subsequent “100 kyr world” corresponds to a period of increased cooling called the Mid Pleistocene Transition associated with cycles of non-Milankovitch periods.

The Mediterranean region offers the opportunity to explore global climate response to orbital forcing of this particular period. It is usually done on marine proxies that may be affected by calorific inertia of marine environments, at the difference of pollen-inferred vegetation and climate changes which were, thus, provided by the ODP leg 161 Site 976 (Alboran Sea; Western Mediterranean Sea). The age-model - tied to biostratigraphic events - was revised by aligning the pollen climate index (PCI) to Mediterranean (KC01b) and global (LR04) oxygen isotope records on the interval $\sim$1.09 Ma (MIS 31) to $\sim$0.90 Ma (MIS 23).

Pollen-inferred vegetation allows a successful application of the modern analogues technique (MAT) to quantitative climate reconstructions for the MPT. Five, long-term, obliquity-related vegetation successions, and eight short-term, precession-related vegetation successions are observed. These vegetation successions, regardless of their duration, show the same pattern: the progressive replacement of temperate trees by mountainous taxa, and then by herbs and steppe maxima. In the Mediterranean region, precession-related successions correspond, therefore, to as dramatic vegetation changes as those driven by obliquity, including a final steppe phase under deteriorated climate conditions.

Wavelet analysis of the PCI record shows that the Western Mediterranean experienced a shift at 1.01 Ma from precession-dominated frequencies to obliquity-dominated frequencies. There is, therefore, an apparent discrepancy between wavelet analysis results and vegetation dynamic analysis (which suggests that obliquity and precession are recorded throughout the entire studied interval). This discrepancy could result from the fact that the PCI record sums, somehow, similar vegetation changes occurring at different periodicities. Such a complex vegetation dynamics is mathematically rendered through a single parameter (i.e. principal component), which does not successfully catch the subtle combinations of variability occurring at two close periodicities. Furthermore, the pollen-inferred Early Pleistocene vegetation dynamic (and climate) of the Western Mediterranean region does not show a decrease of the obliquity response relative to the precession response at the onset of the MPT.

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