Climate system in continental Eurasia: a response to orbital inclination forcing?

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Spectral analysis of untuned water content data (a proxy for diatom abundance) in Lake Baikal sediments is presented for the past 800,000 years. The power spectrum is dominated by a 100-kyr cycle which is, however, incompatible with the classical Milankovitch model of insolation forcing driven by variations in the Earth's orbital eccentricity. On the other hand, the narrow peak centered at 100-kyr is remarkably similar to a newly proposed theory of glacial cycles that invokes variation in the inclination of the Earth's orbital plane. Our statistical analysis suggests that the waxing and waning of the Late Pleistocene ice sheets exerted a dominant influence on the climate of continental Eurasia.

Considerable information about past global climates and environments has been obtained in recent years, especially from ice cores and deep sea cores. However, climate systems in remote continental locations remain poorly understood, yet such information is crucial for our understanding of the Earth's climate on a truly global basis. Here we present paleoclimate data composited from sediment cores recovered from the Academician Ridge region within Lake Baikal, a Miocene-age rift lake located in southeastern Siberia. We employ water content in the lake sediments as a proxy for climate change, since in the case of Lake Baikal, water content in sediments is primarily controlled by the abundance of diatom frustules preserved in the sedimentary record. Spectral analysis is performed in order to elucidate the forcing mechanism(s) controlling the climate system in this high-latitude continental interior region. The age model we employ for spectral analysis is derived using the basic assumption that sediments accumulated at a uniform rate between the surface and age control points provided by geomagnetic polarity boundaries. Spectral analysis of the untuned water content data for the past 800,000 years yields a power spectrum which is dominated by a strong 100-kyr cycle, a feature customary attributed to variations in the orbital eccentricity of the Earth according to the conventional Milankovitch theory. However, the analysis shows the presence of a single narrow 100-kyr peak, incompatible with orbital eccentricity, which over the same time interval we consider here is characterized by a triplet of peaks near 400, 122 and 97-kyr periods. In contrast, the orbital inclination parameter, which has been recently proposed to account for the Late Pleistocene 100-kyr glacial cycles, provides an extremely good match to the spectrum of the climate data. Moreover, the narrow 100-kyr peak in the Lake Baikal water content data is identical to that recently reported for untuned oxygen isotope records (a proxy for global ice volume) from marine sediments. The significance of this observation with respect to the influence of the waxing and waning of the Late Pleistocene 100-kyr ice sheets on the climate system of a remote continental interior location such as Lake Baikal will be discussed. Finally, the presence of a smaller peak of 41-kyr obliquity cycle in the power spectrum of the Lake Baikal record indicates that direct insolation forcing according to the Milankovitch model does play a role, albeit a subordinate one, in the climate system of this continental interior location.