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Mechanisms that triggered hydrological changes in the tropical lowlands of northern Central America during the past 85 ka

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Orbital precession is thought to have been the major mechanism that drove precipitation and temperature changes in the tropics during the Quaternary. Other mechanisms, however, such as the rate of meridional overturning of the ocean, tropical carbon production, atmospheric methane and water vapour, and hence the modes of tropical ocean-atmosphere interactions, need to be considered. Few sites are suitable to explore the sensitivity of these different components of the climate system or their relative contributions to climate conditions through time. We present new, continuous, high-resolution paleoenvironmental and paleoclimate results from a long sediment sequence collected in Lake Petén Itzá, northern Guatemala. The composite core (PI-6) was dated using radiocarbon and tephra stratigraphy and spans the last ∼85 ka. We inferred past conditions using aquatic bioindicators (diatoms, ostracods) that are abundant in the sediment and respond rapidly to climate and environmental changes, especially lake-level changes. Lake-level highstands occurred during the intervals 80-61 ka, 40-32 ka, 23-16 ka, and with a lower-amplitude episode between 47 and 45 ka. Sharp transitions from humid to arid, and arid to humid conditions are recorded during Heinrich events H1, H2, H3, and H4, whereas H5 and H6 correspond to persistent low lake levels. Lake-level fluctuations are largely in phase with precession cycles, except before 50 ka. Lake status, however, is not always in phase with expectations from insolation forcing. For instance, during MIS 4 (ca. 71-57 ka) and the Last Glacial Maximum (ca. 23-19 ka), lake level was high in Petén Itzá, implying moister conditions, whereas low lake level would be expected because of the southerly position of the ITCZ during those times. The moist conditions are attributed to intensified cold air masses during glacial stages, coming mainly from the North American interior and bringing precipitation during winter (Hodell et al., 2008). Moreover, between 80 and 61 ka, fresher sea surface waters are inferred from the adjacent oceans, associated with globally warmer temperatures, implying moister conditions for the Yucatán Peninsula (Leduc et al., 2007). Our results highlight shifts through time in the major forcing mechanisms that triggered water-level changes in Lake Petén Itzá. These new paleoenvironmental proxy data will be useful for selecting parameters to be included in future modelling experiments that test forcing of tropical climatic changes during the late Quaternary.

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