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Late Pliocene ice-age cycles untangled

L.J. Lourens (1), J. Becker (1,2), R. Bintanja (3), and R.S.W. van der Wal (3)

(1) Faculty of Geosciences, Utrecht University, Netherlands, (2) Now at School of Earth, Ocean and Planetary Sciences, Cardiff University, UK, (3) Institute for Marine and Atmospheric Research Utrecht, Utrecht University, Netherlands (llourens@geo.uu.nl / Fax: +31 30 2532648 / Phone: +31 30 2535173)

The occurrence of glacial cycles has unequivocally been attributed to the Earth's astronomical perturbations by the internal consistency of spectral peaks in foraminiferal oxygen isotope (δ18O) records. Hence, emphasis has been taken on establishing chronologies of sedimentary records by tuning δ18O records to astronomically paced ice sheet models taking into account a fixed time lag between insolation forcing and ice sheet response. Here, we present constraints on the response times of ice volume and surface air temperature (Tair) for the obliquity-controlled marine oxygen isotope stages (MIS) 100, 98 and 96, which mark a major step in Northern Hemisphere glaciations ($\sim$2.56-2.4 Ma). These constraints are derived from a high-resolution benthic δ18O record of ODP Site 967 (Mediterranean) in combination with an ice sheet model and an inverse method to untangle the δ18O record into an ice volume and a deep-water temperature component. In addition, we have run a transient experiment with a climate model of intermediate complexity to demonstrate that the Ta/Al ratio of ODP Site 967 used for our chronology is directly linked to changes in runoff from the African continent. Our results indicate that Tair leads ice volume by 3.8-5.6 ky and lags obliquity and African aridity by 3-3.8 ky, and that deglaciations are paced by a nonlinear 28-ky component, while precession forcing is lacking, thereby excluding a dominant role of Northern Hemisphere summer insolation as trigger for late Pliocene deglaciations.