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Evidence for orbital pacing through the middle Miocene climatic deterioration from the Southwest Pacific

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The middle Miocene climatic deterioration was the beginning of the global climate shift to today's 'ice-house' world. It is characterised by a 1–1.5‰ enrichment in the deep-sea sedimentary oxygen isotope record over a ∼1Ma period. It began at ∼14.6Ma with the Mi-3 isotope event, at which time a volume of ice equivalent to the East Antarctic Ice Sheet (EAIS) accumulated on land (Pekar *et al*, 2005). A sedimentary record has not yet been recovered from the Antarctic margin, so the behaviour of the EAIS during this cooling period is still poorly understood. However, southern New Zealand is ideally placed to record the distal influence and evolution of the Cryosphere because it lies in the path of the Antarctic Circum Polar (ACC) and Deep Western Boundary (DWBC) currents.

Here we present a middle Miocene magnetic susceptibility record from western Southland, New Zealand. The magnetic susceptibility record serves as a proxy for ice volume driven, ocean productivity and therefore is a useful indicator of Cryosphere behaviour. The record has a resolution of ∼500 years and was collected from a ∼650 metre thick, deep-water (>1500 metres) succession. It spans the interval 16.014 Ma to 13.510 Ma and is calibrated against the Geomagnetic Polarity Time Scale (GPTS) using a high resolution magnetostratigraphic age model. The data were spectrally analysed using the Lomb-Scargle Fourier Transform as implemented by Schulz and Stattegger (1997). The spectral peaks were correlated with known orbital parameters and a sedimentation rate determined from the correlation. The astronomical sedimentation rate was within ±3cm/k.y. of the average sedimentation rate determined from the magnetostratigraphic age model.

Spectral analysis of the magnetic susceptibility record indicates that the growth of the EAIS was paced with eccentricity prior to the Mi-3 isotopic inflection at $\sim$14.6 Ma. During the Mi-3 isotope enrichment period, the cycles are paced with obliquity. This switch to obliquity-paced cycles is also coincident with a $\sim$200 k.y. hiatus in the section. The peak isotopic value of the Mi-3 isotope event occurs at $\sim$13.7 Ma and is interpreted to be the time of maximum ice volume on the Antarctic continent. At this point the magnetic susceptibility cycles again become paced with eccentricity.

The findings indicate that the degree of terrestrial ice build up on the Antarctic continent modulates the orbital frequencies with which the glacial cycles can be paced. Therefore obliquity paced glaciations may only possible during times of low global ice volume and eccentricity paced glaciations may be more efficient during times of high global ice volume. A sedimentary succession from the Antarctic margin is now needed to verify the observed orbitally-paced productivity cycles, and to confirm that they are the result of the orbitally-paced growth of the EAIS.