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A 25 ka diatom-based oxygen isotope record from Lake Malawi

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Palaeoclimatic investigations from Lake Malawi (10-15 ˚S), has forced a re-evaluation of the processes controlling long-term climate changes in the region. In Lake Malawi at the last glacial maximum (LGM) abundant diatom periphyton (up to 30% at the LGM) and reduced biogenic silica accumulation in cores M98-1P and M98-2P suggests low lake level and a relatively dry climate. The implication is that orbital forcing of southern tropical African climate was subservient to glacial boundary conditions. Here we present new oxygen isotope data from diatom silica ($\delta^{18}O_{diatom}$) from core M98-2P thereby producing one of the longest continuous $\delta^{18}O$ records from tropical Africa, and the first $\delta^{18}O_{diatom}$ curve from a large African lake. Diatoms were extracted from the sediments using oxidation, sieving, and SPLITT separation. The water balance of Lake Malawi is controlled by direct precipitation and evaporation from the lake surface (80% of water loss). During the last 25 ka, changes in the precipitation-evaporation ratio were also the dominant control on isotope fractionation, as demonstrated by the positive relationship between high $\delta^{18}O_{diatom}$ values and the concentration and influx of diatom periphyton (broadly a lake level proxy). Furthermore, during the last 15 ka $\delta^{18}O_{diatom}$ is positively correlated with total diatom biovolume; a variable that is greatest during strong mixing and low lake level in the instrumental period.

Time series analysis of $\delta^{18}O_{diatom}$ reveals periodicities $\sim$4500, $\sim$2300 and $\sim$1570 years. The longer cycles could be harmonics and combination tones of the major orbital frequencies (precession and obliquity), while the shortest (and weakest) may be related to thermohaline circulation. The strongest 2300 year period is comparable to results from extratropical regions including Antarctic and Greenland ice cores (Yiou

et al. 1991; Mayewski et al. 1997) and Aegean Sea foraminifera (Rohling et al 2002). Further work to investigate phasing and forcing is ongoing.

We conclude that the major control on $\delta^{18}O_{diatom}$in Lake Malawi has been the strength and duration of the dry season. Unlike shallower polymictic lakes, the seasonal nature of diatom productivity in Malawi will skew isotope values toward conditions persisting in the dry season. Nevertheless, at the millennial scale, the most severe droughts occurred during the late glacial, ca. 8.2 ka, and ca. 4 ka, all well known dry intervals in Africa that have been found in previous $\delta^{18}O_{diatom}$investigations.