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DeepCHALLA – a 250,000 year record of hydroclimate from equatorial East Africa using diatom and organic isotope data

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Long-term variability of rainfall in equatorial East Africa is thought to be associated with Hominin evolution and ecology. At the millennial scale, rainfall patterns have been quite well constrained for the last 25,000 years but earlier records are more fragmentary hindering consideration of the role of climate in the evolution of our species. Here, we provide information on past hydrological changes using oxygen and carbon isotopes in fossil diatom frustules (δ18Odiatom) and sedimentary organic matter (δ13Corg) from the $\sim$214-meter long ICDP DeepCHALLA sediment record retrieved from Lake Chala (3°19'S, 37°42'E), a freshwater crater lake (92 m deep) situated on the lower eastern flank of Mt. Killimanjaro. Provisional chronologies suggest this record extends to MIS 8, and the consistent laminated structure imply few discontinuities. Lake Chala's hydrology is driven by evaporation exceeding local precipitation and surface inflows, and lake level being maintained by groundwater inflow and outflow. Precipitation and shallow groundwater inputs deliver water with low oxygen isotope ratios to Chala's surface water (δ 18Olake) where it is subjected to evaporation. Sedimentary δ18Odiatom signatures are thus a measure of local insolation and relative humidity, skewed towards the diatom growth season (Southern Hemisphere winter when conditions are dry and windy) over inter-annual timescales. Sedimentary δ13Corg signatures are driven by variation in autochthonous productivity and terrestrial inwash. Seasonal and long-term variation in East African rainfall reflects shifts in the latitudinal position of the tropical rain belt linked to the Intertropical Convergence Zone (ITCZ), which migrates meridionally in response to changes in interhemispheric heat distribution. However, the intensity and movement of the ITCZ itself is driven largely by variation in Indian Ocean Sea Surface Temperatures (SSTs), which in turn determine the strength of monsoonal dynamics delivering rainfall to eastern Africa. These new isotope data from Lake Chala appear to match long SST records from the Indian Ocean suggesting that they reflect regional changes in monsoon rainfall over this $\sim$250,000-year period.