Late Pleistocene climate in the West Pacific: A new speleothem record from Borneo

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The western tropical Pacific is the warmest region of the oceans and therefore an important source of heat and moisture for higher latitudes. The aim of this study is to better understand the forcings and responses of tropical West Pacific climate on glacial-interglacial timescales and its role during large global climate shifts.

We analyzed two stalagmites from different caves in Northern Borneo (4°N, 115°E) for their oxygen isotopic composition. The tropical climate of Borneo results in year-round precipitation, with ENSO being the most important source of inter-annual variability in precipitation today. Available oxygen isotope data for precipitation at our site suggest a negative correlation between amount and $\delta^{18}O$ of precipitation, as well as a secondary influence of the trajectory of air masses to Northern Borneo, which changes seasonally with the movement of the intertropical convergence zone (ITCZ).

The samples we studied cover the time period from 170 ka to roughly 500 ka (MIS 7 to probably MIS 13). Although both speleothems contain several growth hiatuses, the data reveal clear glacial-interglacial cycles in $\delta^{18}O$ with amplitudes of around 3-4‰. This signal is a combination of global changes in seawater $\delta^{18}O$ (about 1‰) and changes in climate.

In order to distinguish between the influences of temperature and precipitation on the $\delta^{18}O$ signal, we reconstructed past cave temperatures in selected intervals using the 'clumped isotope' paleothermometer. The clumped isotope data from peak glacial and interglacial intervals (identified by $\delta^{18}O$ maxima and minima) yield temperature estimates that are statistically indistinguishable from each other and from the modern cave temperature. The results suggest that there was no significant glacial-interglacial change in cave temperature within our errors of ±1°C (1 s.e.). Thus, the $\delta^{18}O$ signal in the stalagmites from Northern Borneo reflects changes in the $\delta^{18}O$ of precipitation, likely due to a combination of changes in source water $\delta^{18}O$, moisture transport, and precipitation amount. An interesting observation is that the amplitude of peak interglacial $\delta^{18}O$ values does not seem to have changed over the last 500 ka, unlike Antarctic temperature and pCO_2.