Pairing stable isotopes with lake level – a path for reconstructing paleo-evaporation?

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Evaporation is a cardinal component of the global-to-regional water balance (Budyko, 1974) and thus understanding changes in water availability through time is linked to the skill of reconstructing paleo-evaporation. However, currently there is a void in the ability to reconstruct changes in paleo-evaporation. Pairing lake area of a closed basin lake with stable isotopes ($\delta^{18}O$, $\delta^{13}C$ and leaf wax δD) in a variety of carbonates (tufa, stalagmite and shells) and organic material can provide quantitative information about changes in the different components of the hydrological cycle. At steady state, water leaving a closed basin lake as evaporation must equal water input, and thus the surface area of the lake is a measure of precipitation minus evaporation or water availability (Goldsmith et al., 2017). In addition, stable isotopes in lacustrine carbonates and stalagmites record different components of the hydrological cycle and thus allow constructing a hydrological isotope model, which once the boundary conditions (temperature, $\delta^{18}O$ of source water and $\delta^{18}O$ of lake water) are constrained, provide information on the magnitude of kinetic fractionation, which in turn is linked to relative humidity and evaporation (Gat, 1995).

Here we present a lake area reconstruction from south China that spans the past 15 ka and $\delta^{18}O$ from lacustrine tufas and a stalagmite that grew at different stages of the lake level history. We use a hydrological model and an isotope hydrological model to assess changes in the magnitude of water availability in southern China, and assess the ability to deconvolved changes in precipitation and evaporation through time. Our results show that changes in the seasonal structure (i.e. not only summer rainfall) impacted water availability in south China throughout the past 15 ka.

References

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