Deciphering Chinese speleothems with an isotope-enabled climate model

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Abstract

Speleothem $\delta^{18}O$ is widely used to reconstruct past hydroclimate variability, particularly over Asia. While this proxy is traditionally interpreted as “monsoon intensity”, recent work has proposed alternative interpretations that challenge or redefine this long-held concept. To better understand the signal preserved in speleothems over various timescales, this study employs a state-of-the-art isotope- enabled climate model to quantify contributions to the oxygen isotope composition of precipitation ($\delta^{18}O_P$) over China. Results suggest that orbital-scale speleothem $\delta^{18}O$ variations at Chinese sites mainly record the meridional migration of the Asian monsoon circulation, accompanied by an early northward movement of the East Asian rain belt. At interannual scales, Chinese speleothem $\delta^{18}O$ is also tied to the intensity of monsoonal circulation, via a change in moisture source locations: enhanced moisture delivery from remote source regions leads to depleted $\delta^{18}O_P$, particularly in late summer and early autumn. Our results offer a re-interpretation of the concept of “monsoon intensity” as “enhanced monsoonal circulation” rather than precipitation amount.