Differentiating summer and winter monsoon signals in precipitation isotope records from East Asia

ELIZABETH K. THOMAS[1]*, STEVEN C. CLEMENS[1], WARREN L. PRELL[1], YOUBIN SUN[2], YONGSONG HUANG[1], GUANGSHAN CHEN[3], ZHENGYU LIU[3,4] AND XINYU WEN[4]

[1]Brown University, 324 Brook St. Providence, RI, 02912 (*correspondence: elizabeth_thomas@brown.edu, steven_clemens@brown.edu, warren_prell@brown.edu, yongsong_huang@brown.edu)

[2]Chinese Academy of Sciences, Xi'an, China (sunyb@ieecas.cn)

[3]University of Wisconsin-Madison, Madison, WI, 53706 (gchen9@gmail.com, zliu3@wisc.edu)

[4]Peking University, Beijing, China (xwen@pku.edu.cn)

Reconstructions of precipitation isotope variability on orbital time scales inform how precipitation responds to large variations in forcing mechanisms (e.g., insolation, ice volume, greenhouse gases). We present two 300-kyr-long, millennial-resolution Pleistocene records of leaf wax hydrogen isotopes (δ^2H_{wax}) from the South China Sea and from the Chinese Loess Plateau. These two precipitation ^2H records contain contrasting seasonality (year-round in subtropical southern China, spring and summer in central China) and thus provide insights into seasonal variability that previously confounded interpretations of isotope records in monsoon regions. δ^2H_{wax} has been widely used as a proxy for precipitation δ^2H. Precipitation δ^2H changes in response to changes in source region and transport history. Using an isotope-enabled simulation of the Community Climate Systemm Model, we determine that precipitation δ^2H is also affected by local condensation temperature on orbital time scales. We account for the temperature effect using independent temperature proxies: alkenones in South China Sea sediments and glycerol dialkyl glycerol tetraethers in the loess. We find that precipitation δ^2H in southern China is primarily affected by far-traveled winter precipitation and summer monsoon transport. In central China, precipitation δ^2H is influenced by both local precipitation recycling as well as summer monsoon transport. Ice volume influences precipitation δ^2H in both regions during glacial periods, whereas insolation is the main mechanism causing precipitation δ^2H variability during interglacials. These findings have implications for understanding climate forcing mechanisms in Asia, and provide reliable benchmarks for validating isotope-enabled climate models designed to predict hydroclimatic changes in monsoon regions.