Precession-band variance missing from East Asian monsoon runoff

*Steven C Clemens[1], Ann Holbourn[2], Yoshimi Kubota[3], Kyung Eun Lee[4], Zhengyu Liu[5], Guangshan Chen[6], Arin Nelson[1], Baylor Fox-Kemper[1]

1. Earth, Environmental and Planetary Sciences, Brown University, Providence, RI USA. , 2. Institute of Geosciences, Christian-Albrechts-University, Kiel, Germany, 3. Geology and Paleontology, National Museum of Nature and Science, Tsukuba, Japan, 4. Ocean Science, Korea Maritime and Ocean University, Busan, South Korea, 5. Atmospheric Sciences, The Ohio State University, Columbus, OH, USA, 6. Institute of Earth Environment, Chinese Academy of Sciences, Xi'an, China.

The iconic Yangtze River Valley (YRV) composite speleothem $\delta^{18}O$ record [Cheng et al., 10.1038/nature18591] is often cited as representative of the East Asian Monsoon (EAM) climate. The spectrum of this record is unique among EAM proxies in that it is dominated by 23-kyr (precession-band) variance whereas other EAM proxies are dominated by variance at ~100-kyr (eccentricity-band), 41-kyr (obliquity-band), or heterodynes thereof. These spectral differences lead to fundamentally different interpretations of the underlying climate mechanisms driving the EAM. Dominance of precession-band variance in YRV speleothem $\delta^{18}O$ leads to the interpretation that EAM variability responds dominantly and directly to northern hemisphere summer insolation whereas dominance of spectral variance at the 100-kyr, 41-kyr, and heterodyn bands, (with very little 23-kyr variance) leads to the conclusion that EAM variability is dominated by global ice volume and greenhouse gas forcing; fundamentally different interpretations of how this critical component of our climate system functions.

We address this difference by attempting to replicate the YRV speleothem $\delta^{18}O$ record at offshore Site U1429 in the East Chain Sea (ECS), drilled during IODP Expedition 346 (Tada et al., 10.2204/iodp.proc.346.101.2015). We utilize the same proxy system, $\delta^{18}O$ of $CaCO_3$, but recorded in surface-dwelling planktonic foraminifera (Foram $\delta^{18}O$). Foram $\delta^{18}O$ replicates the precession-band and millennial-scale structure in YRV speleothem $\delta^{18}O$ to a very high degree. We next quantitatively remove the effects of local surface temperature and global source-water $\delta^{18}O$ to reconstruct local seawater $\delta^{18}O$, a record that responds primarily to dilution by local precipitation and runoff. Unlike speleothem $\delta^{18}O$, dominated almost exclusively by precession-band (23-kyr) variance, local seawater $\delta^{18}O$ is dominated by eccentricity (100-kyr), obliquity (41-kyr), and heterodyne variance, with almost no precession-scale variance. The spectral structure of this record closely matches the spectral structure of global ice volume and greenhouse gasses, indicating that the EAM is more sensitive to high latitude ice sheet and greenhouse gas forcing than to direct insolation forcing.

Keywords: East Asian Monsoon, speleothem oxygen isotopes, seawater oxygen isotopes, East China Sea, Paleoclimate, greenhouse gas

