



## **Wet Little Ice Age in tropical Vietnam consistent with amplification of Pacific Walker Circulation**

Lora Stevens and Kelsey Doiron

California State University-Long Beach, Geological Sciences, United States (lora.stevens@csulb.edu)

Mean climate of tropical mainland SE Asia (MSEA) results from complex interactions of the ITCZ and related monsoon, Pacific Walker Circulation (PWC) and ENSO. Although millennial and centennial-scale climate variability for MSEA is most frequently attributed to variations in summer monsoon strength, MSEA is “sandwiched” between two monsoonal branches, the Indian summer monsoon and the East Asian monsoon, which may not behave synchronously. In addition to longer climatic trends, abrupt, short-lived droughts in MSEA have been linked to societal instability and food shortages. Specific triggers for, and spatial extent of, the droughts are not well understood. To explore causes and refine the spatial distribution of these droughts, as well as to place them within the mean climate state, a high-resolution oxygen-isotopic record of lacustrine carbonates was constructed from a sediment core from Ao Tiên (Fairy Pond), NW Vietnam ( $22^{\circ} 26.9' N$ ,  $105^{\circ} 37.03' E$ ). Ao Tiên is a small sinkhole in the karst region of Bac Kạn Province. It is hydrologically connected via fractured limestone to a larger lake, Ba Be, and the Nặng River. The lake is currently anoxic below 4 m depth, and the carbonate-rich sediment preserves alternating homogeneous and laminated sediment packets. We sampled the 1.3 m core in contiguous 5 mm increments for a record with  $\sim 2$ -3 yr resolution. High/low isotopic values are interpreted as drier/wetter as a function of moisture balance (inputs minus evaporation) of the lake.

Overall dry conditions prevailed during the period AD 1390-1520. A steady increase in effective moisture occurred from  $\sim$  AD 1520 to 1645 with peak effective moisture from AD 1645 to 1750, during the heart of the Little Ice Age (LIA). This pattern of hydroclimate is consistent with records from the South China Sea and Indonesia, but opposite to speleothem records from Central China. Thus climatic shifts at Ao Tiên are not consistent with a simple weakening of the summer monsoon or southward shift of the ITCZ during the LIA. More likely, a strengthening of the PWC and shift in the position of the rising limb is the reason for climatic pattern seen in northern Vietnam.

Superimposed on these centennial climate variations are several drought events. The duration and age of these events, within the errors of the radiocarbon chronology, identify them as the Angkor II, Ming Dynasty, Strange Parallels, and Bengali famine droughts, documented across China and SE Asia from tree-ring and historical records. The intense Angkor I drought (AD 1345-1374) was not captured but may have triggered the collapse of the karst that formed the lake. A prominent fifth drought (AD 1560-1582) in the Ao Tiên record has not been identified in the tree-ring records for MSEA.