Dissecting the East Asian Monsoon: Seasonal Rainfall Patterns from late Oligocene Fossil Wood

William E. Lukens¹, Jamie R. Vornlocher², Brian A. Schubert³, and Cheng Quan⁴

¹Department of Geology and Environmental Science, James Madison University, Harrisonburg, VA 22807

²Department of Geology and Environmental Science, University of Pittsburgh, Pittsburgh, PA 15260

³School of Geosciences, University of Louisiana at Lafayette, Lafayette, LA, 70504 ⁴Research Center of Paleontology & Stratigraphy, Jilin University, Changchun, Jilin 130026, China

Abstract

The wet summers and dry winters of the East Asian Summer Monsoon are a first-order control on food and water security for a significant portion of global population. This climate system is thought to have emerged sometime in the late Paleogene to Neogene, driven by the Himalayan orogeny and retreat of the Paratethys Sea. The identification and analysis of paleo-monsoon conditions from deep-time is inhibited by the fact that most paleoclimate proxies either estimate mean annual conditions or offer qualitative indicators of rainfall seasonality. Here we quantify summer and winter precipitation levels for the late Oligocene of southeast China using the intra-annual variation in carbon isotopes across growth-rings of exquisitely preserved fossil wood. We show a clear pattern of summer-dominated precipitation that is similar in magnitude for both modern and late Oligocene tree-rings. The carbon-isotope pattern across fossil tree-rings is remarkably similar within samples (6-8 years each), but notably differs between samples. We suggest that the annual onset of summer rains was more variable in the Paleogene, driven by higher atmospheric CO₂ levels or more variable sea surface temperatures.