Investigating the Holocene ENSO variability through isotope-enabled modeling and model-data comparison

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El Nino–Southern Oscillation (ENSO) is the leading climate variability at interannual timescale and its response to anthropogenic global warming is inconclusive in future climate projections. Paleoclimate proxies suggest that ENSO has undergone substantial variations during the Holocene, e.g., a 30–60% reduction of variance in sea-surface temperature (SST) during the Mid-Holocene (MH). Most of previous model simulations of the MH, however, exhibited a modest ENSO reduction of 5–15%. This model-data discrepancy in magnitude of reduction in ENSO variance, which could arise from issues from data interpretation/representation or model missing physics/forcings, poses a major challenge to our understanding of ENSO dynamics and its response to external forcing.

Here we conduct time-slice simulations of the Holocene using the water isotope-enabled Community Earth System Model version 1.2 and compare model simulated isotopes directly with proxy records. Realistic climatic forcings are employed, including the vegetation cover from a green Sahara following recommendations from the Paleoclimate Modeling Intercomparison Project phase 4. ENSO strength as indicated by variance of the Niño 3.4 SST is reduced by more than 60% in the MH experiment. Model-data comparison of water isotopes and additional sensitivity experiments exploring the driving mechanisms (e.g., orbital versus vegetation) will be presented. Implications on proxy interpretation and ENSO dynamics will be discussed.