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Speleothems of South American and Asian Monsoons Influenced by a Green Sahara

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Compared to preindustrial, the mid-Holocene (6 ka) had significantly greater Northern Hemisphere summer insolation, slightly warmer global surface temperature, and slightly lower CO_2 concentration. Vegetation was also different during the mid-Holocene. Possibly most prominent was the growth of temperate vegetation in the now barren Sahara. This Saharan vegetation response was related to intensification of the African Monsoon associated with the mid-Holocene orbital configuration. Hydroclimate of the Asian Monsoon and South American Monsoon also responded to mid-Holocene forcings, with general wetting and drying, respectively.

The mid-Holocene is frequently used for model-proxy comparison studies. However, climate models often struggle to replicate the proxy signals of this period. Here, we attempt to reduce these model-proxy discrepancies by exploring the significance of a vegetated Sahara during the mid-Holocene. Using the water isotopologue tracer enabled version of the Community Earth System Model (iCESM1), we perform mid-Holocene simulations that include and exclude temperate vegetation in the Sahara. We compare our model results with $\delta^{18}O$ values from mid-Holocene speleothem records in the Asian and South American Monsoon regions.

We find that inclusion of vegetated Sahara during the mid-Holocene leads to global warming, alters the hemispheric distribution of energy, and generally amplifies the $\delta^{18}O$ of precipitation responses in the South American and Asian Monsoon regions; these feedbacks improve the $\delta^{18}O$ agreement between model outputs and speleothem records of the mid-Holocene. Our results highlight the importance of regional vegetation alteration for accurate simulation of past climate, even when the region of study is far from the source of vegetation change.