

## **Holocene landscape and ecosystem changes in the American southwest driven by changes in winter precipitation**

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Over the past decade, extended periods of drought in the southwestern United States have highlighted the susceptibility of water resources and ecosystems to variations in climate. However, over much of the southwest, there is a dearth of long, high-resolution archives of climate and ecosystem change that would allow an improved understanding of longer-term natural variations in this system and associated climate-vegetation linkages. To address this here, we present a new record of vegetation and climate changes from variations in the carbon and hydrogen isotope composition of sedimentary leaf waxes in the sediments in Hall's Cave, central Texas. Over the past 13,000 years, the record shows coherent, millennial-scale variations in  $\delta D$  and  $\delta^{13}C$  superimposed on a long-term trend towards more depleted  $\delta D$  and  $\delta^{13}C$  values, reflecting increases in winter moisture and an expansion of  $C_3$  plants. Similarities with records from the tropical Pacific suggest that these late Holocene climate and vegetation changes in the southwest were driven by an increase in winter precipitation, likely driven by changes in tropical Pacific climate variability. The Hall's Cave record also highlights the sensitivity of grassland-shrubland ecosystems in the American southwest to changes in winter precipitation and suggests that the recent expansion of woody plants over the last century is not unusual.