A 1000-yr record of temperature from isotopic analysis of the deep critical zone in central China

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Temperature proxies for paleoclimate reconstruction have been made typically via ice cores, tree rings, stalagmites, and lake sediments. While extremely useful, these proxies can be limited spatially for regions of interest. Here we show how soil water in a deep unsaturated zone can be extracted and used to reconstruct a 1000-year climate record. We sampled a 98 m “soil core” from the Loess Plateau of China and examined the relationship between pore water isotopic values and hydroclimate history. We measured soil water chloride concentration and performed cryogenic extraction of soil pore water for $\delta^{18}O$, $\delta^{2}H$, and 3H. The 3H-peak at 6 m—a clear measure of the 1963 bomb peak — was used to quantify the rate of vertical movement of water in the unsaturated zone and to turn depth into calendar year. We confirmed this approach with the chloride mass balance. A 1000 year span was revealed in the 98 m core. Soil water $\delta^{18}O$ and $\delta^{2}H$ values between 14 – 50 m were anomalously low — bracketing well the Little Ice Age period from 1420 to 1870. The Little Ice Age identification was consistent with other more standard climate proxy data in the region and showed the same temporal dynamics of temperature within this time period. Our study shows the potential of stable isotopes of water extracted from soil for paleoclimate reconstruction in regions with deep soils.