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Robust land surface temperature record for north China over the past 21,000 years

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Numerous proxy reconstructions have provided general insight into late Quaternary East Asian Monsoon variability. However, challenges persist in precisely assessing absolute temperature impacts on proxy variations. Here we employ two independent paleothermometers, based on bacterial membrane lipids and clumped isotopes of snail shells, in the same section of the western Chinese Loess Plateau to establish a robust land surface temperature record spanning the past *ca.* 21,000 years. Our independent temperature records consistently reveal similar land surface temperatures between the Last Glacial Maximum and late Holocene, and a gradual cooling Holocene which contrasts with the climate model predictions. We propose that changes in soil moisture availability over the deglaciation modulates the land surface temperature recorded by the proxies. A land surface energy partitioning model confirms this mechanism, suggesting that effects of soil moisture availability should be properly considered when comparing proxy records with climate model outputs.