Identifying drivers of past vegetation change in East Asia using molecular climate proxies

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The Chinese Loess Plateau (CLP), located in the northern part of China, consists of thick (>100m) wind-deposited dust accumulations, known as loess. It is regarded as one of the best continental paleoclimate archives, as glacial-interglacial cycles have been stored in a sequence of alternating layers of loess and paleosols. Changes in the bulk organic carbon isotopic composition $\delta^{13}C$ throughout these loess-paleosol sequences has revealed shifts in the relative occurrence of C_3 and C_4 vegetation in the past, with increased abundance of C_4 vegetation during interglacial periods. Although increased temperatures generally lead to an expansion of C_4 vegetation, increased humidity has an opposite effect, as does pCO_2. In spite of this contradiction, the absence of independent air temperature, precipitation, and vegetation records prevents identification of the drivers of past vegetation change in this region.

Here we present combined records of changes in continental air temperature, monsoon precpitation, and vegetation type during the past 200,000 years based on the occurrence, distribution, and isotopic value ($\delta^{13}C$ and $\delta^{2}H$) of plant waxes and soil microbial membrane lipids (brGDGTs) stored in the Lingtai section of the CLP. Our multi-proxy record indicates that fluctuations in plant wax-$\delta^{13}C$ are relatively small (<2‰) given that end-member plant wax-$\delta^{13}C$ values for C_3 and C_4 vegetation on the CPL differ by over 10‰. We, therefore, interpret our plant wax-$\delta^{13}C$ as a reflection of differences in water-use efficiency between C_3 woody vegetation dominating during interglacials and shrub-dominated vegetation during interglacials. Comparison with precipitation (plant wax-$\delta^{2}H$) and temperature (brGDGT) proxy records reveals that simultaneous shifts in monsoon precipitation and growth-season temperature have indeed induced changes in vegetation type rather than large variations in C_3-C_4 vegetation on the southern CLP across glacial-interglacial transitions.