Late Cretaceous terrestrial paleoclimate recorded by paleosols in the Songliao Basin, northeast China

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The Late Cretaceous (late Campanian to Maastrichtian) was characterized by a variable greenhouse climate, with evidence for cooling and/or glaciation and warming events. Most of these climatic signals are derived from marine records, and knowledge of the terrestrial climate, especially in the mid-latitudes, is limited due to the fragmentary geological record on continents. In this study, we report terrestrial stable oxygen and carbon and clumped isotope data from pedogenic carbonates in the nearly continuous Late Cretaceous age SK-1 core drilled in the mid-latitude Songliao Basin, northeastern China. More than 50 paleosol layers are preserved in the Sifangtai-Mingshui Formations in the SK-1 core. Our sedimentary and isotopic data indicate mid-latitude terrestrial climate in the Late Cretaceous characterized by distinct perturbations (GAO et al., 2015). We interpret a negative excursion of pedogenic carbonate $d^{18}O$ in the early Maastrichtian to be the result of decreasing temperature and/or southward-shifted westerlies during global cooling and possible glaciation, providing the first mid-latitude terrestrial evidence for this event at ~70.5 Ma. A negative $d^{13}C$ isotopic excursion ca. 66 Ma is modeled as higher primary productivity caused by increasing temperature and precipitation in response to a warming climate in the latest Cretaceous. The terrestrial temperature record spanning K-Pg boundary suggests a pre-impact cooling coincident with glacioeustatic regression and then warming caused be Deccan volcanism followed by a short-term cooling caused by Chicxulub impact. Our continuous stable isotopic and paleotemperature records in the Songliao Basin are in accordance with previously published global Late Cretaceous records of climate variability from marine and terrestrial regions. These records demonstrate the mid-latitude terrestrial climate of East Asia tightly linked to global climate in the Late Cretaceous greenhouse world, and indicate that temperature changes caused by Deccan volcanism probably destabilized terrestrial ecosystems prior to the devastation caused by Chicxulub impact at the K-Pg boundary.

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