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Terrestrial Middle Miocene (Δ_{47}) temperature record reveals highly dynamic climate for the Central Europe

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The Miocene experienced both, ice-house periods with continental ice-sheets covering both poles and warm greenhouse conditions with strongly increased global temperature, glacier retreat and sea-level rise. The Mid-Miocene Climatic Optimum (MMCO) is the most pronounced warming event in the last 24 Ma, standing out in a time of protracted cooling. The MMCO is marked by a period of intensive global warming between ca. 17 and 15 Ma. The subsequent Mid-Miocene Climate Transition (MMCT), in contrast, was affected by global temperature decline, growth of Antarctic ice sheets, sea level fall and marine biota overturn.

Miocene climate conditions were intensely studied on both, global and regional scales, based on i.a. marine isotope records and continental paleobotanical and mammalian fossil data sets. Despite the dense data sets continental Miocene temperature evolution still remains unclear owing to a large range of inferred temperatures and/or poor age constraints of the associated records.

Here, we present a long-term terrestrial climate record that covers the time interval between ~20 and ~13 Ma and is based on stable ($\delta^{18}O$) and clumped isotope (Δ_{47}) geochemical data. We apply Δ_{47} thermometry on terrestrial foreland basin sediments to reconstruct the Middle Miocene continental temperature evolution for central Europe. Pedogenic carbonates from well dated fossil soils from several sites in the Northern Alpine Foreland Basin (Switzerland) reveal warm and stable temperatures for the early Miocene (20 – 19 Ma), followed by overall strongly enhanced variability in temperatures with maximum values attained between ca. 17 and 14 Ma. We observe a highly dynamic transition to cooler climates at the end of the MMCO and a subsequent rapid temperature decline of approximately 20°C after 14 Ma during the MMCT. The highly variable temperature patterns during the cooling period coincide with phases of high seasonality in the precipitation pattern as derived from oxygen isotope compositions of soil water.