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Thermoluminescence paleothermometry – A new method for terrestrial surface air temperature reconstruction and its application to key sites in the northern hemisphere

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Quantifying the magnitude of past climate variations is essential for improving our understanding of the climate system in general and for constraining climate sensitivity. While various proxies allow for surface air temperature reconstructions, methodological challenges and preservation issues limit their spatial coverage and the timeframes for which they can be effectively applied. Consequently, for major climate system shifts – such as the Pleistocene-Holocene transition, marked by rapid warming and environmental adaptations following the Last Glacial Maximum (LGM) – the scarcity of terrestrial records increases uncertainty in continental temperature reconstructions, especially in the tropics.

Recently, low-temperature thermoluminescence (TL) signals of feldspar (200–280 °C) have been demonstrated to be sensitive to terrestrial temperature fluctuations over geological timescales, making them a valuable tool for reconstructing past surface temperatures in terrestrial environments. Using physical principles derived from trapped charge dating, the trapped charge population can be used to infer paleotemperatures in the form of the most likely time-temperature paths through inverse modeling. This process incorporates time-resolved relative temperature records – such as Greenland ice sheet $\delta^{18}O$ data, speleothem records, or pollen records – as additional model constraints.

This contribution first discusses the method's basic principles and persisting challenges. We then present initial surface air temperature reconstructions since the LGM at several study sites, alongside a series of validation samples. Our ultimate goal is to integrate these data with other Euro-African records to better constrain the evolution of altitudinal and latitudinal surface air temperature gradients since the LGM.