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Central European LGM temperatures revealed using an innovative luminescence approach

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Understanding and quantifying variations in past climate is paramount to our awareness of the scale and impact of current and future climate change. Especially surface air temperature reconstructions for major changes in our climate system like the Pleistocene-Holocene transition including the rapid warming and environmenal adaptions following the Last Glacial Maximum (LGM) enable a better understanding of accelerated warming trends. Generally, climatic records are plenty, especially for the more recent Holocene. However, the further back in time the period of interest, the more sparcely temperature proxies are available. Especially the lack of terrestrial proxy records for past temperature leads to increased uncertainty in reconstructions of the continental temperature for times like the LGM and the following transition period.
Applying the recently developed thermouminescence (TL) paleothermometry approach (Biswas et al., 2020), we here present first results of LGM surface air temperature reconstructions at central European study sites. The method exploits the physical principles best known from trapped charge dating, where valence electrons are released from their natural sites through ionizing radiation and then stored in lattice defect sites (traps) of quartz and feldspar crystals before being thermally released to produce luminescence.
In feldspar, trapped electrons with comparatively short lifetimes in the 200-250 °C TL glow curve range can be thermally released from their trapping sites at ambient temperatures between ~0-30 °C, making the trapped charge population of these metastable traps susceptible to surface air temperature fluctuations. The currently measured trapped charge population at known ambient temperature can thus be used to infer paleotemperatures in the form of temperature histories through inverse modelling.
Assuming past temperature variations followed fluctuations recovered from other time resolved temperature records such as the Greenland ice sheet δ^{18}O-, speleothem-, or pollen records, these relative time-temperature series can be manipulated to fit the measured luminescence data using Bayesian modelling, depending on the study site. The best-fitting variations of the manipulated record are then extracted and combined into a “most-likely” temperature history. For the presented results, δ^{18}O records from the Greenland ice sheet form the base of the temperature reconstruction.
We are confident that the presented central European data, together with further samples taken from study sites along a latitudinal profile from Norway to the Equator, as well as two altitudinal transects within the Rwenzori mountains (Uganda) and Mont Blanc Massif (France) will improve our understanding of Euro-African LGM continental surface air temperature and climate sensitivity.

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