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Impact of long-term climate histories on estimated ground warming patterns: A spatial analysis over North America

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Climate reconstructions from borehole temperature profiles are important independent estimates of past temperature variability over the last millennium. There remain, however, uncertainties in the interpretation of these data as climatic indicators as well as in the evaluation of heat gain/loss by the terrestrial land masses. One of these uncertainties is associated with the often unaccounted for impact of the Last Glacial Maximum (LGM) on the estimate of the background steady-state signal associated with the diffusion of accretionary energy from the Earth's interior. Here we use basal temperature values from the data-calibrated Glacial Systems Model (GSM) to quantify the extent of the perturbation to estimated steady-state temperature profiles and derive spatial maps of the expected impacts on estimated profiles over North America. Furthermore, we present quantitative estimates of the potential effects of LGM temperature changes on the borehole reconstructions over the last millennium for North America. The range of these possible impacts are estimated using basal temperatures generated from the GSM for a period covering 120 kyrs to the present day and a 1000-member Monte Carlo experiment at each location in which Gaussian noise is added to the basal temperature history from the GSM. For all the locations, we find the LGM induced perturbation to the steady-state temperature profile to be constant on the order of 10 mW m^{-2} within the depth ranges that are typical for available boreholes ($\sim$ 600m) and reduce with greater depths. As a result of LGM induced perturbations, most of the locations show heat gain within the top 80 m in the subsurface and heat loss beyond 80 m. Furthermore as a result of these perturbations, most of the locations show an average temperature increase of 0.5° over the last 500 years before present.