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Linking Borehole Temperatures to Air Temperatures

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Achieving agreement among different methods of paleoclimate analysis is crucial in our effort to understand anthropogenic climate forcing and natural climate variability. The path to agreement requires that we understand the strengths and weaknesses of our methods and that we undertake critical tests of the applications and findings of our research. We have applied these concepts to the borehole method of paleoclimatology by engaging a multidisciplinary team that includes expertise in geophysics, climatology, solar radiation, meteorology, and remote sensing. One of our goals has been to test the hypothesis that differences between multi-proxy reconstructions of temperature change and inversions of borehole temperatures are largely due to the fact that snow cover decouples air and ground temperatures and causes biased trends in the GST recorded in boreholes. We tested this hypothesis by analysis of daily, monthly, and annual meteorological data and repeat measurements of T-z profiles in boreholes in the mid-continent region of North America. Our results show that although seasonal freezing and snow cover do cause systematic differences between soil temperatures and air temperatures, trends in borehole temperatures closely agree with trends in surface air temperatures and soil temperatures on multi-decadal timescales. Not all results of our research have supported the borehole method. In a larger scale study using monthly and annual air temperature data from the Global Historical Climatology Network, we found that some of the borehole sites in the global database are affected by changes in land use or terrain and require reevaluation or possibly rejection. Our conclusion from this finding is that, although the ensemble approach to the analysis of borehole data is best, careful analysis of individual sites is essential.