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Impact of maximum borehole depths on ground warming patterns: A spatial analysis over the Northern Hemisphere

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Past variations in the Earth's surface energy balance are preserved in the terrestrial subsurface and can be inferred from borehole temperature-depth profiles. These profiles are used to reconstruct past ground surface temperature (GST) histories. Recent work by Beltrami et al. (2011) has shown that estimated GST histories can be significantly impacted by the maximum depth of the borehole temperature measurement. In the present study, we use temperature-depth profiles measured at 558 sites distributed between 30^{o} N and 60^{o} N in the Northern Hemisphere. For each site, the background steady-state temperature profile is estimated using progressively deeper maximum depths of truncation. Additionally, GST histories are reconstructed using multiple maximum depth truncations. In order to control on the influence of the geographical sampling, shallow boreholes are dropped from the analysis once their depth is surpassed. The estimated temperature changes over 50-yr intervals are evaluated in these reconstructions as a function of the maximum truncation depth in the database. Similarly, the total terrestrial heat gain is also estimated using progressive depths of truncations. All calculations show a significant dependence on the maximum depths of the borehole profiles and further indicate the importance of this factor in estimates of past temperature and heat content histories derived from geothermal data. Further, calculations also show that the ground has warmed by 0.5^{o} over last 100 years consistent with the earlier studies by Beltrami and Bourlon (2004).