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Can ice sheet models contribute to the understanding of deep borehole temperature profiles?

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It has been argued many times that deep boreholes in Northern America and Europe have recorded basal ice sheet conditions during the last glacial cycle. However, though most of the very deep and well documented boreholes available today belong into this group, systematic investigations of this effects have been rare, and are only now emerging (Matharoo et al., Rath et al., in prep.). Here we present some early results from a case study in Northern Europe,analyzing several well-known deep boreholes in the light of the recent ice sheet model of Tarasov et al.(2008). These boreholes include temperature profiles from the Kola SG3 (Russia, >4000 m) Outokumpu (Finland, 2500 m), Udryn (Poland, 2250 m), Torun (Poland, 2920 m), and Czeszowo (Poland, 3450 m). All of these data have been independently investigated before with forward and inverse methods.

For this study, we have chosen a very simple approach. Starting from a small ensemble of ground surface temperatures derived from the data-calibrated glacial Systems Model, we employed an 1D subsurface model based on the best available knowledge on local geology and climatic conditions. The synthetic borehole temperature profiles derived are then compared to the observations, and discussed with respect to earlier interpretations. Several problems related to this approach are discussed: (1) the imperfect representation of local subsurface conditions, e.g., the assumption of 1D structure; (2) the role of the driving climate, which will determine the conditions under ice-free conditions; (3) the well-known imperfect coupling of surface air and ground temperatures. We believe that this contribution will be the base for in-depth discussions, and could be seminal for further investigations.