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Comparison of last millennium global climate model simulations and borehole temperatures

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Transient simulations for the last 1000 years produced with the ECHO-g ocean-atmosphere global climate model and temperature variability recorded in terrestrial boreholes over the Northern Hemisphere are compared. The climate simulations were produced forcing the model with realistic annual estimations of the changes in several external forcing factors: solar irradiance, volcanic activity and the concentrations of greenhouse gases. Temperature profiles measured in terrestrial boreholes as well as ground surface temperature reconstructions are used to analyze the consistency of proxy and simulated data sets at a hemispheric and regional level.

Since the lowest soil temperature level simulated by ECHO-g is at a depth of about 9.8 m, forward models are used to translate the climate simulated by the model at the surface to virtual borehole temperature profiles. The simulated borehole profiles and actual borehole temperature profiles are compared to assess the consistency of simulations with this proxy dataset. A second approach comprises the reconstruction of ground surface temperatures using inversion models to recover the long term trends of temperature simulated by ECHO-g. The results allow for evaluating the skill of inversion methods to recover the surface temperature signal from the borehole profiles.

Results are discussed in terms of the potential and limitations of borehole climate reconstructions and model simulations to understand climate variability and changes through the last millennium.