

Long-term Surface Temperature (LoST) Database as a Complement for GCM Preindustrial Simulations

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Estimates of climate sensitivity from General Circulation Model (GCM) simulations still present a large spread despite the continued improvements in climate modeling since the 1970s. This variability is partially caused by the dependence of several long-term feedback mechanisms on the reference climate state. However, it is difficult to provide a reference to assess the climatology of preindustrial control simulations due to the lack of long-term preindustrial observations.

In the ground, recent changes in ground surface temperature are observed at shallow depths as perturbations to the quasi-steady state geothermal regime. However, if undisturbed by recent surface temperature changes, the deep ground temperatures vary linearly as a function of depth, and the extrapolation of this linear behavior to the surface can be interpreted as the long-term surface temperature.

We assemble a new gridded database of past long-term ground surface temperatures (LoST database) obtained from 514 borehole temperature profiles measured across North America, and we explore its use as a potential reference for the evaluation of GCM preindustrial simulations. All temperature profiles are truncated at 300 m depth, allowing to estimate the ground surface climatology for the period 1300-1700 of the common era. We compare the LoST database with observations from the CRU database, as well as with five past millennium simulations and five preindustrial control simulations from the third phase of the Paleoclimate Modelling Intercomparison Project (PMIP3) and the fifth phase of the Coupled Model Intercomparison Project (CMIP5) archives. Our results suggest that LoST temperatures could be employed as a reference to narrow down the spread of surface temperature climatologies on GCM preindustrial control and past millennium simulations.