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# Ground surface heat flux histories in the Urals inferred from geothermal data

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Ground surface temperature histories (GSTHs) inferred from borehole temperature data have been successfully used in paleoclimate investigations for a long time. More rarely geothermal data are used for estimation of the past climatic ground surface heat flux histories (SHFHs) (Beltrami et al., 2000, 2001, 2002, 2006). The determination of SHFH is important because this parameter is a fundamental one in general circulation models (GCMs). It characterizes a portion of external forcing which contributes to the change of heat content in the upper crust. And there is a set of difficulties with the experimental and theoretical evaluation of heat flux anomaly associated with its small quantity.

In the report we present the reconstructions of SHFHs in the Urals calculated from GSTHs obtained using geothermal data. The investigations were conducted on several time intervals: 1) the recent 30 kyr; 2) the last millennium and 3) the 150-years reconstruction of SHFH on the basis of the Ural long-term meteorological records. Surface temperature change was preceded by heat flux change with amplitudes about several tens of mW per square meter in all periods under study. The obtained SHFH for the recent 30 kyr was compared with the insolation data at the latitude of 60º N and with the variation of carbon dioxide concentrations. The comparison gives us the timing and general similarity of the heat flux and insolation variations. Changes in carbon dioxide by its shape and chronology are much closer to temperature changes rather than to heat flux changes. The reconstructed SHFH for the last millennium is very close to the variations of total solar irradiance (TSI). A comparison of the reconstructed SHFH and TSI for the last 150 years reveals their non-synchronous oscillation against the background of general increase trend. The ratio of the surface heat flux change to radiative forcing amounts to a few percent for all time intervals and the amplitude's ratio decreases with the increase of time interval.