EMS Annual Meeting Abstracts
Vol. 13, EMS2016-596-1, 2016
16th EMS / 11th ECAC

Simulation and inversion of borehole temperature profiles in surrogate climates: last millennium LULC influence on Spatial distribution and surface coupling

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The knowledge of last millennium climate variability leans on simulations with climate models and reconstruction methods that use proxy data as predictors. Borehole reconstructions are a well stablished approach to reconstruct past surface air temperature (SAT) based on the assumption that SAT changes are coupled to ground surface temperature (GST) changes and transferred to the subsurface by thermal conduction.

In this work we have used a heat-conduction forward model driven by surface temperature from a set of simulations with the Community Earth System Model (CESM) Last Millennium Ensemble to simulate underground temperature perturbation profiles. Subsequently, a pseudo reality experiment has been developed in which an inversion approach has been applied to reconstruct ground surface temperature histories from the simulated profiles and to compare them with climate model temperatures.

We have focused on the influence of land use/land cover change (LULC) on surface air and ground temperatures coupling within the last millennium. Thus, we considered simulations forced by all last millennium external forcing factors (orbital, solar, volcanic, changes in greenhouse gases, anthropogenic aerosols and LULC) as well as by LULC forcing alone in order to identify LULC effects on surface air and ground temperatures coupling.

Previous works have employed similar approaches and their results support the skill of borehole inversion methods to retrieve long-term temperature trends, and the robustness of using the present-day borehole network for reconstructing SAT variations. However, the specific influence of LULC has not yet been analysed. This work offers a discussion about the impact that last millennium LULC have had on subsurface heat transfer both at global and regional scales.