Geophysical Research Abstracts
Vol. 18, EGU2016-8405-1, 2016
EGU General Assembly 2016

Optimization of Borehole Heat Exchanger Arrays

Daniel Schulte (1,2), Wolfram Rühaak (1,2), Bastian Welsch (1,2), Sergey Oladyshkin (3), Ingo Sass (1,2)

(1) Darmstadt Graduate School of Excellence Energy Science and Engineering, Technische Universität Darmstadt, Darmstadt, Germany, (2) Geothermal Science and Technology, Technische Universität Darmstadt, Darmstadt, Germany, (3) Institute for Modelling Hydraulic and Environmental Systems, University of Stuttgart, Stuttgart, Germany

Arrays of borehole heat exchangers are an increasingly popular source for renewable energy. Furthermore, they can serve as borehole thermal energy storages for seasonally fluctuating heat sources like solar thermal energy or district heating grids. However, the uncertainty of geological parameters and the nonlinear behavior of the complex system make it difficult to simulate and predict the required design of borehole heat exchanger arrays. As a result, the arrays easily turn out to be over or undersized, which compromises the economic feasibility of these systems. Here, we present a novel optimization strategy for the design of borehole thermal energy storages. The arbitrary polynomial chaos expansion method is used to build a proxy model from a set of numerical training simulations, which allows for the consideration of parameter uncertainties. Thus, the resulting proxy model bypasses the problem of excessive computation time for the numerous function calls required for a mathematical optimization. Additionally, we iteratively refine the proxy model during the optimization procedure using additional numerical simulation runs. With the presented solution, many aspects of borehole heat exchanger arrays can be optimized under geological uncertainty.