Bayesian Inference for Geothermal Model Calibration

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In geothermal systems, heat flux from underlying magma causes convection of groundwater in the overlying surface layers, with hot rising and cool water descending. The size and shape of the resulting convective plume is determined by the deep heat flux and the shallow geological structures such as major faults, fractured zones and capping formations. Development of a numerical model for predicting the operation of a geothermal field requires parameter values to be obtained by calibrating the model against near-surface data collected in well tests and field exploitation. Our study investigates model calibration, or the inverse geothermal modelling problem, as a problem in statistical inference within a Bayesian framework. Efficiency of sample-based inference is improved using a novel parallel rejection algorithm that utilizes multiple independent compute servers, along with application of the delayed acceptance Metropolis-Hastings algorithm. The methodology is applied to determining the geophysical reservoir parameters near a single well in Fushime, Japan, using measurements of flowing enthalpy and well-head pressure, and to a complete reservoir model for the Mokai field, New Zealand, using measurements of natural-state temperature versus depth.