Correlation based snapshot models of the archeomagnetic field

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For the global time stationary geomagnetic core field, a new modeling concept for Holocene archeomagnetic data is presented. Major challenges consist of the uneven data distribution, missing vector field components and non-linear relations between observations and the geomagnetic potential. Instead of a truncated spherical harmonics approach, we propose a fully Bayesian, Gaussian process based model. Inherently, the Bayesian approach provides location dependent uncertainties.

The geomagnetic potential is assumed to be a Gaussian process whose covariance structure is given by an explicit kernel function, including several hyperparameters. For this kind of non-parametric models, the full Bayesian posterior is numerically intractable. Instead, we propose an approximate computation using a Bayesian update system. In a first step, the full vector records are used to obtain, within Laplace approximation, a rough field estimate. This estimate serves as a point of linearization for the non-linear observations. The approximate posterior is then given by a Gaussian mixture. Marginals for all relevant parameters and the field itself can be computed. We are able to quantify the impact of data coverage on uncertainty reduction.