Geophysical Research Abstracts
Vol. 15, EGU2013-10443, 2013
EGU General Assembly 2013

Modelling geomagnetic reversals as a Gaussian Cox Process

Graeme Sarson, Richard Boys, Andrew Golightly, and Daniel Henderson
Newcastle University, School of Mathematics & Statistics, Newcastle upon Tyne, UK (g.r.sarson@ncl.ac.uk)

The mean rate of reversal of the geomagnetic field, as recorded in the Geomagnetic Polarity Time Scale (GPTS), has long been an object of study. The significance of the apparent long-term variations in the mean rate of reversals — including the occurrence of superchrons — has been debated, as has the possible origins of these variations in external control of the geodynamo (e.g. by the time-varying boundary conditions imposed by mantle convection). Here we model the long-term variations in the reversal rate nonparametrically, in terms of an inhomogeneous Poisson process. Specifically, we consider a Gaussian Cox process, a type of doubly-stochastic Poisson process where the mean rate (or intensity) is modelled in terms of a Gaussian process. Such processes are amenable to likelihood-based inference using Bayesian Markov Chain Monte-Carlo (MCMC) methods, which we employ to provide posterior distributions of the model parameters. The specification of a Gaussian process requires a covariance function, relating the intensity at nearby times; crucially, however, the timescale of the covariance function is not prescribed, but appears as a model hyperparameter, whose posterior distribution is an important output of the analysis. For the geodynamo, this hyperparameter should robustly characterise the timescale of long-term variations. Two different types of Gaussian Cox process are considered: a Log Gaussian Cox Process, applied to binned reversal data; and a Sigmoidal Gaussian Cox Process, applied to the discrete reversal data using a technique involving latent variables. Different MCMC algorithms for sampling the posterior distribution of the model parameters are investigated for both types of process, to check (and to optimise) the convergence of the MCMC chains. This analysis is applied to different records of the GPTS, including those of Cande & Kent (1995) and Gradstein & Ogg (1996). The implications of this analysis for the geodynamo, and the possibility of comparable analysis of the output of numerical geodynamo simulations, are discussed.