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A Bayesian Monte Carlo Markov Chain Method for the Analysis of GPS Position Time Series

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Position time series from continuous GPS are an essential tool in many areas of the geosciences and are, for example, used to quantify long-term movements due to processes such as plate tectonics or glacial isostatic adjustment. It is now widely established that the stochastic properties of the time series do not follow a random behavior and this affects parameter estimates and associated uncertainties. Consequently, a comprehensive knowledge of the stochastic character of the position time series is crucial in order to obtain realistic error bounds and for this a number of methods have already been applied successfully.

We present a new Bayesian Monte Carlo Markov Chain (MCMC) method to simultaneously estimate the model and the stochastic parameters of the noise in GPS position time series. This method provides a sample of the likelihood function and thereby, using Monte Carlo integration, all parameters and their uncertainties are estimated simultaneously. One advantage of the MCMC method is that the computational time increases linearly with the number of parameters, hence being very suitable for dealing with a high number of parameters. A second advantage is that the properties of the estimator used in this method do not depend on the stationarity of the time series. At least on a theoretical level, no other estimator has been shown to have this feature. Furthermore, the MCMC method provides a means to detect multi-modality of the parameter estimates.

We present an evaluation of the new MCMC method through comparison with widely used optimization and empirical methods for the analysis of GPS position time series.