Bayesian Inference and Forecast on Renewal Processes for Recurrent Earthquakes with Uncertain Occurrence Times

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We discuss parameter inference and forecast in renewal processes for recurrent earthquakes suffering from uncertainties in their occurrence times. Exact likelihood and hazard evaluation in point process theory involves multiple integral with respect to uncertain occurrence dates and are often difficult to calculate even numerically. Alternatively, Monte Carlo simulation of the uncertain occurrence histories can be used for the evaluation by calculating the integrated functions for respective simulated histories and simply averaging them. We apply a renewal model with the Brownian Passage Time (BPT) distribution to Japanese paleoseismic catalog in which at least 2 latest events are specified for each fault segment. It is shown that the Monte Carlo method yields almost the same results as numerical integration. In parameter inference, we assume a common coefficient of variation (COV) parameter for recurrence intervals of Japanese paleoearthquakes due to scarcity of their histories. From datasets in 73 inland paleoseismic sites in Japan, we obtain a Bayes estimate of the common COV at 0.50, which is significantly larger than the COV estimate at 0.24 currently applied in the long-term forecast held by the Headquarters for Earthquake Research Promotion (HERP) of Japan. The difference in COV’ s estimates makes critical influences on long-term probability forecast in several fault segments. We also show numeric experiments of parameter inference and forecast for virtual active fault and compare Bayesian inference and forecast to plug-in methods with maximum likelihood estimates.

Keywords: Bayesian forecast, Coefficient of variation, Renewal process

