A Bayesian prediction for active faults using spatial similarity of variation of recurence intervals

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We propose a new Bayesian method of probability prediction for recurrent earthquakes of inland active faults in Japan. Renewal processes with the Brownian Passage Time (BPT) distribution are applied for over a half of active faults in Japan by the Headquarters for Earthquake Research Promotion (HERP) of Japan. Long-term forecast with the BPT distribution needs two parameters; the mean and coefficient of variation (COV) for recurrence intervals. The HERP applies a common COV parameter for all of these faults because most of them have very few specified paleoseismic events, which is not enough to estimate reliable COV values for respective faults. However, different COV estimates are proposed for the same paleoseismic catalog by some related works. It can make critical difference in forecast to apply different COV estimates and so COV should be carefully selected for individual faults.
Recurrence intervals on a fault are, on the average, determined by the long-term slip rate caused by the tectonic motion but fluctuated by nearby seismicities which influence surrounding stress field. The COVs of recurrence intervals depend on such stress perturbation and so have spatial trends due to the heterogeneity of tectonic motion and seismicity. Thus we introduce a spatial structure on its COV parameter by Bayesian modeling with a Gaussian process prior. The COVs on active faults are correlated and take similar values for closely located faults. It is found that the spatial trends in the estimated COV values coincide with the density of active faults in Japan. We also show Bayesian forecasts by the proposed model using Markov chain Monte Carlo method. Our forecasts are different from HERP’s forecast especially on the active faults where HERP's forecasts are very high or low.

Keywords: earthquake recurrence interval, BPT distribution, Coefficient of variation

