Statistical forecasts and tests for small interplate repeating events near the east coast of NE Japan in 2008

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1. Introduction

A lot of sequences of small repeating earthquakes with nearly identical waveform have been found near the east coast of NE Japan. Those events are considered to be occurring on the same small asperity surrounded by creeping zone on the plate boundary [Igarashi et al., 2003; Uchida et al., 2003]. They are unique data to test predictability of statistical models on renewal process, because the events are identified objectively by waveform correlation and the recurrence times are short enough to evaluate the forecast. Forecast bin to specify the event compared with those for CSEP by Schorlemmer et al. (2007) is fairly smaller in volume of location and in focal mechanism but larger in magnitude. We prospectively estimated the probabilities of occurrence in 2008 for 127 sequences consisting of five events or more in the period from 1993 through 2007 and opened them on a Web site.

http://www.aob.geophys.tohoku.ac.jp/˜uchida/kenkyuu/souji-yosoku/souji-kakuritsu-e.html

2. Model for probabilities

We computed the conditional probabilities, not rate, for bin with a Bayesian approach using log-normal distribution for recurrence time between successive events. Prior distributions are uniform and inverse gamma for mean and variance of logarithm of time interval, respectively. The probability is binary forecast of occurrence.

3.Testing and results

We tested forecasted probabilities and compared performances with alternative model, based on the log-likelihood score (LL) and Brier score (BS). The LL is the sum of sequence values expressed as Ev$*$ln(Pi)+(1-Ev)$*$ln(1-Pi) where Pi is the event occurrence probability of the i-th sequence and Ev is binary function, Ev=1 for event occurrence and Ev=0 otherwise. The LLmean is the mean log-likelihood of sequence value. The model is considered to be better, when LL and LLmean are larger than alternative one. If BS, which is defined as average of (Pi-Ev)ˆ2, is smaller, we treat the forecast is better.

As we have not finished compiling the catalogue of repeating events for 2008 at abstract submission, we write here the testing results for the period from January through July, 2008, in which 31 bins are filled with specified events. The forecast results in LLmean=-0.448 and BS=0.150, for which the N-, L-, and BS-test accept the validity of our forecast. The R-test reveals that proposed prediction is significantly superior to Poissonian forecast whose LLmean is -0.537 and BS is 0.178. Test of the difference in Brier scores also shows our forecast is in high significance statistically in comparison with Poissonian one.