Comments on the BPT model for recurrent earthquakes with uncertain origin times

*Masajiro Imoto[1], Nobuyuki Morikawa[1], Hiroyuki Fujiwara[1]

1. National Research Institute for Earth Science and Disaster Resilience

Great earthquakes (M8 and larger) repeatedly occur along the Kurile Trench off Hokkaido. The Earthquake Research Committee (ERC), the Government of Japan has reported the long-term probability of a much larger one in the 17-th century (17-th type earthquake), as indicated by studies of tsunami deposits (ERC report, 2017). In calculating the probability, the Brownian Passage Time (BPT) distribution is adopted to the recurrent earthquake series. Here, two kind of uncertainties are managed, one related to uncertain origin times given in the form of intervals, the other related to consolidating two different series of origin times obtained at the Mochirippu-toh and the Kiritappu Marsh.
For the former uncertainty, Ogata (JGR, 1999) formulated the likelihood function of such cases in a multi-product form of a probability density function integrated with respect to origin times over uncertain intervals (ERC report, 2001). A Monte Carlo simulation method proposed by Parsons (2008) becomes a good approximation of Ogata's formula with a sufficiently large number of simulated series. This method is practically applied to an M8 earthquake along the Sagami trough (ERC report, 2014). However, the method applied to the 17-th type earthquake in the ERC report (2017) (ERC method) differs from that by either Ogata or Parsons. Accordingly, optimal sets of model parameters determined by the ERC method differ from those determined by them, as shown by a simulation reproducing the ERC report. It is difficult to interpret the ERC method in terms with statistics except for a certain optimization of model parameters.
The latter uncertainty concerns a procedure for two or more independent earthquake series considered as candidates of recurrent earthquakes in a common period. If the reliability of data is likely to differ from set to set, a weighted likelihood procedure could be useful for constructing a statistical model. In the present study, applying the same weight, 0.5, to the sets at the Mochirippu-toh and the Kiritappu Marsh, a likelihood function is represented by the product of the square root of the likelihood for the set of the Mochirippu-toh and that of the Kiritappu Marsh. An advantage of this procedure is that the reliability of each set is explicitly given as a weight of the likelihood function.

Keywords: Brownian Passage Time distribution, Inverse Gaussian distribution, Uncertain origin times, Great Earthquake, Kurile Trench

