Difference of foreshock characteristics between real data and synthetic ETAS catalogs: through the application of an empirical earthquake forecast model based on foreshocks

*Fuyuki Hirose[1], Koji Tamaribuchi[1], Kenji Maeda[2]

1. Seismology and Tsunami Research Department, Meteorological Research Institute, 2. Seismology and Volcanology Department, Japan Meteorological Agency

It is pointed out that there is no effective earthquake forecast model than ETAS model [Ogata, 1988, JASA] because earthquakes are probabilistic phenomena driven by seismically cascading process represented by a superposition of background activity and epidemic-type aftershock sequence [e.g., Felzer et al., 2004, BSSA; 2015, NatureGeo]. On the other hand, it is also pointed out that the information of foreshock characteristics could be an effective clue of earthquake forecast because foreshocks are a part of the nucleation process, including precursory slips, which ETAS model cannot represent [e.g., Lippiello et al., 2012, SciRep; Bouchon et al., 2013, NatureGeo].

To investigate reproducibility of real data by ETAS model, we made synthetic earthquake catalogs (hereafter ETAS catalogs) based on ETAS parameters obtained from real data, and then we applied the earthquake forecast model that was formulated using real foreshock data [e.g., Maeda & Hirose, 2017, Yochiren98] to ETAS catalogs, and investigated the efficiency of the forecast. The forecast model optimized for Izu Islands is as follows: when 3 events (foreshocks) of M >= 3.0 occur in area of latitude $0.2°$ ×longitude $0.2°$ during 3 days, a mainshock of M >= 5.0 will occur within 5 days just after the event. This model with specific parameters is the most efficient one among those with other parameters by the measurement of likelihood.

Our investigation resulted in that real data yielded higher scores than ETAS catalogs. In other words, it is hard for ETAS model to reproduce foreshock characteristics, which might be related to precursory slips, well, indicating the earthquake forecast model based on foreshock characteristics is more efficient rather than ETAS model. However, our investigation might be biased because our forecast model based on foreshocks was optimized for real data. To perform reliable testing, it may also be necessary to investigate using our forecast model parameters optimized for ETAS catalogs.

Keywords: Earthquake forecast model, Foreshocks, ETAS model, Izu Islands