A database of stochastic declustered catalogs

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Declustering is often required before analyzing earthquake catalogs, especially when testing some hypotheses of seismcity associated with tectonic environments, for temporal clustering of foreshocks, aftershocks, and swarms always complicate the analysis. As deterministic declustering methods include subjective choice of parameters, clustering-model based probability declustering methods, such as stochastic declustering (Zhuang et al., 2002, 2004), become more and more popular. However, as these probability declustering methods are not straightforward for computing programming. Many studies still rely on window-based or link-based deterministic declustering methods. This study tries to make an effort on providing an accessible database of declustered catalogs.

The ETAS model, on which we base the stochastic delcustering method, can be represented by a time-varying seismicity rate function (Ogata and Zhuang, 2006)

$$\lambda(t,x,y) = \mu(x,y) + \sum_{\{k:\ t_k<t\}} \kappa(m_k) g(t-t_k) f(x-x_k, y-y_k|m_k). \qquad (1)$$

In the above equation, $\mu(x,y)$ is the background intensity function and is assumed independent of time. The functions $g(t)$ and $f(x,y|m_k)$ are respectively the normalized response functions of the occurrence time and the locationof an offspring from an ancestor of magnitude m_k.

In the seismicity rate function of the ETAS model, the proportion of the contribution from event i at the occurrence of (t_j, x_i, y_j) could be explained as the probability that event j is triggered by the ith event,

$$\rho_{ij} = \xi(t_j, x_j, y_j; t_i, x_i, y_i)/\lambda(t_j, x_j, y_j), \quad j > i. \qquad (2)$$

The probability that the jth event belongs to the background is

$$\varphi_j = \mu(x_j, y_j)/\lambda(t_j, x_j, y_j). \qquad (3)$$

If we select each event j with probabilities ρ_{ij} or φ_j, we can form up a new process being the triggered process by the ith event, or the background process, respectively.

In this study, we have built the database of stochastically declustered catalogs for the JMA catalog ($M_J \geq 4.0$, 1926–2009) and the SCEC catalog ($M \geq 3.5$, 1932–2009), including: 1) background probabilities for each earthquake, 2) copies of background catalogs, 3) probability matrix of ρ_{ij} and φ_j, and 4) random realizations of the family tree structures in the original catalog.

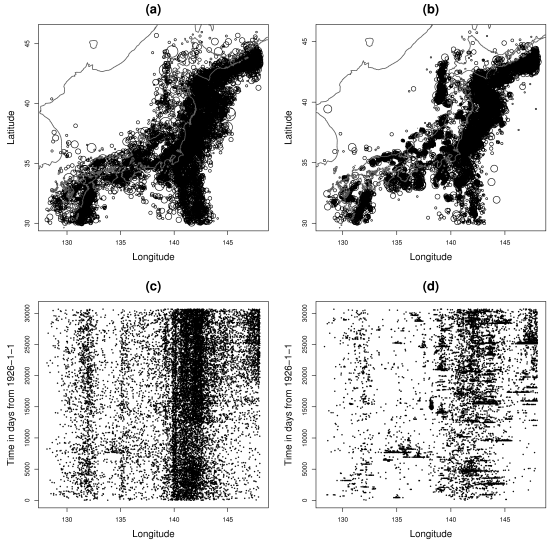

Figure 1: A realization of stochastically declustered JMA catalog ($M_J \geq 4.0$). (a) and (b) are the location maps for background events and triggered events, respectively. (c) and (d) are space-time plots for background seismicity and triggered seismicity, respectively.

References

[1] Ogata Y. and Zhuang J. (2006). Space–time ETAS models and an improved extension. Tectonophysics. 413(1-2), 13-23.

[2] Zhuang J., Ogata Y. and Vere-Jones D. (2002). Stochastic declustering of space-time earthquake occurrences. J. Amer. Statist. Assoc. 97: 369-380.

[3] Zhuang J., Ogata Y. and Vere-Jones D. (2004). Analyzing earthquake clustering features by using stochastic reconstruction. J. Geophys. Res., 109, No. B5, B05301.