Detection of significant changes in the background seismicity

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Changes in the background seismicity of shallow crustal events in the whole region of inland Japan from 1998 to 2002 are examined by using the JMA catalog. The search shows two areas where significant changes took place. The most significant was the volcanic earthquake swarm occurring prior to the M6.1 Northern Iwate earthquake of 1998. Another was seismic quiescence in the Mie prefecture in 1999. It started simultaneously with the swarm activity in an adjacent area. However, no large earthquake occurred in and around the anomalous area after the quiescence.

This study intends to produce statistical data on seismic quiescence, especially how often significant quiescence appears without a following large event. The earthquake occurrence rate is expressed as a sum of two terms. One is the aftershock activity given by the space-time extended ETAS model (Ogata, 1998) with small modifications in the spatial term. Another is the background activity. We assume a box-car-function type temporal change lasting one year. We adopt the EM algorithm (Dempster et al., 1977) to obtain the maximum likelihood estimate of parameters in the earthquake occurrence model. We found that the algorithm correctly gives convergence regardless of the wide range of initial parameters we tried. Statistical significance of changes in the background seismicity is examined by comparing AICs of two models, i.e., a constant occurrence rate model and a one-year anomaly model. The confidence level for recognizing seismicity anomaly is determined on the basis of results of Monte Carlo simulation. We use -10.8 for the minimum threshold of the difference in AICs, which was the smallest among the values of AIC difference obtained from 1500 trials, in which occurrence rate is assumed to be constant. The whole area of inland Japan is divide by grids with spacing of 0.2 degrees in longitude and latitude. We used ZMAP (Wiemer, 2001) to select 200 earthquakes for each of 1,000 grids.