Statistical confirmation of a relationship between excitation of the electric signal and earthquakes in the Beijing region

Jiancang Zhuang[1], Yosihiko Ogata[2], David Vere-Jones[3], Li Ma[4]

[1] Dept Statist. Sci., Graduate Univ. Advanced Studies, [2] Inst. Stats. Math., [3] Victoria University of Wellington, [4] China Seismological Bureau

This paper presents a probability model to modeling the relationship between the occurrence times of earthquakes and the precursory data. The model used is a version of Ogata"s LIN-LIN algorithm for examining the influence of an explanatory signal on the occurrence of events in a stochastic point process, which can be also used for multi-station and multi-precursor data.

To test the causality, we applied the suggested model to the observation data from the ultra-low frequency electric field. Signals from 4 stations monitoring the electric field in the vicinity of Beijing are used as explanatory variables in forecasting the occurrence of events with M$¥ge$4 within a 300 km circle centered on Beijing. The explanatory effect is shown to be highly significant, and greatly superior to the explanatory effect of the same signals applied to a randomized version of the earthquake data. All four stations show significant explanatory power, although in combination the two most effective tend to dominate the forecasts. The results are stable against perturbations in the time period or region of observation. The predictions appear to be most effective for events with M$¥ge$5, and for events closer to the observing stations, although some of the smaller events appear to produce detectable signals of over 100km from the source. Probability gains over the simple Poisson process are in the region up to 3 - 4 for the events of magnitudes 5 or larger. Special consideration is given to detection of events in the region around the Ms7.8 Tangshan Earthquake in 1976, and an interesting spatial pattern of predicted and unpredicted events has been found in the region, which need further studies.

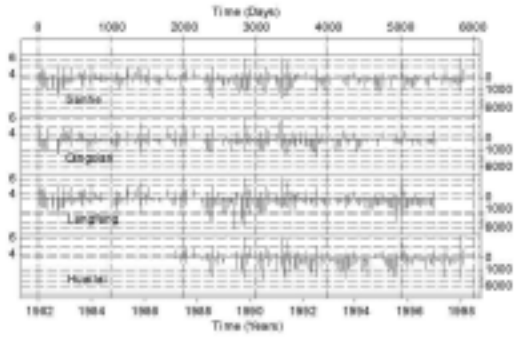

Figure 2: Signal strengthes recorded by each station (below the level) and the earthquake occurrence times within 300 km around the stations (above the level). The signals are drawn in the scale their 4-th roots.

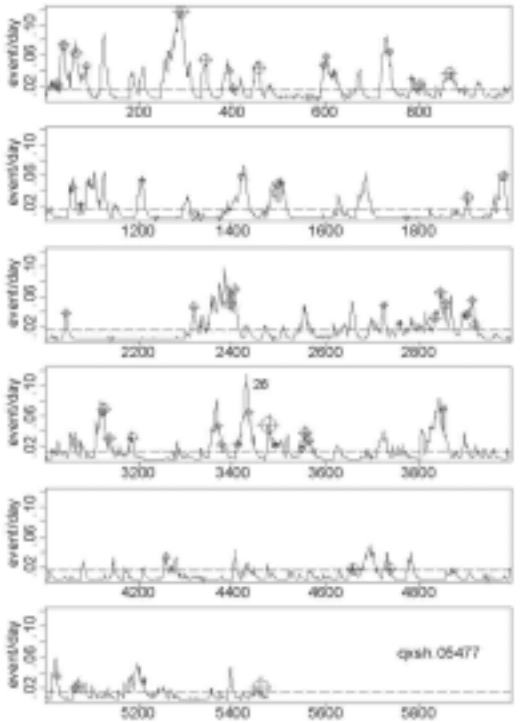

Figure 6: Plot of the conditional intensity function fitted from multi-predictor model with inputs from Qingxian (Q) and Sanhe (S) stations. The dash horizontal line represents the mean rate. The earthquake are marked by circles, with different sizes representing the differences in magnitudes.