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Information Gains of Seismicity Models for Moderate Earthquakes Based on a P Wave Velocity Model in Japan

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Seismicity models provide comprehensible results in earthquake prediction research. Higher-performance models must incorporate various kinds of predictive information. In this study, we consider information from a P wave velocity model as a predictive parameter, which may be useful for estimating time invariant seismic potential. Estimating P wave perturbations throughout Japan, Matsubara reported characteristic features of the perturbations in zones beneath active faults. Before building a seismicity model incorporating such information, it is necessary to estimate the model's performance by retrospective analysis. When we estimate the performance of a seismicity model with certain predictive parameters, we can use the Kullback-Leibler quantity of statistics in terms of information gain per event (IGpe). We define two distributions of parameters: the background distribution, which includes parameters over the entire space domain, and the conditional distribution, which includes parameters at earthquake hypocenters. The distance between the conditional and background distributions gives the IGpe value. We selected 200 epicenters of earthquakes with magnitudes of 5.0 and larger for 1961 to 2008 to estimate the conditional distribution. More than 4000 points are selected at every 0.1 degree by 0.1 degree grid for the background distribution, which incompletely cover inland parts of Japan since points with lower resolution are removed. P wave perturbations are considered at four different depths (10, 15, 20 and 25km of each point) for both distributions. We compared the two distributions at each depth but found no significant difference in the average value of perturbations between the conditional group and the background group. All these distributions are well approximated with normal distributions. Therefore, IGpe can be estimated directly from the means and standard deviations of both distributions at each depth. We obtain an IGpe of 0.03 or less for all depths. However, the correlation coefficients between perturbations at two different depths in the conditional distributions exceed those in the background distributions. Considering multiple parameters with correlations, we estimate an IGpe of 0.3 with the method proposed by Imoto. This value corresponds to a probability gain of 1.35.