A new method for assessing the completeness of earthquake catalogues

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A new method based on the Chi-square test was developed for the assessment of the completeness of earthquake catalogues, with the null hypothesis,

$H_0 : p_k = p_{0k}$ for all k

where p_k and p_{0k} are probabilities of the k-th magnitude interval calculated from an earthquake catalogue and a model distribution assumed, respectively. Doubly-truncated exponential function was assumed for the model distribution. Given an earthquake catalogue, the Pearson's test statistic is calculated for each magnitude interval and compared with the Chi-square of the significance level of α, $X^2_{1-\alpha}$. All the magnitude intervals at which the Pearson's test statistics are less than the Chi-square values are identified, then the minimum magnitude interval of them is chosen as the magnitude of catalogue completeness, m_c.

To determine a proper range of the significance level, the performance test was carried out with synthesized incomplete earthquake catalogues where the Richter-b value, the maximum magnitude, and the magnitude range of complete portion are given. The goal of the performance test was not to see how accurately m_c is located but to see how accurately the Richter-b value and the maximum magnitude are estimated, which is in line with the reason why we assess the completeness of earthquake catalogues. The performance test showed that the significance level of 5~10 % yields reasonable estimates of the Richter-b value and the maximum magnitude. At larger significance levels, while the estimates of the Richter-b value and the maximum magnitude are little improved, m_c increases and more catalogues fail to have m_c estimate, which means we discard more earthquake data.