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Frequency distribution of the number of earthquake occurrence

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Considering that seismic activity includes correlated events such as fore- and aftershocks, a frequency distribution of the number of earthquake occurrence must be different from the Poisson distribution. In this presentation, improved distribution functions are discussed in order to promote better understanding one of the features of seismic activity and a proper evaluation for earthquake forecast.

A frequency distribution of earthquakes has sometimes been fitted by the negative binomial distribution. However, this will be valid for the case that a mean r of the data set is large, e.g. r>>1, and it is questionable when the events occur only scarcely. In the case that the mean value is small, the distribution seems to be well fitted by a power-law distribution. Consequently, the authors proposed a following function as a possible improved distribution function (Yamashina et. al, JPGU, 2012), f(x) = c (x^-a) exp(-bx) (i.e. a discrete gamma distribution). In addition, another function, f(x) = c (x^-a) exp(-b/x) (i.e. a discrete negative gamma distribution) is discussed here. As a whole, these two functions fit the data for a wide range of the mean values. Here, in the case of a large mean value, there seems to be a tendency that the latter fits well rather than the former.

The present functions diverge at x=0, if the parameter a is positive. In the present discussion, the functions are applied only for x=1 or larger. It is because, for example, the frequency of x=2 will correlate much with that of x=1, but there are no particular reasons that the correlation with x=0 is also large. Consequently, it may be difficult to fit the frequency of x=0, 1 and 2 by the same distribution function. The frequency of x=0 is determined by the rest of the summation for those of x=1, 2, and so on.

In the CSEP earthquake-forecast project, the performance of respective forecast is evaluated with assuming the Poisson distribution. Since the actual frequency distribution of earthquake occurrence is somewhat different from the Poisson distribution, the reliability of the result is left for further discussions. In order to advance the prediction-oriented research, it will be desired to prove the difference of the result with a plausible function of the frequency distribution.

Keywords: frequency distribution, number of earthquake occurrence, CSEP