Assessing temporal variations in the Gutenberg-Richter distribution for a short-term forecast model

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The Gutenberg-Richter distribution plays a major part in earthquake forecasting and subsequent earthquake hazards modeling. The spatial variability of the parameters of the distribution, a and b, has been studied extensively. The general consensus is that the parameters vary spatially, and that using a common value of the parameters over a large area will result in a poor fit of the model (Schorlemmer, Wiemer et al. 2004).

In contrast, the temporal variability of the parameters a and b has not been studied as rigorously. There are various reasons behind this incongruity. For example, some studies have shown that the temporal variability is not as great as the spatial variability (Wiemer and Wyss 2002). Other studies have shown that the parameter's variations will average out over time (Schorlemmer, Wiemer et al. 2004) and as earthquake forecasts are often specified for a long period of time, short-term fluctuations in the parameters are not of interest. However, for a short-term forecast, these fluctuations may be very important. If they do exist they have the potential to form the basis of an intuitive short-term forecast model.

Therefore, this research investigates the temporal variability of the parameters of the Gutenberg-Richter distribution over a 32 year period in the Tamba region of Japan. To statistically test if the parameters differ temporally, ANOVAs and ANCOVAs are applied to both the least squares and maximum likelihood estimates of the parameters.

The results show that the models with temporally-variant parameter values described the data significantly better than a temporally-invariant model, irrespective of reasonable minimum magnitudes of completeness values of the data. It is not always true that the maximum likelihood estimates and the least squares estimates agree from year to year. This is important, as it suggests that there may be valuable information in the least squares estimates of the parameters, particularly if the investigator is interested in modeling the extremes of the distribution. Future work will involve modeling the fluctuations in the b value from year to year, in order to forecast next year's distribution of earthquakes, for potential submission to a CSEP initiative.

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