The EEPAS forecasting model: rationale, formulation and testing

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Abstract

The EEPAS (Every Earthquake a Precursor According to Scale) model is a method of long range forecasting that uses the catalogue of past earthquakes to estimate the time-varying occurrence rate density of future large earthquakes. It is based on the precursory scale increase (ψ) phenomenon, which has been retrospectively recognised before most of the larger shallow earthquakes in the catalogues of New Zealand, California, Japan, Greece and Italy. An analysis of all the ψ-data has shown that precursory scaling relations exist by which the mainshock-magnitude, precursor-time and precursor-area can all be estimated from the magnitude level of the precursory earthquakes. Setting aside the question of how to recognise the ψ pattern before the mainshock occurs, we treat each earthquake in the catalogue as a long-term precursor of a future larger event. Each earthquake thus contributes to the rate density of future earthquake occurrence on a scale determined by its magnitude through the ψ precursory scaling relations. The weight of each earthquake's contribution is allowed to depend on its proximity to other earthquakes, e.g. an aftershock may be given low weight.

The model has been fitted to shallow earthquakes in the New Zealand catalogue above magnitude 5.75. On a likelihood criterion, it explains the data better than either a stationary uniform Poisson model or a stationary Poisson model with a location density that depends on proximity to past earthquakes. When applied with unchanged parameters to the CNSS catalogue for California, it again explains the data better than the other two models fitted to an early period of the same catalogue. The EEPAS model outperforms the other two models if all earthquakes are weighted equally, and more so if aftershocks are down-weighted. The results show that nearly all earthquakes above magnitude 5.75 in the New Zealand and California regions exhibit the ψ phenomenon.