EGU21-8775
https://doi.org/10.5194/egusphere-egu21-8775
EGU General Assembly 2021

Prospective Evaluation of Multiplicative Hybrid Earthquake Forecast Models for California

Jose A. Bayona[1], William Savran[2], Maximilian Werner[1], and David A. Rhoades[3]
[1]University of Bristol, School of Earth Sciences, Bristol, United Kingdom of Great Britain – England, Scotland, Wales (jose.bayona@bristol.ac.uk)
[2]University of Southern California, Southern California Earthquake Center, Los Angeles, U.S.A.
[3]GNS Science, Lower Hutt, New Zealand.

Developing testable seismicity models is essential for robust seismic hazard assessments and to quantify the predictive skills of posited hypotheses about seismogenesis. On this premise, the Regional Earthquake Likelihood Models (RELM) group designed a joint forecasting experiment, with associated models, data and tests to evaluate earthquake predictability in California over a five-year period. Participating RELM forecast models were based on a range of geophysical datasets, including earthquake catalogs, interseismic strain rates, and geologic fault slip rates. After five years of prospective evaluation, the RELM experiment found that the smoothed seismicity (HKJ) model by Helmstetter et al. (2007) was the most informative. The diversity of competing forecast hypotheses in RELM was suitable for combining multiple models that could provide more informative earthquake forecasts than HKJ. Thus, Rhoades et al. (2014) created multiplicative hybrid models that involve the HKJ model as a baseline and one or more conjugate models. Particularly, the authors fitted two parameters for each conjugate model and an overall normalizing constant to optimize each hybrid model. Then, information gain scores per earthquake were computed using a corrected Akaike Information Criterion that penalized for the number of fitted parameters. According to retrospective analyses, some hybrid models showed significant information gains over the HKJ forecast, despite the penalty. Here, we assess in a prospective setting the predictive skills of 16 hybrids and 6 original RELM forecasts, using a suite of tests of the Collaboratory for the Study of Earthquake Predicitability (CSEP). The evaluation dataset contains 40 M≥4.95 events recorded within the California CSEP-testing region from 1 January 2011 to 31 December 2020, including the 2016 Mw 5.6, 5.6, and 5.5 Hawthorne earthquake swarm, and the Mw 6.4 foreshock and Mw 7.1 mainshock from the 2019 Ridgecrest sequence. We evaluate the consistency between the observed and the expected number, spatial, likelihood and magnitude distributions of earthquakes, and compare the performance of each forecast to that of HKJ. Our prospective test results show that none of the hybrid models are significantly more informative than the HKJ baseline forecast. These results are mainly due to the occurrence of the 2016 Hawthorne earthquake cluster, and four events from the 2019 Ridgecrest sequence in two forecast bins. These clusters of seismicity are exceptionally unlikely in all models, and insufficiently captured by the Poisson distribution that the likelihood functions of tests assume. Therefore, we are currently examining alternative likelihood functions that reduce the sensitivity of the

evaluations to clustering, and that could be used to better understand whether the discrepancies between prospective and retrospective test results for multiplicative hybrid forecasts are due to limitations of the tests or the methods used to create the hybrid models.