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Does using Coulomb stress change information create quantifiable improvements in earthquake forecast models?

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The Darfield, New Zealand earthquake sequence has provided an interesting and active sequence for rigorous testing of earthquake forecast models that include Coulomb stress change information. Coulomb forecast models have long been discussed in the scientific literature as providing useful forecast information during aftershock sequences; however, a challenge that has limited our understanding of their ability is the difficulty in specifying such models so that they are prospective and unbiased. With the Darfield sequence we have the opportunity to use the Collaboratory for the Study of Earthquake Predictability (CSEP) earthquake forecast testing centre, that is already in operation in New Zealand, to develop Coulomb models in such a way. By taking advantage of archived data sets to provide all of the necessary inputs into the models, we are able to pseudo-prospectively test the models within the CSEP testing centre. An initial study by Steacy et al (2013) tested several models with Coulomb information. These models include a hybrid model with STEP (Gerstenberger, 2005), a rate-and-state based model, and several non-Coulomb models. Results of this study indicate that adding Coulomb information that was available 10-days after each main event, to a more traditional Omori-based model, provides a statistically improved forecast, even when attempting to test in an unbiased fashion. The experiment also highlighted significant differences when testing models retrospectively and pseudo-prospectively; these differences are driven by the reduced quality of data available to models in pseudo-prospective tests. Following this study, we are now implementing a larger experiment in collaboration with the European Union funded Strategies and Tools for Real Time Earthquake Risk Reduction (REAKT) project. In this experiment we are testing more than 20 Coulomb and non-Coulomb models within the NZ-CSEP testing centre. These models include hybrid statistical-Coulomb models and pure statistical and Coulomb models. We will discuss both experiments and their implications.

Keywords: Earthquake forecasting, New Zealand, CSEP, Coulomb, aftershock model, Christchurch