Geophysical Research Abstracts,
Vol. 11, EGU2009-3289, 2009
EGU General Assembly 2009

A Test of Earthquake Forecasting with Numerical Earthquake Simulators: Do Similar Pasts in Simulation Data Imply Similar Futures?

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Topologically realistic earthquake simulations are now possible using numerical codes such as Virtual California (VC). Currently, VC is written in modern object-oriented C++ code, and runs under MPI-II protocols on parallel HPC machines such as the NASA Columbia supercomputer. In VC, an earthquake fault system is modeled by a large number of Boundary Elements interacting by means of linear elasticity. A friction law is prescribed for each boundary element, and the faults are driven at a stressing rate that is consistent with their observed long-term average offset rate. We have carried out simulations for earthquakes on models of California's fault system for simulation runs over time intervals from tens of thousands of years to millions of years. We then use a data "scoring" technique to determine which times in the simulations are most similar to today (2009), as judged by having similar (simulated) paleoseismic histories. Using the top-scoring 1% of "optimal" times, we compute, for example, the probabilities for occurrence of M > 6.7 magnitude earthquakes. We then determine the probabilities for participation of each boundary element in >1 events having M > 6.7 over the next 30 years (note that the threshold M>6.7 is arbitrary, and the method can be adapted to events of any reasonable magnitude). A major question that we address in this study is: Given that 2 or more optimal times have similar event histories, how similar are their event futures over the next 30 years? This question, which is of primary concern in all forecasting methods, has not been addressed previously in earthquake forecasting studies. In this talk, we will address this question using VC simulations. We present a method to compute not only 30-year forecast probabilities and their uncertainties, but also outline a method for comparing the statistics of all optimal 30-year forecast windows to determine statistically the extent of their similarity.