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Computing earthquake forecast probabilities using numerical simulations of the physics of realistic fault systems (Virtual California)

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Earthquake forecasting in space and time has been accomplished in the past using methods based on “expert opinion”. However, recent studies have called attention to the desirability of using more automated methods, including the use of numerical simulations of interacting earthquake fault systems [1]. “Virtual California” is a topologically realistic model which has been used to simulate earthquakes on the San Andreas fault and its associated fault system. The Virtual California model includes elastic interactions among the faults in the model, driving at the correct plate tectonic rates, and frictional physics on the faults using the physics obtained from laboratory models with parameters consistent with the occurrence of historic earthquakes. An important consequence of the elastic interactions in the model is the appearance of correlations and space-time patterns of occurrence of events. Without the interactions, each fault element would behave independently, but with the interactions, cooperative phenomena and patterns are observed. Previous numerical analysis of this simulation has focused on the distribution of recurrence times between large events. From this it is possible to compute the waiting times until the next great earthquake for California faults. Here we report on a variety of recent results. 1) We have developed a new method for generating and scoring a synthetic earthquake catalog utilizing Virtual California. The idea is to use paleoseismic data to identify (“score”) intervals within

the artificial data which most closely resemble the current seismic state of California; 2) We use the scored simulations to compute probability of future large earthquakes in space and time; 3) We have developed advanced simulation algorithms to handle large data runs, including models having dipping faults, and depth dependent slip. In this talk we summarize and discuss these issues, and indicate directions for the future.

[1] EH Field, BSSA, 97, 1033, (2007)