SPATIOTEMPORAL CLUSTERING IN SIMPLE EARTHQUAKE FAULT SYSTEMS

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ABSTRACT

While understanding the dynamics of seismic activity is fundamental to the investigation of the earthquake process, detailed studies of the earthquake fault system are difficult because the underlying dynamics of the system are not observable In addition, the fact that real earthquake fault systems are not composed of identical homogenous materials The variety of materials with different physical properties, such as frictional strength under pressure, can cause a variety of behaviors Inhomogeneities in the form of stress-relieving micro-cracks have been incorporated into long-range OFC models, resulting in a better understanding of GR scaling In addition, inhomogeneities have been introduced into fully elastic models resulting in either power-law statistics of event sizes or a separate distribution of events combined with large, system size events However, to date, none of these approaches have been able to reproduce both the temporal clustering and the complete magnitude-frequency distribution scaling regime that are primary features of natural seismicity and a critical component in the assessment of earthquake hazard In order to study a system with some aspects of spatial heterogeneities, we established a simple, long-range cellular automata model for earthquake fault systems based on the OFC model that incorporates a fixed percentage of stronger sites, or 'asperity cells', into the lattice These asperity sites are significantly stronger than the surrounding lattice sites but eventually rupture when the applied stress reaches their higher threshold stress The introduction of these spatial heterogeneities results in a rich array of spatial and temporal clustering in the model, including large, recurrent events with foreshock and aftershock sequences and accelerating seismic moment release and mimics those seen in natural fault systems along with GR scaling

INTRODUCTION

Despite the multitude of space-time patterns of activity observed in natural earthquake fault systems, the bulk of the research associated with these patterns has focused on a relatively small fraction of the events, those associated with either larger magnitudes or persistent, localized signals such as aftershock sequences