Damage in simple models of earthquake fault systems

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Natural earthquake fault systems are highly heterogeneous in space, where inhomogeneities occur because the earth is made of a variety of materials which hold and dissipate stress differently. The spatial arrangement of these materials is dependent on the geologic history and because this history typically is quite complex, the spatial distribution of these various materials occurs on a variety of length scales. One way that the inhomogeneous nature of fault systems manifests itself is in the spatial patterns which emerge in seismicity (Tiampo et al., 2002, 2007). Despite their inhomogeneous nature, real faults are often modeled as spatially homogeneous systems. One argument for this approach is that earthquake faults experience long range stress transfer, and if this range is longer than the length scales associated with the inhomogeneities of the system, the dynamics of the system may be unaffected by the inhomogeneities. However, it is not clear that this is always the case. In this work we study the scaling of earthquake models that are variations of Olami-Feder-Christensen (OFC) and Burridge-Knopoff (BK) models, in order to explore the effect of spatial inhomogeneities on earthquake-like systems when interaction ranges are long, but not necessarily longer than the distances associated with the inhomogeneities of the system (Burridge and L. Knopoff, 1967; Rundle and Jackson, 1977; Olami et al., 1988). For long ranges and without inhomogeneities, such models have been found to produce scaling similar to GR scaling found in real earthquake systems (Rundle and Klein, 1993). In the earthquake models discussed here, damage is distributed inhomogeneously throughout and the interaction ranges, while long, are not longer than all of the damage length scales. We find that the scaling depends not only on the amount of damage, but also on the spatial distribution of that damage.