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A stress dependent BASS model for earthquakes, damage and fracture

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The Branching AfterShock Sequence (BASS) model is a self-similar statistical model for the occurrence of aftershocks. BASS is related to the Epidemic Type Aftershock Sequence model (ETAS) that has been widely used to carry out statistical studies of both aftershocks and regional seismicity. The ETAS model is based upon the Gutenberg-Richter frequency magnitude relation, Omori's law, and a productivity relation based primarily on a mean parent-daughter ratio. We have introduced the BASS model as a complementary alternative to ETAS (Turcotte et al., GRL, 34, L12303, 2007). The models are closely related but differ in that the BASS model is totally self-similar, the statistics of aftershock occurrence do not depend on the magnitude of the mainshock, in contrast to ETAS. In this talk we introduce a new idea for BASS, by linking seismicity production to a regional stress variable. This new form of BASS has the additional physics in it of regional stress accumulation and release. In particular, we incorporate the idea that Bath's law suggests the existence of a critical point, in which the difference in magnitude Δm* between mainshock and largest aftershock is a kind of scaling parameter. The value of parameter Δm* = 0, which we use in the BASS productivity law, determines the critical point, where only pure scaling is observed. For values of Δm* $>$ 0, the potential chain reaction of earthquakes rarely results in a larger mainshock, and sequences of earthquakes usually yield sequences of diminishing magnitude aftershocks. However, for values of Δm* $<$ 0, the chain reaction of earthquake seismicity has a much higher probability of resulting in a larger magnitude mainshock. This model therefore holds the potential to describe the earth-

quake nucleation process. In order to implement these ideas, we must introduce an additional internal variable, which in this case will be a regional stress variable S. Furthermore, the introduction of an additional independent internal variable upon which Δm* depends demands the introduction of another equation governing the evolution of σ. In this talk, we discuss this new model, and show some a number of first results.