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Reproducing the scaling laws for Slow and Fast ruptures

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Modelling long term behaviour of large, natural fault systems, that are geometrically complex, is a challenging problem. This is why most of the research so far has concentrated on modelling the long term response of single planar fault system. To overcome this limitation, we appeal to a novel algorithm called the Fast Multipole Method which was developed in the context of modelling gravitational N-body problems. This method allows us to decrease the computational complexity of the calculation from $O(N^2)$ to $O(N \log N)$, N being the number of discretised elements on the fault. We then adapted this method to model the long term quasi-dynamic response of two faults, with step-over like geometry, that are governed by rate and state friction laws. We assume the faults have spatially uniform rate weakening friction. The results show that when stress interaction between faults is accounted, a complex spectrum of slip (including slow-slip events, dynamic ruptures and partial ruptures) emerges naturally. The simulated slow-slip and dynamic events follow the scaling law inferred by Ide et al. 2007 i. e. $M \propto T$ for slow-slip events and $M \propto T^2$ (in 2D) for dynamic events.