Geophysical Research Abstracts
Vol. 19, EGU2017-7815, 2017
EGU General Assembly 2017

Learning from physics-based earthquake simulators: a minimal approach

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Physics-based earthquake simulators are aimed to generate synthetic seismic catalogs of arbitrary length, accounting for fault interaction, elastic rebound, realistic fault networks, and some simple earthquake nucleation process like rate and state friction. Through comparison of synthetic and real catalogs seismologists can get insights on the earthquake occurrence process. Moreover earthquake simulators can be used to to infer some aspects of the statistical behavior of earthquakes within the simulated region, by analyzing timescales not accessible through observations.
The develoment of earthquake simulators is commonly led by the approach "the more physics, the better", pushing seismologists to go towards simulators more earth-like. However, despite the immediate attractiveness, we argue that this kind of approach makes more and more difficult to understand which physical parameters are really relevant to describe the features of the seismic catalog at which we are interested. For this reason, here we take an opposite minimal approach and analyze the behavior of a purposely simple earthquake simulator applied to a set of California faults. The idea is that a simple model may be more informative than a complex one for some specific scientific objectives, because it is more understandable. The model has three main components: the first one is a realistic tectonic setting, i.e. a fault dataset of California; the other two components are quantitative laws for earthquake generation on each single fault, and the Coulomb Failure Function for modeling fault interaction.
The final goal of this work is twofold. On one hand, we aim to identify the minimum set of physical ingredients that can satisfactorily reproduce the features of the real seismic catalog, such as short-term seismic cluster, and to investigate on the hypothetical long-term behavior, and faults synchronization. On the other hand, we want to investigate the limits of predictability of the model itself.