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Solid Earth
Discussions

Interactive comment on "Factors controlling the sequence of asperity failures in a fault model" *by* Emanuele Lorenzano and Michele Dragoni

Anonymous Referee #1

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The presented manuscript aims to investigate the factors that control fault rupture sequences in a scenario where a fault is made up of two asperities. These two asperities are thought to be present along a fault "plane" (shear zone) that is otherwise freely slipping (i.e., does not build up strain). Additionally to elastic interaction between those asperities, the authors have added viscoelastic relaxation to approximate the post-seismic behavior of the coseismically strained asthenosphere. The authors treat their investigation in a formalized mathematical framework –a dynamical system whose basic elements are the aforementioned asperities. Although I am not the right reviewer to evaluate the mathematical formulation of the setup that is used, I still want to provide some comments.

General comments: Generally speaking, I find the treatment of the "earthquake"system

overly simplified –to the degree that I want to question whether the provided results actually bear any insights into the recurrence of earthquake rupture (including the effect of viscoelastic relaxation).

The authors mention that knowledge of the initial state of stress in the system would allow to calculate/predict the following sequence of earthquakes i.e., asperity ruptures (in absence of stress perturbations). While this may be in theory correct, this approach is in my view not appropriate to describe earthquake rupture and recurrence, considering the spatial and temporal variation of physical parameters that in fact control earthquake rupture. In the present work, all that existing and important complexity is removed i.e., not considered.

The authors mention that the aim of the presented study is to expand on previous work (P2L19). But that is not really motivating anything. What are the authors actually trying to constrain/identify? How can the results applied? What insights regarding earthquake rupture does it provide? The study needs an improved motivation/introduction section.

The proximity of the two asperities considered here relative to each other should play a role (on the probability of respective rupture modes) -maybe I missed it, but do the authors consider that point?

Below are by-line comments:

By line: P1L4 –colon after "degrees of freedom" indicates that a list of those is following –but that does not seem to be the case; please rephrase

P1L5 –the slipping modes should be mentioned here; current formulation too implicit/vague

Abstract – does not stand alone; the reader learns to some extend what the authors wanted to do but not what they learned/have found out; this needs to be included into the abstract

P1L13 –replace "by asperity models " -> the "by" is wrong -> the models don't investi-

gate anything

P1L22 –how are “non-asperties” defined/characterized? Needs to be mentioned here; they also have a role within the earthquake system and the authors need to state what that role is; include corresponding explanation in the model formulation section.

P2L17 –what the authors mean with “source functions”? is that source time function? Please clarify

P2L24 –the term “seismic efficiency” should be defined properly

P3L3 – language is vague “by a much higher friction than the surrounding region of the fault” -> be specific/quantitative please

P3L4 –I cannot follow that logic: the authors argue that they can neglect the seismic moment contributed from the “weaker regions” of the fault that surround the asperities -> but why? Regardless of strength, if the fault slips (coseismically) then it will contribute to seismic moment -> so I want to question the author’s approach here; they need to better explain justify this simplification.

P3L20 –why using a rate-dependent law? Did the authors experiment with other laws as well? Please better motivate the use of this friction law.

P12L8 –the authors will need to explain how their analytical toy model is able to inform our understanding of earthquake rupture and rupture sequences; after all, we don’t know the “initial state of stress” and real faults do exhibit stress perturbations, along with a range of other processes and parameters that affect earthquake rupture and that are not considered here. So, how does the presented study help to learn about earthquakes?

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