Response to comments by the reviewers and editor

We appreciate the comments and suggestions from the editor and reviewers, which have allowed us to greatly improve our manuscript. All comments have been addressed. In what follows we give response to the individual points raised.

Reply to the comments of the Anonymous Referee #2.

The following response format will be used:

- Question/Comment (from the reviewer)
- Answer (reply from the authors)
- Changes (new/modified text added to the manuscript)

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1. **Question / comment**

When presenting the background of the model construction, right in the abstract the authors write that FBM is a discrete element model. Discrete element model (DEM) is not a proper wording here. DEM has a well defined meaning in physics and engineering and according to the generally accepted definition of DEM, FBM is not a DEM. FBMs are stochastic discrete models of materials failure.

1. **Answer:**

The definition of the Fiber Bundle model as Discrete Element Model were found in Biswas et al. 2015 "Statistical Physics of Fracture, Breakdown and Earthquake: Effects of disorder and heterogeneity, page 34".
The Discrete Element method has a different meaning as Referee 2 says, since it is a numerical technique that models the interaction between individual particles and boundaries to predict bulk solids behavior.
It is our understanding that conceptually the Fiber Bundle model is a Discrete Element model since it describes the interaction of individual elements as a part of a collective medium.
However to solve any ambiguity we are agree to define FBMs are stochastic discrete models of materials failure.

2. Question / comment

When presenting FBMs the authors write that FBM is a numerical approach ... Actually, FBMs can be solved analytically in the mean field limit so I think "numerical approach" is not a proper wording here

2. Answer:

It is indeed true that, the “Equal Load sharing rule” is a mean-field model and can be solved analytically. However, the other extreme is the “Local load sharing” where the analytical solution becomes difficult and the best approach to solve the FBM equations is by carrying out a numerical procedure. In summary, the Referee’s observation is appropriated. Therefore, we will substitute “numerical approach” by “mathematical tool” on Page 3.

3. Question / comment

To represent materials’ randomness the authors use uniform distributions throughout the work. This is questionable even if relatively good agreement is obtained with field measurements. The authors elaborate on this aspect of the model construction.

3. Answer:

In seismicity process simulations the lack of knowledge of some important features such as the initial stress distribution or the strength and material heterogeneities generates a wide spectrum of uncertainties.
Without loss of generality, we consider that one way to aboard this issue can be considering a simple distribution such as the uniform distribution. We find that the validity of this assumption is given by the comparison of the simulated results with real data. It is possible that other distributions might also give similar results. However, the intention of TREMOL v0.1 is to propose a model which can be used to assign values to the unknown properties mentioned before, including different distributions. So we encourage users to try other possibilities.

4. Question / comment

The authors mention on Page 7 that they are able to simulate "materials weakness or fatigue". I think what they have in the model is "weakening" and not simply weakness

4. Answer:

Yes, we agree that the correct model process is a weakening process. We corrected the wording in that respect on Page 7.

5. Question / comment

Load transfer is realized through the quantity \pi(x,y). According to the model construction \pi is set such that it generates a localized load sharing in the system, meaning that only nearest and next nearest neighbors share the load of a failed element. However, measurements usually show that long range stress transfer may play a role in earthquake sequences. Do the authors claim that at least in the studied cases short range stress transfer dominated the behaviour of faults?

5. Answer:

In our simulation short range interactions convert to long-range processes through the avalanche mechanism in TREMOL v0.1. As the Referee 2 pointed out, the most obvious (or explicit) interaction range is the short since after a rupture in a individual element the load share is local and this produces a load concentration in neighbors cells, promoting ruptures in local manner (short-range). However, the long-range is also captured in more implicit way. This is allowed for two reasons, 1) the randomness in the initial stress distribution and 2) the selection rule for the next failed cell in the model, these produces that two cells far apart can be activated in successive steps, in analogy to a long-range interaction.

6. Question / comment

In the validation process the authors only considered subduction earthquakes. Do the authors claim that the model is only applicable to this type of earthquakes? This is an important point which should be clarified in the discussion.

6. Answer:

TREMOL v0.1 was focused on the asperity rupture process in a Subduction escenario because of the following reasons.
1. Due to the expertise of some of the co-authors in the teleseismic fault slip inversion applied to subduction zone earthquakes (Q. Rodríguez-Pérez, 2013). This provided the first motivation to study the rupture of asperities from the point of view of the Fiber Bundle model.
2. Related with the previous point, the data required to initialize the model was available to test the application of our hypothesis to a real case.
3. In a subduction event the rupture plane could be modeled in two dimensional domain, so this facilitated our study for the development of TREMOL v0.1
However, after validating the capability of the model, constraining the input parameters and analyzing the results, we consider that the coceptual basis of TREMOL can be expanded to model other tectonic regimes. In fact, some work is currently carried out in this sense. We recently submitted the study of the interaction of Faults systems and the production of aftershocks (Monterrubio-Velasco et al. In Review se-2019-65. Modeling active fault systems and seismic events by using a Fiber Bundle model. Example case: Northridge aftershock sequence).
We are also working on a three dimensional version to simulate the mainshock and aftershocks (Sholz D. (2018). Numerical simulations of stress transfer as a future alternative to classical Coulomb stress changes?: Investigation of the El Mayor Cucapah event. Unpublished Master thesis).