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Geoscientific Model Development Discussions

Interactive comment on "The role of asperities in seismicity frequency-magnitude relations using the TREMOL v0.1.0. The case of the Guerrero-Oaxaca subduction zone, México" *by* Marisol Monterrubio-Velasco et al.

Anonymous Referee #1

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The scaling relation of seismicity frequency-magnitude is an important topic for the application of seismic hazard assessment. This paper investigates the possible role of asperities in the seismicity frequency-magnitude relations by using their developed code, TREMOL v0.1.0. This paper also studies how the aspect ratio of asperities affects the seismicity frequency-magnitude scaling relations. This is a very interesting idea. But, I find in this paper the conclusion based on the current tests are not sufficiently convincing. For instance, the magnitude shall not only depend on the ruptured area but also depends on the stress drop or the final slip. In the current version, the

effects of the aspect ratio on the final slip and magnitude are ignored somehow. In addition, in Section 6, the number of cells in the computational domain might affect the seismicity frequency-magnitude curve, which was fixed. Therefore, I recommend a major revision for this paper, with my suggestions listed below.

In another paper of theirs, which introduces the code TREMOL, I find they considered the stress drop of each broken patches. Combining the rupture area and the stress drop, they can uniquely determine the magnitude of each earthquake, such as using the inversion of Okada's matrices. This is important because, given the same rupture area and stress drop, the magnitude of earthquakes also depends on the aspect ratio [Leonard, 2010; Hanks and Bakun, 2002]. So, I suggest the authors estimating the magnitude based on the numerical methods, rather than the empirical magnitude-area relations (equations 2-5).

Line 170: They consider each SA region as independent for an individual TREMOL simulation. But these four regions can affect each other by the static stress perturbation, such as the Coulomb stress. In addition, each asperity may have different earthquake cycles due to various loading condition and their TREMOL implementation does not allow simulating a full earthquake cycle. It might be tricky to simply combine all SA curves into one synthetic aggregated curve. At lease, the authors shall discuss the possible effects of this procedure in the manuscript.

Fig. 12 is very interesting but hard to understand. Do these two models have the same effective width? Why does the narrow fault tend to produce larger earthquakes? Based on the fracture mechanics theory, wider faults (larger elastic energy release) are more likely to propagate larger earthquakes. More explanations for this figure are needed.

Line 275 – "In that sense, we could conclude that the maximum magnitude is related to the total rupture area and not to its aspect ratio or shape". This is not correct if the aspect ratio is large. Magnitude depends on final slip. Given the same stress drop, the final slip depends on the shorter dimension of the rupture areas if the aspect ratios are high. From the observations, the scaling relation between magnitude and rupture area is different for aspect ratio =1 and >1 (See the difference between the L-model and W-model [Hanks and Bakun, 2002]).

References:

Leonard, M. (2010). "Earthquake fault scaling: self-consistent relating of rupture length, width, average displacement, and moment release." Bulletin of the Seismological Society of America 100(5A): 1971-1988.

Hanks, T. C. and W. H. Bakun (2002). "A bilinear source-scaling model for M-log A observations of continental earthquakes." Bulletin of the Seismological Society of America 92(5): 1841-1846.

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