Review of the manuscript “Impact of rupture complexity on seismic hazard: Case of the 2018 Mw7.5 Palu earthquake” by Jiao et al.

The 2018 M 7.5 Palu, Indonesia earthquake nucleated on a previously unmapped fault in the north of the Palu Bay and ruptured southwards 150+ km of multiple fault segments with varying orientation. The authors investigate the effect of the variation of fault geometry on long term fault formation by discrete element numerical modeling and present the model verification on the 2018 Palu earthquake. The manuscript starts with an Introduction section, and is followed by the tectonic settings of the study area and the main features of the 2018 rupture. Next, the methodology of the numerical modeling, model properties, and simulation results are presented. Last, discussions and conclusions are provided.

I think that the objective of the paper is interesting and useful to advance our understanding on the long term evolution of complex fault networks, but the current version of the manuscript is not convincing about the validity of model results for different choice of initial conditions, and the writing needs a significant revision, as I detailed below. Therefore, I suggest major revision for this manuscript before a publication at EGU - Natural Hazards and Earth System Sciences.

Major comments:

- The initial conditions assume that the northern unmapped fault never ruptured (Fig. 6, top panel), but it may have only ruptured at depth with no surface deformation (i.e., buried fault). In addition, the submarine fault geometry is not well known. A detailed sensitivity analysis, including other input parameters, can help to verify the validity of the conclusions of the study.

- Limitations should be discussed: 1) Surface slip/deformation is not only governed by multiple-fault complexity but several factors, including off-fault plasticity, stress heterogeneity, damage zones, roughness instead of a planar fault plane; 2) The model is claimed to be dynamic, but given the lack of dynamic effects associated with the (coseismic) rupture process, it is a quasi-static modeling; 3) There is no lithological variation along strike or depth.

- Presentation, including the title, needs revision that can improve the readability. Overall the current version is not concise. The objective is unclear. The interpretation of findings is hyped and implicit. I further give suggestions below.

Minor comments:

- Line numbering is not reviewer friendly.

- Title needs rewording, otherwise it is misleading. This is neither a PSHA (seismic hazard), nor a seismic source study (rupture complexity?). You can highlight the novelty of this study.

- Vague expressions are present throughout the text. For example: rupture complexity; fault pattern of propagation; dynamic formulation; rupture behaviour; super-fast rupture.

- L19: Do you use these data of InSAR or just giving info? Unclear in the current sentence.

- L34: Do you mean fault maturity by complexities, given the reference of Perrin et al. 2016?

- L38-42: You only cite 1968 and 2022 papers about the progression in PSHA. You should provide a complete picture of the progress in that subfield. There are PSHA studies that do consider multiple faults (e.g., Chartier et al., 2021 https://doi.org/10.5194/nhess-21-2733-2021). Since this is not a PSHA study, I even doubt the relevancy of such a discussion.

- L49: Do you mean you verified your model on the 2018 Palu earthquake?

- L55: This sentence should go to the conclusions/abstract section.

- L58: Please include landslides

- What is ca.? It repeats a lot. Please provide the long version at least once for the first use.

- L76: more observations of what?

- L81: Rupture behaviour? Vague.

- L 82: How does 177 km rupture length and 20 km of hypocentral depth compare to other studies? If the other studies have different values, please justify your choice.

- L98: “exceeds” shear wave velocity instead of “reaches”.
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- L99: How does the supershear relate to rupture depth?

- Do you mean surface rupture by superficial rupture?

- L108: 160 km? How does it compare to L82? Please avoid being repetitive.

- How do you formulate healing without plasticity and/or thermo-mechanical rheology?

- What does rapid healing correspond to in the sense of material properties?

- Table 1: How does element size affect model results?

- Element radius and ratio of largest/smallest element size: how do you choose the values?

- Passive voice is not the ideal choice for a scientific article.

- Fig. 5b: Why is there a sharp slope change at low strain for 400 MPa case? Please clarify.

- Fig. 6: Can you interpolate the outputs in a regular grid for a better visualization. Scatter plot is poor to comment on. Please also show colorbar.

- L225: Paragraph is difficult to follow with Fig.6.

- What is the definition of mature/immature fault in this study? What is the parameter and threshold to make this clasification? Please clarify. You can use Introduction for this purpose.

- L260: How do you assess the impact of fault maturity on fault segments? Only one set of simulation is shown. Do you have a reference case with a different assumption of fault maturity? Please clarify.

- Fig 7b: Scatter plot with coloring is not the ideal way to quantify. Please add a 1D plot of slip vs strike distance and superpose the synthetics with INSAR data for a quantitative comparison.

- Discussion: Please provide a detailed discussion on also limitations. Current version is mostly a conclusion section.

- PSHA discussion: maximum magnitude is not only controlled by rupture size but also slip amount and rigidity. Please avoid too strong arguments and rather acknowledge the limitations when interpreting the results.