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Natural Hazards and Earth System Sciences
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Discussions

Interactive comment on "Width of surface rupture zone for thrust earthquakes. Implications for earthquake fault zoning." *by* Paolo Boncio et al.

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Reply to the comments of Referee #1 (F. Livio)

We would like to thank the reviewer for the appropriate comments and very useful suggestions. We are going to comply all the comments in the revised version of the manuscript. The queries to the scientific comments have been answered separately in the following section.

REVIEWER's SCIENTIFIC COMMENTS: 1) Firstly, I strongly suggest the Authors to add as supplementary Material the georeferenced maps they used. Ideally, the trace of the main and distributed faults could be provided, as georeferenced shapefiles or .kmz files. This could provide the original datasets that can be used by other scientists for further analysis, data checking etc. and it is one of the main objective of this kind of “data mining” papers. At the moment, no further inspection on the used dataset can be made and this is one of the major faults of the paper in the present form.

RESPONSE: We will add electronic supplementary material including a summary table with all the measured data and several maps, one for every earthquake, showing the measurement details, including the chosen average strike of the main fault.

REVIEWER: 2) A note on the methodological approach used for measuring distances. The approach depicted in Figure 1 could result in some biased measurements In fact, it is depending on the azimuth of the main fault strike, in turn derived from the chosen fault tips, fault segmentation etc. This is working well for distributed fault striking parallel to the main one but can be misleading for non-parallel faults. Why not to use a GRID-based approach (like in Petersen al. or in Youngs et al.)? This would also assure data comparison with previous works.

RESPONSE: Actually, our approach is very similar to that used by Petersen et al. (2011), but more detailed (we used more closely spaced measurements). We will explain better the method in the text. In any case, independently from the used method, we need to define the azimuth along which the distance from the main fault is measured. One target of the paper is zoning the hazard around a mapped fault. Therefore, we need distances from the fault trace. We were careful in defining the measurement azimuth, taking into account the variations in strike of the main fault, and avoiding duplication of measurements. The maps we are adding in the auxiliary material will help the reader in judging our choices.

REVIEWER: 3) At lines 167 – 173 some characteristics of the bending moment faults (BMF), significantly contributing in widening the WRZ, are described. Regarding this point, wavelenght of the thrust-related fold can be considered in order to recognized distant ruptures due to BMF but has not to be taken alone: these secondary structures a more related to hinge zones (and thus geometric characteristics of the fold i.e., curvature of the fold, thickness of the folded single-layer etc.) than to wavelength alone. Distances proposed to distinguish between pressure ridge anticline vs larger scale structures are just cutoff distance not discussed in their significance. Moreover, I find hard to distinguish between the two of them at intermediate scale. I think that the choice to exclude these structures from a probabilistic analysis can be right but further discussion or objective criteria are needed in order to correctly hierarchize thrust-related faults. Some attempts can be made considering structurally derived cutoff distances: e.g., depth of the sole of the thrust, axial planes (i.e. possible hinge zones) predicted by kink band modeling, etc. In any case, the Authors should provide schematic cross-sections of the considered case studies presenting BMF, so that a direct comparison can be made with the schemes in Figure 2.

RESPONSE: We are now analyzing the data both with and without BMF and F-S secondary ruptures (two different PDFs). In general, we agree that all the points suggested by the Referee should be better dis-cussed in the revised version of the manuscript.

REVIEWER: 4) The best probability density function (PDF) of the distributed faults has been obtained through a commercial software (lines 174-177) but no detailed information is available on the procedure of fitness testing used by the software (a Kolmogorov-Smirnov test is cited but no scores are reported). Maybe this information should be provided as Supplementary Material. A quantitative comparison of the different tested PDF should be provided. Did you test only unimodal distribution or also multimodal? Did you tried to include also bending-moment and flexural-slip faults and fit the entire dataset with a multimodal PDF? Very few people know the Birbaum-Saunders distribution (originally thought to predict the life of mechanical parts subject to stress before failure). Some consideration should be made on the chosen PDF. I found that the statistical analytics are not well explained in the present form of the text and that maybe some other ways of data fitting should have been tested. Lines 185-197 (Figure 4) briefly describe the trend of the fitted PDF considering distances corresponding to progressively increasing cumulative probabilities of occurrence. Here, a strong statistical approach is lacking in transforming cumulative probabilities in distances proposed for setback etc. a qualitative approach is used. The Authors state that “90% probability : : :seems to be a reasonable value to cut the outliers” (line 185-186) and “: : :40% probability bounds reasonably well the zone where the most of the ruptures occur”. These statements are not quantitively constrained. If you use a PDF like the Birbaum-Saunders, that can be characterized by a strong skewness and a long right tail, maybe outliers have to be evaluated with cautiousness. Vanegas, L. H., Rondón, L. M., & Cysneiros, F. J. A. (2012). Diagnostic procedures in Birnbaum–Saunders nonlinear regression models. Computational Statistics & Data Analysis, 56(6), 1662-1680. Provide a review of the tests that can be performed of this PDF in order to identify outliers.

RESPONSE: The final PDFs are subject to variations as we are adding additional data (suggestion from Referee 2) and we are analyzing data with and without secondary ruptures belonging to BMF and F-S faults. In general, the aim is to find a PDF only based on its ability to fit the data. In order to find this PDF in the easiest way the possible, we decided to use a commercial software, assuming that the software is working sufficiently well. We think that a deep statistical analysis of the data is very interesting, but beyond the aim of this paper. In any case, all the suggestions by the Referee will be taken into account, including a reading of the suggested reference. Concerning the percentiles used for sizing the zones, we acknowledge that they are subjective choices. In the revised version we will state even more clearly that these are subjective choices. We think that it is very difficult to define really objective criteria. We also think that the reader can accept our suggestions as an “expert judgement” or, most importantly, can make its own choice.

RESPONSE to MINOR POINTS AND TECHNICAL CORRECTIONS: All the minor points and technical corrections suggested by the Referee will be carefully taken into account.

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