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Reply on RC2

Paola Sbarra et al.

Author comment on "Modern earthquakes as a key to understanding those of the past: the intensity attenuation curve speaks about earthquake depth and magnitude" by Paola Sbarra et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2022-30-AC2, 2022

We thank the anonymous Reviewer #2 for his/her interest in our work and for all comments and suggestions. We will follow his/her comments to make our text more understandable even for a non-specialist, and clarify some methodological steps that we did not describe in detail in the first version of the manuscript.

Below we respond to the Reviewer's main comments.

2.1. Title

We will consider changing the title, although we would like to emphasise that our procedure is based on the analysis of earthquake intensity attenuation curves.

2.2. Pilot study 2019a

We will make sure that the work is self-explanatory, avoiding to reference our previous work too often, as suggested also by reviewer #1 (https://doi.org/10.5194/nhess-2022-30-RC1).

2.3. Uncertainties

As suggested, we will improve the discussion, in particular on the uncertainty associated with the input parameters of the method (macroseismic intensity and instrumental data). We want to clarify to what extent these uncertainties affect the estimation of depth and magnitude. In addition, we will explain the statistics of uncertainties in better detail.

2.4. Trade-offs

Concerning the trade-offs between depth, magnitude and seismic wave attenuation properties, we have shown that the steepness of the attenuation curve of the earthquakes

of the *learning set*, does not vary significantly between northern and central-southern Italy, at least over the first 50 km of epicentral distance (as shown in Figure 5). This result implies that our new function holds for the whole Italian territory, despite the well-known complexity of Italian geodynamics and the consequent geological heterogeneity. Moreover, we show that our method is independent of magnitude, meaning that the slope of the attenuation curve calculated within 50 km from the epicenter is affected only by earthquake depth, not by earthquake size. We maintain that the trade-offs among depth, magnitude and seismic wave attenuation properties are fully addressed in the manuscript. Nevertheless, we will try to clarify this critical issue by discussing it more thoroughly in the text. This reviewer maintains that a methodology based on joint inversion is more appropriate than a step-by-step methodology, precisely because of the known trade-off between magnitude and depth. For this reason, we will expose our results more clearly, based on experimental data, so as to make readers fully understand the potential of our method, which may be used to estimate the depth of an earthquake from its macroseismic field without the need to know its magnitude.

2.5 Large magnitudes

We preferred an automatic approach even for large-magnitude events because we believe that the case-by-case approach is subjective and not repeatable in all cases. In the same section, we will present more clearly the ranges of source parameters for which our method is applicable, as suggested by Reviewer #2.

2.6. Cumulative effects

We are aware of the role of cumulative effects for earthquakes occurring close in time and space. In fact, we already discussed this issue in the article. This question is crucial, especially for historical earthquakes for which intensities are derived through indirect sources (primarily written texts), leading to an even higher risk of confusing the effects of different events. As recommended, we will devote a separate section to this issue in the revised version of the manuscript.

2.7. Length of the paper

We will remove unnecessary details or move them into the supplementary material section. We conceived this paper as a methodological article aiming to illustrate a new approach for calculating magnitude and depth, using well-documented Italian earthquakes as a test case. For this reason, and due to the inherent complexity of our analyses, we refrained from developing a geological-structural interpretation of our results, but we will do it in a subsequent dedicated paper, as suggested by Reviewer #2.

2.8. Wording, terminology, formal issues

We will be more careful in using the same notation for the same parameter and the same concept to avoid possible confusion for non-specialists. We will also try to dispel any ambivalence in the case of terms for which a different name is required.