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Interactive comment on "From mapped faults to earthquake magnitude: A test on Italy with methodological implications" *by* Fabio Trippetta et al.

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Concerning the comments posted by Valensise et alii, below, we respond point-by-point to all their arguments. We apologize for our repetitive responses that are induced by reiterated comments by Valensise et alii.

Introduction Comments by Valensise et alii, as happens also for most comments by

Referee 1, seem influenced by an initial and radical misunderstanding. Our manuscript IS NOT titled "A new map of expected earthquake magnitudes for seismic hazard and risk mitigation in Italy Simply, this is not the goal of the article. Our maps (Figs. 7 and 8) ARE NOT AT ALL predictive maps of seismic hazard.

Our manuscript is titled "From mapped faults to earthquake magnitude: A test on Italy with methodological implications" and our aim is stated clearly from the introduction where we say: "We anticipate that, with this work, we do not intend to propose an alternative method for seismic hazard assessment or to better previous methods (e.g., Giardini, 1999; Jiménez et al., 2001; Michetti et al., 2005; Field et al., 2009, 2015; Reicherter et al., 2009). Our main aim is to test whether solely considering the known mapped faults (both active, inactive, and undetermined) and disregarding further information (e.g., historically- and instrumentally-recorded earthquakes as well as the regional stress field and strain rate) it is possible to provide, through existing seismic scaling laws of faults and earthquakes, reasonable assessments of the maximum possible earthquake magnitude over an entire area. The resulting (assessed) magnitudes (PEMM) are compared (i.e., the mathematical difference) with catalogued earthquake magnitudes that are the only existing points of reference against which assessed magnitudes can be presently compared."

The empirical relationships (used by many geoscientists including Valensise et alii) between fault size and earthquake magnitude are notoriously problematic for issues such as fault segmentation, fault continuity, and seismic partial activation of long faults. These problems have been ascertained ex-post on most single faults after earthquakes. We work on these same problems at the national scale with a different approach (ex-ante). That is, given a set of "official" faults of a nation (from geological maps and other official datasets), is it possible to test, quantify, and ascertain the above-mentioned problems connected with the empirical relationships? One way to do this, is to apply the relationship to the fault dataset and then compare the results with a seismic catalogue. This is what we do in Figs. 10, 11, 12, and 13 + Table 1. The re-

sults of this work cannot be used for Seismic Hazard Assessment but rather, they can highlight areas where further studies are required to better asses expected earthquake magnitudes

In the revision we will better emphasize the above-mentioned concepts, starting from the abstract that in the previous version of the manuscript could have left some space for misinterpretation. We will also add disclaimers in Figures 7 and 8 saying that these figures are not at all for use for Civil Protection, officials, and, in general, for seismic hazard.

Comment 1: The geology of Italy is normally considered to be extraordinarily complex, which makes it very fascinating but also quite difficult to investigate. The authors of this paper indeed make an exception, as they approach Italian geology as if major scientific questions concerning the relationships between earthquakes and their causative faults could be addressed by following a handful of simple, universally recognised rules.

Response 1: As geologists, we all know that tectonics can be complex and not only in Italy. On the other hand, all scaling laws and in particular well-recognized laws, like those proposed by Wells and Coppersmith, 1994 and Leonard, 2010, must overcome the complexity of regional settings and focus on the fault size/displacement to infer the potential magnitude.

Moreover the same authors to whom we are answering wrote several papers where the magnitude of paleoearthquakes was inferred from fault size/displacement measured at or near the Earth's surface (Pantosti et al. 1993 doi: 10.1029/92JB02277; Valensise and Pantosti, 2001 doi: 10.1023/A:1011463223440; Galli et al., 2008 doi: 10.1016/j.earscirev.2008.01.001; Pantosti et al., 1993 doi: 10.1029/95JB03213; Collier et al., 1998 doi: 10.1029/98JB02643; Galadini et al., 2005 doi: 10.1111/j.1365-246X.2005.02571.x; Galadini and Galli 2003 doi: 10.4401/ag-3457 and several others by Valensise et alii).

Also the DISS database (Database of Individual Seismogenic Sources in Italy,

http://diss.rm.ingv.it/diss/), which is run by Valensise et alii, makes large use of the scaling relationships between fault size/displacement and earthquake magnitude to infer this latter parameter in Italy.

In our study, we used the same relationships (by Wells and Coppersmith, 1994, later revised by Leonard, 2010) that many authors including Valensise et alii have used for years to infer the earthquake magnitude from fault attributes. Simul stabunt vel simul cadent

Comment 2: We doubt this is the case. In fact, we argue that Trippetta and co-workers did not consider at least two decades of literature on the relationships between seismogenic faulting at upper-mid crustal levels and brittle faulting at shallow crustal depth. Their paper is essentially a GIS exercise;, backed by references that are generally highly selective, often inappropriate and sometimes very old.

Response 2: In this paper, we tried to use the most updated literature; however, since we know very well that Valensise et alii are expert in this field, we look forward to follow their suggestions on updated papers to be added and on how and why each of these missed papers affected/biased our analyses and results. However, it must be noted that it is not the presence of one or more unmapped faults that falsifies the proposed simple technique..

Comment 3: For instance, a very general statement such as "Larger earthquakes characterize the Apennines southern portion (Calabria), with historical seismic events that reached magnitudes up to 6.9-7.5" is backed by a reference to Cello et al. (2003), a 15 years-old paper dealing with a specific earthquake in Val d'Agri, 50 km north of Calabria, and to Gasparini et al. (1985), a 33 years-old paper that belongs to a distant past of seismotectonics in Italy. A simple reference to the Catalogo Parametrico dei Terremoti Italiani (CPTI), the Italian reference parametric catalogue, would have been enough; it would also have prevented a mistake, since no M 7.5 earthquake is reported anywhere in Italy

Response 3: This criticism refers to a sentence extracted from the seismotectonic setting (Page 5 Line 13) and not from the method and results sections. We will accept with pleasure the suggestion by Valensise et alii and will enrich the Seismotectonic Setting with some recent references in the revised version of our manuscript. However, we have to point out that the core and science of our paper is not at all affected by a supposed lack of consideration of previous works, as argued by the comment.

More importantly, in section 3.2 earthquake data, we do mention CPTI together with the most comprehensive catalogues of instrumental and historical seismicity like CSI1.1 and ISIDe.

Comment 4: The conclusions of the paper are based on several misconceptions, leading to results that could have catastrophic outcomes for seismic risk mitigation in Italy, if taken seriously by any authority in charge. Its main misconception probably rests in the assumption that "...all considered faults are active or can be potentially reactivated..." (section 4.2, page 9 of the manuscript).

Response 4: The statement "The conclusions of the paper are based on several misconceptions . . ." is too vague e generic. Please be specific. We are available for improvements.

If Valensise et alii mean that our misconceptions are due to the assumption that "...all considered faults are active or can be potentially reactivated...", then the long list of previous experiences on apparently inactive faults abruptly reactivated by earthquakes support our assumption. (Bouchon et al., 1998; Camelbeeck et al., 2007; Kafka, 2007; Stein and Mazzotti, 2007; Swafford et al., 2007; Braun et al., 2009; Boyd et al., 2013; Leonard et al., 2014; Talwani, 2014; Campbell et al., 2015; Walsh III and Zoback, 2016; Christophersen et al., 2017). This is clearly explained at P. 10 L.20-28. The same map of seismic hazard in Italy has changed with time once some new earthquake strokes an "unexpected areas". Faults may be apparently inactive because of the short time frame in which we observe them, or they may be active at depth without surface expression,

possibly due to a thinner brittle crust and to low magnitude. It is evident that very long faults may be activated only along specific segments, as it happens for example along the plates interface of subduction zones. However, in the testb site of Italy, there are very few areas that are seismically silent, suggesting active faults being present almost everywhere, particularly along the Apennines rifting area.

We acknowledge that this study developed within the framework of nuclear waste repositories planning. In societal challenges such as the construction of nuclear waste repositories, the future time span to consider is 1 Ma or more. In such a time span, any fault, including those that are now sutured and apparently inactive, could slowly accumulate stress to be released in future earthquakes. For this reason, it is important to attempt knowing what type (magnitude) of earthquake could these (presumably-inactive) faults produce, regardless their recurrence time and probability of occurrence. For this reason, we have considered all know faults independently of their presumed age.

Finally, dealing with catastrophic outcomes for seismic risk mitigation. In the last two sentences of the conclusions we clearly state that: "This method cannot, however, be a substitute for time-dependent (paleo)seismological methods for seismic hazard assessments. Rather, it can rapidly provide an approximate perspective time-independent seismic potential of faults and highlight areas where further detailed studies are required".

Comment 5: It is unfortunate that the fault database that should support this bold statement is not accessible (see Petricca, P., et al., Revised dataset of known faults in Italy, GFZ Data Services, https://doi.org/10.5880/fidgeo.2018.003, http://pmd.gfz-potsdam.de/panmetaworks/, 2018; the first link leads to an error page, while the second leads to a generic page of the GFZ website).

Response 5: The database is fully and publicly available at the indicated database under this link that we will report also on the revised manuscript: http://pmd.gfz-potsdam.de/panmetaworks/review/924b171fd21c78f295d58a7e9e321e8ad07667ab6201634b23d3cb5a3f170d10/

Comment 6: Simply put, Trippetta and co-workers maintain that they can obtain the Potential Expected Maximum Magnitude of earthquakes (PEMM) from any fault that appears in their (currently inaccessible) compilation, which includes (from the caption of their Figure 2): âËŸA ′c the Structural Model of Italy at the 1:500,000 scale; âËŸA ′c the Italian Geological Maps at the 1:100,000 scale; âËŸA ′c the GNDT database of active faults (Galadini et al., 2000); âËŸA ′c the ITHACA database (Michetti et al., 2000); âËŸA ′c selected active faults from complementary (complementary to what?) studies published by different authors.

Response 6: This is the core of our work and its strength point. As explained in the text (P. 6 L. 8-10), "the strength point of our approach is the assemblage of different fault datasets heterogeneously built for different purposes and based on different primary information and methods. In this approach, we consider all known faults (see above) to form a dataset as comprehensive as possible." In other words, all known faults are considered as potential seismogenic sources. As mentioned previously, many studies have demonstrated that faults considered inactive can be abruptly reactivated and be the source of damaging earthquakes (see examples and a comprehensive explanation at Response 5).

Comment 7: Notice that three of these studies refer explicitly to active - or at least capable - faults, but the other two sets, which happen to be the most numerous, do not. Also notice that Trippetta and co-workers subdivided each dataset into Class A (high quality), that includes ": : :exposed faults where subsurface and surface data allow for a detailed and reliable characterization of fault length: : :", and class B (low quality), containing ": : :buried and off-shore faults investigated mainly by seismic surveys, for which a precise characterization of fault length cannot be achieved: : :". Finally, notice that Trippetta and co-workers deliberately ignore the down-dip dimension (width) of the faults.

Response 7: Concerning the used heterogeneous dataset, please see our previous responses (Responses 4 and 6). We support our subdivision into Class A (high quality)

and Class B (low quality) faults as correct. Concerning the horizontal length/continuity of faults, indeed, the quality of exposed (accessible) faults (Class A faults in our work) is surely larger than that of buried/submerged faults (Class B faults in our work) that are detected solely through indirect techniques. It is therefore necessary to highlight this difference in the quality of fault datasets (Class A and Class B). All this is clearly explained at P. 10 L. 5-19 and 30-31, P. 12 L. 29-31, and P. 15 L. 6-10.

Concerning the down-dip dimension, the empirical relationship (between fault length and earthquake magnitude, Leonard, 2010) we used does not include the down-dip dimension of the fault. The reason is clearly explained in Leonard (2010). In particular, Leonard (2010) states: "A related problem is that published empirical relations are not self-consistent. By self-consistent, I mean relations that enable seismic moment, fault length, width, area, and displacement to be estimated from each other, with all these relations being consistent with the definition of seismic moment. That is, if you start with one parameter (e.g., fault length) and determine all of the others (area, width, displacement, moment), you retrieve the same set of parameters, no matter which parameter you start with." Leonard (2010) provides instead a self-consistent relationship. For this reason, we used the relationship by Leonard (2010), and retrieved the earthquake magnitude from the fault length.

Comment 8: A basic consideration is that by assembling faults from such different and nonhomogeneous sources, Petricca et al. inevitably put together a) alternative views on the same faults, possibly stemming from widely alternative conceptual models; b) faults that are mutually exclusive due to their geometry (typically, faults crossing each other in the subsurface: if one fault ends against another, its seismic potential based solely on length is largely overestimated); c) faults that cannot be simultaneously active, or reactivated, in the current stress regime; and d) blind faults whose actual length may be strongly biased by the availability and density of subsurface data.

Response 8: We think that this is the strength of our work. For the reasons explained above (Response 4) we propose that most of the faults within the Italian territory can

host an earthquake. Therefore a comprehensive fault dataset, as the one used in the present work, can help in: 1) reducing bias induced by the availability and density of subsurface data; 2) highlighting areas where detailed future studies are required to improve seismic hazard, that is not the target of this work.

All this is clearly stated in the Introduction and in the Conclusions sections. However, we will better stress the above-mentioned concepts in the Abstract, Introduction, and Conclusions of the revised manuscript. This is a product for scientific use only (i.e. testing the empirical relationships).

Comment 9: In our opinion it is extremely unsafe to derive the maximum earthquake magnitude from the length of a fault of which we do not even know (a) if it is active or if it can be reactivated (e.g. whether or not it cuts or deforms deposits of a specified age or it is suitably oriented with respect to the current stress regime), and (b) whether and how it is connected with a deep-seated seismogenic source. For decades earthquake geologists have investigated the surface expression of presumed active faults to gain insight into their long-term behaviour and seismogenic potential. The main purpose of such studies is to distinguish between active and non-active faults (sealed, truncated, or misoriented with respect to the current stress field). From this paper we learned that this is no longer necessary, as any mapped fault has the potential of generating a large earthquake.

Response 9: Valensise et alii may be right in stating that "it is extremely unsafe to derive the maximum earthquake magnitude from the length of a fault of which we do not even know ..." But this statement has to be tested, quantitatively measured, and experimented. This is exactly what we try to do in our paper. After the experiment, we do not assert that it is extremely safe to derive the maximum earthquake magnitude from the length of a fault. We simply discuss our quantitative results and reach the following conclusions: "These results are partly encouraging and suggest the testing and validation of this experiment elsewhere. In case it is successfully validated elsewhere, this method would be useful as well as fast where historical and instru-

mental earthquake catalogues are limited, the returning time of (strong) earthquakes is possibly very long, and information on the age of faults is poor. This method cannot, however, be a substitute for time-dependent (paleo)seismological methods for seismic hazard assessments. Rather, it can rapidly provide an approximate perspective of time-independent seismic potential of faults and highlight areas where further detailed studies are required."

The statement by Valensise et alii asserting that from our paper "it is no longer necessary to distinguish between active and non-active faults" does not match our conclusion section where we state: "This method cannot, however, be a substitute for time-dependent (paleo)seismological methods for seismic hazard assessments." Notoriously, the main objective of paleoseismology is to distinguish between active and non-active faults.

Comment 10: Trippetta and co-workers propose a very simplistic approach to a rather complicated problem, based on criteria and assumptions that are not exposed in the text.

Response 10: All our criteria and assumptions are clearly exposed in Sections 3 and 4 (Pages 6-10).

Comment 11: The question to ask is: for how many of these earthquakes could the authors declare a positive relationship between the magnitude and the surface length of the presumed earthquake causative fault? âËŸA 'c probably for the Amatrice and Norcia shocks of the 2016 sequence; âËŸA 'c not for the 6 April 2009, Mw 6.3, Aquilano earthquake, for which the fault dataset supplied by Trippetta and co-workers in their Supplementary Data (Dataset-S1-ItalianFaults.kmz: Figure 1) shows a fault that is less than 1 km in length, reportedly taken from the Structural model of Italy and included in Class A. This fault is at least 15 times shorter than the fault necessary to generate a Mw 6.3 earthquake, and it does not even coincide with the surface ruptures observed following the 6 April 2009 mainshock; âËŸA 'c not for the 23 November 1980, Mw

6.8 Irpinia-Basilicata earthquake, for which the Class A subset of the dataset used by Trippetta and co-workers, derived from the Ithaca database, reports a 10 km-long fault; nearly four times shorter than the 38 km-long rupture reported in the classical paper by Pantosti and Valensise (1990), among those used by Wells and Coppersmith (1994) to derive their empirical relationships. At any rate, even this 10 km-long fault was not known prior to the earthquake; âËŸA ′c and finally, nor for the 1968 Belice, 1976 Friuli, 1984 Abruzzo, 1990 Potentino, 1997 Colfiorito, 2002 Molise, 2012 Pianura emiliana earthquakes, whose causative faults were most likely blind.

One could argue that the earthquakes that occurred over the past 50 years were not very large, on average, and hence are not representative of the problem at hand. But even the M 7+ earthquakes that have occurred in the early 20th century, the 1908 Messina Straits and the 1915 Avezzano (both of Mw 7.1 according to CPTI), provided contrasting evidence; âËŸA ′c no surface breaks have ever been reported for the 40-kmlong source of the 1908, Messina Straits earthquake, whose causative fault was most likely blind. Nevertheless, the Class A subset of the dataset used by Trippetta and coworkers, derived from GNDT, does report a 36-km-long offshore fault, probably based on geodetic evidence, showing that this dataset in fact reports a combination of inferred seismogenic sources and actual surface faults; âËŸA ′c for the 1915, Avezzano earthquake the Class A subset of the dataset used by Trippetta and co-workers, derived from both the Ithaca and GNDT datasets, reports a 15-km-long fault. This fault accounts only partially for the 30-50-km-long fault that is needed to justify a Mw 7.1 event. The reported faults appear as the surface projection of a deeper portion of the seismogenic fault and do not follow the reported coseismic breaks. In summary, it is likely that none of these earthquakes have been generated by a surface fault reported in Petricca et al.'s database and having the characteristics upon which the paper by Trippetta and co-workers is based. In other words, for none of these earthquakes could the magnitude be derived with confidence based solely on the reported length of their surface trace, which is systematically shorter than that observed (or inferred) after the earthquake. But if the proposed approach does not work on relatively large and

recent earthquakes for which there is good control on the causative fault and on the magnitude, why should it work for older events and, most importantly for future ones?

The largest earthquakes require an additional consideration. Virtually no 20-40-kmlong fault has ever been reported in the areas that were struck by the largest Italian earthquakes prior to their occurrence; but such long faults do occur in areas of more mature geology were seismicity is minimal or absent, such as in the Alps. This might indicate that currently active, seismogenic dip-slip faults (recall that most Italian upper crustal earthquakes are generated by normal, reverse or thrust faults) are normally characterised by a discontinuous surface expression. The established basic geology of the orogens seems to show that when their activity stops, some of these faults are uplifted and rejuvenated along with their associated landscape, making them appear more continuous, more mature and downright ominous, right at a time of their evolution when they are no longer a concern for seismic hazard.

At the opposite end of the spectrum lie some catastrophic Italian earthquakes of the past few centuries that occurred in foreland areas and that reportedly were not accompanied by surface faulting. Such is the case of the 1693 Eastern Sicily earthquake, the largest in the Italian earthquake catalogue (Mw 7.3).

Under these ill-posed assumptions (assuming that any mapped fault is potentially active, or can be reactivated; mixing faults that may be mutually exclusive; disregarding the post-orogenic rejuvenation of many faults, etc.), the results obtained by Trippetta and co-workers - and plastically represented in their Figures 11 and 12 - are all but unexpected. They show very high-magnitude values of the PEMM for the less-reliable Class B faults; a circumstance that can be simply explained considering that buried fault traces obtained by interpolating sparse data over wide areas will necessarily appear longer than faults within an exposed fault system. It is true that we may have yet to see some exceptionally large crustal earthquake, i.e. larger than any earthquake already known to the historical record; but without adopting any criteria regarding the likelihood of these large ruptures, such scenario is totally at odd with the unique histor-

ical, archaeological and palaeoseismological richness of the Italian earthquake record. This information provides the basis for a much more mindful way to estimating the magnitude of future large earthquakes, also in view of the frequency-magnitude distribution of earthquake occurrence.

Response 11: The discrepancy reported by Valensise et alii between the known faults and the historically/instrumentally-recorded earthquakes is precisely our aim and the subject of our experiment. That is, (1) we consider a large dataset of known/mapped easily-accessible faults in Italy, (2) we calculate the potential magnitude (PEMM) from the fault length, (3) compare the PEMMs with the historically/instrumentally-recorded earthquakes, (4) discuss this comparison and the pros and cons of the used method, and (5) conclude that "These results are partly encouraging and suggest the testing and validation of this experiment elsewhere."

In other words, the discrepancy mentioned by Valensise et alii is included in our comparison between PEMM and the historically/instrumentally-recorded earthquakes and represented in Figs. 11, 12, 13, and 14 and Table 1 (see also the related discussion at pages 11, 12, and 13).

Our aim is not at all to compute the expected magnitudes of earthquakes in Italy. Rather, it is to test the validity of those scaling relationships (between fault attributes and earthquake magnitude) when using available fault datasets at the national scale. This is clearly and unmistakably stated in our Introduction: "Our main aim is to test whether solely considering the known mapped faults (both active, inactive, and undetermined) and disregarding further information (e.g., historically- and instrumentally-recorded earthquakes as well as the regional stress field and strain rate) it is possible to provide, through existing seismic scaling laws of faults and earthquakes, reasonable assessments of the maximum possible earthquake magnitude over an entire nation. The resulting (assessed) magnitudes (PEMM) are compared (i.e., the mathematical difference) with catalogued earthquake magnitudes that are the only existing points of reference against which assessed magnitudes can be compared."

Yes, obviously in our dataset of faults there are problems connected with poorly known faults, or buried or segmented ones, as stated by Valensise et alii. Well, how do these problems affect the computation of the expected magnitude of earthquakes? We contribute to answer this question with Figures 11, 12, 13, and 14 and Table 1 (see also the related discussion at pages 11, 12, and 13). This is our job in this paper.

Concerning the area of Paganica-L'Aquila and Messina Straits mentioned by Valensise et alii, we remark that, regardless of the faults invoked by Valensise et alii, the magnitude obtained in our experiment (PEMM) is between 6.0 and 6.5 for the Paganica-L'Aquila area and larger than 7.0 for some cells of the Messina Straits. These results are consistent with the earthquakes mentioned by Valensise et alii, that is the 2009 Mw 6.3 L'Aquila earthquake and the 1908 Mw 7.1 Messina Straits earthquake.

Comment 12 The bottom line is that the approach proposed in the paper by Trippetta and co-workers goes against the knowledge acquired during decades of seismic hazard studies in Italy and the rest of the world. It does not predict anything useful but is potentially dangerous and very costly, if not put in the right perspective.

Response 12: Our aim is not at all prediction or forecasting. We simply discuss the results of our experiment. The seismic hazard is not included in this work (see our previous responses) and not recurrence time and probabilistic calculations are included.

Comment 13: The authors never admit that their results are pointless, even when they remark (Page 12) that "... the negative occurrences are very limited...", i.e. that the number of predicted magnitudes that are larger than those observed in the historical record outnumbers by far the opposite case, resulting in the very asymmetric pattern shown in Figure 12. In fact, they refer to a "...limited difference... between PEMMs and the catalogued earthquake magnitudes..." (!), neglecting the obvious consideration that magnitude is a logarithmic quantity, implying that a 0.2 increase in Mw, for example from 6.0 to 6.2, doubles the seismic moment. For a typical continental fault having an aspect ratio in the range 2-3 and standard scaling for coseismic slip, doubling the

moment implies that fault length may increase by over 20%. For a magnitude increase of 0.5, for example from 6.0 to 6.5, the seismic moment becomes 5.6 times larger, which may require a fault that is 100% or more longer than that necessary to generate the smaller earthquake.

Response 13: Thanks. We accept this comment. We will rephrase this statement (the negative occurrences are very limited...). We agree that it is useless commenting this result as very limited. We will susbstitute "very limited" with the exact numbers that we obtain from the experiment. The term limited is too vague and subjective. However, once again, it is worth to underline that we are not proposing a forecast method, we are testing very well-known scaling laws at the national scale.

Comment 14: In commenting their rather disappointing results the authors invoke potential incompleteness of the earthquake catalogue, which is always possible locally, but is also very unlikely for a work that considers the whole of Italy and all the data available in the richest earthquake catalogue worldwide. This record has certainly missed specific events but is reliable enough to constrain the frequency-magnitude distribution of Italian seismicity. A piece of information that a study about the estimates of earthquake magnitude cannot neglect.

Response 14: By stating that "this record has certainly missed specific events", Valensise et alii confirm that invoking a potential incompleteness of the earthquake catalogue (as we did) may be correct.

Comment 15: Trippetta and co-workers conclude by stating that "...more detailed studies should be developed...". This is always a good thing to do, except for the fact that detailed studies of Italian faults do exist and are often more accurate and to the point with respect to what is proposed here.

Response 15: This statement by Valensise et alii confirms that our experiment was really necessary. Valensise et alii believe indeed that detailed studies of geological structures are good enough and sufficient. Results from our experiment (see in partic-

ular Figs 10, 11, 12, and 13 and Table 1), in contrast, show that "more detailed studies should be developed". We refer, in particular, to the discrepancy between the PEMMs and the historically/instrumentally-recorded magnitudes of earthquakes.

The experiment that we realized is a test also for other countries. One of the pillars of our experiment is its RAPIDITY. We consider indeed fault databases easily available and accessible, testing how much they are reliable to infer the earthquake magnitude. This is a completely different job from the DISS database (run by Valensise et alii) that has being implemented for almost 20 years. Our aim is to test whether we can infer possible earthquake magnitudes from available and easily-accessible datasets of faults.

Comment 16: The conclusions of this paper are worrisome, in consideration of the large number of areas where the authors envision the possibility of M 7.5 and larger earthquakes, that is to say earthquakes bigger than the largest magnitude ever recorded in Italy, without any consideration as to how frequently this may occur. In a standard PSHA approach these large magnitudes would be assigned a very low probability of occurrence, leading to a minimal statistical impact on the expected ground shaking for short average return periods. The information about the possible largest earthquakes may generate a great deal of confusion if not appropriately communicated. We cannot imagine how the residents of Bologna, Ancona, Pescara, but also Padua, Trento, Vicenza and even Venice, cities lying in areas that are currently considered mid- to low-hazard, would react to knowing that very large earthquakes may occur below their feet at any moment.

Response 16: We completely agree with the sentence "The information about the possible largest earthquakes may generate a great deal of confusion if not appropriately communicated". In fact, we are NOT proposing a new seismic hazard map, and this is really clear by reading the paper (not only looking at the figures). We simply compute potential earthquake magnitude from fault size and compare these results with seismic catalogs (Figs. 10-13 and Table1) to reason upon the validity of the scaling relation-

ships between fault attributes and earthquake magnitude at the national scale with available fault datasets. The comment by Valensise et alii is therefore inappropriate.

However, in the revised manuscript we will better stress the above-mentioned concepts (i.e., our aim is not a new and reliable map of expected earthquakes in Italy). We will also add disclaimers in Figures 7 and 8 saying that these figures are not at all for use for Civil Protection, officials, and, in general, for seismic hazard. They are a product for scientific use only (i.e. testing the empirical relationships).

Comment 17: Another major flaw in the approach taken by Trippetta and co-workers lies in their discretisation of seismogenic zones into 25x25 km sub-areas. Of course, some discretisation is inevitable, but one has to be aware that a 25x25 km cell may host a 35 km-long fault, at the most. According to the equation proposed by Leonard (2010), the empirical law adopted by Trippetta and co-workers, a 35 km fault length corresponds to a Mw 6.8 earthquake. Hence, any larger earthquake will necessarily encompass two or more cells. A close inspection of Figures 7 and 8 of the paper, however, reveals that several cells filled in red or dark red, which according to the adopted colour-coding should correspond to an expected Mw in the range 7.4 to 7.8, occur isolated, i.e., surrounded by cells for which the expected PEMM is much smaller. According to same equation by Leonard (2010), this magnitude range corresponds to a fault length in the range 78 to 135 km, which should involve a minimum of 2 to 4 adjacent cells, depending on fault strike. An isolated cell capable of a Mw 7.4 earthquake is hence a seismological paradox that has no physical meaning, as the earthquake causative fault will necessarily extend to adjacent cells.

Response 17: At which cell are Valensise et alii referring to? As we can see from figure 7 and 8 there are no red (M.7.5) isolated cells. In each cell, we consider the longest fault that touches/crosses the cell. This means that the faults can be longer than 35 km as indicated by Valensise et alii. This is clearly stated in our method section at Lines 27-28 Page 8: "The length of the longest fault crossing each cell determined the parameter "fault length" (Lf) of the considered cell." Our computation

is selfsustained and the complete database is available at the following link for reproducibility of our results (see also the Data availability section): http://pmd.gfz-potsdam.de/panmetaworks/review/924b171fd21c78f295d58a7e9e321e8ad07667ab6201634b23d3cb5a3f170d10/

Comment 18: We are a group of INGV seismologists and earthquake geologists who regularly provid active faulting data and seismogenic models to Italian, European, and global SHA practitioners, and to the Italian Civil Protection authorities. As such we are especially concerned that inaccurately collected fault data, inconsistent elaborations and unjustified conclusions such as those presented by Trippetta and co-workers may be implicitly validated by appearing in a respectable journal such as Solid Earth, thus becoming embedded in the literature. In addition to that, chasing the problem of the occurrence of very large earthquakes with an overly simplistic approach is the most effective way to shift our attention from the areas where earthquakes in the Mw range 6-0-7.0 are more likely to hit. These areas include most of the eastern Alps, various portions of the Apennines, most of Calabria and several parts of Sicily. Encouraging earthquake retrofitting in these areas should be the main target of any responsible seismological community.

Response 18: We do not see the scientific question posed by this comment and at the same time we are aware that Valensise et al., are INGV seismologists and earthquake geologists working on active faulting for SHA. We acknowledge the expertise of the Authors on this topic, but at the same time we emphasise the conflict of interest they have maintaining the monopoly of fundings on the seismic hazard in Italy since decades.

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2018-98, 2018.