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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Tectonic styles of expected earthquakes in Italy as an input for seismic hazard modeling" *by* Silvia Pondrelli et al.

Anonymous Referee #2

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The aim of this paper is to propose a procedure to characterize the predominant kinematic styles (strike, dip and rake) of each of the 50 Seismogenic Areas of the Italian Model ZS16. The authors first present the database used, which is composed of seismic moment tensors (Mw > 4.5) and focal mechanisms. For some events, the kinematic interpretation and the magnitude estimates rely on an existing database of seismogenic sources that is based on the interpretation of different geological and geophysical information. In the second part they present a procedure, which consists in identifying, for each seismic zone, the percentage of events in the database that fall in each kinematic style, identifying predominant nodal plane(s) based on a procedure that weighs the final focal mechanisms based on cumulated seismic moment criteria. Where necessary, total or partial random source contributions are attributed instead of specific kinematic

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styles.

Review

This paper represents an important preliminary step in the building of seismic hazard models that use modern GMPEs, whereby expected motions may differ considerably depending on the kinematic style of the causative fault. It deserves to be published but only after major revisions. The structure of the paper needs to be improved and the seismogenic depth parameter of the reference Italian Model ZS16 better discussed; introductory paragraphs should be re-grouped in the introduction; explanations for how the database was constructed better justified (e.g. why the CPTI15 magnitude is not used?); final selection of events actually used for the computation of the predominant kinematic styles (strike, dip and rake) should be easily accessible to the reader (see comments for Table1suppmat). The weighting procedure could be better illustrated, in particular for regions where the final result may potentially be driven by just the biggest event in the zone. Finally, I would suggest adding uncertainties in strike, dip and rake to Table 2, reflecting the color scheme in Figure 2 and providing end-users with a measure of dispersion for each zone.

Additional requests/suggestions:

1. Abstract

The abstract mentions that uncertainties in the attribution of kinematic styles would be quantified. At present this is not the case. See comments below.

2. Structure of the paper

Line 150- Entire paragraph needs re-writing: I suggest you shift all “introductory” material to the introduction, present how seismogenic depths proposed in the reference ZS Model are used or not in the selection of events used in Table 1.

3. Database – Choice of Magnitudes

Line 115 – “Considering the high magnitude of these events (1905 M6.9 in Calabria and the 1915 M6.9 in the Southern Apennines) and the aim of this study, we looked for quaternary tectonics information in the DISS database (DISS Working Group, 2018), according to which the seismogenic sources of both events are described as pure extensional, based on geological studies (e.g. Loreto et al., 2013 for the 1905 Calabria earthquake; Galli and Galadini, 1999 for the 1915 earthquake) Could you locate these two events on a Figure and indicate a reference to the DISS ID used. I found information about these two events in the online version of CPTI15, which presents quite different magnitude estimates:

In Table1 sup material:

o D190509080143A 1905-09-08 Mw6.8

o D191501130652A 1915-01 Mw 6.6

In DISS:

o ITCS110 Sant’Eufemia (1905) Mw 6.8

o ITCS025 Salto Lake-Ovindoli-Barrea (1915) Mw 6.7

In the CPTI15 database:

o 1905 Calabria centrale Mw 6.95

o 1915 Marsica Mw 7.08

This is quite confusing. Mmax being a critical parameter for defining seismogenic potential you may want to clarify your procedure or, in any case, justify why you consider DISS rather than CPTI15 as a reference for Magnitude estimates of historical earthquakes.

4. Database -Choice of depths -

Given that the ZS Model is the reference, you may want to comment on the depths

currently used in the ZS model to justify for the final depth range used to select events determining the kinematic styles of each zone. For example: Line 158 “in some zones the most representative seismicity is deeper, thus we used a thickness of 40 km to ensure the inclusion of all crustal seismicity” –does this depth correspond to definition of depth in the ZS model? a. Deeper zones may have different geometries than superficial zones: can you justify prolonging the same geometrical boundaries of superficial zones to the deeper zones? b. Shouldn’t there be a deeper zone to represent the Calabrian subducting plate? The ITSD001 in the DISS database, corresponding to the “the Calabrian subducting slab”, suggests a seismogenic zone between 10 and 50 km with pure thrusting kinematics. Your procedure leads to a strike-slip/normal kinematics between 0 and 40 km depth (e.g. ZS 41, ZS 39). This difference of definition in terms of seismogenic “volume” and kinematic styles between DISS and your proposal may be worth discussing.

5. Procedure - Uncertainties -

I’m surprised to see a unique value (strike, dip, rake) triplet attributed to each source zone in Table 2. Are you suggesting to use just this single value in hazard computations? Shouldn’t uncertainties be associated to such estimates, quantified in Table 2 and used in hazard computations? - In the discussion, could you address the sensitivity of your procedure to the presence of very high magnitude events in some source areas in the final attribution of kinematic styles (Table 2)? One information that may be useful for the discussion is to also indicate which event contributes most to the total seismic moment in the source zone (for the zone of the 1905 earthquake, for example). - line 125 Knowing that for some regions the possible largest earthquake may not be represented in the available observations, how would this impact the procedure you propose? - Line 160-168 - list the 3 zones for which a separate deeper kinematic style is defined: 19d Tuscany-Emilia Apennines Deep; 20d Emilia Deep; 25d Inner part of Marche (this one is not plotted in Figure 5)

6. Figures

Figure 1: There is a clear SW-NE alignment of deeper events between latitude 41 and 42, on the eastern coast of Italy which cuts across source zone boundaries ZS34 and ZS35. Are these characterized in the Italian Model ZS16 by some deeper sources not shown in Figure 1 or are they excluded in further analysis? Please comment.

Figure 2: The label says “the entire available dataset in black”..but I no longer see the same alignment as in Figure 1, are some events excluded in this Figure?

Figure 5: 25d Inner part of Marche is not plotted

7. Tables

Table 2 should contain a measure of the dispersion associated to each evaluation which should correspond to the color scheme used in Figure 2

Table 1SuppMat - should contain the source zone ID for each event used to apply the procedure, the events excluded because too deep will have no ID. . .and should not be shown in Figure 1.

8. Mistakes

Line 50: "a narrow bend striking" you mean "narrow band"?

Line 69" geological databases, such as DISS", DISS is defined on the web site as a database of “seismogenic sources” not of fault sources nor geological sources

Table 1SuppMat: "The ID of each event starts with a letter that identiïňĄes . . .."- missing the end of the table caption?

Line 146 “because they do not include any seismic event with magnitude greater or equal than M 4.5”-suggestion: "because no events with M>= 4.5 are present"

Line 150: “.. the depth distribution of the Italian seismicity (Figure 1), it becomes immediately evident”- it is not really immediately evident. You may want to re-phrase

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