Comment to “BSHAP project strong ground motion database and selection of suitable ground motion models for the Western Balkan Region”

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Comment to "BSHAP project strong ground motion database and selection of suitable ground motion models for the Western Balkan Region"

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Salic et al. (2016), hereinafter SEA16, describe the procedures adopted and the choices made within the latest phase of the NATO-funded project BSHAP (Improvements in the Harmonized Seismic Hazard Maps for the Western Balkan Countries; http://wbalkanseismicmaps.org/) as to the compilation of a strong ground-motion database and the selection of the ground-motion models to be used for probabilistic seismic hazard assessment (PSHA) in the Western Balkan region.

Consistent with current practice in PSHA studies, SEA16 tentatively selected a set of global and regional ground-motion prediction (GMP) models that were subsequently ranked using different published methods. The candidate GMP models were those of Abrahamson et al. (2014), Boore et al. (2014), Campbell and Bozorgnia (2014), Chiou and Youngs (2014), Akkar et al. (2014a, b), Bindi et al. (2014), Cauzzi et al. (2015). Since SEA16 refer to these models as ASK14, BSSA14, CB14, CY14, Aetal14, Betal14, Cetal15, respectively, the same acronyms are used in this Comment. ASK14, BSSA14, CB14, CY14 are global models derived based on the NGA-West2 database (Ancheta et al. 2014); Aetal14, Betal14 are regional (pan-European) models based on the RESORCE database (Akkar et al. 2014a); Cetal15 is an independent global model dominated by Japanese data. The logic-tree weights implemented by SEA16 are based on the ranking scores obtained using the log-likelihood (LLH; Scherbaum et al. 2009) and Euclidean distance ranking (EDR; Kale and Akkar 2013) methods.

Ranking scores are provided by SEA16 for all pre-selected models but three, namely ASK14, CB14, Cetal15. The CB14 and Cetal15 models were clearly removed from the list of candidates based on the deterministic scenarios shown in Figure 18 [*Comparison of the median predictions of the candidate GMPEs for EC site class A (VS30* = 800 *m/s, Faulting style: SS, Earthquake size: Mw* = 7.5] of SEA16. The authors write "Behavior of CB14 model shown in Fig. 18 is consistent with the between event residual plots: Figs. 8

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and 9 indicate a considerable overestimation for Mw > 5 events for CB14 model. For all distances, the Cetal15 model often fall below the majority of models and display a different spectral shape with two peaks, especially at longer source-to-site distances. Figure 18a [that we identify as the top-left panel of Figure 18] is especially useful to understand the difference between the median predictions of models; since BSHAP strong motion database is empty in the large magnitude-short distance range, the data testing and ranking methods fall short to distinguish the inconsistencies in the large magnitude scaling among the candidate models. Based on these observations, CB14 and Cetal15 models are eliminated from the candidate GMPE list". We believe that the comparison shown in Figure 18 of SEA16 is misleading, as explained in the following. We focus in this Comment on Cetal15, that we know better, while we note incidentally that Campbell (2016) recently demonstrated that CB14 "can be used to estimate ground motions from moderate-to-large-magnitude earthquakes in pan-Europe".

Cetal15 proposed three alternative (i.e., non-equivalent) GMPE formulations (and a neat strategy to mitigate oversaturation with magnitude), with functional forms given in their Eqs. (2)-to-(9). If one uses only Eqs. (3) and (4) of Cetal15, a generic ground-motion prediction on rock is obtained, representative of the median spectral amplitudes recorded on Eurocode 8 (CEN 2004) ground type A in the Cetal15 dataset (RHS of their Figure 2), which contains many VS30 values largely exceeding 800 ms^{-1} (i.e., the *lowermost* VS30 value of Eurocode 8 ground type A). This results most likely into the lower short-period spectral amplitudes displayed by Cea15 in the comparison of Figure 18 of SEA16 (especially at 5 km distance, while at larger distances Cetal15 is fairly comparable with the other models). However, if VS30 is used instead of ground types as predictor (consistently with the other GMP models in Figure 18) and site spectral amplification is represented through Eq. (6) of Cetal15, then Figure 18 of SEA16 changes as shown in the present Fig. 1, where the more appropriate implementation of Cetal15 is shown by the thick

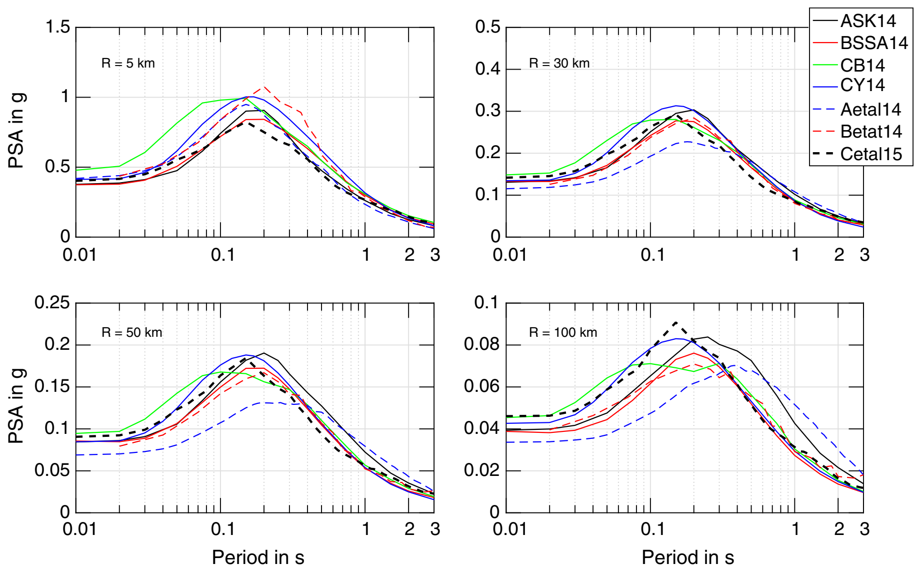

Fig. 1 Same as Fig. 18 of Salic et al. (2016) but for the implementation of the Cetal15 model, as explained in the text

dashed black curves. As apparent from Fig. 1, Cetal15 does no longer "often fall below the majority of models" (remarkably, this is now the case for Aetal14), nor does it "display a different spectral shape with two peaks", that is nothing but an obvious perturbation of the spectral shape around the peak of the response spectrum, that we did not smooth in our 2015 paper. For completeness, we note that Eq. (7) of Cetal15, a legacy of Cauzzi and Faccioli (2008), was derived only for the sake of consistency with the simple ground-type-based prediction of Eqs. (3) and (4), and has limited physical meaning as mentioned in Cauzzi and Faccioli (2008) and in Cetal15. To sum up, we recommend using Eqs. (3) + Eq. (4) + Eq. (6) of Cetal15 if VS30 is known for the application at hand. This choice was made, e.g., in the comparisons of Figure 7 of Cetal15, that SEA16 have apparently overlooked. We note that, representing the site term of the Cea15 model based on our Eq. (6), would have led SEA16 to quite different conclusions, and we invite the Authors to outline, in their response to this Comment, what such conclusions would have been like.

After presenting and discussing our point of view with the Authors, we have followed the indication of the Chief Editor of the Bulletin of Earthquake Engineering to write this comment that, we believe, along with the reply from the Authors, will provide useful additional information to the readers of the journal. This case, in our opinion, carries an important take-home message for the larger community of GMP models' users and developers. Several recent generation GMP models are published (especially in Europe) with alternative functional forms based on different predictors. The resulting median models are different and come along with different prediction uncertainties. For example, Bindi et al. (2014) developed four alternative models using either Eurocode 8 ground types or VS30, point-source or finite-fault distance metrics; Akkar et al. (2014a, b) presented three alternative models based on different distance metrics; Cauzzi et al. (2015), as previously discussed, proposed alternative representations of the site term. Only one model *per* published paper is presented in Figure 18 of SEA16. While this would make sense for Aetal14 who proposed only one finite-fault distance model, the scenarios depicted in Figure 18 of SEA16 are definitely not exhaustive for Cetal15 and Betal14, not to mention the assumptions that the Authors had to make to plot the NGA-West2 models. When developers provide alternative GMPE representations, communication with the authors is critical to be advised as to the preferred model for a given application. Otherwise, all relevant available models should be considered for testing and ranking as done, e.g., by Lanzano et al. (2016) for Akkar et al. (2014a, b) and Bindi et al. (2014) within the context of updating the seismic hazard map of Italy. While we do not intend to discuss here the final choices operated by the project leaders and working group, we cannot avoid thinking that a more careful consideration of the input data to Figure 18 of SEA16 would have resulted into a quite different logic tree for BSHAP.

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