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Solid Earth
Discussions

Interactive comment on "ER3D: a structural and geophysical 3D model of central Emilia-Romagna (Northern Italy) for numerical simulation of earthquake ground motion" *by* Peter Klin et al.

Anonymous Referee #2

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The manuscript describe the construction of a 3D geophysical model of a 60km x 60km x 20km volume in the Po Plain basin (Italy) using some informations on the interfaces geometry and elastic properties available in the literature. The main aim of the 3D model is the simulation of seismic wavefield in the region. The authors implemented the model in a 3D computational mesh for a Fourier pseudo-spectral element method. They claim that the final model and the computational mesh is able to accurately simulate frequency up to 2 Hz. They compare the simulated seismograms with the recorded ones, comparing the PGV and the duration (Airy duration) for two events recorded by $\sim$ 29 stations. The main conclusion of the work is that the 3D model is able to reproduce the long shaking duration observed in the data, better than

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Discussion paper

a 1D model. The authors also analyse a 2D section of the simulated wavefield in order to understand from which part of the model the wiggles observed many seconds after the origin time come from.

As general consideration, the paper appears well written, the topic might be of interest of the journal and I would suggest it for publication in Solid Earth after a revision following the remarks below.

General comments: The method and the aim of the manuscript is not original per se. As mentioned by the authors, there are already 3 published work in which, with different aims, region and methods, the authors built a 3D model of the basin for seismic wave propagation purposes. This would be the 4th attempt. For that reason, I strongly suggests the authors to make their model publicly available (downloadable by the public) and if it possible also the a priori data used, in order to allow a comparison between the response of the various models and the reproducibility of the final result.

From some of the papers already published, the conclusion that a 3D model is better than a 1D model was already clear. It would be interesting to highlight here what is better or different for this model.

I am a bit skeptical regarding the accuracy of 2Hz in the simulations, especially because the 3D model does not have such detail in the data used to built the model itself. Some more word regarding this point will be appreciated. In particular it is not so clear how it is possible to reach such details in the model if only 3 2D sections (+ 2 interfaces) are used as input for the 3D model constructions (more comments on this point are below).

And other consideration is the following: in this work I do not see a real quantitatively comparison or validation of the 3D model. The authors only use two events and compare only PGV and Arias duration (without showing any example). The full waveform is not really compared.

Comments (following the text):

P2/L1-3: This period is a bit too long. What do you mean for geophysical model?

P2/L18: developedâĂŤ> built?

P3/L5-7: Is it 2Hz too optimistic?

P3/L21: In order to set up of a reliable âĂŤ> delete “of”

P3/L25: Boccaletti et al. 20111 âĂŤ> check the year

P4/L31-41: The authors use a commercial software to built the 3D model. The procedure of building the model is not so clear (it appears as a black box), especially how the software creates the features and the interfaces between the three 2D sections and the two horizontal horizon (Pliocene deposit and plane deposit), where no information is available. I suggest to improve this part.

P5/L18-19: what is new in the 2D sections from Boccaletti et al., 2004 and 2011, if compared with Pieri and Groppi (1981)? Better interpretations of the original data?

Figure 4-5-6: It would be nice to show a section of the 3D model that so not follow the 2D section used as input data, in order to show the final result in the region where the model is really created. I have noticed that, in figures 11-12 one 13, the authors show a section that do not coincide with the ones used to build the model. However in this section, it is possible to notice that there are some very small details at the section borders (up-left and up-right) not labeled with any structural units. What are they? Horizons? Faults? Which structural unit they belong with? How do you know these are real features?âĂİThe 3 figures are not at a high resolution. Labels are not readable.

P6: The assignment of the physical properties is pretty standard. Why do not include more local informations? In Table 1, I would show also the VS and density values for each geological formation.

P7-L15: frequency rage: 0-2 Hz. Really from 0 Hz? In A computational mesh of 60km

x 60km x 20km you cannot simulate long wavelength.

P7/L27: The simulated signals are 65s long. Could it be that you are missing some late arrival (at time > than 1 minute after the OT)? Did you test this point?

P8/L26-28: I suggest to show in one figure an example, for one event and one or two stations, of the 3 compared signals (data, 3D, and 1D model) and the measure done on these signals (Arias duration , marking the 5% and 95% and PGV). I do not find very satisfactory the duration boxes showed in figure 10.

Figure 10: Why you do not show the Z component? And instead you show the Norm? "Empirical" are the Data, right? Of course we do not expect that the 3D model is able to match every wiggle of the data; however comparing data and synthetics from 3D model, it is clear that the arrival time and the number of energy packages in the data are not the same as the simulated ones. This might be mainly due, in my opinion, to wrong interfaces in the 3D model that causes or not, spurious arrivals. Also the first arrival appears to not fit the data. Can the author comment on that? Moreover the duration boxes plotted in the figures appear to have a strange starting and ending point, neglecting some shaking.

Figure 11-12-13: I would merge the 3 figures in a single panel, if possible.

Figure 12, panel b): what is the wave package that appear to propagate from bottom-left to up-right, near the station T0824 (at its left), at the section top?

In the text sometimes the authors write "elongation of the ground motion". I would change it with long shaking duration or something like that.

It would be great, for the geophysical community, to have the model publicly available, in order to allow other scientists to compare models and to add, if possible new data.

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