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Solid Earth Discussions

Interactive comment on "Regional wave propagation using the discontinuous Galerkin method" *by* S. Wenk et al.

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General comments

This paper presents an application of discontinuous Galerkin method to 3D regional wave simulations using CUBIT as a mesh generator. The method takes the advantage of using unstructured tetrahedral meshes to describe complex geometries of Earth structures in numerical simulations. The synthetic seismograms for a 1D reference model are benchmarked those computed by the spectral element method (SEM) by Komatitsch & Tromp (2002) using explosive and shear dislocation sources. In the final section, an example of mesh generation with CUBIT is shown for the 3D European crustal model EPCrust (Molinari & Morelli 2011) which is implemented on top of the 1D mantle model ak135 (Kennett et al. 1995) to run wave simulations for the 2009 L'Aquila earthquake.

It is an important contribution to present an alternative method for regional wave simulations in terms of the flexibility of the unstructured tetrahedral mesh to capture complex crustal structures, Moho/surface topographies etc. which are crucial to accurately simulate wave propagation. The literature is nicely summarized. It is, in general, well written, however, the paper would benefit from a careful proofreading. In addition, some figures need clarification.

Overall, the paper presents a good start for these kind of studies, however, I have the feeling after reading that, in its current form, it seems a bit incomplete in terms of discussions on the performance and simulation results to present the advantages of the proposed method. My detailed comments and suggestions are as given below:

1- The authors compare synthetic seismograms computed by the presented method using 1D PREM model to those from SEM which were benchmarked with normal mode seismograms. The authors could have directly compared their 1D experiments to the normal mode seismograms as well. What is the reason of using spectral element seismograms for 1D comparisons?

2- In Figure 6, the comparisons of observed data with synthetics computed in 3D crustal model EPCrust (Molinari & Morelli 2011) are nicely illustrated. However, it is not clear what the main message is here. The comparisons are not very quantitative and do not tell much about the validity of simulations in 3D models. The main advantage of the method described in the paper is the flexibility of meshing complex structures with unstructured tetrahedral meshes which can be critical to honor especially crustal structure, Moho and surface topographies etc. Following the previous remarks, 3D simulations could have been compared to the SEM simulations which would lead to interesting discussions on the implementation of 3D crust in numerical simulations and the advantage of the flexibility of unstructured tetrahedral meshing to honor crustal structure.

3- It is not surprising that body wave agreements between synthetic and observed

data are quite good since they are less sensitive to the crustal heterogeneities and even 1D models are good at explaining the body waves. This can easily be verified by also plotting seismograms computed for the same paths using a 1D background model in Figure 6. However, it is worthwhile to mention that surface wave misfits should also be biased due to the use of 1D mantle model in simulations since the period range considered in the paper (> $\sim$33 s) is sensitive to both crustal and uppermantle structure. I suggest to add 1D seismograms to Figure 6 to see the effect of 3D crust and even 3D crust + 3D mantle on waveforms.

4- Since the authors take SEM method as a reference for the validation of their method, that would be good to mention the computational cost and performance analysis compared to SEM method which help better understand the advantages and disadvantages of the method.

5- Figure 2 & 3: Show the source and receiver locations or at least denote the epicentral distance of each station-source pair. From the plots, it looks like the focus is on minor arc surface waves but please explain the reason of not using the same duration of simulations for all source-station pairs.

6- Figure 4 needs some clarification. A map on top of the surface mesh would be helpful to locate the area of interest. Instead of density, shear-wave speeds would make more sense to show the complexity of the reference 3D crustal model.

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