COMPARISONS OF 3D EARTH MODELS FOR IBERIA

Rosa Martín (1), Daniel Stich (1,2), José Morales (1,2)

1 Instituto Andaluz de Geofísica, Universidad de Granada (Spain)
2 Departamento de Física Teórica y del Cosmos, Universidad de Granada (Spain)
rosa@iag.ugr.es, daniel@iag.ugr.es, morales@iag.ugr.es

We show 3D wave propagation in 3D Earth Models (Crust 2.0, Eucrust 07 + Crust 2.0, Epcrust and IBERREF model) across the Iberia Peninsula. To evaluate these 3D Earth models we use the 20070812 Pedro Muñoz event with 4.7 Mw, occurred in the centre of Iberian Peninsula and recorded by a great coverage of seismic stations deployed overall Iberia, and the 20091217 Cape of St. Vincent event with 5.5 Mw. For numerical sumulations of regional wave propagation in a 3D model, we use the parallel computing infrastructures of the Red Española de Supercomputación (RES) and the global espectral element code Specfem3D GLOBE (Komatitsch and Tromp, 2002a,b). We evaluate the predictive power of the models through comparison of observed and modelled waveforms in the period bands 20-50s.

3D CRUSTAL MODEL IBERREF

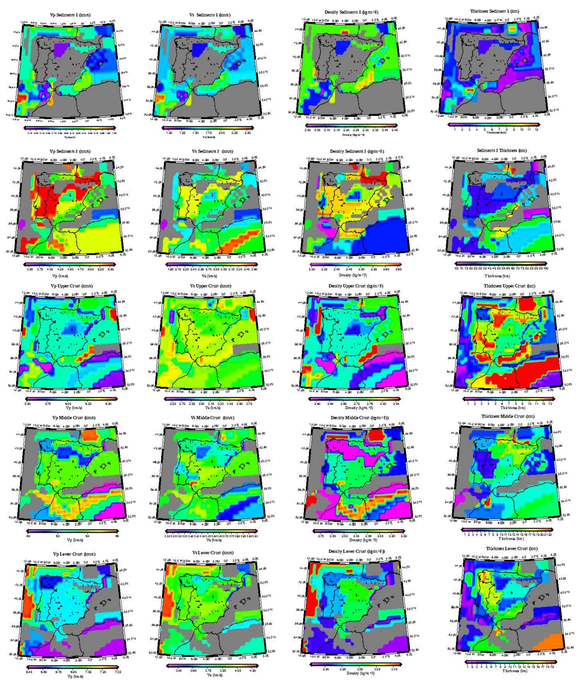


Fig.1 P-wave, S-wave, density and thickness maps defined for each layer of 3D Earth Model IBERREF.

3D CRUSTAL MODEL IBERREF

In the last years several geophysical experiments have been in the Iberia–Magreb Region (i.e, Consolider Topoiberia, Nearest-Seis, Picasso) which have permitted to have recents data about main physicals parameters of the crust in this region. We have developed a new reference 3D Earth Model for Iberia–Maghreb region (IBERREF) compiling recents data obtained of wide-angle seismic profiles offshore Iberian Peninsula, in the Atlantic Ocean (NEAREST–SEIS proyect, Sallarès et al. 2011, Sallarès et al, 2013), as onshore (IBERSEIS profile, Palomeras et al. 2009) and current results of receiver functions analysis in Northern Morroco and Southern Iberia (Mancilla et. al. 2011, Mancilla et al. 2013, not submitted) combining with selected previous data of gravity models, refraction and reflexion seismic profiles, geological studies and local and global models.

The 3D Earth Model IBERREF is a model crust of resolution 0.5º x 0.5º composed by four layers including one o two sediments layer, a layer for the upper, middle and lower crust, respectively. For each layer is defined P-wave and S-wave velocity, density and thickness (fig. 1).

3D EARTH MODEL COMPARISON

We represent main characterics parameters of the crust for the four 3D Earth model Crust 2.0 (Gabi & Laske, 2002), Crustmap (Tesauro (2008) & Matthias Meschede), Epcrust (Molinari, 2011) and Iberref. We compare the differents models plotting the weighted values P-wave and S-wave velocity and density, and the Moho depth (fig. 2).

3D EARTH MODEL COMPARISON

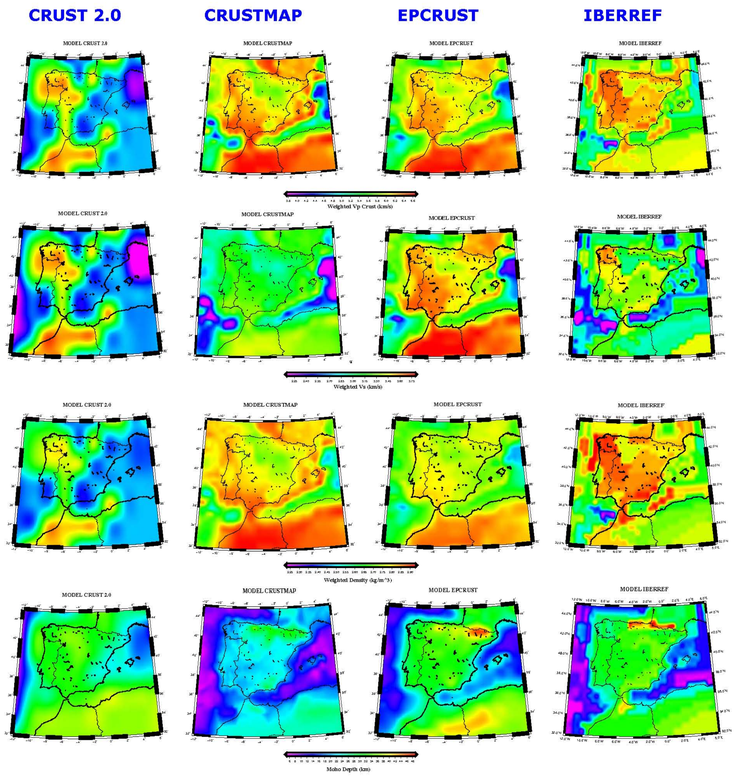
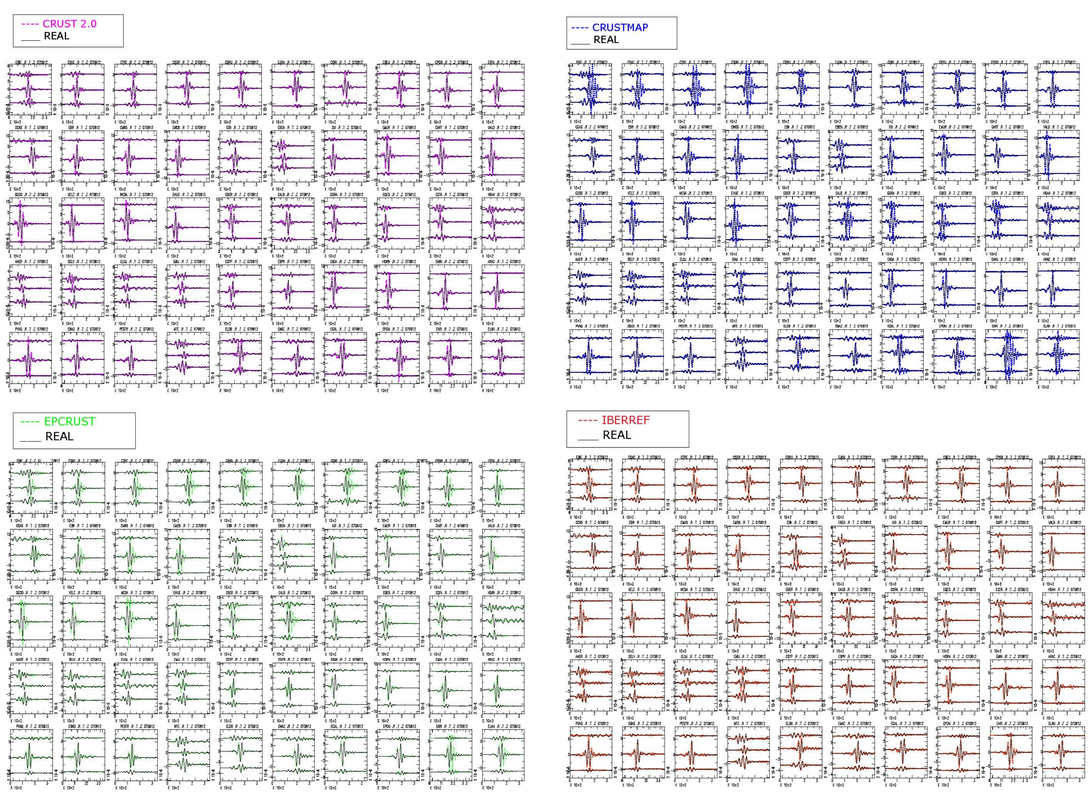


Fig.2 Weighted values of P-wave, S-wave, density and Moho depth maps obtained for CRUST 2.0, CRUSTMAP, EPCRUST and IBERREF models.

20070812 PEDRO MUÑOZ EVENT 4.7 Mw



20091217 CAPE ST. VICENT EVENT 5.5 Mw

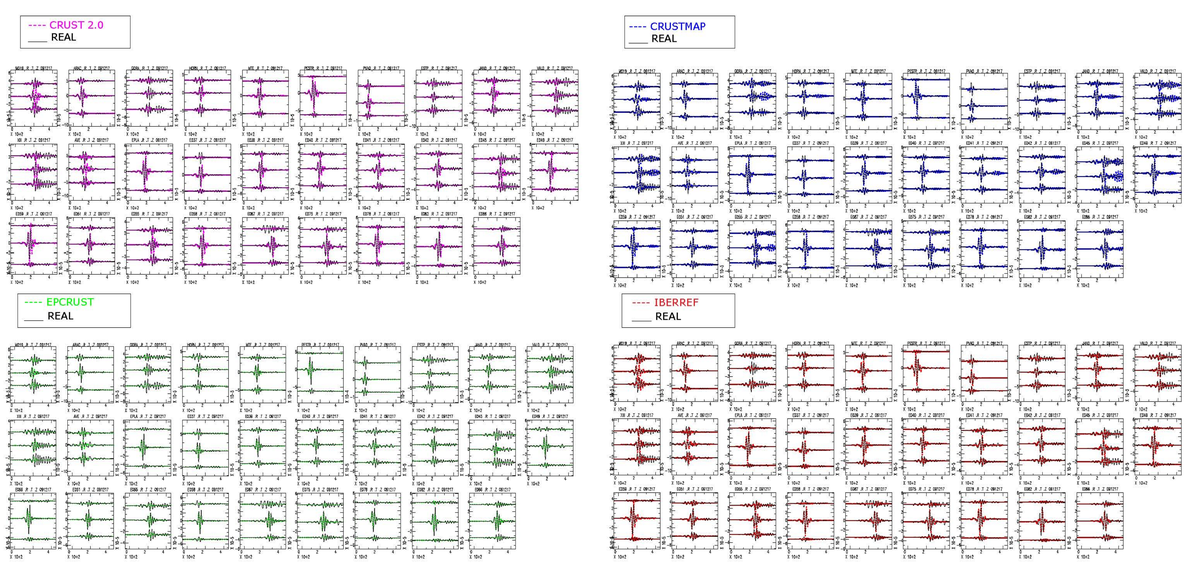


Fig.3 Comparison between observed and sintetics waveforms obtained for the four differents 3D Earth Model Crust 2.0 (magenta), Crustmap (blue), Epcrust (green), Iberref (red) modelled for the 20070812 Pedro Muñoz event with 4.7 Mw and the 20091217 Cape St. Vicent event with 5.5 Mw. All seismograms are bandpassed filtered between corner frequencies 0.02 Hz and 0.05 (20s-50s).

CONCLUSIONS

Our a priori 3D Earth model IBERREF for the Iberian-Maghreb region incorporates more detailed, more recent, and presumably more accurate information on regional Earth structure, compared to previous 3D Earth models. This should improve the prediction of regional intermediate period waveforms from earthquakes in this area. Drawing on two examples, we show that this the case e.g. for waves propaga tion in northern Iberia, near the coast of the Cantabrian Sea (e.g. ELAN station), where IBERREF uses a deeper Moho compared to other models. Also, a better prediction can be observed in the Alboran Sea (EALB station) and Southeast Iberia (e.g. MESA station) where we have now available significantly more constraints on crustal thickness variations. In general, IBERREF performs better than CRUST 2.0 or CRUSTMAP, and has similar performance as EPCRUST. However, still IBERREF does not permit satisfactory fitting of intermediate period waves along a number of regional paths, and in particular fails to predict the most complex waveforms (e.g. Gibraltar arc).

MODELLING 3D WAVE PROPAGATION

To evaluate 3D wave propagation across CRUST 2.0, CRUSTMAP and EPCRUST we use the spectral elements software SPECFEM3D-GLOBE which has implemented these models in its code. For numerical simulations in the 3D model IBERREF we modelled a 16º x 16º regional mesh centred in the south of the Iberian Peninsula. We use four layers of spectral elements to represent the crust and we consider the effects of topography and bathymetry, oceans and attenuation. The mantle is represented by global model S20-RTS. For the simulations we selected two events of the moment tensor catalogue of Instituto Andaluz de Geofísica, one of them ocurred in the center of Iberia (20080712, Pedro Muñoz event with 4.7 Mw) and the other one, offshore Southwest of Iberia, in the Atlantic Ocean (20091217, Cape St. Vicent event with 5.5 Mw). Both events have been recorded by numerous seismic stations in Iberian Peninsula with a high quality signal. (Fig. 4)

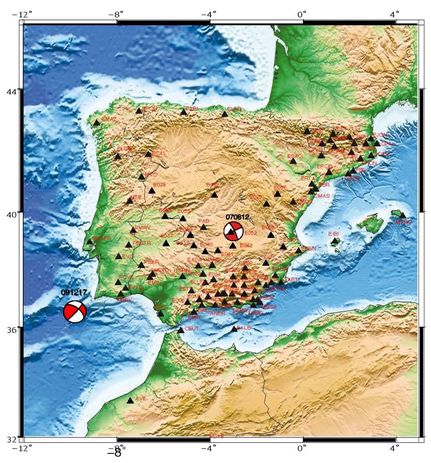


Fig.4 Map of the Iberian-Magrheb region with seismic stations and 20080712 and 20091217 earthquake sources (IAG moment tensor catalog) used for testing the 3D crustal models.

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