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Towards a 3D structural model of the Hellenic Subduction Zone: simultaneous determination of moment tensors and 1D path-specific models

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Waveform tomographic investigations applied to data of the temporary broadband EGELADOS network can give a detailed insight into the complex and different properties of the Hellenic Subduction Zone. It leads to an improved 3D structural model of this region showing the contact zone between the subducted African lithosphere and the overlying Aegean mantle as well as the mantle wedge above the slab and the lateral variation of its properties. Of course, the determination of 1D source-receiver path models is a first step towards obtaining a 3D model for the Hellenic Subduction Zone.

The main challenge during the inversion is to determine both moment tensor and 1D model. For that, an appropriate starting model should be defined previously. Examples show that using one average starting model for all the stations would give large misfits during the inversion and sometimes lead to complete divergence. A solution to this problem is to perform a grid-search varying the Moho depth and average S wave velocity in the crust. Synthetics from all the obtained models are compared to data to find the ones presenting the smallest misfit. At this point, they should be in agreement with what we already know about the geological structures of their corresponding source-receiver path. The best models from the grid-search are then used as starting models for the 1D inversion.

The waveform inversion is performed using seismograms of 103 events that occurred during the period of deployment of the EGELADOS network from October 2005 to April 2007. These events with magnitude down to 4.1 were recorded at an average of 60 land, ocean-bottom and GEOFON stations and relocated with better accuracy. As first step, a 1D inversion using the waveform envelope is done. It permits to obtain an estimation of the moment tensor. Then a second 1D full waveform inversion using this moment tensor gives an improved 1D model for each event-station pair that is again used to recalculate the moment tensor.

Results show valuable improvements with starting models obtained from the grid-search, a noticeable misfit reduction and a good concordance with geology. This presents an interesting perspective for the subsequent 3D waveform inversion.