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First-arrival vs joint refraction/reflection tomography - a comparative study from SE Poland

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This study is focused on the methodological aspects of modelling the huge 3D refraction/wide-angle reflection dataset. This constitutes a part of the CELEBRATION 2000 deep seismic sounding project, covering a 500 by 500 km area in SE Poland. It spans very complicated geological setting: from precambrian East European Craton, through the palaeozoic terranes in the TESZ, to the Alpine (Carpathians) orogen. In the first-arrival tomography we used nearly 15000 arrivals of Pg and Pn phases up to 300 km offsets. The inversion was performed in the FAST package with a quasi-multiscale approach, gradually stepping from bigger cell-size to the finer grid. We found it superior to the single-parameterization approach. The relative high speed of computations allow us to perform several model assesment tests, like checkerboard and resolution restoration tests or even the quasi Monte Carlo error analysis. In order to obtain better ray-coverage in the lower crust and the Moho interface, we have applied the joint refraction-reflection tomography implemented in package JIVE3D. The modelling was performed in two steps: first we inverted 12000 Pg arrivals for the crustal structure and then we added ca. 3000 PmP arrivals and performed joint inversion for the crustal structure and Moho depths. Obtained model is much smoother in comparison to the FAST model, which might be partly explained by the B-spline parameterization of the velocity field used in the JIVE3D. The advantage of using reflection tomography is that we were able to obtain a realistic Moho depths map for the study area. On the other hand, the extremely slow performance of the JIVE3D is prohibitive for performing detailed resolution analysis, thus the only presented model quality assesment was the DWS plot. We conclude that probably the best tradeoff between those two methods would be maintained when using the first-arrival tomography for constraining crust/mantle velocities and subsequent inversion for the "floating" Moho interface.