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Interactive comment on "Upper mantle structure around the Trans-European Suture Zone obtained by teleseismic tomography" *by* I. Janutyte et al.

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We thank Anonymous Reviewer for the useful comments and present our replies:

Fig. 1 and introduction part: The purpose of Fig. 1a is only to show the location of the study area in Europe. We limit Fig. 1b to the study area because we want to show the structural units which we relate to the velocity anomalies in our results. The Reviewer may be right, that an additional figure showing the tectonic settings of the surrounding areas (discussed in the Introduction part) may be useful. We made an overview of the upper mantle structure on larger scale compared to the overview of the crustal structure. Using the method of the teleseismic tomography one is able to resolve relatively large structures in the upper mantle, which might extend outside the study territory, thus, it is very important to make an overview of the upper mantel

structure on larger scale (around the study area as well). As for the crust, it is thin compared to the entire velocity model (which extends 700 km in our study), and the seismic rays hit the area from steeply below, thus, the seismic raypaths are affected only locally by the heterogeneities in the Earth's crust depending on the geological conditions close to the seismic station. Moreover, we aim to study the upper mantle while crustal structure is important only to correct for the crustal effects (which is done using the crustal model described by Majdanski (2012)). Thus, we do not present the crustal structure outside the study area. We thank Reviewer for the reference to Zielhuis and Nolet (1994) study. In the study by Zielhuis and Nolet (1994) S waves and surface waves were used while our results are based on teleseismic P waves. However, we found it interesting and useful, thus, we included the reference.

Data: That is true, we picked the absolute arrival times.

Method: In our study we use the TELINV code which was used primarily by e.g. Weiland et al. (1995), and later by Arlitt et al. (1999) and Sandoval et al. (2003). The program utilizes a nonlinear inversion method and can either 1) calculate propagation of rays through a 3-D velocity model and output TT, raypaths and synthetic relative TT, or 2) invert teleseismic relative P wave residuals for 3-D velocity structure. The ray tracing is performed computing the 3-D minimum TT raypaths assuming a constant slowness in each cell (Steck and Prothero, 1991). A raypath is determined through a model, i.e. which nodes the ray crosses and how much time it spends at each node. An algorithm produces the theoretical TT which are used in computing the relative residual arrival time data. A ray tracer affects both a matrix kernel G and a data vector d (Steck and Prothero, 1991). The procedure performs a simplex search for the fastest path of a planar wavefront to a point at the surface. In this procedure the departure point of a ray from the plane wave is not fixed, but determined by the algorithm itself. It assumes that the ray bending and distortions are caused by heterogeneities along their paths (Weiland et al., 1995; Sandoval, 2002). As the calculations in the TELINV are performed using the basic steps which were developed and published in the provided references, we did not present any formulas in our paper. We also compare our results for the NW part of our study area with the results obtained by Sandoval et al. (2003) in the discussion part.

Crustal corrections, Fig.6 and Fig.7: The results with the crustal TT corrections obtained using the EUCRUST07 model show artificial structure of high amplitudes ("high-low-high“ velocities) which are obviously related to the thick sedimentary cover within the TESZ (this is not precisely included into the EUCRUST07 model). Moreover, the grid of the crustal model is large (1 degree in horizontal direction). Due to these reasons we used the other set of crustal corrections which was compiled using the precise (and denser grid) crustal model by Majdanski (2012) and results of some DSS projects. The results with the latter set of crustal TT corrections show no obvious artifacts and reveal distribution of the velocity variations as expected (higher velocities beneath the craton and lower ones to the west from the TESZ) from the previous studies discussed in the introduction part (Fig. 7c). Comparing our results with Sandoval et al. (2003), we also recognize importance of the precise crustal TT corrections in the tomography inversion. As mentioned before, the set of crustal TT corrections was compiled using data of the controlled source seismic (CSS) projects. Sandoval et al. (2003) was also using the CSS data in order to compile the precise set of the crustal TT corrections which they used in their study. In our results down to about 200 km we observe some significant effects from the crustal TT corrections and in the deeper parts this effect decreases, which is also reported by Sandoval et al. (2003). Used reference in the reply: Sandoval, S., Kissling, E., Ansorge, J. and the SVEKALAPKO STWG: High- Resolution body wave tomography beneath the SVEKALAPKO array: I. A-priori 3D crustal model and associated traveltime effects on teleseismic wavefronts. Geoph . J. Int., 153, 75-87, 2003.

Resolution. Fig. 8: The synthetic dataset was compiled adding random perturbations ranging about $\pm$0.5 sec. The cell size in the horizontal directions is 50 km.

Fig.9: The statement of "poorly and well resolved areas“ means that the ray coverage

and crossing of the rays in the area is poor or good, respectively. Yes, we are plotting the diagonal element of the resolution matrix which is sensitive to the geometric distribution of seismic rays. The resolution is the best for the area which is depicted in very dark grey, almost back (area -350<x<0 and -150<y<100 down to about 250 km), and for the rest of the area it is fairly good (lighter grey). It is obvious that we cannot obtain any "fair resolution“ where are no seismic stations at all, thus, the area x=-500 and -200<y<+250, indicated by Reviewer, is an artifact of interpolation. The "dark“ area at the bottom (below 300 km) is due to the large number of rays which enter the study area from below. On the other hand, the raypaths there do not cross, thus, the resolution (especially the vertical one) is not good. We agree with the Reviewer that we should more precisely indicate the regions where we can trust the results most.

Results. Fig. 10: That is true that the anomalies (denoted by 3-7 in Fig. 10c) are relatively small and it may seem that they are not worth to be trusted. However, as we obtain good ray coverage for the areas to the west from the TESZ (Fig. 9) and the anomalies are observed in many layers, we assume that we can interpret the anomalies denoted by 5-7. The anomaly denoted by 4 is quite faint, but we wanted to demonstrate some consistency with the results obtained by Knapmeyer-Endrun et al. (2013a). The velocity anomaly denoted by 3 is also not very significant, however, we are familiar with the complex geology of the region and many debates among the geoscientists from that region, thus, we wanted to emphasize that we observed some features which might be related to some other results (e.g. Motuza, 2004, 2005; Motuza and Staškus, 2009). The Reviewer is right that we do not resolve the same average velocities in the synthetic test (Fig. 10b) compared to the input velocity model (Fig. 10a). However, the relative total ratio between the higher and lower velocities remains almost the same in both the reference model and the inversion results. In the results with the real dataset the most important feature is that we observe the higher velocities to the east and the lower ones to the west of the TESZ. It is possible that the reddish areas should look light blue instead, however, to the west from the TESZ many previous studies indicate negative anomalies (especially beneath the Bohemian Massif and the Eger Rift).

Interactive comment on Solid Earth Discuss., 6, 1723, 2014.