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Resolution of group velocity models obtained by adjoint inversion in the Czech Republic region

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We performed tomographic inversion of crosscorrelation traveltimes of group waves in the Bohemian massif. The traveltimes used for inversion come from ambient seismic noise measurements between pairs of stations filtered for several period ranges between 2-20s. The inverse problem was solved by the conjugate gradients, which were calculated using efficient adjoint method. Assuming that the propagation of group waves can be approximated by membrane waves for each period separately, the computations are reduced to 2D domain. The numerical calculations were carried out using adjoint version of SeisSol, which solves elastodynamic system using Discontinuous Galerkin method with arbitrary high order time derivatives (ADER-DG).

The adjoint inversion is based on computation of so called sensitivity kernels for each data, which are then combined into Fréchet kernel of misfit gradient. Therefore, if using only the longest wavelength data i.e. the traveltimes of 20s and 16s group waves, structures of even shorter wavelengths can be obtained by the inversion. However, these smaller-scale structures are possibly more affected by data noise and thus require careful treatment. Note that in the classical tomography based on ray method, such structures are subdued by regularization. This leads to question on the influence of data noise on the obtained models.

Several synthetic tests were carried out to reveal the effect of data errors on the resulting model. Firstly, we tested the level of data noise required to obtain artificial small scale structures. As a target model we constructed simple heterogenous model consisting of one very long wavelength structure. The synthetic traveltime data were modified using random shifts for several distributions with different variances. The method appears to be extremely sensitive even for relatively small level of noise.

The other set of tests concentrated on the main feature of models obtained from the real data. All models inverted using longer period data contain distinct decrease in velocity with well defined boundary in SE of our domain, where the station coverage is rather poor. The synthetic tests show us whether this feature originates in the real model or is only an artifact of data coverage in this part of domain. We tested several types of structures in order to find out, whether they could produce results similar to the one obtained by the inversion of real data.