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Interpretation of ambient noise cross-correlation traveltimes: Finite-frequency tomography of Love group velocities in the Czech Republic

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In recent years, great emphasis has been laid on finite-frequency tomography. The inverted observables are considered to be dependent not only on model parameters along infinitely thin raypaths but to exhibit more complicated spatial dependency represented by so-called sensitivity kernels. Efficient tool for the calculation of the sensitivity kernels is adjoint method. It is based on two calculations: forward calculation of wavefield propagating from source to receivers in an initial model, and adjoint calculation where the residuals between observed data and synthetics backpropagate from the receivers to the source (so-called adjoint wavefield).

The aim of the presented work is obtaining surface wave group velocity maps of the Czech Republic for specific periods in the range of 2 – 20 s. Data used in the inversion consist of crosscorrelation traveltimes of Love waves between stations located in the Czech Republic and adjacent areas acquired from ambient seismic noise band-pass filtered around the specific periods. The inverse problem for the L2 crosscorrelation traveltime misfit is solved by the conjugate gradient technique, with misfit gradients calculated using the adjoint method. Assuming that propagation of surface waves along Earth's surface can be approximated by membrane wave problem, the computations are reduced to only 2D domain. Therefore, the calculations could be performed using adjoint version of SeisSol, elastodynamic equation solver using Discontinuous Galerkin method with Arbitrary High Order time Derivatives (ADER-DG).

More attention is paid to the inversion of data of the highest periods i.e. 16s and 20s. The main advantage are lower computational demands. Moreover, 16s and 20s Love waves have similar depth sensitivities, thus the travel times and the resulting models are expected to exhibit only very minor differences. However, in real application this may not be valid, as the data and their processing are subject to various kinds of errors. Thus the 16s and 20s traveltimes can be considered as independent datasets providing estimates of the data errors. Comparing the models inferred from the 16s and 20s data may help to distinguish which features of the inverted models are stable and which are only artifacts originating from noisy data. To gain better insight into the inversion process, we performed several synthetic tests regarding the effect of data coverage, errors in data etc. These tests may also reveal, which regularization method is more suitable to handle our data set to minimize the artifacts of the inversion.