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Shear-Wave Velocity Model of the Bohemian Massif Crust from Ambient Noise Tomography

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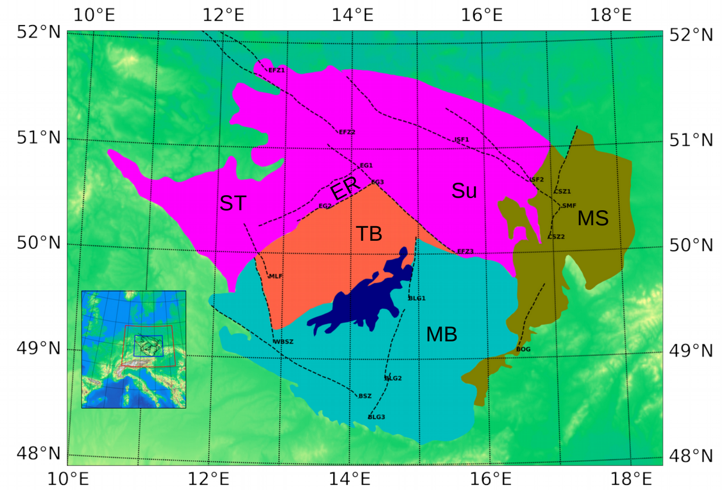
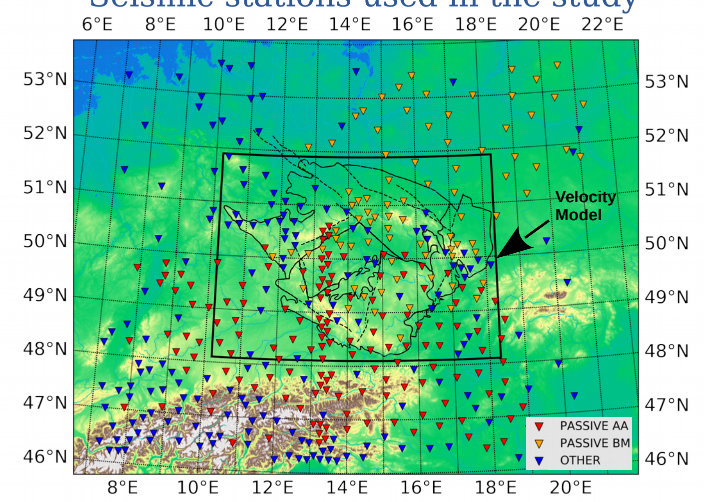
Introduction

- The current knowledge of the structure of the Bohemian Massif (BM) crust is mostly based on interpretation of refraction and reflection seismic experiments performed along 2D profiles. The recent development of ambient noise tomography, in combination with dense networks of permanent seismic stations and arrays of passive seismic experiments, provides unique opportunity to build the high-resolution 3D velocity model of the BM crust from long sequences of ambient seismic noise data.
- The new 3D shear-wave velocity model is built from surface-wave group-velocity dispersion measurements derived from ambient seismic noise cross-correlations by conventional two-step inversion approach. First, the 2D fast marching travel time tomography is applied to regularise velocity dispersions. Second, the stochastic inversion is applied to compute 1D shear-wave velocity profiles beneath each location of the processing grid.
- We processed continuous waveform data from 404 seismic stations (permanent and temporary stations of passive experiments BOHEMA I-IV, PASSEQ, EGER RIFT, ALPARRAY-EASI and ALPARRAY-AASN) in a broader region of the BM (in an area of 46-54^{0} N 7-21^{0} E). The overlapping period of each possible station-pair and cross-correlation quality review resulted in more than 21,000 dispersion curves, which further served as an input for surface-wave inversion at high-density grid with the cell size of 22 km.
- We present the new high-resolution 3D shear-wave velocity model of the BM crust and uppermost mantle. We compare this model with the crustal thickness (Moho depth) extracted from P-wave receiver functions (see Kampfova Exnerova et al., D1439 | EGU2020-7845).

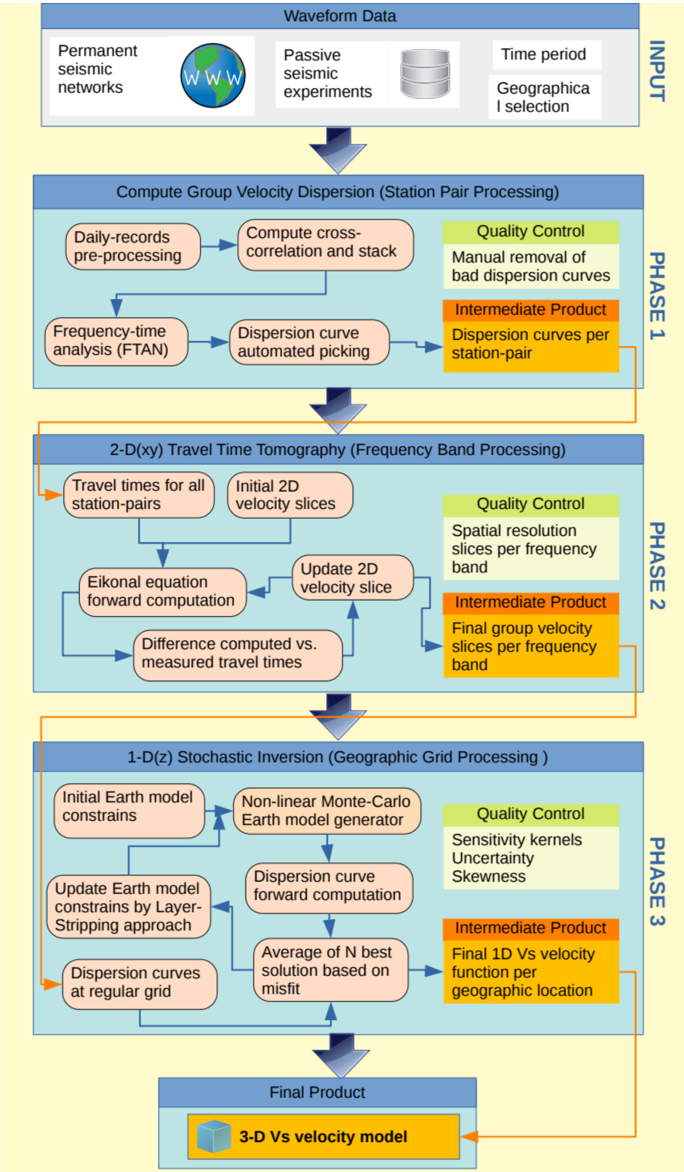
Tectonic map of BM



Seismic stations used in the study

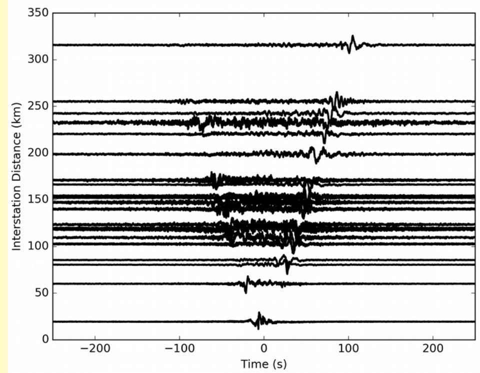


Ambient Noise Tomography



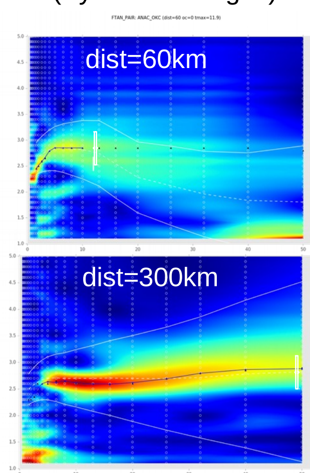
Cross-correlation functions

- MSNOISE package, Lecocq et al., 2014



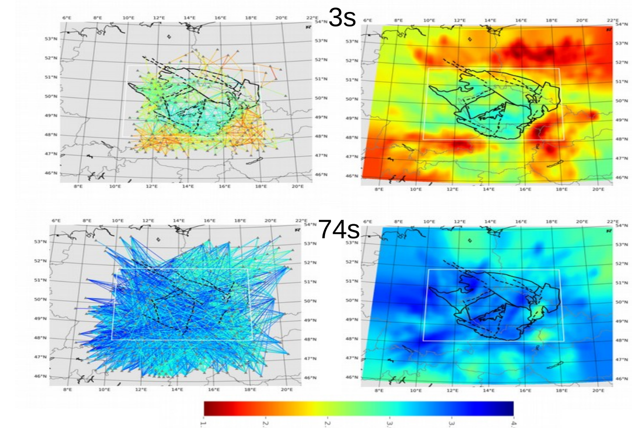
FTAN Analysis and dispersion curve picking

- Automated picker (Python Packages)



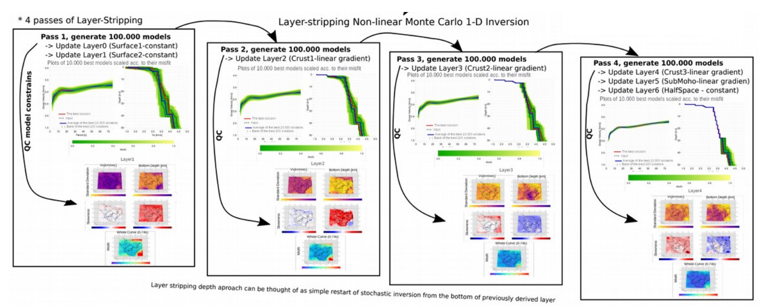
2D Fast Marching Surface Wave Tomography

- FMST Package (Rowlinson 2005)
- Surface sampling 22 x 22 km
- 6 iterations (velocity search per period)



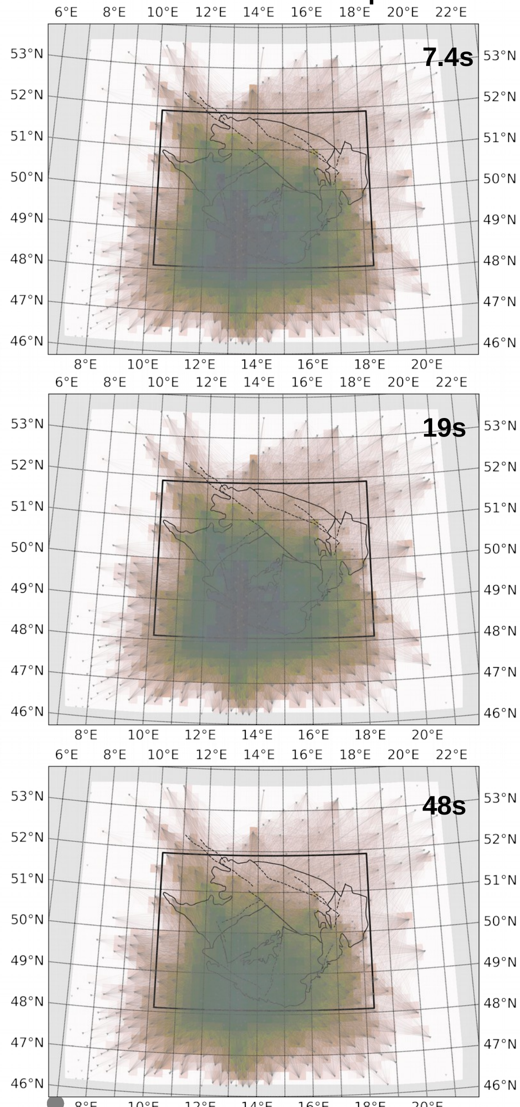
1D Non-linear Monte Carlo (GEOPSY package, Wathelet 2008)

- 360 iteration, 280 initial models => 100 000 resulting models
- 7-layered model based on IASP91 constrains
- 4 passes of Layer-Stripping



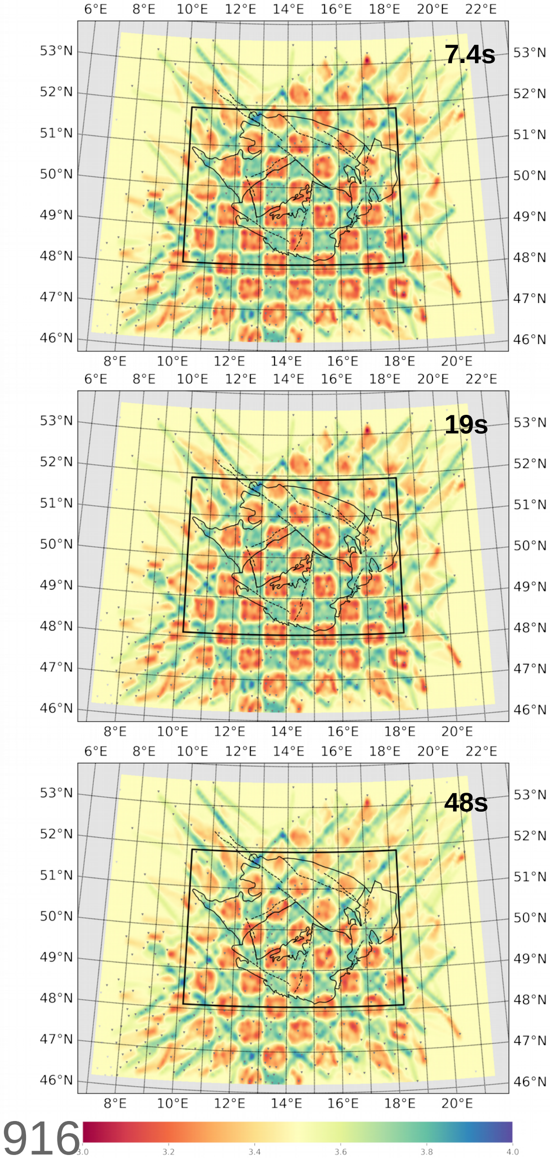
Data Coverage and Model Resolution

Hitcount overlaid by paths between station pairs



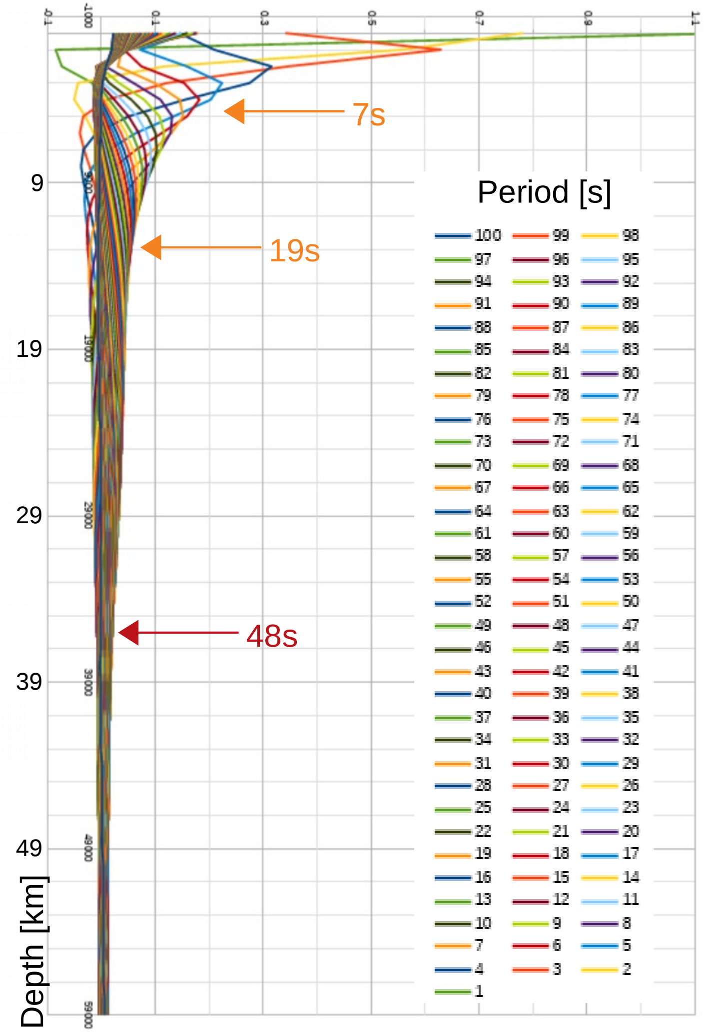
Checkerboard test

- checker size 66x66 km

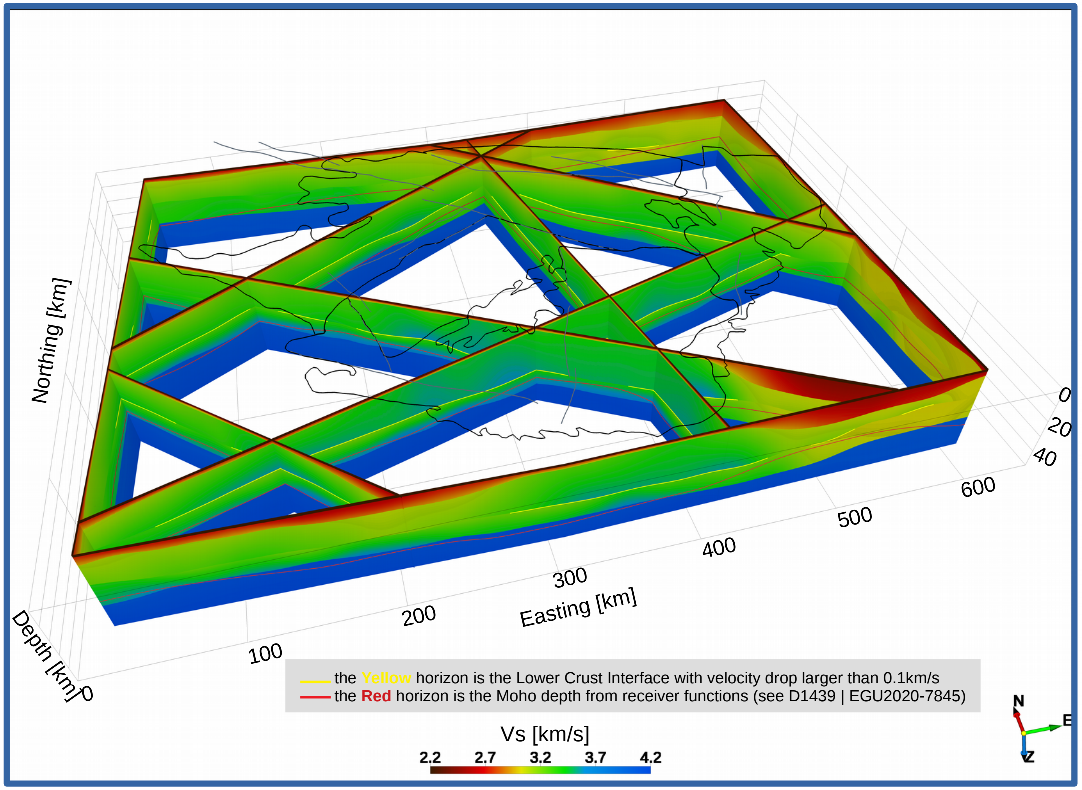


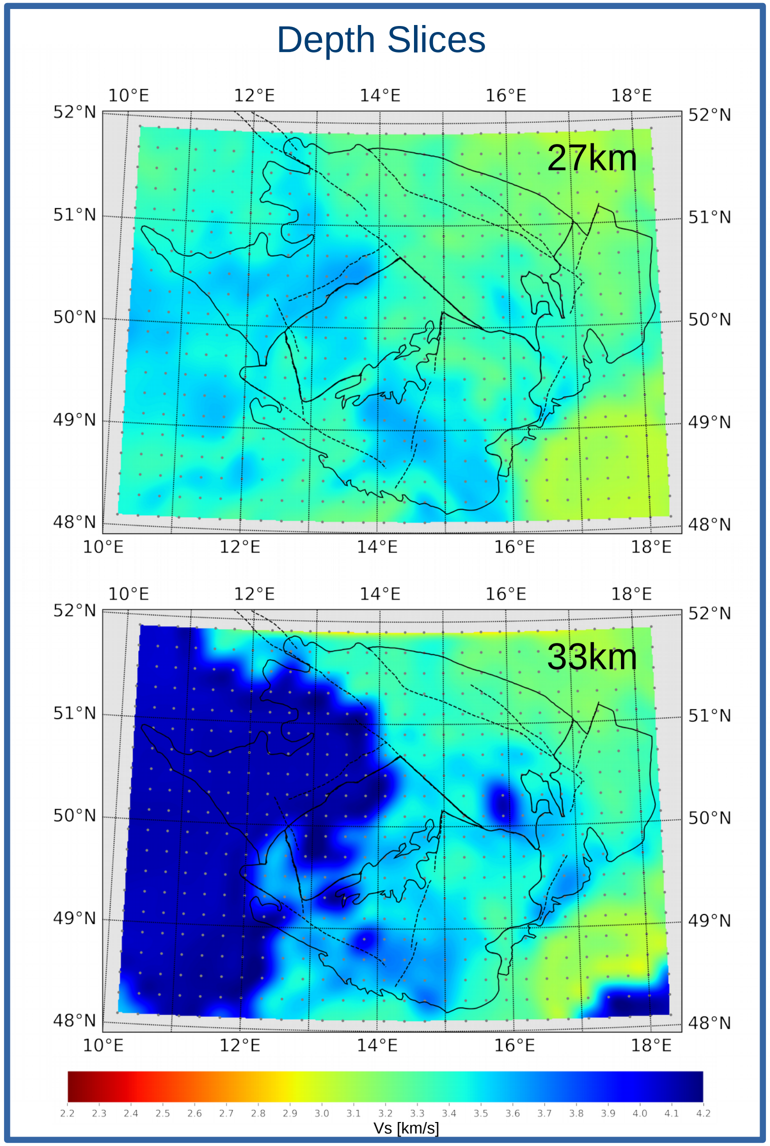
Depth Sensitivity

- sensitivity kernels δc/δβ



3D Velocity Model





Conclusions

- Velocities within the upper crust of the BM are ~0.2 km/s higher than those in its surroundings. The highest crustal velocities occur in the Moldanubian unit (MB).

- The velocity model confirms, in accord with results from receiver functions and other seismic studies, a relatively thin crust in the Saxothuringian unit (ST), whilst thickness of the Moldanubian crust is at least 36 km in its central and southern parts.

- The most distinct interface with a velocity inversion at the depth of about 20 to 25 km occurs in the Moldanubian unit.

- The velocity decrease in the lower crust reflects probably its transversely isotropic structure.