Investigations of the Earth's crust structure in the NW Dinarides using local earthquake tomography method

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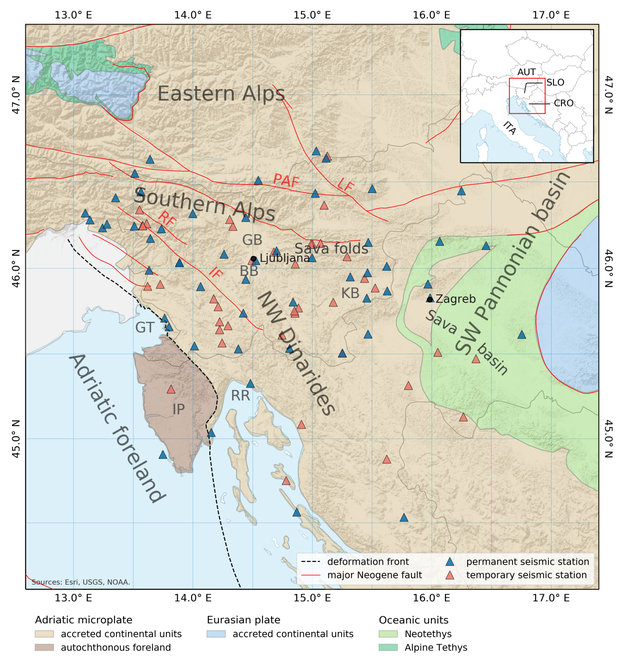
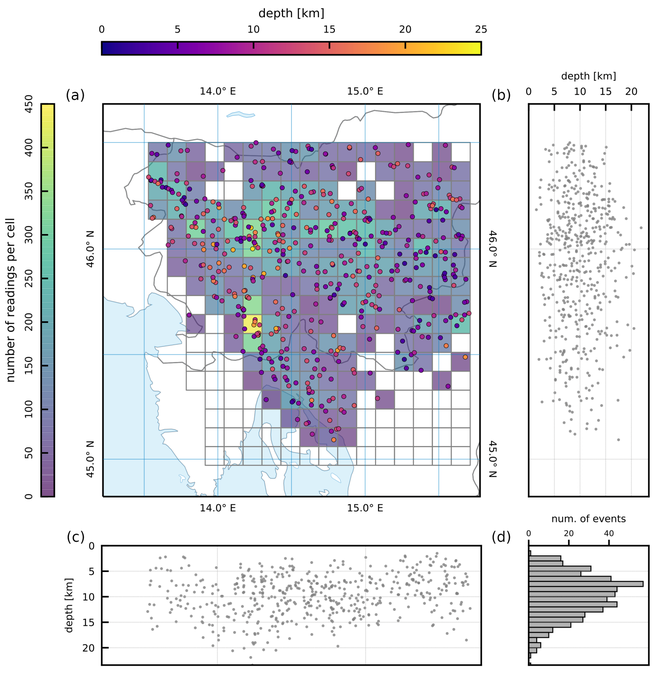
Introduction

The studied area of the NW Dinarides lies in the NE corner of the Adriatic microplate. We investigated the velocity structure of the Earth's crust using the concept of the minimum 1-D velocity model and the method of local earthquake tomography (LET). We performed 1-D and 3-D simultaneous hypocentre–velocity tomographic inversions with P- and S-wave arrival times picked in routine earthquake analysis at Slovenian Environment Agency (ARSO).

The main reason for this study was the need for a high-resolution 3-D velocity model of the Earth's crust in the broader NW Dinarides region, which would constrain both P- and S-wave velocities. For the purpose of the AdriaArray workshop, we focus on the sampling and resolution of the 3-D model, which can serve as a guide for future station deployments.

We took advantage of the greatly increased amount of data available after the modernisation of the Seismic network of the Republic of Slovenia (SNRS). We used also data from surrounding seismic networks (Croatia, Austria, Italy) and temporary station deployments (e.g. AlpArray).

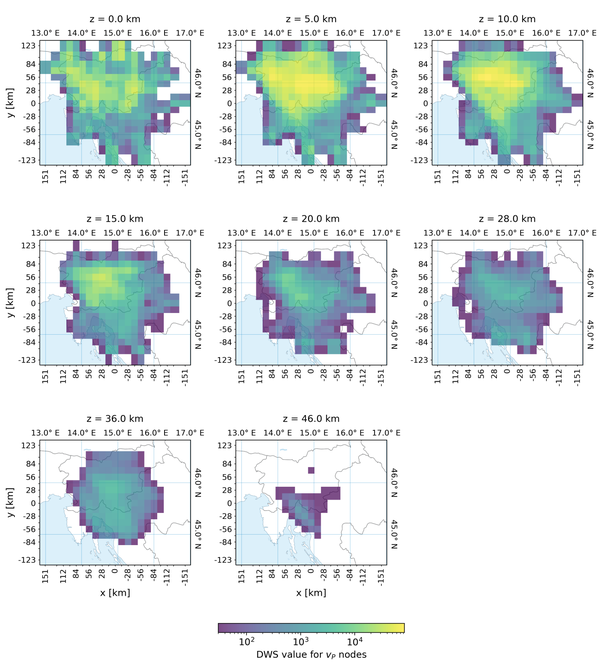




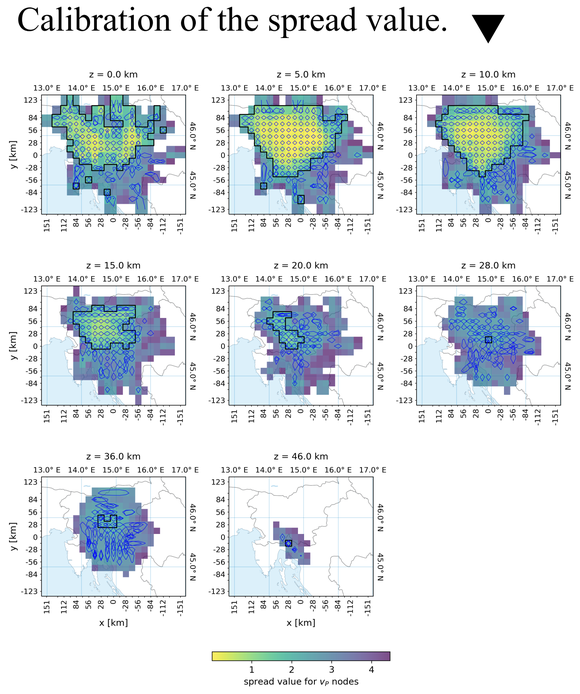
The dataset for the 3-D inversion consists of 510 earthquakes between 2004 and 2018 CE with at least 10 P and 5 S arrivals, gap ≤ 160°, $M_L \geq 1.0$, and rms residual ≤ 0.5 s. Suspicious arrival times and the ones with high uncertainty (> 0.5 s) were removed from the dataset.

This dataset allows us to densely sample the upper crust in the northern part of our study area. The station coverage in the south and SE is worse, which is reflected in the sampling of this region and thus the resolution of the final model.

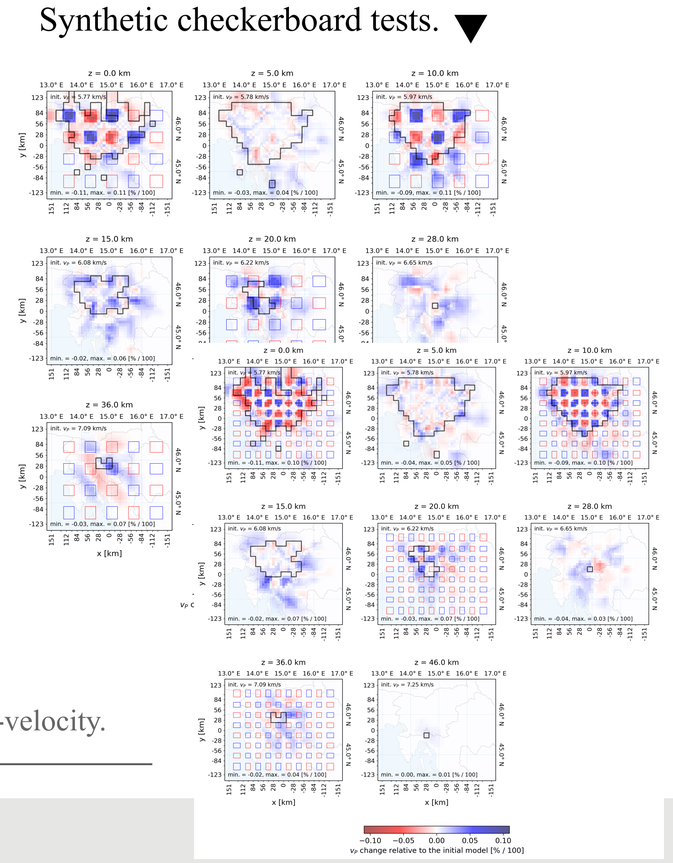
Velocity models computed in the 1-D hypocentre–velocity inversion (Rajh et al., 2022) were used as starting models for the graded 3-D inversion.



Calibration of the spread value.

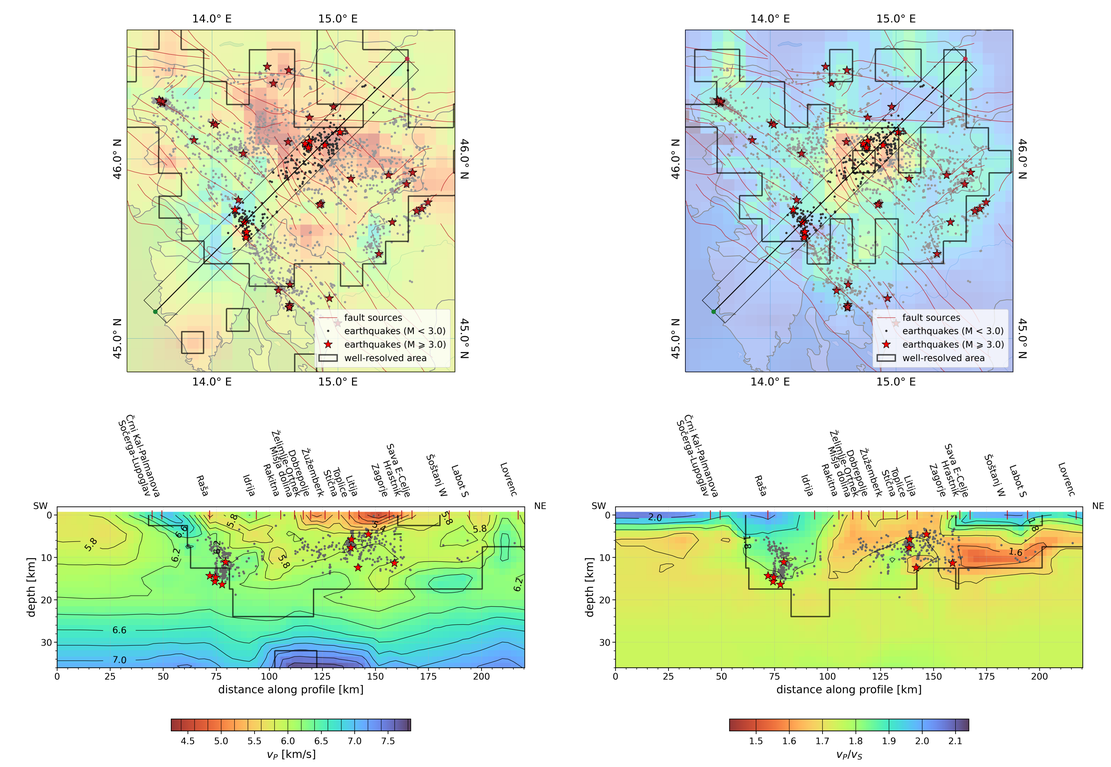


Synthetic checkerboard tests.



* For brevity, figures on sampling, resolution estimates, and synthetic tests show only examples for P-velocity.

Vertical profiles of the final 3-D P-velocity and v_P/v_S models with relocated seismicity running approximately perpendicular on major faults.



The final velocity models are parameterized on the 3-D grid with the minimum horizontal and vertical separation of 14 and 5 km, respectively.

Conclusions

> The 3-D velocity structure of the Earth's crust can be recovered very well in the seismically active regions with dense and uniform station coverage (northern part of the study area).

> Lack of stations and unfavourable geometry leads to poorly constrained velocity model in the southern and SE part of the study area.

> Distinct velocity contrast between western and eastern part of the study area.

> The high resolution P-velocity and v_P/v_S models computed in this study represent another step toward a 3-D velocity model for the entire Dinarides region that will greatly improve our understanding of the evolution of this orogen. The deployment of additional seismic stations in the scope of AdriaArray project could prove essential in completing this task.

> Improved locations, smaller travel-time reisudals, shallower hypocentres compared to the routine locations. Implications for seismic hazard.

1-D inversion: Rajh et al., 2022. One-dimensional velocity structure modeling of the Earth's crust in the northwestern Dinarides, Solid Earth, 13, 177–203.

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The AdriaArray workshop 2023 in Dubrovnik is partly supported by ORFEUS & EPOS within the EPOS SP project (Horizon 2020 Grant Agreement No. 871121).