Lithospheric structure of the Pannonian Basin using Rayleigh wave ambient noise tomography – preliminary results

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1. Pannonian Basin

The Pannonian Basin is a back arc basin located within the arcuate Alpine–Carpathian mountain chain. Together with the Aegean Trough and the Western Mediterranean basins it forms one of the backarc basins in the tectonically active broader Mediterranean region. Its evolution is ultimately linked with slab rollback, asthenospheric updoming, and formation of the Carpathian mountain chain in the east and the Alpine–Dinaric orogeny in the west. Tectonically the Pannonian Basin comprises the AlCaPa unit that is of Adriatic origin and the Tisza-Dacia unit that is of Eurasian affinity.

The formation of the Pannonian Basin took place in the last 20 Ma (Handy et al. 2015; Horváth et al. 2015). Several models have been proposed to explain the extension in the Pannonian Basin within the collisional setting of the Alpine–Carpathian mountain chain but many key questions are still under debate.

The crust in the Pannonian Basin is quite thin. Its thickness ranges from 24 to 30 km beneath the basin and from 30 to 50 km beneath the surrounding orogenic regions (Grad et al. 2009). The lithosphere is also thinned but the topography of the lithosphere–asthenosphere boundary is not very well constrained. The average thickness of the lithosphere has been estimated to approximately 60–70 km in the center of the basin (Tari et al. 1999; Lenkey 2002).

In this project we will estimate a three-dimensional S-wave velocity model beneath the Pannonian basin. Imaging the velocity structure of the crust and the upper mantle may help us to understand better the structure and formation of the region.

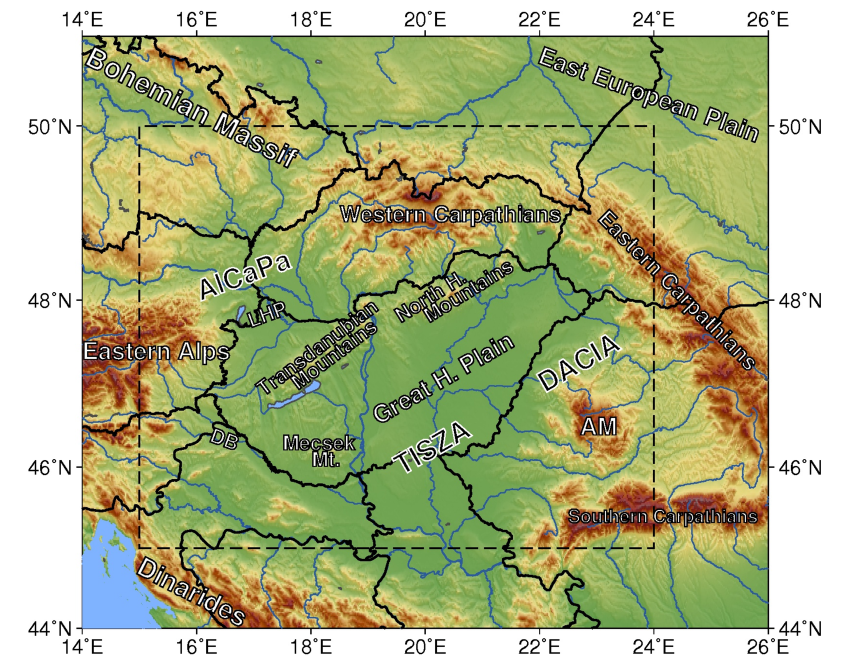


Figure 1. Map showing the Pannonian Basin and its surrounding regions. LHP – Little Hungarian Plain, AM – Apuseni Mountains.

2. Data & Method

For the preliminary investigation we chose all the available stations within the broader Central Eropean region which were operating during 2017 to ensure the data coverage in the Pannonian Basin and minimize the smearing effect at the edge of the research area.

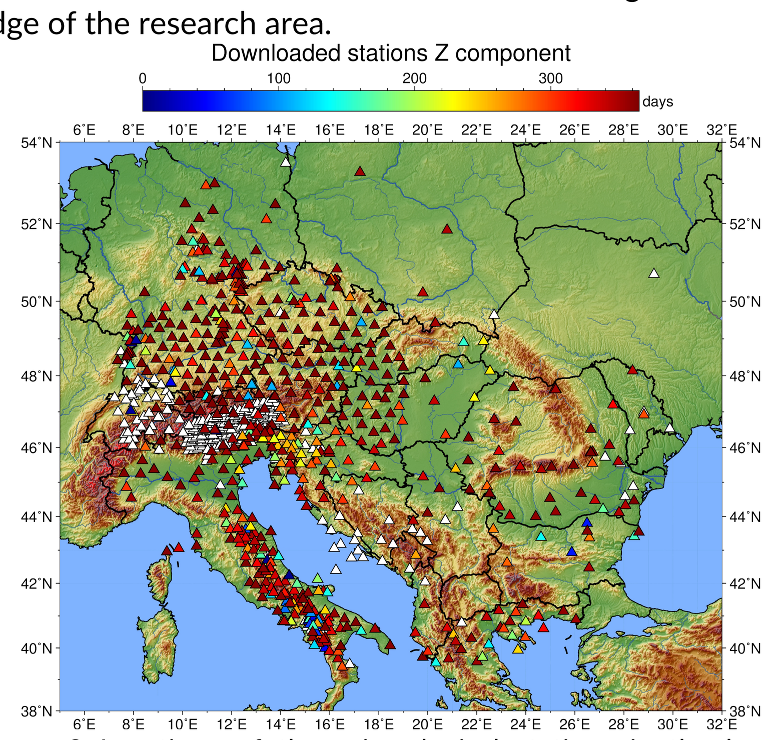


Figure 2 Locations of the seismological stations in the broader Central European region. The colored triangles show the stations that we used for the ambient noise study. The colorscale shows the available 24h long segments on each station.

Altogether, we have collected data from 641 seismic stations which corresponds more than 200 thousand cross-correlation functions (CCF). During the data collection we downloaded 24 hour long Z component segments. For choosing only reliable data we used various quality criteria between the processing steps. The data processing was mainly carried out following the procedure described by Bensen et al. (2007).

After the cutting, filtering and resampling processes, a normalization in time domain is performed on each waveforms. The spectrum normalization carried out only for the CCFs.

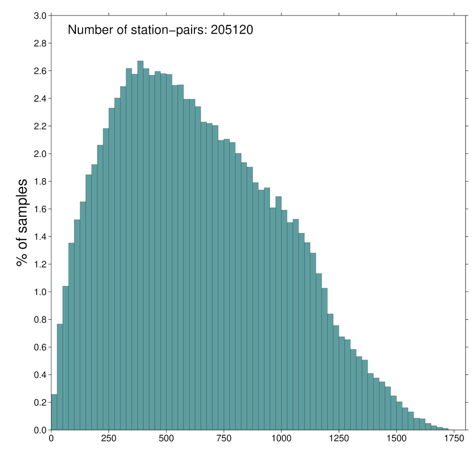


Figure 3. Histogram showing the distribution of the interstation distances considered in this study.

3. Cross-correlation

The huge portion of the available CCFs (Fig. 2) is not related to the Pannonian Basin, so we only calculates those, where at least one member of the station pair is actually located inside the area.

This limitation reduced the number of the CCFs to ~70 thousand. Also, for visualization and quality checking purposes we calculated all possible 640 CCFs regarding to a base station (A029A) and rendered an animation based on the simmetric part of the calculated CFFs. The CCFs were filtered between 1 and 20 s.

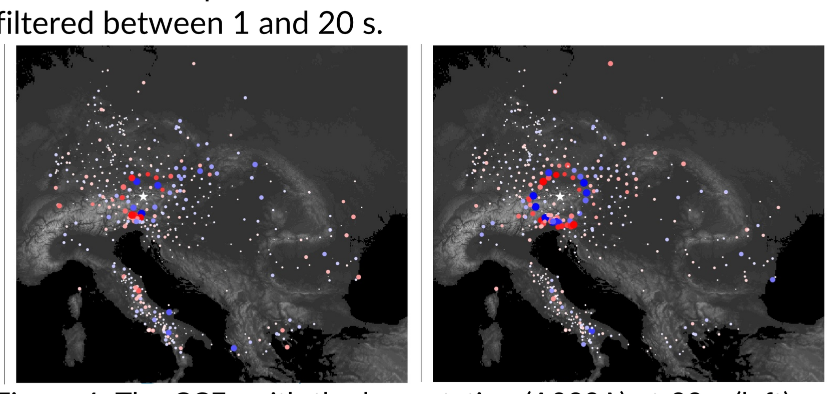


Figure 4. The CCFs with the base station (A029A) at 33 s (left) and 49 s (right) lagtimes

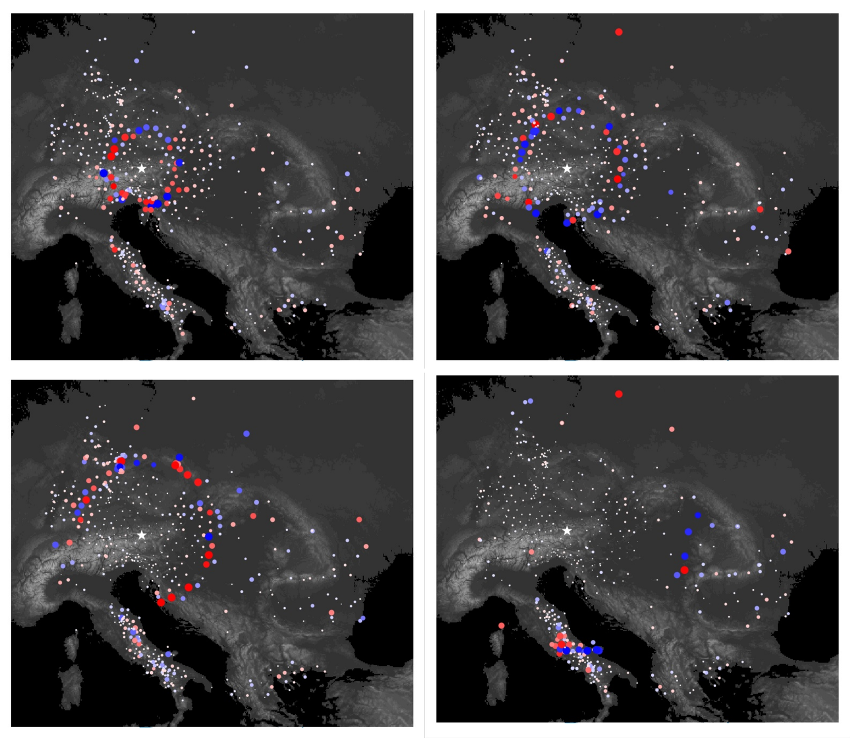


Figure 5. The CCFs at 66 s (top-left) and 95 s (top-right) 126 s (bottom-left) and 323 s (bottom-right) lagtimes

4. Dispersion Measurements

Based on the calculated 70059 CCF dataset we determined the phase velocity dispersion curves between 2s and 50s periods. After, we used an automated picking process to extract the dispersion curves, introduced by Soomro et al. (2016). Due to the strict dispersion curve quality criteria we only kept 18940 dispersion curves (less than the 30% of the excisting dispersion curves). Most of the measurements are located in the frequency range of 10 - 18s.

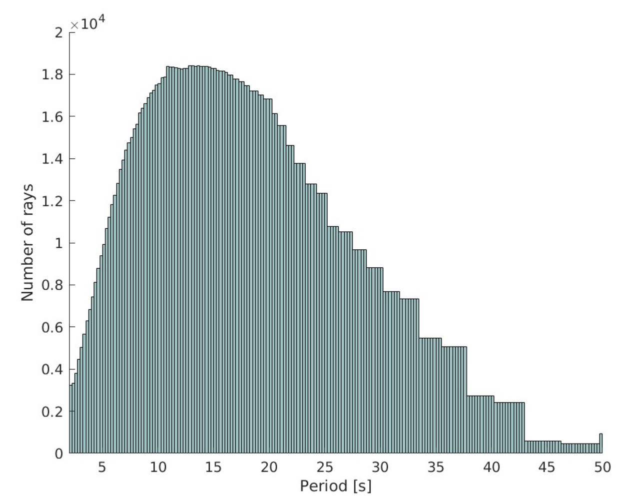


Figure 8. Histogram shows the number of excisting dispersion curve segments for each period.

The resulting 2D histogram (Fig 9) shows that the dispersion curves show good fit with the known geological features.

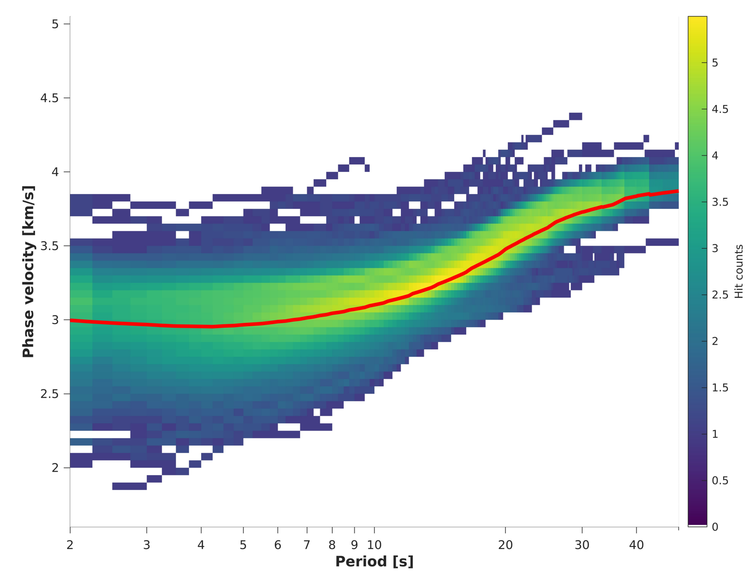
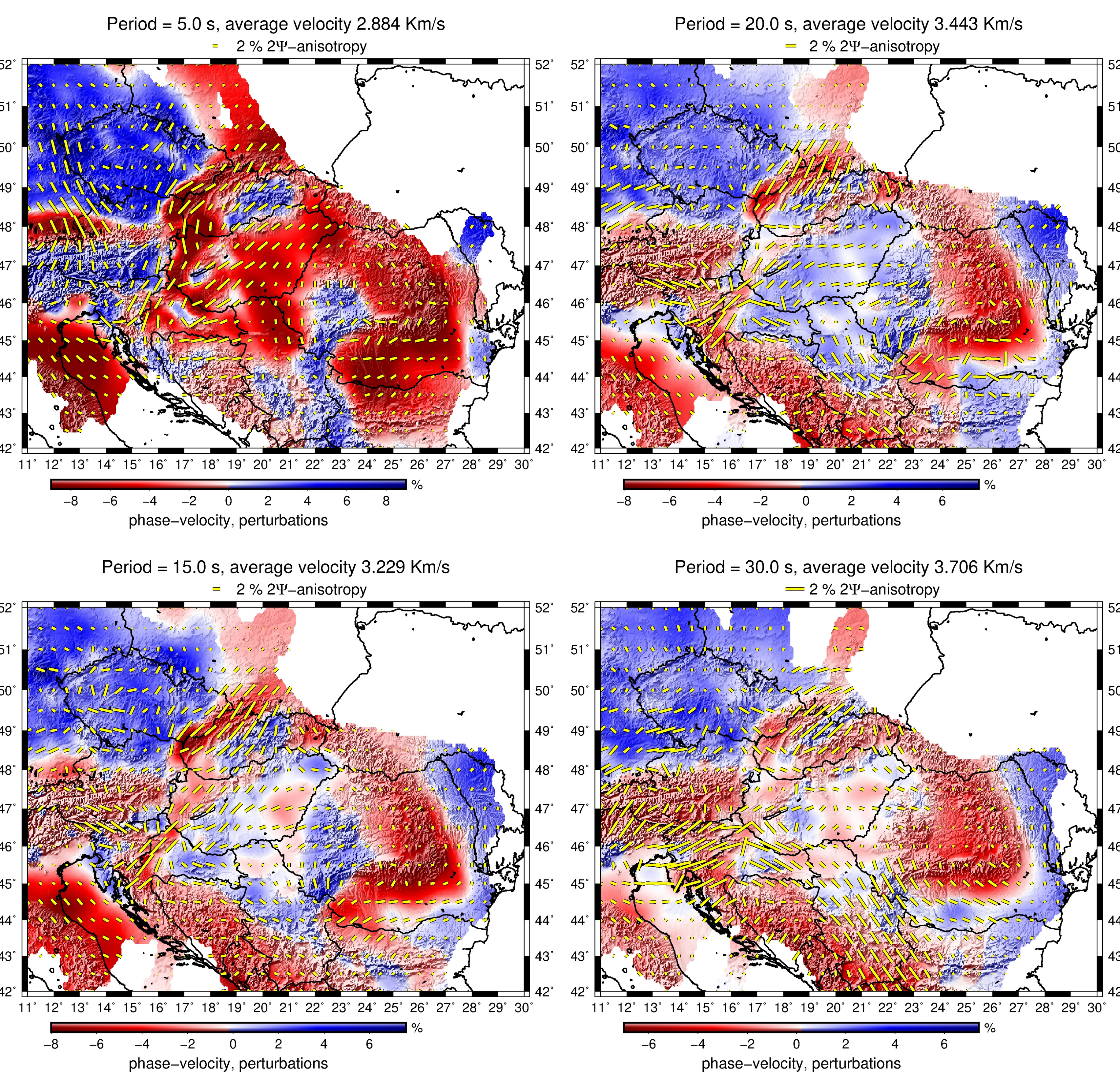


Figure 9. 2D histogram from the accepted dispersion curves. The red curve shows the mean dispersion curve.

At lower periods (shallower depths) the dispersion curves are more diverse due to the heterogeneities in the upper crust (sedimentary basins of the PB). Also, the Moho discontinuity appears to be shallower than the continental average (~15-20 s). At greater depths (longer periods) the dispersion curves are less diverse mostly because the upper mantle has lower velocity differences.

5. Phase Velocity Maps



6. Conclusions & Future Plans

The main features of the retrieved phase-velocity images highly resemble the known geologic and tectonic structure of the area (crystalline rocks, orogenic belts and the deep sedimentary basins) and are comparable to recent tomographic models published in the literature.

The current steps will follow by the the extraction of the local dispersion curves and 3D S-wave velocity inversion. Synthetic resolution tests will allow us to determine the well resolved area for the tectonic interpretation.

Also, we may add the phase velocity dispersion curve measurements from the earthquake generated surface wave studies to achive the resolution of the deeper parts of the area.

We will collect the horizontal components (*E* and *N*) to perform the Love wave measurements to invert for radial anisotropy as well both in the crust and the mantle.

The reacently started PACASE project will provide us far better station resulotion at the Eastern Pannonian region.

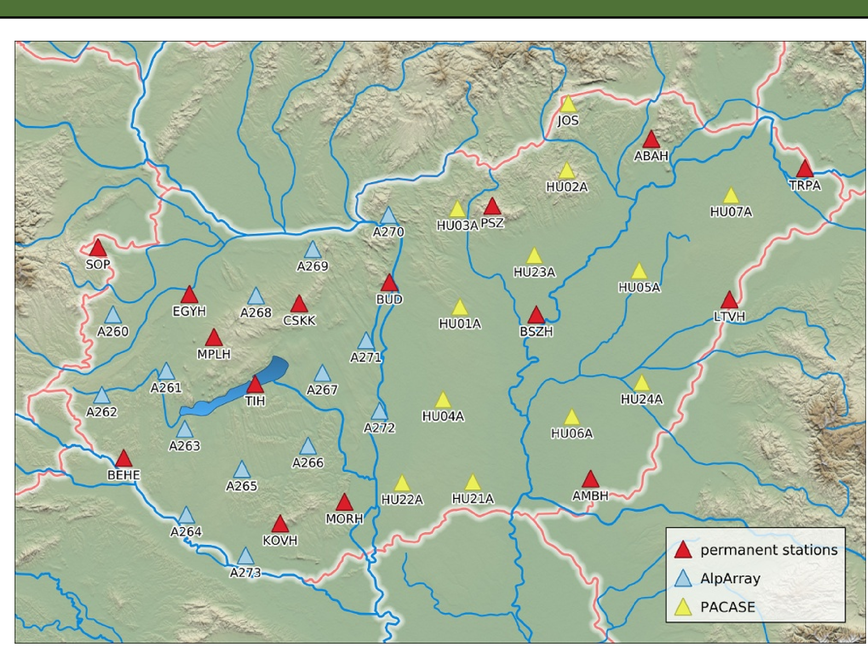


Figure 10. Map shows the recently started PACASE stations with the temporary AlpArray stations and permanent national stations.

References & Acknowledgement

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