Ambient noise tomography in the Pannonian Basin

Máté Timkó[1], Lars Wiesenberg[2], Amr El-Sharkawy[2,3], Zoltán Wéber[1], Thomas Meier[2] and the AlpArray Working Group

1 – Kövesligethy Radó Seismological Observatory, CSFK GGI, Budapest, Hungary

2 – Institute of Geosciences, Christian-Albrechts-Universität zu Kiel, Germany

3 – National Research Institute of Astronomy and Geophysics, Helwan (11421), Cairo, Egypt

1. Pannonian Basin

The Pannonian basin and the surrounding orogens are located in the northern part of the central Mediterranean and are parts of the Alpine–Carpathian orogenic mountain belts. Several studies have shown that the active tectonics of the Pannonian region is mostly controlled by the northward movement and counter clockwise rotation of the Adriatic microplate relative to Europe (Horváth 1993, Bada et al. 1999).

The Pannonian basin is a backarc basin characterized by a thinned lower crust an updoming mantle and a strong geothermal anomaly. The crust is quite thin, it's ranging from 22 to 30 km beneath the basin and 30 to 50 km beneath the orogenic regions (Grad et al. 2009). The litosphere is also thinned, it's approximately 80 km (Horváth 1993). The average heat flow is rather high compared with the surrounding regions (Lenkey et al. 2002). This indicates higher temperature which causes lower seismic velocities beneath the basin.

The seismicity of the region can be characterized as moderate, but the majority of the seismic events occur in the marginal parts of the basin.

In this study 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.

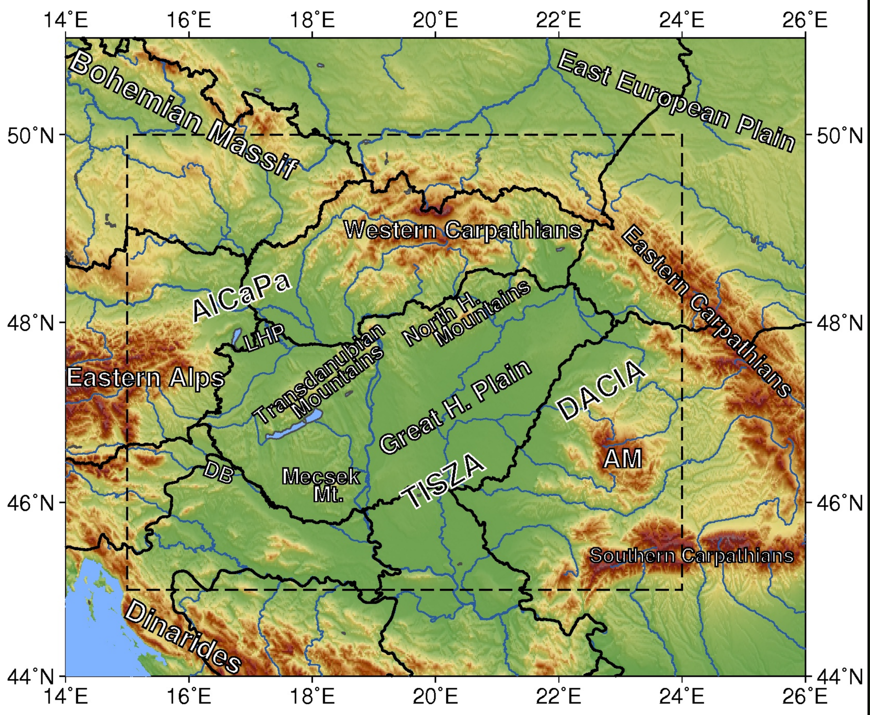


Figure 1. Map showing the Pannonian Basin and its surrounding regions. LHP – Little Hungarian Plain, AM – Apuseni Mountains.

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.

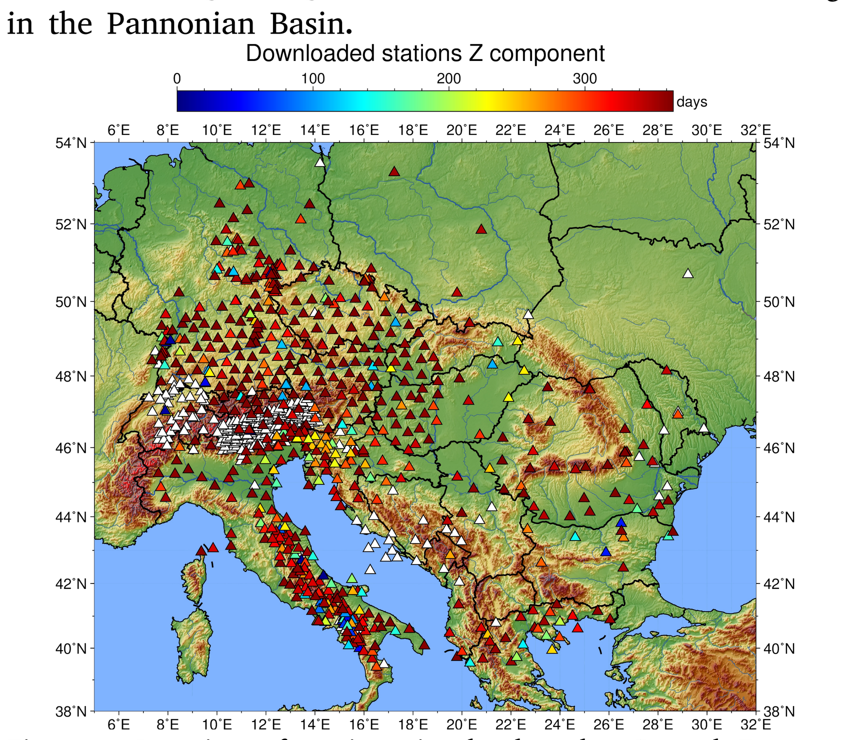


Figure 2 Location of stations in the broader Central European region. The colored triangles show the stations that we used during the ambient noise study. The color of the triangles represents the availability of the stations (see the color bar).

Altogether we have collected 641 stations which corresponds more than 200 thousand cross-correlation functions (CCF). The data processing was carried out following the procedure described by Bensen et al. (2007).

During the data collection we only downloaded the Z component with 24 hours segments. For choosing only reliable data only we used various quality checks during the processing steps.

For calculating the CCFs we were using the running absolute mean normalization to normalize the traces in the time domain. The spectrum normalization carried out only for the CCF.

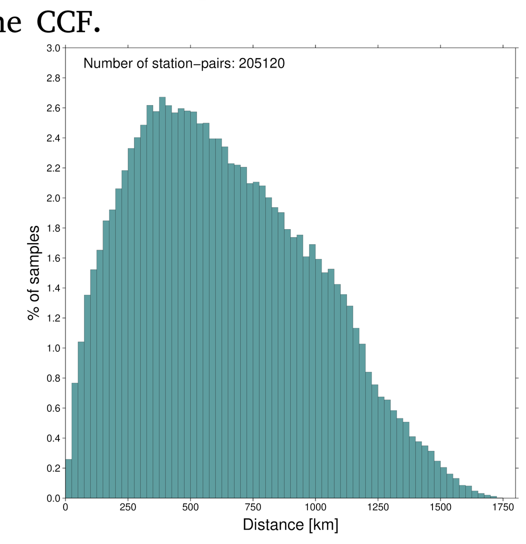


Figure 3. Histogram showing the distribution of the interstation distances considered in this study

3. Cross-correlation

The huge portion of the available CCFs (Fig. 2) are not related on the Pannonian Basin, so we only used those, where at least one of the stations are 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 the 640 CCFs regarding to a base station (A029A) and rendered a movie based on the simmetric part of the calculated CFFs.

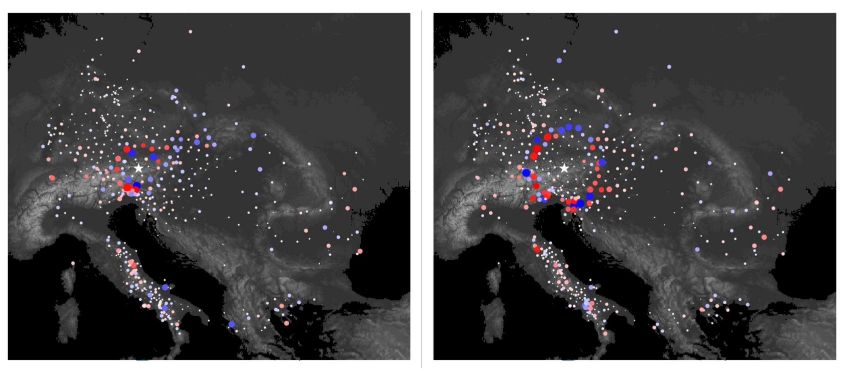


Figure 4. The CCFs with the base station (A029A) at 33 s (left) and 66 s (right) lagtimes

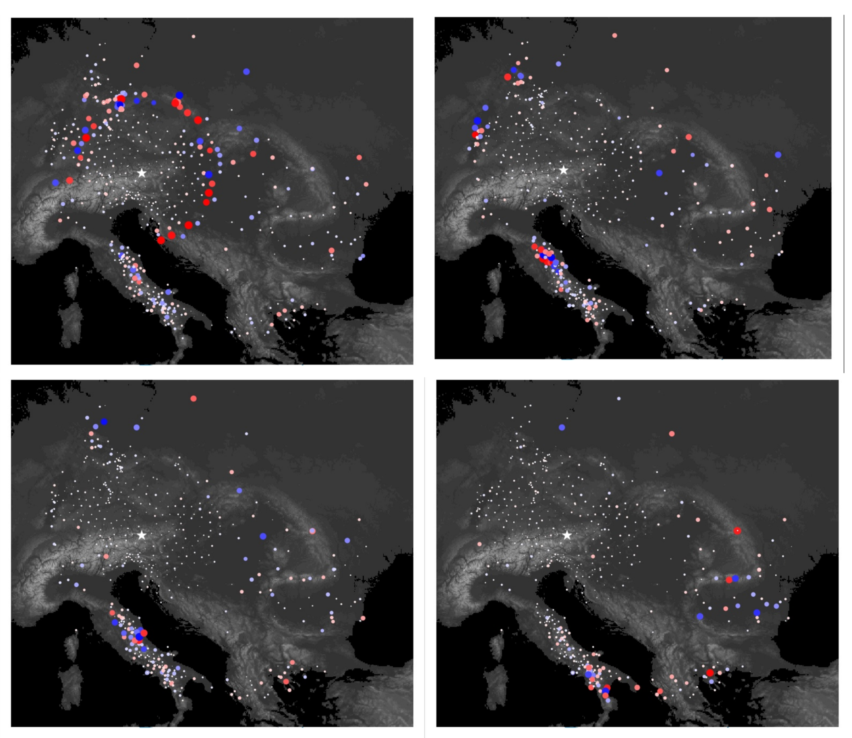


Figure 5. The CCFs at 126 s (top-left) and 186 s (top-right) 206 s (bottom-left) and 323 s (bottom-right) lagtimes

4. Dispersion Measurements

Based on our dataset we performed an automatic dispersion curve determination from 70059 phase velocity measurement between 2s and 50s periods. Due to the strict dispersion curve quality criteria the algorithm only kept 18940 dispersion curves (less than the 30% of the excisting dispersion curves).

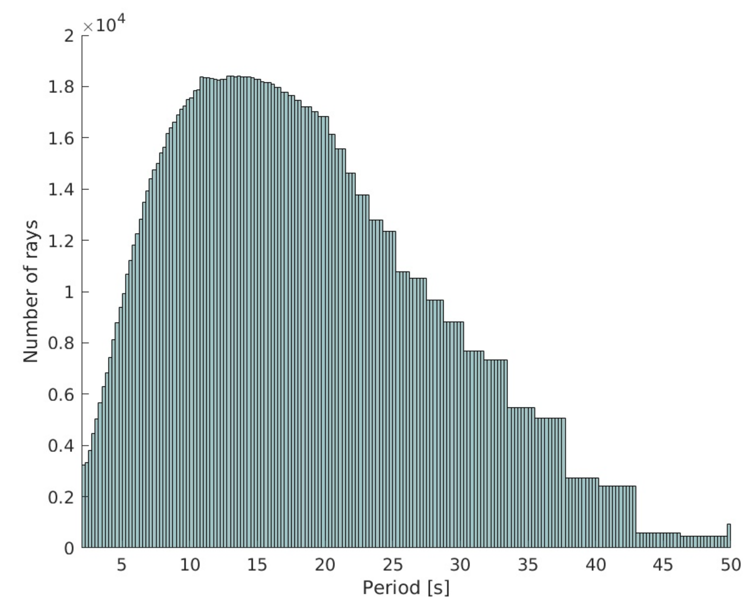


Figure 8. Histogram shows the number of excisting dispersion curve segments for every period.

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

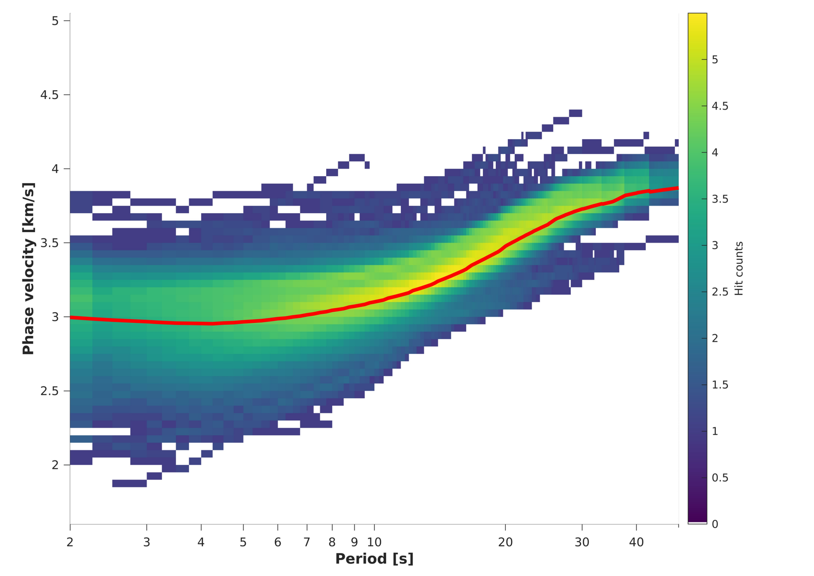
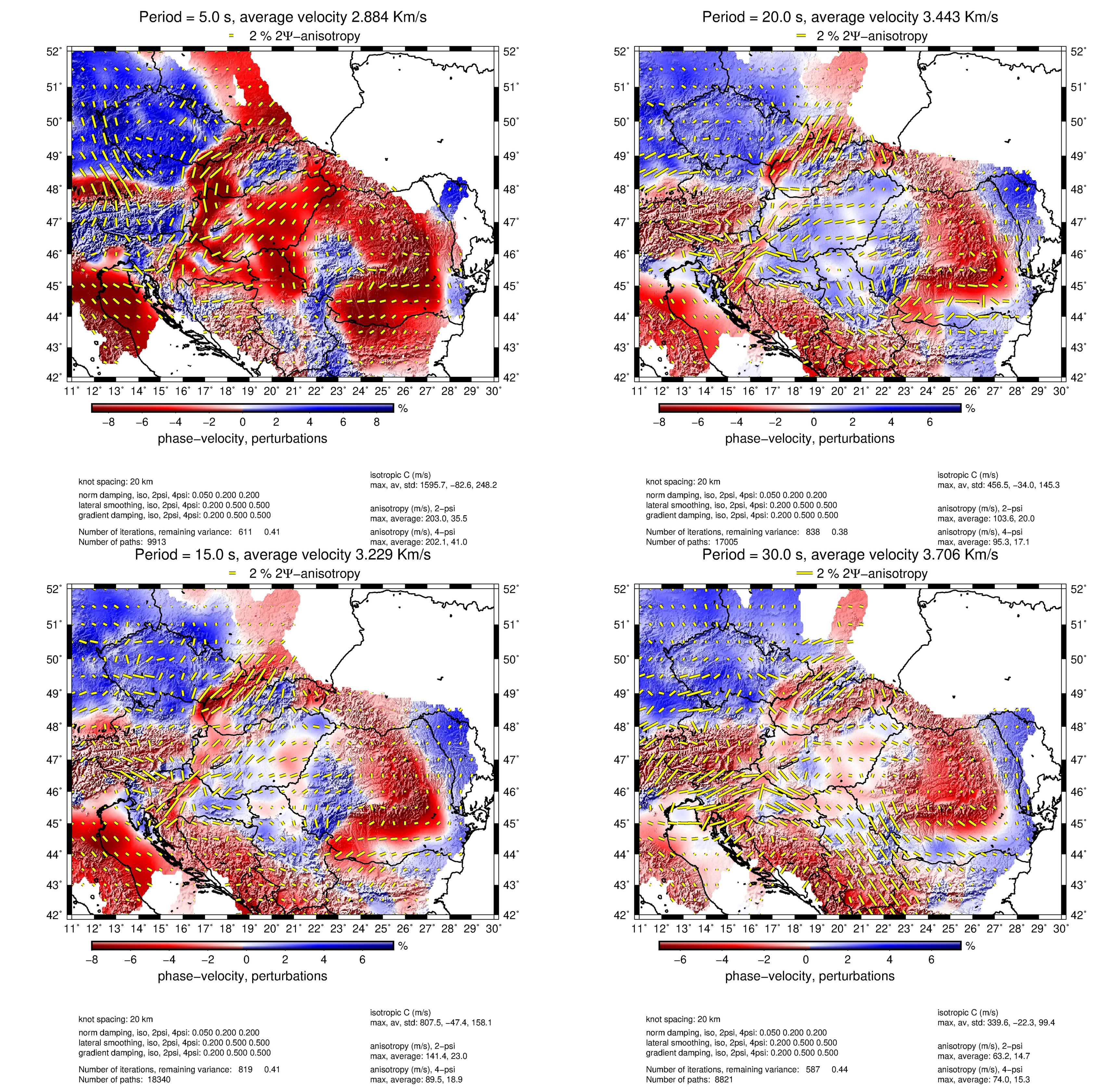


Figure 9. 2D histogram from the accepted dispersion curves. The red curve shows the mean dispersion curve.

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 shallower than the continental average (~15-20 s). At higher depths (longer periods) the dispersion curves are less diverse mostly because the upper mantle has lower velocity anomalies.

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 basins) and are comparable to recent tomographic models published in the literature.

The current steps will follow by the the computation of the local dispersion curves and S-wave velocity inversion. Adding the remaining CCFs from the boader region may help us to achive better horizontal and vertical model resolution on the surronding regions as well.

Also, we will add the dispersion curve measurements from the surface wave studies to support the resulotion 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.

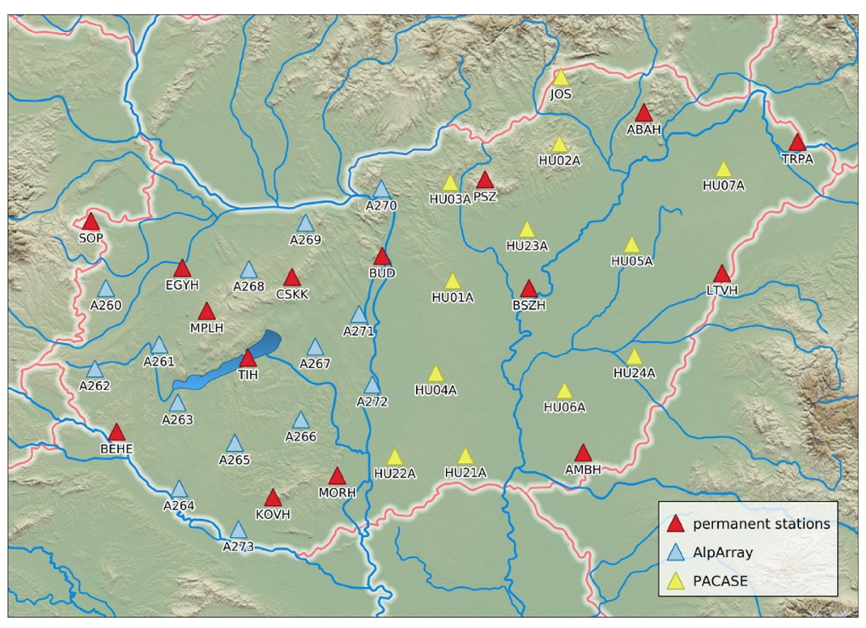


Figure 10. Map shows the recently started PACASE stations with the temporary AlpArray stations and permanent national stations.

References & Acknowledgement

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