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Use of Double Difference seismic tomography to reveal seismicity and crustal structure patterns across the Eastern Carpathians, Romania

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The most active deformation process in the Carpathian Orogen takes place in the southern edge of the Eastern Carpathians. This segment of the European Alpine system has raised numerous debates and controversies due to its complexity. The Eastern Carpathians branch is characterized by the strong cluster of seismicity in the Vrancea region, placed at the bending between Southern and Eastern Carpathians, which generates a significant hazard in southeastern Europe, the Neogene volcanic chain located northwest relative to Vrancea, several major faults and the Trans-European Suture Zone (TESZ) crossing the region. TESZ is the most complex suture in Europe delimiting the edge of the East European Craton (EEC), extending from Denmark to the Black Sea. TESZ is covered in Romania by the Carpathian thrust-belt and due to this reason, it is difficult to decipher it.
Due to the recent development of the Romanian Seismic Network maintained by the National Institute for Earth Physics, we were able to decrease the magnitude detection threshold for the crustal events which occurred within this area. The initial locations based on 1-D local velocity model have enough accuracy to be considered reliable. To image the crustal structure of the Eastern Carpathians and investigate changes in crustal properties across the buried TESZ we applied the double-difference tomography technique (Zhang and Thurber, 2003) and waveform differential times derived from 721 crustal events, with magnitudes higher than 0.9 (Mw), recorded between 2005 and 2017.
Our results provide the highest resolution 3-D P and S -wave velocity models down to the Moho discontinuity. We noticed low Vp and Vs beneath the Neogene volcanic belt, in the inner Carpathians. The main sedimentary basins located in the Carpathians foredeep are emphasized by the low Vs distributed especially in the upper crust, while the East European Craton is revealed by a significant velocity contrast in the lower crust. Supplementary analysis of Vp/Vs ratio in connection with maps of the magnetic field and heat flow distribution brings new insights into the change of crustal composition across the Eastern Carpathians and the architecture of the East European Craton edge beneath the orogen.