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Surface Kinematics in the Alpine–Carpathian-Dinaric and Balkan Region inferred from a Multi-network Combination Solution from national and regional GPS Networks

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The understanding of the intraplate tectonics of Central Europe requires a detailed picture of how stress is transferred from the interaction of the Eurasian, Nubian and Anatolian plates to the Alpine, Carpathian, Pannonian and Dinaric regions, and of the role played by additional stress sources such as volcanism and formation of oceanic crust in the Thyrrenian or gravitational instabilities in the Vrancea seismic zone. Local GPS networks can certainly contribute to constrain the horizontal, and possibly vertical velocity field at continental level provided that sufficient homogeneity is granted in the reduction of raw data, so that velocities obtained from the different networks can be combined. We present here the results of a new combination of nine different GPS networks formed of permanent and campaign stations. The backbone is the CEGRN (Central European Geodynamic Research Network) network, operational since 1994 and which includes permanent stations from the European Permanent Network (EPN) of EUREF and of IGS, assuring accurate alignment to the International Terrestrial Reference Frame. Seven additional networks at the national level complement and densify the EPN and CEGRN networks thanks to a standardized processing scheme adopted by the CEGRN analysis centers for CEGRN, EPN and local network processing.. We present a horizontal velocity field for the Alpine-Carpathian-Pannonic-Dinaric and Balkan region resulting from a multi-network approach. Dedicated velocity profiles in two specific regions are studied in detail. One is the Alpine Pannonian region, with a detailed picture of the NS indentation of the Adria microplate into the Southern Alps, in NE Italy, the deformation in the Tauern Window and the eastwards extrusion of the squeezed wedge towards the Pannonian Basin. The second study region includes Transylvania, the Southern Carpathians up to the Aegean sea, Macedonia and Albania, where a major right lateral shear deformation exists as a consequence of the NE convergence of the Apulia platform towards the Dinarids, and the SSW motion of Macedonia, Western Bulgaria and Rumania, related to the Hellenic arc dynamics in the Eastern Mediterranean.

The new combination solution with longer time span and the densification by additional networks allows a more precise identification of the location and amount of the deformation pattern. A NS profile in the Southern Eastern Alps, parallel to the TRANSALP seismic profile, confirms earlier findings of a velocity drop of 2.5 +/- 0.4 mm/yr associated with the Adria indentation, but also shows that the shortening concentrates on a segment of some 80 km south of the Periadriatic line. We find that

the deformation becomes extensional by a similar amount just north of the Periadriatic line, in Tirol, where the updoming of the Tauern window implies vertical motion which could well be associated to surface extension (extensional collapse). The velocity data of the permanent network of Austrian stations enable us to consider an EW profile, from the Tauern window to the Pannonian basin, which runs in parallel to seismic profiles such as ALP02 and Alp'75. Here we observe a sudden velocity change of 1.4 +/- 0.2 mm/yr in 30 km, in correspondence to the right lateral Lavant line, which seems to mark the border between dominant indentation kinematics to the West and dominant extrusion kinematics to the East.

Three profiles are considered in the Balkan and SE Carpathians: one across the lower Adriatic sea from Apulia in Italy to the southern Dinarides, which enables to constrain the velocity drop associated to the subduction of the Adria microplate into the Dinarides to 3.2 +/- 0.5 mm/yr in 140 km. The second profile is longitudinal and constrains the velocity inversion of 7.4 +/- 1.0 mm/yr in 350 km associated to right lateral shear faults in Macedonia, a highly seismic region. The third profile crosses the Transylvania (6.7 +/- 1.0 mm/yr shortening in 320 km) region in the Eastern Carpathians, the Wallachia-Moesian region up to the Calcidic peninsula in N Greece. This profile constrains the steady velocity increase of 6.6 +/- 0.9 mm/yr in 440 km, culminating in the Hellenic arc.