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Modeling surface GPS velocities in the Southern and Eastern Alps by finite dislocations at crustal depths

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The indentation of the Adria plate into the Southern and Eastern Alps is an ongoing collisional process accompanied by seismicity, surface and rock uplift and lateral escape. We present a 3D quantitative description of the process by combining GPS and structural data with an elastic dislocation model. Horizontal velocities of 70 Austrian and Italian permanent GPS stations in the Eastern and Southern Alps serve as boundary condition on the free surface of an elastic half space containing six rectangular faults, each with an uniform slip rate. The geometry of the rectangular faults and the slip rate vector are constrained by least squares, taking into account the structural setting of the area and the geographic distribution of the velocity data. We find that the surface velocities of the order of some mm/yr require reverse (North side of the Tauern window), transpressional (Giudicarie, North Alpine Wrench Corridor, Pustertal, Dinarids) and normal (Brenner fault) slips at crustal depth ranging from 10 to 30 mm/yr. The regional stress pattern computed from fault plane solutions agrees with the principal directions of our rectangular fault planes. The model, although constrained by horizontal velocities only, predicts a pattern of vertical motion which qualitatively agrees with known phenomena such as the surface uplift in the Tauern Window area, of the order of up to few mm/yr. If the heat on the shearing fault planes is removed mostly by upwards diffusion, the absence of large heat anomalies on the Earth surface suggests, for nominal geotherms, shear stresses and concentration of subcrustal radiogenic elements, that time of initiation of the slip dates back to Pliocene, hence more recent than late Oligocene – Miocene time of collision of the Adria indenter.