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Deformation pattern of the Western Alps from two decades of campaign and permanent GNSS measurements

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Since the permanent GNSS stations in the Western Alps have exceeded 10 years of measurements, their individual horizontal velocities converge to amplitudes of less than 0.3 mm/yr with respect to stable Europe. Facing these small displacement rates, the availability of a velocity field based on GNSS campaign data over 22 years and several independent velocity solutions based on up to 16 years of permanent GNSS data is the opportunity to search for persistent (and therefore reliable) deformation patterns in the Western Alps for a tectonic interpretation. The velocities of 15 campaign stations compare within 0.16/0.20/1.32 mm/yr on the N/E/U components to nearby permanent stations. Two independent velocity solutions of permanent GNSS data calculated in double differences (GAMIT software) and PPP mode (CSRS software) can be superposed within 0.15 mm/yr on the horizontal components and 0.44 mm/yr on the vertical.
While individual velocities are still too uncertain to be interpreted, a global deformation pattern based on the combination of campaign and permanent stations confirms EW extension as observed by a preliminary GNSS solution from 2002 and by regional campaign networks in the inner W-Alps. However, the observed amplitudes are now 10 times smaller than the ones published in the 2000's (0.6 nanostrain/yr over a zone large of 150 km, 2.6 nanostrain/yr over the inner 50 km of the belt).
The analysis of both campaign and permanent GNSS velocities on profiles across the belt highlights zones of extension in the center of the belt (12.5 - 15.3 nanostrain/yr in the northern and central part, 3.1-3.3 nanostrain/yr in the southern part), but also some compression along the eastern and western border of the belt (2.6-8.1 and 1.3-1.5 nanostrain/yr in the northern and central part, and in the south, respectively). This result is confirmed and strengthened by the comparison of the double difference and the PPP solution.
This contrasted geodetic deformation pattern is largely coherent with earthquake focal mechanisms and related strain/stress patterns over the entire W-Alps. The GNSS results finally provide reliable regionalization and quantification of the strain rates.
The motor of this present day deformation is strongly constraint by the average vertical motions of 2.0 to 0.5 mm/yr of uplift from north to south located in the core of the W-Alpine belt. It excludes an extensional plate tectonic mechanism that would be related to subsidence, as well as a gravity collapse of the belt in a simple post-orogenic setting. Candidates are rather buoyancy forces related to postglacial rebound, erosional unloading and/or viscosity anomalies in the crustal and lithospheric root.