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Slow deformation in the Western Alps from a decade of Continuous GPS measurements

Jean-Mathieu Nocquet (1), Andrea Walpersdorf (2), François Jouanne (2), Frédéric Masson (3), Jean Chéry (4), and Philippe Vernant (4)

(1) GeoAzur, Nice, France (nocquet@geoazur.unice.fr, +33 492942610), (2) ISTerre, Grenoble, France, (3) Eost, Universite de Strasbourg, France, (4) Laboratoire Géosciences, Université de Montpellier, France

The western Alps is a collisional belt, part of the plate boundary between the Nubia and Eurasian plate. Its present-day tectonic activity is characterized by a moderate seismicity and sparse geological and geomorphological observations of recent deformation. There, previous GPS studies have concluded that horizontal velocities with respect to stable Europe do not exceed 2 mm/yr, and that the present-day crustal deformation is consistent with a model where strain is essentially controlled by the counterclockwise rotation of the Adriatic micro-plate with respect to Eurasia (Calais et al., 2002, Nocquet et al., 2003). We revisit these results, now benefiting from a higher density of sites and time series exceeding 10 years of duration. We base our results on a homogeneous reprocessing of the whole data set, using reprocessed orbits from the IGS, and a weekly combination of solution using CatRef (Altamimi et al., 2002). Obtained weekly repeatabilities are better that 1mm on the horizontal components and around 1.5 mm in average for the vertical component. Using the approach of Williams (2003), we find that the noise content of the time series is best characterized by a power-law noise model with spectral index of -0.7 for the horizontal components, leading to velocity determined at the level of 0.2 mm/yr. Vertical component time series show noise characteristics different from one site to another, with spectral indices ranging from -0.4 to -2.0. However, even accounting for the time-correlated noise, most sites show vertical rates uncertainties better than 0.5 mm/yr. Residual horizontal velocities with respect to stable Europe do not show any motion larger than 0.5 mm/yr, with a wrms of 0.19 mm/yr. Sites located in the western part of the Pô plain, do not show any significant motion with respect to Eurasia. As an example, the relative velocity of Torino with respect to Lyon is 0.1 ± 0.1 mm/yr. No horizontal deformation is found to be statistically significant within the Alps. Vertical velocities range from 0.0 to 2.5 mm/yr and show a clear pattern of uplift within the Alps with respect to their surroundings, increasing with the average topography. Although the mechanisms driving the observed GPS velocity field has yet to be proposed, our new analysis rules out the idea that kinematic boundary conditions imposed by the counter-clockwise rotation of the Adriatic micro-plate controls the present-day deformation. The observed vertical velocities also preclude crustal/lithospheric scale gravitational spreading as being the main driving force.