3D deformation in the South-Western European Alps (Briançon region) revealed by 20 years of geodetic data

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Abstract

The overall Briançon region undergoes a moderate but steady seismic activity with instrumental magnitudes up to Ml 5.0. Previous studies pointed out that this area is characterized by a great majority of extensional and dextral focal mechanisms, along north–south to N160 oriented faults. Current works aim at measuring and quantifying the upper-crustal deformation in this seismically active area, and at deciphering the seismic part of the deformation. A dense, local network of 30 GPS stations, covering a 50 × 60 km2 area has been temporarily surveyed in 1996, 2006, 2011 and 2016 by GPS, which represents one of the longest repeated set of geodetic campaigns in the European Alps.
The combined analysis of the GPS temporary surveys over 20 years with the continuous GPS measurements over 18 years from the French RENAG network confirms horizontal velocity amplitudes below 1 mm/year within the local network. The long observation interval and the redundancy of the dense campaign network measurement help to constrain a significant local deformation pattern in the Briançon region, yielding an average E–W extension of 22 ± 8 nanostrain/year, coherent with but more precise than previous results obtained before the 2016 measurements. The direction and amplitude of the geodetic rate is both qualitatively and quantitatively coherent with the deformation rate previously derived from 37 years of seismic data (1970-2007). The next step of this project is to assess whether the deformation is localized on a particular tectonic feature or whether it represents distributed deformation. Several strain computation methods are compared in order to do so. The results may enable us to define more precisely the boundary between Eurasian and Adriatic plates, which is known to be located in the South-Western Alps.
A good vertical accuracy is also revealed for the first time in the area by the long time span of temporary GPS observations. We find that the accuracy of vertical measures depends on the type of geodetic marker used. Our new integrated analysis (including the 2016 survey) confirms a vertical average rate of 0.78 ± 0.5 mm/yr over 10 years of measurement. The uplift of the core (so-called high chain) of the Alpine belt in this extensional regime has already been observed on a larger scale by permanent GPS stations, and is well discussed. Thanks to the forced antenna centering, dense campaign networks are able to provide significant constraints on geodynamic models of the Alps, with a complementary spatial coverage with respect to permanent GPS networks.

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