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Crustal deformation pattern of the Morocco-Iberian area: constraints from 14 years of GPS measurements

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We present an improved rendition of crustal motion field of the Morocco-Iberian area, based on an extensive GPS dataset covering about 14 years of observations from 1999.00 up to 2013.79 in order to provide a detailed spatial resolution of geodetic velocity and strain-rate fields. In particular, we included all available data from public continuous GPS stations, considering also data coming from networks developed mainly for mapping, engineering and cadastre purposes. In addition to continuous GPS sites, we included data from 31 episodic GPS sites located in Morocco with surveys spanning the 1999-2006 time interval, whose data are available through the UNAVCO archive (www.unavco.org). All GPS data were processed by using the GAMIT/GLOBK software, taking into account precise ephemerides from the IGS (International GNSS Service; http://igscb.jpl.nasa.gov) and Earth orientation parameters from the International Earth Rotation Service (http://www.iers.org). To improve the overall configuration of the network and tie the regional measurements to an external global reference frame, data coming from more than 25 continuously operating global tracking stations, largely from the IGS and EUREF permanent networks, were introduced in the processing. All stations were organized (and processed) into seven sub-networks of about 40-50 sites each, on average, sharing a few common sites to provide ties between them. Finally, by using the GLORG module of GLOBK, the GAMIT-solutions and their full covariance matrices were combined to estimated a consistent set of positions and velocities in the ITRF2008 reference frame by minimizing the horizontal velocity of the continuously operating global tracking stations mentioned above. To adequately investigate the crustal deformation pattern over the study area, we aligned our estimated GPS velocities to an Eurasian and a Nubian fixed reference frames. In addition, by taking into account the observed GPS horizontal velocity field and associated covariance information we derived a continuous velocity gradient tensor on a regular 0.35° x 0.35° grid using a “spline in tension” technique. The velocity field was interpolated by removing from the computation all sites with fewer than 2.5 years of data and/or because of their suspicious movements with respect to nearby sites. Geodetic data reveals that appreciable deformation occurs prevailing along the W and SE margins of the Iberian Peninsula (up to 35 nanostrain/yr) and along the Gibraltar arc (up to 90 nanostrain/yr), while on the inner parts of the peninsula, the crustal deformation occurs locally at rate < 15 nanostrain/yr. Finally, we compared our findings with the regional frame illustrated by geological and seismological data published in literature. In addition, we statistically tested our GPS velocity field solution on a possible independent motion of the Iberian Peninsula with respect the Eurasian plate.