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3D GPS velocity field of the Iberian Peninsula

Giorgi Khazaradze (1), Sara Pena-Castellnou (2), Alvaro Santamaría-Gómez (3), and Philippe Vernant (4)

(1) Grup RISKNAT, Institut Geomodels, University of Barcelona, Faculty of Earth Sciences, Department of Earth and Ocean Dynamics, Barcelona, Spain, (2) Neotectonics and Natural Hazards – Neotektonik und Georisiken, RWTH Aachen University, Aachen, Germany, (3) GET, Université de Toulouse, CNRS, IRD, UPS, Toulouse, France, (4) Laboratoire Géosciences Montpellier, Université Montpellier, Montpellier, France

We present a 3D crustal deformation velocity field of the Iberian Peninsula based on the analysis of more than 400 continuous GPS stations covering the period from 2010 to 2018 and distributed throughout the Iberian Peninsula, northern Africa and southern France. We describe the procedures followed to obtain a combined uniform velocity solution from daily GPS data using GAMIT/GLOBK and SARI software for post-processing the time series. The previous studies have estimated only the 2D horizontal rates, since the vertical component of deformation is more complicated to derive. Only the studies by Serpelloni et al. (2013) and Nguyen et al. (2016) have calculated the vertical rates of deformation in some limited areas of the Iberian Peninsula. In the present work, we provide the velocity vectors in horizontal and vertical directions. The calculated horizontal GPS velocities, in Eurasia fixed reference frame, indicate that the Iberian Peninsula presents a heterogeneous crustal deformation field, which can be roughly grouped into 7 distinct domains/blocks. Each domain can be related to the known geo-tectonic structural units of the Iberian Peninsula. The highest velocities, as well as the highest geodetic strain rates, are detected along the Iberia-Nubia plate boundary and the Eastern Betics Shear Zone (EBSZ), areas where the highest seismicity rates are observed.

The obtained vertical velocity field has to be considered as preliminary, since a more careful treatment of various phenomena affecting the GPS vertical signal (e.g. ocean, tidal and atmospheric loading) should be performed in order to better resolve them. There are some locations with anomalously high rates that cannot be of a tectonic origin. These motions are related to local processes, often triggered by anthropogenic activities, such as the ongoing subsidence of 6 cm/yr in the Guadalentín basin near the city of Lorca (Murcia), caused by extensive groundwater extraction.

The presented 3D velocity field provides useful information for multi-risk analysis since it can be used to identify zones and/or faults where the geodetic strain accumulates the most, contributing towards the improvement of seismic hazard assessment. This is especially relevant for evaluating long-term earthquake hazard in areas with slow deformation rates, like the Iberian Peninsula. The detected vertical motions are useful for studying long-term tectonic processes (uplift/subsidence), as well as, studying more short-term and local phenomena such as landslides, sediment settlement and/or anthropogenic activities (e.g. groundwater withdrawal, mining).

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