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Ground deformation across the Corinth rift from 22 years of GPS observations

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Between 1990 and 2012 sixteen GPS campaigns have been carried out in the western and central rift of Corinth area and surroundings in order to map and monitor the extension and the vertical motions of the rift. Since 2001 five permanent GPS stations are also operated in the western rift plus a EUREF station located at the University of Patras. Fieldwork involved in total more than eighty people. The campaign network was designed as the sum of a "first order" network with approximately 70 points measured in several campaigns during sessions of several days and a "second order" with more than 100 points measured once during a few hours and available for future measurements. Spacing between points in the centre of the network (Corinth Rift Laboratory, CRL, http://crlab.eu) is approximately one point every five kilometres. This density was defined so as sample each main known fault of the southern coast of the rift and to provide in principle ten to twenty points with significant motion in case of a M=6 earthquake like the June 15, 1995 Aigion earthquake, and possibly one point with significant motion in case of M=5 shallow earthquake like those of January 18 and 22, 2010 near Nafpaktos. The density of points is less outside the central area but enough to provide constraints on the boundary conditions of the rift, in particular at its western termination near the city of Patras. The percentage of destroyed points is approximately 10% in 10 years and if maintained the network could be usable during several more decades. Kinematic GPS data were also acquired along several hundred of kilometres of roads on both sides of the rift. The ten years time series at the five permanent stations provides an accurate determination of the overall extension and a local reference frame for the network. The permanent station located at Trizonia island exhibits a 2mm/yr subsidence rate, the four others (Kounina, Psaromita, Lidoriki, Efpalio) show no vertical velocity. However Efpalio shows a co-seismic displacement in January 2010. The extension rate at all stations except Efpalio is steady over the ten years period. The velocities determined at approximately a hundred network points (1st order and 2nd order observed twice or more) show no temporal variation during the sampled period except the co-seismic of the large 1995 Aigion earthquake. The southern side of the rift behaves as a rigid body with less than 1mm/yr internal deformation except around the Psathopirgos fault. Most of the extension, more than 12 mm/yr at the longitude of Trizonia, occurs offshore in the centre of the rift. The northern side of the rift is less rigid, with 3 mm/yr accommodated between Trizonia and Lidoriki. The points located along the northern shore between Nafpaktos and Itea show a westward (or clockwise) component with respect to the overall velocity field. No significant deformation is observed in the area located between Nafpaktos and the eastern termination of the Trichonis lake and the block located between Etoliko, Thermo, Lidoriki and Nafpaktos has less than 1mm/yr internal deformation. At the western termination of the Psathopirgos fault both GPS and SAR interferometry show the existence of localized deformation in the first few kilometres inland that becomes progressively dominated by right lateral strike slip corresponding probably to the northern termination of the crustal discontinuity activated more to the southwest during the M=6.4 June 8, 2008 Andravida earthquake. No vertical motion is detected at campaign points except at the Drepano lighthouse northwest of the Psathopirgos fault. Further steps forward in the knowledge of the deformation of this exceptional area during the next few decades require among others the deployment of a few ten of permanent GPS stations across the main actives structures on both sides of the rift and at its western termination around Patras, a complete analysis of the available and future InSAR data and fusion with the GPS, and the development of a strategy for measuring the ground deformation offshore where most of the deformation is localized. This work in presented on behalf of the members of the CRL project team who contributed along the twenty two years with fieldwork and GPS data processing or deformations analyis and modelling.