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Present-day crustal deformation in Pyrenees by CGPS measurements

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The Pyrenees mountain belt, that separates the Iberian Peninsula from the rest of Europe, is part of the Alpine-Himalayan orogenic belt, formed as a result of a collision between the African and Eurasian plates. Although the instrumental seismicity in the Pyrenees, taking into account the magnitude and the number of occurred earthquakes is moderate, in the past centuries a number of destructive earthquakes have occurred in the area. In addition, the actual spatial distribution of earthquakes is not homogenous across the mountain belt: in the western part, the number of earthquakes is considerably higher than in the eastern part, where the distribution of the events is significantly more diffuse than in the in the west.

Combined studies of geologic and geodetic deformations in this area are few. For this reason the main objective of our study is to determine whether the Pyrenees mountain range continues its orogenic activity and whether any signs of active crustal deformation can be detected. In terms of more specific goals, we are interested to investigate the relationship between the GPS measured deformations and the seismicity. According to geologic studies, the tectonic activity in the Pyrenees is mainly associated with the previously existing structures, where the slip rates are lower than 1 mm/yr. Moreover, the analysis of the continuous GPS station on the both side of the mountain range by Nocquet and Calais (2003) showed no statistically significant deformation across the Pyrenees. Our goal is to confirm (or reject) this finding using a denser network of CGPS stations, in a more detailed and quantitative way.

We processed data from 34 continuously operated GPS stations (CGPS) belonging to various GPS networks operating in the Pyrenees area covering the 6 year long time period from 2005 to 2010. We have intended to include all of the publicly available data from this time period, to ensure maximum spatial and temporal coverage, but discarded stations with observations less than 1.5 years, not to compromise the associated errors of the velocity estimates. The majority of the data came from Spanish and French regional networks, such as CATNET (ICC, Spain), REGAN (in Navarra, Spain) and stations from Euskadi and RGP (IGN, France). The GPS data were analyzed using GAMIT/GLOBK software from MIT employing a network mode, where all the stations (including IGS continuous GPS sites) are analyzed together and the ambiguities are resolved. The majority (90%) of the Pyrenees stations have horizontal velocities less than 1 mm/yr. However, almost half of these stations have errors higher than the signal (at 95% confidence level), indicating that the deduced velocities for these stations cannot exceed the calculated error (usually of the order of 0.5 mm/yr). To summarize, present-day crustal deformation rates in Pyrenees, deduced after analyzing 6 years of the CGPS data, show no significant deformation above 1 mm/yr across the mountain chain. Below this level, it can be that the Pyrenees undergo either compression or extension, which will require further GPS observations to be resolved.

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