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Current plate movements across the Azores triple junction determined from 17 years of continuous GPS measurements

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The Azores Islands are located at the triple junction between the Eurasian, Nubian and North American plates. Frequent earthquakes and eruptions make them an ideal natural laboratory for ground deformation studies. Crustal deformation in the Azores has been mapped with GPS geodetic measurements for more than three decades, to study both tectonic plate motion as well as deformation related to volcanic unrest areas. Compared to campaign GPS surveys, the use of continuous GPS stations (CGPS) improve temporal resolution and increase the quality of velocity estimations. We compute daily positions of GPS data spanning almost 17 years (2000-2017) from 24 CGPS regional stations, using Bernese software 5.2. We constrained the positions to ITRF2008 reference frame by including data from around 75 IGS (International GNSS Service) stations and precise products from CODE (Center for Orbit Determination in Europe). The CGPS daily position time series are extensively analyzed by searching for discontinuities, velocity changes, and periodic functions. Velocity uncertainties are smaller than in previous geodetic studies for the region. Excluding the stations around Fogo (Água de Pau) volcano in São Miguel Island, we observe a very stable motion relative to the Eurasian plate. The residuals of the computed station velocities relative to ITRF2008 plate motion model are at sub-millimeter level. As predicted, we find local disturbances in the velocity field around Fogo volcano. The Fogo–Congro area, in the central part of the island has experienced repeated intense earthquake swarms in the past, including a significant episode in 2003–06 and a minor one in 2011–12. In both periods, we observe a general uplift of the volcano followed by slight deflation in Fogo stations. From 2013 to the present, we see a steady-slow deflation of the volcano edifice. The maximum horizontal rate of displacement measured at a CGPS site was $\sim$30 mm/year from 2004 to 2005, during an inflation phase. The CGPS station velocities agree well with previous modeling results using GPS campaign datasets suggesting a center of deformation in Monte Escuro region, NE of Fogo volcano caldera lake, for both inflation and deflation periods. The activity in Fogo volcano can be explained as a result of interaction between regional tectonics and local volcanic sources. The results from this study show the importance of continuous and dense GPS observations in the Azores. The computation of precise velocities using longer data span is critical for improved tectonic motion estimations in the Azores and to understand the influence in recent Fogo volcano unrest episodes. Further research is being carried out to investigate in more detail the relationship between the active tectonic boundary in São Miguel Island and the local deformation in Fogo, from the integrated analysis of dense annual GPS campaign surveys, existing InSAR images and recorded seismicity.