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Post-large earthquake seismic activities mediated by aseismic deformation processes

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Two aseismic deformation processes are commonly invoked to explain the transient geodetic surface displacements that follow a major earthquake: afterslip and viscoelastic relaxation. Both induce time dependent stress variations in the crust, potentially affecting aftershock occurrence. However, the two mechanisms' relative impacts on crustal deformation and seismicity remain unclear, and discriminating between the two is challenging. We achieve this result by applying a variational Bayesian Independent Component Analysis to the position time series from 125 GPS stations following the Mw 7.2 El Mayor-Cucapah earthquake, 2010 (Mexico). Among the retrieved Independent Components, two are clearly related to post-seismic activity: one is characterized by long relaxation time and broad spatial signature, while the other is concentrated in space and time near the mainshock and largest aftershock events. This separation helps to resolve the modeling tradeoff between these contributions. We further compare our geodetic results with the seismic activity that followed the mainshock. We find not only that, for the case of the 2010 Mw 7.2 El Mayor-Cucapah (EMC) earthquake, afterslip drove clustered seismicity after the earthquake, but also that long-range earthquake interactions were modulated by viscoelastic relaxation at large scales in space (>5 times the fault rupture length) and time (>7 years). This has important implications for the study of the "seismic cycle" and for seismic hazard estimation, since post-seismic deformation related to a single Mw 7.2 earthquake affects interseismic velocities for more than a decade.