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Inference of coseismic slip via joint inversion of GPS and aftershock data: The 2004 Parkfield example

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In many co-seismic slip inversions, the number of model parameters is much larger than that of the independent observations, and the problem is extremely under-determined. It is thus instructive to incorporate additional datasets into the slip inversion. In this study I describe a new approach for co-seismic slip inversion, whereby both GPS displacements and first day aftershock rate changes are used jointly to constrain the solution. The joint inversion incorporates the Dieterich's aftershock model, which adopts a constitutive friction that depends logarithmically on the sliding rate. The method is applied to the 2004 Parkfield earthquake. The joint inversion not only provides resolving power of slip at depths inaccessible to GPS-only inversions, but it also helps to gain insight on the fault mechanical properties. I show that the data are consistent with the adopted aftershock model being the dominant mechanism for aftershock production along the Parkfield segment, and obtain an upper bound on the friction dependence on the log-of-rate of fault patches that have experienced aftershock activity. A consequence of the irregular aftershock distribution is that the slip distribution is extremely non-smooth, with the aftershock zones acting as barriers.