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Description and modeling of surface motion transients extracted from continuous GPS networks in Chile and Japan

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Many time-series analysis developments have been made in recent years that allow for the retrieval of transient (unexpected) motions from time series of permanently installed GPS stations. In addition to the steady-state motions, it is suspected that these transient motions provide valuable information pertaining to the physics of earthquake nucleation, as suggested by observations of subtle seismic and geodetic transients preceding some of the largest earthquakes of the recent decade (e.g. Tohoku-Oki, Japan 2011; Iquique, Chile 2014).

Here we show the transient motions of the Chilean and Japanese continuous GPS networks that have been extracted using sparse regression. We provide details of the separation process with both synthetic and real-data examples. We describe the features of the transient deformation fields, and quantify the occurrence of transient episodes in both the inter- and post-seismic phases of the seismic cycle. In the Northern Chile subduction margin, the joint analysis of the transient motions along with a high resolution seismic catalogue (complete to low magnitudes) helps in providing additional clues as to the kinematics behind observed transient motions.

Guided by recent insights from laboratory friction experiments we use simple models of elastic dislocation and numerical simulations of fault friction to investigate the mechanisms responsible for the observed transient motions.