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Combined co-seismic effects of the 2010 Mw8.8 Maule, the 2014 Mw8.0 Iquique and the 2015 Mw8.3 Illapel earthquakes in Chile

Luyuan Huang, Bei Zhang, Huihong Chen, Wulin Qu, Huai Zhang, and Yaolin Shi
University of Chinese Academy of Sciences

This paper examines the combined co-effects caused by three devastating earthquakes

with magnitudes larger than 8.0 in Chile (the 2010 M_w 8.8 Maule earthquake, the 2014 M_w 8.0

Iquique earthquake and the 2015 M_w 8.3 Illapel earthquake), with total ruptures propagating nearly 2000 km along the Chile Andean megathrust fault zone. To estimate the influences of these earthquakes on surrounding areas and the fracture zone, we built a heterogeneous ellipsoid Earth model using the Finite Element Method. The co-seismic displacements in both near field and far field and the stresses change induced by each earthquake were investigated, and the combined co-seismic effects of the three earthquakes were also calculated to estimate future earthquake risk.

Results show that the horizontal co-seismic offsets of the 2010 Maule earthquake were well consistent with observations in both near-field and far-field. The maximum total displacement reached 10.5m due to the three earthquakes, with ∼6m induced by the 2015 Illapel earthquake. The magnitude of stress changes were ∼1.0-10.0 kPa, represent about 2-3 years of accumulation of tectonic compressive stress. Based on the distribution of changes of Coulomb failure stress on faults, a large earthquake will likely occur in the seismic rupture zone around the epicenter of the 1960 M_w9.6 earthquake, the overlap area that did not rupture during the 2010 Mw8.8 and 2015 M_w 8.3 earthquakes and the seismogenic zone between the locations of the 2014 Iquique earthquake and the 1995 Antofagasta earthquake.