Dynamic rupture simulation of the 2015 Mw 8.3 Illapel (Chile) earthquake

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The 2015 Mw 8.3 Illapel mega-thrust earthquake in the Chilean subduction has been studied by different researches in its kinematics using the Chilean national networks of accelerograms and continuous GPS as well as teleseismic data. In this study, we carry out dynamic rupture simulations to characterize the frictional parameters. We suppose that the fault heterogeneity is expressed by supposition of circular patches of different size and each of them is governed by slip-weakening relation (dynamic strength drop $\Delta\tau_b$ and critical slip displacement D_c) with respect to the initial shear stress τ_0. Firstly, we found that the largest, main patch of a 50 km radius with $\Delta\tau_b$ = 10 MPa, D_c = 1.6 m and τ_0 = 5 MPa, whose center is by 60 km north in strike and by 50 km in up-dip from the hypocenter, gives a comparable slip to the kinematic inversion results. When assuming a uniform growth of the dynamic rupture from the hypocenter, the strong directivity to the north appears in the simulations. However the observed waveforms in the near-field (accelerograms and continuous GPS time series) indicate more complex, heterogeneous rupture growth. We then introduce several small patches allowing complex growth of dynamic rupture between the hypocenter and the largest patch. Our preferred model includes a secondary nucleation from the depth about 20 seconds later, namely double events, also inferred from the seismological analyses on the accelerograms and by back propagation studies..