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Towards coupled earthquake dynamic rupture and tsunami simulations: The 2011 Tohoku earthquake.

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The 2011 Mw9 Tohoku earthquake has been recorded with a vast GPS and seismic network given an unprecedented chance to seismologists to unveil complex rupture processes in a mega-thrust event. The seismic stations surrounding the Miyagi regions (MYGH013) show two clear distinct waveforms separated by 40 seconds suggesting two rupture fronts, possibly due to slip reactivation caused by frictional melting and thermal fluid pressurization effects.

We created a 3D dynamic rupture model to reproduce this rupture reactivation pattern using SPECFEM3D (Galvez et al, 2014) based on a slip-weakening friction with sudden two sequential stress drops (Galvez et al, 2015) . Our model starts like a M7-8 earthquake breaking dimly the trench, then after 40 seconds a second rupture emerges close to the trench producing additional slip capable to fully break the trench and transforming the earthquake into a megathrust event. The seismograms agree roughly with seismic records along the coast of Japan. The resulting sea floor displacements are in agreement with 1Hz GPS displacements (GEONET). The simulated sea floor displacement reaches 8-10 meters of uplift close to the trench, which may be the cause of such a devastating tsunami followed by the Tohoku earthquake. To investigate the impact of such a huge uplift, we ran tsunami simulations with the slip reactivation model and plug the sea floor displacements into GeoClaw (Finite element code for tsunami simulations, George and LeVeque, 2006). Our recent results compare well with the water height at the tsunami DART buoys 21401, 21413, 21418 and 21419 and show the potential using fully dynamic rupture results for tsunami studies for earthquake-tsunami scenarios.