MULTI-STAGE DYNAMIC EARTHQUAKE SOURCE INVERSION OF THE 2023 MW 7.8 KAHRAMANMARAS, TURKEY EARTHQUAKE

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We show results of the dynamic inversion of 2023 Mw 7.8 Kahramanmaraş, Turkey, earthquake. Dynamic source inversion of earthquakes consists of inferring frictional parameters and initial stress on a fault consistent with co-seismic seismological and geodetic data and dynamic earthquake rupture models. In a Bayesian inversion approach, the nonlinear relationship between model parameters and data (e.g. seismograms) requires a computationally demanding Monte Carlo (MC) approach. As the computational cost of the MC method grows exponentially with the number of parameters, dynamic inversion of a large earthquake, with hundreds to thousands parameters, has problems with convergence and sampling. We introduce a novel multi-stage approach to dynamic inversions. We divide the earthquake rupture into two successive temporal (0-21 s, 21-60 s) and spatial stages (140 km central segment, whole 330 km fault). As each stage requires a lower number of independent model parameters, their inversion is faster. Stages are interdependent: earlier stage inversion results are a prior for a later stage inversion. Our main advancement is the use of Generative Adversarial Networks (GAN) to transfer the prior information between inversion stages, inspired by Patel and Oberai (2019). GANs are a class of unsupervised machine learning algorithms originally used for generating images similar to the training set. The trained generator generates synthetic images/samples with low-dimensional noise as an input. We train GANs on samples of dynamic parameters from an earlier stage of the inversion and use the GAN to suggest the dynamic parameters in a later stage. We handle the large rupture by adopting a 2.5D approximation that solves for source properties averaged across the rupture depth.