RuptureNet2D, A DEEP NEURAL NETWORK-BASED SURROGATE FOR DYNAMIC EARTHQUAKE RUPTURE SIMULATION IN TWO DIMENSIONS

Ziyi WANG [1], ***Zekang GONG*** [1], ***Chao LIANG*** [1], ***Jianze WANG*** [2]

[1] Institute for Disaster Management and Reconstruction, Sichuan University, Chengdu, China
[2] Depart of Civil Engineering, Sichuan University, Chengdu, China

contact: chao.liang@scu.edu.cn

Dynamic rupture simulations of earthquakes are crucial for physics-based seismic hazard assessment. However, due to the intricate dynamics of earthquake rupture mechanisms spanning vast spatial and temporal scales, seismic dynamic rupture simulations pose a complex and computationally expensive interface instability problem. Here, we propose an end-to-end deep learning model (RuptureNet2D) as a cost-effective alternative to expensive numerical simulations. This model is trained on dynamic rupture datasets generated by numerical simulations in two dimensions and is capable of simultaneously predicting two key earthquake source parameters: rupture time and final slip. Testing reveals that our model performs exceptionally well on faults with homogeneous and heterogeneous (with one or two asperities) frictional parameters but only requires a fraction (1/1000) of the prediction time compared to numerical simulations. Our work is the first to demonstrate the applicability and efficiency of neural networks as a surrogate model for seismic dynamic rupture simulations, which has a potential of drastically accelerating physics-based earthquake source inversion and advancing our understanding of earthquake physics.