
Investigating Supershear Rupture Signatures Through Dynamic Rupture Modeling and Optical Image Correlation of the 2025 Mw 7.7 Mandalay Earthquake, Myanmar

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Résumé

The 2025 Mw 7.7 earthquake has been identified as a supershear rupture. This conclusion is drawn primarily from rupture models and seismic data. However, to determine the precise location of this transition remains challenging, largely due to the limited resolution of available datasets. Nevertheless, numerical models of dynamic ruptures have shown that the transition to supershear speeds is associated with a reduction in the width of distributed off-fault deformation. While some geodetic studies also supported this relationship, they were conducted at relatively low resolution. Therefore, a high-resolution investigation is required to validate these findings.

We use combination of optical image correlation and dynamic rupture models to understand the location of the transition from sub shear to supershear speed. First we simulate the 2025 Myanmar earthquake using thermodynamically based micro-mechanical model of brittle failures. This model takes into account pre-existing deformation and is capable to simulate the extent and properties of the inelastic off-fault deformation created during an earthquake event. The model is integrated in source 2D Spectral Element code (sem2dpack) and simulates earthquake ruptures along a geometrically complex fault system.

Subsequently we use optical image correlation to orthorectify and correlate very high resolution satellite imagery (Pleiades, SPOT 6) and correlate the pre and post earthquake datasets using open source photogrammetry and remote sensing software (ASP, Cosi-Corr, MicMac). The results of optical image correlation is NS and EW displacement map from which we extract rectangular profiles and measure the width of the fault zone along the part of the earthquake rupture.

A direct comparison and consistency among field observations, dynamic rupture models, and seismic data indicate that the model is both robust and well validated. In addition, a distinct gap in distributed deformation provides critical empirical evidence for the occurrence of a supershear transition. Together, these findings establish a stronger link between geodetic observations and dynamic rupture models, improve constraints on the transition zone, and offer new insights into the fault properties that may facilitate the shift from subshear to supershear rupture velocities.

Mots-Clés: supershear rupture, remote sensing, active tectonics, Myanmar earthquake, rupture models

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