

EGU2020-19871

<https://doi.org/10.5194/egusphere-egu2020-19871>

EGU General Assembly 2020

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Rupture dynamics and fault mechanics of intraplate earthquakes in Brazil

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Mitigating intraplate earthquakes is necessary, as local populations are at risk both directly from strong shaking and indirectly from the threat to public infrastructure such as dams. However, the infrequency of these events and insufficient knowledge of how the ground will respond to passing seismic waves challenges mitigation. In Brazil, one M 5 earthquake occurs about every 5 years. M 4 earthquakes are more common and produce shaking intensities up to VI and VII on the Modified Mercalli scale. Brazilian earthquakes are shallower on average than events in other intraplate regions, which raises the possibility that fault mechanics and earthquake dynamics are different here. To work toward improving hazard mitigation and to better understand the physics of earthquakes in Brazil, we present 3D numerical models of the rupture process of two recent earthquakes using the open-source dynamic rupture and wave propagation software, SeisSol (www.seissol.org). Typically, sparse data prohibits the modeling of intraplate events. However, the 2010 Mara Rosa earthquake, the largest earthquake ever recorded in the Goiás-Tocantins Seismic Zone in central Brazil, and the 2017 Maranhão earthquake, which occurred in a previously aseismic region of northern Brazil, are relatively well studied and ample data is available. We report results within the range of uncertainty from the uncertainty in observations of stress drop, epicentral depth, fault geometry and regional stress state. The Mara Rosa earthquake occurred at an epicentral depth of ~2 km, while the Maranhão earthquake occurred between ~12-16 km depth. Modeling these two events allows us to contrast the influence of depth on the modeled earthquake source characteristics. We propose that fault cohesion dominates fault strength for the shallowest intraplate events, assuming a typical Mohr-Coulomb relationship.