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# Dynamic ruptures with thermal pressurization: Effect of changes in physical properties due to phase transition of water

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Phase transitions of pore water have never been considered in dynamic rupture simulations to investigate effect of thermal pressurization (TP), although they can control TP. From our 3-D numerical simulations of dynamic rupture propagation including TP in the absence of any phase transition processes of water, we predict, for a strike-slip fault under depth-dependent stress in the semi-infinite medium, that frictional heating and TP are likely to change liquid pore water into supercritical pore water. The transition from liquid to supercritical phase causes changes in viscosity, compressibility, and thermal expansion of water by a few orders of magnitude, which can affect diffusion of pore pressure. Accordingly, we performed numerical simulations of dynamic ruptures with TP, taking into account the physical properties varying with pressure and temperature of pore water. The characteristics of the rupture were examined under uniform stress in the infinite medium. The results suggest that the varying physical properties suppress the total slip amount when stresses are high at depth and shear zone thickness is small. When spatial variations of the fluid density and viscosity are allowed in the diffusion equation of pore water, the total slip amount decreases further. The results also suggest that TP reduces temperature rise in a fault zone less effectively, compared to that estimated with constant physical properties. It has been considered that TP works more effectively in thinner shear zone. Our simulations, however, show that the transition from liquid to supercritical phase can produce situations violating the relationship.