Diverse slip propagation speeds and directions in simulations of slow slip events

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We model slow slip events (SSEs) using the 3D simulation code, RSQSim, which employs rate- and state-dependent constitutive properties to set different modes of fault slip. For computational efficiency we impose the slip speed for SSEs, otherwise the simulations are fully deterministic in the nucleation, propagation speed, extent of slip, and final distribution of slip. Results from simulations are broadly consistent with a variety of SSE observations. Simulated SSEs initiate slowly over 1-5 days, followed by unilateral and/or bilateral growth of the slip region. Simultaneous slip often originates at multiple locations. Separate slip regions often merge to form a single SSE. Additionally the simulations show diverse rupture propagation speeds associated with renewed slip during a SSE. Propagation speeds for initiation of slip range from 7-21 km/day. Simulations also show renewed slip that propagates parallel to, but in the opposite direction (back propagation), and perpendicular (along-dip propagation) to the rupture front at higher speeds. If one assumes tremor is a proxy for slip, these may be analogous to rapid tremor reversal (RTRs) and along-dip streaks identified along the Cascadia and Nankai Subduction Zones. This rapid propagation for renewed slip may be related to incomplete fault healing that allows for re-initiation of slip at low stresses behind the slip pulse.