Predicting the propagation and interaction of frontal accretionary thrust faults with work optimization

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This study assesses the ability of work optimization to predict the spatial and temporal initiation of faults. We focus on the growth of flaws that develop into thrust faults at the toe of accretionary prisms because observations from physical laboratory accretion experiments provide rich data with which to validate the models, and the processes of accretionary thrust fault initiation remain unclear. In order to model these systems, we apply new implementations to the fault growth code GROW that improve its prediction of fault interaction using work optimization, including: 1) CPU parallelization, 2) a new growth algorithm that propagates only the most efficient fault in each growth increment, the single run mode, and 3) a new growth algorithm that only considers fault propagation from fault tips that host high sums of modes I and II stress intensity factors, K_G, the limiting mode. The single and limiting mode produce the geometries that best match the observed geometries, rather than the previous algorithm that allows all the faults to propagate simultaneously, regardless of K_G, the multiple and non-limiting mode. The single limiting models predict that frontal accretionary thrusts initiate at the midpack or shallower depths, consistent with findings of previous studies. The thrusts propagate upward, link with the surface, and then propagate downward and link with the detachment. The backthrust tends to propagate before the forethrust, and then influence the forethrust propagation. This temporal and spatial sequence of faulting arises from the lower compression, higher shear strain, higher Coulomb stress and higher strain energy density that develop near the wedge surface and the inflection of the wedge slope. The models reveal that the final slip distributions do not reliably indicate the initiation location of the faults, in contrast to the assumptions of previous analyses.