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Quantitative comparisons of numerical models of brittle wedge dynamics

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Numerical and laboratory models are often used to investigate the evolution of deformation processes at various scales in crust and lithosphere. In both approaches, the freedom in choice of simulation method, materials and their properties, and deformation laws could affect model outcomes. To assess the role of modelling method and to quantify the variability among models, we have performed a comparison of laboratory and numerical experiments. Here, we present results of 11 numerical codes, which use finite element, finite difference and distinct element techniques.

We present three experiments that describe shortening of a sand-like, brittle wedge. The material properties of the numerical 'sand', the model set-up and the boundary conditions are strictly prescribed and follow the analogue setup as closely as possible. Our first experiment translates a non-accreting wedge with a stable surface slope of 20 degrees. In agreement with critical wedge theory, all models maintain the same surface slope and do not deform. This experiment serves as a reference that allows for testing against analytical solutions for taper angle, root-mean-square velocity and gravitational rate of work. The next two experiments investigate an unstable wedge in a sandbox-like setup, which deforms by inward translation of a mobile wall. The models accommodate shortening by formation of forward and backward shear zones. We compare surface slope, rate of dissipation of energy, root-mean-square velocity, and the location, dip angle and spacing of shear zones. We show that we successfully simulate sandbox-style brittle behaviour using different numerical modelling techniques and that we obtain the same styles of deformation behaviour in numerical and laboratory experiments at similar levels of variability.

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