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LAF: Theoretical Model of Large Amplitude Folding of a Single Viscous Layer

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We present a theoretical model for Large Amplitude Folding (LAF) during buckling of a single, viscous layer. The model accurately predicts the evolution of geometrical fold parameters (amplitude, wavelength, and thickness) and is not restricted to any viscosity ratio or type of perturbation. The model employs two corrections to the formula of the initial growth rate of folds that is calculated using the thick-plate solution of Fletcher (Tectonophysics, 1977). The growth rate is modified by incorporating 1) the evolution of wavelength to thickness ratio, after Fletcher (American Journal of Science, 1974) and 2) the reduction of the growth rate, originally introduced by Schmalholz and Podladchikov (EPSL, 2000). The former correction is a consequence of the layer shortening and thickening. The latter modification is the result of using an effective rate of layer shortening as the driving force for fold growth, rather than the applied background shortening rate. The effective rate of the layer shortening is approximated by the rate of fold arclength shortening. In the model, we use an analytical expression derived based on the evolution of sinusoidal waveforms. These two modifications to the growth rate were already separately employed in previous studies. Through comparison with numerical models, we show that the simultaneous application of both corrections in LAF provides a better prediction of the evolution of the fold geometry parameters up to large amplitudes, compared to the models with only one correction. Our studies of the fold evolution from initial single and multiple (random noise, step and bell-shape function) waveforms show a remarkable fit between LAF and the numerical results. In the multiple waveform models, we predict a coupling between the components. In LAF, folds developed from initial random perturbations exhibit irregular but periodic shapes, characteristic for folds observed in nature. We also show that the evolution of folds from localized perturbations exhibits lateral propagation.