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Consistent three-equation model for thin films. GAEL RICHARD, MARGUERITE GISCLON, CHRISTIAN RUYER-QUIL, Universite Savoie Mont Blanc, JEAN-PAUL VILA, Universite de Toulouse — Numerical simulations of thin films of newtonian fluids down an inclined plane use reduced models for computational cost reasons. These models are usually derived by averaging over the fluid depth the physical equations of fluid mechanics with an asymptotic method in the long-wave limit. Two-equation models are based on the mass conservation equation and either on the momentum balance equation or on the work-energy theorem. We show that there is no two-equation model that is both consistent and theoretically coherent and that a third variable and a three-equation model are required to solve all theoretical contradictions. The linear and nonlinear properties of two and three-equation models are tested on various practical problems. We present a new consistent three-equation model with a simple mathematical structure which allows an easy and reliable numerical resolution. The numerical calculations agree fairly well with experimental measurements or with direct numerical resolutions for neutral stability curves, speed of kinematic waves and of solitary waves and depth profiles of wavy films. The model can also predict the flow reversal at the first capillary trough ahead of the main wave hump.

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