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Turbulent motion of mass flows. Mathematical modeling

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New mathematical models for unsteady turbulent mass flows, e.g., dense snow avalanches and landslides, are presented. Such models are important since most of large scale flows are turbulent. In addition to turbulence, the two other important points are taken into account: the entrainment of the underlying material by the flow and the nonlinear rheology of moving material. The majority of existing models are based on the depth-averaged equations and the turbulent character of the flow is accounted by inclusion of drag proportional to the velocity squared. In this paper full (not depth-averaged) equations are used. It is assumed that basal entrainment takes place if the bed friction equals the shear strength of the underlying layer (Issler D, M. Pastor Peréz. 2011). The turbulent characteristics of the flow are calculated using a three-parameter differential model (Lushchik et al., 1978). The rheological properties of moving material are modeled by one of the three types of equations: 1) Newtonian fluid with high viscosity, 2) power-law fluid and 3) Bingham fluid. Unsteady turbulent flows down long homogeneous slope are considered. The flow dynamical parameters and entrainment rate behavior in time as well as their dependence on properties of moving and underlying materials are studied numerically.

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