Geophysical Research Abstracts
Vol. 12, EGU2010-10628-1, 2010
EGU General Assembly 2010

Modeling the shallow gravity-driven flows as saturated binary mixtures over temporally varying topography

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Based on the "shallow water models over arbitrary topography" by Bouchut and Westdickenberg [2004], and the "Coulomb-mixture theory" by Iversion and Denlinger [2001], we propose a saturated binary mixture model over temporally varying topography, where the effects of the entrainment and deposition are considered. Due to the deposition or erosion processes, the interface between the moving material and the stagnant base is a non-material singular surface that moves with its own velocity. Its motion is thus determined by the mass exchange between the flowing layer and the ground. Through the introduction of the unified coordinate method (e.g. Hui [2004, 2007]) and dimension analysis, the leading-order depth-integrated mass and momentum equations are presented in the time-dependent and topography-fitted curvilinear coordinate system, where the evolving curvature effect is neatly included in the total derivative operator of the variable topography-fitted coordinates. The motion of the basal interface is postulated by function of basal friction coefficient, sliding velocity, local thickness of the flowing layer and a threshold kinetic energy. A shock-capturing numerical scheme is implemented to solve the derived equation system (e.g. Tai and Kuo [2008] or Tai and Lin [2008]). And the key features are investigated and illustrated by the numerical results.

References:

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