Geophysical Research Abstracts
Vol. 20, EGU2018-10495-1, 2018
EGU General Assembly 2018

Upscaling of granular processes in sediment transport : from discrete to continuous modeling.

julien chauchat (1), Raphaël Maurin (2), Tim Nagel (1), Cyrille Bonamy (1), Zhen Cheng (3), Antoine Mathieu (1), Tian-Jian Hsu (4), and Xiaofeng Liu (5)

(1) LEGI, Grenoble Alpes, Grenoble INP, CNRS, 38000 Grenoble, France (julien.chauchat@univ-grenoble-alpes.fr), (2) IMFT, Université de Toulouse; INPT, UPS; Toulouse, France, (3) Applied Ocean Physics & Engineering, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA, (4) Center for Applied Coastal Research, University of Delaware, Newark, DE 19716, USA., (5) Dept. of Civil and Environmental Eng., Pennsylvania State Univ., State College, PA 16802, USA.

In this contribution we will report on a research effort on multi-scale sediment transport modeling across. The scales investigated ranges from the particle size to the water depth. At the smallest scale, using a coupled Eulerian-Lagrangian model the granular rheology in bed-load transport has been investigated (Maurin et al., 2016). A Discrete Element Method for the granular phase is coupled with a fluid momentum equation through the drag force and a phenomenological mixing length model is used for the turbulence modeling. Numerical experiments have been performed using this model that shows the relevancy of a μ(I) frictional rheology to describe the dense granular flow in bed load transport. The actual coefficients of the rheology are slightly different from that obtained for dry granular flows. In particular, the scaling of the frictional coefficient with the inertial number holds up to unexpected high values (I$\sim$2) compared with dry granular flows (I$\sim$0.2). The proposed rheology has been implemented and successfully tested in a Eulerian-Eulerian two-phase flow model (Chauchat, 2017; Maurin et al., 2016). The granular phase velocity and concentration profiles in the dense mobile granular layer are well reproduced by the continuous model and so is the bed-load sediment flux. The Eulerian-Eulerian model has been further implemented in a multi-dimensional numerical model under the CFD toolbox OpenFOAM (Chauchat et al., 2017). Using two-equation turbulence closures (k-ε, k-ω) the two-phase flow model has been further applied to the scour phenomenon around hydraulic structures (Nagel et al., 2017). These applications illustrate how the upscaling from discrete simulations to continuous modeling can be beneficial for the understanding of sediment transport in unsteady flow and complex geometries.

Chauchat, J. A comprehensive two-phase flow model for unidirectional sheet-flows. Journal of Hydraulic Research, in press(0):1–14, 2017.
Chauchat, J., Z. Cheng, T. Nagel, C. Bonamy, and T.-J. Hsu. Sedfoam-2.0: a 3-d two-phase flow numerical model for sediment transport. Geoscientific Model Development, 10(12):4367–4392, 2017.
Maurin, R., J. Chauchat, and P. Frey. Dense granular flow rheology in turbulent bedload transport. Journal of Fluid Mechanics, 804:490–512, 10 2016.
Nagel, T., J. Chauchat, Z. Cheng, C. Bonamy, X. Liu, T.-J. Hsu, O. Bertrand. Two-phase flow simulation of scour around a cylindrical pile, Proceedings of the Costal Dynamics conference. Helsingor, Denmark, 12-16 June 2017.