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# Cumulant lattice Boltzmann approach: an application to hydraulic risk

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The purpose of this work is the implementation and the application of a semi-automatic procedure for modelling flood events, based on the coupled use of a GIS subroutine and a two-dimensional (2D) lattice Boltzmann hydraulic model solving shallow water equations. The lattice Boltzmann method (LBM) with cumulant collision operator is chosen as a numerical technique for the solution of the hydrodynamic problem. The cumulant LBM is based on the use of cumulants as basis and relaxes, in the collision step, quantities (cumulants) that are Galilean invariant by construction. It overcomes the defects in Galilean invariance of the original multi relaxation times methods and it has been shown to further improve stability. An adaptation of the original formulation for a single-phase fluid is therefore proposed and developed to reproduce shallow free surface flows. Special attention is due to the wet-dry front in shallow flows; in fact, a correct simulation of such processes plays a crucial role in practical engineering studies.

The chosen mesoscopic model, thanks to the peculiar characteristic of LBM codes of being easily parallelized, could allow accurate and realistic wave prediction in a low computation time, introducing the possible application for the assessment of the hydraulic risk.

The preparation of the input data (pre-processing) and the analysis of the modelling results (post-processing) are assisted by an interchange routines using an open source GIS platform.

The proposed methodologies are tested and validated through the use of analytical solutions and experimental solutions. Moreover, the suitability of the proposed mathematical model for large scale hydraulic engineering applications is discussed through the modelling of a real flood event, highlighting the good performances of the cumulant model.