Submitted Abstract

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Abstract

Validating the numerical implementation of process based gravitational mass flow models is a challenging but crucial step. Test cases with an analytical solution are rare. One example is the dam break case, a test case with depth integrated equations and Riemann initial conditions, which can be used to validate the first few seconds of a simulation. Another example is the similarity solution which allows to check the pressure gradient or the friction force implementation.

To extend the repertoire of precise reference solutions, we propose the use of a geometrical solution that is related to the total energy of the system. Soley considering coulomb friction this solution is motivated by the first principle of energy conservation along a simplified topography. Here friction force only depends on the slope angle. The analytical run-out is the intersection of the path profile with the so-called alpha line defined by the friction angle. It is also possible to extract from this alpha line information about the flow mass averaged velocity at any time or position along the path profile.

We present an implementation of this energy evaluation and verification approach in the simulation toolbox AvaFrame, including the following steps: the avalanche path profile is extracted from the mass average particles position from the Dense Flow Avalanche (DFA) simulation module (com1DFA) using Coulomb friction. On this path profile, the alpha line solution (which corresponds to the energy line) is computed and used as reference to validate the DFA simulation. Both velocity and run-out can be verified with this method.

We finally explore and explain the limitations of this approach. For example, the geometrical energy solution appears to only coincide with the DFA solution when the flow direction is in line with the steepest descent.