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A Shallow Layer Approach for Geo-flow emplacement

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Geophysical flows such as lahars or lava flows severely threat the communities located on or near the volcano flanks. Risks and damages caused by the propagation of this kind of flows require a quantitative description of this phenomenon and reliable tools for forecasting their emplacement. Computational models are a valuable tool for planning risk mitigation countermeasures, such as human intervention to force flow diversion, artificial barriers, and allow for significant economical and social benefits.
A FORTRAN 90 code based on a Shallow Layer Approach for Geo-flows (SLAG) for describing transport and emplacement of diluted lahars, water and lava was developed in both serial and parallel version. Three rheological models, such as those describing i) a viscous, ii) a turbulent, and iii) a dilatant flow respectively, were implemented in order to describe transport of lavas, water and diluted lahars.
The code was made user-friendly by creating some interfaces that allow the user to easily define the problem, extract and interpolate the topography of the simulation domain. Moreover SLAG outputs can be written in both GRD format (e.g., Surfer), NetCDF format, or visualized directly in GoogleEarth.
In SLAG the governing equations were treated using a Godunov splitting method following George (2008) algorithm based on a Riemann solver for the shallow water equations that decomposes an augmented state variable the depth, momentum, momentum flux, and bathymetry into four propagating discontinuities or waves. For our application, the algorithm was generalized for solving the energy equation. For validating the code in simulating real geophysical flows, we performed few simulations the lava flow event of the the 3rd and 4th January 1992 Etna eruption, the July 2001 Etna lava flows, January 2002 Nyragongo lava flows and few test cases for simulating transport of diluted lahars.

Ref: George, D.L. (2008), Augmented Riemann Solvers for the Shallow Water Equations over Variable Topography with Steady States and Inundation, J. Comput. Phys., 227 (6), 3089-3113, doi:10.1016/j.jcp.2007.10.027.