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Quantifying uncertainties in models of geophysical mass flows using the Titan2D toolkit

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We report here on recent work to extend the computational simulation capabilities of Titan2D[1] to include a the effects of model and parameter uncertainties. Titan2D simulates the motion of a depth averaged incompressible Couloumb continuum by solving the conservation equations for mass and momentum with a parallel, adaptive mesh, Godunov scheme. Adaptive gridding dynamically concentrates computing power in regions where the solution has sharp features (e.g. the perimeter of the moving avalanche) while parallel computing allows the use of large grids to compute realistic flows. Integration with a geographical information systems enables the computation of flows over natural terrain.

We will present here the incorporation of uncertain parameters namely basal and internal friction parameters and uncertain initial conditions into Titan2D. Classical Monte Carlo methods for quantifying uncertainty are unaffordable for such systems. The recently introduced methodology of polynomial chaos(PC)[2] is usually more affordable but has several insurmountable technical difficulties for such non-linear hyperbolic systems. We introduce a variant of the PC methodology namely polynomial chaos quadrature(PCQ) that is easily applied to such systems and provides a robust methodology for most such non-linear hyperbolic systems. The incorporation of this methodology allows us to estimate statistics on the output quantities of interest (e.g. mean and variances of the expected maximum velocity, probability that a flow will reach a location) for given distributions of input parameters on the friction parameters and/or initial conditions. We will present results for sample laboratory scale problems and

larger scale flows at Colima volcano.

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