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Numerical modeling of volcanic flows: towards a short-term hazard assessment tool

S.J. Charbonnier, C.B. Connor, L. Connor, T. Dixon, and J.A. Saballos
Dpt of Geology, University of South Florida, Tampa, USA (sylvain@usf.edu)

Current views on volcanic flow dynamics are largely based on the interpretation of deposits from field observations, but also on the use of laboratory experiments and the subsequent development of numerical models. Traditional, qualitative techniques for studying volcanic flows are crucial to improve our knowledge of their transport and depositional processes. However, they are often based on localised interpretations of the internal deposits structure and limited by poor exposures and/or shallow excavation. Recent advances have been made in creating computational models of volcanic flows for the purpose of hazard mitigation, but there is an urgent need to test these models against well constrained field examples. Previous studies all suggest that the performance of numerical models in simulating actual events is critically dependent on the choice of key input parameters. Therefore, a good awareness of model uncertainty arising from poor parameter estimation, topographic resolution and/or mechanical understanding is critical to determination of the appropriateness of computational models in hazard assessment.
The latest events at Merapi Volcano, as well as some case studies from volcanoes in Central and South Americas, offered great opportunities to test the ability of some flow models to reproduce the studied actual events. Moreover, high-resolution remote sensing data from current X-band Synthetic Aperture Radar satellites like TerraSAR-X and TanDEM-X (from the German Aerospace center, DLR) can provide accurate numerical topography and/or capture rapid topographic changes associated with the emplacement/removal of volcanic deposits over short periods. This has tremendous potential to help us better understand the dynamics of hazardous volcanic flows and to define hazard zonations for key areas at risk from future volcanic activity.
By combining detailed field observations, high-resolution remote sensing data and probability modeling with statistical methods for defining best-fit input parameters, the systematic use of these models in predicting probabilities of different outcomes, given distributions of inputs, can provide an invaluable tool for guiding hazard assessment of volcanic flows.