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Landscape and hazard evolution during the Montserrat volcanic crisis 1995–2010: an integrated simulation with r.avafLOW

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An active phase of Soufrière Hills Volcano (Montserrat, Lesser Antilles) has started in 1995 and had its most intense period between 1995 and 2010, when phases of lava dome growth were interrupted by dome collapses triggering ash clouds and different types of pyroclastic flows. These flows were released in various directions, so that two thirds of the island were left in an inhabitable state. The material deposited was later remobilized through lahar flows, burying the centre of the former capital town of Plymouth. In the present work, we attempt to back-calculate the sequences of dome growth – pyroclastic flows, and the subsequent lahar flows, in an integrated way, using the mass flow simulation tool r.avafLOW. Thereby, we build on the reconstruction of the pre-event topography as well as on various reference data obtained from the large amount of available literature – mainly, the peak elevation and volumes of the lava domes, the impact areas of the flow processes, and ash fall characteristics. Most observations are successfully reproduced with physically plausible, though calibrated, parameter sets and temporal scaling of lava dome growth. Due to the complexity and multi-stage nature of the volcanic crisis, a number of simplifications had to be introduced, such as considering only the twelve largest sequences of dome growth and pyroclastic flows, and evaluating some of the results on the basis of aggregated impact areas for more than one event. Consequently, the results reflect a strong conceptual component, but can - at least in part - be considered useful for predictive modelling of similar events. Another scope of the simulation results, however, is its educational use. Appropriately presented, they greatly facilitate the generation of a better understanding for complex chains of volcanic processes and their consequences to learners at various levels in different educational contexts, from school and university all the way to targeted awareness-building campaigns.